Advisory Committee on Fisheries Management **ICES CM 2000/ACFM:5**

REPORT OF THE

WORKING GROUP ON THE ASSESSMENT OF MACKEREL, HORSE MACKEREL, SARDINE, AND ANCHOVY

ICES, Headquarters
14–23 September 1999

PARTS 1, 2 AND 3

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Terms of Reference

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy met at ICES headquarters from 14–23 September 1999 to address the following terms of reference, as decided at the 86th Statutory Meeting :

a) assess the status of and provide catch options for 2000 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 2000 for the sardine stock in Divisions VIIIc and IXa, and the anchovy stocks in Sub-area VIII and Division IXa;

c) review progress in determining precautionary reference points;

d) provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 1998 by statistical rectangle of the North Sea for mackerel and horse mackerel) and review the time series of quarterly catch and weights at age for North Sea mackerel, western mackerel, North Sea horse mackerel and western horse mackerel used by the MAWG in Doc. ICES C.M. 1997/Assess:16, suggesting and documenting any necessary revisions to those series;

e) for sardine update information on the stock identification, composition, distribution and migration in relation to climatic effects.

The Working Group was also asked to assist ICES in:

1) Replying to a request from Portugal specifying the formulation of the advice for sardine in ICES Divisions VIII and IX as follows:

   Assess the status of the stock(s) of sardine, redefining unit stocks in accordance with the information update provided by item e) and provide catch options for 2000 regarding the scenarios of, at least, two different units of management: 1) the management unit of Division IXa; 2) the management unit in Sub-area VIII as appropriate;

2) Replying to a request from the European Community and Norway to expand its advice to be forthcoming in November 1999 for (among other stocks) Mackerel (Combined Southern, Western and North Sea component). The request states that:

   “The option table presented by ACFM should, for each year in the medium term (5 years) show the probability that catches will exceed the catch in year 1, the probability that the SSB will exceed the SSB in year 1 (for the years when a deterministic SSB cannot be provided) and the risk that SSB falls below B_{pa} and, if appropriate, B_{lim}.

   The European Community and Norway would request ICES to assess these medium-term consequences of the various management options and present the results in tables as suggested below:

F	Year				
	Year 1	Year 2	Year 3	Year 4	Year 5
F1	Yield1	Prob(Yield2$>$Yield1)	Prob(Yield3$>$Yield1)	Prob(Yield4$>$Yield1)	Prob(Yield5$>$Yield1)
	SSB1	SSB2	Prob(SSB3$>$SSB1)	Prob(SSB4$>$SSB1)	Prob(SSB5$>$SSB1)
		Prob(SSB2$<B_{pa}$	Prob(SSB3$<B_{pa}$	Prob(SSB4$<B_{pa}$	Prob(SSB5$<B_{pa}$
		Prob(SSB2$<B_{lim}$	Prob(SSB3$<B_{lim}$	Prob(SSB4$<B_{lim}$	Prob(SSB5$<B_{lim}$
F2	Yield 1	Prob(Yield2$>$Yield1)	Prob(Yield3$>$Yield1)	Prob(Yield4$>$Yield1)	Prob(Yield5$>$Yield1)
	SSB1	SSB2	Prob(SSB3$>$SSB1)	Prob(SSB4$>$SSB1)	Prob(SSB5$>$SSB1)
		Prob(SSB2$<B_{pa}$	Prob(SSB3$<B_{pa}$	Prob(SSB4$<B_{pa}$	Prob(SSB5$<B_{pa}$
		Prob(SSB2$<B_{lim}$	Prob(SSB3$<B_{lim}$	Prob(SSB4$<B_{lim}$	Prob(SSB5$<B_{lim}$

and

" For mackerel, consider probabilities for SSB falling below 2.3 Million t with constant Fs in the range 0.15 to 0.2. "

1.2 Participants

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Maria Manuela Azevedo	Portugal
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Miguel Bernal	UK (Scotland)
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Andres Uriarte	Spain
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Christopher Zimmermann	Germany

1.3 Report on progress with respect to Recommendations

The Working Group reviewed the progress that had been made in respect to the various recommendations made at the 1998 meeting. This is reviewed briefly as follows.

- Observers have been placed on board vessels as part of EU programmes in which U.K. (Scotland), Norway and Spain are participating as recommended. The results of these programmes are not yet available.
- All data used at the Working Group will be backed up by ICES on CD Rom and will be available to working group members on request, with the condition that the information may only be used for addressing terms of reference to the working group.
- Access to the NEAFC data base on mackerel has not yet been agreed by ICES but the matter will be discussed at the 1999 Annual Science Council to be held at Stockholm.
- The present tagging and genetic studies are now complete. Although there are no plans to carry out new tagging programmes the annual Norwegian tagging programme will continue. A project on genetics and otolith micro chemistry on North Sea and Western mackerel is in the proposal stage.
- A number of new countries have now commenced reading horse mackerel otoliths as recommended and the situation in regards to ageing this species has much improved.
- Egg surveys, using the application of the Daily Egg Production Method for sardine, have been carried out by Spain and Portugal in 1999 as recommended.
- Acoustic surveys on sardine have been carried out by Portugal on spawning concentrations in Div.IXa as recommended.
- Joint acoustic surveys on sardine in Divs. VIIIc and IXa have been carried out as recommended.

- Information relating to sardine surveys, catch composition and eggs larval distribution have been made available by some countries. Additional information is available at various national laboratories and should also be made available. Spain and Portugal are at present participating in an EU project relation to this matter.
- Studies on daily growth increments on sardine otoliths will start in early 2000 as a result of a new project involving Spain and Portugal.
- Information on anchovy was not collected during the Portugal acoustic surveys carried out in Div.IXa as recommended.
- Direct surveys aimed at anchovy were continued in Sub-area VIII as recommended.

1.4 Quality and Adequacy of Fishery and Sampling data

1.4.1 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 appears to be adequate for mackerel (approx 82% coverage of catch), sardine and anchovy. Although it has improved for horse mackerel it remains at a low level for many of the important fisheries. A short summary of the data, similar to that presented in recent Working Group is shown for each stock species. The overall sampling intensity is similar in recent years. Intensive sampling programmes continue to be carried out by Spain and Portugal. Sampling programmes in Spain, Portugal, Ireland, England, France continue to be supported by EU funded programmes.

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

<u>Mackerel</u>

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	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

In mackerel it appears that over 80% of the total catch was covered by the sampling programmes. The overall sampling level appears to be very consistent in recent years and at a satisfactory level. Spain and Portugal continue to carry out extremely intensive programme on their catches but Germany have not continued with their sampling programme in 1997 or 1998 which it had commenced in 1996. Norway and U.K (Scotland) reduced their programmes, but on the other hand Netherlands and U.K. (England) increased their programmes. Denmark only carry out sampling on their catches during the fourth quarter. There are still, however, a number of important mackerel catching countries which did not carry out any sampling programmes, e.g France, Germany and Sweden.

The main areas, that do not appear to be adequately sampled, are

- Div.IIIa in which 4,700 t are taken, but where no sampling is carried out;
- Div IVc where 2,500 t are taken, but inadequately sampled;
- Div VIIb where over 18,000 t are taken (mainly by France), but which are not sampled at all;
- Div VIIj where over 13,000 t taken by UK are also not sampled;
- Div VIa where over 22,000 t taken by UK and Germany are not sampled.

The summarised details of the more important mackerel catching countries are shown in the following table:

Country	Official Catch	Catch covered by sampling programme	Samples	Measured	Aged
Norway	158,177	158,177	106	11,096	2,016
U.K. (Scotland)	144,983	136,814	69	7,979	2,380
Russia	67,837	67,837	74	13,457	696
Ireland	64,975	66,650	57	10,407	3,014
Spain *	44,607	44,607	378	27,353	3,163
Netherlands	30,163	30,163	96	7,722	2,400
Denmark	27,415	15,050	8	493	475
UK (England) Wales)	26,694	8,750	40	10,499	1,603
Germany	21,411	0	0	0	0
France	17,835	0	0	0	0
U.K. (Nr.Ireland)	14,271	0	0	0	0
Faroe Is.	11,229	2,716	12	2,898	837
Estonia	7,356	0	0	0	0
Sweden	5,146	0	0	0	0
Portugal	2,897	2,897	393	37,009	1,194
Others**	21,704	0	0	0	0
Total	666,700	533,661	1233	128,913	17,778

* Unofficial catch

**Includes discards, unallocated and small catches from other countries, and new information on catches received during the WG meeting.

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

The overall sampling levels on horse mackerel appears to have remained at about the same intensity in recent years. However, although the overall number of fish aged in 1998 was very similar to that of 1997 the number of horse mackerel aged in the northern fisheries has increased and there has been a decrease in the numbers aged in the southern fisheries.

Countries that carried out comprehensive sampling programmes in 1998 were Netherlands, Portugal, Spain, while Ireland, Germany, and Norway all increased their sampling intensity. Countries that have important horse mackerel fisheries like United Kingdom, and France do not carry out any sampling programmes whatsoever. The lack of sampling data for large portions of the horse mackerel catch continues to have a serious effect on the accuracy and reliability of the assessment and the Working Group remain concerned about the low number of fish that are aged.

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 1998:

Country	Catches	Catch covered by sampling programme	Samples	Measured	Aged
Netherlands	103,246	103,246	129	16,757	3,225
Ireland	73,672	35,635	21	3,470	649
Spain∗	43,829	43,829	690	54,936	1,115
Germany	33,716	3,467	35	16802	327
Denmark	31,023	1,755	52	1,245	0
France	26,658	0	0	0	0
Portugal	21,344	21,344	1,586	149,461	1,044
U.K.(Scotland)	18,283	0	0	0	0
Norway	13,363	12,445	26	2,549	56
U.K.(England)	13,068	0	0	0	0
U.K. (Nr. Ireland)	1,158	0	0	0	0
Others∗∗,	20,330	0	0	0	0
Total	399,700	221,721	2,539	245,220	6,416

∗Unofficial catches

∗∗Includes discards, small catches by other countries, and some unallocated catches.

The sampling coverage for the various fisheries carried out by each country is shown below:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	129	16,757	3,225
Spain	100	690	54,936	1,115
Portugal	100	1,586	149,461	1,044
Norway	93	26	2,549	56
Ireland	48	21	3,470	649
Germany	10	35	16,802	327
Denmark	6	52	1,245	0
Others	0	0	0	0
Total 399,700	62	2,539	245,220	6,416

The sampling intensity for the western fisheries was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	96	12,686	2,400
Spain	100	42	2,649	953
Norway	93	26	2,549	56
Ireland	50	21	3,470	649
Denmark	6	18	642	0
Others	0	0	0	0
Total 303,500	54	203	21,996	4,058

The sampling intensity for the North Sea fishery was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	33	4,071	825
Denmark	100	34	603	0
Others	0	0	0	0
Total 30,500	66	67	4,674	825

The sampling intensity for the Southern fishery was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Spain	100	690	54,936	1,115
Portugal	100	1586	149,461	4,176
Total 64,500 t	100	2276	204,397	5,291

Sardines

The sampling programmes on sardines 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

The sampling programmes carried out by Spain and Portugal were intensified in 1998 and very good coverage of the catches appears to have been achieved on about 95% of the catch. France did not carry out any sampling on their catches of 10,600 t.

The summarised details of individual sampling programmes in 1998 are shown below:

Country	Catch t	Catch covered by sampling programme	Samples	Measured	Aged
Spain∗	108,923	108,923	871	67,445	6,984
Portugal	82,890	82,890	501	56,309	5,179
France	10,674	0	0	0	0
U.K. England	4,727	0	0	0	0
U.K. Scotland	2,111	0	0	0	0
Germany	97	0	0	0	0
Total	209,422	191,813	1,372	123,754	12,163

∗ Unofficial catches

An additional 14,316 t of sardine was taken by Denmark from Sub area VII but information on this catch was received too late during the meeting to be included in the assessments. These catches were not sampled.

Anchovy

The sampling programmes carried out on anchovy in 1998 are summarised below. The programmes are shown separately for Sub area VIII and for Div. IXa. Sampling throughout Divs VIIb+d and VIIIc appears to be satisfactory. A full sampling programme was carried out by France on catches in Div VIIIa compared with 1997 when catches from this area were only sampled for length.

The overall sampling levels for recent years are shown below:

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1992	40,800	37,700	289	17,112	3,805
1993	39,700	39,700	323	21,113	6,563
1994	34,600	34,400	281	17,111	2,923
1995	42,104	35,048	?	?	?
1996	38,773	36,053	214	17,800	4,029
1997	27,440	20,966	258	18,850	5,194
1998	31,617	31,617	268	15,520	5,181

The sampling programmes for France and Spain are summarised below:

Country	Div	Catch	Catch covered	Samples	Measured	Aged
France	VIIIa	16,888	16,888	25	1,068	924
France	VIIIb,d	6,099	6,099	27	1,245	986
Spain∗	VIIIb,d	4,336	4,336	93	4,619	1,187
Spain∗	VIII c(east)	4,294	4,294	123	8,588	2,084
Total		31,617	31,617	268	15,520	5,181

∗ Unofficial catches

The sampling programmes for the fisheries in Div. IXa are summarised below:

Country	Div	Catch	Catch covered	Samples	Measured	Aged
Spain∗	Div.IXa	9,349	9,349	58	10,133	0
Portugal	Div.IXa	1,613	0	0	0	0
Total	Div.IXa	10,962	9,349	58	10,133	0

∗Unofficial catches

Sampling by Spain was confined to length measurements only while no sampling was carried out by Portugal.

1.4.2 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 in 1996, 1997 and 1998 there has been a considerable improvement in the accuracy of the total landing figures. This is because of tighter enforcement of the management measures in respect of the national quota and because of the increasing awareness of the importance of accurate catch figures for possible zonal attachment of some stocks. There is still, however large scale area misreporting of catches particularly in Areas IV, VI and VII and possibly some species misreporting. Underreporting of catches because of transhipping of catches at sea has decreased in recent years because most of the catches are now landed to factories ashore.

However in one country (France) there appears to be a general problem in relation to the collection of all fishery statistics due to a decrease in the number of people involved in the control, collection and validation of fishery data. For this reason it is becoming increasingly difficult to provide accurate catch statistics particularly in relation to the less important species exploited mainly by the artisanal fishermen. The provision of accurate statistics is easier to provide for the larger freezer and industrial trawlers.

Information on discard levels is available for only one fleet but discarding may also be carried out by other fleets. Therefore the total amounts discarded may be underreported. (See Section 1.4.3. below).

1.4.3 Discards

Mackerel

Only one country (Netherlands) supplies information on level of discards. This information is not applied to any other fleet and there is no new information on discard levels in other fleets during 1998.

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) in Norway 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. In the fisheries in these areas the difference in prices paid for small and large mackerel has decreased since 1994 and the Working Group assumed that discarding may have been reduced in these areas.

In some fisheries e.g. those in Sub-areas VI and VII mackerel is taken as a by catch in the directed fisheries for horse mackerel. 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 prices and by quota.

In autumn 1997 an EU funded programme involving Norway and Scotland commenced with the intention of studying the performance of the purse seine fisheries for herring and mackerel. This programme, which will continue over two years, has now been completed but the results which will provide information on discard levels for these fleets are not yet available. Further studies on discards, funded under the PESCA programme and the CFP Study programme, are currently planned but have not yet commenced.

The Working Group would also like to draw attention to the possibility that discarding of small mackerel may again become a problem in all areas particularly if a strong year class enters the fishery.

An EU programme carried out by Spain studied the rate of discards of all species taken by the Spanish bottom trawl fleets, fishing in Sub-areas VI, VII, VIIIc and IXa. The results of this study (Perez *et. al.* 1994) showed that the discard rates varied by species and by area and fishing fleet. The observed levels of discards were between 0.2% - 25.7% for horse mackerel, between 0.1% and 8.1% for mackerel and less than 1% for sardine.

Horse Mackerel

As with mackerel only the Netherlands provides information on discards in the horse mackerel fisheries. The amounts of horse mackerel discarded by the Dutch fleet represents a much smaller proportion (3%) of their total catch than in the mackerel fisheries (79%) and there appears to be no apparent reason why vessels would discard significant amounts apart from losses due to damage to nets. There appears to be no significant amounts of discarding in the Southern horse mackerel fishery but there is no data available.

Sardine

Discarding in the sardine fishery is not considered to be a significant problem but there are no estimates available.

Anchovy

As in the sardine fishery there are no estimates of discards in the anchovy fishery but there does not appear to be any significant problem.

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. This observer programme should be continued.**

1.4.4 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

A considerable improvement in the quality of the ageing data, resulted from the 1995 otolith workshop. This Working Group continues to have confidence in the precision of the age readings from all countries.

Horse Mackerel

The otolith exchange, carried out in 1996, showed a considerable bias in the age readings. As a consequence an otolith workshop was held in Lowestoft in January 1999 (ICES 1999/G:16). The problem of underestimating the age of older fish was thoroughly investigated. Following discussion and comparisons there was some improvement in the precision and accuracy of age reading during the workshop. However the underestimation of older age groups (bias) could not be significantly improved on. As a consequence the Workshop recommended that horse mackerel otolith exchanges should continue on a regular basis to check for an improvement in agreement between readers of different countries. The Workshop also recommended that this Working Group should use age groups up to and including age 11 with a 12+ age group. Biological data containing a 15+ age group should also be provided to the Working Group. A comparison of different techniques in otolith preparation was also included in the recommendations.

A review of the Horse Mackerel Otolith Workshop can be found in Section 4.7 of this report.

As a direct result of the Workshop horse mackerel age determination is now carried out by two additional countries, Germany and Ireland, and there has been an overall increase in the number of otoliths read.

Country	Catch (t)	Otoliths read
Netherlands	92,535	2400
Ireland	70,811	649
Denmark	29,542	0
Portugal	21,344	1044
UK and Northern Ireland	31,603	0
Norway	13,363	56
Spain	43,829	2068
Germany	27,872	123
France	24,267	0
Others	593	0

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

A problem of possible mis-interpretation of the age of the younger age groups (0 – 2), was reported to the Working Group in 1998, This has been partially resolved via an otolith exchange and improved collaboration between Spain and Portugal. Further improvement in the precision of age determination is anticipated if the proposed new project, to investigate and validate the use of daily growth increments on sardine otoliths, proceeds.

Anchovy

Informal otolith exchanges occur routinely between Spain and France and age determination appears to be satisfactory in Sub-area VIII.

In Division IXa North some otoliths were collected but they did not cover the whole length range and were therefore not considered to be representative of the whole population.

In the Gulf of Cadiz the problems of interpretation of otolith readings continues. An otolith exchange, reported in detail in Section 11.3.1 has failed to resolve all the problems. Consideration is now being given to holding a Workshop to establish standardised principles for age interpretation in anchovy.

1.4.5 Biological data

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

Mackerel

No new information was available to the Working Group on mackerel maturity in the western area. A sampling regime was planned for the 1998 egg surveys, to resolve the problem of overestimation of the maturity of 1 to 3 year old mackerel. Only 3 samples of 100 fish were collected and the resultant data were too limited for a revision of the current maturity ogive. In the southern area sampling was adequate and the results were reported to this Working Group (Perez *et al.,* 1999 WD.). The revised maturity ogive was accepted by the Working Group for use in the current assessment.

This Working Group recommends that histological studies are carried out on mackerel in the western spawning area in order to revise the current maturity ogive. Samples for this study should be taken from both predominantly adult and predominantly juvenile areas of distribution according to the sampling plan established for the 1998 egg survey.

Horse Mackerel

The selection of an appropriate maturity ogive for the western area continues to prove difficult. Extensive sampling and analysis of the data collected during the 1998 egg surveys has failed to resolve the problem (Eltink, 1999 WD). Sampling was carried out as planned in the designated, mainly juvenile and mainly adult, areas and differences in maturity at age were observed. However, it has so far proved impossible to apportion the catches in the separate sampling areas in order to construct a weighted maturity ogive. The Working Group decided to continue to use the maturity ogive from the southern area for the western area.

Observations have been carried out on the maturation stages of horse mackerel ovaries in Divisions VIIIc and IXa North in order to review the maturity ogive. Samples have been analysed both macroscopically and histologically and a maturity ogive obtained for each method. (Perez *et al.* WD 1999). Samples have also been collected in IXa South but they have not yet been analysed. Once the data from all areas are available, the maturity ogive for the southern Horse mackerel will be revised.

The uncertainty about the level of natural mortality (ICES 1998/ Assess:6) still persists.

Sardine

The main biological problem for sardine is that of finding an explanation for the changed pattern of distribution resulting in reduced biomass in the Division VIIIc and IXa North and an apparent increase further South. This was thoroughly discussed at the Working Group and is reported in detail in the review of sardine stock identity in section 14.

EU funding is being sought for a proposal to carry out an extensive acoustic survey, in 2000/01 from Gibraltar to the Celtic Sea. The aim of the proposed survey is to study the distribution and abundance of sardine over this area.

Some problems with the maturity ogive were reported to the Working Group. The maturity of fish aged 3 and older was lower when compared with a maturity ogive constructed on the basis of length. The implication of this observation is being investigated further. Portuguese sampling shows that some fish mature during their first year, as '0' groups. This observation is not currently taken into account in the assessment.

The Working Group noted the anomaly that the mean weight at age '0' in the stock is currently set at zero. This is because mean weights are set from 1 January before the '0'groups are present. The issue will be kept under review.

Anchovy

No further progress was reported in understanding the migration of '0' group fish. Studies on their pre-recruit distribution continue under an EU funded project (FAIR CT 97 3374).

Variations in natural mortality across age groups was reported to the Working Group (Prouzet *et al*. 1999). This has been the subject of further investigations during 1998 and 1999 via an international project (Project 95/018) between France and Spain. It is expected that the results of this project will be available to the WGMHSA in 2000.

1.5 Egg Survey Working Group

1.5.1 Review of the Mackerel and Horse Mackerel Egg Report

One of the terms of reference in the 1999 Working Group on mackerel and horse mackerel egg surveys (Hamburg, 13-17 April 1999) was to obtain a review of the report from the MHMSA Working Group. This review was meant to be based on the comments from three anonymous referees and the ensuing discussion during the MHMSA Working Group meeting. Up to the starting date of the meeting only one referee had made his/her comments available. For that, two members of the working group (that were not involved in the egg report) were also asked to review the report and the external referee's comments and guide the discussion in a plenary session. The points presented here form a summary of these reviews and the overall opinion of the working group.

It is obvious from the external referee's comments that he/she is not familiar with the ICES framework and the nature of working group reports. The referee's report was generally negative, but the feeling was that a lot of the referee's frustration had to do with minor editorial mistakes, the structure of the report (which was largely determined by the terms of reference) and the incomplete reference to methodological and biological decisions affecting sampling and estimation. Also, the fact that some Tables and Figures of the report didn't reach the referee, made his/her task harder.

We felt that this criticism could equally apply to any ICES Working Group report, where time constrains rarely allow a polished document to be produced. A way to alleviate some of these problems in the future would be to introduce a short section in each ICES report that would highlight the main conclusions reached in earlier reports and make reference to the report where each issue (biological or methodological) was dealt with.

Putting these issues aside, the external referee made some interesting points that need to be addressed. For some of these points, it became clear in the discussion that they had already been addressed in previous reports, thus brief statements in this year's report could have removed any ambiguity. For example, in the referee's experience, the assumption of all mature fish spawning in a given year is not necessarily true and therefore is an important adult parameter to estimate. Also, the referee was puzzled by the use of stage I eggs alone for the estimation of egg production. However, both of these issues were extensively covered in earlier reports and there is no reason to question the rationale of such decisions. Nevertheless, the introduction of negative bias in the estimate of egg production (and thus spawning biomass) when natural egg mortality during Stage I is not taken into account is something that should be stressed in each report.

Some of the major concerns of the external referee were related to:

- Determinate versus indeterminate spawning in horse mackerel

Some evidence was presented in the egg working group that female horse mackerel may perform *de novo* vitellogenesis during the course of the spawning season. That would mean horse mackerel is an indeterminate spawner and thus one of the main assumptions of the AEPM would be violated. In the egg report, it is recommended that tank experiments with horse mackerel be carried out to investigate this issue. For some cases, for example in the North Sea egg surveys, DEPM can be a valid alternative if resource limitations and AEPM assumption violations occur.

- Fecundity estimation

Some problems related to the estimation of potential fecundity have been raised both by the external referee and a WD presented in the MHMSA WG. Darby (WD 1999) examines the estimates of potential fecundity per gram and questions whether forcing the regression of potential fecundity on fish weight to have a zero intercept is appropriate, suggesting an alternative analysis.

- Sampling design

There is a concern about the temporal and spatial coverage of the surveys. It is recognised that a big effort has been made to improve the survey coverage, by defining new standard survey areas and using adaptive sampling. Nevertheless, in the northwestern and northern boundaries of the 1998 survey there are appreciable egg densities in the outer stations of several transects, particular during the final surveys. Although such problems are inherent to oceanographic surveys of this scale, conflict areas for each survey should be localised and clearly stated on the text. Results about the sensitivity of the egg production estimates to incomplete spatio-temporal coverage using both the traditional estimate and GAMs are expected soon from an EU funded project (EC 97/0097).

Another question that was raised during the WG discussion was related to variance estimation of the annual egg production. Problems associated with the assumption of a constant coefficient of variation (CV) of the mean egg density where found. During 1998, not enough replicate samples were available to estimate the coefficient of variation necessary for variance estimation of egg production, so the CV estimate for 1995 was used instead. This was due to the limited ship time available to cover the study area while obtaining adequate replicate samples. There is a recommendation that this problem is highlighted during future survey planning, in order to avoid the similarly strong assumptions in the future.

In conclusion, we feel that each of the above problems are resolvable, and would improve the quality of the egg production and the spawning biomass estimate. It is a general belief that the egg production methods should continue to be carried out in the future, not only because they provide an independent estimate of spawning biomass, but also because they provide important biological information, while allowing to explore direct links between early life history stages and environmental conditions. In that sense, the working group recommends that an extensive review report of the Annual Egg Production Method is produced, in order to compile the most recent biological and methodological information available for obtaining reliable estimates of spawning stock biomass.

1.5.2 Updates to egg abundance estimates

A review of the historic time series of egg abundance estimates for mackerel and horse mackerel was reported to the previous Working Group meeting (ICES.1999/ACFM:6). This review included documentation of all the changes in methodology and data interpretation made since the first in the series of triennial surveys, in 1977.

A preliminary report of the 1998 egg surveys was also given to the Working Group in October 1998. This was based on an incomplete data set for egg abundance and no new information on fecundity, maturity or atresia for either mackerel or horse mackerel.

The Mackerel and Horse Mackerel Egg Survey Working Group met in February 1999 to analyse and review all the 1998 survey data. Final stage I egg production estimates for North East Atlantic mackerel in the western and southern areas and for the western and southern horse mackerel are given in the text table below.

A survey, to estimate the production of mackerel eggs in the North Sea was carried out in 1999 (Section 3.1.4.1) The resultant estimate of production is included in the text table below.

MACKEREL	Annual stage 1 egg production	s.e
Western spawning component	1.370×10^{15}	0.212
Southern spawning component	0.461×10^{15}	0.186
North Sea stock (1999 survey)	40×10^{12}	
HORSE MACKEREL		
Western stock	1.003×10^{15}	0.325
Southern stock	1.003×10^{15}	0.807
Southern stock (excl.2 high rectangle values)	0.186×10^{15}	0.077

Preliminary exploration of the data set for mackerel and horse mackerel in the western area was carried out using the Generalised Additive Model (GAM) previously described in ICES 1996 H:2. The results and problems with the application of this model to the 1998 data set are described in detail in the report of that Working Group. Briefly the stage I mackerel egg production from the GAM was 1.16×10^{15} eggs which is much lower than that from the traditional method. Further exploration of the problems with the GAM will continue before a final model selection can be made and a production estimate with standard error can be made.

The same model was used to explore the western horse mackerel data. The main problem with this data set was generated by some high egg densities on the final survey in June. This resulted in a seasonal production curve with a peak on the final survey and an estimate of total egg production which was much higher than by the traditional method.

1.6 Quality Control Procedures and Data Archiving

Last year the Working Group decided to annually review its procedures for collection and maintenance of national catch, catch sampling and age-structured information. However, it was noted that a comprehensive assessment of this topic was outside the resources of the Working Group.

The Working Group endorses the procedures recommended in the draft ‘Code of practice for data handling by assessment working groups’ prepared by the Study Group on Future Requirements for Fisheries Assessment Data and Software. The Working Group’s approach to implementing these recommendations was to:

- develop further a spreadsheet used for national data submissions, which has internal consistency checks, where possible species-specific data validation and range-checking and a facility to export data in a standard format;

- develop a long-term data storage format as specified in Patterson (WD 1998). Allocations of unsampled catches to age-distributions for calculating total international catches at age and weights at age are made from 1998 onward (catch year 1997) as described therein. Age distributions should always be stored together with the relevant information on sampling intensity;

- start to collect historical data and to save them on a secure long-term electronic data storage facility (to be provided by ICES) to allow the Working Group to build a long-term database.

Input data quality. The quality and format of input data provided to the species co-ordinators is still highly variable. Table 1.6.1 gives an overview of possible problems by nation. This table should be updated in next year’s report to track improvements. Sardine data were again not provided using the WG-data spreadsheets, however, this will be implemented from next year onwards. For anchovy, a complex method of catch sampling based on stratifying by commercial size-categories is used. Because of this, the software system described above is not suitable for this species and an alternative system should be developed.

Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Data co-ordinators have the responsibility for combining, collating, and interpolating information where necessary. A number of validation checks will, however, be made by the co-ordinators (using suitable software which will be developed further intersessionally) who will in the first instance report anomalies to the laboratory which provided the data. When reports of catches without accompanying sampling information are provided, it would be helpful to provide an indication of what data could be used as representative of these unsampled catches. Information on stratification should also be provided.

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.

Future requirements on data handling. Information on official, area mis-reported, unallocated, discarded and sampled catches are recorded on the WG-data exchange sheet (MS Excel; for definitions see text table below). However at present only sampled, official, WG and discards are reported to the *disfad* file structure, whereby unallocated and area mis-reported are combined into the WG catch. This information is available in the file *Sam.out*. For the construction of catch tables by area according to the WG report Tables 2.2.2.1 to 2.2.2.6 the following changes are necessary:

a) to record the unallocated and area mis-reported catches separately in the *disfad* file. This can be achieved by changing the macro;

b) to add code to the *sallocl.exe* file which will deal with the extra catch categories and produce the grouping of catches for Tables 2.2.2.1 to 2.2.2.6 which are grouped to different degrees by country, area, catch type and quarter.

As mentioned above, input data from some sources contained obvious errors. It is suggested that more sophisticated validation checks should be added to the WG-data exchange spreadsheet in order to prevent spurious values at the data entry stage.

Finally, the WG repeats that compiled and documented programmes (and not spreadsheets) should be used for the preparation of standard tables of biological information for assessment purposes.

Definitions of the different catch categories as used by the mackerel 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 mis-reported 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 mis-reported 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 control. The Working Group documents sampling coverage of the catches in two ways. Sampling effort will be tabulated against official catches by species (as in Section 1.4). The Working Group also suggests that plots of cumulative sampling effort on cumulative catch (accumulated across the area, time and Sub-Divisions which are used as data reporting units) can be used as a qualitative guide to the effectiveness of sampling effort. Examples are given as Figures 1.6.1. and 1.6.2. If the number of samples were proportional to the catch weight this would generate roughly a straight diagonal line. From Figure 1.6.1 it can be seen that sampling effort for NE Atlantic mackerel is too much concentrated on smaller catches. When this is examined by quarter (Figure 1.6.2) it can be seen that relatively large catches which are not sampled for age occur in the latter half of the year. As it can not be simply derived from this figure, an evaluation on the stratification of samples would be helpful.

Securing of historical data. As a first approach, WG members were asked to provide any kind of national data reported to previous working groups (official catches, working group catches, catch-at-age and biological sampling data), and the species co-ordinators provided their summary tables. However, there was little response from the national institutes. Prior to 1997, most of the data was handled in multiple spreadsheet systems in different formats. These are now stored in the original format, separately for each stock and catch year. Table 1.6.2 gives an overview on data collected by Sept. 1999. The data are saved on the ICES system and on Compact Disk. The WG recommends an increase of national efforts to gain historic data. It should at least be possible to provide an overview which data are stored where, in which format and for what time frame within the next year. This overview should then build the basis 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.

1.7 Future Research

The Working Group is aware that a number of research programmes are being carried out at different laboratories that will be of assistance to future assessments. It is important that the results of these investigations should be made available to the Working Group as soon as possible and that the Working Group should be kept informed of the progress in these programmes.

Some of the programmes that seem of particular interest are

- EU Project No:97/0097. The final report of this project entitled "The Evaluation and Development of spatio-temporal models and survey designs for efficient assessment of mackerel and horse mackerel " is due by the end of 1999. The main objective of this project is to "establish whether the current GAM- based point, variance and interval estimators are unbiased". Also the performance of the GAM-based estimator will be compared with that of the traditional estimator and a survey design that will improve the cost efficiency and reliability of the stock biomass estimates used in management will be developed. As a result of the project, usable and documented software for routine assessment of the stocks using a GAM based AEPM will be produced.

- Russian scientists will continue to collect physiological samples of mackerel during the Spring from the spawning grounds and during the Summer from the feeding grounds. Investigations will also continue on fecundities of mackerel.

- A new project has been proposed within the V Famework programme of the EU (RTD projects) by the institutes of IEO, IPIMAR, MI (FRC), DISA-UNITUS, IMBC, UVIGO, UABDN, IMR, FFCUL and BFA Fi to identify horse mackerel stocks in the northeast Atlantic and the Mediterranean. This project entitled "A multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis" (HOMSIR), will provide information currently lacking for effective definition of horse mackerel boundaries, and will evaluate the status of the horse mackerel populations. The overall objective will be achieved integrating the results of several techniques such as genetic markers, other biological tags like morphometric studies and the use of parasites, physical tagging and life history traits (growth, reproduction and distribution).

- A project aimed at evaluating the reliability of probability statements made about fisheries forecasts is underway and is expected to assist in calculating medium-term forecasts with appropriate assumptions.

Table 1.6.1. Overview of the availability and format of data provided to the species co-ordinators and possible problems (e.g. inconsistencies, missing data)

A. Mackerel

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

C. Sardine

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

C. Anchovy

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

Table 1.6.2. available disaggregated data for the WG MHSA per Sept. 1999
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
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
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
	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
	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
		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
Sardine						
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1997		W	D	W for Portugal only, files provided by Pablo Carrera and Kenneth Patterson
		1998		W		files provided by Pablo Carrera sept 1999
Anchovy						
	Anchovy in VIII	1987-95	X			revised data, all in on e 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
	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

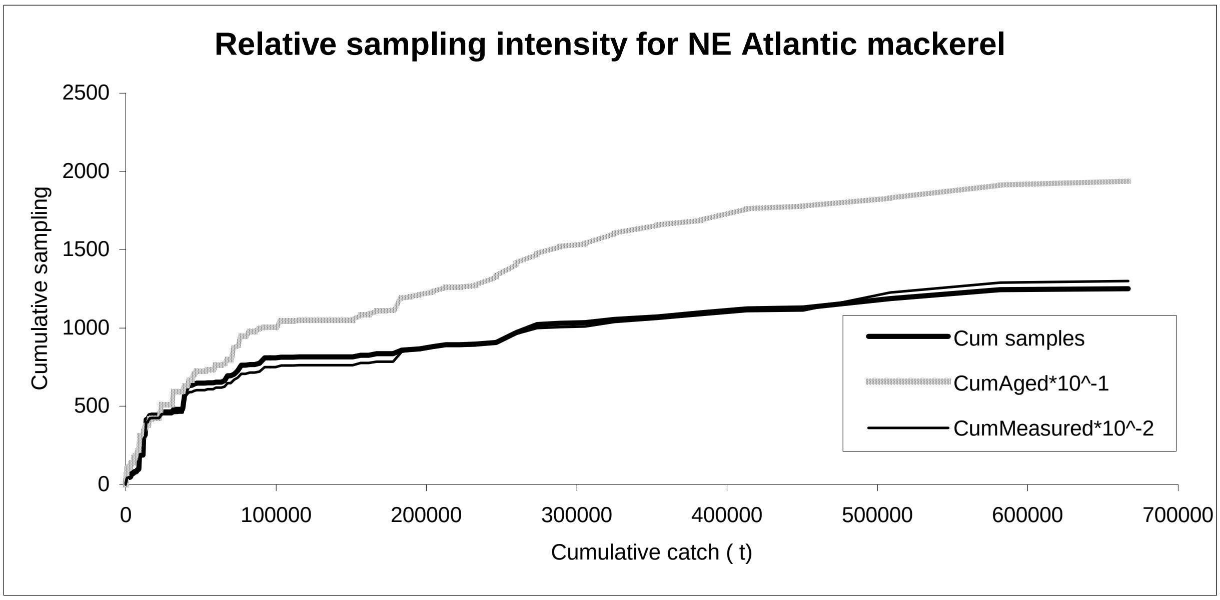

Fig 1.6.1 Sampling relative to catch for NE Atlantic mackerel ordered by increasing catch over all periods

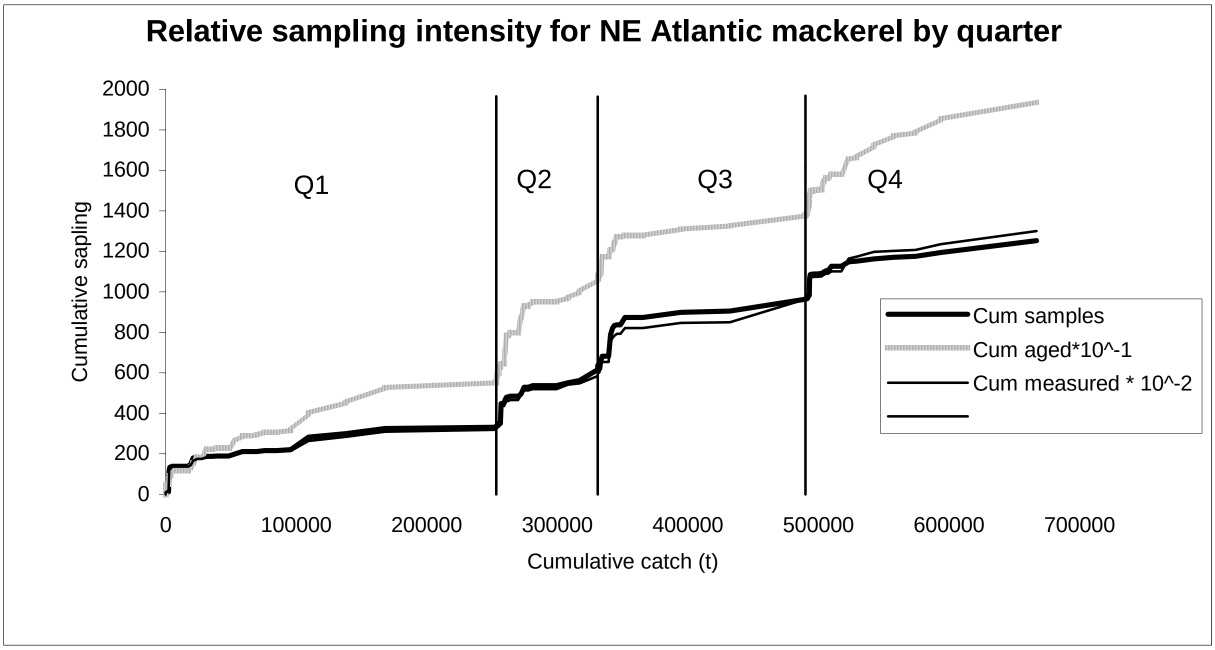

Fig 1.6.2 Sampling relative to catch for NE Atlantic mackerel ordered by increasing catch within each quarter

2 NORTHEAST ATLANTIC MACKEREL

2.1 ACFM advice and management applicable to 1998 and 1999

The TACs agreed by the various management authorities and the advice given by ACFM for 1998 and 1999 were as follows:

	1998			1999	
Stock/Area	Advice recommended by ACFM	Agreed TAC	Catch	ACFM: Highest tabulated option within precautionary range	Agreed TAC
North Sea stock	Lowest possible level	62.4	?	LPL	62.5
Western area	Sigificant reduction in F	451.9	623.0[1]	477.0[1]	464.2
Southern area	Significant reduction in F	35.	44.2[2]	27.0[2]	35[2]

[1]Assumed to be mainly Western stock mackerel, taken from Sub-area IV, Division IIIa and IIa, and included in the total agreed TAC for the western stock.
[2]Division VIIIc, Sub-areas IX and X and CECAF Division 34.1.1 (EU waters only), of which 3000 tonnes can be taken in Division VIIIb.

The agreed TAC for 1998 for all stocks combined amounts to 549,335 t, and that for 1999 to 561,625 t.

For 1999, the Working Group's understanding is that the following agreements are in effect.

North Sea and Division IIIa: (Norway: 40400, EU: 22,055)	62,455

Western area (IIa (Norwegian and international zone), Vb (EU zone),VI, VII, VIIIa,b,d,e,XII,XIV)

EU and Norway agreement: (Norway: 111350, EU: 310810)	422,160
Net quota Faeroes-Norway	5,650
Net quota Faroes-EU:	– 790
Russian quota in Faroese waters (bycatch quota):	18,600
Icelandic quota in Faroese waters:	1,300
Faroese national quota:	17,250
Total TAC Western area:	464,170
Southern area (VIIIc and IXa (of which 3000t can be taken in VIIIb):	35,000
Grand total.	561,625

For 1998, ACFM recommended a fishing mortality between 0.15 and 0.20, the highest tabulated F consistent with the precautionary approach was given as $0.8F_{97.}$ For 1999, a fishing mortality not exceeding Fpa = 0.17 was recommended.

It is again important to stress that while the TAC options are meant to apply to the total catch of all mackerel over the total distribution area the actual agreed TACs do not apply to the catches taken in international waters. The total catches in international waters, which are mainly taken by Russia in the Norwegian Sea, have been increasing in recent years. In 1999, the Russian catch in Faroese and international waters was somewhat below that in the recent years.

In addition to the TACs and the national quota the following are some of the more important additional management measures which were in force in 1998 and are again in force in 1999. These measures are mainly designed to afford maximum protection to the North Sea stock while it remains in it's present depleted state while at the same time allowing fishing on the western stock while it is present in the North Sea, as well as to protect juvenile mackerel.

1. Prohibition of fishing in Division IVa during Quarters 1 and 2, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year. (Norway opened for a fishery in Division IVa the first half of the year since 1996)

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.

2.2 The Fishery in 1998

2.2.1 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.

Table 2.2.1.1 shows the Spanish landings by sub-division in the period 1982-1998. In 1998 the catch in Division VIIIb was 1218 t, higher than in 1997. The catch in Sub-division VIIIc East reached 1753 t in 1998, a fall with respect to 1997, the year in which the highest catches since 1982 were registered. In Sub-division VIIIc West the catch was 12 t, having fallen greatly in comparison with 1997. In Sub-division IXa North the catch was 412 t in 1998, a fall with respect the previous years. The total Spanish catch in 1998 was 4364 t.

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 made based on the monthly percentages of the ports in which they are separated and based on the samplings carried out on the ports of this area. There is no error in the identification of mackerel species 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 969 t of Spanish mackerel in 1998. In the bottom trawl surveys carried out in the Gulf of Cadiz in 1998, catches of *S. Scombrus* increased with respect to previous years, with *S. japonicus* making up 75% and *S. Scombrus* 25% of the total catch in weight of both species (M. Millán, pers. comm). 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). Due to the uncertainties as to the proportion of *S. Scombrus* in landings, they have never been included in the mackerel catches reported to this Working Group by Spain.

In Portugal the landings of Spanish mackerel from Division IXa (CN, CS and S) were 7,659 t in 1998, more abundant in the southern areas than those of the north (Table 2.2.1.1). These species are landed by all fleets but the purse seiners accounted for 73% of total weight. 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 error in the 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.

2.2.2 Catch Estimates

The total estimated catch in 1998 was about 667,000 t which was nearly 98,000t higher than the catch taken in 1997. The TACs set for 1998 for all those areas for which TACs were agreed amounted to 549,335 t (See Section 2.1.). The corresponding TAC for 1997 was 440,225 t. The increase in catches taken in 1998 appears mainly to have been a result of the increase in the overall TACs together with an increase in the catches taken from the unregulated international fisheries (54,000 t in 1997 and 75,000 t in 1998). The corresponding TACs as best ascertained by the Working Group (Section 2.1) agreed for 1999 amount to 561,625 t.

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.2.1. This table shows the development of the fisheries since 1969. Some slight changes have been made to the 1994 and 1995 catches due to the provision of revised data.

During 1998 the highest catches (over 269,700 t) were again taken from Sub-area IV and Division IIIa – nearly 264,000 t of these having been taken in Division IVa. The catches, taken from Divs. IIa and Divisions Va and Vb (134,200 t), where the international fisheries take place, were about 28,800 t higher than recorded in 1997. The overall catch taken in the fisheries in Sub-areas VI and VII and in Divisions VIIa,b,d,e was 218,600 t compared to 195,800 t in 1997.

The catch taken in Division VIa increased from 67,300 t in 1997 to over 110, 200 t in 1998.

There was a decrease of over 20,100 t in the catch recorded from Sub area. VII and Divisions VIII a,b,d,e for 1998 compared with that of 1997.

The catches taken in Divisions VIIIc and IXa have slowly increased in recent years and the 1998 catch of nearly 44,200 t continued this trend and is the highest recorded since 1977.

The amounts of catch misreported during 1998 was about 98,300 t compared with 73,500 t in the previous year. These catches were mainly taken in Division IVa but were reported as having been taken in Division VIa. Small amounts of catches were also misreported from Divisions IIa and Vb. Catches from the fishery in the southern part of Division VIa, which had increased considerably in recent years, were about 20,000 in 1998 which was about the same level as that of the mid nineties.

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 1998 was similar to those of 1997.

Percentage distribution of the total catches from 1990 – 1998

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

The catches per quarter and per Sub-area and by Division are shown in Table 2.2.2.6. These catches are shown per statistical rectangle in Figures 2.7 1.1 to 2.7.1.4 and are discussed in more detail in Section 2.7. It should be noted that these figures are based on details submitted on the official log books supplied by fishermen and should not be taken to indicate the true location of the stock.

The quarterly distributions of the fisheries in 1998 which are shown in Table 2.2.2.6 were very similar to that of 1996 and 1997. Over 38% of the total catch was taken during the 1st quarter as the shoals migrate from Division IVa through Sub-area VI to the main spawning areas in Sub-area VII. About 12% of the total catch was taken in Quarter 2, most of it from Sub-areas VI and VII. During Quarter 3 in which over 24% of the total catch was taken the main catches were recorded from Division IIa and Division IVa from the shoals on the summer feeding areas. During Quarter 4, in which over 26% of the total catch was taken, the main catches were recorded from Divisions IVa and IIa. The main catches from Divisions VIIIc (88%) of the total for the division were taken in Quarters 1 and 2. The main catch from Div. IXa was taken from Quarter 3 (60%) in contrast to previous years when catches were evenly distributed throughout the year.

National catches

The national catches recorded by the various countries for the different areas are shown in Tables 2.2.2.2 - 2.2.2.5. 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 because of the "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, United Kingdom, Ireland, Netherlands and Russia.

The total catch recorded from Divisions IIa and Vb (Table 2.2.2.2) in 1998 was about 134,200 t which was over 28,800 t higher than in 1997. Most of the catches from this area are taken by Norway and Russia, both of which increased their catches in 1998. The total catch taken from the “international” fishery was about 74,600 t compared with 54,600t in 1997. High levels of misreporting were recorded from this area in 1994 (109,600t) between Divisions IVa and Division IIa. However, there appears to have been little misreporting in recent years although there are no data to support this assumption.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.2.3) in 1998 was 269,700 t compared with 227,600 t in 1997. The slight increase was probably due to the increase in the 1997 TAC compared to that of 1996. About 98,400 t, believed to have been taken in Division IVa, were reported as having been taken in Division VIa. The main catches were recorded by Norway (103,700 t), while substantial catches were also recorded by Denmark, (25,300 t) and the United Kingdom (19,800 t). The amount of discard, (information supplied by one country only) increased from 2,800 t to 4,700 t.

The total catch estimated to have been taken from the Western areas (Table 2.2.2.4) was 218,600 t. About 98,300 t were reported as having been taken in this area but were believed to have been taken in Division IVa. This is substantiated by the very large catches reported as having been taken from two statistical rectangles (48,E5 and 49,E5) which lies immediately west of the 4° which separated Division IVa from Division VIa. The main catches continue to be taken by United Kingdom (166,00 t) and Ireland. (66,500 t). The Netherlands, (28,800 t) Germany (21,000 t) and France (15,900 t) continue to have important fisheries in this area. Information on discards indicate a considerable decrease (3,300 t in 1998 compared with 16,100 t in 1997).

The total catch recorded from Divisions VIIIc and IXa (Table 2.2.2.5) in 1998 was 44,200 t. compared with 40,100 t in 1997. This was the highest catch recorded from this area since before 1977 and continues the increasing trend in catches observed in recent years. The TAC for 1998 was 35,000 t which is the same as that set for 1999. The increased catches in recent years are probably as a result of increased prices for mackerel. and a consequential increased effort by the Spanish handline fleet which target mackerel. in Division VIII c (east). Recent low sardine catches in Division IXa(N) and VIIIc(W) have resulted in a redirection of effort towards the mackerel fishery. Most of the catch from this area is taken by Spain (>90%).

2.2.3 Discards

Only Netherlands provided information on discards.

Table 2.2.1.1: Catches in tonnes of *Scomber japonicus* in Divisions VIIIb, VIIIc and IXa in the period 1982-1998.

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Spain	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427	247	778	362	1218
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2633	4416	1753
	VIIIc west															47	610	12
	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2679	5026	1765
	IXa North												2557	7560.2	4705	5066	1727	412
	IXa South											895	800	1012.7	364	370	613	969
	Total	0	0	0	0	0	0	0	0	0	0	895	3357	8572.9	5068	5437	2340	1381
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903	7872	8894	7729	4364
Portugal	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481
	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779	1578	1427	1749	2778	2796
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759	5408	6690
TOTAL	**Division VIIIb**										487	7	4	427	247	778	362	1218
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416	1753
	VIIIc west															47	610	12
	Division VIIIc	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026	1765
	IXa North												2557	7560	4705	5066	1727	412
	IXa Central-North		0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481
	IXa Central-South		244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414
	IXa South		129	3899	4113	4177	3409	2813	4061	2547	3080	3698	2579	2591	1790	2120	3391	3764
	Division IXa	664	373	8059	9118	8184	8876	3816	6447	8568	10142	9876	10698	13003	8952	10195	7748	8071
	Total	**986**	**627**	**8715**	**9631**	**8934**	**10026**	**5030**	**9538**	**10491**	**12131**	**10742**	**12594**	**15333**	**11756**	**13653**	**13137**	**11054**

Table 2.2.2.1 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 Division IIIa			Divs. IIa,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	66,300		66,300	739,182		739,182			810,282		810,282
1970	3,900		3,900	100,300		100,300	322,451		322,451	163		426,814		426,814
1971	10,200		10,200	122,600		122,600	243,673		243,673	358		376,831		376,831
1972	10,000		10,000	157,800		157,800	188,599		188,599	88		356,487		356,487
1973	52,200		52,200	167,300		167,300	326,519		326,519	21,600		567,619		567,619
1974	64,100		64,100	234,100		234,100	298,391		298,391	6,800		603,391		603,391
1975	64,800		64,800	416,500		416,500	263,062		263,062	34,700		779,062		779,062
1976	67,800		67,800	439,400		439,400	303,842		303,842	10,500		821,542		821,542
1977	74,800		74,800	259,100		259,100	258,131		258,131	1,400	27,417	620,848		620,848
1978	151,700	15,100	166,900	355,500	35,500	391,000	148,817		148,817	4,200	26,508	686,725	50,700	737,425
1979	203,300	20,300	223,600	398,000	39,800	437,800	152,323	500	152,823	7,000	22,475	783,098	60,600	843,698
1980	218,700	6,000	224,700	386,100	15,600	401,700	87,391		87,391	8,300	15,964	716,455	21,600	738,055
1981	335,100	2,500	337,600	274,300	39,800	314,100	64,172	3,216	67,388	18,700	18,053	710,325	45,516	755,841
1982	340,400	4,100	344,500	257,800	20,800	278,600	35,033	450	35,483	37,600	21,076	691,909	25,350	717,259
1983	315,100	22,300	337,400	245,400	9,000	254,400	40,889	96	40,985	49,000	14,853	665,242	31,396	696,638
1984	306,100	1,600	307,700	176,100	10,500	186,600	39,374	202	39,576	93,900	20,308	635,782	12,302	648,084
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	8,191	614,275
1986	104,100		104,100	128,499		128,499	236,309	7,431	243,740	101,000	24,789	594,697	7,431	602,128
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000	22,187	644,016	10,789	654,805
1988	115,600	3,100	118,700	75,600	2,700	78,300	308,550	29,766	338,316	116,200	24,772	640,722	35,566	676,288
1989	121,300	2,600	123,900	72,900	2,300	75,200	279,410	2,190	281,600	86,900	18,321	578,831	7,090	585,921
1990	114,800	5,800	120,600	56,300	5,500	61,800	300,800	4,300	305,100	116,800	21,311	610,011	15,600	625,611
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	30,700	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	25,000	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	18,180	825,036
1994	134,338	1,390	135,728	113,088	2,830	115,918	474,830	1,150	475,980	69,900	25,043	817,198	5,370	822,568
1995	145,626	74	145,700	117,883	6,917	124,800	322,670	730	323,400	134,100	27,600	747,879	7,721	755,600
1996	129,895	255	130,150	73,351	9,773	83,124	211,451	1,387	212,838	103,376	34,123	552,196	11,415	563,611
1997	65,044	2,240	67,284	114,719	13,817	128,536	224,759	2,807	227,566	105,449	40,708	550,679	18,864	569,543
1998*	110141	71	110,212	105,181	3,206	108,387	264,947	4,735	269,700	134,219	44,164	658,652	8,030	666,682

*Preliminary.
[1]For 1976–1985 only Division IIa.
[2]Discards estimated only for one fleet in recent years.

NB: Landings from 1969–1978 were taken from the 1978 Working Group report (Tables 2.1, 2.2 and 2.5).

Table 2.2.2.2 Catches (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**
Denmark	11,787	7,610	1,653	3,133	4,265	6,433
Faroe Islands	137				22	1,247
France		16				11
Germany, Fed. Rep.			99		380	
German Dem. Rep.			16	292		2,409
Norway	82,005	61,065	85,400	25,000	86,400	68,300
Poland						
United Kingdom			2,131	157	1,413	
USSR	4,293	9,405	11,813	18,604	27,924	12,088
Discards						
Total	98,222	78,096	101,112	47,186	120,404	90,488

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	6,800	1,098	251			4,746	3,198	37	2,090
Estonia			216		3,302	1,925	3,741	4,422	7,356
Faroe Islands	3,100	5,793	3,347	1,167	6,258	9,032	2,965	7,628	2,716
France		23	6	6	5	5	0	270	-
Germany							1	-	-
Iceland							92	925	357
Latvia			100	4,700	1,508	389	233	-	-
Netherlands							561	-	-
Norway	77,200	76,760	91,900	110,500	141,114	93,315	47,992	41,000	54,477
Russia			42,440	49,600	28,041	44,537	44,545	50,207	67,201
United Kingdom	400	514	802		1,706	194	48	938	199
USSR[2]	28,900	13,631[2]							-
Poland								22	-
Misreported (Iva,Vb)					-109,625	-18,647	-	-	-177-
Discards	2,300						-	-	-
Total	118,700	97,819	139,062	165,973	72,309	135,496	103,376	105,449	134,219

[1]Preliminary for 1998

[2]Russia.

Table 2.2.2.3 Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and Division IIIa). (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991
Belgium		49	14	20	37		125
Denmark	12,424	23,368	28,217	32,588	26,831	29,000	38,834
Estonia							
Faroe Islands	1,356				2,685	5,900	5,338
France	322	1,200	2,146	1,806	2,200	1,600	2,362
Germany, Fed. Rep.	217	1,853	474	177	6,312	3,500	4,173
Ireland					8,880	12,800	13,000
Latvia							
Netherlands	726	1,949	2,761	2,564	7,343	13,700	4,591
Norway	30,835	50,600	108,250	59,750	81,400	74,500	102,350
Sweden	760	1,300	3,162	1,003	6,601	6,400	4,227
United Kingdom	170	559	19857	1,002	38,660	30,800	36,917
USSR (Russia from 1990)							
Romania							
Misreported (IIa)							
Misreported (VIa)		148,000	117,000	180,000	92,000	126,000	130,000
Unallocated	-	7,391	8,948	29,630	6,461	-3,400	16,758
Discards	3,656	7,431	10,789	29,776	2,190	4,300	7,200
Total	50,466	243,700	301,618	338,316	281,600	305,100	365,875

Country	1992	1993	1994	1995	1996	1997	1998
Belgium	102	191	351	106	62	114	125
Denmark	41,719	42,502	47,852	30,891	24,057	21,934	25,326
Estonia	400					-	-
Faroe Islands		11,408	11,027	17,883	13,886	1,367	4,832
France	956	1,480	1,570	1,599	1,316	1,532	1,908
Germany, Fed. Rep.	4,610	4,940	1,479	712	542	213	423
Ireland	13,136	13,206	9,032	5,607	5,280	280	145
Latvia	211					-	-
Netherlands	6,547	7,770	3,637	1,275	1,996	951	1,373
Norway	115,700	112,700	114,428	108,890	88,444	96,300	103,700
Sweden	5,100	5,934	7,099	6,285	5,307	4,714	5,146
United Kingdom	35,137	41,010	27,479	21,609	18,545	19,204	19,755
Russia						3,525	635
Romania			2,903			-	-
Misreported (IIa)			109,625	18,647	-	-	-
Misreported (VIa)	127,000	146,697	134,765	106,987	51,781	73,523	98,432
Unallocated	13,566	-	-	983	236	1,102	3,147
Discards	2,980	2,720	1,150	730	1,387	2,807	4,753
Total	367,164	390,558	472,397	322,204	212,839	227,566	269,700

[1]Preliminary for 1998

Table 2.2.2.4 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	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Denmark	200	400	300	100		1,000	
Faroe Islands	9,200	9,900	1,400	7,100	2,600	1,100	1,000
France	12,500	7,400	11,200	11,100	8,900	12,700	17,400
Germany	11,200	11,800	7,700	13,300	15,900	16,200	18,100
Ireland	84,100	91,400	74,500	89,500	85,800	61,100	61,500
Netherlands	99,000	37,000	58,900	31,700	26,100	24,000	24,500
Norway	34,700	24,300	21,000	21,600	17,300	700	
Poland							
Spain	100				1,500	1,400	400
United Kingdom	198,300	205,900	156,300	200,700	208,400	149,100	162,700
USSR	200						
Unallocated	18000	75100	49299	26000	4700	18900	11,500
Misreported (IVa)			-148,000	-117,000	-180,000	-92,000	-126,000
Discards	12,100	4,500			5,800	4,900	11,300
Grand Total	479,600	467,700	232,599	284,100	197,000	199,100	182,400

Country	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Denmark	1,573	194		2,239	1,443	1,271	-	-
Estonia					361		-	-
Faroe Islands	4,095		2,350	4,283	4,248	-	2,158	3,681
France	10,364	9,109	8,296	9,998	10,178	14,347	19,114	15,927
Germany	17,138	21,952	23,776	25,011	23,703	15,685	15,161	20,989
Ireland	64,827	76,313	81,773	79,996	72,927	49,033	52,849	66,505
Netherlands	29,156	32,365	44,600	40,698	34,514	34,203	22,749	28,790
Norway			600	2,552			-	-
Spain	4,020	2,764	3,162	4,126	4,509	2,271	7,842	3,340
United Kingdom	162,588	196,890	215,265	208,656	190,344	127,612	128,836	165,994
Unallocated	-3,802	1,472	0	4,632	28,245	10,603	4,577	8,351
Misreported (IVa)	-130,000	-127,000	-146,697	-134,765	-106,987	-51,781	-73,523	-98,255
Discards	23,550	22,020	15,660	4,220	6,991	10,028	16,057	3,277
Grand Total	183,509	236,079	248,785	251,646	270,476	213,272	195,820	218,599

[1]Preliminary

Table 2.2.2.5 Landings (tonnes) of mackerel in Divisions VIIIc and IXa, 1977–1997. Data submitted by Working Group members.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Spain[1]	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533	15,982
Portugal[2]	1,743	1,555	1,071	1,929	3,108	3,018	2,239	2,250	4,178	6,419	5,714
Spain[2]	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123	1,837	491
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
TOTAL	27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111	24,789	22,187

[1]Division VIIIc.

[2]Division IXa.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Spain[1]	16,844	13,446	16,086	16,940	12,043	16,675	21,146	23,631	28,386	35,015	36,174
Portugal[2]	4,388	3,112	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080	2,897
Spain[2]	3,540	1,763	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613	5,093
Poland[2]	-	-	-	-	-	-	-	-	-	-	-
USSR[2]	-	-	-	-	-	-	-	-	-	-	-
Total[2]	7,928	4,875	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693	7,990
TOTAL	24,772	18,321	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708	44,164

[1]Division VIIIc.

[2]Division IXa.

Table 2.2.2.6 Catches of mackerel by Division and Sub-area in 1998.
(Data submitted by Working Group members.)

Area \ Quarter	1	2	3	4	Total
IIa & Vb	2,800	12,400	102,000	16,900	134,100
IIIa	900	300	2,700	800	4,700
IVa	103,500	3,900	40,700	111,400	259,500
IVb,c	1,300	500	2,400	1,300	5,500
VI	86,600	8,500	200	15,000	110,300
VII	39,700	32,600	5,000	25,500	102,800
VIIIa,b,d,e	2,000	1,100	100	2,400	5,600
Sub-total	236,700	59,400	153,100	173,300	622,500
VIIIc	15,400	16,400	1,600	2,800	36,200
IXa	1,100	1,400	4,800	700	8,000
Grand Total	253,200	77,100	159,500	176,800	666,600

Catches rounded to nearest 100t

2.3 Definition of Stock Components for Assessment and Management

2.3.1 Treatment of biological data of S,W and N components in assessments and forecasts

The combined data set for the analysis of the North East Atlantic mackerel is restricted to the years 1984-1996. The data series for the southern area is only available for this period. The portion of the stock spawning in the North Sea had been reduced to near the present low level by 1984, so that its contribution to the catch at age data is considered to be negligible.

Mean weight in the catch is obtained as a catch number weighted average of the weights used for the three components. Catch weights for the 0 and 1 groups are determined primarily from the southern area and those for all other ages primarily from the western area.

Weights in the stock and maturity ogives are calculated as averages weighted by the relative proportion of the egg production estimates of spawning stock biomass within the respective areas. Weighting factors of 0.15 and 0.85 were used for the southern and western data in the years prior to 1998 and 0.25:0.75 in 1998. Similar weights were applied to the maturity at age. Natural mortality was taken as 0.15 and the proportions of F and M before spawning were 0.4.

The weighting factors described above were also applied to stock weights and maturity ogives used in the stock forecasts. Weights at age in the catch were determined as averages of the last three years data from each area. Partial fishing mortalities at each age were determined from the overall fishing mortalities scaled by the ratio of the catch in numbers of fish from an area and the total catch number. The average of the last three years of partial fishing mortality was used in the forecast, scaled or unscaled to the level of fishing mortality estimated for final year.

2.3.2 New Information on stock components

Two documents supplied new information contributing to discussion of the definition of stock components: The report of the WGMEGS (ICES CM 1999/G:5) and the final report of the Tagging Project on mackerel (Uriarte *et al.* 1999 WD, Eur.Contract 96/035), both of which were presented at the WG.

The major conclusions from these two reports concerning mackerel components were:

- The WGMEGS concluded that it was currently impossible to distinguish between southern and western spawning components based upon the distribution of eggs from the surveys. This is because no clear natural discontinuity could be seen between the spawning in these areas.

- The Tagging Project on mackerel (96/035) concluded *inter alia* that (Figure 2.3.2.1):

    a) There was a strong representation of southern adult mackerel during spring in the western spawning grounds. This was deduced from the observation that 15 out of 20 recoveries of externally tagged southern mackerel in the spring of 1998 were reported from the western area. As mixing of southern and western mackerel has already been demonstrated for the other quarters of the year, it seems likely that mixing takes place throughout the entire year.

    b) In relation to the present understanding of mackerel components (see 2.3.3.) it can be stated that mackerel from the southern and western areas mix throughout most of the year. In particular they are found together in the western spawning grounds (with the likely possibility of mixing). This casts doubt on the reliability of the assumption of separate spawning components in these areas. These observations do not affect the perception of the North Sea Stock as a separate spawning component.

The report of tagging Project states in the discussion that the tagging observations seem to better support the hypothesis of the existence of a single population without separate components in the southern and western areas than the hypothesis of the existence of two separate spawning components. However it should be noted that there is very little evidence for western component adults migrating into the southern area.

The perception of the North Sea Stock as a separate spawning component is not affected by this new information. Iversen (WD99) has presented a review on the biological information coming from egg surveys, genetics, parasitology and otolith measurements that support the existence of a separate spawning stock (component) of mackerel in the North Sea.

Recent studies on genetics (Nesbo *et al.* in press) have analysed two regions in mtDNA (D-Loop and *Cyt*b) and micro-satellites and showed different degrees of heterogeneity between samples taken in the southern, western and North sea spawning grounds. The highest level of diversity was found in the southern area. This implies some population structuring.

All the new information available (egg survey distributions, tagging and genetics) is not entirely in agreement concerning the biological validity of defining different spawning components in the western and southern areas as traditionally defined in the WG. However, there is no biological information, which can support the delimitation of these spawning components at the boundaries between the southern and western area as traditionally defined at the boundary between VIIIb and VIIIc).

2.3.3 Proposal for New Terminology

At their meeting in May ACFM asked the WGMHSA "*to come up at its next meeting with a proposal for terminology to be used for the definition of the mackerel components and the consequences for ACFM advice*".

The WGMHSA currently use the term **"North East Atlantic Mackerel"** to define the mackerel present in the area extending from ICES Division IXa in the south to Division IIa in the north, including mackerel in the North Sea. The spawning grounds of mackerel from this area are widely spread and in the North Sea are sufficiently discrete to be clearly identified as a separate spawning component. The identity of separate spawning components in the southern and western areas of distribution is not clear. However, the Working Group needs to be able to follow the development of the spawning population in these two areas separately. One reason for this is that the long time series of triennial egg surveys covers only the western area, and the southern area was not fully covered until the 1998 survey. Also, given uncertainty in the extent to which the spawning components mix, it is considered advisable to monitor and advise on changes in relative abundance of the spawning components.

The question of the terminology in current use was discussed by the Working Group and it was decided that the definition described by the Egg Survey Working Group in 1999 (ICES 1999/G:5) should be accepted, with clarification. This Working Group defined the terminology and produced a table for easy reference. The table lists the area of distribution and fishing of North East Atlantic mackerel, and the separate spawning areas of its three components, in ICES Sub- areas and Divisions.

The Egg Survey Working Group also defined the spawning and fishing areas of the three populations of horse mackerel (*Trachurus trachurus*), currently regarded as discrete stocks, in the North East Atlantic.

The expanded definitions for both species are endorsed by this Working Group and given below.

<u>Mackerel</u>

Traditionally and according to main spawning sites three mackerel stocks were previously considered by ICES, the southern, the western and the North Sea stock.

However, although there is a sound basis for distinguishing a North Sea component, data from egg surveys have demonstrated that it is impossible clearly to distinguish between a southern and a western spawning area.

Tagging experiments have demonstrated that after spawning fish from Southern and Western areas migrate to feed in the Norwegian Sea and the North Sea during the second half of the year. Here they mix with the North Sea component in the North Sea. Since it is at present impossible to allocate catches to the stocks previously considered by ICES they are at present, for practical reasons, considered as one stock: the **North East Atlantic Mackerel Stock.** However, to be able to keep track of the development of the spawning biomasses in the different spawning areas, the North East Atlantic mackerel stock is divided into three area components termed the **Western Spawning Component**, the **North Sea Spawning Component** and the **Southern Spawning Component**. The Western Component is defined as mackerel spawning in the western area (ICES Divisions and Sub-Areas VI, VII, VIII a,b,d,e). This component comprises approximately 85% of the entire North East Atlantic Stock. Similarly, the Southern Component is defined as mackerel spawning in the southern area (ICES Divisions VIIIc and IXa). Although the North Sea component has been at an extremely low level since the early 1970s the WGMHSA regards the North Sea component as still existing (section 13). This component is spawning in the North Sea and Skagerrak (ICES Sub-Area IV and Division IIIa).

The egg surveys indicate that minor spawnings also occur outside the three main spawning areas as described above.

The North East Atlantic mackerel stock is distributed and fished in the ICES Sub-Areas and Divisions: IIa, IIIa, IV, Vb, VI, VII, VIII, IXa.

The definitions of stock, components and spawning areas, as used by this Working Group, are summarised in the text table below.

North-East Atlantic Mackerel			
Distributed and fished in ICES Divisions IIa, IIIa, IV, Vb, VI, VII, VIII and IXa			
Spawning Component	**Western**	**Southern**	**North Sea**
Spawning Areas	VI, VII, VIIIa,b,d,e.	VIIIc, IXa.	IV, IIIa.

Horse Mackerel

There is some biological evidence (see ICES 1999/G:16) that horse mackerel form three different spawning populations which are termed as stocks, although the biological basis for the separation is not stronger than the basis for the separation of mackerel components. A research programme addressing the issue of horse mackerel population structure is due to begin and is expected to help clarify this issue. i.e., the Southern stock, the North Sea stock and the Western stock. Extensive migration and mixing of these stocks is likely to occur. The catches are allocated to the different stocks on an arbitrary basis according to the temporal and spatial distribution of the fishery (ICES 1999/ACFM:6).

The definitions of stocks, spawning areas and fishing areas, as used by this Working Group are summarised in the text table below. Fishing areas do not correspond to TAC areas.

	Horse Mackerel		
Stock	**Western**	**Southern**	**North Sea**
Spawning Area	VI, VIIa-c, e-k, VIIIa,b,d,e.	VIIIc, IXa.	IVb, c and VIId
Fishing Area	IIa, IVa, VIa, VIIa-c, e-k, VIIIa,b,d,e, IIIa (western)	VIIIc, IXa	IIIa (eastern), IVb, c and VIId

It should be noted that fishing areas may not necessarily correspond to TAC areas.

2.3.4 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 1998. It should be pointed out that if the North Sea stock increases then 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 (<100,00 t) (W.D. Iversen and Eltink 1999). A further egg survey in the North Sea is planned for 2002 and should give additional information on the state of the stock.

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 and 1998 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 fixed at 35,000t, 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 assessment for the Western area and the provision of catch options for that area.

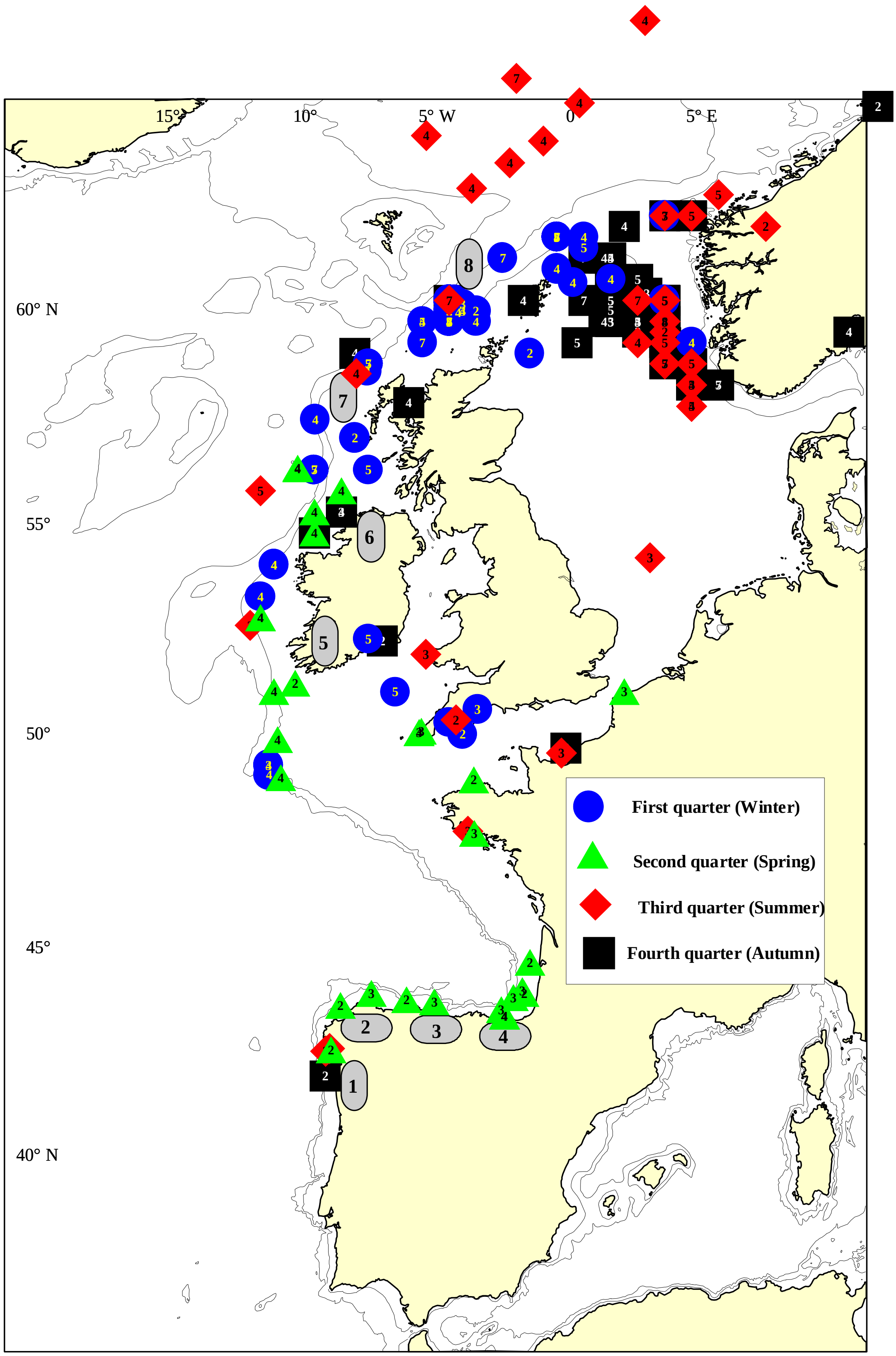

Figure 2.3.2.1: 1997 and 1998 recaptures of mackerel tagged in adult areas in the 1997 surveys of the International project on tagging (EU contract 96/035, Uriarte et al. WD99). The number inside the symbols indicates the tagging area of the mackerel recaptured.

2.4 Biological Data

2.4.1 Catch in numbers at age

The 1998 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. These catch in numbers relate to a tonnage of 666,861t and do not include a catch of 357t from Iceland which was received during the WG and after the data files had been compiled for the assessment and also do not include a small correction of –540t for the Russian catches in IIa. The correction for the Russian catches was not included in the caton file for the 1999 assessment. These revisions have a negligible effect on the SOP for the 1999 total catch (101%). The percentage catch by numbers at age is given in Table 2.4.1.2.

The age structure of the catches of NE Atlantic mackerel is predominantly 2-6 year old fish. These age groups constitute 75% of the total catches. The 1996 year class (2 year old fish) dominated the catches throughout half of the areas where mackerel was caught. Older Fish belonging to the 1993 & 1994 year classes were dominant in the catches in northern and western areas and VIIIc east (Divisions IIa IIIa IVa Vb VIIj VIIk). In other areas the catches were dominated by younger fish (1 to 3 year olds) and the pattern of age distributions was similar to last year.

Age distributions of catches were provided by Denmark England Faroes Ireland Netherlands Norway Portugal Russia Scotland and Spain. There are still major gaps in the overall sampling for age from countries which take substantial catches notably France Germany Estonia and Sweden (combined catch of 51,928t) and theUK which provide aged data from only 20% of their catches. In addition there were no aged samples to cover the entire catch from IIIa, VIIa, VIIg, VIIk and VIb (total catch 5,076t). As in 1997 catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleets. This is obviously undesirable where the only aged samples available are from a different type of gear.

Sampling data is further discussed in Section 1.4.1.

2.4.2 Length composition by fleet and country

Length distributions of some of the 1998 catches by some of the fleets were provided by England Ireland Netherlands Norway Portugal Scotland Spain Russia the Faroes and Denmark. The length distributions were available from most of the fishing fleets and account for about 90% of the official 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 1998 are shown in Table 2.4.2.1.

2.4.3 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter for 1998 for the NE Atlantic is 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 1998 are shown in Table 2.4.3.2. Mean weights at age in the stock at spawning time for NE Atlantic mackerel are based on a weighted mean of the stock weights for the Western, Southern and North Sea stock components, with the exception of age group 1, which is based on a constant value used since 1988. The stock weights for NE Atlantic mackerel and the Western, Southern and North Sea components are given in Table 2.4.3.3. The stock weights of NE Atlantic are based on a relative weighting of the North Sea, Western and Southern mackerel components (0.026, 0.825, 0.15 respectively). In the case of North Sea and Southern components constant values for the stock weights have been used since the start of the data series in 1984. For the Western component the stock weights were based on Dutch mean weights at age from commercial catch data from Division VIIj over the period March to May. From the 1997 WG onwards the stock weights for the Western component are 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 is weighted by the number of observations from each country. The stock weight for age group 1 of the NEA Atlantic mackerel has been a constant value since 1988.

2.4.4 Maturity Ogive

A maturity ogive for 1998 for the Northeast Atlantic mackerel was constructed based on the following information:

North Sea component — No changes to the historic maturity ogive (ICES, 1998/Assess:6).

Western component — No changes to the historic maturity ogive, as insufficient maturity samples were collected during the 1998 Egg Survey (ICES, 1999/G:5 and see also section 3.2.1.3).

Southern component — A new maturity ogive for 1998 was made available based on a histological analysis of mackerel samples collected during the 1998 Egg Survey (Perez, Villamor and Abaunza, 1999 WD). Further details are presented in section 3.3.1.3). At this Working Group it was concluded that the proportion mature for ages 4-6 should be set at 1.00, because spent fish with only atretic oocytes have been assigned to immature fish in this analysis. This was due to the definition of an ovary in the *resorbing* stage: if there are no oocytes >425µm or if there are and all have atresia.

The text table below shows the new maturity ogive for 1998 for Northeast Atlantic mackerel and how it is achieved by combining the ogives from the three areas:

Area	Weighting based on 1998 egg prod. by area	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
North Sea	0.02	0.00	0.00	0.37	1.00	1.00	1.00	1.00	1.00
Western	0.73	0.00	0.08	0.60	0.90	0.97	0.97	0.99	1.00
Southern	0. 25 *	0.00	0.02	0.54	0.70	1.00	1.00	1.00	1.00
All areas	1.00	0.00	0.06	0.58	0.85	0.98	0.98	0.99	1.00
All areas 97	1.00	0.00	0.14	0.65	0.91	0.97	0.97	0.99	1.00

* Egg production in the North Sea in 1999 was estimated at $40*10^{12}$ eggs (Iversen and Eltink, 1999 WD).

2.4.5 Natural Mortality 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 agrees with 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 this is the same as for western mackerel.

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

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5
1	0	0	0	0	0	0	162	0	0	0	0	0	0	0	1,757	3	32	36	804	9,483	1,376	642	14,294
2	0	59	15,621	1	4,198	141	4,944	0	0	497	224	10,105	1	1,160	1,936	4	13	346	3,895	1,730	1,155	1,291	47,321
3	1	147	34,173	2	525	445	20,600	0	0	1,517	34	10,620	1	516	3,960	74	3	1,655	8,886	1,721	157	975	86,013
4	3	382	49,782	5	1,049	1,008	44,768	1	0	5,071	58	5,617	1	967	8,692	129	0	474	4,542	385	35	147	23,114
5	4	529	72,849	6	525	1,051	53,042	1	0	10,596	29	2,215	0	516	12,973	197	0	1,246	8,037	405	26	103	64,348
6	2	294	32,366	3	263	1,099	37,765	1	0	6,504	14	518	0	65	7,068	117	0	780	6,128	231	28	49	93,295
7	1	206	31,276	2	0	632	26,044	1	0	3,152	0	439	0	0	2,904	74	0	312	2,507	79	20	16	67,667
8	1	117	17,297	1	0	649	9,627	0	0	4,529	0	124	0	0	2,391	35	0	212	1,622	39	6	6	36,658
9	1	117	10,896	1	0	148	10,686	0	0	1,775	0	0	0	0	2,174	26	0	182	1,530	37	1	7	27,581
10	0	0	3,313	0	0	251	6,478	0	0	1,897	0	11	0	0	1,503	21	0	99	1,060	24	1	3	14,661
11	0	29	3,312	0	0	21	3,476	0	0	434	0	0	0	0	185	8	0	164	767	17	2	2	8,418
12	1	88	1,803	1	0	44	2,163	0	0	805	0	0	0	0	405	11	0	110	727	15	1	2	6,176
13	0	29	844	0	0	157	1,437	0	0	152	0	4	0	0	218	3	0	74	193	4	0	0	3,116
14	0	0	858	0	0	48	300	0	0	46	0	46	0	0	38	2	0	16	120	3	0	0	1,478
15	0	29	825	0	0	102	783	0	0	74	0	0	0	0	142	0	0	14	117	6	0	0	2,093
SOP	6	842	103,405	10	1,278	2,803	86,551	2	0	16,112	70	5,675	1	695	16,879	267	9	1,940	13,431	1,962	509	596	253,043
Catch	6	881	103,504	10	1,275	2,806	86,552	2	0	16,099	70	5,684	1	701	16,887	267	9	1,941	13,434	1,964	509	597	253,199
SOP%	100%	105%	100%	100%	100%	100%	100%	100%		100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	1	24	0	0	29	0	0	39	10	71	0	1	15	0	0	12	1,284	1,298	1,188	443	4,415
2	989	31	6,018	32	715	390	810	0	0	957	637	206	1	2	1,996	4	0	41	819	2,083	817	1,387	17,934
3	2,841	79	4,792	90	89	1,121	1,833	0	0	3,680	102	189	1	1	8,720	19	0	132	2,879	1,664	159	842	29,233
4	4,317	145	1,739	153	179	1,700	4,552	2	0	5,054	165	94	0	2	17,613	31	0	147	3,889	508	45	276	40,612
5	6,981	264	1,085	274	89	2,753	3,801	2	0	4,888	81	40	0	1	22,792	32	0	593	9,168	856	39	341	54,078
6	1,697	38	431	41	45	663	3,034	1	0	3,511	39	10	0	0	11,886	15	0	490	7,549	712	53	193	30,408
7	1,710	37	108	37	0	672	2,186	1	0	1,768	1	7	0	0	5,745	7	0	282	3,306	353	67	65	16,351
8	799	53	70	54	0	311	2,107	1	0	575	0	2	0	0	4,135	4	0	199	2,215	289	35	31	10,880
9	459	7	27	7	0	181	699	0	0	299	0	0	0	0	2,028	2	0	187	2,162	302	22	28	6,412
10	355	22	95	22	0	138	397	0	0	0	0	0	0	0	1,301	1	0	110	1,280	253	26	21	4,021
11	167	22	21	22	0	66	612	0	0	762	0	0	0	0	118	0	0	186	928	175	66	14	3,159
12	15	11	7	11	0	5	172	0	0	386	0	0	0	0	201	0	0	105	944	178	34	16	2,086
13	3	4	2	4	0	0	10	0	0	0	0	0	0	0	152	0	0	62	305	51	16	6	614
14	1	2	1	2	0	0	276	0	0	0	0	1	0	0	36	0	0	63	255	30	7	3	677
15	2	2	1	2	0	0	5	0	0	0	0	0	0	0	0	0	0	9	484	49	4	13	570
SOP	8,861	314	3,916	329	218	3,484	8,471	3	0	7,029	203	132	1	2	25,284	35	0	1,135	13,967	2,392	558	819	77,153
Catch	9,443	315	3,911	330	217	3,484	8,469	3	0	7,032	202	128	1	2	25,193	35	0	1,134	13,971	2,394	560	820	77,644
SOP%	107%	100%	100%	100%	100%	100%	100%	100%		100%	100%	97%	100%	100%	100%	100%		100%	100%	100%	100%	100%	101%

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	1,686	34,631	36,355
1	0	0	223	512	1,234	0	0	0	1	1,510	33	637	0	487	0	0	224	0	263	634	2,318	6,819	14,893
2	23,896	335	7,548	1,495	858	0	0	0	1	6,360	34	959	0	154	31	1	90	1	365	3,989	875	1,239	48,230
3	44,639	858	14,256	827	238	0	20	0	0	2,951	23	705	0	1	157	7	22	3	150	2,240	338	160	67,596
4	53,177	1,440	22,166	804	1	0	40	0	0	2,135	10	246	0	1	208	11	0	1	28	291	158	9	80,726
5	52,448	1,344	19,535	687	48	0	61	0	0	1,436	5	110	0	1	191	13	0	1	27	189	195	5	76,294
6	29,315	975	14,062	514	0	0	101	0	0	872	1	47	0	0	81	6	0	1	18	79	149	2	46,225
7	10,669	347	5,001	169	0	0	61	0	0	430	0	7	0	0	36	3	0	0	11	22	82	0	16,840
8	7,357	341	4,891	179	0	0	161	1	0	152	0	6	0	0	23	2	0	0	10	6	15	0	13,144
9	4,543	106	1,552	52	0	0	20	0	0	73	0	2	0	0	12	1	0	0	10	5	18	0	6,395
10	1,594	86	1,243	42	0	0	0	0	0	0	0	1	0	0	6	1	0	0	7	3	19	0	3,003
11	1,890	42	594	20	0	0	0	0	0	185	0	0	0	0	2	0	0	0	5	2	5	0	2,745
12	88	9	139	5	0	0	20	0	0	94	0	0	0	0	2	0	0	0	5	1	0	0	364
13	103	25	361	12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	505
14	32	5	66	2	0	0	20	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	126
15	67	3	41	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	114
SOP	101,622	2,720	40,699	1,950	459	0	233	1	0	3,988	25	662	0	107	235	15	63	2	178	1,443	1,414	3,345	159,161
Catch	101,622	2,720	40,701	1,951	461	0	232	1	0	3,991	25	663	0	108	232	15	63	2	179	1,445	1,414	3,348	159,173

Table 2.4.1.1 (Continued)

SOP%	100%	100%	100%	100%	100%		100%	100%		100%	100%	100%		101%	99%	100%	100%	100%	101%	100%	100%	100%	100%

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0	0	0	0	0	0	21	0	0	0	16	1,316	0	6,256	0	0	350	2	2,890	8,313	1,667	3,935	24,766
1	0	282	6,064	199	441	0	6,512	2	0	5,135	2,836	21,254	0	15,639	0	0	2,101	441	1,045	2,804	805	189	65,749
2	2,274	421	31,737	308	919	0	26,745	10	0	20,964	2,509	19,040	0	4,170	61	1	3,356	587	324	2,677	160	19	16,281
3	6,359	429	40,484	317	493	0	13,532	2	0	7,034	1,080	8,741	0	0	447	5	1,328	178	113	1,150	30	2	81,724
4	6,696	274	54,473	218	184	0	7,254	1	0	3,097	754	3,033	0	0	318	3	2,096	22	20	278	12	0	78,735
5	8,686	240	51,086	192	169	0	2,630	0	0	845	6	1,733	0	0	204	2	1,118	7	17	272	17	0	67,224
6	4,482	70	31,596	64	0	0	469	0	0	62	0	500	0	0	43	0	140	6	14	227	16	0	37,691
7	1,242	66	15,360	53	6	0	152	0	0	0	297	287	0	0	12	0	0	0	4	40	10	0	17,530
8	2,151	27	9,402	24	3	0	21	0	0	41	149	211	0	0	9	0	0	0	4	17	4	0	12,064
9	1,093	19	5,792	16	0	0	0	0	0	0	0	32	0	0	0	0	0	0	3	8	1	0	6,965
10	328	4	2,347	4	0	0	0	0	0	0	0	13	0	0	0	0	0	0	2	2	0	0	2,701
11	656	4	1,509	4	48	0	0	0	0	0	0	2	0	0	0	0	0	0	2	4	0	0	2,228
12	984	0	1,526	1	0	0	0	0	0	0	0	21	0	0	0	0	0	0	2	3	0	0	2,537
13	115	0	325	0	51	0	0	0	0	0	149	2	0	0	0	0	0	0	1	0	0	0	643
14	66	0	944	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,010
15	16	0	805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	822
SOP	16,917	827	111,394	630	648	0	14,998	4	0	7,791	2,097	11,831	0	3,389	405	4	2,094	260	517	2,269	415	327	176,817
Catch	16,917	827	111,390	629	646	0	15,001	4	0	7,804	2,094	11,883	0	3,388	405	4	2,111	261	518	2,270	414	328	176,894
SOP%	100%	100%	100%	100%	100%		100%	100%		100%	100%	100%		100%	100%	100%	101%	100%	100%	100%	100%	100%	100%

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0	0	0	0	0	0	21	0	0	0	16	1,316	0	6,256	0	0	393	2	2,890	8,313	3,353	38,567	61,127
1	0	284	6,288	734	1,675	0	6,703	2	1	6,683	2,878	21,961	1	16,127	1,772	3	2,357	488	3,396	14,219	5,687	8,093	99,352
2	27,159	846	60,924	1,835	6,689	531	32,499	10	1	28,777	3,404	30,310	2	5,486	4,024	11	3,458	975	5,404	10,478	3,008	3,936	229,767
3	53,839	1,512	93,705	1,236	1,345	1,566	35,985	3	1	15,182	1,239	20,255	2	518	13,285	106	1,354	1,969	12,028	6,775	684	1,979	264,566
4	64,192	2,241	128,160	1,180	1,413	2,708	56,613	4	0	15,357	987	8,991	1	970	26,831	175	2,096	643	8,479	1,463	250	432	323,186
5	68,118	2,376	144,555	1,160	832	3,804	59,533	3	0	17,765	121	4,097	0	518	36,159	243	1,118	1,847	17,249	1,722	276	449	361,945
6	35,496	1,377	78,455	623	308	1,763	41,369	2	0	10,949	55	1,075	0	65	19,078	138	140	1,276	13,710	1,249	247	244	207,619
7	13,622	655	51,745	262	6	1,304	28,443	2	0	5,350	299	740	0	0	8,698	83	0	595	5,828	494	179	82	118,388
8	10,308	539	31,659	258	3	960	11,917	2	0	5,297	150	344	0	0	6,559	41	0	411	3,851	350	59	38	72,745
9	6,096	250	18,268	77	0	328	11,406	1	0	2,147	0	35	0	0	4,213	29	0	370	3,706	352	42	35	47,353
10	2,277	112	6,997	68	0	389	6,874	0	0	1,897	0	26	0	0	2,809	23	0	210	2,350	282	46	24	24,386
11	2,713	97	5,436	46	48	87	4,088	1	0	1,381	0	2	0	0	305	8	0	350	1,702	198	73	16	16,551
12	1,087	108	3,476	18	0	50	2,355	0	0	1,285	0	21	0	0	607	11	0	216	1,678	198	35	18	11,162
13	221	58	1,532	17	51	157	1,447	0	0	152	149	7	0	0	371	3	0	136	501	55	16	6	4,879
14	99	6	1,869	5	0	48	597	0	0	46	0	47	0	0	75	2	0	79	376	34	7	4	3,292
15	85	34	1,671	4	0	102	787	0	0	74	0	0	0	0	142	0	0	24	602	55	4	14	3,599
SOP	127,404	4,704	259,409	2,918	2,603	6,287	110,250	10	1	34,918	2,395	18,297	1	4,194	42,805	322	2,166	3,338	28,094	8,068	2,895	5,088	666,175
Catch	127,988	4,743	259,505	2,921	2,599	6,290	110,254	10	1	34,927	2,391	18,307	1	4,199	42,717	322	2,183	3,339	28,101	8,073	2,897	5,093	666,861
SOP%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	100%

Table 2.4.1.2 North East Atlantic Mackerel 1998 Quarter 1-4 percentage catch numbers at age

Quarter 1-4

Ages	IIIa	IIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	1%	0%	21%	0%	0%	3%	18%	24%	72%	3%
1	3%	0%	1%	10%	14%	0%	2%	7%	22%	5%	22%	6%	31%	25%	9%	54%	1%	0%	4%	31%	41%	15%	5%
2	8%	10%	10%	24%	54%	4%	11%	34%	32%	10%	33%	26%	37%	34%	33%	18%	3%	1%	6%	23%	22%	7%	12%
3	14%	19%	15%	16%	11%	11%	12%	10%	12%	21%	25%	14%	13%	23%	31%	2%	11%	12%	14%	15%	5%	4%	14%
4	21%	22%	20%	16%	11%	20%	19%	13%	19%	7%	11%	14%	11%	10%	16%	3%	21%	20%	10%	3%	2%	1%	17%
5	23%	24%	23%	15%	7%	28%	20%	10%	10%	19%	6%	16%	1%	5%	7%	2%	29%	28%	21%	4%	2%	1%	20%
6	13%	12%	12%	8%	2%	13%	14%	8%	1%	13%	1%	10%	1%	1%	2%	0%	15%	16%	16%	3%	2%	0%	11%
7	6%	5%	8%	3%	0%	9%	9%	7%	0%	6%	1%	5%	3%	1%	1%	0%	7%	10%	7%	1%	1%	0%	6%
8	5%	4%	5%	3%	0%	7%	4%	5%	0%	4%	0%	5%	2%	0%	0%	0%	5%	5%	5%	1%	0%	0%	4%
9	2%	2%	3%	1%	0%	2%	4%	2%	0%	4%	0%	2%	0%	0%	0%	0%	3%	3%	4%	1%	0%	0%	3%
10	1%	1%	1%	1%	0%	3%	2%	1%	0%	2%	0%	2%	0%	0%	0%	0%	2%	3%	3%	1%	0%	0%	1%
11	1%	1%	1%	1%	0%	1%	1%	2%	0%	4%	0%	1%	0%	0%	0%	0%	0%	1%	2%	0%	1%	0%	1%
12	1%	0%	1%	0%	0%	0%	1%	0%	0%	2%	0%	1%	0%	0%	0%	0%	0%	1%	2%	0%	0%	0%	1%
13	1%	0%	0%	0%	0%	1%	0%	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
14	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%

Table 2.4.2.1 MACKEREL length distributions in 1998 catches by country and by various fleets.

Length	Portugal			Spain			Netherlands	Ireland	Norway	Scotland		England			Russia	Denmark	Faroes
(cm)	artisanal	purse seine	trawl	artisanal	purse seine	trawl	pel. trawl	pel. trawl	purse seine	Purse Seine	Pel. Trawl	hand lines	Gill nets	Pel. Trawl	all gears	all gears	all gears
13	0%																
14	0%																
15	0%																
16	0%				0%												
17	0%				2%		0%										
18	0%				6%	0%		0%						0%			
19	0%	1%	0%		15%	0%	0%	0%						1%			
20	1%	2%	1%		11%	0%	1%	0%						1%			
21	2%	4%	2%		9%	1%	1%			0%		0%		2%			
22	2%	12%	6%		5%	6%	0%	0%		0%		0%		2%			
23	2%	7%	5%	0%	2%	10%	0%	0%		0%		0%		1%			
24	4%	1%	8%	0%	1%	7%	0%	0%				0%		0%			
25	6%	4%	10%	1%	1%	4%	0%	0%				0%		3%			
26	7%	4%	6%	0%	1%	3%	3%	1%		1%	1%	1%		10%	0%	0%	
27	14%	4%	5%	0%	3%	3%	4%	1%	0%	1%	1%	3%		15%	0%	0%	0%
28	16%	2%	7%	0%	7%	8%	4%	1%	0%	3%	2%	4%		14%	1%	2%	0%
29	12%	3%	15%	1%	6%	10%	4%	6%	1%	4%	1%	6%		11%	3%	2%	0%
30	9%	3%	14%	1%	4%	12%	4%	8%	2%	4%	1%	9%	6%	10%	5%	5%	0%
31	7%	4%	9%	2%	3%	8%	5%	10%	3%	7%	6%	12%	6%	10%	6%	7%	2%
32	4%	7%	5%	4%	3%	7%	6%	12%	6%	12%	11%	14%	16%	8%	7%	7%	3%
33	3%	9%	2%	4%	2%	4%	7%	11%	8%	11%	12%	18%	22%	4%	9%	6%	6%
34	2%	9%	1%	6%	2%	4%	7%	11%	11%	13%	15%	11%	16%	3%	10%	7%	8%
35	2%	10%	1%	10%	2%	4%	7%	10%	14%	11%	11%	7%	16%	1%	11%	9%	12%
36	2%	7%	1%	15%	3%	3%	11%	9%	16%	12%	16%	6%	9%	1%	13%	15%	12%
37	1%	4%	1%	17%	3%	3%	10%	8%	14%	7%	9%	4%	3%	1%	13%	10%	13%
38	1%	3%	0%	12%	3%	2%	8%	5%	11%	4%	4%	2%		0%	9%	12%	16%
39	1%	1%	0%	9%	2%	1%	4%	3%	6%	3%	4%	1%	3%	0%	6%	7%	12%
40	1%	1%	1%	7%	1%	1%	5%	2%	4%	1%	1%	0%		0%	4%	4%	7%
41	1%	0%	0%	4%	1%	0%	3%	1%	2%	1%	1%	0%	3%	0%	3%	4%	4%
42	0%	0%	0%	2%	1%	0%	2%	1%	1%	1%	2%	0%		0%	2%	1%	2%
43	0%	0%	0%	1%	0%	0%	1%	0%	1%	0%	1%	0%			1%	0%	1%
44	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%				0%	0%	1%
45	0%		0%	1%	0%	0%	0%	0%	0%	0%	0%				0%	0%	0%
46																	
47				0%	0%				0%								
48			0%		0%	0%											
49					0%												
50																	

0% implies a value greater than zero and less than 0.5%

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Table 2.4.3.1 Mean length at age for NE Atlantic mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0.0	0.0	0.0	0.0	0.0	20.1
1	0.0	0.0	0.0	0.0	0.0	0.0	22.5	22.5	0.0	0.0	0.0	0.0	0.0	0.0	22.3	22.5	27.9	26.9	25.0	23.9	25.6	24.7	23.9
2	28.2	28.2	29.5	28.2	28.3	31.6	29.3	29.0	0.0	28.3	28.2	26.1	26.1	30.7	28.3	29.6	30.3	30.0	29.9	29.5	30.5	29.4	28.7
3	32.4	32.4	33.0	32.4	33.0	33.3	33.1	33.2	0.0	33.7	32.6	31.1	31.1	31.9	32.7	33.4	33.5	32.0	32.4	31.6	32.5	31.2	32.7
4	33.5	33.5	34.3	33.5	31.8	34.6	34.4	34.0	0.0	35.9	31.8	32.7	32.7	30.3	35.0	34.9	0.0	35.3	35.1	33.9	35.0	33.2	34.4
5	36.2	36.2	35.7	36.2	35.5	36.5	36.1	35.4	0.0	37.4	35.5	35.2	35.2	28.4	36.6	36.4	0.0	36.5	36.6	35.7	35.9	35.0	36.0
6	36.8	36.8	36.7	36.8	38.5	37.5	37.4	37.0	0.0	38.1	38.5	36.9	36.9	32.5	38.5	38.2	0.0	37.4	37.4	36.7	36.7	36.2	37.3
7	37.7	37.7	36.7	37.7	0.0	37.6	37.9	37.3	0.0	38.9	37.8	37.8	37.8	0.0	38.8	38.0	0.0	39.2	38.4	37.6	37.6	37.1	37.5
8	38.8	38.8	38.5	38.8	0.0	38.4	39.0	38.5	0.0	40.9	36.2	36.2	36.2	0.0	40.6	40.2	0.0	39.7	39.7	39.5	38.6	39.6	39.1
9	39.6	39.6	40.1	39.6	0.0	39.2	40.0	39.3	0.0	41.0	0.0	0.0	0.0	0.0	41.2	40.7	0.0	40.6	40.1	39.7	39.5	39.6	40.2
10	0.0	0.0	41.2	0.0	0.0	39.1	40.4	40.4	0.0	41.6	39.3	39.3	39.3	0.0	42.4	41.1	0.0	41.2	41.0	40.3	40.2	39.6	41.0
11	40.1	40.1	41.0	40.1	0.0	41.0	40.5	39.8	0.0	41.7	0.0	0.0	0.0	0.0	41.2	41.2	0.0	42.1	41.0	40.7	41.2	40.1	40.9
12	41.2	41.2	42.4	41.2	0.0	40.5	41.8	41.2	0.0	43.7	0.0	0.0	0.0	0.0	43.3	42.6	0.0	41.9	41.3	41.1	42.3	40.2	42.2
13	41.0	41.0	42.7	41.0	0.0	41.4	41.3	41.1	0.0	42.9	40.5	40.5	40.5	0.0	43.3	42.8	0.0	42.5	42.5	42.4	42.4	41.2	42.0
14	0.0	0.0	40.9	0.0	0.0	41.6	42.3	42.8	0.0	42.5	41.6	41.6	41.6	0.0	44.5	44.5	0.0	43.0	43.3	43.2	44.4	41.5	41.6
15+	41.8	41.8	42.4	41.8	0.0	41.7	42.1	41.6	0.0	45.2	0.0	0.0	0.0	0.0	44.5	44.5	0.0	43.0	43.6	45.5	44.7	41.5	42.6

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	24.0	24.0	24.0	22.0	0.0	0.0	31.0	0.0	0.0	26.5	28.5	28.5	28.5	27.2	21.5	21.5	0.0	26.6	25.7	26.5	26.1	27.2	26.2
2	30.6	29.0	29.6	29.0	28.3	30.6	32.5	31.5	26.1	30.3	28.3	27.9	27.9	30.0	29.5	29.4	0.0	29.4	29.3	29.2	30.5	28.9	29.6
3	33.1	32.3	32.2	32.3	33.0	33.1	34.0	33.5	31.1	32.8	32.7	31.7	31.7	32.0	32.5	32.5	0.0	32.1	33.4	31.6	33.1	31.8	32.7
4	35.5	34.8	33.8	34.8	31.8	35.5	34.5	34.2	32.7	35.0	31.8	32.5	32.5	32.2	34.4	34.1	0.0	36.8	36.0	34.9	35.0	34.5	34.8
5	36.0	36.3	36.1	36.3	35.5	36.0	36.3	36.0	35.2	35.8	35.4	34.6	34.6	33.3	36.3	36.0	0.0	37.4	36.9	36.7	35.9	35.9	36.3
6	37.4	38.0	37.7	38.0	38.5	37.4	37.0	36.4	36.9	37.2	38.4	37.0	37.0	36.5	37.8	37.5	0.0	38.1	37.6	37.8	36.8	36.7	37.6
7	38.7	39.0	38.7	39.0	0.0	38.7	38.7	38.9	37.8	38.3	37.3	37.3	37.3	38.5	39.2	38.9	0.0	39.5	38.6	38.8	38.0	37.4	38.8
8	39.2	39.8	39.5	39.8	0.0	39.2	39.8	38.5	36.2	39.4	37.0	37.0	37.0	38.3	39.4	38.9	0.0	40.0	39.8	40.2	38.7	39.4	39.6
9	41.1	41.0	41.1	41.0	0.0	41.1	39.3	39.8	0.0	41.6	36.3	36.3	36.3	40.6	41.4	41.0	0.0	40.6	40.1	40.6	39.5	39.6	40.6
10	41.2	41.3	43.5	41.3	0.0	41.2	40.6	40.5	39.3	0.0	37.3	37.3	37.3	42.0	42.1	42.0	0.0	41.1	40.8	41.7	40.3	40.5	41.4
11	42.5	41.8	42.1	41.8	0.0	42.6	40.3	40.3	0.0	41.1	39.5	39.5	39.5	41.0	41.0	41.0	0.0	42.2	40.8	41.6	41.3	41.0	41.1
12	44.7	42.6	42.8	42.6	0.0	45.0	44.1	40.8	0.0	42.5	0.0	0.0	0.0	40.6	41.0	40.8	0.0	41.9	41.5	42.0	42.3	41.7	42.0
13	41.5	43.2	43.2	43.2	0.0	0.0	42.3	41.9	40.5	0.0	40.5	40.5	40.5	40.5	41.1	40.8	0.0	42.3	43.2	42.8	42.2	43.4	42.5
14	41.8	44.3	44.3	44.3	0.0	0.0	43.5	42.5	41.6	0.0	41.6	41.6	41.6	44.5	44.5	44.5	0.0	44.4	44.4	43.1	44.3	43.9	44.0
15+	41.8	45.0	45.0	45.0	0.0	0.0	44.2	42.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.0	45.2	44.5	43.7	45.6	45.1

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0.0	0.0	0.0	24.6	19.6	19.9
1	0.0	0.0	27.5	28.4	27.8	0.0	0.0	0.0	28.5	27.4	28.5	28.4	28.5	27.2	21.5	21.5	27.9	26.9	26.0	26.6	30.3	28.3	28.3
2	30.6	31.7	30.8	31.0	30.0	0.0	0.0	0.0	30.4	30.6	30.4	30.6	30.4	29.2	30.2	30.7	30.3	29.8	28.9	29.3	33.3	29.8	30.5
3	33.1	34.1	33.8	33.5	33.1	0.0	33.5	33.5	32.5	33.1	32.5	32.6	32.5	32.7	32.9	33.1	33.5	31.9	31.1	31.0	35.1	31.4	33.2
4	34.6	35.0	34.8	34.9	31.8	0.0	34.5	34.5	32.2	34.8	32.2	32.8	32.2	34.2	34.4	34.7	0.0	34.6	33.9	33.1	35.8	34.0	34.7
5	36.3	36.8	36.7	36.7	41.4	0.0	36.8	36.8	33.7	35.5	33.7	34.7	33.7	35.7	36.0	36.2	0.0	36.0	35.8	34.7	36.7	35.0	36.4
6	37.6	37.1	37.1	37.2	38.5	0.0	37.9	37.9	37.2	37.9	37.2	38.0	37.2	37.4	37.6	37.8	0.0	37.0	37.3	35.8	37.7	36.7	37.4
7	38.1	37.8	37.8	37.8	0.0	0.0	39.2	39.2	36.7	38.3	36.7	36.7	36.7	38.3	38.6	38.8	0.0	39.0	38.8	36.2	38.5	38.1	38.0
8	39.3	39.7	39.7	39.5	0.0	0.0	41.3	41.3	38.0	40.0	38.0	38.0	38.0	37.9	38.5	38.8	0.0	39.3	40.5	38.8	39.5	38.8	39.5
9	40.4	38.9	38.9	38.9	0.0	0.0	37.5	37.5	36.3	41.6	36.3	36.3	36.3	40.6	41.0	41.2	0.0	40.2	40.6	38.3	40.3	39.1	40.0
10	40.8	40.5	40.5	40.5	0.0	0.0	0.0	0.0	34.5	0.0	34.5	34.5	34.5	42.0	42.0	42.1	0.0	41.0	41.4	38.2	40.5	39.6	40.7
11	41.6	40.6	40.6	40.6	0.0	0.0	0.0	0.0	39.5	41.1	39.5	39.5	39.5	41.0	41.0	41.0	0.0	42.3	41.4	39.3	40.6	39.0	41.4
12	43.5	43.0	42.9	43.0	0.0	0.0	45.5	45.5	0.0	42.5	0.0	0.0	0.0	40.6	40.8	41.0	0.0	41.9	42.0	39.7	42.1	38.8	43.1
13	41.4	41.4	41.4	41.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5	40.8	41.0	0.0	42.3	43.0	41.6	0.0	40.5	41.4
14	41.6	44.2	44.2	44.2	0.0	0.0	44.5	44.5	0.0	0.0	0.0	0.0	0.0	44.5	44.5	44.5	0.0	43.4	41.9	45.1	0.0	0.0	43.6
15+	41.7	44.4	44.4	44.4	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	43.4	43.7	45.0	0.0	0.0	42.8

Table 2.4.3.1 (Continued)

Table 2.4.3.1 Mean length at age for NE Atlantic mackerel

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	0.0	20.8	0.0	20.8	20.8	20.8	21.0	0.0	0.0	20.1	26.3	22.7	21.6	23.4	21.7	21.6
1	0.0	32.2	31.8	32.2	28.7	0.0	27.8	28.8	27.6	28.0	29.0	27.9	27.6	27.2	0.0	0.0	27.9	29.3	26.8	29.3	29.8	27.6	28.2
2	32.1	34.6	32.4	34.5	30.9	0.0	31.1	30.9	29.7	30.9	30.5	30.1	29.7	30.0	33.6	33.6	30.6	31.5	31.1	31.2	32.6	29.1	31.2
3	33.6	36.7	34.3	36.5	33.7	0.0	33.0	32.5	32.0	33.4	33.9	32.5	32.0	0.0	34.6	34.6	32.1	32.4	32.8	33.1	34.7	31.2	33.7
4	34.9	38.2	35.1	37.8	34.1	0.0	33.8	32.5	32.2	34.6	35.7	32.7	32.2	0.0	35.9	35.9	30.3	33.8	34.6	35.0	35.7	34.2	34.7
5	36.5	38.7	36.6	38.4	36.5	0.0	34.8	34.0	33.5	35.3	33.5	34.4	33.5	0.0	36.1	36.1	28.4	35.1	36.2	36.2	36.7	35.6	36.3
6	37.2	39.3	37.5	38.9	0.0	0.0	37.4	0.0	37.5	38.5	37.5	38.5	37.5	0.0	38.4	38.4	32.5	35.9	37.1	36.6	37.9	36.7	37.5
7	38.1	40.6	38.3	40.3	40.0	0.0	39.1	39.5	38.5	0.0	40.0	39.1	38.5	0.0	37.5	37.5	0.0	38.5	38.8	37.6	38.6	37.5	38.3
8	39.0	40.4	38.5	40.0	40.5	0.0	41.5	0.0	37.6	40.5	40.5	38.3	37.6	0.0	36.5	36.5	0.0	39.8	40.0	38.0	39.5	37.5	38.7
9	39.9	40.1	39.8	40.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5	0.0	0.0	0.0	0.0	0.0	40.8	40.4	37.9	39.5	37.5	39.8
10	41.0	43.5	40.1	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5	0.0	0.0	0.0	0.0	0.0	42.1	41.4	38.6	41.1	0.0	40.2
11	40.5	41.5	41.5	41.5	40.5	0.0	0.0	0.0	0.0	0.0	0.0	39.5	0.0	0.0	0.0	0.0	0.0	41.6	41.2	37.8	41.1	0.0	41.2
12	42.3	0.0	40.4	40.4	0.0	0.0	0.0	0.0	33.5	0.0	33.5	33.5	33.5	0.0	0.0	0.0	0.0	43.2	41.6	38.3	41.5	0.0	41.1
13	44.3	0.0	41.9	41.8	38.9	0.0	0.0	0.0	0.0	0.0	44.5	44.5	0.0	0.0	0.0	0.0	0.0	44.2	42.9	40.9	0.0	0.0	42.7
14	45.0	0.0	41.2	41.2	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	42.5	41.9	41.5	0.0	0.0	41.4
15+	46.0	0.0	43.5	43.5	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	44.3	43.6	41.5	0.0	0.0	43.5

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa central	IXa north	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	0.0	20.8	0.0	20.8	20.8	20.8	21.0	0.0	0.0	20.1	26.3	22.7	21.6	24.0	19.8	20.6
1	24.0	32.1	31.6	29.2	28.0	0.0	27.6	28.8	28.5	27.8	29.0	27.9	28.5	27.2	22.3	22.5	27.9	29.0	25.9	25.3	28.2	28.0	27.5
2	30.7	32.8	31.2	31.6	28.9	30.9	30.8	30.9	29.2	30.8	29.9	28.8	27.5	30.1	29.0	29.9	30.6	30.9	29.8	29.8	31.4	29.3	30.4
3	33.2	34.6	33.6	34.2	33.3	33.2	33.1	32.7	32.0	33.2	33.7	31.8	31.5	31.9	32.6	33.3	32.2	32.1	32.6	31.6	34.0	31.5	33.1
4	34.7	35.1	34.7	35.4	32.1	35.2	34.4	33.9	32.4	35.2	34.8	32.7	32.6	30.3	34.6	34.8	30.3	35.6	35.5	34.3	35.5	34.0	34.6
5	36.3	36.8	36.1	36.9	36.0	36.1	36.0	35.7	34.3	36.7	35.3	34.9	34.8	28.4	36.4	36.3	28.4	36.8	36.7	36.2	36.5	35.6	36.2
6	37.5	37.2	37.1	37.4	38.5	37.5	37.4	36.9	37.1	37.8	38.4	37.6	36.9	32.5	38.1	38.1	32.5	37.6	37.5	37.2	37.4	36.6	37.4
7	38.2	38.1	37.3	38.5	40.0	38.2	38.0	38.4	37.4	38.6	40.0	38.3	37.6	38.4	39.0	38.1	0.0	39.3	38.5	38.4	38.2	37.3	37.9
8	39.3	39.5	38.7	39.6	40.5	38.7	39.2	39.8	37.4	40.7	40.5	37.5	36.8	38.1	39.8	40.0	0.0	39.9	39.8	40.0	38.9	39.4	39.2
9	40.4	39.4	39.9	39.4	0.0	40.3	40.0	39.3	36.3	41.1	36.3	38.4	36.3	40.6	41.3	40.7	0.0	40.6	40.1	40.4	39.8	39.6	40.2
10	40.9	40.8	40.8	40.9	0.0	39.9	40.4	40.5	35.2	41.6	35.7	36.6	37.3	42.0	42.2	41.2	0.0	41.1	40.9	41.5	40.4	40.4	40.9
11	41.4	40.8	41.1	41.2	40.5	42.2	40.5	40.2	39.5	41.3	39.5	39.5	39.5	41.0	41.1	41.2	0.0	42.1	40.9	41.4	41.3	40.8	41.0
12	42.4	41.5	41.5	42.5	0.0	41.0	42.0	43.9	33.5	43.2	33.5	33.5	33.5	40.6	42.5	42.5	0.0	41.9	41.4	41.8	42.3	41.5	42.0
13	42.9	41.3	42.2	41.8	38.9	41.4	41.3	41.1	40.5	42.9	44.5	41.8	40.5	40.5	42.4	42.6	0.0	42.4	42.9	42.8	42.2	43.3	42.1
14	43.9	44.2	41.2	43.9	0.0	41.6	42.9	43.4	41.6	42.5	41.6	41.6	41.6	44.5	44.5	44.5	0.0	44.1	44.0	43.2	44.3	43.8	42.1
15+	42.5	42.2	43.0	44.3	0.0	41.7	42.2	41.6	0.0	45.2	0.0	0.0	0.0	0.0	44.5	44.5	0.0	43.0	44.9	44.6	43.8	45.5	43.2

Table 2.4.3.2 Mean Weight at age (kg) in the catch for NE Atlantic mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.049
1	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.068	0.154	0.133	0.095
2	0.166	0.166	0.206	0.166	0.146	0.326	0.179	0.177	0.000	0.155	0.145	0.121	0.121	0.225	0.155	0.176	0.213	0.189	0.174
3	0.269	0.269	0.288	0.269	0.271	0.361	0.275	0.285	0.000	0.269	0.256	0.198	0.198	0.260	0.248	0.265	0.321	0.233	0.263
4	0.312	0.312	0.325	0.312	0.229	0.401	0.318	0.310	0.000	0.353	0.229	0.231	0.231	0.208	0.307	0.309	0.000	0.319	0.316
5	0.416	0.416	0.369	0.416	0.309	0.465	0.370	0.354	0.000	0.398	0.308	0.296	0.296	0.159	0.360	0.358	0.000	0.355	0.368
6	0.437	0.437	0.409	0.437	0.459	0.504	0.422	0.412	0.000	0.423	0.456	0.344	0.344	0.261	0.427	0.423	0.000	0.382	0.415
7	0.468	0.468	0.413	0.468	0.000	0.507	0.444	0.428	0.000	0.463	0.356	0.356	0.356	0.000	0.436	0.414	0.000	0.444	0.429
8	0.497	0.497	0.484	0.497	0.000	0.542	0.481	0.472	0.000	0.529	0.319	0.319	0.319	0.000	0.510	0.502	0.000	0.465	0.490
9	0.562	0.562	0.552	0.562	0.000	0.576	0.532	0.507	0.000	0.537	0.000	0.000	0.000	0.000	0.527	0.521	0.000	0.498	0.536
10	0.000	0.000	0.597	0.000	0.000	0.572	0.549	0.551	0.000	0.587	0.422	0.422	0.422	0.000	0.589	0.546	0.000	0.520	0.565
11	0.563	0.563	0.592	0.563	0.000	0.660	0.556	0.523	0.000	0.567	0.000	0.000	0.000	0.000	0.542	0.542	0.000	0.559	0.565
12	0.601	0.601	0.656	0.601	0.000	0.635	0.597	0.591	0.000	0.659	0.000	0.000	0.000	0.000	0.637	0.612	0.000	0.551	0.614
13	0.592	0.592	0.674	0.592	0.000	0.663	0.585	0.581	0.000	0.620	0.460	0.460	0.460	0.000	0.561	0.615	0.000	0.574	0.611
14	0.000	0.000	0.589	0.000	0.000	0.691	0.627	0.649	0.000	0.601	0.496	0.496	0.496	0.000	0.707	0.707	0.000	0.600	0.601
15+	0.625	0.625	0.658	0.625	0.000	0.681	0.635	0.611	0.000	0.734	0.000	0.000	0.000	0.000	0.660	0.660	0.000	0.594	0.649

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.133	0.133	0.133	0.077	0.000	0.000	0.262	0.000	0.000	0.110	0.184	0.184	0.184	0.158	0.053	0.053	0.000	0.128	0.128
2	0.277	0.227	0.209	0.227	0.146	0.277	0.309	0.230	0.121	0.182	0.147	0.164	0.164	0.206	0.159	0.158	0.000	0.178	0.197
3	0.342	0.308	0.272	0.305	0.271	0.341	0.340	0.282	0.198	0.233	0.260	0.227	0.227	0.229	0.223	0.223	0.000	0.235	0.260
4	0.407	0.392	0.318	0.390	0.229	0.407	0.337	0.303	0.231	0.291	0.231	0.249	0.249	0.233	0.274	0.266	0.000	0.365	0.311
5	0.428	0.435	0.393	0.433	0.309	0.428	0.398	0.358	0.296	0.314	0.308	0.298	0.298	0.257	0.329	0.318	0.000	0.382	0.358
6	0.489	0.492	0.416	0.493	0.459	0.489	0.419	0.372	0.344	0.360	0.456	0.362	0.362	0.337	0.380	0.366	0.000	0.404	0.390
7	0.533	0.526	0.531	0.526	0.000	0.533	0.473	0.461	0.356	0.400	0.374	0.374	0.374	0.398	0.427	0.414	0.000	0.457	0.443
8	0.579	0.580	0.580	0.580	0.000	0.579	0.490	0.447	0.319	0.443	0.367	0.367	0.367	0.393	0.433	0.415	0.000	0.474	0.466
9	0.655	0.575	0.644	0.575	0.000	0.656	0.511	0.498	0.000	0.529	0.408	0.408	0.408	0.476	0.486	0.481	0.000	0.499	0.498
10	0.651	0.600	0.688	0.600	0.000	0.653	0.543	0.527	0.422	0.000	0.388	0.388	0.388	0.534	0.538	0.536	0.000	0.515	0.537
11	0.738	0.612	0.664	0.612	0.000	0.739	0.523	0.518	0.000	0.506	0.527	0.527	0.527	0.495	0.495	0.495	0.000	0.562	0.525
12	0.733	0.625	0.637	0.625	0.000	0.742	0.732	0.546	0.000	0.566	0.000	0.000	0.000	0.474	0.501	0.490	0.000	0.551	0.546
13	0.662	0.650	0.650	0.650	0.000	0.000	0.706	0.593	0.460	0.000	0.460	0.460	0.460	0.473	0.491	0.483	0.000	0.564	0.553
14	0.689	0.650	0.650	0.650	0.000	0.000	0.642	0.617	0.496	0.000	0.496	0.496	0.496	0.650	0.650	0.650	0.000	0.664	0.638
15+	0.680	0.650	0.650	0.650	0.000	0.000	0.799	0.609	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.596	0.653

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.059
1	0.000	0.000	0.162	0.182	0.156	0.000	0.000	0.000	0.184	0.124	0.184	0.180	0.184	0.158	0.053	0.053	0.154	0.132	0.168
2	0.278	0.291	0.261	0.255	0.206	0.000	0.000	0.000	0.222	0.188	0.222	0.226	0.222	0.192	0.189	0.192	0.213	0.184	0.250
3	0.369	0.386	0.372	0.347	0.258	0.000	0.301	0.301	0.266	0.247	0.266	0.273	0.266	0.246	0.247	0.250	0.321	0.229	0.357
4	0.412	0.403	0.395	0.394	0.229	0.000	0.340	0.340	0.273	0.294	0.273	0.292	0.273	0.285	0.288	0.293	0.000	0.300	0.402
5	0.485	0.484	0.481	0.480	0.601	0.000	0.409	0.409	0.301	0.319	0.301	0.352	0.301	0.326	0.331	0.334	0.000	0.338	0.480
6	0.534	0.502	0.501	0.499	0.459	0.000	0.411	0.411	0.386	0.406	0.386	0.437	0.386	0.380	0.384	0.386	0.000	0.370	0.519

Continued

Table 2.4.3.2 Mean Weight at age (kg) in the catch for NE Atlantic mackerel

7	0.547	0.541	0.539	0.541	0.000	0.000	0.463	0.463	0.398	0.400	0.398	0.398	0.398	0.408	0.417	0.423	0.000	0.438	0.540
8	0.603	0.610	0.609	0.603	0.000	0.000	0.503	0.503	0.433	0.495	0.433	0.433	0.433	0.396	0.412	0.419	0.000	0.450	0.602
9	0.608	0.576	0.575	0.576	0.000	0.000	0.413	0.413	0.408	0.529	0.408	0.408	0.408	0.476	0.481	0.483	0.000	0.482	0.597
10	0.596	0.663	0.661	0.663	0.000	0.000	0.000	0.000	0.342	0.000	0.342	0.342	0.342	0.534	0.536	0.537	0.000	0.514	0.625
11	0.697	0.660	0.660	0.660	0.000	0.000	0.000	0.000	0.527	0.506	0.527	0.527	0.527	0.495	0.495	0.495	0.000	0.570	0.674
12	0.707	0.725	0.717	0.725	0.000	0.000	0.772	0.772	0.000	0.566	0.000	0.000	0.000	0.474	0.487	0.501	0.000	0.554	0.674
13	0.663	0.666	0.666	0.666	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.473	0.482	0.489	0.000	0.566	0.665
14	0.691	0.750	0.750	0.750	0.000	0.000	0.669	0.669	0.000	0.000	0.000	0.000	0.000	0.650	0.650	0.650	0.000	0.614	0.720
15+	0.681	0.760	0.760	0.760	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	0.612	0.712

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.068	0.000	0.068	0.068	0.068	0.059	0.000	0.000	0.049	0.123	0.072
1	0.000	0.286	0.274	0.286	0.182	0.000	0.167	0.204	0.161	0.134	0.188	0.166	0.161	0.139	0.000	0.000	0.154	0.174	0.170
2	0.303	0.372	0.304	0.369	0.241	0.000	0.241	0.258	0.201	0.193	0.222	0.209	0.201	0.203	0.315	0.315	0.222	0.220	0.243
3	0.394	0.461	0.380	0.456	0.326	0.000	0.292	0.301	0.251	0.258	0.325	0.264	0.251	0.000	0.343	0.343	0.270	0.240	0.339
4	0.423	0.519	0.409	0.505	0.310	0.000	0.316	0.301	0.261	0.297	0.390	0.281	0.261	0.000	0.385	0.385	0.208	0.275	0.387
5	0.497	0.547	0.476	0.538	0.411	0.000	0.351	0.350	0.295	0.323	0.295	0.329	0.295	0.000	0.393	0.393	0.159	0.311	0.463
6	0.531	0.602	0.512	0.581	0.000	0.000	0.446	0.000	0.414	0.441	0.414	0.465	0.414	0.000	0.473	0.473	0.261	0.334	0.511
7	0.526	0.636	0.538	0.622	0.530	0.000	0.472	0.403	0.447	0.000	0.530	0.497	0.447	0.000	0.439	0.439	0.000	0.419	0.536
8	0.606	0.625	0.549	0.609	0.679	0.000	0.629	0.000	0.390	0.534	0.679	0.491	0.390	0.000	0.404	0.404	0.000	0.467	0.560
9	0.630	0.634	0.606	0.630	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.527	0.000	0.000	0.000	0.000	0.000	0.507	0.610
10	0.686	0.680	0.605	0.654	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.342	0.000	0.000	0.000	0.000	0.000	0.558	0.614
11	0.690	0.698	0.681	0.695	0.595	0.000	0.000	0.000	0.000	0.000	0.000	0.527	0.000	0.000	0.000	0.000	0.000	0.540	0.681
12	0.726	0.000	0.625	0.624	0.000	0.000	0.000	0.000	0.280	0.000	0.280	0.280	0.280	0.000	0.000	0.000	0.000	0.606	0.661
13	0.757	0.000	0.816	0.829	0.476	0.000	0.000	0.000	0.000	0.000	0.663	0.663	0.000	0.000	0.000	0.000	0.000	0.649	0.742
14	0.800	0.000	0.680	0.680	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	0.573	0.688
15+	0.875	0.000	0.787	0.788	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	0.654	0.788

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.068	0.000	0.068	0.068	0.068	0.059	0.000	0.000	0.049	0.123	0.065
1	0.133	0.285	0.270	0.207	0.163	0.000	0.165	0.204	0.184	0.132	0.188	0.167	0.184	0.140	0.070	0.068	0.154	0.170	0.157
2	0.280	0.320	0.264	0.274	0.167	0.290	0.233	0.256	0.194	0.191	0.203	0.180	0.154	0.207	0.160	0.180	0.222	0.207	0.227
3	0.371	0.392	0.340	0.372	0.289	0.347	0.284	0.297	0.241	0.251	0.317	0.229	0.217	0.260	0.235	0.260	0.271	0.234	0.310
4	0.412	0.401	0.373	0.414	0.240	0.405	0.319	0.306	0.255	0.313	0.353	0.250	0.242	0.208	0.286	0.302	0.208	0.328	0.354
5	0.481	0.470	0.422	0.478	0.347	0.438	0.371	0.361	0.299	0.365	0.307	0.312	0.298	0.160	0.340	0.352	0.159	0.364	0.408
6	0.531	0.493	0.467	0.507	0.459	0.498	0.422	0.395	0.373	0.401	0.454	0.405	0.357	0.262	0.398	0.416	0.261	0.390	0.452
7	0.543	0.527	0.463	0.555	0.530	0.521	0.446	0.447	0.373	0.437	0.529	0.411	0.365	0.403	0.430	0.415	0.000	0.450	0.462
8	0.602	0.583	0.523	0.598	0.679	0.554	0.484	0.477	0.396	0.518	0.677	0.427	0.353	0.394	0.461	0.489	0.000	0.469	0.518
9	0.615	0.574	0.571	0.587	0.000	0.620	0.531	0.490	0.408	0.536	0.408	0.519	0.408	0.476	0.507	0.517	0.000	0.498	0.550
10	0.618	0.651	0.613	0.642	0.000	0.600	0.549	0.537	0.354	0.587	0.362	0.376	0.389	0.534	0.565	0.546	0.000	0.518	0.573
11	0.698	0.621	0.624	0.639	0.595	0.720	0.551	0.519	0.527	0.525	0.527	0.527	0.527	0.495	0.524	0.540	0.000	0.561	0.591
12	0.724	0.614	0.645	0.649	0.000	0.646	0.608	0.705	0.280	0.624	0.280	0.280	0.280	0.474	0.591	0.608	0.000	0.551	0.614
13	0.712	0.628	0.703	0.663	0.476	0.663	0.586	0.582	0.460	0.620	0.663	0.528	0.460	0.473	0.532	0.604	0.000	0.570	0.627
14	0.764	0.722	0.640	0.702	0.000	0.691	0.635	0.641	0.496	0.601	0.496	0.496	0.496	0.650	0.679	0.703	0.000	0.650	0.640
15+	0.717	0.638	0.723	0.702	0.000	0.681	0.636	0.611	0.000	0.734	0.000	0.000	0.000	0.000	0.660	0.660	0.000	0.595	0.684

Table 2.4.3.3 Mean weight (kg) at age in the Stock for NE Atlantic mackerel based on the the Western Southern and North Sea components

	Western Stock		Southern Stock[1]		N. Sea Stock[2]		NE Atlantic Stock
Age	Weight (kg)	Relative weghting	Weight (kg)	Relative weghting	Weight (kg)	Relative weghting	Weight (kg)
1	0.070	0.825	0.161	0.150	0.138	0.026	0.840[3]
2	0.139	0.825	0.248	0.150	0.230	0.026	0.168
3	0.217	0.825	0.305	0.150	0.314	0.026	0.241
4	0.277	0.825	0.354	0.150	0.357	0.026	0.298
5	0.339	0.825	0.385	0.150	0.438	0.026	0.353
6	0.407	0.825	0.427	0.150	0.464	0.026	0.413
7	0.434	0.825	0.455	0.150	0.418	0.026	0.439
8	0.473	0.825	0.493	0.150	0.471	0.026	0.478
9	0.515	0.825	0.511	0.150	0.529	0.026	0.514
10	0.567	0.825	0.545	0.150	0.545	0.026	0.561
11	0.535	0.825	0.548	0.150	0.550	0.026	0.539
12	0.588	0.825	0.617	0.150	0.630	0.026	0.569
13	0.550	0.825	0.622	0.150	0.660	0.026	0.570
14	0.655	0.825	0.656	0.150	0.680	0.026	0.656
15+	0.660	0.825	0.716	0.150	0.690	0.026	0.675

[1] Constant values used since 1984

[2] Constant values used since 1984

[3] Constant values used since 1988

2.5 Fishery-Independent Information

2.5.1 Long-term tagging studies to estimate mortality

Tagging of mackerel has been performed in the Western spawning grounds since 1970. The present analysis is restricted to releases from 1984 onwards. Each year except in 1987, 15-35,000 (normally about 20,000) mackerel have been tagged with internal steel tags.

The tagging procedure is highly standardised, and the team has largely been the same for the whole period. The fish is caught with handline, and the fish is kept on deck in tanks. Care is taken to avoid damaging the skin during handling. All tagged fish is measured. Fish which show signs of damage are not tagged, but are collected for biological sampling, including age determination. The mortality associated with the tagging is not known precisely, and can be expected to vary, in particular with the weather conditions and with the abundance of gannets in the area. The numbers released each year are shown in Figure 2.5.1.1.

Tags are recovered either from fish meal factories using magnets, or from fresh fish using metal detectors. Occasional tags are returned from the public. The amount of catch that is screened for tags is largely unknown. Therefore, the information that can be extracted from the material is the composition of the returned tags in terms of release years, which can be related to the total mortality, while absolute abundance estimates beyond of reach.

Since all tagged fish are measured, and there are good age-length keys, a probability distribution of age at release time can be given to each tagged fish. Accordingly, the recaptured fish can be classified by release year and a stochastic age at release. Denote the number released in year $y1$ at age $a1$ by $R(y1,a1)$, and the number of these recaptured in year $y2$ by $r(y1,y2,a1)$. These numbers are presented as input data to the AMCI model (Section 2.9.1). The number of recaptured tags in the material is shown by recapture year in Figure 2.5.1.2 and by release year in Figure 2.5.1.3. The increase in number of recaptured tags in the early 1990ies is partly due to a larger number of tags in the sea. In this period, screening of fresh mackerel in fillet plants also became more efficient.

These data relate to the mortalities as follows: Between release and recapture, the tagged population will have suffered a mortality which is the cumulated mortality between release and recapture:

$$z(y1,y2,a1) = \Sigma_{i=0,y2-y1}\, z\,(y1+i,a1+i)$$

Then, the expected relative representation by each $\{y1,a1\}$ category in the recaptures in year $y2$ becomes:

$$\hat{p}(y1,y2,a1) = \frac{R(y1,a1)e^{-z(y1,y2,a1)}}{\sum_{i,j} R(yi,aj)e^{-z(yi,y2,aj)}} * \sum_{i,j} r(yi,y2,aj) \ *q(a)$$

where $a = a1+y2-y1$ is the age in year $y2$, and $q(a)$ is the catchability at age a in year $y2$.

Thus, it is the relative representation by each release category that is actually modelled.

2.5.2 Egg surveys

Egg surveys covering all the southern and western spawning areas of the North East Atlantic mackerel were carried out between 17 January and 5 July in 1998. A total of eight countries participated in the surveys. The detailed description of the results of these surveys and the subsequent data analysis is given in the report of the Egg Survey Working Group (ICES 1999/G:5). A review of that report by this Working Group can be found in section 1.5.1.

The surveys were split into six sampling periods with sampling confined to the area south of 43°N in the first two periods. Subsequent surveys covered the spawning areas to the north of 43°N but there was no temporal overlap in sampling in these two areas. As a consequence some spawning may have been missed in the southern area, Division IXa, during period three.

Most of the observed egg production from March to mid-May occurred along the shelf edge from the Cantabrian Coast northwards to Northwest of Ireland. During late May and June egg production shifted to the north and spread across the shelf in the Celtic Sea and west of Scotland. In general the spatial distribution of stage I egg production was adequately covered although there was some high production at the western edge of the surveyed area, west of Ireland in periods 4 and 5. Sampling to the north of the standard area in the final period and high egg production at the northern edge in the previous period confirms the continuing trend of a northwards shift in the extent of the spawning area.

The peak daily production of stage I eggs occurred in period 4 (22.15×10^{12}). This value was only slightly higher than in the previous period (19.55×10^{12}) and confirms that spawning was well under way by the time that sampling began north of 43°N.

The estimates of total seasonal egg production were calculated separately for the western and southern areas (defined in section 2.3.3) and are given in a text table in section 1.5.2. Annual stage I egg production in the western area, 1.37×10^{15} eggs, was slighltly lower than when previuosly estimated in 1995. In the southern area estimated stage I egg production showed a 125% increase over the 1995 estimate.

Sampling of adult mackerel was carried out in the southern area in February 1998 and in the western area in March 1998 to estimate fecundity. Sampling of adult mackerel was also carried out during the egg surveys to estimate atresia and maturity.

The estimate of potential fecundity in the western area, 1206 (s.e 20.5) oocytes per gram female, is the lowest in the time series of observations. The observed rate of atresia in the population, 204 (s.e 36.5) oocytes per gram female, was the highest observed. The resultant value for realised fecundity in the western area 1002 (s.e 40.7) oocytes per gram female is 23% lower than the observed value during the previous egg surveys in 1995. In view of the size of the observed change, and the implications for the calculation of SSB, the data set and methodology have been subjected to additional close scrutiny both before and after the Egg Survey Working Group meeting. The initial results were reported to that Working Group and subsequent investigations presented to this Working Group. Witthames (WD 1999) considered whether or not the low fecundity measured in 1998 could have been caused by deficiencies in the screening process which could have resulted in some fish which had already started to spawn being included in the sample for potential fecundity. The possibility that this could have happened was raised because of the high egg production on the first plankton survey. This could mean that spawning had started earlier than in previous years and may have been well under way by the time that the fecundity sample was taken in March. In the WD Witthames compared the samples used for fecundity in 1998 with those used in 1995 using a simple measure of ovary condition based on weight / $length^3$. This comparison showed that the fish used in the 1995 estimate were in a much more advanced stage of maturation than the fish used in 1998. He concluded that the lower estimate of fecundity in 1998 was very unlikely to have been caused by an increased possibility of fish which had already begun spawning being included in the potential fecundity sample thus generating an underestimate of fecundity.

The analysis of ovary condition in 1995 and 1998, shown in Figure 2.5.2.1 (from Witthames WD 1999), showed that the mean ovary condition was significantly higher ($P<0.001$) in 1995 (0.74 s.e. 0.03 n= 28) compared with 1998 (0.52 s.e. n=54). This same order was also found when samples throughout each of the two series were compared. Both series of samples show a drop in egg production during the middle of the spawning season but the reduction was much more pronounced in 1998.

Witthames (WD 1999) also compared the relative timing and magnitude of egg production per female between 1995 and 1998. He found strong indications that both the proportion of fish spawning and their individual egg production was lower at the start of spawning in 1998 compared with 1995.

On the estimate of atresia, Witthames commented that the sampling in 1998 was concentrated in the area south of 49°N compared with 1995 when sampling was more evenly spread across the spawning area. He accepted that the 1998 samples may not have been as representative of the spawning population as in 1995. However he did not conclude that this could have generated the higher estimate of atresia in 1998. This Working Group also commented on the timing and distribution of the fecundity sampling, noting that the samples were taken further south than in 1995. This was at a time when most of the spawning population could be further north, having only begun their migration from their over-wintering areas in the North Sea during late January and February.

Overall these results strongly indicate that the proportion of fish spawning and their egg production in 1998 was much lower at the start of the spawning season compared to 1995. Individual egg production throughout 1998 was also much lower in magnitude compared to 1995 and these observations are consistent with the order of potential fecundity and atresia estimated in 1995 and 1998.

Darby (WD1999) examined the model used to convert egg production to spawning stock biomass. It was established that the assumption of a constant number of eggs produced per gram of female body weight did not hold for data collected in the years 1989, 1992 and 1998. A significant, negative, intercept in the fecundity weight regression was recorded in each year. The intercepts were not significantly different between years. After scaling to remove the intercept, a generalised linear model was used to estimate differences in the slope between years. It was established that the fecundity in 1998 is significantly lower than that from the earlier surveys.

Forcing the fecundity regression through the origin over estimates the contribution from smaller fish and under-estimates that from the heavier fish. The bias induced in the estimate of the spawning stock biomass will be small if the average weight of a female fish in the fecundity sample is close to the average weight of a fish in the population. A model was proposed for calibration of the ICA utilising the fecundity regressions, with intercepts and the estimated VPA population structure, but could not be developed in the time available.

The WD also examined the potential errors that could be induced into the estimate of fecundity per gram body weight by the collection of data by length classes when the regression is made against weight. It concluded that bias could be induced by an inappropriate sampling regime. A recommendation was made for a review of the design of the sampling program. This should include the collection of data by weight classes and a study of the feasibility of collecting data on the spatial distribution of fecundity parameters.

The WG notes with some concern that sampling during the egg surveys appears relatively unbalanced, with a very large survey effort directed at estimating egg production, whilst relatively small effort is directed at estimating fecundity. In the estimation of biomass, both values have equal importance. There was considerable concern that the low fecundity estimates calculated from small sample sizes may have had an unduly large influence, especially in the absence of any evidence of any decrease in the condition factor of the adults in the same year. The lowered fecundity estimate resulted in a change in perception of trends in stock size, because a decrease in egg abundance became translated into an increase trend in stock abundance.

However, following discussion of all the additional information, the validity of the 1998 estimates of both fecundity (and atresia used to calculate potential fecundity) for the calculation of the survey estimate of stock abundance, was accepted by the WG.

The estimate of potential fecundity in the southern area was 1276 (s.e. 39.98) oocytes per gram female. The estimate of atresia in the southern area, 105 oocytes per gram female, gives a value for realised fecundity of 1171 oocytes per gram female. The atresia estimate in the southern area was based on partial analysis of the samples collected. These samples have still not been analysed and as a result it is not yet possible to combine the estimates of realised fecundity in the western and southern areas.

Total spawning stock biomass was calculated for each area separately using the values of stage I egg production and realised fecundity described above. A sex ratio of 1:1 and a factor of 1.08, to convert from pre-spawning biomass, was used for both areas. This gave an estimate of SSB in the western area in 1998 of 2.95 million tonnes and in the southern area of 850 thousand tonnes. The values, for the western area have been added to the historic time series and are give in Table 2.5.2.1 together with the 1995 and 1998 values in the southern area.

The 1998 estimate by Generalised Additive Modelling has not yet been finalised (section 1.5.2). The provisional estimates for 1989, 1992 and 1995 are included in Table 2.5.2.1.

The estimates of realised fecundity in the southern and western areas were not significantly different and could have been combined if all the atresia data for the southern area had been available. However, the Egg Survey Working Group identified potential problems with combining the estimates because of differences in the length compositions of spawners in the two areas. As a consequence they decided that the best estimate of the SSB of the North East Atlantic Mackerel was the sum of the estimates for each area which gives a value of 3.80 million tonnes. It should be noted that this does not include the 1999 SSB estimate of 67,000 tonnes of North Sea spawning component.

The Working Group recommends that the WGMHMEGG notes the comments of this WG in relation to the problem of collection of adult parameters, particularly in relation to the disproportionate division of effort, and plan appropriately for the proposed 2001 surveys.

2.5.3 Winter acoustic surveys

As discussed in the WGMHMSA report for 1998 (ICES CM 1999/ACFM:6) it was agreed that an acoustic stock assessment survey should be carried out on the mackerel overwintering in the N. Sea prior to their spawning migration. The Marine Laboratory Aberdeen will carry out a survey in January 2000 on FRV Scotia. The results of this survey will be reported to the 2000 meeting of WGMHMSA.

2.5.4 Trawl surveys for juvenile mackerel (Mackerel recruit indices)

Once again the traditional mackerel recruit index for mackerel has not been calculated this year. In part, this is due to previous doubts about the performance of the index which had shown an upward trend in recent years in relation to the recruitment calculated from the assessment (ICES 1999/ACFM:6). Secondly, following the decision by WGMHMSA not to use the recruit index, a number of surveys were discontinued. This makes any calculation of the traditional recruit index impossible.

The results of the exploratory analyses of the western and NEA mackerel assessment indicated that there might be expected to be a strong year class in 1996. To investigate this a new and simple recruitment index was calculated. This index involved determining an area, which had been regularly surveyed over the last ten years. The area used was from 25^{o} to 62^{o}N on the western side and from 58^{o} to 62^{o}N in the N. Sea. The decision to include the N. Sea area was based on the large number of presumed western juveniles in this area in 1997 (see 13.2.5). The index was then calculated from the total number of first winter juveniles caught in each quarter. Very similar results were found using means. The results of this analysis are presented in Table 2.5.4.1 (below) and in Figures 2.5.4.1 to 3. It should be emphasised that these calculations are exploratory in nature and should not be taken as a final recruitment index.

As mentioned above, it was decided not to use the traditional index as it displayed a trend, which was not seen in the assessment. In this context it should be noted that the results of the 1999 assessment (see 2.9.2) also indicate a trend in recruitment in recent years. It is suggested that the potential for calculating an index similar to the traditional but allowing for the poor data coverage be investigated. One positive feature is that the co-ordination of the western IBTS will, once again, allow full coverage of the area in the fourth quarter. It is to be hoped that this will also transpire for the first quarter surveys, although this has not yet been achieved. This should be encouraged as the results of these surveys are useful not only in assessment but also in understanding recruit distributions in the context of international negotiations.

The analysis approach developed using Generalized Additive Modelling (GAM) (ICES 1998/ACFM:6) has also been applied again this year. The results are presented in section 2.8. It should be noted that this approach was adopted principally to cope with the trend observed in the recruit data.

The recruit distributions are presented in Section 2.7.2.

Table 2.5.2.1. Spawning stock biomass of mackerel in the western and southern spawning areas Spawning stock biomass estimates are corrected for atresia. A sex ratio of 1:1 is assumed. The SSB was calculated from the total egg production based on the arithmetic mean of adjacent rectangles for unsampled rectangles, if available.

Annual egg production method – western area mackerel						
Year	Total egg prod ($x10^{-15}$) (mean for unsampled rectangles)		Potential fecundity (eggs/g female)	Realised fecundity corrected for atresia	Pre-spawning stock biomass ($x10^{-6}$ tonnes)	Spawning stock biomass ($x10^{-6}$ tonnes)
	Geometric	Arithmetic	[atresia oocytes/gm female]	(eggs/g female)		(conversion factor 1.08)
1977	1.98		1526 [211]	1315	3.01	3.25
1980	1.48 a		1526 [211]	1315	2.25	2.43
1980	1.84 b		1526 [211]	1315	2.80	3.02
1983	1.50	1.53	1526 [211]	1315	2.33	2.51
1986	1.15	1.24	1457 [211]	1246	1.99	2.15
1989	1.45	1.52	1608 [326]	1282	2.37	2.56
1992	1.83	1.94	1569 [138]	1431	2.71	2.93
1995	-	1.49	1473 [171]	1302	2.28	2.47
1998	-	1.37	1206 [204]	1002	2.73	2.95

Annual egg production method – southern area mackerel						
Year	Total egg prod ($x10^{-15}$) (mean for unsampled rectangles)		Potential fecundity (eggs/g female)	Realised fecundity corrected for atresia	Pre-spawning stock biomass ($x10^{-6}$ tonnes)	Spawning stock biomass ($x10^{-6}$ tonnes)
	Geometric	Arithmetic	[atresia oocytes/gm female]	(eggs/g female)		(conversion factor 1.08)
1992		0.0092c				
1995		0.207	-	-		0.371
1998		0.461	1276 [105]	1171	0.787	0.850

a Egg survey data for period 3 included. b Egg survey data for period 3 excluded.
c Survey targeted at DEPM. Incomplete temporal coverage for AEPM.

Estimates by Generalised Additive Modelling (provisional)

Egg Production x 10^{15}			
Year	Area	Mackerel	
		GAM (no bc)	GAM (with bc)
1995	Western	0.854 *0.02* [2.7]	1.623 *0.05* [2.9]
	Southern	0.136	0.202
1992	Western	1.744 *0.05* [2.6]	2.366 *0.07* 2.9
1989	Western	1.373 *0.09* [6.5]	3.027 *0.12* [3.8]

bc = bias correction. Figures in italics are standard errors. Figures in brackets are % cv's.

Table 2.5.4.1. Total age 0 recruits in Q4 and age 1 recruits in the area west of the British Isles and in the northern N. Sea.

year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
total recruits Q4	2824	20922	68661	6770	73585	8423	42773	5244	11503
total recruits Q1	38273	5632	42384	27038	94746	4836	259001	106933	35154
total recruits	41097	26553	111044	33808	168331	13258	301774	112177	46657

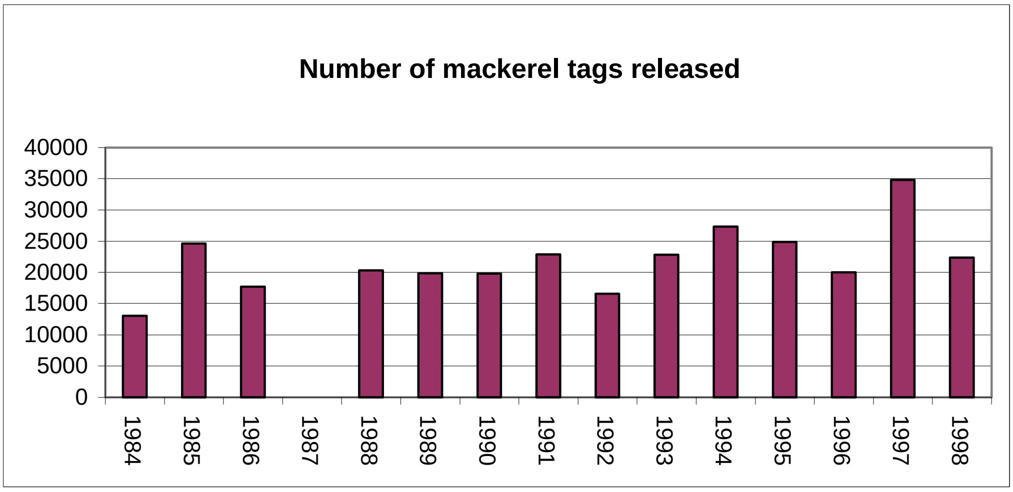


Figure 2.5.1.1.

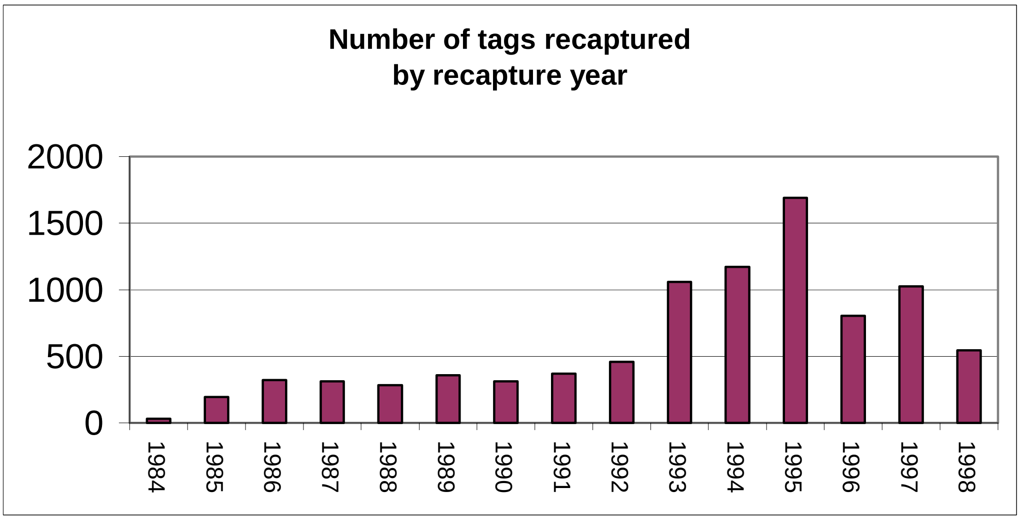


Figure 2.5.1.2

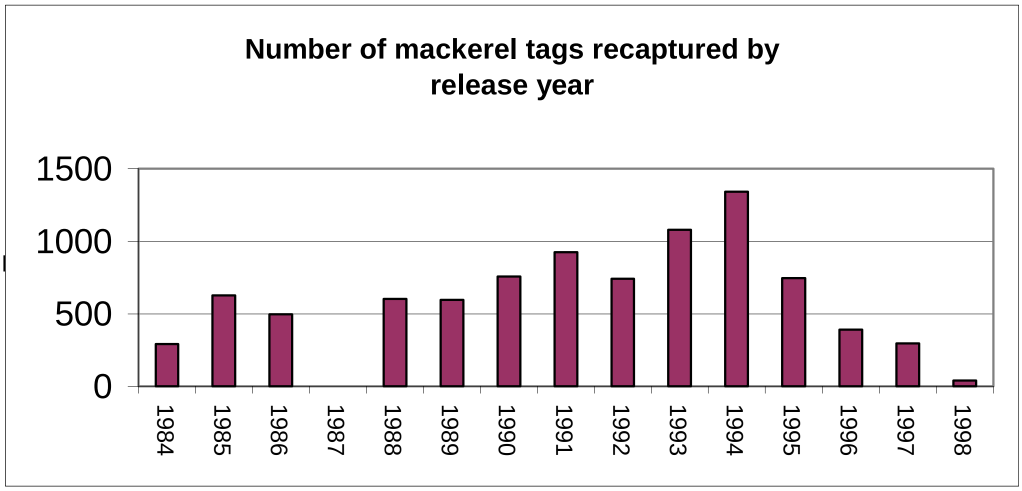
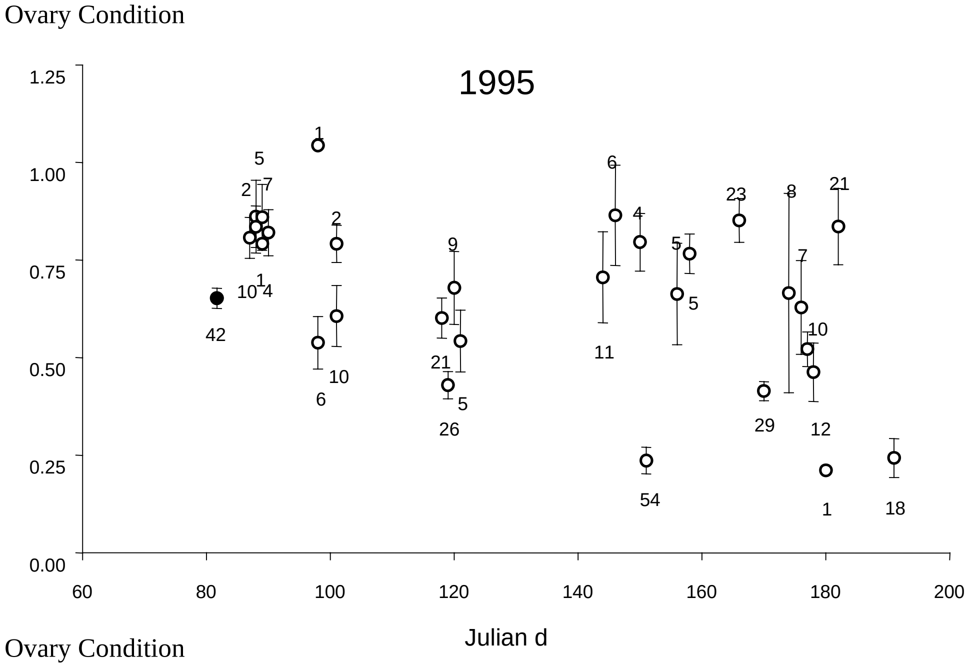


Figure 2.5.1.3.

Figure 2.5.2.1 Ovary condition (ovary weight / length^3 (mm) x 10^6)) in western mackerel spawning component samples (fecundity(closed circles) and atresia (open circles)) caught at each station are shown above or below each error bar (1SE). Sampling area and dates (expressed as Julian day) are in ICES CM 1996/H: 2 Table 5.5.3. and ICES CM 1999/G:5 Table 5.4.1.



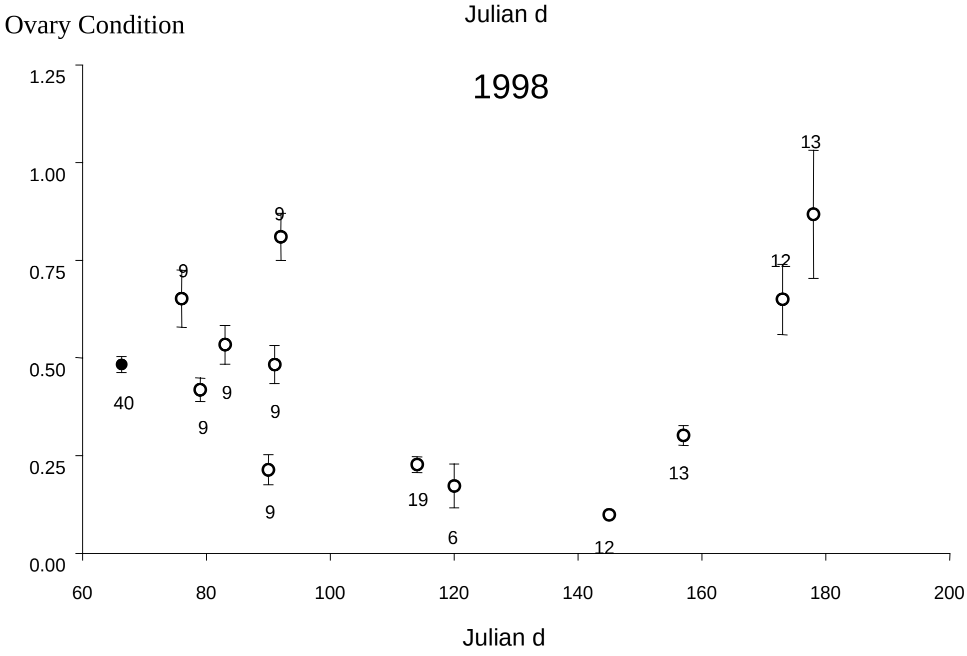


Figure 2.5.4.1. Total age 0recruits in the area west of the British Isles and in the northern N. Sea in quarter 4

Figure 2.5.4.2 Total age 1recruits in the area west of the British Isles and in the northern N. Sea in quarter 1

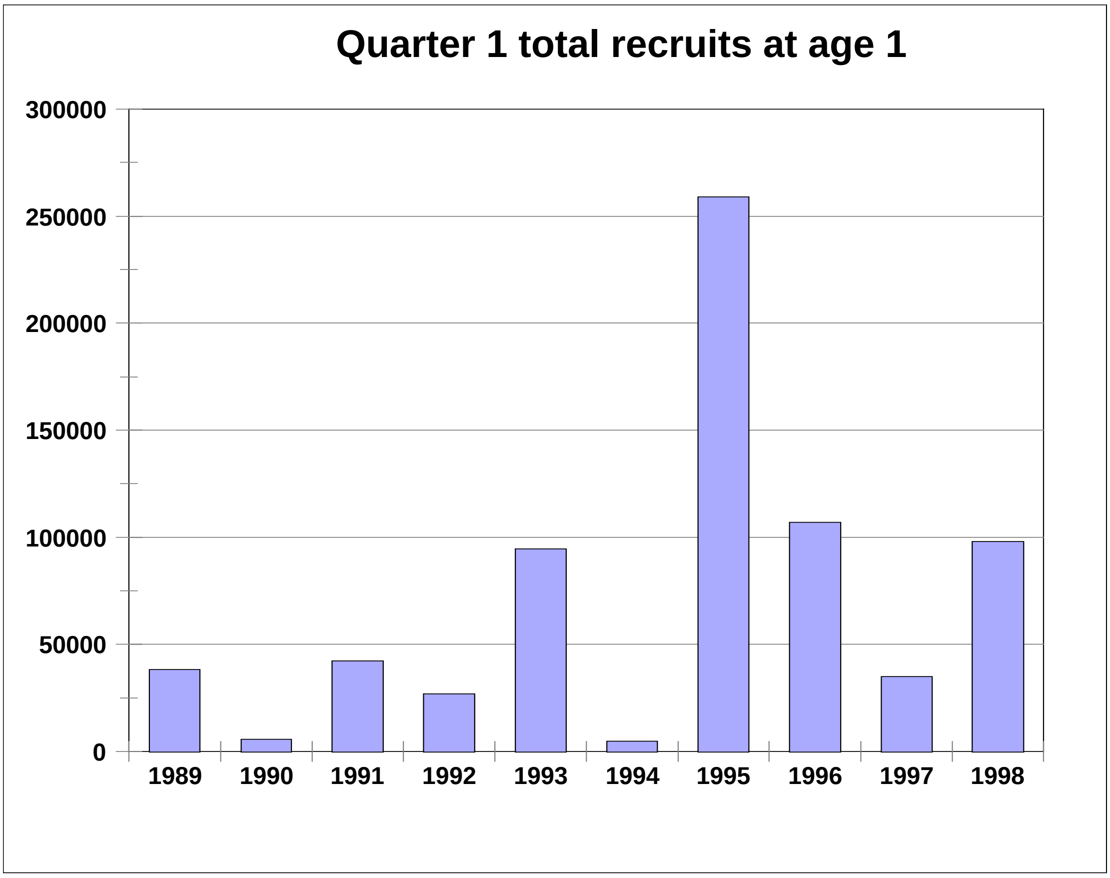
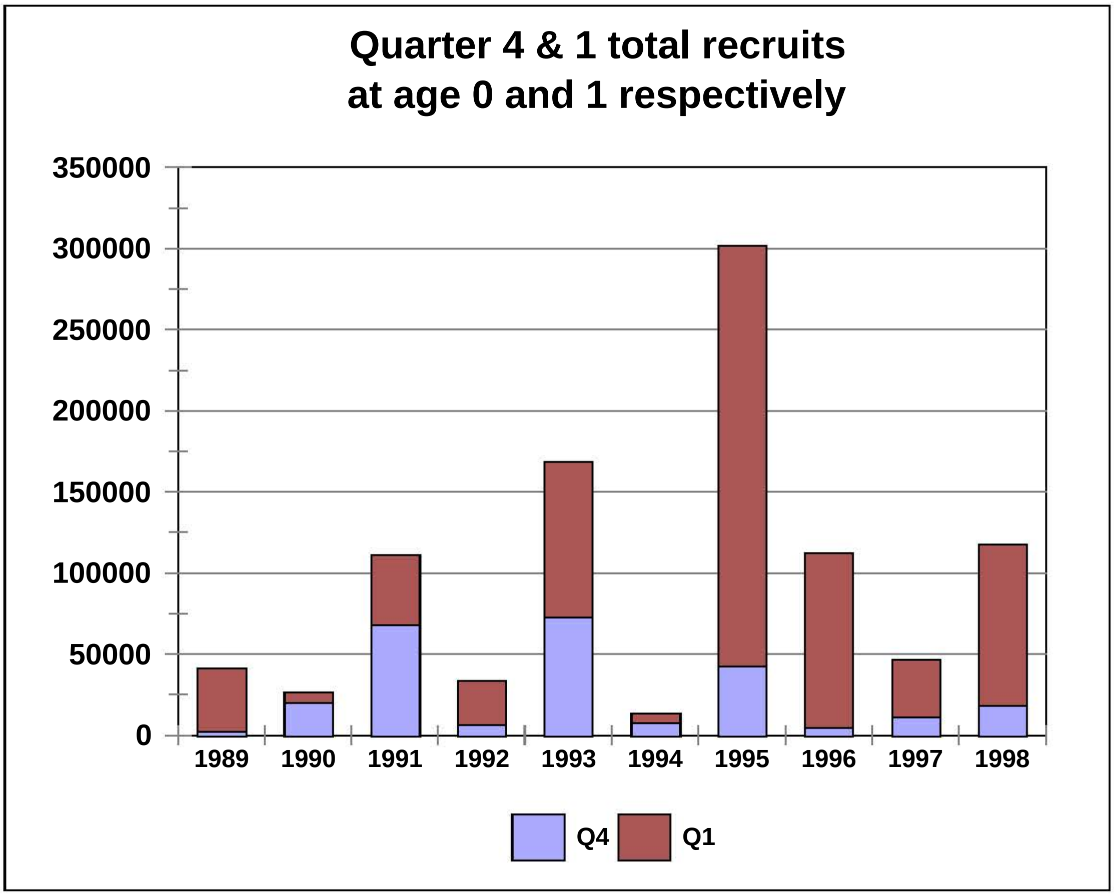


Figure 2.5.4.3 Total age 0 & 1recruits in the area west of the British Isles and in the northern N. Sea in quarter 4 and 1 respectively.



2.6 Effort and Catch per Unit Effort

2.6.1 Commercial CPUE

The catch-per-unit- effort 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 1998 and from 1990 to 1998 respectively, for which mackerel is the target species from March to May. The figure also show the effort of the Aviles and La Coruna trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 1998. 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 1992 for which mackerel is a by catch is also presented.

Portuguese Mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988 - 1997 is also included and as in Spain mackerel is a by catch. This data series has been revised in 1999 and has small changes compared to the one presented previously, but the trend shown is the same.

Figure 2.6.2 and Table 2.6.2 show CPUE corresponding to the fleets referred to in Table 2.6.1. The Spanish hand-line fleets in 1998 showed an increase compared with the ones from 1997.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the various fleets is shown in Table 2.6.3.

Table 2.6.1. SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN			
	TRAWL		HOOCK (HAND-LINE)	
	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)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY
1983	12568	33999	-	-
1984	10815	32427	-	-
1985	9856	30255	-	-
1986	10845	26540	-	-
1987	8309	23122	-	-
1988	9047	28119	-	-
1989	8063	29628	-	605
1990	8492	29578	322	509
1991	7677	26959	209	724
1992	12693	26199	70	698
1993	7635	29670	151	1216
1994	9620	39590	130	1926
1995	6146	41452	217	1696
1996	4525	35728	560	2007
1997	4699	35211	736	2095
1998	5929	-	754	3022

- 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	-	20.9
1995	94.9	34.0	3136.1	1987.9	-	24.5
1996	124.5	29.1	1165.7	1508.9	-	23.8
1997	133.2	35.7	2137.9	1867.8	-	18.5
1998	142.1		2361.5	2128.0	-	

- Not available

Table 2.6.3 SOUTHERN MACKEREL. CPUE at age from fleets.

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9
1995	1696	0	41	83	793	1001	789	1092	998	928	519	339	300	159	83	81	63
1996	2007	0	0	28	401	1234	865	701	1361	802	773	330	288	105	13	28	18
1997	2095	0	7	255	709	3475	2591	894	880	693	471	248	146	98	24	11	11
1998	3022	0	1	100	1580	2017	4456	3461	1496	1015	1006	594	428	443	155	114	296

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1990	322	0	0	0	6	25	66	132	41	86	83	28	8	11	0	2	2
1991	209	0	0	5	45	96	60	39	43	14	14	23	4	1	1	1	4
1992	70	0	0	4	60	47	51	15	7	8	2	2	2	0	0	0	0
1993	151	0	0	1	2	43	26	63	33	15	15	9	5	3	3	1	2
1994	130	0	2	18	56	110	205	146	101	40	36	18	10	5	2	2	1
1995	217	0	3	33	171	168	144	225	227	222	107	70	56	22	9	11	9
1996	560	0	0	6	89	276	191	152	293	171	164	70	60	22	3	6	4
1997	736	0	0	22	170	963	754	368	472	398	328	170	100	74	18	8	10
1998	754	0	391	86	486	644	1419	1035	403	250	232	127	96	82	19	9	9

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

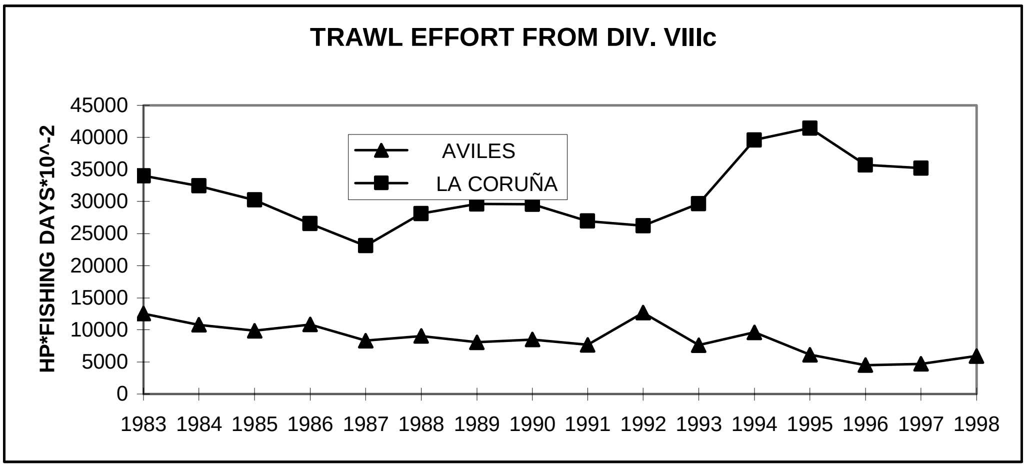
Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	2	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1
1995	6146	0	9	139	261	168	125	177	156	147	74	50	44	20	10	11	9
1996	4525	0	327	126	274	527	149	81	134	70	63	27	21	8	1	2	3
1997	4699	368	786	934	183	391	167	48	49	43	37	22	14	13	3	2	5
1998	5929	0	537	1442	868	237	341	221	74	34	29	15	10	9	1	0	1

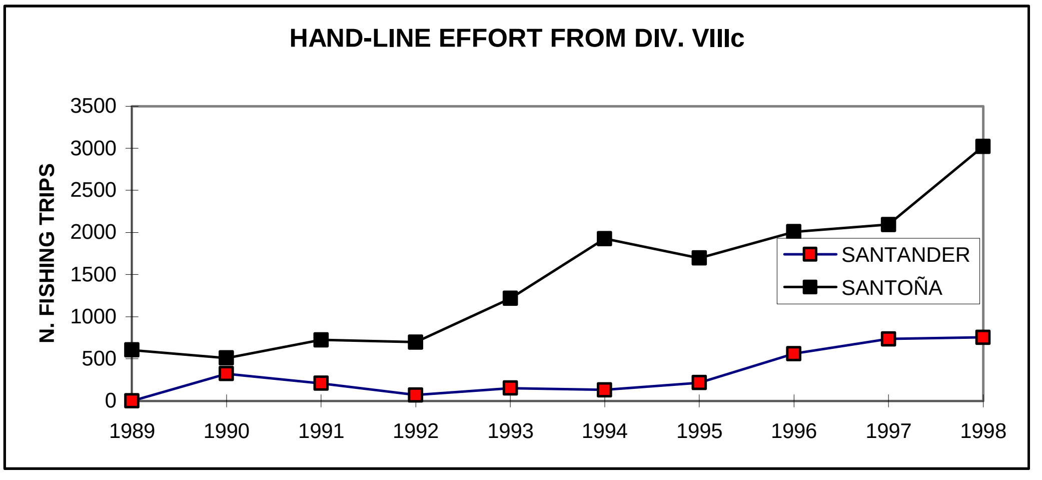
VIIIc West trawl fleet (Spain:La Coruña) (Catch thousands)

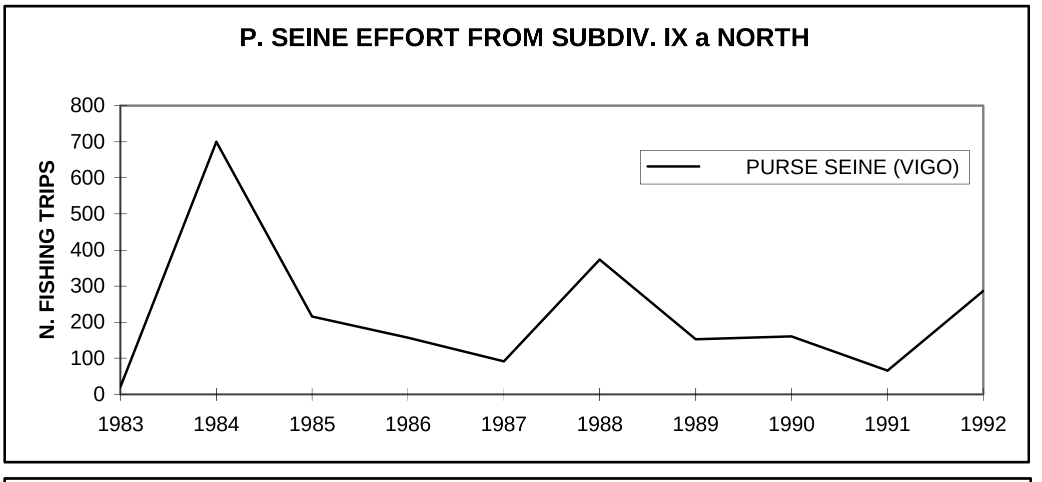
Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41452	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35728	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35211	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	-	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18

IXa trawl fleet (Portugal) (Catch thousands)

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







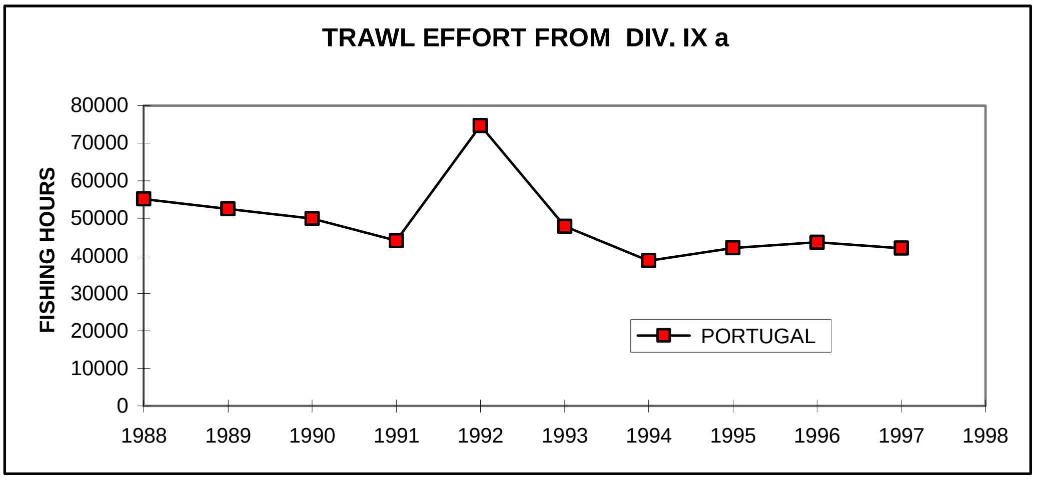
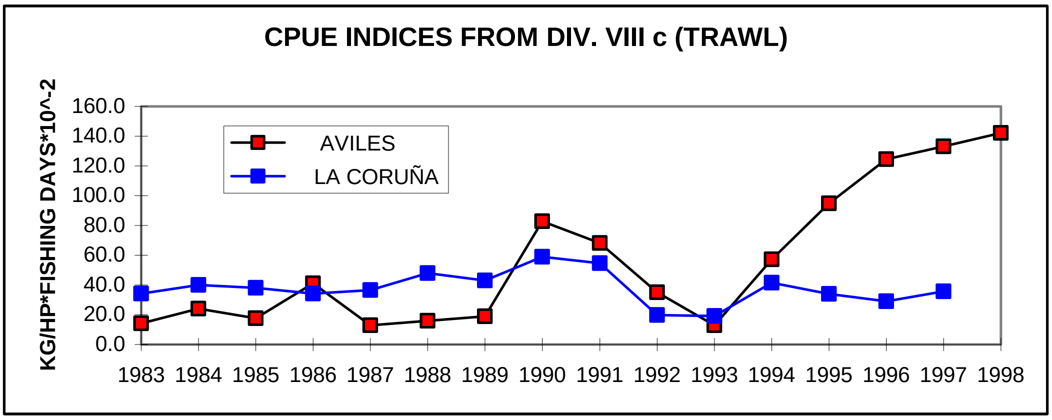
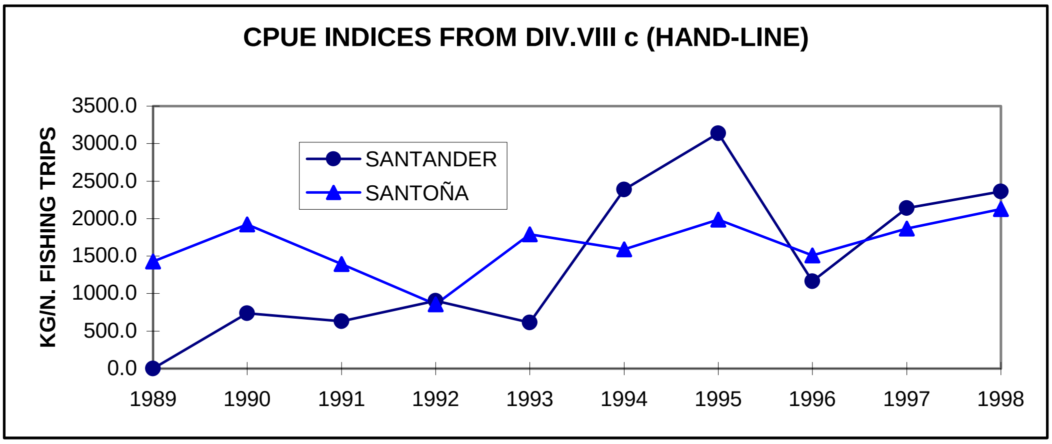
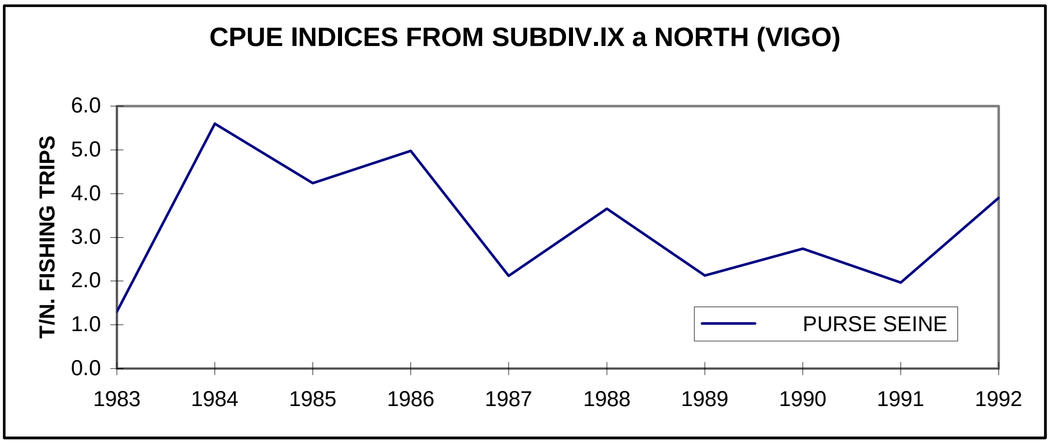


Figure 2.6.1. Effort data by fleet and area.







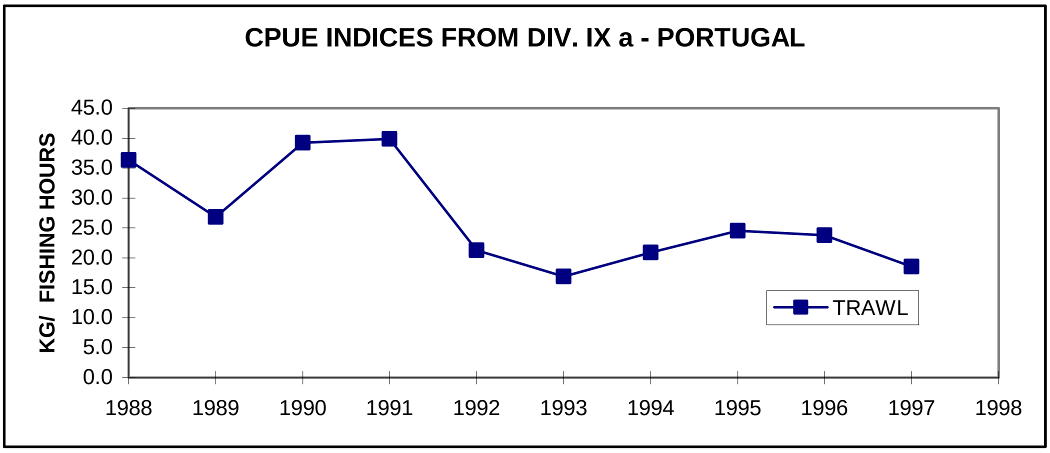


Figure 2.6.2 CPUE indices by fleet and area.

2.7 Distribution of Mackerel in 1998

2.7.1 Distribution of commercial catches for mackerel

The distribution of the mackerel catches taken in 1998 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, Denmark, Norway, Sweden, Russia, Faroes, UK and Ireland. In these data the Spanish and Portuguese catches are not based on official data.

First Quarter 1998

Catches during this quarter totalled about 233,300 tonnes, well up on 1997. There was again evidence of mis-reporting between Divisions IVa and VIa, with large catches west of 4^{o} W, although major catches were reported in UK waters east of Shetland. Again the split between these two areas should be treated with caution. The general distribution of catches was similar to 1995 to 1997 suggesting that the pattern and timing of the pre-spawning migration remains relatively constant. Slightly more catches were apparently taken in the English channel area in 1997 than 1996. The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 1998

Catches during this quarter totalled about 57,200 tonnes, down slightly from 1997.The general distribution of catches was similar to 1997. The main catches being taken east of Faroe, SW of Ireland and around the Iberian peninsula. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 1998

Catches during this quarter totalled about 147,000 tonnes, down slightly from 1997. The general distribution of catches was similar to 1996 and 1995. The main catch areas were in the area west of Norway and in Faroese and international waters in the Norwegian Sea. There was some increase from 1997 in the catches taken around Scotland. The catch distribution is shown in Figure 2.7.1.3.

Fourth Quarter 1998

Catches during this quarter totalled about 172,600 tonnes, up substantially from 1997. The general distribution of catches was similar to 1996. The main catches were taken in the area west of Norway across to Shetland, with the main increase in catches taking place west of Norway. Smaller catches were taken west of Scotland and Ireland and in the English Channel. The catch distribution is shown in Figure 2.7.1.4.

The catch totals by quarter represent only catches from those countries which provided data by ICES rectangle. They do not include those countries which provide catch by area.

2.7.2 Distribution of juvenile mackerel

Surveys in winter 1998/99

Fourth Quarter 1998

No data were available at this time for the North Sea, Western Approaches or Biscay for quarter 4 1997. In those areas covered, there were large catches only in the area NW of Ireland for 0 year old fish (Fig. 2.7.2.1), catches were low for the rest of the area surveyed. Very low abundances were recorded for 1 year old fish throughout the area surveyed (Fig. 2.7.2.2). The only other area to maintain reasonable abundances was the area off the north Portuguese coast, although this was slightly down from 1997.

First quarter 1999

Catch rates in this quarter were better than those found in 1998. Good catches of 1 year old fish were taken in Shetland and Donegal waters, however catch rates in the Celtic Sea area were similar to 1998 area (Figure 2.7.2.3). Good catches of 1 year old fish were taken in the central N. Sea in 1998, but data for this area were unavailable for this report. There were very good catches of 2 year old fish throughout the area in particular around Shetland, the Hebrides, south west of Ireland and off Cornwall (Figure 2.7.2.3).

Trends in survey results

Reduced survey effort continues to make it difficult to assess whether the trends in recruit survey data reported previously (ICES 1999/ACFM:6) have been maintained. In quarter 4 there continues to be a “hot spot” near the Spanish Portuguese border particularly for 0 group fish. Catch rates west of Ireland and the Hebrides remain low, however good catches of 0 group fish were recorded in the area NW of Ireland. In quarter 1 better catch rates of 1 year old fish were recorded in the area NW of Ireland and in Shetland waters. Again, as in 1998 large numbers of 2 year old fish were caught from the Celtic Sea to Shetland. Based on recent trends (ICES 1998/Assess:6 & ICES 1999/ACFM:6), the improved catch rates off NW Ireland and the maintenance of the “hot spot” off Portugal would suggest that 1998 may be a reasonable year for recruitment.

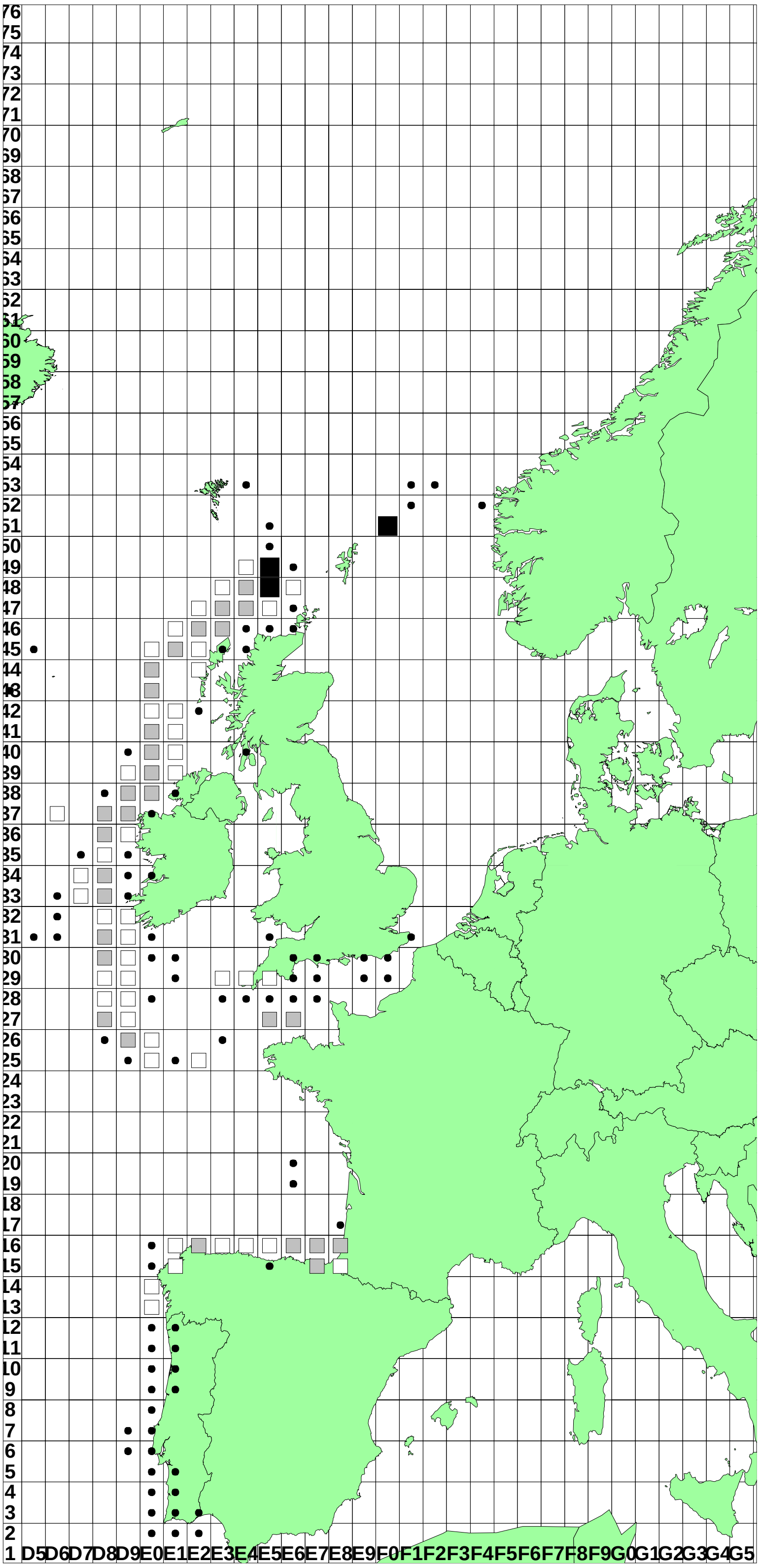
The problems of inadequate coverage, at least in the 4^{th} quarter, should be solved in 1999, as co-ordination of the western IBTS surveys has now been initiated. It is expected that usable bottom trawl surveys will be carried out over the bulk of the western area, and the results made available to this working group.

2.7.3 Distribution of spawning fish

The distribution of spawning mackerel based on the 1998 egg surveys in the western area was fully described in the 1998 report of this Working Group (ICES 1999/ACFM:6). There is no further information to report.

The 1998 egg surveys show that in the southern area most of the spawning occurs off the Cantabrian coast and is strongly associated with the narrow shelf in that area. There is very little spawning over depths greater than 500m. The area south of 43^{o}N was only surveyed between mid January and the end of February. Spawning in this area was at a very low level, confined to the shelf at a few locations off the Galician and north and central Portuguese coasts.

Figure 2.7.1.1. Mackerel commercial catches in Quarter 1 1998



■ > 10,000 tonnes
■ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 2.7.1.2. Mackerel commercial catches in Quarter 2 1998

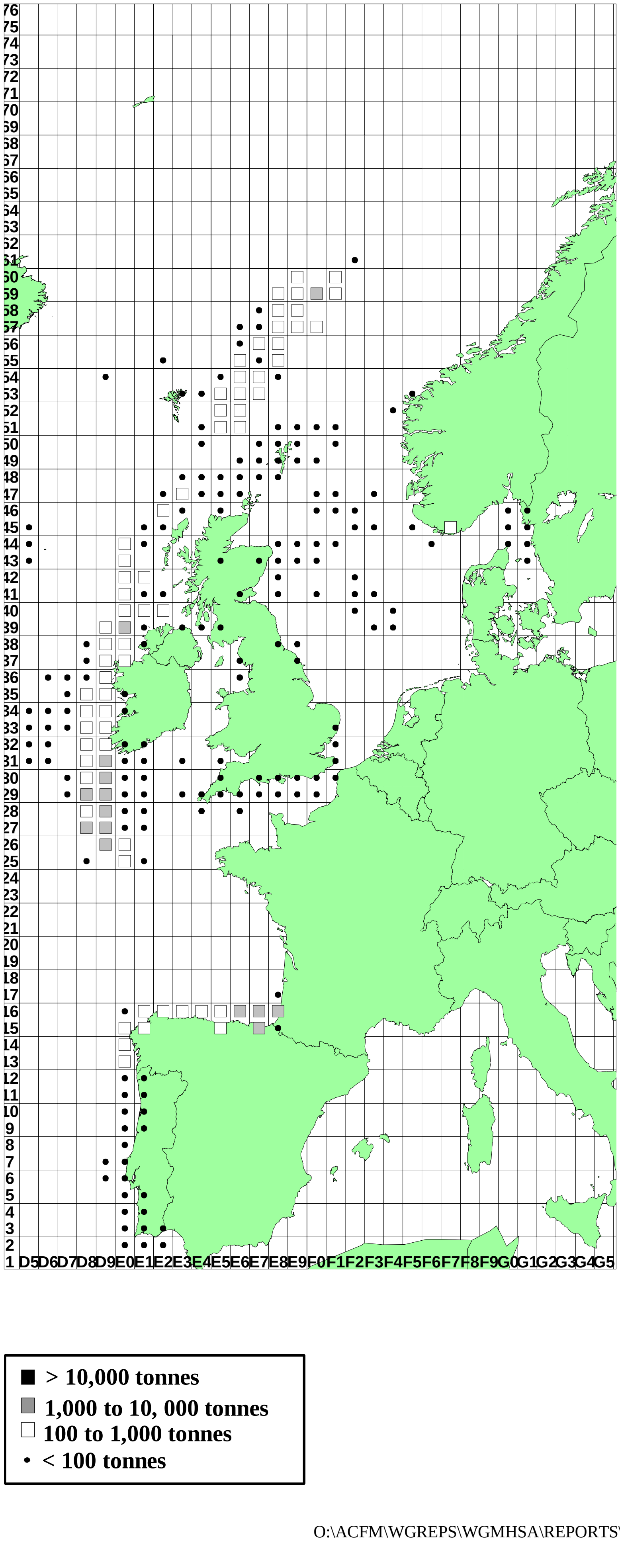
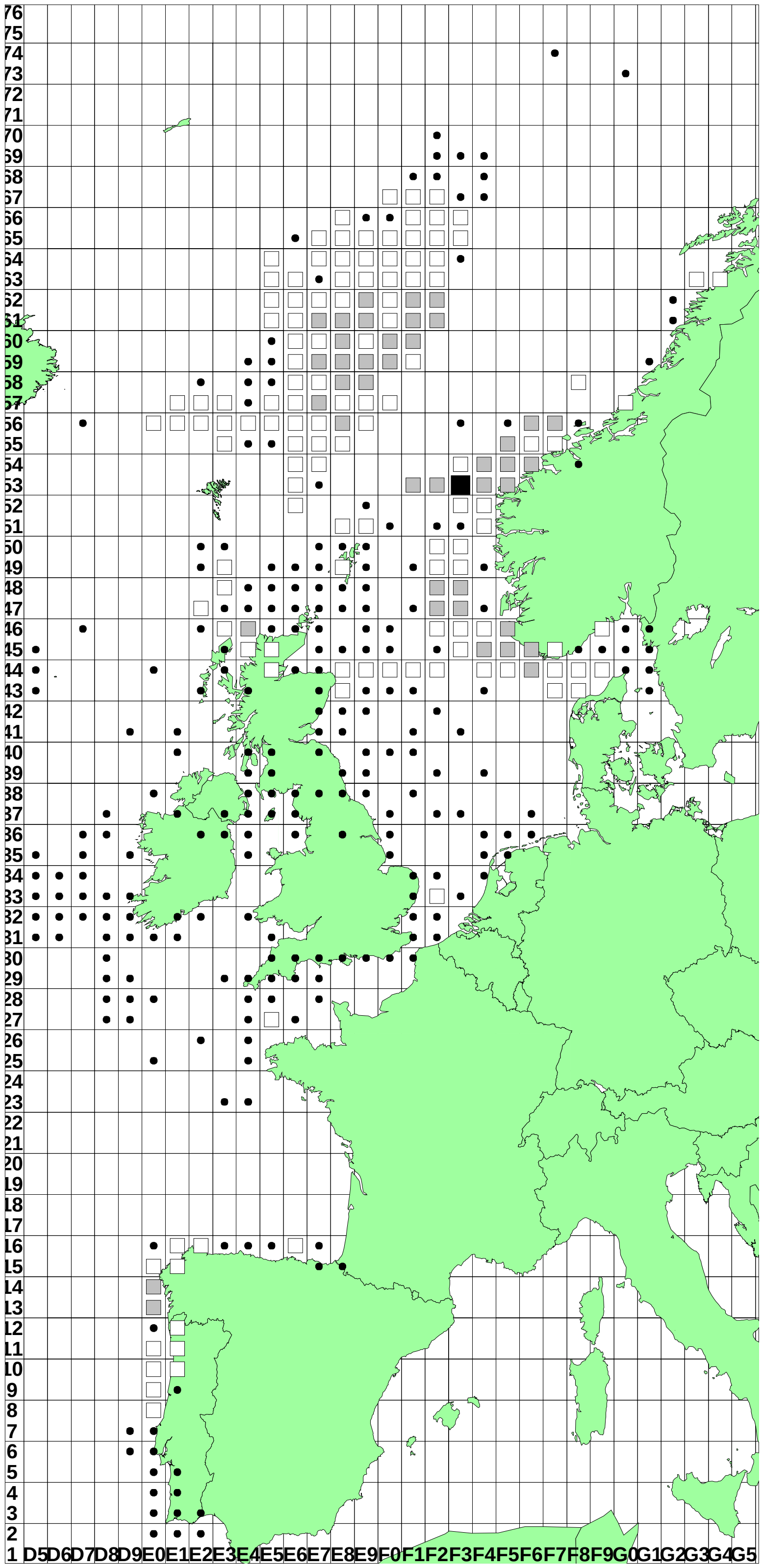
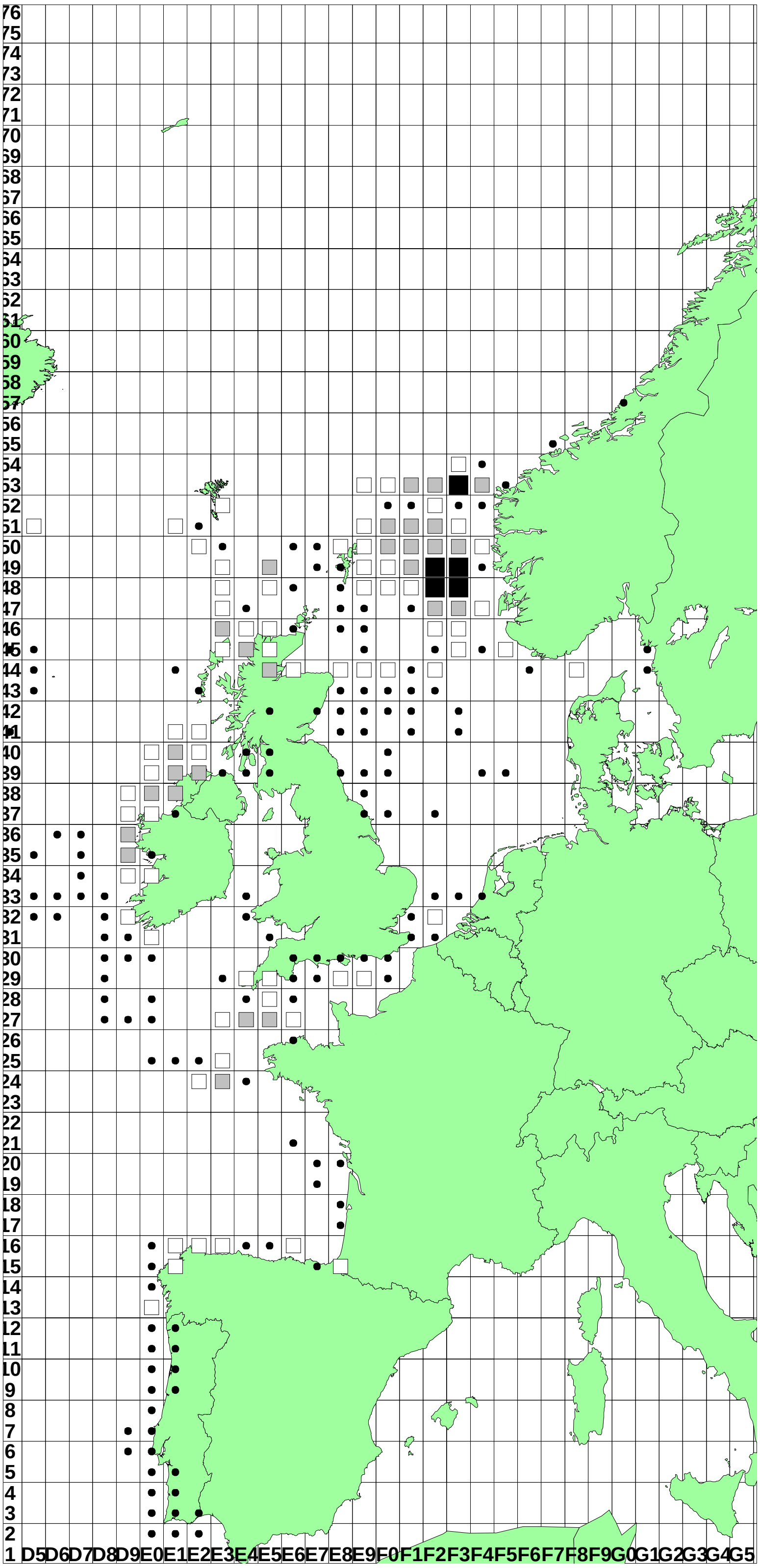


Figure 2.7.1.3. Mackerel commercial catches in Quarter 3 1998



■ > 10,000 tonnes
1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 2.7.1.4. Mackerel commercial catches in Quarter 4 1998



■ > 10,000 tonnes

■ 1,000 to 10, 000 tonnes

□ 100 to 1,000 tonnes

• < 100 tonnes

Figure. 2.7.2.1. Distribution of mackerel recruits. Quarter 4 – Age 0 – 1998 (Catch rates per hour)

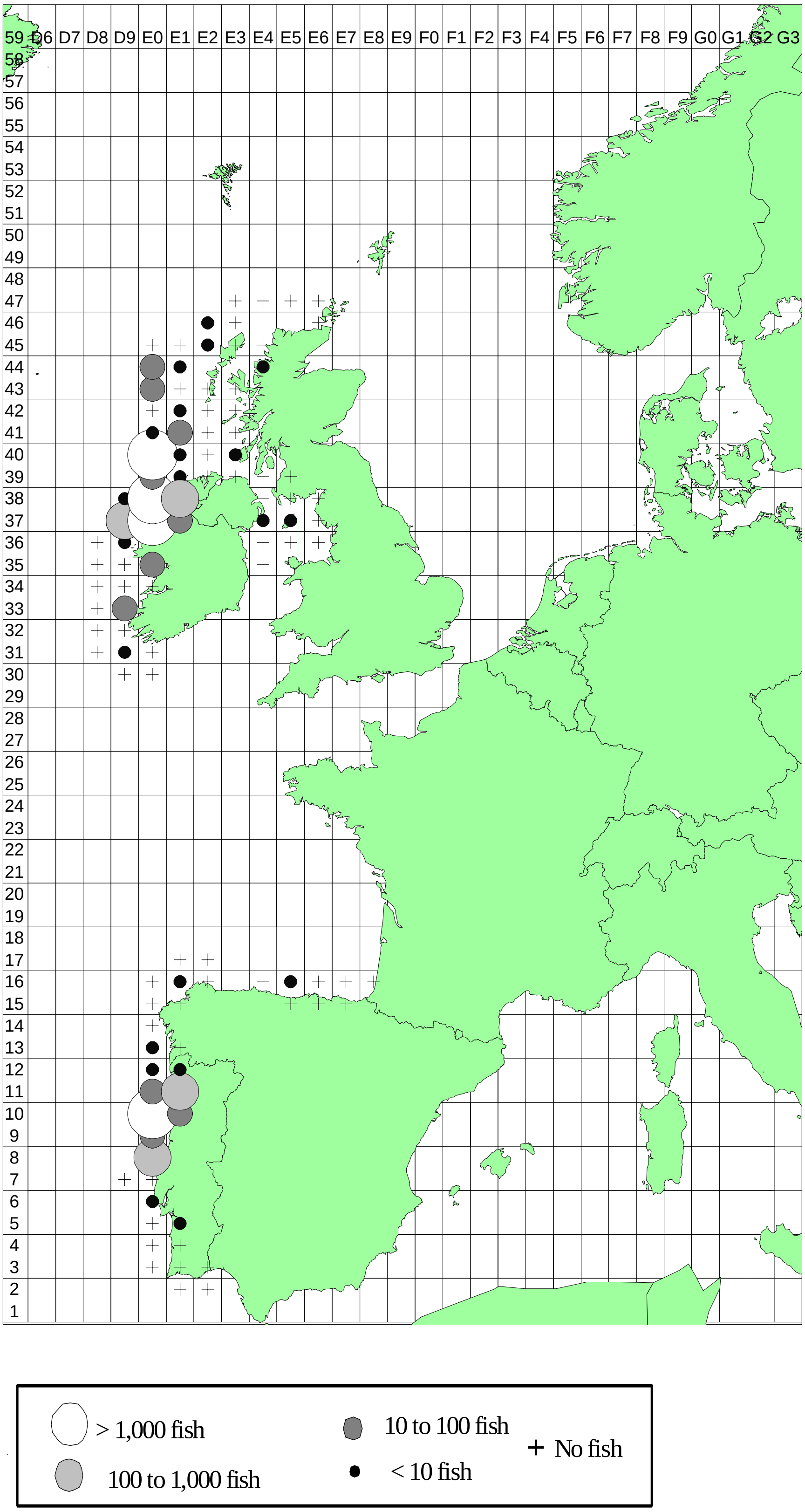


Figure. 2.7.2.2. Distribution of mackerel recruits. Quarter 4 – Age 1 – 1998 (Catch rates per hour)

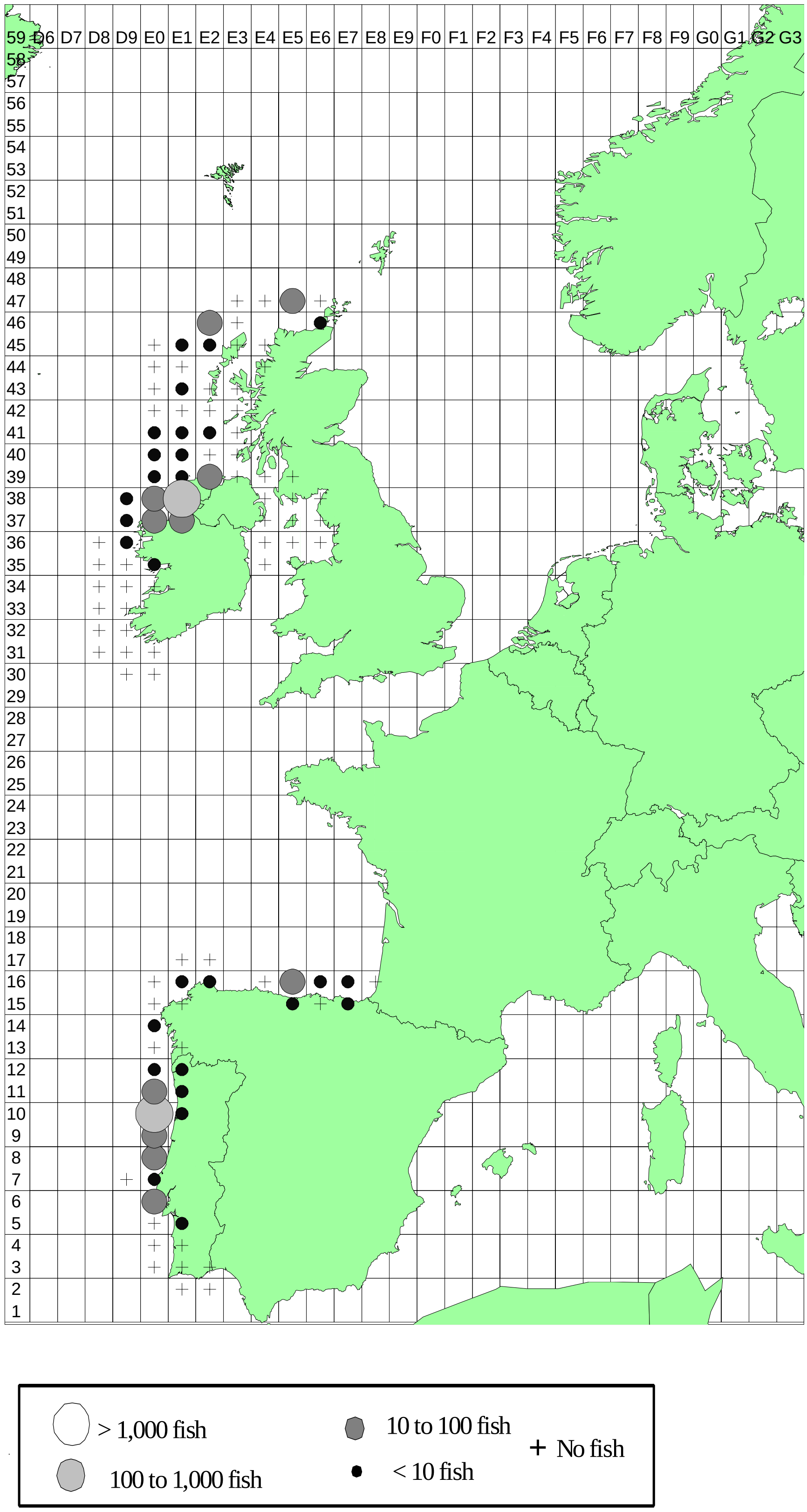


Figure. 2.7.2.3. Distribution of mackerel recruits. Quarter 1 – Age 1 – 1999 (Catch rates per hour)

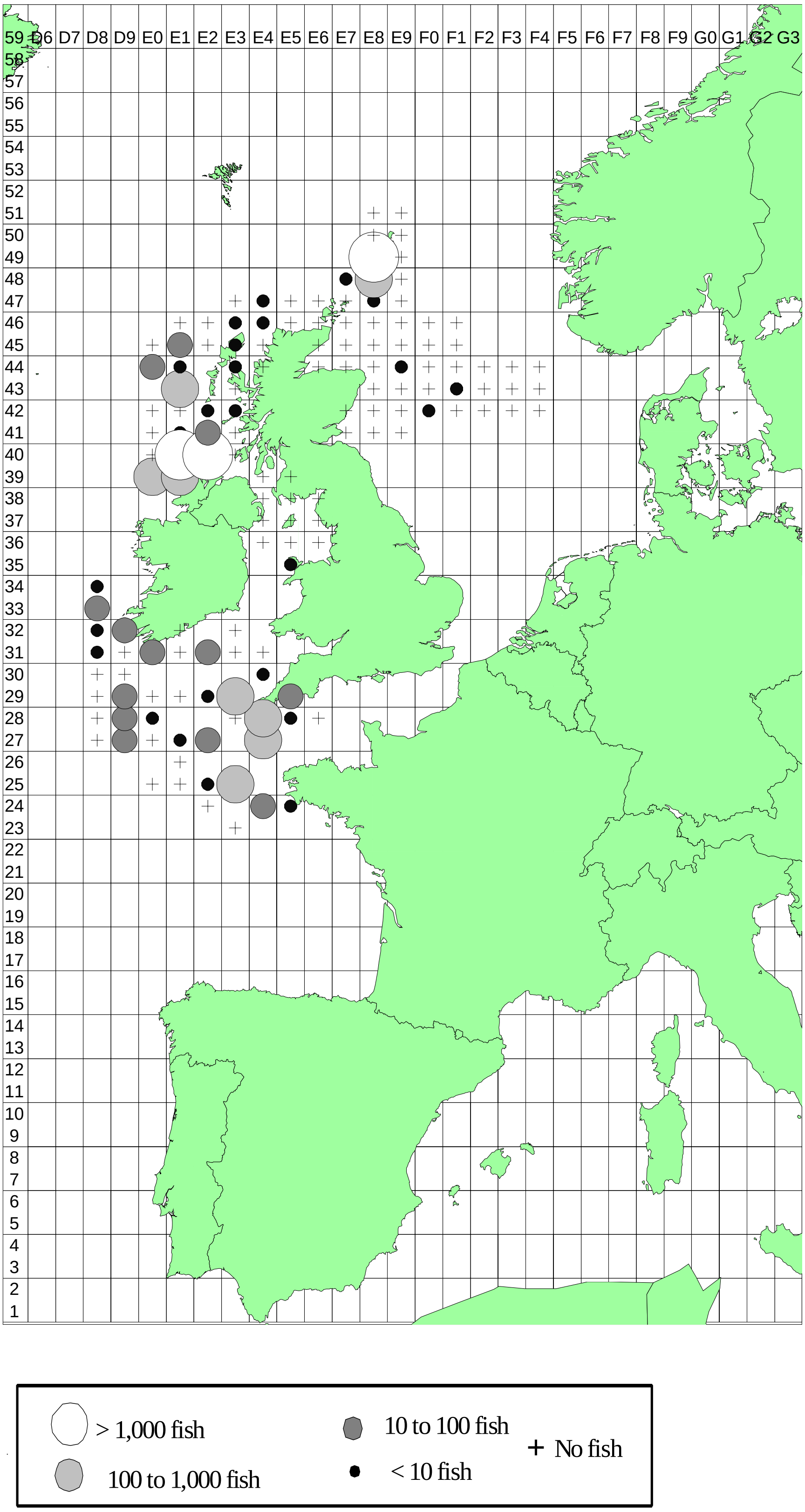
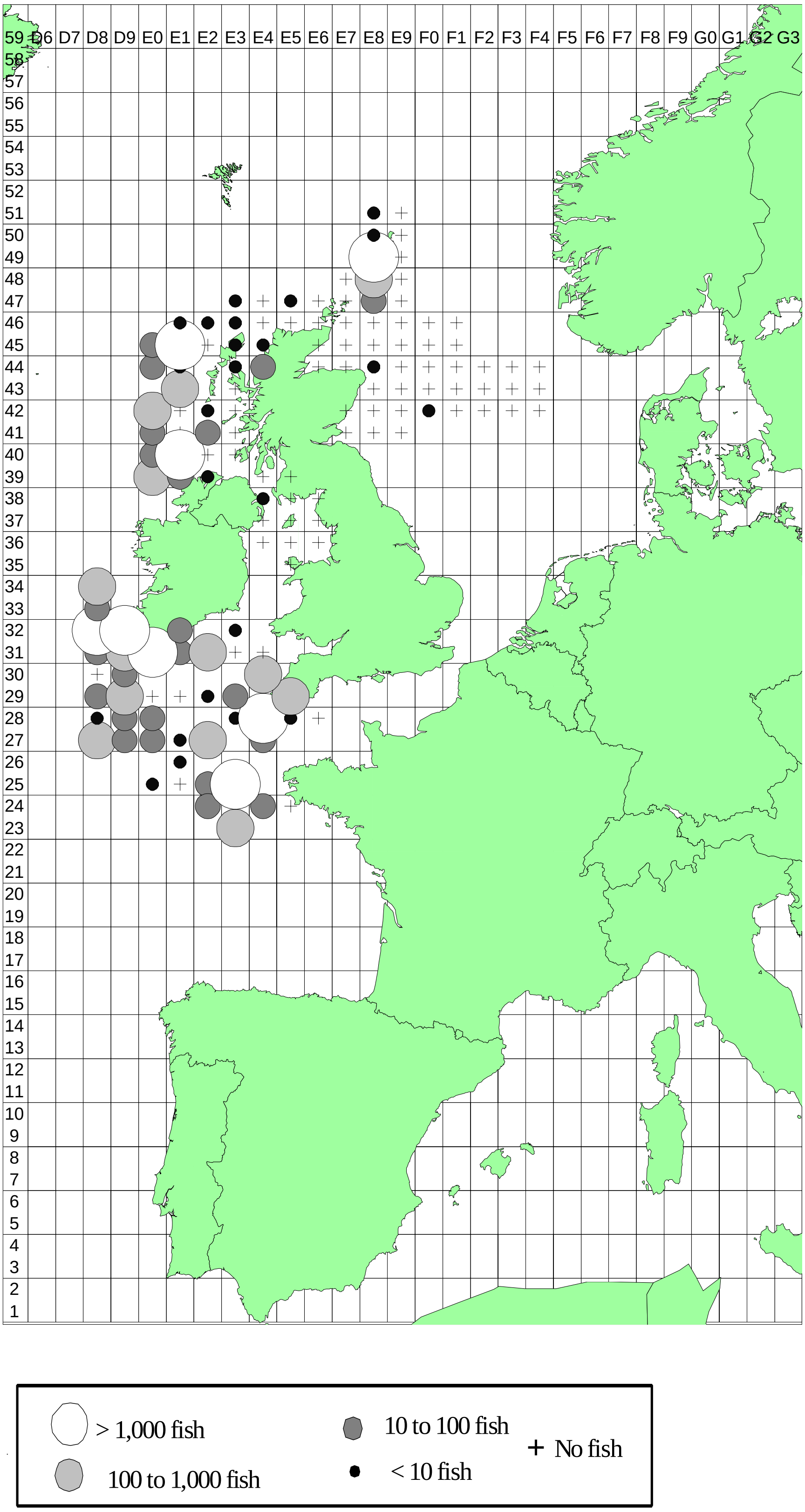


Figure. 2.7.2.4. Distribution of mackerel recruits. Quarter 1 – Age 2 – 1999 (Catch rates per hour)



2.8 Recruitment forecasting

In previous working groups doubt has been expressed about the value of the combined mackerel recruit index derived from the series of bottom trawl surveys in quarters 1 and 4 of each year (ICES 1996/Assess:7; ICES 1995/Assess:2). Assessment estimates of recruitment exhibited no trend whereas the survey data showed an increase over time. Evidence was presented (ICES 1997/Assess:3) that this might be explained by the more northerly distribution of the juvenile fish in recent years and it was recommended that further modelling studies be carried out to explore this possibility. In the new assessment the high spawning stock biomass estimate for 1998 has induced an upwards trend in the estimated recruitment and in view of this changed perception of the stock dynamics the survey time series are re-examined.

Figures 2.8.1a,b plot the survey estimates of recruitment at age 0 and age 1 as a time series for comparison with the ICA estimates. The current trend in the ICA estimates is showing closer agreement with the survey information than that seen in previous years (ICES 1999/ ACFM:6). The Scottish quarter 1 and Irish surveys appear to follow the changes in the 0 group relatively well and further use of these surveys in the estimation of recruitment should be explored.

Last year a two stage Generalised Additive Model (GAM, Hastie, T. and Tibshirani, R., 1990.) was fitted to the catch data for age group 0. The model incorporated a lowess smoothed latitude-longitude surface for the position at which the catches are taken, a lowess smoothed annual temperature effect and separate responses for each of the surveys. In Stage 1 the model was fitted to binomial data, indicating whether a catch was recorded at a station, using a log link function (McCullagh, P. and Nelder, J. A.,1983). In Stage 2 the stations at which catches were taken were modelled with a Gamma error structure again with a log link. The model was fitted to the updated survey time series. However, temperature data was not available for 1998 at the meeting and this covariate had to be excluded from the analysis. A combined survey index, calculated by multiplying together the exponents of the year class effects from the two stages, is presented in Figure 2.8.1a.

In 1997 it was suggested that the fit between the assessment series and the Scottish west coast quarter 1 survey had broken down in 1997, the survey index giving a very low estimate for the 1996 year class. The juvenile distribution maps (ICES 1998/Assess:6) showed a dramatic increase in age 1 fish in the northern North Sea and based on the assumption that these fish might belong to the Western component rather than the North Sea component they were then included in the west coast index. This resulted in an improved fit to the VPA estimates from the catch at age data. However, subsequent surveys from the Western area have indicated that the strength of the 1996 year class is either below the average of recent years or of average strength. The only survey which indicates an abundant 1996 year class is the Spanish 3rd quarter.

If the current trend in the ICA estimated recruitment is considered to be valid, indices from trawl surveys could potentially be utilised for modelling the recruitment to the mackerel stock. However the range of years over which the survey indices can be calculated do not include the extreme variation observed in the 1970’s and early 1980’s and the predictive power of any correlations has not been tested at these levels. Any such index would also be sensitive to the spatial distribution changes recorded by the 1996 year class and information on such anomalies is essential.

The analysis does not provide strong support for the perception that the 1995 and 1996 year classes were especially abundant.

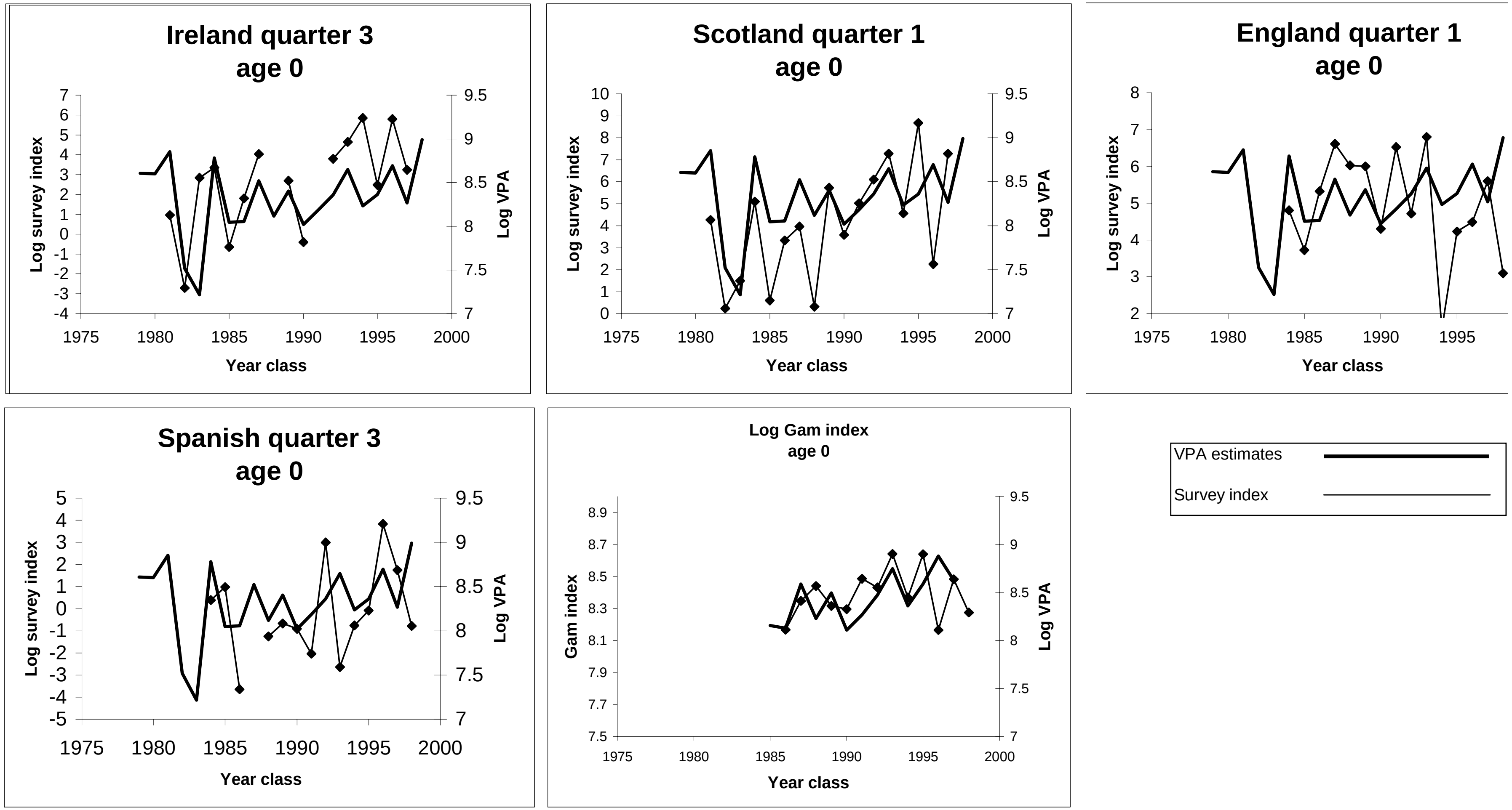


Figure 2.8.1a The time series of ICA estimated recruitments for the NEA mackerel and indices of abundance at age 0 from trawl surveys

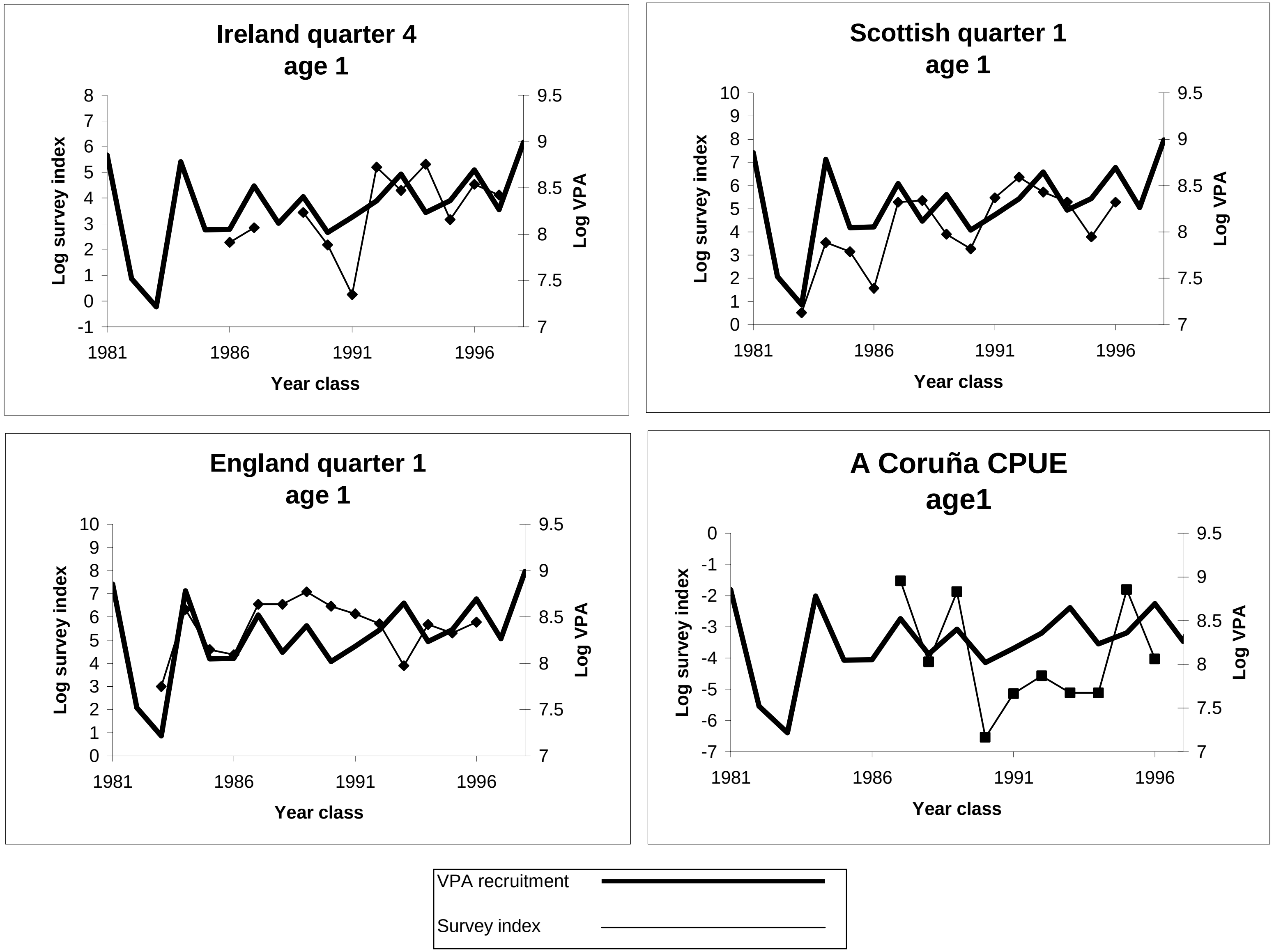


Figure 2.8.1b The time series of ICA estimated recruitments for the NEA mackerel and indices of abundance at age 1 from trawl surveys

2.9 State of the Stock

2.9.1 Data exploration and Preliminary Modelling

The standard procedure in the ICA assessment by recent working groups has been to give the contribution from each single observation a weight of one in the total objective function. Furthermore, the egg survey estimates of SSB have been taken to be absolute. Studies by previous WG's have shown that the result in terms of SSB and F estimates in the last years are very sensitive to the weighting of the SSB estimates, and that giving a low weight to these data leads to estimation of a low SSB and a high F in the last years. The background for this may be that catches alone in general do not contain sufficient information to estimate all parameters in a separable model (Pope and Shepherd 1982). Then, the apparent signal in the catches as to the development of the stock in the recent years may be largely an artefact due to the balance of the residuals, and the final result becomes a compromise between this artefact and the survey measurements of the stock. This, together with the previously encountered problems with the weighting called for a complete revision of the assessment method and its underlying assumptions.

Last year, the 1998 survey data were still preliminary. Because of the problem noted above, which was amplified by the fact that the last SSB estimate by then was 2 years old, the WG decided not to make a new assessment, but rather to project the stock numbers the previous years assessment one year forwards, using the reported catches the last year.

The validity of the assumption that the egg estimate should be treated as an absolute measure of the SSB was also questioned. This is a very strong assumption, taking into account both the long and complicated process leading to this estimate, and the fact that the VPA estimates of the SSB in the past would in general be expected to be lower than the egg survey biomass as the catches represent only the fishable population, and that relatively arbitrary values of natural mortality, maturity and terminal selection are used in the assessment model.

These problems were approached by reviewing:

- The egg survey estimate, which include the estimate of the egg production and that of the individual fecundity.
- Indicators of recruitment in recent years.
- Simulation studies of the long-term performance of ICA as a tool for assessment and for guidance to management, in particular with respect to weighting and model assumptions for the egg survey estimates.
- Stock estimates using tagging data as a source of information about the mortality.

Egg surveys: The egg survey estimate in the Western area showed a somewhat reduced egg production, but a stronger reduction in the fecundity, leading to an increase in the SSB estimate compared to 1995. The area coverage in 1998 was considered to be satisfactory, but the timing gave rise to some concern, since the egg abundance was already quite high at the beginning of the coverage. In 1995, the coverage may have been less complete. The fecundity estimates have been discussed extensively (cfr. Section 2.5.2.), and there seems to be no good reason to reject this estimate. It is a matter of concern, however, that the estimate is based on a relatively low number of fish, sampled only from the core area of spawning, and before the bulk of the spawning stock has moved into the area from the overwintering area. The effort in estimating fecundity is out of proportion with the effort in collecting the eggs.

The egg survey in the Southern area (Section 3.3.2.1) was only performed in 1992, 1995 and 1998. In 1998 it indicated a higher production than in 1995, while the fecundity was in line with previous years. As a result of this, the Southern area comprised 25% of the total SSB estimate in 1998, while it was approximately 15% in the two previous survey years. The Working Group found no convincing reason for rejecting this estimate, but notes that the coefficient of variance is as high as 40%. The acoustic surveys (Carrera, Villamor and Abaunza. WD) give support to the possible increase in the abundance of mackerel in the south.

Recruitments: The increase in SSB from 1995 to 1998, as indicated in the egg surveys, can only be explained by some strong year classes coming in to the spawning stock. Independent evidence for such a big year class, which would be the 1995 or 1996 year class, was therefore examined.

Ground fish surveys to the West of the British Isles and in the Northern North Sea were reexamined (see Sections 2.8 and 2.5.4). Indices from these surveys have previously been used as recruitment indices, but have been rejected in recent years because the results were not in line with later assessments of relative year class strength. These surveys indicate that the most likely candidate for a strong year class would be the 1995 year class rather than the 1996 year class, but none of them appear to be outstanding. In the catch at age data, the 1996 year class is better represented. The 1996 year class was exceptional in its area distribution, with large amounts in the Northern North Sea, and very low amounts in the traditional areas in the West. In the southern area, the impression from acoustic surveys is that the amounts of mackerel are increasing, but there is no clear evidence of an exceptionally strong 1996 year class. The evidence for such a year class is therefore not very strong from outside sources.

Simulation studies: A study of the perfomance of ICA using Monte Carlo simulations with an operating model for a stock like mackerel was presented (Kolody and Patterson, WD). The performance measures were the mean yield and the risk of exceeding Flim and SSBpa over a 20 year period, when the intention was to keep F at a fixed level. The operating model updated the biological status and generated input data for ICA, and the TAC's were set according to the results of ICA, aiming at a fishing mortality of 0.17. The results indicated lower risk if the SSB data were taken as relative rather than absolute if the survey was biased by 25% or more (high or low). The simulations did not indicate a serious management performance decrease if a relative survey model was adopted and the estimate actually was unbiased. A survey weighting of 5 over the catch data seemed to result in the best performance (more conservative in terms of risk, and sometimes yield) over the widest range of cases. Larger weightings were prone to optimisation problems and hardly improved performance.

Using tagging data: A new assessment model was presented (AMCI, Skagen WD) which can make use of tagging data as a source of information, in addition to survey indices and biomass indices. Tagging data were obtained from the Norwegian mackerel tagging experiments, which have been carried out since 1969 (see Section 2.5.1). Here only releases in the period covered by the assessment, i.e. 1984 - 1998 were considered. Altogether, this includes close to 9000 returned tags. The model compares the proportion of the tags by category amongst the tags recovered in each year, where each category is characterised by a given release year and age at release. The modelled proportions are derived from cumulated mortalities between release and recapture, and the numbers released each year. Thus, the tagging data are used as a source of information about total mortalities. The AMCI model in principle estimates separable fishing mortalities, but allows for gradual changes in the selection pattern according to the age composition in the catches. It also allows the user to choose between a range of objective functions for each category of data.

Two runs were presented with the AMCI model for NEA mackerel, one using the SSB data in addition to the catches, but no tagging data, and one using the tagging data in addition to the catches, but no SSB data. Output from these runs are presented in Tables 2.9.1.1 and 2.9.1.2, and an overview of the main results are shown in Figure 2.9.1.1-3. The results from these runs, which are based on information from quite independent sources, were in good accordance with each other, and also with the ICA run adopted as the final assessment (see Section 2.9.1.2). Similar runs were made for the Western stock alone. These results are shown in Figure 2.9.1.4-6, and again were quite well in accordance with each other and with the final ICA run. For the earlier part of the assessment period,, however, the run using tagging data indicated a higher mortality than the run using the SSB data as support.

Exploratory ICA runs: A series of exploratory runs were made with ICA to show the effect of:

- using the egg survey data as absolute or relative measures of the SSB.
- high and low survey weighting
- for the NEA mackerel, using data from the three last egg surveys covering the whole stock, as opposed to using the data from the Western area for the whole time period as a relative measure.

All other assumptions applied in previous years, i.e. two selection periods (1986-88 and 1989-1998) and downweighting of catch data at age 0 to 0.01, were kept unchanged. The results, which are summarised in Figures 2.9.1.7 and 2.9.1.8, suggest that:

- the converged part of the assessment gives stock estimates that generally are lower than the egg survey estimates. This may be because the egg surveys overestimate the stock, the converged catch-based assessment underestimates the stock or both, but suggests that to have consistency between the early and late assessment periods, the egg estimates should be treated as relative (Darby, 1993).
- A low weighting on the surveys make the stock estimate diverge downwards away from the survey results in the recent years, in line with what has been demonstrated by this WG several times. The difference between weights 5 and 10 is small, i.e. a weighting of 5 should be sufficient to stabilise the assessment, without forcing the stock estimate towards the survey data unduly for the earlier years.
- Using the western egg survey data in the assessment of the NEA mackerel, gives a catchability of 0.88, compared to 1.09 for the western stock assessment, which is in accordance with the perception that the southern spawners have comprised about 15-20% of the whole stock.

Based on these observations, and on the experience from the performance studies and the results using the AMCI model, it was decided to use a weighting of 5 and treat the survey estimates as relative for both stocks. For the NEA mackerel, it was decided to use only the last three egg surveys, which covered the whole area, both since these would be the more important for the stock estimate, and to avoid assuming that the southern component comprised 15% of the whole stock also in earlier years.

The first period with separable fishing mortality (1986-88) now would have no supporting data independent of the catches. It was realised that the model for this period would be overparameterised, leading to unrealistically high variance estimates for the recruitments. Several ways of handling this problem were discussed, including restricting the separable period to that covered by egg survey data for the NEA stock, prolonging the egg survey data series using raised data from the western area, splitting the egg survey series in two with different catchability estimates, or using the raised egg survey estimates in addititon to the three points covering the whole area. None of these made much difference to the final estimates. Reducing the separable period to the 7 years 1992-1998 was chosen, both because this is a simple solution to the problem and because it solved the problem of unrealistic variance estimates.

Table 2.9.1.3 gives a summary of the options used in the present assessments and in previous years.

Table 2.9.1.1.
Results of population estimates for NEA mackerel using the AMCI method.
Population fitted to catches at age and egg survey SSB estimates.

Spawning stock biomass (tonnes) for NEA Mackerel

Year	Modelled	Observed
1984	2969136.22	-1.00
1985	2818156.09	-1.00
1986	2852432.91	-1.00
1987	2918846.62	-1.00
1988	3029726.93	-1.00
1989	2939623.88	-1.00
1990	2745153.52	-1.00
1991	3025102.17	-1.00
1992	3048028.13	3370000.00
1993	2841751.57	-1.00
1994	2619700.63	-1.00
1995	2803203.69	2840000.00
1996	2869901.18	-1.00
1997	3119783.81	-1.00
1998	3425065.89	3800000.00

Table 2.9.1.1. cont.
AMCI estimates
Yield (tonnes) for NEA Mackerel

Year	Modelled	Observed
1	626761.2	644408.1
2	601896.2	610022.9
3	557677.3	584557.1
4	598131.5	656245.7
5	657365.1	650681.6
6	579446.7	585920.2
7	598067.4	626107.4
8	651347.2	675665.4
9	774647.3	760689.6
10	837317.8	824567.8
11	841655.3	819086.7
12	730540.1	756276.5
13	557991.2	563471.5
14	546479.4	573028.9
15	666951.9	666315.5

Table 2.9.1.1. cont.
Stocknumbers at age, (1. Jan.), for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	8322446.7	3835125.4	3635254.2	4635782.6	4093937.8	5543732.4	3603525.6	3922903.3
1	1267827.4	6379498.8	2942585.1	2791851.4	3567433.4	3144462.3	4264279.7	2773941.6
2	1433888.1	1057893.4	5334213.7	2468907.9	2345078.8	2975918.5	2635606.6	3565584.0
3	4339332.6	1149527.7	860783.9	4344195.3	2003446.2	1891366.0	2403985.9	2121081.6
4	2333386.8	3254788.1	886290.7	672446.4	3353193.8	1531120.2	1461923.9	1836918.8
5	1300229.9	1672182.0	2402512.7	664593.2	503959.9	2468132.9	1148041.3	1090433.0
6	518431.9	887077.9	1186957.2	1730783.7	476822.6	356050.8	1782790.6	828139.7
7	198411.1	345810.4	616506.6	837742.8	1217101.1	328568.4	252321.6	1262774.1
8	392488.2	136468.4	246203.7	442481.3	595336.6	849502.6	234195.1	179062.9
9	287148.2	267412.4	96845.7	176893.7	314141.3	412825.9	605486.7	165220.5
10	217380.4	195984.5	189318.3	69708.0	125751.8	218957.1	294317.9	431313.7
11	182861.8	148230.7	138436.6	135487.8	48680.2	86276.0	154439.1	208362.1
12	502732.9	474342.7	445174.2	422337.0	398911.3	309667.2	280725.9	309726.4

	1992	1993	1994	1995	1996	1997	1998
0	5515930.8	6595680.7	5252224.7	5853399.5	10521723.2	8072036.8	3427700.0
1	3034734.4	4257349.8	5105200.8	4065620.8	4536304.7	8164474.5	6263859.7
2	2324861.0	2529574.5	3535195.2	4241262.1	3397577.4	3817212.6	6887205.0
3	2860771.6	1846997.5	1984582.0	2777129.0	3361846.1	2750590.5	3107895.2
4	1615561.0	2132708.6	1346207.9	1441667.9	2056292.0	2584776.0	2137363.5
5	1316955.3	1129232.2	1452700.6	914186.4	1002663.5	1508718.1	1919397.8
6	772839.5	885062.4	736509.9	947169.0	614121.0	715287.2	1092461.4
7	583138.8	524038.3	561761.8	465605.6	620172.1	431271.0	509707.6
8	890159.5	396923.9	334013.3	351822.6	298778.6	427921.8	302629.5
9	118870.7	588240.9	252053.9	209150.0	225210.7	205943.5	301468.9
10	111614.5	69284.9	345325.2	146943.7	126179.9	147753.2	138683.0
11	302582.9	70977.0	35667.3	182525.4	82341.9	79175.6	96024.4
12	368043.6	471294.9	331806.8	212210.4	240165.9	213817.0	199389.5

Table 2.9.1.1. cont.
AMCI estimates
Fishing mortalities at age, (1. Jan.), for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	0.0159	0.0149	0.0140	0.0120	0.0139	0.0124	0.0116	0.0067
1	0.0310	0.0289	0.0255	0.0244	0.0313	0.0265	0.0289	0.0266
2	0.0710	0.0562	0.0553	0.0589	0.0650	0.0634	0.0672	0.0702
3	0.1376	0.1101	0.0969	0.1089	0.1189	0.1075	0.1190	0.1222
4	0.1832	0.1536	0.1379	0.1384	0.1565	0.1379	0.1432	0.1828
5	0.2324	0.1927	0.1779	0.1820	0.1974	0.1753	0.1766	0.1943
6	0.2549	0.2139	0.1984	0.2021	0.2224	0.1944	0.1949	0.2008
7	0.2242	0.1897	0.1817	0.1916	0.2096	0.1886	0.1930	0.1997
8	0.2337	0.1930	0.1806	0.1926	0.2161	0.1886	0.1989	0.2597
9	0.2320	0.1954	0.1788	0.1912	0.2110	0.1884	0.1892	0.2422
10	0.2329	0.1976	0.1845	0.2090	0.2268	0.1991	0.1954	0.2045
11	0.2184	0.1854	0.1734	0.1853	0.2184	0.1939	0.1900	0.1919
12	0.2184	0.1881	0.1776	0.1838	0.1991	0.1731	0.1700	0.1886
Fref	0.2257	0.1886	0.1753	0.1813	0.2004	0.1770	0.1813	0.2074

	1992	1993	1994	1995	1996	1997	1998
0	0.0090	0.0062	0.0061	0.0049	0.0036	0.0036	0.0074
1	0.0321	0.0359	0.0354	0.0295	0.0226	0.0201	0.0209
2	0.0801	0.0926	0.0914	0.0824	0.0612	0.0556	0.0574
3	0.1437	0.1663	0.1696	0.1505	0.1129	0.1022	0.1087
4	0.2081	0.2340	0.2370	0.2131	0.1596	0.1476	0.1610
5	0.2474	0.2774	0.2777	0.2478	0.1877	0.1728	0.1905
6	0.2385	0.3046	0.3086	0.2735	0.2035	0.1888	0.2061
7	0.2347	0.3004	0.3180	0.2936	0.2211	0.2042	0.2270
8	0.2643	0.3041	0.3181	0.2961	0.2221	0.2003	0.2245
9	0.3898	0.3826	0.3896	0.3553	0.2715	0.2454	0.2560
10	0.3027	0.5140	0.4876	0.4292	0.3160	0.2809	0.2928
11	0.2027	0.3412	0.3991	0.3469	0.2610	0.2349	0.2480
12	0.2216	0.2265	0.2268	0.2044	0.1528	0.1386	0.1475
Fref	0.2386	0.2841	0.2919	0.2648	0.1988	0.1828	0.2018

Table 2.9.1.1. cont.
AMCI estimates
Modelled catches by year, for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	116315.4	50403.1	44786.6	48923.1	50044.2	60625.8	37032.5	23281.3
1	36047.0	169409.9	68982.7	62593.4	102294.3	76616.0	113229.4	67787.8
2	91560.1	53816.9	267175.2	131495.3	137454.5	170282.3	159466.6	225194.7
3	519846.4	111613.4	74064.0	417679.6	209208.8	179661.3	251372.3	227414.2
4	364212.7	432011.3	106375.8	81013.4	452688.6	183861.0	181761.9	286113.5
5	251540.3	273371.9	365159.1	103134.1	84205.8	369992.5	173313.9	179545.6
6	108876.3	159326.0	199249.8	295396.0	88703.0	58655.8	294383.3	140487.9
7	37184.8	55731.4	95498.9	136211.3	214650.4	52662.5	41295.0	213165.7
8	76323.3	22335.1	37934.1	72276.1	107932.1	136175.6	39391.8	38225.3
9	55465.8	44258.0	14785.0	28714.6	55733.7	66095.3	97330.9	33167.0
10	42137.1	32776.7	29750.1	12265.7	23803.4	36862.7	48715.7	74395.8
11	33462.7	23391.0	20551.5	21370.7	8909.2	14181.4	24926.1	33936.2
12	91997.3	75841.4	67546.4	66106.0	67151.4	45895.4	40924.2	49652.1

	1992	1993	1994	1995	1996	1997	1998
0	43840.5	35927.0	28285.0	25447.7	34022.4	25813.9	22561.2
1	89152.3	139651.3	165263.9	110007.3	94305.1	151391.7	120619.5
2	166658.2	208470.8	287462.7	312317.5	187932.3	192114.5	357797.5
3	356885.3	263766.2	288647.4	361707.1	334246.6	249026.0	298215.8
4	283167.5	415127.9	265068.2	258147.0	282840.3	330652.4	296358.3
5	269380.7	255355.8	328844.3	187277.7	160038.3	223260.1	310435.8
6	153024.2	217020.6	182630.6	211563.7	105447.6	114787.4	189788.9
7	113814.4	126972.0	142907.9	110624.9	114745.8	74305.3	96592.3
8	192954.9	97195.8	85011.1	84193.7	55514.7	72435.6	56763.9
9	35873.1	174829.8	76030.8	58450.0	49984.7	41822.6	63543.7
10	27222.6	26070.8	124728.0	47958.5	31934.4	33785.7	32866.7
11	51787.0	19170.7	10973.3	49988.9	17655.6	15465.3	19679.0
12	68246.6	89106.0	62822.3	36598.3	31730.4	25793.2	25494.0

Table 2.9.1.1. cont.
AMCI estimates
Catch residuals: log (Obs/mod)for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	0.9	0.5	0.1	-1.9	0.1	0.1	-0.4	-0.8
1	-0.1	0.5	-0.2	-0.4	0.4	-0.2	0.2	-0.1
2	-0.1	-1.0	0.4	0.2	0.0	0.6	0.3	-0.1
3	0.3	-0.7	-0.7	0.5	-0.1	0.1	0.5	-0.1
4	0.1	0.0	-0.4	-0.4	0.1	-0.1	0.1	0.3
5	0.0	-0.1	0.0	-0.1	-0.2	0.0	-0.1	0.0
6	-0.1	0.0	0.0	-0.2	-0.1	-0.2	-0.1	-0.1
7	-0.5	0.1	0.2	0.1	-0.1	0.1	0.0	-0.1
8	-0.2	-0.1	0.1	0.2	0.1	-0.2	0.2	0.3
9	-0.1	0.1	-0.1	0.2	0.0	0.0	-0.1	0.3
10	-0.1	0.1	0.1	0.5	-0.2	-0.1	-0.4	0.0
11	-0.1	0.1	0.1	0.2	0.3	0.0	-0.4	-0.1
12	-0.3	0.2	0.2	0.0	-0.2	-0.2	-0.4	0.1

	1992	1993	1994	1995	1996	1997	1998
0	0.0	-0.6	-0.1	-0.5	0.1	0.3	1.0
1	-0.1	-0.1	-0.1	-0.3	0.2	0.0	-0.2
2	-0.1	0.0	-0.3	0.1	-0.1	0.0	-0.4
3	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1
4	-0.1	0.0	0.0	0.1	0.0	0.1	0.1
5	0.1	0.0	-0.1	0.0	0.1	0.1	0.2
6	0.0	0.2	0.0	-0.1	-0.1	0.2	0.1
7	0.0	0.2	0.3	0.3	0.0	0.1	0.2
8	-0.3	0.0	0.2	0.3	0.0	-0.1	0.2
9	0.4	-0.4	0.1	0.2	0.2	-0.1	-0.3
10	0.3	0.4	-0.8	-0.1	-0.2	-0.2	-0.3
11	-0.2	0.4	0.6	-0.3	0.0	-0.1	-0.2
12	0.0	-0.3	-0.1	0.1	0.0	0.0	-0.1

Table 2.9.1.2.
Results of population estimates for NEA mackerel using the AMCI method.
Population fitted to catches at age and tag recapture data.

Spawning stock biomass (tonnes) for NEA Mackerel

Year	Modelled	Observed
1984	2597587.10	-1.00
1985	2446218.73	-1.00
1986	2534696.48	-1.00
1987	2652275.74	-1.00
1988	2769224.30	-1.00
1989	2753573.92	-1.00
1990	2575029.88	-1.00
1991	2803717.67	-1.00
1992	2873969.84	3370000.00
1993	2794733.21	-1.00
1994	2713591.14	-1.00
1995	2983621.52	2840000.00
1996	3046680.21	-1.00
1997	3184691.23	-1.00
1998	3349100.63	3800000.00

Table 2.9.1.2. cont.
AMCI estimates
Yield (tonnes) for NEA Mackerel

Year	Modelled	Observed
1	744320.9	644408.1
2	749108.6	610022.9
3	592330.3	584557.1
4	659180.8	656245.7
5	697097.9	650681.6
6	599366.8	585920.2
7	646318.7	626107.4
8	603036.2	675665.4
9	676994.7	760689.6
10	708718.9	824567.8
11	768205.6	819086.7
12	721376.0	756276.5
13	582970.0	563471.5
14	565070.0	573028.9
15	660113.5	666315.5

Table 2.9.1.2. cont.
AMCI estimates
Stocknumbers at age, (1. Jan.), for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	9039846.7	4165715.6	3943715.6	5347306.4	3822162.9	4859905.9	3756379.8	4213214.9
1	1854514.7	6940501.3	3192564.4	3028035.2	4122080.3	2941262.1	3739457.5	2892320.2
2	2074076.6	1559131.3	5811196.4	2683973.3	2557167.7	3463800.6	2474308.2	3132211.2
3	3896933.3	1679803.0	1267741.6	4740292.8	2201790.2	2091389.8	2825603.1	2007168.3
4	2004853.9	2407274.1	1064643.0	847251.5	3294738.2	1535255.9	1485940.7	2002892.2
5	980842.9	1241593.3	1501472.6	699352.2	585426.9	2263293.5	1075674.7	1040522.2
6	415826.6	702926.3	882460.7	1076588.6	514522.6	428646.6	1665040.8	787306.0
7	122157.8	282406.8	473639.6	606246.5	757054.9	359030.8	304247.9	1178047.2
8	317957.1	82291.8	189259.3	322715.8	422442.9	517022.9	248728.7	210847.1
9	277072.9	209163.2	53841.4	127098.1	221825.8	283822.3	350809.4	167758.5
10	227765.6	199033.9	148488.0	38526.2	91756.0	156917.0	200629.5	244202.0
11	195507.7	167194.9	144866.0	108844.5	27359.4	64144.8	110308.7	140469.5
12	433075.7	452963.7	445444.4	431155.7	398061.2	295727.6	251384.4	252235.1

	1992	1993	1994	1995	1996	1997	1998
0	5865478.4	6814612.0	4909747.0	5137750.3	8696777.7	7406347.2	3427700.0
1	3262671.3	4534153.1	5281120.1	3803566.8	3983108.5	6747859.5	5745958.9
2	2434882.8	2735865.5	3790607.5	4409632.2	3186480.7	3351355.5	5684628.8
3	2541278.1	1965944.2	2193483.9	3033978.2	3541868.0	2596367.3	2737858.7
4	1476031.5	1860470.3	1440182.6	1598203.1	2243241.1	2707453.2	2001558.6
5	1418967.2	1035743.9	1282747.9	985846.3	1113448.2	1637624.2	1996400.3
6	760184.6	1003249.1	711440.1	868998.1	679401.9	803616.1	1194400.0
7	566253.9	533814.3	680348.2	474520.6	588249.6	484912.0	579398.8
8	834879.1	394148.5	355662.0	445109.3	312981.0	409366.4	341962.9
9	142831.2	570770.8	263050.9	232361.8	295059.7	219192.2	290650.6
10	115227.4	90565.2	366657.3	165710.2	148511.8	200728.7	151525.2
11	166243.0	74045.5	53076.8	216629.0	100930.9	97868.6	135835.3
12	274997.4	298781.4	230988.5	170757.1	241882.2	229817.1	224741.3

Table 2.9.1.2. cont.
AMCI estimates
Fishing mortalities at age, (1. Jan.), for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	0.0143	0.0161	0.0142	0.0102	0.0120	0.0121	0.0114	0.0057
1	0.0235	0.0276	0.0235	0.0190	0.0240	0.0229	0.0272	0.0222
2	0.0608	0.0569	0.0537	0.0480	0.0511	0.0536	0.0592	0.0591
3	0.3317	0.3060	0.2530	0.2138	0.2106	0.1918	0.1941	0.1574
4	0.3292	0.3220	0.2702	0.2197	0.2255	0.2057	0.2063	0.1947
5	0.1832	0.1914	0.1826	0.1569	0.1617	0.1570	0.1621	0.1639
6	0.2369	0.2448	0.2254	0.2021	0.2098	0.1928	0.1960	0.1796
7	0.2450	0.2502	0.2337	0.2112	0.2313	0.2170	0.2167	0.1943
8	0.2688	0.2742	0.2482	0.2249	0.2477	0.2378	0.2438	0.2395
9	0.1808	0.1926	0.1847	0.1758	0.1962	0.1969	0.2122	0.2256
10	0.1592	0.1677	0.1606	0.1923	0.2080	0.2024	0.2065	0.2345
11	0.1777	0.1809	0.1642	0.1550	0.2136	0.2088	0.2104	0.2063
12	0.1777	0.1881	0.1728	0.1512	0.1588	0.1498	0.1511	0.1674
Fref	0.2526	0.2566	0.2320	0.2030	0.2152	0.2021	0.2050	0.1944

	1992	1993	1994	1995	1996	1997	1998
0	0.0074	0.0049	0.0053	0.0046	0.0037	0.0038	0.0077
1	0.0261	0.0291	0.0303	0.0270	0.0227	0.0215	0.0225
2	0.0639	0.0710	0.0727	0.0691	0.0548	0.0522	0.0554
3	0.1618	0.1612	0.1666	0.1520	0.1186	0.1102	0.1186
4	0.2042	0.2218	0.2290	0.2114	0.1647	0.1547	0.1704
5	0.1967	0.2256	0.2394	0.2223	0.1761	0.1656	0.1837
6	0.2035	0.2384	0.2550	0.2402	0.1872	0.1771	0.1939
7	0.2123	0.2561	0.2743	0.2662	0.2125	0.1993	0.2197
8	0.2303	0.2544	0.2757	0.2611	0.2062	0.1925	0.2143
9	0.3056	0.2926	0.3121	0.2976	0.2352	0.2192	0.2331
10	0.2922	0.3843	0.3762	0.3458	0.2670	0.2405	0.2535
11	0.2399	0.3287	0.3590	0.3210	0.2499	0.2271	0.2352
12	0.2129	0.2338	0.2492	0.2360	0.1827	0.1663	0.1737
Fref	0.2094	0.2393	0.2547	0.2402	0.1893	0.1778	0.1964

Table 2.9.1.2. cont.
AMCI estimates
Modelled catches by year, for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	113699.9	58937.3	49399.5	48338.3	40400.7	51799.2	37789.4	21181.5
1	40075.1	175761.8	69082.4	53070.6	90939.5	61910.5	93390.2	58991.3
2	113983.6	80277.1	282794.8	117162.3	118527.3	168430.0	132497.2	167276.9
3	1027675.3	413585.5	264468.1	851065.6	389977.4	340363.1	464969.5	272441.0
4	525301.0	619113.6	235340.0	155870.0	620573.4	266295.2	258393.2	330410.0
5	153073.6	201733.1	233727.2	94673.2	81486.2	306489.8	150047.4	146655.5
6	81847.7	142436.9	166162.6	183755.1	90841.7	70093.8	276377.3	120668.3
7	24774.6	58345.5	92089.9	107679.8	145888.2	65346.4	55298.5	194033.1
8	69957.3	18424.9	38814.8	60633.5	86498.4	102119.2	50224.3	41898.0
9	42732.5	34174.2	8467.3	19107.3	36851.9	47306.8	62579.4	31611.9
10	31240.4	28643.4	20535.5	6284.8	16071.7	26821.0	34909.9	47637.7
11	29671.9	25798.9	20448.2	14564.8	4909.3	11273.3	19526.1	24423.4
12	65727.1	72433.6	65891.4	56399.0	54487.4	38348.4	32856.9	36253.2

	1992	1993	1994	1995	1996	1997	1998
0	38623.8	29753.1	22964.2	20715.4	28719.0	25199.5	23315.0
1	78220.8	121078.6	146919.8	94373.6	83186.9	133320.7	119161.2
2	140391.5	174502.8	247350.8	274288.5	158205.0	158651.2	285096.2
3	353984.4	272851.6	313839.9	398667.6	369202.2	252366.8	285295.8
4	254322.2	345300.5	275041.6	284093.6	317520.7	361640.4	292293.3
5	236288.6	195145.9	254850.3	183313.7	167624.5	233001.4	312447.4
6	130561.0	198562.9	149445.5	173141.7	108185.7	121632.5	196289.3
7	101040.6	112551.8	152355.4	103506.6	105065.9	81708.1	106592.5
8	160234.2	82621.5	80000.6	95482.7	54393.4	66845.9	61534.8
9	35122.9	135181.9	65865.6	55855.3	57707.0	40249.5	56389.2
10	27263.7	27014.2	107462.1	45264.5	32488.1	40041.3	31665.1
11	33084.6	19379.5	14959.3	55554.8	20828.2	18550.7	26565.7
12	49192.2	58126.5	47540.7	33488.2	37656.6	32820.6	33405.3

Table 2.9.1.2. cont.
AMCI estimates
Catch residuals: log (Obs/mod)for NEA mackerel

	1984	1985	1986	1987	1988	1989	1990	1991
0	0.9	0.3	0.0	-1.9	0.3	0.2	-0.4	-0.8
1	-0.2	0.4	-0.2	-0.3	0.5	0.0	0.4	0.0
2	-0.3	-1.4	0.4	0.3	0.1	0.6	0.5	0.2
3	-0.4	-2.0	-2.0	-0.2	-0.8	-0.5	-0.1	-0.3
4	-0.3	-0.3	-1.2	-1.0	-0.2	-0.5	-0.2	0.1
5	0.5	0.2	0.4	-0.1	-0.2	0.2	0.0	0.3
6	0.2	0.1	0.2	0.3	-0.1	-0.4	-0.1	0.1
7	-0.1	0.1	0.3	0.3	0.3	-0.1	-0.3	0.0
8	-0.1	0.1	0.1	0.3	0.3	0.1	0.0	0.2
9	0.1	0.3	0.4	0.6	0.4	0.4	0.3	0.3
10	0.2	0.3	0.4	1.1	0.2	0.2	-0.1	0.4
11	0.0	0.0	0.1	0.6	0.9	0.2	-0.2	0.2
12	0.1	0.3	0.2	0.1	0.0	-0.1	-0.2	0.4

	1992	1993	1994	1995	1996	1997	1998
0	0.1	-0.4	0.1	-0.3	0.3	0.4	1.0
1	0.1	0.1	0.0	-0.1	0.4	0.1	-0.2
2	0.1	0.2	-0.1	0.2	0.1	0.2	-0.2
3	0.0	0.0	0.0	-0.2	-0.1	-0.1	-0.1
4	0.0	0.1	0.0	0.0	-0.1	0.0	0.1
5	0.3	0.2	0.2	0.0	0.1	0.1	0.1
6	0.2	0.3	0.2	0.1	-0.1	0.1	0.1
7	0.1	0.3	0.2	0.3	0.1	0.0	0.1
8	-0.1	0.2	0.3	0.2	0.0	0.0	0.2
9	0.4	-0.1	0.2	0.2	0.0	0.0	-0.2
10	0.3	0.4	-0.6	-0.1	-0.2	-0.4	-0.3
11	0.2	0.4	0.3	-0.4	-0.1	-0.3	-0.5
12	0.3	0.2	0.2	0.2	-0.2	-0.3	-0.4

Table 2.9.1.2. cont.

AMCI estimates

Modelled tag returns

Recapt. year	Release year	Age at release 0	1	2	3	4	5	6	7	8	9	10	11	12
1985	1984	0.0	0.0	0.7	18.6	16.9	13.7	5.7	0.9	6.4	3.9	4.7	4.8	0.0
1986	1984	0.0	0.0	0.5	13.5	12.8	10.1	4.2	0.7	5.0	3.1	3.6	0.0	0.0
1986	1985	0.0	4.1	2.9	13.4	58.0	34.0	26.1	9.3	2.8	6.1	3.2	2.8	0.0
1987	1984	0.0	0.0	0.4	11.5	10.6	8.2	3.5	0.6	4.4	2.7	0.0	0.0	0.0
1987	1985	0.0	3.7	2.4	11.2	49.2	28.2	21.4	7.8	2.4	5.3	2.9	0.0	0.0
1987	1986	0.0	0.2	7.4	3.3	5.9	60.0	25.0	14.7	7.0	4.1	4.9	2.8	0.0
1988	1984	0.0	0.0	0.2	6.5	5.9	4.7	2.0	0.3	2.7	0.0	0.0	0.0	0.0
1988	1985	0.0	2.1	1.4	6.5	27.9	15.7	12.2	4.5	1.4	3.2	0.0	0.0	0.0
1988	1986	0.0	0.1	4.2	1.9	3.4	34.0	13.9	8.4	4.0	2.3	2.9	0.0	0.0
1988	1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1989	1984	0.0	0.0	0.2	4.4	4.1	3.3	1.4	0.2	0.0	0.0	0.0	0.0	0.0
1989	1985	0.0	1.5	1.0	4.5	18.9	10.8	8.6	3.1	1.0	0.0	0.0	0.0	0.0
1989	1986	0.0	0.1	3.0	1.4	2.4	23.0	9.6	5.9	2.8	1.7	0.0	0.0	0.0
1989	1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1989	1988	0.0	5.5	8.2	27.6	39.5	2.6	6.8	22.4	9.5	7.9	2.7	1.6	0.0
1990	1984	0.0	0.0	0.1	2.2	2.1	1.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0
1990	1985	0.0	0.8	0.5	2.3	9.5	5.6	4.4	1.7	0.0	0.0	0.0	0.0	0.0
1990	1986	0.0	0.0	1.6	0.7	1.2	11.6	5.0	3.0	1.5	0.0	0.0	0.0	0.0
1990	1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1990	1988	0.0	3.0	4.2	14.6	20.9	1.4	3.4	11.3	4.9	4.1	1.4	0.0	0.0
1990	1989	0.0	2.9	18.8	21.9	16.6	18.3	0.9	3.5	8.0	6.5	2.5	0.7	0.0
1991	1984	0.0	0.0	0.1	1.7	1.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	1985	0.0	0.6	0.4	1.7	7.3	4.3	3.5	0.0	0.0	0.0	0.0	0.0	0.0
1991	1986	0.0	0.0	1.2	0.5	0.9	8.8	3.8	2.4	0.0	0.0	0.0	0.0	0.0
1991	1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1991	1988	0.0	2.4	3.4	11.7	16.4	1.0	2.6	8.6	3.8	3.2	0.0	0.0	0.0
1991	1989	0.0	2.5	14.7	17.3	13.3	14.3	0.7	2.6	6.0	5.0	2.0	0.0	0.0
1991	1990	0.0	8.7	24.7	49.0	10.2	3.7	5.7	0.7	2.2	3.4	1.8	1.7	0.0

Table 2.9.1.2. cont.

	0	1	2	3	4	5	6	7	8	9	10	11	12
1992 1984	0.0	0.0	0.1	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992 1985	0.0	0.5	0.3	1.4	6.2	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992 1986	0.0	0.0	1.1	0.4	0.8	7.6	3.4	0.0	0.0	0.0	0.0	0.0	0.0
1992 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1992 1988	0.0	2.1	3.0	10.4	14.3	0.8	2.2	7.4	3.4	0.0	0.0	0.0	0.0
1992 1989	0.0	2.3	13.1	15.6	11.8	12.6	0.6	2.2	5.2	4.4	0.0	0.0	0.0
1992 1990	0.0	8.4	22.4	43.7	9.2	3.3	5.0	0.6	1.9	2.9	1.6	0.0	0.0
1992 1991	0.0	0.1	27.6	30.6	38.7	11.9	9.8	11.3	2.5	4.0	9.9	7.2	0.0
1993 1984	0.0	0.0	0.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993 1985	0.0	0.9	0.5	2.2	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993 1986	0.0	0.0	1.7	0.7	1.1	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1993 1988	0.0	3.6	5.0	17.1	23.0	1.2	3.3	12.1	0.0	0.0	0.0	0.0	0.0
1993 1989	0.0	3.8	21.9	25.8	19.5	20.1	0.8	3.3	8.5	0.0	0.0	0.0	0.0
1993 1990	0.0	14.4	37.6	73.1	15.2	5.4	7.9	0.8	2.8	4.7	0.0	0.0	0.0
1993 1991	0.0	0.3	47.3	51.5	64.8	19.6	16.1	18.2	3.6	6.1	16.2	0.0	0.0
1993 1992	0.0	1.9	7.9	39.3	29.0	49.8	26.6	23.6	31.9	9.6	6.9	18.0	0.0
1994 1984	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
1994 1985	0.0	0.6	0.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994 1986	0.0	0.0	1.1	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1994 1988	0.0	2.5	3.5	11.8	14.9	0.8	2.3	0.0	0.0	0.0	0.0	0.0	0.0
1994 1989	0.0	2.7	15.5	18.0	13.4	13.1	0.5	2.3	0.0	0.0	0.0	0.0	0.0
1994 1990	0.0	10.4	27.0	51.6	10.6	3.7	5.2	0.5	1.9	0.0	0.0	0.0	0.0
1994 1991	0.0	0.2	34.3	36.9	45.7	13.7	11.0	11.8	2.3	4.2	0.0	0.0	0.0
1994 1992	0.0	1.5	5.9	28.5	20.8	35.1	18.6	16.2	20.8	6.1	4.8	0.0	0.0
1994 1993	0.0	6.1	45.2	47.8	72.8	53.6	60.2	31.7	22.3	24.0	3.1	6.9	0.0
1995 1984	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
1995 1985	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995 1986	0.0	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1995 1988	0.0	2.5	3.4	11.0	13.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995 1989	0.0	2.7	15.5	17.7	12.6	12.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0
1995 1990	0.0	10.7	27.1	51.7	10.4	3.5	4.8	0.5	0.0	0.0	0.0	0.0	0.0
1995 1991	0.0	0.2	35.3	37.2	45.8	13.5	10.4	10.9	2.2	0.0	0.0	0.0	0.0
1995 1992	0.0	1.6	6.2	29.3	21.0	35.2	18.2	15.2	19.2	5.9	0.0	0.0	0.0
1995 1993	0.0	7.1	48.8	49.9	74.9	53.9	60.3	31.1	20.9	22.2	3.1	0.0	0.0
1995 1994	0.0	2.0	63.7	126.6	84.4	142.1	65.2	112.1	45.3	31.2	14.0	5.2	0.0

Table 2.9.1.2. cont.

	0	1	2	3	4	5	6	7	8	9	10	11	12
1996 1984	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
1996 1985	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996 1986	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1996 1988	0.0	0.8	1.0	3.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996 1989	0.0	0.8	4.7	5.2	3.6	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996 1990	0.0	3.3	8.3	15.7	3.0	1.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
1996 1991	0.0	0.1	10.9	11.4	13.9	3.9	3.0	3.3	0.0	0.0	0.0	0.0	0.0
1996 1992	0.0	0.5	2.0	9.1	6.4	10.7	5.3	4.4	5.8	0.0	0.0	0.0	0.0
1996 1993	0.0	2.4	15.6	15.8	23.2	16.6	18.3	9.1	6.1	6.7	0.0	0.0	0.0
1996 1994	0.0	0.7	21.1	40.5	26.7	44.0	20.0	34.0	13.3	9.0	4.3	0.0	0.0
1996 1995	0.0	0.3	23.0	85.8	54.9	26.6	34.4	22.1	18.5	12.4	8.7	7.3	0.0
1997 1984	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
1997 1985	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
1997 1986	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
1997 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1997 1988	0.0	0.6	0.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 1989	0.0	0.7	4.0	4.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 1990	0.0	2.9	7.2	13.2	2.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 1991	0.0	0.1	9.5	9.9	11.7	3.3	2.6	0.0	0.0	0.0	0.0	0.0	0.0
1997 1992	0.0	0.5	1.7	7.9	5.6	9.0	4.5	3.8	0.0	0.0	0.0	0.0	0.0
1997 1993	0.0	2.1	14.0	13.9	20.3	14.3	15.4	7.6	5.3	0.0	0.0	0.0	0.0
1997 1994	0.0	0.7	19.1	36.3	23.5	38.4	17.3	28.6	11.1	7.9	0.0	0.0	0.0
1997 1995	0.0	0.2	21.4	77.7	49.1	23.4	30.1	19.1	15.6	10.3	7.6	0.0	0.0
1997 1996	0.0	0.0	33.9	56.3	67.6	46.5	31.2	23.9	11.5	17.6	6.6	4.6	0.0
1998 1984	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
1998 1985	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
1998 1986	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
1998 1987	0.0	.	.	.	.	.	.	.	.	.	.	.	.
1998 1988	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998 1989	0.0	0.2	1.2	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998 1990	0.0	0.9	2.1	3.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998 1991	0.0	0.0	2.9	2.9	3.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998 1992	0.0	0.1	0.5	2.4	1.7	2.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
1998 1993	0.0	0.7	4.3	4.3	6.2	4.3	4.6	2.4	0.0	0.0	0.0	0.0	0.0
1998 1994	0.0	0.2	6.0	11.2	7.2	11.7	5.1	8.5	3.4	0.0	0.0	0.0	0.0
1998 1995	0.0	0.1	6.8	24.5	15.2	7.2	9.2	5.7	4.6	3.2	0.0	0.0	0.0
1998 1996	0.0	0.0	11.1	17.9	21.3	14.4	9.6	7.3	3.4	5.2	2.0	0.0	0.0
1998 1997	0.0	0.0	15.6	32.3	61.4	48.1	26.2	10.7	13.8	9.4	6.2	1.7	0.0

Table 2.9.1.2. cont.
AMCI estimates
Observed tag returns

Recapt. year	Release year	Age at release 0	1	2	3	4	5	6	7	8	9	10	11	12
1985	1984	0.0	0.0	0.2	14.9	16.5	13.4	6.0	0.8	6.6	4.4	4.9	5.1	3.5
1986	1984	0.0	0.0	0.3	13.3	12.7	10.3	4.0	0.7	5.4	4.0	3.8	4.0	1.6
1986	1985	0.0	4.2	1.7	11.2	54.7	32.3	24.7	9.4	2.3	6.6	3.0	2.3	3.5
1987	1984	0.0	0.0	0.1	8.9	9.8	8.1	3.9	0.4	4.2	2.2	2.2	2.6	1.6
1987	1985	0.0	1.7	2.1	10.0	45.9	24.8	20.9	7.3	2.2	4.4	1.6	1.8	1.6
1987	1986	0.0	0.2	7.2	2.5	5.0	59.7	24.4	15.2	7.8	4.2	4.8	2.9	9.1
1988	1984	0.0	0.0	0.1	4.1	3.2	2.4	1.1	0.1	1.5	1.2	1.3	1.4	0.7
1988	1985	0.0	1.7	1.2	6.0	24.4	14.2	10.8	4.5	1.9	2.5	1.7	1.5	2.1
1988	1986	0.0	0.0	1.8	1.9	3.6	35.4	14.6	8.9	4.7	2.5	2.9	1.4	5.1
1988	1987	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
1989	1984	0.0	0.0	0.4	6.2	3.8	3.1	0.6	0.1	1.4	0.9	1.2	1.5	1.5
1989	1985	0.0	0.0	0.5	3.5	15.9	8.2	6.8	2.4	0.4	1.6	0.6	0.4	0.3
1989	1986	0.0	0.1	2.1	0.9	1.6	16.7	7.1	4.4	2.1	1.1	1.2	0.4	1.9
1989	1987	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
1989	1988	0.0	5.0	7.8	30.5	43.1	2.8	7.3	24.4	10.0	7.5	2.8	1.7	3.1
1990	1984	0.0	0.0	0.5	2.6	2.2	1.7	0.9	0.0	0.6	0.6	1.0	0.6	0.5
1990	1985	0.0	0.8	0.4	2.3	10.7	6.1	4.9	1.6	0.4	1.1	0.5	0.3	0.9
1990	1986	0.0	0.0	1.3	0.7	1.4	11.1	4.7	2.9	1.3	0.7	0.8	0.3	1.4
1990	1987	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
1990	1988	0.0	3.0	4.7	14.9	23.3	1.1	2.7	8.7	3.8	3.0	0.7	0.6	0.9
1990	1989	0.0	2.0	16.3	22.8	16.0	14.6	0.8	2.8	7.8	4.7	2.7	0.3	0.0
1991	1984	0.0	0.0	0.1	3.8	1.8	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1991	1985	0.0	1.7	0.0	0.8	4.2	2.6	2.0	1.1	0.4	0.5	0.3	0.2	0.2
1991	1986	0.0	0.0	1.1	0.9	1.3	10.1	5.2	2.6	0.7	0.4	0.4	0.1	0.4
1991	1987	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
1991	1988	0.0	2.5	3.4	10.6	13.4	0.7	1.6	5.2	2.3	1.8	0.5	0.2	0.4
1991	1989	0.0	0.9	9.3	16.8	12.3	14.1	0.7	2.8	5.1	4.2	1.7	0.3	0.0
1991	1990	0.0	9.3	28.3	62.2	11.3	3.5	5.0	0.7	2.1	2.4	1.4	1.6	0.6
1992	1984	0.0	0.0	0.0	2.5	2.9	2.2	0.5	0.0	0.4	0.3	0.2	0.1	0.0
1992	1985	0.0	0.0	0.1	0.8	4.3	2.3	2.0	0.7	0.1	0.3	0.1	0.1	0.0
1992	1986	0.0	0.0	1.9	0.9	0.9	7.4	3.6	2.3	0.6	0.6	0.4	0.0	0.4
1992	1987	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
1992	1988	0.0	1.0	1.5	7.2	12.3	0.6	2.2	7.5	3.5	1.9	0.6	0.3	0.8
1992	1989	0.0	2.0	11.1	10.7	8.1	9.1	0.5	1.8	3.1	2.8	1.3	0.2	0.0
1992	1990	0.0	9.3	27.2	47.4	9.7	3.5	4.0	0.2	1.4	1.8	0.9	1.0	0.2
1992	1991	0.0	0.0	19.5	31.5	43.6	12.9	10.8	11.8	2.0	4.3	8.6	6.3	5.4

Table 2.9.1.2. cont.

	0	1	2	3	4	5	6	7	8	9	10	11	12
1993 1984	0.0	0.0	0.3	2.7	1.2	1.1	0.4	0.0	0.4	0.1	0.3	0.4	0.0
1993 1985	0.0	0.8	0.4	2.1	8.5	4.6	3.6	1.4	0.4	0.6	0.3	0.2	0.1
1993 1986	0.0	0.0	1.1	0.7	1.2	7.8	3.7	2.5	0.7	0.5	0.6	0.2	1.3
1993 1987	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
1993 1988	0.0	3.0	3.6	13.3	19.6	0.9	3.0	10.2	4.5	3.4	1.0	0.7	0.9
1993 1989	0.0	1.8	15.2	20.4	14.8	14.7	0.7	3.0	6.3	6.1	2.3	0.8	0.0
1993 1990	0.0	12.9	38.6	71.4	13.5	4.3	4.7	0.7	2.2	6.1	1.8	1.9	0.2
1993 1991	0.0	0.2	40.9	52.4	70.5	19.8	14.8	14.6	3.0	4.0	10.7	6.7	5.6
1993 1992	0.0	1.0	6.7	36.0	27.5	47.6	25.9	23.0	31.8	9.9	5.8	16.0	18.6
1994 1984	0.0	0.0	0.0	2.0	2.0	1.4	1.1	0.0	0.5	0.3	0.6	0.2	0.0
1994 1985	0.0	0.0	1.0	1.9	4.7	2.3	2.0	0.8	0.1	0.6	0.3	0.1	0.2
1994 1986	0.0	0.0	1.5	0.4	0.3	5.3	2.7	1.6	0.3	0.3	0.2	0.2	1.5
1994 1987	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
1994 1988	0.0	2.0	3.1	12.5	13.5	0.7	2.6	8.1	3.2	2.5	1.0	0.5	1.2
1994 1989	0.0	1.5	13.5	13.5	9.3	7.5	0.5	1.4	3.6	4.4	0.8	1.2	0.0
1994 1990	0.0	5.9	18.7	46.3	9.4	3.7	4.6	0.5	2.8	2.6	1.6	1.3	0.5
1994 1991	0.0	0.1	22.3	38.9	50.1	15.6	14.0	17.4	3.4	5.8	12.3	8.6	6.7
1994 1992	0.0	1.3	4.9	26.2	17.5	28.5	15.0	13.6	17.9	5.6	3.6	8.1	11.5
1994 1993	0.0	2.0	21.5	32.3	58.2	51.4	61.9	31.0	19.8	21.4	2.5	5.8	10.0
1995 1984	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
1995 1985	0.0	1.7	0.3	2.0	6.5	3.4	2.9	0.5	0.1	0.2	0.2	0.1	0.1
1995 1986	0.0	0.0	0.3	0.3	0.5	6.4	2.0	1.5	0.6	0.3	0.5	0.3	1.8
1995 1987	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
1995 1988	0.0	4.0	4.6	16.8	18.0	1.2	2.8	8.4	3.5	2.3	0.8	0.4	1.2
1995 1989	0.0	2.6	17.1	22.3	15.0	11.2	0.5	1.9	4.0	3.2	1.4	0.2	0.0
1995 1990	0.0	8.8	26.8	48.5	9.0	2.8	3.8	0.8	2.1	3.2	1.2	1.6	0.5
1995 1991	0.0	0.1	28.4	31.7	41.4	11.6	9.1	9.6	2.7	5.2	9.4	6.8	4.4
1995 1992	0.0	0.5	3.9	23.8	15.3	26.0	15.0	14.0	19.3	6.6	4.3	10.9	14.6
1995 1993	0.0	2.4	30.6	37.2	65.5	50.6	57.4	31.2	24.2	26.5	4.3	7.9	14.4
1995 1994	0.0	1.4	49.5	97.8	73.6	137.0	59.3	98.0	39.5	28.3	13.5	6.3	19.1
1996 1984	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
1996 1985	0.0	0.0	0.0	0.0	0.6	0.4	0.4	0.2	0.0	0.1	0.0	0.1	0.0
1996 1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.9
1996 1987	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
1996 1988	0.0	1.0	0.9	0.6	2.2	0.2	0.5	1.2	0.7	0.6	0.1	0.0	0.2
1996 1989	0.0	1.5	8.3	8.2	5.5	4.2	0.2	0.8	1.0	1.4	0.5	0.2	0.0
1996 1990	0.0	2.6	7.3	20.0	5.3	2.4	2.2	0.2	0.7	0.5	0.4	0.4	0.0
1996 1991	0.0	0.0	4.9	8.4	10.8	3.0	3.2	3.1	0.8	1.2	2.2	1.6	0.9
1996 1992	0.0	1.5	4.6	11.3	9.7	16.5	7.2	4.9	5.6	1.6	1.1	3.1	3.1
1996 1993	0.0	0.8	4.6	8.3	15.6	13.5	18.1	9.0	7.7	8.0	1.3	1.9	4.4
1996 1994	0.0	0.4	12.9	50.3	33.8	44.2	17.1	32.3	15.4	9.9	5.5	1.0	5.1
1996 1995	0.0	0.1	12.4	66.9	47.0	23.3	30.8	20.4	17.8	12.1	9.7	5.9	9.2

Table 2.9.1.2. cont.

	0	1	2	3	4	5	6	7	8	9	10	11	12
1997 1984	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
1997 1985	0.0	0.0	0.0	0.2	0.9	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0
1997 1986	0.0	0.0	0.0	0.0	0.1	2.4	0.6	0.3	0.3	0.0	0.2	0.1	0.2
1997 1987	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
1997 1988	0.0	0.0	0.0	0.9	2.4	0.1	0.1	0.3	0.1	0.0	0.0	0.0	0.0
1997 1989	0.0	0.4	2.5	4.3	2.3	1.5	0.0	0.3	1.7	0.3	0.7	0.0	0.0
1997 1990	0.0	0.0	0.8	10.8	2.4	0.7	1.4	0.2	0.5	0.4	0.5	0.3	0.0
1997 1991	0.0	0.0	3.4	6.8	9.0	2.7	1.5	2.1	0.3	1.0	1.7	1.3	1.2
1997 1992	0.0	0.0	1.3	10.3	5.3	5.5	3.0	2.5	4.1	1.3	0.7	1.8	2.6
1997 1993	0.0	0.8	11.2	14.3	14.3	10.6	11.9	6.1	3.9	4.8	0.6	2.0	2.0
1997 1994	0.0	0.8	24.6	41.4	23.9	27.6	13.2	24.5	11.7	7.8	3.1	0.3	4.4
1997 1995	0.0	0.2	21.0	103.6	62.3	24.6	29.7	18.0	14.2	10.5	6.8	5.4	7.3
1997 1996	0.0	0.0	38.7	59.0	51.3	31.9	21.4	16.6	9.5	15.6	5.2	3.9	9.0
1998 1984	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
1998 1985	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
1998 1986	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.1	0.1	0.0	0.0	0.0	0.0
1998 1987	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
1998 1988	0.0	0.0	0.3	0.6	0.8	0.0	0.2	0.6	0.4	0.1	0.0	0.0	0.1
1998 1989	0.0	0.0	0.9	2.5	1.5	1.1	0.0	0.1	0.5	0.7	0.2	0.2	0.0
1998 1990	0.0	1.5	4.2	3.2	0.6	0.4	0.7	0.2	0.2	0.2	0.4	0.2	0.1
1998 1991	0.0	0.0	0.8	1.5	3.0	0.9	1.0	1.1	0.2	0.8	1.1	0.9	0.7
1998 1992	0.0	0.0	0.6	2.0	1.0	1.6	1.0	0.9	1.5	0.5	0.2	0.4	0.4
1998 1993	0.0	0.6	4.4	4.3	5.7	3.2	4.1	2.2	1.6	1.7	0.2	0.2	0.6
1998 1994	0.0	0.2	5.6	10.0	4.9	7.3	3.6	7.0	2.8	1.9	0.9	0.1	0.9
1998 1995	0.0	0.1	4.6	17.5	12.8	6.1	9.8	7.1	5.8	3.2	2.5	1.3	2.0
1998 1996	0.0	0.0	13.2	18.4	19.0	13.6	9.3	7.3	3.9	5.8	2.2	1.4	3.4
1998 1997	0.0	0.0	11.1	29.3	64.6	44.5	25.4	9.6	11.2	6.0	4.6	1.0	6.9

Table 2.9.1.2. cont.

AMCI estimates

Tag returns: (obs-mod)^2/mod

Recapt. year	Release year	Age at release												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1985	1984		0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		
1986	1984		0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0			
1986	1985	0.0	0.5	0.3	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.1		
1987	1984		0.2	0.6	0.1	0.0	0.1	0.0	0.0	0.1				
1987	1985	1.0	0.0	0.1	0.2	0.4	0.0	0.0	0.0	0.2	0.6			
1987	1986	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0		
1988	1984		0.1	0.9	1.2	1.1	0.4	0.2	0.5					
1988	1985	0.1	0.0	0.0	0.4	0.1	0.2	0.0	0.2	0.2				
1988	1986	0.1	1.4	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0			
1988	1987													
1989	1984		0.4	0.7	0.0	0.0	0.5	0.1						
1989	1985	1.5	0.2	0.2	0.5	0.6	0.4	0.2	0.3					
1989	1986	0.0	0.3	0.2	0.3	1.7	0.6	0.4	0.2	0.2				
1989	1987													
1989	1988	0.0	0.0	0.3	0.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0		
1990	1984		2.2	0.1	0.0	0.0	0.0							
1990	1985	0.0	0.0	0.0	0.1	0.0	0.1	0.0						
1990	1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1990	1987													
1990	1988	0.0	0.0	0.0	0.3	0.1	0.2	0.6	0.3	0.3	0.4			
1990	1989	0.3	0.3	0.0	0.0	0.8	0.0	0.1	0.0	0.5	0.0	0.3		
1991	1984		0.0	2.6	0.0	0.0								
1991	1985	2.0	0.4	0.5	1.3	0.7	0.6							
1991	1986	0.0	0.0	0.2	0.2	0.2	0.5	0.0						
1991	1987													
1991	1988	0.0	0.0	0.1	0.5	0.1	0.4	1.4	0.6	0.6				
1991	1989	1.0	2.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0			
1991	1990	0.0	0.5	3.6	0.1	0.0	0.1	0.0	0.0	0.3	0.1	0.0		
1992	1984		0.1	0.8	1.5									
1992	1985	0.5	0.1	0.3	0.6	0.6								
1992	1986	0.0	0.6	0.5	0.0	0.0	0.0							
1992	1987													
1992	1988	0.6	0.8	1.0	0.3	0.1	0.0	0.0	0.0					
1992	1989	0.0	0.3	1.6	1.2	1.0	0.0	0.1	0.8	0.6				
1992	1990	0.1	1.0	0.3	0.0	0.0	0.2	0.2	0.1	0.4	0.3			
1992	1991	0.1	2.4	0.0	0.6	0.1	0.1	0.0	0.1	0.0	0.2	0.1		

Table 2.9.1.2. cont.

	0	1	2	3	4	5	6	7	8	9	10	11	12
1993 1984		0.6	0.0										
1993 1985	0.0	0.0	0.0	0.3									
1993 1986	0.0	0.2	0.0	0.0	1.7								
1993 1987													
1993 1988	0.1	0.4	0.9	0.5	0.1	0.0	0.3						
1993 1989	1.0	2.1	1.1	1.1	1.5	0.0	0.0	0.6					
1993 1990	0.2	0.0	0.0	0.2	0.2	1.3	0.0	0.1	0.4				
1993 1991	0.0	0.9	0.0	0.5	0.0	0.1	0.7	0.1	0.7	1.9			
1993 1992	0.4	0.2	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2		
1994 1984		0.1											
1994 1985	0.6	1.7	0.1										
1994 1986	0.0	0.1	0.0	0.3									
1994 1987													
1994 1988	0.1	0.0	0.0	0.1	0.0	0.1							
1994 1989	0.5	0.3	1.1	1.2	2.4	0.0	0.4						
1994 1990	2.0	2.5	0.5	0.1	0.0	0.1	0.0	0.4					
1994 1991	0.0	4.2	0.1	0.4	0.3	0.8	2.6	0.5	0.6				
1994 1992	0.0	0.2	0.2	0.5	1.2	0.7	0.4	0.4	0.0	0.3			
1994 1993	2.8	12.4	5.0	2.9	0.1	0.0	0.0	0.3	0.3	0.1	0.2		
1995 1984													
1995 1985	2.7	0.0											
1995 1986	0.0	0.5	0.0										
1995 1987													
1995 1988	0.9	0.4	3.0	1.3	0.2								
1995 1989	0.0	0.2	1.2	0.5	0.1	0.0							
1995 1990	0.3	0.0	0.2	0.2	0.1	0.2	0.2						
1995 1991	0.1	1.3	0.8	0.4	0.3	0.2	0.2	0.1					
1995 1992	0.8	0.9	1.0	1.5	2.4	0.6	0.1	0.0	0.1				
1995 1993	3.1	6.8	3.2	1.2	0.2	0.1	0.0	0.5	0.8	0.5			
1995 1994	0.2	3.1	6.6	1.4	0.2	0.5	1.8	0.7	0.3	0.0	0.2		
1996 1984													
1996 1985	0.2												
1996 1986	0.0	0.3											
1996 1987													
1996 1988	0.1	0.0	2.1	1.0									
1996 1989	0.5	2.8	1.8	1.0	0.1								
1996 1990	0.2	0.1	1.2	1.7	1.9	0.4							
1996 1991	0.1	3.3	0.8	0.7	0.2	0.0	0.0						
1996 1992	1.8	3.5	0.5	1.7	3.2	0.6	0.1	0.0					
1996 1993	1.0	7.8	3.6	2.5	0.6	0.0	0.0	0.4	0.2				
1996 1994	0.1	3.2	2.4	1.9	0.0	0.4	0.1	0.3	0.1	0.4			
1996 1995	0.1	4.9	4.1	1.1	0.4	0.4	0.1	0.0	0.0	0.1	0.3		

Table 2.9.1.2. cont.

		0	1	2	3	4	5	6	7	8	9	10	11	12
1997	1984													
1997	1985													
1997	1986	0.0												
1997	1987													
1997	1988	0.6	0.8	1.3										
1997	1989	0.1	0.5	0.0	0.2									
1997	1990	2.9	5.7	0.4	0.0	0.0								
1997	1991	0.1	4.0	0.9	0.6	0.1	0.5							
1997	1992	0.5	0.1	0.7	0.0	1.3	0.5	0.5						
1997	1993	0.8	0.6	0.0	1.8	1.0	0.8	0.3	0.4					
1997	1994	0.0	1.6	0.7	0.0	3.1	1.0	0.6	0.0	0.0				
1997	1995	0.0	0.0	8.6	3.5	0.1	0.0	0.1	0.1	0.0	0.1			
1997	1996		0.7	0.1	3.9	4.6	3.1	2.2	0.3	0.2	0.3	0.1		
1998	1984													
1998	1985													
1998	1986													
1998	1987													
1998	1988	0.2	0.0											
1998	1989	0.2	0.1	1.0										
1998	1990	0.4	2.0	0.1	0.0									
1998	1991	0.0	1.5	0.7	0.1	0.0								
1998	1992	0.1	0.0	0.1	0.3	0.4	0.1							
1998	1993	0.0	0.0	0.0	0.0	0.3	0.1	0.0						
1998	1994	0.0	0.0	0.1	0.7	1.7	0.5	0.3	0.1					
1998	1995	0.0	0.7	2.0	0.4	0.2	0.0	0.4	0.3	0.0				
1998	1996		0.4	0.0	0.3	0.0	0.0	0.0	0.1	0.1	0.0			
1998	1997		1.3	0.3	0.2	0.3	0.0	0.1	0.5	1.2	0.4	0.3		

Table 2.9.1.3 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1996-1999.

Assessment year	1999	1998 ###	1997	1996
First data year	1984	1984	1984	1984
Final data year	1998	1997	1996	1995
No of years for separable constraint ?	7	12	11	10
Constant selection pattern model (Y/N)	S1(92-98)	S1(86-88); S2(89-97)	S1(86-88); S2(89-96)	S1(86-88); S2(89-95)
S to be fixed on last age	1.2	1.2 / 1.2	1.2 / 1.2	1.0 / 1.2
Reference age for separable constraint	5	5	5	5
First age for calculation of reference F	4	4	4	4
Last age for calculation of reference F	8	8	8	8
Shrink the final populations	No	No	No	No

Tuning indices

SSB from egg surveys	Years	92 + 95 + 98	86 + 89 + 92 + 95 + 98	86 + 89 + 92 + 95	86 + 89 + 92 + 95
	Abundance index	relative index: linear	absolute index	absolute index	absolute index

Model weighting

Relative weights in catch at age matrix		all 1, except 0-group 0.01	all 1, except 0-group 0.01	all 1, except 0-group 0.01	all 1, except 0-group 0.01
Survey indices weighting	Egg surveys	5.0	1.0	1.0	1.0
Stock recruitment relationship fitted?		No	No	No	No
Parameters to be estimated		36	55	53	?
Number of observations		87	149	136	?

At the 1998 Working Group meeting only a provisional assessment was carried (the 1997 assessment was regarded to be more reliable)

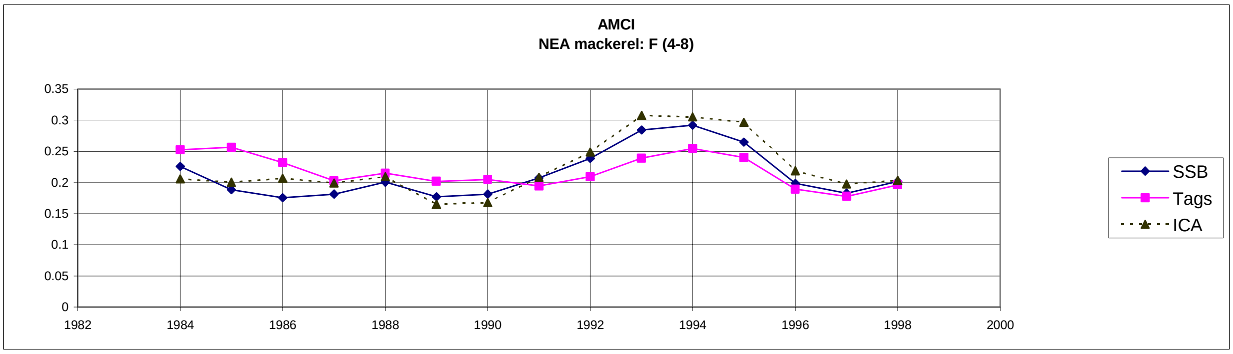


Figure 2.9.1.1
Fishing mortality (F4-8) for NEA mackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.

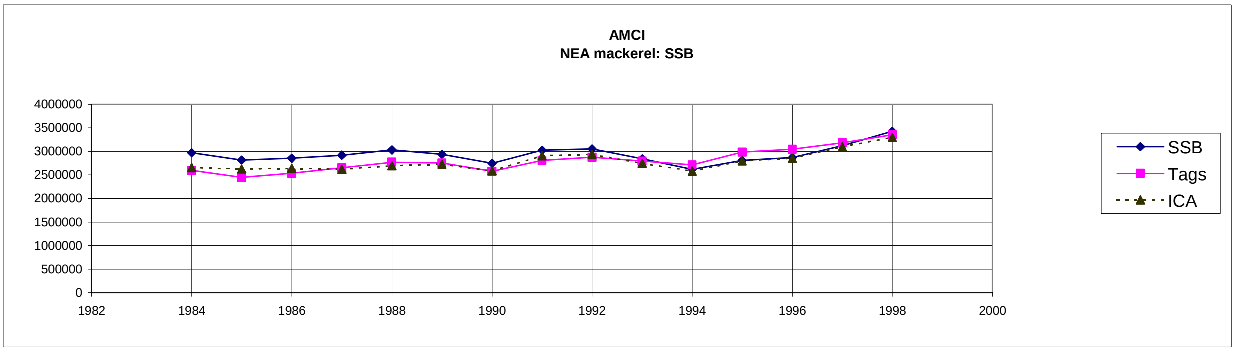


Figure 2.9.1.2
SSB estimates (tonnes) for NEAmackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.

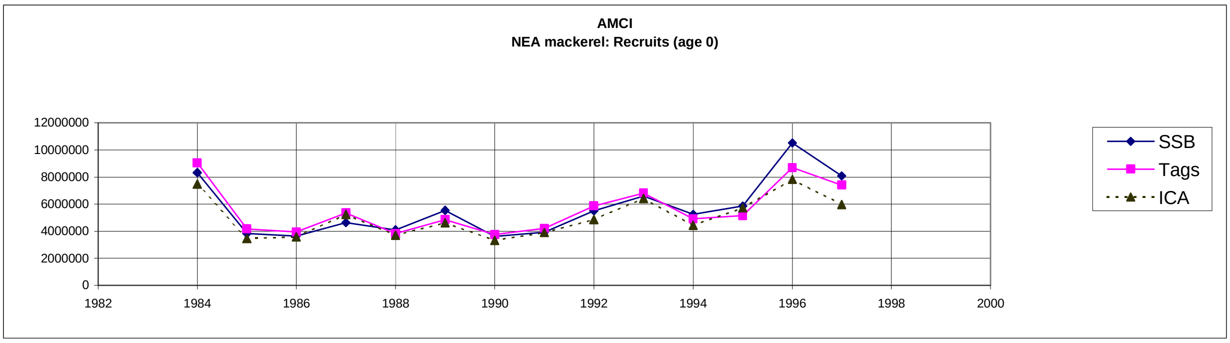


Figure 2.9.1.3
Recruitment ('000, age 0) for NEA mackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.

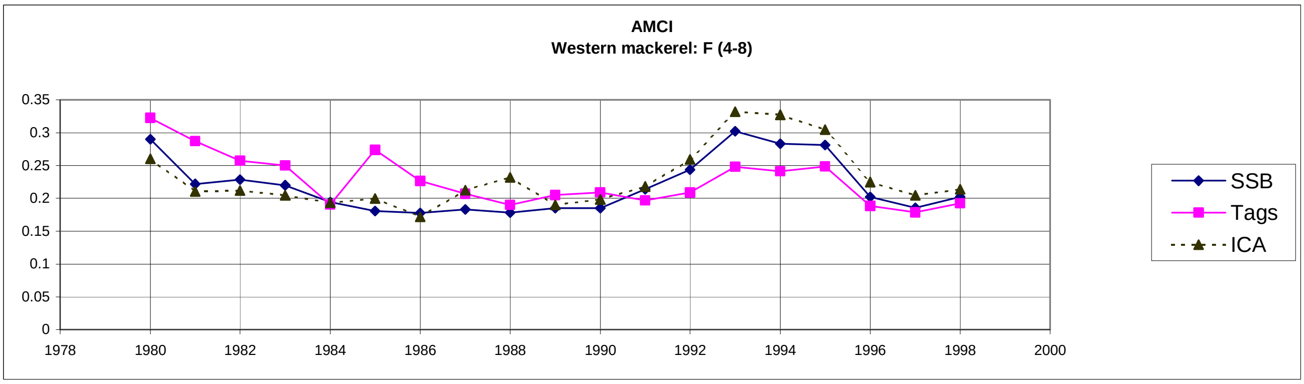


Figure 2.9.1.4
Fishing mortality (F4-8) for Western mackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.

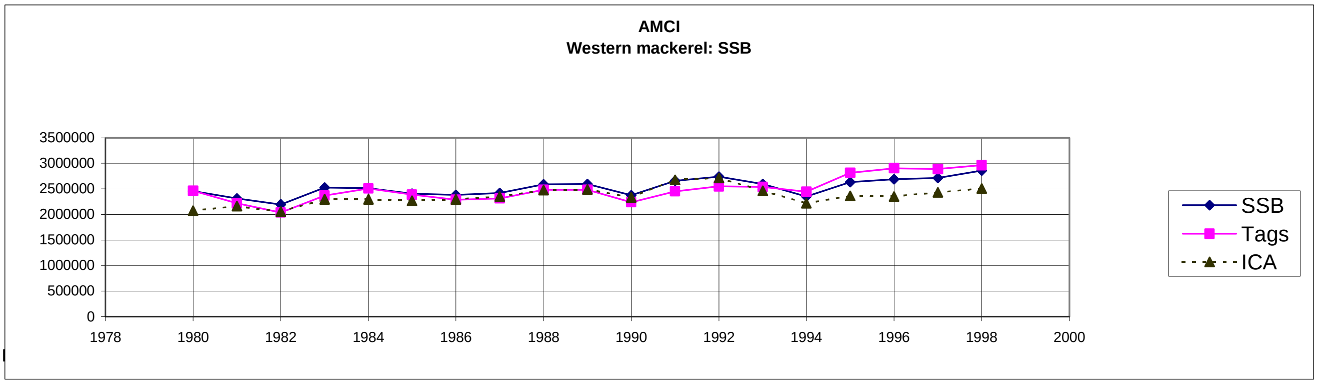


Figure 2.9.1.5
SSB estimates (tonnes) for Western mackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.

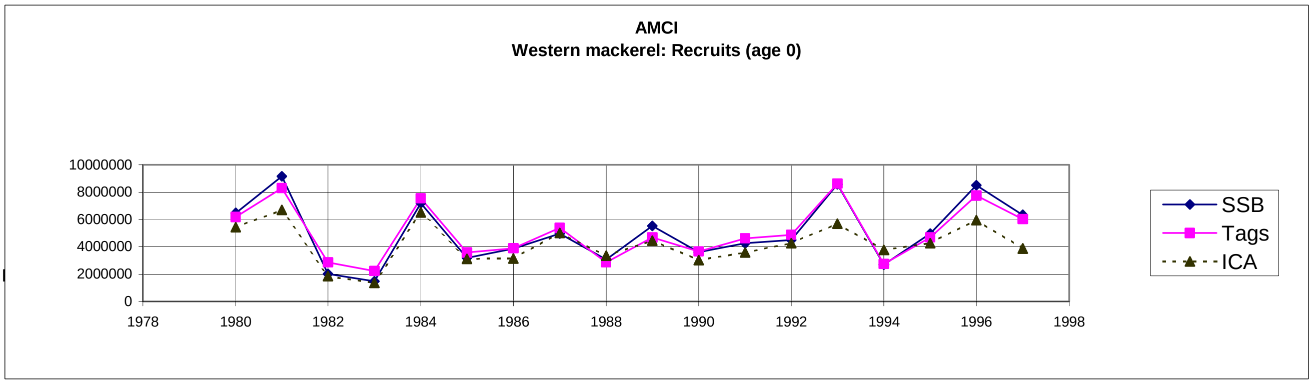
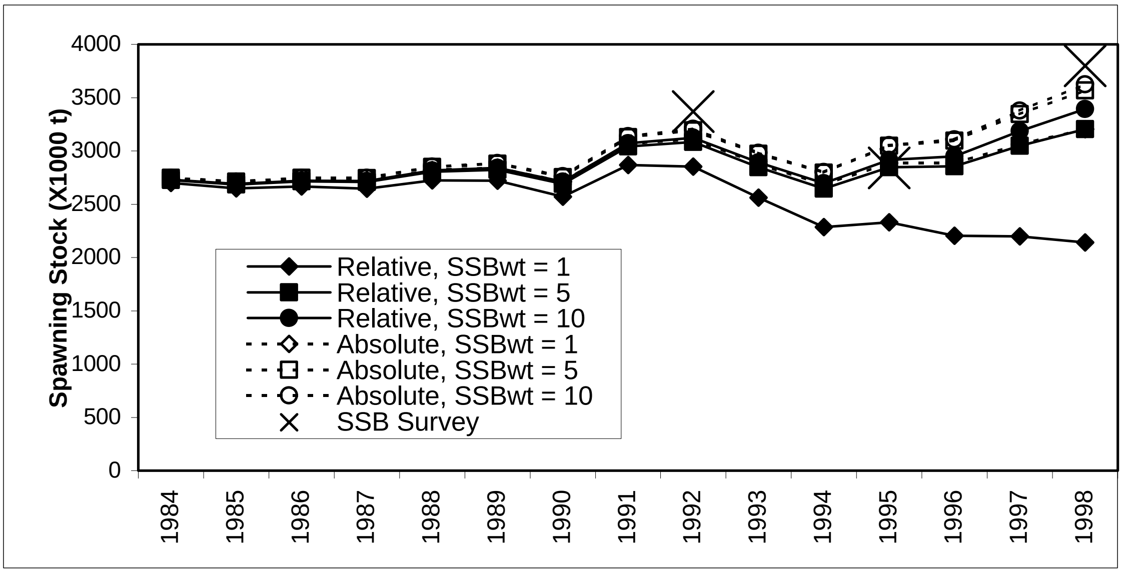
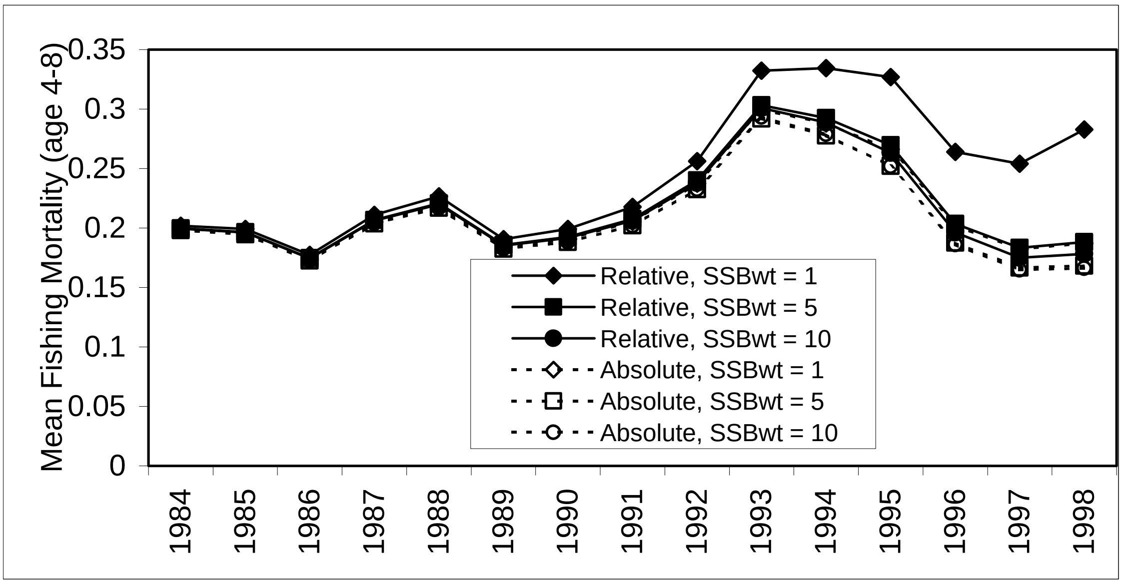


Figure 2.9.1.6
Recruitment ('000, at age 0) for Western mackerel, assessed using the AMCI method with two kinds of data.
SSB:Model fitted to catch at age data and SSB estimates form egg surveys.
Tags:Model fitted to catch at age data and tag recapture data.
ICA: Results from the final ICA assessment for comparison.





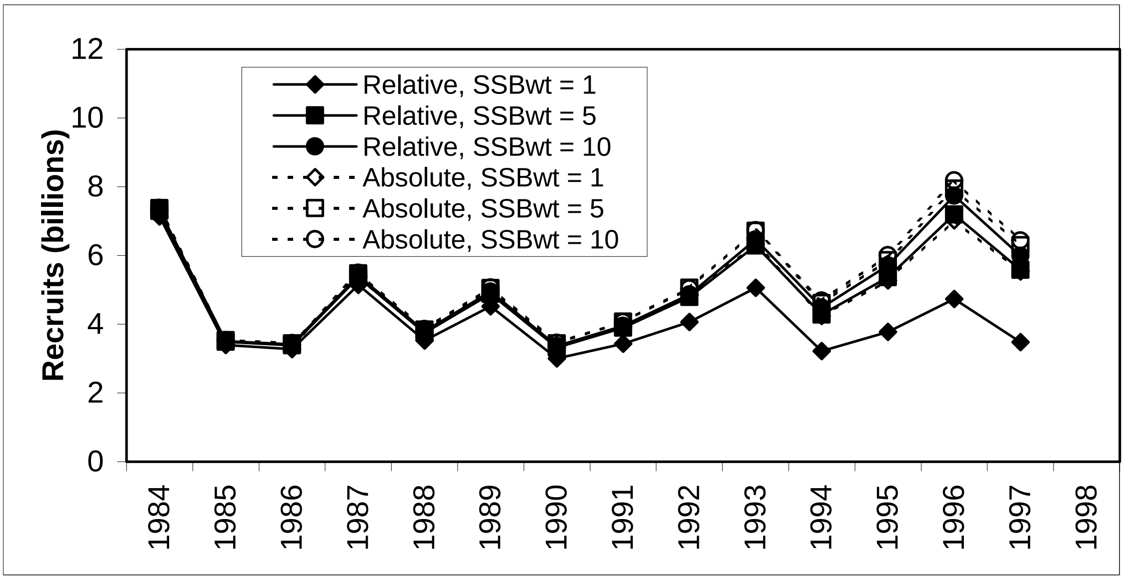


Fig. 2.9.1.7. Time series from exploratory ICA assessments for NEA mackerel.

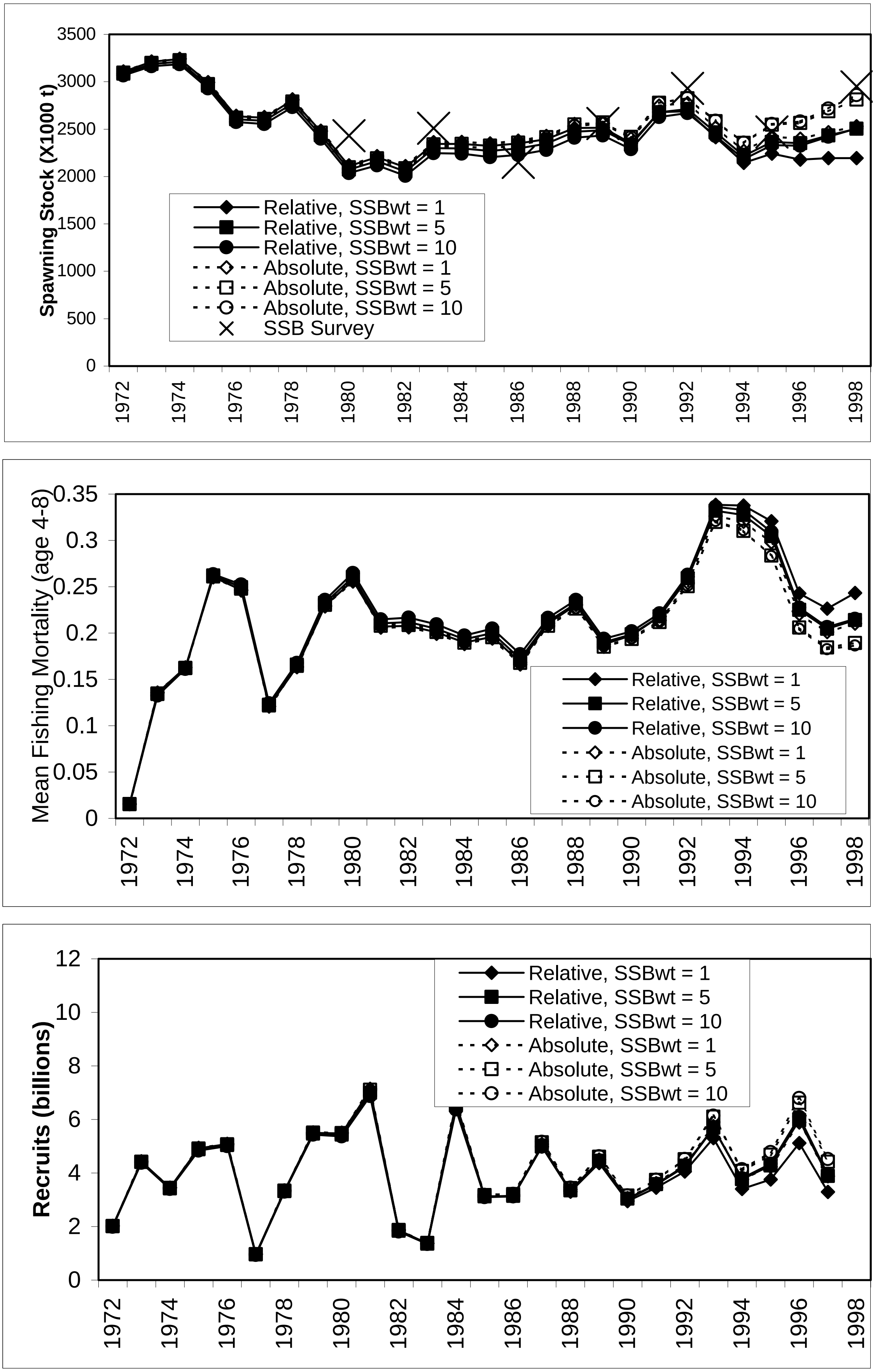


Fig. 2.9.1.8. Time series from exploratory ICA assessments for Western mackerel.

2.9.2 Stock Assessment

Tables 2.9.2.1 to 2.9.2.5 show the catches in number, the SSB index values used in the assessment the mean weights at age in the catch and mean weights at age in the stock and the proportion offish spawning. Natural mortality was again assumed to be 0.15 for all age groups.

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. Given that the SSB estimated from the 1998 egg survey was again higher than the SSB predicted from a projection of the 1997 assessment, the method by which SSB index is used to tune ICA was explored (see section 2.9.1). The WG decided to use the SSB index as a relative index of abundance and to give the index series a weighting of 5. Egg surveys prior to 1992 were only carried out in the western area and were raised to give retrospective SSB for the NEA stock assuming that the proportion of the NEA stock in the western area was 0.85. This proportion was estimated as 0.75 from the 1998 egg survey and this cast doubt on the validity on using a fixed value to raise the western SSB estimates for years prior to 1992. Thus only the 3 most recent SSB estimates were used in the analysis. In this years assessment the separable constraint was changed to one period of 7 years as there was no SSB index for the first period (1986-1988) due to the reason given above. The effect of this change is described in section 2.9.1. A terminal selection of 1.2 was used for the period of separable constraint. The selection pattern was calculated relative to the reference fishing mortality at age 5. The changes in the inputs used in ICA this year relative to other years is given in Table 2.9.1.3.

The model was fitted by a non-linear minimisation of:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=1998} \lambda_a (\ln(C_{a,y}) - \ln(F_y . S_a . \overline{N}_{a,y}))^2 +$$

$$\sum_{y=1992}^{y=1998} (\ln(EPB_y) - \ln(Q \sum_a N_{a,y} . O_{a,y} . W_{a,y} . \exp(-PF . F_y . S_a - PM . M)))^2$$

subject to the constraints

$S_5 = 1.0$

$S_{11} = 1.2$

where

Nbar - 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 1992–1998, referenced to age 5.

λ - weighting factor set to 0.01 for age 0, 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 2.9.2.6, 2.9.2.7 present the estimated fishing mortalities, population numbers-at-age. Tables 2.9.2.8a,b,c,d,e and Figures 2.9.2.1–2.9.2.4 present the ICA diagnostic output. The stock summary is presented in Table 2.9.2.9.

Table 2.9.2.1 North east Atlantic mackerel. Catch in numbers at age.

Output Generated by ICA Version 1.4 RUN 22

Mackerel NE Atlantic WG99

Catch in Number

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	288.40	81.22	48.52	7.42	55.12	65.40	24.25	10.01	43.45	19.35	25.37	14.76	37.96	36.01	61.13
1	32.02	267.06	56.42	40.20	145.97	64.26	140.53	58.46	83.58	128.14	147.31	81.53	119.85	144.39	99.35
2	86.40	20.75	412.12	156.97	131.61	312.74	209.85	212.52	156.29	210.32	221.49	340.90	168.88	186.48	229.77
3	685.13	57.93	37.26	664.65	182.06	207.69	410.75	206.42	356.21	266.68	306.98	340.21	333.37	238.43	264.57
4	389.08	442.20	74.30	56.79	514.81	167.59	208.15	375.45	266.59	398.24	267.42	275.03	279.18	378.88	323.19
5	252.47	250.43	353.45	89.17	69.72	362.47	156.74	188.62	306.14	244.28	301.35	186.85	177.67	246.78	361.94
6	98.44	164.05	201.93	245.04	83.50	48.70	254.01	129.15	156.07	255.47	184.93	197.86	96.30	135.06	207.62
7	22.17	61.92	122.48	150.88	192.22	58.12	42.55	197.89	113.90	149.93	189.85	142.34	119.83	84.38	118.39
8	62.05	19.42	41.32	86.03	117.13	111.25	49.70	51.08	138.46	97.75	106.11	113.41	55.81	66.50	72.75
9	48.11	47.22	13.14	34.86	53.46	68.24	85.45	43.41	51.21	121.40	80.05	69.19	59.80	39.45	47.35
10	37.63	37.34	31.82	19.70	19.80	32.23	33.04	70.84	36.61	38.79	57.62	42.44	25.80	26.73	24.39
11	30.22	26.77	22.30	25.80	12.60	13.90	16.59	29.74	40.96	29.07	20.41	37.96	18.35	13.95	16.55
12	69.45	96.96	78.78	63.27	54.98	35.81	27.91	52.99	68.20	68.22	57.55	39.75	30.65	24.97	22.93

x 10 ^ 6

Table 2.9.2.2 North East Atlantic mackerel. Biomass estimates from egg surveys

INDICES OF SPAWNING BIOMASS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	3370.0	*******	*******	2840.0	*******	*******	3800.0

x 10 ^ 3

Table 2.9.2.3 North East Atlantic mackerel. Catch weights at age

Weights at age in the catches (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.03100	0.05500	0.03900	0.07600	0.05500	0.04900	0.08500	0.06800	0.05100	0.06100	0.04600	0.07200	0.05800	0.07600	0.06500
1	0.10200	0.14400	0.14600	0.17900	0.13300	0.13600	0.15600	0.15600	0.16700	0.13400	0.13600	0.14300	0.14300	0.14300	0.15700
2	0.18400	0.26200	0.24500	0.22300	0.25900	0.23700	0.23300	0.25300	0.23900	0.24000	0.25500	0.23400	0.22600	0.23000	0.22700
3	0.29500	0.35700	0.33500	0.31800	0.32300	0.32000	0.33600	0.32700	0.33300	0.31700	0.33900	0.33300	0.31300	0.29500	0.31000
4	0.32600	0.41800	0.42300	0.39900	0.38800	0.37700	0.37900	0.39400	0.39700	0.37600	0.39000	0.39000	0.37700	0.35900	0.35400
5	0.34400	0.41700	0.47100	0.47400	0.45600	0.43300	0.42300	0.42300	0.46000	0.43600	0.44800	0.45200	0.42500	0.41500	0.40800
6	0.43100	0.43600	0.44400	0.51200	0.52400	0.45600	0.46700	0.46900	0.49500	0.48300	0.51200	0.50100	0.48400	0.45300	0.45200
7	0.54200	0.52100	0.45700	0.49300	0.55500	0.54300	0.52800	0.50600	0.53200	0.52700	0.54300	0.53900	0.51800	0.48100	0.46200
8	0.48000	0.55500	0.54300	0.49800	0.55500	0.59200	0.55200	0.55400	0.55500	0.54800	0.59000	0.57700	0.55100	0.52400	0.51800
9	0.56900	0.56400	0.59100	0.58000	0.56200	0.57800	0.60600	0.60900	0.59700	0.58300	0.58300	0.59400	0.57600	0.55300	0.55000
10	0.62800	0.62900	0.55200	0.63400	0.61300	0.58100	0.60600	0.63000	0.65100	0.59500	0.62700	0.60600	0.59600	0.57700	0.57300
11	0.63600	0.67900	0.69400	0.63500	0.62400	0.64800	0.59100	0.64900	0.66300	0.64700	0.67800	0.63100	0.60300	0.59100	0.59100
12	0.66300	0.71000	0.68800	0.71800	0.69700	0.73900	0.71300	0.70800	0.66900	0.67900	0.71300	0.67200	0.67000	0.63600	0.63100

Table 2.9.2.4 North East Atlantic mackerel. Stock weights at age.

Weights at age in the stock (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.08700	0.08700	0.08700	0.08600	0.08400	0.08400	0.08400	0.08400	0.08400	0.08400	0.08400	0.08400	0.08400	0.08400	0.09400
2	0.19800	0.16800	0.18000	0.15800	0.16100	0.18700	0.14600	0.16400	0.22100	0.20100	0.18600	0.16600	0.14100	0.19700	0.16800
3	0.25700	0.29500	0.27000	0.24600	0.24400	0.24800	0.22700	0.23900	0.26400	0.27000	0.24100	0.26600	0.25300	0.23200	0.24100
4	0.29700	0.31100	0.30200	0.28400	0.31000	0.30700	0.29100	0.31400	0.31600	0.31800	0.29900	0.32200	0.32000	0.30100	0.29800
5	0.32100	0.34000	0.35300	0.36800	0.33600	0.34800	0.33900	0.36000	0.36300	0.36100	0.35800	0.39100	0.36000	0.36300	0.35300
6	0.38900	0.37800	0.35400	0.38200	0.43300	0.37300	0.37400	0.41100	0.40400	0.41800	0.41000	0.44200	0.44000	0.40400	0.41300
7	0.43500	0.42900	0.40700	0.40400	0.45500	0.42400	0.41200	0.43500	0.42900	0.45800	0.46600	0.48700	0.46300	0.44700	0.43900
8	0.43500	0.45100	0.47300	0.41900	0.44500	0.47200	0.40800	0.50400	0.46800	0.46800	0.46800	0.50400	0.50300	0.48200	0.47800
9	0.47400	0.46000	0.45500	0.47000	0.46800	0.45200	0.43400	0.54200	0.49200	0.48500	0.47800	0.54100	0.56600	0.51900	0.51400
10	0.52100	0.55400	0.46900	0.49500	0.53100	0.46500	0.51900	0.57000	0.52600	0.51700	0.54900	0.50800	0.57500	0.54000	0.56100
11	0.50800	0.57500	0.48800	0.46200	0.59700	0.50400	0.51900	0.57000	0.55500	0.59000	0.60200	0.61500	0.61300	0.53300	0.53900
12	0.57300	0.61100	0.58600	0.56900	0.64700	0.59700	0.53700	0.58600	0.59200	0.57400	0.57900	0.63500	0.63800	0.60100	0.62400

Table 2.9.2.5 North East Atlantic mackerel. Proportion of fish spawning.

Proportion of fish spawning

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.0600
2	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.5800
3	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.8500
4	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800
5	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	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	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	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	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	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	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	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.2.6 Northeast Atlantic mackerel. Fishing mortlaity at age.

Fishing Mortality (per year)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.04240	0.02558	0.01472	0.00153	0.01616	0.01536	0.00788	0.00277	0.00495	0.00612	0.00607	0.00590	0.00435	0.00393	0.00404
1	0.02456	0.04772	0.02114	0.01438	0.03551	0.02231	0.03940	0.02242	0.02606	0.03219	0.03195	0.03104	0.02290	0.02067	0.02128
2	0.06284	0.01889	0.09166	0.07150	0.05664	0.09422	0.08940	0.07319	0.06462	0.07983	0.07922	0.07696	0.05677	0.05125	0.05277
3	0.20913	0.05186	0.04060	0.19799	0.10518	0.11290	0.16326	0.11299	0.12763	0.15768	0.15649	0.15202	0.11214	0.10123	0.10423
4	0.21346	0.19172	0.08260	0.07616	0.21937	0.12622	0.14979	0.20854	0.19430	0.24004	0.23823	0.23143	0.17072	0.15411	0.15867
5	0.26181	0.19599	0.21839	0.12783	0.11970	0.22396	0.15798	0.18639	0.22735	0.28087	0.27875	0.27079	0.19976	0.18032	0.18566
6	0.24069	0.25612	0.22660	0.21889	0.16050	0.10892	0.22862	0.17887	0.24407	0.30153	0.29925	0.29071	0.21445	0.19359	0.19932
7	0.11860	0.22180	0.29181	0.24938	0.25221	0.15176	0.12420	0.26446	0.28793	0.35571	0.35303	0.34294	0.25299	0.22838	0.23513
8	0.19498	0.13713	0.21387	0.32354	0.29480	0.21443	0.17766	0.20366	0.29177	0.36046	0.35773	0.34752	0.25636	0.23142	0.23827
9	0.21329	0.21110	0.12275	0.26603	0.32274	0.26418	0.23996	0.21967	0.32619	0.40298	0.39993	0.38851	0.28660	0.25872	0.26637
10	0.21617	0.24120	0.20341	0.25763	0.22470	0.31035	0.18664	0.30248	0.28708	0.35466	0.35198	0.34192	0.25224	0.22770	0.23443
11	0.25309	0.22250	0.20988	0.23868	0.24649	0.23006	0.24562	0.24138	0.27282	0.33704	0.33450	0.32494	0.23971	0.21639	0.22279
12	0.25309	0.22250	0.20988	0.23868	0.24649	0.23006	0.24562	0.24138	0.27282	0.33704	0.33450	0.32494	0.23971	0.21639	0.22279

Table 2.9.2.7 North East Atlantic mackerel. Population at age.

Population Abundance (1 January)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	7477.	3462.	3574.	5241.	3703.	4620.	3324.	3892.	4852.	6422.	4423.	5725.	7819.	5966.	16316.
1	1421.	6168.	2904.	3032.	4504.	3136.	3916.	2839.	3341.	4155.	5494.	3784.	4899.	6700.	5114.
2	1526.	1194.	5062.	2448.	2572.	3741.	2640.	3240.	2389.	2801.	3463.	4580.	3158.	4121.	5649.
3	3900.	1234.	1008.	3975.	1961.	2092.	2930.	2078.	2592.	1928.	2226.	2754.	3650.	2568.	3370.
4	2174.	2723.	1008.	833.	2807.	1520.	1608.	2142.	1597.	1964.	1417.	1639.	2036.	2808.	1997.
5	1176.	1512.	1935.	799.	665.	1940.	1153.	1192.	1497.	1132.	1329.	961.	1119.	1477.	2072.
6	494.	779.	1069.	1339.	605.	507.	1335.	847.	851.	1026.	736.	866.	631.	789.	1062.
7	213.	334.	519.	734.	926.	444.	392.	914.	610.	574.	653.	469.	557.	438.	559.
8	376.	163.	230.	334.	492.	619.	328.	298.	604.	394.	346.	395.	287.	372.	300.
9	269.	267.	122.	160.	208.	315.	430.	236.	209.	388.	236.	208.	240.	191.	254.
10	208.	187.	186.	93.	106.	130.	208.	291.	163.	130.	223.	136.	122.	155.	127.
11	145.	144.	127.	130.	62.	73.	82.	149.	185.	106.	78.	135.	83.	81.	106.
12	333.	522.	447.	320.	270.	187.	138.	265.	307.	256.	217.	154.	154.	138.	123.

x 10 ^ 6

Population Abundance (1 January)

AGE	1999
0	(6331).
1	13987.
2	4309.
3	4612.
4	2613.
5	1467.
6	1481.
7	749.
8	381.
9	204.
10	168.
11	86.
12	158.

x 10 ^ 6

Table 2.9.2.8a North East Atlantic mackerel. Diagnostic output.

Predicted Catch in Number

AGE	1992	1993	1994	1995	1996	1997	1998
0	22.25	36.36	24.86	31.26	31.51	21.71	61.13
1	79.83	122.30	160.49	107.44	103.01	127.32	100.03
2	138.94	199.80	245.19	315.34	161.95	191.31	269.81
3	288.85	261.66	300.05	361.30	360.06	229.86	310.14
4	262.55	390.29	279.81	315.27	297.34	373.18	272.68
5	283.47	258.30	301.35	212.47	188.62	226.86	326.76
6	171.72	249.04	177.35	203.57	113.42	129.22	178.61
7	142.17	160.26	181.28	127.11	116.03	83.35	109.16
8	142.43	111.09	97.11	108.18	60.41	71.65	59.29
9	54.25	120.17	72.66	62.59	55.79	40.56	55.41
10	37.99	36.16	61.80	36.81	25.25	29.44	24.70
11	41.20	28.15	20.78	34.97	16.54	14.73	19.79

x 10 ^ 6

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997	1998
0	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	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
4	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
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	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
9	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
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.2.8b North East Atlantic mackerel. Diagnostic output.

Predicted SSB Index Values

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	3236.9	*******	*******	3086.4	*******	*******	3640.4

x 10 ^ 3

Fitted Selection Pattern

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.1620	0.1305	0.0674	0.0119	0.1350	0.0686	0.0499	0.0149	0.0218	0.0218	0.0218	0.0218	0.0218	0.0218	0.0218
1	0.0938	0.2435	0.0968	0.1125	0.2967	0.0996	0.2494	0.1203	0.1146	0.1146	0.1146	0.1146	0.1146	0.1146	0.1146
2	0.2400	0.0964	0.4197	0.5593	0.4732	0.4207	0.5659	0.3926	0.2842	0.2842	0.2842	0.2842	0.2842	0.2842	0.2842
3	0.7988	0.2646	0.1859	1.5488	0.8787	0.5041	1.0334	0.6062	0.5614	0.5614	0.5614	0.5614	0.5614	0.5614	0.5614
4	0.8153	0.9782	0.3782	0.5958	1.8327	0.5636	0.9481	1.1188	0.8546	0.8546	0.8546	0.8546	0.8546	0.8546	0.8546
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
6	0.9193	1.3068	1.0376	1.7124	1.3409	0.4864	1.4471	0.9597	1.0736	1.0736	1.0736	1.0736	1.0736	1.0736	1.0736
7	0.4530	1.1317	1.3362	1.9509	2.1071	0.6776	0.7862	1.4189	1.2665	1.2665	1.2665	1.2665	1.2665	1.2665	1.2665
8	0.7447	0.6997	0.9793	2.5310	2.4629	0.9575	1.1245	1.0926	1.2834	1.2834	1.2834	1.2834	1.2834	1.2834	1.2834
9	0.8147	1.0771	0.5621	2.0811	2.6963	1.1796	1.5189	1.1785	1.4347	1.4347	1.4347	1.4347	1.4347	1.4347	1.4347
10	0.8257	1.2306	0.9314	2.0154	1.8772	1.3858	1.1814	1.6228	1.2627	1.2627	1.2627	1.2627	1.2627	1.2627	1.2627
11	0.9667	1.1352	0.9610	1.8672	2.0592	1.0273	1.5547	1.2950	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
12	0.9667	1.1352	0.9610	1.8672	2.0592	1.0273	1.5547	1.2950	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Table 2.9.2.8c Northeast Atlantic mackerel. Diagnostic output

---

No of years for separable analysis : 7
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1984 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 36
Number of observations : 87

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.2273	7	0.1981	0.2610	0.2119	0.2439	0.2279
2	1993	0.2809	7	0.2441	0.3232	0.2615	0.3017	0.2816
3	1994	0.2787	7	0.2394	0.3245	0.2580	0.3012	0.2796
4	1995	0.2708	8	0.2285	0.3209	0.2483	0.2953	0.2718
5	1996	0.1998	9	0.1649	0.2419	0.1812	0.2203	0.2007
6	1997	0.1803	10	0.1457	0.2232	0.1617	0.2010	0.1814
7	1998	0.1857	12	0.1455	0.2370	0.1639	0.2103	0.1871
Separable Model: Selection (S) by age								
8	0	0.0218	51	0.0079	0.0601	0.0130	0.0365	0.0249
9	1	0.1146	7	0.0980	0.1341	0.1058	0.1242	0.1150
10	2	0.2842	7	0.2458	0.3286	0.2639	0.3061	0.2850
11	3	0.5614	7	0.4883	0.6455	0.5228	0.6028	0.5628
12	4	0.8546	6	0.7465	0.9784	0.7977	0.9157	0.8567
	5	1.0000		Fixed : Reference Age				
13	6	1.0736	6	0.9444	1.2203	1.0056	1.1461	1.0759
14	7	1.2665	6	1.1200	1.4322	1.1895	1.3485	1.2690
15	8	1.2834	5	1.1411	1.4434	1.2087	1.3627	1.2857
16	9	1.4347	5	1.2804	1.6077	1.3538	1.5205	1.4372
17	10	1.2627	6	1.1216	1.4216	1.1886	1.3414	1.2650
	11	1.2000		Fixed : Last true age				
Separable model: Populations in year 1998								
18	0	16316459	136	1119919	237719683	4159436	64005508	41522620
19	1	5114458	18	3547197	7374182	4243468	6164222	5204367
20	2	5649171	13	4339959	7353326	4938179	6462531	5700510
21	3	3369808	11	2684581	4229937	3000775	3784225	3392551
22	4	1997339	10	1615244	2469821	1792272	2225869	2009093
23	5	2071875	10	1689814	2540319	1867231	2298949	2083110
24	6	1061694	10	863672	1305119	955563	1179613	1067599

Table 2.9.2.8d North East Atlantic mackerel. Diagnostic output

25	7	559366	10	453769	689538	502734	622378	562562
26	8	300248	11	240240	375246	267963	336424	302198
27	9	254319	12	200806	322092	225440	286897	256173
28	10	126917	12	98533	163477	111540	144414	127980
29	11	106419	13	81502	138953	92878	121934	107409

Separable model: Populations at age

30	1992	185188	14	140574	243959	160893	213150	187028
31	1993	105511	11	84469	131796	94191	118191	106193
32	1994	78394	10	63511	96763	70410	87283	78847
33	1995	135184	10	108986	167679	121113	150888	136003
34	1996	83330	11	66240	104830	74121	93683	83904
35	1997	81325	12	63814	103641	71862	92035	81950

SSB Index catchabilities

INDEX1

Linear model fitted. Slopes at age :

36	1	Q	1.104	7	1.031	1.363	1.104	1.273	1.188

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998
0	0.6693	-0.6306	0.0204	-0.7503	0.1861	0.5062	0.0000
1	0.0460	0.0467	-0.0857	-0.2760	0.1514	0.1258	-0.0068
2	0.1176	0.0513	-0.1016	0.0779	0.0419	-0.0256	-0.1607
3	0.2096	0.0190	0.0228	-0.0601	-0.0770	0.0366	-0.1589
4	0.0153	0.0202	-0.0453	-0.1365	-0.0630	0.0152	0.1699
5	0.0770	-0.0558	0.0000	-0.1284	-0.0598	0.0842	0.1023
6	-0.0956	0.0255	0.0418	-0.0285	-0.1636	0.0442	0.1505
7	-0.2217	-0.0666	0.0462	0.1132	0.0322	0.0123	0.0812
8	-0.0283	-0.1280	0.0886	0.0472	-0.0792	-0.0746	0.2046
9	-0.0578	0.0101	0.0969	0.1003	0.0694	-0.0278	-0.1571
10	-0.0369	0.0702	-0.0700	0.1424	0.0216	-0.0965	-0.0129
11	-0.0060	0.0320	-0.0183	0.0821	0.1038	-0.0547	-0.1788

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	0.04028	*******	*******	-.08320	*******	*******	0.04291

Table 2.9.2.8e North East Atlantic mackerel. Diagnostic output.

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 ---------------------------------------------------
 Separable model fitted from 1992  to 1998
 Variance                          0.0154
Skewness test stat.               -1.1164
Kurtosis test statistic            0.0881
Partial chi-square                 0.0653
Significance in fit                0.0000
Degrees of freedom                     49

 PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES
 ---------------------------------------------
   DISTRIBUTION STATISTICS FOR   INDEX1

 Linear catchability relationship assumed
 Variance                          0.0260
Skewness test stat.               -0.4993
Kurtosis test statistic           -0.5303
Partial chi-square                 0.0035
Significance in fit                0.0017
Number of observations                  3
Degrees of freedom                      2
Weight in the analysis             5.0000

 ANALYSIS OF VARIANCE
--------------------------
 Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         2.4495      87          36   51   0.0480
Catches at age                          2.4391      84          35   49   0.0498
  SSB Indices
  INDEX1                                0.0104       3           1    2   0.0052
 Weighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         1.0158      87          36   51   0.0199
Catches at age                          0.7562      84          35   49   0.0154
  SSB Indices
  INDEX1                                0.2596       3           1    2   0.1298
```

Table 2.9.2.9 North East Atlantic mackerel. Stock summary.

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1984	7476670	3400551	2656510	648084	0.2440	0.2059	100
1985	3461810	3601383	2625244	614275	0.2340	0.2006	100
1986	3574450	3588699	2640482	602128	0.2280	0.2067	103
1987	5240530	3467232	2618803	654805	0.2500	0.1992	99
1988	3702810	3631719	2693258	676288	0.2511	0.2093	103
1989	4619660	3644155	2727426	585921	0.2148	0.1651	100
1990	3324440	3443861	2582459	625611	0.2423	0.1676	99
1991	3892190	3798365	2906727	667883	0.2298	0.2084	98
1992	4851550	3902150	2933037	760351	0.2592	0.2491	99
1993	6422060	3806197	2747166	825036	0.3003	0.3077	100
1994	4423490	3718345	2578859	823477	0.3193	0.3054	100
1995	5725330	3887235	2796607	756291	0.2704	0.2967	100
1996	7818770	3869863	2853940	563585	0.1975	0.2189	100
1997	5965520	4355191	3095277	569543	0.1840	0.1976	99
1998	(16316460)	4732311	3298591	667218	0.2023	0.2034	100

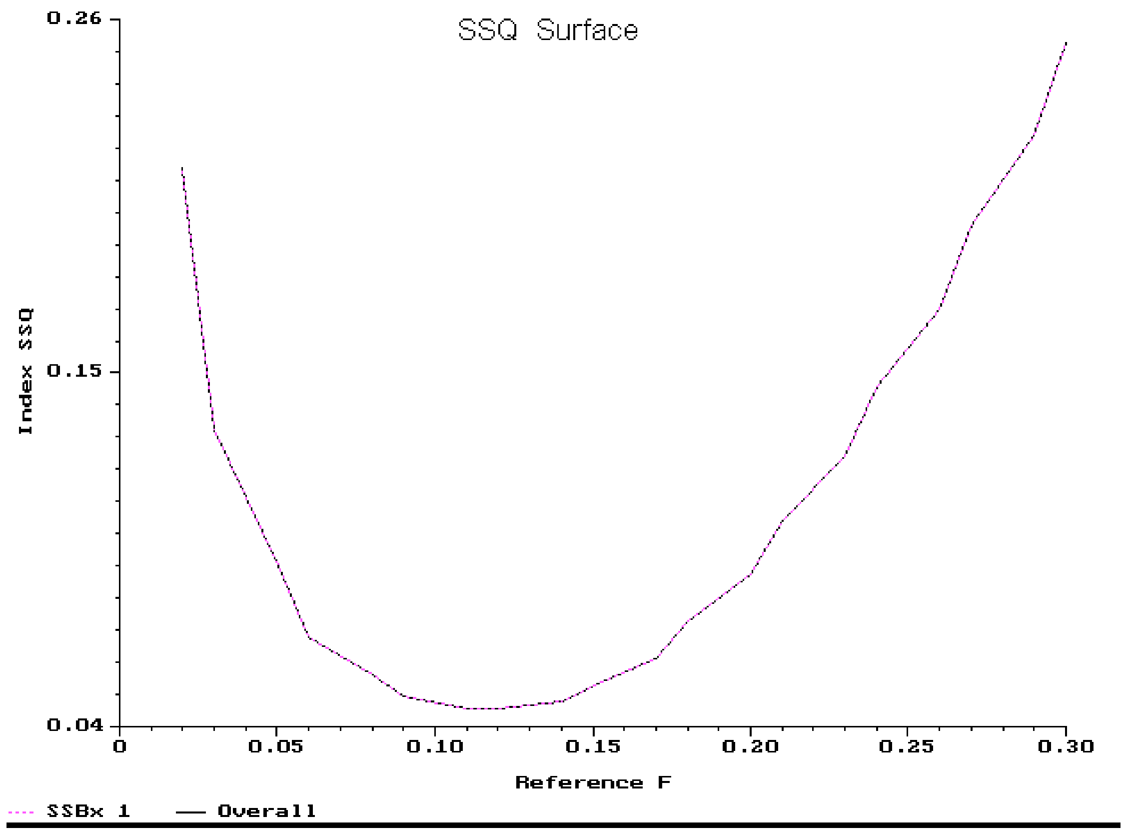


Figure 2.9.2.1 The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (1992-1998). There is only one period of separable constraint (1992-1998).

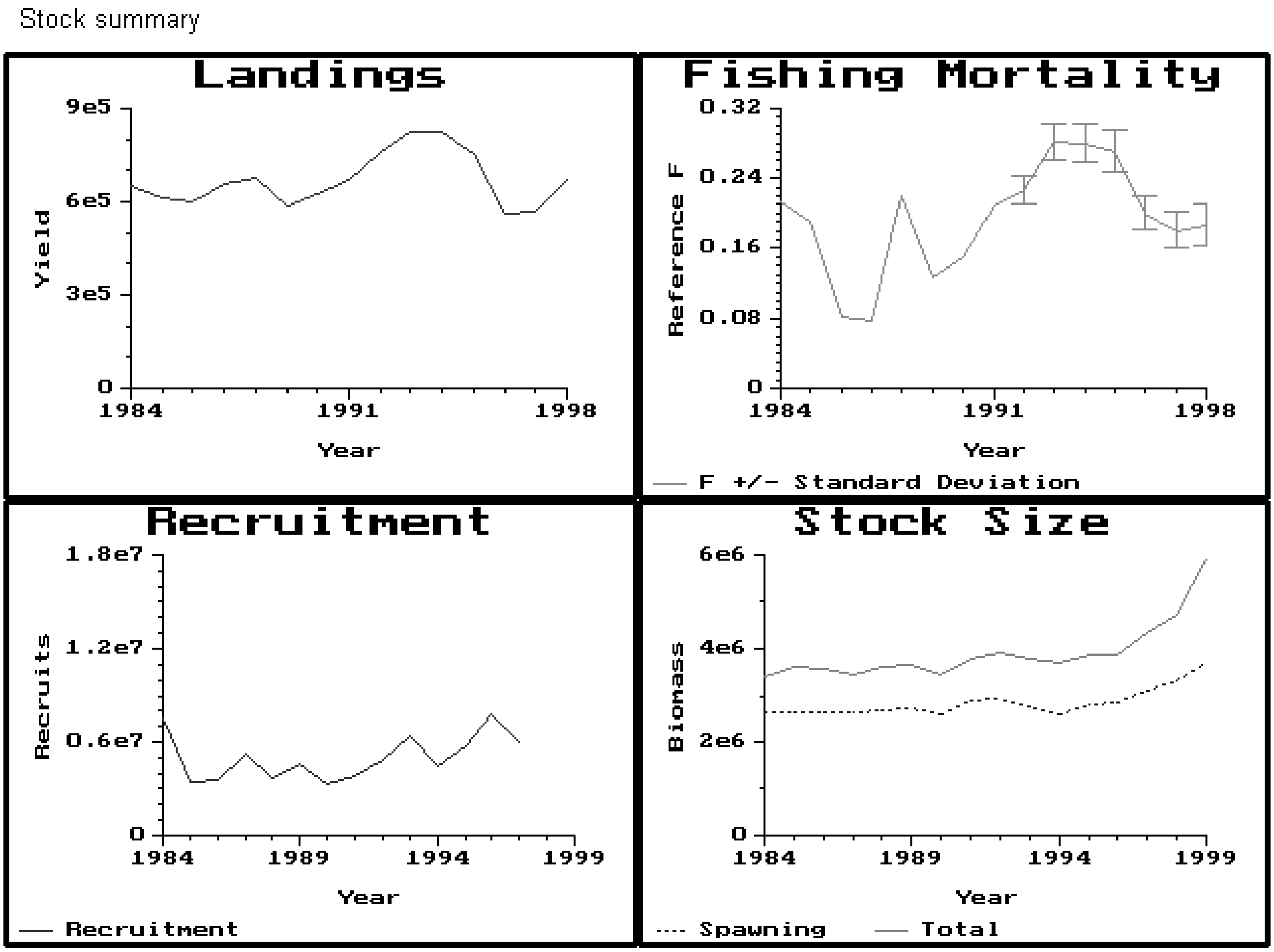


Figure 2.9.2.2 The long term trends in stock parameters for North Eastern Atlantic mackerel. Only SSB estimates from egg surveys covering the entire range of North East Atlantic mackerel are used (1992-1998) in the biomass index .

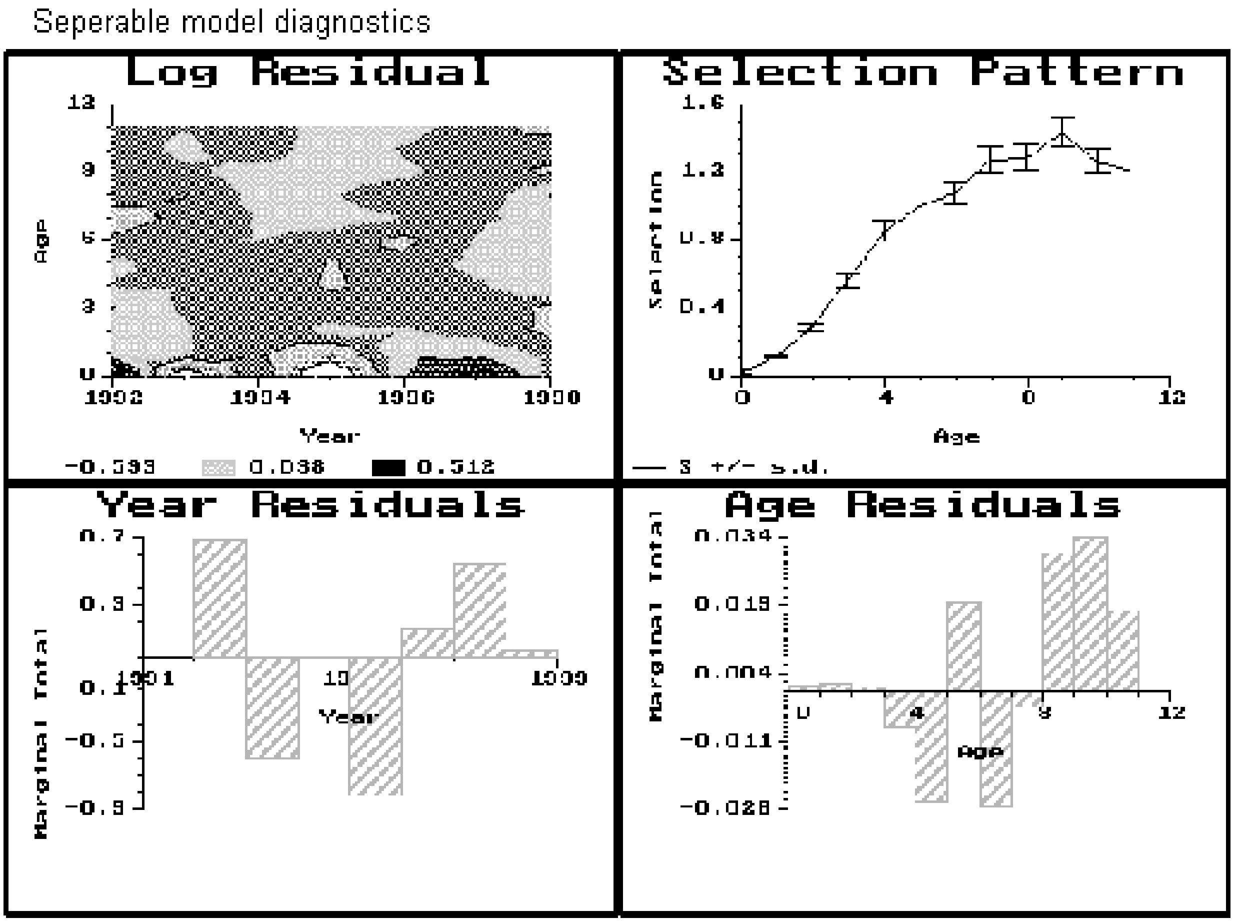


Figure 2.9.2.3 The catch at age residuals and ages fitted by ICA to the North East Atlantic mackerel data. Only SSB estimates from egg surveys covering the entire range of North East Atlantic mackerel are used (1992-1998) in the biomass index and there is only one period of separable constraint (1992-1998).

Tuning diagnostics: Biomass index 1

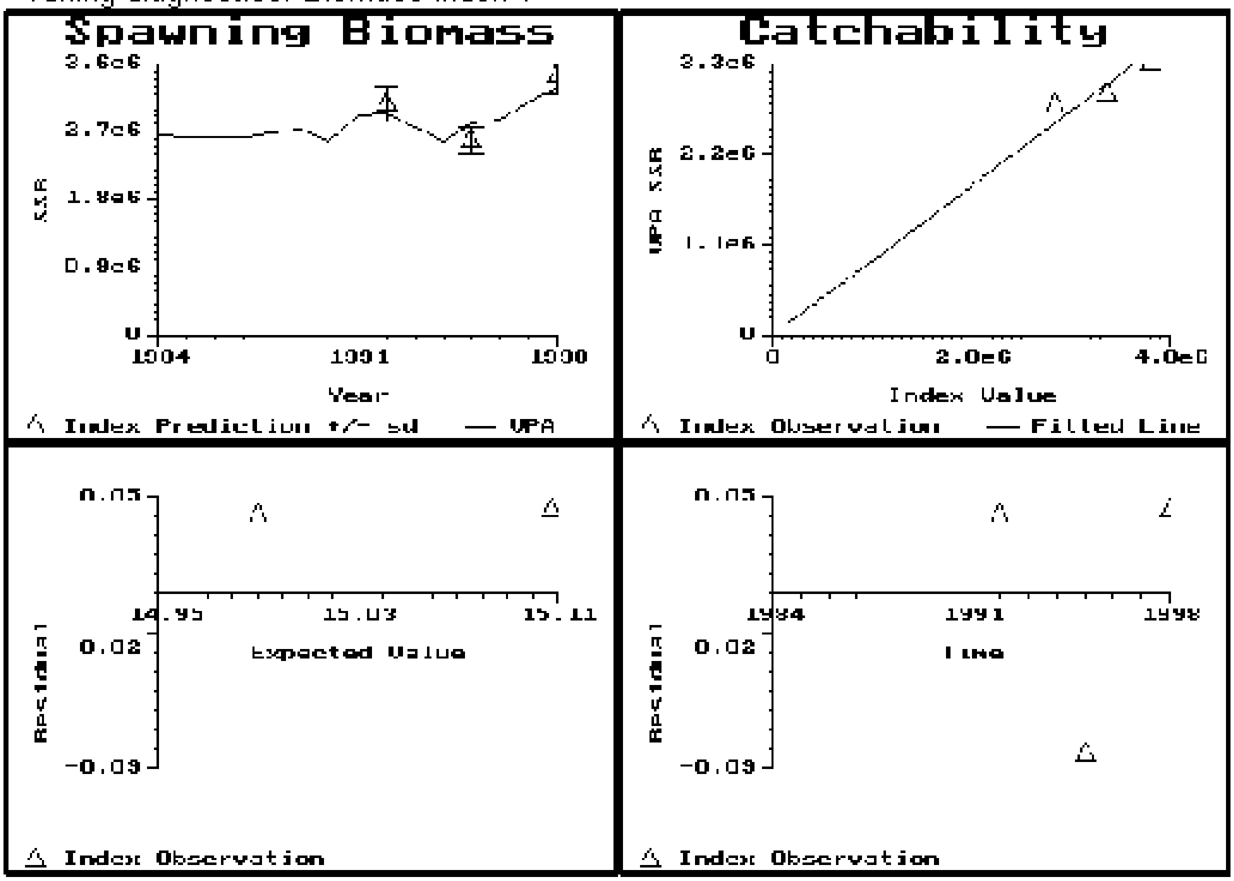


Figure 2.9.2.4 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic mackerel. Only SSB estimates from egg surveys covering the entire range of North East Atlantic mackerel are used (1992-1998) in the biomass index and there is only one period of separable constraint (1992-1998).

2.9.3 Reliability of the Assessment and Uncertainty estimation

Assessment: In previous years, the relatively poor sampling of some parts of the fishery, which may lead to quite large errors in the catch at age data, was pointed out as a problem in the assessment. This is still the case.

The problem of assessing the stock with very little supplementary data, which also has been pointed out previously, is still serious, although it presents itself in a somewhat different way this year. Last year, the problem was to obtain a stable stock estimate when the last independent information was far back in time, this year the problem relates more to the dependence of the estimate on the last data point. The WG considers the egg survey estimates of SSB to be quite reliable information. The most serious concern is that an increase in SSB as measured, can only be explained by at least one strong year class coming into the spawning stock, while there is not yet clear evidence that such a year class has recruited to the stock. The situation is further complicated by the strange area distribution of the 1996 year class, which makes its abundance difficult to evaluate using survey data.

An attempt to use existing supplementary information not previously used was made this year, by introducing the AMCI model which can use the large data set of Norwegian tags material as a source of information about mortality. Although this program is very newly developed and not extensively tested, it is somewhat reasssuring that it gives results in line with the ICA assessment.

Uncertainty: The variance estimates by ICA do not reflect directly the effect of these sources of uncertainty, but rather 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 are in the order of 20-25%, which is slightly better than in the last assessment done in 1997. The 1997 and 1998 year classes, for which there are very sparse data, have far higher CV's.

The SSB estimates as obtained by previous Working Groups (1995 - 1998) are shown in Figure 2.9.3.1. These estimates are quite well in accordance, although the estimates have tended to be revised upwards as more years data are included.

Estimates of uncertainty in future stock and catches by a parametric bootstrap method are given in Sections 2.11 and 2.12. This was done with the ICP program. This program takes the points estimates of stock numbers and fishing mortalities from ICA, with the option that recruitment estimates for the youngest ages may be substituted with other values. The variance-covariance matrix for these parameters derived from the optimisation process in ICA are used to provide distribution parameters for a parametric bootstrap of these parameters as stochastic starting values for projections. Thus, the distribution of interest parameters (SSB, and Fishing mortality) in the first prediction year is indicative of the uncertainty of the parameter estimation by the ICA assessment. This uncertainty assumes a lognormal distribution, and does not necessarily reflect the uncertainty in model specification. It should also be noted that these distributions will be biased, i.e. the mean of the lognormal distribution will not coincide with the point estimate, since the log-transform is non-linear. Correction for this bias is not straightforward. Unless mentioned specifically, this has not been attempted.

Projections more years ahead require stochastic recruitments. These are drawn by a non-parametric bootstrap, i.e. by drawing residuals around the stock-recruitment curve from the collection of residuals in the historical series of stock-recruitment pairs.

It should also be noted, that because the SSB estimates of both the Western and NEA mackerel, are modelled values fitted to different data, they are not directly comparable. Therefore, the difference between the two cannot be taken as an estimate of the Southern component.

Diagrams for the assessment quality control for the Northeast Atlantic mackerel combined are provided in Tables 2.9.3.1 (average F), 2.9.3.2 (recruitment) and 2.9.3.3 (spawning stock biomass).

Table 2.9.3.1: Assessment quality control diagram for North East Atlantic mackerel combined (average F(4-8,u))

Assessment Quality Control Diagram 1

Average F(4-8,u)												
Date of assessment	Year											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989												
1990												
1991												
1992												
1993												
1994												
1995	0.183	0.195	0.154	0.159	0.175	0.213	0.283	0.292				
1996	0.200	0.217	0.168	0.172	0.185	0.218	0.278	0.276	0.270			
1997	0.203	0.215	0.172	0.178	0.192	0.223	0.286	0.281	0.270	0.208		
1998	#	#	#	#	#	#	#	#	#	#	0.22	
1999	0.199	0.209	0.165	0.168	0.208	0.249	0.308	0.305	0.298	0.219	0.198	0.203

[1]Fishing mortalities not directly comparable due to increases in egg survey estimates used to tune the assessment.

Remarks: F values in 1998 (#) the same as in 1997, because assessment of WG97 was maintained.

Table 2.9.3.2: Assessment quality control diagram for North East Atlantic mackerel combined (Recruitment)

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
1989												
1990												
1991												
1992												
1993												
1994												
1995	3666	4903	2699	2793	3077	3394	2083					
1996	3910	5127	3000	3278	3764	4626	2589	1592				
1997	3805	5086	3027	3473	4007	5040	3021	5185	6757			
1998	#	#	#	#	#	#	#	#	#			
1999	3703	4620	3324	3892	4852	6422	4423	5725	7819	5966	16316	

[1]Average recruitment.
[2]Strong recruitment.
[3]1991 and 1992 year class abundance based on recruitment surveys as (1-2)year olds and (0-1), respectively. Numbers at age 0 have been calculated by using F and M in 1992 (for the 1992 year class) and in 1991 and 1992 (for the 1991 year class).
[4]Geometric mean.

Remarks: Recruitment in 1998 (#) the same as in 1997, because assessment of WG97 was maintained.

Table 2.9.3.3: Assessment quality control diagram for North East Atlantic mackerel combined (Spawning stock biomass)

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)														
Date of assessment	Year													
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1989														
1990														
1991														
1992														
1993[4]														
1994														
1995	3113	3145	2983	3325	3235	2786	2357							
1996	2869	2906	2801	3195	3206	2879	2549	2538						
1997	2827	2883	2769	3145	3158	2853	2556	2598	2456					
1998	#	#	#	#	#	#	#	#	#	2530				
1999	2693	2727	2582	2907	2933	2747	2579	2797	2854	3095	3299			

[1]Forecast.
[2]Average level of recruitment of 3,600 million at age 0.
[3]High level recruitment of 6,100 million at age 0.
[4]Forecast based on the assumption that the catch in 1993will be 750,000 tonnes and $F_{94}=F_{92.}$

Remarks: SSB values in 1998 (#) the same as in 1997, because assessment of WG97 was maintained.

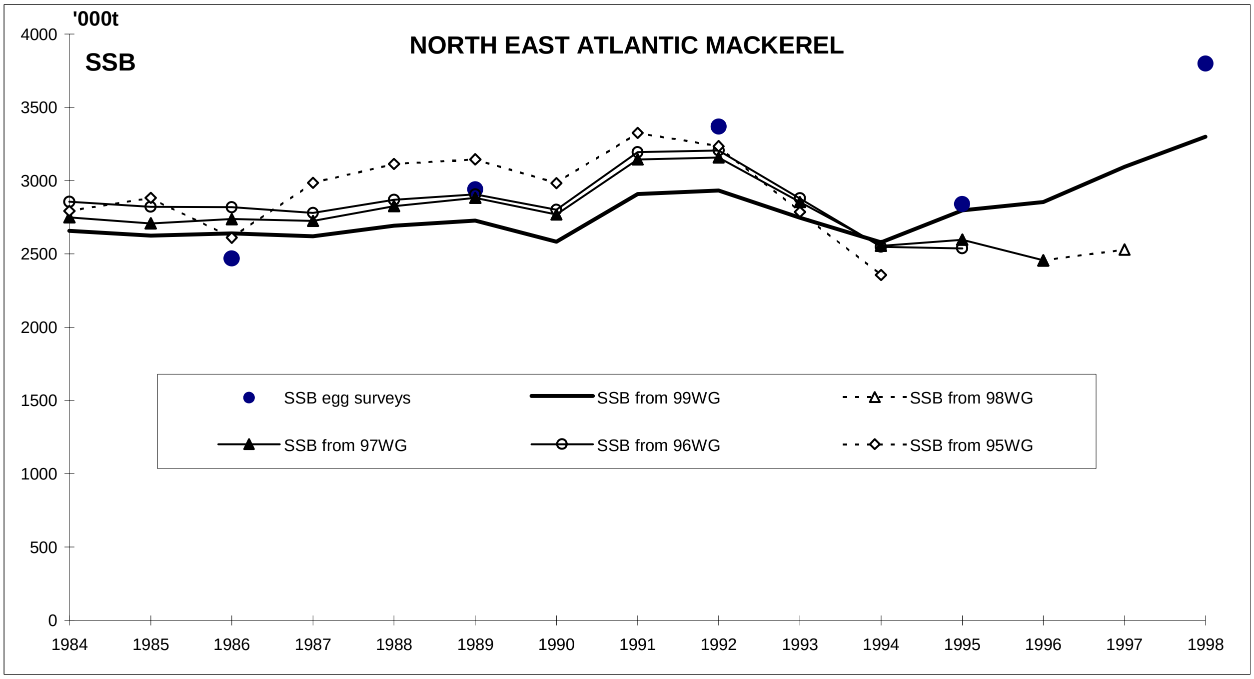


Figure 2.9.3.1 **Comparison of spawning stock biomass estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1992, 1995 and 1998 are also shown. At the 1999 working group only the last three biomass estimates (1992, 1995 and 1998) from the egg surveys were used. In the 1998 working group meeting the 1997 assessment was projected forward.**

2.10 Catch Predictions

Table 2.10.1 and Table 2.10.2 present the calculations for the input values for the catch forecasts and the input data for the predictions.

Apart from the recruitment of year class 1999 (age 0) and year class 1998 (age 1), the ICA-estimated abundances at all ages were used as the starting populations in the prediction.

The following assumptions were made regarding recruitment at age 0 and age 1 in 1999:

Age 0 No recruitment indices are available for the 1999 year class. A precautionary approach is to assume that this year class is of average strength. Therefore, the geometric mean was used for the 1999 recruitment. The value of 4072 million fish is calculated from the geometric mean (1972-1995) of recruitment to the Western mackerel, raised by the ratio (1.125) of the estimated Western and North East Atlantic mackerel recruitments for the period 1984-1995.

Age 1 The recruitment at age 1 is taken to be the geometric mean recruitment brought forward 1 year by the total mortality at age 0 in that year.

Recruitment at age 0 in 2000 and 2001 was also assumed to be 4072 million fish.

Catch forecasts have been calculated for the provision of area based TACs. Two “fleets” have been defined, corresponding to the exploitation of the western area, including the North Sea and the unregulated catches taken in international waters, Division IIa (Northern), and the southern area (Southern).

The exploitation pattern used in the prediction was the separable ICA Fs for the final year and then re-scaled according the ratio status quo F (1996-1998) and reference F (F_{4-8}). This exploitation pattern was subdivided into partial F’s for each fleet using the average ratio of the fleet catch at each age for the years 1996–1998. Weight at age in the catch was taken as an average of the values for the period 1995–1997 for each area. Weight at age in the stock was calculated from an average (1996–1998) of weights at age for the NEA mackerel stock.

The catch for 1999 is assumed to be the same as the catch of 670,000 t in 1998, since the TAC’s in both years were approximately the same (see Section 2.1).

Six single option summary tables are presented and summarised in the text tables below. Tables 2.10.3a–d refer to *status quo* fishing mortality in 1999 and Tables 2.10.3e-h refer to a catch constraint of 670 kt in 1999. Each of these two options for 1999 are then followed by:

F2000 = F2001 = 0.15 corresponding to earlier EU-Norway agreements;
F2000 = F2001 = 0.17 corresponding to F_{pa} and the EU-Norway agreements for 2000;
F2000 = F2001 = 0.20 upper level of F of the F-range 0.15-0.20 as requested by EU to give advise;
F2000 = F2001 = 0.2066 corresponding to the mean fishing mortality for the period 1996–1998.

UNITS: ‘000 t

	Status quo (F96-98=0.2066) F=0.15 2000,2001			*Status quo* (F96-98=0.2066) F= F_{pa} = 0.17 2000,2001			*Status quo* (F96-98=0.2066) F= 0.20 2000,2001			*Status quo* (F96-98=0.2066) F= F_{sq} =0.2066 1999,2000		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
1999	0.2066	723	3754	0.2066	723	3754	0.2066	723	3754	0.2066	723	3754
2000	0.15	571	3898	0.17	642	3872	0.20	746	3834	0.2066	769	3826
2001	0.15	600	3970	0.17	664	3886	0.20	754	3765	0.2066	772	3739

UNITS: ‘000 t

	Catch 1999 = 670 kt F=0.15 2000,2001			Catch 1999 = 670 kt F= F_{pa} = 0.17 2000,2001			Catch 1999 = 670 kt F= 0.20 2000,2001			Catch 1999 = 670 kt F= F_{sq} =0.2066 1999,2000		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
1999	0.19	670	3773	0.19	670	3773	0.19	670	3773	0.19	670	3773
2000	0.15	578	3940	0.17	650	3914	0.20	755	3876	0.2066	778	3867
2001	0.15	606	4006	0.17	671	3921	0.20	761	3799	0.2066	780	3772

The forecasts for 2000 and 2001 predict that SSB will increase for options F=0.15 and F=0.17 compared to 1999. However, the SSB in 2001 will be about the same compared to 1999 for the options F=0.20 and $F_{status\ quo}$ =0.2066.

A detailed multifleet prediction table is presented in Table 2.10.4.

Two multifleet management option tables are presented. Table 2.10.5 presents the option for *status quo* F in 1999, Table 2.10.6 presents a constant catch for each fleet in 1999; each is followed by a range of F_{99} values for both areas.

The forecasts of SSB for the two scenarios are higher compared to the predicted SSB values last year, because the SSB obtained from the 1998 egg surveys was high and strong year classes seem to recruit to the adult population. A warning should be given that the strength of these recruiting year classes might be estimated lower at next years working group meeting when more information regarding these year classes becomes available (see also Section 2.8).

Table 2.10.1 CALCULATION FOR INPUT PREDICTIONS FOR NORTH EAST ATLANTIC MACKEREL

UNIT: millions

Year class	AGE	Stock in numbers at 1/1/99
99	**0**	*4072*
98	**1**	*3488*
97	**2**	4309
96	**3**	4612
95	**4**	2613
94	**5**	1467
93	**6**	1481
92	**7**	749
91	**8**	381
90	**9**	204
89	**10**	168
88	**11**	86
	12+	158

< = geometric mean over period 1972-1995 of Western recruitment, raised by the average ratio of the estimated Western and NEA area recruitments for the period 1984-1995.

CALCULATION OF MEAN RECRUITMENT AT AGE 0		
Geometric mean western **84-95**	4067848	UNIT:
Geometric mean NEA **84-95**	4577702	thousands
RATIO	**1.125**	
Geometric mean western **72-95**	3618188	

CALCULATION OF RECRUITMENT AT AGE 1	
Numbers at age **1**	13987
At age **0** one year earlier	16316
CORRECTED **1**-YEAR OLDS	3488

Calculation of mean F over period 1996-1998	
F(4-8)96 =	0.2189
F(4-8)97 =	0.1976
F(4-8)98 =	0.2034
Fsq (4-8) 96-98 =	**0.2066**

	Mean F(4-8) **0.2034**	**Rescaling factor** **1.016**		**Rescaled fishery pattern for the prediction**	
AGE	**F-values from ICA**		**Rescaled F-values**	**SOUTH**	**NORTH**
0	0.00404		0.00410	**0.0034**	**0.0007**
1	0.02128		0.02162	**0.0052**	**0.0164**
2	0.05277		0.05361	**0.0052**	**0.0484**
3	0.10423		0.10588	**0.0050**	**0.1009**
4	0.15867		0.16118	**0.0086**	**0.1526**
5	0.18566		0.18860	**0.0103**	**0.1783**
6	0.19932		0.20248	**0.0124**	**0.1901**
7	0.23513		0.23886	**0.0171**	**0.2218**
8	0.23827		0.24205	**0.0203**	**0.2217**
9	0.26637		0.27059	**0.0280**	**0.2426**
10	0.23443		0.23814	**0.0257**	**0.2125**
11	0.22279		0.22632	**0.0267**	**0.1996**
12+	0.22279		0.22632	**0.0213**	**0.2050**
	F of WG99				

MAC-south TOTAL (n)	**MAC-north TOTAL (n)**	**MAC-south fraction**	**MAC-north fraction**
112250	23303	0.82809	0.17191
88017	279358	0.23958	0.76042
56326	526541	0.09664	0.90336
39496	799100	0.04710	0.95290
52337	929562	0.05330	0.94670
43131	743149	0.05485	0.94515
26791	411869	0.06107	0.93893
23042	299704	0.07139	0.92861
16403	178848	0.08401	0.91599
15197	131518	0.10358	0.89642
8293	68684	0.10773	0.89227
5777	43161	0.11806	0.88194
7390	71231	0.09400	0.90600

Table 2.10.1 **CALCULATION FOR INPUT PREDICTIONS FOR NORTH EAST ATLANTIC MACKEREL**
CONTINUED

AGE	Proportion MATURE		1996	1997	1998
0	0.00		0.00	0.00	0.00
1	0.11		0.14	0.14	0.06
2	0.63		0.65	0.65	0.58
3	0.89		0.91	0.91	0.85
4	0.97		0.97	0.97	0.98
5	0.97		0.97	0.97	0.98
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

AGE	NEA Mean weight at age in the STOCK		1996	1997	1998
0	0.000		0.000	0.000	0.000
1	0.087	NEA	0.084	0.084	0.094
2	0.169		0.141	0.197	0.168
3	0.242		0.253	0.232	0.241
4	0.303		0.32	0.301	0.289
5	0.359		0.36	0.363	0.353
6	0.419		0.44	0.404	0.413
7	0.450		0.463	0.447	0.439
8	0.488		0.503	0.482	0.478
9	0.533		0.566	0.519	0.514
10	0.559		0.575	0.540	0.561
11	0.562		0.613	0.533	0.539
12+	0.621		0.638	0.601	0.624

AGE	NORTHERN Mean weight at age in the CATCH		1996	1997	1998
0	0.064		0.055	0.076	0.060
1	0.156	NORTHERN	0.152	0.150	0.165
2	0.232		0.229	0.235	0.231
3	0.309		0.314	0.295	0.317
4	0.366		0.380	0.361	0.356
5	0.418		0.426	0.418	0.411
6	0.466		0.486	0.455	0.458
7	0.490		0.522	0.484	0.465
8	0.536		0.558	0.529	0.522
9	0.567		0.583	0.559	0.558
10	0.589		0.602	0.583	0.583
11	0.605		0.611	0.598	0.605
12+	0.653		0.675	0.640	0.645

AGE	SOUTHERN Mean weight at age in the CATCH		1996	1997	1998
0	0.067		0.059	0.076	0.065
1	0.122	SOUTHERN	0.117	0.111	0.138
2	0.181		0.175	0.176	0.192
3	0.261		0.272	0.274	0.237
4	0.319		0.326	0.319	0.313
5	0.376		0.410	0.366	0.350
6	0.414		0.450	0.416	0.375
7	0.441		0.466	0.449	0.407
8	0.471		0.493	0.472	0.449
9	0.493		0.510	0.509	0.461
10	0.523		0.545	0.529	0.494
11	0.528		0.546	0.544	0.493
12+	0.580	= weighted mean weight	0.561	0.583	0.513
			0.656	0.596	0.566
			0.626	0.644	0.616
			0.663	0.664	0.643

AGE	NEA Mean weight at age in the CATCH		1996	1997	1998
0	0.066		0.058	0.076	0.065
1	0.148	NEA	0.143	0.143	0.157
2	0.228		0.226	0.230	0.227
3	0.306		0.313	0.295	0.310
4	0.363		0.377	0.359	0.354
5	0.416		0.425	0.415	0.408
6	0.463		0.484	0.453	0.452
7	0.487		0.518	0.481	0.462
8	0.531		0.551	0.524	0.518
9	0.560		0.576	0.553	0.550
10	0.582		0.596	0.577	0.573
11	0.595		0.603	0.591	0.591
12+	0.646		0.670	0.636	0.631

Table 2.10.2 North East Atlantic Mackerel. Multifleet prediction: Input data

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction with mangement option table: Input data

1999	NORTHERN		SOUTHERN							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0007	0.064	0.0034	0.067	4072.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0164	0.156	0.0052	0.122	3488.000	0.1500	0.1100	0.4000	0.4000	0.087
2	0.0484	0.232	0.0052	0.181	4309.000	0.1500	0.6300	0.4000	0.4000	0.169
3	0.1009	0.309	0.0050	0.261	4612.000	0.1500	0.8900	0.4000	0.4000	0.242
4	0.1526	0.366	0.0086	0.319	2613.000	0.1500	0.9700	0.4000	0.4000	0.303
5	0.1783	0.418	0.0103	0.376	1467.000	0.1500	0.9700	0.4000	0.4000	0.359
6	0.1901	0.466	0.0124	0.414	1481.000	0.1500	0.9900	0.4000	0.4000	0.419
7	0.2218	0.490	0.0171	0.441	749.000	0.1500	1.0000	0.4000	0.4000	0.450
8	0.2217	0.536	0.0203	0.471	381.000	0.1500	1.0000	0.4000	0.4000	0.488
9	0.2426	0.567	0.0280	0.493	204.000	0.1500	1.0000	0.4000	0.4000	0.533
10	0.2125	0.589	0.0257	0.523	168.000	0.1500	1.0000	0.4000	0.4000	0.559
11	0.1996	0.605	0.0267	0.528	86.000	0.1500	1.0000	0.4000	0.4000	0.562
12+	0.2050	0.653	0.0213	0.580	158.000	0.1500	1.0000	0.4000	0.4000	0.621
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

2000	NORTHERN		SOUTHERN							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0007	0.064	0.0034	0.067	4072.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0164	0.156	0.0052	0.122	.	0.1500	0.1100	0.4000	0.4000	0.087
2	0.0484	0.232	0.0052	0.181	.	0.1500	0.6300	0.4000	0.4000	0.169
3	0.1009	0.309	0.0050	0.261	.	0.1500	0.8900	0.4000	0.4000	0.242
4	0.1526	0.366	0.0086	0.319	.	0.1500	0.9700	0.4000	0.4000	0.303
5	0.1783	0.418	0.0103	0.376	.	0.1500	0.9700	0.4000	0.4000	0.359
6	0.1901	0.466	0.0124	0.414	.	0.1500	0.9900	0.4000	0.4000	0.419
7	0.2218	0.490	0.0171	0.441	.	0.1500	1.0000	0.4000	0.4000	0.450
8	0.2217	0.536	0.0203	0.471	.	0.1500	1.0000	0.4000	0.4000	0.488
9	0.2426	0.567	0.0280	0.493	.	0.1500	1.0000	0.4000	0.4000	0.533
10	0.2125	0.589	0.0257	0.523	.	0.1500	1.0000	0.4000	0.4000	0.559
11	0.1996	0.605	0.0267	0.528	.	0.1500	1.0000	0.4000	0.4000	0.562
12+	0.2050	0.653	0.0213	0.580	.	0.1500	1.0000	0.4000	0.4000	0.621
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

(cont.)

2001	NORTHERN		SOUTHERN							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0007	0.064	0.0034	0.067	4072.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0164	0.156	0.0052	0.122	.	0.1500	0.1100	0.4000	0.4000	0.087
2	0.0484	0.232	0.0052	0.181	.	0.1500	0.6300	0.4000	0.4000	0.169
3	0.1009	0.309	0.0050	0.261	.	0.1500	0.8900	0.4000	0.4000	0.242
4	0.1526	0.366	0.0086	0.319	.	0.1500	0.9700	0.4000	0.4000	0.303
5	0.1783	0.418	0.0103	0.376	.	0.1500	0.9700	0.4000	0.4000	0.359
6	0.1901	0.466	0.0124	0.414	.	0.1500	0.9900	0.4000	0.4000	0.419
7	0.2218	0.490	0.0171	0.441	.	0.1500	1.0000	0.4000	0.4000	0.450
8	0.2217	0.536	0.0203	0.471	.	0.1500	1.0000	0.4000	0.4000	0.488
9	0.2426	0.567	0.0280	0.493	.	0.1500	1.0000	0.4000	0.4000	0.533
10	0.2125	0.589	0.0257	0.523	.	0.1500	1.0000	0.4000	0.4000	0.559
11	0.1996	0.605	0.0267	0.528	.	0.1500	1.0000	0.4000	0.4000	0.562
12+	0.2050	0.653	0.0213	0.580	.	0.1500	1.0000	0.4000	0.4000	0.621
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

Notes: Run name : MANELT02
Date and time: 22SEP99:23:50

Table 2.10.3a North East Atlantic Mackerel. Two area prediction summary table.
Status quo F constraint of 0.2066 for each fleet in 1999 and F= 0.15 in 2000 and 2001.

22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.1929	1775097	679256	1.0000	0.0137	147691	43760	1922788	723017	23788000	4958784	14372820	4250738	12812908	3754257
2000	0.7260	0.1401	1356683	536657	0.7260	0.0100	111251	34673	1467933	571330	22767765	4954473	13940515	4349463	12570415	3897882
2001	0.7260	0.1401	1373287	562955	0.7260	0.0100	115128	37379	1488415	600334	22309838	5021330	13585571	4440149	12223760	3969754
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT02
Date and time : 23SEP99:00:39
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.3b North East Atlantic Mackerel. Two area prediction summary table.
Status quo F constraint of 0.2066 for each fleet in 1999 and F= 0.17 in 2000 and 2001.

23:33 Wednesday, September
23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.1929	1775097	679256	1.0000	0.0137	147691	43760	1922788	723017	23788000	4958784	14372820	4250738	12812908	3754257
2000	0.8228	0.1587	1525844	603163	0.8228	0.0113	125253	38971	1651096	642134	22767765	4954473	13940515	4349463	12498109	3872263
2001	0.8228	0.1587	1522813	622788	0.8228	0.0113	128010	41337	1650824	664124	22140623	4956018	13423648	4376490	12006898	3886373
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT02
Date and time : 23SEP99:00:39
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.3c North East Atlantic Mackerel. Two area prediction summary table. Status quo F constraint of 0.2066 for each fleet in 1999 and F= 0.20 in 2000 and 2001.

The SAS System 12:42 Thursday, September 23, 1999

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.1929	1775097	679256	1.0000	0.0137	147691	43760	1922788	723017	23788000	4958784	14372820	4250738	12812908	3754257
2000	0.9681	0.1867	1774714	700832	0.9681	0.0133	145911	45283	1920625	746115	22767765	4954473	13940515	4349463	12390565	3834186
2001	0.9681	0.1867	1734260	706757	0.9681	0.0133	146397	46887	1880657	753644	21891749	4860150	13185627	4283075	11690809	3765139
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name             : SPRELT02
       Date and time        : 23SEP99:12:50
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis     : F factors
```

Table 2.10.3d North East Atlantic Mackerel. Two area prediction summary table. Status quo F constraint of 0.2066 for each fleet in 1999, 2000 and 2001.

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.1929	1775097	679256	1.0000	0.0137	147691	43760	1922788	723017	23788000	4958784	14372820	4250738	12812908	3754257
2000	1.0000	0.1929	1828694	721988	1.0000	0.0137	150401	46650	1979095	768639	22767765	4954473	13940515	4349463	12367052	3825865
2001	1.0000	0.1929	1778790	724337	1.0000	0.0137	150297	48049	1929087	772386	21837781	4839392	13134032	4262852	11622716	3739070
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name             : SPRELT02
       Date and time        : 23SEP99:00:39
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis     : F factors
```

Table 2.10.3e North East Atlantic Mackerel. Two area prediction summary table. Catch constraint of 670 kt in 1999 and F= 0.15 in 2000 and 2001.

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	0.9207	0.1776	1643930	629457	0.9207	0.0127	136658	40550	1780587	670007	23788000	4958784	14372820	4250738	12868490	3773336
2000	0.7260	0.1401	1370854	543020	0.7260	0.0100	112278	35098	1483132	578119	22899066	5003323	14065495	4396906	12681860	3940040
2001	0.7260	0.1401	1385095	568613	0.7260	0.0100	116044	37783	1501139	606396	22408788	5062610	13682472	4480823	12309704	4005752
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name             : SPRELT02
       Date and time        : 23SEP99:00:39
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis     : F factors
```

Table 2.10.3f North East Atlantic Mackerel. Two area prediction summary table. Catch constraint of 670 kt in 1999 and F= 0.17 in 2000 and 2001.

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	0.9207	0.1776	1643930	629457	0.9207	0.0127	136658	40550	1780587	670007	23788000	4958784	14372820	4250738	12868490	3773336
2000	0.8228	0.1587	1541760	610307	0.8228	0.0113	126406	39448	1668165	649755	22899066	5003323	14065495	4396906	12608746	3914096
2001	0.8228	0.1587	1535824	629016	0.8228	0.0113	129018	41781	1664843	670797	22237846	4996534	13518843	4416407	12090663	3921410
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name             : SPRELT02
       Date and time        : 23SEP99:00:39
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis     : F factors
```

Table 2.10.3g North East Atlantic Mackerel. Two area prediction summary table. Catch constraint of 670 kt in 1999 and F= 0.20 in 2000 and 2001.

The SAS System 12:42 Thursday, September 23, 1999

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	0.9207	0.1776	1643930	629457	0.9207	0.0127	136658	40550	1780587	670007	23788000	4958784	14372820	4250738	12868490	3773336
2000	0.9681	0.1867	1793186	709119	0.9681	0.0133	147249	45836	1940434	754956	22899066	5003323	14065495	4396906	12500004	3875537
2001	0.9681	0.1867	1748936	713772	0.9681	0.0133	147531	47387	1896467	761159	21986444	4899547	13278324	4321884	11771414	3798786
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name            : SPRELT02
       Date and time       : 23SEP99:12:50
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis    : F factors
```

Table 2.10.3h North East Atlantic Mackerel. Two area prediction summary table. Catch constraint of 670 kt in 1999 and status quo F= 0.2066 in 2000 and 2001.

23:33 Wednesday, September 22, 1999

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Summary table

	NORTHERN				SOUTHERN				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	0.9207	0.1776	1643930	629457	0.9207	0.0127	136658	40550	1780587	670007	23788000	4958784	14372820	4250738	12868490	3773336
2000	1.0000	0.1929	1847719	730523	1.0000	0.0137	151779	47220	1999498	777743	22899066	5003323	14065495	4396906	12476229	3867111
2001	1.0000	0.1929	1793811	731515	1.0000	0.0137	151457	48560	1945269	780075	21931929	4878546	13226189	4301421	11702644	3772419
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name            : SPRELT02
       Date and time       : 23SEP99:00:39
       Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
                              SOUTHERN: Simple mean, age 4 - 8
       Prediction basis    : F factors
```

Table 2.10.4 North East Atlantic Mackerel. Two area prediction detailed table. Status quo F constraint of 0.2066 for each fleet in 1999, 2000 and 2001.

22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction: Detailed tables

Year 1999. NORTHERN F-factor 1.0000 and reference F 0.1929
SOUTHERN F-factor 1.0000 and reference F 0.0137

	NORTHERN			SOUTHERN			Total				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0007	2642	169	0.0034	12831	860	15472	1029	4072000	0	0	0	0	0
1	0.0164	52564	8200	0.0052	16667	2033	69231	10233	3488000	303456	383680	33380	358228	31166
2	0.0484	188695	43777	0.0052	20273	3669	208968	47447	4309000	728221	2714670	458779	2502350	422897
3	0.1009	410579	126869	0.0050	20346	5310	430925	132179	4612000	1116104	4104680	993333	3705313	896686
4	0.1526	342664	125415	0.0086	19311	6160	361976	131575	2613000	791739	2534610	767987	2237949	678099
5	0.1783	221885	92748	0.0103	12818	4819	234703	97567	1467000	526653	1422990	510853	1242742	446144
6	0.1901	237268	110567	0.0124	15477	6407	252745	116974	1481000	620539	1466190	614334	1273370	533542
7	0.2218	137635	67441	0.0171	10611	4680	148246	72121	749000	337050	749000	337050	641096	288493
8	0.2217	69879	37455	0.0203	6398	3014	76277	40469	381000	185928	381000	185928	325707	158945
9	0.2426	40400	22907	0.0280	4663	2299	45063	25206	204000	108732	204000	108732	172411	91895
10	0.2125	29587	17427	0.0257	3578	1871	33165	19298	168000	93912	168000	93912	143837	80405
11	0.1996	14306	8655	0.0267	1914	1010	16219	9665	86000	48332	86000	48332	73982	41578
12+	0.2050	26993	17627	0.0213	2805	1627	29798	19253	158000	98118	158000	98118	135921	84407
Total		1775097	679256		147691	43760	1922788	723017	23788000	4958784	14372820	4250738	12812908	3754257
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 2.10.4 (Continued)

Year 2000. NORTHERN F-factor 1.0000 and reference F 0.1929
SOUTHERN F-factor 1.0000 and reference F 0.0137

	NORTHERN			SOUTHERN			Total				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0007	2642	169	0.0034	12831	860	15472	1029	4072000	0	0	0	0	0
1	0.0164	52601	8206	0.0052	16678	2035	69280	10241	3490463	303670	383951	33404	358481	31188
2	0.0484	128658	29849	0.0052	13823	2502	142480	32350	2937998	496522	1850939	312809	1706173	288343
3	0.1009	312940	96699	0.0050	15507	4047	328448	100746	3515233	850686	3128558	757111	2824163	683447
4	0.1526	468255	171381	0.0086	26389	8418	494645	179800	3570700	1081922	3463579	1049464	3058187	926631
5	0.1783	289524	121021	0.0103	16725	6289	306249	127310	1914198	687197	1856773	666581	1621578	582147
6	0.1901	167518	78063	0.0124	10927	4524	178445	82587	1045630	438119	1035174	433738	899037	376697
7	0.2218	191299	93736	0.0171	14748	6504	206047	100241	1041037	468467	1041037	468467	891061	400977
8	0.2217	93112	49908	0.0203	8526	4016	101638	53924	507674	247745	507674	247745	433998	211791
9	0.2426	50984	28908	0.0280	5884	2901	56869	31809	257443	137217	257443	137217	217578	115969
10	0.2125	23591	13895	0.0257	2853	1492	26444	15387	133957	74882	133957	74882	114691	64112
11	0.1996	18955	11468	0.0267	2536	1339	21491	12807	113950	64040	113950	64040	98027	55091
12+	0.2050	28613	18684	0.0213	2973	1724	31586	20409	167481	104006	167481	104006	144077	89472
Total		1828694	721988		150401	46650	1979095	768639	22767765	4954473	13940515	4349463	12367052	3825865
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year 2001. NORTHERN F-factor 1.0000 and reference F 0.1929
SOUTHERN F-factor 1.0000 and reference F 0.0137

	NORTHERN			SOUTHERN			Total				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0007	2642	169	0.0034	12831	860	15472	1029	4072000	0	0	0	0	0
1	0.0164	52601	8206	0.0052	16678	2035	69280	10241	3490463	303670	383951	33404	358481	31188
2	0.0484	128748	29870	0.0052	13832	2504	142581	32373	2940073	496872	1852246	313030	1707378	288547
3	0.1009	213372	65932	0.0050	10573	2760	223945	68692	2396786	580022	2133139	516220	1925594	465994
4	0.1526	356901	130626	0.0086	20114	6416	377015	137042	2721562	824633	2639915	799894	2330928	706271
5	0.1783	395639	165377	0.0103	22855	8594	418494	173971	2615778	939064	2537305	910892	2215908	795511
6	0.1901	218584	101860	0.0124	14258	5903	232842	107763	1364378	571675	1350735	565958	1173099	491528
7	0.2218	135063	66181	0.0171	10413	4592	145476	70773	735003	330751	735003	330751	629115	283102
8	0.2217	129417	69367	0.0203	11850	5581	141267	74949	705617	344341	705617	344341	603214	294369
9	0.2426	67935	38519	0.0280	7841	3866	75776	42385	343037	182839	343037	182839	289918	154526
10	0.2125	29772	17536	0.0257	3601	1883	33372	19419	169051	94499	169051	94499	144737	80908
11	0.1996	15114	9144	0.0267	2022	1067	17136	10211	90860	51063	90860	51063	78163	43928
12+	0.2050	33003	21551	0.0213	3429	1989	36432	23540	193173	119961	193173	119961	166179	103197
Total		1778790	724337		150297	48049	1929087	772386	21837781	4839392	13134032	4262852	11622716	3739070
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT02
Date and time : 23SEP99:00:39
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.5 North East Atlantic Mackerel. Two area management option table. Assuming *status quo* fishing mortality of 0.2066 for each fleet in 1999.

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)
Multi fleet prediction with mangement option table

Year: 1999								
NORTHERN			SOUTHERN			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1929	679256	1.0000	0.0137	43760	723017	4958784	3754257
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2000									Year: 2001	
NORTHERN			SOUTHERN			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	4954473	4096170	5549249	4666626
0.0500	0.0096	39210	0.0500	0.0007	2533	41744	.	4082160	5510625	4614286
0.1000	0.0193	78074	0.1000	0.0014	5044	83118	.	4068203	5472351	4562628
0.1500	0.0289	116594	0.1500	0.0021	7533	124127	.	4054299	5434424	4511641
0.2000	0.0386	154773	0.2000	0.0027	10000	164773	.	4040448	5396838	4461317
0.2500	0.0482	192616	0.2500	0.0034	12445	205061	.	4026650	5359592	4411647
0.3000	0.0579	230125	0.3000	0.0041	14868	244993	.	4012905	5322681	4362620
0.3500	0.0675	267304	0.3500	0.0048	17270	284574	.	3999212	5286103	4314229
0.4000	0.0772	304156	0.4000	0.0055	19651	323807	.	3985570	5249854	4266463
0.4500	0.0868	340684	0.4500	0.0062	22011	362695	.	3971981	5213931	4219316
0.5000	0.0965	376891	0.5000	0.0069	24350	401241	.	3958444	5178331	4172777
0.5500	0.1061	412780	0.5500	0.0076	26669	439449	.	3944958	5143050	4126838
0.6000	0.1157	448355	0.6000	0.0082	28968	477323	.	3931523	5108086	4081492
0.6500	0.1254	483618	0.6500	0.0089	31246	514864	.	3918139	5073435	4036729
0.7000	0.1350	518573	0.7000	0.0096	33505	552078	.	3904806	5039093	3992542
0.7500	0.1447	553222	0.7500	0.0103	35744	588966	.	3891524	5005060	3948923
0.8000	0.1543	587569	0.8000	0.0110	37963	625532	.	3878292	4971330	3905863
0.8500	0.1640	621616	0.8500	0.0117	40163	661780	.	3865111	4937901	3863356
0.9000	0.1736	655366	0.9000	0.0124	42345	697711	.	3851979	4904770	3821393
0.9500	0.1833	688823	0.9500	0.0131	44507	733330	.	3838897	4871935	3779966
1.0000	0.1929	721988	1.0000	0.0137	46650	768639	.	3825865	4839392	3739070
1.0500	0.2025	754865	1.0500	0.0144	48776	803641	.	3812883	4807138	3698695
1.1000	0.2122	787457	1.1000	0.0151	50882	838339	.	3799949	4775171	3658835
1.1500	0.2218	819766	1.1500	0.0158	52971	872737	.	3787065	4743487	3619482
1.2000	0.2315	851795	1.2000	0.0165	55042	906837	.	3774229	4712085	3580631
1.2500	0.2411	883547	1.2500	0.0172	57095	940642	.	3761442	4680961	3542273
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)
Multi fleet prediction with mangement option table

Year: 2000									Year: 2001	
NORTHERN			SOUTHERN			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
1.3000	0.2508	915024	1.3000	0.0179	59130	974154	.	3748704	4650112	3504402
1.3500	0.2604	946230	1.3500	0.0185	61148	1007377	.	3736013	4619537	3467012
1.4000	0.2701	977165	1.4000	0.0192	63149	1040314	.	3723371	4589231	3430095
1.4500	0.2797	1007835	1.4500	0.0199	65132	1072967	.	3710777	4559193	3393646
1.5000	0.2894	1038240	1.5000	0.0206	67099	1105339	.	3698230	4529420	3357657
1.5500	0.2990	1068383	1.5500	0.0213	69049	1137432	.	3685731	4499909	3322122
1.6000	0.3086	1098267	1.6000	0.0220	70982	1169250	.	3673279	4470658	3287036
1.6500	0.3183	1127895	1.6500	0.0227	72899	1200794	.	3660874	4441664	3252392
1.7000	0.3279	1157268	1.7000	0.0234	74800	1232068	.	3648516	4412925	3218183
1.7500	0.3376	1186390	1.7500	0.0240	76685	1263075	.	3636204	4384438	3184405
1.8000	0.3472	1215262	1.8000	0.0247	78554	1293816	.	3623939	4356201	3151051
1.8500	0.3569	1243887	1.8500	0.0254	80407	1324294	.	3611721	4328212	3118115
1.9000	0.3665	1272268	1.9000	0.0261	82244	1354512	.	3599549	4300467	3085591
1.9500	0.3762	1300406	1.9500	0.0268	84067	1384473	.	3587422	4272965	3053475
2.0000	0.3858	1328305	2.0000	0.0275	85873	1414178	.	3575341	4245703	3021760
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANELT02
Date and time : 22SEP99:23:50
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Si

Table 2.10.6 North East Atlantic Mackerel. Two area management option table. Assuming a catch constraint of 670 kt in 1999.

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction with mangement option table

Year: 1999								
NORTHERN			SOUTHERN			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.9207	0.1776	629457	0.9207	0.0127	40550	670007	4958784	3773336
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2000									Year: 2001	
NORTHERN			SOUTHERN			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	5003323	4140850	5596777	4710763
0.0500	0.0096	39679	0.0500	0.0007	2565	42244	.	4126661	5557692	4657805
0.1000	0.0193	79006	0.1000	0.0014	5107	84113	.	4112527	5518962	4605538
0.1500	0.0289	117985	0.1500	0.0021	7626	125611	.	4098446	5480583	4553951
0.2000	0.0386	156620	0.2000	0.0027	10123	166743	.	4084418	5442551	4503036
0.2500	0.0482	194913	0.2500	0.0034	12598	207511	.	4070445	5404862	4452783
0.3000	0.0579	232867	0.3000	0.0041	15052	247919	.	4056524	5367514	4403182
0.3500	0.0675	270488	0.3500	0.0048	17483	287971	.	4042657	5330502	4354225
0.4000	0.0772	307776	0.4000	0.0055	19893	327669	.	4028842	5293825	4305902
0.4500	0.0868	344736	0.4500	0.0062	22282	367018	.	4015080	5257477	4258205
0.5000	0.0965	381372	0.5000	0.0069	24650	406021	.	4001371	5221457	4211125
0.5500	0.1061	417685	0.5500	0.0076	26997	444682	.	3987713	5185760	4164653
0.6000	0.1157	453679	0.6000	0.0082	29324	483003	.	3974108	5150384	4118781
0.6500	0.1254	489358	0.6500	0.0089	31630	520988	.	3960554	5115326	4073500
0.7000	0.1350	524724	0.7000	0.0096	33916	558640	.	3947052	5080582	4028802
0.7500	0.1447	559781	0.7500	0.0103	36182	595962	.	3933601	5046149	3984680
0.8000	0.1543	594530	0.8000	0.0110	38428	632959	.	3920202	5012024	3941125
0.8500	0.1640	628977	0.8500	0.0117	40655	669632	.	3906853	4978205	3898129
0.9000	0.1736	663122	0.9000	0.0124	42863	705985	.	3893555	4944687	3855684
0.9500	0.1833	696970	0.9500	0.0131	45051	742021	.	3880308	4911469	3813783
1.0000	0.1929	730523	1.0000	0.0137	47220	777743	.	3867111	4878546	3772419
1.0500	0.2025	763784	1.0500	0.0144	49371	813154	.	3853964	4845918	3731583
1.1000	0.2122	796755	1.1000	0.0151	51503	848258	.	3840867	4813579	3691269
1.1500	0.2218	829440	1.1500	0.0158	53616	883057	.	3827820	4781528	3651469
1.2000	0.2315	861842	1.2000	0.0165	55712	917554	.	3814822	4749762	3612177
1.2500	0.2411	893962	1.2500	0.0172	57789	951751	.	3801873	4718278	3573384
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

23:33 Wednesday, September 22, 1999

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction with mangement option table

Year: 2000									Year: 2001	
NORTHERN			SOUTHERN			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
1.3000	0.2508	925805	1.3000	0.0179	59849	985653	.	3788974	4687073	3535085
1.3500	0.2604	957371	1.3500	0.0185	61891	1019262	.	3776123	4656145	3497272
1.4000	0.2701	988665	1.4000	0.0192	63915	1052580	.	3763322	4625490	3459940
1.4500	0.2797	1019689	1.4500	0.0199	65922	1085611	.	3750568	4595106	3423080
1.5000	0.2894	1050444	1.5000	0.0206	67912	1118356	.	3737863	4564991	3386687
1.5500	0.2990	1080935	1.5500	0.0213	69885	1150820	.	3725206	4535141	3350754
1.6000	0.3086	1111163	1.6000	0.0220	71841	1183005	.	3712598	4505555	3315275
1.6500	0.3183	1141132	1.6500	0.0227	73781	1214912	.	3700036	4476230	3280244
1.7000	0.3279	1170842	1.7000	0.0234	75704	1246546	.	3687523	4447162	3245654
1.7500	0.3376	1200298	1.7500	0.0240	77611	1277908	.	3675056	4418350	3211500
1.8000	0.3472	1229501	1.8000	0.0247	79501	1309002	.	3662637	4389792	3177776
1.8500	0.3569	1258453	1.8500	0.0254	81376	1339829	.	3650265	4361483	3144475
1.9000	0.3665	1287158	1.9000	0.0261	83235	1370393	.	3637940	4333423	3111591
1.9500	0.3762	1315618	1.9500	0.0268	85078	1400696	.	3625661	4305609	3079120
2.0000	0.3858	1343834	2.0000	0.0275	86906	1430740	.	3613429	4278038	3047056
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANELT02
Date and time : 22SEP99:23:50
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Simple mean, age 4 - 8
Basis for 1999 : F factors

2.11 Short-term Stochastic Forecasts

The European Union and Norway requested an assessment of the medium term (5 year) consequences of a range of management options (F = 0.15 - 0.20) for NE Atlantic mackerel. The request was ambiguous with respect to how the harvesting policy in the first year should be specified. We decided to examine the implications of using F(status quo) for 1999, and a range of fixed harvest policies (0.15, 0.17, 0.19, 0.20) for 2000-2003. The ICA-ICP software was used to make 5 year projections conditional on the final stock assessment (section 2.9.2). Results were summarized with the following performance indices:

1) Pr(yield(X) > yield(1999)) = the probability that the yield in year X (X = each of 2000 - 2003) exceeds the yield in 1999. The 1999 value was set corresponding to Fsq, and differed for each projection because of the stochastic initialization described below.
2) Pr(SSB(X) > SSB(1999)) = the probability that SSB in year X exceeds 1999 SSB. As above, 1999 SSB differed with each projection.
3) Pr(SSB(X) < SSBpa) = the proportion of projections in which the SSB in year X dropped below 2.3 million t.

Two thousand stochastic projections were calculated with the following assumptions:

- The population state and fishery selectivities were initialized according to the parameter covariance matrix from the final ICA assessment. The starting parameters were scaled by the factor exp(-Var/2), where Var represents the corresponding diagonal component in the variance-covariance matrix to correct for lognormal bias in the projections. An additional F scaling factor was added to ensure that the stochastic SSB estimates for 1999 correspond to the value of the short term deterministic predictions (section 2.10).
- A double linear stock-recruitment relationship (Ockham) was used. The horizontal component of the SRR was defined by the geometric mean of the Western mackerel recruitment time series (1972-95) scaled by the ratio of the geometric mean of the NE Atlantic to the Western recruitment (1984-95); the slope joined the origin to the mean recruitment and SSBpa. Independent recruitments were drawn using a non-parametric bootstrap of the residuals from this relationship (1972-95).
- Recruitment in years 1998-99 were drawn from the SRR because ICA estimates are not reliable for these years.
- 1999 fishing mortality was taken to be Fsq = geometric mean (1996-98) = 0.207.
- The mean and variability of the values of the maturity ogive and stock weights at age in the projections were estimated from historic observations from 1996 to 1998. Mean values of the catch weights at age from this period were used but variability was not modelled in the projections.

Results are summarized in Table 2.11.1 in the requested format. The table suggests that the stock is likely to increase in the medium term with all of the harvesting options considered. The risk of violating SSBpa in 5 years is twice as high with F = 0.2 (9%) relative to F = 0.15 (4%). It should be noted that the uncertainty in these projections is conditional on the structural accuracy of the model. Additionally, if the large recruitment estimated for 1996 does not materialize, then we will know that the projections are over-optimistic.

Table 2.11.1. Assessment of the medium term consequences of harvesting policies as requested by the European Community and Norway. Probabilities are calculated from 2000 ICA-ICP stochastic projections. F(*status quo*) was used in 1999, while the indicated F(4-8) was used for 2000-2003.

	PROJECTION YEAR				
F(4-8)	**1-1999**	**2-2000**	**3-2001**	**4-2002**	**5-2003**
	Yield1 (X1000 t)	P(Y2>Y1)	P(Y3>Y1)	P(Y4>Y1)	P(Y5>Y1)
0.15	*723	0.02	0.08	0.18	0.26
	SSB (X1000 t)	P(SSB2>SSB1)	P(SSB3>SSB1)	P(SSB4>SSB1)	P(SSB5>SSB1)
	*3 750	0.72	0.74	0.75	0.74
	P(SSBY<SSBpa)	P(SSBY<SSBpa)	P(SSBY<SSBpa)	P(SSBY<SSBpa)	P(SSBY<SSBpa)
	0.03	0.03	0.04	0.04	0.04
	Yield1 (X1000 t)	P(Y2>Y1)	P(Y3>Y1)	P(Y4>Y1)	P(Y5>Y1)
0.17	*723	0.12	0.31	0.40	0.45
	SSB1 (X1000 t)	P(SSB2>SSB1)	P(SSB3>SSB1)	P(SSB4>SSB1)	P(SSB5>SSB1)
	*3 750	0.69	0.70	0.69	0.67
	P(SSB1<SSBpa)	P(SSB2<SSBpa)	P(SSB3<SSBpa)	P(SSB4<SSBpa)	P(SSB5<SSBpa)
	0.04	0.04	0.04	0.04	0.05
	Yield1 (X1000 t)	P(Y2>Y1)	P(Y3>Y1)	P(Y4>Y1)	P(Y5>Y1)
0.19	*723	0.35	0.50	0.54	0.54
	SSB1 (X1000 t)	P(SSB2>SSB1)	P(SSB3>SSB1)	P(SSB4>SSB1)	P(SSB5>SSB1)
	*3 750	0.66	0.66	0.63	0.60
	P(SSB1<SSBpa)	P(SSB2<SSBpa)	P(SSB3<SSBpa)	P(SSB4<SSBpa)	P(SSB5<SSBpa)
	0.03	0.04	0.05	0.06	0.07
	Yield1 (X1000 t)	P(Y2>Y1)	P(Y3>Y1)	P(Y4>Y1)	P(Y5>Y1)
0.20	*723	0.62	0.66	0.65	0.61
	SSB1 (X1000 t)	P(SSB2>SSB1)	P(SSB3>SSB1)	P(SSB4>SSB1)	P(SSB5>SSB1)
	*3 750	0.64	0.62	0.59	0.54
	P(SSB1<SSBpa)	P(SSB2<SSBpa)	P(SSB3<SSBpa)	P(SSB4<SSBpa)	P(SSB5<SSBpa)
	0.03	0.04	0.06	0.08	0.09

- point estimates from short-term deterministic projections. The probability that yield and SSB in 2000-2003 exceeded the values in 1999 were calculated with respect to the individual stochastic values, not the point estimates.

2.12 Sensitivity Analysis

ICES (1991/Assess:22) performed a sensitivity analysis for *status quo* forecasts made using data from this stock. The results revealed that the forecasts were sensitive to the estimates of the strength of the year class that recruited two years before the year of the assessment. The forecast made in 1998 was sensitive to the accuracy of the estimated fishing mortality in 1999 (ICES/ACFM:6).

The sensitivity analysis need stock numbers, recruit estimates, fishing and natural mortalities and other population parameters and their associated uncertainty estimates (CVs) to be run. Thus, the population numbers for 1999 from the this years assessment (Section 2.10) and CVs of the various population parameters were entered into the sensitivity analysis. Recruitment input used in the forecast was a geometric mean of the time series (1972–1995) of the Western recruitment, raised by the average ratio of the estimated Western NEA area recruitment for the period 1984-1995 (Section 2.10). To obtain an estimate of the CV for the recruitment, the CV of the GM estimate was used. See Table 2.12.1 for a complete list of input data to the sensitivity analysis and Table 2.12.2 for a short explanations of the input parameters.

The linear sensitivity analysis is performed with the WGFRAN4 and SENPLOT software at ICES. WGFRAN4 produces a file of the various (input) population parameters in descending order of significance to the uncertainty of the short-term prediction to be plotted with SENPLOT. The resulting plot shows that the estimation of the accuracy of the catches or the fishing mortality in 2000 (HF00 - effort multiplier) is the single most important factor to the sensitivity of the short-term prediction (Figure 2.12.1, left panel). Apart from the fishing mortality in year 2000 the assessment is most sensitive to the 1996 year class (N3). The short-term risk ogive plots for the yield in 2000 and SSB in 2001 from the sensitivity analysis are shown in Figure 2.12.2.

Table 2.12.1 **Mackerel Northeast Atlantic: Input data for the linear sensitivity analysis.**

Name	Value	C.V.	Name	Value	C.V.
Population at age in 1999			Exploitation pattern		
N0	4072	0.48	sH0	0.004	1.04
N1	3488	0.19	sH1	0.022	0.16
N2	4309	0.13	sH2	0.054	0.15
N3	4612	0.12	sH3	0.106	0.14
N4	2613	0.11	sH4	0.161	0.14
N5	1467	0.10	sH5	0.189	0.13
N6	1481	0.11	sH6	0.202	0.13
N7	749	0.11	sH7	0.239	0.13
N8	381	0.11	sH8	0.242	0.12
N9	204	0.12	sH9	0.271	0.12
N10	168	0.13	sH10	0.238	0.12
N11	86	0.14	sH11	0.226	0.12
N12	158	0.14	sH12	0.226	0.12
Catch weight at age			Stock weight at age		
WH0	0.066	0.14	WS0	0	0
WH1	0.148	0.05	WS1	0.087	0.07
WH2	0.228	0.01	WS2	0.169	0.17
WH3	0.306	0.03	WS3	0.242	0.04
WH4	0.363	0.03	WS4	0.306	0.04
WH5	0.416	0.02	WS5	0.359	0.01
WH6	0.463	0.04	WS6	0.419	0.04
WH7	0.487	0.06	WS7	0.450	0.03
WH8	0.531	0.03	WS8	0.488	0.03
WH9	0.560	0.03	WS9	0.533	0.05
WH10	0.582	0.02	WS10	0.559	0.03
WH11	0.595	0.01	WS11	0.562	0.08
WH12	0.646	0.03	WS12	0.621	0.03
Natural mortality at age			Maturity		
M0	0.15	0.1	MT0	0	0
M1	0.15	0.1	MT1	0.11	0.1
M2	0.15	0.1	MT2	0.63	0.1
M3	0.15	0.1	MT3	0.89	0.1
M4	0.15	0.1	MT4	0.97	0.1
M5	0.15	0.1	MT5	0.97	0.1
M6	0.15	0.1	MT6	0.99	0.1
M7	0.15	0.1	MT7	1.00	0
M8	0.15	0.1	MT8	1.00	0
M9	0.15	0.1	MT9	1.00	0
M10	0.15	0.1	MT10	1.00	0
M11	0.15	0.1	MT11	1.00	0
M12	0.15	0.1	MT12	1.00	0
Effort multiplier in year			Natural mortality multiplier in year		
HF1999	1	0.1	K1999	1	0.1
HF2000	1	0.1	K2000	1	0.1
HF2001	1	0.1	K2001	1	0.1
Recruitment in year					
R2000	4072	0.48			
R2001	4072	0.48			

Table 2.12.2. Sensitivity analysis - key to variable names, numerals apply to age groups or, where relevant, years. Data from the ICA run on NEA mackerel (Section 2.9.2) and from data used in the catch predictions (2.10).

N0…12	population number at age 0…12 in 1999
sH0…12	exploitation pattern (human consumption fleets) at age 0…12
WH0…12	catch weights (landings) at age 0…12 in prediction
WS0…12	stock weights at age 0…12 in prediction
M0…12	natural mortality at age 0…12
MT0…12	proportion mature at age 0…12
HF99…01	year effect on (landings and discards) fishing mortality in 1999…2001
K99…01	year effect on natural mortality in prediction in 1999…2001
R00…01	recruitment in 2000 and 2001

Figure 2.12.1 Mackerel,NEA Mackerel. Sensitivity analysis of short term forecast.

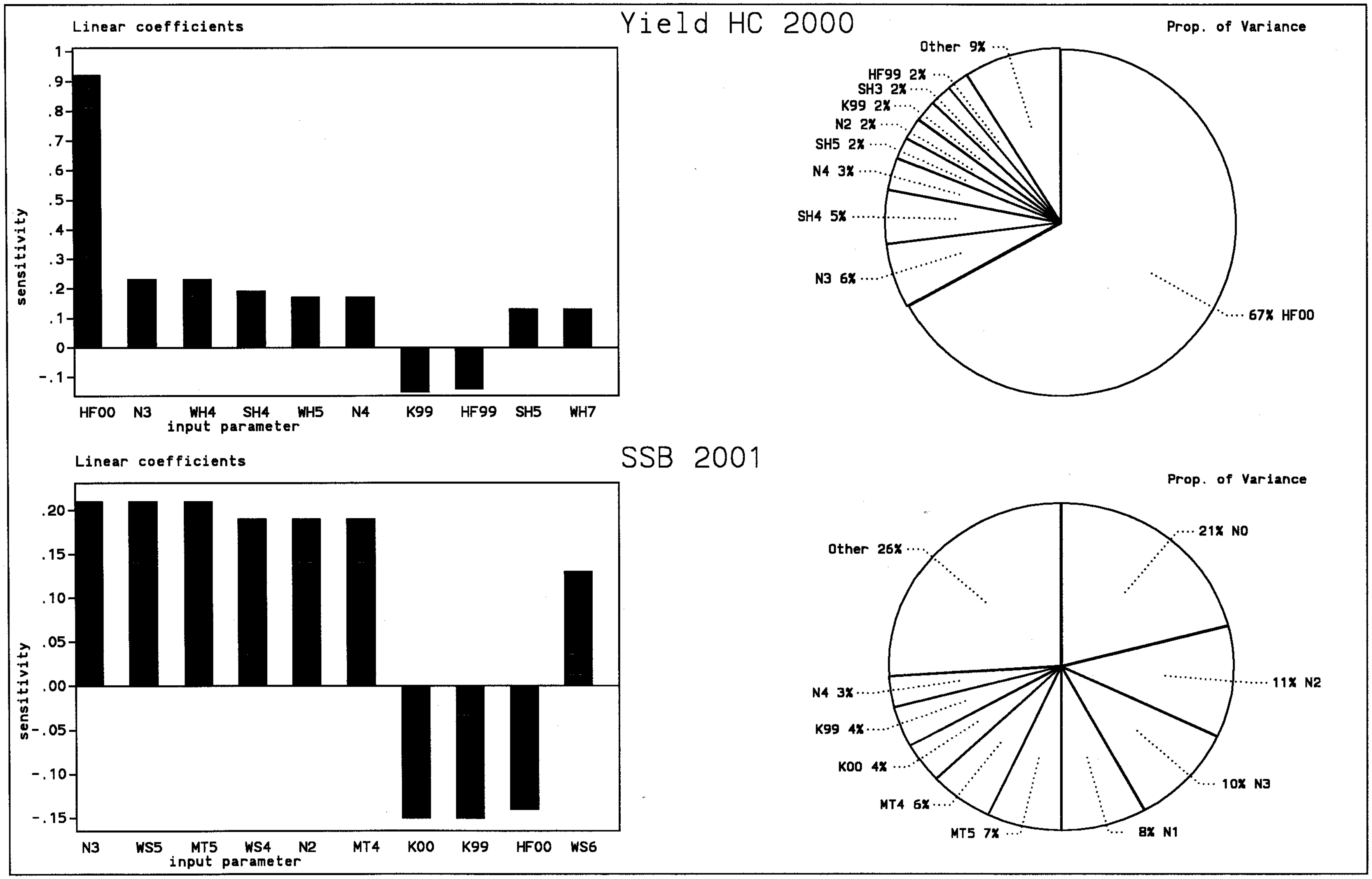
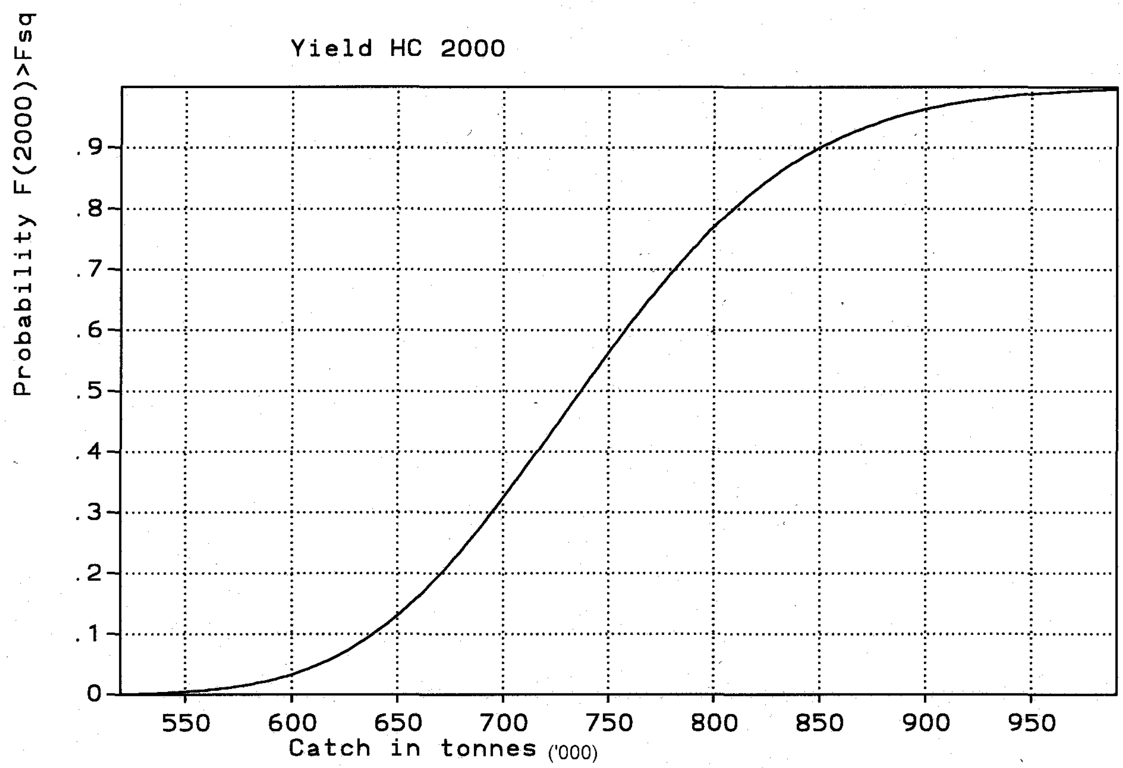
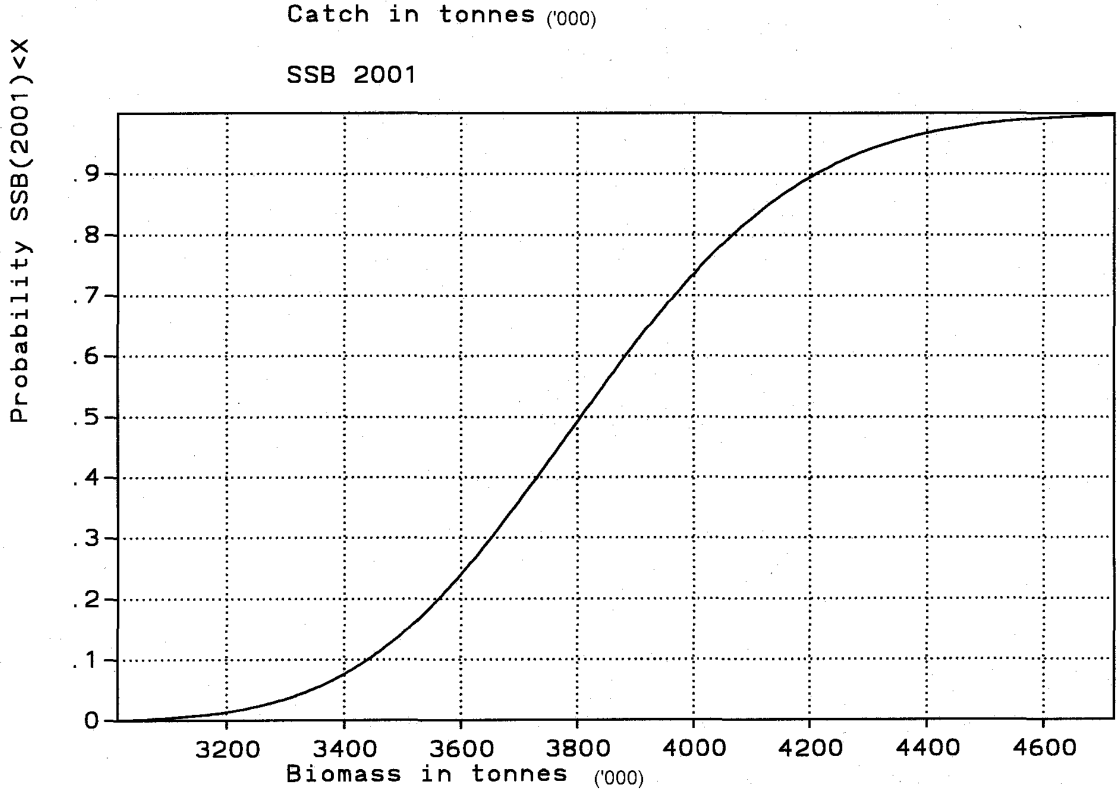


Figure 2.12.2 Mackerel,NEA Mackerel. Probability profiles for short term forecast.





2.13 Medium-term predictions

Medium term predictions (10 year) for NE Atlantic mackerel were conducted using the methods and definitions of section 2.11. Three constant harvesting policies were compared: F = 0.15, F = 0.17, and F(status quo). In all cases, Fsq = 0.207 was used for 1999. Results are indicated in Figs. 2.13.1-2.13.3. None of the policies suggest strong trends over the next 10 years.

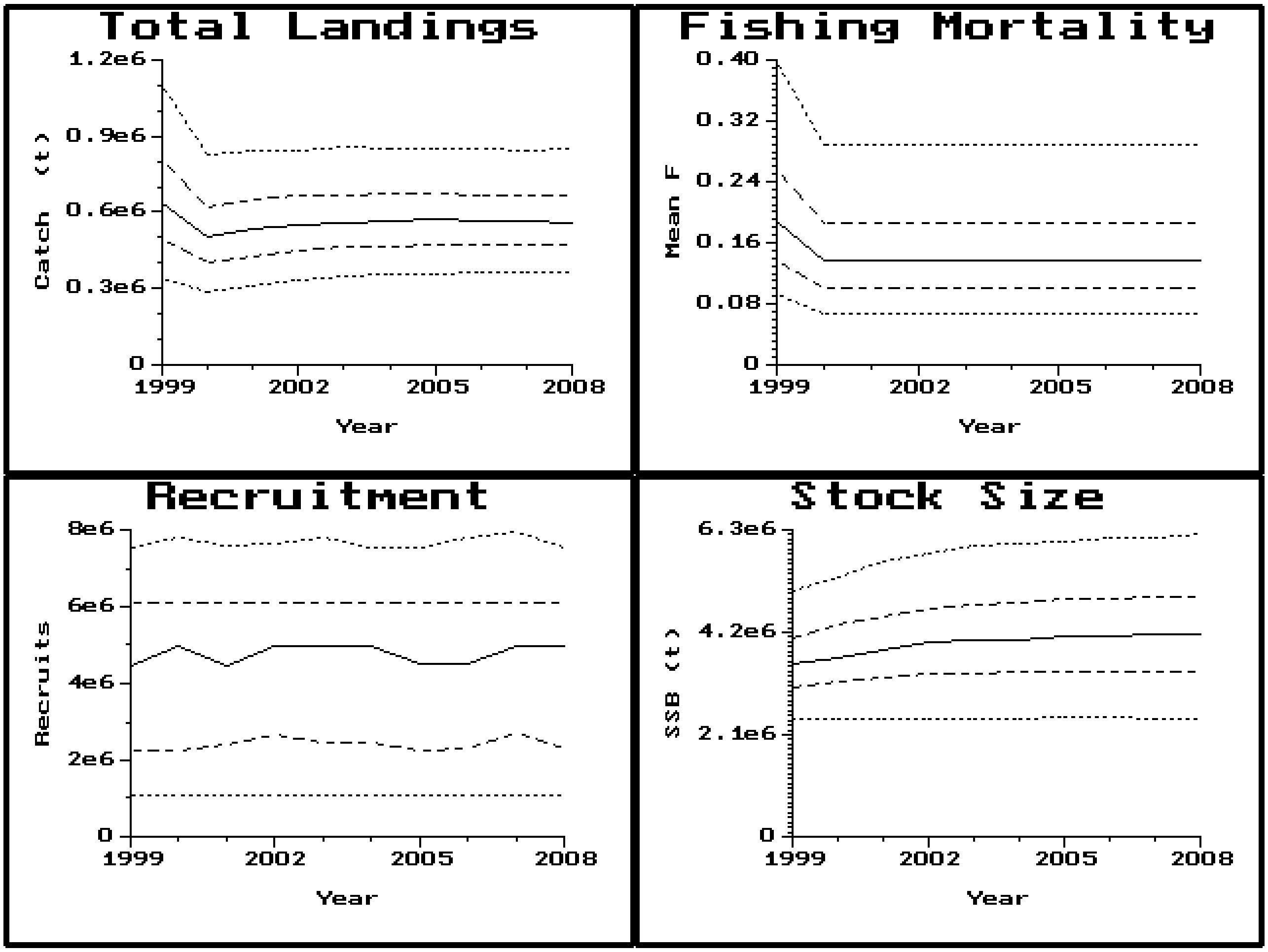


Figure 2.13.1. ICA/ICP stochastic medium term projections for NE Atlantic mackerel based on the 1999 assessment . F(*status quo*) was assumed in 1999, and a fixed harvest rate of 0.15 in subsequent years. Figures show percentiles (5, 25, 50, 75 and 95) of the projected distributions.

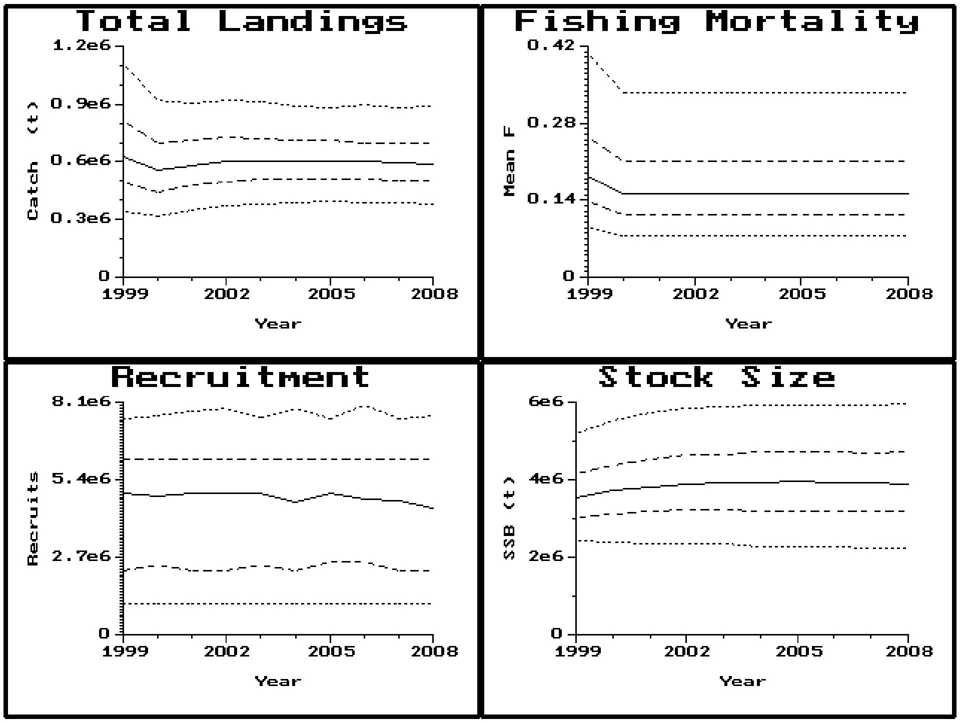


Figure 2.13.2. ICA/ICP stochastic medium term projections for NE Atlantic mackerel based on the 1999 assessment. F(status quo) was assumed in 1999, and a fixed harvest rate of 0.17 in subsequent years. Figures show percentiles (5, 25, 50, 75 and 95) of the projected distributions.

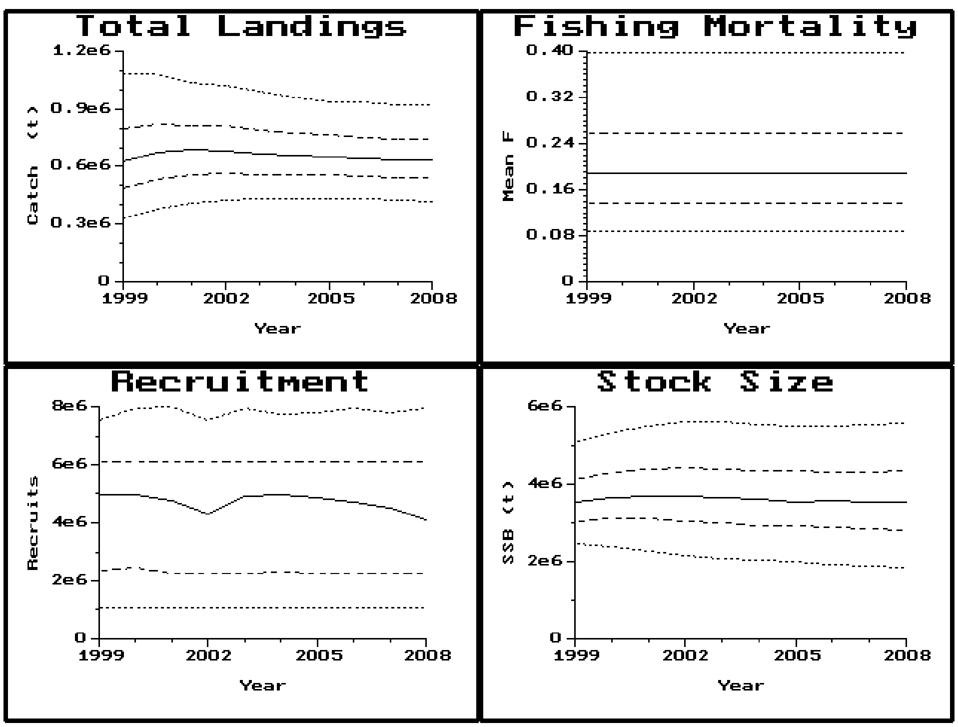


Figure 2.13.3. ICA/ICP stochastic medium term projections for NE Atlantic mackerel based on the 1999 assessment . A fixed harvest rate of F(status quo) was assumed in all years. Figures show percentiles (5, 25, 50, 75 and 95) of the projected distributions.

2.14 Long-term yield

Table 2.14.1 and Figure 2.14.1 present the yield per recruit forecasts for the both areas. F_{max} is poorly defined at a combined reference F of about 0.7. 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. $F_{0.1}$ was estimated using the same selection pattern as used in the short-term predictions, the full age range and a 12 plus group, to be 0.189.

The time series of stock and recruitment estimates for this management unit are short. The estimates of F_{med}, F_{high} and F_{low} for short time series will be unreliable. Therefore, these estimates are obtained from the longer time series of the Western mackerel raised to the North East Atlantic mackerel. In section 2.15 estimates of F_{med}, F_{high} and F_{low} for the North East Atlantic mackerel as well as the stock recruitment plot are provided.

Table 2.14.1 Two area yield per recruit table for the Mackerel in the North East Atlantic

23:33 Wednesday, September 22, 1999
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet yield per recruit: Summary table

NORTHERN			SOUTHERN			Total			1 January		Spawning time	
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.0000	0.0000	0.000	0.000	7.179	2272.845	5.034	2131.124	4.741	2007.017
0.2000	0.0386	61.258	0.2000	0.0027	4.858	66.116	6.245	1748.426	4.105	1607.959	3.812	1490.239
0.4000	0.0772	95.261	0.4000	0.0055	7.295	102.556	5.656	1431.976	3.521	1292.711	3.228	1180.302
0.6000	0.1157	115.905	0.6000	0.0082	8.599	124.504	5.249	1221.988	3.118	1083.875	2.826	975.951
0.8000	0.1543	129.227	0.8000	0.0110	9.327	138.553	4.947	1073.129	2.822	936.123	2.529	832.044
1.0000	0.1929	138.207	1.0000	0.0137	9.745	147.952	4.713	962.294	2.592	826.354	2.301	725.615
1.2000	0.2315	144.456	1.2000	0.0165	9.993	154.449	4.525	876.569	2.409	741.653	2.118	643.854
1.4000	0.2701	148.904	1.4000	0.0192	10.147	159.052	4.370	808.218	2.258	674.291	1.967	579.106
1.6000	0.3086	152.118	1.6000	0.0220	10.250	162.368	4.238	752.356	2.130	619.383	1.841	526.547
1.8000	0.3472	154.458	1.8000	0.0247	10.326	164.784	4.125	705.759	2.021	573.707	1.732	483.000
2.0000	0.3858	156.163	2.0000	0.0275	10.389	166.553	4.026	666.219	1.927	535.058	1.638	446.296
2.2000	0.4244	157.397	2.2000	0.0302	10.448	167.845	3.939	632.179	1.843	501.881	1.556	414.909
2.4000	0.4630	158.272	2.4000	0.0330	10.506	168.778	3.861	602.513	1.769	473.050	1.482	387.733
2.6000	0.5015	158.873	2.6000	0.0357	10.566	169.439	3.790	576.382	1.702	447.731	1.417	363.953
2.8000	0.5401	159.258	2.8000	0.0385	10.630	169.888	3.726	553.155	1.642	425.290	1.357	342.952
3.0000	0.5787	159.472	3.0000	0.0412	10.698	170.170	3.668	532.342	1.587	405.242	1.303	324.255
3.2000	0.6173	159.552	3.2000	0.0440	10.769	170.321	3.614	513.561	1.537	387.205	1.254	307.492
3.4000	0.6559	159.521	3.4000	0.0467	10.844	170.366	3.564	496.509	1.490	370.876	1.208	292.367
3.6000	0.6944	159.403	3.6000	0.0495	10.923	170.326	3.518	480.940	1.447	356.012	1.166	278.645
3.8000	0.7330	159.212	3.8000	0.0522	11.004	170.216	3.475	466.655	1.408	342.414	1.128	266.133
4.0000	0.7716	158.962	4.0000	0.0550	11.089	170.051	3.434	453.489	1.371	329.919	1.091	254.673
-	-	Grams	-	-	Grams	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDELT02
Date and time : 23SEP99:02:08
Computation of ref. F: NORTHERN: Simple mean, age 4 - 8
SOUTHERN: Simple mean, age 4 - 8
Recruitment : Single recruit

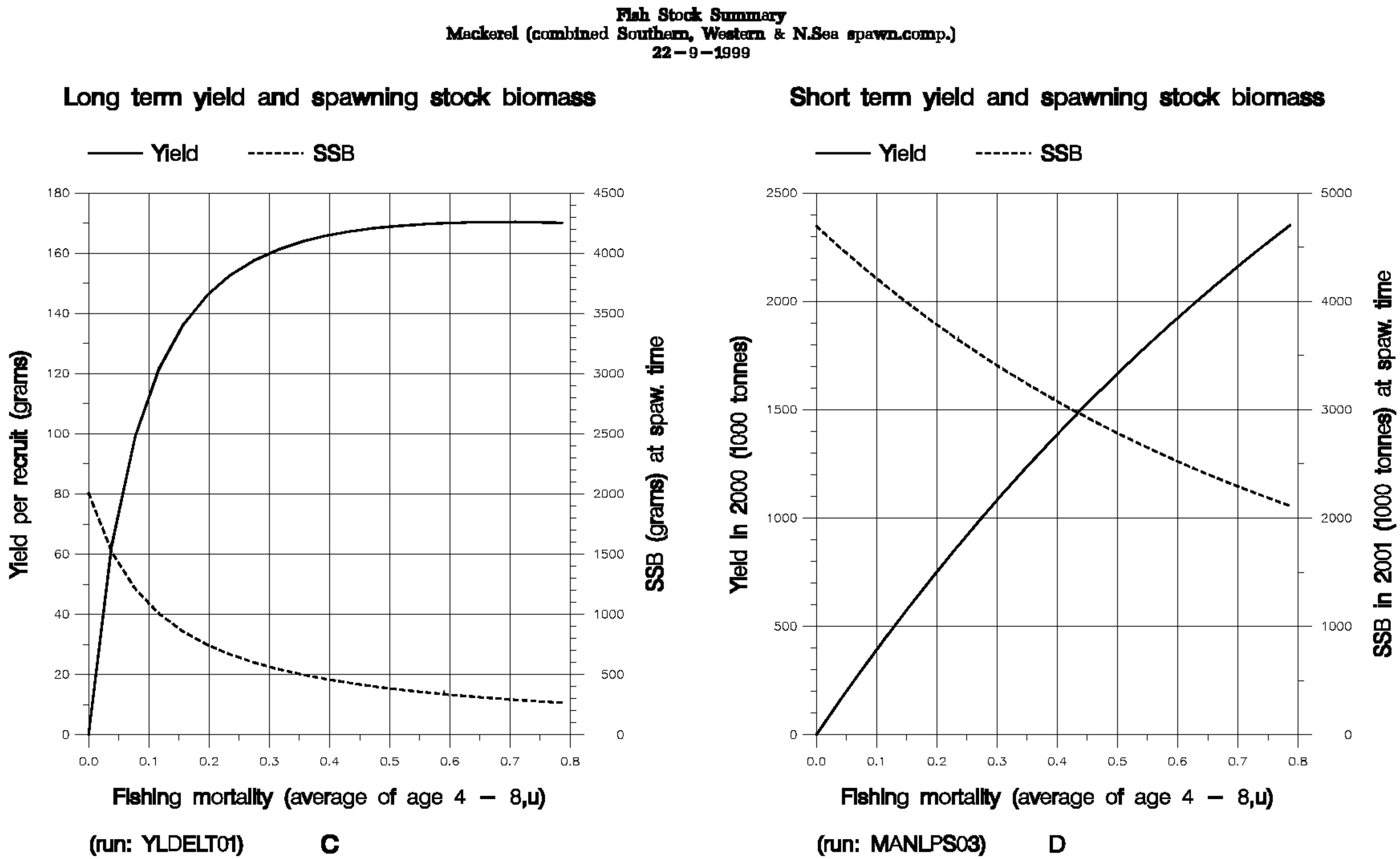


Figure 2.14.1 The North East Atlantic Mackerel two area yield per recruit.

2.15 Reference Points for Management Purposes

In the 1997 Working Group Report (ICES 1998/Assess: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 1998/ACFM:6), see text table below.

The PA software (CEFAS, Lowestoft) at ICES were used to calculate various precautionary reference points of spawning stock biomass and fishing mortality. To capture the whole variation in the long (1972-1998) data series of the western mackerel stock compared to the shorter time series for NEA mackerel (1984-1998), the western time series was raised by a scaling factor between the geometric means of the NEA and western mackerel over the period 1984-1995. For example the geometric mean over period 1972-1995 of Western recruitment were raised by the average ratio of the estimated Western and NEA area GM recruitments for the period 1984-1995. Similarly the SSBs, TSBs, catches and Fbar-values were all raised by their appropriate geometric scaling factor to produce input (*.sum file) to the PA software.

The resulting graphs and tables of reference points are shown in Figures 2.15.1–7 and Tables 2.15.1–2. The values of the reference points calculated are similar to the values used previously by the Working Group (Table 2.15.2).

WGMHSA '97 proposal
B_{low} = MBAL = B_{loss} = 2.3 million t, being a low biomass to be avoided. B_{lim} = undefined F_1 = 0.122, being F when SSB is less than B_{low}. Basis replacement line for 1 SD below geometric mean recruitment (see sec. 3.4.9 in ICES CM 1998/Assess:6). F_{pa} = $F_{0.1}$ = 0.175
Used by ACFM '97
2.3 million t implicitly accepted as MBAL F between 0.2 and 0.15 gives low probability of SSB < MBAL
SGPAFM proposal and adopted by WGMHSA '98
B_{pa} = MBAL = B_{loss} = 2.3 million t. B_{lim} = undefined F_{pa} = $F_{0.1}$ = 0.175 F_{lim} = 0.25 to 0.3
ACFM '98 proposal and adopted by present Working Group
B_{pa} = MBAL = B_{loss} = 2.3 million t. B_{lim} = undefined F_{lim} = F_{loss} = 0.26 F_{pa} = 0.17 ($F_{lim}\, e^{-1.645\sigma}$ = 0.17, with σ = 0.25)

The MBAL value of 2.3 million t, which corresponds to B_{loss}, has previously been regarded as a limit, below which strong measures were taken to bring the stock above this value. This was suggested as a B_{pa} in 1998 (ICES 1999/ACFM:6) and adopted by ACFM in 1998. A B_{lim} cannot be defined in this case.

A fishing mortality at $F_{0.1}$ = 0.175 was suggested last year by the Working Group as a candidate for F_{pa} (ICES 1999/ACFM:6). ACFM proposed a value of F_{pa} = 0.17 based on following considerations:

- $F_{0.1}$ was estimated to be 0.175.
- F_{loss} was estimated to be 0.26, and $F_{loss}\, e^{-1.645\sigma}$ = 0.17, with σ = 0.25.

Simulations indicated that F values below about 0.185 would lead to a low (< 5%) probability levels of the spawning biomass falling below B_{pa} in the medium term.

The present results from the PA run do not substantiate any changes to the proposed reference points above, and the Working Group consequently adopted the reference points indicated in the lower part of the text table above.

Table 2.15.1 NEA Mackerel: PA excel software add-in inputs and outputs.

Detailed Excel sheets of PA results are included in the workbook:
W:\ACFM\WGMHSA\1999\Data\MAC_NEA\PA\PA_Mac99_NEA-West.XLS

RefPts - provides stochastic output in the form of a table of reference points and a chart summarising the distributions of some reference points.

Plots - provides 5 plots:
A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
A plot of YPR and SPR curves with some reference points indicated.
A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
A plot of the time series of stock and recruitment with expected recruits based on the LOWESS stock recruitment relationship.

PD - gives the value of the reference points during each iteration of the simulation and the percentiles plotted on the chart on RefPts.

SV - contains the steady state vectors and stock recruitment series used. These can be used as the basis for further runs.

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

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

Data source:
W:\ACFM\WGMHSA\1999\Data\MAC_NEA\PA\NEA_ICA.SEN
W:\ACFM\WGMHSA\1999\Data\MAC_NEA\PA\NEA-West_ICA.SUM

22-09-1999 20:49:36

FishLab DLL used
FLVB32.DLL built on May 6 1999 at 12:54:28
PASoft 10 June 1999

Table 2.15.2 Reference points calculated for Northeast Atlantic mackerel (standard output from PA software). Data for NEA mackerel obtained by applying a scaling factor (ratio between the geometric means of NEA and western mackerel for the period 1984-1995, see sec. 2.15) to the time series from the Western mackerel. The MBAL for NEA mackerel is 2.3 million tonnes.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
Median Recruits	4802885	4802885	4847898	5494960	
MBAL	2300000				0.00
Bloss	2307777				
SSB90%R90%Survey	2546751	2669560	2763049	2896131	16.00
SPR%ofVirgin	37.35	35.10	39.44	46.10	
VirginSPR	2.01	1.87	2.13	2.53	
SPRloss	0.48	0.48	0.52	0.69	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.21	0.21	0.20	0.19	56.00
Fmax	0.70	0.70	0.61	0.51	0
F0.1	0.19	0.19	0.17	0.15	72.00
Flow	0.11	0.06	0.02	0	100.00
Fmed	0.26	0.24	0.20	0.15	12.00
Fhigh	0.50	0.40	0.34	0.28	0
F35%SPR	0.22	0.20	0.18	0.14	36.00
Floss	0.38	0.32	0.27	0.18	0

Figure 2.15.1 NEA mackerel stock-recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated (PA output).

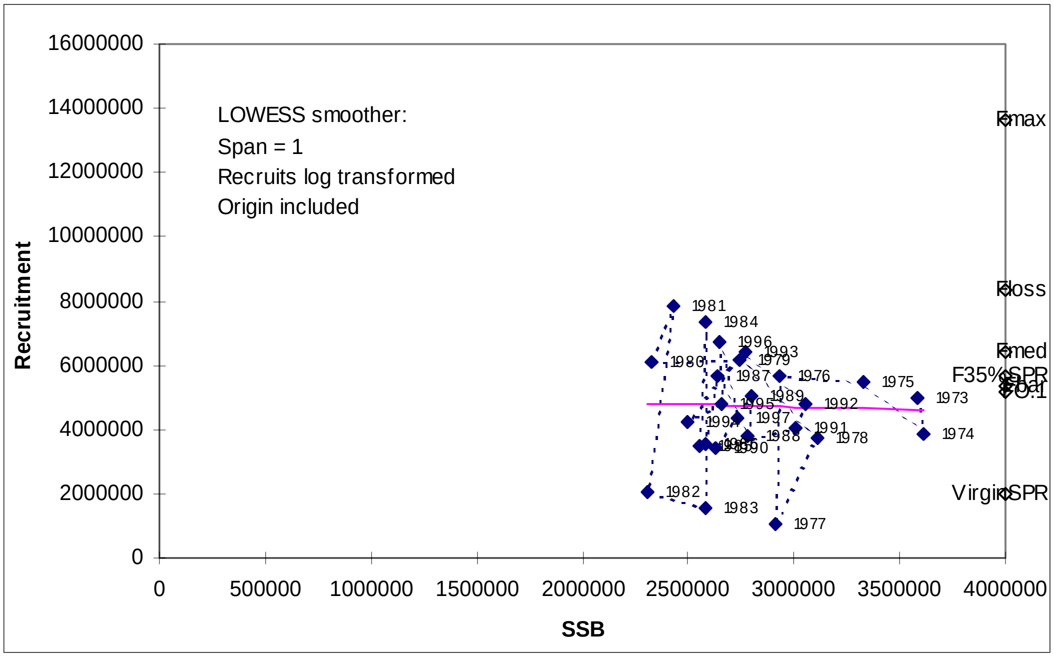


Figure 2.15.2 Plot of YPR and SPR curves with some reference points indicated for NEA mackerel.

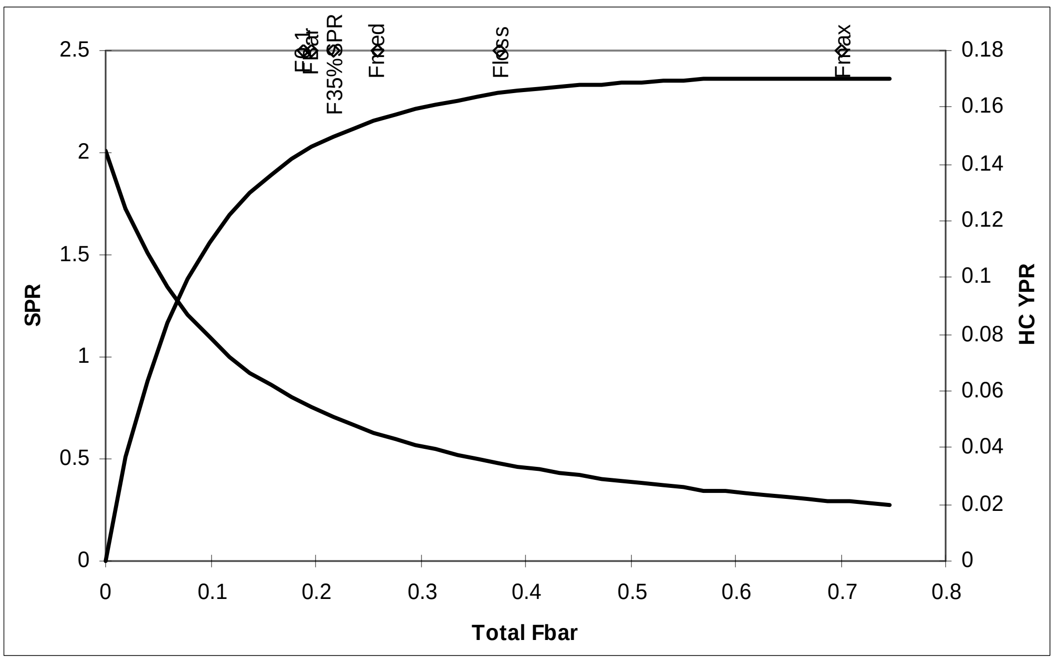


Figure 2.15.3 Plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship for NEA mackerel.

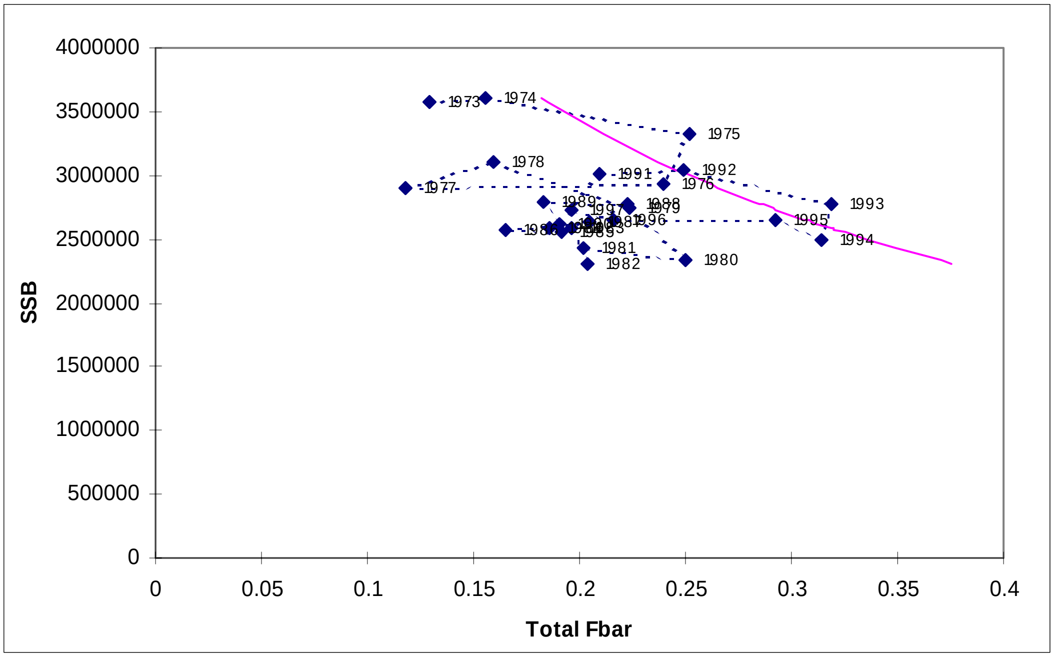


Figure 2.15.4 Plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship for NEA mackerel.

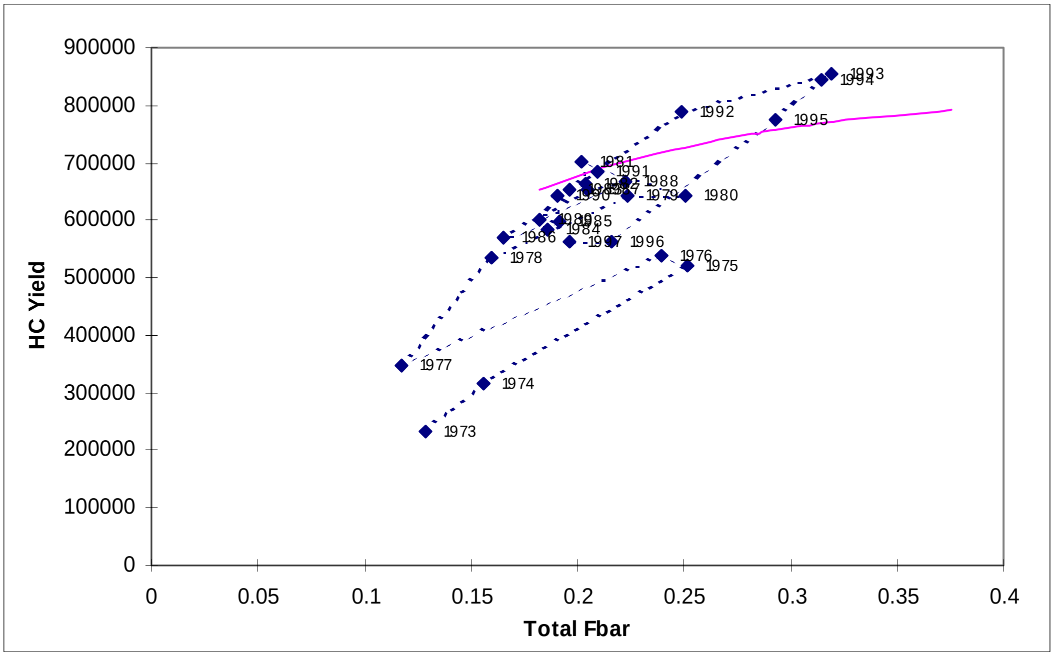


Figure 2.15.5 Plot of the time series of stock and recruitment with expected recruits based on the LOWESS stock recruitment relationship for NEA mackerel.

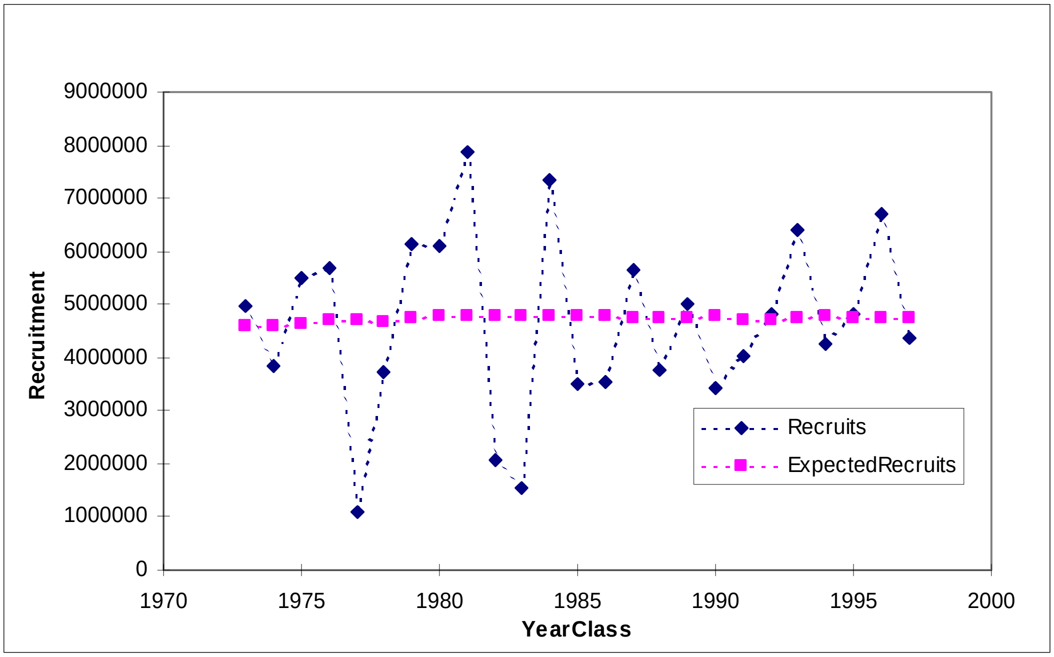


Figure 2.15.6 Various Reference points calculated for NEA mackerel.

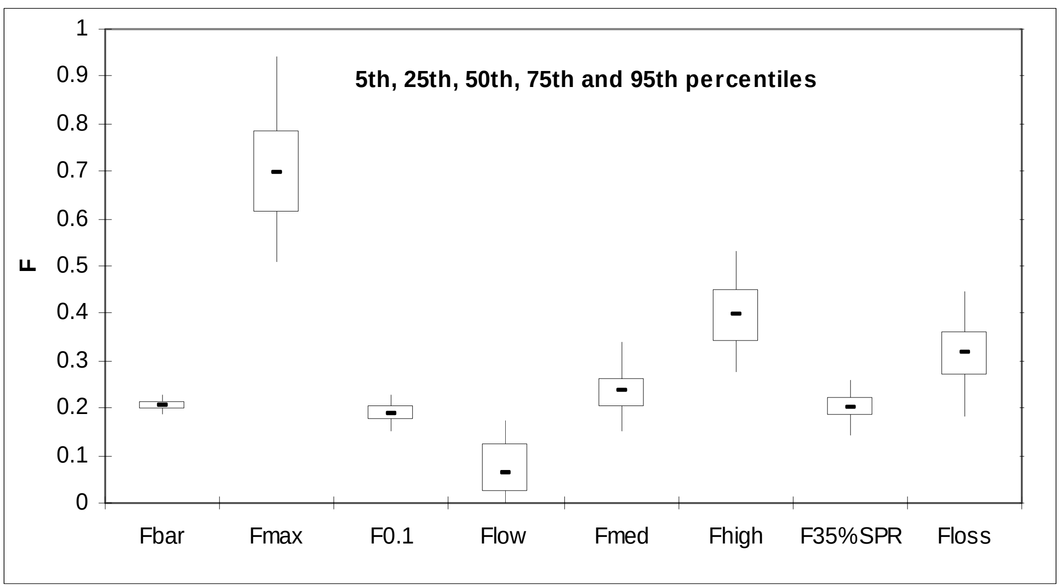
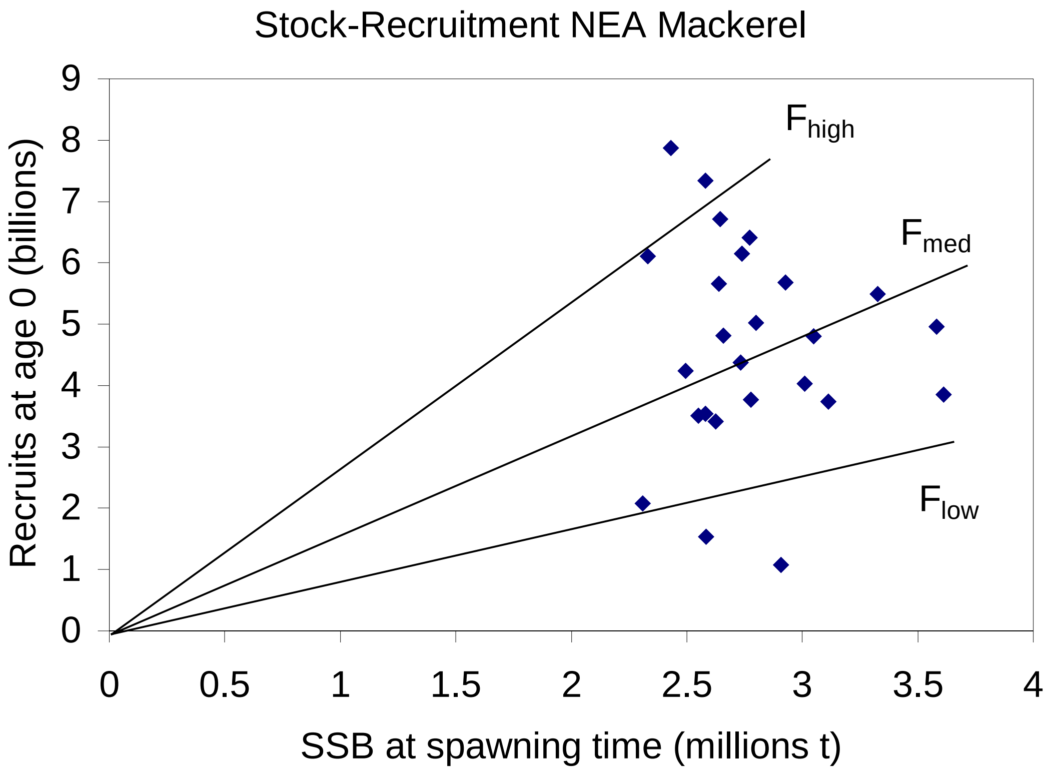


Figure 2.15.7 Sock-recruitment plot for NEA Mackerel with lines indicating the F_{low}, F_{med} and F_{high}.



2.16 Harvest Control Rules

The only new work addressing harvest control rules for NE Atlantic mackerel was a by-product of management simulation studies (Kolody and Patterson WD 1999) that were undertaken in an effort to help resolve problems relating to the specification of the NE Atlantic mackerel assessment model (see section 2.9.1). The operating model approach was used to compare different stock assessment models and regimes on the basis of the long-term management performance (indexed by over-fishing risk and mean yield). These studies involved iterative simulation of fish population dynamics, ICA stock assessment, management by TAC (fixed harvesting strategies), and generation of catch and survey observations with errors. One of the interesting results suggested that different (sometimes structurally incorrect) assessment models may provide similar long-term management performance, even though different models indicate substantially different stock sizes in any given year. Some of the output from this analysis is presented in Fig. 2.16.1, but we do not advocate the specific preliminary results shown. In principle, this approach is a powerful tool for comparing harvest control rules (and assessment models), and is worth further investigation. Disadvantages include difficulties in specifying operating models, and computational time constraints.

The subjects of reference points and management measures were treated extensively by two previous Working Groups (ICES CM 1997/Assess:3, ICES CM 1998/Assess:6).

The Working Group has over several years recommended to maintain SSB above 2.3 million tonnes. This value corresponds approximately to the historical minimum, and was adopted as an MBAL value for the biomass (and was subsequently accepted as SSBpa). Within the range of historical SSBs, there is no clear dependence of the recruitment on the SSB. Below this value, there is no basis for assumptions about the stock-recruitment relationship.

Previous studies concentrated on a harvesting regime based on a constant fishing mortality, which should be set sufficiently low to imply a low risk of reducing the stock below the historical minimum. The recruitment of this stock has moderate year-to-year variations, and a fairly large number of year classes are represented in the fishery. In this case, a fixed catch regime might be considered. This could give a gain in terms of more stable and predictable catches, but requires a lower fixed catch than the average expected by an optimal fixed F regime. It involves a greater risk to the stock if the monitoring and management system is unable to react rapidly to changes in the state of the stock.

A further alternative would be to set quotas for 2–3 years (Anon. 1999), which is more relevant with this stock than with many others since the catch-independent information only comes every third year. The initial simulation work that has been done along these lines (see above and Figure 2.16.1) suggested that this change would not likely have an adverse affect on management performance. More comprehensive simulation studies are recommended to explore the implications of changing the assessment frequency.

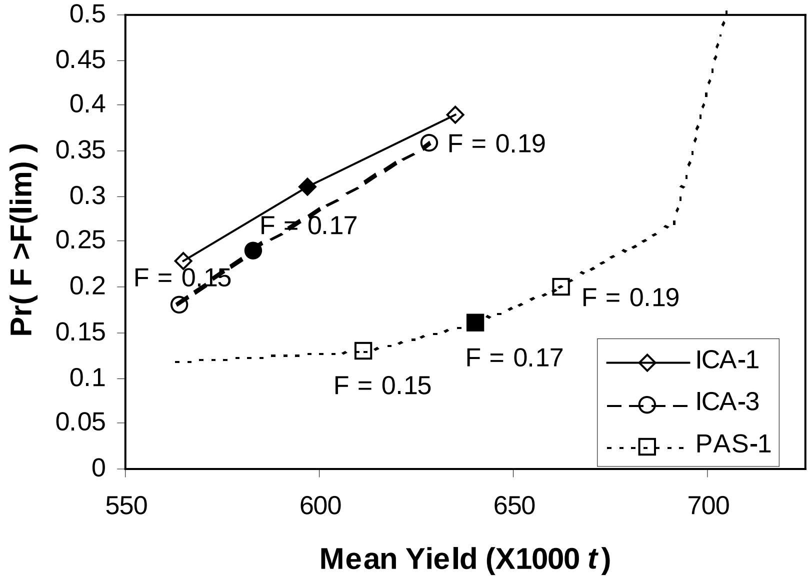


Figure 2.16.1. Typical results of NE Atlantic mackerel fishery simulations comparing the management performance of several harvest control rules (from Kolody and Patterson WD 1999). Each point on the figure represents the trade-off between over-fishing risk and mean yield attained over 20 y of management by the specified fixed harvesting strategy (average of 300 stochastic simulations). In this case, annual (ICA-1) and triennial (ICA-3) assessment regimes are compared over a range of fixed harvest rate policies. The triennial assessment appears to be slightly better (lower risk for any given level of yield), under the operating model conditions specified. Comparison with the hypothetical performance that could be achieved given perfect knowledge of the stock (PAS-1) indicates that differences are trivial.

2.17 Management Measures and Considerations

This years assessment indicates that the stock is larger than predicted in the previous years. According to this estimate, the stock is now safely away from B_{lim}, and the largest in the time series. The present stock estimate is uncertain, however, and the perception of a substantial increase in stock size depends on a limited number of observations. In particular, the abundance of the youngest year classes is poorly substantiated, and the predictions are heavily dependent on these.

The present agreement beween EU and Norway is to maintain a fishing mortality of 0.17, unless advised otherwise, and the Working Group sees no reason to deviate from this strategy. Medium and long term predictions made in previous Working Groups have indicated that a long term harvesting strategy with a Fixed F near $F_{0.1}$ would be optimal with respect to long term yieald and low risk. ACFM has recommended F=0.17 as F_{pa}.

The Working Group once again has to emphasise that the fishing mortalities derived from studies of predictions and simulation apply to the total exploitation of the stock, including areas where no quota regulations apply. Even though Norway and EU have agreed on TAC's derived from a fishing mortality of about 0.15 in recent years, the actual fishing mortality has been around 0.20 because of fisheries outside this agreement. Thus, although the biomass is high, the stock is still exploited outside the safe biological limit indicated by F_{pa}.

A survey carried out in 1998 inside the regulated area known as the 'mackerel box' (Nichols & Warnes, WD 1999) showed that the proportion of juvenile mackerel in that area remains high (69%). Current regulations restricting directed fishery for mackerel in that area should remain in force.

3 MACKEREL STOCK COMPONENTS: NORTH SEA, WESTERN AND SOUTHERN AREAS

3.1 North Sea Mackerel Component

3.1.1 ACFM Advice applicable to 1998 and 1999

Due to the depleted level of the North sea stock the ACFM advice for 1998 and 1999 were the same as given since 1988:

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

- There should be no fishing for mackerel in Division IVa during the period 1 January–31 July;

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

The last one about the 30 cm landing size was not repeated by ACFM in the advice for 1999, but no reason for this was given by ACFM.

3.1.2 The Fishery in 1998

It is not possible to allocate the catches taken in the North Sea to any of the components. For several years the Working Group has assumed a yearly catch of this component of 10,000 t (section 12).

3.1.3 Biological Data

The catches of North Sea mackerel are caught in the mackerel fishery which takes place in its distribution area, but in a mixture with mackerel from the southern and western components which are feeding in this area. It is impossible to divide these catches by components and the catch of North Sea mackerel are included in the tables given in sections 2.4.1 (catch in numbers), 2.4.2 (length compositions by fleet and country) and 2.4.3 (mean lengths and weights at age).

During the egg surveys biological data of the spawning population was sampled (section 12.1.2).

3.1.4 Fishery-independent Information

3.1.4.1 Egg Surveys

During the period 25 May-25 June 1999 Netherlands and Norway carried out egg surveys in the North Sea to estimate the spawning stock biomass (SSB) of mackerel, preliminary results are given in Iversen and Eltink (WD 1999). During this period the spawning area was covered three times. The last time the North Sea was covered several times during the spawning season was in 1996. The spawning period of mackerel in the North Sea is as in previous years defined as 17 May-27 July (72 days). In 1990 about 95 ship days were spent during the egg surveys while only 30 ship days were spent in 1996 and 1999.

The data were sampled and handled according to ICES (1997/H:4). R/V “Tridens” carried out the survey with a Gulf III working in double oblique hauls from the surface to 5m above the bottom. “G. O. Sars” towed a 20 cm Bongo for 5 minutes in each of the depths 20m, 15m, 10m, 5m and in the surface.

The eggs were sorted from each of the sampled stations and their age were estimated according to development stage and to the observed temperature in 5 m. The development stages used in the calculations are eggs without visible embryo (i.e. stage 1A+1B, Lockwood *et. al*.(1981)). The average number of eggs produced per day per m^2 was calculated for each statistical rectangle of 0.5^o latitude x 0.5^o longitude. During the investigation the spawning area was covered three times and the egg production was calculated for the total investigated area for each of the three periods:

Coverage	1	2	3
«Tridens»	25 May-1 June	7-10 June	
«G.O.Sars»		6-11 June	11-25 June
Midpoint of survey	29 May	9 June	18 June
Egg production x10^{-12}	0.41	0.30	1.38 (1.71)

The distribution of stage I eggs are shown in Figures 3.1.4.1.1-3.1.4.1.3.

During the third survey some unsampled rectangles were given interpolated values which increased the egg production estimate by 24% as given in the parenthesis in the text table above. Based on the three production estimates the spawning curve was drawn (Figure 3.1.4.1.4). In 1999 the third coverage is considered to represent the peak of spawning. If the spawning also in 1999, after the peak period, has a similar development as in previous years it is assumed that the egg production after the third survey follows a line from this point to zero production towards the end of July.

By applying the weight fecundity relationship given by Adoff and Iversen (1983) this corresponds to an SSB of 68,000 tons which is the same level as calculated in 1990 (78,000 tons, Iversen *et. al.* (1991)). If the peak of spawning in 1999 was later then in previous years the SSB is underestimated. It seems that the SSB in the North Sea this year mainly consists of young fish (Eltink and Iversen pers cam.). Since younger fish usually spawn later this might indicate that the SSB is underestimated.

By applying the same weight fecundity relationship the SSB estimates based on egg surveys in the previous years are as follows:

Year	1980	1981	1982	1983	1984	1986	1988	1990	1996
Egg production x 10^{-12}	60	40	126	160	78	30	25	53	77
SSB x 10^{-3} t	86	57	180	228	111	43	36	76	110

3.1.4.2 Trawl Surveys

As mentioned elsewhere, it is not presently possible to positively identify juvenile mackerel caught in the North Sea IBTS as belonging to the North Sea or western components. In the 1997 WGMHMSA report (ICES 1998/ACFM:6) the presence was noted of large numbers of 1 year old fish in the NE North Sea. At the time it was not clear whether these represented an upsurge in recruitment to the North Sea stock or were western juveniles which had unusually entered the North Sea. The results of the 1999 North Sea mackerel egg survey (Section 3.1.4.1.) would suggest that no major new recruitment had occurred in the North Sea and that these fish were probably of western origin.

In the absence of useable genetic, morphometric, parasitological or otolith microchemistry research, it is to expected that it will remain impossible to differentiate western and North Sea juveniles in the North Sea.

3.1.5 Effort and catch per unit effort

No data available.

3.1.6 Distribution of North Sea Mackerel

Little is known about the present distribution of the North Sea mackerel outside the spawning period. The spawning area is well defined due to the egg surveys. Based on available information on seasonal changes in areas of fishing and on the basis of results from tagging (Bolster, 1974; Hamre, 1978; Lindquist and Hannerz, 1974) Hamre (1980) gives a general pattern of seasonal migration of the North Sea stock in the 1960's and 1970's. The stock overwintered in the north-western part of the Norwegian Trench and on the shelf west of the Shetland and migrated southward and eastward in April-May towards the spawning areas. Often the mackerel formed dense schools during this migration and thereby was rather available for the purse seiners. The school dispersed when the fish approached maturity and started spawning. After spawning the North Sea stock dispersed over a wide area in the North Sea and occurred in July-August in a large area covering Kattegat, the southern Baltic, and along the Norwegian west coast as far north as Lofoten. A major part of the stock seemed to migrate to the bank area of the northern North Sea, particularly to the area north and east of Shetland where North Sea mackerel were caught together with mackerel coming from the western spawning grounds. In September the North Sea mackerel returned to the bank area in the eastern North Sea and congregated before descending to deeper waters for wintering. It was on the basis of these large autumn concentrations that the extremely rich purse seine fishery developed in the late 60's.

The present situation in the distribution area of the North Sea stock has changed drastically due to the depleted level of this stock and the large amount of western and southern mackerel feeding in these areas during the second half of the year. How this might have influenced the present migration pattern and thereby the distribution of the North Sea stock is unknown.

3.1.7 Recruitment Forecasting

There are no information available which can be used to predict the recruitment to the North Sea. Since the stock is still at a very low level there has been no strong year classes recruited to this stock since the strong 1969 year class.

3.1.8 State of the Stock

The stock is still at a historical low level, preliminary estimated at 68,000 t in 1999. This estimate will be evaluated at the next meeting in 2000 of the Working Group for Mackerel and Horse Mackerel Eggs. The present Working group still considers the North Sea mackerel to be severely depleted.

3.1.9 Management Measures and considerations

Since the Working Group considers the North Sea mackerel to be severely depleted it still needs maximum protection until the SSB show evidence of recovery, while at the same time allowing fishing on the western and southern mackerel while they are in the North Sea.

ACFM has for several years recommended the closure of Division IVa for fishing during the first half of the year until the Western Mackerel stock enter the North Sea in July early August to stay there until late December and in January the following year. There are restrictions for fishing in the North Sea and this has particularly during the first quarter resulted in large scale misreporting from the Northern part of the North Sea (Division IVa) to Division VIa. To allow a fishery during the first quarter might solve the misreporting problem. Since the western mackerel in later years have left the North Sea later than in the 1980’s (section 13.5) it is recommended that the closing date for mackerel fishing in Division IVa be changed from 1 January to 1 February.

With this change the Working Group endorses the recommendations made by ACFM since 1988:

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

- There should be no fishing for mackerel in Division IVa during the period 1 February–31 July;

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

The closure of the mackerel fishery in Divisions IVb,c and IIIa the whole year will protect the North Sea stock in this area and the juvenile Western fish which are numerous particularly in Division IVb,c during the second half of the year. This closure has unfortunately resulted in increased discards of mackerel in the non-directed fisheries in the these area as vessels at present are permitted to take only 10% of their catch as mackerel by-catch. No data on the actual size of mackerel by-catch have been available for the Working Group concerning 1998 but the reported landings of Mackerel in Divisions IIIa and IVb,c for 1998 might be seriously under-estimated due to discarded by-catch.

3.2 Western MacKerel Component

3.2.1 Biological Data

The biological data used in the assessement of the western mackerel component is shown below in the following sections.

3.2.1.1 Catch in numbers at age

The 1998 catches in numbers at age by quarter for Western mackerel (Areas II, III, IV, V, VI, VII and Divisions VIIIa and VIIIb) are shown in Table 3.2.1.1.

The age structure of the catches of Western mackerel is predominantly 2-6 year old fish. These age groups constitute 75% of the total catches. The 1996 year class (2 year old fish) dominated the catches throughout half of the areas where mackerel was caught. Older Fish belonging to the 1993 and 1994 year classes were dominant in the catches in northern and western areas (Divisions IIa IIIa IVa Vb VIIj VIIk). In other areas the catches were dominated by younger fish (1 to 3 year olds) and the pattern of age distributions was similar to last year.

Age distributions of catches were provided by Denmark England Faroes Ireland Netherlands Norway Russia Scotland and Spain. There are still major gaps in the overall sampling for age from countries which take substantial catches notably France Germany Estonia and Sweden (combined catch of 51,928t) and the UK (England and Wales) which provide aged data from only 20% of their catches. In addition there were no aged samples to cover the entire catch from IIIa, VIIa, VIIg, VIIk and VIb (total catch 5,076t). As in 1997 catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleets. This is obviously undesirable where the only aged samples available are from a different type of gear.

Sampling data is further discussed in Section 1.4.1.

Details of allocations of unsampled catches to sampled age-structures are recorded in the Working Group archives.

3.2.1.2 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter for 1998 for Western mackerel is shown in Table 3.2.1.2.1. These data continue the long time series and are useful in investigating changes in relation to stock size.

Mean weights

The mean weights at age in the catches per quarter for Western mackerel is shown in Table 3.2.1.2.2. The mean weights at age in the stock at spawning time for Western mackerel are given in Table 2.4.3.3. These data are based on samples from the Dutch and Irish fleets (VIIj), fishing on the spawning grounds during the period March to May 1998.

3.2.1.3 Maturity Ogive

This Working Group had asked the Mackerel and Horse Mackerel Egg Survey Working Group to provide data for a new maturity ogive based on sampling during the 1998 egg surveys. This was included in the terms of reference for this Working Group and a sampling strategy was worked out at the planning meeting in 1997 (ICES H:4). Unfortunately the sampling plan failed and only 3 samples, each of 100 fish, were collected in the western area during the 1998 egg surveys. These data were too limited for constructing a new maturity ogive.

The results of the Spanish and Portuguese histological investigation of the mackerel maturity ogive indicated that there were substantial differences from a macroscopic determination (see section 3.3.1.3.). This study showed substantial differences in the maturity determination particularly for 2 year old fish newly recruited to the spawning stock. As this can have a major impact on the determination of SSB, the WG recommends that similar studies be carried out in the western area.

The assumptions made about maturity for western mackerel, by the Working Group in previous years, were retained including the reduced maturity at age 2 of the 1984 year class agreed in 1997 (ICES. 1998. Assess. 6). Maturity at age is still assumed constant for each year of the assessment. The values are given in the text table below

Age	0	1	2	3	4	5	6	7	8+
%	0	8	60	90	97	99	99	100	100

3.2.2 Fishery independent information

3.2.2.1 Egg surveys

Information on the historic time series of egg surveys which cover the area of the Western stock are given in section 2.5.2. Based on the 1998 egg survey the relative contribution of the Western area to the NE Atlantic egg survey estimates is 0.75.

3.2.2.2 Trawl surveys

Bottom trawl surveys which provide information on Western stock juvenile mackerel include; Scottish surveys to the north and west of the British Isles in quarters 1 and 4, an English survey in the western approaches in quarter 1 and an Irish survey on the west & south coasts of Ireland in quarter 4. Distribution of relevant data is given in section 2.7.2. The index of recruitment derived from these surveys was not used in the assessment; reasons for this are given in section 2.5.4. A Generalised additive model (GAM) was used to try and improve the performance of the recruitment index; details of this are given in section 2.8. Data from these surveys continue to be the only source of information on the distribution of juvenile mackerel.

3.2.3 State of the Stock Component

An ICA model has been fitted to the western component of the mackerel stock in order to maintain the long time series of information on trends in SSB and recruitment, which are not available for the combined stock.

Tables 3.2.3.1 to 3.2.3.4 show the catches in number, the SSB index values used in the assessment the mean weights at age in the catch and mean weights at age in the stock . The proportion of fish spawning remains unchanged since the beginning of the time series and is given in the text table in section 3.2.1. Natural mortality was again assumed to be 0.15 for all age groups.

ICA fits to the catch at age data and the estimates of SSB were used to examine the relationship between the indices and the catch at age data as estimated by a separable VPA. Given that the SSB estimated from the 1998 egg survey was again higher than the SSB predicted from a projection of the 1997 assessment, the method by which SSB index is used to tune ICA was explored (see section 2.9.1). The WG decided to use the SSB index as a relative index of abundance and to give the index series a weighting of 5 (see section 2.9.2). As in previous years, two selection patterns were used in order to model an apparent change in selection that took place in the late eighties (1986–1988 and 1989–1998, Figure 3.2.3.3). The short time span for the first period was selected in order to exclude the 1985 catch data, which includes a zero catch of 0-group. A terminal selection of 1.2 was used for both periods, as there is no evidence for a difference between the values estimated for the oldest ages. Both selection patterns were calculated relative to the reference fishing mortality at age 5.

The model was fitted by a non-linear minimisation of:

$$\sum_{a=0}^{a=11}\sum_{y=1986}^{y=1988}\lambda_a(\ln(C_{a,y})-\ln(F_y.S1_a.\overline{N}_{a,y}))^2+$$

$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=1998}\lambda_a(\ln(C_{a,y})-\ln(F_y.S2_a.\overline{N}_{a,y}))^2+$$

$$\sum_{y=1977}^{y=1986}(\ln(EPB_y)-\ln(Q\ {}_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S1_a-PM.M))^2+$$

$$\sum_{y=1989}^{y=1998}(\ln(EPB_y)-\ln(Q\ {}_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a-PM.M))^2$$

subject to the constraints

$S1_5 = S2_5 = 1.0$
$S1_{11} = S2_{11} = 1.2$

where

Nbar - 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.
S1, S2 - selection at age over the time periods 1986–1988 and 1989–1998, referenced to age 5.
λ - weighting factor set to 0.01 for age 0, 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 is ratio between egg survey estimates of biomass and assessment model estmate of biomass

Tables 3.2.3.5 and 3.2.3.6 present the estimated fishing mortalities and population numbers at age. Tables 3.2.3.7a,b,c,d, Figures 3.2.3.1 to 3.2.3.4 present the diagnostic output and Table 3.2.3.8 presents the stock summary.

3.3 Southern Mackerel Component

3.3.1 Biological Data

3.3.1.1 Catch in numbers at age

The catch in numbers at age for Divisions VIII c and IX a are discussed in Section 2.4. (Table 2.4.1 NEA mackerel).

3.3.1.2 Mean lengths at age and mean weigths at age

The mean lengths at age and mean weigths at age for Divisions VIII c and IX a are discussed in Section 2.4. (Tables 2.4.3.1 and 2.4.3.2 - NEA mackerel).

The mean weights at age in the stock for the southern mackerel are based on samples obtained from the commercial catches during Quarter 1 and Quarter 4 as a mean over 1991 till 1995 (table below):

Stock Weights at Age (kg) for Southern Mackerel														
Age in Years														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
.161	.248	.305	.354	.385	.427	.455	.493	.511	.545	.548	.617	.622	656	.716

3.3.1.3 Maturity ogive

For purposes of evaluation it is important that the maturiy ogive represents the proportion of fish which spawn, as the assessment of the Northeast Atlantic mackerel is tunned by spawning stock biomass obtained from the eggs surveys. Following the recommendations of Mackerel, Horse mackerel, Sardine and Anchovy 1998 Working Group an estimation of the maturity ogive in 1998 was estimated for the Northeast Atlantic mackerel females from the Southern area in Sub-divisions IXa North, VIIIc West and VIIIc East. These estimations were based on histological and macroscopical analysis (Perez, Villamor and Abaunza 1999 W.D.).

Samples were obtained in the Spanish acustic survey in March 1998, around the peak of spawning in this area. Samples were analysed histologically to provide a more accurate estimate of the numbers of fish that which will actually spawn in this year.

Figure 3.3.1.3.1 shows the percentage mature, resorbing and immature mackerel at age for the whole area. High numbers of immature fish are observed in age group 1.The proportion of fish with ovaries in which the vitellogenic oocytes are resorbed is high for ages 2 and 3, and remaining high at age 10.

Figure 3.3.1.3.2 compares the proportions of maturity at age obtained macroscopically, microscopically and that used on the WG without applying the logistic model. An overestimation is seen in maturity of macroscopic ogive on the one used in the ICES WG for ages 1 to 3 with respect to the maturity obtained microscopically. The logistic model has been used and fits to the maturity data perfectely, obtaining R^2 equal to 100% in the ogives estimated using macroscopic and microscopic criteria. When comparing both ogives with that used in the WG a good agreement is observed with the macroscopic ogive, and overestimation of maturity results from the microscopic ogive for the age range below 5 years (Perez *et al*, 1999 W.D.).

This Working Group set the proportion mature for ages 4-6 to 1.00, because spent fish with only atretic oocytes have been assigned to immature fish in this analysis. (see Section 2.4.4)

The text table below shows the new maturity ogive for the Southern area:

Maturity ogive of mackerel from southern area														
Age														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
0	.02	.054	1	1	1	1	1	1	1	1	1	1	1	1

3.3.1.4 Natural Mortality

The value for natural mortality used by the WG for the Southern component as well as for all the others of the NE Atlantic mackerel stock is 0.15. (see section 2.4.5).

3.3.2 Fishery- independent information and CPUE indices of stock size

3.3.2.1 Egg Surveys

The egg survey carried out in 1998 was the second in the series in the southern area for the annual egg production method. A limited survey was carried out in 1992 with poor temporal and spatial coverage.

The temporal and spatial coverage in 1998 was improved compared with the previous survey in 1995. Sampling began in the southern area in Division IXa only on 17 January. However because of ship time constraints this area was only surveyed during the first two sampling periods up to the end of February. As a result there was no overlap in sampling between IXa and VIIIc. Sampling was carried out in Division VIIIc from period 3, beginning 15 March through to the end of the last sampling period on 5 July.

There was very low production of stage I eggs during the first two periods in Division IXa. Most of the mackerel egg production in the southern area occurred during sampling periods 3 and 4, from mid-March to mid-May, on the shelf along the Cantabrian coast. The annual production curve for the southern area shows a large increase between periods 2 and 3 indicating the possibility of some missed production in period 2 along the Cantabrian coast.

The total annual production of stage I eggs was 0.461 x 10^{15} (s.e. 0.186 x10^{15}). This estimate is more than double the estimate obtained in 1995 of 0.207 x 10^{15} (s.e. 0.013 x10^{15}). The extent to which improvements in temporal and spatial coverage may have resulted in a higher estimate is not known.

The coefficient of variation of the total annual stage I egg production, 40.34%, was very high, mainly due to the high standard error values during sampling periods 3 and 4 on the Cantabrian coast. It is possible that the adaptive sampling strategy, adopted at the survey planning meeting in 1997 (ICES /1997 H:4) may have been largely responsible for these high standard errors. The strategy resulted in a gap of up to two weeks between sampling on some adjacent transects. The strategy may not be appropriate for the Cantabrian coast where the shelf edge runs from east to west.

Estimates of both fecundity and atresia were made from the adult sampling carried out before and during the 1998 egg survey (ICES 1999 / G:5). The total potential fecundity of 1276 oocytes per gram female was similar to that obtained in the western spawning area. Anlaysis of all the atresia samples has not yet been completed. The samples analysed to date give an atresia value of 105 oocytes per gram female resulting in a realised fecundity of 1,171 oocytes per gram female for the southern area.

The estimate of total spawning stock biomass, using a sex ratio of 1:1 and a raising factor of 1.08 to convert from pre-spawning biomass, was 850, 000 tonnes with a standard error of 313,000 tonnes. This is an increase of 125% compared with the previous estimate of SSB by egg survey in 1995 of 380,000 tonnes. In view of the high standard error of this estimate it should be treated with caution.

The 1998 values for stage I egg production, potential fecundity atresia and SSB are summarised in Table 2.5.2.1.

3.3.2.2 Demersal trawl surveys

Table 3.3.2.2.1 shows the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 1998 in September-October and the numbers at age per hour trawl (*1000) from Portuguese bottom trawl Autumn surveys from 1986 to 1998.

The two sets of Autumn surveys covered Sub-divisions VIIIc East, VIIIc West and IXa North (Spain) from 20-500 m depth, using Baka 44/60 gear and Sub-divisions IXa Central North, Central South and South (Portugal), from 20-750 m depth, using a Norwegian Campell Trawl (NCT), that is a trawl net having a 14 m horizontal opening, rollers on the ground-roper and has been fitted with a 20 mm mesh size cod end. The same sampling methodology is used in both surveys.

Within the SESITS Project (DG XIV Study contract 96-029) an analysis of the data of mackerel to estimate the conversion coefficients between R/V Thalassa/GOV and R/V Cornide Saavedra using Baka 44/60 gear from overlapping experiments (Panterne *et al.* W.D. 1999). Conversion coeficients of R/V Talassa using GOV 36/47 to R/V Cornide Saveedra using Baka 44/60 gear for 1997 and 1998 combined was 0.14 (error 0.15) and conversion coeficient of R/V Cornide Saavedra using Baka 44/60 gear to R/V Thalassa using GOV 36/47 was 8.45 (error 0.41).

3.3.3 Effort and Catch per Unit Effort

This information is now given in section 2.6.

3.3.4 State of the stock component

As noted in section 3.3.2.1, the SSB estimated by egg survey, 850,000 t in 1998 showed an increase of 125% compared with the previous estimate by egg survey, in 1995, of 380,000 t. The MHMEGG WG advised that, in view of the high standard error estimate, it should be treated with caution.

The size of the southern mackerel component relative to the NEA mackerel is uncertain but believe to be between 15-25%. Acoustic surveys in Divisions VIIIc and IXa also suggest an increase in the abundance of this stock component (Carrera P.,Villamor B.and Abaunza P. WD 1999, and Carrera P. WD 1999).

Table 3.2.1.1 catch numbers at at age (000's) for Western mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
1	0	0	0	0	0	0	162	0	0	0	0	0	0	0	1,757	3	32	36	1,989
2	0	59	15,621	1	4,198	141	4,944	0	0	497	224	10,105	1	1,160	1,936	4	13	346	39,250
3	1	147	34,173	2	525	445	20,600	0	0	1,517	34	10,620	1	516	3,960	74	3	1,655	74,274
4	3	382	49,782	5	1,049	1,008	44,768	1	0	5,071	58	5,617	1	967	8,692	129	0	474	118,005
5	4	529	72,849	6	525	1,051	53,042	1	0	10,596	29	2,215	0	516	12,973	197	0	1,246	155,777
6	2	294	32,366	3	263	1,099	37,765	1	0	6,504	14	518	0	65	7,068	117	0	780	86,858
7	1	206	31,276	2	0	632	26,044	1	0	3,152	0	439	0	0	2,904	74	0	312	65,044
8	1	117	17,297	1	0	649	9,627	0	0	4,529	0	124	0	0	2,391	35	0	212	34,985
9	1	117	10,896	1	0	148	10,686	0	0	1,775	0	0	0	0	2,174	26	0	182	26,007
10	0	0	3,313	0	0	251	6,478	0	0	1,897	0	11	0	0	1,503	21	0	99	13,573
11	0	29	3,312	0	0	21	3,476	0	0	434	0	0	0	0	185	8	0	164	7,629
12	1	88	1,803	1	0	44	2,163	0	0	805	0	0	0	0	405	11	0	110	5,431
13	0	29	844	0	0	157	1,437	0	0	152	0	4	0	0	218	3	0	74	2,919
14	0	0	858	0	0	48	300	0	0	46	0	46	0	0	38	2	0	16	1,355
15	0	29	825	0	0	102	783	0	0	74	0	0	0	0	142	0	0	14	1,970
SOP	6	842	103,405	10	1,278	2,803	86,551	2	0	16,112	70	5,675	1	695	16,879	267	9	1,940	236,545
Catch	6	881	103,504	10	1,275	2,806	86,552	2	0	16,099	70	5,684	1	701	16,887	267	9	1,941	236,695
SOP%	**100%**	**105%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**	**100%**	**100%**	**101%**	**100%**	**100%**	**100%**	**100%**	**100%**

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	1	24	0	0	29	0	0	39	10	71	0	1	15	0	0	12	202
2	989	31	6,018	32	715	390	810	0	0	957	637	206	1	2	1,996	4	0	41	12,828
3	2,841	79	4,792	90	89	1,121	1,833	0	0	3,680	102	189	1	1	8,720	19	0	132	23,689
4	4,317	145	1,739	153	179	1,700	4,552	2	0	5,054	165	94	0	2	17,613	31	0	147	35,894
5	6,981	264	1,085	274	89	2,753	3,801	2	0	4,888	81	40	0	1	22,792	32	0	593	43,676
6	1,697	38	431	41	45	663	3,034	1	0	3,511	39	10	0	0	11,886	15	0	490	21,901
7	1,710	37	108	37	0	672	2,186	1	0	1,768	1	7	0	0	5,745	7	0	282	12,560
8	799	53	70	54	0	311	2,107	1	0	575	0	2	0	0	4,135	4	0	199	8,310
9	459	7	27	7	0	181	699	0	0	299	0	0	0	0	2,028	2	0	187	3,898
10	355	22	95	22	0	138	397	0	0	0	0	0	0	0	1,301	1	0	110	2,441
11	167	22	21	22	0	66	612	0	0	762	0	0	0	0	118	0	0	186	1,976
12	15	11	7	11	0	5	172	0	0	386	0	0	0	0	201	0	0	105	913
13	3	4	2	4	0	0	10	0	0	0	0	0	0	0	152	0	0	62	237
14	1	2	1	2	0	0	276	0	0	0	0	1	0	0	36	0	0	63	382
15	2	2	1	2	0	0	5	0	0	0	0	0	0	0	0	0	0	9	20
SOP	8,861	314	3,916	329	218	3,484	8,471	3	0	7,029	203	132	1	2	25,284	35	0	1,135	59,417
Catch	9,443	315	3,911	330	217	3,484	8,469	3	0	7,032	202	128	1	2	25,193	35	0	1,134	59,899
SOP%	**107%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**	**97%**	**100%**	**100%**	**100%**	**100%**		**100%**	**101%**

Table 3.2.1.1 (Continued)

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	37
1	0	0	223	512	1,234	0	0	0	1	1,510	33	637	0	487	0	0	224	0	4,860
2	23,896	335	7,548	1,495	858	0	0	0	1	6,360	34	959	0	154	31	1	90	1	41,762
3	44,639	858	14,256	827	238	0	20	0	0	2,951	23	705	0	1	157	7	22	3	64,708
4	53,177	1,440	22,166	804	1	0	40	0	0	2,135	10	246	0	1	208	11	0	1	80,240
5	52,448	1,344	19,535	687	48	0	61	0	0	1,436	5	110	0	1	191	13	0	1	75,879
6	29,315	975	14,062	514	0	0	101	0	0	872	1	47	0	0	81	6	0	1	45,978
7	10,669	347	5,001	169	0	0	61	0	0	430	0	7	0	0	36	3	0	0	16,725
8	7,357	341	4,891	179	0	0	161	1	0	152	0	6	0	0	23	2	0	0	13,114
9	4,543	106	1,552	52	0	0	20	0	0	73	0	2	0	0	12	1	0	0	6,361
10	1,594	86	1,243	42	0	0	0	0	0	0	0	1	0	0	6	1	0	0	2,974
11	1,890	42	594	20	0	0	0	0	0	185	0	0	0	0	2	1	0	0	2,733
12	88	9	139	5	0	0	20	0	0	94	0	0	0	0	2	0	0	0	357
13	103	25	361	12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	503
14	32	5	66	2	0	0	20	0	0	0	0	0	0	0	1	0	0	0	125
15	67	3	41	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112
SOP	101,622	2,720	40,699	1,950	459	0	233	1	0	3,988	25	662	0	107	235	15	63	2	152,781
Catch	101,622	2,720	40,701	1,951	461	0	232	1	0	3,991	25	663	0	108	232	15	63	2	152,787
SOP%	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**		**100%**	**100%**	**100%**		**101%**	**99%**	**100%**	**100%**	**100%**	**100%**

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0	0	0	0	0	0	21	0	0	0	16	1,316	0	6,256	0	0	350	2	7,960
1	0	282	6,064	199	441	0	6,512	2	0	5,135	2,836	21,254	0	15,639	0	0	2,101	441	60,907
2	2,274	421	31,737	308	919	0	26,745	10	0	20,964	2,509	19,040	0	4,170	61	1	3,356	587	113,101
3	6,359	429	40,484	317	493	0	13,532	2	0	7,034	1,080	8,741	0	0	447	5	1,328	178	80,429
4	6,696	274	54,473	218	184	0	7,254	1	0	3,097	754	3,033	0	0	318	3	2,096	22	78,424
5	8,686	240	51,086	192	169	0	2,630	0	0	845	6	1,733	0	0	204	2	1,118	7	66,918
6	4,482	70	31,596	64	0	0	469	0	0	62	0	500	0	0	43	0	140	6	37,433
7	1,242	66	15,360	53	6	0	152	0	0	0	297	287	0	0	12	0	0	0	17,476
8	2,151	27	9,402	24	3	0	21	0	0	41	149	211	0	0	9	0	0	0	12,039
9	1,093	19	5,792	16	0	0	0	0	0	0	0	32	0	0	0	0	0	0	6,953
10	328	4	2,347	4	0	0	0	0	0	0	0	13	0	0	0	0	0	0	2,696
11	656	4	1,509	4	48	0	0	0	0	0	0	2	0	0	0	0	0	0	2,222
12	984	0	1,526	1	0	0	0	0	0	0	0	21	0	0	0	0	0	0	2,532
13	115	0	325	0	51	0	0	0	0	0	149	2	0	0	0	0	0	0	643
14	66	0	944	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,010
15	16	0	805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	821
SOP	16,917	827	111,394	630	648	0	14,998	4	0	7,791	2,097	11,831	0	3,389	405	4	2,094	260	173,289
Catch	16,917	827	111,390	629	646	0	15,001	4	0	7,804	2,094	11,883	0	3,388	405	4	2,111	261	173,364
SOP%	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**		**100%**	**100%**	**100%**		**100%**	**100%**	**100%**	**101%**	**100%**	**100%**

Table 3.2.1.1 (Continued)

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0	0	0	0	0	0	21	0	0	0	16	1,316	0	6,256	0	0	393	2	8,003
1	0	284	6,288	734	1,675	0	6,703	2	1	6,683	2,878	21,961	1	16,127	1,772	3	2,357	488	67,958
2	27,159	846	60,924	1,835	6,689	531	32,499	10	1	28,777	3,404	30,310	2	5,486	4,024	11	3,458	975	206,941
3	53,839	1,512	93,705	1,236	1,345	1,566	35,985	3	1	15,182	1,239	20,255	2	518	13,285	106	1,354	1,969	243,100
4	64,192	2,241	128,160	1,180	1,413	2,708	56,613	4	0	15,357	987	8,991	1	970	26,831	175	2,096	643	312,562
5	68,118	2,376	144,555	1,160	832	3,804	59,533	3	0	17,765	121	4,097	0	518	36,159	243	1,118	1,847	342,249
6	35,496	1,377	78,455	623	308	1,763	41,369	2	0	10,949	55	1,075	0	65	19,078	138	140	1,276	192,169
7	13,622	655	51,745	262	6	1,304	28,443	2	0	5,350	299	740	0	0	8,698	83	0	595	111,804
8	10,308	539	31,659	258	3	960	11,917	2	0	5,297	150	344	0	0	6,559	41	0	411	68,448
9	6,096	250	18,268	77	0	328	11,406	1	0	2,147	0	35	0	0	4,213	29	0	370	43,218
10	2,277	112	6,997	68	0	389	6,874	0	0	1,897	0	26	0	0	2,809	23	0	210	21,684
11	2,713	97	5,436	46	48	87	4,088	1	0	1,381	0	2	0	0	305	8	0	350	14,561
12	1,087	108	3,476	18	0	50	2,355	0	0	1,285	0	21	0	0	607	11	0	216	9,233
13	221	58	1,532	17	51	157	1,447	0	0	152	149	7	0	0	371	3	0	136	4,301
14	99	6	1,869	5	0	48	597	0	0	46	0	47	0	0	75	2	0	79	2,872
15	85	34	1,671	4	0	102	787	0	0	74	0	0	0	0	142	0	0	24	2,924
SOP	127,404	4,704	259,409	2,918	2,603	6,287	110,250	10	1	34,918	2,395	18,297	1	4,194	42,805	322	2,166	3,338	614,676
Catch	127,988	4,743	259,505	2,921	2,599	6,290	110,254	10	1	34,927	2,391	18,307	1	4,199	42,717	322	2,183	3,339	622,697
SOP %	**100%**	**101%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**101%**	**100%**	**101%**

Table 3.2.1.2.1 Mean length at age for Western mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0.0	20.1
1	0.0	0.0	0.0	0.0	0.0	0.0	22.5	22.5	0.0	0.0	0.0	0.0	0.0	0.0	22.3	22.5	27.9	26.9	22.5
2	28.2	28.2	29.5	28.2	28.3	31.6	29.3	29.0	0.0	28.3	28.2	26.1	26.1	30.7	28.3	29.6	30.3	30.0	28.4
3	32.4	32.4	33.0	32.4	33.0	33.3	33.1	33.2	0.0	33.7	32.6	31.1	31.1	31.9	32.7	33.4	33.5	32.0	32.7
4	33.5	33.5	34.3	33.5	31.8	34.6	34.4	34.0	0.0	35.9	31.8	32.7	32.7	30.3	35.0	34.9	0.0	35.3	34.3
5	36.2	36.2	35.7	36.2	35.5	36.5	36.1	35.4	0.0	37.4	35.5	35.2	35.2	28.4	36.6	36.4	0.0	36.5	36.0
6	36.8	36.8	36.7	36.8	38.5	37.5	37.4	37.0	0.0	38.1	38.5	36.9	36.9	32.5	38.5	38.2	0.0	37.4	37.3
7	37.7	37.7	36.7	37.7	0.0	37.6	37.9	37.3	0.0	38.9	37.8	37.8	37.8	0.0	38.8	38.0	0.0	39.2	37.4
8	38.8	38.8	38.5	38.8	0.0	38.4	39.0	38.5	0.0	40.9	36.2	36.2	36.2	0.0	40.6	40.2	0.0	39.7	39.1
9	39.6	39.6	40.1	39.6	0.0	39.2	40.0	39.3	0.0	41.0	0.0	0.0	0.0	0.0	41.2	40.7	0.0	40.6	40.2
10	0.0	0.0	41.2	0.0	0.0	39.1	40.4	40.4	0.0	41.6	39.3	39.3	39.3	0.0	42.4	41.1	0.0	41.2	41.0
11	40.1	40.1	41.0	40.1	0.0	41.0	40.5	39.8	0.0	41.7	0.0	0.0	0.0	0.0	41.2	41.2	0.0	42.1	40.9
12	41.2	41.2	42.4	41.2	0.0	40.5	41.8	41.2	0.0	43.7	0.0	0.0	0.0	0.0	43.3	42.6	0.0	41.9	42.4
13	41.0	41.0	42.7	41.0	0.0	41.4	41.3	41.1	0.0	42.9	40.5	40.5	40.5	0.0	43.3	42.8	0.0	42.5	41.9
14	0.0	0.0	40.9	0.0	0.0	41.6	42.3	42.8	0.0	42.5	41.6	41.6	41.6	0.0	44.5	44.5	0.0	43.0	41.5
15+	41.8	41.8	42.4	41.8	0.0	41.7	42.1	41.6	0.0	45.2	0.0	0.0	0.0	0.0	44.5	44.5	0.0	43.0	42.5

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	24.0	24.0	24.0	22.0	0.0	0.0	31.0	0.0	0.0	26.5	28.5	28.5	28.5	27.2	21.5	21.5	0.0	26.6	27.0
2	30.6	29.0	29.6	29.0	28.3	30.6	32.5	31.5	26.1	30.3	28.3	27.9	27.9	30.0	29.5	29.4	0.0	29.4	29.8
3	33.1	32.3	32.2	32.3	33.0	33.1	34.0	33.5	31.1	32.8	32.7	31.7	31.7	32.0	32.5	32.5	0.0	32.1	32.7
4	35.5	34.8	33.8	34.8	31.8	35.5	34.5	34.2	32.7	35.0	31.8	32.5	32.5	32.2	34.4	34.1	0.0	36.8	34.6
5	36.0	36.3	36.1	36.3	35.5	36.0	36.3	36.0	35.2	35.8	35.4	34.6	34.6	33.3	36.3	36.0	0.0	37.4	36.2
6	37.4	38.0	37.7	38.0	38.5	37.4	37.0	36.4	36.9	37.2	38.4	37.0	37.0	36.5	37.8	37.5	0.0	38.1	37.6
7	38.7	39.0	38.7	39.0	0.0	38.7	38.7	38.9	37.8	38.3	37.3	37.3	37.3	38.5	39.2	38.9	0.0	39.5	38.9
8	39.2	39.8	39.5	39.8	0.0	39.2	39.8	38.5	36.2	39.4	37.0	37.0	37.0	38.3	39.4	38.9	0.0	40.0	39.5
9	41.1	41.0	41.1	41.0	0.0	41.1	39.3	39.8	0.0	41.6	36.3	36.3	36.3	40.6	41.4	41.0	0.0	40.6	41.0
10	41.2	41.3	43.5	41.3	0.0	41.2	40.6	40.5	39.3	0.0	37.3	37.3	37.3	42.0	42.1	42.0	0.0	41.1	41.7
11	42.5	41.8	42.1	41.8	0.0	42.6	40.3	40.3	0.0	41.1	39.5	39.5	39.5	41.0	41.0	41.0	0.0	42.2	41.1
12	44.7	42.6	42.8	42.6	0.0	45.0	44.1	40.8	0.0	42.5	0.0	0.0	0.0	40.6	41.0	40.8	0.0	41.9	42.5
13	41.5	43.2	43.2	43.2	0.0	0.0	42.3	41.9	40.5	0.0	40.5	40.5	40.5	40.5	41.1	40.8	0.0	42.3	41.5
14	41.8	44.3	44.3	44.3	0.0	0.0	43.5	42.5	41.6	0.0	41.6	41.6	41.6	44.5	44.5	44.5	0.0	44.4	43.7
15+	41.8	45.0	45.0	45.0	0.0	0.0	44.2	42.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.0	43.6

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0.0	20.1
1	0.0	0.0	27.5	28.4	27.8	0.0	0.0	0.0	28.5	27.4	28.5	28.4	28.5	27.2	21.5	21.5	27.9	26.9	27.7
2	30.6	31.7	30.8	31.0	30.0	0.0	0.0	0.0	30.4	30.6	30.4	30.6	30.4	29.2	30.2	30.7	30.3	29.8	30.6
3	33.1	34.1	33.8	33.5	33.1	0.0	33.5	33.5	32.5	33.1	32.5	32.6	32.5	32.7	32.9	33.1	33.5	31.9	33.3
4	34.6	35.0	34.8	34.9	31.8	0.0	34.5	34.5	32.2	34.8	32.2	32.8	32.2	34.2	34.4	34.7	0.0	34.6	34.7
5	36.3	36.8	36.7	36.7	41.4	0.0	36.8	36.8	33.7	35.5	33.7	34.7	33.7	35.7	36.0	36.2	0.0	36.0	36.4
6	37.6	37.1	37.1	37.2	38.5	0.0	37.9	37.9	37.2	37.9	37.2	38.0	37.2	37.4	37.6	37.8	0.0	37.0	37.4
7	38.1	37.8	37.8	37.8	0.0	0.0	39.2	39.2	36.7	38.3	36.7	36.7	36.7	38.3	38.6	38.8	0.0	39.0	38.0
8	39.3	39.7	39.7	39.5	0.0	0.0	41.3	41.3	38.0	40.0	38.0	38.0	38.0	37.9	38.5	38.8	0.0	39.3	39.5
9	40.4	38.9	38.9	38.9	0.0	0.0	37.5	37.5	36.3	41.6	36.3	36.3	36.3	40.6	41.0	41.2	0.0	40.2	40.0
10	40.8	40.5	40.5	40.5	0.0	0.0	0.0	0.0	34.5	0.0	34.5	34.5	34.5	42.0	42.0	42.1	0.0	41.0	40.7
11	41.6	40.6	40.6	40.6	0.0	0.0	0.0	0.0	39.5	41.1	39.5	39.5	39.5	41.0	41.0	41.0	0.0	42.3	41.4
12	43.5	43.0	42.9	43.0	0.0	0.0	45.5	45.5	0.0	42.5	0.0	0.0	0.0	40.6	40.8	41.0	0.0	41.9	43.1
13	41.4	41.4	41.4	41.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5	40.8	41.0	0.0	42.3	41.4
14	41.6	44.2	44.2	44.2	0.0	0.0	44.5	44.5	0.0	0.0	0.0	0.0	0.0	44.5	44.5	44.5	0.0	43.4	43.6
15+	41.7	44.4	44.4	44.4	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	43.4	42.8

Table 3.2.1.2.1 (Continued)

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	0.0	20.8	0.0	20.8	20.8	20.8	21.0	0.0	0.0	20.1	26.3	20.9
1	0.0	32.2	31.8	32.2	28.7	0.0	27.8	28.8	27.6	28.0	29.0	27.9	27.6	27.2	0.0	0.0	27.9	29.3	28.2
2	32.1	34.6	32.4	34.5	30.9	0.0	31.1	30.9	29.7	30.9	30.5	30.1	29.7	30.0	33.6	33.6	30.6	31.5	31.2
3	33.6	36.7	34.3	36.5	33.7	0.0	33.0	32.5	32.0	33.4	33.9	32.5	32.0	0.0	34.6	34.6	32.1	32.4	33.7
4	34.9	38.2	35.1	37.8	34.1	0.0	33.8	32.5	32.2	34.6	35.7	32.7	32.2	0.0	35.9	35.9	30.3	33.8	34.7
5	36.5	38.7	36.6	38.4	36.5	0.0	34.8	34.0	33.5	35.3	33.5	34.4	33.5	0.0	36.1	36.1	28.4	35.1	36.3
6	37.2	39.3	37.5	38.9	0.0	0.0	37.4	0.0	37.5	38.5	37.5	38.5	37.5	0.0	38.4	38.4	32.5	35.9	37.5
7	38.1	40.6	38.3	40.3	40.0	0.0	39.1	39.5	38.5	0.0	40.0	39.1	38.5	0.0	37.5	37.5	0.0	38.5	38.3
8	39.0	40.4	38.5	40.0	40.5	0.0	41.5	0.0	37.6	40.5	40.5	38.3	37.6	0.0	36.5	36.5	0.0	39.8	38.7
9	39.9	40.1	39.8	40.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5	0.0	0.0	0.0	0.0	0.0	40.8	39.8
10	41.0	43.5	40.1	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5	0.0	0.0	0.0	0.0	0.0	42.1	40.2
11	40.5	41.5	41.5	41.5	40.5	0.0	0.0	0.0	0.0	0.0	0.0	39.5	0.0	0.0	0.0	0.0	0.0	41.6	41.2
12	42.3	0.0	40.4	40.4	0.0	0.0	0.0	0.0	33.5	0.0	33.5	33.5	33.5	0.0	0.0	0.0	0.0	43.2	41.1
13	44.3	0.0	41.9	41.8	38.9	0.0	0.0	0.0	0.0	0.0	44.5	44.5	0.0	0.0	0.0	0.0	0.0	44.2	42.7
14	45.0	0.0	41.2	41.2	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	42.5	41.4
15+	46.0	0.0	43.5	43.5	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	44.3	43.5

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	0.0	20.8	0.0	20.8	20.8	20.8	21.0	0.0	0.0	20.1	26.3	20.9
1	24.0	32.1	31.6	29.2	28.0	0.0	27.6	28.8	28.5	27.8	29.0	27.9	28.5	27.2	22.3	22.5	27.9	29.0	28.0
2	30.7	32.8	31.2	31.6	28.9	30.9	30.8	30.9	29.2	30.8	29.9	28.8	27.5	30.1	29.0	29.9	30.6	30.9	30.5
3	33.2	34.6	33.6	34.2	33.3	33.2	33.1	32.7	32.0	33.2	33.7	31.8	31.5	31.9	32.6	33.3	32.2	32.1	33.2
4	34.7	35.1	34.7	35.4	32.1	35.2	34.4	33.9	32.4	35.2	34.8	32.7	32.6	30.3	34.6	34.8	30.3	35.6	34.6
5	36.3	36.8	36.1	36.9	36.0	36.1	36.0	35.7	34.3	36.7	35.3	34.9	34.8	28.4	36.4	36.3	28.4	36.8	36.2
6	37.5	37.2	37.1	37.4	38.5	37.5	37.4	36.9	37.1	37.8	38.4	37.6	36.9	32.5	38.1	38.1	32.5	37.6	37.4
7	38.2	38.1	37.3	38.5	40.0	38.2	38.0	38.4	37.4	38.6	40.0	38.3	37.6	38.4	39.0	38.1	0.0	39.3	37.8
8	39.3	39.5	38.7	39.6	40.5	38.7	39.2	39.8	37.4	40.7	40.5	37.5	36.8	38.1	39.8	40.0	0.0	39.9	39.2
9	40.4	39.4	39.9	39.4	0.0	40.3	40.0	39.3	36.3	41.1	36.3	38.4	36.3	40.6	41.3	40.7	0.0	40.6	40.2
10	40.9	40.8	40.8	40.9	0.0	39.9	40.4	40.5	35.2	41.6	35.7	36.6	37.3	42.0	42.2	41.2	0.0	41.1	40.9
11	41.4	40.8	41.1	41.2	40.5	42.2	40.5	40.2	39.5	41.3	39.5	39.5	39.5	41.0	41.1	41.2	0.0	42.1	41.0
12	42.4	41.5	41.5	42.5	0.0	41.0	42.0	43.9	33.5	43.2	33.5	33.5	33.5	40.6	42.5	42.5	0.0	41.9	42.1
13	42.9	41.3	42.2	41.8	38.9	41.4	41.3	41.1	40.5	42.9	44.5	41.8	40.5	40.5	42.4	42.6	0.0	42.4	42.0
14	43.9	44.2	41.2	43.9	0.0	41.6	42.9	43.4	41.6	42.5	41.6	41.6	41.6	44.5	44.5	44.5	0.0	44.1	41.8
15+	42.5	42.2	43.0	44.3	0.0	41.7	42.2	41.6	0.0	45.2	0.0	0.0	0.0	0.0	44.5	44.5	0.0	43.0	42.8

Table 3.2.1.2.2 Mean Weight at age (kg) in the catch for Western mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.049
1	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.068	0.154	0.133	0.073
2	0.166	0.166	0.206	0.166	0.146	0.326	0.179	0.177	0.000	0.155	0.145	0.121	0.121	0.225	0.155	0.176	0.213	0.189	0.171
3	0.269	0.269	0.288	0.269	0.271	0.361	0.275	0.285	0.000	0.269	0.256	0.198	0.198	0.260	0.248	0.265	0.321	0.233	0.268
4	0.312	0.312	0.325	0.312	0.229	0.401	0.318	0.310	0.000	0.353	0.229	0.231	0.231	0.208	0.307	0.309	0.000	0.319	0.316
5	0.416	0.416	0.369	0.416	0.309	0.465	0.370	0.354	0.000	0.398	0.308	0.296	0.296	0.159	0.360	0.358	0.000	0.355	0.370
6	0.437	0.437	0.409	0.437	0.459	0.504	0.422	0.412	0.000	0.423	0.456	0.344	0.344	0.261	0.427	0.423	0.000	0.382	0.418
7	0.468	0.468	0.413	0.468	0.000	0.507	0.444	0.428	0.000	0.463	0.356	0.356	0.356	0.000	0.436	0.414	0.000	0.444	0.430
8	0.497	0.497	0.484	0.497	0.000	0.542	0.481	0.472	0.000	0.529	0.319	0.319	0.319	0.000	0.510	0.502	0.000	0.465	0.491
9	0.562	0.562	0.552	0.562	0.000	0.576	0.532	0.507	0.000	0.537	0.000	0.000	0.000	0.000	0.527	0.521	0.000	0.498	0.540
10	0.000	0.000	0.597	0.000	0.000	0.572	0.549	0.551	0.000	0.587	0.422	0.422	0.422	0.000	0.589	0.546	0.000	0.520	0.571
11	0.563	0.563	0.592	0.563	0.000	0.660	0.556	0.523	0.000	0.567	0.000	0.000	0.000	0.000	0.542	0.542	0.000	0.559	0.572
12	0.601	0.601	0.656	0.601	0.000	0.635	0.597	0.591	0.000	0.659	0.000	0.000	0.000	0.000	0.637	0.612	0.000	0.551	0.628
13	0.592	0.592	0.674	0.592	0.000	0.663	0.585	0.581	0.000	0.620	0.460	0.460	0.460	0.000	0.561	0.615	0.000	0.574	0.615
14	0.000	0.000	0.589	0.000	0.000	0.691	0.627	0.649	0.000	0.601	0.496	0.496	0.496	0.000	0.707	0.707	0.000	0.600	0.602
15+	0.625	0.625	0.658	0.625	0.000	0.681	0.635	0.611	0.000	0.734	0.000	0.000	0.000	0.000	0.660	0.660	0.000	0.594	0.652

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.133	0.133	0.133	0.077	0.000	0.000	0.262	0.000	0.000	0.110	0.184	0.184	0.184	0.158	0.053	0.053	0.000	0.128	0.154
2	0.277	0.227	0.209	0.227	0.146	0.277	0.309	0.230	0.121	0.182	0.147	0.164	0.164	0.206	0.159	0.158	0.000	0.178	0.205
3	0.342	0.308	0.272	0.305	0.271	0.341	0.340	0.282	0.198	0.233	0.260	0.227	0.227	0.229	0.223	0.223	0.000	0.235	0.264
4	0.407	0.392	0.318	0.390	0.229	0.407	0.337	0.303	0.231	0.291	0.231	0.249	0.249	0.233	0.274	0.266	0.000	0.365	0.310
5	0.428	0.435	0.393	0.433	0.309	0.428	0.398	0.358	0.296	0.314	0.308	0.298	0.298	0.257	0.329	0.318	0.000	0.382	0.359
6	0.489	0.492	0.416	0.493	0.459	0.489	0.419	0.372	0.344	0.360	0.456	0.362	0.362	0.337	0.380	0.366	0.000	0.404	0.396
7	0.533	0.526	0.531	0.526	0.000	0.533	0.473	0.461	0.356	0.400	0.374	0.374	0.374	0.398	0.427	0.414	0.000	0.457	0.453
8	0.579	0.580	0.580	0.580	0.000	0.579	0.490	0.447	0.319	0.443	0.367	0.367	0.367	0.393	0.433	0.415	0.000	0.474	0.472
9	0.655	0.575	0.644	0.575	0.000	0.656	0.511	0.498	0.000	0.529	0.408	0.408	0.408	0.476	0.486	0.481	0.000	0.499	0.523
10	0.651	0.600	0.688	0.600	0.000	0.653	0.543	0.527	0.422	0.000	0.388	0.388	0.388	0.534	0.538	0.536	0.000	0.515	0.568
11	0.738	0.612	0.664	0.612	0.000	0.739	0.523	0.518	0.000	0.506	0.527	0.527	0.527	0.495	0.495	0.495	0.000	0.562	0.547
12	0.733	0.625	0.637	0.625	0.000	0.742	0.732	0.546	0.000	0.566	0.000	0.000	0.000	0.474	0.501	0.490	0.000	0.551	0.587
13	0.662	0.650	0.650	0.650	0.000	0.000	0.706	0.593	0.460	0.000	0.460	0.460	0.460	0.473	0.491	0.483	0.000	0.564	0.528
14	0.689	0.650	0.650	0.650	0.000	0.000	0.642	0.617	0.496	0.000	0.496	0.496	0.496	0.650	0.650	0.650	0.000	0.664	0.647
15+	0.680	0.650	0.650	0.650	0.000	0.000	0.799	0.609	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.596	0.662

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.049
1	0.000	0.000	0.162	0.182	0.156	0.000	0.000	0.000	0.184	0.124	0.184	0.180	0.184	0.158	0.053	0.053	0.154	0.132	0.152
2	0.278	0.291	0.261	0.255	0.206	0.000	0.000	0.000	0.222	0.188	0.222	0.226	0.222	0.192	0.189	0.192	0.213	0.184	0.258
3	0.369	0.386	0.372	0.347	0.258	0.000	0.301	0.301	0.266	0.247	0.266	0.273	0.266	0.246	0.247	0.250	0.321	0.229	0.362
4	0.412	0.403	0.395	0.394	0.229	0.000	0.340	0.340	0.273	0.294	0.273	0.292	0.273	0.285	0.288	0.293	0.000	0.300	0.403
5	0.485	0.484	0.481	0.480	0.601	0.000	0.409	0.409	0.301	0.319	0.301	0.352	0.301	0.326	0.331	0.334	0.000	0.338	0.480
6	0.534	0.502	0.501	0.499	0.459	0.000	0.411	0.411	0.386	0.406	0.386	0.437	0.386	0.380	0.384	0.386	0.000	0.370	0.520
7	0.547	0.541	0.539	0.541	0.000	0.000	0.463	0.463	0.398	0.400	0.398	0.398	0.398	0.408	0.417	0.423	0.000	0.438	0.540
8	0.603	0.610	0.609	0.603	0.000	0.000	0.503	0.503	0.433	0.495	0.433	0.433	0.433	0.396	0.412	0.419	0.000	0.450	0.603
9	0.608	0.576	0.575	0.576	0.000	0.000	0.413	0.413	0.408	0.529	0.408	0.408	0.408	0.476	0.481	0.483	0.000	0.482	0.597
10	0.596	0.663	0.661	0.663	0.000	0.000	0.000	0.000	0.342	0.000	0.342	0.342	0.342	0.534	0.536	0.537	0.000	0.514	0.626
11	0.697	0.660	0.660	0.660	0.000	0.000	0.000	0.000	0.527	0.506	0.527	0.527	0.527	0.495	0.495	0.495	0.000	0.570	0.675
12	0.707	0.725	0.717	0.725	0.000	0.000	0.772	0.772	0.000	0.566	0.000	0.000	0.000	0.474	0.487	0.501	0.000	0.554	0.677
13	0.663	0.666	0.666	0.666	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.473	0.482	0.489	0.000	0.566	0.665
14	0.691	0.750	0.750	0.750	0.000	0.000	0.669	0.669	0.000	0.000	0.000	0.000	0.000	0.650	0.650	0.650	0.000	0.614	0.722
15+	0.681	0.760	0.760	0.760	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	0.612	0.713

Table 3.2.1.2.2 (Continued)

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.068	0.000	0.068	0.068	0.068	0.059	0.000	0.000	0.049	0.123	0.060
1	0.000	0.286	0.274	0.286	0.182	0.000	0.167	0.204	0.161	0.134	0.188	0.166	0.161	0.139	0.000	0.000	0.154	0.174	0.169
2	0.303	0.372	0.304	0.369	0.241	0.000	0.241	0.258	0.201	0.193	0.222	0.209	0.201	0.203	0.315	0.315	0.222	0.220	0.244
3	0.394	0.461	0.380	0.456	0.326	0.000	0.292	0.301	0.251	0.258	0.325	0.264	0.251	0.000	0.343	0.343	0.270	0.240	0.341
4	0.423	0.519	0.409	0.505	0.310	0.000	0.316	0.301	0.261	0.297	0.390	0.281	0.261	0.000	0.385	0.385	0.208	0.275	0.387
5	0.497	0.547	0.476	0.538	0.411	0.000	0.351	0.350	0.295	0.323	0.295	0.329	0.295	0.000	0.393	0.393	0.159	0.311	0.463
6	0.531	0.602	0.512	0.581	0.000	0.000	0.446	0.000	0.414	0.441	0.414	0.465	0.414	0.000	0.473	0.473	0.261	0.334	0.512
7	0.526	0.636	0.538	0.622	0.530	0.000	0.472	0.403	0.447	0.000	0.530	0.497	0.447	0.000	0.439	0.439	0.000	0.419	0.536
8	0.606	0.625	0.549	0.609	0.679	0.000	0.629	0.000	0.390	0.534	0.679	0.491	0.390	0.000	0.404	0.404	0.000	0.467	0.560
9	0.630	0.634	0.606	0.630	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.527	0.000	0.000	0.000	0.000	0.000	0.507	0.610
10	0.686	0.680	0.605	0.654	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.342	0.000	0.000	0.000	0.000	0.000	0.558	0.614
11	0.690	0.698	0.681	0.695	0.595	0.000	0.000	0.000	0.000	0.000	0.000	0.527	0.000	0.000	0.000	0.000	0.000	0.540	0.682
12	0.726	0.000	0.625	0.624	0.000	0.000	0.000	0.000	0.280	0.000	0.280	0.280	0.280	0.000	0.000	0.000	0.000	0.606	0.661
13	0.757	0.000	0.816	0.829	0.476	0.000	0.000	0.000	0.000	0.000	0.663	0.663	0.000	0.000	0.000	0.000	0.000	0.649	0.742
14	0.800	0.000	0.680	0.680	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	0.573	0.688
15+	0.875	0.000	0.787	0.788	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	0.654	0.788

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.068	0.000	0.068	0.068	0.068	0.059	0.000	0.000	0.049	0.123	0.060
1	0.133	0.285	0.270	0.207	0.163	0.000	0.165	0.204	0.184	0.132	0.188	0.167	0.184	0.140	0.070	0.068	0.154	0.170	0.165
2	0.280	0.320	0.264	0.274	0.167	0.290	0.233	0.256	0.194	0.191	0.203	0.180	0.154	0.207	0.160	0.180	0.222	0.207	0.231
3	0.371	0.392	0.340	0.372	0.289	0.347	0.284	0.297	0.241	0.251	0.317	0.229	0.217	0.260	0.235	0.260	0.271	0.234	0.317
4	0.412	0.401	0.373	0.414	0.240	0.405	0.319	0.306	0.255	0.313	0.353	0.250	0.242	0.208	0.286	0.302	0.208	0.328	0.356
5	0.481	0.470	0.422	0.478	0.347	0.438	0.371	0.361	0.299	0.365	0.307	0.312	0.298	0.160	0.340	0.352	0.159	0.364	0.411
6	0.531	0.493	0.467	0.507	0.459	0.498	0.422	0.395	0.373	0.401	0.454	0.405	0.357	0.262	0.398	0.416	0.261	0.390	0.458
7	0.543	0.527	0.463	0.555	0.530	0.521	0.446	0.447	0.373	0.437	0.529	0.411	0.365	0.403	0.430	0.415	0.000	0.450	0.465
8	0.602	0.583	0.523	0.598	0.679	0.554	0.484	0.477	0.396	0.518	0.677	0.427	0.353	0.394	0.461	0.489	0.000	0.469	0.522
9	0.615	0.574	0.571	0.587	0.000	0.620	0.531	0.490	0.408	0.536	0.408	0.519	0.408	0.476	0.507	0.517	0.000	0.498	0.558
10	0.618	0.651	0.613	0.642	0.000	0.600	0.549	0.537	0.354	0.587	0.362	0.376	0.389	0.534	0.565	0.546	0.000	0.518	0.583
11	0.698	0.621	0.624	0.639	0.595	0.720	0.551	0.519	0.527	0.525	0.527	0.527	0.527	0.495	0.524	0.540	0.000	0.561	0.605
12	0.724	0.614	0.645	0.649	0.000	0.646	0.608	0.705	0.280	0.624	0.280	0.280	0.280	0.474	0.591	0.608	0.000	0.551	0.635
13	0.712	0.628	0.703	0.663	0.476	0.663	0.586	0.582	0.460	0.620	0.663	0.528	0.460	0.473	0.532	0.604	0.000	0.570	0.635
14	0.764	0.722	0.640	0.702	0.000	0.691	0.635	0.641	0.496	0.601	0.496	0.496	0.496	0.650	0.679	0.703	0.000	0.650	0.643
15+	0.717	0.638	0.723	0.702	0.000	0.681	0.636	0.611	0.000	0.734	0.000	0.000	0.000	0.000	0.660	0.660	0.000	0.595	0.693

Table 3.2.3.1 Western mackerel. Catch in numbers at age.

Catch in Number

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	1.6	0.0	1.3	1.0	34.2	2.0	10.3	79.5	19.5	38.3	2.0	0.0	0.5	0.0	18.1
1	12.4	33.8	87.0	52.5	279.4	153.5	31.3	351.1	484.5	266.1	203.0	43.6	15.2	234.3	25.7
2	12.1	49.4	24.3	104.0	184.9	289.5	563.8	61.6	468.7	506.4	435.9	712.7	79.5	16.0	397.8
3	29.4	64.0	123.5	94.5	322.3	154.0	425.0	602.5	75.2	225.1	483.6	444.6	661.8	49.1	29.9
4	507.7	115.5	108.5	306.3	170.6	166.0	243.7	365.5	381.3	31.7	184.1	391.6	374.6	420.3	63.6
5	0.0	582.3	191.8	192.2	288.8	51.0	258.3	217.2	282.0	174.8	24.7	130.4	238.2	242.6	331.9
6	0.0	0.0	567.0	143.8	118.6	140.0	71.9	233.1	145.2	158.5	136.6	20.2	92.0	158.4	193.9
7	0.0	0.0	0.0	1246.2	279.7	64.4	151.9	86.8	158.4	99.5	108.6	91.3	15.5	58.9	119.5
8	0.0	0.0	0.0	0.0	438.8	89.4	56.7	154.2	52.4	116.6	84.5	70.9	51.5	16.2	38.3
9	0.0	0.0	0.0	0.0	0.0	158.5	83.2	70.5	139.6	35.3	87.0	47.1	39.3	42.0	11.1
10	0.0	0.0	0.0	0.0	0.0	0.0	210.8	74.6	43.6	138.7	24.4	48.9	25.1	33.0	28.6
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	189.1	47.9	29.4	90.3	19.1	21.4	20.4	20.2
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	115.4	176.1	147.6	126.2	44.2	80.3	60.1

x 10 ^ 6

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	2.5	0.3	24.4	5.3	4.9	1.7	13.1	0.5	3.7	7.1	8.2	8.0
1	22.9	99.0	42.8	108.6	47.1	75.0	114.7	144.5	74.1	90.8	120.6	68.0
2	148.4	127.3	306.9	202.3	202.7	150.9	202.8	215.1	335.0	158.3	161.3	206.9
3	653.6	175.4	203.3	408.1	194.9	347.3	264.2	301.1	331.0	323.3	232.7	243.1
4	51.9	505.1	163.4	205.3	362.8	261.1	387.4	261.0	268.3	263.9	353.1	312.6
5	79.3	66.5	356.5	152.1	181.8	298.3	239.8	289.7	181.8	171.4	229.5	342.2
6	237.4	77.9	45.9	247.4	125.0	152.6	247.2	176.3	190.6	91.3	128.4	192.2
7	148.8	179.2	54.0	40.6	192.3	111.8	145.6	183.8	135.4	110.2	77.7	111.8
8	83.9	111.5	105.7	45.0	49.7	135.6	95.6	103.5	106.5	49.6	60.8	68.4
9	33.0	51.6	66.7	80.0	42.0	50.3	119.1	77.5	65.4	53.6	34.7	43.2
10	18.0	19.3	31.4	31.5	67.9	35.6	37.4	56.4	39.8	23.0	24.0	21.7
11	24.7	12.3	13.6	15.9	29.2	39.8	28.1	19.6	35.7	16.2	12.4	14.6
12	60.8	52.4	34.8	27.0	52.4	67.5	65.6	56.4	36.6	29.0	22.9	19.3

x 10 ^ 6

Table 3.2.3.2 Western mackerel. Biomass estimates from egg surveys

INDICES OF SPAWNING BIOMASS

INDEX1

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	3250.0	*******	*******	2430.0	*******	*******	2510.0	*******	*******	2150.0	*******	*******	2560.0	*******	*******

x 10 ^ 3

INDEX1

	1992	1993	1994	1995	1996	1997	1998
1	2930.0	*******	*******	2470.0	*******	*******	2950.0

x 10 ^ 3

Table 3.2.3.3 Western mackerel. Catch weights at age

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.06600	0.06600	0.06600	0.06600	0.06600	0.06600	0.00000	0.00000	0.06600	0.06600	0.06600	0.06600	0.06900	0.00000	0.00000
1	0.13700	0.13700	0.13700	0.13700	0.13700	0.13700	0.13700	0.13700	0.13100	0.13100	0.13100	0.17800	0.13700	0.15100	0.16600
2	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.24800	0.24800	0.24800	0.21600	0.17600	0.27300	0.24500
3	0.24100	0.24100	0.24100	0.24100	0.24100	0.24100	0.24100	0.24100	0.28300	0.28300	0.28300	0.27000	0.29400	0.34900	0.33900
4	0.41600	0.31400	0.31400	0.31400	0.31400	0.31400	0.31400	0.31400	0.34300	0.34300	0.34300	0.30600	0.32400	0.41800	0.42100
5	0.00000	0.43700	0.33400	0.33400	0.33400	0.33400	0.33400	0.33400	0.37300	0.37300	0.37300	0.38300	0.34100	0.41600	0.47300
6	0.00000	0.00000	0.47200	0.39800	0.39800	0.39800	0.39800	0.39800	0.45500	0.45500	0.45500	0.42500	0.42900	0.43400	0.44400
7	0.00000	0.00000	0.00000	0.48000	0.41000	0.41000	0.41000	0.41000	0.49700	0.49700	0.49700	0.43000	0.53800	0.52000	0.45600
8	0.00000	0.00000	0.00000	0.00000	0.50800	0.50300	0.50300	0.50300	0.50800	0.50800	0.50800	0.49100	0.46800	0.54400	0.54100
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.51100	0.51100	0.51100	0.53900	0.53900	0.53900	0.54200	0.56100	0.56200	0.59300
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.51100	0.51100	0.51100	0.57300	0.57300	0.57300	0.60800	0.61900	0.62700	0.54600
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51100	0.57300	0.57300	0.57300	0.60800	0.63600	0.66600	0.69200
12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.57300	0.57300	0.57300	0.60800	0.63600	0.70400	0.69200

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.04900	0.07100	0.06100	0.06100	0.06000	0.05500	0.05300	0.05400	0.07300	0.05500	0.07600	0.06000
1	0.17600	0.15700	0.15400	0.16700	0.15500	0.16400	0.13600	0.13500	0.14100	0.15200	0.15000	0.16500
2	0.22200	0.26000	0.23800	0.23400	0.25500	0.23800	0.24100	0.25700	0.23400	0.22900	0.23500	0.23100
3	0.31800	0.32600	0.32100	0.33700	0.33200	0.33400	0.31700	0.34100	0.33400	0.31400	0.29500	0.31700
4	0.39900	0.39000	0.37700	0.38000	0.39700	0.39800	0.37700	0.39100	0.39000	0.38000	0.36100	0.35600
5	0.47800	0.46200	0.43400	0.42500	0.42600	0.46200	0.43700	0.45100	0.45300	0.42600	0.41800	0.41100
6	0.51300	0.53700	0.45500	0.46900	0.47100	0.49700	0.48600	0.51700	0.50300	0.48600	0.45500	0.45800
7	0.49200	0.56700	0.54600	0.53000	0.50800	0.53400	0.53000	0.54600	0.54200	0.52200	0.48400	0.46500
8	0.49600	0.56300	0.59600	0.55800	0.55600	0.55700	0.55000	0.59300	0.58200	0.55800	0.52900	0.52200
9	0.57700	0.56800	0.57900	0.61200	0.61200	0.59900	0.58500	0.58500	0.59800	0.58300	0.55900	0.55800
10	0.63500	0.61700	0.58200	0.61100	0.63500	0.65400	0.59900	0.62900	0.60900	0.60200	0.58300	0.58300
11	0.63400	0.62700	0.64900	0.59200	0.65100	0.66700	0.65100	0.68300	0.63500	0.61100	0.59800	0.60500
12	0.72100	0.70500	0.74200	0.71700	0.70800	0.67000	0.68000	0.71400	0.67500	0.67500	0.64000	0.64500

Table 3.2.3.4 Western mackerel. Stock weights at age.

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.11300	0.11300	0.11300	0.11300	0.11300	0.11300	0.09500	0.09500	0.09500	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000
2	0.13100	0.13100	0.13100	0.13100	0.13100	0.13100	0.15000	0.15000	0.15000	0.17200	0.10800	0.15600	0.18700	0.15000	0.16400
3	0.20100	0.20100	0.20100	0.20100	0.20100	0.20100	0.21500	0.21500	0.21500	0.24100	0.20200	0.22000	0.24600	0.29200	0.26100
4	0.38000	0.25100	0.25100	0.25100	0.25100	0.25100	0.27500	0.27500	0.27500	0.30000	0.26000	0.26100	0.28300	0.30000	0.29000
5	0.00000	0.41000	0.26400	0.26400	0.26400	0.26400	0.32000	0.32000	0.32000	0.30000	0.37900	0.32200	0.30500	0.32800	0.34500
6	0.00000	0.00000	0.44000	0.31600	0.31600	0.31600	0.35500	0.35500	0.35500	0.35900	0.32900	0.36000	0.37900	0.36600	0.33700
7	0.00000	0.00000	0.00000	0.47000	0.38000	0.38000	0.38000	0.38000	0.38000	0.40100	0.38800	0.38400	0.42900	0.42100	0.39500
8	0.00000	0.00000	0.00000	0.00000	0.49000	0.41200	0.40000	0.40000	0.40000	0.41200	0.41700	0.42000	0.42100	0.44000	0.46700
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.51100	0.42000	0.42000	0.42000	0.42700	0.42500	0.49700	0.46500	0.44800	0.44100
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.51100	0.48500	0.48500	0.48500	0.41300	0.46000	0.45300	0.51500	0.55400	0.45100
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48500	0.48500	0.50900	0.51300	0.55000	0.49700	0.57900	0.47200
12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48500	0.50900	0.51300	0.55000	0.54900	0.59900	0.56800

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000	0.07000
2	0.13900	0.14600	0.17600	0.12800	0.14900	0.21600	0.19300	0.17500	0.15100	0.12200	0.18700	0.13900
3	0.23300	0.23300	0.23800	0.21300	0.22700	0.25700	0.26400	0.23000	0.25900	0.24400	0.21600	0.21700
4	0.26800	0.30200	0.29900	0.28000	0.30700	0.30900	0.31100	0.28900	0.31600	0.31400	0.29000	0.27700
5	0.36300	0.32700	0.34200	0.33100	0.35600	0.35900	0.35700	0.35300	0.39200	0.35600	0.35700	0.33900
6	0.37100	0.43400	0.36300	0.36500	0.40800	0.40000	0.41600	0.40700	0.44500	0.44300	0.39800	0.40700
7	0.39200	0.45500	0.41900	0.40500	0.43100	0.42400	0.45800	0.46800	0.49300	0.46400	0.44600	0.43400
8	0.40200	0.43600	0.46800	0.39300	0.50600	0.46400	0.46400	0.46400	0.50600	0.50500	0.48000	0.47300
9	0.45900	0.46000	0.44100	0.42000	0.54700	0.48900	0.48000	0.47200	0.54600	0.57600	0.52000	0.51500
10	0.48300	0.52800	0.45100	0.51400	0.57400	0.52300	0.51200	0.55000	0.50200	0.58000	0.53900	0.56700
11	0.44200	0.60600	0.49600	0.51400	0.57400	0.55600	0.59700	0.61200	0.62700	0.62400	0.53000	0.53500
12	0.54700	0.64500	0.58500	0.51400	0.57400	0.58200	0.56100	0.56800	0.63300	0.63800	0.57900	0.58800

Table 3.2.3.5 Western mackerel. Fishing mortality at age.

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.00086	0.00000	0.00041	0.00022	0.00733	0.00226	0.00334	0.01577	0.00387	0.00591	0.00117	0.00000	0.00008	0.00000	0.00057
1	0.00255	0.02133	0.02500	0.01937	0.07423	0.03909	0.04196	0.14196	0.11926	0.06347	0.03718	0.03005	0.01410	0.04596	0.01123
2	0.00687	0.01190	0.01817	0.03579	0.08334	0.09732	0.18610	0.10305	0.26945	0.16691	0.13307	0.16752	0.06679	0.01747	0.06273
3	0.01361	0.04328	0.03538	0.08641	0.14044	0.08785	0.19133	0.29252	0.16704	0.18962	0.22490	0.18460	0.21895	0.05083	0.08065
4	0.07630	0.06456	0.09110	0.10946	0.20951	0.09461	0.18467	0.23644	0.28750	0.09335	0.22104	0.27067	0.22110	0.19924	0.09661
5	0.00000	0.11161	0.13759	0.21814	0.13545	0.08456	0.19744	0.23558	0.27310	0.19555	0.09275	0.22760	0.24812	0.20607	0.14064
6	0.00000	0.13850	0.14332	0.13752	0.19215	0.08528	0.15595	0.25966	0.23109	0.22964	0.21820	0.09688	0.23507	0.24537	0.17453
7	0.00000	0.17819	0.21966	0.49722	0.40356	0.14356	0.11898	0.26968	0.26665	0.23190	0.23004	0.20994	0.09533	0.21959	0.22454
8	0.00000	0.17799	0.21942	0.34788	0.30671	0.20466	0.17181	0.16127	0.24485	0.30277	0.29748	0.21843	0.16616	0.12908	0.22429
9	0.00000	0.13513	0.16659	0.26413	0.16400	0.16359	0.28146	0.31514	0.20332	0.24480	0.36571	0.25423	0.17101	0.18794	0.17029
10	0.00000	0.14474	0.17843	0.28290	0.17566	0.10966	0.32034	0.41262	0.30951	0.30103	0.25196	0.34028	0.19784	0.20092	0.18239
11	0.00000	0.13393	0.16510	0.26177	0.16254	0.10147	0.23693	0.49869	0.47921	0.33423	0.30879	0.30170	0.23102	0.23108	0.16877
12	0.00000	0.13393	0.16510	0.26177	0.16254	0.10147	0.23693	0.49869	0.47921	0.33423	0.30879	0.30170	0.23102	0.23108	0.16877

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.00070	0.00077	0.00095	0.00100	0.00109	0.00130	0.00167	0.00164	0.00153	0.00113	0.00103	0.00107
1	0.01389	0.01515	0.01988	0.02078	0.02281	0.02711	0.03474	0.03425	0.03187	0.02354	0.02142	0.02238
2	0.07752	0.08457	0.05939	0.06206	0.06813	0.08097	0.10377	0.10232	0.09521	0.07031	0.06397	0.06684
3	0.09968	0.10875	0.10896	0.11384	0.12499	0.14854	0.19036	0.18770	0.17465	0.12898	0.11734	0.12262
4	0.11940	0.13026	0.15350	0.16038	0.17608	0.20926	0.26818	0.26442	0.24605	0.18170	0.16531	0.17274
5	0.17382	0.18962	0.18426	0.19252	0.21136	0.25119	0.32192	0.31741	0.29536	0.21811	0.19844	0.20736
6	0.21571	0.23532	0.18435	0.19261	0.21147	0.25131	0.32208	0.31757	0.29550	0.21822	0.19853	0.20746
7	0.27752	0.30275	0.20889	0.21826	0.23962	0.28477	0.36496	0.35985	0.33485	0.24728	0.22497	0.23508
8	0.27720	0.30240	0.21941	0.22925	0.25169	0.29911	0.38333	0.37797	0.35171	0.25973	0.23629	0.24692
9	0.21046	0.22960	0.25325	0.26460	0.29050	0.34524	0.44245	0.43626	0.40595	0.29978	0.27273	0.28500
10	0.22542	0.24592	0.23493	0.24546	0.26948	0.32026	0.41044	0.40470	0.37658	0.27809	0.25300	0.26438
11	0.20859	0.22755	0.22111	0.23102	0.25363	0.30143	0.38630	0.38089	0.35443	0.26174	0.23812	0.24883
12	0.20859	0.22755	0.22111	0.23102	0.25363	0.30143	0.38630	0.38089	0.35443	0.26174	0.23812	0.24883

Table 3.2.3.6 The Western mackerel population numbers at age

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	2005.1	4407.1	3424.7	4882.7	5043.9	954.6	3324.4	5469.4	5430.7	6997.7	1844.2	1361.5	6522.5	3121.6	3148.8
1	5237.1	1724.3	3793.3	2946.5	4201.6	4309.6	819.8	2851.8	4633.9	4656.1	5987.5	1585.4	1171.8	5613.5	2686.8
2	1902.3	4496.1	1452.8	3184.3	2487.4	3357.7	3567.1	676.6	2129.7	3540.0	3761.1	4965.4	1324.2	994.5	4614.5
3	2341.3	1626.1	3824.0	1227.9	2644.4	1969.7	2622.0	2548.9	525.3	1400.1	2578.5	2833.9	3614.6	1066.1	841.1
4	7435.4	1988.0	1340.3	3177.0	969.4	1977.8	1552.8	1863.8	1637.5	382.6	996.9	1772.4	2028.0	2499.3	872.1
5	0.0	5929.6	1604.1	1053.2	2450.9	676.6	1548.7	1111.1	1266.4	1057.2	299.9	687.9	1163.7	1399.3	1762.6
6	0.0	0.0	4564.7	1203.2	728.8	1842.3	535.2	1094.1	755.6	829.5	748.3	235.3	471.5	781.5	980.1
7	0.0	0.0	0.0	3404.3	902.5	517.6	1456.1	394.1	726.4	516.2	567.5	517.8	183.8	320.8	526.3
8	0.0	0.0	0.0	0.0	1782.1	518.9	386.0	1112.7	259.0	478.9	352.3	388.0	361.3	143.8	221.7
9	0.0	0.0	0.0	0.0	0.0	1128.7	363.9	279.8	815.0	174.5	304.5	225.2	268.5	263.4	108.8
10	0.0	0.0	0.0	0.0	0.0	0.0	824.9	236.4	175.7	572.4	117.6	181.8	150.3	194.7	187.8
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	515.4	134.7	111.0	364.6	78.7	111.3	106.2	137.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	324.5	664.7	596.0	519.8	230.3	417.9	415.9

x 10 ^ 6

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	5024.8	3350.5	4460.3	3038.2	3581.6	4268.0	5696.0	3770.7	4275.1	5968.7	3885.6	8039.3	(4108.2)
1	2708.6	4321.8	2881.6	3835.4	2612.4	3079.3	3668.7	4894.5	3240.1	3674.0	5131.5	3341.0	6912.1
2	2286.7	2299.2	3663.9	2431.4	3233.3	2197.8	2579.5	3049.9	4070.8	2701.3	3088.7	4323.2	2812.0
3	3730.3	1821.4	1818.5	2971.7	1966.8	2599.6	1744.5	2001.4	2369.7	3185.6	2167.2	2493.7	3480.4
4	667.9	2906.1	1406.1	1403.6	2282.6	1493.9	1928.7	1241.3	1427.8	1712.8	2410.1	1658.8	1898.7
5	681.5	510.1	2195.8	1038.1	1029.1	1647.4	1043.1	1269.5	820.1	960.9	1229.3	1758.3	1201.2
6	1318.0	493.0	363.2	1571.9	737.0	717.0	1103.0	650.7	795.5	525.4	665.0	867.6	1230.0
7	708.5	914.3	335.4	260.0	1115.9	513.4	480.0	687.9	407.7	509.5	363.5	469.3	606.8
8	361.9	462.0	581.4	234.2	179.9	755.8	332.4	286.8	413.2	251.0	342.5	249.9	319.3
9	152.5	236.1	293.9	401.8	160.3	120.4	482.4	195.0	169.2	250.2	166.6	232.7	168.0
10	79.0	106.3	161.5	196.4	265.5	103.2	73.4	266.7	108.5	97.0	159.6	109.2	150.6
11	134.7	54.3	71.6	109.9	132.2	174.5	64.5	41.9	153.2	64.1	63.2	106.6	72.1
12	346.7	276.6	188.4	140.4	251.0	278.3	219.3	190.8	131.5	135.0	115.9	94.2	134.8

x 10 ^ 6

Table 3.2.3.7a Western mackerel. diagnostic output.

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1972 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 58
Number of observations : 164

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1988
Abrupt change in selection specified.

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	1986	0.1406	16	0.1024	0.1932	0.1196	0.1654	0.1425
2	1987	0.1738	15	0.1285	0.2350	0.1490	0.2027	0.1759
3	1988	0.1896	14	0.1422	0.2528	0.1637	0.2196	0.1917
4	1989	0.1843	11	0.1462	0.2322	0.1638	0.2073	0.1855
5	1990	0.1925	11	0.1531	0.2420	0.1713	0.2164	0.1938
6	1991	0.2114	11	0.1687	0.2648	0.1884	0.2371	0.2128
7	1992	0.2512	11	0.2008	0.3142	0.2241	0.2816	0.2528
8	1993	0.3219	11	0.2570	0.4033	0.2870	0.3611	0.3240
9	1994	0.3174	12	0.2508	0.4016	0.2815	0.3579	0.3197
10	1995	0.2954	12	0.2294	0.3803	0.2596	0.3360	0.2978
11	1996	0.2181	13	0.1660	0.2865	0.1898	0.2507	0.2202
12	1997	0.1984	14	0.1485	0.2652	0.1711	0.2301	0.2006
13	1998	0.2074	16	0.1499	0.2869	0.1757	0.2447	0.2102
Separable Model: Selection (S1) by age 1986 1988								
14	0	0.0040	148	0.0002	0.0744	0.0009	0.0179	0.0122
15	1	0.0799	20	0.0532	0.1200	0.0649	0.0983	0.0816
16	2	0.4460	20	0.2988	0.6657	0.3636	0.5471	0.4554
17	3	0.5735	20	0.3843	0.8558	0.4675	0.7034	0.5856
18	4	0.6869	20	0.4603	1.0251	0.5600	0.8426	0.7014
	5	1.0000	Fixed : Reference Age					
19	6	1.2410	20	0.8346	1.8451	1.0136	1.5193	1.2667
20	7	1.5966	20	1.0774	2.3659	1.3063	1.9513	1.6290
21	8	1.5948	20	1.0745	2.3670	1.3038	1.9507	1.6275
22	9	1.2108	20	0.8175	1.7934	0.9909	1.4795	1.2354
23	10	1.2969	19	0.8796	1.9122	1.0638	1.5810	1.3226
	11	1.2000	Fixed : Last true age					

Table 3.2.3.7b Western mackerel. diagnostic output.

Separable Model: Selection (S2) by age from 1989 to 1998

24	0	0.0052	85	0.0010	0.0279	0.0022	0.0122	0.0075
25	1	0.1079	12	0.0837	0.1391	0.0948	0.1228	0.1088
26	2	0.3223	12	0.2534	0.4100	0.2851	0.3644	0.3248
27	3	0.5913	11	0.4687	0.7460	0.5252	0.6658	0.5955
28	4	0.8331	11	0.6647	1.0441	0.7424	0.9348	0.8386
	5	1.0000	Fixed : Reference Age					
29	6	1.0005	10	0.8082	1.2385	0.8973	1.1156	1.0064
30	7	1.1337	10	0.9228	1.3928	1.0207	1.2592	1.1400
31	8	1.1908	10	0.9772	1.4510	1.0766	1.3171	1.1969
32	9	1.3744	9	1.1354	1.6637	1.2468	1.5151	1.3810
33	10	1.2750	10	1.0467	1.5531	1.1529	1.4100	1.2815
	11	1.2000	Fixed : Last true age					

Separable model: Populations in year 1998

34	0	.8039E+07	270	.4007E+05	.1613E+10	.5377E+06	.1202E+09	.3118E+09
35	1	3340959	31	1802718	6191766	2438739	4576958	3510646
36	2	4323149	21	2832191	6598997	3484072	5364304	4424977
37	3	2493733	17	1755312	3542790	2084712	2983003	2534073
38	4	1658789	16	1204568	2284288	1408942	1952940	1681040
39	5	1758314	14	1317692	2346275	1517668	2037117	1777462
40	6	867607	14	651516	1155369	749643	1004133	876921
41	7	469275	14	351442	626616	404911	543871	474410
42	8	249863	15	185864	335897	214851	290580	252726
43	9	232738	15	172182	314592	199568	271421	235505
44	10	109191	16	78936	151044	92532	128850	110698
45	11	106629	17	75258	151078	89263	127374	108327

Separable model: Populations at age

46	1986	137106	29	76957	244267	102116	184086	143188
47	1987	134720	23	84875	213837	106429	170532	138515
48	1988	54263	20	36118	81523	44087	66788	55446
49	1989	71570	19	49302	103894	59176	86559	72875
50	1990	109905	17	78700	153485	92686	130323	111513
51	1991	132219	16	96471	181214	112577	155289	133940
52	1992	174502	15	129852	234505	150077	202902	176497
53	1993	64474	14	48287	86088	55632	74721	65179
54	1994	41891	15	31128	56374	36001	48743	42374
55	1995	153169	16	111653	210121	130352	179979	155174
56	1996	64082	16	45996	89278	54108	75894	65005
57	1997	63228	17	45078	88686	53203	75142	64177

SSB Index catchabilities

INDEX1

Linear model fitted. Slopes at age :

58	1	Q	1.094	5	1.041	1.276	1.094	1.214	1.154

Table 3.2.3.7c Western mackerel. diagnostic output.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	2.386	-0.277	-2.109	1.824	0.645	0.297	-1.094	0.400	-2.505	-0.485	0.127	0.794	0.000
1	-0.081	-0.414	0.495	-0.207	0.394	-0.150	-0.020	-0.015	-0.058	-0.243	0.135	0.178	-0.010
2	0.422	-0.066	-0.309	0.447	0.398	0.024	-0.052	-0.153	-0.248	-0.026	-0.074	-0.097	-0.227
3	-0.706	0.686	0.005	0.153	0.317	-0.098	0.040	-0.063	-0.057	-0.066	-0.103	0.042	-0.096
4	-0.160	-0.297	0.425	-0.130	0.059	0.056	-0.006	-0.087	-0.029	-0.078	-0.004	0.033	0.244
5	0.434	-0.244	-0.210	0.036	-0.107	-0.004	-0.133	-0.110	-0.105	-0.073	-0.023	0.108	0.110
6	0.283	-0.003	-0.212	-0.215	-0.036	-0.045	0.028	-0.136	0.066	0.005	-0.050	0.141	0.239
7	0.193	-0.073	-0.217	-0.086	-0.156	-0.141	-0.058	0.061	-0.054	0.225	0.058	0.131	0.200
8	-0.080	0.027	-0.008	-0.009	0.007	0.288	-0.295	-0.032	0.206	-0.071	-0.075	-0.100	0.296
9	-0.357	0.202	0.135	0.085	-0.085	0.109	0.429	-0.301	0.185	0.217	-0.119	-0.065	-0.219
10	-0.019	0.191	-0.114	-0.003	-0.234	0.151	0.299	0.483	-0.384	0.226	0.047	-0.326	-0.086
11	0.019	0.044	0.180	0.026	-0.284	0.057	-0.062	0.379	0.460	-0.177	0.162	-0.010	-0.407

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.1379	*******	*******	0.0687	*******	*******	-0.0022	*******	*******	-0.1555	*******	*******	-0.0622	*******	*******

INDEX1

	1992	1993	1994	1995	1996	1997	1998
1	-0.0131	*******	*******	-0.0468	*******	*******	0.0734

Table 3.2.3.7d Western mackerel. diagnostic output.

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

 Separable model fitted from 1986  to 1998
 Variance                             0.0672
Skewness test stat.                   2.1109
Kurtosis test statistic               2.5349
Partial chi-square                    0.6024
Significance in fit                   0.0000
Degrees of freedom                        **

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

    DISTRIBUTION STATISTICS FOR   INDEX1


 Linear catchability relationship assumed

 Variance                             0.0425
Skewness test stat.                  -0.1709
Kurtosis test statistic              -0.4063
Partial chi-square                    0.0201
Significance in fit                   0.0000
Number of observations                     8
Degrees of freedom                         7
Weight in the analysis                5.0000

 ANALYSIS OF VARIANCE
--------------------------
 Unweighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                       29.0432     164          58  106   0.2740
Catches at age                        28.9837     156          57   99   0.2928

SSB Indices
  INDEX1                               0.0595       8           1    7   0.0085

 Weighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        8.1380     164          58  106   0.0768
Catches at age                         6.6496     156          57   99   0.0672

SSB Indices
  INDEX1                               1.4884       8           1    7   0.2126
```

Table 3.2.3.8 The Western mackerel. stock summary.

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	2005070	4137065	3085197	170775	0.0554	0.0153	76
1973	4407130	4040805	3186181	219445	0.0689	0.1342	68
1974	3424730	4155956	3211784	298054	0.0928	0.1622	72
1975	4882680	4052576	2959920	491380	0.1660	0.2620	56
1976	5043910	3669028	2604145	507178	0.1948	0.2495	74
1977	954580	3567255	2587350	325974	0.1260	0.1225	85
1978	3324390	3549856	2768774	503913	0.1820	0.1658	80
1979	5469370	3253872	2436994	605744	0.2486	0.2325	78
1980	5430650	3026255	2073166	604761	0.2917	0.2606	75
1981	6997690	3111999	2161690	661762	0.3061	0.2106	94
1982	1844160	3008672	2052903	623819	0.3039	0.2119	89
1983	1361470	3163141	2298855	614287	0.2672	0.2047	90
1984	6522460	2941410	2296788	550929	0.2399	0.1932	97
1985	3121620	3084259	2269309	561292	0.2473	0.1999	100
1986	3148790	3100755	2295279	537615	0.2342	0.1721	100
1987	5024800	3072518	2347149	615380	0.2622	0.2127	97
1988	3350480	3314517	2472379	628000	0.2540	0.2321	100
1989	4460320	3343373	2489550	567400	0.2279	0.1901	99
1990	3038200	3118721	2336390	605937	0.2593	0.1986	100
1991	3581570	3510883	2678858	646169	0.2412	0.2180	98
1992	4267950	3638450	2712847	742305	0.2736	0.2591	99
1993	5696040	3450926	2464609	805039	0.3266	0.3321	100
1994	3770670	3236114	2218695	795723	0.3586	0.3274	99
1995	4275120	3318090	2365276	728742	0.3081	0.3047	100
1996	5968690	3166308	2352061	529464	0.2251	0.2250	100
1997	3885620	3407146	2432310	528835	0.2174	0.2047	99
1998	(8039290)	3400661	2505136	623411	0.2489	0.2139	100

Table 3.3.2.2.1 SOUTHERN MACKEREL. CPUE at age from surveys.

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1984	1	1.467	0.200	0.106	0.371	0.149	0.209	0.039	0.013	0.029	0.018	0.065
1985	1	2.653	1.598	0.016	0.055	0.370	0.138	0.085	0.030	0.017	0.029	0.084
1986	1	0.026	0.174	0.140	0.022	0.026	0.060	0.025	0.002	0.000	0.004	0.029
1987												
1988	1	0.286	0.028	0.027	0.014	0.021	0.005	0.010	0.012	0.004	0.001	0.001
1989	1	0.510	0.000	0.020	0.000	0.040	0.020	0.000	0.010	0.000	0.000	0.000
1990	1	0.400	0.940	0.040	0.000	0.010	0.020	0.000	0.000	0.000	0.000	0.000
1991	1	0.130	0.270	0.220	0.270	0.340	0.070	0.030	0.010	0.030	0.000	0.010
1992	1	19.900	0.480	0.160	0.150	0.090	0.030	0.010	0.000	0.000	0.000	0.000
1993	1	0.071	1.256	0.789	0.026	0.063	0.018	0.008	0.002	0.002	0.002	0.005
1994	1	0.468	0.106	0.122	0.145	0.043	0.040	0.012	0.006	0.002	0.001	0.000
1995	1	0.916	0.031	0.187	0.164	0.049	0.013	0.011	0.003	0.002	0.001	0.000
1996	1	46.092	6.396	1.316	0.074	0.101	0.019	0.000	0.007	0.010	0.000	0.000
1997	1	5.725	27.105	6.283	0.67	0.389	0.000	0.000	0.000	0.000	0.000	0.000
1998	1	0.456	3.819	0.969	0.241	0.053	0.086	0.060	0.021	0.019	0.000	0.008

October Portugal Survey, Bottom trawl survey (Catch: thousands per hour)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1986	1	515	2759	1004	512	36	14	9	4	0	0	0
1987	1	1026	23280	14792	2939	545	0	0	0	0	0	0
1988	1	86467	24547	354	328	35	11	0	0	0	0	0
1989	1	11643	28427	4707	3452	22	9	0	0	0	0	0
1990	1	1344	2991	1753	89	5	1	0	0	0	0	0
1991	1	309	374	288	185	32	19	15	6	1	1	0
1992	1	123551	2738	664	302	57	14	5	0	0	0	0
1993	1	52323	385	115	47	75	0	0	0	0	0	0
1994	1	12211	771	297	106	42	49	18	14	0	0	0
1995	1	318598	9076	282	110	31	10	5	2	0	0	0
1996*	1	235262	2157	216	22	4	1	0	0	0	0	0
1997	1	772029	39402	7655	39	0	0	0	0	0	0	0
1998	1	226587	11584	313.5	0	37	16	0	0	17	0	0

* DIFFERENT SHIP

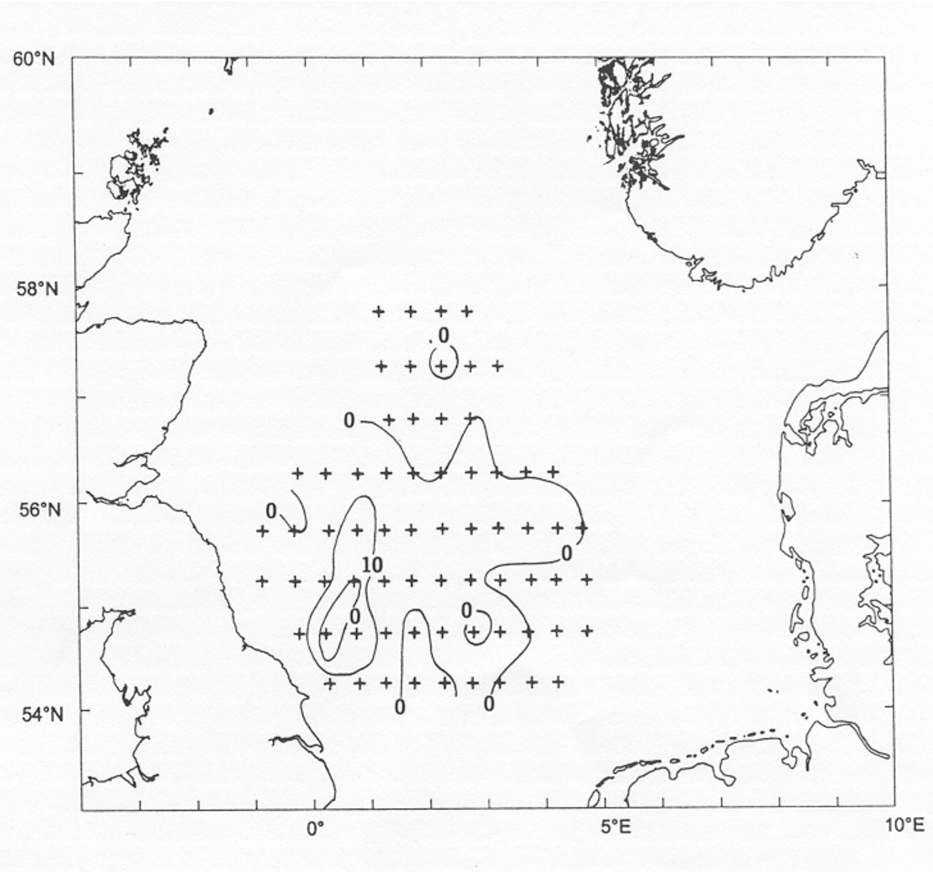


Figure 3.1.4.1.1. The distribution of daily production of mackerel eggs per m^2 during the first coverage, 25 May-1 June 1999, and the stations sampled by R/V "Tridens".

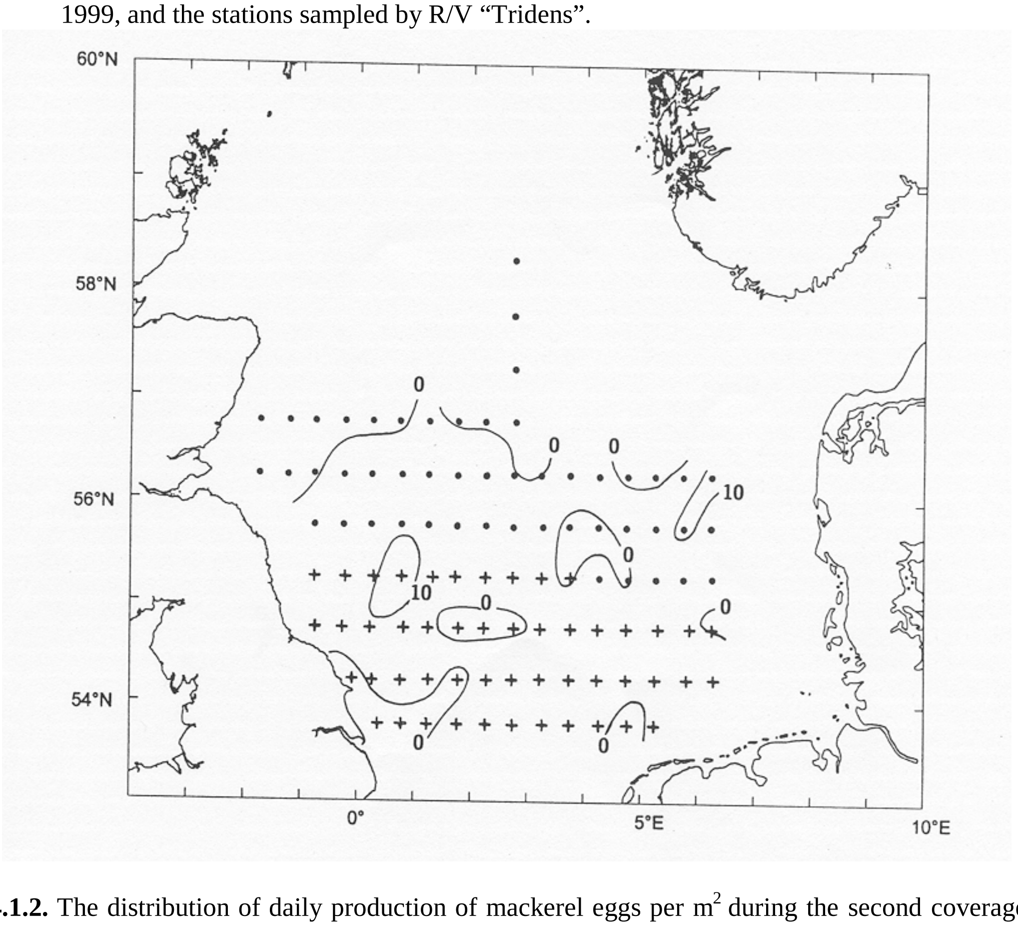


Figure 3.1.4.1.2. The distribution of daily production of mackerel eggs per m^2 during the second coverage, 6-11 June 1999, and the stations sampled by R/V "Tridens" and by R/V "G. O. Sars".

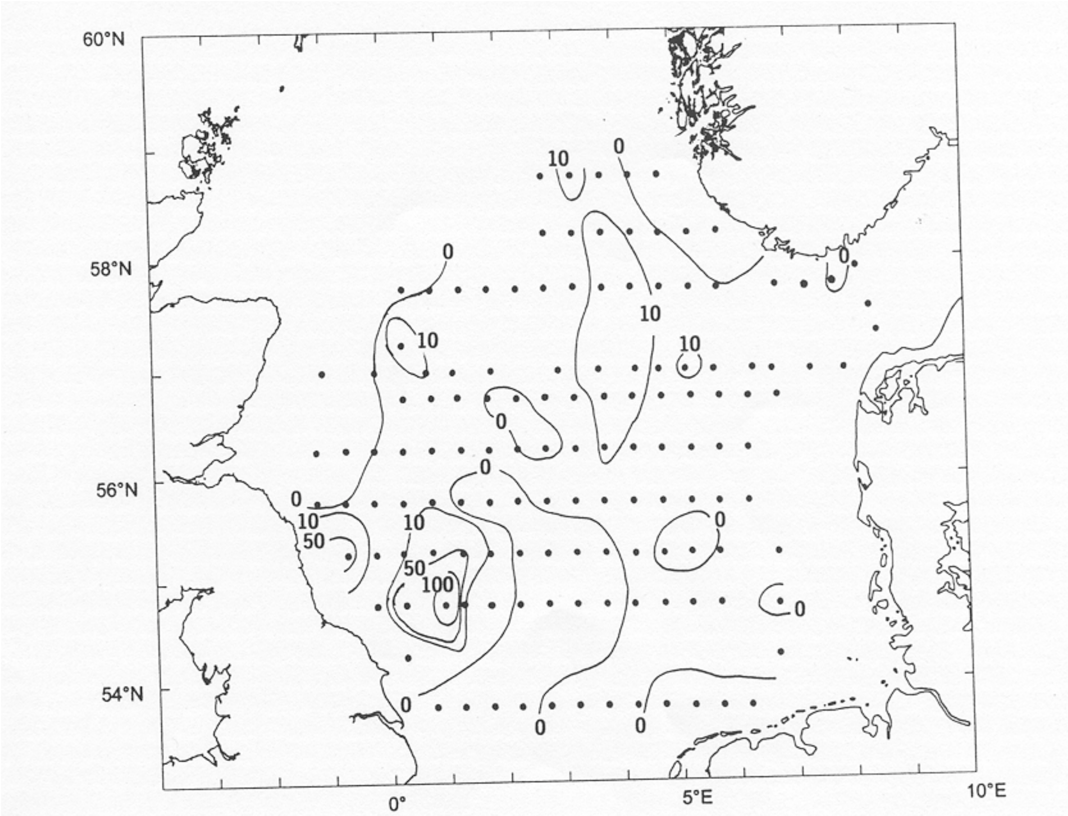


Figure 3.1.4.1.3. The distribution of daily production of mackerel eggs per m^2 during the third coverage, 11-25 June 1999, and the stations sampled by R/V "G. O. Sars".

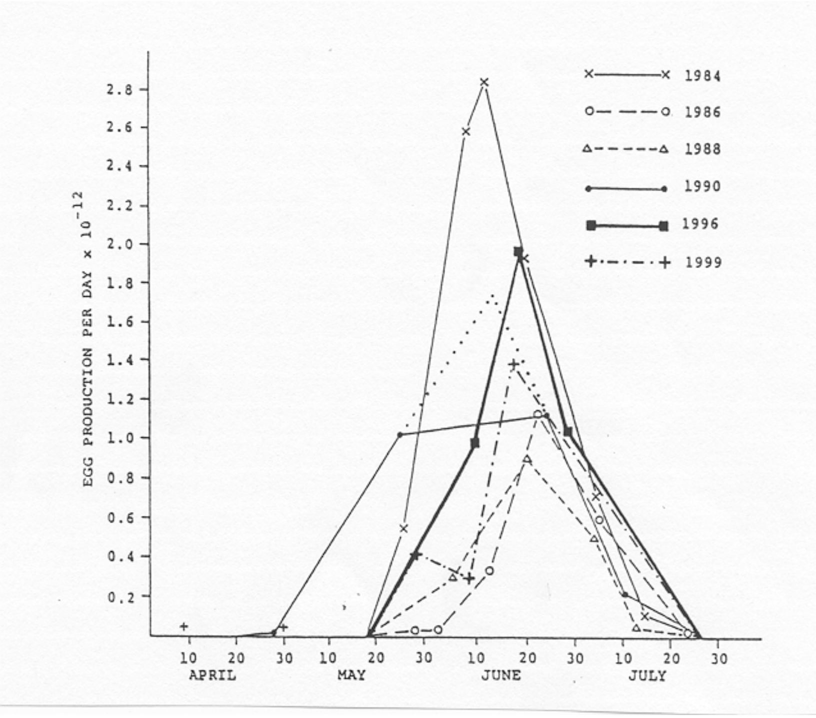


Figure 3.1.4.1.4. Mackerel egg production curves for the period 1984-1999. The + indicates that few eggs were observed during two coverages in April 1988. Dotted line indicates suggested alternative pattern for the peak spawning period in 1990.

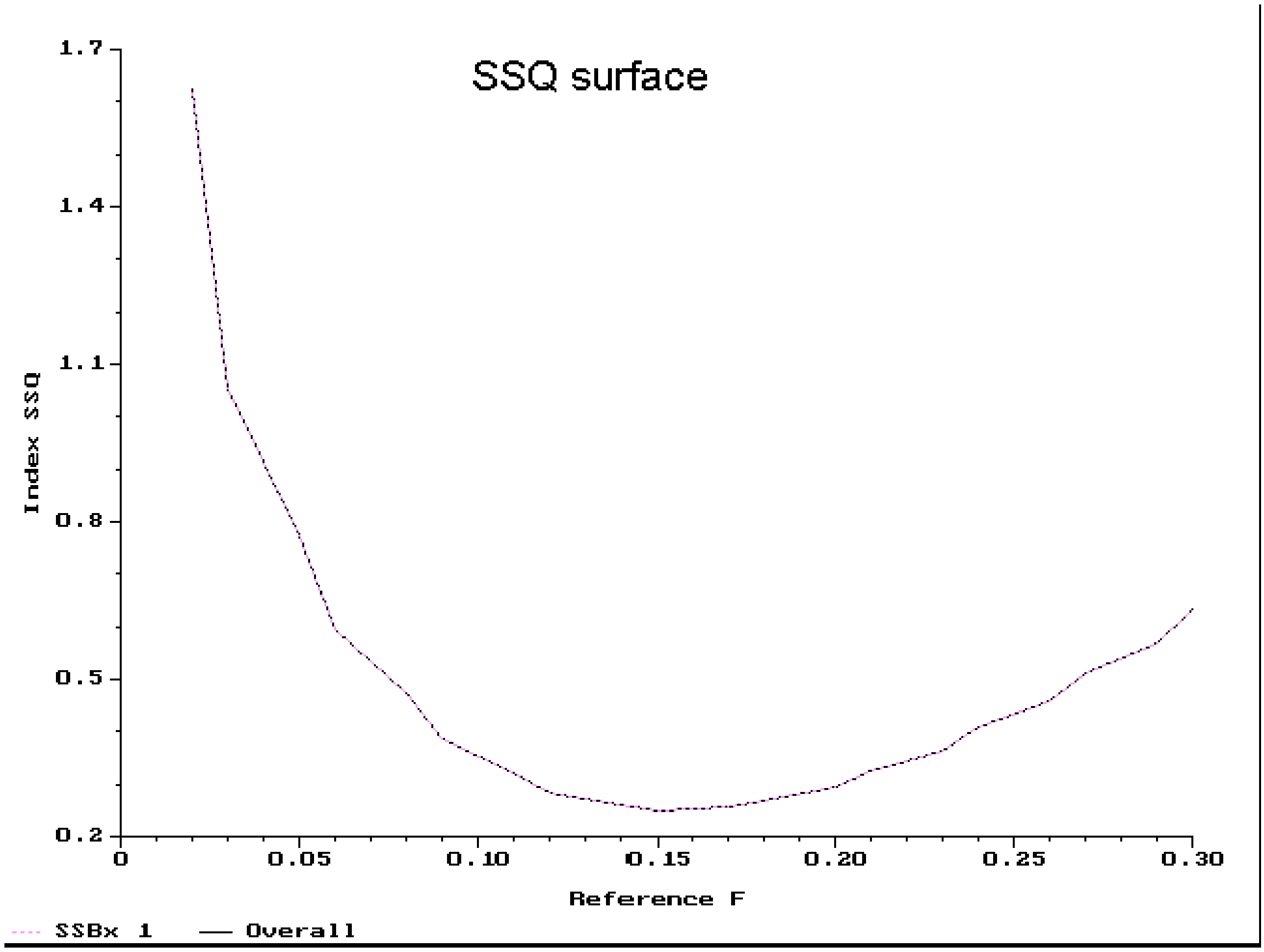


Figure 3.2.3.1 The sum of squares surface for the ICA separable VPA fit to the Western mackerel egg survey biomass estimates.

Stock Summary

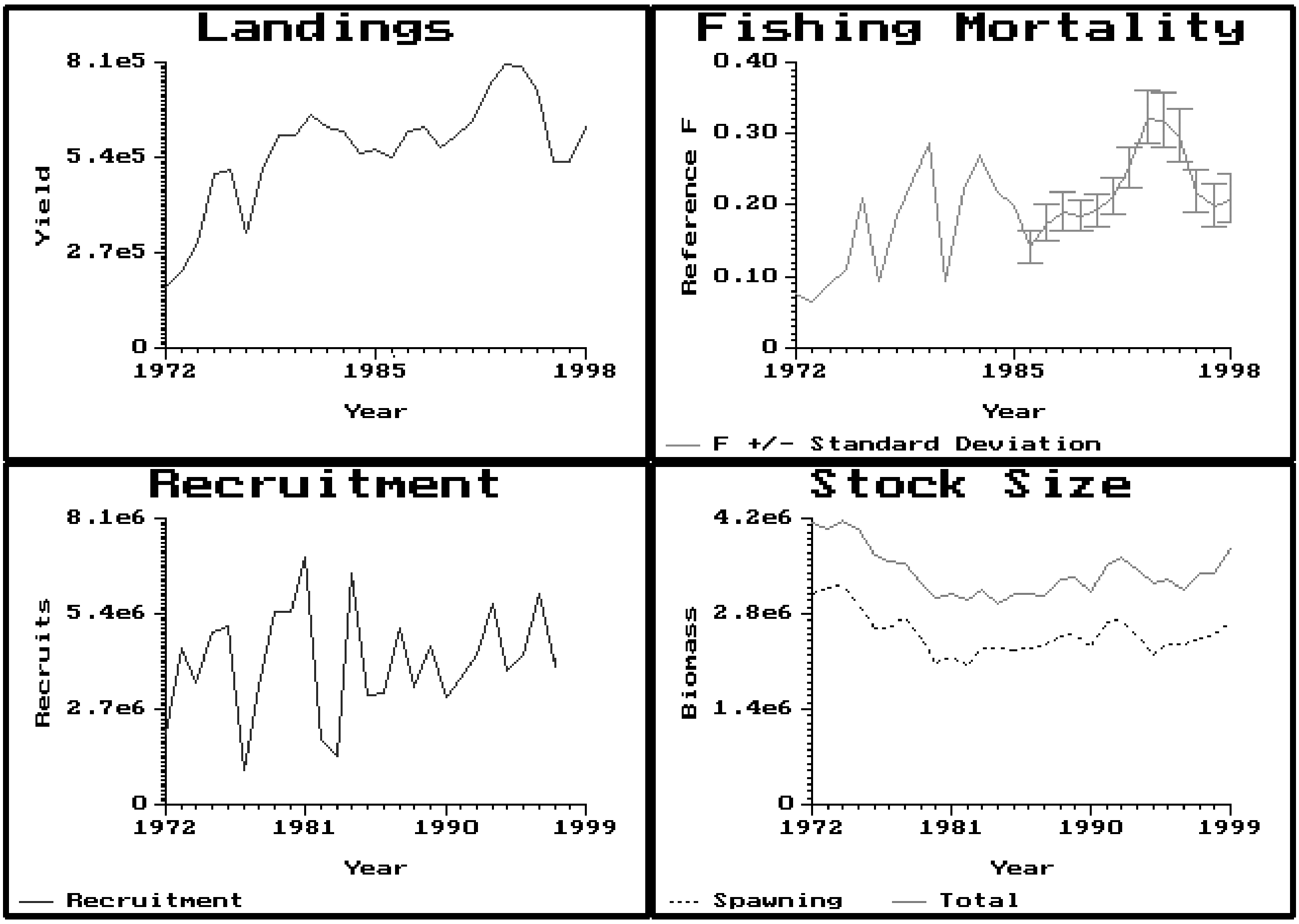


Figure 3.2.3.2 The long term trends in stock parameters for Western mackerel.

Separable Model Diagnostics

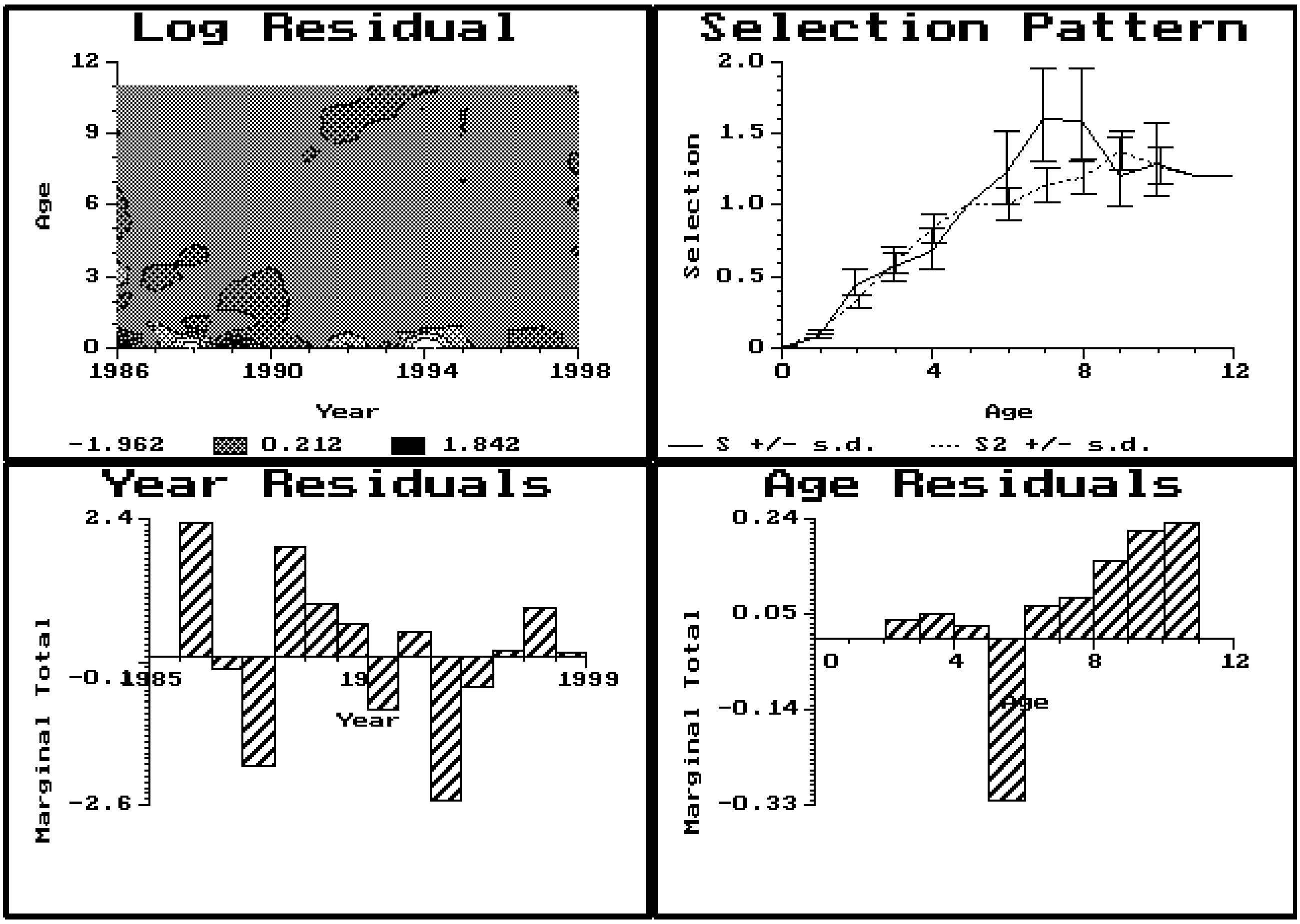


Figure 3.2.3.3 The catch at age residuals and ages fitted by ICA to the Western mackerel data.

Tuning Diagnostics: Biomass index 1

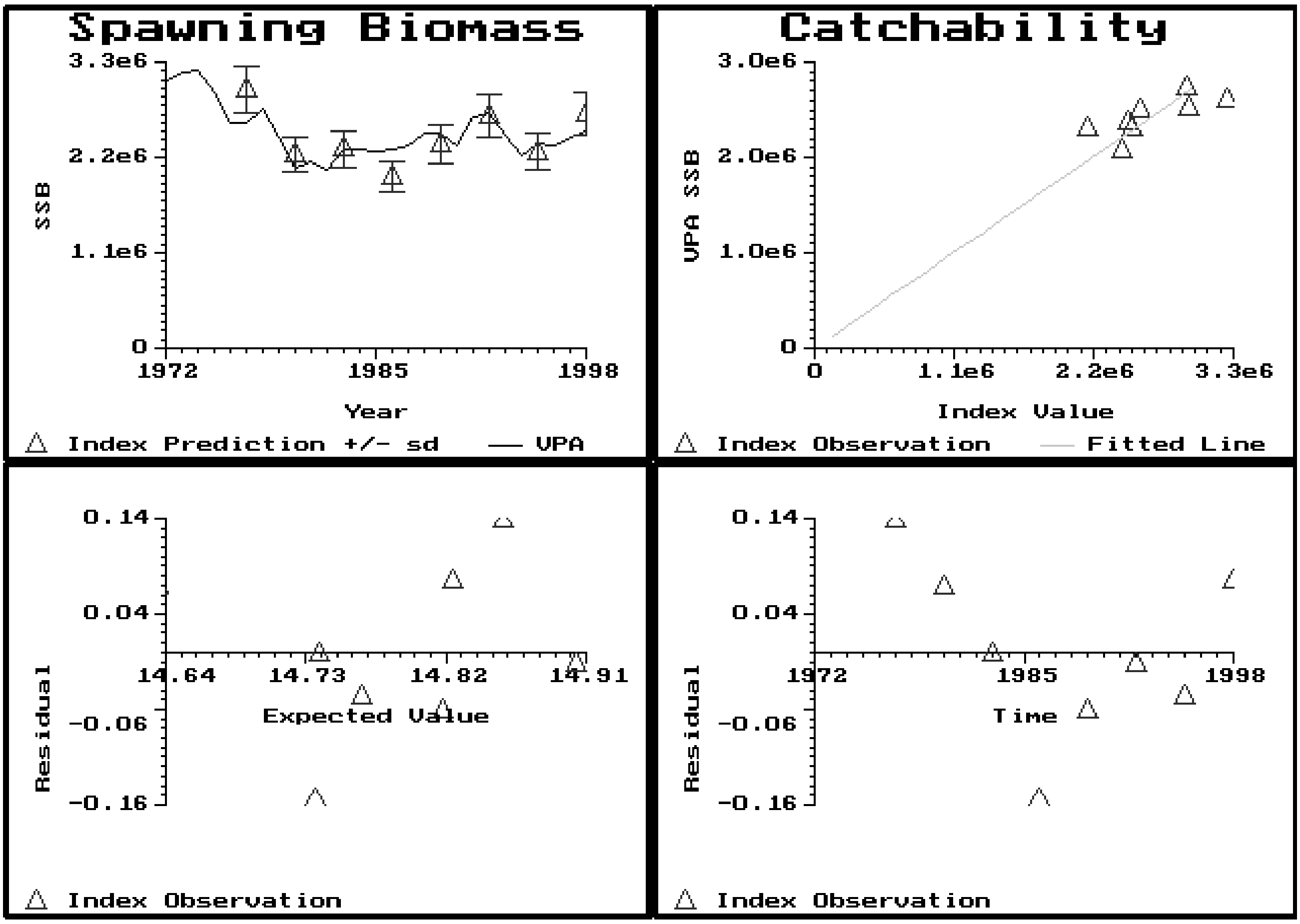


Figure 3.2.3.4 The diagnostics for the egg production index as fitted by ICA to the Western mackerel data.

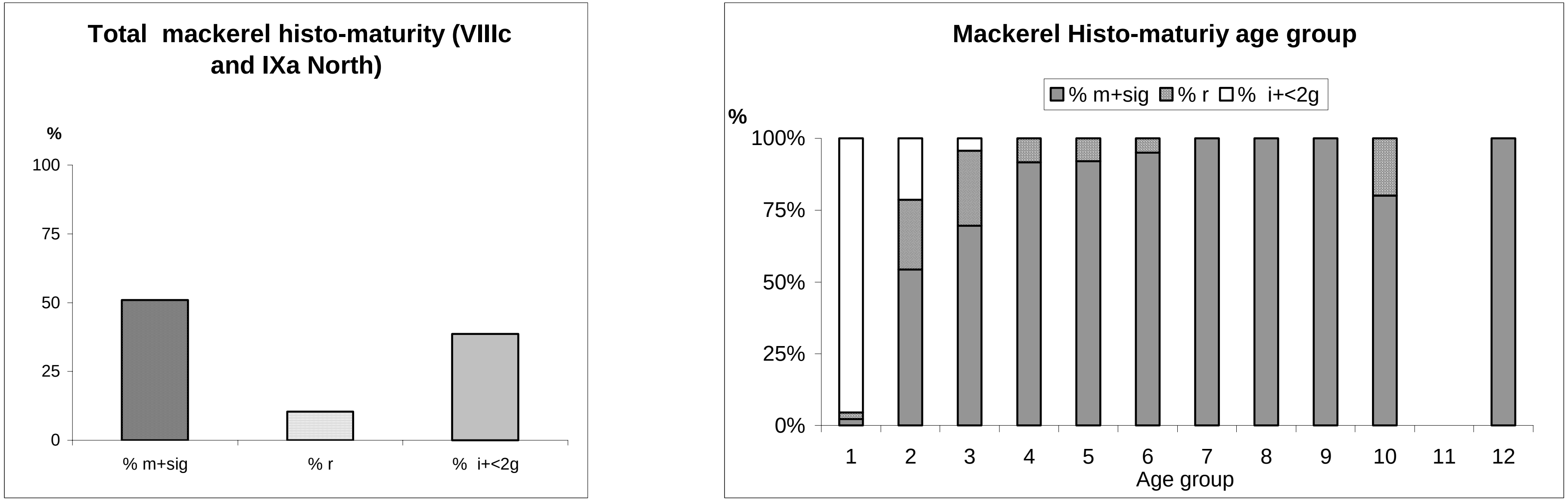
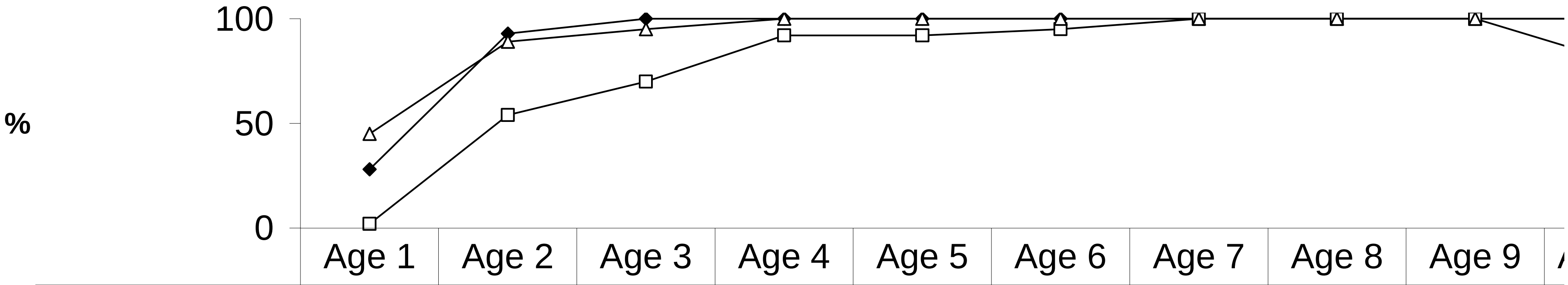


Figure 3.3.1.3.1.- Mackerel microscopic maturity and percentage at age, including the ovaries with spawning signs in divisions ICES VIIIc and IX a North (1998).
(mature (m), resorbing (.r), inmature (i))



	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
Macroscopic	28	93	100	100	100	100	100	100	100
Microscopic	2	54	70	92	92	95	100	100	100
ICES WG	45	89	95	100	100	100	100	100	100

Figure 3.3.1.3.2 Mackerel maturity ogives without applaying logistic model.

4 HORSE MACKEREL

4.1 Fisheries in 1998

The total international catches of horse mackerel in the North East Atlantic are shown in Table 4.1.1 and Figure 4.3.1. The total catch from all areas in 1998 was 399,700 t which is 119,000 t less than in 1997. Ireland, Denmark and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have a directed trawl and purse seine fishery.

The quarterly catches of horse mackerel by Division and Sub-division in 1998 are given in Table 4.1.2. The distribution of the fisheries in 1998 are given in Figure 4.1.1.a–d. The figures are based on data provided by England and Wales, Scotland, Ireland, Northern Ireland, Faroese Isles, Germany, Denmark, Netherlands, Norway, Portugal and Spain covering 92 % of the total catches.

First quarter: 104,900 t. This is 70,000 t less than 1997. The catches this quarter (Figure 4.1.1.a) are distributed in the western and southern areas as in previous years. For the first time small catches were reported both from the northern North Sea, 1667 t, and from Skagerrak and Kattegat, 26 t.

Second quarter: 69,100 t. This is 7,000 t less than in 1997. As usual, rather low catches were taken during the second quarter and the catches are distributed as in previous years (Figure 4.1.1.b).

Third quarter: 67,700 t. This is 19,000 less than in 1997, and the catches were distributed as in previous years (Figure 4.1.1.c).

Fourth quarter: 158,000 t. This is the quarter when relatively large catches have been taken in Division IVa since 1987. The catches in this quarter were reduced from 260,000 t in 1995 to 153,000 t in 1996. This was particularly due to a drop in the fishery in Division IVa (Figure 4.1.1.d).

4.2 Stock Units

The last 10 years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three management stocks: the North Sea, The Southern and the Western stocks (ICES 1990/Assess:24, ICES 1991/Assess:22). Since little information from research surveys is available, this separation is based on the observed egg distributions and the temporal and spatial distribution of the fishery. Western horse mackerel are thought to have similar migration patterns as Western mackerel. As for mackerel, the egg surveys have demonstrated that it is difficult to determine a realistic border between a western and southern spawning area. In later years some horse mackerel have been tagged in Portuguese and Spanish waters, but so far no tags have been recovered.

4.3 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 management stocks as follows:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. It seems strange that only catches from western part of Division IIIa are allocated to this stock. The reason for this is that the catches in the western part of this Division taken in the fourth quarter usually are taken in neighbouring area of catches of western fish in Division IVa.

At present there is only set a TAC for the western stock in EU waters. The present management area for this stock is therefore restricted to Divisions VIa, VIIa–c,e–k and VIIIa,b,d,e and western part of Division IVa, which do not cover the total distribution area. If TACs are set by stocks, they should apply to all areas where the different stocks are distributed.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId. Due to the distribution of catches (Figures 4.1.1a-d) all catches in Division IIIa in 1998 were allocated to the North Sea stock.

Southern stock: Divisions VIIIc and IXa.

The catches by stock are given in Table 4.3.1 and Figure 4.3.1. Only one country provides data for discards. Therefore the amount of discards given in Table 4.3.1 are not representative for the total fishery.

4.4 Estimates of discards

Only Netherlands provided information on discards.

4.5 Species Mixing

Trachurus sp.

Three species of *Trachurus* genus, *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in the 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 1999/ACFM: 6), 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 4.5.1 shows the catch of *T. mediterraneus* by Sub-divisions since 1989. In Divisions VIIIab and Sub-division VIIIc East , the total catch of *T. mediterraneus* was 4495 t in 1998. In Sub-division VIIIc West and Division IXa North there are no catches of this species.

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 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 1986-1998 are also given in Table 4.5.1. 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 ten 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 and ICES 1999/ ACFM:6), 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 *T. trachurus spp*. in general, as is the case at present . It would then be appropriate to set TACs for the other species as well.

4.6 Length Distribution by Fleet and by Country:

The 1998 annual length composition by fleet were provided by the Denmark, England and Wales, Netherlands, Norway, Germany, Ireland a Portugal, and Spain. These length distributions cover 88% of the total landings and are shown in Table 4.6.1.

4.7 Results of Otolith Workshop

The results from the 1996 horse mackerel otolith exchange showed that a horse mackerel otolith workshop was needed to deal with serious problems in age reading. The ages of fish from approximately age 8 onwards were underestimated. This bias increased to approximately one year of underestimation at age 13. Furthermore the interpretation of the edge of otoliths appeared to be a major difficulty, if these were taken from fish caught in the second half of the year (otoliths collected in the first half of the year have only translucent edges, while otoliths collected in the second half of the year have both translucent and opaque edges). To solve these problems a Horse Mackerel Otolith Workshop was held at CEFAS, Lowestoft, England from 15-19 January 1999, at which 15 otolith readers participated (ICES, 1999/G:16).

Three sets of otoliths were used, which contained only otoliths of the extremely strong 1982 year class collected during the period 1983 -1995. These otoliths had a very high probability that the originally estimated age was correct and were therefore treated as otoliths of 'known' or 'actual' age.

Two otolith sets were used for training. The first set contained otoliths with only translucent edges and the second otoliths with both translucent and opaque edges. The age reading comparisons of the first set showed that the precision was low for many readers and that the ages of the older fish were underestimated. The results from the second set showed that the underestimation of older ages was less. However, the precision was much lower compared to the first set, most likely due to difficulties in the interpretation of the otolith edge. Discussions on the results of both training otolith sets and the discussions on specific otoliths projected on a large screen resulted in an improvement of the ageing method of almost all readers. There was an evident improvement in precision and accuracy for almost all readers, but the underestimation in the ageings of the older age groups (bias) could not be decreased significantly during this workshop.

One of the last terms of reference of the Workshop was to “Determine to what extent age reading errors affect stock assessments of horse mackerel”. However, this term of reference could not be addressed at the Workshop meeting, because the final results on precision, accuracy and absolute bias became only available at the end of the Workshop. Therefore this specific term of reference was addressed after the Workshop meeting by the chair of the Horse Mackerel Otolith Workshop (Guus Eltink, Netherlands) in an evaluation that was attached as an addendum to the Workshop report (ICES, 1999/G:16).

The effect of age reading errors on the horse mackerel assessment was investigated by applying different levels of precision (coefficient of variation of 5%, 10% and 15%) and by applying an absolute bias in age reading as observed at the workshop. This absolute bias or underestimation of age starts at age 7 and is gradually increasing to a 1-year difference at age 13. The factor between largest and smallest recruitment also affects the level of errors in the assessment. Therefore 3 different factors were used to determine the errors in the assessment (factor 1, which implies constant recruitment and the factors 4 and 16). The assessments were tuned to absolute spawning stock biomass values as is done for the western horse mackerel with spawning stock biomass values obtained from egg surveys. The effects on the assessment caused by the age reading errors were expressed in percentage over- or underestimation of recruitment, spawning stock biomass, fishing mortality, population at age and selection pattern. This analysis only indicated the effects caused by the errors in age reading, but not by errors in biological sampling, proportion mature at age, fecundity and egg sampling for the biomass estimate.

Age reading errors as were observed at the end of the 1999 Horse Mackerel Otolith Workshop (CV=15% with bias) have the following estimated effects on the assessment of horse mackerel:

- Below average recruitment might be over 200% overestimated and above average recruitment up to 35% underestimated. In addition the recruitment of the most recent years will be overestimated (gradually increasing up to 20% in the last year). The assessment will provide only very smoothed recruitment estimates and the difference between highest and lowest observed recruitment might be 5 times higher.

- Fishing mortality (F) will be 1-9% overestimated except in the last two or three years, when it might be slightly underestimated.

- Spawning stock biomass (SSB) will be 0-7% underestimated except in the last two or three years, when it might be slightly overestimated.

- The population at age in the last year will show the highest overestimation in the younger age groups, which gradually decreases up to age 10, becomes an underestimation from age 11 onwards and the 15+ age group shows a sudden increase in the underestimation. There is an additional effect of overestimating weak year classes and underestimating strong year classes.

- The fitted selection pattern in the last year will become dome shaped because of the bias. The highest selection is obtained at approximately age 7 or 8 (approximately 20-25% overestimation).

It is a first priority that the bias in age reading is reduced and in addition the precision is increased (CV lower). Improving the precision considerably without reducing the bias would result in an even worse assessment, because precision errors have a compensating effect on the bias error.

Table 4.1.1 Landings (t) of HORSE MACKEREL by Sub-area. Data as submitted by Working Group members.

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[1]
II + Vb	2,538
IV + IIIa	31,295
VI	35,073
VII	250,656
VIII	38,562
IX	41,574
Total	399,698

[1]Preliminary.

Table 4.1.2 Quarterly catches of HORSE MACKEREL by Division and Sub-division in 1998.

Division	**1Q**	**2Q**	**3Q**	**4Q**	**TOTAL**
IIa+Vb	435	90	743	1270	2538
IIIa	26	0	16	3651	3693
IVa	1667	64	1173	14147	17051
IVbc	145	198	2678	7530	10551
VIId	1652	1062	1381	12102	16197
VIa,b	6957	4926	10948	12242	35073
VIIa–c,e–k	78629	45528	31142	79164	234463
VIIIa,b,d,e	1602	664	565	12825	15656
VIIIc	4725	6650	6856	4675	22906
IXa	9017	9892	12239	10427	41575
Sum	104855	69074	67741	158033	399703

Table 4.3.1 Landings and discards of HORSE MACKEREL (t) by year and division, for the North Sea, Western and Southern horse mackerel. (Data submitted by Working Group members.)

Year	North Sea horse mackerel					Western horse mackerel							Southern horse mackerel			Total
	IIIa	IVb,c	Discards	VIId	Total	IIa	IVa	VIa,b	VIIa-c,e-k	VIIIa,b,d,e	Discards	Total	VIIIc	IXa	Total	All stocks
1982	- 2,788[3]	-		1,247	4,035	-	-	6,283	32,231	3,073	-	41,587	19,610	39,726	59,336	104,958
1983	- 4,420[3]	-		3,600	8,020	412	-	24,881	36,926	2,643	-	64,862	25,580	48,733	74,313	147,195
1984	- 25,893[3]	-		3,585	29,478	23	94	31,716	38,782	2,510	500	73,625	23,119	23,178	46,297	149,400
1985	1,138	22,897		2,715	26,750	79	203	33,025	35,296	4,448	7,500	80,551	23,292	20,237	43,529	150,830
1986	396	19,496		4,756	24,648	214	776	20,343	72,761	3,071	8,500	105,665	40,334	31,159	71,493	201,806
1987	436	9,477		1,721	11,634	3,311	11,185	35,197	99,942	7,605	-	157,240	30,098	24,540	54,638	223,512
1988	2,261	18,290		3,120	23,671	6,818	42,174	45,842	81,978	7,548	3,740	188,100	26,629	29,763	56,392	268,163
1989	913	25,830		6,522	33,265	4,809	85,304[2]	34,870	131,218	11,516	1,150	268,867	27,170	29,231	56,401	358,533
1990	14,872[1]	17,437		1,325	18,762	11,414	112,753[2]	20,794	182,580	21,120	9,930	373,463	25,182	24,023	49,205	441,430
1991	2,725[1]	11,400		600	12,000	4,487	63,869[2]	34,415	196,926	25,693	5,440	333,555	23,733	21,778	45,511	391,066
1992	2,374[1]	13,955	400	688	15,043	13,457	101,752	40,881	180,937	29,329	1,820	370,550	24,243	26,713	50,955	436,548
1993	850[1]	3,895	930	8,792	13,617	3,168	134,908	53,782	204,318	27,519	8,600	433,145	25,483	31,945	57,428	504,190
1994	2,492[1]	2,496	630	2,503	5,689	759	106,911	69,546	194,188	11,044	3,935	388,875	24,147	28,442	52,589	447,153
1995	240	7,948	30	8,666	16,756	13,133	90,527	83,486	320,102	1,175	2,046	510,597	27,534	25,147	52,681	580,034
1996	1,657	7,558	212	9,416	18,843	3,366	18,356	81,259	252,823	23,978	16,870	396,652	24,290	20,400	44,690	460,185
1997	2,037[4]	15,504[5]	10	5,452	19,540	2,617	63,647	40,145	318,101	11,677	2,921	442,571	29,129	27,642	56,771	518,882
1998	3,693	10,530	83	16,194	30,500	2,540[6]	17,011	35,043	232,451	15,662	830	303,543	22,906	41,574	64,480	398,523

[1]Norwegian and Danish catches are included in the Western horse mackerel.
[2]Norwegian catches in Division IVb included in the Western horse mackerel.
[3]Divisions IIIa and IVb,c combined.
[4]Included in Western horse mackerel (Danish and Swedish catches).
[5]Norwegian catches in IVb (1,426 t) included in Western horse mackerel.
[6]Includes 1937 t from Vb

Table 4.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa in the period 1989-1998 and Trachurus picturatus in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-1998.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
T. mediterraneus	**VIIIab**		**-**	**-**	**-**	23	298	2122	1123	649	1573	2271	1175	557	740
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755
		VIIIc west	-	-	-	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755
	IXa	IXa North	-	-	-	0	0	0	0	0	0	0	0	0	0
		IXa C, N & S	-	-	-	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0	0
	TOTAL		**-**	**-**	**-**	**3926**	**3241**	**7142**	**5927**	**6225**	**4917**	**6856**	**4618**	**3821**	**4495**
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**

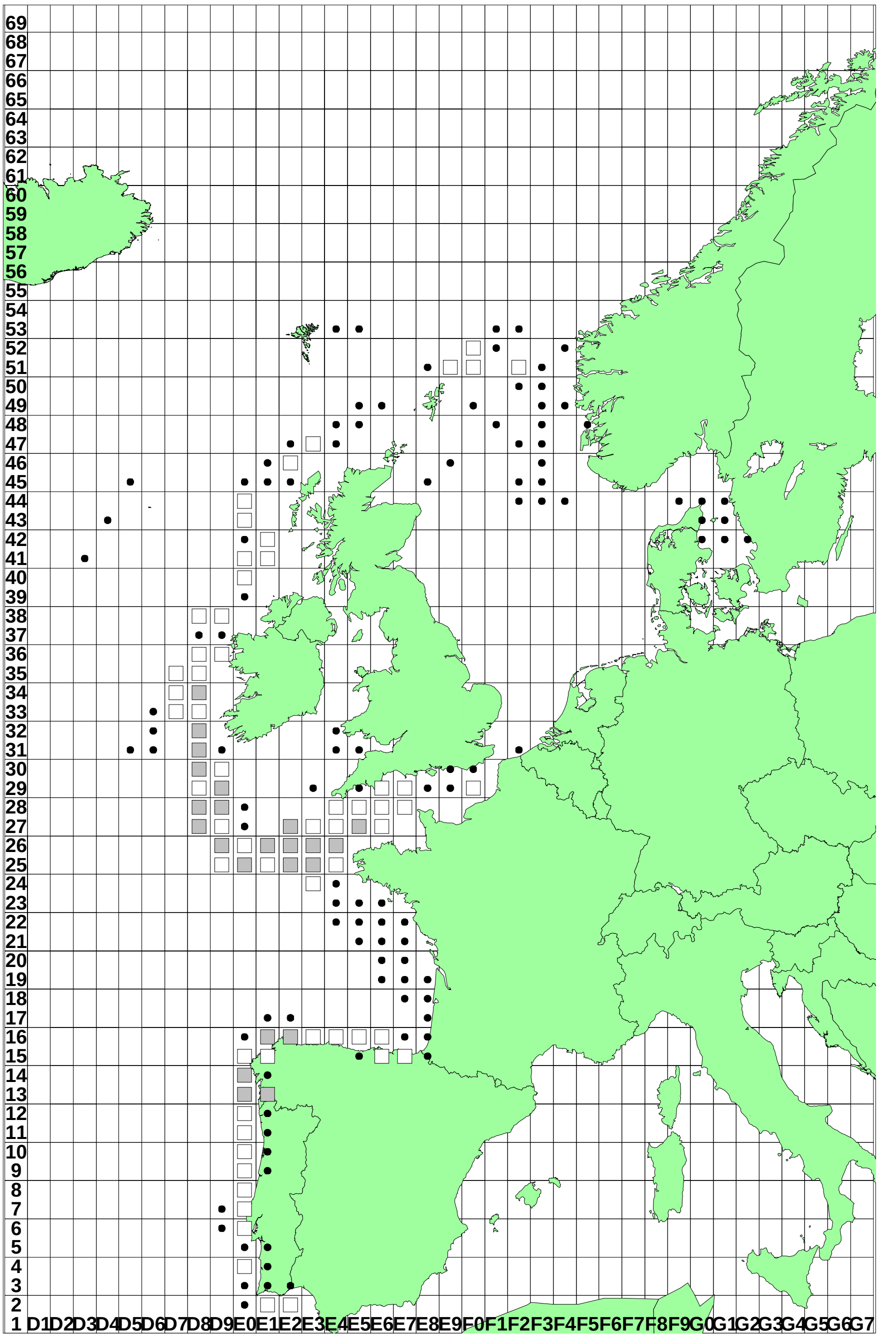
(-) Not available

Table 4.6.1: Length distributions (%) of HORSE MACKEREL catches by fleet and country in 1998

	England & Wales	Netherlands	Germany	Norway	Ireland	Spain				Portugal		
cm	Pair trawl	Pel.trawl	Pel. Trawl	P.seine	Pel. trawl	P.seine	Dem.trawl	Gill net	Hook	Artisan	trawl	P.seine
5												
6												
7												
8												
9											0.01	
10						0.02					0.09	0.23
11						0.45				0.30	0.88	0.25
12						2.84	0.04			5.13	5.36	3.01
13			0.01			5.88	0.09			13.88	12.21	3.36
14			0.08			7.69	1.35			6.64	14.72	10.99
15			0.22			9.67	1.87			6.40	15.99	20.66
16			0.74			5.70	3.51			6.52	11.96	32.14
17		0.04	1.05			4.16	4.07			3.31	6.25	12.63
18		0.21	1.97			3.56	3.65	0.02		3.31	5.16	8.69
19		0.26	1.19			4.89	3.20	0.02		5.05	6.59	4.39
20		0.91	1.50			4.69	2.83	0.14		4.45	6.04	2.12
21	10.67	2.17	5.25			3.73	1.89	0.53		2.87	3.54	0.87
22	14.00	11.87	16.30			2.93	1.65	0.57	1.05	2.13	1.90	0.31
23	20.67	21.41	24.42		0.12	4.71	1.30	0.73	2.95	2.20	1.37	0.16
24	20.67	19.42	20.99		1.66	7.42	2.70	1.85	5.59	3.59	1.02	0.06
25	9.33	9.05	12.84		6.33	5.76	3.19	4.39	11.76	6.28	1.12	0.06
26	9.33	7.02	6.82	0.08	15.68	4.68	3.18	5.95	13.78	7.11	1.28	0.04
27	9.33	5.76	3.76	0.20	22.99	3.61	3.58	6.52	15.15	5.48	0.99	0.01
28	4.00	4.46	1.40	0.71	20.63	2.60	5.84	7.17	10.62	3.90	0.70	
29		3.91	0.71	3.53	10.51	2.89	6.83	6.60	9.48	2.83	0.56	
30		4.02	0.34	9.06	5.16	3.15	9.60	9.16	8.57	1.84	0.46	
31		2.82	0.14	15.42	3.83	3.36	9.08	9.53	7.39	1.62	0.40	
32	2.00	1.76	0.11	17.34	3.14	2.28	7.48	8.87	3.81	1.68	0.32	
33		3.71	0.08	17.77	2.60	1.18	5.05	8.41	2.13	1.29	0.26	
34		0.64	0.04	14.87	2.32	0.67	4.05	8.26	1.53	0.85	0.23	
35		0.34	0.02	11.77	2.33	0.44	2.96	5.61	1.74	0.51	0.17	
36		0.10	0.01	5.89	1.66	0.29	2.31	3.32	1.36	0.28	0.12	
37		0.12		2.39	0.41	0.16	2.28	2.85	1.10	0.23	0.09	
38		0.01		0.63	0.35	0.11	1.84	3.12	0.73	0.08	0.07	
39				0.27	0.24	0.08	2.35	2.48	0.58	0.05	0.05	
40				0.08	0.04	0.07	1.28	1.62	0.25	0.03	0.03	
41					0.01	0.06	0.60	1.33	0.27	0.05	0.02	
42+						0.24	0.33	0.94	0.15	0.14	0.04	
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

0.00=<0.005%

Figure 4.1.1a. Mackerel commercial catches in Quarter 1 1998



■ > 10,000 tonnes
1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 4.1.1b. Mackerel commercial catches in Quarter 2 1998

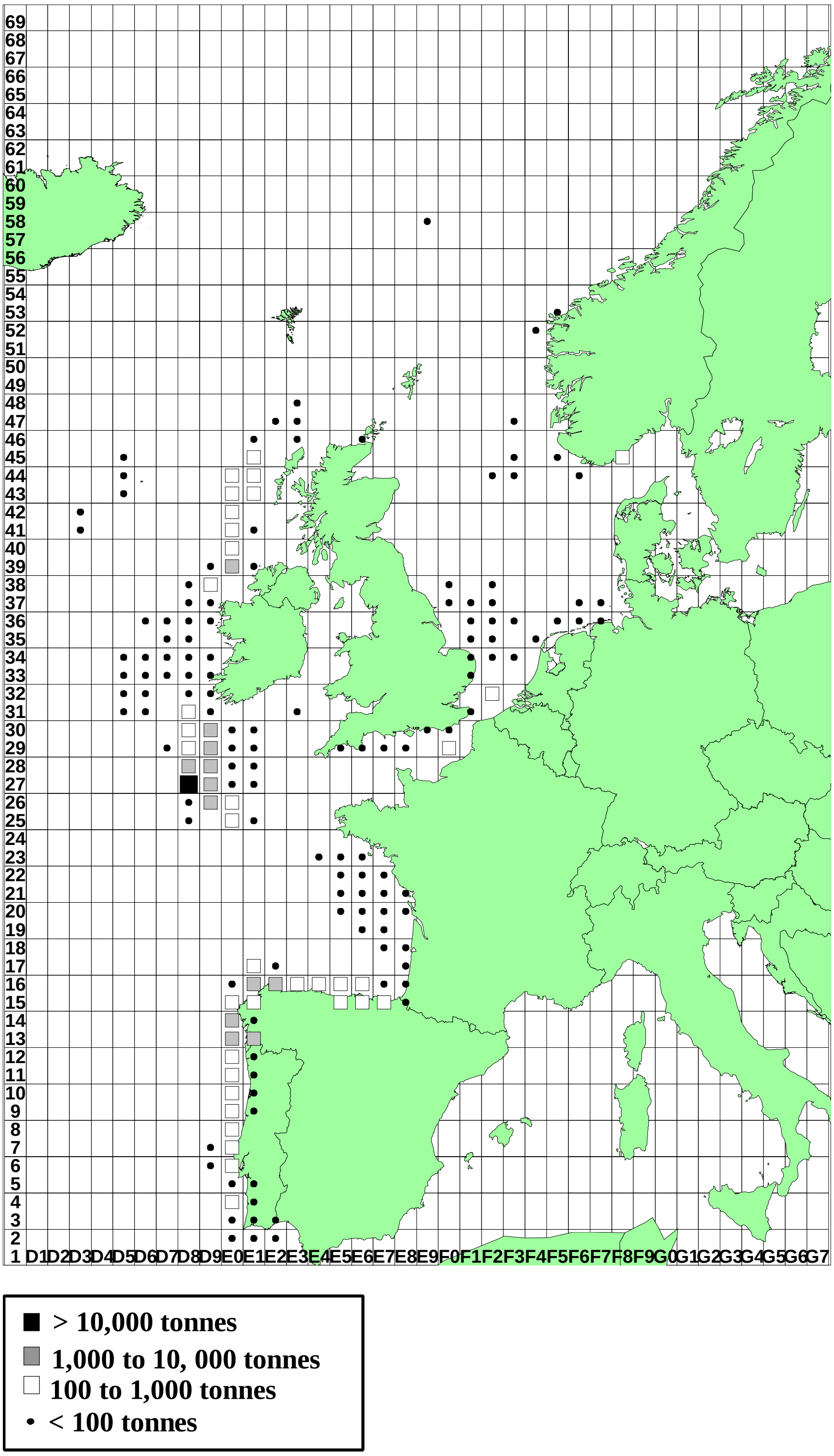
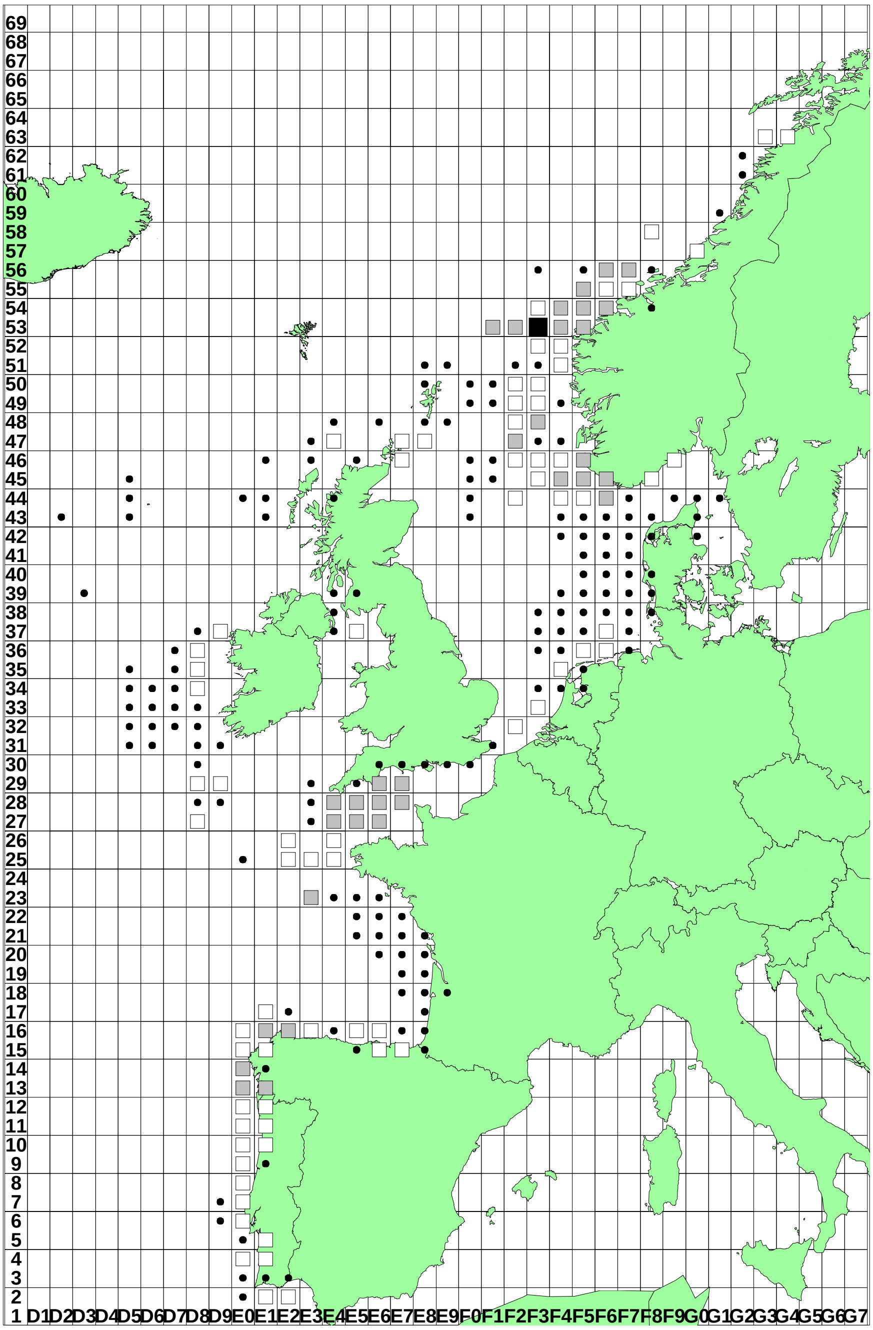
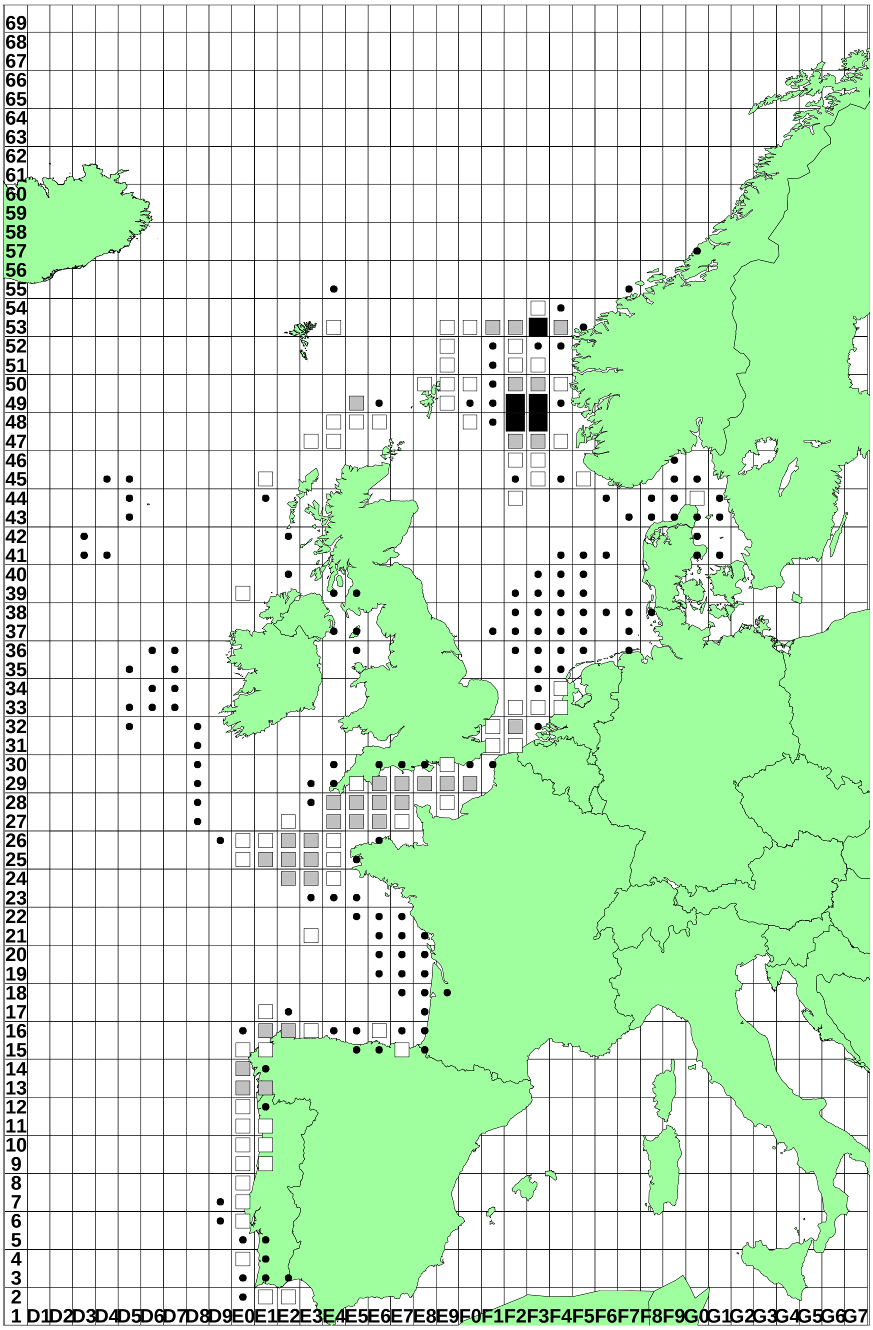


Figure 4.1.1c. Mackerel commercial catches in Quarter 3 1998



■ > 10,000 tonnes
▪ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 4.1.1d. Mackerel commercial catches in Quarter 4 1998



■ > 10,000 tonnes
▨ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

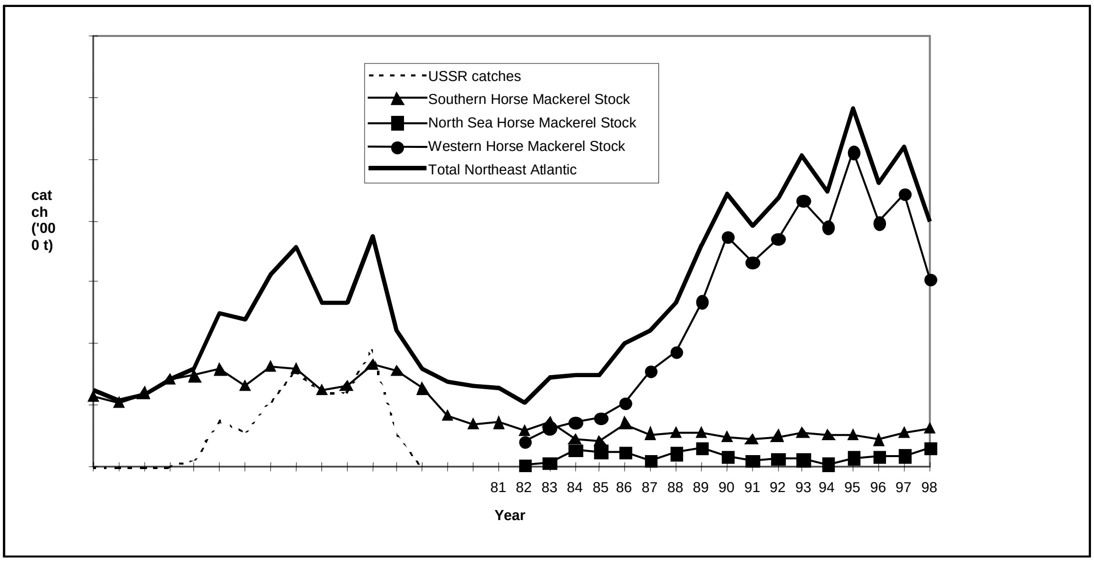


Figure 4.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 1998. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic.

5 NORTH SEA HORSE MACKEREL (DIVISIONS IIIA (EXCLUDING WESTERN SKAGERRAK), IVBC AND VIID

5.1 ACFM advice Applicable to 1998 and 1999

As usual no TAC advice was given. ACFM suggested that due to the age composition of the relatively small catches and past biomass estimates from egg surveys, 1988-1991, the explotation rate may have been low. Both in 1997 and 1998 ICES recommended that consistent with a precautionary approach a management plan including monitoring of the development of the stock and fishery with corresponding regulations should be developed and implemented.

EU has since 1987 set a TAC for EU waters in Division IIa and Sub-arae IV which is a wider area than the North Sea stock is distributed in. This TAC has since 1993 been fixed at 60,000 t.

5.2 The Fishery in 1998

Catches of horse mackerel in the North Sea and Division IIIa consists of western and North Sea fish. These catches dropped from a level of 100,000 t–140,000 t during the period 1992–1995 to 28,000 t in 1996 (Table 4.1.1). In 1997 the catches increased to 81,200 t and dropped to 31,300 t in 1998. The catches in Division VIId are allocated to the North Sea stock and have varied between 600 t and 9,400 during the period 1982-1997 (Table 4.3.1). In 1998 these catches increased to 16,200 t.

Usually catches taken in Divisions IIIa - except western part of Skagerrak - IVb,c and VIId are regarded as belonging to the North Sea horse mackerel stock (see Sections 4.2 and 4.3). Table 4.3.1 shows the catches of this stock from 1982–1998. For the first time horse mackerel catches were reported from Divisions IVa, IIa , Vb during the two first quarters (Table 4.1.2). These catches were allocated to the western horse mackerel stock. Sweden reported a catch of 3401 t from IIIa and were assumed to be of the North Sea stock. The total catch taken from this stock in 1998 is 30,500 t which is the largest catch since 1982. 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. However, since 1995 at least 70% of the catch has been taken in a directed horse mackerel fishery for human consumption.

5.3 Fishery-independent Information from Egg Surveys

No egg surveys for horse mackerel have been carried out in the North since 1991. Such surveys were carried out during the period 1988-1991 and the SSB was estimated at:

Year	1988	1989	1990	1991
SSB x 10^{-3} t	120	217	255	247

The relatively low SBB estimated in 1988 was regarded as an underestimate.

5.4 Biological Data

5.4.1 Catch in Numbers at Age

Catch in numbers at age (Tables 5.4.1.1 and 5.4.1.2) were calculated according to a few Dutch and German samlpes collected in Divisions IVb and IVc the third and fourth quarter, and in VIId the first, third and fourth quarter. The allocations of samples to calculate catch in numbers by age for the different Divisions are available in the Working Group archive. 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. These Dutch samples covered only a small proportion of the total catch, but give a rough indication of the age composition of the stock (Figure 5.4.1.1). Catch in numbers by age since 1995 is given in Table 5.4.1.2.

The strength of the 1982 year class in the central and southern North Sea does not seem as strong as in the western area (Figures 5.4.1.1 and 6.4.1.1). The 1987 year class is relatively stronger in the western stock than in the North Sea. In the 1997 and 1998 catches the 1994 year classes are relatively abundant both in the western catches and in the North Sea catches.

5.4.2 Mean Length at Age and Mean Weight at Age

Mean length at age and mean weight at age in the catches based on the Dutch and German age readings are given in Tables 5.4.1.2, 5.4.2.1 and 5.4.2.2.

5.4.3 Maturity at age

No data have been made available for this Working Group.

5.4.4 Natural mortality

There is no information available about natural mortality.

5.5 State of the Stock

It was not possible to do any analytical assessment. Estimates of total age composition are available since 1995 mainly based on Dutch samples. Estimates of age composition prior 1995 are considered unreliable, that is, not representative for the entire fishery, and should not be used for analytical assessment. During the period the catch rates were relatively low with an average of 18,000 t. The Working Group considered this a moderate exploitation compared to SSB estimates from the egg surveys 1988-1991. The egg surveys in later years for mackerel in the North Sea do not cover the spawning area of horse mackerel. In 1998 the catch level increased by 70% compared to the average long term catch level. The present stock level is uncertain since the last SSB estimate was made in 1991. Since allocation of catches to stock is based on the temporal and spatial distribution of the fishery it is important that catches are reported by ICES rectangle and quarters. Since this was not the case with the Swedish catches in Division IIIa the catch level of the North Sea stock in 1998 is uncertain. Due to the uncertainty of the catch level and since there are no information of the SSB since 1991 it is not known if this stock is still exploited moderately. The Working Group therefore recommends that a new egg survey should be carried out.

5.6 Reference Points for Management Purposes

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

5.7 Harvest Control Rules

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

5.8 Management Measures and Considerations

EU has since 1987 set a TAC for EU waters in Division IIa and Sub-area IV. This TAC has been 60,000 t since 1993. However, this TAC is set for a wider area than the North Sea horse mackerel is distributed in. This TAC area also covers parts of the distribution area of western horse mackerel in EU waters of Divisions IVa and IIa. No forecast has been made for 2000.

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

The Working Group recommends that if a TAC is set for this stock, it should apply to those areas where the North Sea horse mackerel are fished, i.e. Divisions IVb,c, VIId and eastern part of Division IIIa.

Table 5.4.1.1.- Catch Numbers at Age by quarter and area

For Period 1

Ages	IIIa	IVb	IVc	VIId	Total
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	2.13	4.21	7.65	135.13	149.12
5	0.00	0.00	0.00	0.00	0.00
6	2.13	4.21	7.65	135.13	149.12
7	4.25	8.42	15.30	270.26	298.23
8	19.14	37.87	68.87	1216.17	1342.05
9	19.14	37.87	68.87	1216.17	1342.05
10	14.89	29.46	53.56	945.91	1043.81
11	12.76	25.25	45.92	810.98	894.91
12	0.00	0.00	0.00	0.00	0.00
13	8.51	16.84	30.62	540.71	596.68
14	0.00	0.00	0.00	0.00	0.00
15	23.39	46.29	84.18	1486.63	1640.49

For Period 2

Ages	IIIa	IVb	IVc	VIId	Total
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	9.42	6.76	86.81	102.99
5	0.00	0.00	0.00	0.00	0.00
6	0.00	9.42	6.76	86.81	102.99
7	0.00	18.84	13.52	173.61	205.98
8	0.00	84.77	60.83	781.03	926.62
9	0.00	84.77	60.83	781.03	926.62
10	0.00	65.93	47.31	607.41	720.65
11	0.00	56.50	40.55	520.61	617.66
12	0.00	0.00	0.00	0.00	0.00
13	0.00	37.69	27.04	347.22	411.95
14	0.00	0.00	0.00	0.00	0.00
15	0.00	103.61	74.35	954.64	1132.60

Table 5.4.1.1 (Continued)

For Period 3

Ages	IIIa	IVb	IVc	VIId	Total
0	0.00	0.00	0.00	0.00	0.00
1	4.31	220.11	476.54	371.75	1072.71
2	14.73	1439.62	979.64	1271.46	3705.45
3	18.41	2229.75	816.86	1589.12	4654.14
4	16.11	2208.17	471.49	1390.57	4086.35
5	16.00	2191.49	470.10	1381.24	4058.83
6	8.30	1169.26	212.58	716.21	2106.35
7	9.99	1486.33	181.92	862.48	2540.72
8	6.36	980.53	82.24	548.48	1617.60
9	2.62	348.36	86.48	225.94	663.40
10	0.42	9.23	58.03	36.24	103.93
11	0.39	60.53	5.08	33.86	99.85
12	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00
14	0.81	69.76	63.11	70.10	203.78
15	1.18	181.46	15.22	101.50	299.36

For Period 4

Ages	IIIa	IVb	IVc	VIId	Total
0	0.00	0.00	0.00	0.00	0.00
1	203.99	29.08	256.98	732.48	1222.52
2	2492.17	383.52	3139.49	12404.15	18419.33
3	5076.95	768.15	6395.64	19798.22	32038.97
4	5566.75	862.16	7012.66	21032.75	34474.32
5	2761.27	502.78	3478.48	9985.46	16727.99
6	1718.98	309.72	2693.97	5019.36	9742.03
7	1880.06	356.88	3425.48	5280.26	10942.68
8	1105.19	218.13	2801.65	2783.21	6908.18
9	634.61	110.65	3265.94	1313.01	5324.21
10	213.69	30.46	1326.29	565.68	2136.12
11	123.06	21.54	859.73	106.58	1110.91
12	92.20	13.14	468.55	133.02	706.91
13	79.83	11.38	452.97	254.74	798.92
14	30.55	8.35	38.48	25.23	102.62
15	279.44	51.93	1232.92	468.07	2032.36

Table 5.4.1.2 Catch in numbers 1995-1998, mean length and mean weight in catch for North Sea horse mackerel 1998

Age	CATCH IN NUMBERS (MILLIONS) 1995	1996	1997	1998	Mean length (cm) in catch 1998	Mean weight (kg) in catch 1998
0	0.000	0.000	0.000	0.000		
1	0.000	0.000	0.000	2.295	19.3	0.070
2	1.760	4.578	5.753	22.125	22.5	0.121
3	3.117	13.778	16.235	36.693	23.9	0.129
4	7.190	11.043	8.140	38.818	24.8	0.144
5	10.321	11.867	11.979	20.787	25.9	0.162
6	12.082	9.637	11.044	12.100	26.8	0.185
7	13.161	12.492	10.151	13.988	27.9	0.199
8	11.426	7.958	8.282	10.794	28.6	0.218
9	12.644	6.599	7.205	8.256	29.5	0.240
10	7.247	1.481	2.386	4.005	30.4	0.254
11	5.872	5.314	0.748	2.723	31.2	0.275
12	0.010	0.290	0.000	0.707	30.2	0.266
13	8.843	1.281	0.187	1.808	30.7	0.252
14	0.202	8.924	0.000	0.306	33.2	0.356
15+	4.369	8.005	0.935	5.105	33.0	0.313

Table 5.4.2.1.- Mean length at age by quarter and area in 1998.

For Period 1

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	25.5000	25.5000	25.5000	25.5000	25.5000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	26.5000	26.5000	26.5000	26.5000	26.5000
7	28.0000	28.0000	28.0000	28.0000	28.0000
8	28.5000	28.5000	28.5000	28.5000	28.5000
9	29.5000	29.5000	29.5000	29.5000	29.5000
10	30.2100	30.2100	30.2100	30.2100	30.2100
11	30.8300	30.8300	30.8300	30.8300	30.8300
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	31.5000	31.5000	31.5000	31.5000	31.5000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	34.2300	34.2300	34.2300	34.2300	34.2300

For Period 2

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	25.5000	25.5000	25.5000	25.5000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	26.5000	26.5000	26.5000	26.5000
7	0.0000	28.0000	28.0000	28.0000	28.0000
8	0.0000	28.5000	28.5000	28.5000	28.5000
9	0.0000	29.5000	29.5000	29.5000	29.5000
10	0.0000	30.2100	30.2100	30.2100	30.2100
11	0.0000	30.8300	30.8300	30.8300	30.8300
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	31.5000	31.5000	31.5000	31.5000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	34.2300	34.2300	34.2300	34.2300

Table 5.4.2.1 (Continued)

For Period 3

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	18.8550	18.7952	19.3186	18.8550	19.0487
2	22.4500	22.5554	21.9023	22.4500	22.3461
3	24.0066	24.0601	23.7753	24.0066	23.9916
4	25.2111	25.1290	25.4838	25.2111	25.1982
5	25.9488	25.9905	25.8096	25.9488	25.9552
6	26.7780	26.9094	26.3930	26.7780	26.8121
7	27.6933	27.7263	27.6374	27.6933	27.7086
8	28.4543	28.4543	28.4543	28.4543	28.4543
9	29.2027	29.1530	29.3835	29.2027	29.2002
10	27.5000	27.5000	27.5000	27.5000	27.5000
11	30.5000	30.5000	30.5000	30.5000	30.5000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	33.0000	32.6280	35.0837	33.0000	33.5180
15	30.5000	30.5000	30.5000	30.5000	30.5000

For Period 4

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	19.4423	19.4423	19.4423	19.4606	19.4533
2	22.3672	22.4065	22.3672	22.5652	22.5014
3	23.7996	23.8228	23.7996	23.9143	23.8710
4	24.6855	24.7185	24.6855	24.7699	24.7378
5	25.7620	25.8137	25.7620	25.9531	25.8776
6	26.7189	26.7568	26.6760	26.9447	26.8246
7	27.7505	27.7379	27.7750	28.0714	27.9126
8	28.5268	28.4916	28.6995	28.7474	28.6846
9	29.2149	29.1939	29.8078	29.2308	29.5821
10	31.0610	31.0610	30.7494	30.7028	30.7727
11	31.9776	31.7032	31.5861	32.0249	31.6738
12	29.3775	29.3775	30.5978	29.2075	30.1543
13	27.5833	27.5833	31.7974	26.7804	29.7166
14	32.5000	32.5000	32.5000	32.5000	32.5000
15	30.6936	30.6485	32.6987	30.0283	31.7556

Table 5.4.2.2.- Mean Weight at Age (Kg) by quarter and area.

For Period 1

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.1620	0.1620	0.1620	0.1620	0.1620
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.1540	0.1540	0.1540	0.1540	0.1540
7	0.1950	0.1950	0.1950	0.1950	0.1950
8	0.1960	0.1960	0.1960	0.1960	0.1960
9	0.2230	0.2230	0.2230	0.2230	0.2230
10	0.2290	0.2290	0.2290	0.2290	0.2290
11	0.2530	0.2530	0.2530	0.2530	0.2530
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.2650	0.2650	0.2650	0.2650	0.2650
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.3280	0.3280	0.3280	0.3280	0.3280

For Period 2

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.1620	0.1620	0.1620	0.1620
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.1540	0.1540	0.1540	0.1540
7	0.0000	0.1950	0.1950	0.1950	0.1950
8	0.0000	0.1960	0.1960	0.1960	0.1960
9	0.0000	0.2230	0.2230	0.2230	0.2230
10	0.0000	0.2290	0.2290	0.2290	0.2290
11	0.0000	0.2530	0.2530	0.2530	0.2530
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.2650	0.2650	0.2650	0.2650
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.3280	0.3280	0.3280	0.3280

Table 5.4.2.2 (Continued)

For Period 3

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0680	0.0680	0.0680	0.0680	0.0680
2	0.1157	0.1181	0.1031	0.1157	0.1133
3	0.1358	0.1372	0.1296	0.1358	0.1353
4	0.1524	0.1527	0.1516	0.1524	0.1525
5	0.1701	0.1714	0.1656	0.1701	0.1703
6	0.1859	0.1912	0.1706	0.1859	0.1873
7	0.1987	0.2025	0.1921	0.1987	0.2005
8	0.2234	0.2234	0.2234	0.2234	0.2234
9	0.2308	0.2311	0.2297	0.2308	0.2308
10	0.1830	0.1830	0.1830	0.1830	0.1830
11	0.2720	0.2720	0.2720	0.2720	0.2720
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.3497	0.3365	0.4233	0.3497	0.3680
15	0.2750	0.2750	0.2750	0.2750	0.2750

For Period 4

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0719	0.0719	0.0719	0.0711	0.0714
2	0.1196	0.1206	0.1196	0.1231	0.1220
3	0.1303	0.1310	0.1303	0.1272	0.1284
4	0.1450	0.1461	0.1450	0.1409	0.1425
5	0.1628	0.1657	0.1628	0.1576	0.1598
6	0.1854	0.1874	0.1863	0.1842	0.1851
7	0.1994	0.2005	0.2042	0.1959	0.1992
8	0.2240	0.2240	0.2245	0.2240	0.2242
9	0.2403	0.2390	0.2559	0.2358	0.2488
10	0.2866	0.2866	0.2821	0.2663	0.2785
11	0.3235	0.3139	0.3001	0.3253	0.3054
12	0.2542	0.2542	0.2728	0.2516	0.2661
13	0.1705	0.1705	0.2969	0.1464	0.2345
14	0.3320	0.3320	0.3320	0.3320	0.3320
15	0.2707	0.2717	0.3238	0.2440	0.2968

Figure 5.4.1.1

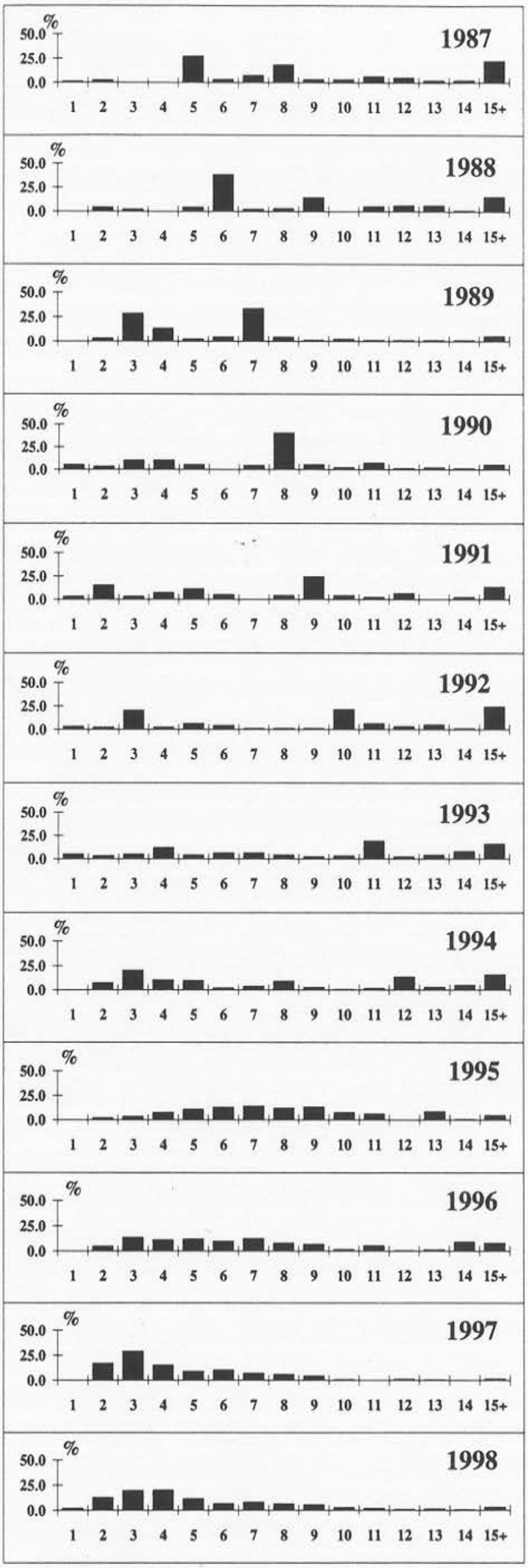


Figure 5.4.1.1 The age composition of the NORTH SEA HORSE MACKEREL based on commercial and research vessel samples from 1987-1998.

6 WESTERN HORSE MACKEREL (DIVISIONS IIA, IIIA (WESTERN PART), IVA, VB, VIA, VIIA–C, VIIE–K, AND VIIIA,B,D,E

6.1 ACFM Advice Applicable to 1998 and 1999

For 1998 ICES recommended a substantial reduction of fishing mortality, at least to 0.15 corresponding to a catch of 150,000 t in 1998. Similarly for 1999 it was adviced that the catches should be effectively limited to no more than 200,000 t. This was aimed at maintaining the SSB above that which produced the 1982 year class. EU has set TACs for horse mackerel since 1989 in Division Vb (EU waters only), Sub areas VI and VII, Divisions VIIIa,b,d,e. These areas do not correspond to the total distribution area of western horse mackerel. The TAC should apply to all areas where western horse mackerel are fished. During the period 1994-1997 the TAC set by EU was 300,000 t, 320,000 t in 1998 and 265,000 t in 1999.

In 1997 and 1998 the catches of western horse mackerel were respectively 195% and 50% above the recommended TACs by ACFM.

6.2 The Fishery in 1998

The fishery for western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. The national catches taken by the countries fishing these areas are shown in Tables 6.2.1–6.2.5, while information on the development of the fisheries by quarter and division is shown in Table 4.1.2 and in Figures 4.1.1.a–d. For the first time the horse mackerel fishery was stopped in EU waters during the season and resulted in a reduced catch compared with 1997.

The total catch allocated to western horse mackerel in 1998 was 303,500 t (Table 4.3.1) which is 139,000 t less than in 1997.

<u>Divisions IIa and Vb</u>

The national catches in this area are shown in Table 6.2.1. The catches in this area have varied from year to year. The catches dropped from the record high catch of 14,000 t in 1995 to 2,500 t in 1998 which is similar to 1996 and 1997.

<u>Sub-area IV and Division IIIa</u>

The total catches in this area have been above or close to 100,000 t during the period 1989 to 1995 (Table 6.2.2). Since then the catches dropped considerably to 26,100t in 1996, increased to 79,100 t in 1997 and dropped to 31,200 t in 1998. The lower catches the later years are mainly due to lower catches by the Norwegian purse seiners in Division IVa.

The catches taken in Division IVa and IIIa (western) part are usually allocated to the western stock. This year none of the IIIa catches were allocated to the western stock. The catch in IVa allocated to the western stock in 1998 was 17,000 t.

<u>Sub-area VI</u>

The catches in this area have increased from 21,000 t in 1990 to a historical high level of 84,000 t in 1995 and 81,000 t in 1996 (Table 6.2.3). The catches in 1997 and 1998 were reduced by 50% to 40,000 t and 35,100 t respectively. The main part of the catches is taken in a directed Irish trawl fishery for horse mackerel.

<u>Sub-area VII</u>

The catches from this area are mainly taken in directed Dutch and Irish trawl fisheries in Divisions VIIb,e,h,j (Table 6.2.4). In 1998 the catches were 250,000 t which is the lowest since 1995 and a reduction by 68,000 t since 1997. The catches in VIId (16,200 t) are allocated to the North Sea stock. The catches in Sub-area VII allocated to the western stock in 1998 were 233,800 t.

Sub-area VIII

Usually about half the catches in these areas are taken in Division VIIIc. The catches are given in Table 6.2.5. Historical high catches of more than 53,000 t were taken in 1992 and 1993. In 1995 the catches declined to 28,000 t and in 1998 the catches were 38,600 t which is similar to 1997. The catches allocated to the western stock in 1998 were 15,700 t.

6.3 Fishery Independent information from Egg Surveys

The 1998 egg surveys in the western area covered the spawning of horse mackerel within four time periods from 15 March to 5 July. Spatial coverage on the first three surveys was good. On the final survey the egg distributions indicate that some spawning occurred outside the surveyed area north-west of Ireland and west of Scotland. Egg production on the first survey was low indicating that the starting point of 10 February, used previously, was appropriate. Egg production on the second survey was high and strongly concentrated along the shelf edge from southern Biscay to south-west of Ireland. On the following survey the rate of daily egg production decreased from 11.7 $x10^{12}$ to 3.9 x 10^{12}. On the final survey daily egg production increased again to 14.4 x 10^{12}, its highest level for the season. The resultant annual stage I egg production curve was bimodal and used the end date of spawning of 31 July as in previous years. The total annual production of stage I eggs was estimated to be 1.003 x 10^{15} (s.e. $0.325x10^{15}$), a reduction of 18% since the previous survey in 1995.

The estimate of annual stage I egg production was regarded as an underestimate by the MHMEGG Working Group (ICES 1999/G:5) for two reasons. First of all some production was missed on the final survey at the northern and western borders of the survey area. Secondly the fact that the peak of egg production occurring on the final survey strongly suggests that the spawning continued after the nominated end date of 31 July. This assumption was also strongly supported by adult sampling for atresia measurements on the final survey. The MHMEGG Working Group (ICES 1999/G:5) has recommended that surveys in future cover at least the whole of July in order to estimate horse mackerel egg production more reliably.

This working Group could find no evidence in the age structure which could help to explain the bimodal egg production curve in 1998.

The estimate of fecundity from the 1998 sampling was rejected by the MHMEGG Working Group (ICES 1999/G:5). The calculated estimate of potential fecundity, 605 oocytes per gram female (s.e. 38) was considerably lower than the value of 1577 oocytes per gram female (s.e. 43), used to calculate SSB from all previous egg surveys.

Histological studies reported to the MHMEGG WG (ICES 1999/G5) showed the possibility that fish used for the estimate of potential fecundity had already started to spawn. The screening process used to reject spawning fish from the estimate depends on the presence of post ovulatory follicles in the ovary. This screening process would partially fail if the duration of the three stages (migrating nucleus stage, hyaline egg stage and post ovulatory follicle stage) were shorter than the batch interval for maturing oocytes. (ICES 1999/G5).

The uncertainties in the estimate of potential fecundity in 1998 raises new doubts about whether or not horse mackerel is a determinate spawner. There was some evidence from the sampling in 1998 that the rate of *de novo* vitellogenesis production is higher than the rate of spawning. If this is the case then horse mackerel would be an indeterminate spawner and the annual egg production method for calculating SSB from egg surveys could not be applied.

Atresia estimates, not available at the MHMEGG WG meeting were presented to this WG by Eltink (WD 1999). From sampling during the egg surveys in 1998 he showed that the rate of atresia measured was very low and did not significantly affect the estimate of realised fecundity.

A spawning stock biomass estimate was calculated using the historical estimate of fecundity of 1504 oocytes per gram female (corrected for historical atresia rate). The resultant biomass estimate was 1.4 million tonnes which for the reasons described above must be regarded as an underestimate. This value is included in Table 6.3.1 which lists the historical estimates.

No attempt has been made to use generalised additive models for the 1998 Western Horse mackerel survey, but the estimates so obtained for 1989, 1992 and 1995 are given in Table 6.3.1.

6.4 Biological data

6.4.1 Catch in numbers

This year there has been a significant increament in samples with age readings, which has improved the catch at age matrix of the western horse mackerel. In addition to the usual countries that are providing catch in numbers, the Netherlands (Division VIa, Subareas IV, VII and VIII) and Norway (Divisions IIa and IVa), this year also Ireland (Division VIa and Divisions VIIbc, VIIj), Germany (Divisions VIIef) and Spain (Division VIIIab) have provided catch in numbers at age. The catch sampled for age reading provides 51.3% of the total catch.

Catches from other countries were converted to numbers at age using adequate data provided by the countries quoted above. The procedure has been carried out using the especific software for calculating international catch at age (Patterson, 1998).

The total anual catch in numbers for western horse mackerel in 1998 is shown in Table 6.4.1.1. The catch in numbers at age by quarters and Divisions is shown in Table 6.4.1.2. The sampling intensity is discussed in Section 1.4. The catch at age matrix shows the predominance and the big strength of the 1982 yearclass (see Figure 6.4.1.1). Currently this cohort has been included in the plus group since 1996.

6.4.2 Mean length at age and mean weight at age

<u>Mean length at age and mean length at age in the catches</u>

As in the case of catch in numbers, the information on mean weights and mean lengths at age in the catches is now provided by several countries (Germany, Ireland, the Netherlands, Norway and Spain) improving the quality of the data. 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, 1998).The mean weight and mean length at age in the catches are shown in Tables 6.4.2.1, 6.4.2.2, 6.4.2.3 and 6.4.2.4.

<u>Mean weight at age in the stock</u>

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 6.4.2.4).

<u>Projected weights at age in catches and in the stock 1998–2007</u>

Projected weights at age in the catches and weights at age in the stock are needed for the forecasts. The mean weights at age in the catch and in the stock for the period 1998–2008 were, except for the 1982 and the 1987, set as the mean weights from 1996, 1997 and 1998. The weight at age in catch and in the stock of the 1982 and the 1987 year classes were obtained from extrapolated growth curves over the period 1999–2008. The mean weights at age in the catch and in the stock of the 1982 year class have been used for the 15+ group since the majority of this group consists of the 1982 year class. The projected weights at age in catches and in the stock for 1999–2008 are the same as those given in Table 6.5.1.1 for 2000-2004.

6.4.3 Maturity ogive

The planning of the sampling for maturity in 1998 is described in report of the ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (ICES, 1997/H:4). A total of 14 trawl hauls were carried out around peak spawning time and 100 ovaries per sample were collected randomly from both juvenile and adult females. The ovaries were preserved in 4% buffered formalin and sent to RIVO-DLO in the Netherlands for the preparation of histological slides. The proportion mature at age was estimated based on histological analysis and the results were presented to this Working Group (Eltink, WD 1999).

A reliable maturity ogive could not be constructed due to a large difference in the proportion mature of especially the 2- and 3- year olds in the Western Channel (juvenile area) compared to the combined samples from the spawning area. Of the 2-year olds only 3% were mature in the western Channel, but 90% in the spawning area. Of the 3-year olds only 2% were mature in the western Channel, but 85% in the spawning area. The actual proportions mature at age are somewhere in between. A mean proportion mature can only be constructed, if weighting factors by age group would be available relative to the number of fish in both areas.

It can be assumed that the juvenile and adult fish are mixed much better in the southern area, where the continental shelf is very narrow compared to the western area. An estimated maturity ogive for the southern area is expected to reflect more accurately the actual proportion mature in the population.

For assessment purposes (ADAPT assessment) of the western horse mackerel a rounded maturity ogive for 1998 was adopted based on the estimated maturity ogive from the Cantabrian Sea (southern area), which is close to the western area (section 7.3.3). The difference between the maturity ogive as used at last years Working Group meeting and the new maturity ogive for 1998 (and used in for later years in the projections) is shown in the text table below:

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1997	0.00	0.00	0.10	0.40	0.60	0.80	1.00
1998	0.00	0.00	0.05	0.25	0.70	0.95	1.00

These are essentially assumed values because only arbitrary weightings of fish in the adult and juvenile areas can be used. Uncertainty in maturity is addressed in part in the Bayesian assessment.

6.4.4 Natural mortality

The natural mortalities applied in the 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.

6.5 State of the Stock

6.5.1 Data Exploration and Preliminary Modelling

As during last year's WG, data exploration, preliminary modelling and preliminary catch predictions were conducted by the 'ADAPT'-type method (Gavaris, 1988) in which an arbitrary choice of selection pattern is made. This method has been used at earlier Working Group meetings in 1994 - 1997 to estimate the size of this stock and associated mortality rates. Since then, it is used for comparability with last years ADAPT assessment and with the Bayesian assessment. The use of the ADAPT method also allows the estimation of some of the uncertainty in the assessment, and of the sensitivity of the assessment to the assumed selection pattern. As fishing mortality has historically been rather low in this stock, VPA 'convergence' does not help stabilise the analysis rapidly and hence the population model is likely to be strongly dependent on starting assumptions.

The model is a conventional VPA, which is fitted by a non-linear minimisation of the sum of squares with respect to population abundance at age 14 in 1998 subject to the constraints detailed below. Given population abundance N, fishing mortality F, natural mortality M, weights at age W, and maturity at age 0, egg survey estimates of SSB U, and the proportion of fishing and natural mortality exerted before spawning PF and PM respectively, the VPA is fitted by minimising:

$$ {}_{y}\Big(\ln\big(U_y\big) - \ln\Big({}_{a,y} N_{a,y} . O_{a,y} . W_{a,y} . \exp(-PF. F_{a,y} - PM. M_{a,y})\Big)\Big)^2 $$

where subscripts a and y denote age and year respectively.

Given the lack of age-structured surveys it is necessary to impose some constraints about the exploitation pattern on the model. Although some of these constraints are not very realistic there are insufficient observations available to make objective parameter estimations. These constraints are somewhat arbitrary:

a) Selection pattern in 1998 and later years is equal to 1 on ages 4 and older (based on exploratory runs);
b) Selection on ages 0 to 4 in 1999 set to the mean of the previous 4 years (in last years assessment a mean over 3 years was used, in the years before a mean of 5 years). This year a 3 year selection period was found to result in an unstable minimisation, 4 years were required for stability. The reasons for the discrepancy could not be resolved at the meeting.
c) Natural mortality, weights at age in the stock and in the catch are assumed to be known precisely;
d) Maturity ogive is assumed to be known precisely.
e) Fishing mortality on the oldest age taken as an arithmetic mean from age 6 to the penultimate true age (14) in the catch at age matrix.

The choices made about constraints listed above were made after a number of exploratory model fits, which are documented in ICES (1996/Assess:7). The model is fitted to the traditional egg production estimates of biomass (Table

6.5.1.2 d). As before, egg survey information prior to 1992 was excluded on account of uncertainty introduced by the unknown maturity of the 1982 cohort.

Input data for the assessment and projections are given in Table 6.5.1.1. Compared to last year’s input data (and apart from minor error corrections in the WEST and WECA-files), the proportion of fish mature at age was changed. As new data on the Western Horse Mackerel maturity at age were lacking, updated information from the southern stock was used for 1998 and onwards (see Sec. 6.4.3). Exploratory runs with changes to historic maturity up to 4 years previously gave negligible differences. Fishing mortality, fitted populations, stock sizes and other parameters calculated by the ADAPT procedure are presented in Table 6.5.1.2. In Figure 6.5.1.1 some of these parameters are compared graphically. From Figure 6.5.1.1.b it is striking that the VPA fit of SSB (expected) to the SSB estimates from egg surveys (observed) shows a discrepancy. This may be caused by invalid assumptions made on the following parameters:

- natural mortality (an exploratory run with M reduced to M=0.05 improved the fit considerably and brought it very close to the results of the Bayesian analysis, as shown in Figure 6.5.1.2),
- selection pattern, which was presumed to be constant, but might have changed over the last years (and there are indications for this, see the increase in F(2-4) since 1994; Figure 6.5.1.1d),
- maturity ogive,
- treatment of the SSB estimates as absolute measures of stock abundance,
- age composition estimates could be biased due to poor sampling coverage,
- the model structure might have been inappropriate.

Due to these uncertainties, it was as in last year decided not to use the ADAPT short and medium term predictions. For comparability, these can be found in a working document (WD Zimmermann 1999).

During the last year, some effort has been put into estimating the possible error to the assessment which is introduced by errors in age readings (see Section 4.7 and ICES 1999/G:16). A rough exploration of this year’s assessment output supported the assumptions made by ICES (1999/G:16) e.g., the observed recruitment at age 1 varies according to this year’s results up to a factor of 15 (excluding the 1982 year class). It should be noted that the highest predicted recruitment is confined to the assessment year (1998), and the lowest to the year before (1997). If only the more reliable year classes until 1993 are taken into account (as done for the predictions), then the factor between the *observed* minimum and maximum recruitment is reduced to 2.7, what implies a variation between the *actual* values of 13 (max. observed value is 35 % underestimated and min. value 211% overestimated). .A dome-shaped selection pattern due to age reading errors could not be verified, as the high variability in calculated fishing mortality masked any possible effect. It can be concluded that the error introduced by uncertainties of other input parameters is of more importance than the ones possibly caused by age reading errors.

6.5.2 Stock assessment

As in previous years an attempt has been made to make a more comprehensive assessment of uncertainty in some quantities used for management purposes (spawning stock size, fishing mortality, F-*status-quo* catch) that includes uncertainty in some critical quantities (maturity ogive, natural mortality). A Bayesian VPA-based method based on a Markov Chain Monte Carlo method similar to that used for Norwegian Spring-Spawning Herring (Patterson, 1997) is used. In addition to the age-structured observation data set, this requires the specification of prior distributions for quantities about which limited or subjective knowledge is available.

As has been noted in previous Assessment Working Group Reports (ICES 1996/H:2, ICES 1997/Assess:3) the assessment of Western Horse Mackerel presents peculiar and special difficulties. The stock has been dominated by two cohorts, the extremely strong 1982 and the much less abundant 1987 year classes comprising the bulk of the catches in recent years. Although there exist plausible catch-at-age data for the period 1982 to 1998 and there also exists a time-series of egg survey estimates of spawning biomass (ICES 1999/G:5) it is not a straightforward task to use the egg survey estimates to 'tune' a population model to the egg survey estimates. This is because maturation of horse mackerel appears to be density-dependent, and also because sampling for maturation is subject to unknown bias due to migration effects. Lastly, the assumption of natural mortality, M = 0.15 was made arbitrarily. Alternative choices of M were explored briefly by ICES (1997/Assess: 3) which suggested that lower rather than higher values of M may provide better fits of VPA-derived population models to egg survey biomass estimates.

The problematic nature of the assessment has led to rather poor consistency in advice. Estimates of the abundance of the 1982 year class were revised upwards successively by successive working groups, and as new egg survey estimates were added to the time-series, the perception of the precision of the earlier surveys was diminished.

6.5.2.1 The assessment model

As last year, the underlying population model is of the 'ADAPT' type, structured so as to make all historic and recent population abundances and mortalities dependent on two parameters, being the abundance of fish aged 14 on 1 January 1999 and the natural mortality. The model is similar to that described by ICES (1997/Assess:3). The following constraints were imposed:

- Selection (relative fishing mortality) in 1998 and later years is constrained = 1 on ages 4 and older.
- Selection on ages 0 to 3 in 1998 is calculated by linear interpolation between 1 at age 4 and 0 at age 0.
- Fishing mortality on the oldest age is taken as the arithmetic mean from age 6 to the penultimate true age in the catch at age matrix.
- Recruitments from 1995 to 1999 were modelled as a geometric mean of the estimated recruitment in the years 1981, 1983–1986 and 1988–1994 in order to avoid inferring recent recruitments from a selection pattern assumption.

6.5.2.1.1 Probability model

The likelihood function is defined analogously to that for the conventional assessment, based on the lognormal distribution. With usual notation indexed by year y and age a, (Egg surveys $U_{y,}$ Population abundance $N_{a,y,}$ Maturity ogive O, fishing mortality F, natural mortality M, survey variance sigma and the proportions of fishing and natural mortality experienced before the time of the survey PF and PM):

$$P(\text{Data} \setminus \text{Model}) = \Pi_y \left| \frac{1}{U_y \sigma (2\pi)^{1/2}} \exp\left(-\frac{[\log(U_y / \Sigma_a N_{a,y} O_{a,y} W_{a,y} \exp(-PF, F_{a,y} - PM, M_{a,y}))]^2}{2\sigma^2} - | \right) \right.$$

6.5.2.2 Data and priors

6.5.2.2.1 Data assumed to be known precisely

Estimates of landings and estimates of catches at age in numbers, weights at age in the catches and weights at age in the stock were as described in Sections 6.4.1 and 6.4.2 and given in Tables 6.5.1.1 a,c and d.

6.5.2.2.2 Uncertainty in maturity

The assumptions concerning the uncertainty in maturity were comprehensively discussed in ICES (1998/Assess:6). The following assumptions for the prior distributions for maturity have been made, based on hypotheses about plausible maturities that are described in Section 6.5 of that report :

1. The strongest year class before the 1982 year class was the 1979 year class, which did not show a retarded growth until 1983. The percentage mature is assumed to be in the range of 75% to 100% with equal probability for all values.

2. Fish of the 1982 year class in 1983 at age 1 are assumed to be all immature, no uncertainty admitted.

3. Because of the retarded growth, the fish of the 1982 year class in 1986 and 1989 at respectively ages 4 and 7 are assumed to have a completely unknown maturity in the range of 0 to 100% with equal probability. It is assumed that the maturity in 1989 must be greater than in 1986.

4. Fish of the 1982 year class in 1992 at age 10 are assumed in the range of 80 to 100% mature with equal probability.

5. Fish of the year class 1992 in 1995 at age 3 are assumed to have a maturity in the range of 0 to 100%, but less mature than the 1979 year class in 1983.

6. Fish of the 1982 year class in 1995 at age 13 are assumed to be all mature with no uncertainty admitted.

These maturity assumptions described above were parameterised as follows, and depending on five parameters $X_{1\text{-}5}$:

$MO(1983,4)=X_1$
$MO(1986,4)=X_2$
$MO(1989,7)=X_3(1-X_2)+X_2$
$MO(1992,10)=X_4$
$MO(1995,3)=X_5.X_1$

The maturity at age for the remaining years and ages are given in Table 6.5.1.1b.

6.5.2.2.3 Uncertainty in natural mortality

In the 1996 assessment of this stock trials with M in the region +/- 50% around M=0.15 were made. Here we consider admissible hypotheses for M in the range 0.05 to 0.15, for reasons given in ICES(1998/Assess:6). No attempt was made to explore uncertainty about possible differences in natural mortality at age.

6.5.2.2.4 Egg survey data

This year an updated estimate of the spawning stock biomass was available from the 1998 surveys (Section 6.3). For the reasons discussed in that section the estimate of the associated CV is considered uncertain. The coefficient of variation of the 1992 western horse mackerel egg survey estimates was estimated at between 18 and 22% depending on the analytic method used (ICES 1994/H:4). For present purposes the egg survey abundance estimates were assumed to be estimated with a CV of 25% on a lognormal distribution. No uncertainty was admitted in this variance estimate.

6.5.2.2.5 Summary of prior assumptions

The prior distributions are summarised in the text table below. All prior distributions are uniform.

Parameter		Lower Bound	Upper Bound	Comment
$N_{1998,14}$	Population Abundance (thousands)	1000	$8 \cdot 10^9$	Unrestrictive, reference parameter for VPA
M	Natural Mortality	0.05	0.15	Section 6.4.4
X_1	Maturity 1983 age 4	0.75	1.0	Section 6.5.2.2
X_2	Maturity 1986 age 4	0	1.0	
X_3	Maturity 1989 age 7, additional to maturity 1986 age 4	0	1.0	
X_4	Maturity 1992 age 10	0.8	1.0	
X_5	Relative Maturity 1995 age 3	0	1.0	

The Working Group noted that sensitivity to alternative prior specifications had not been tested and recommended that an alternative specification of the population abundance at age 14 as uniform on a log scale should be evaluated.

6.5.2.3 Posterior distributions of population parameters

Estimates of the historic development of the stock parameters are plotted in Figure 6.5.2.1, and the expectations and 5th, 25th, 50th, 75th and 95th percentiles of these distributions are given in Table 6.5.2.1. In Figure 6.5.2.1. it can be seen that the 1983 and 1986 egg survey observations lie outside the 95th percentile of the SSB distribution, indicating that even with the relaxation of assumptions allowed in this assessment compared with the conventional assessment procedure, the early egg surveys in the time series, the reported catches, the VPA assumptions and the assumption of a 25% CV in egg survey estimates are mutually incompatible. The estimate for the 1998 survey biomass lies within the 75th percentile of the stock trajectory.

It should be noted from Figure 6.5.2.1 that the SSB estimates in the years in which the Bayesian priors have been applied to maturity at age (1986, 1989, 1992, 1995), appear to be biased towards the egg survey values. This may result from lower expected values for maturity at age in the survey years when compared to the deterministic values of adjacent years. A future development of the model, which should be considered is the use of a density dependent model for maturity, the parameters for which are estimated within the objective function.

Posterior distributions for population abundance, natural mortality and spawning biomass in 1999 and 2000 (the latter predicated on an assumption of a status quo catch of 300,000 t in 1999) are shown in Figure 6.5.2.2. The distribution of the ratio F/M is plotted because as both F and M are uncertain parameters, the distribution of F alone has an uncertain meaning. This shows that:

1. The data and model indicate values of natural mortality higher than 0.12 are improbable.

2. The lower limit of natural mortality is constrained by the prior assumptions, and the data and model do not give information about this lower limit.

3. Spawning stock size estimates of 840 kt to 1,420 kt (25th and 75th percentiles) in 1998 are calculated.

4. Estimates of the ratio of fishing mortality to natural mortality in 1998 1.96 to 3.46 (25th and 75th percentiles) are calculated.

5. The distribution of the estimate of spawning stock biomass in 1983, which has been used for reference purposes, is 835 kt to 1020 kt (25th and 75th percentiles).

6.5.3 Reliability of the Assessment and Uncertainty Estimation

Perceptions of maturity parameter estimates (X_1 to X_5) are given in Figure 6.5.3.1. This shows that there is little information in the model and data about these parameters, with the exception that lower values of maturity of the age 4 fish in 1986 appear more likely.

Last year comparisons were made between the SSB trajectories from the assessments carried out in 1997 and 1998. This revealed that the assessment results are very sensitive to the egg survey estimate for 1998. The latest revision of this value from 1.3 to 1.4 million tonnes will not have made a substantial effect on the estimated trends in stock size and mortality. However, the results should considered in relation to the reliability of the 1998 AEPM survey estimate of biomass described in Section 6.3.

In the ADAPT analysis the sensitivity to the constant selection pattern for the recent years of the analysis was examined in response to information that the fleets are moving from older to younger ages as the 1982 year class is reduced. The Bayesian ADAPT assumes a constant selection on the oldest ages with a linear decline from age 4 to age 0. It does not estimate the selection on the youngest ages. Increased selection at age on the youngest ages will result in higher juvenile mortality for a given weight of catch and the assessment results and projections will be highly sensitive to this.

6.6 Catch Prediction

A calculation of the consequences of different short-term catch options can be made from the Bayesian assessment, but a different presentation is necessary to take account of the fact that most of the important variables (stock size, natural mortality, fishing mortality etc.) are treated as stochastic. No attempt is made to find a joint maximum-likelihood solution. A stochastic version of the conventional catch option table is presented in Table 6.6.1.

The following assumptions were made in the calculations:

1. Recruitments in 1995 and later were treated as lognormal variates with mean and variance estimated from the mean and variance of the recruitments in 1981, 1983–1986 and 1988–1994. This treatment is as used by ICES (1997/Assess:3) and represents a cautious approach to modelling recruitment as the mean and variance of the weak year classes, ignoring the few stronger year classes.

2. Exploitation in 1999 and later was assumed to follow the selection pattern assumed for 1998.

3. Catches in 1999 were assumed to be 300,000 t (section 6.4). The assumption of 300,000 t in 1999 was thought preferable to an assumption of *status quo* fishing mortality, because such a mortality would imply much lower catches than those which are anticipated from this stock.

4. Weights at age in the stock and in the catch, and maturity in years 1999 and later, were taken as the average of the years 1996 to 1998.

5. Options of F=M, and of Catch (2000) = Catch (2001) = 50, 100, 150, 200, 250, 300 and 400 thousand tonnes were simulated.

6. In the simulations, an upper bound restriction was placed on fishing mortality = 1.5, in order to avoid simulations of extreme fishing mortalities when a catch constraint is imposed on a stock size which has a stochastic distribution which may extend to low values (possibly lower than the putative catch constraint).

For each option, the expectation of spawning stock size in 2000 and 2001, and the 25th, 50th and 75th percentiles of the SSB distribution are tabulated as is the risk that the stock size may fall under each of two reference levels. These reference levels are the model estimate of SSB in 1983 and a value of 500,000 t.

Presentation of the F=M-based option is somewhat complex, as both M and the F=M catch are here considered as uncertain. Here, for the F=M option, the distribution of corresponding SSB has been tabulated, and also the distribution of the corresponding catch. However, it would be incorrect to interpret the former as being conditional on the expectation of the latter.

6.7 Short term risk analysis

A calculation of risk was made for some levels of fishing mortality between 0.1M and 3M, expressed as the probability of the stock being under 500,000 t at spawning time in 2001 and 2008. This calculation was made from estimates of the probability distribution of spawning stock size using the assumptions given above, but assuming exploitation between 1999 and 2008 = 0.1M, 0.25M, ... 3M. Risk so calculated is given in Figure 6.7.1.

6.8 Medium-Term Projections

The outcome of some simple harvest strategies in the medium-term was evaluated by taking samples from the multivariate posterior distribution of parameters for the stock assessment, and projecting from each drawn parameter sample under the harvest control from 2000 until 2008.

The assumptions described in Section 6.5.2 were retained for all cases. The following scenarios were modelled, applying from 2000 onwards:

(1) Constant catch = 50, 100, 150, 200, 250, 300 or 400 thousand tonnes by year.
(2) Constant fishing mortality = natural mortality.

Some percentiles of the distribution of fishing mortality, recruitment, spawning stock size and landings, calculated under these assumptions, are given in Figures 6.8.1 to 6.8.8.

6.9 Long-Term Yield

Given the uncertainty, both to the mortalities and to the future recruitment, long-term yield has not been computed.

6.10 Uncertainty in Assessment

The assessment calculation expressed in Section 6.5 and concomitant forecasts in Sections 6.6 and 6.7 are made with an explicit consideration of perceived uncertainty in natural mortality, egg survey biomass estimates and in maturity parameters for specific ages in the early years of the egg survey. Distribution percentiles for various quantities from the assessment and short-term projection are given in Tables 6.5.2.1 and 6.6.1, which represents the best available estimates of quantified uncertainty.

Additional, unquantified uncertainty exists. The following sources of uncertainty have not been taken into account in the assessment:

- Uncertainty about reported catches;

- Uncertainty about selection pattern assumptions, which have a strong effect on the estimation of recent recruitments. These include possible bias in the estimated selection at age induced by age reading errors, Eltink(WD1999, Section 4.7) and the apparent recent change in the selection pattern towards younger fish as the 1982 year class diminishes in importance.

- Uncertainty in maturity, except for the years and ages mentioned in Section 6.5.2.2. In particular it should be noted from Figure 6.5.2.1 that the SSB estimates in the majority of years in which the Bayesian priors have been applied to maturity at age (1986,1989,1992,1995), appear to be biased towards the egg survey values. This may result from lower expected values for maturity at age in the survey years when compared to the deterministic values of adjacent years. A future development of the model, which should be considered is the use of a density dependent model for maturity, the parameters for which are estimated within the objective function.

- Uncertainty in stock weights and catch weights at age, either for the historic, measured values of for future, projected values;

- Uncertainty in sampling and ageing commercial catches (Section 4.7).

- Treatment of the egg survey estimates as absolute measures of stock abundance.

Uncertainty in natural mortality has been incorporated into the model by the use of the Bayesian prior. The posterior distribution has established that within the structure of the model used for the assessment the highest probability of agreement between the estimated SSB and the egg surveys is achieved at the lowest bound of the natural mortality distribution. Although this could be taken as an inference for too high a value of natural mortality, the final natural mortality distribution could be artificially induced by mis-specification of the model structure, specifically - selection at age, maturity at age and/or the use of an absolute scaling for the egg survey estimates.

6.11 Reference Points for Management Purposes

Biomass reference points

This stock is characterised by infrequent, extremely large recruitments. As only a short time series of data are available, it is not possible to quantify stock-recruit relationships, but one may make the precautionary assumption that the likelihood of a strong year class appearing would decline if stock size were to fall lower than the stock size at which the only such event has been observed. The basis for the level of B_{pa} is the stock size in 1983 (as estimated by an egg survey and the assessment), which is used as a proxy for the stock size present in 1982; that which produced the strong 1982 year class.

As noted above, population model estimates of the SSB in 1983 differ from the egg survey biomass estimate. The model estimates are in the range 757 to 1251 thousand tonnes with 90% confidence, yet the egg survey biomass estimate was 530,000 t. This years assessment has not altered the estimate or the confidence limits. However, in Section 6.10 it is noted that the assessment of uncertainty in the population model estimates is incomplete, and therefore it is proposed to retain the use of the egg survey biomass estimate as the reference value for B_{pa}. Conventionally this has been rounded to 500,000 t. The Study Group on the Precautionary Approach to Fisheries Management has accepted this Working Groups recommendation that these values should be used as B_{pa}.

6.11.1 Fishing mortality reference points

Given the extreme dynamics of the stock it is inappropriate to attempt to calculate F_{msy} , F_{med} or F_{low} reference points over the time-series available. Possibly useful reference points for management purposes might be F=M, F=2/3M or $F_{0.1.}$ A probability distribution for estimates of $F_{0.1}$ and $F_{0.1}$ relative to M from the stock assessment is shown in Figure 6.11.2.1. The percentiles of the distribution $F_{0.1}$ relative to M are given in the text table below:

Expected	5%	25%	50%	75%	95%
1.25	1.03	1.14	1.24	1.36	1.45

This illustrates that even these measures may be problematic as management tools, due to the uncertainty of their estimates in this assessment.

6.12 Harvest control Laws

The stock is at present in a transition from harvesting the large 1982 year class to the fishing of younger ages. Given the structural uncertainties within the model it was considered that the definition of Harvest control rules would be inappropriate. At a later stage, a harvesting strategy will need to be provided, which can be applied when a large year classes dominate the stock structure.

6.13 Environmental Effects

The Norwegian fishery for horse mackerel is unregulated and is carried out by purse seiners mainly in the Norwegian economical zone in the North Sea in October. This fishery is therefore reflecting the availability of horse mackerel in these areas. There is good correlation between modelled inflow of Atlantic water the first quarter of a year and the Norwegian horse mackerel catches later that year (Iversen *et al.* 1998). This relation has been used to predict the catches in 1997 and 1998. In 1997 the catches were predicted to increase to 70,000 t from a low level of 16,000 t in 1996. The predicted and actual catches are given below.

Year	1997	1998	1999
Predicted Norwegian catches	70,000 t	30,000 t	30,000 t
Actual Norwegian catches	46,000 t	13,400 t	?

The predictions have reflected the trend in the catches but have overestimated the catches which is expected when the stock is declining. Since the same catch are predicted for 1999 as were predicted for 1998, the actual catches in 1999 will probably be similar to 1998.

6.14 Management Considerations

This stock has been dependent on the abundant 1982 year class for many years and there were no significant recruitments. Recently however fisheries in Divisions VIId and VIIe,f have taken large catches of mainly juvenile horse mackerel from both the North Sea and western stocks. For example in 1998 over 13,400 t of horse mackerel were taken in the third and fourth quarter from Division VIId in which between 54% to 68% of the catch was between 1-4 years old. Similarly in Divisions VIIe-f over 42,600 t of horse mackerel were taken the third and fourth quarter in which between 63% to 96% of the catches were between 1-4 years old. Figure 6.4.1 and Table 4.6.1 shows a clear change in the age-structure of the catches from older to younger fish since 1996.

It is not known how abundant the more recent year classes are, nor can fishing mortality on these year-classes be estimated. Therefore, the Working Group expresses concern about this high exploitation of juvenile fish at a time when recruitment is at a low level. Consideration should therefore be given to prohibiting directed horse mackerel fisheries in these areas and industrial fisheries in which horse mackerel is taken as a bycatch.

The medium-term projections (Figures 6.8.1-6.8.8) suggest that a constant catch strategy with catches of 150,000t will halt the decline of the stock. This corresponds to an F/M ratio of approximately 2. In this range, it is estimated (based on the assumption of continued low recruitment and a constant selection pattern) that the spawning stock size has less than a 25% probability of falling below B_{lim} in 2008.

If the fishing mortality in 1999 is the same as in 1998 the catch will be 380,000 t, and a yearly catch level of 150,000 t will keep the SSB above B_{lim} in 2004 (Figure 6.8.3). With a yearly catch of 300,000 t the SSB will be below B_{lim} in 2004.

TAC has been overshot considerably since 1988 (ICES 1997/Assess:3). However, 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, VIIe–k and VIIIa,b,d,e.

Table 6.2.1 Landings (t) of HORSE MACKEREL in Sub-area II. (Data as submitted by Working Group members.)

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	-	-	-	-	1
Germany, Fed.Rep.	-	+	-	-	-
Norway	-	-	-	412	22
USSR	-	-	-	-	-
Total	-	+	-	412	23

Country	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	-	-	-	-	-	964[3]	1,115
Denmark	-	-	39	-	-	-	-
France	1	-[2]	-[2]	-[2]	-	-	-
Germany, Fed.Rep.	-	-	-	64	12	+	-
Norway	78	214	3,272	6,285	4,770	9,135	3,200
USSR	-	-	-	469	27	1,298	172
UK (England + Wales)	-	-	-	-	-	17	-
Total	79	214	3,311	6,818	4,809	11,414	4,487

	1992	1993	1994	1995	1996	1997	1998[1]
Faroe Islands	9,157[3]	1,068	-	950	1,598	799[3]	188[3]
Denmark	-	-	-	200	-	-	1,755[3]
France	-	-	55	-	-	-	-
Germany	-	-	-	-	-	-	-
Norway	4,300	2,100	4	11,300	887	1,170	234
Russia	-	-	700	1,633	881	648	345
UK (England + Wales)	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	22
Total	13,457	3,168	759	14,083	3,366	2,617	2,544

[1]Preliminary.
[2]Included in Sub-area IV.
[3]Includes catches in Division Vb.

Table 6.2.2 Landings (t) of HORSE MACKEREL in Sub-area IV by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	8	34	7	55	20
Denmark	199	3,576	1,612	1,590	23,730
Faroe Islands	260	-	-	-	-
France	292	421	567	366	827
Germany, Fed.Rep.	+	139	30	52	+
Ireland	1,161	412	-	-	-
Netherlands	101	355	559	2,029[4]	824
Norway	119	2,292	7	322	[4]
Poland	-	-	-	2	94
Sweden	-	-	-	-	-
UK (Engl. + Wales)	11	15	6	4	-
UK (Scotland)	-	-	-	-	3
USSR	-	-	-	-	489
Total	2,151	7,245	2,788	4,420	25,987

Country	1985	1986	1987	1988	1989	1990
Belgium	13	13	9	10	10	13
Denmark	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]	20,605[2]
Estonia	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	942
France	298	231[3]	189[3]	784[3]	248	220
Germany, Fed.Rep.	+	-	3	153	506	2,469[6]
Ireland	-	-	-	-	-	687
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172	1,970
Norway[2]	203	776	11,728[5]	34,425[5]	84,161	117,903[2]
Poland	-	-	-	-	-	
Sweden	-	2[2]	-	-	-	-
UK (Engl. + Wales)	71	3	339	373	10	102
UK (N. Ireland)	-	-	-	-	-	10
UK (Scotland)	998	531	487	5,749	2,093	-
USSR	-	-	-	-	-	458
Unallocated + discards	-	-	-	-	-12,482[5]	- -317[5]
Total	24,238	20,808	20,895	62,877	112,047	145,062

Country	1991	1992[7]	1993	1994	1995	1996	1997	1998[1]
Belgium	-	+	74	57	51	28	-	19
Denmark	6,982[2]	7,755	6,120	3,921	2,432	1,433	648	2,048[2]
Estonia	-	293	-		17	-	-	22
Faroe Islands	340	-	360	275	-	-	296	28
France	174	162	302		-	-	-	379
Germany, Fed.Rep.	5,995	2,801	1,570	1,014	1,600	7	7,603	4,620
Ireland	2,657	2,600	4,086	415	220	1,100	8,152	-
Netherlands	3,852	3,000	2,470	1,329	5,285	6,205	37,778	3,811
Norway[2]	50,000[2]	96,000	126,800	94,000	84,747	14,639	45,314	13,129
Poland	-	-	-	-	-	-	-	-
Russia		-	-	-	-	-	-	-
Sweden	953[2]	800	697	2,087	-	95	232	3,411[2]
UK (Engl. + Wales)	132	4	115	389	478	40	242	2
UK (N. Ireland)	350	-	-		-	-	-	-
UK (Scotland)	7,309	996	1,059	7,582	3,650	2,442	10,511	3,041
USSR	-							
Unallocated + discards	-750[5]	-278	-3,270	1,511	-28	136	-31,615	737
Total	77,994	114,133	140,383	112,580	98,452	26,125	79,161	31,247

[1]-Preliminary. [2] Includes Division IIIa. [3] Includes Division IIa. [4] Estimated from biological sampling. [5] Assumed to be misreported. [6] Includes 13 t from the German Democratic Republic. [7] Includes a negative unallocated catch of -4,000 t.

Table 6.2.3 Landings (t) of HORSE MACKEREL in Sub-area 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	24,881	31,716	33,025	20,455	35,157	45,842

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997[1]
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	-	-	-	-	-	-	-	-	-
Russia				-	-	-	-	-	-
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	-	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[1]
Denmark	-
Faroe Islands	-
France	221
Germany, Fed. Rep.	414
Ireland	21,608
Netherlands	885
Norway	-
Russia	-
Spain	-
UK (Engl. + Wales)	10
UK (N.Ireland)	1,132
UK (Scotland)	10,447
Unallocated +disc.	98
Total	34,815

[1]Preliminary.
[2]Included in Sub-area VII.
[3]Includes Divisions IIIa, IVa,b and VIb.
[4]Includes a negative unallocated catch of -7,000 t.

Table 6.2.4 Landings (t) of HORSE MACKEREL in Sub-area VII by country. Data submitted by the Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	-	1	1	-	-
Denmark	5,045	3,099	877	993	732
France	1,983	2,800	2,314	1,834	2,387
Germany, Fed.Rep.	2,289	1,079	12	1,977	228
Ireland	-	16	-	-	65
Netherlands	23,002	25,000	27,500[2]	34,350	38,700
Norway	394	-	-	-	-
Spain	50	234	104	142	560
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279
UK (Scotland)	1	-	-	-	1
USSR	-	-	-	-	-
Total	45,697	34,749	33,478	40,526	42,952

Country	1985	1986	1987	1988	1989	1990
Faroe Islands	-	-	-	-	-	28
Belgium	+	+	2	-	-	+
Denmark	1,477[2]	30,408[2]	27,368	33,202	34,474	30,594
France	1,881	3,801	2,197	1,523	4,576	2,538
Germany, Fed.Rep.	-	5	374	4,705	7,743	8,109
Ireland	100	703	15	481	12,645	17,887
Netherlands	33,550	40,750	69,400	43,560	43,582	111,900
Norway	-	-	-	-	-	-
Spain	275	137	148	150	14	16
UK (Engl. + Wales)	1,630	1,824	1,228	3,759	4,488	13,371
UK (N.Ireland)	-	-	-	-	-	-
UK (Scotland)	1	+	2	2,873	+	139
USSR	120	-	-	-	-	-
Unallocated + discards	-	-	-	-	28,368	7,614
Total	39,034	77,628	100,734	90,253	135,890	192,196

Country	1991	1992	1993	1994	1995	1996	1997	1998[1]
Faroe Islands	-	-	-	-	-	-	-	-
Belgium	-	-	-	1	-	-	18	18
Denmark	28,888	18,984	16,978	41,605	28,300	43,330	60,412	25,492
France	1,230	1,198	1,001	-	-	-	27,201	24,223
Germany, Fed.Rep.	12,919	12,951	15,684	14,828	17,436	15,949	28,549	25,414
Ireland	19,074	15,568	16,363	15,281	58,011	38,455	43,624	51,720
Netherlands	104,107	109,197	157,110	92,903	116,126	114,692	81,464	91,946
Norway	-	-	-	-	-	-	-	-
Russia		-	-	-	-	-	-	-
Spain	113	106	54	29	25	33	-	-
UK (Engl. + Wales)	6,436	7,870	6,090	12,418	31,641	28,605	17,464	12,832
UK (N.Ireland)	2,026	1,690	587	119	-	-	1,093	-
UK (Scotland)	1,992	5,008	3,123	9,015	10,522	11,241	7,931	5,095
USSR	-							
Unallocated + discards	24,541	15,563	4,010[3]	14,057	68,644	26,795	58,718	12,706
Total	201,326	188,135	221,000	200,256	330,705	279,100	326,474	249,446

[1]Provisional.
[2]Includes Sub-area VI.
[3]Includes a negative unallocated catch of -4,000 t.
[4]Includes 5 t from Jersey.

Table 6.2.5 Landings (t) of HORSE MACKEREL in Sub-area VIII by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	3,361	3,711	3.073	2,643	2,489
Netherlands	-	-	-	-	-[2]
Spain	34,134	36,362	19,610	25,580	23,119
UK (Engl. + Wales)	-	+	1	-	1
USSR	-	-	-	-	20
Total	37,495	40,073	22,683	28,223	25,629

Country	1985	1986	1987	1988	1989	1990
Denmark	-	446	3,283	2,793	6,729	5,726
France	4,305	3,534	3,983	4,502	4,719	5,082
Germany	-	-	-	-	-	-
Netherlands	-[2]	-[2]	-[2]	-	-	6,000
Spain	23,292	40,334	30,098	26,629	27,170	25,182
UK (Engl. + Wales)	143	392	339	253	68	6
USSR	-	656	-	-	-	-
Unallocated + discards	-	-	-	-	-	1,500
Total	27,740	45,362	37,703	34,177	38,686	43,496

Country	1991	1992	1993	1994	1995	1996	1997	1998[1]
Denmark	1,349	5,778	1,955	-	340	140	729	1,728
France	6,164	6,220	4,010	28	-	7	8,690	1,844
Germany	80	62	-		-	-	-	3,268
Netherlands	12,437	9,339	19,000	7,272	-	14,187	2,944	6,604
Russia		-	-	-	-	-	-	-
Spain	23,733	27,688	27,921	25,409	28,349	29,428	31,081	23,599
UK (Engl. + Wales)	70	88	123	753	20	924	430	9
USSR	-							
Unallocated + discards	2,563	5,011	700	2,038	-	3,583	-2,944	1,884
Total	46,396	54,186	53,709	35,500	28,709	48,269	40,930	38,936

[1]Preliminary.
[2]Included in Sub-area VII.

Table 6.3.1 Spawning stock biomass of horse mackerel in the western area. The biomass estimates have been corrected for atresia. A sex ratio of 1:1 is assumed. The SSB has been calculated from the total egg production based on the arithmetic mean of adjacent rectangles for unsampled rectangles, if availaable.

Annual egg production method – western horse mackerel							
Year	Total egg prod ($x10^{-15}$) (mean for unsampled rectangles)		Potential fecundity (eggs/g female)	Realised fecundity corrected for atresia (eggs/g female)	Pre-spawning stock biomass ($x10^{-6}$ tonnes)	Spawning stock biomass (conv f 1.05) ($x10^{-6}$ tonnes)
	Geometric	Arithmetic				
1977	0.533 a		1557	1504	0.71	0.74
1980	0.635 a		1557	1504	0.84	0.89
1983	0.381 a		1557	1504	0.51	0.53
1986	0.508 a		1557	1504	0.68	0.71
1989	1.54	1.63	1557	1504	2.17	2.28
1992	1.37	1.58	1557	1504	2.10	2.21
1995	-	1.226	1557	1504	1.63	1.71
1998		1.003	(1557) b	(1504) b	(1.33) b	(1.40) b

a. Eaton (1989) Incomplete coverage in 1977. b See section 6.3.

Provisional estimates for horse mackerel by the Generalised Additive Modelling (GAM)

	Egg Production x 10^{15}		
Year	**Area**	**GAM (no bc)**	**GAM (with bc)**
1989	Western	1.308 *0.09* [6.7]	1.635 *0.14* [9.2]
1992	Western	1.44 *0.11* [7.5]	1.804 *0.21* [11.9]
1995	Western	0.886 *0.09* [10.2}	1.554 *0.24* [15.4]
	Southern	0.396	0.553

bc = bias correction.
Figures in italics are standard errors. Figures in brackets are %cv's.

'able.- 6.4.1.1 . **Western horse mackerel catch in numbers by area and total** in 1998.

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.00	0.00	112.81	10.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123.46
1	0.00	0.00	64640.45	2595.22	0.00	4566.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71801.90
2	0.00	0.00	28605.00	2184.45	5575.94	93317.09	104.80	21116.37	2896.67	11.04	0.00	0.00	0.00	153811.34
3	0.00	0.00	40932.73	290.77	33933.50	158067.70	1123.86	204715.59	25405.87	66.48	0.00	0.00	0.00	464536.50
4	162.34	609.82	30913.57	138.70	30902.63	57515.09	1049.12	178560.69	32238.85	64.24	7804.45	1.33	280.54	340241.34
5	666.57	2701.82	11604.40	183.46	15165.61	24328.43	274.74	62687.12	48396.09	67.72	38886.99	5.67	1286.31	206254.91
6	564.18	4886.40	4514.48	133.05	9114.22	13821.68	43.02	23065.74	50559.16	62.32	34058.95	4.86	1133.27	141961.31
7	306.88	3838.82	1223.31	89.26	8246.26	5534.95	10.25	18224.52	47990.88	60.93	25301.08	3.95	775.87	111606.97
8	81.98	4138.54	933.14	42.27	4657.08	9167.05	10.19	11867.86	35107.38	40.64	8518.70	3.30	258.88	74827.01
9	36.61	1377.65	462.73	19.89	4317.75	10151.18	0.34	9868.63	33917.73	40.54	4372.43	1.49	179.25	64746.23
10	28.61	562.47	542.85	41.96	4090.70	5943.99	0.17	9275.32	23164.60	32.65	4045.29	1.26	205.57	47935.44
11	141.18	4824.03	1046.03	55.43	3804.40	5118.60	0.30	8427.16	29238.09	34.80	7507.46	3.31	444.23	60645.04
12	105.92	5532.86	417.89	23.02	2509.14	555.91	0.17	4277.47	15803.70	18.46	3933.24	2.23	319.33	33499.35
13	83.79	3132.02	493.63	23.57	5389.31	4001.34	0.34	12649.98	36947.91	48.32	4430.04	2.09	445.18	67647.53
14	195.33	4509.91	450.22	19.82	4307.48	750.04	0.29	10593.00	30805.80	40.79	8400.21	3.10	659.43	60735.43
15	408.68	19890.93	1000.41	43.60	12325.34	10765.96	0.58	24705.27	61881.57	91.26	22701.62	11.25	1980.33	155806.77

Table 6.4.1.2.- Western horse mackerel catch in numbes at age by quarter and area in 1998.

For Period 1

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	6364.28	762.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7126.77
2	0.00	0.00	13135.89	1573.79	0.08	0.00	0.00	6.11	0.66	0.01	0.00	0.00	0.00	14716.52
3	0.00	0.00	1609.61	192.84	358.73	0.00	0.05	27401.41	3970.34	24.74	0.00	0.00	0.00	33557.71
4	0.00	0.00	788.89	94.52	1470.63	0.00	0.05	25283.82	4676.60	27.42	0.00	0.00	0.00	32341.94
5	0.00	44.61	981.53	117.60	3846.53	0.00	0.07	13477.49	20535.64	36.61	237.89	0.05	11.64	39289.65
6	0.00	40.54	725.69	86.94	4249.33	630.37	0.07	12032.75	23885.71	36.71	216.17	0.05	10.57	41914.89
7	0.00	135.63	516.15	61.84	3899.51	1260.73	0.06	11367.64	20544.03	34.67	723.24	0.16	35.38	38579.04
8	0.00	0.00	160.97	19.29	1408.16	5673.30	0.04	6246.76	11365.13	19.06	0.00	0.00	0.00	24892.68
9	0.00	52.55	73.87	8.85	2977.48	5673.30	0.04	7815.99	11808.35	23.85	128.88	0.06	13.71	28576.93
10	0.00	375.07	268.77	32.20	3089.81	4412.56	0.05	7952.38	13163.08	24.26	1385.87	0.45	97.83	30802.35
11	0.00	475.47	187.70	22.49	2834.01	3782.20	0.04	6813.15	10209.92	20.79	1769.89	0.57	124.02	26240.25
12	0.00	226.27	82.52	9.89	2186.57	0.00	0.02	3604.68	4980.97	11.00	1206.56	0.27	59.02	12367.76
13	0.00	601.11	57.49	6.89	4319.12	2521.46	0.06	11053.89	17064.77	33.72	2439.86	0.72	156.79	38255.89
14	0.00	675.92	29.12	3.49	3336.45	0.00	0.05	9291.39	13831.44	28.35	2990.14	0.81	176.31	30363.47
15	0.00	2641.29	82.49	9.88	9436.49	6934.03	0.12	21315.41	28753.60	65.03	10616.17	3.17	688.96	80546.64

For Period 2

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	2818.99	160.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2979.29
2	0.00	0.00	5340.39	303.67	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5644.33
3	0.00	0.00	419.25	23.84	85.55	1266.80	0.09	288.14	6491.04	4.24	0.00	0.00	0.00	8578.94
4	0.00	0.00	266.65	15.16	159.83	1124.76	0.17	538.35	12127.68	7.92	0.00	0.00	0.00	14240.52
5	0.00	0.00	387.51	22.04	264.47	890.14	0.29	890.78	20067.11	13.11	0.00	0.00	0.00	22535.45
6	0.00	0.00	370.41	21.06	282.67	623.28	0.31	952.09	21448.28	14.01	0.00	0.00	0.00	23712.12
7	0.00	22.06	297.72	16.93	293.04	1259.95	0.32	987.02	22235.03	14.52	1694.52	1.03	30.98	26853.13
8	0.00	55.01	78.21	4.45	261.81	711.38	0.29	881.84	19865.65	12.98	4224.85	2.57	77.23	26176.26
9	0.00	22.06	14.80	0.84	273.79	864.84	0.30	922.18	20774.34	13.57	1694.52	1.03	30.98	24613.26
10	0.00	11.03	38.20	2.17	117.58	603.97	0.13	396.02	8921.29	5.83	847.26	0.52	15.49	10959.47
11	0.00	33.09	49.87	2.84	237.34	640.84	0.26	799.40	18008.40	11.76	2541.78	1.55	46.47	22373.58
12	0.00	22.06	46.74	2.66	139.27	324.02	0.15	469.10	10567.74	6.90	1694.52	1.03	30.98	13305.19
13	0.00	11.03	58.74	3.34	252.93	1016.08	0.28	851.93	19191.93	12.54	847.26	0.52	15.49	22262.06
14	0.00	11.03	29.56	1.68	219.72	518.14	0.24	740.07	16671.98	10.89	847.26	0.52	15.49	19066.59
15	0.00	88.10	129.64	7.37	418.72	1513.22	0.46	1410.34	31771.51	20.75	6766.64	4.12	123.70	42254.58

For Period 3

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.00	0.00	73.66	9.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.33
1	0.00	0.00	2844.85	373.68	0.00	883.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4101.61
2	0.00	0.00	857.94	112.69	3044.13	46803.54	0.00	5938.02	1821.61	9.36	0.00	0.00	0.00	58587.30
3	0.00	0.00	1359.74	31.57	6341.90	67114.64	0.00	12370.80	3795.00	19.49	0.00	0.00	0.00	91033.13
4	7.36	83.86	711.75	14.31	3932.37	12363.14	0.00	6286.29	3660.54	12.09	2249.38	0.11	48.07	29369.26
5	54.65	622.43	506.15	21.25	4426.04	2649.24	0.00	5557.28	5553.85	13.60	16695.80	0.80	356.80	36457.91
6	54.97	626.07	100.15	1.85	3552.06	2649.24	0.00	4160.16	4740.25	10.92	16793.46	0.80	358.89	33048.84
7	49.55	564.37	3.58	0.47	3815.27	0.00	0.00	4185.08	5158.92	11.58	14742.34	0.72	323.52	28855.41
8	11.67	132.89	13.16	1.73	2748.66	0.00	0.00	3054.48	3823.70	8.45	3564.63	0.17	76.18	13435.71
9	15.84	185.51	9.00	1.18	1066.48	0.00	0.00	1130.47	1335.04	3.13	2309.85	0.23	103.42	6160.14
10	9.81	115.24	16.51	2.17	883.31	0.00	0.00	926.92	1080.23	2.56	1137.12	0.14	64.05	4238.07
11	12.32	148.45	95.18	12.50	733.05	0.00	0.00	814.61	1019.76	2.25	376.60	0.18	80.45	3295.37
12	14.01	169.65	31.38	4.12	183.29	0.00	0.00	203.69	254.98	0.56	55.14	0.20	91.46	1008.51
13	29.27	351.60	37.78	4.96	817.25	0.00	0.00	744.15	691.22	2.06	145.72	0.43	191.12	3015.57
14	34.73	415.74	46.71	6.14	751.31	0.00	0.00	561.53	302.38	1.55	187.49	0.51	226.74	2534.82
15	110.30	1319.30	64.52	8.47	2470.13	0.00	0.00	1979.52	1356.45	5.48	1779.53	1.61	720.11	9815.43

For Period 4

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.00	0.00	39.16	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.12
1	0.00	0.00	52612.34	1298.75	0.00	3683,14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57594.22
2	0.00	0.00	9270.78	194.29	2531.73	46513.29	104.80	15172.23	1074.40	1.68	0.00	0.00	0.00	74863.21
3	0.00	0.00	37544.14	42.51	27147.33	89686.27	1123.72	164655.25	11149.48	18.01	0.00	0.00	0.00	331366.72
4	154.98	525.96	29146.29	14.71	25339.79	44027.20	1048.90	146452.23	11774.03	16.81	5555.07	1.22	232.47	264289.63
5	611.91	2034.78	9729.22	22.58	6628.57	20789.04	274.38	42761.56	2239.49	4.40	21953.29	4.82	917.87	107971.92
6	509.20	4219.79	3318.22	23.19	1030.17	9918.79	42.64	5920.75	484.92	0.68	17049.32	4.01	763.81	43285.49
7	257.33	3116.76	405.87	10.02	238.45	3014.27	9.87	1684.78	52.89	0.16	8140.97	2.03	385.99	17319.38
8	70.31	3950.65	680.81	16.81	238.45	2782.37	9.87	1684.78	52.89	0.16	729.22	0.55	105.47	10322.35
9	20.77	1117.53	365.06	9.01	0.00	3613.05	0.00	0.00	0.00	0.00	239.18	0.16	31.15	5395.92
10	18.80	61.12	219.37	5.42	0.00	927.46	0.00	0.00	0.00	0.00	675.04	0.15	28.20	1935.55
11	128.86	4167.02	713.28	17.61	0.00	695.56	0.00	0.00	0.00	0.00	2819.19	1.01	193.29	8735.83
12	91.91	5114.88	257.25	6.35	0.00	231.90	0.00	0.00	0.00	0.00	977.02	0.72	137.87	6817.90
13	54.52	2168.28	339.61	8.38	0.00	463.79	0.00	0.00	0.00	0.00	997.21	0.43	81.78	4114.00
14	160.60	3407.22	344.83	8.51	0.00	231.90	0.00	0.00	0.00	0.00	4375.32	1.26	240.90	8770.53
15	298.38	15842.24	723.77	17.87	0.00	2318.71	0.00	0.00	0.00	0.00	3539.28	2.35	447.56	23190.16

Table.- 6.4.2.1. Western horse mackerel mean weight at age in the catch by area and total.in 1998.

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.0000	0.0000	0.0144	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0144
1	0.0000	0.0000	0.0400	0.0390	0.0000	0.0519	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0407
2	0.0000	0.0000	0.0573	0.0533	0.0930	0.0967	0.0833	0.0881	0.0947	0.0983	0.0000	0.0000	0.0000	0.0874
3	0.0000	0.0000	0.1000	0.0707	0.1024	0.1068	0.1013	0.0992	0.0981	0.0989	0.0000	0.0000	0.0000	0.1020
4	0.1570	0.1560	0.1109	0.0822	0.1132	0.1202	0.1109	0.1100	0.1121	0.1169	0.1452	0.1564	0.1548	0.1132
5	0.1706	0.1719	0.1164	0.0897	0.1333	0.1525	0.1224	0.1269	0.1351	0.1392	0.1655	0.1711	0.1716	0.1400
6	0.1979	0.2149	0.1326	0.1251	0.1562	0.1642	0.1504	0.1556	0.1497	0.1553	0.1816	0.1969	0.1944	0.1624
7	0.2014	0.2295	0.1530	0.1561	0.1682	0.1914	0.1925	0.1793	0.1588	0.1727	0.1812	0.1892	0.1956	0.1723
8	0.2729	0.2827	0.1772	0.1770	0.1725	0.2011	0.1650	0.1830	0.1660	0.1801	0.1893	0.1952	0.2241	0.1830
9	0.2507	0.2698	0.2140	0.2367	0.1974	0.2232	0.1769	0.1945	0.1764	0.1891	0.1938	0.2047	0.2264	0.1916
10	0.2273	0.2556	0.2279	0.2342	0.2203	0.2314	0.1998	0.2182	0.2005	0.2146	0.2323	0.2319	0.2478	0.2133
11	0.2374	0.2826	0.2728	0.2740	0.2265	0.2548	0.2086	0.2261	0.2074	0.2206	0.2383	0.2477	0.2496	0.2265
12	0.2960	0.3233	0.3584	0.3418	0.2338	0.2190	0.2190	0.2170	0.2112	0.2177	0.2670	0.2599	0.2888	0.2417
13	0.2814	0.3237	0.3384	0.3460	0.2382	0.2494	0.2154	0.2277	0.2097	0.2245	0.3123	0.3131	0.3052	0.2314
14	0.2592	0.3192	0.2808	0.2998	0.2751	0.2283	0.2181	0.2416	0.2175	0.2354	0.2488	0.2730	0.2847	0.2392
15	0.2880	0.3621	0.3869	0.3840	0.2706	0.3208	0.2330	0.2479	0.2275	0.2445	0.3105	0.3037	0.3077	0.2721

Table.- 6.4.2.2. Western horse mackerel mean length at age in the catch by area and totalin 1998.

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Tota
0	0.0000	0.0000	11.6432	11.6430	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	11.643
1	0.0000	0.0000	16.6332	16.4549	0.0000	18.1046	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	16.720
2	0.0000	0.0000	18.9453	18.4180	22.5605	22.4776	22.0321	22.2441	22.7239	22.8530	0.0000	0.0000	0.0000	21.738
3	0.0000	0.0000	23.1450	20.3711	23.4741	23.5093	23.4186	23.3452	23.6219	23.5946	0.0000	0.0000	0.0000	23.406
4	25.9034	25.8181	24.3675	21.4325	24.5157	24.3459	24.3609	24.3348	24.7588	24.9778	25.6501	25.8696	25.7841	24.430
5	26.7835	26.8889	24.6433	22.0877	25.9553	25.7869	25.4201	25.6836	26.2243	26.4089	26.9363	26.8315	26.8925	26.043
6	28.5519	29.0409	25.9042	24.7181	27.2765	26.6388	27.2494	27.3246	27.1247	27.2715	27.9400	28.5040	28.3773	27.355
7	28.5407	29.4444	26.6036	26.7443	27.7017	27.8031	28.4677	28.4087	27.6812	28.2294	27.9362	28.4794	28.4070	27.921
8	30.8161	31.1616	28.0347	27.9898	28.3862	28.6140	28.4952	28.9117	28.2722	28.8003	28.7862	29.4072	29.6432	28.645
9	31.1986	31.2951	29.8131	30.9348	29.3735	29.2867	29.0787	29.3404	28.8841	29.2606	28.7970	29.5208	30.1733	29.107
10	30.8045	31.9003	30.6038	30.9559	30.7335	30.2579	30.2947	30.6937	30.1690	30.6171	31.0554	31.2681	31.5660	30.437
11	30.2332	31.5673	32.4295	32.5900	31.0733	30.8751	30.8623	30.9890	30.6312	30.9505	31.0573	31.4143	31.2474	30.893
12	33.0788	32.6228	35.9288	35.3277	31.6681	29.5385	31.2885	30.6205	30.8215	30.8487	32.5541	32.2774	33.1630	31.435
13	32.3835	33.1327	35.0092	35.3619	31.4947	31.2093	31.1400	31.2838	30.8542	31.2466	34.0356	34.0287	33.7667	31.373
14	31.3573	33.4988	32.6229	33.5036	33.1042	30.6076	31.3540	31.9596	31.1830	31.7984	31.2982	32.3843	32.9167	31.666
15	32.3999	34.3284	36.7791	36.7062	32.6692	33.6869	31.8118	31.8921	31.4497	31.8758	33.8836	33.5789	33.6912	32.560

Table 6.4.2.3.- Western horse mackerel mean weight at age in the catch by quarter and area (in Kg). in 1998.

For Period 1

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
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
1	0.0000	0.0000	0.0360	0.0361	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0361
2	0.0000	0.0000	0.0522	0.0524	0.0930	0.0000	0.0930	0.0930	0.0930	0.0930	0.0000	0.0000	0.0000	0.0522
3	0.0000	0.0000	0.0710	0.0709	0.0916	0.0000	0.0916	0.0835	0.0919	0.0916	0.0000	0.0000	0.0000	0.0839
4	0.0000	0.0000	0.0781	0.0783	0.1403	0.0000	0.1220	0.1020	0.1184	0.1220	0.0000	0.0000	0.0000	0.1055
5	0.0000	0.1960	0.0849	0.0849	0.1594	0.0000	0.1498	0.1460	0.1454	0.1498	0.1960	0.1960	0.1960	0.1457
6	0.0000	0.2060	0.1250	0.1251	0.1719	0.1540	0.1657	0.1657	0.1599	0.1657	0.2060	0.2060	0.2060	0.1623
7	0.0000	0.2670	0.1612	0.1614	0.1793	0.1950	0.1882	0.1882	0.1711	0.1882	0.2670	0.2670	0.2670	0.1798
8	0.0000	0.0000	0.1738	0.1735	0.1924	0.1960	0.2003	0.2003	0.1750	0.2003	0.0000	0.0000	0.0000	0.1871
9	0.0000	0.1920	0.2672	0.2674	0.2063	0.2230	0.1997	0.1997	0.1822	0.1997	0.1920	0.1920	0.1920	0.1979
10	0.0000	0.2672	0.2348	0.2345	0.2246	0.2290	0.2206	0.2206	0.2054	0.2206	0.2695	0.2672	0.2672	0.2188
11	0.0000	0.2686	0.2730	0.2730	0.2333	0.2530	0.2308	0.2308	0.2110	0.2308	0.2691	0.2686	0.2686	0.2303
12	0.0000	0.3160	0.3140	0.3140	0.2365	0.0000	0.2170	0.2170	0.1939	0.2170	0.3160	0.3160	0.3160	0.2238
13	0.0000	0.3217	0.3522	0.3524	0.2412	0.2650	0.2292	0.2292	0.2066	0.2292	0.3291	0.3217	0.3217	0.2312
14	0.0000	0.3180	0.3590	0.3590	0.2783	0.0000	0.2417	0.2417	0.2217	0.2417	0.3139	0.3180	0.3180	0.2460
15	0.0000	0.3432	0.3641	0.3643	0.2810	0.3280	0.2521	0.2521	0.2277	0.2521	0.3473	0.3432	0.3432	0.2698

For Period 2

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
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
1	0.0000	0.0000	0.0336	0.0336	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0336
2	0.0000	0.0000	0.0511	0.0511	0.0000	0.0930	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0511
3	0.0000	0.0000	0.0708	0.0708	0.0900	0.0916	0.0900	0.0900	0.0900	0.0900	0.0000	0.0000	0.0000	0.0892
4	0.0000	0.0000	0.0856	0.0856	0.1096	0.1065	0.1096	0.1096	0.1096	0.1096	0.0000	0.0000	0.0000	0.1089
5	0.0000	0.0000	0.0959	0.0959	0.1274	0.1308	0.1274	0.1274	0.1274	0.1274	0.0000	0.0000	0.0000	0.1269
6	0.0000	0.0000	0.1208	0.1208	0.1399	0.1455	0.1399	0.1399	0.1399	0.1399	0.0000	0.0000	0.0000	0.1398
7	0.0000	0.1510	0.1391	0.1391	0.1486	0.1575	0.1486	0.1486	0.1486	0.1486	0.1510	0.1510	0.1510	0.1490
8	0.0000	0.1760	0.1638	0.1638	0.1612	0.1636	0.1612	0.1612	0.1612	0.1612	0.1760	0.1760	0.1760	0.1637
9	0.0000	0.1900	0.2825	0.2825	0.1735	0.1743	0.1735	0.1735	0.1735	0.1735	0.1900	0.1900	0.1900	0.1748
10	0.0000	0.2020	0.2518	0.2518	0.1925	0.2022	0.1925	0.1925	0.1925	0.1925	0.2020	0.2020	0.2020	0.1940
11	0.0000	0.2470	0.3185	0.3185	0.2053	0.2054	0.2053	0.2053	0.2053	0.2053	0.2470	0.2470	0.2470	0.2105
12	0.0000	0.2140	0.3549	0.3549	0.2193	0.1911	0.2193	0.2193	0.2193	0.2193	0.2140	0.2140	0.2140	0.2184
13	0.0000	0.3450	0.4071	0.4071	0.2122	0.1957	0.2122	0.2122	0.2122	0.2122	0.3450	0.3450	0.3450	0.2172
14	0.0000	0.2320	0.3887	0.3887	0.2129	0.2124	0.2129	0.2129	0.2129	0.2129	0.2320	0.2320	0.2320	0.2140
15	0.0000	0.2880	0.4207	0.4207	0.2279	0.2233	0.2279	0.2279	0.2279	0.2279	0.2880	0.2880	0.2880	0.2383

For Period 3

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.0000	0.0000	0.0144	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0144
1	0.0000	0.0000	0.0410	0.0410	0.0000	0.0560	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0442
2	0.0000	0.0000	0.0624	0.0624	0.1010	0.1000	0.0000	0.1010	0.1010	0.1010	0.0000	0.0000	0.0000	0.0996
3	0.0000	0.0000	0.0991	0.0702	0.1080	0.1070	0.0000	0.1080	0.1080	0.1080	0.0000	0.0000	0.0000	0.1071
4	0.1400	0.1400	0.1116	0.0877	0.1183	0.1220	0.0000	0.1191	0.1179	0.1183	0.1400	0.1400	0.1400	0.1216
5	0.1740	0.1740	0.1075	0.0858	0.1273	0.1570	0.0000	0.1267	0.1287	0.1273	0.1740	0.1740	0.1740	0.1520
6	0.1830	0.1830	0.1282	0.1255	0.1403	0.1550	0.0000	0.1401	0.1418	0.1403	0.1830	0.1830	0.1830	0.1647
7	0.1804	0.1804	0.1407	0.1407	0.1567	0.0000	0.0000	0.1564	0.1534	0.1564	0.1810	0.1804	0.1804	0.1692
8	0.1850	0.1850	0.2357	0.2357	0.1640	0.0000	0.0000	0.1640	0.1640	0.1640	0.1850	0.1850	0.1850	0.1700
9	0.2297	0.2305	0.2589	0.2589	0.1785	0.0000	0.0000	0.1764	0.1702	0.1764	0.1893	0.2297	0.2297	0.1830
10	0.2413	0.2419	0.2673	0.2673	0.2089	0.0000	0.0000	0.2084	0.2071	0.2084	0.2169	0.2413	0.2413	0.2122
11	0.2552	0.2558	0.2719	0.2719	0.2070	0.0000	0.0000	0.2070	0.2070	0.2070	0.2420	0.2552	0.2552	0.2167
12	0.2825	0.2825	0.3503	0.3503	0.2130	0.0000	0.0000	0.2130	0.2130	0.2130	0.2825	0.2825	0.2825	0.2406
13	0.3038	0.3041	0.3319	0.3319	0.2299	0.0000	0.0000	0.2220	0.2174	0.2220	0.2959	0.3038	0.3038	0.2438
14	0.2984	0.2985	0.2925	0.2925	0.2790	0.0000	0.0000	0.2790	0.2790	0.2790	0.2931	0.2984	0.2984	0.2855
15	0.2900	0.2921	0.3739	0.3739	0.2382	0.0000	0.0000	0.2170	0.2129	0.2170	0.2422	0.2900	0.2900	0.2438

For Period 4

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.0000	0.0000	0.0144	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0144
1	0.0000	0.0000	0.0408	0.0408	0.0000	0.0509	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0414
2	0.0000	0.0000	0.0677	0.0589	0.0833	0.0933	0.0833	0.0830	0.0841	0.0833	0.0000	0.0000	0.0000	0.0875
3	0.0000	0.0000	0.1016	0.0697	0.1013	0.1069	0.1013	0.1012	0.1016	0.1013	0.0000	0.0000	0.0000	0.1028
4	0.1578	0.1585	0.1120	0.0982	0.1109	0.1200	0.1109	0.1110	0.1104	0.1109	0.1473	0.1578	0.1578	0.1135
5	0.1703	0.1707	0.1208	0.1127	0.1224	0.1529	0.1224	0.1210	0.1250	0.1224	0.1587	0.1703	0.1703	0.1366
6	0.1996	0.2197	0.1357	0.1291	0.1505	0.1684	0.1505	0.1487	0.1561	0.1505	0.1798	0.1996	0.1996	0.1730
7	0.2055	0.2373	0.1531	0.1531	0.1940	0.2040	0.1940	0.1940	0.1940	0.1940	0.1803	0.2055	0.2055	0.1965
8	0.2875	0.2875	0.1784	0.1784	0.1650	0.2210	0.1650	0.1650	0.1650	0.1650	0.2875	0.2875	0.2875	0.2386
9	0.2667	0.2815	0.1993	0.1993	0.0000	0.2353	0.0000	0.0000	0.0000	0.0000	0.2653	0.2667	0.2667	0.2440
10	0.2200	0.2200	0.2122	0.2122	0.0000	0.2620	0.0000	0.0000	0.0000	0.0000	0.2200	0.2200	0.2200	0.2392
11	0.2357	0.2854	0.2697	0.2697	0.0000	0.3100	0.0000	0.0000	0.0000	0.0000	0.2106	0.2357	0.2357	0.2601
12	0.2980	0.3254	0.3742	0.3742	0.0000	0.2580	0.0000	0.0000	0.0000	0.0000	0.2974	0.2980	0.2980	0.3201
13	0.2694	0.3273	0.3249	0.3249	0.0000	0.2820	0.0000	0.0000	0.0000	0.0000	0.2458	0.2694	0.2694	0.3003
14	0.2508	0.3223	0.2633	0.2633	0.0000	0.2640	0.0000	0.0000	0.0000	0.0000	0.2057	0.2508	0.2508	0.2569
15	0.2873	0.3715	0.3847	0.3847	0.0000	0.3630	0.0000	0.0000	0.0000	0.0000	0.2776	0.2873	0.2873	0.3540

Table. 6.4.2.4. Western horse mackerel mean length at age in the catch by quarter and area (in cm) in 1998.

For Period 1

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
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
1	0.0000	0.0000	15.9798	15.9798	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	15.9798
2	0.0000	0.0000	18.3050	18.3050	23.5000	0.0000	23.5000	23.5000	23.5000	23.5000	0.0000	0.0000	0.0000	18.3074
3	0.0000	0.0000	20.4015	20.4015	23.6159	0.0000	23.6159	22.9932	23.6386	23.6159	0.0000	0.0000	0.0000	22.9375
4	0.0000	0.0000	21.0782	21.0782	26.2217	0.0000	25.4708	24.3168	25.3379	25.4708	0.0000	0.0000	0.0000	24.4636
5	0.0000	29.0000	21.6876	21.6876	27.1341	0.0000	26.9958	26.9414	26.8419	26.9958	29.0000	29.0000	29.0000	26.7768
6	0.0000	29.5000	24.6520	24.6520	27.8117	26.5000	27.6520	27.6520	27.5497	27.6520	29.5000	29.5000	29.5000	27.5462
7	0.0000	32.3000	27.0335	27.0335	28.0673	28.0000	28.8929	28.8923	28.1039	28.8929	32.3000	32.3000	32.3000	28.4111
8	0.0000	0.0000	27.7930	27.7930	29.2153	28.5000	29.5848	29.5848	28.5123	29.5848	0.0000	0.0000	0.0000	28.8140
9	0.0000	29.5000	32.4828	32.4828	29.6285	29.5000	29.4826	29.4826	28.7224	29.4826	29.5000	29.5000	29.5000	29.1959
10	0.0000	32.4485	31.0041	31.0041	30.9316	30.2100	30.7916	30.7916	30.2135	30.7916	32.5162	32.4485	32.4485	30.5804
11	0.0000	32.5503	32.6759	32.6759	31.3069	30.8300	31.0963	31.0963	30.3238	31.0963	32.5399	32.5503	32.5503	30.9234
12	0.0000	34.3000	34.3195	34.3195	31.6993	0.0000	30.4694	30.4694	29.5600	30.4694	34.3000	34.3000	34.3000	30.8115
13	0.0000	34.4898	35.6952	35.6952	31.4697	31.5000	31.2874	31.2874	30.5548	31.2874	34.7489	34.4898	34.4898	31.2869
14	0.0000	34.3743	35.9870	35.9870	33.0935	0.0000	31.9126	31.9126	31.0714	31.9126	34.1837	34.3743	34.3743	31.9564
15	0.0000	35.2844	36.0909	36.0909	33.0012	34.2300	32.0332	32.0332	31.1710	32.0332	35.4289	35.2844	35.2844	32.6147

For Period 2

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
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
1	0.0000	0.0000	15.4852	15.4852	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	15.4852
2	0.0000	0.0000	18.1653	18.1653	0.0000	23.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	18.1656
3	0.0000	0.0000	20.3791	20.3791	23.7325	23.6159	23.7325	23.7325	23.7325	23.7325	0.0000	0.0000	0.0000	23.5421
4	0.0000	0.0000	21.7054	21.7054	24.7500	24.8317	24.7500	24.7500	24.7500	24.7500	0.0000	0.0000	0.0000	24.6962
5	0.0000	0.0000	22.5857	22.5857	25.7928	26.2430	25.7928	25.7928	25.7928	25.7928	0.0000	0.0000	0.0000	25.7523
6	0.0000	0.0000	24.4795	24.4795	26.7310	26.6409	26.7310	26.7310	26.7310	26.7310	0.0000	0.0000	0.0000	26.6915
7	0.0000	28.0000	25.7391	25.7391	27.3838	27.4219	27.3838	27.3838	27.3838	27.3838	28.0000	28.0000	28.0000	27.4064
8	0.0000	29.1000	27.1995	27.1995	28.1925	28.0138	28.1925	28.1925	28.1925	28.1925	29.1000	29.1000	29.1000	28.3356
9	0.0000	29.0000	33.1020	33.1020	29.0182	28.3530	29.0182	29.0182	29.0182	29.0182	29.0000	29.0000	29.0000	28.9961
10	0.0000	30.5000	31.7222	31.7222	30.1183	30.2359	30.1183	30.1183	30.1183	30.1183	30.5000	30.5000	30.5000	30.1612
11	0.0000	31.8300	34.4372	34.4372	30.8270	30.1045	30.8270	30.8270	30.8270	30.8270	31.8300	31.8300	31.8300	30.9324
12	0.0000	31.0000	35.7932	35.7932	31.3998	29.5661	31.3998	31.3998	31.3998	31.3998	31.0000	31.0000	31.0000	31.3189
13	0.0000	35.5000	37.5855	37.5855	31.1062	30.3552	31.1062	31.1062	31.1062	31.1062	35.5000	35.5000	35.5000	31.2625
14	0.0000	31.5000	37.0100	37.0100	31.2300	31.1033	31.2300	31.2300	31.2300	31.2300	31.5000	31.5000	31.5000	31.2484
15	0.0000	33.2500	38.0470	38.0470	31.7526	31.1779	31.7526	31.7526	31.7526	31.7526	33.2500	33.2500	33.2500	31.9999

For Period 3

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.0000	0.0000	11.6429	11.6429	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	11.6429
1	0.0000	0.0000	16.7549	16.7549	0.0000	18.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	17.1306
2	0.0000	0.0000	19.4821	19.4821	23.0000	22.7600	0.0000	23.0000	23.0000	23.0000	0.0000	0.0000	0.0000	22.7500
3	0.0000	0.0000	22.9166	20.3187	23.7000	23.4500	0.0000	23.7000	23.7000	23.7000	0.0000	0.0000	0.0000	23.5028
4	25.0000	25.0000	24.1234	21.9825	24.8667	24.7100	0.0000	24.8220	24.8929	24.8667	25.0000	25.0000	25.0000	24.7858
5	27.2000	27.2000	23.8301	21.8143	25.7433	26.1700	0.0000	25.7533	25.7207	25.7433	27.2000	27.2000	27.2000	26.4520
6	27.8000	27.8000	26.1353	24.8990	26.6867	26.5000	0.0000	26.6771	26.7381	26.6867	27.8000	27.8000	27.8000	27.2769
7	27.6580	27.6580	25.9142	25.9142	27.3026	0.0000	0.0000	27.3000	27.2718	27.3000	27.6993	27.6580	27.6580	27.5108
8	27.9000	27.9000	30.8190	30.8190	27.9700	0.0000	0.0000	27.9700	27.9700	27.9700	27.9000	27.9000	27.9000	27.9534
9	30.0385	30.0635	31.8753	31.8753	28.7529	0.0000	0.0000	28.6200	28.2283	28.6200	28.2642	30.0385	30.0385	28.5011
10	30.8130	30.8339	32.4001	32.4001	30.1223	0.0000	0.0000	30.1000	30.0462	30.1000	29.8407	30.8130	30.8130	30.0639
11	31.6690	31.6884	32.5550	32.5550	30.2500	0.0000	0.0000	30.2500	30.2500	30.2500	31.1733	31.6690	31.6690	30.5357
12	33.3515	33.3515	35.6302	35.6302	31.5000	0.0000	0.0000	31.5000	31.5000	31.5000	33.3515	33.3515	33.3515	32.2521
13	33.9951	34.0022	34.9335	34.9335	31.7475	0.0000	0.0000	31.4340	31.2516	31.4340	33.8224	33.9951	33.9951	32.1292
14	34.1869	34.1908	33.4180	33.4180	33.7000	0.0000	0.0000	33.7000	33.7000	33.7000	34.0550	34.1869	34.1869	33.8512
15	33.2380	33.3261	36.3334	36.3334	31.5562	0.0000	0.0000	30.4720	30.2638	30.4720	31.1383	33.2380	33.2380	31.4986

For Period 4

Ages	IIa	IVa	VIIIa	VIIIb	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.0000	0.0000	11.6437	11.6437	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	11.6437
1	0.0000	0.0000	16.7672	16.7672	0.0000	18.0097	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	16.8467
2	0.0000	0.0000	20.2523	19.1111	22.0321	22.1934	22.0321	21.9477	22.2554	22.0321	0.0000	0.0000	0.0000	21.8904
3	0.0000	0.0000	23.3017	20.2677	23.4186	23.5521	23.4186	23.3765	23.5250	23.4186	0.0000	0.0000	0.0000	23.4237
4	25.9463	25.9485	24.4869	22.8925	24.3608	24.2313	24.3608	24.3155	24.4963	24.3608	25.9134	25.9463	25.9463	24.3721
5	26.7463	26.7475	25.0657	23.9431	25.4193	25.7186	25.4193	25.2759	25.6771	25.4193	26.7134	26.7463	26.7463	25.7003
6	28.6331	29.2206	26.3301	25.1678	27.2525	26.6845	27.2525	27.2095	27.3834	27.2525	28.0580	28.6331	28.6331	27.5960
7	28.7107	29.6539	26.6971	26.6971	28.5000	27.8800	28.5000	28.5000	28.5000	28.5000	27.9641	28.7107	28.7107	28.3124
8	31.3000	31.3000	28.1339	28.1339	28.5000	29.0000	28.5000	28.5000	28.5000	28.5000	31.3000	31.3000	31.3000	29.9273
9	32.0835	31.6292	29.0887	29.0887	0.0000	29.1752	0.0000	0.0000	0.0000	0.0000	32.1249	32.0835	32.0835	29.8363
10	30.8000	30.8000	29.7836	29.7836	0.0000	30.5000	0.0000	0.0000	0.0000	0.0000	30.8000	30.8000	30.8000	30.5382
11	30.0959	31.4488	32.2076	32.2076	0.0000	31.8300	0.0000	0.0000	0.0000	0.0000	29.4143	30.0959	30.0959	30.8360
12	33.0372	32.5314	36.5061	36.5061	0.0000	29.5000	0.0000	0.0000	0.0000	0.0000	33.0485	33.0372	33.0372	32.6732
13	31.5182	32.6034	34.4558	34.4558	0.0000	31.5000	0.0000	0.0000	0.0000	0.0000	31.0773	31.5182	31.5182	32.2297
14	30.7455	33.2472	31.8550	31.8550	0.0000	29.5000	0.0000	0.0000	0.0000	0.0000	29.1690	30.7455	30.7455	30.9426
15	32.0901	34.2585	36.6702	36.6702	0.0000	33.7000	0.0000	0.0000	0.0000	0.0000	31.8399	32.0901	32.0901	33.8407

Table 6.5.1.1: Western Horse Mackerel: Input to ADAPT

a. Catch in numbers (thousands)(canum)

thousands

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0	0	0	123
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843	4036	3726	71802
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412	615759	417131	153811
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838	841304	703245	464537
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181	157053	390131	340241
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812	67924	231570	206255
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565	45939	112433	141961
7	6013	37775	29105	9808	79428	34886	10613	1159554	19305	19000	42840	124050	205842	26425	48597	120131	111607
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028	49091	122121	74827
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838	44193	103944	64746
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799	48439	95516	47935
11	4473	2428	0	263	2255	16252	14301	12629	95505	13060	12000	1177060	21847	58051	89046	79553	60645
12	12560	12204	486	659	746	7484	15158	21975	14040	51200	22750	6420	909325	62531	65209	148103	33499
13	19489	17142	1337	2888	619	1173	4537	12471	32496	9710	69970	16110	9861	1044929	54915	80255	67648
14	13205	27505	3866	970	211	168	4285	8162	16935	9000	12110	52610	14411	38647	343831	38548	60735
15+	5579	33335	38732	27005	37295	27613	28378	16468	53023	49400	32200	33490	37138	149957	165073	239225	155807

Other input parameters

Minimum acceptable stock size:
500000 t
CV of the egg survey: 0.2
Ref. age for calculation of F
at last age: 6
Lowest/Highest age for ref. F:
5/14
First fully recruited age: 4
Forthcoming rocruitmont at ago 1:
'3077900000
Years to recalculate the selection:
4 (smallest possible value)
500 iterations

b. Proportion of fish mature at start of year (matprop)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	000-2004
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
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
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
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
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
6	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
8	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
10	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
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 6.5.1.1 (cont'd): Western Horse Mackerel: Input to ADAPT

c. Mean weight at age in the catch (kg) (weca)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	000-2004
0	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.012	0.015	0.012	0.008	0.010	0.021	0.015	0.015	0.017	0.014	0.015	0.015
1	0.054	0.039	0.034	0.029	0.029	0.068	0.031	0.050	0.032	0.031	0.014	0.033	0.037	0.038	0.059	0.039	0.041	0.046	0.046
2	0.090	0.113	0.073	0.045	0.045	0.067	0.075	0.075	0.031	0.046	0.092	0.083	0.052	0.052	0.078	0.075	0.067	0.080	0.080
3	0.142	0.124	0.089	0.087	0.110	0.110	0.114	0.149	0.090	0.113	0.117	0.120	0.106	0.073	0.090	0.093	0.102	0.095	0.095
4	0.178	0.168	0.130	0.150	0.107	0.155	0.132	0.142	0.124	0.125	0.139	0.126	0.124	0.089	0.125	0.109	0.113	0.116	0.116
5	0.227	0.229	0.176	0.156	0.171	0.143	0.147	0.142	0.126	0.148	0.143	0.142	0.158	0.126	0.141	0.142	0.140	0.141	0.141
6	0.273	0.247	0.216	0.199	0.196	0.174	0.157	0.220	0.129	0.141	0.157	0.154	0.153	0.130	0.155	0.179	0.162	0.165	0.165
7	0.276	0.282	0.245	0.243	0.223	0.198	0.240	0.166	0.202	0.144	0.163	0.163	0.167	0.170	0.166	0.189	0.172	0.176	0.176
8	0.292	0.281	0.278	0.256	0.251	0.249	0.304	0.258	0.183	0.187	0.172	0.183	0.194	0.176	0.177	0.199	0.183	0.186	0.186
9	0.305	0.254	0.262	0.294	0.296	0.264	0.335	0.327	0.227	0.185	0.235	0.199	0.199	0.200	0.191	0.209	0.192	0.197	0.197
10	0.369	0.260	0.259	0.257	0.280	0.321	0.386	0.330	0.320	0.215	0.222	0.177	0.280	0.204	0.206	0.234	0.213	0.218	0.218
11	0.348	0.300	0.255	0.241	0.319	0.336	0.434	0.381	0.328	0.303	0.288	0.238	0.275	0.222	0.224	0.240	0.227	0.230	0.230
12	0.348	0.310	0.344	0.251	0.287	0.244	0.404	0.400	0.355	0.323	0.306	0.308	0.240	0.215	0.233	0.246	0.242	0.240	0.240
13	0.348	0.315	0.232	0.314	0.345	0.328	0.331	0.421	0.399	0.354	0.359	0.327	0.326	0.246	0.229	0.272	0.231	0.244	0.244
14	0.356	0.311	0.306	0.346	0.260	0.245	0.392	0.448	0.388	0.365	0.393	0.376	0.342	0.237	0.280	0.309	0.239	0.276	0.276
15+	0.366	0.332	0.308	0.321	0.360	0.373	0.424	0.516	0.379	0.330	0.401	0.421	0.383	0.298	0.332	0.288	0.272	0.297	0.297

d. Mean weight at age in the stock (kg) (west)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	000-2004
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
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
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	0.088	0.088
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	0.113	0.113
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	0.127	0.127
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	0.151	0.151
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	0.164	0.164
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	0.176	0.176
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	0.182	0.182
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	0.200	0.200
11	0.344	0.305	0.300	0.300	0.300	0.291	0.337	0.263	0.272	0.266	0.292	0.211	0.197	0.187	0.206	0.197	0.202	0.202	0.202
12	0.348	0.309	0.300	0.300	0.300	0.297	0.352	0.302	0.404	0.295	0.211	0.258	0.231	0.229	0.217	0.226	0.217	0.220	0.220
13	0.348	0.311	0.300	0.325	0.300	0.303	0.361	0.411	0.404	0.349	0.245	0.288	0.270	0.218	0.221	0.236	0.207	0.221	0.221
14	0.361	0.312	0.305	0.325	0.300	0.303	0.352	0.383	0.404	0.361	0.361	0.338	0.270	0.272	0.237	0.260	0.212	0.236	0.236
15+	0.364	0.310	0.285	0.303	0.346	0.339	0.390	0.358	0.404	0.381	0.403	0.405	0.338	0.348	0.273	0.256	0.225	0.251	0.251

Table 6.5.1.2: Western Horse Mackerel: Historical assessment (output from ADAPT)

a. Fishing mortality

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0	0	0	0	0	0	0.000	0	0	0.001	0.003	0	0.000	0	0	0.000	0.000
1	0.001	0.000	0	0.000	0	0	0.005	0	0.009	0.011	0.036	0.026	0.004	0.012	0.002	0.006	0.008
2	0.007	0.001	0.004	0.002	0	0.000	0.002	0	0.027	0.027	0.017	0.026	0.292	0.122	0.177	0.193	0.338
3	0.017	0.013	0.002	0.011	0.001	0	0.001	0.009	0.039	0.011	0.046	0.006	0.066	0.210	0.368	0.297	0.321
4	0.006	0.008	0.019	0.003	0.014	0.002	0.002	0.006	0.032	0.068	0.045	0.044	0.048	0.161	0.118	0.275	0.216
5	0.008	0.011	0.030	0.026	0.005	0.025	0.014	0.002	0.013	0.085	0.113	0.094	0.041	0.063	0.072	0.241	0.216
6	0.008	0.032	0.019	0.024	0.045	0.002	0.033	0.013	0.006	0.035	0.095	0.192	0.037	0.109	0.068	0.156	0.216
7	0.010	0.043	0.035	0.013	0.030	0.041	0.012	0.056	0.023	0.013	0.026	0.139	0.180	0.044	0.079	0.238	0.216
8	0.003	0.026	0.035	0.018	0.030	0.034	0.050	0.015	0.078	0.029	0.012	0.049	0.131	0.295	0.103	0.274	0.216
9	0.013	0.008	0.027	0.008	0.026	0.019	0.032	0.095	0.055	0.089	0.030	0.024	0.033	0.222	0.080	0.309	0.216
10	0.051	0.229	0.012	0.020	0.021	0.016	0.019	0.049	0.154	0.041	0.104	0.006	0.047	0.107	0.139	0.234	0.216
11	0.095	0.141	0	0.001	0.008	0.037	0.034	0.034	0.076	0.039	0.028	0.151	0.052	0.083	0.130	0.334	0.216
12	0.059	0.380	0.036	0.060	0.004	0.029	0.042	0.064	0.046	0.051	0.084	0.018	0.158	0.193	0.119	0.312	0.216
13	0.067	0.100	0.061	0.290	0.070	0.007	0.021	0.042	0.120	0.038	0.086	0.075	0.033	0.259	0.245	0.200	0.216
14	0.038	0.120	0.028	0.054	0.029	0.023	0.030	0.046	0.070	0.042	0.058	0.082	0.084	0.164	0.120	0.257	0.216
15+	0.038	0.120	0.028	0.054	0.029	0.023	0.030	0.046	0.070	0.042	0.058	0.082	0.084	0.164	0.120	0.257	0.216
mean F5-14																	
unweighted	0.035	0.109	0.028	0.051	0.027	0.023	0.029	0.042	0.064	0.046	0.063	0.083	0.080	0.154	0.116	0.255	0.216
weighted	0.018	0.039	0.029	0.021	0.025	0.025	0.032	0.050	0.066	0.072	0.086	0.123	0.116	0.190	0.109	0.245	0.216
mean F2-4 u	0.010	0.008	0.008	0.005	0.005	0.001	0.001	0.005	0.032	0.035	0.036	0.025	0.135	0.164	0.221	0.255	0.292

b. Population numbers (millions)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	71119	2744	4552	5359	3672	5824	2321	2592	2153	2960	4694	5207	5570	3453	782	11599	3576
1	2393	61213	2362	3918	4612	3160	5013	1997	2231	1853	2545	4029	4482	4792	2972	673	9983
2	2227	2057	52681	2033	3371	3970	2720	4292	1719	1902	1577	2112	3380	3843	4077	2554	576
3	5811	1904	1769	45173	1746	2902	3416	2336	3695	1440	1593	1335	1772	2174	2927	2940	1813
4	1311	4917	1617	1519	38447	1502	2498	2939	1993	3059	1227	1310	1142	1429	1517	1743	1881
5	1292	1121	4196	1366	1305	32638	1291	2146	2514	1662	2460	1009	1079	937	1046	1160	1140
6	1138	1104	955	3506	1146	1117	27399	1095	1843	2135	1314	1891	791	891	758	838	785
7	644	972	920	806	2946	942	960	22818	931	1577	1774	1028	1344	656	688	610	617
8	393	549	802	765	685	2462	779	816	18566	783	1340	1487	770	966	540	547	414
9	24	337	460	666	647	572	2048	638	692	14778	654	1140	1219	582	619	419	358
10	24	21	288	386	569	543	483	1708	499	564	11633	547	958	1015	401	492	265
11	53	20	14	245	325	479	460	408	1400	368	466	9028	468	787	785	300	335
12	238	41	15	12	211	278	397	382	339	1117	305	390	6681	382	623	593	185
13	326	193	24	12	10	181	232	328	309	279	914	241	329	4909	271	476	374
14	380	262	150	20	8	8	154	196	271	236	231	722	193	274	3260	183	336
15+	161	318	1507	550	1401	1303	1023	395	848	1294	615	459	497	1065	1565	1133	861

Table 6.5.1.2 (cont'd): Western Horse Mackerel: Historical assessment (output from ADAPT)

c. Spawning stock biomass (tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
median	1869735	2105593	2281447	3184204	4243185	4980051	5648223	5007458	4615558	4546036	3654273	3391266	2800840	2339889	2149517	1256479	984651

d. Observed and expected spawning stock biomass (from egg survey estimates)(tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
observed											2210000			1710000			140000
expected	1868111	2103688	2279338	3181318	4239339	4975431	5642798	5002431	4610466	4540654	3649595	3386445	2796271	2335394	2144688	1253030	981237

e. Landings (tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	41588	64862	73625	80521	105665	156247	188100	268867	373463	333600	368200	432000	347842	512995	396448	442571	303543

f. Recruitment at age 1 (millions)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	2393	61213	2362	3918	4612	3160	5013	1997	2231	1853	2545	4029	4482	4792	2972	673	9983
Geometric mean over yearclasses 1981 and 1983-1993																	**3036**

Table 6.5.2.1. Western Horse Mackerel . Summary results of Bayesian stock assessment. Percentiles of the distribution of fishing mortality relative to natural mortality (Population mean fishing mortality over ages 4 to 14 divided by natural mortality), spawning stock size, and recruitment by year from 1982-1997. Percentiles calculated from 1000 drawn parameter vectors from the Markov Chain.

a. Fishing Mortality relative to Natural Mortality (F 4-14w/M)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	0.24	0.34	0.42	0.27	0.23	0.33	0.39	0.59	0.78	0.84	0.94	1.25	1.10	1.69	0.86	1.81	1.33
25	0.38	0.53	0.65	0.41	0.34	0.49	0.57	0.84	1.11	1.19	1.31	1.75	1.53	2.37	1.22	2.63	1.96
50	0.50	0.70	0.85	0.54	0.44	0.63	0.73	1.07	1.40	1.48	1.64	2.19	1.92	3.01	1.56	3.40	2.60
75	0.62	0.87	1.04	0.67	0.53	0.76	0.88	1.28	1.67	1.76	1.95	2.59	2.32	3.71	1.94	4.33	3.46
95	0.75	1.04	1.25	0.80	0.63	0.90	1.04	1.53	2.00	2.11	2.36	3.19	2.90	4.78	2.61	6.06	5.30
Expectation	0.50	0.70	0.84	0.54	0.43	0.63	0.72	1.06	1.39	1.48	1.64	2.20	1.95	3.08	1.62	3.60	2.86

b. Spawning Stock Size (Thousand t at spawning time)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	687	757	803	1332	890	2308	2840	1532	2596	2585	2091	2165	1819	1492	1320	781	588
25	749	835	873	1453	1061	2513	3099	2051	2844	2841	2333	2442	2087	1768	1619	1022	840
50	812	916	944	1574	1272	2708	3332	2508	3079	3080	2562	2693	2356	2042	1927	1269	1106
75	909	1020	1051	1751	1604	2985	3659	2915	3359	3388	2839	3021	2673	2370	2306	1566	1420
95	1121	1251	1268	2111	2296	3484	4244	3405	3900	3951	3366	3668	3302	2996	2954	2102	2001
Expectation	848	949	980	1630	1386	2781	3414	2486	3141	3149	2622	2772	2427	2107	2004	1329	1170

c. Recruitment (Millions of fish aged 0)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	21521	696	1099	1532	1384	2460	880	1057	861	1364	2642	2923	3074	790	880	812	756
25	23575	808	1359	1824	1528	2702	1026	1236	1049	1618	2954	3338	3670	1344	1316	1395	1282
50	25857	921	1606	2087	1676	2934	1168	1405	1226	1854	3236	3712	4276	1867	1854	1982	1805
75	29313	1094	1951	2469	1888	3260	1342	1620	1455	2174	3612	4199	4990	2747	2700	2745	2587
95	36676	1436	2619	3175	2271	3823	1686	2021	1869	2727	4281	5161	6383	4535	4399	4580	4171
Expectation	27135	977	1701	2191	1732	3016	1208	1454	1279	1933	3325	3829	4432	2207	2153	2229	2064

d. Natural Mortality (all ages) (approx.)

Percentile	M
5	0.052
25	0.056
50	0.064
75	0.076
95	0.100
Expectation	0.069

Table 6.6.1. Western Horse Mackerel. Catch option table, calculated as expectation and percentiles of Bayes posterior distributions. (a) SSB, catch and F/M in 1999, (b) SSB in 2000, for F=M or catch = 50 to 300Kt in 2000; (c) SSB in 2001, for F=M or catch = 50 to 400Kt in 2000 and 2001; (d) Catch corresponding to F=M; (e) F/M in 2000; (f) F/M in 2001

(a)	**1999**				Estimated Risk in 1999	
	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
SSB (Thousand t)	1194	799	1110	1478		
Catch (Thousand t)	300	*no uncertainty admitted*			0.05	0.34
F(4-14,w)/M	3.56	2.45	3.22	4.31		

(b)	**SSB in 2000 (Kt)**				Estimated Risk in 2000	
Catch (Thousand t)	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
Catch for F=M	984	633	910	1242	0.13	0.52
50	1160	738	1075	1464	0.07	0.38
100	1142	721	1057	1445	0.09	0.40
150	1124	704	1038	1426	0.10	0.41
200	1105	686	1018	1407	0.11	0.42
250	1087	667	998	1387	0.12	0.45
300	1079	657	989	1377	0.12	0.45
400	1026	603	936	1325	0.16	0.50

(c)	**SSB in 2001 (Kt)**				Estimated Risk in 2001	
Catch (Thousand t)	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
Catch for F=M	1056	684	982	1323	0.10	0.45
50 Kt in 2000 and 2001	1272	813	1177	1599	0.06	0.32
100 Kt in 2000 and 2001	1211	754	1117	1535	0.08	0.36
150 Kt in 2000 and 2001	1151	693	1056	1471	0.11	0.41
200 Kt in 2000 and 2001	1090	631	993	1407	0.15	0.46
250 Kt in 2000 and 2001	1028	575	933	1342	0.18	0.50
300 Kt in 2000 and 2001	978	526	880	1290	0.24	0.54
400 Kt in 2000 and 2001	846	386	743	1150	0.33	0.63

(d)	**Catch for F=M**			
Catch (Thousand t)	Expected	Percentiles		
		25%	50%	75%
2000	67	48	63	81
2001	73	54	69	88

(e)
Fishing Mortality Relative to Natural Mortality in 2000, for catch options in 2000 = 50 to 400 000t and catch in 1999=300 000t

Catch in 2000 (Thous. t)	Expected	Percentiles		
		25%	50%	75%
50	0.61	0.40	0.54	0.74
100	1.26	0.82	1.11	1.51
150	1.94	1.25	1.70	2.33
200	2.67	1.70	2.32	3.19
250	3.45	2.16	2.96	4.10
300	3.68	2.27	3.10	4.29
400	6.03	3.64	5.08	7.27

(f)
Fishing Mortality Relative to Natural Mortality in 2001, for catch options in 2000 -2001 = 50 to 400 000t and catch in 1999=300 000t

Catch in 2000 and 2001	Expected	Percentiles		
(Thousand t)		25%	50%	75%
50	0.55	0.37	0.50	0.66
100	1.19	0.77	1.04	1.43
150	1.95	1.21	1.66	2.30
200	2.87	1.70	2.36	3.35
250	3.97	2.22	3.14	4.62
300	4.64	2.41	3.46	5.28
400	8.13	4.20	6.34	10.70

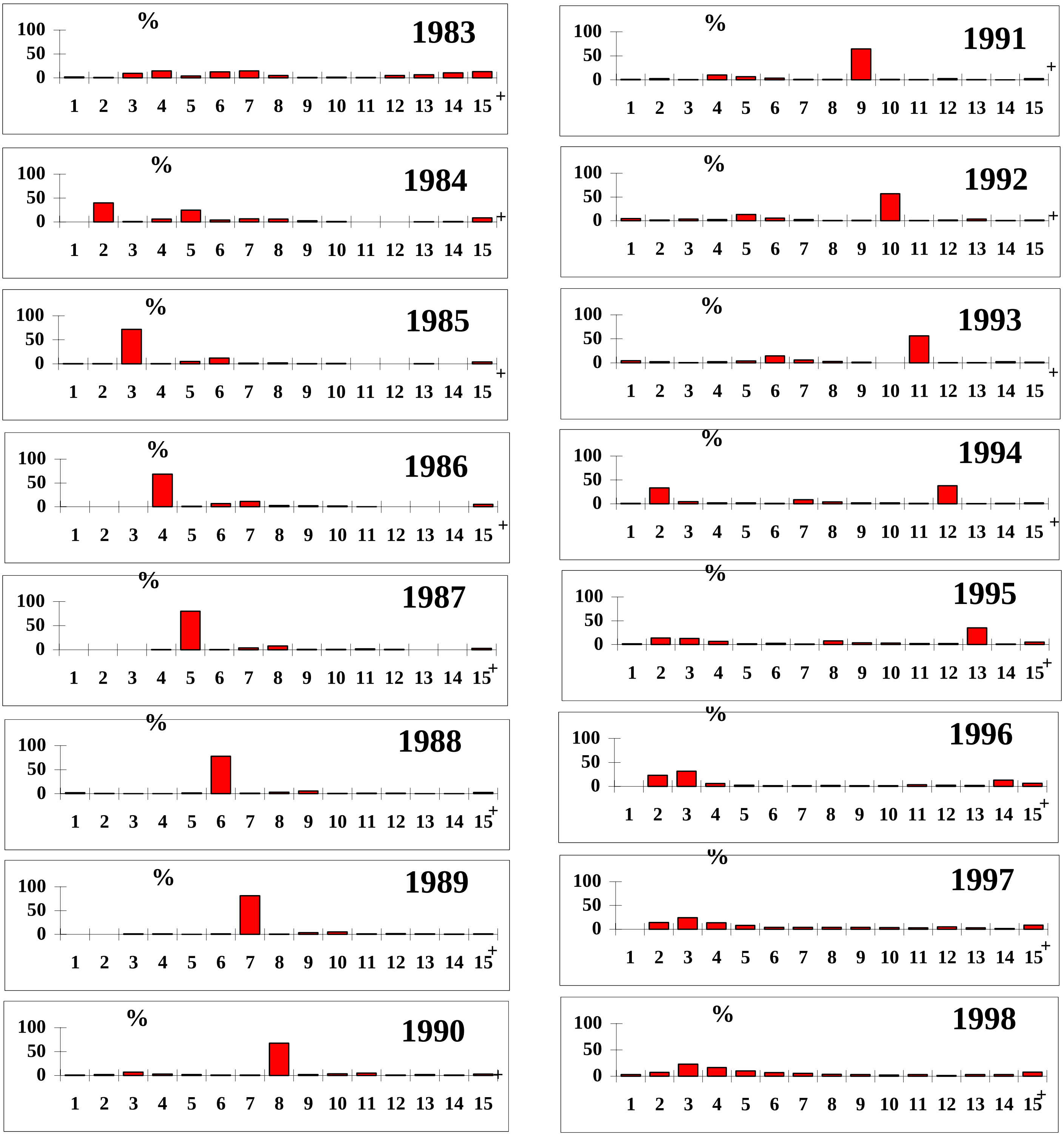


Figure 6.4.1.1 The age composition of the WESTERN HORSE MACKEREL in the internationa catches from 1983-1998.

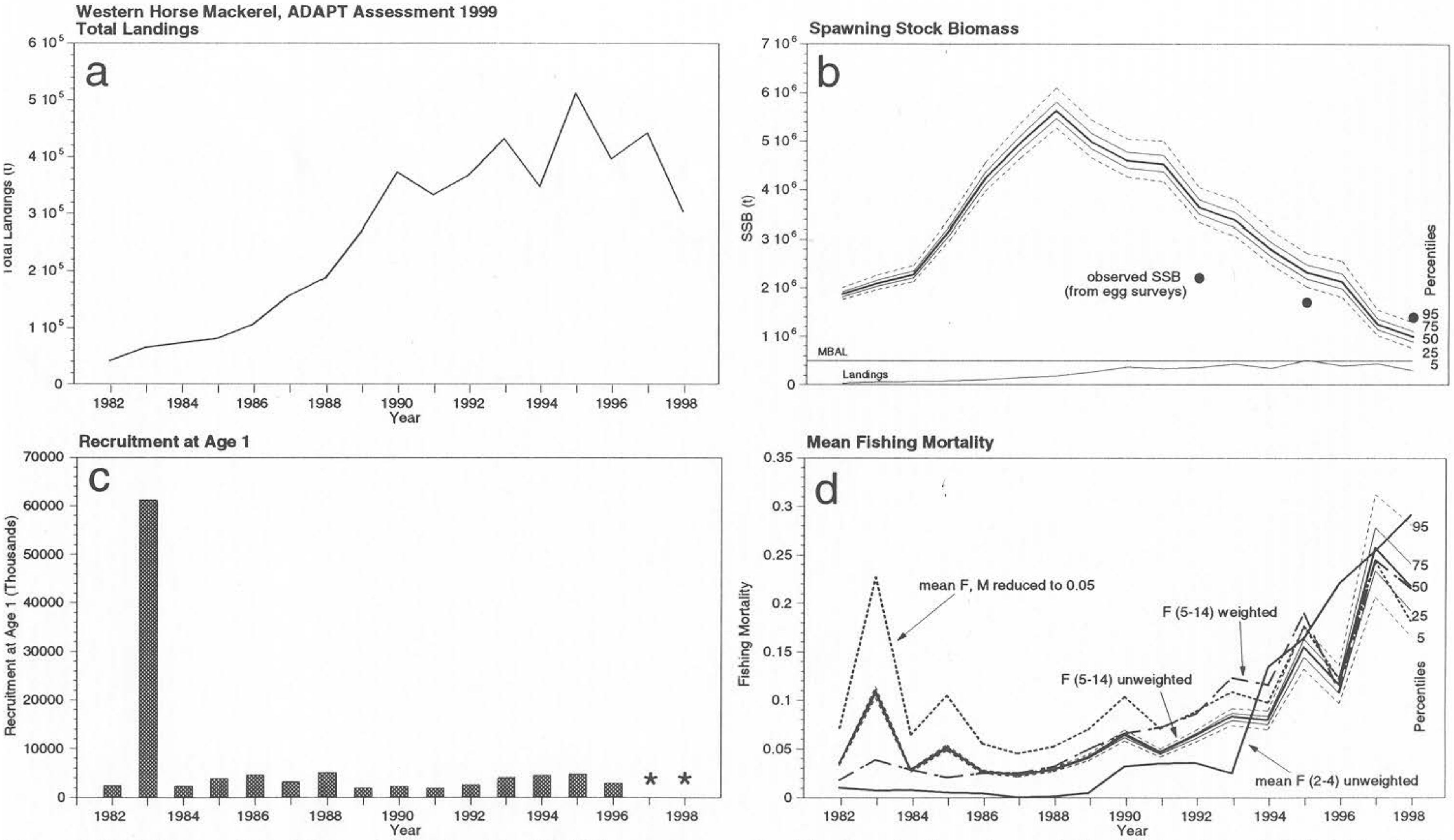


Figure 6.5.1.1. Western Horse Mackerel: Results of the ADAPT-assessment.**a.:** Total landings; **b.:** Spawning stock biomass (median, 5th, 25th, 75th and 95th percentiles of the expected SSB fitted to SSB estimates from egg surveys) compared to SSB values estimated from egg surveys (as circles) and the Minimum Biological Acceptable Level (MBAL); **c.:** Recruitment at age 1; *values for 1997 and 1998 are not presented because of the unreliability of data from most recent years; **d.:** Mean fishing mortality (median, 5th, 25th, 75th and 95th percentiles), means for age groups 5-14 (unweighted and weighted by stock numbers), mean F on ages 2-4 and mean F resulting from the exploratory run with reduced Natural Mortality (M=0.05 instead of 0.15).

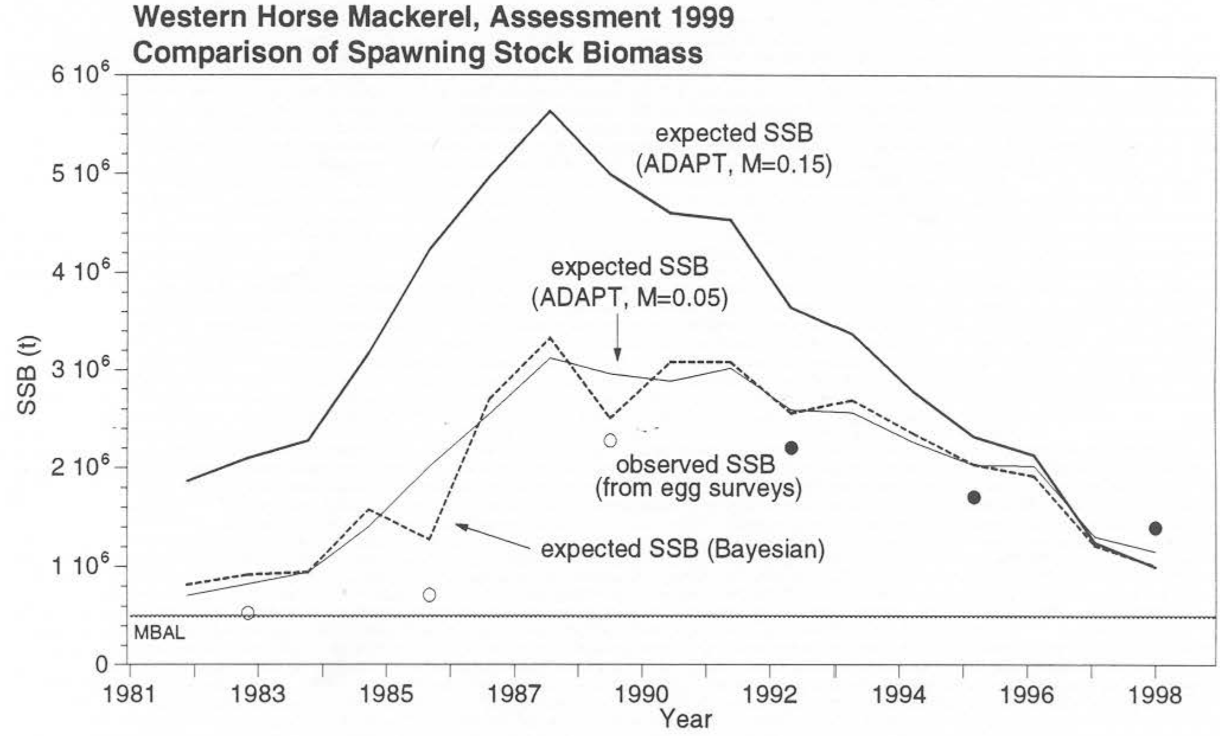


Figure 6.5.1.2. Western Horse Mackerel: Comparison of spawning stock biomass calculated with different assessments (ADAPT vs. Bayesian) and assumptions (using fishing mortalities of either 0.15 or 0.05). Circles give SSB values observed at egg surveys, filled ones were used for the ADAPT assessment, open ones were excluded.

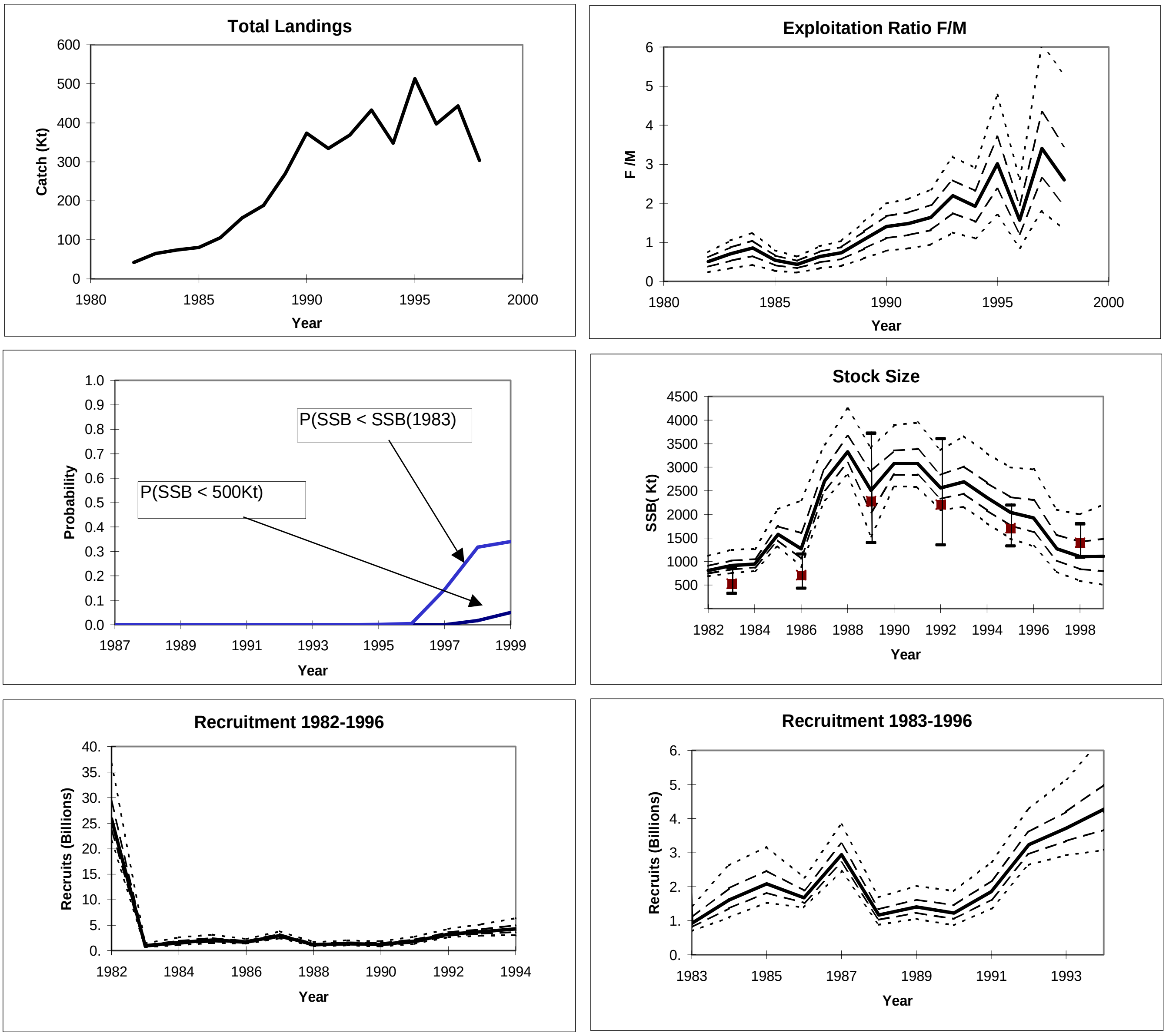


Figure 6.5.2.1 Western Horse Mackerel. Estimated historic stock trajectories for some population dynamics parameters. Fishing mortality calculated as population-weighted mean over ages 5 to 14 and referenced to natural mortality.Square markers indicate egg survey biomass estimates, +/- 95% confidence intervals based on 25% CV. Bold lines, medians. Dashed lines, 25th and 25th percentiles. Dotted lines, 5th and 95th percentiles.

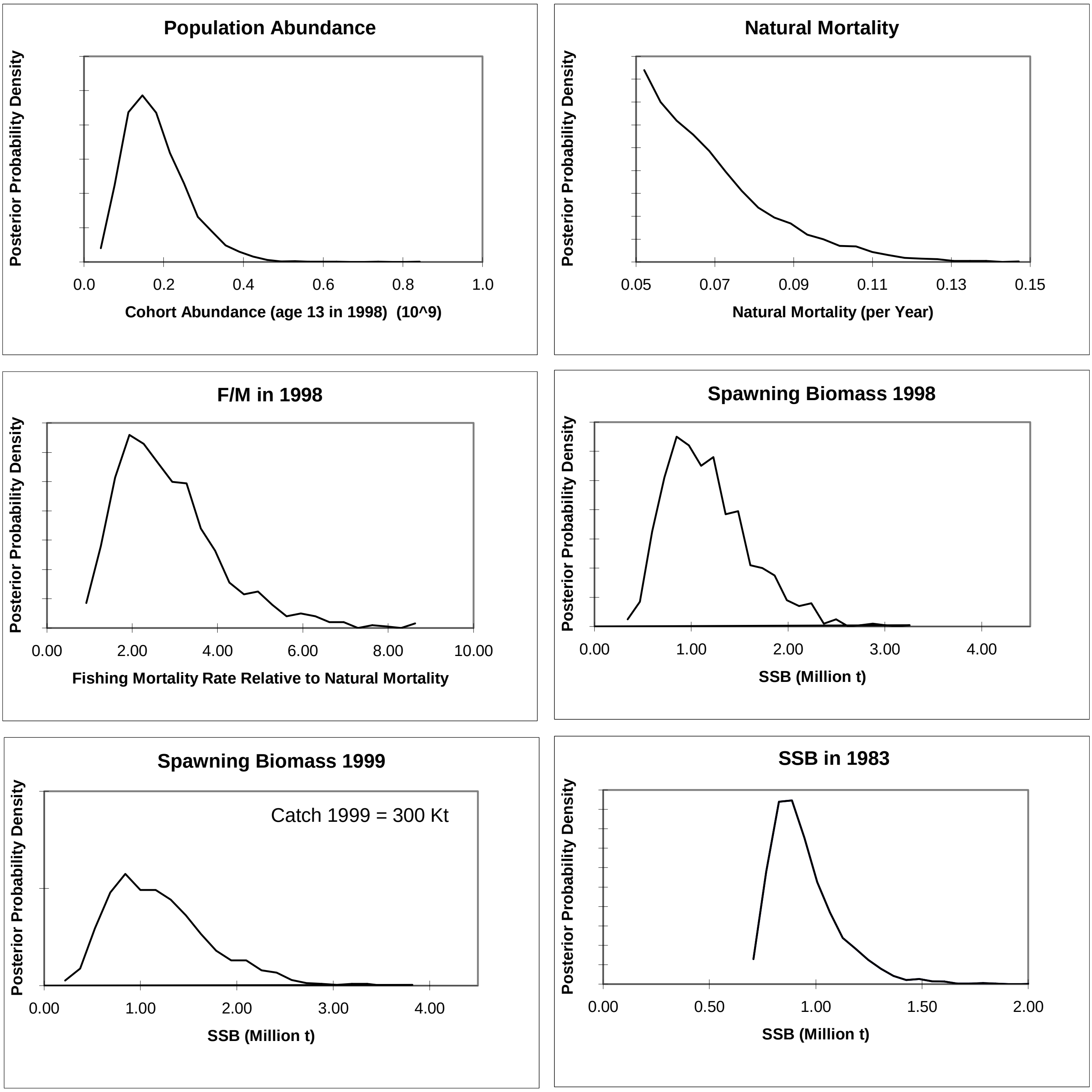


Figure 6.5.2.2. Western Horse Mackerel.Estimates of posterior probability density for some key parameters in the stock assessment.'F' here is taken as the population-weighted arithmetic mean F from ages 4 to 14, and is referenced to M because M is a stochastic variable. Distributions calculated from 5000 samples from Markov Chain thinned at intervals of 100 iterations.

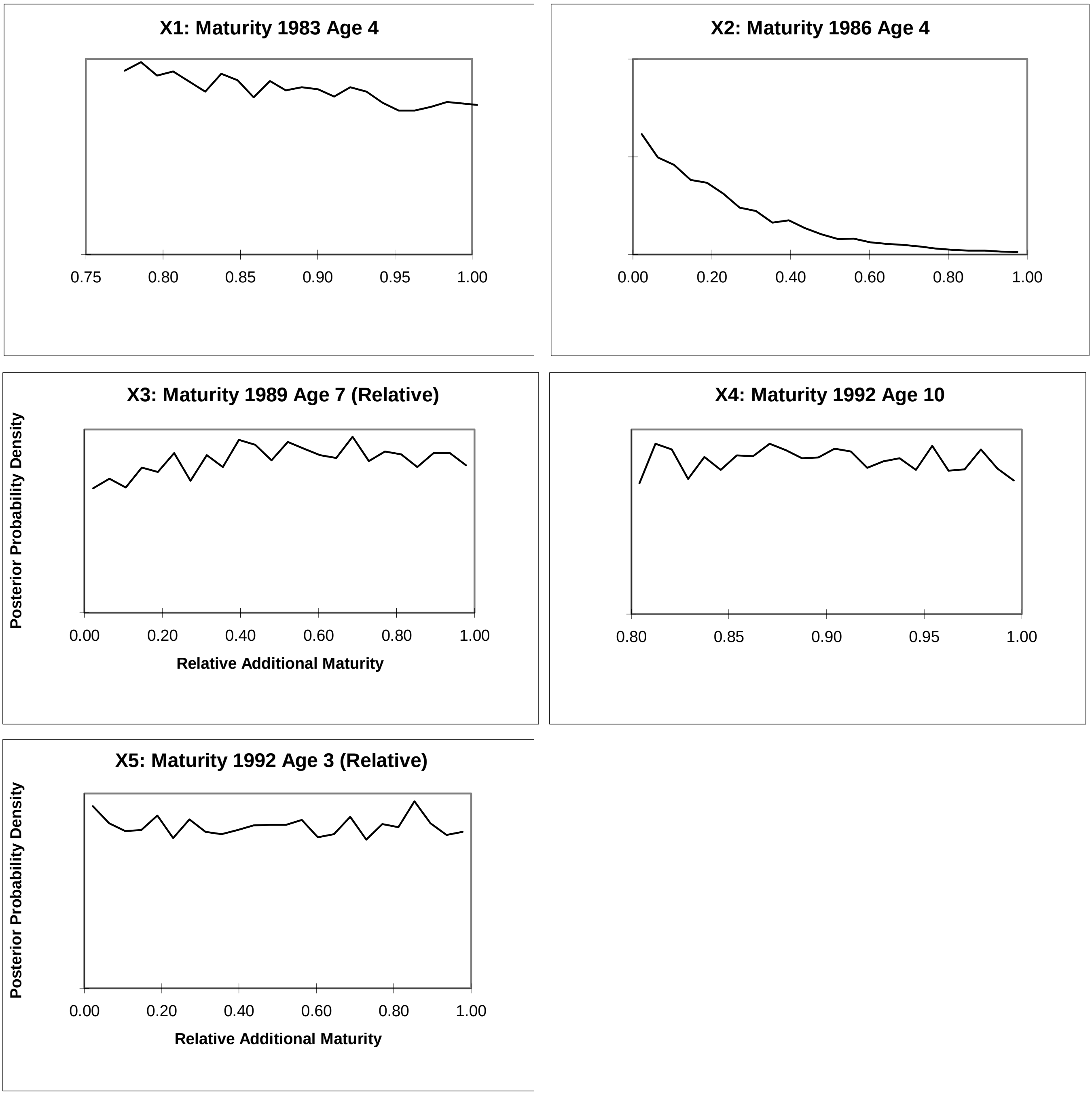


Figure 6.5.3.1. Western Horse Mackerel.Estimates of posterior probability density for some parameters of maturity proportions in the stock assessment.See section 6.7.2.2. for description of the expression of maturity in terms of parameters X1-X5

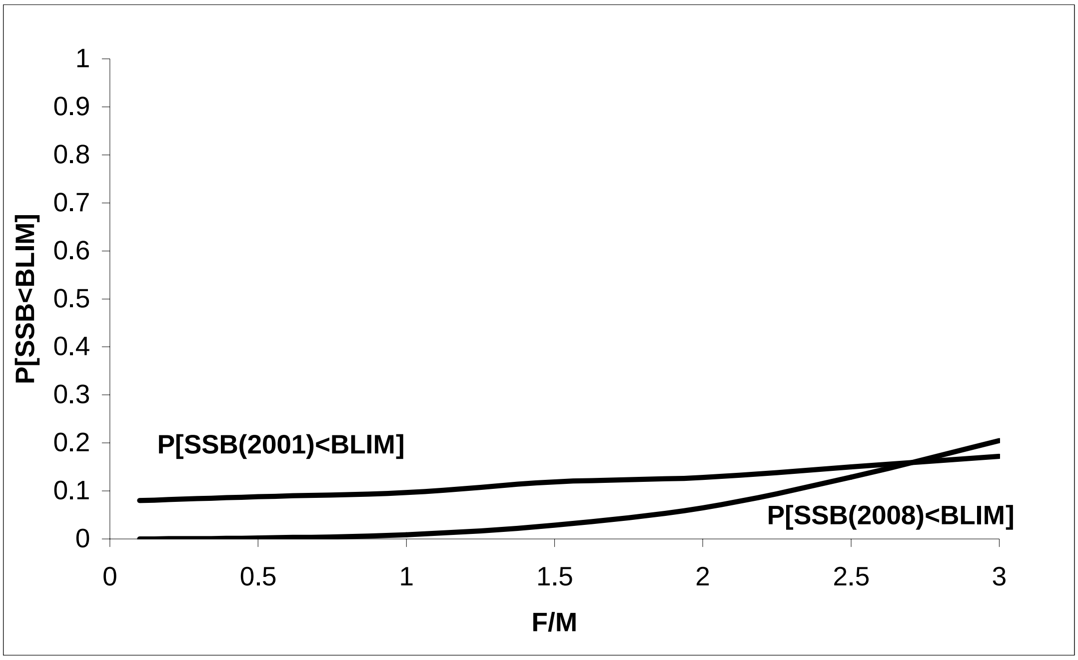


Figure 6.7.1 **The probability of the stock being under 500,000 t at spawning time in 2001 and 2008 for increasing levels of constant exloitation expressed as F/M**

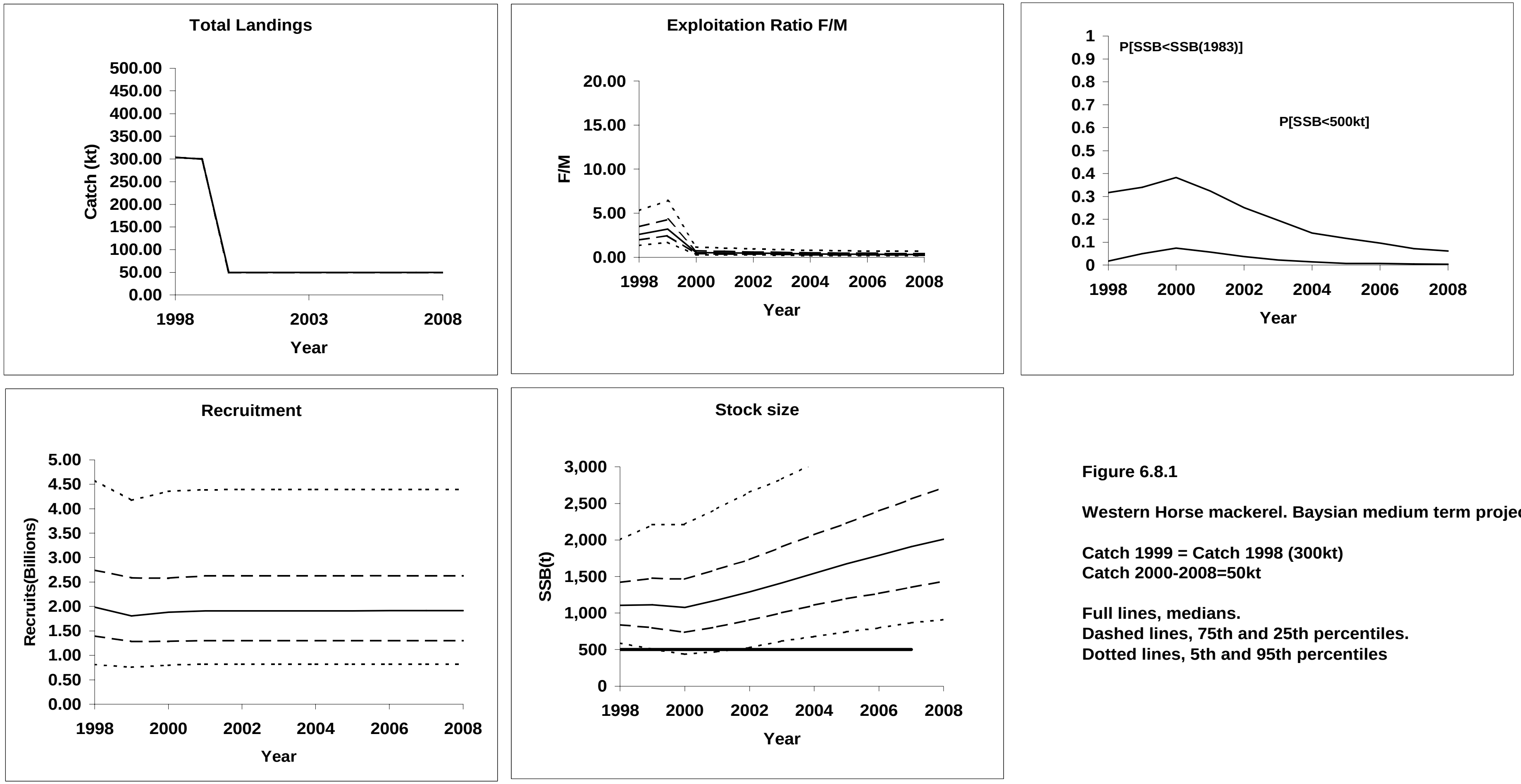
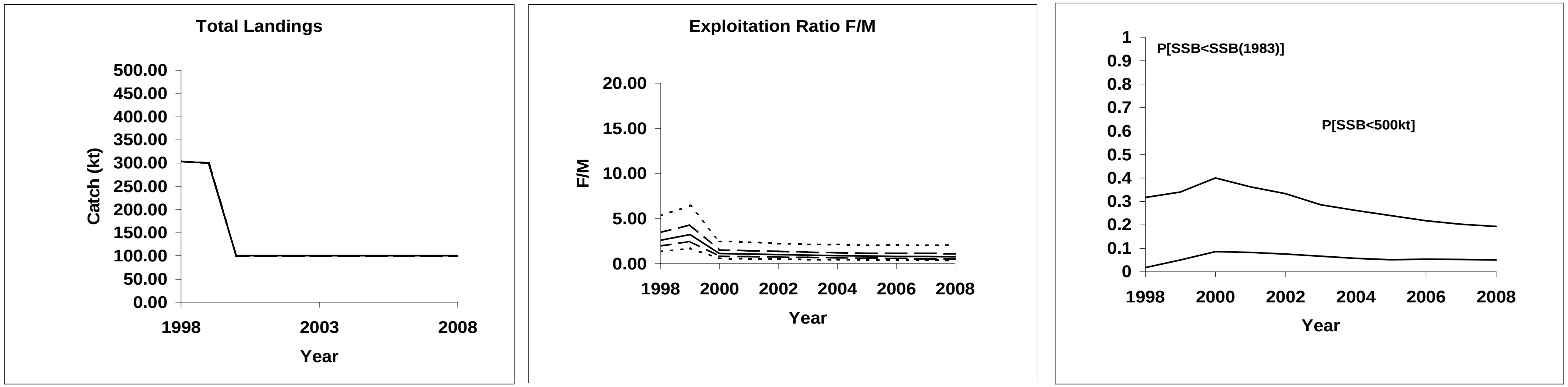


Figure 6.8.1

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=50kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles



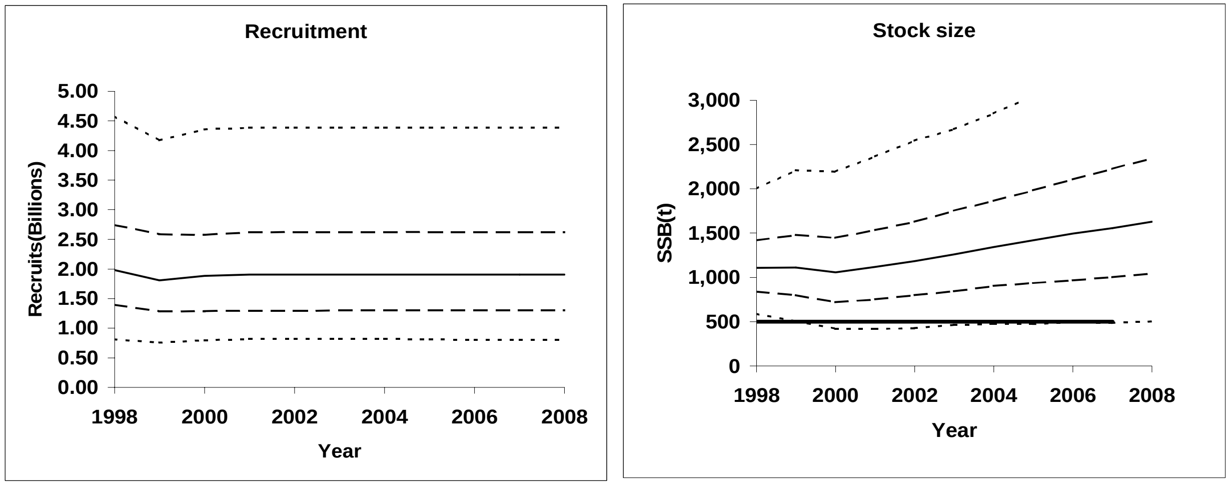
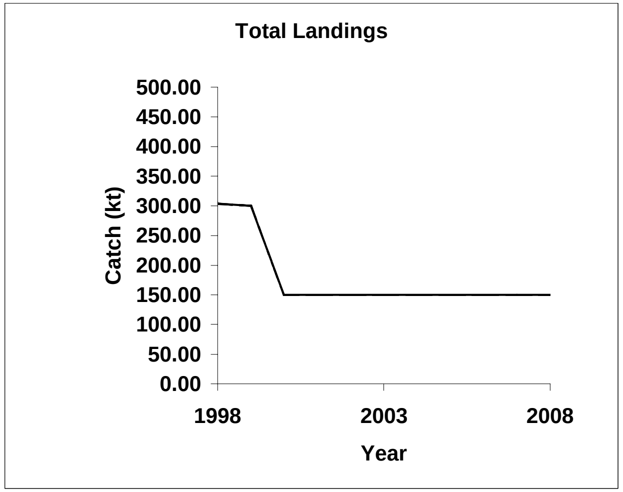


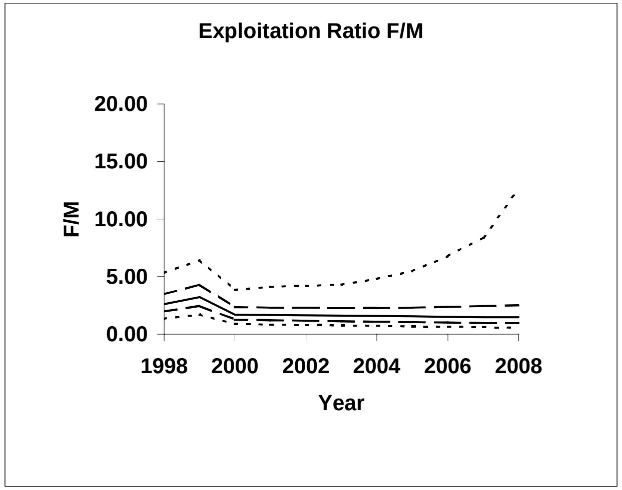
Figure 6.8.2

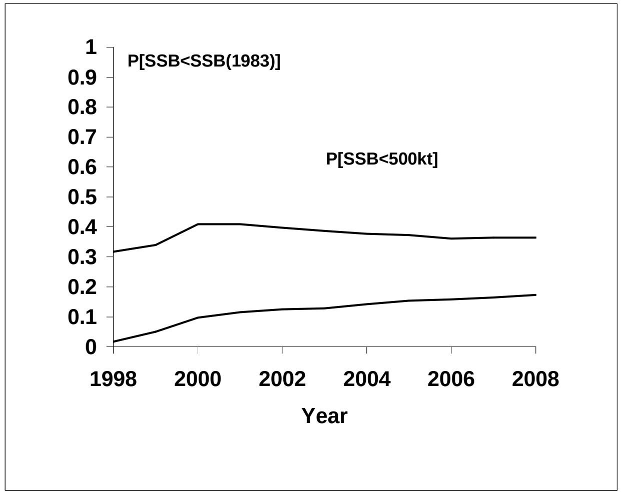
Western Horse mackerel. Baysian medium term projections.

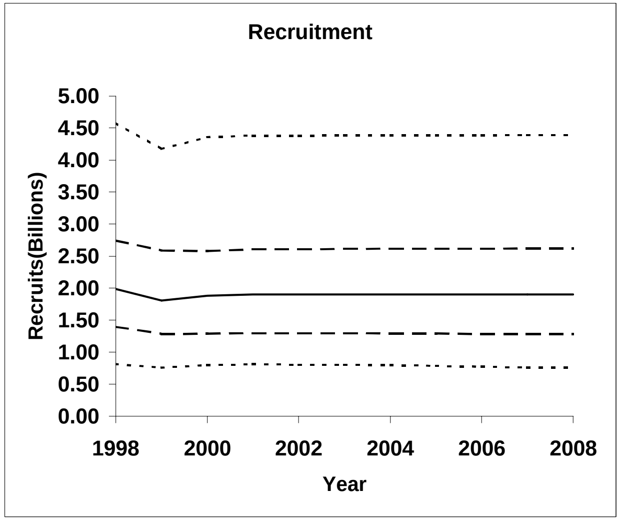
Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=100kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles









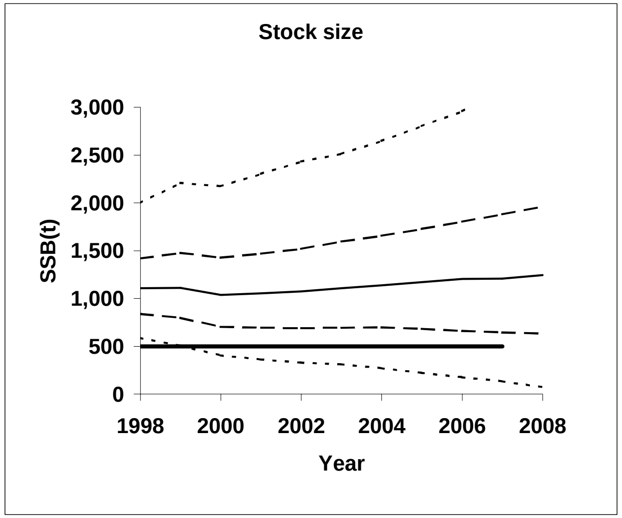


Figure 6.8.3

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=150kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

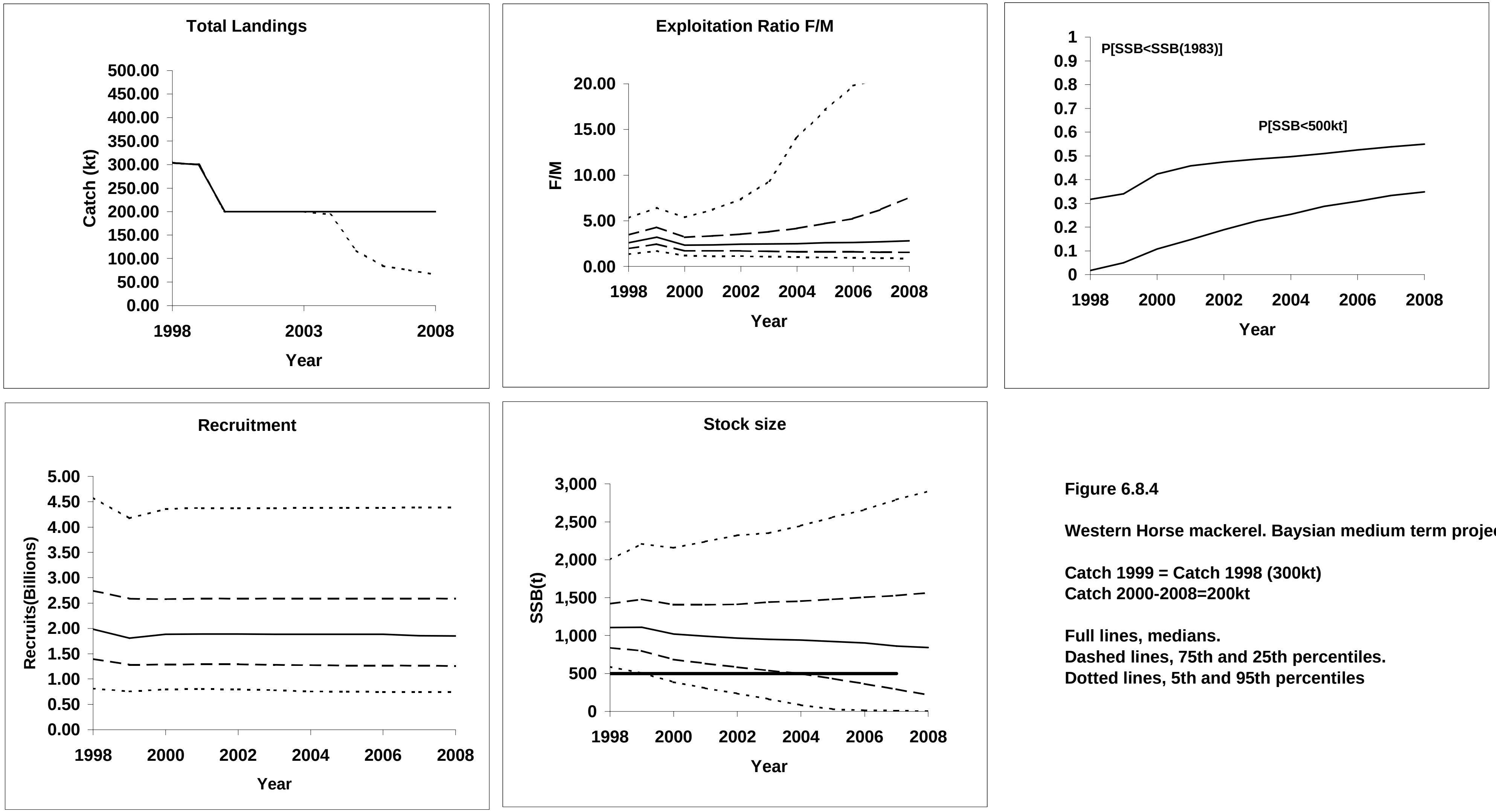
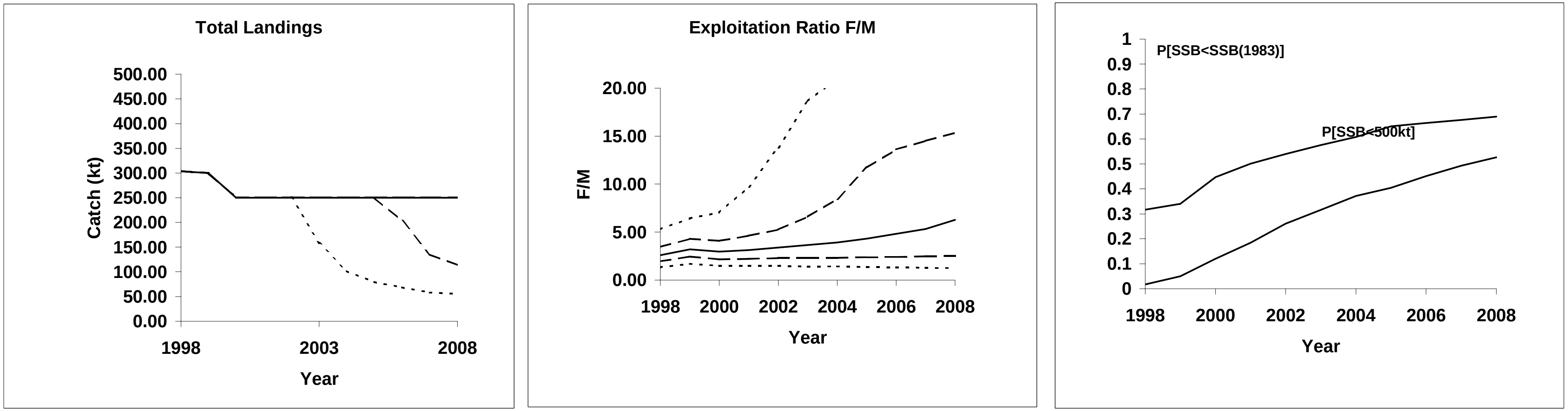


Figure 6.8.4

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=200kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles



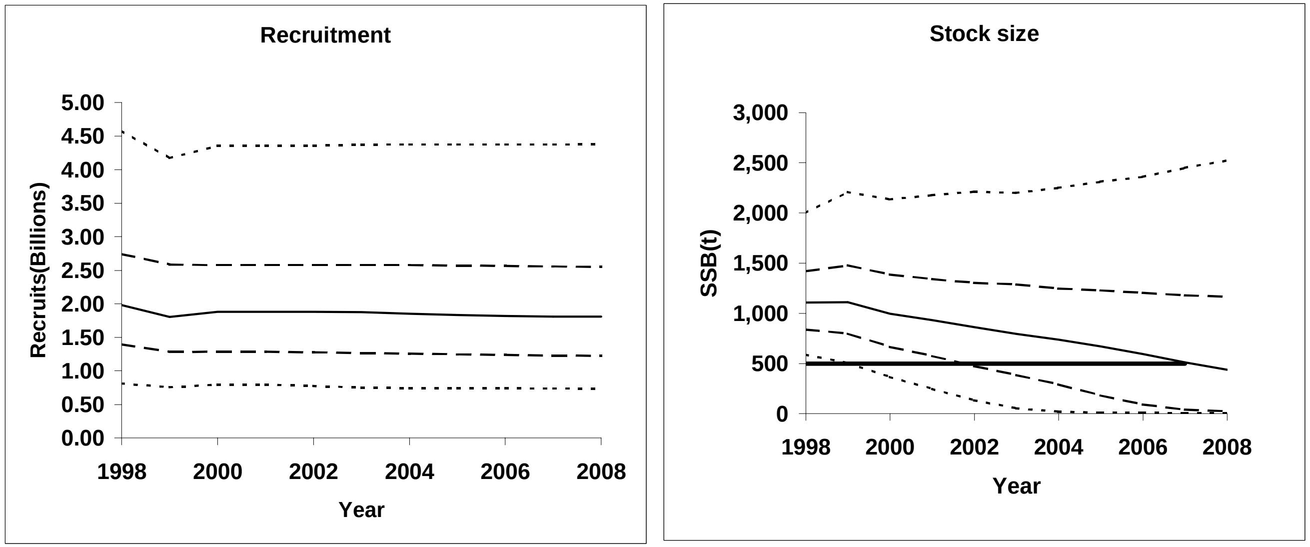
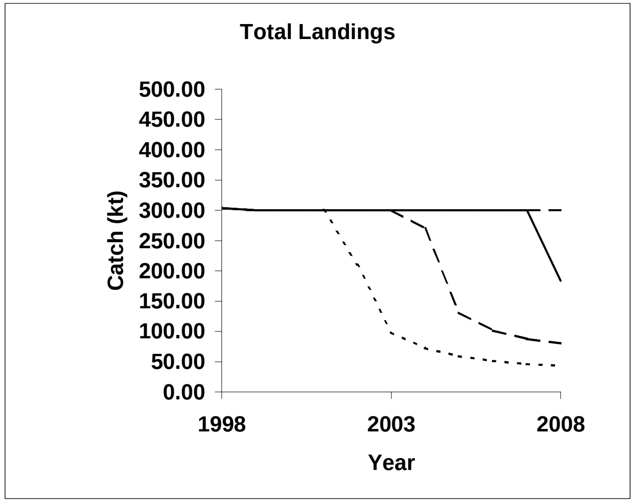


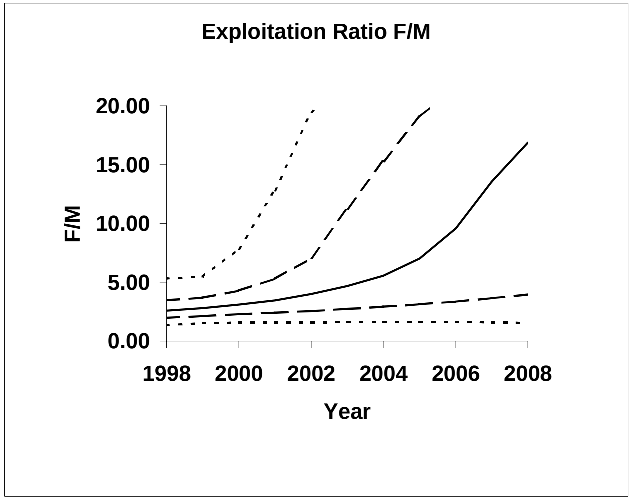
Figure 6.8.5

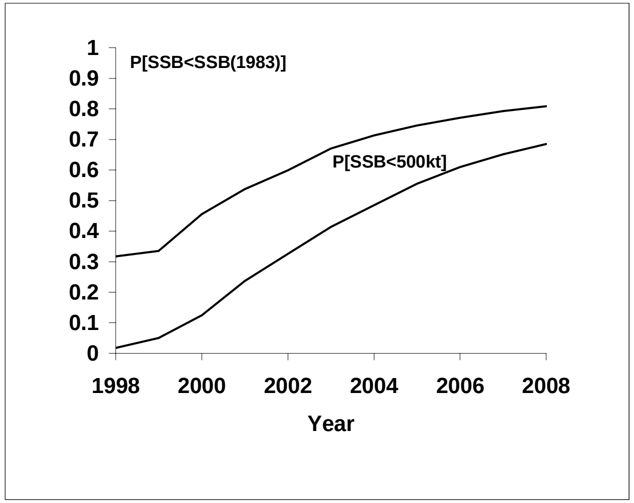
Western Horse mackerel. Baysian medium term projections.

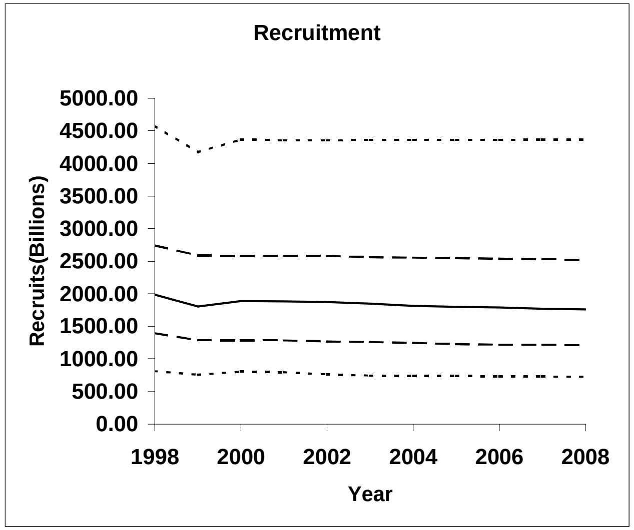
Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=150kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles









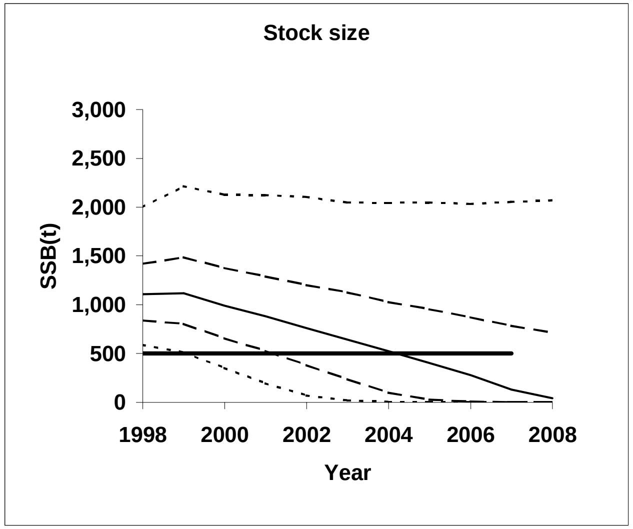


Figure 6.8.6

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=300kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

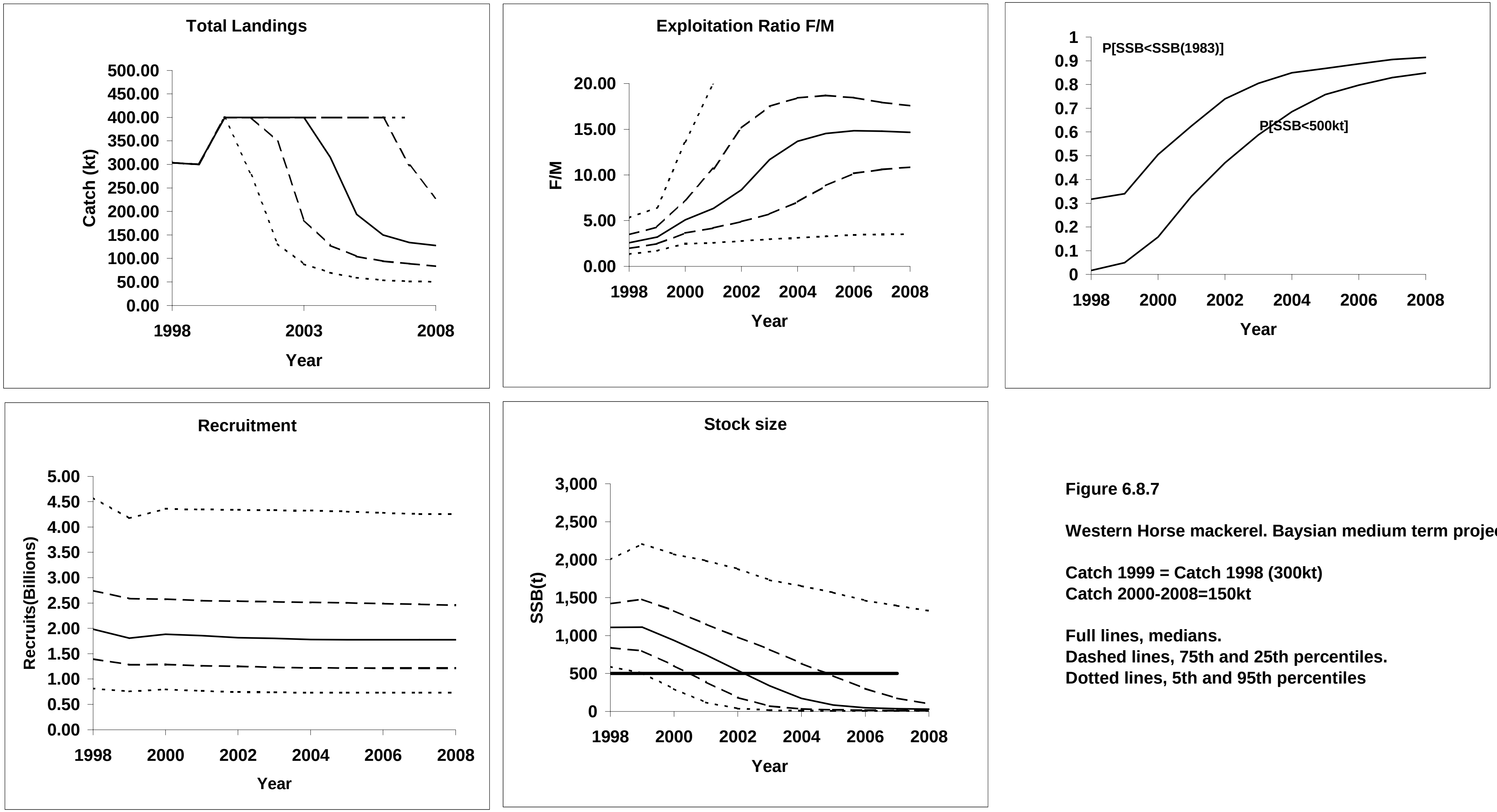


Figure 6.8.7

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
Catch 2000-2008=150kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

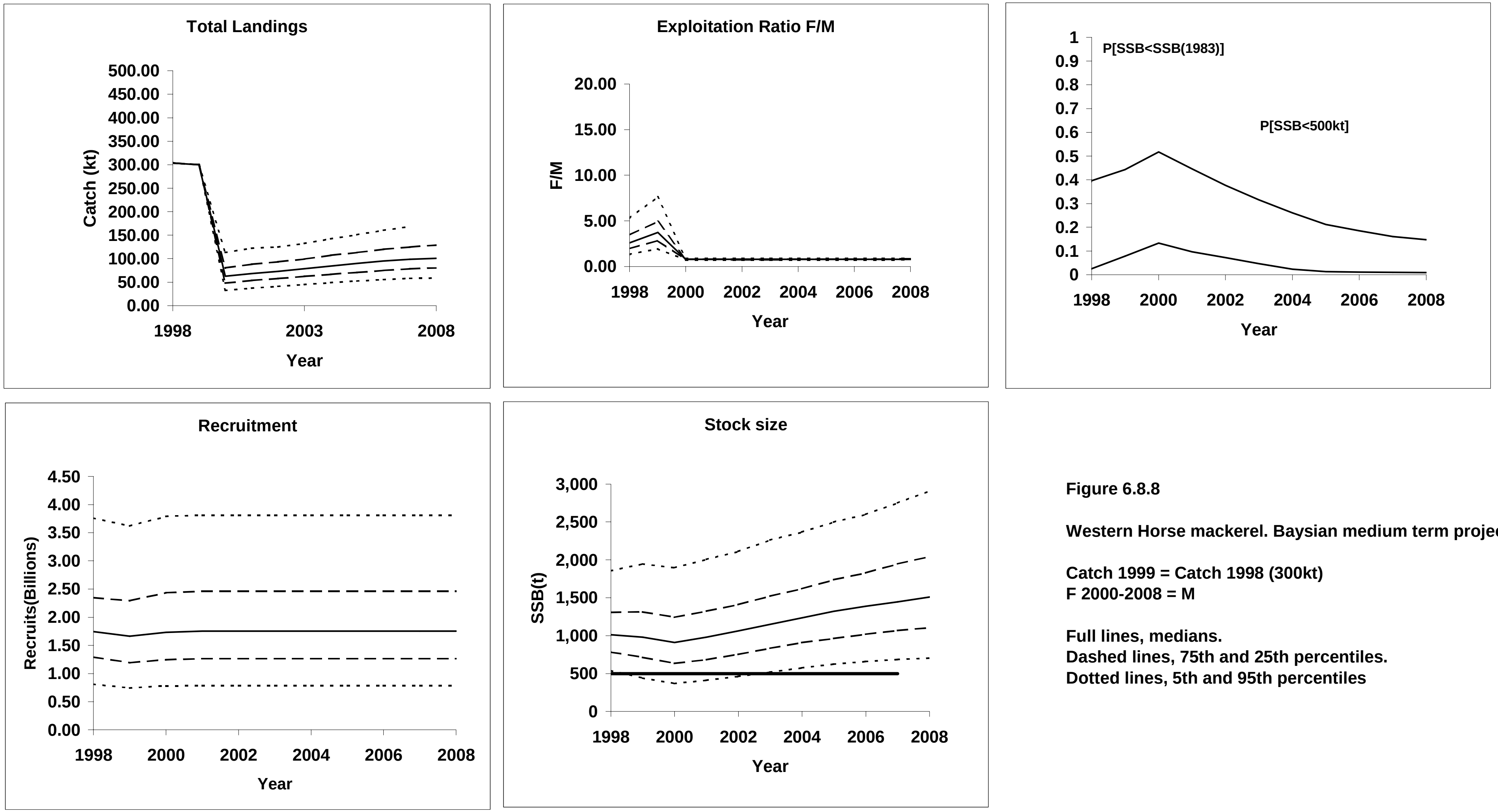
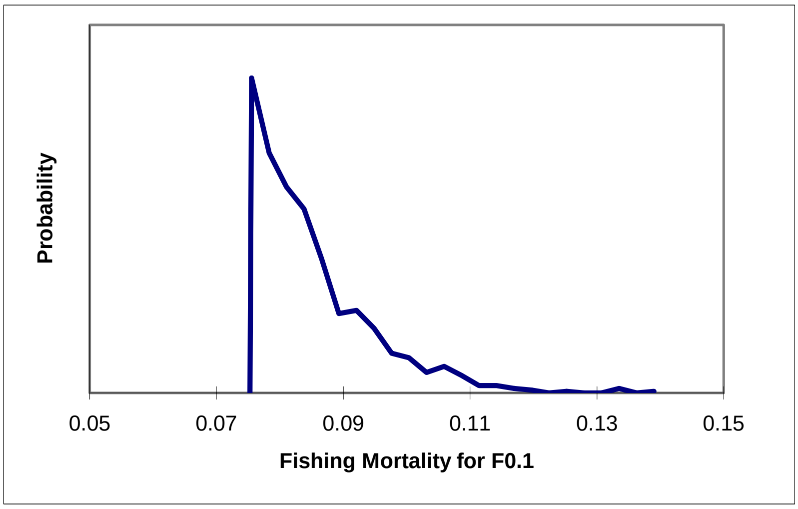


Figure 6.8.8

Western Horse mackerel. Baysian medium term projections.

Catch 1999 = Catch 1998 (300kt)
F 2000-2008 = M

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles



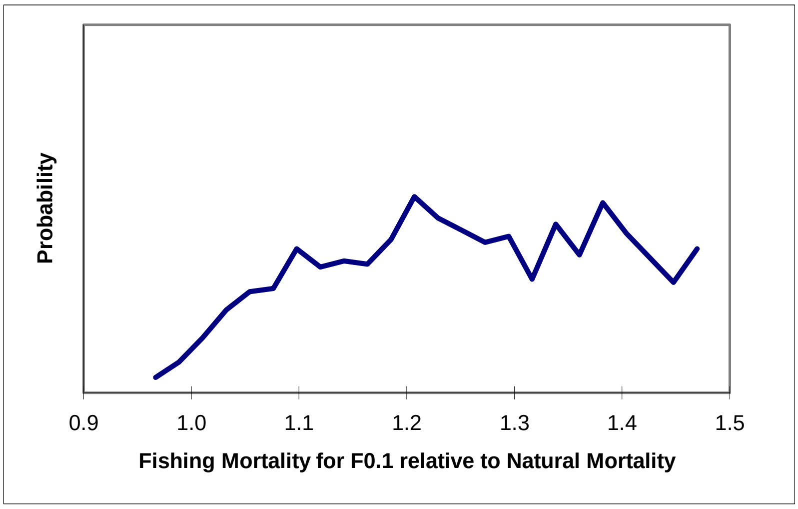


Figure 6.11.2.1 Western Horse Mackerel. Estimated posterior probability distribution for F0.1 (upper panel) and for F0.1/M (lower panel).

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIC AND IXA)

7.1 ICES advice Applicable to 1998 and 1999

ICES in 1999 stated that there are no explicit management objectives for this stock. However, for any management objectives to meet precautionary criteria, their aim should be to reduce or maintain F below F_{pa} and to increase or maintain spawning stock biomass above B_{pa}. ICES stated that fishing mortality should not be allowed to increase from 1997, corresponding to landings of 58,000 t in 1999. ICES proposes that B_{pa} be set at 205000 t and F_{pa} be established at 0.17, which is considered to provide 95% probability of avoiding F_{lim}. This level of F was estimated to correspond to a catch in 1999 of 58,000 t. A total catch of 69,000 t in 1999 ($F = 0.21$) was considered inconsistent with the precautionary approach. ICES recommended that the TAC for this stock should only apply to *Trachurus trachurus* and that other species of horse mackerel be excluded. The present TAC (73,000 t) includes catches of other species of horse mackerel.

7.2 The Fishery in 1998

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 64,480 t in 1998 which represents an increase of 13.6% compared to the 1997 catches. This level of catch is the highest since 1986 according to the time series data. The catch by country and gear is shown in Table 7.2.1. The Portuguese catches show an increase of 22% principally due to the increase in the catches from bottom trawlers, whereas in the Spanish catches the increase is 7.7% compared to 1997 catches, which represents the highest figure in the last fourteen years. The high level of catches reached on this stock during the last two years is due first to the higher catches obtained by the purse seiners and in second place to the increase by the Spanish (62%) and Portuguese (40%) bottom trawl catches during 1998. The large rise in the Spanish purse seiners catches in 1997 and 1998 can be explained by the falls in abundance of other target species, like sardine in the Spanish area, which has forced them to target other species like the horse mackerel (Villamor *et al.*, WD 1998). The proportion of the catches by gear presents a similar pattern than in 1998, being the purse seiners catches the most important ones in the Spanish area (69% of the catches) whereas in the Portuguese waters, the trawler's catches are the majority, representing the 62% of the Portuguese total catch. In 1998 the bottom trawl catches from Portugal and Spain present an increase of 40% and 62% respectively compared with the low values obtained in 1997.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.*, 1995; Villamor *et al.*, 1997), although the second and third quarter show relatively higher catches. (see Table 7.2.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus* in the area, not only *Trachurus trachurus* L. which is the species at present under assessment by this Working Group. The reported catch therefore always has to be revised by the Working Group in order to eliminate species of horse mackerel other than *Trachurus trachurus* (see Section 4.5).

7.3 Biological Data

7.3.1 Catch in numbers at age

The catch in numbers at age from all gears for 1998 are presented by quarter and area, disaggregated by Sub-division: VIIIc East, VIIIc West, IXa North, IXa Central North, IXa Central South and IXa South (Table 7.3.1.1a and 7.3.1.1b). Table 7.3.1.2 and Figure 7.3.1.1 present the catch in numbers by year. The 1982 year class is well represented in the catch in numbers at age matrix. The 1986 and 1987 year classes are strong but do not reach the extreme high level of the 1982 year class. The 1991 and 1992 year classes are shown as strong in the catches. In 1998 the increase in catches on intermediate ages (3 to 7) is also noticeable.

The sampling scheme is believed to achieve good coverage of the fishery. The number of fish aged seems also to be appropriate, with a total of 2,159 fish aged distributed by quarters. 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. The sampling intensity is discussed in Section 1.4.1. The data before 1985 have not yet been revised according to the approved ageing methodology. So, they have been considered inappropriate for a VPA and have not been included in the analytical assessment.

7.3.2 Mean length and mean weight at age

Tables 7.3.2.1a,b and 7.3.2.2a,b show the 1998 mean weights and mean lengths at age in the catch by quarter and Sub-division for the Spanish and Portuguese data. Table 7.3.2.3 presents the weight at age in the stock and in the catch. The matrix of mean weights at age in the stock was calculated in the following way: for each age, the mean weight in the catch in the fourth quarter of each year, was averaged with the mean weight in the catch in the first quarter of the following year. Then an overall average over the years was calculated for the final mean weight estimate for each age.

The data before 1985 have not yet been revised according to the approved ageing methodology and should therefore be considered only correct for ages 0 and 1, ages in which both methods were in agreement.

7.3.3 Maturity at age

The proportions of fish mature at each age have been considered to be constant over the assessment period. The maturity ogive used previous to the 1992 assessment (ICES 1993/Assess:7) presented low estimates at the age range 5 to 8 due to lower availability of this range of fish on the catches (ICES 1993/Assess:7; ICES 1998/Assess:6). As ACFM requested in 1992 the maturity ogive was smoothed as follows. It has been presented to the Working Group new information on maturity ogives based on samples from Sub-divisions VIIIc East, VIIIc West and IXa North (WD Pérez *et al.* 1999). As no new information has been presented from Sub-divisions IXa Central-North, IXa Central-South and IXa South it has not been possible to estimate a new maturity ogive for the whole stock, consequently changes in the maturity ogive have not been proposed. The Working Group recommends that new information on maturity at age from Division IXa be analysed and presented next meeting.

Age Group												
0	1	2	3	4	5	6	7	8	9	10	11	12
0.00	0.00	0.04	0.27	0.63	0.81	0.90	0.95	0.97	0.98	0.99	1.0	1.0

7.3.4 Natural mortality

According to the ageing methodology established in the ICES area (Eltink and Kuiper, 1989; ICES 1991/H:59) the life span for the southern horse mackerel was considered to be longer. Therefore the natural mortality was revised (ICES 1992/Assess:17), changing the previous level from 0.20 to the present 0.15. The analytical assessments performed since 1992 have not shown any inconsistency due to this level of natural mortality.

7.4 Fishery Independent Information and CPUE Indices of Stock Size

7.4.1 Trawl surveys

There are three survey series: The Portuguese July survey, the Portuguese October survey and the Spanish 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 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). This explains the special characteristics of the composition of the catches, the lower availability of fish after first maturing which creates a peculiar selection pattern.

Table 7.4.1.1 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. The biomass index from the Portuguese October survey was shown to be 74% lower than the high value obtained in 1997. The extremely high CPUE index obtained in 1993 has been revised changing from the initial estimation of 235.3 Kg/h to 57.6 Kg/h, which is much more consistent with the time series available. The series of the Portuguese July survey has a less variability in the data than that of the Portuguese October survey. In 1998 the index has also decreased 32% comparing with the index obtained in 1997. There was not Portuguese July survey in 1996. The Spanish October survey biomass index shows opposite trend to that indicated by the Portuguese surveys, with an increase of 94% compared with the 1997 index. This represents the highest CPUE level since 1985 and a continuity in the upward biomass trend that can be observed since 1992 (that had been broken with the value obtained in 1997).

Table 7.4.1.2 shows the number at age from the Spanish and Portuguese bottom trawl in the October surveys and from the Portuguese July survey. The Spanish September/October survey series is available from 1985 to 1998 and the Portuguese October survey from 1981–1998. Both are carried out during fourth quarter when the recruits have entered the area. In the Portuguese October survey the recruitment (age 0) observed in 1998 was one of the lowest value in the series contrasting with the extremely high value reached in 1997. In the Spanish area, the index at age 0 from the October survey is also one of the lowest value reached in the series, although higher than that obtained in 1997, continuing the low levels obtained since 1995. It seems that there exists no good agreement in trends between these surveys in the abundance index for 0 group. In the Spanish October survey in 1998 the strong 1986 and 1987 year classes are still abundant, an increase in the yields on the range of ages from 2 to seven years old was evident, changing the pattern observed in 1997 (Table 7.4.1.2). In the Portuguese July survey there is a strong fall in the 1995 abundance indices observed except for ages 0 and 1 that it is continuing in 1997 and 1998 compared with those obtained in 1994 despite using the same vessel, sampling and gear methodology. The 1982 year class is conspicuous in all the survey series but is stronger in the October Spanish bottom trawl survey.

7.4.2 Egg surveys

The problems of temporal and spatial coverage in 1998 were similar to those described for mackerel in section 3.3.2.1. Briefly the coverage was improved compared with the previous survey in 1995. Sampling began in the southern area in Division IXa on 17 January but this area was only surveyed during the first two sampling periods up to the end of February with no overlap with sampling in Division VIIIc. Sampling in VIIIc began in period 3 on 15 March and continued to the end of the last sampling period on 5 July.

Stage I horse mackerel eggs were found in each sampling period. Peak production of 26.6 x 10^{12} eggs per day (s.e. 25.11) occurred in IXa during February. Most of this was attributable to two adjacent rectangles close to the coast around 41°N. Production in these two rectangles was the highest in the whole of the southern area in 1998. Doubts have been raised about reliability of these values and checks are now being made on the identification of the eggs.

Egg production increased to a high on the Cantabrian coast during the fourth sampling period, declined and then increased again in the final period. This pattern was similar to that found in the western area.

The MHMEGG WG provided two values of annual egg production for 1998. The first included all the observed data including the two high values in period 2. This gave an estimate of 100.3 x 10^{13} eggs (s.e 80.7 x 10^{13}). By excluding the two high rectangle values in period 2 the estimate was reduced to 18.593 x 10^{13} eggs (s.e. 7.7 x 10^{13}).

Estimates of both potential fecundity and atresia were made. Some uncertainty was expressed about the potential fecundity estimate of 1247 oocytes per gram female because it was lower than the previous estimate in 1995 of 1572 oocytes per gram female. The atresia estimate was 69 oocytes per gram female.

Because of the uncertainty in the estimate of annual egg production the MHMEGG WG did not provide an estimate of SSB from the 1998 egg survey.

7.5 Effort and Catch per Unit Effort

Figure 7.5.1 shows the evolution of the commercial effort series from the Spanish trawl fleets fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Avilés) from 1984 to 1998. In 1998 there is no reliable estimation on the La Coruña bottom trawl fleet effort. The effort in Avilés bottom trawl fleet is at the similar level reached in 1997.

Table 7.5.1 presents the commercial catch rates from the trawl fleet fishing in Sub-divisions IXa Central North, IXa Central South and South (Portugal) from 1979 to 1990 and trawl fleets from Spain fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Avilés) from 1983 to 1998. In 1998 the Avilés trawl fleet showed a slight increase in the CPUE (4%) compared with the low level obtained in 1997. Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are not available since 1991, because the effort data series is under revision.

Catch per unit effort at age

CPUE at age from the Galician (La Coruña) bottom trawl fleet (Sub-division VIIIc West) and from the Cantabrian (Avilés) trawl fleet fishing in Sub-division VIIIc East are available from 1984 to 1998.

In the Galician trawl fleet a decrease in the catch rates of the ages in the range between "0" group to six years old was observed in 1997. The younger ages are also poorly represented in the Aviles trawl fleet in 1998. The extremely strong 1982 year class is still very prominent in the data for both fleets at age plus group 15 (Table 7.5.2). In 1998, the 1986 and 1987 year classes were confirmed as being strong ones, giving high indices of abundance in the Aviles trawl fleet and in the La Coruña trawl fleet for the time span available. As in the case of the catches at age, the CPUE at age from the Avilés trawl fleet in the range of ages (2–7) has increased significantly with respect to 1997 values.

7.6 Recruitment Forecasting

In 1998 the indices of the 0 group from the surveys carried out in the recruitment season were 22.7 fish/h for the Spanish October survey and 90.53 fish/h for the Portuguese October survey. Age 0 abundance indices obtained from these surveys cannot be analysed comparatively to each other, given that a conversion factor accounting for differences in gear and ship performance is not available yet. Figure 7.6.1 shows the evolution of these indices from 1985 to 1998. Both surveys present a large variability, especially in recent years. Indices variability in the Portuguese survey is higher that in the Spanish one, and no trends are noticed along the years in the Portuguese survey. The abundance indices of the Spanish survey present a slight decreasing trend over the years. From 1989 to 1994 these surveys show an opposite trend, but in 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate.

7.7 State of the Stock

7.7.1 Data exploration and preliminary modelling

All available data were used in the preliminary assessment of this stock. Given the high coherence of the time series and of the previous assessments carried out using Extended Survivors Analysis (XSA), no alternative methods were considered to be used with this stock. As in last year's assessment, XSA parameters were set at catchability independent of age for ages equal or greater than 9 years old, and the plus group at 12.

The strength of shrinkage has a significant decreasing effect on the standard errors of the log catchability (Anon. 1995/Assess:2). In order to compare the independent information provided by the different fleets, XSA was firstly run with each fleet in separate, without shrinkage.

The external information used in the tuning was:

Fleet 1: *Catch per unit of effort of the trawl fleet from A Coruña (VIIIc West - North Galicia)*
Fleet 2: *Catch per unit of effort of the trawl fleet from Avilés (VIIIc East - Cantabrian Sea)*
Fleet 3: *Portuguese October Trawl Survey during the recruitment season (Division IXa)*
Fleet 4: *Portuguese July Trawl Survey end of spawning season in Division IXa*
Fleet 5: *Spanish October trawl Survey during the recruitment season (Sub-division IXa North and Division VIIIc)*

The slopes of the linear regressions between log-catchability and log-population were analysed: Fleet 1, presented a negative slope at age 0, with a low coefficient of determination, as did Fleet 2, at age 1 with a slightly higher coefficient of determination. Therefore those ages were not included in the tuning, because they were not providing any information. For Fleet 2 it was considered also appropriate to eliminate ages 0 and 2 because these ages presented very high standard errors. The same procedure was used in Fleet 5 for ages 0 and 1 which also presented negative slopes with R-square close to 0, and in Fleet 4 for age 0 which also presented a high standard error and R-square equal to 0.

Figure 7.7.1.1 compares the SSB estimated for 1996, 1997 and 1998 by tuning fleet. The lowest SSB values were estimated from the July surveys and the highest ones correspond to the estimates provided by Fleet 2 which operates in the Cantabrian Sea during all year. The adults are more abundant in this area during spawning season, when spawning aggregations occur. In 1998 the CPUE of Fleet 1 increased, however there was no estimate of fishing effort provided for this fleet in 1998, hence the mean effort of the last 5 years was used instead. However, this made the SSB estimates from this fleet to rise to over 1 million tonnes. This figure is not consistent with the information from other fleets and from previous years, which suggests that this 5 year average is not suitable to replace the actual value of fishing effort. Therefore, it was decided to remove the 1998 CPUE of Fleet 1 from the assessment. The options for the final assessment were taken in accordance with this exploratory analysis, and keeping consistency with last year assessment.

7.7.2 Stock assessment

The final stock assessment was performed following the conclusions of the preliminary modelling (Section 7.7.1). Figure 7.7.2.1. also presents the SSB estimates from this year and last year assessments. A slight increase of SSB may be noticed from the 1998 assessment to the present one, and both assessments look very consistent with the SSB estimates provided by all fleets except for Fleet 2. Figure 7.7.2.1 shows the comparison of the Fs of the 1997 and 1998 assessments, which included all fleets with an F shrinkage of 1.00. It is clear that for the reference F_{bar} (1–11) the estimate shows an extremely close agreement with last year's assessment. Given the pattern of exploitation this stock is under a higher fishing mortality in the younger and older ages and a more reduced mortality at 4–6 years old. The estimates of F_{bar} (0–3) and F_{bar} (7–11) also show a very close agreement with last year assessment. Figure 7.7.2.2 represents the retrospective SSB estimates performed by the final VPA, and the 1995 egg survey estimate, indicating a very good agreement among them. The tuning diagnostics and final results are given in Tables 7.7.2.1–7.7.2.4. Figure 7.7.2.3 shows the fish stock summary trends over the period 1985–1998 according to the final assessment.

7.7.3 Reliability of the assessment and uncertainty estimation

This assessment is very consistent with the assessments performed in previous years. The spawning stock biomass estimated from the 1995 egg surveys is in close agreement with the 1995 SSB level estimated using the two October surveys, the July survey information and the two commercial fleets. Thus this assessment seems to be highly reliable, with a relatively low level of uncertainty.

7.8 Catch Predictions

The terminal population in 1998 from the final VPA was used as input to the catch forecast for age groups 1 and older. Recruitment at age 0 was assumed to be the geometric mean of the period 1985–1995. The exploitation pattern was taken as the arithmetic mean of the last three years, without scaling to the last year, which is assumed to correspond to the most likely exploitation in the short term. Table 7.8.1 gives the input parameters and Tables 7.8.2.a–c and Figure 7.8.1 show the results of the short-term predictions of the catch and spawning stock biomass.

At $F_{status\ quo}$ (F_{bar} 96–98) the predicted catch in weight for 1999 is 60,723 t. In 2000, assuming the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 60,954 t. The spawning stock biomass is predicted to decrease from 251,174 t at the beginning of 1999 to 238,450 t in 2000 (Table 7.8.2.a) at $F_{status\ quo}$, and to 223,000 t if the TAC of 73,000 t is taken in 1999 (Table 7.8.2.b). Assuming F status quo in 1999, the spawning stock biomass is predicted to decrease in 2001, at $F_{status\ quo}$ to 227567 t.

7.9 Short-Term Risk Analysis

A sensitivity analysis was performed on our short-term catch predictions using the methodology and software by Cook (1993). The results of this analysis are shown in the plots of Figure 7.9.1. The values plotted in the barplots are proportional to the influence of each parameter on the final value of the variables of interest: the yield in 2000 and the SSB in 2001 (a list of the parameters is given in Table 7.9.1 and their input values are in Table 7.9.2). The pies on the right side of Figure 7.9.1 show the relative percentages of the parameters variance.

The plot at the top of Figure 7.9.2 describes the probability of F(2000) being higher than $F_{\textit{status quo}}$, given several values of yield for 2000. It can be seen that for a catch of approximately 60,000 t in 2000, the F(2000) has a 0.5 probability of becoming higher than $F_{\textit{status quo}}$. The plot at the bottom of Figure 7.9.2 shows the probability of the SSB in 2001 being lower than a given value (in abcissa) assuming $F_{\textit{status quo}}$ for the whole period (1999–2001).

The probabilities shown in Figure 7.9.2 were calculated by the method of Cukier *et al.* (1978), in which values for the state variables are repeatedly calculated introducing periodic disturbances in the parameters. Empirical distributions of the state variables are then obtained, from which the variability due to each parameter can be estimated by Fourier analysis.

7.10 Medium-Term Predictions

Medium-term predictions were carried out using the software WGTERMA (ICES 1994/Assess:6). Predictions were made assuming stochastic recruitment and uncertainty in the initial population sizes. 500 simulations were performed. Figure 7.10.1 shows from left to right and top to bottom the stock-recruitment plot, the evolution of the yield, of the recruitment and of the SSB assuming $F_{\textit{status quo}}$ till 2007. The dotted line represents the average and solid lines the 5, 10, 20, 50 and 95 percentiles.

Figures 7.10.2 and 7.10.3 show the predicted values of SSB until 2000 and until 2007 assuming different Fs. F-factor 1.0 corresponds to $F_{\textit{status quo}}$. The value of this reference point is represented in these figures, along with $\mathbf{F}_{med}$ and F_{max}. All three reference points present relatively similar values. $\mathbf{B}_{pa}$ and $\mathbf{B}_{loss}$ are also represented in these figures as solid parallel lines. $\mathbf{B}_{pa}$ was defined as 200,000 t (see Section 7.12), corresponding roughly to the minimum observed SSB, if we exclude one extreme observation that is placed far from the cloud of points (see top-left plot in Figure 7.10.1). $\mathbf{B}_{loss}$ was defined as 132,000 t corresponding to the lowest SSB observed considering all points of the SSB-recruitment plot.

7.11 Long-Term Yield

The long-term yield per recruit and spawning biomass-per-recruit curves, against F, derived using the input data in Table 7.8.1 are shown in Figure 7.8.1. Table 7.11.1 presents the yield per recruit summary table. $F_{0.1}$ is estimated to be 0.1, and F_{max} to be 0.18, at the reference age (1–11).

7.12 Reference Points for Management Purpose

The reference points were estimated using the PA software (CEFAS, Lowestoft). The estimated $\mathbf{F}_{med}$ value is 0.17 and F_{high} corresponds to 0.26 (see Figure 7.12.1). The present level of $F_{status\ quo}$ of 0.18 is above the $\mathbf{F}_{med}$ level but bellow F_{max} which is 0.19.

As can be seen from Figure 7.12.2, the range of SSBs is quite narrow, and no stock-dependent trend in the recruitment can be inferred from these observations. The extremely strong 1982 year class has contributed substantially to the SSB during the whole period 1985–1998. The lowest biomass attained during the period was 132,000 t in 1985, which originated a medium recruitment. $\mathbf{F}_{loss}$ is 0.28, well above F_{max} and $\mathbf{F}_{med}$.

Last year this Working Group proposed F_{max} as $\mathbf{F}_{pa}$. This was further supported by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10). Our present results do not suggest any changes for this recommendation.

In 1998 ACFM defined B_{lim} as B_{loss}, and B_{pa} was defined as B_{loss} x 1.5 that corresponds to 198,000 t. F_{lim} was considered equal to F_{loss}, and F_{pa} was defined as F_{lim} x 0.63 which corresponds to 0.18. This working group considers there are not reasons to change these reference points.

7.13 Harvest Control Rules

No harvest control rules were proposed neither by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) nor by this Working Group.

7.14 Management Considerations

Table 7.14.1 summarises several management options at: $F_{status\ quo}$, F constrained to the official TAC of 73,000 t, F corresponding to TAC 1999, F_{med} and F_{max} (= F_{pa}).

In 1998, F attained a value higher than F_{pa} (F_{98} = 0.20). In order to prevent future increase of the fishing mortality two measures could be considered: a reduction of TAC to 65,000 t, which corresponds to F_{pa}, and a reduction of fishing effort. An increase of the fishing effort should be avoided.

The Working Group noted that the Study Group on Multiannual assessment proposed that assessments may only be necessary every three years for this stock, and endorses this conclusion.

The Working Group also considers that the TAC should not be applied to all *Trachurus* species combined but only to *Trachurus trachurus*.

Table 7.2.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984–1998 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1962	7,231	46,345	3,400	56,976	-	-	-	-	53,202	110,778
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,733	28,776	19,330	376[1]	-	48,482	72,235
1982	12,676	9,906	8,304	30,886	-[2]	-[2]	-[2]	-	28,450	59,336
1983	16,768	6,442	7,741	30,951	8,511	34,054	797	-	43,362	74,313
1984	8,603	3,732	4,972	17,307	12,772	15,334	884	-	28,990	46,297
1985	3,579	2,143	3,698	9,420	16,612	16,555	949	-	34,109	43,529
1986	-[2]	-[2]	-[2]	28,526	9,464	32,878	481	143	42,967	71,493
1987	11,457	6,744	3,244	21,445	-[2]	-[2]	-[2]	-[2]	33,193	54,648
1988	11,621	9,067	4,941	25,629	-[2]	-[2]	-[2]	-[2]	30,763	56,392
1989	12,517	8,203	4,511	25,231	-[2]	-[2]	-[2]	-[2]	31,170	56,401
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205
1991	9,437	5,003	3,056	17,497	9,681	18,019	187	127	28,014	45,511
1992	12,189	7,027	3,438	22,654	11,146	16,972	81	103	28,302	50,956
1993	14,706	4,679	6,363	25,747	14,506	16,897	124	154	31,681	57,428
1994	10,494	5,366	3,201	19,061	10,864	22,382	145	136	33,527	52,588
1995	12,620	2,945	2,133	17,698	11,589	23,125	162	107	34,983	52,681
1996	7,583	2,085	4,385	14,053	10,360	19,917	214	146	30,637	44,690
1997	9,446	5,332	1,958	16,736	8,140	31,582	169	143	40,034	56,770
1998	13,221	5,906	2,217	21,334	13,150	29,805	63	118	43,136	64,480

[1]Estimated value.
[2]Not available by gear.

Table 7.2.2 Southern horse mackerel catches by quarter and area.

Country/Sub-division	Spain 8c-E, 8c-W, 9a-N		Unit:tonnes		Total
Quarter/ Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34116
1986	-	-	-	-	42967
1987	5179	8678	11067	8269	33193
1988	6445	7936	7918	8464	30763
1989	7824	7480	8011	7855	31170
1990	6827	7871	7766	6783	29247
1991	5369	7220	8741	6686	28016
1992	4065	8750	10042	5445	28302
1993	5546	9227	9823	7085	31681
1994	6486	8966	9732	8343	33527
1995	6050	10328	10969	7636	34983
1996	7188	8045	8211	7193	30637
1997	6638	11132	13854	8410	40034
1998	8244	10696	13089	11107	43135

Country/ Sub-division	Portugal 9a-CN, 9a-CS, 9a-S		Unit:tonnes		Total
Quarter/ Year	1	2	3	4	
1984	4669	6506	3577	2358	17110
1985	1226	3055	2946	2192	9419
1986	4627	8093	7542	8264	28526
1987	3902	5474	6654	3524	19554
1988	3069	7402	7554	7100	25125
1989	4074	9096	8543	3513	25226
1990	3341	5753	5873	4992	19959
1991	3101	5630	5094	3672	17497
1992	2516	5661	7196	7281	22654
1993	5455	6401	8384	5507	25747
1994	4418	5051	6386	3206	19061
1995	3240	4618	6038	3802	17698
1996	2649	3830	4068	3506	14053
1997	4449	5370	4218	2699	16736
1998	5498	5846	6005	3995	21344

Table 7.3.1.1a.- Southern horse mackerel catch in numbers at age by quarter and area

For Period 1

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	44451.83	1735.22	38416.21	3883.23	375.53	646.10	89508.12
2	13676.83	2114.82	8347.62	1393.66	2023.83	947.80	28504.56
3	10755.98	7247.61	6525.21	3865.44	2134.65	1407.16	31936.05
4	1146.72	1436.89	420.96	567.53	573.36	869.67	5015.14
5	579.67	1599.87	493.35	444.37	1142.97	1748.62	6008.85
6	1157.35	1772.44	833.84	424.23	1552.49	2927.09	8667.44
7	1061.02	967.21	994.50	146.60	1311.60	2402.22	6883.15
8	835.30	566.08	638.05	57.61	765.08	1680.01	4542.13
9	607.88	464.44	397.48	18.40	356.34	949.58	2794.13
10	547.71	443.79	468.95	15.05	273.10	702.73	2451.34
11	234.93	109.84	470.93	2.80	220.81	734.17	1773.48
12	110.24	70.87	387.17	0.29	162.58	519.38	1250.54
13	247.38	86.24	125.68	0.37	54.42	137.81	651.90
14	216.52	45.43	206.95	0.00	77.28	242.43	788.61
15	164.74	22.90	723.19	0.00	160.84	538.41	1610.08

For Period 2

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	51270.42	706.56	29559.17	1953.75	4811.92	46.17	88348.00
2	18791.07	906.06	13561.58	1812.95	4682.66	1480.54	41234.86
3	12895.46	4979.00	2896.86	2416.26	1510.34	2886.13	27584.06
4	2515.78	2304.81	100.34	1018.51	957.71	2107.46	9004.61
5	856.52	714.74	142.91	177.32	1740.85	4147.25	7779.59
6	959.21	356.21	629.70	55.42	2403.43	5362.93	9766.89
7	892.79	300.28	1203.36	27.02	1152.75	3620.12	7196.32
8	520.23	200.56	903.67	9.67	667.50	2243.93	4545.56
9	503.02	181.94	709.27	6.58	270.07	1113.83	2784.72
10	756.51	251.43	774.40	7.20	173.06	936.39	2898.99
11	571.07	194.06	865.33	3.23	112.17	769.40	2515.25
12	285.75	73.22	688.37	2.49	85.70	578.09	1713.62
13	427.46	153.75	207.45	2.72	32.55	168.92	992.85
14	52.99	20.20	364.80	0.30	45.69	285.85	769.83
15	613.84	47.68	1319.91	0.22	99.28	1035.61	3116.55

For Period 3

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	653.02	2266.40	19.04	401.26	279.05	329.22	3947.99
1	28299.21	840.36	6898.34	5768.16	1970.62	8544.09	52320.79
2	9607.07	8572.54	3984.71	3956.33	556.00	12122.22	38798.85
3	1242.68	1567.63	673.37	823.63	228.65	7933.82	12469.79
4	1744.69	1999.00	1287.22	571.42	1612.12	5872.25	13086.69
5	1746.60	1113.99	2549.36	203.82	1157.85	1280.13	8051.75
6	1296.35	697.29	3663.43	81.19	734.96	1180.25	7653.47
7	1096.22	742.69	4020.39	52.20	314.93	1361.63	7588.06
8	505.60	291.78	2253.37	15.15	115.01	829.85	4010.76
9	347.06	206.13	933.67	10.16	76.69	547.73	2121.46
10	296.53	154.63	551.00	11.63	7.47	438.47	1459.73
11	66.06	12.83	1421.44	1.26	36.21	709.88	2247.67
12	318.61	28.02	1564.57	1.68	46.39	763.31	2722.58
13	132.12	25.66	578.80	2.52	10.60	407.52	1157.21
14	1027.64	22.50	254.36	0.00	6.03	209.47	1520.00
15	270.01	23.24	2029.72	2.37	164.42	1238.83	3728.59

For Period 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	7228.58	1247.22	1679.10	1131.83	12.29	0.00	11299.02
1	6047.41	404.95	6727.76	1119.66	1362.33	1946.42	17608.54
2	19370.12	2453.49	6564.68	4154.82	760.11	8058.81	41362.02
3	2163.10	3295.98	1638.01	1206.86	251.44	7772.31	16327.71
4	505.01	1621.62	7762.26	618.13	619.59	7262.64	18389.25
5	440.29	696.52	4675.39	331.04	528.38	1648.78	8320.40
6	427.14	432.83	3853.58	196.28	453.86	819.58	6183.27
7	842.08	682.57	2965.52	218.44	300.80	511.91	5521.33
8	306.69	190.62	1452.81	35.00	128.99	241.73	2355.84
9	91.01	29.13	704.72	4.15	60.95	142.81	1032.76
10	40.55	22.21	317.74	1.01	11.14	77.27	469.92
11	30.12	25.77	849.16	1.45	54.36	184.80	1145.65
12	28.50	17.24	923.95	1.01	62.83	180.76	1214.28
13	5.73	3.95	266.64	0.00	7.79	151.58	435.69
14	5.48	1.42	149.99	0.00	2.53	72.19	231.60
15	4.25	0.82	1076.41	0.00	54.89	834.07	1970.44

Table 7.3.1.1.b.- Catch in numbers at age by area in 1998

For Periods 1 to 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	7881.60	3513.63	1698.14	1533.09	291.34	329.22	15247.02
1	130068.87	3687.10	81601.49	12724.79	8520.40	11182.79	247785.44
2	61445.09	14046.90	32458.59	11317.75	8022.60	22609.37	149900.28
3	27057.23	17090.23	11733.45	8312.19	4125.09	19999.41	88317.61
4	5912.20	7362.32	9570.78	2775.58	3762.79	16112.02	45495.68
5	3623.08	4125.11	7861.02	1156.54	4570.06	8824.79	30160.61
6	3840.05	3258.76	8980.54	757.12	5144.74	10289.86	32271.07
7	3892.11	2692.75	9183.77	444.26	3080.08	7895.89	27188.85
8	2167.82	1249.04	5247.90	117.43	1676.58	4995.51	15454.28
9	1548.98	881.64	2745.14	39.29	764.05	2753.96	8733.07
10	1641.30	872.07	2112.09	34.90	464.76	2154.87	7279.99
11	902.17	342.50	3606.86	8.74	423.55	2398.25	7682.06
12	743.09	189.35	3564.06	5.47	357.50	2041.54	6901.01
13	812.68	269.61	1178.57	5.61	105.36	865.82	3237.64
14	1302.64	89.55	976.10	0.30	131.53	809.94	3310.05
15	1052.83	94.64	5149.23	2.59	479.43	3646.93	10425.66

TABLE 7.3.1.2 -Catch in numbers at age by year.

The SAS System 15:09 Tuesday, September 21, 1999
HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

CANUM01: Catch in Numbers (Total International Catch) (Total) (Thousands)

Year	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
1981	53700	315700	136200	58800	20400	47800	34800	23000	24100	0	0	0	0	0	0	0
1982	104700	122600	115000	77700	27000	22200	28000	28300	27600	0	0	0	0	0	0	0
1983	182300	1109100	74800	24400	22600	31500	34900	20600	20200	0	0	0	0	0	0	0
1984	12200	71100	459700	40700	3800	8900	21600	20000	18000	0	0	0	0	0	0	0
1985	393697	297486	84887	79849	26197	14665	7075	7363	3981	6270	4614	3214	2702	1699	864	4334
1986	615298	425659	96999	64701	122560	27584	13610	24346	12080	6694	8198	6349	5838	3244	2023	2963
1987	53320	618570	170015	66303	28789	81020	21825	10485	5042	3795	2337	1999	1666	951	1029	1906
1988	121951	271052	94945	39364	22598	20507	92897	17212	11669	10279	7042	4523	6050	2514	1379	3717
1989	242537	158646	70438	93590	37363	25474	22839	52657	11308	14892	11182	2728	2243	4266	1456	3791
1990	48100	164206	100833	60289	35931	14307	11786	12913	76713	9463	6562	3481	2568	2017	2430	4409
1991	31786	69544	71451	24222	33833	28678	13952	14578	11948	64501	8641	5671	3933	1970	2113	2164
1992	45629	285197	107761	51971	21596	23308	24973	14167	11384	12496	52251	4989	4043	2480	1815	4045
1993	10719	101326	262637	95182	35647	23159	22311	35258	11881	15094	5813	36062	1653	879	823	2304
1994	9435	113345	264744	93214	23624	11374	18612	22740	26587	8207	5142	2546	10266	1291	1001	1210
1995	3512	161142	124731	93349	47507	15997	11235	13608	19931	16763	8550	5664	4846	11717	2367	2809
1996	38345	35453	57096	41157	53002	27873	11580	11378	8384	19061	14339	6302	5896	3923	9571	4317
1997	8553	376888	157423	58132	34944	22297	11403	11704	17014	9206	19672	13436	4009	2045	906	7297
1998	15247	247786	149900	88318	45496	30161	32271	27189	15454	8733	7280	7682	6901	3238	3310	10426

Table 7.3.2.1a.- Southern horse mackerel mean weight at age by quarter and area

For Period 1

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0224	0.0268	0.0253	0.0206	0.0337	0.0222	0.0237
2	0.0276	0.0443	0.0568	0.0350	0.0708	0.0882	0.0428
3	0.0640	0.0613	0.0747	0.0628	0.0843	0.0971	0.0683
4	0.0881	0.1000	0.1161	0.0943	0.1341	0.1403	0.1088
5	0.1152	0.1085	0.1652	0.1082	0.1576	0.1587	0.1377
6	0.1405	0.1229	0.1939	0.1175	0.1735	0.1791	0.1599
7	0.1634	0.1584	0.2284	0.1396	0.2008	0.2135	0.1962
8	0.1457	0.1737	0.2285	0.1466	0.2080	0.2203	0.1989
9	0.2158	0.2188	0.2456	0.1814	0.2164	0.2357	0.2271
10	0.2193	0.2192	0.3135	0.1936	0.2636	0.2685	0.2562
11	0.2878	0.2645	0.3042	0.2099	0.2746	0.2696	0.2814
12	0.2650	0.2650	0.3186	0.2650	0.2899	0.2839	0.2927
13	0.2899	0.2899	0.3183	0.2899	0.2713	0.2869	0.2932
14	0.3534	0.3524	0.3206	0.0000	0.2898	0.2941	0.3203
15	0.5122	0.4425	0.4121	0.0000	0.3986	0.4020	0.4180

For Period 2

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0274	0.0315	0.0287	0.0332	0.0326	0.0328	0.0283
2	0.0315	0.0392	0.0457	0.0381	0.0496	0.0914	0.0408
3	0.0666	0.0633	0.0728	0.0664	0.0936	0.0968	0.0713
4	0.0932	0.1005	0.0955	0.0979	0.1390	0.1372	0.1108
5	0.1275	0.1226	0.2146	0.1214	0.1485	0.1498	0.1451
6	0.1454	0.1431	0.2454	0.1390	0.1593	0.1681	0.1676
7	0.1591	0.1603	0.2567	0.1539	0.1848	0.2005	0.2004
8	0.1802	0.1808	0.2503	0.1678	0.1909	0.2100	0.2104
9	0.2027	0.1949	0.2609	0.1629	0.2021	0.2258	0.2261
10	0.2215	0.2049	0.3095	0.1729	0.2420	0.2836	0.2647
11	0.2356	0.2096	0.2929	0.1943	0.2833	0.2746	0.2673
12	0.2422	0.2125	0.3081	0.1726	0.2878	0.2917	0.2863
13	0.2236	0.2029	0.3181	0.1868	0.2681	0.2856	0.2521
14	0.2327	0.2146	0.3157	0.1990	0.2810	0.2977	0.2985
15	0.3859	0.2929	0.4255	0.2268	0.3920	0.4207	0.4130

For Period 3

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0218	0.0183	0.0254	0.0232	0.0184	0.0262	0.0201
1	0.0404	0.0501	0.0532	0.0419	0.0449	0.0506	0.0442
2	0.0625	0.0722	0.0701	0.0682	0.0690	0.0914	0.0751
3	0.1014	0.1021	0.1249	0.1010	0.1312	0.1206	0.1155
4	0.1255	0.1211	0.1480	0.1176	0.1609	0.1308	0.1334
5	0.1427	0.1385	0.2146	0.1345	0.1836	0.1805	0.1765
6	0.1562	0.1586	0.2320	0.1546	0.2001	0.2351	0.2091
7	0.1782	0.1776	0.2461	0.1769	0.2220	0.2566	0.2300
8	0.2109	0.2018	0.2604	0.2060	0.2312	0.2744	0.2517
9	0.2108	0.2041	0.2848	0.2086	0.2258	0.3147	0.2701
10	0.2160	0.2137	0.3227	0.2180	0.3369	0.3279	0.2903
11	0.2429	0.2429	0.2931	0.2429	0.2851	0.3040	0.2947
12	0.2655	0.2655	0.2891	0.2655	0.2883	0.3271	0.2967
13	0.2429	0.2429	0.3932	0.2429	0.3956	0.3936	0.3726
14	0.3318	0.3017	0.4051	0.0000	0.3816	0.3896	0.3517
15	0.5294	0.2217	0.3418	0.2217	0.5076	0.3605	0.3681

For Period 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0355	0.0308	0.0179	0.0346	0.0185	0.0000	0.0323
1	0.0421	0.0383	0.0519	0.0426	0.0521	0.0728	0.0499
2	0.0610	0.0691	0.0815	0.0602	0.0731	0.0933	0.0712
3	0.0802	0.0930	0.1322	0.0907	0.1241	0.1221	0.1094
4	0.1168	0.1109	0.1537	0.1132	0.1537	0.1363	0.1407
5	0.1442	0.1330	0.1884	0.1329	0.1920	0.1686	0.1755
6	0.1628	0.1492	0.2149	0.1408	0.2112	0.2126	0.2038
7	0.1840	0.1706	0.2388	0.1467	0.2309	0.2383	0.2179
8	0.1950	0.1907	0.2539	0.1643	0.2431	0.2562	0.2394
9	0.2500	0.2242	0.2674	0.1746	0.2360	0.2718	0.2630
10	0.2459	0.2253	0.3275	0.1828	0.3163	0.3244	0.3145
11	0.2016	0.2016	0.2836	0.2016	0.2663	0.3641	0.2917
12	0.2200	0.2011	0.2886	0.1828	0.2627	0.3299	0.2905
13	0.3757	0.3736	0.3867	0.0000	0.3366	0.4303	0.4007
14	0.4571	0.4165	0.3895	0.0000	0.3665	0.4403	0.4069
15	0.4754	0.4296	0.3318	0.0000	0.2816	0.4980	0.4011

Table 7.3.2.1b.- Mean weight at age by area

For Periods 1 to 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0344	0.0227	0.0179	0.0316	0.0184	0.0262	0.0291
1	0.0292	0.0343	0.0311	0.0341	0.0386	0.0528	0.0316
2	0.0448	0.0653	0.0588	0.0564	0.0585	0.0919	0.0585
3	0.0683	0.0717	0.0851	0.0717	0.0927	0.1161	0.0835
4	0.1037	0.1083	0.1506	0.1046	0.1500	0.1346	0.1292
5	0.1349	0.1232	0.1959	0.1220	0.1647	0.1595	0.1604
6	0.1495	0.1363	0.2220	0.1291	0.1740	0.1825	0.1823
7	0.1710	0.1670	0.2432	0.1484	0.1999	0.2166	0.2111
8	0.1762	0.1840	0.2530	0.1613	0.2055	0.2264	0.2222
9	0.2124	0.2106	0.2685	0.1847	0.2139	0.2493	0.2415
10	0.2204	0.2142	0.3165	0.1971	0.2580	0.2891	0.2702
11	0.2486	0.2279	0.2923	0.2075	0.2768	0.2887	0.2822
12	0.2547	0.2390	0.2959	0.2080	0.2844	0.3063	0.2923
13	0.2480	0.2370	0.3705	0.2189	0.2876	0.3620	0.3234
14	0.3319	0.3096	0.3514	0.1990	0.2925	0.3331	0.3357
15	0.4428	0.3128	0.3711	0.2221	0.4212	0.4152	0.3955

Table 7.3.2.2a. Southern horse mackerel mean length at age by quarter and area

For Period 1

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	13.4968	14.3451	14.1512	13.1002	15.6174	13.5247	13.7860
2	14.2484	17.0658	18.6801	15.3466	20.1812	21.8894	16.4843
3	19.5512	19.2247	20.7259	19.4066	21.5600	22.6843	19.9719
4	21.8413	22.8288	24.0576	22.3624	25.4136	25.8373	23.4706
5	23.9730	23.5023	27.3324	23.4850	26.8978	26.9582	25.5125
6	25.6391	24.4824	28.8737	24.1408	27.8288	28.0998	26.8636
7	27.0144	26.7030	30.6078	25.5949	29.3163	29.9166	28.9111
8	25.0982	27.4182	30.6539	25.8847	29.7044	30.2862	28.8725
9	29.6911	29.8635	31.4470	27.9719	30.1070	31.0228	30.4638
10	29.8927	29.9029	34.1193	28.6356	31.9990	32.3684	31.6398
11	32.7768	31.7700	33.8903	29.4200	32.6598	32.5117	32.8805
12	32.0000	32.0000	34.4377	32.0000	33.2138	33.0606	33.3530
13	33.0000	33.0000	34.4281	33.0000	32.3908	33.1386	33.2538
14	35.3169	35.2803	34.5290	0.0000	33.1658	33.4643	34.3277
15	39.8429	38.1072	37.6589	0.0000	37.1703	37.1274	37.6622

For Period 2

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	14.5255	15.2886	14.8197	15.5853	15.5226	15.4863	14.7083
2	15.2535	16.4928	17.4139	16.3342	17.7833	22.1831	16.5749
3	19.8117	19.4322	20.5698	19.7644	22.3185	22.6194	20.2497
4	22.2755	22.8829	22.4762	22.6799	25.7739	25.6533	23.6416
5	24.8621	24.5269	30.0199	24.4469	26.3853	26.4420	26.0997
6	26.0145	25.8653	31.4780	25.6124	27.0524	27.5059	27.4334
7	26.8171	26.8874	31.9699	26.5290	28.4490	29.2494	29.1656
8	27.9558	28.0099	31.7181	27.3248	28.8148	29.7770	29.7300
9	29.0435	28.6941	32.1871	27.0031	29.3737	30.5400	30.4472
10	29.9004	29.1769	34.0474	27.5581	31.1071	32.8630	31.9686
11	30.5598	29.4316	33.4620	28.7340	33.0286	32.6937	32.2317
12	30.7784	29.4838	34.0514	27.5649	33.1652	33.3366	33.0156
13	30.0317	29.1038	34.4602	28.3559	32.3029	33.0291	31.3932
14	30.4825	29.6843	34.3704	29.0000	32.8680	33.5562	33.5862
15	36.1771	32.8137	38.0286	30.3268	36.9784	37.9355	37.5192

For Period 3

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	12.9343	12.1368	14.2148	13.2474	12.6499	14.3989	12.6165
1	16.2008	17.2413	18.3645	16.4007	17.2886	17.8769	16.8395
2	18.9155	20.0047	20.2133	19.5293	20.0516	22.1943	20.3927
3	22.6259	22.6925	24.8864	22.6120	25.3063	24.5899	24.0541
4	24.4451	24.1371	26.3710	23.8776	27.1794	25.2666	25.2682
5	25.5962	25.3127	30.0402	25.0540	28.4611	28.1656	27.7708
6	26.4473	26.5927	30.8805	26.3500	29.3345	31.0025	29.5613
7	27.7168	27.6854	31.5391	27.6454	30.4340	31.9916	30.6183
8	29.4363	28.9869	32.1651	29.1902	30.8211	32.7347	31.6580
9	29.4409	29.1105	33.1006	29.3327	30.4995	34.3053	32.3131
10	29.7174	29.6011	34.7049	29.8150	35.2301	34.9027	33.1742
11	31.0000	31.0000	33.3970	31.0000	33.0794	33.8876	33.4614
12	32.0000	32.0000	33.2377	32.0000	33.2112	34.7059	33.4905
13	31.0000	31.0000	37.0495	31.0000	37.2190	37.1102	36.2345
14	34.5933	33.4724	37.5196	0.0000	36.8000	37.0365	35.4119
15	40.2263	30.0000	35.1385	30.0000	40.3837	35.8836	35.9505

For Period 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	15.4775	14.6120	12.5711	15.3352	12.6688	0.0000	14.9327
1	16.4640	15.9059	18.0594	16.5394	18.2757	20.5723	17.6598
2	18.8356	19.6545	21.3745	18.7271	20.4365	22.4074	20.0016
3	20.7781	21.9281	25.3786	21.7207	24.8323	24.6968	23.4692
4	23.7439	23.3458	26.7464	23.5182	26.7191	25.6321	25.8146
5	25.6785	24.9460	28.6804	24.9473	28.8922	27.5575	27.8513
6	26.7389	25.9702	30.0538	25.4785	29.8916	29.9311	29.3655
7	27.9135	27.1762	31.2019	25.8329	30.8476	31.1724	29.9682
8	28.5428	28.3303	31.8685	26.9012	31.3872	31.9488	31.0574
9	31.1499	29.9061	32.3370	27.4720	30.9827	32.5036	32.0874
10	30.8560	29.9269	34.8849	28.0000	34.4628	34.7649	34.2584
11	29.0000	29.0000	33.0944	29.0000	32.4345	35.8047	33.2953
12	29.6441	28.8084	33.2380	28.0000	32.2450	34.7417	33.2589
13	36.2208	36.1515	36.8582	0.0000	35.1486	38.2790	37.3072
14	38.7924	37.5787	37.0298	0.0000	36.3020	38.6284	37.5652
15	39.3514	38.0000	34.8025	0.0000	33.0169	40.1622	37.0326

Table 7.3.2.2b. Mean length (cm) at age by area and total. 1998.

For Periods 1 to 4

Ages	IXaCN	IXaCS	IXaN	IXaS	VIIIcE	VIIIcW	Total
0	15.2667	13.0154	12.5895	14.7888	12.6507	14.3989	14.3330
1	14.6286	15.3574	15.0718	15.2805	16.3754	18.0848	15.0349
2	16.7316	19.2746	18.8842	18.2080	18.7968	22.2567	18.4914
3	19.9147	20.1246	21.5757	20.1642	22.2448	24.2130	21.2816
4	22.9570	23.3148	26.5329	23.0483	26.4768	25.5127	24.9689
5	25.1730	24.4125	29.0611	24.3275	27.3292	27.0027	26.9120
6	26.1281	25.2827	30.3813	24.8322	27.8632	28.2691	28.1552
7	27.3615	27.1145	31.3858	26.0097	29.2555	30.0499	29.6696
8	27.2831	28.0188	31.8223	26.7328	29.5563	30.5447	30.1807
9	29.5105	29.4475	32.4291	28.1087	29.9571	31.5572	31.0998
10	29.8884	29.6407	34.3609	28.7880	31.7778	33.1849	32.2474
11	31.1172	30.2078	33.4058	29.3247	32.7644	33.2311	32.8999
12	31.4399	30.7365	33.5253	29.2460	33.0315	33.9027	33.3069
13	31.1363	30.6339	36.2709	29.8517	33.0532	35.8864	34.2940
14	34.5640	33.6003	35.6333	29.0000	33.2893	34.8808	34.8797
15	37.8020	33.4490	36.1631	30.0281	37.7571	37.6285	36.8883

TABLE 7.3.2.3 - Southern Horse Mackerel Mean Weight At Age In The Stock

The SAS System 15:09 Tuesday, September 21, 1999

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WEST01: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	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
1981	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1982	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1983	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1984	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1985	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1986	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1987	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1988	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1989	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1990	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1991	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1992	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1993	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1994	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1995	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1996	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1997	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1998	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381

The SAS System 15:09 Tuesday, September 21, 1999

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WECA01: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	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
1981	0.02300	0.04000	0.06700	0.09700	0.17400	0.25400	0.29200	0.34100	0.40700	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1982	0.02000	0.03300	0.08200	0.11500	0.15200	0.22600	0.26100	0.29600	0.36300	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1983	0.01300	0.02800	0.06100	0.12500	0.15900	0.22500	0.26700	0.29400	0.36100	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1984	0.01500	0.02500	0.04900	0.08000	0.12400	0.17800	0.24600	0.27500	0.33100	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1985	0.01400	0.02700	0.07000	0.09100	0.11700	0.13200	0.15200	0.18200	0.24900	0.26400	0.28400	0.31200	0.32000	0.34400	0.35700	0.37800
1986	0.01600	0.02900	0.05500	0.07600	0.10400	0.13700	0.18500	0.19400	0.20900	0.29000	0.30100	0.31900	0.32900	0.33900	0.34900	0.34900
1987	0.02438	0.03103	0.04907	0.05773	0.09611	0.10599	0.13089	0.16139	0.19782	0.21087	0.24560	0.30215	0.28754	0.35218	0.36110	0.35816
1988	0.02675	0.03620	0.06615	0.08189	0.11089	0.12563	0.15601	0.15642	0.20171	0.23866	0.24866	0.27488	0.31379	0.33343	0.32738	0.35506
1989	0.01552	0.04060	0.06185	0.08931	0.10854	0.13226	0.15202	0.18910	0.19973	0.20304	0.24761	0.31987	0.34492	0.35909	0.37478	0.38929
1990	0.01627	0.03514	0.04741	0.07572	0.12389	0.13047	0.15456	0.16970	0.18229	0.21408	0.25974	0.27211	0.31612	0.34461	0.36809	0.38845
1991	0.01602	0.03339	0.06310	0.10214	0.13343	0.15142	0.16788	0.17345	0.19267	0.19640	0.23322	0.23563	0.28031	0.30412	0.32301	0.37211
1992	0.01800	0.02900	0.04800	0.07800	0.10500	0.14100	0.16200	0.17300	0.18200	0.19100	0.21400	0.24000	0.27800	0.31300	0.34100	0.38700
1993	0.01500	0.03400	0.04000	0.06400	0.10900	0.15500	0.17100	0.20200	0.22500	0.22500	0.25500	0.25000	0.32100	0.36400	0.39700	0.46100
1994	0.02100	0.03600	0.05800	0.06900	0.09700	0.14200	0.18200	0.20500	0.22600	0.25000	0.27600	0.29900	0.29500	0.34300	0.36300	0.39100
1995	0.02900	0.03600	0.05800	0.09100	0.11000	0.13900	0.17300	0.18900	0.21800	0.23500	0.27300	0.29100	0.30500	0.29000	0.36200	0.39200
1996	0.01300	0.02900	0.06600	0.10400	0.13000	0.15400	0.18100	0.20600	0.21200	0.22600	0.25700	0.27900	0.26000	0.31300	0.31000	0.44100
1997	0.02200	0.03300	0.05400	0.09100	0.12300	0.14900	0.17100	0.20200	0.20900	0.24600	0.23300	0.26500	0.31300	0.35000	0.39000	0.34700
1998	0.02500	0.03800	0.06200	0.09300	0.12200	0.15200	0.17300	0.19500	0.20800	0.22600	0.25700	0.26000	0.26600	0.30600	0.33500	0.38700

Table 7.4.1.1 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

	Portugal IXa (20-500 m depth)			Spain (20-500m depth)
	Bottom trawl (20-mm codend)			
Year	Kg/h March	kg/h Jun-Jul	kg/h Oct	kg/30 minutes Sept-Oct
1979		12.2	5.5[1]	-
1980		20.6	2.5[1]	-
1981		11.6	1.8	-
1982		42.1	36.9	-
1983		79.1	24.6	37.97
1984		-	-	51.98
1985		9.5	3.8	20.93
1986		4.8	23.5	10.14
1987		-	6.9	-
1988		-	26.0	12.05
1989		14.9	11.7	15.48
1990		14.4	21.5	9.62
1991		11.8	16.9	4.92
1992	17.5	38.0	40.8	20.30
1993	100.24	35.6	57.6[2]	18.11
1994	_	49.3	12.4	21.61
1995	_	9.8	18.9	21.99
1996	_	_	23.3	26.75
1997	_	21.0	59.6	14.43
1998	_	14.3	15.4	27.99

[2].- Revised

TABLE 7.4.1.2 - CPUE at age from surveys

The SAS System 15:21 Tuesday, September 21, 1999

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT03: Oct Pt Survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	1	0.070	0.060	0.003	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	1	706.196	123.479	82.500	70.046	12.621	2.445	0.313	0.552	0.370	0.238	0.189	0.286	0.181	0.126	0.051	0.115
1987	1	95.243	24.377	29.541	12.419	9.802	5.673	1.163	0.519	0.487	0.368	0.225	0.165	0.248	0.047	0.022	0.019
1988	1	29.416	704.046	54.984	20.207	13.920	6.472	21.741	8.294	1.834	0.878	0.298	0.030	0.001	0.001	0.001	0.001
1989	1	377.665	93.538	40.406	20.064	6.196	3.956	3.847	2.395	0.662	0.320	0.430	0.398	0.162	0.139	0.012	0.004
1990	1	508.494	269.582	28.907	16.472	17.014	9.822	1.794	1.187	3.577	2.600	1.532	0.624	0.770	0.266	0.239	0.179
1991	1	336.245	97.414	14.704	13.411	14.272	6.571	3.895	2.275	2.331	1.951	1.006	0.405	0.350	0.238	0.220	0.185
1992	1	677.806	500.049	184.896	34.300	15.932	8.153	6.113	6.745	4.196	3.251	3.805	0.497	0.702	0.178	0.082	0.086
1993	1	394.160	48.720	74.690	25.385	8.416	0.491	0.216	0.216	0.152	0.196	0.130	0.305	0.084	0.050	0.016	0.011
1994	1	4.217	9.499	75.879	44.908	19.693	5.142	2.013	1.022	0.850	0.534	0.234	0.189	0.126	0.089	0.053	0.030
1995	1	6.972	9.386	148.650	56.402	26.310	8.156	3.383	0.709	0.527	0.383	0.260	0.219	0.227	0.228	0.221	0.215
1996	1	1225.000	5.750	6.979	16.346	19.530	8.052	2.129	0.592	0.209	0.135	0.106	0.062	0.047	0.031	0.005	0.005
1997	1	2832.548	21.619	110.750	18.102	51.410	67.224	19.203	14.257	5.914	6.939	2.386	0.109	0.028	0.126	0.079	0.054
1998	1	90.534	33.609	182.002	4.166	1.937	1.448	1.071	1.289	0.270	0.032	0.012	0.011	0.012	0.000	0.000	0.041

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT04: Oct Sp. Survey,bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	1	182.630	84.360	322.000	468.000	7.100	6.500	4.710	4.050	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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	1	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

TABLE 7.4.1.2 ctd. - CPUE at age from surveys

The SAS System
15:21 Tuesday, September 21, 1999
HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT05: Jul Pt. Survey, bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1989	1	81.91291	38.35600	45.52200	60.64800	26.99800	5.84600	3.16400	6.63400
1990	1	82.17500	51.60500	69.39700	26.15700	12.39300	5.58800	3.67000	3.51500
1991	1	17.42900	53.09400	19.47900	3.50700	3.90600	3.97800	2.49500	3.12800
1992	1	109.17800	1822.95000	39.70100	21.08100	7.98000	5.01300	3.42700	3.34800
1993	1	1.81000	263.39000	263.80000	150.04000	20.84000	39.56000	89.15000	31.34000
1994	1	54.98100	408.26200	232.99500	110.93500	49.98800	34.72400	38.43800	20.98500
1995	1	5.41000	38.57100	16.13200	23.07100	26.69900	12.23300	5.57700	2.07100
1996	0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1997	1	29.13900	330.30500	71.13100	8.19900	11.93200	4.99300	1.96900	1.37100
1998	1	116.24343	166.29800	74.10800	7.29200	4.74000	2.50880	1.27600	0.64800

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1989	3.04200	3.71600	1.44000	0.79300	0.61300	0.21400	0.15700	0.24400
1990	7.74500	3.00100	1.36300	0.69500	0.75800	0.44500	0.35600	0.47000
1991	3.56600	7.63700	3.53700	3.57400	2.28800	2.49100	0.50800	0.41300
1992	3.87900	5.61600	9.99800	3.98800	5.77200	3.20500	1.03800	0.48100
1993	22.69000	9.53000	0.52000	0.64000	0.05000	0.02000	0.00000	0.00000
1994	5.72500	3.90500	3.55000	3.19300	5.48500	1.88300	1.05700	0.86700
1995	0.54000	0.27000	0.22300	0.15800	0.26300	0.11500	0.09100	0.10300
1996	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1997	0.24900	0.16900	0.17000	0.46200	0.05400	0.00000	0.00000	0.01200
1998	0.21200	0.15140	0.12100	0.00866	0.08126	0.01733	0.03333	0.01895

Table 7.5.1 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Division IXa (Portugal)	Division VIIIc (Spain)	
	Trawl	Trawl	
		Sub-div. VIIIc East Aviles	Sub-div. VIIIc West La Coruña
	kg/h	kg/Hp.day. 10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.4
1984	55.9	142.94	135.87
1985	24.4	131.22	118.00
1986	41.6	116.90	130.84
1987	71.0	109.02	176.65
1988	91.1	88.96	146.63
1989	69.5	98.24	172.84
1990	98.9	125.35	146.27
1991	n.a.	106.42	145.09
1992	n.a.	73.70	163.12
1993	n.a.	71.47	200.50
1994	n.a.	137.56	136.75
1995	n.a.	130.44	124.11
1996	n.a.	145.64	156.50
1997	n.a.	89.56	117.39
1998	n.a.	93.28	n.a.

TABLE 7.5.2 - CPUE at age from fleets

The SAS System 15:21 Tuesday, September 21, 1999

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT01: 8c West trawl fleet (La Coruna) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	32427	1	356	644	124	38	38	8	87	30	42	5	6	1	6	3	12
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	23668	0	0	16	58	101	90	130	147	96	58	48	56	50	20	18	74

The SAS System 15:21 Tuesday, September 21, 1999

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT02: 8c East trawl fleet (Aviles) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	10185	4	882	759	138	412	39	11	65	18	31	3	4	1	6	3	11
1985	9856	1	167	613	574	130	18	16	13	17	21	14	4	4	1	4	19
1986	10845	36	223	271	176	535	42	19	14	10	8	9	2	1	1	0	2
1987	8309	1	244	350	166	48	396	40	19	7	9	6	5	3	1	1	4
1988	9047	181	264	53	23	18	19	148	14	17	22	15	12	22	6	5	27
1989	8063	65	275	62	105	50	42	18	100	13	38	35	1	1	18	2	15
1990	8492	1	726	373	257	72	19	21	24	192	10	13	3	4	4	4	9
1991	7677	39	495	882	41	85	51	10	12	9	67	3	2	1	1	1	1
1992	12693	2	35	21	67	35	60	63	20	16	19	114	3	1	1	0	7
1993	7635	0	215	462	77	44	23	18	42	6	14	2	35	1	0	0	1
1994	9620	1	47	632	12	6	17	69	118	135	25	14	3	38	1	0	0
1995	6146	1	182	441	141	70	32	25	39	89	71	31	12	4	37	1	1
1996	4525	0	225	608	129	230	128	32	24	22	49	32	10	4	4	17	0
1997	5061	0	48	10	15	34	43	36	49	83	34	76	42	8	2	0	14
1998	5032	0	0	2	34	34	63	93	102	63	28	16	16	11	3	4	5

Table 7.7.2.1 - XSA Diagnostics

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 Lowestoft VPA Version 3.1

   18/09/1999  17:22

 Extended Survivors Analysis

 S. horse mackerel (run: XSAHOM14/X14)

 CPUE data from file fleet

 Catch data for  14 years. 1985 to 1998. Ages  0 to  12.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,    year, year,  age ,  age
 FLT01: 8c West trawl,   1985, 1998,   0,    11,   .000,  1.000
 FLT02: 8c East trawl,   1985, 1998,   0,    11,   .000,  1.000
 FLT03: Oct Pt Survey,   1985, 1998,   0,    11,   .800,   .900
 FLT04: Oct Sp. Surve,   1985, 1998,   0,    11,   .790,   .880
 FLT05: Jul Pt. Surve,   1989, 1998,   0,    11,   .540,   .630


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  2


      Catchability independent of age for ages >=    9


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


TABLE 7.7.2.1 ctd. - XSA Diagnostics


 Tuning had not converged after   70 iterations


 Total absolute residual between iterations
 69 and  70 =     .00147

 Final year F values
 Age         ,      0,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 69,  .0140,  .2728,  .2428,  .3973,  .2398,  .0858,  .0954,  .1189,  .2204,  .1419
 Iteration 70,  .0140,  .2730,  .2434,  .3976,  .2398,  .0859,  .0954,  .1190,  .2204,  .1419


 Age         ,     10,     11
 Iteration 69,  .2146,  .1521
 Iteration 70,  .2145,  .1520



Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
```

Table 7.7.2.1 ctd. - XSA Diagnostics

Fishing mortalities

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	.257	.060	.019	.027	.009	.013	.005	.028	.007	.014
1	.276	.262	.110	.217	.075	.116	.290	.063	.384	.273
2	.108	.268	.164	.236	.300	.268	.171	.149	.408	.243
3	.152	.120	.090	.163	.318	.156	.135	.074	.211	.398
4	.190	.076	.087	.102	.152	.114	.105	.100	.079	.240
5	.167	.097	.076	.075	.144	.063	.100	.079	.053	.086
6	.240	.103	.123	.084	.091	.156	.077	.093	.040	.095
7	.087	.197	.170	.168	.154	.120	.155	.099	.121	.119
8	.201	.166	.266	.183	.197	.158	.139	.128	.200	.220
9	.307	.244	.194	.463	.371	.192	.134	.180	.191	.142
10	.595	.204	.347	.225	.383	.196	.295	.154	.271	.214
11	.416	.348	.257	.326	.227	.271	.324	.348	.200	.152

XSA population numbers (Thousands)

	AGE									
YEAR	0	1	2	3	4	5	6	7	8	9
1989	1.16E+06	7.09E+05	7.44E+05	7.14E+05	2.33E+05	1.78E+05	1.15E+05	6.84E+05	6.69E+04	6.07E+04
1990	8.86E+05	7.69E+05	4.63E+05	5.75E+05	5.28E+05	1.66E+05	1.30E+05	7.80E+04	5.40E+05	4.71E+04
1991	1.86E+06	7.18E+05	5.10E+05	3.05E+05	4.39E+05	4.21E+05	1.30E+05	1.01E+05	5.51E+04	3.94E+05
1992	1.81E+06	1.58E+06	5.53E+05	3.72E+05	2.40E+05	3.47E+05	3.36E+05	9.87E+04	7.32E+04	3.64E+04
1993	1.31E+06	1.52E+06	1.09E+06	3.76E+05	2.72E+05	1.86E+05	2.77E+05	2.66E+05	7.18E+04	5.25E+04
1994	8.12E+05	1.12E+06	1.21E+06	6.96E+05	2.36E+05	2.01E+05	1.39E+05	2.17E+05	1.96E+05	5.08E+04
1995	7.32E+05	6.90E+05	8.56E+05	7.99E+05	5.12E+05	1.81E+05	1.63E+05	1.02E+05	1.66E+05	1.44E+05
1996	1.52E+06	6.27E+05	4.45E+05	6.21E+05	6.01E+05	3.97E+05	1.41E+05	1.30E+05	7.54E+04	1.24E+05
1997	1.31E+06	1.28E+06	5.07E+05	3.30E+05	4.97E+05	4.68E+05	3.16E+05	1.10E+05	1.01E+05	5.71E+04
1998	1.19E+06	1.12E+06	7.48E+05	2.90E+05	2.30E+05	3.95E+05	3.82E+05	2.61E+05	8.42E+04	7.12E+04

Estimated population abundance at 1st Jan 1999

0.00E+00	1.01E+06	7.32E+05	5.04E+05	1.68E+05	1.56E+05	3.12E+05	2.99E+05	2.00E+05	5.82E+04

Taper weighted geometric mean of the VPA populations:

1.25E+06	1.01E+06	6.63E+05	4.65E+05	3.53E+05	2.78E+05	2.04E+05	1.42E+05	9.53E+04	6.72E+04

Standard error of the weighted Log(VPA populations) :

.3476	.3451	.3536	.4601	.5057	.5398	.5880	.6243	.6671	.7169

	AGE	
YEAR	10	11
1989	2.69E+04	8.64E+03
1990	3.84E+04	1.28E+04
1991	3.18E+04	2.70E+04
1992	2.79E+05	1.93E+04
1993	1.97E+04	1.92E+05
1994	3.11E+04	1.16E+04
1995	3.61E+04	2.20E+04
1996	1.08E+05	2.31E+04
1997	8.94E+04	8.01E+04
1998	4.06E+04	5.87E+04

Estimated population abundance at 1st Jan 1999

5.32E+04	2.82E+04

Taper weighted geometric mean of the VPA populations:

4.36E+04	2.69E+04

Standard error of the weighted Log(VPA populations) :

.7877	.8843

TABLE 7.7.2.1 ctd. - XSA Diagnostics

Log catchability residuals.

Table 7.7.2.1 ctd. - XSA Diagnostics

Fleet : FLT01: 8c West trawl

Age	1985	1986	1987	1988
0	99.99	99.99	99.99	99.99
1	-.10	.51	-.26	.68
2	.83	.04	.83	.80
3	1.37	2.10	1.91	1.29
4	-.24	1.16	2.21	1.00
5	.24	.31	1.43	.67
6	.13	-.18	.93	.49
7	-.24	-.61	.25	-.21
8	-.10	-.41	-.81	-.60
9	-.12	-.63	.14	-.54
10	-.31	.33	.13	-.24
11	-.50	-.06	-.12	-.29

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	1.11	.80	-.86	.44	-.28	.42	-.04	-.69	-1.07	99.99
2	-.72	.82	-.37	-.01	1.26	.71	.16	-.47	-2.74	99.99
3	1.10	.17	-2.03	-.56	.74	-1.01	.72	-.68	-1.92	99.99
4	.95	.32	-.67	-.83	.68	-.93	-.24	.33	-1.87	99.99
5	.60	-.57	-.59	-.04	1.05	-.50	-.21	.42	-1.67	99.99
6	.17	-.35	-.25	.11	.05	.95	-.25	.42	-1.70	99.99
7	-.27	-.08	.26	.00	.36	.29	.18	.05	-.44	99.99
8	-.09	.09	.43	.07	.17	.34	.19	-.01	-.02	99.99
9	.59	-.77	.06	.60	.50	-.27	-.31	.23	.08	99.99
10	1.26	-.33	.33	.41	-.11	-.42	.03	.21	.23	99.99
11	-.25	-.85	-.33	-.28	.11	-.90	-.48	.74	.24	99.99

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-19.1027	-19.9855	-19.4129	-18.7905	-18.2980	-17.6490	-17.4539	-17.0486	-17.0486	-17.0486
S.E(Log q)	1.1262	1.3500	1.0769	.8457	.7209	.2943	.3363	.4560	.4553	.5265

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	.000	.00	.00	0	.00	.00
1	.39	.908	16.57	.21	13	.74	-20.84

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.42	1.438	15.82	.43	13	.45	-19.10
3	.62	.603	17.40	.23	13	.87	-19.99
4	1.25	-.280	21.09	.13	13	1.42	-19.41
5	1.10	-.168	19.40	.26	13	.98	-18.79
6	1.29	-.531	20.07	.29	13	.97	-18.30
7	.93	.444	17.26	.84	13	.29	-17.65
8	.86	1.034	16.62	.87	13	.29	-17.45
9	.98	.096	16.93	.74	13	.47	-17.05
10	.88	.747	16.20	.83	13	.40	-16.93
11	.78	1.773	15.70	.89	13	.34	-17.26

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Fleet : FLT02: 8c East trawl

Age	1985	1986	1987	1988
0	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	.49	1.02	1.15	-.87
4	1.02	.56	.36	-.81
5	-.70	.04	.71	-.40
6	-.45	-.58	.51	-.19
7	-.32	-.72	-.44	-.67
8	-.05	-.54	-1.03	-.62
9	-.19	-.83	-.19	.13
10	-.10	-.76	-.52	.74
11	-.54	-1.71	-.73	.47

Table 7.7.2.1 ctd. - XSA Diagnostics

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	-.06	.99	-.13	-.30	.41	-2.37	.39	.83	-.74	.30
4	.35	-.21	.25	-.53	.11	-1.99	.13	1.47	-.38	.48
5	.38	-.42	-.28	-.42	-.22	-.87	.34	1.23	-.15	.43
6	-.08	-.16	-.79	-.42	-.97	.86	.10	.80	-.02	.77
7	-.61	.14	-.73	-.70	-.45	.54	.65	.21	.98	.86
8	-.54	.00	-.63	-.88	-1.33	.53	.72	.41	1.37	1.29
9	.43	-.73	-.87	-.13	-.34	-.04	.38	.49	.79	.36
10	1.29	-.28	-1.39	-.49	-1.30	-.13	1.01	.19	1.19	.40
11	-1.21	-.58	-1.68	-1.41	-.78	-.64	.57	.66	.67	.00

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	.0000	-17.6170	-17.6296	-17.5783	-17.4920	-17.0998	-16.8359	-16.5832	-16.5832	-16.5832
S.E(Log q)	.0000	.9758	.8727	.5957	.6215	.6616	.9029	.5275	.8925	.9721

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	.000	.00	.00	0	.00	.00
1	.00	.000	.00	.00	0	.00	.00

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.00	.000	.00	.00	0	.00	.00
3	1.05	-.075	17.87	.17	14	1.08	-17.62
4	.61	1.201	15.75	.51	14	.52	-17.63
5	.68	1.453	15.96	.69	14	.38	-17.58
6	1.11	-.280	18.05	.42	14	.72	-17.49
7	.96	.135	16.87	.49	14	.66	-17.10
8	.67	1.170	15.09	.58	14	.60	-16.84
9	1.03	-.113	16.74	.64	14	.57	-16.58
10	.89	.335	15.92	.50	14	.83	-16.56
11	.83	.652	15.85	.61	14	.74	-17.00

Fleet : FLT03: Oct Pt Survey

Age	1985	1986	1987	1988
0	-2.54	-.22	-.23	-.18
1	-4.01	.84	-.72	1.79
2	-9.17	.98	.00	-.15
3	-11.06	1.98	.17	.66
4	-8.83	-1.18	.54	.76
5	-7.22	-.09	-1.13	1.05
6	-7.00	-1.44	-.03	.95
7	99.99	-.36	-.80	2.17
8	99.99	.15	-.08	.88
9	99.99	-.12	.55	.98
10	99.99	-.38	.12	.99
11	99.99	.63	-.23	-1.44

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	.43	.73	-.15	.10	.25	-.64	-.38	.45	.85	-.09
1	.95	1.55	.87	1.21	-.35	-1.09	-.52	-.87	-.54	-.18
2	-.24	.03	-.83	1.68	.15	.03	.97	-1.45	1.40	1.37
3	-.16	-.17	.23	1.03	.85	.67	.74	-.30	.56	-.63
4	.01	.11	.13	.86	.13	1.10	.60	.14	1.28	-1.09
5	.43	1.35	.00	.41	-1.72	.48	1.08	.27	2.20	-1.44
6	1.37	.37	1.16	.63	-2.51	.46	.76	.45	1.80	-1.23
7	-1.14	.42	.79	1.90	-2.54	-.82	-.40	-.86	2.50	-.77
8	.10	-.33	1.61	1.85	-1.44	-.76	-1.09	-1.23	1.88	-1.01
9	-.39	1.91	-.55	2.57	-.68	.20	-1.22	-2.08	2.65	-2.99
10	.97	1.55	1.44	.49	-.10	-.13	-.09	-2.21	1.20	-3.35
11	1.87	1.87	.61	1.21	-1.66	.71	.26	-1.03	-1.83	-3.86

Table 7.7.2.1 ctd. - XSA Diagnostics

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11
Mean Log q,	-9.3579,	-10.0590,	-10.2602,	-10.8783,	-11.3446,	-11.2209,	-11.3301,	-11.3749,	-11.3749,	-11.3749,
S.E(Log q),	2.0273,	2.2456,	1.8622,	1.8181,	1.8383,	1.5199,	1.2565,	1.8013,	1.5148,	1.7674,

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,	.30,	1.111,	12.50,	.21,	14,	.70,	-8.92,
1,	.65,	.293,	11.21,	.07,	14,	1.31,	-9.83,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	.43,	.720,	11.65,	.15,	14,	.90,	-9.36,
3,	-.57,	-2.097,	14.75,	.16,	14,	1.11,	-10.06,
4,	.83,	.168,	10.68,	.10,	14,	1.63,	-10.26,
5,	.98,	.021,	10.92,	.08,	14,	1.87,	-10.88,
6,	.84,	.188,	11.49,	.13,	14,	1.62,	-11.34,
7,	-2.03,	-2.237,	13.27,	.06,	13,	2.61,	-11.22,
8,	1.88,	-.764,	11.19,	.08,	13,	2.42,	-11.33,
9,	-6.54,	-1.579,	9.51,	.00,	13,	10.99,	-11.37,
10,	1.29,	-.361,	11.62,	.14,	13,	2.05,	-11.41,
11,	-2.44,	-3.154,	6.63,	.09,	13,	3.07,	-11.70,

Fleet : FLT04: Oct Sp. Surve

Age ,	1985,	1986,	1987,	1988
0 ,	99.99,	99.99,	99.99,	99.99
1 ,	99.99,	99.99,	99.99,	99.99
2 ,	4.01,	.69,	1.21,	.09
3 ,	3.15,	.84,	.89,	1.01
4 ,	.51,	.50,	1.65,	.24
5 ,	.46,	.20,	-.47,	.87
6 ,	.20,	.09,	.18,	.61
7 ,	.32,	1.02,	.31,	.05
8 ,	.36,	.57,	.26,	-.10
9 ,	.11,	.84,	.87,	.58
10 ,	.20,	.98,	.71,	1.32
11 ,	-.35,	.55,	.65,	.57

Age ,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998
0 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	-1.71,	-.73,	-.29,	-2.24,	-1.33,	.34,	.09,	1.49,	.16,	.78
3 ,	1.05,	-.83,	-3.10,	-1.30,	-1.69,	-1.69,	-.20,	1.04,	1.06,	2.37
4 ,	.20,	.52,	-1.69,	-2.49,	-.74,	-1.00,	-.44,	1.20,	-.14,	2.71
5 ,	1.51,	.40,	-1.69,	-1.36,	.10,	-.63,	-.07,	.72,	-.57,	1.13
6 ,	1.51,	.56,	-1.80,	-.95,	.38,	.09,	.12,	.32,	-1.05,	.40
7 ,	.54,	.44,	-2.10,	-.16,	.21,	-.20,	.59,	.44,	-.40,	-.24
8 ,	.44,	.58,	-.57,	.05,	-.16,	-.26,	.12,	-.77,	.51,	-.29
9 ,	.65,	-.38,	-.30,	.57,	-.01,	-.71,	-.24,	.56,	-.36,	-1.03
10 ,	2.62,	.23,	.84,	.57,	.84,	-.70,	.06,	-.46,	.22,	-1.48
11 ,	-.22,	-.26,	.94,	1.08,	.18,	-.17,	-.01,	-.62,	-.02,	-1.04

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11
Mean Log q,	-10.9581,	-11.2204,	-10.7379,	-10.4751,	-10.0857,	-9.6043,	-9.2220,	-8.9322,	-8.9322,	-8.9322,
S.E(Log q),	1.3595,	1.6992,	1.4132,	.9457,	.8464,	.7391,	.4398,	.6118,	1.0598,	.6307,

Table 7.7.2.1 ctd. - XSA Diagnostics

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,	.000,	.00,	.00,	0,	.00,	.00,
1,	.00,	.000,	.00,	.00,	0,	.00,	.00,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	15.25,	-.768,	-23.90,	.00,	14,	21.15,	-10.96,
3,	.68,	.389,	11.80,	.14,	14,	1.21,	-11.22,
4,	.92,	.091,	10.89,	.13,	14,	1.37,	-10.74,
5,	2.56,	-1.136,	7.27,	.05,	14,	2.38,	-10.48,
6,	1.11,	-.205,	9.86,	.28,	14,	.98,	-10.09,
7,	.90,	.299,	9.84,	.47,	14,	.69,	-9.60,
8,	.86,	.758,	9.53,	.77,	14,	.39,	-9.22,
9,	1.34,	-.952,	8.19,	.46,	14,	.82,	-8.93,
10,	1.46,	-.781,	7.65,	.24,	14,	1.49,	-8.61,
11,	1.06,	-.255,	8.79,	.64,	14,	.70,	-8.88,

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TABLE 7.7.2.1 ctd. - XSA Diagnostics

Fleet : FLT05: Jul Pt. Surve

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
1	-.03,	-.03,	.02,	.24,	-.29,	.15,	.00,	99.99,	.00,	-.08
2	-.45,	.54,	-.88,	-.21,	1.04,	.79,	-1.59,	99.99,	.56,	.11
3	.46,	-.18,	-1.57,	.06,	2.11,	1.10,	-.63,	99.99,	-.73,	-.61
4	1.07,	-.59,	-1.55,	-.22,	.64,	1.64,	.23,	99.99,	-.56,	-.62
5	.10,	.08,	-1.20,	-.77,	1.95,	1.70,	.78,	99.99,	-1.09,	-1.59
6	.07,	.02,	-.35,	-1.01,	2.45,	2.33,	.20,	99.99,	-1.53,	-2.12
7	-.96,	.64,	.25,	.34,	1.58,	1.36,	-.18,	99.99,	-.69,	-2.30
8	.91,	-.26,	1.30,	1.05,	2.85,	.44,	-1.76,	99.99,	-2.01,	-1.97
9	1.09,	1.09,	-.13,	2.10,	2.21,	1.25,	-2.50,	99.99,	-2.01,	-2.37
10	1.12,	.48,	1.71,	.50,	.29,	1.64,	-1.21,	99.99,	-2.41,	-1.99
11	1.55,	.99,	1.83,	2.31,	-1.87,	2.57,	-1.05,	99.99,	-1.34,	-5.03

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11
Mean Log q,	-9.1037,	-9.6604,	-9.9392,	-10.2393,	-10.3472,	-10.4466,	-10.7032,	-10.5196,	-10.5196,	-10.5196,
S.E(Log q),	.8752,	1.1149,	.9845,	1.3150,	1.6121,	1.2389,	1.7411,	1.9596,	1.5652,	2.5792,

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,	.000,	.00,	.00,	0,	.00,	.00,
1,	.28,	4.085,	12.36,	.84,	9,	.16,	-8.54,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.66,	.524,	10.57,	.28,	9,	.61,	-9.10,
3,	.57,	.707,	11.10,	.30,	9,	.66,	-9.66,
4,	-3.35,	-1.470,	22.02,	.02,	9,	3.07,	-9.94,
5,	-.67,	-3.576,	14.00,	.42,	9,	.55,	-10.24,
6,	-1.92,	-1.277,	15.85,	.03,	9,	2.98,	-10.35,
7,	1.64,	-.547,	9.45,	.10,	9,	2.14,	-10.45,
8,	4.60,	-.832,	7.38,	.01,	9,	8.18,	-10.70,
9,	-8.03,	-1.155,	16.72,	.00,	9,	15.38,	-10.52,
10,	1.86,	-.612,	10.46,	.08,	9,	3.04,	-10.58,
11,	-1.34,	-2.416,	9.89,	.15,	9,	2.67,	-10.64,

1

Table 7.7.2.1 ctd. - XSA Diagnostics

Terminal year survivor and F summaries :

Age 0 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
FLT01: 8c West trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	920050.,	.736,	.000,	.00,	1,	.162,	.000
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT05: Jul Pt. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	1009645.,	.35,,,,				.749,	.014
F shrinkage mean ,	1146794.,	1.00,,,,				.089,	.012

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1005903.,	.30,	.07,	3,	.246,	.014

Age 1 Catchability dependent on age and year class strength

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	1328397.,	.678,	.443,	.65,	2,	.086,	.160
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000

TABLE 7.7.2.1 ctd. - XSA Diagnostics

FLT05: Jul Pt. Surve,	679262.,	.300,	.000,	.00,	1,	.443,	.291
P shrinkage mean ,	663497.,	.35,,,,				.419,	.297
F shrinkage mean ,	1125380.,	1.00,,,,				.052,	.186

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
731794.,	.21,	.13,	5,	.596,	.273

1

Age 2 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
FLT01: 8c West trawl,	173782.,	.817,	.000,	.00,	1,	.077,	.588
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	724885.,	.640,	.391,	.61,	3,	.131,	.176
FLT04: Oct Sp. Surve,	1100320.,	1.418,	.000,	.00,	1,	.038,	.119
FLT05: Jul Pt. Surve,	513441.,	.288,	.038,	.13,	2,	.659,	.240
F shrinkage mean ,	468146.,	1.00,,,,				.096,	.260

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
503935.,	.24,	.16,	8,	.640,	.243

Table 7.7.2.1 ctd. - XSA Diagnostics

Age 3 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
FLT01: 8c West trawl,	40334.,	.692,	.984,	1.42,	2,	.176,	1.109
FLT02: 8c East trawl,	227185.,	1.018,	.000,	.00,	1,	.128,	.308
FLT03: Oct Pt Survey,	119618.,	.638,	.336,	.53,	4,	.217,	.522
FLT04: Oct Sp. Surve,	582557.,	1.130,	1.101,	.97,	2,	.086,	.132
FLT05: Jul Pt. Surve,	167150.,	.744,	.584,	.79,	2,	.197,	.399
F shrinkage mean ,	417360.,	1.00,,,,				.197,	.179

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
167701.,	.35,	.32,	12,	.934,	.398

Age 4 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
FLT01: 8c West trawl,	85155.,	.606,	.530,	.87,	3,	.117,	.403
FLT02: 8c East trawl,	155619.,	.682,	.591,	.87,	2,	.133,	.240
FLT03: Oct Pt Survey,	80316.,	.628,	.239,	.38,	5,	.109,	.422
FLT04: Oct Sp. Surve,	1055347.,	.897,	.504,	.56,	3,	.071,	.039
FLT05: Jul Pt. Surve,	135973.,	.289,	.192,	.66,	3,	.485,	.270
F shrinkage mean ,	361775.,	1.00,,,,				.085,	.110

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
155697.,	.22,	.20,	17,	.901,	.240

Age 5 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
FLT01: 8c West trawl,	202708.,	.537,	.551,	1.03,	4,	.122,	.129
FLT02: 8c East trawl,	422242.,	.459,	.294,	.64,	3,	.208,	.064
FLT03: Oct Pt Survey,	306054.,	.569,	.375,	.66,	6,	.104,	.087
FLT04: Oct Sp. Surve,	616320.,	.664,	.324,	.49,	4,	.095,	.044
FLT05: Jul Pt. Surve,	262863.,	.275,	.360,	1.31,	4,	.421,	.101
F shrinkage mean ,	304835.,	1.00,,,,				.050,	.088

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
311904.,	.19,	.16,	22,	.813,	.086

Age 6 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
FLT01: 8c West trawl,	195862.,	.468,	.485,	1.04,	5,	.145,	.142
FLT02: 8c East trawl,	490611.,	.376,	.331,	.88,	4,	.273,	.059
FLT03: Oct Pt Survey,	354779.,	.566,	.368,	.65,	7,	.089,	.081
FLT04: Oct Sp. Surve,	348187.,	.536,	.288,	.54,	5,	.131,	.082
FLT05: Jul Pt. Surve,	210383.,	.280,	.271,	.97,	5,	.317,	.133
F shrinkage mean ,	312363.,	1.00,,,,				.046,	.092

Table 7.7.2.1 ctd. - XSA Diagnostics

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
298833.,	.18,	.15,	27,	.824,	.095

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	124647.,	.414,	.467,	1.13,	6,	.168,	.184
FLT02: 8c East trawl,	293015.,	.332,	.475,	1.43,	5,	.298,	.083
FLT03: Oct Pt Survey,	260097.,	.567,	.299,	.53,	8,	.078,	.093
FLT04: Oct Sp. Surve,	132894.,	.443,	.313,	.71,	6,	.167,	.174
FLT05: Jul Pt. Surve,	212566.,	.284,	.393,	1.38,	6,	.247,	.112
F shrinkage mean ,	181441.,	1.00,,,,				.041,	.130

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
199500.,	.17,	.17,	32,	1.000,	.119

1

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	41709.,	.251,	.138,	.55,	7,	.335,	.295
FLT02: 8c East trawl,	97302.,	.317,	.392,	1.24,	6,	.205,	.137

TABLE 7.7.2.1 ctd. - XSA Diagnostics

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT03: Oct Pt Survey,	110209.,	.548,	.401,	.73,	9,	.059,	.122
FLT04: Oct Sp. Surve,	42846.,	.323,	.171,	.53,	7,	.221,	.289
FLT05: Jul Pt. Surve,	69032.,	.291,	.360,	1.24,	7,	.148,	.189
F shrinkage mean ,	80101.,	1.00,,,,				.032,	.165

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
58151.,	.14,	.13,	37,	.882,	.220

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	52929.,	.205,	.083,	.40,	8,	.386,	.142
FLT02: 8c East trawl,	61513.,	.279,	.234,	.84,	7,	.220,	.124
FLT03: Oct Pt Survey,	63557.,	.547,	.508,	.93,	10,	.047,	.120
FLT04: Oct Sp. Surve,	49349.,	.290,	.257,	.89,	8,	.211,	.152
FLT05: Jul Pt. Surve,	47662.,	.297,	.323,	1.09,	8,	.110,	.157
F shrinkage mean ,	33903.,	1.00,,,,				.025,	.214

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
53151.,	.13,	.10,	42,	.770,	.142

Table 7.7.2.1 ctd. - XSA Diagnostics

1
Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	32743.,	.192,	.133,	.70,	9,	.419,	.188
FLT02: 8c East trawl,	45318.,	.274,	.160,	.58,	8,	.210,	.139
FLT03: Oct Pt Survey,	14913.,	.550,	.557,	1.01,	11,	.048,	.374
FLT04: Oct Sp. Surve,	16500.,	.285,	.241,	.85,	9,	.202,	.343
FLT05: Jul Pt. Surve,	23906.,	.320,	.380,	1.18,	9,	.092,	.249
F shrinkage mean ,	22687.,	1.00,,,,				.028,	.261

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
28244.,	.12,	.11,	47,	.907,	.214

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	53439.,	.180,	.055,	.31,	10,	.439,	.125
FLT02: 8c East trawl,	55389.,	.269,	.223,	.83,	9,	.205,	.121
FLT03: Oct Pt Survey,	17372.,	.533,	.495,	.93,	12,	.050,	.344
FLT04: Oct Sp. Surve,	34559.,	.269,	.226,	.84,	10,	.229,	.187
FLT05: Jul Pt. Surve,	18555.,	.504,	.637,	1.26,	9,	.049,	.325
F shrinkage mean ,	41448.,	1.00,,,,				.029,	.159

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
43434.,	.12,	.11,	51,	.898,	.152

Table 7.7.2.2 - Terminal Fs derived using XSA (With F shrinkage)

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    Run title : S. horse mackerel (run: XSAHOM14/X14)

    At 18/09/1999  17:24

                   Terminal Fs derived using XSA (With F shrinkage)

       Table  8    Fishing mortality (F) at age
       YEAR,       1985,    1986,    1987,    1988,

       AGE
         0,        .2879,   .2824,   .0419,   .1481,
         1,        .4395,   .5432,   .4798,   .2911,
         2,        .2223,   .2346,   .4077,   .1163,
         3,        .0501,   .2491,   .2357,   .1455,
         4,        .1222,   .0961,   .1581,   .1112,
         5,        .0928,   .1731,   .0806,   .1529,
         6,        .0707,   .1107,   .1908,   .1186,
         7,        .1521,   .3463,   .1107,   .2140,
         8,        .1068,   .3758,   .1049,   .1642,
         9,        .1540,   .2488,   .1821,   .3037,
        10,        .1850,   .2916,   .1217,   .5631,
        11,        .2911,   .3929,   .1008,   .3438,
       +gp,        .2911,   .3929,   .1008,   .3438,
 0  FBAR  1-11,    .1715,   .2784,   .1975,   .2295,
    FBAR  0- 3,    .2500,   .3273,   .2912,   .1752,
    FBAR  7-11,    .1778,   .3311,   .1240,   .3178,
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Table  8    Fishing mortality (F) at age
      YEAR,       1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,      FBAR 96-98

      AGE
        0,        .2566,   .0603,   .0185,   .0275,   .0089,   .0126,   .0052,   .0275,   .0071,   .0140,       .0162,
        1,        .2762,   .2615,   .1103,   .2171,   .0746,   .1158,   .2898,   .0629,   .3835,   .2730,       .2398,
        2,        .1076,   .2677,   .1638,   .2356,   .3003,   .2681,   .1708,   .1489,   .4077,   .2434,       .2667,
        3,        .1523,   .1199,   .0896,   .1630,   .3183,   .1560,   .1346,   .0741,   .2107,   .3976,       .2275,
        4,        .1896,   .0762,   .0867,   .1021,   .1521,   .1144,   .1053,   .0999,   .0789,   .2398,       .1395,
        5,        .1673,   .0975,   .0763,   .0752,   .1438,   .0628,   .1002,   .0787,   .0527,   .0859,       .0724,
        6,        .2404,   .1030,   .1233,   .0836,   .0909,   .1560,   .0773,   .0928,   .0397,   .0954,       .0760,
        7,        .0866,   .1967,   .1695,   .1681,   .1543,   .1196,   .1547,   .0994,   .1213,   .1190,       .1132,
        8,        .2011,   .1662,   .2661,   .1834,   .1965,   .1580,   .1385,   .1276,   .2004,   .2204,       .1828,
        9,        .3073,   .2440,   .1943,   .4628,   .3713,   .1915,   .1340,   .1804,   .1907,   .1419,       .1710,
       10,        .5953,   .2035,   .3470,   .2255,   .3828,   .1960,   .2950,   .1537,   .2706,   .2145,       .2129,
       11,        .4160,   .3485,   .2570,   .3261,   .2267,   .2710,   .3244,   .3479,   .1996,   .1520,       .2332,
      +gp,        .4160,   .3485,   .2570,   .3261,   .2267,   .2710,   .3244,   .3479,   .1996,   .1520,
0  FBAR  1-11,    .2491,   .1895,   .1713,   .2039,   .2192,   .1645,   .1750,   .1333,   .1960,   .1984,
   FBAR  0- 3,    .1982,   .1774,   .0956,   .1608,   .1755,   .1381,   .1501,   .0783,   .2522,   .2320,
   FBAR  7-11,    .3212,   .2318,   .2468,   .2732,   .2663,   .1872,   .2093,   .1818,   .1965,   .1696,
```

Table 7.7.2.3 - Stock number at age (start of year)

Run title : S. horse mackerel (run: XSAHOM14/X14)

At 18/09/1999 17:24

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1985,	1986,	1987,	1988,
AGE				
0,	1696305,	2696002,	1401529,	954757,
1,	901589,	1094773,	1749632,	1156840,
2,	458969,	500014,	547378,	932048,
3,	1761205,	316285,	340376,	313402,
4,	245567,	1441804,	212203,	231452,
5,	178390,	187058,	1127268,	155936,
6,	111786,	139936,	135411,	895083,
7,	56233,	89651,	107818,	96302,
8,	42353,	41569,	54577,	83072,
9,	47346,	32760,	24572,	42297,
10,	29444,	34934,	21986,	17628,
11,	13718,	21062,	22462,	16756,
+gp,	40783,	46397,	62250,	50341,
0 TOTAL,	5583688,	6642247,	5807462,	4945913,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	GMST 85-96
AGE												
0,	1155028,	885910,	1864749,	1814018,	1309604,	812340,	732284,	1522989,	1307900,	1185493,	0,	1308233,
1,	708628,	769130,	717886,	1575515,	1519008,	1117242,	690434,	627025,	1275274,	1117785,	1005903,	991700,
2,	744235,	462739,	509655,	553371,	1091469,	1213418,	856464,	444764,	506794,	747983,	731794,	650465,
3,	714136,	575221,	304736,	372376,	376316,	695776,	798784,	621447,	329841,	290153,	503935,	516450,
4,	233228,	527835,	439164,	239817,	272291,	235594,	512381,	600916,	496701,	229966,	167701,	358143,
5,	178247,	166078,	420977,	346604,	186377,	201292,	180861,	396936,	468041,	395096,	155697,	252834,
6,	115190,	129786,	129671,	335733,	276701,	138930,	162702,	140827,	315787,	382160,	311904,	179067,
7,	684220,	77957,	100773,	98665,	265799,	217460,	102311,	129615,	110468,	261222,	298833,	129021,
8,	66919,	540062,	55118,	73212,	71779,	196065,	166072,	75435,	101005,	84222,	199500,	87637,
9,	60675,	47107,	393665,	36356,	52452,	50758,	144089,	124449,	57150,	71151,	58151,	61873,
10,	26869,	38408,	31766,	278991,	19699,	31143,	36074,	108467,	89431,	40648,	53151,	37889,
11,	8640,	12752,	26970,	19325,	191654,	11562,	22034,	23117,	80055,	58723,	28244,	20925,
+gp,	37004,	41631,	48214,	47726,	29962,	62253,	84150,	86504,	84656,	181989,	177987,	
TOTAL,	4733021,	4274614,	5043345,	5791706,	5663110,	4983832,	4488641,	4902492,	5223103,	5046592,	3692799,	

Table 7.7.2.4 - SUMMARY (without SOP correction)

Run title : S. horse mackerel (run: XSAHOM14/X14) ,

At 18/09/1999 17:24

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 1-11,	FBAR 0- 3,	FBAR 7-11,
1985,	1696305,	308693,	133113,	43530,	.3270,	.1715,	.2500,	.1778,
1986,	2696002,	347184,	187982,	71490,	.3803,	.2784,	.3273,	.3311,
1987,	1401529,	369049,	212234,	54650,	.2575,	.1975,	.2912,	.1240,
1988,	954757,	365704,	216231,	56390,	.2608,	.2295,	.1752,	.3178,
1989,	1155028,	354219,	213343,	56396,	.2643,	.2491,	.1982,	.3212,
1990,	885910,	358772,	228692,	49207,	.2152,	.1895,	.1774,	.2318,
1991,	1864749,	350732,	232608,	45511,	.1957,	.1713,	.0956,	.2468,
1992,	1814018,	368995,	224744,	50956,	.2267,	.2039,	.1608,	.2732,
1993,	1309604,	380552,	212428,	57428,	.2703,	.2192,	.1755,	.2663,
1994,	812340,	350962,	179181,	52588,	.2935,	.1645,	.1381,	.1872,
1995,	732284,	364442,	207156,	52681,	.2543,	.1750,	.1501,	.2093,
1996,	1522989,	361505,	228598,	44690,	.1955,	.1333,	.0783,	.1818,
1997,	1307900,	386926,	245758,	56770,	.2310,	.1960,	.2522,	.1965,
1998,	1185493,	406176,	267096,	64480,	.2414,	.1984,	.2320,	.1696,
Arith. Mean ,	1381351,	362422,	213512,	54055,	.2581,	.1984,	.0000,	.2310,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

1

TABLE 7.7.2.4 ctd. - SUMMARY (without SOP correction)

Run title : S. horse mackerel (run: XSAHOM14/X14) ,

At 18/09/1999 17:24

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 1-11,	FBAR 0- 3,	FBAR 7-11,
1985,	1696305,	315996,	136262,	43530,	.3195,	1.0237,	.1715,	.2500,	.1778,
1986,	2696002,	354945,	192184,	71490,	.3720,	1.0224,	.2784,	.3273,	.3311,
1987,	1401529,	377853,	217297,	54650,	.2515,	1.0239,	.1975,	.2912,	.1240,
1988,	954757,	360951,	213421,	56390,	.2642,	.9870,	.2295,	.1752,	.3178,
1989,	1155028,	349256,	210354,	56396,	.2681,	.9860,	.2491,	.1982,	.3212,
1990,	885910,	360823,	229999,	49207,	.2139,	1.0057,	.1895,	.1774,	.2318,
1991,	1864749,	355037,	235463,	45511,	.1933,	1.0123,	.1713,	.0956,	.2468,
1992,	1814018,	366584,	223276,	50956,	.2282,	.9935,	.2039,	.1608,	.2732,
1993,	1309604,	380591,	212450,	57428,	.2703,	1.0001,	.2192,	.1755,	.2663,
1994,	812340,	351084,	179243,	52588,	.2934,	1.0003,	.1645,	.1381,	.1872,
1995,	732284,	364327,	207090,	52681,	.2544,	.9997,	.1750,	.1501,	.2093,
1996,	1522989,	364210,	230309,	44690,	.1940,	1.0075,	.1333,	.0783,	.1818,
1997,	1307900,	384209,	244033,	56770,	.2326,	.9930,	.1960,	.2522,	.1965,
1998,	1185493,	400764,	263537,	64480,	.2447,	.9867,	.1984,	.2320,	.1696,
Arith. Mean ,	1381351,	363331,	213923,	54055,	.2572		.1984,	.0000,	.2310,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),					

1

Table 7.8.1 - Input Data For Predictions

The SAS System 12:43 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Input data

Year: 1999

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	1308.233	0.1500	0.0000	0.2500	0.2500	0.000	0.0162	0.019
1	1005.903	0.1500	0.0000	0.2500	0.2500	0.032	0.2398	0.033
2	731.794	0.1500	0.0400	0.2500	0.2500	0.055	0.2667	0.057
3	503.935	0.1500	0.2700	0.2500	0.2500	0.075	0.2275	0.083
4	167.701	0.1500	0.6300	0.2500	0.2500	0.105	0.1395	0.114
5	155.697	0.1500	0.8100	0.2500	0.2500	0.127	0.0724	0.139
6	311.904	0.1500	0.9000	0.2500	0.2500	0.154	0.0760	0.165
7	298.833	0.1500	0.9500	0.2500	0.2500	0.176	0.1132	0.186
8	199.500	0.1500	0.9700	0.2500	0.2500	0.213	0.1828	0.208
9	58.151	0.1500	0.9800	0.2500	0.2500	0.240	0.1710	0.230
10	53.151	0.1500	0.9900	0.2500	0.2500	0.269	0.2129	0.256
11	28.244	0.1500	1.0000	0.2500	0.2500	0.304	0.2332	0.280
12+	177.987	0.1500	1.0000	0.2500	0.2500	0.347	0.2332	0.334
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1308.233	0.1500	0.0000	0.2500	0.2500	0.000	0.0162	0.019
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2398	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2667	0.057
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.2275	0.083
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1395	0.114
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0724	0.139
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0760	0.165
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1132	0.186
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1828	0.208
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1710	0.230
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2129	0.256
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.2332	0.280
12+	.	0.1500	1.0000	0.2500	0.2500	0.347	0.2332	0.334
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

(cont.)

The SAS System 12:43 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Input data

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1308.233	0.1500	0.0000	0.2500	0.2500	0.000	0.0162	0.019
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2398	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2667	0.057
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.2275	0.083
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1395	0.114
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0724	0.139
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0760	0.165
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1132	0.186
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1828	0.208
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1710	0.230
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2129	0.256
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.2332	0.280
12+	.	0.1500	1.0000	0.2500	0.2500	0.347	0.2332	0.334
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRHOM01
Date and time: 23SEP99:12:47

Table 7.8.2.a - Prediction with management option table

The SAS System 14:33 Thursday, September 23, 1999
Southern horse mackerel (Divisions VIIIc and IXa)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1759	389263	251174	60723	0.0000	0.0000	378865	248702	0	439517	281707
.	.	.	.	.	0.1000	0.0176	.	247655	6650	431904	275705
.	.	.	.	.	0.2000	0.0352	.	246613	13170	424446	269842
.	.	.	.	.	0.3000	0.0528	.	245576	19562	417140	264115
.	.	.	.	.	0.4000	0.0704	.	244544	25829	409983	258521
.	.	.	.	.	0.5000	0.0880	.	243516	31974	402971	253057
.	.	.	.	.	0.6000	0.1055	.	242494	37999	396101	247718
.	.	.	.	.	0.7000	0.1231	.	241476	43907	389370	242503
.	.	.	.	.	0.8000	0.1407	.	240462	49701	382775	237408
.	.	.	.	.	0.9000	0.1583	.	239454	55382	376313	232431
.	.	.	.	.	1.0000	0.1759	.	238450	60954	369982	227567
.	.	.	.	.	1.1000	0.1935	.	237451	66418	363777	222815
.	.	.	.	.	1.2000	0.2111	.	236456	71777	357698	218172
.	.	.	.	.	1.3000	0.2287	.	235466	77032	351740	213635
.	.	.	.	.	1.4000	0.2463	.	234480	82187	345902	209202
.	.	.	.	.	1.5000	0.2639	.	233499	87243	340181	204869
.	.	.	.	.	1.6000	0.2815	.	232523	92202	334574	200635
.	.	.	.	.	1.7000	0.2990	.	231551	97067	329078	196498
.	.	.	.	.	1.8000	0.3166	.	230584	101839	323692	192454
.	.	.	.	.	1.9000	0.3342	.	229621	106520	318414	188502
.	.	.	.	.	2.0000	0.3518	.	228662	111112	313240	184639
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHOM06
Date and time : 23SEP99:14:34
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1999 : F factors

Table 7.8.2.b - Prediction with management option table

The SAS System 14:28 Thursday, September 23, 1999
Southern horse mackerel (Divisions VIIIc and IXa)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.2283	0.2161	389263	248894	73000	0.0000	0.0000	365055	239753	0	425196	271131
.	.	.	.	.	0.1000	0.0176	.	238747	6395	417865	265370
.	.	.	.	.	0.2000	0.0352	.	237746	12664	410682	259743
.	.	.	.	.	0.3000	0.0528	.	236749	18811	403646	254246
.	.	.	.	.	0.4000	0.0704	.	235757	24838	396753	248876
.	.	.	.	.	0.5000	0.0880	.	234770	30748	389999	243631
.	.	.	.	.	0.6000	0.1055	.	233788	36543	383382	238506
.	.	.	.	.	0.7000	0.1231	.	232809	42225	376899	233499
.	.	.	.	.	0.8000	0.1407	.	231836	47798	370547	228607
.	.	.	.	.	0.9000	0.1583	.	230867	53262	364322	223828
.	.	.	.	.	1.0000	0.1759	.	229902	58622	358223	219158
.	.	.	.	.	1.1000	0.1935	.	228942	63878	352247	214595
.	.	.	.	.	1.2000	0.2111	.	227986	69033	346390	210136
.	.	.	.	.	1.3000	0.2287	.	227034	74089	340650	205779
.	.	.	.	.	1.4000	0.2463	.	226087	79048	335026	201521
.	.	.	.	.	1.5000	0.2639	.	225145	83912	329514	197359
.	.	.	.	.	1.6000	0.2815	.	224206	88683	324111	193293
.	.	.	.	.	1.7000	0.2990	.	223272	93364	318817	189318
.	.	.	.	.	1.8000	0.3166	.	222342	97955	313627	185433
.	.	.	.	.	1.9000	0.3342	.	221417	102459	308541	181636
.	.	.	.	.	2.0000	0.3518	.	220496	106878	303555	177925
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHOM06
Date and time : 23SEP99:14:30
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1999 : TAC constraints

Table 7.8.2.c - Prediction with management option table

The SAS System 14:47 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Detailed tables

Year: 1999 F-factor: 1.0000 Reference F: 0.1759

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0162	19526	379	1308233	0	0	0	0	0
1	0.2398	199759	6669	1005903	32189	0	0	0	0
2	0.2667	159611	9104	731794	40249	29272	1610	26376	1451
3	0.2275	95490	7938	503935	37795	136062	10205	123809	9286
4	0.1395	20312	2307	167701	17609	105652	11093	98275	10319
5	0.0724	10107	1405	155697	19774	126115	16017	119294	15150
6	0.0760	21217	3503	311904	48033	280714	43230	265293	40855
7	0.1132	29742	5519	298833	52595	283891	49965	265813	46783
8	0.1828	31021	6453	199500	42494	193515	41219	178066	37928
9	0.1710	8506	1954	58151	13956	56988	13677	52593	12622
10	0.2129	9490	2430	53151	14298	52619	14155	48056	12927
11	0.2332	5471	1532	28244	8586	28244	8586	25664	7802
12+	0.2332	34479	11530	177987	61687	177987	61687	161727	56051
Total		644733	60723	5001033	389263	1471059	271443	1364966	251174
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.1759

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0162	19526	379	1308233	0	0	0	0	0
1	0.2398	220017	7345	1107912	35453	0	0	0	0
2	0.2667	148574	8475	681190	37465	27248	1499	24552	1350
3	0.2275	91412	7599	482412	36181	130251	9769	118521	8889
4	0.1395	41846	4752	345484	36276	217655	22854	202459	21258
5	0.0724	8150	1133	125547	15945	101693	12915	96193	12217
6	0.0760	8479	1400	124650	19196	112185	17277	106022	16327
7	0.1132	24764	4596	248811	43791	236371	41601	221318	38952
8	0.1828	35714	7429	229680	48922	222789	47454	205003	43666
9	0.1710	20920	4806	143024	34326	140164	33639	129355	31045
10	0.2129	7532	1929	42184	11348	41762	11234	38140	10260
11	0.2332	7163	2005	36975	11240	36975	11240	33597	10213
12+	0.2332	27234	9107	140583	48723	140583	48723	127740	44272
Total		661330	60954	5016686	378865	1407676	258205	1302902	238450
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

The SAS System 14:47 Thursday, September 23, 1999

The SAS System 14:47 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Detailed tables

(cont.)

Year: 2001 F-factor: 1.0000 Reference F: 0.1759

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0162	19526	379	1308233	0	0	0	0	0
1	0.2398	220017	7345	1107912	35453	0	0	0	0
2	0.2667	163641	9334	750270	41265	30011	1651	27042	1487
3	0.2275	85091	7073	449053	33679	121244	9093	110325	8274
4	0.1395	40059	4549	330729	34727	208359	21878	193812	20350
5	0.0724	16790	2335	258643	32848	209501	26607	198170	25168
6	0.0760	6837	1129	100513	15479	90461	13931	85492	13166
7	0.1132	9897	1837	99436	17501	94464	16626	88448	15567
8	0.1828	29736	6185	191234	40733	185497	39511	170688	36357
9	0.1710	24085	5533	164660	39518	161367	38728	148923	35742
10	0.2129	18525	4743	103753	27910	102716	27630	93807	25234
11	0.2332	5685	1592	29346	8921	29346	8921	26665	8106
12+	0.2332	23447	7841	121037	41949	121037	41949	109980	38117
Total		663334	59875	5014817	369982	1354002	246524	1253352	227567
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM02
Date and time : 23SEP99:14:57
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.9.1 Codes used in the output of the short-term forecast sensitivity analysis.

N1	Population at age 1
sH1	Exploitation pattern of age 1
WH1	Catch weight at age 1
WS1	Stock weight at age 1
M1	Natural mortality at age 1
MT1	Maturity at age 1
HF00	Effort multiplier in 2000
K99	Natural mortality multiplier in 1999
R00	Recruitment in 2000

(Numbers in these codes represent age class or year)

Table 7.9.2 Parameter values and CV's used as input for the sensitivity analysis.

Parameter	Value	CV	Parameter	Value	CV	Parameter	Value	CV	Parameter	Value	CV
N0	1308223	0.4	**WH0**	0.021	0.38	**M0**	0.15	0.1	**R00**	1308223	0.4
N1	1005903	0.37	**WH1**	0.033	0.11	**M1**	0.15	0.1	**R****	1361478	0.4
N2	731794	0.19	**WH2**	0.059	0.1	**M2**	0.15	0.1	**HF99**	1	0.22
N3	503935	0.37	**WH3**	0.095	0.08	**M3**	0.15	0.1	**HF00**	1	0.22
N4	167701	0.21	**WH4**	0.121	0.08	**M4**	0.15	0.1	**HF****	1	0.22
N5	155697	0.19	**WH5**	0.147	0.05	**M5**	0.15	0.1	**K99**	1	0.1
N6	311904	0.17	**WH6**	0.175	0.03	**M6**	0.15	0.1	**K00**	1	0.1
N7	298833	0.16	**WH7**	0.199	0.04	**M7**	0.15	0.1	**K****	1	0.1
N8	199500	0.14	**WH8**	0.213	0.02	**M8**	0.15	0.1			
N9	58151	0.13	**WH9**	0.236	0.04	**M9**	0.15	0.1			
N10	53151	0.12	**WH10**	0.254	0.08	**M10**	0.15	0.1			
N11	28244	0.12	**WH11**	0.278	0.05	**M11**	0.15	0.1			
N12	177987	0.12	**WH12**	0.326	0.04	**M12**	0.15	0.1			
sH0	0.014	1.11	**WS0**	0	0	**MT0**	0	0			
sH1	0.296	0.53	**WS1**	0.032	0	**MT1**	0	0.1			
sH2	0.331	0.5	**WS2**	0.055	0	**MT2**	0.04	0.1			
sH3	0.192	0.48	**WS3**	0.075	0	**MT3**	0.27	0.1			
sH4	0.101	0.45	**WS4**	0.105	0	**MT4**	0.63	0.1			
sH5	0.069	0.22	**WS5**	0.127	0	**MT5**	0.81	0.1			
sH6	0.053	0.49	**WS6**	0.154	0	**MT6**	0.9	0.1			
sH7	0.097	0.32	**WS7**	0.176	0	**MT7**	0.95	0.1			
sH8	0.128	0.06	**WS8**	0.213	0	**MT8**	0.97	0.1			
sH9	0.152	0.26	**WS9**	0.24	0	**MT9**	0.98	0.1			
sH10	0.233	0.25	**WS10**	0.269	0	**MT10**	0.99	0.1			
sH11	0.299	0.46	**WS11**	0.304	0	**MT11**	1	0.1			
sH12	0.299	0.46	**WS12**	0.351	0.02	**MT12**	1	0			

Table 7.11.1 - Yield per recruit summary table

```
The SAS System                                                  14:59 Thursday, September 23, 1999
   Southern horse mackerel (Divisions VIIIc and IXa)
```

Yield per recruit: Summary table

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0.000	0.000	7.179	1013.992	3.774	866.595	3.635	834.699
0.1000	0.0176	0.100	14.716	6.516	841.950	3.184	701.202	3.054	672.231
0.2000	0.0352	0.179	24.404	5.989	712.406	2.726	577.861	2.604	551.514
0.3000	0.0528	0.244	30.888	5.558	611.776	2.360	483.022	2.246	459.033
0.4000	0.0704	0.298	35.255	5.198	531.687	2.061	408.345	1.954	386.477
0.5000	0.0880	0.344	38.186	4.891	466.698	1.812	348.417	1.711	328.460
0.6000	0.1055	0.384	40.124	4.627	413.122	1.602	299.577	1.508	281.344
0.7000	0.1231	0.419	41.364	4.396	368.370	1.423	259.261	1.335	242.585
0.8000	0.1407	0.450	42.108	4.193	330.571	1.269	225.622	1.186	210.353
0.9000	0.1583	0.477	42.498	4.013	298.343	1.136	197.296	1.058	183.301
1.0000	0.1759	0.501	42.633	3.852	270.638	1.020	173.254	0.946	160.414
1.1000	0.1935	0.523	42.585	3.708	246.652	0.918	152.710	0.849	140.918
1.2000	0.2111	0.543	42.405	3.578	225.754	0.828	135.050	0.763	124.209
1.3000	0.2287	0.561	42.133	3.461	207.445	0.748	119.787	0.687	109.812
1.4000	0.2463	0.577	41.794	3.354	191.325	0.678	106.536	0.620	97.348
1.5000	0.2639	0.592	41.412	3.257	177.067	0.615	94.983	0.561	86.513
1.6000	0.2815	0.605	41.000	3.168	164.406	0.559	84.872	0.508	77.057
1.7000	0.2990	0.618	40.571	3.087	153.120	0.508	75.994	0.460	68.776
1.8000	0.3166	0.629	40.133	3.012	143.025	0.463	68.175	0.418	61.502
1.9000	0.3342	0.640	39.692	2.943	133.969	0.423	61.268	0.380	55.095
2.0000	0.3518	0.650	39.253	2.879	125.818	0.386	55.152	0.346	49.436
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

```
Notes: Run name              : YLDHOM03
       Date and time         : 23SEP99:15:01
       Computation of ref. F: Simple mean, age 1 - 11
       F-0.1 factor          : 0.5640
       F-max factor          : 1.0189
       F-0.1 reference F     : 0.0992
       F-max reference F     : 0.1792
       Recruitment           : Single recruit
```

Table 7.14.1 - Single option prediction summary table

F status quo: The SAS System 15:03 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.1759	644733	60723	5001033	389263	1471059	271443	1364966	251174
2000	1.0000	0.1759	661330	60954	5016686	378865	1407676	258205	1302902	238450
2001	1.0000	0.1759	663334	59875	5014817	369982	1354002	246524	1253352	227567
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM02
Date and time : 23SEP99:15:04
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

The SAS System 15:03 Thursday, September 23, 1999

F max:

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0800	0.1900	690703	65088	5001033	389263	1471059	271443	1360907	250372
2000	1.0800	0.1900	700519	64444	4974329	373952	1389441	254904	1282010	234624
2001	1.0800	0.1900	697935	62615	4942272	360890	1317095	240018	1215374	220821
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM05
Date and time : 23SEP99:15:05
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

F med:

The SAS System 15:03 Thursday, September 23, 1999

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	0.9700	0.1706	627296	59069	5001033	389263	1471059	271443	1366491	251476
2000	0.9700	0.1706	646190	59600	5032758	380728	1414587	259456	1310837	239903
2001	0.9700	0.1706	649807	58787	5042598	373463	1368141	249015	1267931	230155
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM06
Date and time : 23SEP99:15:06
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.14.1 - Single option prediction summary table (Continued)

F corresponding to constant TAC:

The SAS System 15:03 Thursday, September 23, 1999
Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1999	1.2283	0.2161	773904	73000	5001033	389263	1471059	271443	1353423	248894
2000	1.2783	0.2249	796117	73000	4897718	365055	1356374	248914	1241842	227240
2001	1.3651	0.2401	823740	73000	4788369	341886	1241039	226550	1132488	205959
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM01
Date and time : 23SEP99:15:07
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

F corresponding to TAC 1998:

The SAS System 15:03 Thursday, September 23, 1999
Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1999	1.2283	0.2161	773923	73002	5001033	389263	1471059	271443	1353422	248894
2000	1.2283	0.2161	768805	70473	4897701	365053	1356367	248913	1244294	227715
2001	1.2283	0.2161	756750	67118	4813488	344752	1251632	228459	1148297	208891
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM04
Date and time : 23SEP99:15:08
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

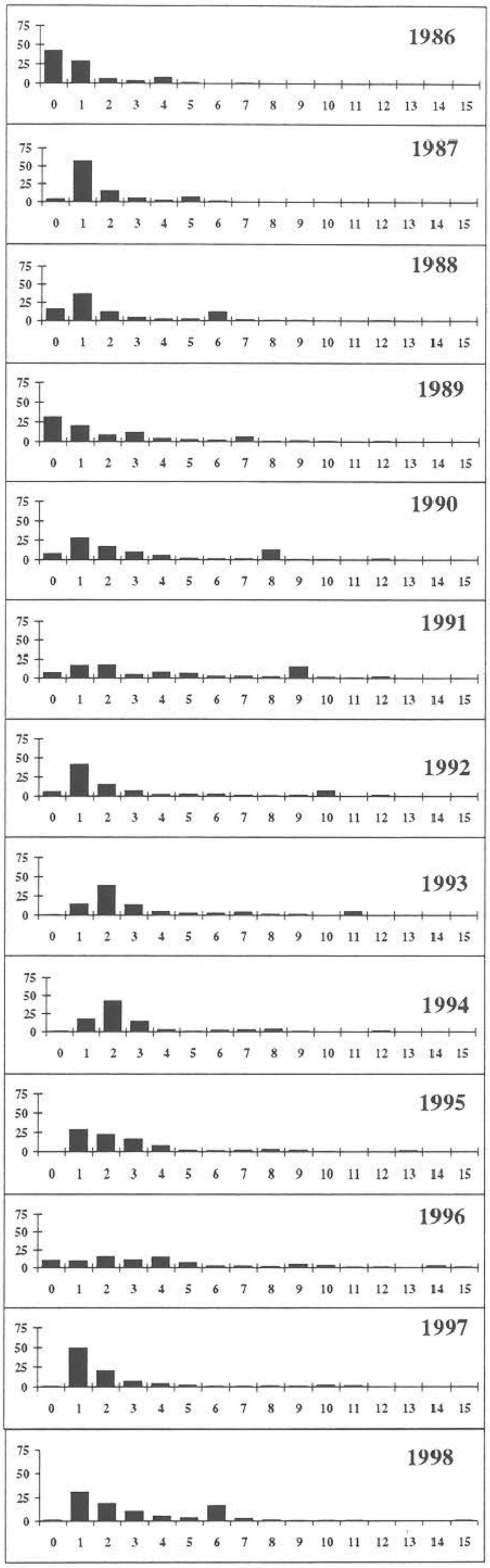


Figure 7.3.1.1.- The age composition of southern horse mackerel in the international catches from 1986-1998. Age 15 is a plus group.

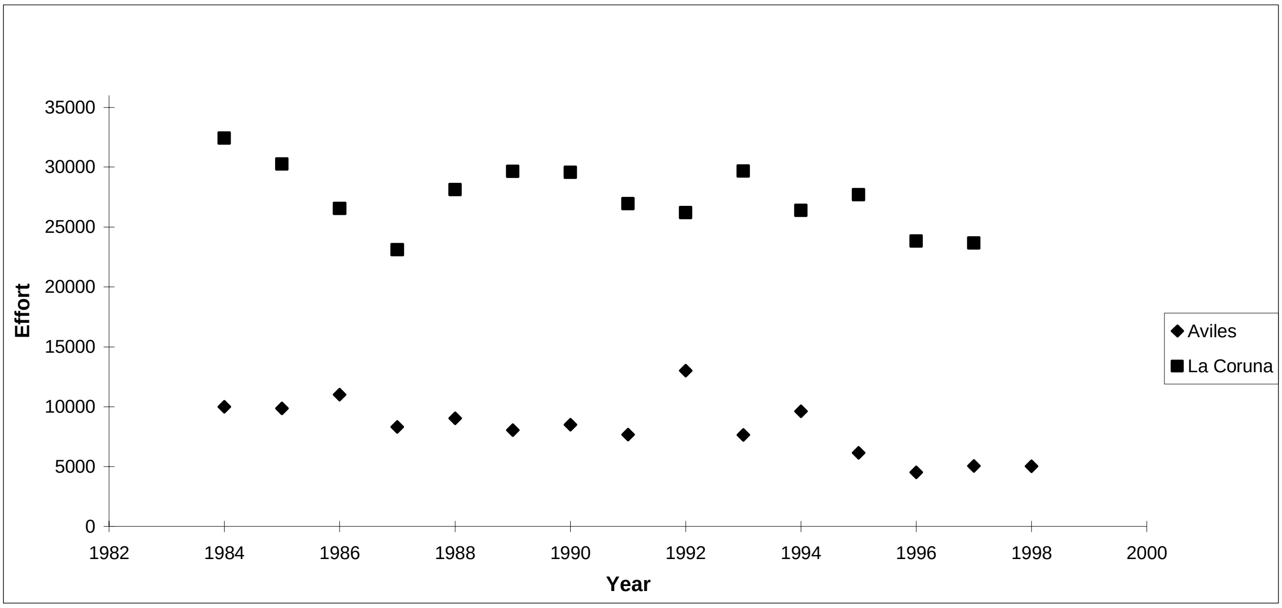


Figure 7.5.1 Effort series from Spanish commercial bottom trawl fleets

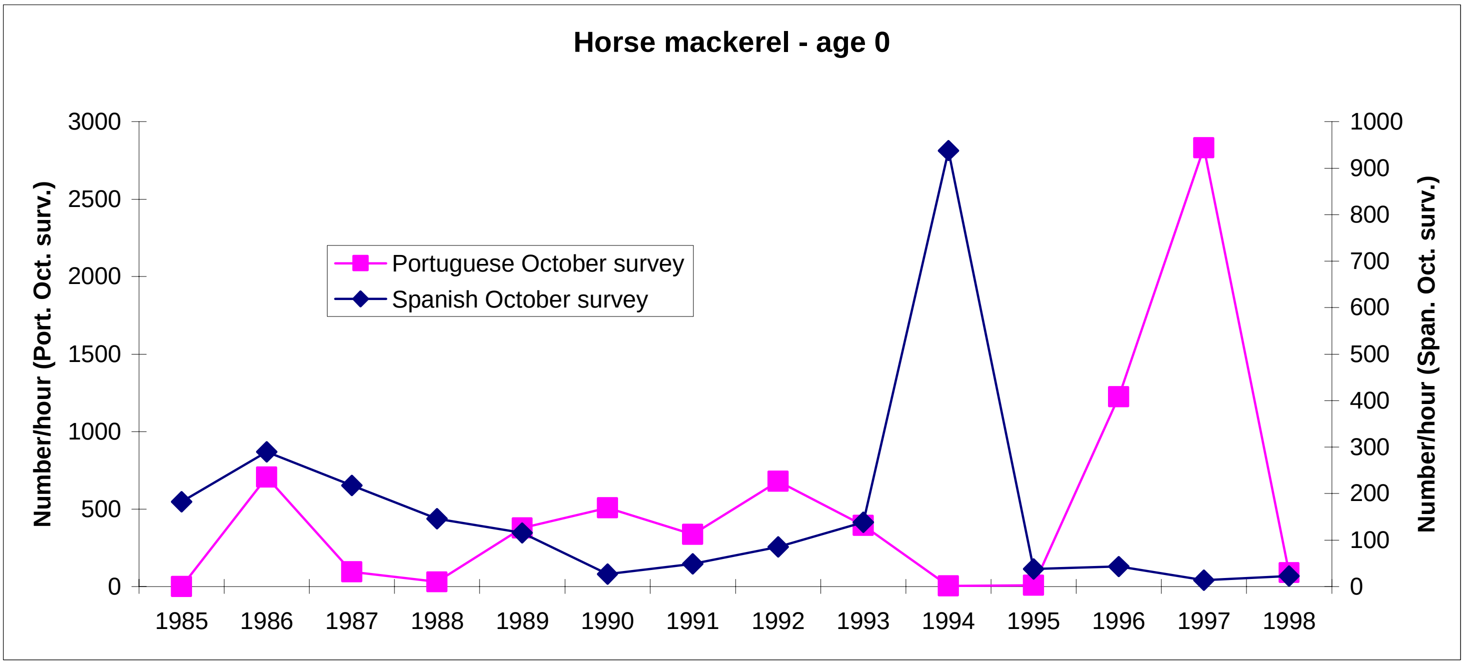


Figure 7.6.1 - Catches of age 0 horse mackerel in bottom trawl surveys used in the tuning of the VPA.

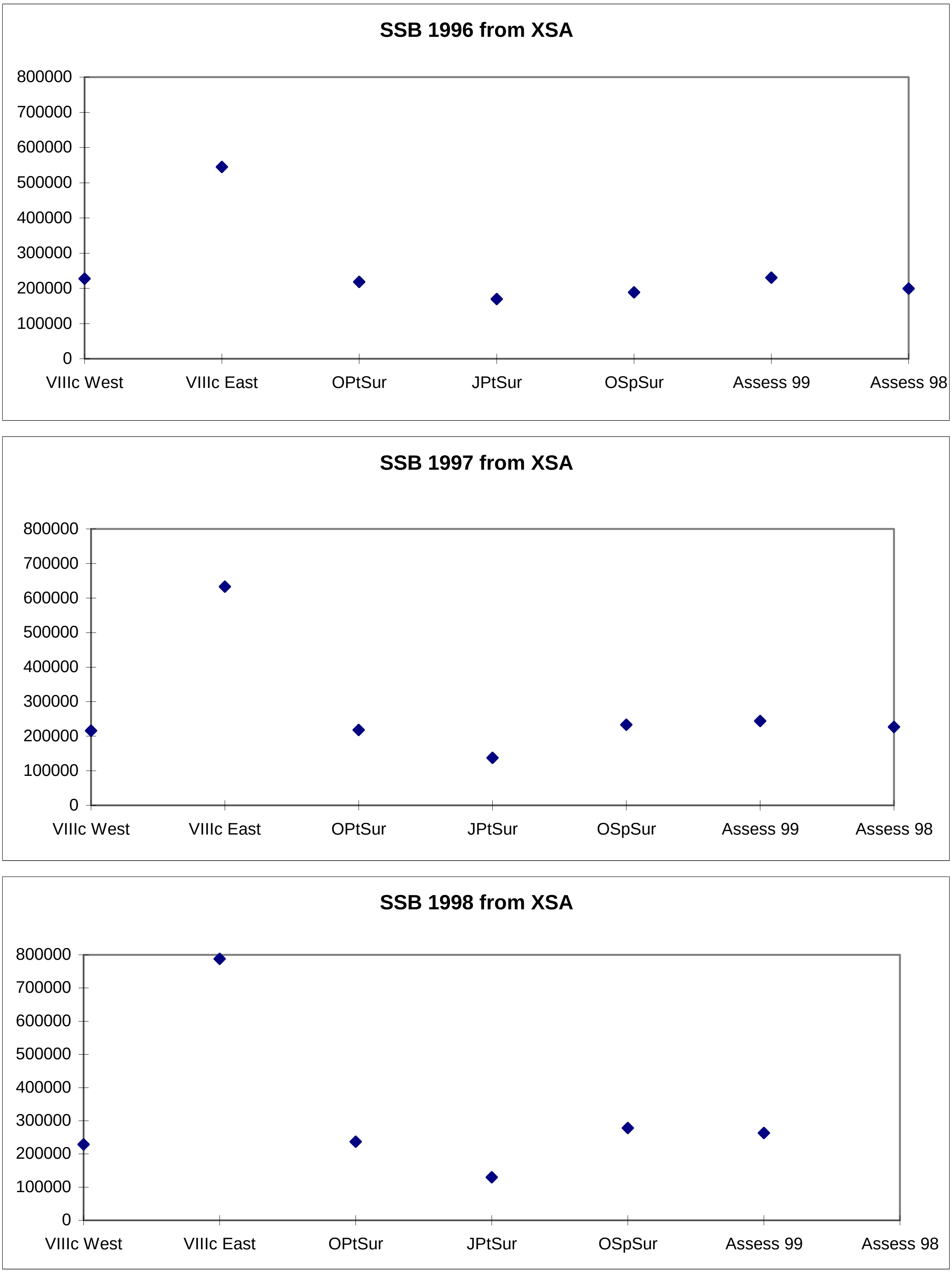


Figure 7.7.1.1 SSB estimates in 1995, 1996 and 1997 by source of independent information.

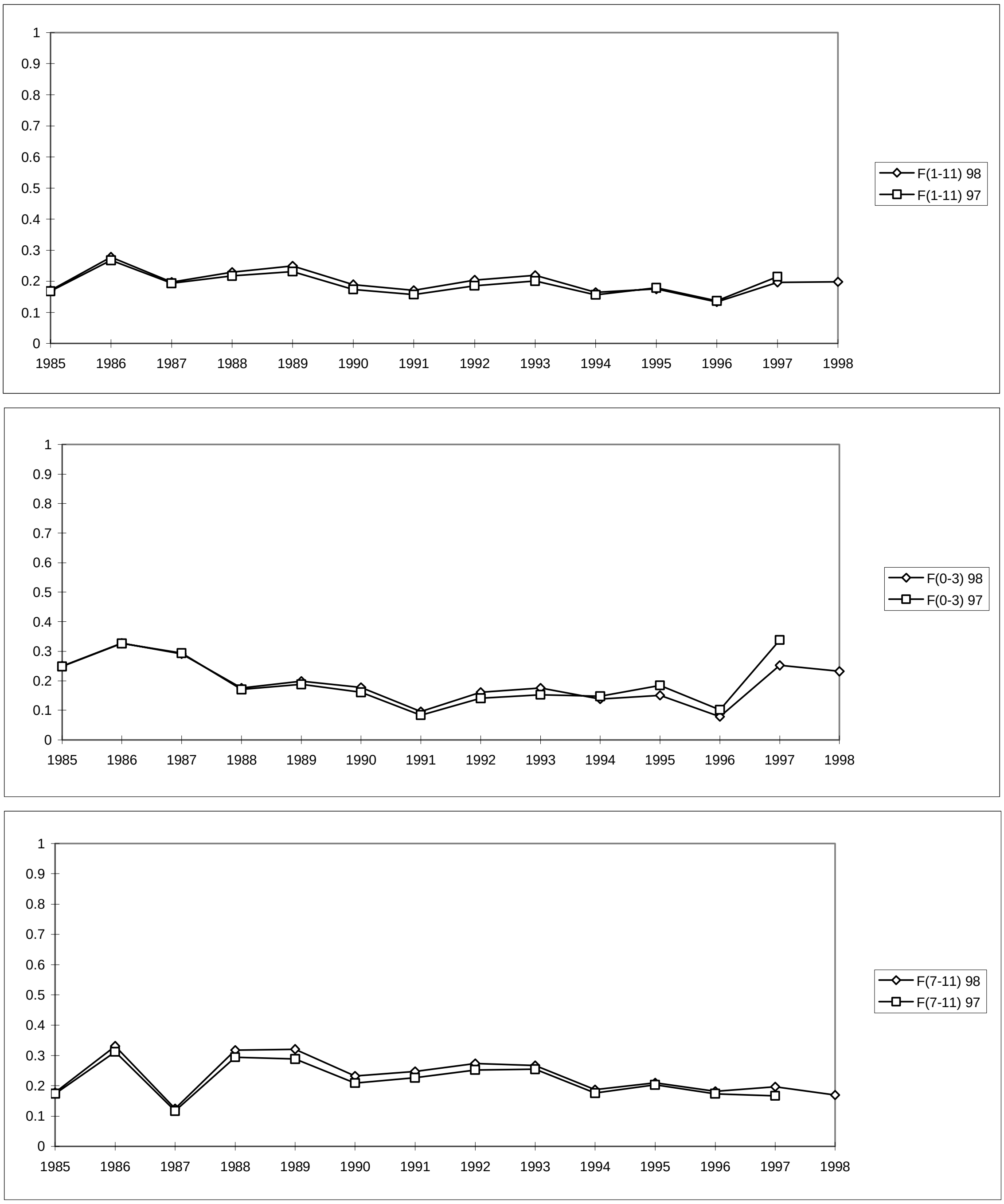


Figure 7.7.2.1 Comparison of the 1996 and 1997 assessments for different F's bar from the final VPA.

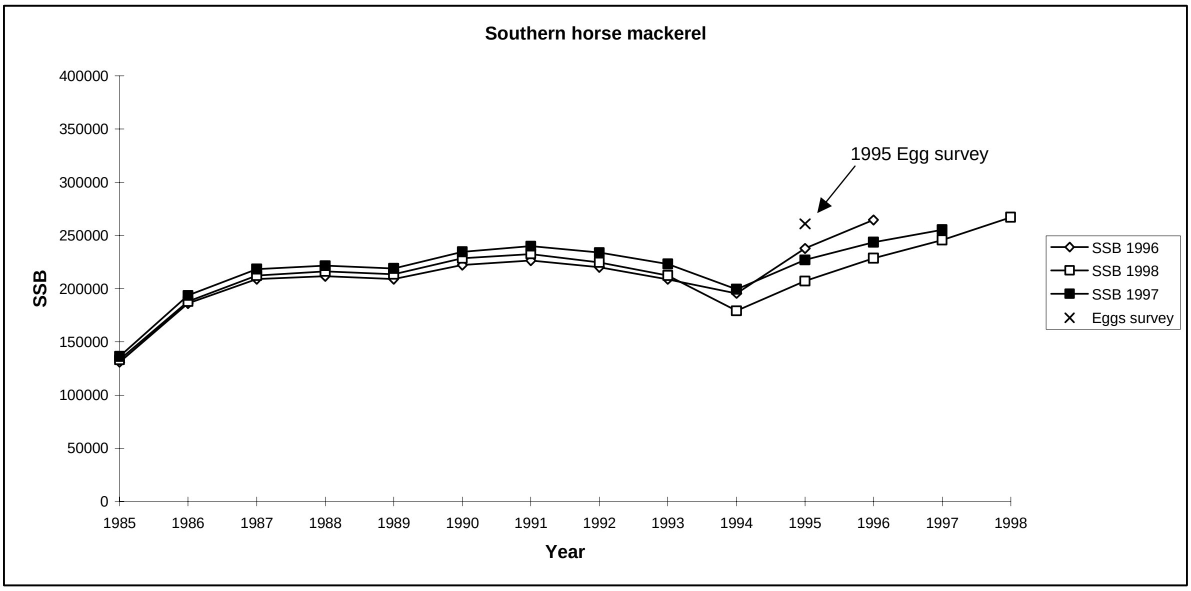


Figure 7.7.2.2 Comparison of the SSB estimates from the 1995 - 1997 analytical assessments and the 1995 egg survey.

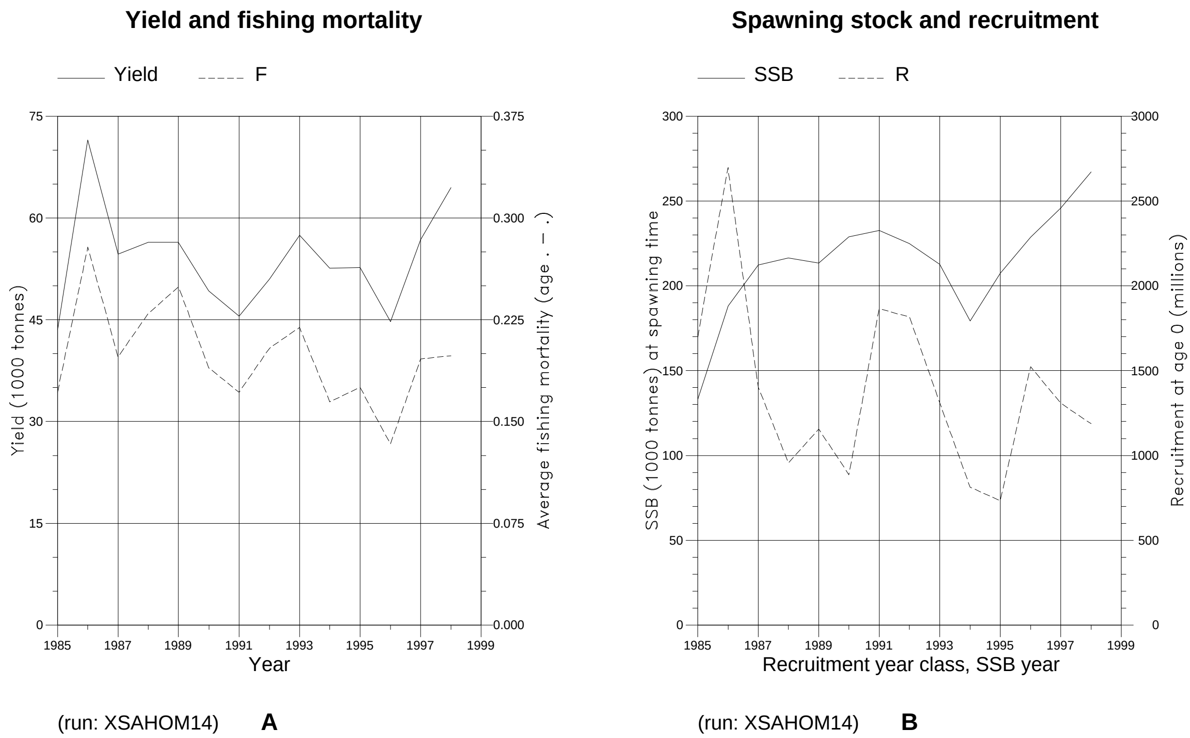
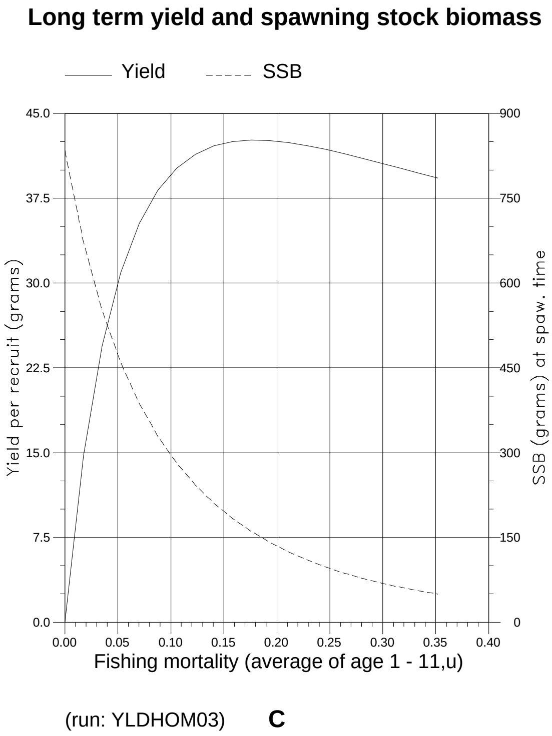


Figure 7.7.2.3 Fish stock summary for the Southern Horse Mackerel



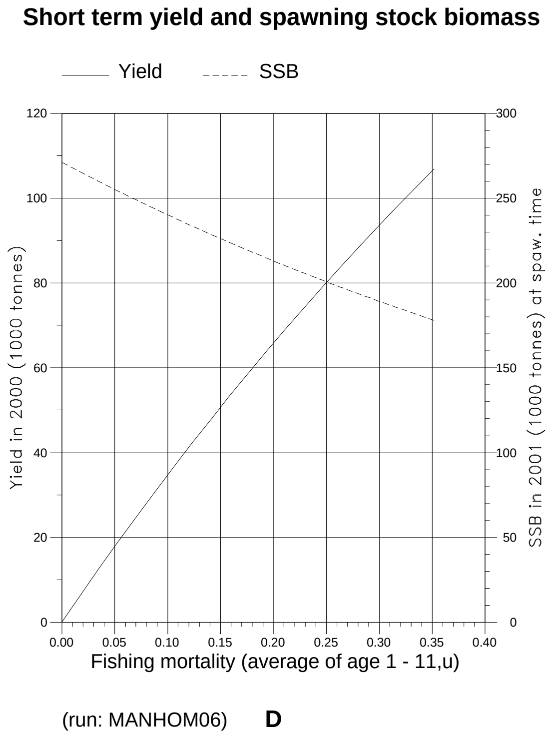


Figure 7.8.1 Long and short-term yield for the Southern Horse Mackerel

Figure 7.9.1 Horse, Iberia. Sensitivity analysis of short term forecast.

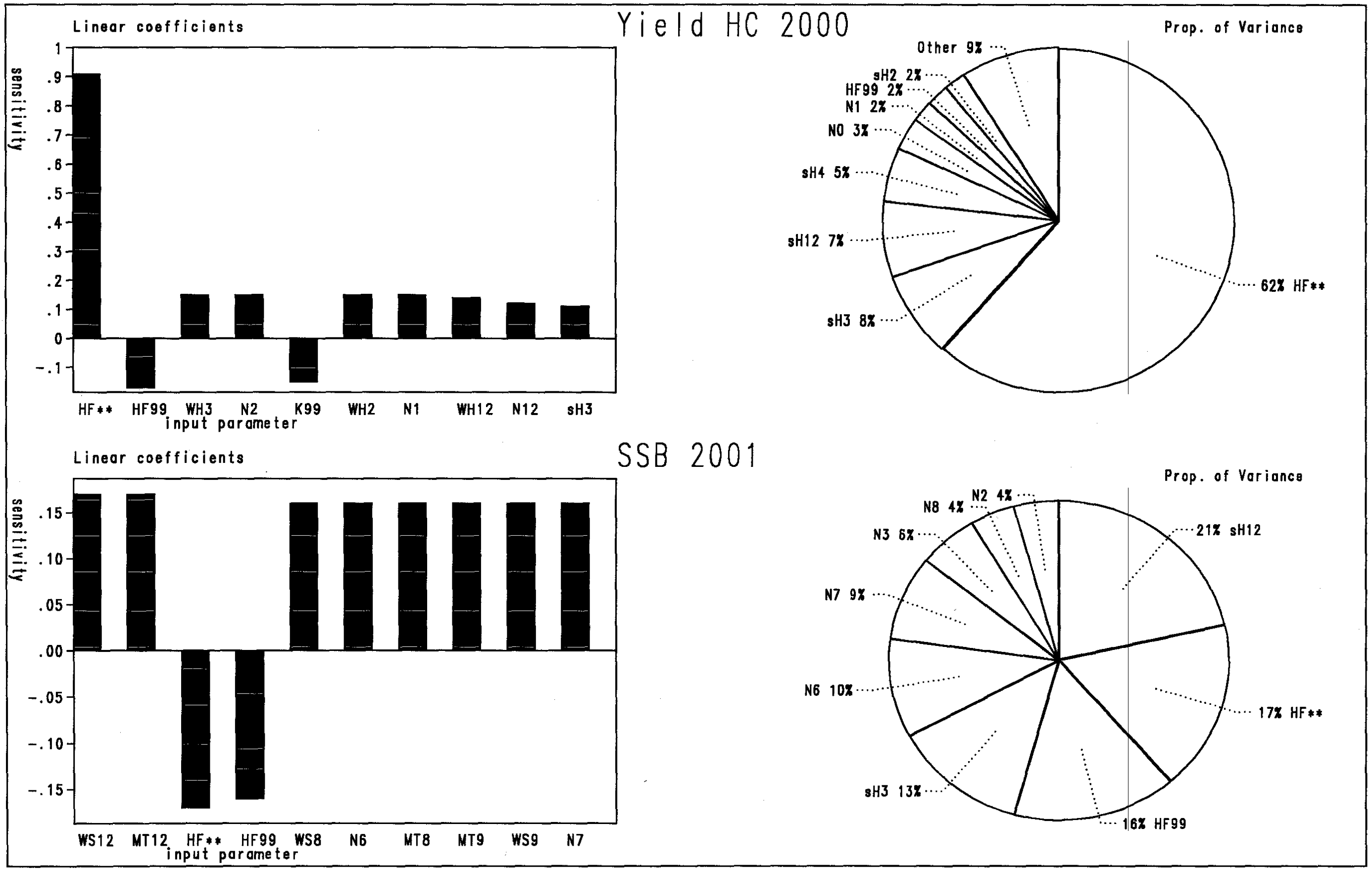
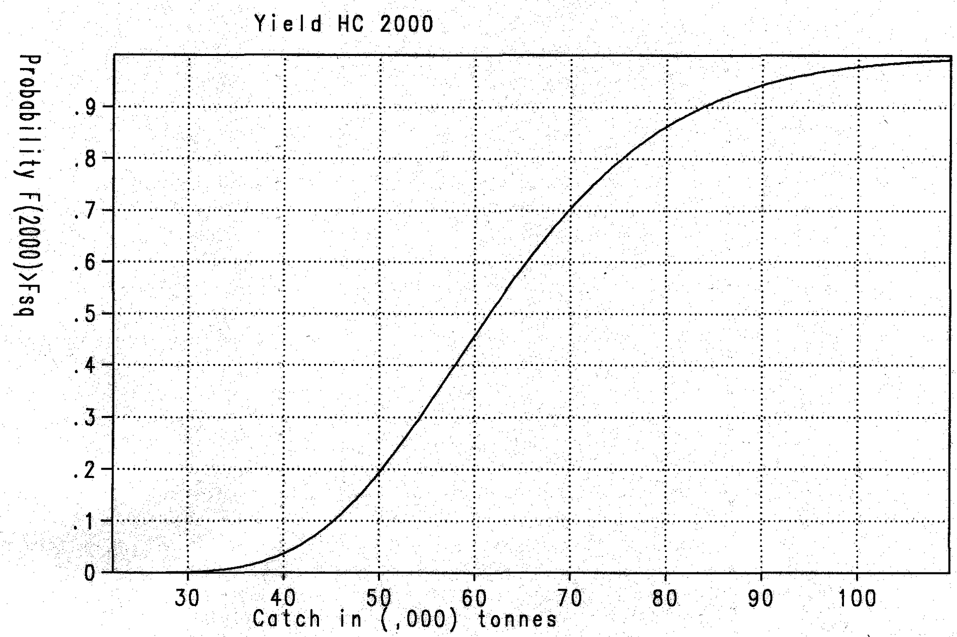


Figure 7.9.2 Horse,Iberia. Probability profiles for short term forecast.



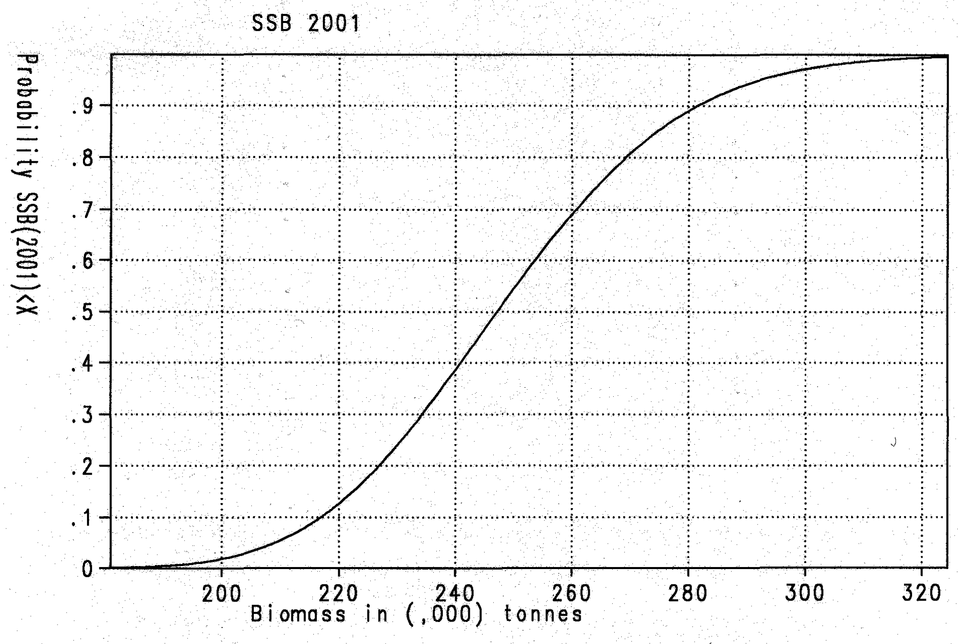


Figure 7.10.1 - **Southern Horse Mackerel. Medium term projections. Solid lines show 5, 10, 20, 50 and 95 percentiles, number of simulations 500, Relative Cons. effort = 1.0**

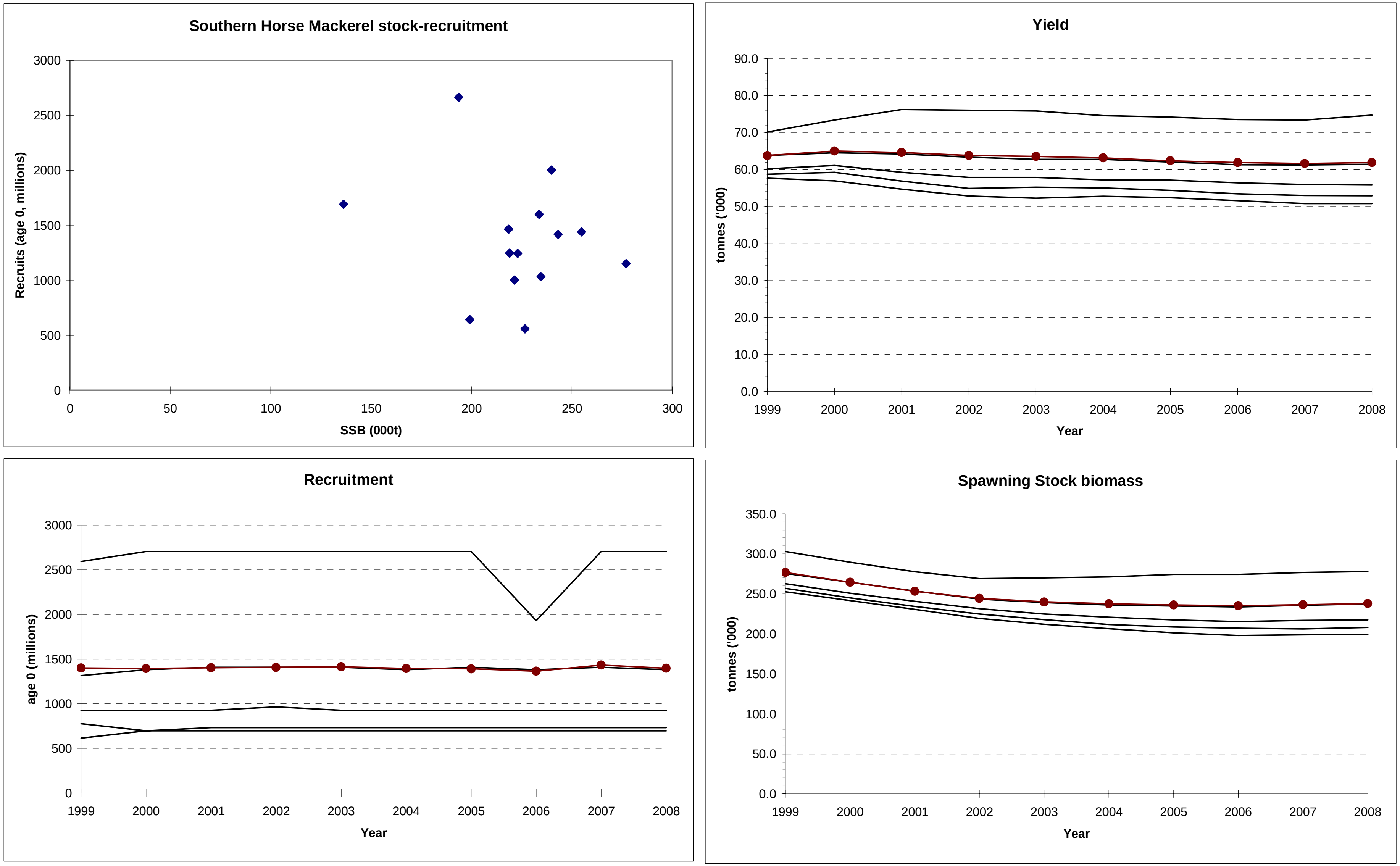


Figure 7.10.2 - Southern Horse Mackerel - Medium term predictions with 5th,10th, 20th and 50th percentiles of SSB in 2001 for different F-factors applied to status quo F. 500 simulations.

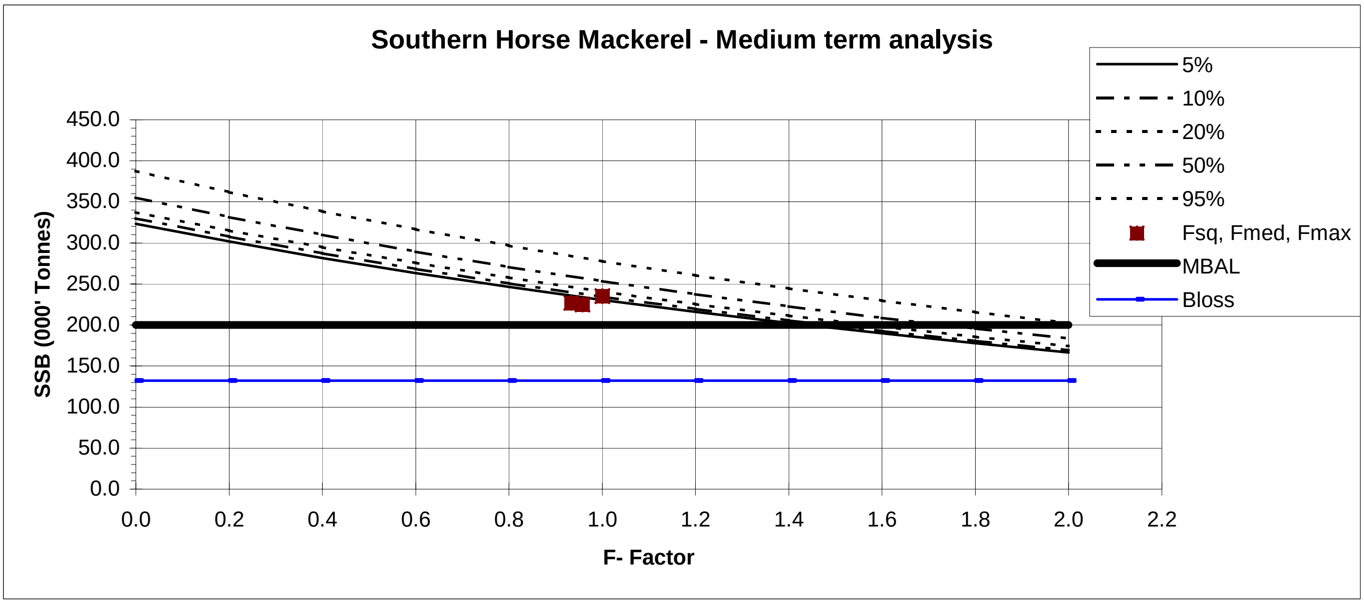
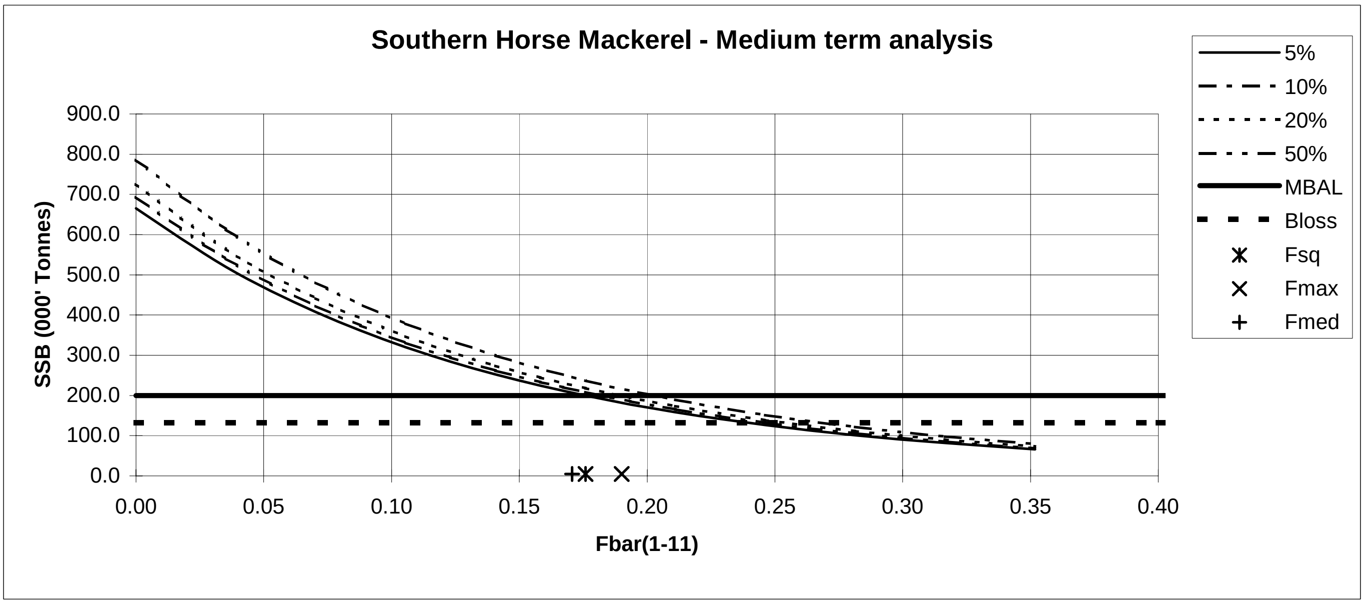
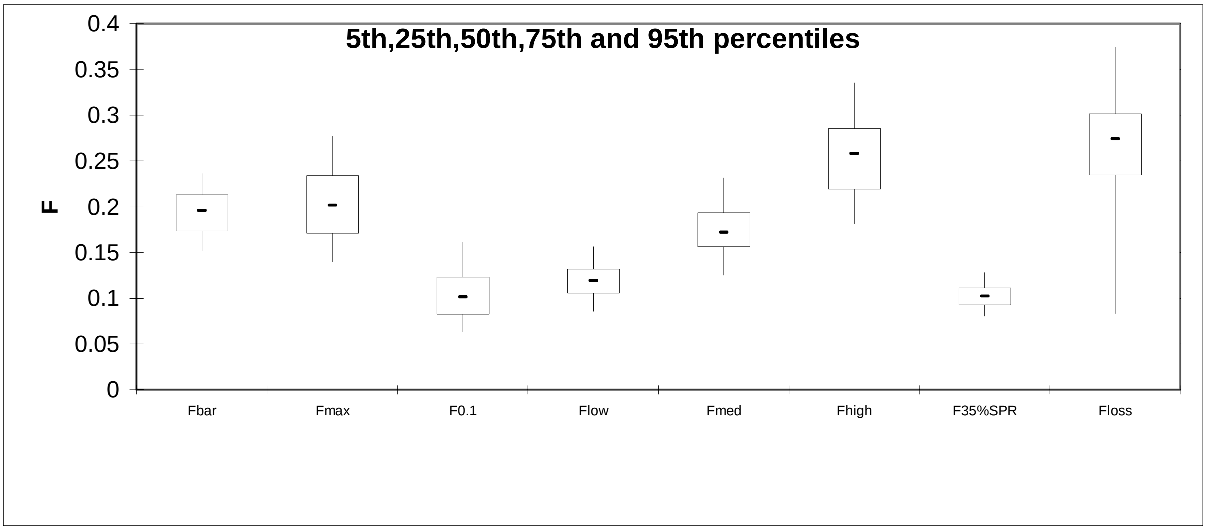


Figure 7.10.3 - Southern Horse Mackerel - Medium term predictions with 5th,10th, 20th and 50th percentiles of SSB in 2008 for different F-factors applied to status quo F. 500 simulations.





Reference point	Deterministic	Median	95th percentile	80th percentile	Hist SSB < ref pt %
MedianRecruits	1392546	1392546	1585688	1459719	
MBAL	0				0.00
Bloss	132268				
SSB90%R90%Surv	172969	177578	233716	227108	7.14
SPR%ofVirgin	16.56	17.39	25.31	22.24	
VirginSPR	0.84	0.85	1.11	0.99	
SPRloss	0.08	0.08	6613.66	0.15	

	Deterministic	Median	5th percentile	20th percentile	Hist F > ref pt %
FBar	0.20	0.20	0.15	0.17	42.86
Fmax	0.19	0.20	0.14	0.17	57.14
F0.1	0.10	0.10	0.06	0.08	100.00
Flow	0.12	0.12	0.09	0.10	100.00
Fmed	0.17	0.17	0.13	0.15	78.57
Fhigh	0.26	0.26	0.18	0.22	7.14
F35%SPR	0.10	0.10	0.08	0.09	100.00
Floss	0.28	0.27	0.08	0.20	0.00

Figure 7.12.1 - Estimates of some biological reference points for southern Horse Mackerel.

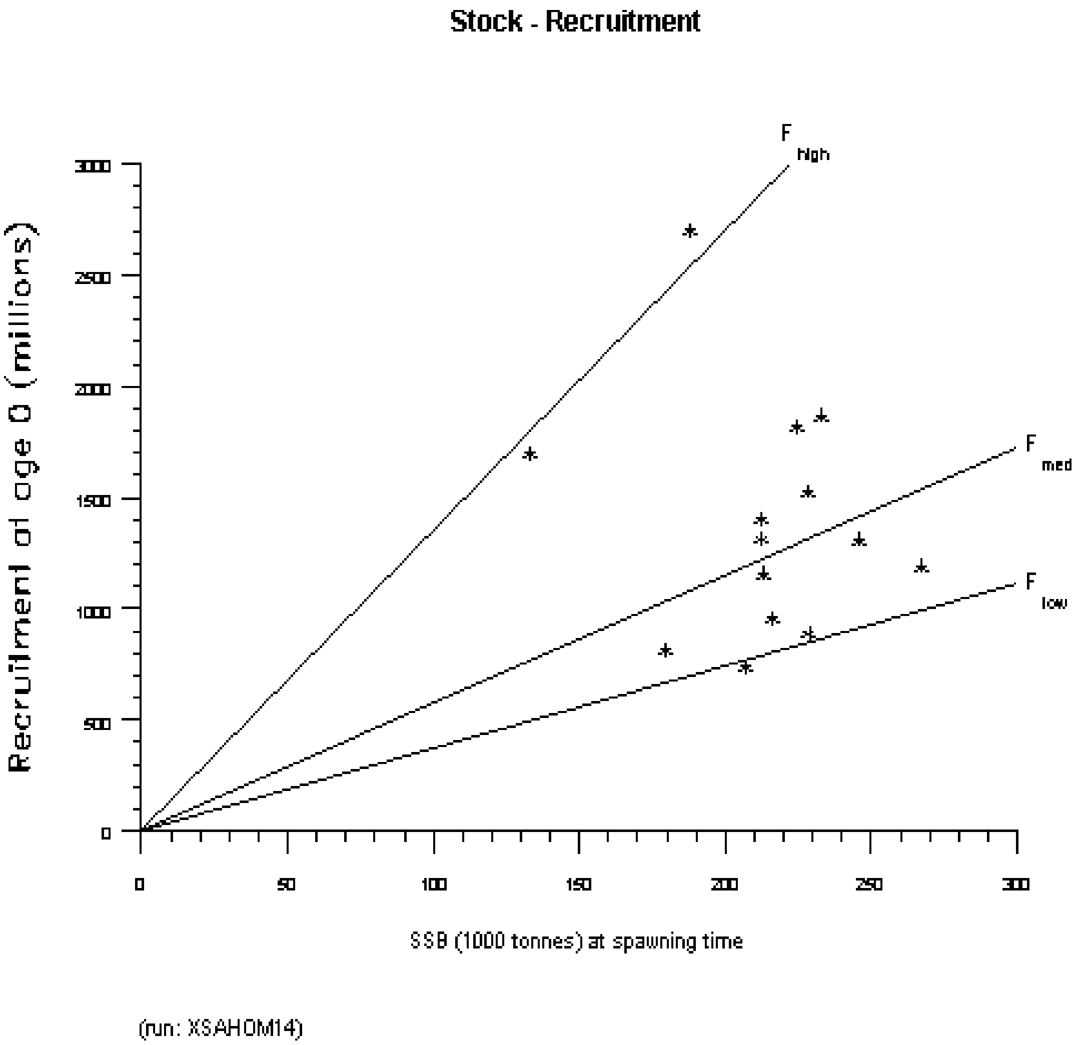


Figure 7.12.2.- Recruits (age 0) versus Spawning Stock Biomass

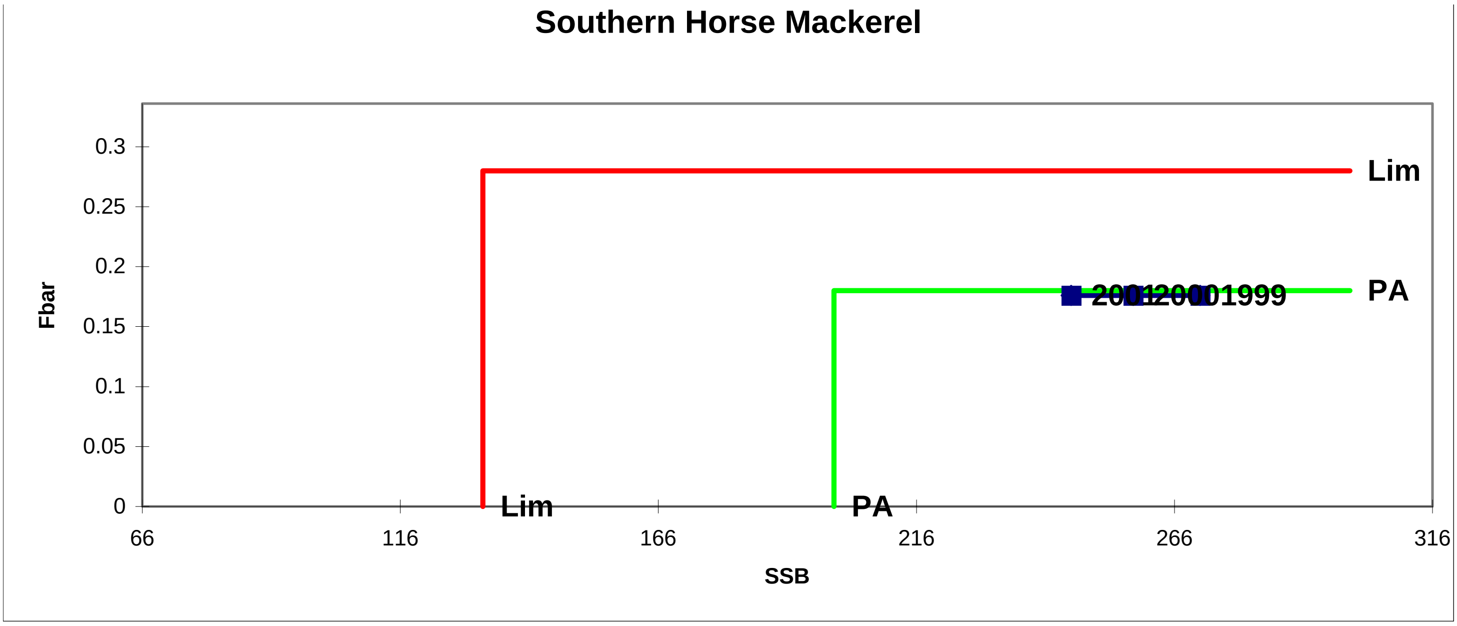


Figure 7.14.1 - Predicted SSB in 1999, 2000 and 2001, and PA reference points for the southern Horse Mackerel.

8 SARDINE IN DIVISIONS VIIIC AND IXA

8.1 ACFM Advice Applicable to 1998 and 1999

In October 1997 ACFM considered that *this stock was in a serious state* and advised that *to prevent a future decline there should be no fishing on this stock and that a recovery plan should be developed and implemented.*

Considering the seriousness of the situation the European Commission, Directorate General of Fisheries, requested in 22 January 1998 advice from ICES, as follows: *The stock of sardine in ICES Divisions VIIIc and IXa is subject to several management measures adopted by national authorities from the concerned EU Member States, following the delicate state of the stock described in recent ACFM reports. Given the seriousness of the situation, it has become evident that a closer follow-up of the stock status is required in order to take any further remedial action. With this in mind, ICES is requested to review, in the course of the 1998 May meeting of the ACFM, the assessment carried out in 1997 in the light of any new scientific information available. In particular, it is requested to consider the results of the acoustic surveys conducted at the end of 1997 and in spring of 1998, as well as the catch figures for 1997.*

In May 1998, the ACFM revised the former advise applying to 1998 based on new information provided on Anon (1998): *This stock is in a serious state. To prevent further decline in the stock during this period of poor recruitment, an immediate and significant reduction of at least 80% in fishing mortality is required in 1998.*

The ACFM advice in October 1998 reads as follows: *ICES recommends that fishing mortality be reduced to F = 0.20 in order to achieve a low probability of further decline in stock size and to promote recovery of the stock. This corresponds to a catch of about 38 000 t in 1999. If the recommended reduction in F cannot be implemented in one year a recovery plan should be applied by steps aiming at an increase of biomass of 20% in 2000 which will amount to decreasing fishing mortality by 40% in 1999 in relation to 1997.*

8.2 The Fishery in 1998

The sardine in the Atlantic European waters has a wide distribution, reaching the North Sea. The major fishery is located at the ICES Division VIIIc and IXa. Further north, several studies (i.e., egg and acoustic surveys) have indicated that significant abundances of sardine exist along a wide distribution from the Celtic Sea, the English Channel and the French continental shelf (Haynes and Nichols, 1994; Massé and Prouzet, 1998). Large catches of sardine are taken just to the south of Division IXa in Moroccan waters (Kifani, 1998).

French official catches in Division VIIIab from 1998 were 10,674 t (Table 8.2.1) being mostly located in the north. In addition, Spanish catches in Division VIIIb were 7,749 t. For Divisions VIId, VIIef and VIIh 103 t, 4,223 t and 101 t, respectively, were provided by the Working Group members. Total reported catches from northern areas were 22,850 tonnes.

Table 8.2.2 shows the length composition by quarter for catches from Divisions VIIe and VIIIb. The main characteristic of those length distributions is the presence of high length classed (> 23 cm) as compared to those obtained in Divisions VIIIc and IXa.

8.2.1 Catch estimates

Catches in Divisions VIIIc and IXa in 1998 as estimated by the Working Group were 108,924 tonnes. Table 8.2.1.1 summarises the quarterly landings by ICES Sub-division.

During March 1998 there was a ban for the purse seine fishery in Galicia (north west corner of the Iberian Peninsula comprising Sub-division VIIIc-West, IXa-North and the westernmost part of VIIIc-East). In addition, there was a voluntary closure of the purse seine fishery in Sub-division IXa Central North during two consecutive months in the 1st Quarter of each year from 1988 until 1997. The two consecutive months were not always the same each year. In 1998 regulations were implemented in order to enforce this fishery closure. During this closure sardine only can be caught for bait purposes (Pestana *et al*. WD 1999).

Total catches in Spain were 26,034 t t including those catches taken in Sub-division IXa-South-Cadiz (6,594 t). In the northern part landings reached 19,440 t. More than half of these were located at the inner part of the Bay of Biscay – Sub-division VIIIc-East- (10,524 t). This situation is new since most of the catches historically occurred off Galicia. In 1998, catches in this region were only 8,916 t, with 5,653 corresponding to Sub-division VIIIc-West and 3263 t to Sub-division IXa-North, which was the lowest value reported in this area. The increase in Sub-division VIIIc East was mainly due to catches taken in winter (74% of the catches made in the first and fourth quarter). This period is in between the anchovy purse seine fishery and the tuna bait boat and troller fisheries, which were mainly conducted in the second and third quarter respectively.

In Portugal catches were estimated to be 82,890 t. The highest landings were taken in Sub-division IXa Central North (32,524 t). During the 1st quarter of 1998, catches in this Sub-division (367 t) together with those reported in Sub-division IXa-North (206 t) were the lowest recorded for a single quarter or area in 1998, a consequence of the fishery closure measure implemented in these areas. In Sub-division IXa Central South and IXa South-Algarve. As in previous years, the bulk of the catches was taken during the second half of the year. The increase of catches in the third quarter in Sub-division IXa Central North seems to be related to the incoming recruitment and younger fish, whereas in Sub-division IXa Central North seems to be related to the incoming recruitment and younger fish, whereas in Sub-division IXa South-Algarve it is rather related with an increase of older ages.

Figure 8.2.1.1 and Table 8.2.1.2 show the annual catches from both Portugal and Spain since 1940. Although there is a coincidence in periods of high catches and low catches among both countries Portuguese catch remains stable at around 90,000 t since 1996, whereas the Spanish ones shows a continuous decrease. Major losses in Spain occurred in IXa-North (Figure 8.2.1.2). From 1997 to 1998 landings in this Sub-division show a slight increase since 1996. During this last period most of the catches were taken in VIIIc-East, while catches from VIIIc-West show a continuous decrease. In IXa-South-Cadiz no trends can be observed; however, catches show two maxima in 1987 and 1997. Portugal presented a time series of sardine landings by ICES Sub-division (Pestana, 1989; Azevedo, 1999 WD) for the first time this year: Although landings from 1940 to 1977 only shows data from the purse seine fishery, this fleet comprises the bulk of the catches and thus, its trend is representative for the overall trend in the catches. Sub-division IXa Central North has the major contribution to the total catches but also shows the highest fluctuations. Since 1994 it shows a declining trend. Sub-divisions IXa Central South and IXa South-Algarve do not show any important fluctuation along the time series. Landings from Sub-division IXa Central South can be divided in three periods: one until 1949 with a high level of catches: one from 1949 to 1980 with low catches, in which some periods of high catches can however be observed; and one since 1981 with a high level of catches and no noticeable fluctuation. In IXa South-Algarve landings are stable and show only a slightly increasing trend since 1991.

8.2.2 Discards

The major part of the catches is taken by purse seines in a directed fishery with negligible discards. Nevertheless, there are no estimates of discards for this stock in other fisheries.

8.3 Biological Data

Biological data were provided both by Spain and Portugal. In Spain samples are taken all among the Sub-divisions VIIIc East, VIIIc West and IXa North. For ALK, samples are pooled on a half year basis, while length weight relationships are calculated for each quarter. In Portugal both ALK and L/W relationship are compiled on a quarterly and ICES-Sub-division basis. Date from IXa South-Cadiz are obtained using the samples of the IXa South-Algarve Sub-division.

A comprehensive revision of the biological data was presented by Azevedo (1999 WD). The principal revisions concerned mean weight at age in the stock, maturity ogive and catch-at-age data. Comments on the main results will be given below in the specific sections.

8.3.1 Length distribution and catch in numbers at age

Landings are structured by length classes (0.5 cm) prior to applying the ALK for each Sub-division on a quarterly basis. Thus, in Table 8.3.1.1 the quarterly length distribution of catches by Sub-division is shown. Sub-division IXa Central North shows a wider length range than the other Sub-divisions. Mean length is higher in Sub-division VIIIc. The lower mean lengths are found at the center of the distribution area (i.e., Sub-division IXa North and IXa Central North) and in Sub-division IXa South-Cadiz, which coincides with the main recruitment areas.

The catch-at-age matrix was reviewed because minor errors have been found as reported in Azevedo (1999 WD). These had effects only on the catch-at-age data from IXa South-Cadiz.

Catch-at-age in number by quarter and Sub-division is shown in Table 8.3.1.2. The catches of age group 0 were estimated to be 436 million fish. The strength of this incoming recruitment was mainly reflected in catches of Sub-divisions IXa North, IXa Central North and IXa Cadiz, which' relative proportion was higher than 30% of the total catch in number (Table 8.3.1.3). Nevertheless, the bulk of the catches belonging to age group 0 was located at Sub-division IXa Central North. No indications of good recruitment were obtained in the other Sub-divisions. Younger fish (i.e., age groups 1 and 2) were mainly caught in Sub-division IXa Central North as well. Nevertheless those fish were also caught in almost all areas in a percentage higher than 35% of the total catches in each area. Younger fish were scarce in the catches in Sub-division IXa South-Algarve. In this Sub-division age groups 4 and 5 represented 50% of the total catches within this Sub-division and 45% of the total catches in the whole area.

Total catch was 2,207 million fish, which was similar to that achieved in 1997 (2,234 million fish). Nevertheless the contribution of younger fish (i.e., age groups 0, 1 and 2) increased to up to 60% of the total catch numbers (Figure 8.3.1.1). Since 1995, when the lowest number of fish was caught (1,938 million fish), the catches increased slightly and the contribution of the younger ages to the total catch significantly (from 26% to 60%).

8.3.2 Mean Length and Mean Weight at Age

Mean length at age by quarter and Sub-division is shown in Table 8.3.2.1. Mean length in the catches was 18 cm. The highest mean length was located in Sub-division VIIIc and then in Sub-divisions IXa Central South and IXa South-Algarve. The lowest mean length was estimated in Sub-divisions IXa Central North, IXa Central North and IXa South-Cadiz. Among the quarters a constant length distribution can be observed. Mean length at age is consistently lower for each age in Sub-divisions IXa South (both Algarve and Cadiz). In the other Sub-divisions values are rather similar except those of the younger fish (i.e., age groups 0, 1 and 2) which are lower in Sub-division IXa Central North. This feature could be explained by the existence of nursery areas in this Sub-division.

Mean weight at age by quarter consistently shows a weight gradient from Sub-division IXa South to Sub-division VIIIc East in which the heaviest sardines at age are located, as can be found in Table 8.3.2.2 This trend also appears in the lengths at age.

8.3.3 Maturity at age

The maturity ogive for 1998 was based on the biological sampling made in the spawning period (i.e., fourth quarter 1997 and first quarter of 1998). Age classes of samples obtained in 1997 were shifted by one year. The Portuguese samples were giving a weighting factor of 90% as most of the fish occurs in Portuguese waters. The result is shown below:

Age	**0**	**1**	**2**	**3**	**4**	**5**	**6+**
Maturity ogive	0	74.80	93.16	96.04	98.83	99.55	100

Carrera (1999 WD) analysed the maturity ogive by length class by fitting a logistic model to observed macroscopic stages. L_{50} was estimated to be 13 cm, which was in agreement with the results obtained using microscopic techniques. With this model most of the females were mature at 15 cm. According to that and taking the mean length at age into account, maturity ogive seems to underestimate the proportion of fish mature at ages 2 onwards, as explained in Azevedo (Op. Cit.).

8.3.4 Natural mortality

According to Pestana (1989), natural mortality is estimated to be 0.33, which is used as a fixed value for all ages and years.

8.4 Fishery-Independent Information

8.4.1 Egg Surveys

In 1999 a new Daily Egg Production method (DEPM) was used both in Portugal and Spain. Samling and estimation methodology was the same as in the previous two DEPM surveys (in 1988 and 1997). However, the 1999 DEPM survey in Portugal was conducted two months earlier (10 th of January to 3rd of February) than the previous survey and the Spanish survey. The reason for this shift was recent evidence from Portuguese maturity and gonadosomatic index data in the 90s (Soares, WD 1999), which suggest an earlier spawning season (October to March/April) that peaks in winter (December/January). Performing a DEPM survey close to the peak of spawning minimises the possibility of underestimating spawning biomass due to a movement of fish that have already completed spawning (Gunderson 1993), and reduces the danger of misinterpreting atretic oocytes or post-ovulatory follicles. The shift in the timing of the

Portuguese egg survey did not allow the egg survey to overlap with the spring acoustic survey, the latter providing in recent years samples of adult fish used for the estimation of batch fecundity, sex ration and spawning fraction. To compensate for this and to allow for larger sample sizes in adult parameter estimation (particularly for the spawning fraction), the collection of adult fish for the Portuguese survey was carried out by a combination of research vessel fishing and opportunistic sampling of commercial vessels fishing in the vicinity of the research vessel. Preliminary quantile-quantile plots of length and weight by sex indicate that fish sampled from the commercial and survey vessels had very similar overall distributions.

Sampling of adult fish from the Spanish survey was carried out with two different gears and ships. As in previous years, pelagic trawls were conducted from the oceanographic vessel performing the acoustic survey, but also a small purse seiner was used in order to increase the effort in the coastal areas. Very few adults were found off the Galician coast, and mature females were only found in some areas off Asturias and Santander.

A description of the 1999 egg surveys can be found in Cunha *et al*. (WD 1999) and Lago de Lanzós *et al*. (WD 1999) for the Portuguese and Spanish DEPM survey respectively. The area sampled extended from the Cadiz region in the south (36°N) to the central Bay of Biscay (45°N). Egg production estimates are only available from the Portuguese survey (Cunha *et al*. WD 1999) and adult parameters estimates for both Spanish and Portuguese surveys are currently under way, not allowing a 1999 estimate of spawning stock biomass to be used in this year’s assessment. As in last year, only the SSB estimates from the 1988 (295 000 tonnes) and 1997 (188 400 tonnes) DEPM surveys are used in this year’s assessment.

Egg distribution in 1999 was similar to that observed in the 1997 surveys. In the northern area (Spanish survey), sardine eggs did not appear anywhere along the Atlantic coast of Galicia while the areas of larger densities are confined to coastal regions over the Cantabrian coast and to the continental shelf in French waters (Figure 8.4.1.1). Some areas with high observed density of eggs (up to 120 eggs/0.05 m^2) were found in Asturias and the Basque Country. In general, the situation is similar to that in 1997, although the areas of egg presence are reduced and confined to more coastal areas, and the overall egg abundance is also reduced. In the southern area (Portuguese survey), spawning area and abundance in the area north to the Canyon of Nazaré was higher than in 1997. High concentrations of eggs were found throughout the southern coast of Portugal and, mainly, in the Cadiz region (Figure 8.4.1.2). Between the Canyon of Nazaré and the Cape of St. Vicente there were two areas with large egg concentrations (north of Lisbon and Setubal areas), but unlike 1997 there were no eggs found along the southwestern Portuguese coast. Table 8.4.1.1 summarises the raw information and the estimates for 1999 egg production and compares it with equivalent information from the previous two Portuguese DEPM surveys. It should be noted that sampling in 1988 did not include the Cadiz region.

In an alternative analysis of the information from the egg surveys, Generalised Additive Models (GAMs) were used in the context described by Borchers *et al*. (1997). Bernal (WD 1999) reviewed the 1988, 1990 and 1997 Spanish surveys and estimated spawning area and egg production, while Stratoudakis (WD 1999) used a longer time series of ichthyoplankton surveys only to estimate spawning areas with Portuguese waters. The results of spawning area estimation are presented separately in section 14.4 of this report. In Table 8.4.1.2 and Figure 8.4.1.4, the traditional egg production estimates from the Spanish DEPM surveys are compared with the GAM based estimates. GAM estimates were slightly lower than the traditional ones in 1988 and 1997, and slightly higher in 1990, the latter having a larger coefficient of variation. 1990 showed a more oceanic distribution of eggs (Figure 8.4.1.3), with areas of high egg densities near the boundaries of the survey. This can cause the difference between the production estimate of the traditional method and the GAM. In general, both the traditional and the GAM estimates show a decrease in egg production from the 1988 and 1990 estimates to the 1997 one (Figure 8.4.1.4). Evaluating the results by Regions, Regions I and II show the same pattern, with higher productions in 1988 and 1990 and a significant decrease in 1997, while the GAM estimates for Regions III show a constant production of eggs over the time series. The variance estimate from the GAM method includes the error in the estimate of spawning areas and the ageing error, but is still lower than the variance estimates for the traditional egg production estimates of 1988 and 1997. Traditional egg production estimates off Portugal (Figure 8.4.1.4) are difficult to compare both over the years and with the Spanish ones, because the three Portuguese surveys cover either a different area (excluding Cadiz in 1988) or different survey periods (March in 1988 and 1997 and January in 1999). The temporal variation of the Portuguese surveys should not invalidate comparisons between SSB estimates, because the adult sampling is done simultaneously with the egg survey.

The use of GAMs in the estimation of spawning area (Stratoudakis WD 1999, Bernal WD 1999), using a new technique for converting stages to ages (Bernal *et al*. 1999), and methodological developments in the estimation of natural egg mortality (Bernal 1999) remove several subjective decisions from the traditional estimation of egg production and could lead to more reliable estimates of sardine egg production in the future. Also, GAMs allow the egg production to be estimated for any region delimitation, so comparisons between years and countries will become easier.

8.4.2 Acoustic surveys

According to the ICES resolution 2:50, the Planning Group for Pelagic Acoustic Surveys in ICES Sub-Areas VIII and IX met in Nantes (France). From the Terms of Reference, a revision of the methodology to be used in data analysis as well as the co-ordination of the acoustic surveys to be carried out in Spring 1999 was done. The normal method to allocate echo-integrated back-scattering strength into fish species was the scrutiny of echo-traces. Fish species were distinguished for the different shape and back+scattering of the schools. In addition, fishing on these schools was conducted to verify the echo integrator results. Since 1996 an increasing number of irregular-shaped schools has been reported, especially in South Portugal, Cadiz and in the inner part of the Bay of Biscay. As some of these schools were found to be mixed-species scholls, it is neither possible to differentiate fish species only from echo-traces nor to allocate the echo-integrated energy. Alternatively, the proportion of fish species found at the fishing stations was used to allocate echo-integrated energy. For each fish species its proportion in number is weighted according to the length distribution and the Target Strength/Length relationship. This method was applied in both Portuguese and Spanish acoustic surveys.

Acoustic surveys: Spain

From 3rd March to 27 th march 1998 the Spanish acoustic survey on board R/V Thalassa was carried out. The survey, directed at sardine, covered the south of the French Coast during the first 10 days and the northern Spanish waters from the 20 m isobath to the 200 m isobath (Carrera *et al*. 1999a WD). The survey coincided in time with the ichthyoplankton survey conducted by R/V Cornide de Saavedra to assess the SSB of sardine using the DEPM Method. Adult parameters for this method were obtained from the sampling obtained during the acoustic survey. A commercial purse seiner was chartered to provide additional samples in those areas where sardine was not accessible, either due to the proximity of the coast or due to the availability of fishing year which did not allow pelagic hauls to be performed. In addition a small experimental survey was carried out from 25 th August to 3rd September. The covered area was Sub-division IXa-North and the main objective was to assess the juvenile fraction of pelagic fish species (Carrera 1999b WD).

Spring Survey: French area

In spring 1999 the area covered in French waters was slightly different from that in the last year. This year the total biomass was estimated to be 126 thousand tonnes corresponding to 2,544 million fish. Since 1997 when this area was first covered in Spring, estimated sardine abundance showed a large variability among years. This is mainly due to the wide range of movements that this sardine population undertakes along the French plateau (Prouzet, pers. comm.). Therefore, as the survey did not cover the whole distribution area of sardine, the assessment as shown in Table 8.4.2.1 should be regarded as a qualitative rather than quantitative.

Spring survey: Spanish area

In the Spanish area the distribution area of sardine was similar to that found in the previous year. Only 5% of the survey track yielded sardine schools (Figure 8.4.2.1). These schools were located close to the coast in isolated and dense patches. There was only spatial continuity between more than two transects close to Cape Peñas)6° W) and close to Bilbao (3°20’W-2°50’W). The distribution area of sardine was 446 sq. mm. This value is three times lower than the one for the previous survey, being noticeably lower in VIIIc-East. The results on adult fish distribution gained from this survey agreed well with the findings of sardine egg distribution made during the plankton survey.

Biomass in the Spanish area was estimated to be 43,000 tonnes corresponding to 726 million fish (Table 8.4.2.1). 50% of the total biomass was estimated to be in the western part of Sub-division VIIIc-E (between 7°20’ and 3°20’W). In Division IXa North only 3,842 tonnes were estimated, whereas the total biomass in Division VIIIc-W was 5,435 tonnes. Figure 8.4.2.2 shows the relative abundance in number by age group and Sub-division. No indication of good recruitment in 1998 was observed. Nevertheless, age group 1 predominated in Sub-division IXa North, VIIc-W and in the eastern part of VIIIc-E. The biomass in 1997 in the Spanish area was estimated to be 35,000 tonnes. This year, sardine were found more aggregated and the mean density was higher (467 thousand fish nm^{-2} in 1997 and 614 thousand fish nm^{-2} in 1998). Estimated fish number decreased from the previous year because in 1997 most of the fish belonged to age group 1.

Summer survey: Spain

During the experimental survey (Carrera, 1999b WD) performed in summer, 400 nm were covered. Only two skools of sardine were detected. Besides, a chartered purse seine only found 200 kg in two different shots. In contrast, the presence of schools of juvenile mackerel was noticeable.

Acoustic surveys: Portugal

During 1998 Portugal undertook two acoustic surveys for sardine with R.V. "Noruega", on in March and one in November, both covering the Portuguese coast and the Gulf of Cadiz (Spain) (Anon., 1998, Marques *et al*., WD 1999). This revision affected mainly the younger age groups in the Algarve area. The abundance by age group was corrected and updated values were provided in Marques *et al*. (WD 1999, Table 3), see Table 8.4.2.2.

The distribution of sardine in November 1998 was similar to that observed in November 1997 but more continuous until Lisbon in Area Oc. North (Figure 8.4.2.3). Estimated abundance and biomass values by area show a decrease from Oc. North to Algarve. A high sardine density appears in Cadiz corresponding to a similar abundance (but higher biomass) to that observed in area Oc. North. This survey indicates a strong 1998 recruitment with 0-group fish comprising 65% of total abundance (Figure 8.4.2.5; Tables 8.4.2.3 and 8.4.2.5). The percentage of recruits decreases from Oc. North (77%) to Algarve (42%) and increase again in Cadiz (70%).

In March 1999, one acoustic survey was carried out with R.V. "Noruega" following the methodology approved by the "Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX" (ICES, 1999). This survey was carried out in rough weather conditions during most of the time (Marques *et al.,* WD 1999). The sardine distribution in the Portuguese area presents a similar pattern to that observed in the previous year (Figure 8.4.2.4). Within the Portuguese coast, larger abundance and biomass values are observed in area Oc. North. Considering the total survey area, almost 50% of the number and biomass of sardine was observed in Cadiz. This survey confirms the strong 1998 recruitment suggested by the November survey. Age 1 sardines comprise 49% of fish abundance in the total survey area, with a similar pattern in the relative importance of different areas to that observed in the November survey (Figure 8.4.2.6; Tables 8.4.2.4 and 8.4.2.5). Compared to the March 1998 survey, a considerable decrease in total abundance (either including or excluding Cadiz was observed). This decrease was negligible in area Oc. North but significant in the other three areas (Table 8.4.2.4). The low values observed in March 1999 may be partially due to the rough weather conditions during almost all the surveys.

Figures 8.4.2.3 and 8.4.2.4 show the acoustic track, sardine density distributions and estimates of abundance and biomass by area of the November 1998 and March 1999 surveys. Tables 8.4.2.2 and 8.4.2.6 present information by age group of sardine numbers, biomass, mean length and mean weight, for each area and survey. Abundance in the Portuguese area shows a considerable increase from 1997 to 1998, mainly due to an increase in area Oc. North (Table 8.4.2.4).

8.5 Effort and Catch per Unit Effort

Data on fishing effort and CPUE of the Portuguese purse-seine fleet has been regularly provided in this section of the report. It has, however, not been used in the assessment model. During the preliminary analysis of data, it was found that the historical series of fishing effort has been overestimated and consequently CPUE underestimated (Pestana, WD 1999). This was due to an error in the software which extracts this information from the Fisheries Directory database, a procedure which is not under the responsibility of IPIMAR. Since it was not possible to correct the data in time for the meeting, and alternative CPUE index for this fleet has been explored (Pestana, WD 1999). This CPUE was calculated based on the catch and effort of purse-seiners sampled by the national sampling program in each sub-area, raised to the total number of vessels fishing in that Sub-area. Due to missing data or small sample size, values were not computed for 1995 and 1996 in Sub-division IXa-South (Algarve).

Table 8.5.1 presents data on fishing effort, number of trips (= number of fishing days) and CPUE by Sub-division and total for Division IXa, for the period 1987–1998. Total CPUE remained approximately stable through the period with a slightly decreasing trend from 1990 to 1993. Values for the last two years are the highest in the whole series and are caused by an increase in CPUE in Sub-division IXa-South. In the rest of the period, trends of CPUE for the whole area mostly follow the CPUE changes in Sub-division IXa-Central-North. This series of CPUE should, however, be considered as preliminary. In fact, CPUE indices for pelagic fish depend not only on searching time needed to find fish concentrations, but also on the absolute fish density (Ulltang, 1976). This dependency should be further investigated using, for example, ship fuel consumption as a possible index of searching time. Table 8.5.1 also presents data on fishing effort and CPUE for three Spanish purse seine fleets. Effort increased slightly in 1998 for SADA fleet, but continued the decreasing trend for Vigo-Riveira fleet. CPUE decreased for both fleets in 1998, continuing the trend observed since 1987/1988. The comments on the need for correction of CPUE indices for differences in searching time also apply to these fleets. Furthermore, there is information that in the last years these fleets have gradually changed their target species to other pelagic species (mainly horse mackerel) due to the low abundance of sardine in the area. Catch per unit effort has declined markedly in the Sada and in the Vigo and Riveira areas, but is stable or increasing in other areas.

8.6 Recruitment Forecasting and Environmental Effects

The year class strength of the Iberian sardine is believed to be affected by hydroclimatic conditions in the North Atlantic. The reproductive strategy of sardine seems to be to minimise offshore transport while assuring favourable larval feeding conditions.

The main spawning season for sardine in ICES Sub-areas VIIIc and IXa is October-May, with marked peaks in winter in Atlantic waters and spring in the Cantabrian Sea (Anon., 1998). Then offshore transport is minimal (larval retention is maximal) and periods of weak winds lasting for 4–6 days are common (Robles *et al.* 1992, Roy *et al.* 1994). The maximum intensity of sardine spawning off Portugal is believed to be predominant in winter (Figueiredo and Santos, 1989; Ré *et al.* 1990, Soares, WD 1999).

The phase of the North Atlantic Oscillation (NAO) and northern extent of the Gulf Stream (as measured by the GULF index) may influence sardine recruitment along the Iberian Peninsula (Borges *et al.* 1997; Santos *et al.* 1997; Cabanas and Porteiro, 1999 – in press). Decreasing trends in the recruitment of sardine seem to be related with the increased conditions favouring upwelling in winter (Santos *et al.* 1997). This may have a negative impact on the recruitment of sardine. Even though these investigations demonstrated some relation between environmental parameters and sardine recruitment, there is no single index available that could be used to forecast recruitment.

There is a strong signal of good recruitment in the Portuguese November survey in 1998. A weaker indication of good recruitment appears in the Portuguese March Survey, and there is a some indication of good recruitment in the Spanish March acoustic surveys. The 1998 year class appeared to be strongly represented in South Galicia, Division IXa(N), IX(CN), IXaS- Cadiz. However, there is no indication from the catches in Division IXa-CS, S Algarve and VIIIc that this year class is particularly strong.

8.7 State of the Stock

8.7.1 Data exploration and preliminary analysis

Several exploratory runs with ICA were performed in order to assess the sensitivity of the model to different assumptions and input data. Table 8.7.1.1 presents a summary of the input data and options for each run. Figures 8.7.1.1, 8.7.1.2 and 8.7.1.3 show the results in terms of stock parameter estimates from all exploratory runs.

Regarding the input data, the catch at age matrix was updated with Cadiz data from 1978–1981, and the Portuguese and Spanish acoustic survey series were revised, as explained in section 8.4.2. In order to assess the effects of the data revision on stock parameters estimation, run-1 was carried out using the time period 1978–1997 and an age range of 0–6+. Run 1 is an update of the previous assessment with corrected historic input data. The DEPM data, the Vigo/Ribeira and Sada CPUE series, and also the Portuguese and Spanish Spring survey series were used for tuning, their catchability models were not changed (i.e., absolute for DEPM, power for the CPUE series and linear for the survey series). ICA options regarding separable constraints and catch at age weighting were kept the same as in the last year's final assessment. No major changes were observed in the quality of the model fit, but there was a very small increase in SSB and a decrease in Fbar(2–5) for the early selection period.

A second run (run-2) was performed with catch at age data and CPUE series from Vigo/Ribeira and Sada updated to 1998 and the Portuguese and Spanish acoustic Spring survey series updated to 1999. This run indicates the results of updating the previous assessment with new data. The output of this run was used to assess the impact of modifications in later exploratory runs performed one at a time. As in last year's assessment, two separable constraint selection periods were considered (1986–1990 and 1991–1998), with an abrupt change in 1990, and these settings were not modified in subsequent runs. Again, there were no major changes in the quality of the model fit, but there was an additional increase in SSB and decrease in Fbar(2–5), this time throughout the time range. Updating the previous assessment model in this way did not result in major changes in the perceptions of stock development.

In the third run (run-3) the DEPM data were excluded. The reason for considering this change was that DEPM estimates are only available for 1988 and 1997, with only the latter including Cadiz. Information for the 1999 DEPM surveys was not yet available, while, as Bernal (WD 1999) and Stratoudakis (WD 1999) reported, egg production data are under revision. This modification, although resulting in negligible changes in the assessment, has an impact in the stock parameters estimates by scaling up SSB in the early part of the time series and providing lower estimates of Fbar(2–5) over the time series.

Run-4 was carried out by excluding both Vigo/Ribeira and Sada CPUE series. The effort calculation used for these purse seine fleets was not corrected for the fish searching time, which in the case of pelagic species like sardine can result in a wrong effort measure and therefore mask the abundance trend along time. Also, in recent years (late 90s) the decreasing sardines catches in both Division VIIIc and sub-area IXa North led these fleets to change the target species from sardine to mainly horse mackerel. The Working Group was uncertain of the extent to which this switching in effort may have exaggerated the perception in the decline in stock abundance from these data series. In addition, assessment diagnostics failed to indicate a well-defined minimum in the sum of squares for these data with respect to fishing mortality. The impact of this exclusion was to scale SSB down until 1990 and up since 1992, the changes accounting for up to 10%.

Run-5 included the Portuguese November acoustic survey series updated with the survey carried out in 1998. One of the main arguments for excluding the Portuguese November acoustic series from last year's final assessment was that there were only two points in the second period of the selection pattern (1991 onwards). This survey is carried out in the sardine spawning season and recruitment time along the Portuguese coast, and gives information for the 80´s (1984–1987) and also for the 90´s (92, 97–98). The results from this run showed that this series has the lowest variance of all tuning data. The effect of the inclusion of this survey series was a slight decrease in SSB from 1982 to 1986 and a slight increase from 1994 onwards. In terms of Fbar(2–5) it indicates a slight increase until 1986, but this effect is reversed in 1989 with a higher decrease observed in 1998.

In run-6, the Spanish Spring survey series was used including only data from Division IXa. Recent findings suggest that during the 90s the larger part of the sardine stock is located in the southern part of the area, whereas in earlier years sardine were more widely distributed in Divisions VIIIc and IXa. (see Section 14). Because of this it was decided to assess the effect of giving more importance to the information obtained from surveys in IXa. The diagnostics of this run showed the removal of the residual trend with time for ages 5 and 6, observed for the Spanish survey series. Removing the survey data for Division VIIIc resulted in a major decrease in SSB during the 80s (1981–1988) and no significant differences during the 90s. The inverse pattern was observed for Fbar(2–5).

In run-7 spawning biomass estimates from the DEPM were used as a relative rather than an absolute index of abundance, given the high variance (CV around 50%) in these estimates. This series has only two points and the improvement in the catchability model fit increased this series' weight in the assessment, scaling downwards SSB and Fbar(2–5) over the whole period. The Working Group reviewed these exploratory exercises (where the effects of each modification were tested one at a time) and concluded that there were good reasons to:

- exclude the Spanish CPUE series (Vigo/Ribeira and Sada)
- include the Portuguese November acoustic series
- explore further the effect of the DEPM index.

The exclusion of the CPUE series was justified on the grounds that there was not an adequate catchability model fit, providing little information on sardine abundance, and on the low reliability on this data to set as an appropriate abundance index. The WG agreed that the Portuguese November acoustic series should be included in this year's assessment, because it was carried out within the sardine spawning and recruitment season along the Portuguese coast, giving information for the 80´s and the 90´s. Observed relative cohort strengths in the Portuguese November survey and in Portuguese catches in Division IXa are in good agreement.

Another three runs were performed by setting DEPM as an absolute biomass index (run-8), a relative index (run-9) and, finally, by excluding it (run-10). Results from these runs are presented in Figure 8.7.1.2. The WG analysed the outputs from these runs and concluded that similar results were obtained with run-9 and run-10. However, the balance in SSB between the 80s and the 90s obtained from run-8 was considered to be more in accordance with the actual perception of the stock.

For the Portuguese March survey only the period 1996–1999 was used because the earlier surveys in 1986 and 1988 did not cover the same area (The Gulf of Cadiz was not included) and sensitivity of the assessment to including these data was not done.

Further exploration was carried out by Azevedo (WD, 1999) who explored alternative assessments using only catch at age data for Division IXa in the period 1978–1998. The assessment was performed with the Spring Spanish acoustic survey (only Div. IXa) and the Spring and November Portuguese acoustic survey data. Using only this area, a different perception of the stock was obtained with lower fishing mortality and higher stock size in the 90s.

On the basis of the above exploration exercise, the Working Group decided to adopt Run 8 as above as a representation of stock dynamics, but stresses that considerable uncertainties about appropriate model structure and data reliability remain.

8.7.2 Stock assessment

Based on the previous analysis, an Integrated Catch at Age analysis (Patterson and Melvin 1996) has again been used for the assessment of sardine. The model was fitted by a non-linear minimisation of the following objective function:

$$\sum_{0}^{6+}\sum_{1986}^{1990}\lambda_a\left[\ln(C_{a,y})-\ln(F_y\cdot S_{1,a}\cdot\overline{N}_{ay})\right]^2+\sum_{0}^{6+}\sum_{1991}^{1998}\lambda_a\left[\ln(C_{a,y})-\ln(F_y\cdot S_{2,a}\cdot\overline{N}_{ay})\right]^2+$$

$$+\sum_{1986}^{1990}\left[\ln(DEPM_y)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{1,a}\cdot PM\cdot M)\right)\right]^2+$$

$$\sum_{1991}^{1998}\left[\ln(DEPM_y)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{2,a}\cdot PM\cdot M)\right)\right]^2+$$

$$+\sum_{1986}^{1990}\sum_{1}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}\cdot M)\right)\right]^2+\sum_{1991}^{1998}\sum_{1}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}\cdot M)\right)\right]^2+$$

$$+\sum_{1986}^{1990}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}\cdot M)\right)\right]^2+\sum_{1991}^{1998}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}\cdot M)\right)\right]^2$$

$$+\sum_{1986}^{1990}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}\cdot M)\right)\right]^2+\sum_{1991}^{1998}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}\cdot M)\right)\right]^2$$

with constrains on $S_{1,3} = S_{1,5} = S_{2,3} = S_{2,5} = 1.0$

and $\overline{N}$ average exploited abundance over the year

population abundance on 1st January

$O_{a,y}$: maturity ogive

Natural mortality

PM and PF: Proportion of M and F before spawning

S_{1a}, S_{2a}: Selection patterns at age for the separable model in the time periods 1986–1990 and 1991–1998 respectively

DEPM: SSB estimation from the daily egg production method

Q_{ASP}, Q_{ASS}: Catchability of the linear indices from Portuguese (P) March and November and Spanish (S) March surveys

λ a,y: weighting factors for the catches at age (0.5 for age group 0 and 1.0 for the others)

Results of the assessment are shown in Table 8.7.2.1 and Figure 8.7.2.1. The inclusion of two selection patterns reflect the change found in the catch at age matrix, but the basis for this change in selection remains unknown. SSB indices from the DEPM are below the estimated SSB in both years.

The assumed linear catchability of the Spanish March acoustic surveys match better for age 3, 4 and 5 whereas the Portuguese March and November acoustic surveys gave better fit for the younger ages. Separable model log residuals are again lower than ±0.5 except those of age group 0 in 1987, 1991, 1993 and 1995 and age group 2 in 1994, as in last year´s assessment. CV expressed in% of the parameter estimates are similar to previous assessments and are mainly in the range 15–30%.

Figure 8.7.1.3 shows the estimated recruitment, F2–-5 and SSB for the whole time series. Estimated recruitments are similar to those estimated in the previous assessment until 1990 but in 1991, 1992 and after 1996 are estimated to be higher. Again the 1983 year class (24,500 million) is estimated to be the highest recruitment along the time series and the 1995 year class (375 million) the lowest recruitment. In 1998 recruitment is estimated to have increased to 14,600 million fish. The time series shows periods of low recruitment, followed by one or two stronger year classes. Fishing mortality shows estimated values around 0.35, with a decreasing trend from 1978 to 1984 and an increasing trend after 1995. In 1998 fishing mortality is estimated to be 0.4. Estimated SSB again shows two clear peaks of higher abundance (1982–86 and 1993–95), with a declining trend after. In 1998 the SSB is estimated to increase again to 405,000 tonnes. This year assessment results indicate that the highest SSBs in the 90s are about the same levels as in the 1980s.

However, as reported previously it is difficult to obtain a reliable scaling of biomass estimates in the 1980s with those of the 1990s because of:

a change in selection between the two periods, -
a discontinuity in the Portuguese November surveys
a perceived differences in the DEPM survey design
uncertainty about appropriate model structure

8.7.3 Reliability of the assessment and uncertainty estimation

Quality control diagrams are presented in Table 8.7.3.1 (Fbar) Table 8.7.3.2 (recruitment) and Table 8.7.3.3 (spawning stock biomass). Sensitivity of the assessment to alternative treatments of selection has not again been explored this year, but in previous explorations it was found that perceptions in biomass trends are highly sensitive to such alternative treatments.

The assessment includes the Spanish and Portuguese catch at age data, DEPM estimates, the Spanish and Portuguese March acoustic surveys and the Portuguese November acoustic surveys.

For the Portuguese March survey only the period 1996–1999 could be used because the data for 1986 and 1988 had to be removed since ICA could not be run with this large gap between observations. There are no March Portuguese survey data available for the period from 1989 to 1995. However this survey includes, for most recent years, information for Cadiz waters. The Portuguese November acoustic survey series started in 1984 and information is available for the 80s (1984–1987) and for three years during the 90s (1992, 1997–1998). In 1992 and 1998 this survey estimated the highest abundance of the November series, at similar levels of 1984–1985. For the Portuguese area in IXa, where the bulk of the catch is taken, the Portuguese March and November acoustic surveys tend towards very low fishing mortalities and indicate higher SSB in the 90s, which would be consistent with a stable or increasing contribution of the proportion of the stock in the southern area of the stock. There is some evidence from the catches (Azevedo, WD 1999) and area where eggs are recorded (Stratoudakis, WD 1999) that agrees with this pattern.

The SSB estimated by DEPM during March 1997, at least for the Portuguese survey, did not coincide with the period of peak spawning. Recent analysis of maturity and gonadossomatic index information from routine biological samples indicates that throughout the 90s the spawning period in Portuguese waters extended from October to March/April with a clear peak in December/January (Soares, WD 1999). However, DEPM indicates a marked decrease in SSB from 1988 to 1997. The DEPM data revision and updated information for 1999 both for DEPM and the Portuguese acoustic survey will help to reduce the assessment uncertainties.

It is not clear whether the mortality estimated by the assessment is representative of the mortality which the population has experienced or a combination of fishing mortality and natural mortality and a change in the spatial distribution of the stock relatively to the 80s. Nevertheless, current views of stock size indicate that sardine distribution pattern has changed in recent years with a reduction in abundance in the north part and a stable situation in the south. These characteristics could imply an increase in vulnerability to the fishery.

The assessment model presently available to the Working Group does not well represent current beliefs about the relationship of the sardine biology and distribution to the available observations. There remains a need for development of a more appropriate and more detailed model.

8.8 Catch predictions

Short term catch predictions (until 2001) were based on the estimated population numbers at the beginning of 1999 from the ICA assessment. Input values for 1999 are presented in Table 8.8.1. As in the assessment model, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25. Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. The use of these mean values is expected to smooth the interannual variability in these parameters. Due to the increasing trend observed in the fishing mortality in the last years, input values for the exploitation pattern were those estimated by the assessment model for 1998. Input value for recruitment in 1999 was fixed at 6676 million fish, which corresponds to the geometric mean of the period 1993-1998. This period contains one strong recruitment, the three lowest recruitments of the whole series and two below average recruitments. The mean value used in projections is not considered to represent an optimistic view because it represents a recruitment decline in 1999 to below average values. Numbers at age 1 in 1999 were taken directly from the ICA output as surveys indicate that this year-class is above the average of recent years.

Results of the predictions are shown in Table 8.8.2 and Table 8.8.3 At Status quo (F2–5 in 1998 equal to 0.39), the predicted catch for 1999 is 130 thousand tonnes and the predicted SSB is 526 thousand tonnes. Compared with the values observed in 1998, these predictions indicate about 18% increase in the catches and a 33% increase in the SSB.

Preliminary landings for the Portuguese sardine fishery from January to August 1999 are at the same levels as those recorded in 1998. The effort for this fishery in 1999 is not expected to have increased, due to additional fisheries regulations enforcing a weekly 48 hour fishing ban.

On the other hand, preliminary landings for the first semester of 1999 from the Sub-Divisions VIIIc-West and IXa-North show a decrease of 34% and 56%, respectively, when compared to the same period in 1998. Effort is not believed to have changed significantly.

At F *status quo*, catch is expected to increase in 2000 to 151 thousand tonnes. SSB is expected to increase in 2000 to 541 thousand tonnes and to decrease in 2001 to 489 thousand tonnes.

8.9 Short-term risk analysis

Due to the uncertainties in the model structure explained in section 8.8, the Working Group considers that any risk analysis would be unreliable. Therefore this analysis will be not performed this year.

8.10 Medium-Term Predictions

Medium-Term Stochastic Predictions were done using ICPROJ package (Patterson, 1995). The analysis was based on the results of the assessment described in section 8.7. Input data were the same as used in the catch forecast. Basically, all data were averaged since 1995. Incoming recruitment was estimated as the geometric mean of the six last estimated recruitments. Predictions were also done over a period of 10 years (1999 to 2008) with autocorrelated errors.

Four different scenarios of F multipliers were chosen (i.e., from F = 0.4*Fsq98 to Fsq98, step 0.2). 1000 Monte-Carlo simulations were run for each scenario. Results for each scenario are given in Figure 8.10.1. SSB will likely decrease for all scenarios except that of F = 0.4*Fsq98.

A great fluctuation of the estimated recruitment at age 0 can be observed in this stock along the time series. Moreover, changes in the distribution pattern has been also observed during the most recent years. Therefore, medium-term predictions performed over ten years with fixed recruitment would not reflect the dynamics of this stock.

8.11 Long-term Yield

Input data for yield per recruit analysis is shown in Table 8.11.1. As for the short term catch predictions, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25. Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. Recruitment was set at 6676 million fish, which corresponds to the geometric mean of the period 1993-1998. Results are shown in Table 8.11.2 and Figure 8.11.1.

8.12 Reference points for Management purposes

Earlier suggestions (ICES, 1998a) for F reference points were based on SSB/Recruitment assuming a linear relationship and a corresponding replacement line. On this basis the 1997 Working Group suggested Flim to be equal to Fcrash which has been estimated at 0.34. The alternative to rebuild the stock was estimated to be at F = 0.17. The Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) did not consider any F reference points for sardine.

The perception of the SSB during the nineties relative to the eighties has changed with the inclusion of new and updated information in this year's assessment. It is not clear to what extent recruitment is controlled by the biomass: low biomasses of the 1990 and 1991, 1997 produced strong year classes in 1991, 1992 and 1998. On the contrary, the high biomasses on the mid-80's produced poor recruitments until 1990. The dynamics of the stock indicates periods of high and low recruitment which seems to be rather controlled by environmental factors (Santos *et al*, 1998; ICES 1998b; Santos 1999 W.D).

Fishing mortality reference points

Some new calculations of reference points were made this year using PA software (CEFAS, Lowestoft (1998)). The results are presented in Figures 8.12.1 and 8.12.2. The Working Group re-discussed the importance of F0.1 as a reference point for this species and concluded that, since this point is derived from growth and selection, it is likely to be more robust than those relating to stock recruitment considerations. In the present assessment the stock is estimated to have been harvested below F0.1 since 1980 up to present. However, the actual as well as the historical fishing mortalities are still uncertain. ICES has not proposed any fishing mortality reference points for this species.

Biomass reference points

The lowest biomass observed from 1978 to 1998 period available was 230 000 tonnes. Using this value as a Blim, a Bpa of 320 000 tonnes was estimated. It was assumed that a 20% CV would take into account the uncertainty of the assessment. ACFM (1998) suggested a Bpa of 300 000 tonnes in order to guarantee a high probability of maintaining SSB above Blim.

The ICES basis for biomass reference points was derived from a lowest estimated biomass of 220 000 t. In the most recent assessment this value is little changed (to only 230 000) and hence no alteration to ICES proposed biomass reference points is suggested

8.13 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), and none are proposed here, given that the assessment is considered not to have stabilised.

It may be the case for this stock that higher levels of fishing mortality may be sustainable in periods when recruitment is good. Some form of harvest control rule in which fishing mortality is adapted according to perceptions of stock size may be appropriate but the Working Group has not yet evaluated nor proposed such a rule.

8.14 Management Considerations

SSB in the 90s is estimated to be at higher levels compared to last year assessment. However, it has decreased between 1995 and 1997, showing a slight increase in 1998. Although the recruitment is estimated to have been increasing since 1995, the periods of low recruitments observed along the time series, if continued, can result in a recruitment decrease in 1999 or in a short time period. Also, despite the lower estimated values of fishing mortality, it shows an increasing trend after 1995. Therefore, and given the uncertainties noted in Section 8.7.3 about changes in the spatial distribution of the stock the Working Group recommends close monitoring of the fishery in Divisions VIIIc and IXa as well as the establishment of accompanying measures for the protection of spawning grounds and nurseries. The new data in 1999 and early 2000 will provide important information on the incoming recruitment while the 1999 DEPM surveys will provide estimates of spawning biomass. If the signal from this new information suggests a sharp decline from current estimates, we consider that immediate action is required.

The Working Group considers that there is no new evidence to recommend a change of the Bpa of 300,000 tonnes proposed by ACFM.

Although the current perception of stock size indicates an increase in recruitment since 1995 and a lower perception of fishing mortality, the present assessment of sardine is not considered wholly reliable for a variety of reasons, which are detailed in Section 8.7.3. The Working Group wishes to stress that in recent years the distribution pattern of sardine around Atlantic waters has changed with a reduction in abundance in the north part and a stable situation in the south. These characteristics could imply an increase in vulnerability to the fishery.

Table 8.2.1: 1983-1998 Annual landings (tonnes) of sardine by Sub-Division in fisheries northern than VIIIc as provided by the Working Group

DIVISION	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
VIId	211	147	465	512	67	29	93	64
VIIe,f	590	661	1 624	2 058	682	438	91	808
VIIg	-	1	-					
VIIh	2	-			216	2 119	957	235
total VII	**803**	**809**	**2 089**	**2 570**	**965**	**2 586**	**1 141**	**1 107**
VIIIa	6 013	4 472	8 090	10 186	7 631	7 770	8 885	8 381
VIIIb	454	19	79	77	77	38	85	104
total VIIIab	**6 467**	**4 491**	**8 169**	**10 263**	**7 708**	**7 808**	**8 970**	**8 485**

DIVISION	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
VIId	170	153	127	2 086	1 621	179	71	103
VIIe,f	4 687	19 635	5 304	20 985	13 787	8 278	2 584	4 223
VIIg		0		0				
VIIh	110	4	71	-	1 439	1 350	1 058	101
total VII	**4 968**	**19 793**	**5 502**	**23 071**	**16 846**	**9 807**	**3 713**	**4 427**
VIIIa	9 113	8 565	4 703	7 164		8 180	11 361	10 674
VIIIb	482	141	548	119		526	160	7 749
total VIIIab	**9 595**	**8 706**	**5 251**	**7 283**	**0**	**8 706**	**11 521**	**18 423**

1983-90 only French data was available for Sub-Area VII

Table 8.2.1.1: Landings by quarter and Sub-Division in tonnes (up) and in percentage (below)

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3411	1694	977	4442	**10524**
VIIIc-W	563	1746	2218	1126	**5653**
IXa-N	367	1319	1058	518	**3263**
IXa-CN	206	5214	13006	14157	**32584**
IXa-CS	7182	5064	7702	9616	**29564**
IXa-S (A)	3645	5169	7880	4049	**20743**
IXa-S (C)	1550	683	1852	2509	**6594**
Total	**16924**	**20889**	**34693**	**36417**	**108923**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3.13	1.56	0.90	4.08	**9.66**
VIIIc-W	0.52	1.60	2.04	1.03	**5.19**
IXa-N	0.34	1.21	0.97	0.48	**3.00**
IXa-CN	0.19	4.79	11.94	13.00	**29.91**
IXa-CS	6.59	4.65	7.07	8.83	**27.14**
IXa-S (A)	3.35	4.75	7.23	3.72	**19.04**
IXa-S (C)	1.42	0.63	1.70	2.30	**6.05**
Total	**15.54**	**19.18**	**31.85**	**33.43**	

Table 8.2.1.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-1998.

	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**

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

*** In the period 1940-1977 some years include only purse seine landings.**

Table 8.2.2a Length composition by quarter in VIIe

	QUARTER				TOTAL
Length	**First**	**Second**	**Third**	**Fourth**	
10					
10.5					
11					
11.5					
12					
12.5					
13					
13.5					
14					
14.5					
15					
15.5					
16					
16.5					
17					
17.5					
18					
18.5					
19				88	88
19.5					
20				88	88
20.5	102			133	236
21	331			442	774
21.5	248			576	823
22	398			1282	1680
22.5	1042			1415	2457
23	1790			2346	4136
23.5	1669			2615	4284
24	2832			2576	5407
24.5	1284			2406	3689
25	1055			2136	3191
25.5	501			360	861
26	452			445	898
26.5	24			45	70
27					
27.5	127			45	172
28					
Total	11853			17000	28853
Catch	1663		280	2266	4209

Table 8.2.2b Length composition (thousand) by quarter in VIIIb (Spanish fleet)

	QUARTER				TOTAL
Length	**First**	**Second**	**Third**	**Fourth**	
10					
10.5					
11					
11.5					
12					
12.5					
13				116	116
13.5				59	59
14	0			234	234
14.5			0	452	453
15	1			197	198
15.5	1			98	99
16	8			21	29
16.5	13				13
17	21				21
17.5	20			77	97
18	29	0	1	730	760
18.5	35	0	3	1632	1670
19	123	1	7	3646	3776
19.5	228	2	11	5780	6020
20	311	2	26	14015	14354
20.5	254	1	29	15861	16146
21	246	2	35	19032	19315
21.5	200	2	24	12799	13025
22	131	40	21	11448	11640
22.5	91	39	12	6668	6811
23	46	115	5	2922	3089
23.5	12	166	3	1393	1573
24	8	77	2	915	1002
24.5	3	51	1	704	760
25	0	38	0	135	174
25.5		13	1	275	288
26			1	439	440
26.5			2	934	935
27			1	467	468
27.5			0	220	220
28			0	192	193
28.5			0	137	138
29			0	137	138
29.5			0	27	28
30					
30.5			0	27	28
31					
Total	1782	550	186	101790	104307
Catch (t)	120	56	14	7559	7749

Table 8.3.1.1a Length distributionof sardine by ICES Sub-Division and quarter

	First Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-s**	**IXa-S (Ca**	**Total**
5								
5.5								
6								
6.5								
7								
7.5								
8								
8.5								
9								
9.5								
10			3					3
10.5			3					3
11	21	10	31					62
11.5	244	47	71	85	27			474
12	922	92	120	169	188		19	1510
12.5	1050	121	116	677	592		75	2631
13	1101	266	158	974	771		187	3457
13.5	413	259	208	425	1252		394	2950
14	304	102	214	348	927	60	1362	3317
14.5	126	45	459	231	1362	126	3374	5722
15	458	10	558	198	1387	123	4270	7004
15.5	291	25	768	76	2266	454	4084	7965
16	449	14	713	42	3489	1674	2932	9312
16.5	422	1	832	50	3846	1549	3333	10034
17	379	125	822	95	8017	3041	4793	17272
17.5	58	162	853	232	14403	4603	5002	25313
18	294	422	584	47	17204	7978	4157	30687
18.5	611	402	437	86	20565	10805	3024	35930
19	1387	440	504	89	20416	12362	2676	37875
19.5	2616	549	349	140	17220	12587	1540	35000
20	5551	838	343	177	16292	10919	876	34994
20.5	6581	1060	255	500	10740	4177	159	23472
21	7158	894	174	411	5671	1310	104	15721
21.5	6231	777	168	138	2853	486		10654
22	6701	836	87	51	555	18		8248
22.5	3318	704	107	47	76	33		4284
23	2412	437	62	214	40			3164
23.5	1154	201	56	0				1411
24	551	76	12	42				682
24.5	196	2	6	42				246
25	60							60
25.5	11							11
26	5							5
26.5	2							2
27								
Total	51077	8916	9071	5587	150161	72304	42360	339477
Mean l	20.5	20.1	17.3	16.5	18.8	19.1	17.0	18.9
s.d.	2.72	2.81	2.41	3.72	1.65	1.18	1.65	2.14
Catch	3411	563	367	206	7182	3645	1550	16924

Table 8.3.1.1b Cont'd

	Second Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-s**	**IXa-S (C)**	**Total**
5								
5.5								
6								
6.5								
7								
7.5								
8								
8.5								
9								
9.5				22				22
10				752				752
10.5				650				650
11	3			2028				2031
11.5				2140				2140
12	25			3415				3440
12.5	62			2088			23	2172
13	40			1877			23	1939
13.5	9			1046			45	1100
14			3	3838			151	3992
14.5	33			2329	112	48	443	2965
15	262		102	11859	441		990	13653
15.5	226	0	352	7151	1308	11	1061	10109
16	169	41	982	22223	1187	12	1572	26186
16.5	77	129	1565	13227	1640	308	2242	19188
17	103	314	2994	19273	2691	1079	2726	29180
17.5	102	1078	3678	13370	3161	3242	2406	27037
18	197	1950	3667	11077	6056	7515	2539	32999
18.5	209	2622	2447	6978	7336	15420	1760	36771
19	702	2888	2644	4839	9647	19771	848	41338
19.5	1379	3386	2114	3290	12736	17183	296	40385
20	2856	3707	2119	3100	13332	15287	37	40439
20.5	2950	2794	1410	2295	13937	6172		29556
21	4328	2714	1285	1408	9960	1587		21281
21.5	2708	1965	446	249	5469	842		11679
22	2586	1601	416	203	711	189		5706
22.5	1439	1053	87	40	414	36		3069
23	1448	667	30	12	51			2208
23.5	514	213	30					757
24	272	114	19					405
24.5	177	30						208
25	73							73
25.5	0							0
26								
26.5								
27								
Total	22950	27266	26391	140777	90187	88701	17162	413433
Mean l	21.1	20.2	18.7	16.7	19.7	19.4	17.3	18.6
s.d.	1.74	1.50	1.53	2.11	1.43	0.89	1.25	2.22
Catch	1694	1746	1319	5214	5064	5169	683	20889

Table 8.3.1.1c Cont'd

	Third Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-s**	**IXa-S (C)**	**Total**
5								
5.5								
6								
6.5								
7								
7.5								
8								
8.5			28				63	91
9			65	26			126	216
9.5			109				1508	1617
10			468		404		2136	3008
10.5			1237		404		3393	5034
11			2581		1212		1319	5112
11.5			2215	1	2559		3557	8332
12	2		2387	6	3236		6436	12068
12.5	1		2218	670	3251		6011	12152
13	5		1820	689	1499		6584	10597
13.5	8		1516	3339	1239		6422	12523
14	9		1056	1289	411	80	5346	8190
14.5	15		848	7681	274	181	5120	14120
15	19		881	5484	1	1079	4261	11725
15.5	13		409	17425	136	2874	2423	23280
16	38		912	7543	35	3693	1612	13834
16.5	93	1	530	12464	800	1870	2303	18061
17	228	2	1097	4244	5109	1030	5126	16836
17.5	325	41	1221	14798	11752	4480	5188	37804
18	377	153	1105	9861	20119	11842	3635	47091
18.5	222	609	797	25139	21775	18762	1241	68546
19	506	2251	1445	12945	19233	24832	580	61792
19.5	558	3835	1318	32386	15527	21445	220	75288
20	1324	5208	1580	23552	11633	19278		62575
20.5	1176	5027	973	29737	6443	8958		52313
21	1835	3642	608	19910	3344	3405		32744
21.5	1105	2155	319	13467	1097	1089		19232
22	1393	1510	146	5576	346	139		9111
22.5	757	1017	13	2674	161			4621
23	722	696	5	719	107			2247
23.5	284	248	18	383				933
24	102	137		74				313
24.5	11	43		24		20		98
25				55				55
25.5	4							4
26								
26.5								
27								
Total	11130	26575	29924	252159	132107	125057	74612	651564
Mean l	21.0	20.7	15.2	19.0	18.3	19.2	14.3	18.3
s.d.	1.69	1.12	3.45	2.19	2.33	1.27	2.42	2.75
Catch	977	2218	1058	13006	7702	7880	1852	34693

Table 8.3.1.1d Cont'd

	Fourth Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-s**	**IXa-S (C)**	**Total**
5								
5.5								
6								
6.5								
7								
7.5				77				77
8				175				175
8.5			11	58				69
9			3	442				445
9.5			68	946				1014
10			309	2089				2397
10.5			657	2301				2957
11			899	5871			53	6823
11.5		24	947	7460			1118	9549
12	9	76	1076	15844			2202	19207
12.5	5	355	873	13119	118		4721	19190
13	23	101	643	29979	177		9246	40169
13.5	37	308	347	16566	471		11719	29449
14	42	465	305	39770	894		14691	56167
14.5	74	222	325	22066	883	28	13206	36805
15	174	223	229	39418	942	247	6239	47472
15.5	60	286	232	15273	1130	303	3402	20687
16	82	164	246	23942	3528	1473	1679	31114
16.5	59	80	278	14823	1915	1996	2545	21696
17	90	44	178	34398	3307	3030	3560	44608
17.5	150	45	94	17381	8739	3102	4056	33568
18	435	72	28	25570	19037	5766	4336	55244
18.5	961	101	49	9794	29134	8161	3691	51890
19	2154	519	75	9784	25330	11633	2085	51581
19.5	3655	1031	177	3091	21103	11290	973	41322
20	7038	1610	381	1940	13821	10912	687	36390
20.5	6909	2510	497	416	8145	5912	57	24445
21	9527	2278	666	163	7078	1931		21644
21.5	6578	1436	714	52	2369	464		11613
22	7039	1326	563		1852	118		10898
22.5	4115	929	385		270			5700
23	2469	591	330					3390
23.5	830	248	212					1290
24	427	126	94					647
24.5	130	40	5					175
25	123		7					130
25.5	74		2					77
26	114							114
26.5	1							1
27	73							73
Total	53458	15210	11904	352808	150243	66368	90266	740255
Mean l	21.2	20.2	16.0	15.4	19.1	19.2	15.1	17.0
s.d.	1.42	2.73	4.52	2.20	1.40	1.22	1.96	2.91
Catch	4442	1126	518	14157	9616	4049	2509	36417

Table 8.3.1.2: Catch in numbers ('000) at age by quarter and by Sub-Division of Sardine in 1998

1998 Age	VIIIc East 1'st Q catch	VIIIc West 1'st Q catch	IXa North 1'st Q catch	IXa Centr-N 1'st Q catch	IXa Centr-S 1'st Q catch	IXa S-A 1'st Q catch	IXa S-C 1'st Q catch	All areas 1'st Q catch
0								
1	7 304	1 801	6 273	2 332	12 723	5 558	21 417	57 408
2	5 649	1 385	1 317	1 208	45 522	6 781	6 769	68 629
3	10 769	1 675	623	382	42 218	10 752	5 245	71 664
4	10 596	1 482	349	349	20 240	21 878	5 307	60 201
5	8 077	1 256	255	413	16 881	20 886	2 800	50 569
6	5 479	834	168	532	11 343	7 040	705	26 102
7	2 546	393	71	145	943	1 640	113	5 851
8	324	42	5	90		167	5	634
9	333	48	11	5				397
10				3				3
11				6				6
Total	51 077	8 916	9 071	5 464	149 871	74 703	42 360	341 463
Tonnes	3 411	563	367	206	7 182	3 645	1 550	16 924

1998 Age	VIIIc East 2'nd Q catch	VIIIc West 2'nd Q catch	IXa North 2'nd Q catch	IXa Centr-N 2'nd Q catch	IXa Centr-S 2'nd Q catch	IXa S-A 2'nd Q catch	IXa S-C 2'nd Q catch	All areas 2'nd Q catch
0								
1	1 628	4 435	12 474	82 272	6 969	2 301	7 723	117 801
2	2 899	7 112	6 948	49 900	12 519	3 523	1 662	84 564
3	5 385	6 123	3 536	8 522	19 442	22 450	4 476	69 935
4	5 139	4 044	1 729	4 682	15 833	33 082	2 508	67 017
5	3 715	2 850	889	1 920	17 321	26 988	713	54 396
6	2 544	1 898	668	1 176	18 141	11 842	79	36 349
7	1 321	673	121	67	1 637	1 419		5 238
8	140	73	16		560			790
9	178	59	9					246
10								
11								
Total	22 950	27 266	26 391	148 539	92 422	101 605	17 162	436 335
Tonnes	1 694	1 746	1 319	5 214	5 064	5 169	683	20 889

1998 Age	VIIIc East 3'rd Q catch	VIIIc West 3'rd Q catch	IXa North 3'rd Q catch	IXa Centr-N 3'rd Q catch	IXa Centr-S 3'rd Q catch	IXa S-A 3'rd Q catch	IXa S-C 3'rd Q catch	All areas 3'rd Q catch
0	162	1	19 020	59 334	11 489	10 117	58 622	158 743
1	2 899	8 700	6 388	58 028	14 995	2 674	5 070	98 755
2	2 678	8 062	2 898	105 061	47 108	13 619	4 112	183 537
3	2 342	5 407	1 110	33 250	33 655	36 623	4 906	117 294
4	1 164	1 758	247	7 635	13 056	36 090	1 595	61 545
5	947	1 523	199	3 828	11 924	24 768	273	43 461
6	622	717	37	247	4 035	5 498	34	11 191
7	284	359	24	15	890			1 572
8	15	20						34
9	19	28						47
10								
11								
Total	11 130	26 575	29 924	267 397	137 152	129 389	74 612	676 179
Tonnes	977	2 218	1 058	13 006	7 702	7 880	1 852	34 693

Table 8.3.1.2: Cont'd.

1998 Age	VIIIc East 4'th Q catch	VIIIc West 4'th Q catch	IXa North 4'th Q catch	IXa Centr-N 4'th Q catch	IXa Centr-S 4'th Q catch	IXa S-A 4'th Q catch	IXa S-C 4'th Q catch	All areas 4'th Q catch
0	532	2 248	7 261	185 532	7 569	4 086	70 524	277 752
1	11 920	3 141	1 097	87 462	30 946	9 262	8 782	152 610
2	13 902	3 531	1 006	68 217	58 975	8 168	3 609	157 408
3	12 539	3 033	990	12 407	29 922	17 040	4 155	80 086
4	5 673	1 254	545	2 428	11 178	16 137	2 410	39 624
5	4 278	1 026	482	2 821	10 741	8 123	661	28 132
6	2 747	625	334	748	6 067	2 787	109	13 417
7	1 526	306	157		691	450	15	3 145
8	279	26	19		430			754
9	61	18	13					92
10								
11								
Total	53 458	15 210	11 904	359 614	156 518	66 052	90 266	753 022
Tonnes	4 442	1 126	518	14 157	9 616	4 049	2 509	36 417

1998 Age	VIIIc East 1-4 Q catch	VIIIc West 1-4 Q catch	IXa North 1-4 Q catch	IXa Centr-N 1-4 Q catch	IXa Centr-S 1-4 Q catch	IXa S-A 1-4 Q Catch	IXa S-C 1-4 Q catch	All areas 1-4 Q catch
0	694	2 249	26 281	244 866	19 057	14 203	129 145	436 495
1	23 751	18 077	26 231	230 094	65 633	19 796	42 992	426 573
2	25 128	20 090	12 169	224 385	164 123	32 091	16 152	494 138
3	31 035	16 238	6 260	54 561	125 238	86 865	18 782	338 979
4	22 572	8 539	2 870	15 094	60 307	107 187	11 819	228 388
5	17 017	6 655	1 824	8 981	56 868	80 765	4 448	176 559
6	11 392	4 074	1 208	2 703	39 588	27 167	927	87 059
7	5 677	1 731	373	227	4 160	3 508	128	15 805
8	758	161	41					959
9	590	153	33					777
10								
11								
Total	138 615	77 967	77 290	781 014	535 963	371 749	224 395	2 206 993
Tonnes	10 524	5 653	3 263	32 584	29 564	20 743	6 594	108 923

Table 8.3.1.3: Annual relative contribution of each age group within each Sub-Division

Age G	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S-A	IXa-S-C
0	0.5	2.9	34.0	31.4	3.6	3.8	57.6
1	17.1	23.2	33.9	29.5	12.2	5.3	19.2
2	18.1	25.8	15.7	28.7	30.6	8.6	7.2
3	22.4	20.8	8.1	7.0	23.4	23.4	8.4
4	16.3	11.0	3.7	1.9	11.3	28.8	5.3
5	12.3	8.5	2.4	1.1	10.6	21.7	2.0
6+	13.3	7.8	2.1	0.4	8.2	8.3	0.5

Table 8.3.1.4: Annual relative contribution of each Sub-Division within each age group

Age G	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S-A	IXa-S-C
0	0.2	0.5	6.0	56.1	4.4	3.3	29.6
1	5.6	4.2	6.1	53.9	15.4	4.6	10.1
2	5.1	4.1	2.5	45.4	33.2	6.5	3.3
3	9.2	4.8	1.8	16.1	36.9	25.6	5.5
4	9.9	3.7	1.3	6.6	26.4	46.9	5.2
5	9.6	3.8	1.0	5.1	32.2	45.7	2.5
6+	17.6	5.8	1.6	2.8	41.8	29.3	1.0

Table 8.3.2.1: Length (cm) at age by quarter and by Sub-Division of Sardine in 1998

1998 Age	VIIIc East 1'st Q Length	VIIIc West 1'st Q Length	IXa North 1'st Q Length	IXa Centr-N 1'st Q Length	IXa Centr-S 1'st Q Length	IXa S-A 1'st Q Length	IXa S-C 1'st Q Length	All areas 1'st Q Length
0								
1	14.9	15.7	16.1	13.2	15.8	16.7	15.7	15.7
2	20.1	19.6	18.7	15.5	17.9	17.8	17.5	18.0
3	20.9	20.8	20.2	19.7	19.0	18.6	18.1	19.2
4	21.6	21.5	21.0	20.4	19.9	19.2	18.8	19.9
5	21.9	22.0	21.7	20.9	20.5	19.8	19.4	20.4
6	22.0	22.0	21.6	21.7	20.8	20.2	19.8	21.0
7	22.8	22.9	23.0	23.0	21.4	20.5	20.3	21.9
8	23.1	23.2	23.3	23.2		21.2	20.8	22.6
9	24.1	23.9	23.9	22.8				24.1
10				22.3				22.3
11				21.8				21.8
0-15+	20.5	20.1	17.3	16.5	18.8	19.1	17.0	18.9

1998 Age	VIIIc East 2'nd Q Length	VIIIc West 2'nd Q Length	IXa North 2'nd Q Length	IXa Centr-N 2'nd Q Length	IXa Centr-S 2'nd Q Length	IXa S-A 2'nd Q Length	IXa S-C 2'nd Q Length	All areas 2'nd Q Length
0								
1	16.9	18.4	17.6	15.3	16.5	17.6	16.3	15.9
2	20.2	19.4	18.9	17.9	18.3	18.4	17.7	18.2
3	20.9	20.4	20.1	19.3	19.4	18.7	18.1	19.3
4	21.6	21.2	20.7	20.3	20.0	19.5	18.2	19.9
5	21.9	21.6	21.0	20.2	20.6	19.8	19.1	20.3
6	22.0	21.6	21.0	20.6	21.0	20.3	19.5	20.9
7	22.9	22.6	22.0	22.4	21.3	21.2		21.9
8	23.2	23.0	22.8		21.8			22.2
9	24.2	24.0	24.0					24.2
10								
11								
0-15+	21.1	20.2	18.7	16.7	19.7	19.4	17.3	18.6

1998 Age	VIIIc East 3'rd Q Length	VIIIc West 3'rd Q Length	IXa North 3'rd Q Length	IXa Centr-N 3'rd Q Length	IXa Centr-S 3'rd Q Length	IXa S-A 3'rd Q Length	IXa S-C 3'rd Q Length	All areas 3'rd Q Length
0	15.8	17.0	12.8	14.1	12.0	16.0	13.3	13.7
1	19.5	20.0	18.7	16.9	16.7	17.9	17.4	17.4
2	20.7	20.5	19.6	18.6	18.5	18.6	17.9	18.7
3	21.5	21.1	20.6	19.7	19.2	19.1	18.1	19.4
4	22.3	21.9	20.9	20.5	20.0	19.7	18.3	19.9
5	22.5	21.9	20.9	20.7	20.6	20.0	19.1	20.4
6	22.9	22.8	22.4	22.0	20.8	20.4	19.5	20.9
7	22.8	22.8	22.2	23.8	20.9			21.7
8	24.3	24.3						24.3
9	24.5	24.4						24.4
10								
11								
0-15+	21.0	20.7	15.2	17.5	18.3	19.2	14.3	17.7

Table 8.3.2.1: Cont'd

1998 Age	VIIIc East 4'th Q Length	VIIIc West 4'th Q Length	IXa North 4'th Q Length	IXa Centr-N 4'th Q Length	IXa Centr-S 4'th Q Length	IXa S-A 4'th Q Length	IXa S-C 4'th Q Length	All areas 4'th Q Length
0	15.1	14.3	12.6	14.9	16.0	16.7	14.2	14.7
1	20.1	20.1	19.1	16.8	17.9	17.9	17.6	17.5
2	20.8	20.8	20.9	18.9	19.0	18.9	18.4	19.2
3	21.5	21.4	21.6	19.8	19.5	19.4	18.8	19.9
4	22.2	22.2	22.4	20.8	20.2	19.9	19.0	20.4
5	22.4	22.3	22.6	20.6	20.9	20.2	19.5	20.9
6	22.8	22.9	23.0	20.4	21.2	20.6	20.0	21.5
7	23.2	22.9	23.0		21.1	20.6	19.8	22.3
8	25.5	24.4	24.5		21.1			22.9
9	24.3	24.3	24.3					24.3
10								
11								
0-15+	21.2	20.2	16.0	16.4	19.1	19.2	15.1	17.5

1998 Age	VIIIc East 1-4 Q Length	VIIIc West 1-4 Q Length	IXa North 1-4 Q Length	IXa Centr-N 1-4 Q Length	IXa Centr-S 1-4 Q Length	IXa S-A 1-4 Q Length	IXa S-C 1-4 Q Length	All areas 1-4 Q Length
0	15.3	14.3	12.8	14.7	13.6	16.2	13.8	14.3
1	18.2	19.2	17.6	16.3	17.1	17.5	16.4	16.8
2	20.6	20.1	19.2	18.5	18.5	18.5	17.8	18.7
3	21.2	20.9	20.4	19.6	19.2	19.0	18.2	19.5
4	21.8	21.5	21.1	20.5	20.0	19.5	18.6	20.0
5	22.1	21.9	21.5	20.6	20.6	19.9	19.4	20.5
6	22.2	22.1	21.7	20.9	21.0	20.4	19.8	21.0
7	22.9	22.8	22.6	22.8	21.2	20.8	20.2	21.9
8	24.0	23.4	23.7					23.9
9	24.2	24.1	24.1					24.1
10								
11								
0-15+	20.9	20.4	16.8	16.8	18.9	19.2	15.4	18.0

Table 8.3.2.2: Weight (g) at age by quarter and by Sub-Divsion of Sardine in 1998

1998 Age	VIIIc East 1'st Q weight	VIIIc West 1'st Q Weight	IXa North 1'st Q Weight	IXa Centr-N 1'st Q Weight	IXa Centr-S 1'st Q Weight	IXa S-A 1'st Q Weight	IXa S-C 1'st Q Weight	All areas 1'st Q weight
0								
1	28	33	33	17	29	34	29	29
2	61	56	49	28	41	40	39	42
3	68	67	61	56	48	45	42	51
4	75	74	70	62	55	49	47	56
5	78	80	76	67	60	54	51	61
6	79	80	76	76	64	57	53	66
7	89	89	90	90	69	59	57	77
8	92	93	95	92		64	60	85
9	104	102	101	86				103
10				81				81
11				75				75
0-15+	67	64	41	38	48	49	36	50

1998 Age	VIIIc East 2'nd Q Weight	VIIIc West 2'nd Q Weight	IXa North 2'nd Q Weight	IXa Centr-N 2'nd Q Weight	IXa Centr-S 2'nd Q Weight	IXa S-A 2'nd Q Weight	IXa S-C 2'nd Q Weight	All areas 2'nd Q weight
0								
1	39	47	41	27	32	39	32	30
2	63	55	51	41	43	44	39	44
3	71	66	62	53	52	46	42	53
4	79	74	69	61	57	51	43	57
5	82	79	72	60	62	53	48	60
6	83	79	71	64	65	57	51	65
7	94	91	83	82	67	64		77
8	99	97	94		72			80
9	113	109	109					112
10								
11								
0-15+	74	64	50	35	55	51	38	48

1998 Age	VIIIc East 3'rd Q Weight	VIIIc West 3'rd Q Weight	IXa North 3'rd Q Weight	IXa Centr-N 3'rd Q Weight	IXa Centr-S 3'rd Q Weight	IXa S-A 3'rd Q Weight	IXa S-C 3'rd Q Weight	All areas 3'rd Q weight
0	35	43	19	22	15	33	20	21
1	69	74	60	41	42	48	43	46
2	83	80	71	58	56	54	48	58
3	94	88	82	69	62	60	50	65
4	106	100	87	79	70	66	52	70
5	109	101	87	82	76	69	60	74
6	116	114	106	101	79	74	64	81
7	115	114	104	131	80			95
8	138	138						138
9	143	141						142
10								
11								
0-15+	88	84	36	49	56	61	26	51

Table 8.3.2.2: Cont'd

1998 Age	VIIIc East 4'th Q weight	VIIIc West 4'th Q Weight	IXa North 4'th Q Weight	IXa Centr-N 4'th Q Weight	IXa Centr-S 4'th Q Weight	IXa S-A 4'th Q Weight	IXa S-C 4'th Q Weight	All areas 4'th Q weight
0	30	26	19	28	36	38	23	27
1	70	71	62	41	51	48	45	47
2	78	78	79	60	60	57	53	62
3	85	84	87	71	65	62	56	69
4	94	94	97	83	73	68	58	75
5	97	97	100	80	80	71	63	81
6	102	104	106	78	84	76	69	87
7	109	104	105		82	77	67	98
8	145	125	128		82			108
9	123	123	123					123
10								
11								
0-15+	83	74	44	39	61	61	29	49

1998 Age	VIIIc East 1-4 Q Weight	VIIIc West 1-4 Q Weight	IXa North 1-4 Q Weight	IXa Centr-N 1-4 Q Weight	IXa Centr-S 1-4 Q Weight	IXa S-A 1-4 Q Weight	IXa S-C 1-4 Q Weight	All areas 1-4 Q weight
0	31	26	19	26	23	34	22	25
1	55	63	44	36	42	43	35	40
2	73	69	58	55	52	51	44	55
3	78	77	70	67	57	55	47	60
4	83	83	76	74	62	58	49	63
5	86	87	82	76	68	60	53	67
6	88	89	83	73	69	63	56	71
7	97	98	95	90	73	63	58	83
8	114	105	110					112
9	110	114	112					111
10								
11								
0-15+	76	73	43	42	55	56	30	49

Table 8.4.1.1 Summary of raw information and estimates of spawning area, egg density and egg production for the three Portuguese DEPM surveys for sardine. Values in square brackets refer to raw data from the 1997 and 1999 surveys excluding the Cadiz region. Values in brackets indicate the coefficient of variation (%) for each egg production estimate.

Variable	1988	1997	1999
Sampled stations	309	373 [304]	417 [333]
Stations with sardine	108	96 [61]	116 [80]
Prevalence (%)	35	26 [20]	28 [24]
Sampled eggs	1307	1454 [1204]	5109 [2919]
Spawning area (,000 km2)	22.3	17.8	16.2
Egg density (per 0.05 m2)	2.94	3.31	6.8
Egg production (1012)	2.87 (22)	4.41 (49)	5.34 (30)

Table 8.4.1.2: Abundance estimates of the traditional method and the presence/absence GAM, together with their 95% confidence intervals and coefficient of variation (C.V.). (* Standard error no available; † confidence interval lower limit below zero)

EGG ABUNDANCE			
Year	**Region**	**Trad. Estimate [95% conf. interv.] (C.V. %)**	**GAM estimate [95 % conf. interv.] (C.V. %)**
1988	Region I	$1.59\ 10^{12}$ [$5.68\ 10^{11}$, $2.62\ 10^{12}$] (32.81)	$1.05\ 10^{12}$ [$7.42\ 10^{11}$, $1.61\ 10^{12}$] (20.83)
	Region II	$1.19\ 10^{12}$ [$7.20\ 10^{11}$, $1.65\ 10^{12}$] (20.04)	$1.32\ 10^{12}$ [$1.04\ 10^{12}$, $1.95\ 10^{12}$] (17.67)
	Region III	$8.04\ 10^{11}$ [$1.32\ 10^{11}$, $1.48\ 10^{12}$] (42.65)	$4.05\ 10^{11}$ [$2.95\ 10^{11}$, $6.11\ 10^{11}$] (21.60)
	Total	**$3.58\ 10^{12}$ ***	**$2.78\ 10^{12}$ [$2.15\ 10^{12}$, $4.03\ 10^{12}$] (17.30)**
1990	Region I	$5.28\ 10^{11}$ [$2.93\ 10^{11}$, $1.32\ 10^{12}$] (22.69)	$1.33\ 10^{12}$ [$4.35\ 10^{11}$, $3.43\ 10^{12}$] (61.90)
	Region II	$1\ 10^{12}$ [$6.12\ 10^{11}$, $1.40\ 10^{12}$] (19.93)	$1.48\ 10^{12}$ [$4.78\ 10^{11}$, $3.68\ 10^{12}$] (57.38)
	Region III	$2.55\ 10^{11}$ [$7.02\ 10^{10}$, $4.40\ 10^{11}$] (36.97)	$3.12\ 10^{11}$ [$7.02\ 10^{10}$, $5.11\ 10^{11}$] (40.64)
	Total	**$1.78\ 10^{12}$ [$8.02\ 10^{11}$, $2.77\ 10^{12}$] (28.08)**	**$3.13\ 10^{12}$ [$1.04\ 10^{12}$, $7.74\ 10^{12}$] (54.44)**
1997	Region I	------	$1.13\ 10^{10}$ [$2.67\ 10^{9}$, $2.64\ 10^{10}$] (55.36)
	Region II	$3.55\ 10^{11}$ [$9.12\ 10^{10}$, $6.19\ 10^{11}$] (37.91)	$2.34\ 10^{11}$ [$7.10\ 10^{10}$, $3.35\ 10^{11}$] (29.16)
	Region III	$3.44\ 10^{11}$ [------]† (65.78)	$3.21\ 10^{11}$ [$1.02\ 10^{11}$, $4.38\ 10^{11}$] (27.89)
	Total	**$6.99\ 10^{11}$ [$1.50\ 10^{11}$, $1.28\ 10^{12}$] (40.32)**	**$5.66\ 10^{11}$ [$1.92\ 10^{11}$, $7.34\ 10^{11}$] (25.37)**

Table 8.4.2.1: Acoustic biomas and abundance estimations during Spanish acoustic survey in March 1999. Number of fish in thousand and biomass in tonnes

	AGE GROUPS											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
Area: IXa-N												
Total biomass	942	1130	489	987	11		283					3842.1
%	24.5	29.4	12.7	25.7	0.3		7.4					
M. weight	28.3	58.8	62.1	71.6	56.8		83.6					46.9
No fish	32569	19085	7853	13729	193		3382					76811
%	42.4	24.8	10.2	17.9	0.3		4.4					
M. length	15.6	20.0	20.3	21.3	19.8		22.5					18.5
s.d.	1.3	0.9	0.8	0.7			0.4					2.8
Area: VIIIc-W												
Total biomass	1645	1408	1283	765	248	49	38					5435
%	30.3	25.9	23.6	14.1	4.6	0.9	0.7					
M. weight	30.3	61.6	68.8	74.4	75.4	84.5	84.7					46.9
No fish	52718	22802	18573	10254	3280	584	447					108658
%	48.5	21.0	17.1	9.4	3.0	0.5	0.4					
M. length	16.0	20.3	21.0	21.6	21.7	22.5	22.6					18.5
s.d.	1.6	0.6	0.8	0.6	0.7	0.3	0.5					2.8
Area VIIIc-Ew												
Total biomass	903	5792	5581	4998	1131	1495	1222		33	119		21273.2
%	4.2	27.2	26.2	23.5	5.3	7.0	5.7		0.2	0.6		
M. weight	38.1	62.4	69.8	77.8	88.0	82.9	82.7		111.8	105.2		68.4
No fish	22836	92300	79639	64085	12815	17983	14719		296	1136		305809
%	7.5	30.2	26.0	21.0	4.2	5.9	4.8		0.1	0.4		
M. length	17.3	20.4	21.2	21.9	22.9	22.4	22.4		24.8	24.3		21.0
s.d.	2.0	0.8	0.8	0.7	0.6	0.7	0.8					1.6
Area VIIIc-Ee												
Total biomass	2119	1697	2088	2942	1096	1039	940		59	246		12226
%	17.3	13.9	17.1	24.1	9.0	8.5	7.7		0.5	2.0		
M. weight	18.8	64.5	72.8	80.8	90.6	86.3	88.1		111.8	105.2		44.4
No fish	106402	26188	28553	36245	12069	11994	10607		526	2339		234923
%	45.3	11.1	12.2	15.4	5.1	5.1	4.5		0.2	1.0		
M. length	13.7	20.6	21.4	22.2	23.1	22.7	22.9		24.8	24.3		18.2
s.d.	1.9	0.9	0.8	0.9	0.7	0.8	1.0					4.4
Area: VIIIb												
Total biomass	22638	32432	21380	19845	12014	6425	8741	1998		249		125722
%	18.0	25.8	17.0	15.8	9.6	5.1	7.0	1.6		0.2		
M. weight	21.9	50.9	67.7	73.7	84.1	84.8	103.9	103.0		118.8		44.2749 1
No fish	1010845	630603	314287	266613	141883	75065	83688	19354		2093		254443 1
%	39.7	24.8	12.4	10.5	5.6	3.0	3.3	0.8		0.1		
M. length	14.8	19.3	21.2	21.7	22.7	22.7	24.2	24.1		25.3		18.5
s.d.	1.2	1.0	0.8	1.2	1.0	1.2	0.9	0.6				3.4
Area: Spain												
Total biomass	5608	10027	9441	9691	2486	2583	2483		92	366		42776
%	13.1	23.4	22.1	22.7	5.8	6.0	5.8		0.2	0.9		
M. weight	24.5	62.2	69.8	77.6	87.3	84.2	84.8		111.8	105.2		54.4
No fish	214525	160375	134618	124313	28357	30562	29155		821	3475		726202
%	29.5	22.1	18.5	17.1	3.9	4.2	4.0		0.1	0.5		
M. length	14.9	20.4	21.2	21.9	22.8	22.5	22.6		24.8	24.3		19.5
s.d.	2.2	0.8	0.8	0.8	0.8	0.7	0.9					3.3

Table 8.4.2.2 - Sardine abundance (abundance in thousands) by age group and area in Portuguese November acoustic surveys series.

	IDADE	SAR84NOV	%	SAR85DEZ	%	SAR86DEZ	%	SAR87NOV	%	SAR92NOV	%	SAR97NOV	%	SAR98NOV	%
	0	41852	0.7	1004091	20.2	1251898	35.8	1781349	44.4	4990438	56.7	881535	31.5	5496580	77.7
	1	4913277	77.9	169704	3.4	1015161	29.0	621717	15.5	2683277	30.5	1374279	49.1	1145690	16.2
OCN	2	693480	11.0	2918694	58.8	797920	22.8	702157	17.5	344338	3.9	424366	15.2	302706	4.3
	3	417112	6.6	388379	7.8	312757	8.9	284117	7.1	433508	4.9	57484	2.1	84739	1.2
	4	240346	3.8	282916	5.7	89818	2.6	494627	12.3	257723	2.9	16995	0.6	13796	0.2
	5			134881	2.7	15806	0.5	109517	2.7	78303	0.9	35584	1.3	18762	0.3
	6			56352	1.1	11360	0.3	4327	0.1	13109	0.1	6902	0.2	9931	0.1
	7+			9181	0.2			11311	0.3	5663	0.1	3640	0.1		
		6306067		**4964198**		**3494720**		**4009122**		**8806359**		**2800785**		**7072204**	
	0	1800487	71.7	493813	11.7	1192877	51.0	1594069	37.9	1231848	27.5	1540183	44.7	2341437	53.0
	1	410604	16.4	1513939	35.8	289824	12.4	1623943	38.6	2224291	49.6	496295	14.4	337144	7.6
OCS	2	149857	6.0	1272134	30.1	565093	24.2	467537	11.1	540422	12.1	200598	5.8	807275	18.3
	3	137122	5.5	550354	13.0	172925	7.4	340988	8.1	353167	7.9	302217	8.8	558828	12.6
	4	13173	0.5	388028	9.2	62893	2.7	93327	2.2	110551	2.5	327704	9.5	167980	3.8
	5			8908	0.2	41021	1.8	53730	1.3	19753	0.4	385268	11.2	150805	3.4
	6			4454	0.1	14885	0.6	22370	0.5			160466	4.7	49126	1.1
	7+							10023	0.2			34460	1.0	8134	0.2
		2511243		**4231630**		**2339518**		**4205987**		**4480032**		**3447191**		**4420729**	
	0	1114282	41.2	565273	24.6	48327	4.4	339122	29.9	126786	10.0	2984	0.2	842359	41.7
	1	409350	15.1	1059882	46.2	306910	27.9	133717	11.8	572971	45.2	90628	4.7	326559	16.2
	2	308823	11.4	357412	15.6	306550	27.9	174001	15.4	272343	21.5	281484	14.8	104627	5.2
ALGARVE	3	482592	17.8	144704	6.3	172703	15.7	303577	26.8	215905	17.0	369198	19.3	179749	8.9
	4	274824	10.2	168271	7.3	170201	15.5	77646	6.9	69150	5.5	695895	36.5	214471	10.6
	5	76423	2.8			70439	6.4	73226	6.5	10168	0.8	350953	18.4	197553	9.8
	6	40140	1.5			23389	2.1	22532	2.0			106580	5.6	120198	6.0
	7+							9340	0.8			10373	0.5	33027	1.6
		2706434		**2295542**		**1098519**		**1133161**		**1267323**		**1908095**		**2018643**	
	0	2956621	25.7	2063177	18.0	2493103	36.0	3714539	39.7	6349072	43.6	2424702	29.7	8680376	64.2
	1	5733231	49.8	2743525	23.9	1611896	23.3	2379377	25.5	5480539	37.7	1961202	24.0	1809393	13.4
	2	1152159	10.0	4548240	39.6	1669563	24.1	1343696	14.4	1157103	8.0	906448	11.1	1214608	9.0
PORTUGAL	3	1036825	9.0	1083437	9.4	658385	9.5	928681	9.9	1002580	6.9	728899	8.9	823316	6.1
	4	528343	4.6	839215	7.3	322912	4.7	665601	7.1	437424	3.0	1040594	12.8	396247	2.9
	5	76423	0.7	143789	1.3	127266	1.8	236474	2.5	108224	0.7	771805	9.5	367120	2.7
	6	40140	0.3	60806	0.5	49634	0.7	49226	0.5	13109	0.1	273948	3.4	179255	1.3
	7+		0.0	9181	0.1			30674	0.3	5663	0.0	48473	0.6	41161	0.3
		11523742		**11491370**		**6932759**		**9348268**		**14553714**		**8156071**		**13511476**	
	0									1865837	51.0			5125275	66.9
	1									1469076	40.2			905253	11.8
	2									219729	6.0			379808	5.0
CÁDIZ	3									94643	2.6			573989	7.5
	4									8347	0.2			300233	3.9
	5													332644	4.3
	6													22727	0.3
	7+													17211	0.2
										3657632				**7657140**	
	0									8214909	45.1			13805651	65.2
	1									6949615	38.2			2714646	12.8
	2									1376832	7.6			1594416	7.5
TOTAL	3									1097223	6.0			1397305	6.6
	4									445771	2.4			696480	3.3
	5									108224	0.6			699764	3.3
	6									13109	0.1			201982	1.0
	7+									5663	0.0			58372	0.3
										18211346				**21168616**	

Table 8.4.2.3 - Sardine abundance (numbers in thousands) by age group and area in Portuguese August acoustic surveys series.

	IDADE	SAR85AGO	%	SAR86AGO	%	SAR87AGO	%	SAR88AGO	%	SAR95MAI	%	SAR96JUL	%
	0	60913	1.5	1278410	34.0	3448347	55.5	420693	14.2			351398	11.3
	1	534373	13.0	1749310	46.6	533227	8.6	1562425	52.6	189691	11.7	895055	28.8
OCN	2	3453152	83.9	379782	10.1	925826	14.9	376728	12.7	125473	7.7	639483	20.6
	3	35569	0.9	338816	9.0	570769	9.2	251910	8.5	275261	16.9	554252	17.9
	4	33208	0.8	11210	0.3	517738	8.3	315419	10.6	748635	46.0	607384	19.6
	5					143374	2.3	39551	1.3	231511	14.2	38859	1.3
	6					46283	0.7	5350	0.2	56760	3.5	18250	0.6
	7+					29682	0.5						
		4117215		**3757528**		**6215246**		**2972076**		**1627331**		**3104681**	
	0	3510	0.2	2594026	46.7	562441	27.9	448605	25.4			31423	1.1
	1	508304	32.4	649416	11.7	306154	15.2	113333	6.4	26946	1.3	414507	14.2
OCS	2	502951	32.1	1953631	35.2	451370	22.4	567064	32.1	53507	2.5	229524	7.9
	3	345297	22.0	354817	6.4	524920	26.0	503747	28.5	582625	27.5	859091	29.5
	4	149362	9.5			151911	7.5	103935	5.9	1124759	53.1	1178150	40.4
	5	52146	3.3			19764	1.0	26895	1.5	260673	12.3	201680	6.9
	6	6436	0.4					3331	0.2	46668	2.2		
	7+									21973	1.0		
		1568006		**5551890**		**2016560**		**1766910**		**2117151**		**2914375**	
	0	393746	60.7	134946	21.4	535640	57.1	2269930	90.1			32100	1.6
	1	141745	21.9	304191	48.1	363922	38.8	147436	5.9	11798	0.4	132878	6.7
	2	73986	11.4	158116	25.0	31063	3.3	44866	1.8	58112	2.2	265615	13.4
ALGARVE	3	29219	4.5	24583	3.9	6628	0.7	46816	1.9	1252983	47.1	808067	40.7
	4	6135	0.9	10005	1.6			6787	0.3	1075557	40.4	490404	24.7
	5	2176	0.3					3498	0.1	237524	8.9	205257	10.3
	6	1186	0.2							24818	0.9	51539	2.6
	7+												
		648193		**631841**		**937253**		**2519333**		**2660792**		**1985860**	
	0	458169	7.2	4007382	40.3	4546428	49.6	3139228	43.3			414921	5.2
	1	1184421	18.7	2702917	27.2	1203303	13.1	1823194	25.1	228435	3.6	1442440	18.0
	2	4030089	63.6	2491529	25.1	1408259	15.4	988659	13.6	237092	3.7	1134622	14.2
PORTUGAL	3	410085	6.5	718216	7.2	1102317	12.0	802473	11.1	2110869	33.0	2221410	27.8
	4	188705	3.0	21215	0.2	669649	7.3	426141	5.9	2948951	46.0	2275938	28.4
	5	54323	0.9			163138	1.8	69944	1.0	729708	11.4	445796	5.6
	6	7622	0.1			46283	0.5	8682	0.1	128246	2.0	69789	0.9
	7+					29682	0.3			21973	0.3		
		6333414		**9941259**		**9169059**		**7258321**		**6405274**		**8004916**	
	0											762086	28.5
	1									791109		1242749	46.5
	2									1506805		580692	21.7
CÁDIZ	3									1612970		87381	3.3
	4									194897			
	5									7354			
	6												
	7+												
										4113135		**2672908**	
	0											1177007	11.0
	1									1019544		2685189	25.1
	2									1743897		1715314	16.1
TOTAL	3									3723839		2308791	21.6
	4									3143848		2275938	21.3
	5									737062		445796	4.2
	6									128246		69789	0.7
	7+									21973			
										10518409		**10677824**	

Table 8.4.2.4 - Sardine abundance (numbers in thousands) by age group and area in February/March acoustic surveys series.

	IDADE	SAR86MAR	%	SAR88MAR	%	SAR96FEV	%	SAR97MAR	%	SAR98MAR	%	SAR99MAR	%
	0												
	1	1120268	32.7	7349646	72.3	600012	57.9	3127264	65.7	594707	12.5	2320453	52.2
OCN	2	1506747	44.0	777398	7.6	399054	38.5	274277	5.8	2459124	51.8	844859	19.0
	3	496750	14.5	539745	5.3	28590	2.8	816283	17.1	635726	13.4	814369	18.3
	4	194373	5.7	707387	7.0	9148	0.9	405372	8.5	409478	8.6	117062	2.6
	5	88078	2.6	549034	5.4			136509	2.9	313065	6.6	150177	3.4
	6	21325	0.6	188333	1.9					306527	6.5	157986	3.6
	7+			53378	0.5					31818	0.7	42064	0.9
		3427541		**10164921**		**1036804**		**4759705**		**4750445**		**4446970**	
	0												
	1	171599	5.8	254253	7.5	646714	23.8	1217173	32.6	694503	22.2	285254	34.3
OCS	2	1510804	50.8	1327803	39.2	224381	8.3	1130561	30.3	769817	24.6	79961	9.6
	3	859078	28.9	675027	19.9	399989	14.7	268308	7.2	534219	17.1	92320	11.1
	4	100224	3.4	606338	17.9	1185810	43.6	478376	12.8	413666	13.2	161927	19.5
	5	330434	11.1	239305	7.1	256687	9.4	543864	14.6	341247	10.9	159684	19.2
	6			232503	6.9	4646	0.2	96469	2.6	342778	11.0	46050	5.5
	7+			50886	1.5					33295	1.1	5446	0.7
		2972139		**3386115**		**2718227**		**3734751**		**3129525**		**830642**	
	0												
	1	1051999	41.7	139099	10.9	47921	2.2	37415	2.0	84111	6.6	257995	29.9
ALGARVE	2	1007153	39.9	579046	45.4	530280	24.7	478738	25.1	184859	14.4	205009	23.8
	3	188648	7.5	402469	31.6	504982	23.5	258990	13.6	194248	15.2	103243	12.0
	4	222927	8.8	133206	10.5	1018007	47.4	349308	18.3	221166	17.3	125270	14.5
	5	52051	2.1	15737	1.2	47067	2.2	673662	35.4	372059	29.0	73776	8.6
	6			4476	0.4			106326	5.6	179074	14.0	70293	8.2
	7+									46444	3.6	26566	3.1
		2522778		**1274033**		**2148257**		**1904439**		**1281961**		**862152**	
	0												
	1	2343866	26.3	7742997	52.2	1294647	21.9	4381852	42.1	1373321	15.0	2863702	46.6
	2	4024705	45.1	2684245	18.1	1153715	19.5	1883576	18.1	3413800	37.3	1129829	18.4
PORTUGAL	3	1544477	17.3	1617241	10.9	933561	15.8	1343581	12.9	1364193	14.9	1009932	16.4
	4	517525	5.8	1446931	9.8	2212965	37.5	1233056	11.9	1044310	11.4	404259	6.6
	5	470564	5.3	804077	5.4	303754	5.1	1354035	13.0	1026371	11.2	383637	6.2
	6	21325	0.2	425311	2.9	4646	0.1	202795	2.0	828379	9.0	274329	4.5
	7+			104264	0.7					111557	1.2	74076	1.2
		8922462		**14825066**		**5903288**		**10398895**		**9161931**		**6139764**	
	0												
	1					330338	9.4	1962293	55.1	262870	11.5	2848041	51.8
	2					928482	26.4	1354564	38.1	601182	26.4	1422794	25.9
CÁDIZ	3					1480967	42.0	208203	5.9	826689	36.3	450745	8.2
	4					693043	19.7	27157	0.8	389662	17.1	440176	8.0
	5					82722	2.3	6031	0.2	158636	7.0	212076	3.9
	6					7318	0.2			26416	1.2	95720	1.7
	7+									13641	0.6	25012	0.5
						3522870		**3558248**		**2279096**		**5494564**	
	0												
	1					1624985	17.2	6344145	45.5	1636191	14.3	5711743	49.1
	2					2082197	22.1	3238140	23.2	4014982	35.1	2552623	21.9
TOTAL	3					2414528	25.6	1551784	11.1	2190882	19.1	1460677	12.6
	4					2906008	30.8	1260213	9.0	1433972	12.5	844435	7.3
	5					386476	4.1	1360066	9.7	1185007	10.4	595713	5.1
	6					11964	0.1	202795	1.5	854795	7.5	370049	3.2
	7+									125198	1.1	99088	0.9
						9426158		**13957143**		**11441027**		**11634328**	

Table 8.4.2.5: Acoustic biomas and abundance estimations during Portuguese acoustic surveys. Upper panel March 1999, low panel November 1998. Number of fish in thousand and biomass in tonnes

	AGE GROUPS							
	1	2	3	4	5	6	7+	Total
Oc North								
Total Biomass	55202	32233	40437	6879	9219	10566	3021	157557
Mean weight	23.8	38.2	49.7	58.8	61.4	66.9	71.8	
No. fish	2320453	844859	814369	117062	150177	157986	42064	4446970
Mean length	14.9	17.6	19.2	20.3	20.6	21.2	21.7	
Oc. South								
Total Biomass	2649	3134	4852	9981	10269	3192	487	34564
Mean weight	9.3	39.2	52.6	61.6	64.3	69.3	89.3	
No. fish	285254	79961	92320	161927	159684	46050	5446	830642
Mean length	10.6	17.6	19.4	20.4	20.7	21.2	23.0	
Algarve								
Total Biomass	7320	7754	5253	7376	4770	4626	1901	39000
Mean weight	28.4	37.8	50.9	58.9	64.7	65.8	71.6	
No. fish	257995	205009	103243	125270	73776	70293	26566	862152
Mean length	15.4	17.0	18.9	19.9	20.6	20.7	21.4	
Cadiz								
Total Biomass	70511	52923	21555	23473	13869	6796	1976	191103
Mean weight	24.8	37.2	47.8	53.3	65.4	71.0	79.0	
No. fish	2848041	1422794	450745	440176	212076	95720	25012	5494564
Mean length	14.9	17.0	18.4	19.0	20.3	20.8	21.6	

	AGE GROUPS								
	0	1	2	3	4	5	6	7+	TOTAL
Oc North									
Total Biomass	88801	34770	18032	5911	1116	1459	717	0	150806
Mean weight	16.2	30.3	59.6	69.8	80.9	77.8	72.2		
No. fish	5496581	1145690	302706	84739	13796	18762	9931	0	7072205
Mean length	12.7	15.5	19.1	20.0	20.9	20.7	20.3		
Oc. South									
Total Biomass	19056	15045	43902	32295	10556	11357	4010	669	136890
Mean weight	8.1	44.6	54.4	57.8	62.8	75.3	81.6	82.2	
No. fish	2341437	337144	807275	558828	167980	150805	49126	8134	4420729
Mean length	10.4	17.5	18.6	18.9	19.4	20.5	21.0	21.0	
Algarve									
Total Biomass	25491	12864	5644	10780	13730	14222	9514	2725	94970
Mean weight	30.3	39.4	53.9	60.0	64.0	72.0	79.1	82.5	
No. fish	842359	326559	104627	179749	214471	197553	120198	33027	2018543
Mean length	15.8	17.0	18.8	19.4	19.8	20.5	21.2	21.4	
Cadiz									
Total Biomass	107738	38821	18723	31271	17724	21024	1633	1282	238216
Mean weight	21.0	42.9	49.3	54.5	59.0	63.2	71.9	74.5	
No. fish	5125275	905253	379808	573989	300233	332644	22727	17211	7657140
Mean length	14.0	17.6	18.5	19.1	19.6	20.0	20.9	21.1	

Table 8.4.2.6 Biomass (thousand tonnes) and abundance estimations (thousand fish) during the Spring 1999 (above) and November 1998 Portuguese acoustic surveys

March 1999

	AGE GROUPS							
	1	**2**	**3**	**4**	**5**	**6**	**7+**	**Total**
Oc North								
Total Biomass	55202	32233	40437	6879	9219	10566	3021	157557
Mean weight	23.8	38.2	49.7	58.8	61.4	66.9	71.8	
No. fish	2320453	844859	814369	117062	150177	157986	42064	4446970
Mean length	14.9	17.6	19.2	20.3	20.6	21.2	21.7	
Oc. South								
Total Biomass	2649	3134	4852	9981	10269	3192	487	34564
Mean weight	9.3	39.2	52.6	61.6	64.3	69.3	89.3	
No. fish	285254	79961	92320	161927	159684	46050	5446	830642
Mean length	10.6	17.6	19.4	20.4	20.7	21.2	23.0	
Algarve								
Total Biomass	7320	7754	5253	7376	4770	4626	1901	39000
Mean weight	28.4	37.8	50.9	58.9	64.7	65.8	71.6	
No. fish	257995	205009	103243	125270	73776	70293	26566	862152
Mean length	15.4	17.0	18.9	19.9	20.6	20.7	21.4	
Cadiz								
Total Biomass	70511	52923	21555	23473	13869	6796	1976	191103
Mean weight	24.8	37.2	47.8	53.3	65.4	71.0	79.0	
No. fish	2848041	1422794	450745	440176	212076	95720	25012	5494564
Mean length	14.9	17.0	18.4	19.0	20.3	20.8	21.6	

November 1998

	AGE GROUPS								
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**TOTAL**
Oc North									
Total Biomass	88801	34770	18032	5911	1116	1459	717	0	150806
Mean weight	16.2	30.3	59.6	69.8	80.9	77.8	72.2		
No. fish	5496581	1145690	302706	84739	13796	18762	9931	0	7072205
Mean length	12.7	15.5	19.1	20.0	20.9	20.7	20.3		
Oc. South									
Total Biomass	19056	15045	43902	32295	10556	11357	4010	669	136890
Mean weight	8.1	44.6	54.4	57.8	62.8	75.3	81.6	82.2	
No. fish	2341437	337144	807275	558828	167980	150805	49126	8134	4420729
Mean length	10.4	17.5	18.6	18.9	19.4	20.5	21.0	21.0	
Algarve									
Total Biomass	25491	12864	5644	10780	13730	14222	9514	2725	94970
Mean weight	30.3	39.4	53.9	60.0	64.0	72.0	79.1	82.5	
No. fish	842359	326559	104627	179749	214471	197553	120198	33027	2018543
Mean length	15.8	17.0	18.8	19.4	19.8	20.5	21.2	21.4	
Cadiz									
Total Biomass	107738	38821	18723	31271	17724	21024	1633	1282	238216
Mean weight	21.0	42.9	49.3	54.5	59.0	63.2	71.9	74.5	
No. fish	5125275	905253	379808	573989	300233	332644	22727	17211	7657140
Mean length	14.0	17.6	18.5	19.1	19.6	20.0	20.9	21.1	

Table 8.5.1 - SARDINE (Divisions VIIIc + IXa). Effort (fishing day) and CPUE (ton/fishing day) series in commercial fisheries (Purse seine)

YEAR	Spain						Portugal							
	VIIIc East(Santona)		VIIIc West (Sada)		IXa N(Vigo+Riveira)		IXa Central North		IXa Central South		IXa South		IXa TOTAL	
	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/f day
1982					7,685	4.87								
1983					7,867	4.01								
1984					8,369	4.65								
1985					5,731	4.86								
1986					3,541	4.23								
1987			4,455	2.07	4,099	4.71								
1988			4,192	2.34	3,601	2.75	6,460	7.48	6,098	4.12	3,388	3.89	15,946	5.43
1989	314	4.10	4,008	1.95	3,059	2.45	6,359	7.40	5,731	4.27	3,035	3.89	15,124	5.51
1990	389	3.65	3,465	1.55	3,488	2.80	6,660	7.22	5,890	3.72	3,534	4.37	16,084	5.31
1991	394	3.13	2,891	0.93	3,279	2.44	6,150	6.08	6,535	3.94	2,803	5.85	15,487	5.14
1992	570	1.63	2,619	1.42	3,790	2.44	6,603	5.38	6,556	3.99	2,127	5.49	15,287	4.80
1993	498	1.70	2,054	2.07	4,758	2.66	7,455	5.62	7,048	3.85	2,450	5.16	16,953	4.82
1994	274	4.00	2,029	2.03	4,452	2.28	4,514	10.50	7,707	3.34	2,931	4.98	15,152	5.79
1995	459	4.08	1,580	2.05	3,911	2.43	4,260	9.06	6,249	4.24	**a**	**a**		
1996	297	2.78	1,346	1.97	3,971	2.10	3717	8.60	6351	4.50	**a**	**a**		
1997	571	4.42	838	1.73	3,998	2.05	3,968	7.31	5,115	4.55	2,657	7.17	11,740	6.08
1998	470	7.23	999	1.32	2275	1.00	4,214	7.21	5,093	5.18	3,266	5.68	12,573	5.99

Table 8.7.1.1. Summary of the exploratory assessment runs with ICA for the Iberian sardine

				CHANGES RELATIVE TO RUN 2		
	RUN WG98	**RUN 1**	**RUN 2**	**RUN 3**	**RUN 4**	**RUN 5**
Year range	1977-1997	1978-1997	1978-1998	-	-	-
Age range	0-6+	0-6+	-	-	-	-
Separable constraint	12 years	12 years	13 years	-	-	-
Reference age	3	3	-	-	-	-
S at reference age	1	1	-	-	-	-
Selection pattern	2 periods: 86-90, 91-97	2 periods: 86-90, 91-97	Updated to 1998	-	-	-
Change in sel. pattern	abrupt	abrupt	-	-	-	-
SSB indices	DEPM (SP+PT) 88,97; Vigo/Rib. 82-97, Sada 87-97	DEPM (SP+PT) 86,97; Vigo/Rib. 82-97, Sada 87-97	Updated to 1998	DEPM out	Vigo/Ribeira+Sada out	PT November survey (84-87,92,97-98) in
Acoustic surveys	SP. March VIIIc+IXa (88-93,96-98), PT March incl Cadiz (96-98)	SP. March VIIIc+IXa (86-88,90-93,96-98), PT March incl Cadiz (96-98)	Updated to 1999	-	-	-
Survey weighting	Manual, equal weights	-	-	-	-	-
Catch-at-age weighting	age 0 = 0.5, remain. =1	age 0 = O.5, remain. =1	-	-	-	-
COMMENTS	-	Catch-at-age revised, Cadiz minor errors rev. and 78-81included, SP. March rev., PT. March rev.	-	SSB scaled upward similarly (<10%) along the time series	SSB scaled downwards until 1990 and upward since 1992 (<10%)	PT November with the lowest variance; SSB scaled downwards until 1986 and upward since 1994 (<10%)

Table 8.7.2.1 Sardine in Divisions VIIIc and IXa. Results of ICA analysis.

Output Generated by ICA Version 1.4

Sardine VIIIc+IXa

Catch in Number

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	869.4	674.5	856.7	1026.0	62.0	1070.0	118.0	268.0
1	2296.6	1535.6	2037.4	1934.8	795.0	577.0	3312.0	564.0
2	946.7	956.1	1562.0	1733.7	1869.0	857.0	487.0	2371.0
3	295.4	431.5	378.8	679.0	709.0	803.0	502.0	469.0
4	136.7	189.1	156.9	195.3	353.0	324.0	301.0	294.0
5	41.7	93.2	47.3	104.5	131.0	141.0	179.0	201.0
6	16.5	36.0	30.0	76.5	129.0	139.0	117.0	103.0

x 10 ^ 6

Catch in Number

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	304.0	1437.0	521.0	248.0	258.0	1580.6	498.3	87.8
1	755.0	543.0	990.0	566.0	602.0	477.4	1001.9	566.2
2	1027.0	667.0	535.0	909.0	517.0	436.1	451.4	1081.8
3	919.0	569.0	439.0	389.0	707.0	406.9	340.3	521.5
4	333.0	535.0	304.0	221.0	295.0	265.8	186.2	257.2
5	196.0	154.0	292.0	200.0	151.0	74.7	110.9	113.9
6	167.0	171.0	189.0	245.0	248.0	105.2	80.6	120.3

x 10 ^ 6

Catch in Number

AGE	1994	1995	1996	1997	1998
0	120.8	30.5	277.1	208.6	436.5
1	60.2	189.1	101.3	548.6	426.6
2	542.2	280.7	347.7	453.3	494.1
3	1094.4	829.7	514.7	391.1	339.0
4	272.5	472.9	652.7	337.3	228.4
5	112.6	70.2	197.2	225.2	176.6
6	72.1	64.5	46.6	70.3	105.9

x 10 ^ 6

Table 8.7.2.1 (Cont'd)

Predicted Catch in Number

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	356.5	614.8	382.4	395.5	438.1	568.9	368.0	148.0
1	671.2	560.8	965.3	601.2	671.6	331.9	721.3	531.7
2	793.1	680.6	566.8	975.6	652.2	469.2	448.3	1115.6
3	1175.0	537.9	459.6	382.3	703.1	422.6	410.6	454.8
4	351.6	618.3	281.7	240.2	213.3	389.9	203.7	233.2
5	206.8	173.7	304.1	138.2	125.9	99.9	134.4	83.2

x 10 ^ 6

Predicted Catch in Number

AGE	1994	1995	1996	1997	1998
0	102.9	72.0	213.2	260.0	508.7
1	164.2	143.8	155.9	373.5	406.4
2	639.9	251.0	335.5	290.0	615.2
3	897.9	667.0	392.2	405.4	305.2
4	206.8	541.8	601.5	265.0	234.2
5	75.8	89.8	355.3	293.7	110.1

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700
1	0.03400	0.03400	0.03400	0.03400	0.03400	0.03400	0.03400	0.03400
2	0.05200	0.05200	0.05200	0.05200	0.05200	0.05200	0.05200	0.05200
3	0.06000	0.06000	0.06000	0.06000	0.06000	0.06000	0.06000	0.06000
4	0.06800	0.06800	0.06800	0.06800	0.06800	0.06800	0.06800	0.06800
5	0.07200	0.07200	0.07200	0.07200	0.07200	0.07200	0.07200	0.07200
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Weights at age in the catches (Kg)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.01700	0.01700	0.01700	0.01300	0.02400	0.02000	0.01800	0.01700
1	0.03400	0.03400	0.03400	0.03500	0.03200	0.03100	0.04500	0.03700
2	0.05200	0.05200	0.05200	0.05200	0.04700	0.05800	0.05500	0.05100
3	0.06000	0.06000	0.06000	0.05900	0.05700	0.06300	0.06600	0.05800
4	0.06800	0.06800	0.06800	0.06600	0.06100	0.07300	0.07000	0.06600
5	0.07200	0.07200	0.07200	0.07100	0.06700	0.07400	0.07900	0.07100
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Table 8.7.2.1 (Cont'd)

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998
0	0.02000	0.02500	0.01900	0.02200	0.02600
1	0.03600	0.04700	0.03800	0.03300	0.04000
2	0.05800	0.05900	0.05100	0.05200	0.05500
3	0.06200	0.06600	0.05800	0.06200	0.06100
4	0.07000	0.07100	0.06100	0.06900	0.06700
5	0.07600	0.08200	0.07100	0.07300	0.07100
6	0.10000	0.10000	0.10000	0.10000	0.10000

Weights at age in the stock (Kg)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500
2	0.03800	0.03800	0.03800	0.03800	0.03800	0.03800	0.03800	0.03800
3	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000
4	0.06400	0.06400	0.06400	0.06400	0.06400	0.06400	0.06400	0.06400
5	0.06700	0.06700	0.06700	0.06700	0.06700	0.06700	0.06700	0.06700
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Weights at age in the stock (Kg)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.01500	0.01500	0.01500	0.01500	0.01500	0.01900	0.02700	0.02200
2	0.03800	0.03800	0.03800	0.03800	0.03800	0.04200	0.03600	0.04500
3	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05700
4	0.06400	0.06400	0.06400	0.06400	0.06400	0.06400	0.06200	0.06400
5	0.06700	0.06700	0.06700	0.06700	0.06700	0.07100	0.06900	0.07300
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Table 8.7.2.1 (Cont'd)

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998
0	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.03100	0.02900	0.03600	0.02500	0.03400
2	0.04000	0.05000	0.04700	0.05000	0.05100
3	0.04900	0.06200	0.06100	0.05800	0.05700
4	0.06000	0.07200	0.06900	0.06800	0.06500
5	0.06700	0.07900	0.07500	0.07400	0.07100
6	0.10000	0.10000	0.10000	0.10000	0.10000

Natural Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Natural Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Table 8.7.2.1 (Cont'd)

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998
0	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000

Proportion of fish spawning

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500
2	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500
3	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
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.2300	0.6000	0.7400	0.7900	0.4700
2	0.9500	0.9500	0.9500	0.8300	0.8100	0.9100	0.9100	0.9300
3	1.0000	1.0000	1.0000	0.9100	0.8800	0.9600	0.9500	0.9400
4	1.0000	1.0000	1.0000	0.9200	0.8900	0.9700	0.9800	0.9700
5	1.0000	1.0000	1.0000	0.9400	0.9400	1.0000	1.0000	0.9900
6	1.0000	1.0000	1.0000	0.9770	0.9870	1.0000	1.0000	1.0000

Table 8.7.2.1 (Cont'd)

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.8000	0.7300	0.8300	0.7270	0.7200
2	0.8900	0.9800	0.8900	0.9180	0.9240
3	0.9600	0.9700	0.9200	0.9500	0.9560
4	0.9600	0.9900	0.9600	0.9720	0.9870
5	0.9700	1.0000	1.0000	0.9930	0.9950
6	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	295.00	*******

x 10 ^ 3

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	188.44

x 10 ^ 3

INDEX1

	1998
1	*******

x 10 ^ 3

Table 8.7.2.1 (Cont'd)

AGE-STRUCTURED INDICES

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

AGE	1986	1987	1988	1989	1990	1991	1992	1993
1	55.1	632.0	224.1	*******	69.1	25.4	168.0	238.6
2	20.6	256.5	63.8	*******	56.0	208.1	77.5	427.3
3	1040.7	27.4	73.6	*******	272.9	163.7	88.4	135.9
4	215.3	2390.4	64.2	*******	53.3	401.0	31.0	126.1
5	408.8	586.2	848.3	*******	87.5	62.4	116.9	145.8
6	571.7	1259.1	885.7	*******	582.3	574.3	122.8	1117.9

x 10 ^ 3

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

AGE	1994	1995	1996	1997	1998	1999
1	*******	*******	10.6	56.5	509.8	214.5
2	*******	*******	54.2	263.1	103.1	160.4
3	*******	*******	90.5	125.7	80.4	134.6
4	*******	*******	350.8	123.3	33.8	124.3
5	*******	*******	213.8	65.7	20.6	28.4
6	*******	*******	24.8	61.0	25.4	64.0

x 10 ^ 3

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

AGE	1996	1997	1998	1999
1	1625.0	6344.1	1636.2	5711.7
2	2082.2	3238.1	4015.0	2552.6
3	2414.5	1551.8	2190.9	1460.7
4	2906.0	1260.2	1434.0	844.4
5	386.5	1360.1	1185.0	595.7
6	12.0	202.8	980.0	469.1

x 10 ^ 6

Table 8.7.2.1 (Cont'd)

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	2956.6	2063.2	2493.1	3714.5	*******	*******	*******	*******
1	5733.2	2743.5	1611.9	2379.4	*******	*******	*******	*******
2	1152.2	4548.2	1669.6	1343.7	*******	*******	*******	*******
3	1036.8	1083.4	658.4	928.7	*******	*******	*******	*******
4	528.3	839.2	322.9	665.6	*******	*******	*******	*******
5	76.4	143.8	127.3	236.5	*******	*******	*******	*******
6	40.1	70.0	49.6	79.9	*******	*******	*******	*******

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1992	1993	1994	1995	1996	1997	1998
0	6349.1	*******	*******	*******	*******	2424.7	8680.4
1	5480.5	*******	*******	*******	*******	1961.2	1809.4
2	1157.1	*******	*******	*******	*******	906.4	1214.6
3	1002.6	*******	*******	*******	*******	728.9	823.3
4	437.4	*******	*******	*******	*******	1040.6	396.2
5	108.2	*******	*******	*******	*******	771.8	367.1
6	18.8	*******	*******	*******	*******	322.4	220.4

x 10 ^ 6

Fishing Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07572	0.05195	0.06155	0.10986	0.00845	0.05265	0.01641	0.04151
1	0.44042	0.21381	0.25207	0.22137	0.13362	0.11593	0.26322	0.11621
2	0.43537	0.38700	0.40875	0.41227	0.40241	0.24046	0.15566	0.35537
3	0.44368	0.42455	0.30245	0.36482	0.34360	0.35166	0.25028	0.25490
4	0.35330	0.68156	0.31249	0.29218	0.38303	0.30234	0.24890	0.26343
5	0.57573	0.51117	0.41902	0.41401	0.37958	0.30096	0.31633	0.30396
6	0.57573	0.51117	0.41902	0.41401	0.37958	0.30096	0.31633	0.30396

Table 8.7.2.1 (Cont'd)

Fishing Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.06599	0.06681	0.06761	0.06860	0.07584	0.03983	0.03414	0.03322
1	0.15920	0.16119	0.16311	0.16552	0.18297	0.08666	0.07429	0.07229
2	0.27444	0.27786	0.28117	0.28533	0.31541	0.21679	0.18584	0.18084
3	0.34843	0.35278	0.35698	0.36225	0.40045	0.40554	0.34764	0.33829
4	0.35935	0.36383	0.36817	0.37361	0.41300	0.47651	0.40847	0.39748
5	0.34843	0.35278	0.35698	0.36225	0.40045	0.40554	0.34764	0.33829
6	0.34843	0.35278	0.35698	0.36225	0.40045	0.40554	0.34764	0.33829

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998
0	0.02459	0.02279	0.03300	0.03915	0.04167
1	0.05351	0.04959	0.07181	0.08519	0.09066
2	0.13385	0.12405	0.17963	0.21309	0.22680
3	0.25038	0.23206	0.33602	0.39863	0.42426
4	0.29420	0.27267	0.39482	0.46838	0.49850
5	0.25038	0.23206	0.33602	0.39863	0.42426
6	0.25038	0.23206	0.33602	0.39863	0.42426

Population Abundance (1 January)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	13969.	15621.	16820.	11543.	8654.	24458.	8507.	7730.
1	7479.	9311.	10662.	11370.	7435.	6169.	16682.	6016.
2	3112.	3461.	5405.	5957.	6551.	4677.	3950.	9217.
3	956.	1447.	1690.	2582.	2836.	3149.	2644.	2430.
4	534.	441.	681.	898.	1289.	1446.	1593.	1480.
5	110.	270.	160.	358.	482.	632.	768.	893.
6	43.	104.	102.	262.	475.	623.	502.	458.

x 10 ^ 6

Population Abundance (1 January)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	6543.	11148.	6855.	6991.	7028.	17086.	12858.	5312.
1	5331.	4403.	7497.	4606.	4693.	4683.	11804.	8934.
2	3851.	3269.	2694.	4579.	2806.	2809.	3088.	7878.
3	4645.	2104.	1780.	1462.	2475.	1472.	1626.	1843.
4	1354.	2357.	1063.	895.	732.	1192.	705.	826.
5	817.	680.	1178.	529.	443.	348.	532.	337.
6	660.	669.	732.	937.	873.	366.	319.	488.

x 10 ^ 6

Population Abundance (1 January)

Table 8.7.2.1 (Cont'd)

AGE	1994	1995	1996	1997	1998	1999
0	4968.	3751.	7703.	7943.	14617.	8484.
1	3694.	3485.	2636.	5358.	5491.	10080.
2	5975.	2517.	2384.	1764.	3537.	3606.
3	4727.	3757.	1599.	1432.	1025.	2027.
4	945.	2646.	2142.	821.	691.	482.
5	399.	506.	1448.	1037.	370.	302.
6	380.	363.	190.	248.	355.	341.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1	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
3	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
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Weighting factors for the catches in number

AGE	1994	1995	1996	1997	1998
0	0.5000	0.5000	0.5000	0.5000	0.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted SSB Index Values

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	414.70	*******

x 10 ^ 3

Table 8.7.2.1 (Cont'd)

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	358.12

x 10 ^ 3

INDEX1

	1998
1	*******

x 10 ^ 3

Predicted Age-Structured Index Values

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Predicted

AGE	1986	1987	1988	1989	1990	1991	1992	1993
1	100.04	82.59	140.56	*******	87.61	89.23	225.48	170.72
2	132.51	112.40	92.59	*******	95.74	97.86	108.24	276.50
3	319.61	144.65	122.26	*******	168.43	100.07	111.92	127.11
4	195.64	340.21	153.30	*******	104.55	168.04	100.87	118.37
5	178.71	148.43	256.97	*******	95.81	75.19	116.35	73.84
6	346.52	350.81	383.54	*******	453.19	190.02	167.55	256.46

x 10 ^ 3

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Predicted

AGE	1994	1995	1996	1997	1998	1999
1	*******	*******	50.38	102.11	104.53	191.88
2	*******	*******	83.69	61.48	122.95	125.32
3	*******	*******	110.29	97.52	69.39	137.28
4	*******	*******	307.17	115.99	96.99	67.63
5	*******	*******	317.40	224.43	79.53	64.94
6	*******	*******	99.99	128.94	183.59	176.18

x 10 ^ 3

Table 8.7.2.1 (Cont'd)

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Predicted

AGE	1996	1997	1998	1999
1	1566.0	3174.2	3249.5	5964.8
2	2557.2	1878.5	3756.7	3829.3
3	2040.0	1803.6	1283.4	2539.1
4	3605.2	1361.3	1138.3	793.8
5	1788.7	1264.8	448.2	366.0
6	127.9	164.9	234.8	225.3

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	3280.3	2909.8	2405.6	4095.8	*******	*******	*******	*******
1	5793.6	2406.2	2046.0	1686.6	*******	*******	*******	*******
2	1724.3	3322.0	1500.0	1269.1	*******	*******	*******	*******
3	1241.6	1136.3	1985.3	895.6	*******	*******	*******	*******
4	858.3	786.2	656.1	1137.2	*******	*******	*******	*******
5	222.5	261.7	229.6	190.0	*******	*******	*******	*******
6	91.8	84.6	117.0	118.1	*******	*******	*******	*******

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1992	1993	1994	1995	1996	1997	1998
0	4874.4	*******	*******	*******	*******	2996.8	5501.4
1	4914.7	*******	*******	*******	*******	2207.6	2250.7
2	1309.5	*******	*******	*******	*******	728.7	1442.4
3	695.6	*******	*******	*******	*******	583.3	407.2
4	326.1	*******	*******	*******	*******	358.5	293.0
5	149.5	*******	*******	*******	*******	277.6	96.5
6	56.6	*******	*******	*******	*******	41.9	58.6

x 10 ^ 6

Table 8.7.2.1 (Cont'd)

Fitted Selection Pattern

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.1707	0.1224	0.2035	0.3011	0.0246	0.1497	0.0656	0.1628
1	0.9927	0.5036	0.8334	0.6068	0.3889	0.3297	1.0517	0.4559
2	0.9813	0.9115	1.3514	1.1301	1.1712	0.6838	0.6219	1.3942
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.7963	1.6054	1.0332	0.8009	1.1148	0.8598	0.9945	1.0335
5	1.2976	1.2040	1.3854	1.1348	1.1047	0.8558	1.2639	1.1925
6	1.2976	1.2040	1.3854	1.1348	1.1047	0.8558	1.2639	1.1925

Fitted Selection Pattern

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.1894	0.1894	0.1894	0.1894	0.1894	0.0982	0.0982	0.0982
1	0.4569	0.4569	0.4569	0.4569	0.4569	0.2137	0.2137	0.2137
2	0.7876	0.7876	0.7876	0.7876	0.7876	0.5346	0.5346	0.5346
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0313	1.0313	1.0313	1.0313	1.0313	1.1750	1.1750	1.1750
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	1994	1995	1996	1997	1998
0	0.0982	0.0982	0.0982	0.0982	0.0982
1	0.2137	0.2137	0.2137	0.2137	0.2137
2	0.5346	0.5346	0.5346	0.5346	0.5346
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.1750	1.1750	1.1750	1.1750	1.1750
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000

Table 8.7.2.1 (Cont'd)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 5	SoP (%)
1978	13969420	324138	235524	145609	0.6182	0.4520	83
1979	15621320	400280	294161	157241	0.5345	0.5011	96
1980	16819940	514299	385218	194802	0.5057	0.3607	95
1981	11543040	633668	482965	216517	0.4483	0.3708	89
1982	8653780	664500	526233	206946	0.3933	0.3772	96
1983	24457990	624874	508342	183837	0.3616	0.2989	104
1984	8506950	736132	562339	206005	0.3663	0.2428	95
1985	7730010	762291	618683	208440	0.3369	0.2944	94
1986	6542520	665965	544968	187363	0.3438	0.3327	97
1987	11148330	558710	456935	177695	0.3889	0.3368	100
1988	6855080	523951	414703	161530	0.3895	0.3408	102
1989	6990650	502646	348732	140962	0.4042	0.3459	96
1990	7027800	464551	336979	149430	0.4434	0.3823	104
1991	17085920	418207	328289	132587	0.4039	0.3761	99
1992	12858050	623521	479822	130249	0.2715	0.3224	99
1993	5311930	782342	568162	142495	0.2508	0.3137	98
1994	4967880	706500	572090	136581	0.2387	0.2322	98
1995	3750920	726674	608205	125280	0.2060	0.2152	98
1996	7702540	579848	467900	116736	0.2495	0.3116	101
1997	7943130	462640	358121	115814	0.3234	0.3697	98
1998	14617170	532209	404572	108925	0.2692	0.3935	94

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 6
Year range in the analysis : 1978 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 3

Parameters to estimate : 58
Number of observations : 219

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1990
Abrupt change in selection specified.

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	1986	0.3484	23	0.2191	0.5542	0.2750	0.4415	0.3583
2	1987	0.3528	23	0.2235	0.5568	0.2795	0.4453	0.3625
3	1988	0.3570	23	0.2241	0.5687	0.2815	0.4527	0.3672
4	1989	0.3623	23	0.2280	0.5756	0.2860	0.4588	0.3725
5	1990	0.4004	23	0.2551	0.6286	0.3181	0.5040	0.4112
6	1991	0.4055	23	0.2542	0.6471	0.3195	0.5147	0.4172
7	1992	0.3476	24	0.2162	0.5589	0.2728	0.4429	0.3580
8	1993	0.3383	25	0.2057	0.5563	0.2625	0.4360	0.3494
9	1994	0.2504	25	0.1532	0.4093	0.1949	0.3217	0.2584
10	1995	0.2321	24	0.1449	0.3715	0.1825	0.2950	0.2388
11	1996	0.3360	22	0.2148	0.5257	0.2674	0.4222	0.3449
12	1997	0.3986	22	0.2544	0.6247	0.3170	0.5013	0.4092
13	1998	0.4243	24	0.2605	0.6910	0.3308	0.5441	0.4376

Table 8.7.2.1 (Cont'd)

Separable Model: Selection (S1) by age 1986 1990

14	0	0.1894	28	0.1085	0.3306	0.1425	0.2516	0.1972
15	1	0.4569	23	0.2910	0.7175	0.3629	0.5752	0.4692
16	2	0.7876	21	0.5138	1.2075	0.6334	0.9795	0.8066
	3	1.0000		Fixed : Reference Age				
17	4	1.0313	19	0.7056	1.5075	0.8498	1.2517	1.0509
	5	1.0000		Fixed : Last true age				

Separable Model: Selection (S2) by age from 1991 to 1998

18	0	0.0982	24	0.0604	0.1596	0.0767	0.1258	0.1013
19	1	0.2137	19	0.1447	0.3156	0.1752	0.2607	0.2180
20	2	0.5346	18	0.3725	0.7672	0.4446	0.6428	0.5437
	3	1.0000		Fixed : Reference Age				
21	4	1.1750	15	0.8704	1.5861	1.0082	1.3693	1.1888
	5	1.0000		Fixed : Last true age				

Separable model: Populations in year 1998

22	0	14617178	42	6373574	33523088	9570727	22324521	15988482
23	1	5491263	28	3130248	9633091	4122254	7314922	5721742
24	2	3537296	23	2245757	5571601	2805458	4460043	3633612
25	3	1024605	21	674339	1556807	827682	1268381	1048211
26	4	691117	22	442166	1080233	550287	867988	709295
27	5	369636	26	221041	618125	284345	480512	382576

Separable model: Populations at age

28	1986	817449	36	402312	1660954	569338	1173683	872713
29	1987	679572	29	383221	1205095	507345	910263	709226
30	1988	1177560	27	682550	2031568	891542	1555335	1224038
31	1989	528810	26	312498	894853	404336	691603	548202
32	1990	443059	25	268745	730436	343309	571791	457709
33	1991	348095	25	210943	574421	269595	449453	359649
34	1992	532108	27	313113	904267	405976	697426	551943
35	1993	337037	28	192458	590229	253235	448572	351095
36	1994	398950	28	227629	699214	299631	531192	415639
37	1995	506134	27	297572	860872	385989	663675	525064
38	1996	1448092	25	884944	2369610	1126350	1861740	1494533
39	1997	1037492	25	635589	1693530	807995	1332172	1070426

SSB Index catchabilities
INDEX1
Absolute estimator. No fitted catchability.

Age-structured index catchabilities
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Linear model fitted. Slopes at age :

40	1	Q	.2079E-01	28	.1585E-01	.4804E-01	.2079E-01	.3661E-01	.2872E-01
41	2	Q	.3907E-01	28	.2982E-01	.8983E-01	.3907E-01	.6857E-01	.5385E-01
42	3	Q	.7935E-01	28	.6031E-01	.1849	.7935E-01	.1405	.1100
43	4	Q	.1670	30	.1247	.4112	.1670	.3070	.2372
44	5	Q	.2521	33	.1835	.6709	.2521	.4884	.3706
45	6	Q	.6053	30	.4500	1.510	.6053	1.123	.8647

Table 8.7.2.1 (Cont'd)

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Linear model fitted. Slopes at age :

46	1	Q	646.4	48	407.3	2686.	646.4	1692.	1174.
47	2	Q	1194.	46	761.3	4779.	1194.	3048.	2129.
48	3	Q	1468.	46	936.6	5862.	1468.	3741.	2614.
49	4	Q	1960.	48	1236.	8131.	1960.	5126.	3558.
50	5	Q	1421.	50	877.1	6283.	1421.	3879.	2663.
51	6	Q	774.1	48	484.4	3286.	774.1	2056.	1421.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear model fitted. Slopes at age :

52	0	Q	537.7	37	376.0	1621.	537.7	1133.	836.7
53	1	Q	613.8	36	430.6	1832.	613.8	1285.	950.7
54	2	Q	695.9	36	488.0	2078.	695.9	1457.	1078.
55	3	Q	819.8	37	571.3	2496.	819.8	1739.	1282.
56	4	Q	939.3	38	648.0	2951.	939.3	2036.	1490.
57	5	Q	538.6	39	367.1	1757.	538.6	1197.	869.7
58	6	Q	340.0	38	234.4	1070.	340.0	737.6	539.7

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993
0	-0.159	0.849	0.309	-0.467	-0.529	1.022	0.303	-0.522
1	0.118	-0.032	0.025	-0.060	-0.109	0.363	0.329	0.063
2	0.258	-0.020	-0.058	-0.071	-0.232	-0.073	0.007	-0.031
3	-0.246	0.056	-0.046	0.017	0.005	-0.038	-0.188	0.137
4	-0.054	-0.145	0.076	-0.083	0.324	-0.383	-0.090	0.098
5	-0.054	-0.121	-0.040	0.369	0.182	-0.291	-0.192	0.314

Separable Model Residuals

Age	1994	1995	1996	1997	1998
0	0.161	-0.859	0.262	-0.221	-0.153
1	-1.003	0.274	-0.431	0.384	0.048
2	-0.166	0.112	0.036	0.447	-0.219
3	0.198	0.218	0.272	-0.036	0.105
4	0.276	-0.136	0.082	0.241	-0.025
5	0.396	-0.247	-0.588	-0.266	0.472

Table 8.7.2.1 (Cont'd)

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	-0.3406	*******

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	-0.6421

INDEX1

	1998
1	*******

AGE-STRUCTURED INDEX RESIDUALS

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-0.597	2.035	0.466	*******	-0.238	-1.256	-0.294	0.335
2	-1.864	0.825	-0.372	*******	-0.536	0.755	-0.334	0.435
3	1.181	-1.663	-0.507	*******	0.483	0.492	-0.236	0.067
4	0.096	1.950	-0.871	*******	-0.673	0.870	-1.181	0.063
5	0.828	1.374	1.194	*******	-0.090	-0.187	0.005	0.680
6	0.501	1.278	0.837	*******	0.251	1.106	-0.311	1.472

Table 8.7.2.1 (Cont'd)

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1994	1995	1996	1997	1998	1999
1	*******	*******	-1.555	-0.592	1.585	0.112
2	*******	*******	-0.434	1.454	-0.176	0.247
3	*******	*******	-0.197	0.254	0.147	-0.020
4	*******	*******	0.133	0.061	-1.055	0.609
5	*******	*******	-0.395	-1.228	-1.351	-0.829
6	*******	*******	-1.395	-0.748	-1.978	-1.012

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Age	1996	1997	1998	1999
1	0.037	0.692	-0.686	-0.043
2	-0.205	0.545	0.066	-0.406
3	0.169	-0.150	0.535	-0.553
4	-0.216	-0.077	0.231	0.062
5	-1.532	0.073	0.972	0.487
6	-2.369	0.207	1.429	0.733

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.104	-0.344	0.036	-0.098	*******	*******	*******	*******
1	-0.010	0.131	-0.238	0.344	*******	*******	*******	*******
2	-0.403	0.314	0.107	0.057	*******	*******	*******	*******
3	-0.180	-0.048	-1.104	0.036	*******	*******	*******	*******
4	-0.485	0.065	-0.709	-0.536	*******	*******	*******	*******
5	-1.069	-0.599	-0.590	0.219	*******	*******	*******	*******
6	-0.827	-0.190	-0.858	-0.390	*******	*******	*******	*******

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1992	1993	1994	1995	1996	1997	1998
0	0.264	*******	*******	*******	*******	-0.212	0.456
1	0.109	*******	*******	*******	*******	-0.118	-0.218
2	-0.124	*******	*******	*******	*******	0.218	-0.172
3	0.366	*******	*******	*******	*******	0.223	0.704
4	0.294	*******	*******	*******	*******	1.066	0.302
5	-0.323	*******	*******	*******	*******	1.022	1.336
6	-1.104	*******	*******	*******	*******	2.040	1.325

Table 8.7.2.1 (Cont'd)

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1986 to 1998

Variance	0.1531
Skewness test stat.	-1.2768
Kurtosis test statistic	2.6737
Partial chi-square	0.4818
Significance in fit	0.0000
Degrees of freedom	43

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance
Last age is a plus-group

Variance	0.2642
Skewness test stat.	-0.6469
Kurtosis test statistic	-0.4865
Partial chi-square	0.0412
Significance in fit	0.0204
Number of observations	2
Degrees of freedom	2
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.1973	0.1307	0.0846	0.1447	0.1447	0.2263
Skewness test stat.	0.6997	-0.5401	-1.1208	0.7911	0.0383	-0.4109
Kurtosis test statisti	-0.3250	0.0884	0.7946	-0.1421	-0.8071	-0.8240
Partial chi-square	0.1745	0.1134	0.0702	0.1197	0.1222	0.1856
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	11	11	11	11	11	11
Degrees of freedom	10	10	10	10	10	10
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.0530	0.0282	0.0357	0.0061	0.1964	0.4575
Skewness test stat.	0.0158	0.3900	-0.0467	0.0930	-0.6292	-0.6894
Kurtosis test statisti	-0.4137	-0.4847	-0.5268	-0.5376	-0.3807	-0.3588
Partial chi-square	0.0073	0.0039	0.0050	0.0009	0.0283	0.0728
Significance in fit	0.0002	0.0001	0.0001	0.0000	0.0013	0.0051
Number of observations	4	4	4	4	4	4
Degrees of freedom	3	3	3	3	3	3
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Table 8.7.2.1 (Cont'd)

DISTRIBUTION STATISTICS FOR FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear catchability relationship assumed

Age	0	1	2	3	4	5	6
Variance	0.0110	0.0063	0.0088	0.0460	0.0558	0.1150	.2082
Skewness test stat.	0.5556	0.3888	-0.3792	-1.0011	0.5096	0.4816	.9072
Kurtosis test statisti	-0.4834	-0.5441	-0.5152	0.1511	-0.4515	-0.6733	-.4870
Partial chi-square	0.0030	0.0018	0.0025	0.0132	0.0167	0.0364	.0701
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0000
Number of observations	7	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6	6
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	.1429

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	96.9622	219	58	161	0.6022
Catches at age	7.7981	78	39	39	0.2000
SSB Indices					
INDEX1	0.5283	2	0	2	0.2642
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	55.7035	66	6	60	0.9284
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	13.9841	24	6	18	0.7769
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	18.9482	49	7	42	0.4511

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.8222	219	58	161	0.0548
Catches at age	5.9714	78	39	39	0.1531
SSB Indices					
INDEX1	0.5283	2	0	2	0.2642
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	1.5473	66	6	60	0.0258
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	0.3884	24	6	18	0.0216
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	0.3867	49	7	42	0.0092

Table 8.7.3.1: Stock: Sardine in Divisions VIIIc and IXa

Assessment Quality Control Diagram 1

Average F(2-5,u)												
Date of assessment	Year											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989	0.23	0.23										
1990	0.20	0.21	0.23									
1991[1]	0.15	0.15	0.15	0.16								
1992	0.25	0.30	0.35	0.48	0.41							
1993	0.31	0.34	0.38	0.46	0.32	0.29						
1994	0.44	0.46	0.51	0.59	0.53	0.36	0.38					
1995	0.38	0.39	0.44	0.55	0.41	0.33	0.44	0.41				
1996	0.40	0.48	0.48	0.62	0.48	0.39	0.55	0.54	0.66			
1997	0.39	0.48	0.48	0.63	0.51	0.42	0.52	0.45	0.44	0.58		
1998	0.41	0.42	0.42	0.40	0.49	0.41	0.44	0.38	0.34	0.50	0.70	
1999	0.34	0.34	0.35	0.38	0.38	0.32	0.31	0.23	0.22	0.31	0.37	0.39

[1] f(2-6,u)

Remarks: Assessments of 1995 1996 performed using ICA.

Table 8.7.3.2:Stock: Sardine in Divisions VIIIc and IXa

Assessment Quality Control Diagram 2

Recruitment (age 0) Unit: millions												
Date of assessment	Year class											
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1989	8.0	24.8										
1990	9.5	18.5	9.9									
1991	10.6	19.3	9.4	8.4								
1992	6.2	10.6	5.5	3.9	6.0							
1993	6.2	11.6	6.0	6.6	5.1	9.0						
1994	6.0	10.1	5.9	6.0	5.7	13.7	7.6					
1995	5.2	10.8	5.9	5.6	5.8	15.1	7.6	1.1				
1996	5.2	10.5	5.4	5.2	4.9	13.0	7.5	1.3	1.6			
1997	5.2	10.0	5.7	5.5	4.9	13.3	9.6	2.3	2.6	1.2		
1998	5.8	10.9	6.3	6.1	5.9	13.5	10.3	3.8	3.8	2.5	6.7	
1999	6.5	11.1	6.9	7.0	7.0	17.1	12.9	5.3	5.0	3.8	7.7	7.9

Remarks: Assessments of 1995 1996 performed using ICA.

Table 8.7.3.3:Stock: Sardine in Divisions VIIIc and IXa

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)														
Date of assessment	Year													
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1989	608	891	888[1]	884[1]										
1990	633	545	519[1]	515[1]	508[1]									
1991	847	819	748	786[1]	764[1]	772[1]								
1992	431	313	275	227	222	246[1]	297[1]							
1993	388	301	282	294	290	377	408[1]	418[1]						
1994	347	271	236	242	350	368		[1]	[1]					
1995	378	314	279	277	399	421	320		[1]	[1]				
1996	350	281	242	233	230	345	261	200		[1]	[1]			
1997	370	293	253	242	341	372	323	290	187					
1998	348	294	290	269	375	427	406	403	285	220				
1999	415	349	337	328	480	568	572	608	468	358	405			

[1]Forecast.

Remarks: Assessments of 1995 1996 performed using ICA.

Table 8.8.1 Sardine in Divisions VIIIc and IXa Prediction with management option table: Input data

The SAS System 16:06 Thursday, September 23, 1999

Year: 1999

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	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000	0.0417	0.022
1	10080000	0.3300	0.7590	0.2500	0.2500	0.032	0.0907	0.037
2	3606000.0	0.3300	0.9110	0.2500	0.2500	0.049	0.2268	0.053
3	2027000.0	0.3300	0.9420	0.2500	0.2500	0.059	0.4243	0.060
4	482000.00	0.3300	0.9730	0.2500	0.2500	0.067	0.4985	0.066
5	302000.00	0.3300	1.0000	0.2500	0.2500	0.073	0.4243	0.072
6+	341000.00	0.3300	1.0000	0.2500	0.2500	0.100	0.4243	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000	0.0417	0.022
1	.	0.3300	0.7590	0.2500	0.2500	0.032	0.0907	0.037
2	.	0.3300	0.9110	0.2500	0.2500	0.049	0.2268	0.053
3	.	0.3300	0.9420	0.2500	0.2500	0.059	0.4243	0.060
4	.	0.3300	0.9730	0.2500	0.2500	0.067	0.4985	0.066
5	.	0.3300	1.0000	0.2500	0.2500	0.073	0.4243	0.072
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.4243	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000	0.0417	0.022
1	.	0.3300	0.7590	0.2500	0.2500	0.032	0.0907	0.037
2	.	0.3300	0.9110	0.2500	0.2500	0.049	0.2268	0.053
3	.	0.3300	0.9420	0.2500	0.2500	0.059	0.4243	0.060
4	.	0.3300	0.9730	0.2500	0.2500	0.067	0.4985	0.066
5	.	0.3300	1.0000	0.2500	0.2500	0.073	0.4243	0.072
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.4243	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANXAN03
Date and time: 23SEP99:10:15

Table 8.8.2 Sardine in Divisions VIIIc and IXa Prediction with management option table

The SAS System 16:06 Thursday, September 23, 1999

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.3935	707287	525768	129621	0.0000	0.0000	703015	579977	0	782926	656087
.	.	.	.	.	0.0500	0.0197	.	577953	8638	774612	646049
.	.	.	.	.	0.1000	0.0393	.	575938	17145	766428	636215
.	.	.	.	.	0.1500	0.0590	.	573932	25525	758371	626581
.	.	.	.	.	0.2000	0.0787	.	571934	33779	750440	617142
.	.	.	.	.	0.2500	0.0984	.	569944	41910	742632	607893
.	.	.	.	.	0.3000	0.1180	.	567963	49921	734945	598830
.	.	.	.	.	0.3500	0.1377	.	565990	57812	727376	589949
.	.	.	.	.	0.4000	0.1574	.	564026	65588	719923	581245
.	.	.	.	.	0.4500	0.1771	.	562071	73248	712584	572715
.	.	.	.	.	0.5000	0.1967	.	560123	80797	705357	564354
.	.	.	.	.	0.5500	0.2164	.	558184	88234	698241	556158
.	.	.	.	.	0.6000	0.2361	.	556253	95564	691232	548125
.	.	.	.	.	0.6500	0.2558	.	554330	102787	684329	540249
.	.	.	.	.	0.7000	0.2754	.	552416	109905	677530	532528
.	.	.	.	.	0.7500	0.2951	.	550509	116921	670834	524958
.	.	.	.	.	0.8000	0.3148	.	548611	123836	664237	517535
.	.	.	.	.	0.8500	0.3345	.	546721	130652	657740	510257
.	.	.	.	.	0.9000	0.3541	.	544838	137370	651338	503119
.	.	.	.	.	0.9500	0.3738	.	542964	143993	645032	496119
.	.	.	.	.	1.0000	0.3935	.	541098	150522	638819	489254
.	.	.	.	.	1.0500	0.4131	.	539239	156958	632697	482521
.	.	.	.	.	1.1000	0.4328	.	537389	163304	626665	475916
.	.	.	.	.	1.1500	0.4525	.	535546	169561	620722	469437
.	.	.	.	.	1.2000	0.4722	.	533711	175730	614865	463081
.	.	.	.	.	1.2500	0.4918	.	531883	181813	609093	456845
.	.	.	.	.	1.3000	0.5115	.	530064	187812	603405	450727
.	.	.	.	.	1.3500	0.5312	.	528252	193728	597799	444724
.	.	.	.	.	1.4000	0.5509	.	526448	199562	592274	438833
.	.	.	.	.	1.4500	0.5705	.	524651	205315	586828	433052
.	.	.	.	.	1.5000	0.5902	.	522862	210990	581459	427379
.	.	.	.	.	1.5500	0.6099	.	521080	216588	576167	421811
.	.	.	.	.	1.6000	0.6296	.	519306	222109	570950	416345
.	.	.	.	.	1.6500	0.6492	.	517540	227556	565807	410981
.	.	.	.	.	1.7000	0.6689	.	515780	232929	560737	405714
.	.	.	.	.	1.7500	0.6886	.	514029	238229	555737	400544
.	.	.	.	.	1.8000	0.7083	.	512284	243459	550808	395468
.	.	.	.	.	1.8500	0.7279	.	510547	248619	545947	390484
.	.	.	.	.	1.9000	0.7476	.	508817	253710	541154	385590
.	.	.	.	.	1.9500	0.7673	.	507094	258733	536427	380785
.	.	.	.	.	2.0000	0.7870	.	505379	263690	531765	376065
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANXAN03
Date and time : 23SEP99:10:15
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1999 : F factors

Table 8.8.3 Sardine in Divisions VIIIc and IXa Single option prediction: Summary table

The SAS System 16:06 Thursday, September 23, 1999

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.3935	2564793	129621	23514000	707287	13957206	606016	12240126	525768
2000	1.0000	0.3935	2815963	150522	21430587	703015	12910513	629854	11181969	541098
2001	1.0000	0.3935	2754298	151244	19724212	638819	11423542	575399	9812972	489254
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRXAN04
Date and time : 23SEP99:10:07
Computation of ref. F: Simple mean, age 2 - 5
Prediction basis : F factors

Table 8.11.1 Sardine in Divisions VIIIc and IXa Yield per recruit: Input data

The SAS System 16:06 Thursday, September 23, 1999

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000	0.0417	0.022
1	.	0.3300	0.7590	0.2500	0.2500	0.032	0.0907	0.037
2	.	0.3300	0.9110	0.2500	0.2500	0.049	0.2268	0.053
3	.	0.3300	0.9420	0.2500	0.2500	0.059	0.4243	0.060
4	.	0.3300	0.9730	0.2500	0.2500	0.067	0.4985	0.066
5	.	0.3300	1.0000	0.2500	0.2500	0.073	0.4243	0.072
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.4243	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDXAN02
Date and time: 21SEP99:11:59

Table 8.11.2 Sardine in Divisions VIIIc and IXa Yield per recruit: Summary table

The SAS System 16:06 Thursday, September 23, 1999

	1 January		Spawning time						
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0	0	23751561	1010036	15419749	946260	14198681	871327
0.0500	0.0197	215443	14340	23104911	953433	14781946	890108	13558951	815983
0.1000	0.0393	407172	26661	22530025	903744	14215771	840862	12990886	767495
0.1500	0.0590	579040	37324	22015225	859815	13709550	797368	12482815	724714
0.2000	0.0787	734110	46615	21551229	820728	13254007	758708	12025462	686725
0.2500	0.0984	874847	54758	21130568	785748	12841674	724148	11611364	652796
0.3000	0.1180	1003258	61937	20747163	754277	12466475	693090	11234446	622332
0.3500	0.1377	1120991	68299	20396018	725825	12123417	665043	10889716	594847
0.4000	0.1574	1229414	73964	20072987	699988	11808361	639604	10573036	569938
0.4500	0.1771	1329672	79033	19774607	676428	11517842	616435	10280943	547269
0.5000	0.1967	1422728	83587	19497958	654860	11248945	595253	10010522	526561
0.5500	0.2164	1509399	87695	19240562	635046	10999195	575817	9759300	507574
0.6000	0.2361	1590385	91416	19000304	616782	10766480	557925	9525165	490107
0.6500	0.2558	1666285	94799	18775369	599892	10548987	541401	9306304	473987
0.7000	0.2754	1737617	97884	18564189	584227	10345150	526096	9101151	459067
0.7500	0.2951	1804831	100707	18365401	569657	10153609	511881	8908348	445217
0.8000	0.3148	1868319	103298	18177819	556070	9973181	498643	8726711	432328
0.8500	0.3345	1928424	105684	18000404	543367	9802829	486284	8555201	420301
0.9000	0.3541	1985449	107886	17832242	531463	9641640	474718	8392908	409053
0.9500	0.3738	2039660	109925	17672525	520282	9488810	463870	8239025	398510
1.0000	0.3935	2091294	111817	17520538	509758	9343625	453673	8092841	388605
1.0500	0.4131	2140561	113577	17375646	499831	9205451	444069	7953719	379281
1.1000	0.4328	2187650	115218	17237281	490450	9073724	435006	7821095	370487
1.1500	0.4525	2232727	116751	17104936	481567	8947938	426437	7694463	362177
1.2000	0.4722	2275945	118186	16978155	473142	8827639	418321	7573369	354311
1.2500	0.4918	2317438	119532	16856528	465138	8712420	410621	7457403	346852
1.3000	0.5115	2357329	120798	16739686	457520	8601911	403304	7346197	339768
1.3500	0.5312	2395729	121988	16627294	450260	8495780	396340	7239418	333029
1.4000	0.5509	2432739	123111	16519049	443329	8393726	389702	7136764	326609
1.4500	0.5705	2468449	124171	16414675	436705	8295475	383365	7037959	320485
1.5000	0.5902	2502944	125174	16313922	430364	8200777	377308	6942754	314634
1.5500	0.6099	2536300	126123	16216560	424287	8109405	371511	6850920	309038
1.6000	0.6296	2568586	127024	16122379	418455	8021150	365956	6762249	303678
1.6500	0.6492	2599865	127878	16031189	412852	7935822	360626	6676549	298538
1.7000	0.6689	2630197	128690	15942812	407463	7853247	355506	6593644	293605
1.7500	0.6886	2659635	129463	15857087	402274	7773263	350583	6513374	288864
1.8000	0.7083	2688229	130199	15773865	397272	7695722	345843	6435589	284303
1.8500	0.7279	2716025	130901	15693007	392445	7620489	341276	6360152	279910
1.9000	0.7476	2743066	131570	15614387	387784	7547437	336871	6286936	275676
1.9500	0.7673	2769390	132209	15537886	383278	7476450	332618	6215825	271592
2.0000	0.7870	2795034	132820	15463396	378919	7407419	328508	6146709	267647
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YLDXAN02
Date and time : 21SEP99:11:59
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.1168
F-max factor : Not found
F-0.1 reference F : 0.4394
F-max reference F : Not found
Recruitment : 6676000 (Thousands)

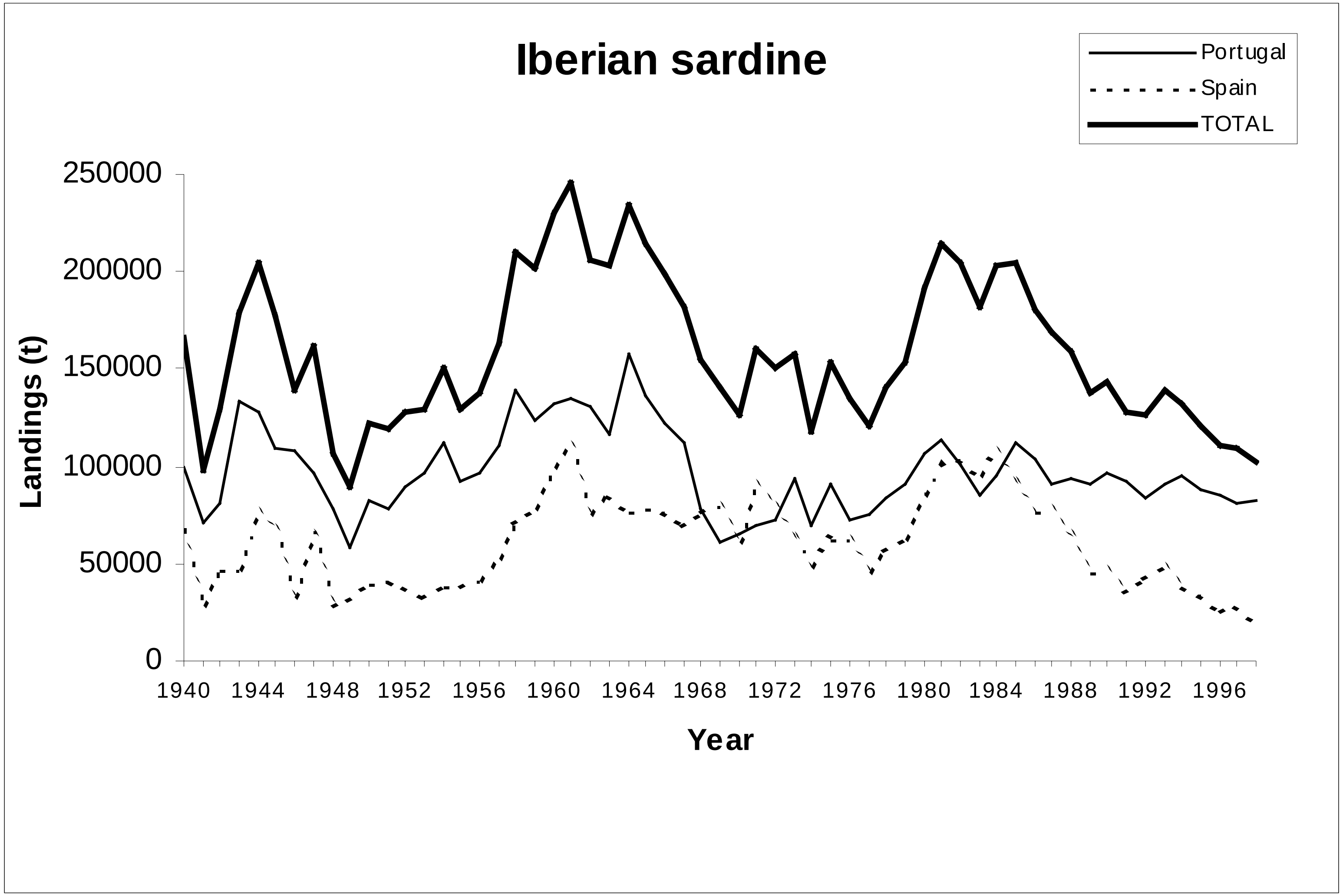


Figure 8.2.1.1 Iberian sardine landings by country and overall for the period 1940-1998

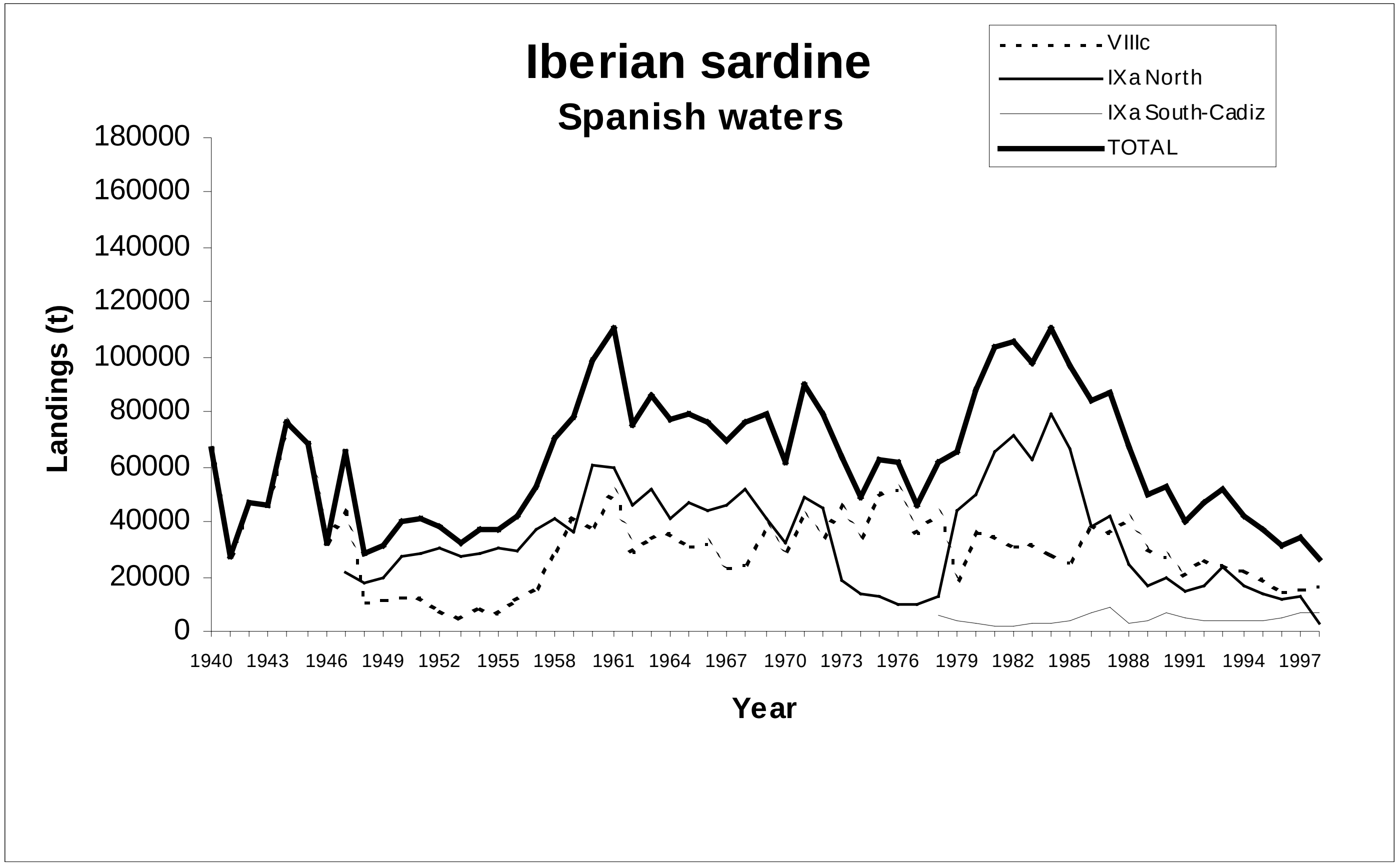


Figure 8.2.1.2 Spanish landings (tonnes) by Sub-Division from 1940 to 1998

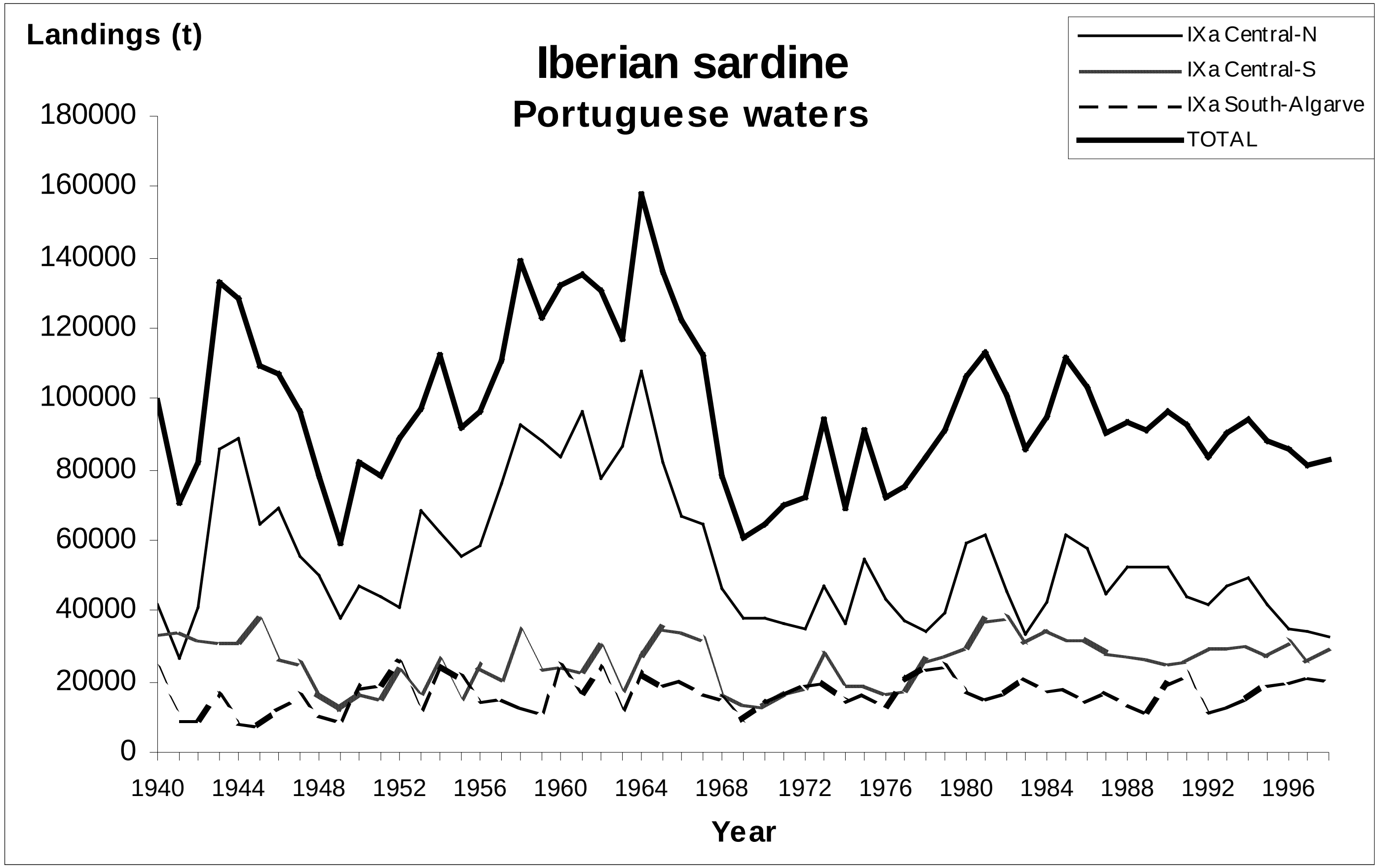
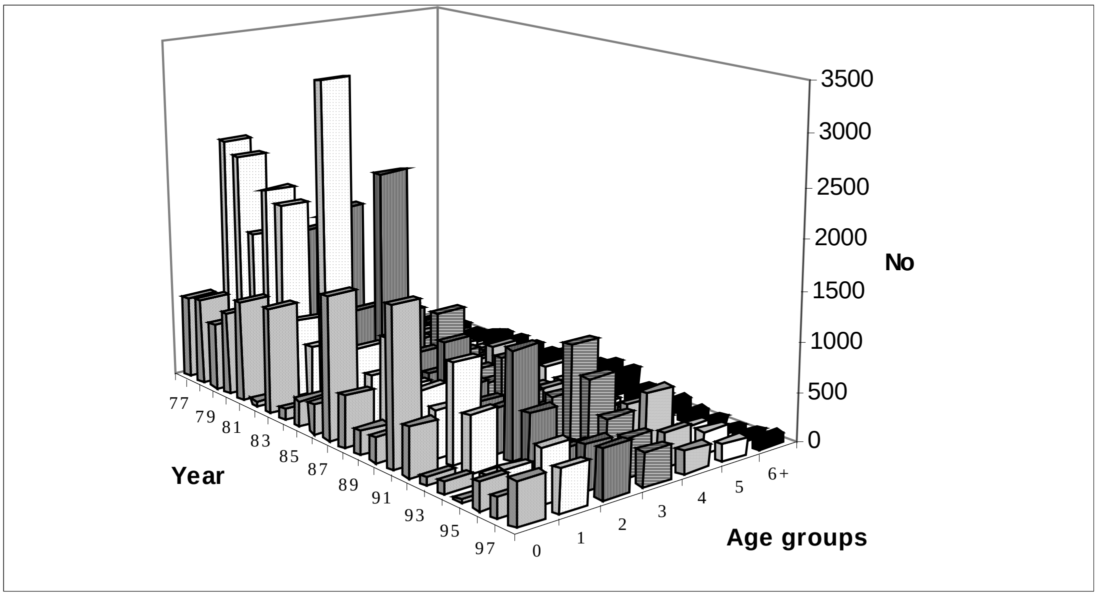


Figure 8.2.1.3 Portuguese landings (tonnes) by Sub-Division from 1940 to 1998



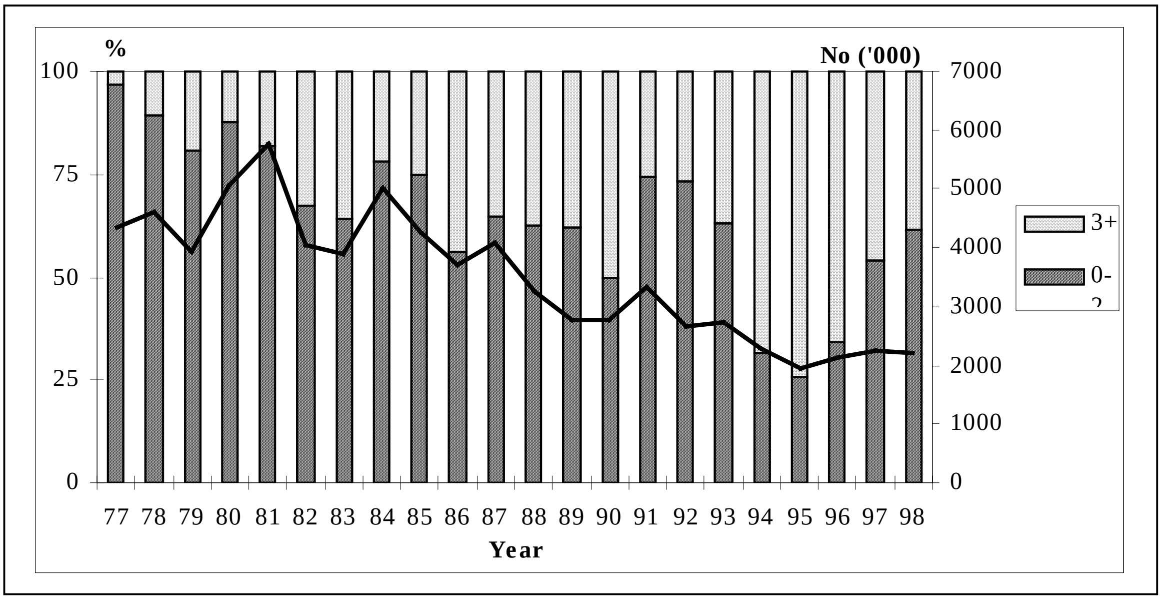


Figure 8.3.1.1 Catch at age matrix for sardine; upper panel split by age groups and year. Lower panel grouped in youngers (0-2) and olders (3+) expressed as a percentage in Y1 whereas Y2 shows the total numbers.

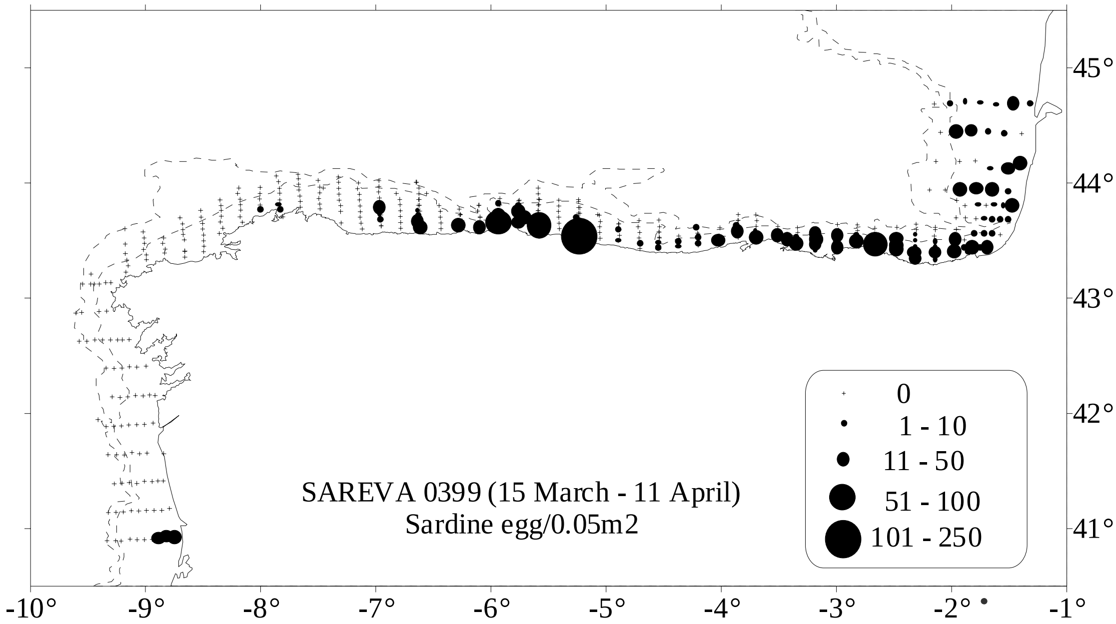


Figure 8.4.1.1: Distribution of sardine egg density (eggs/0.05 m^2) for the March 1999 Spanish DEPM survey.

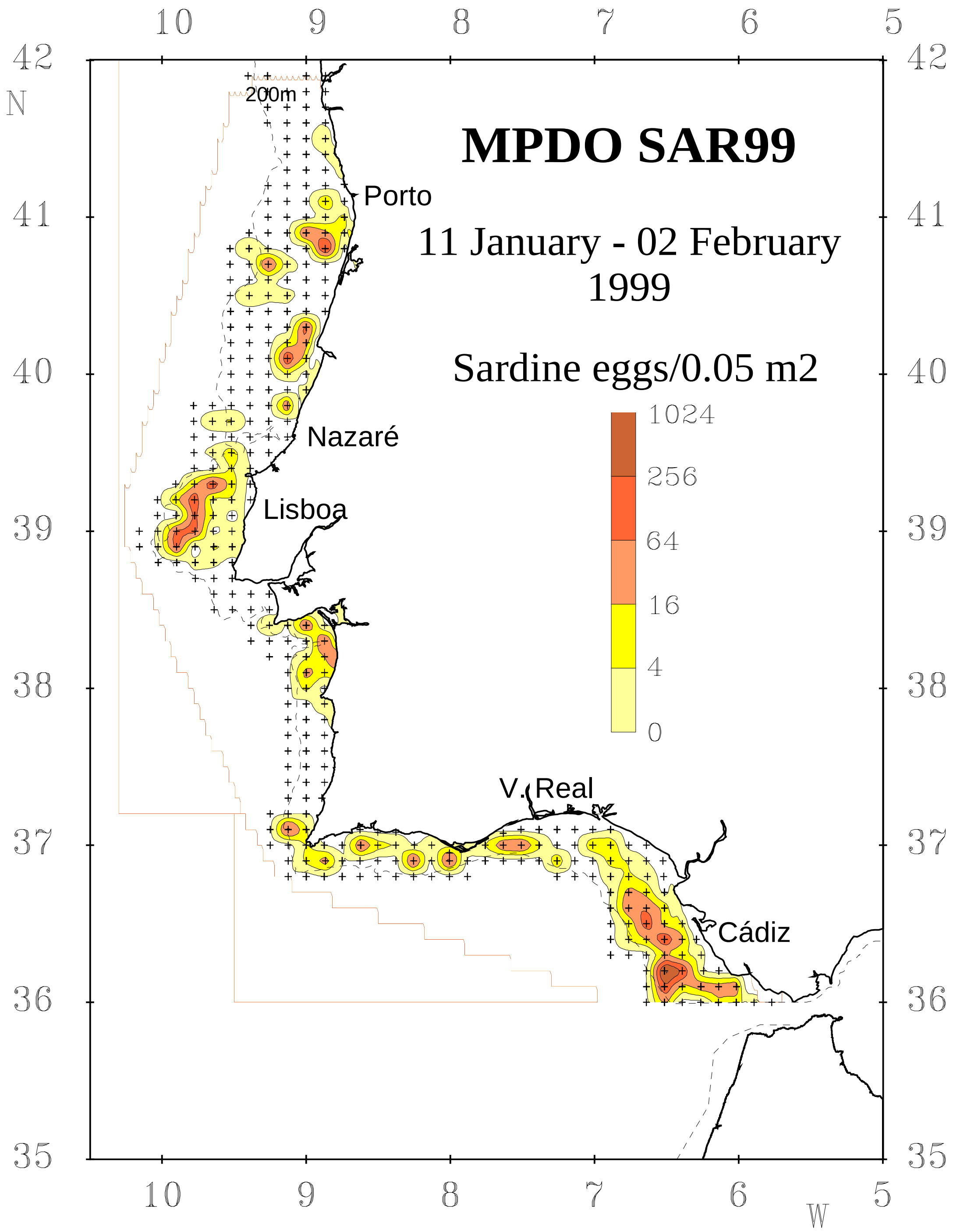


Figure 8.4.1.2 Distribution of sardine egg density (eggs/0.05 m^2) for the January 1999 Portuguese DEPM survey.

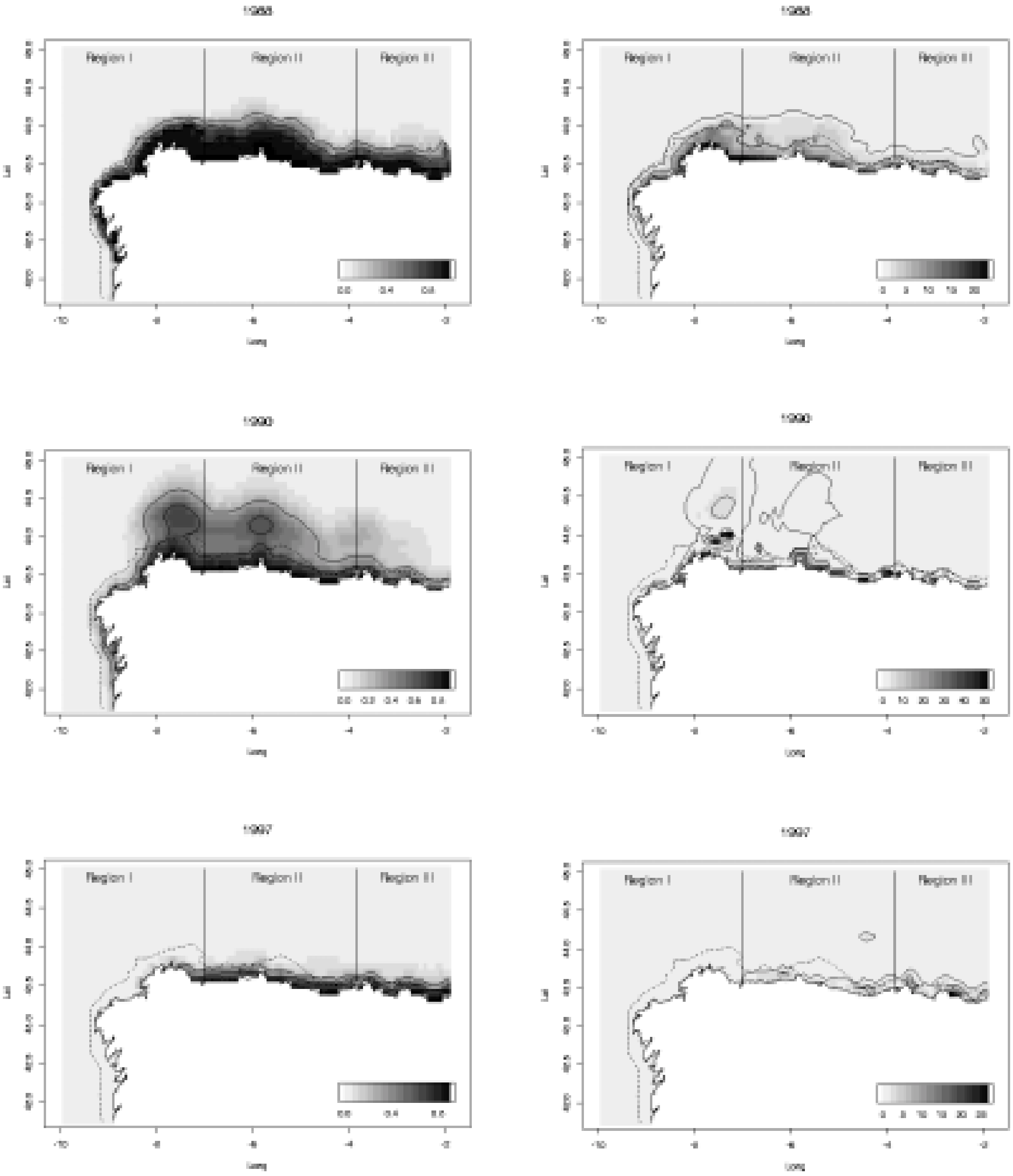


Figure 8.4.1.3: Predicted distribution of egg presence probabilities (Left panels) and egg production (eggs 0.05 m^{-2} day^{-1}) (Right panels) off the Spanish coast. The dotted line represent the 200m depth contour line.

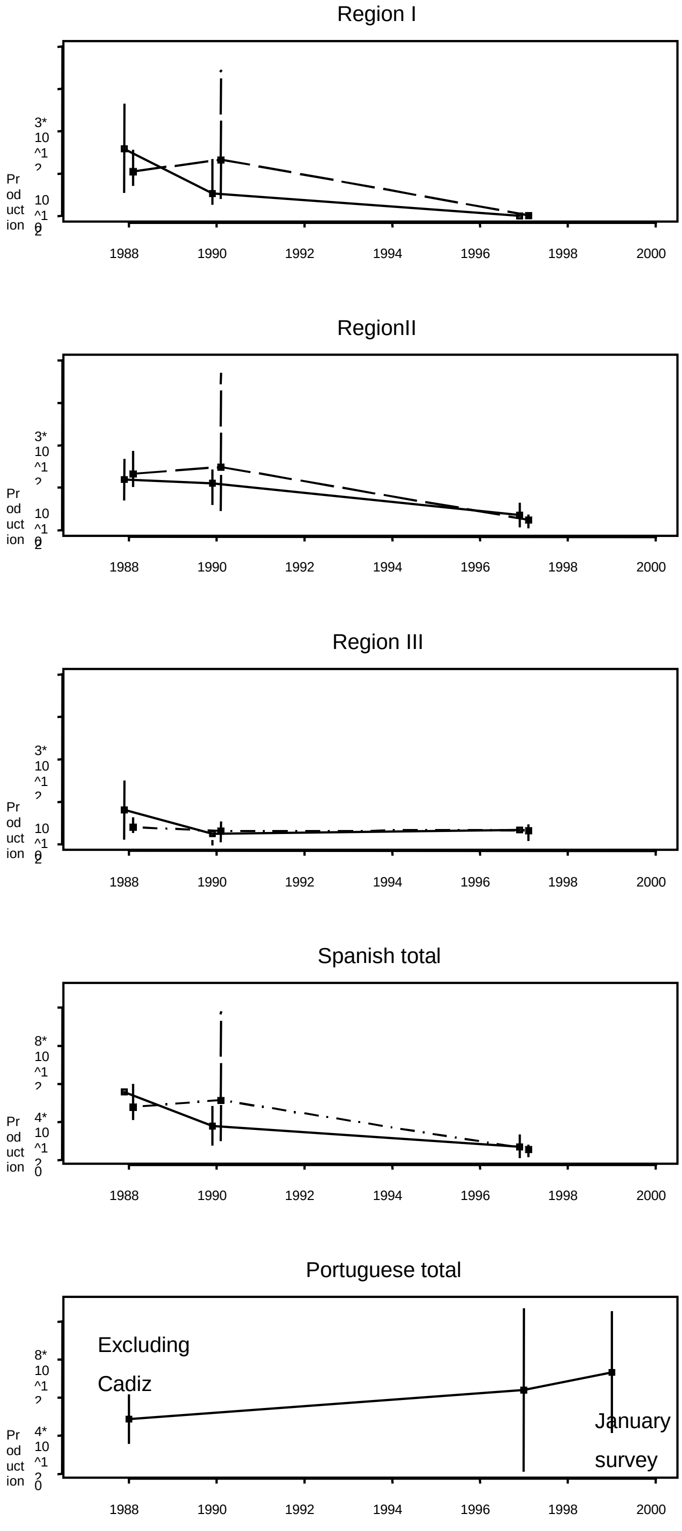


Figure 8.4.1.4: Traditional (solid line) and GAM based (dotted line) egg production estimates by Region and overall for the Spanish DEPM surveys. Traditional estimates of egg production off Portugal are also included. Note that Portuguese survey in 1988 excluded Cadiz and in 1999 it was made two months earlier than usual.

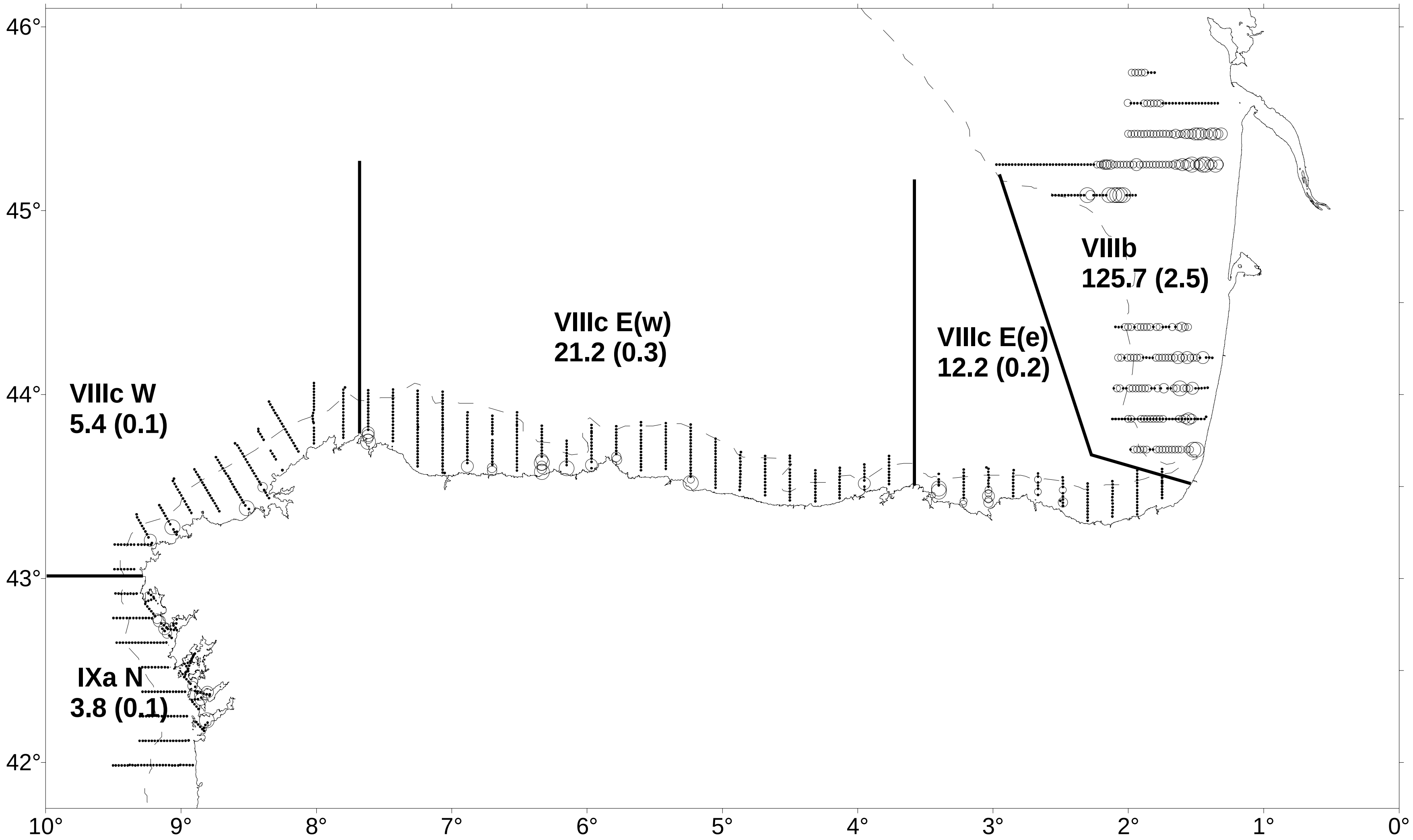


Figure 8.4.2.1: Spanish 1999 March acoustic survey. Relative sardine distribution (allocated echo-integrated energy by nmi) Circles are proportional to the square root. Biomass expressed in thousand tonnes and number of fish (in brackets) in billion (10^9).

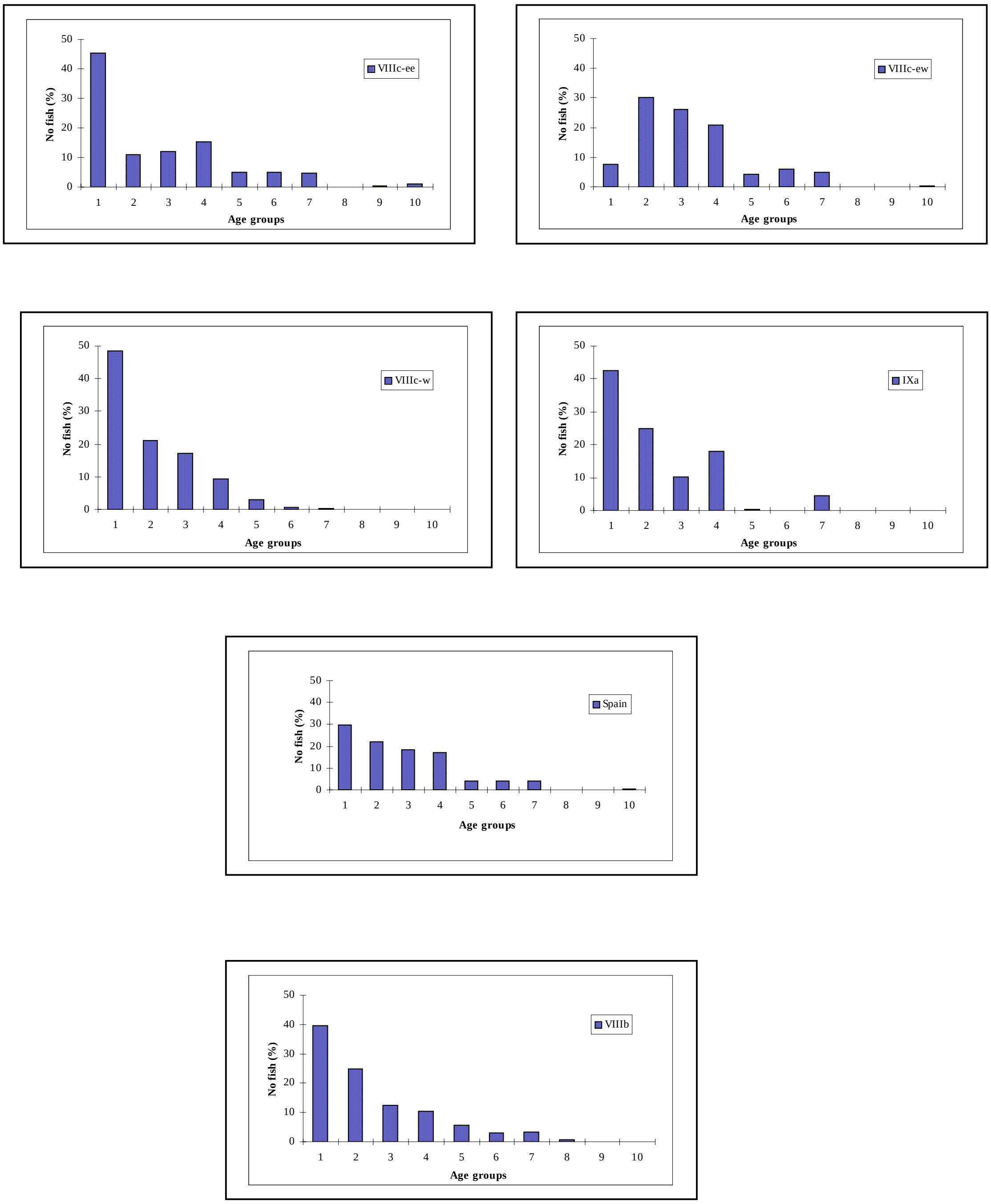


Figure 8.4.2.2: Relative estimated abundance in number by age group and ICES Sub-Division during Spanish Spring 1999 acoustic survey. Sub-Division VIIIc-East was split in two sub-areas: western part from 7º20' to 3º20' and the eastern part corresponding to the inner part of the Bay of Biscay (3º20' to the Spanish/French border).

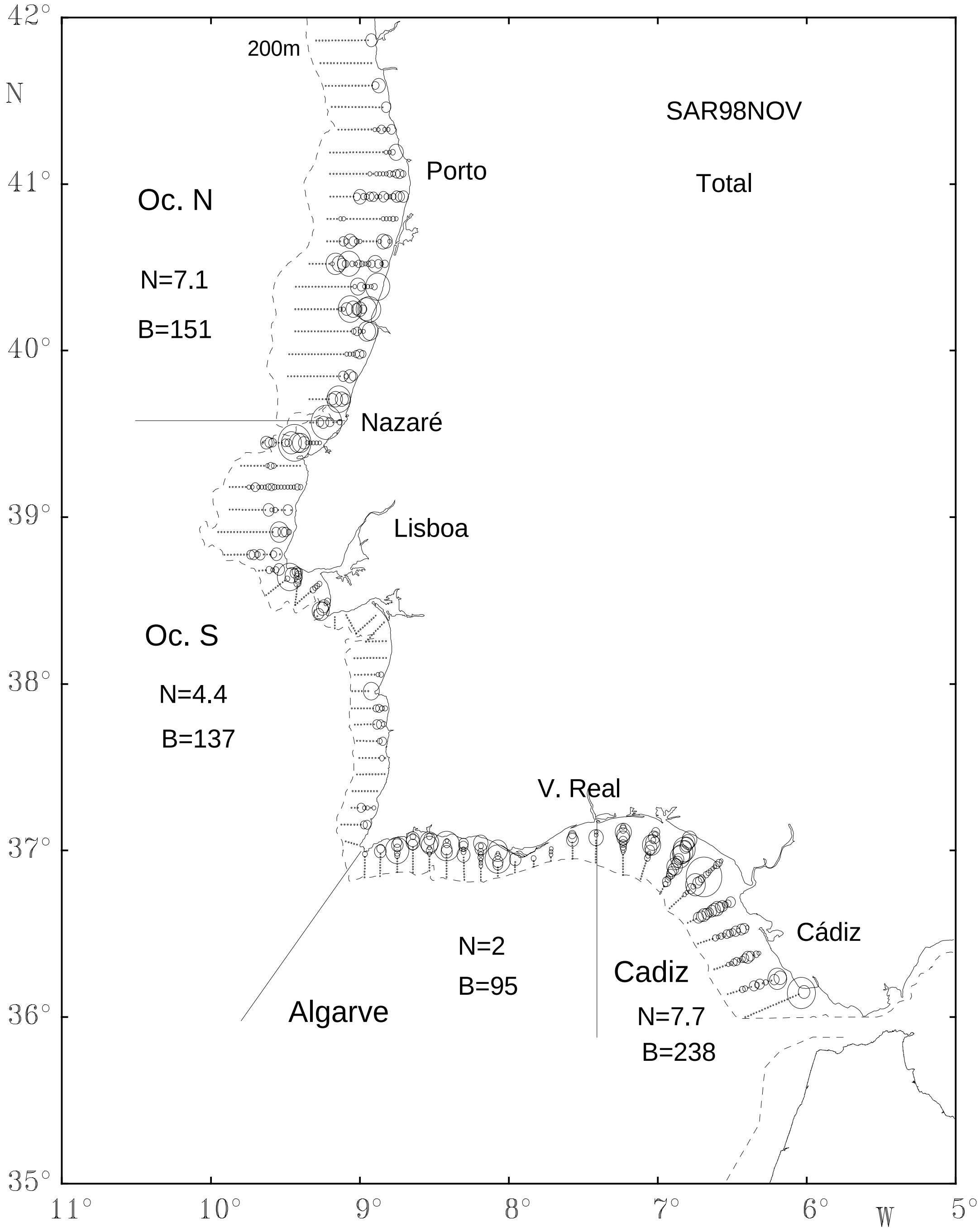


Figure 8.4.2.3 – November 1998 survey: acoustic energy distribution per nautical mile. The circle diameter is proportional to the square root of the acoustic energy value. Number of fish (N) in billion (10^9) and biomass (B) in thousand tonnes.

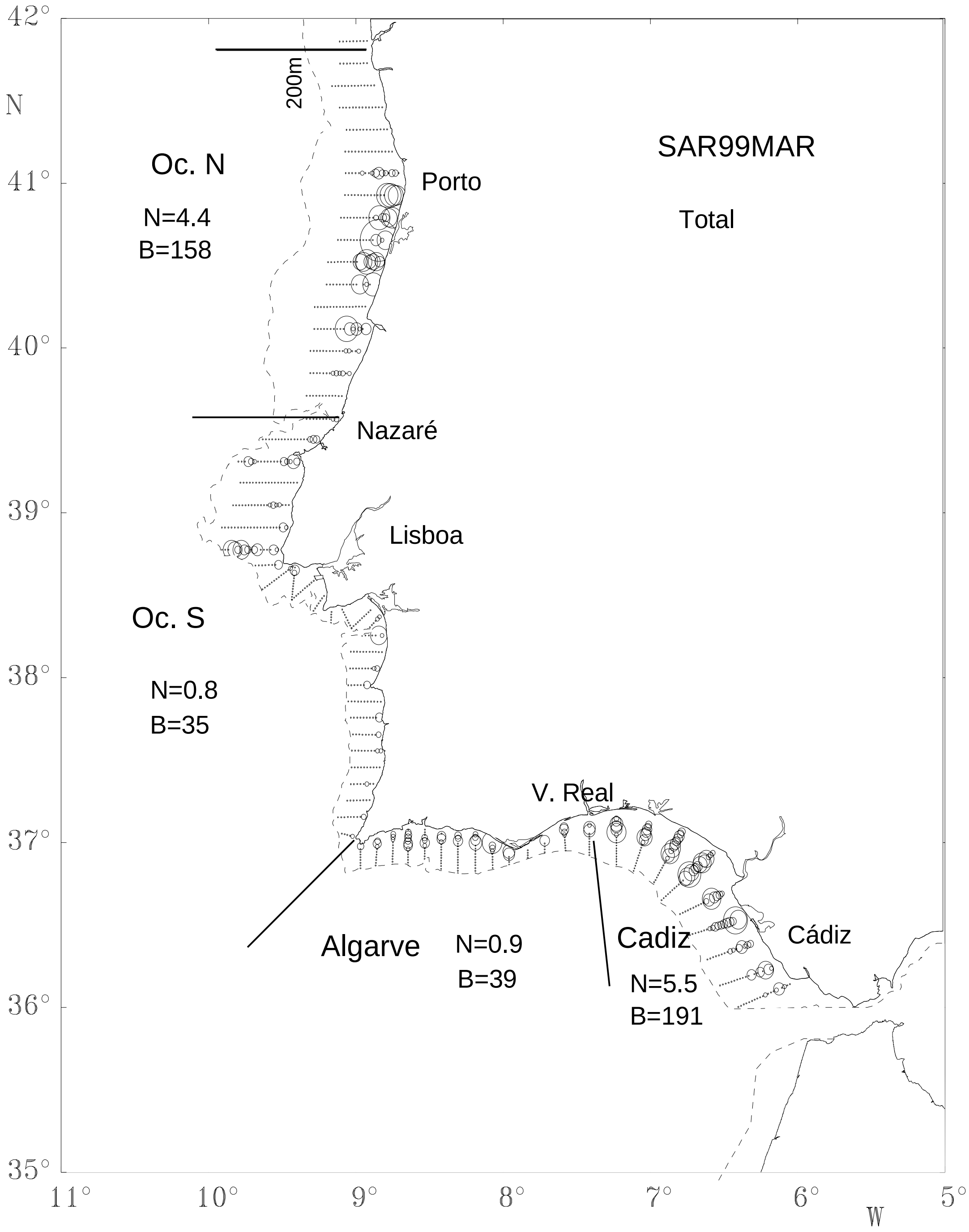


Figure 8.4.2.4 – March 1999 survey: acoustic energy distribution per nautical mile. The circle diameter is proportional to the square root of the acoustic energy value. Number of fish (N) in billion (10^9) and biomass (B) in thousand tonnes.

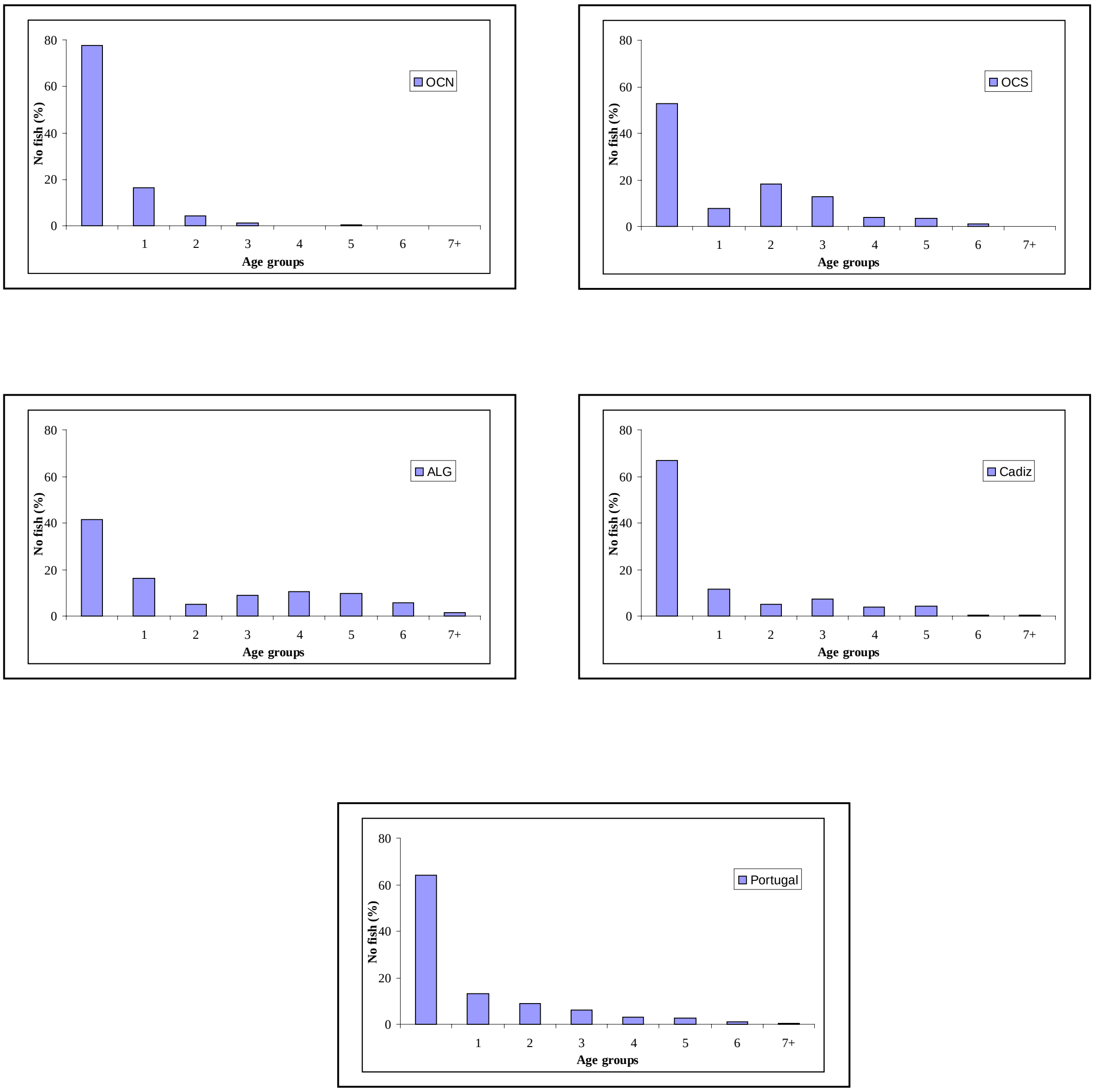


Figure 8.4.2.5: Relative abundance of sardine in number by Age Group and area during November Portuguese 1998 acoustic survey. Areas Ocidental Norte (OCN) and Ocidental Sur (OCS) roughly correspond to Sub-Division IXa Central North and Central South, whereas Algarve (ALG) and Cadiz correspond to IXa South-Algarve and IXa Sout-Cadiz respectively.

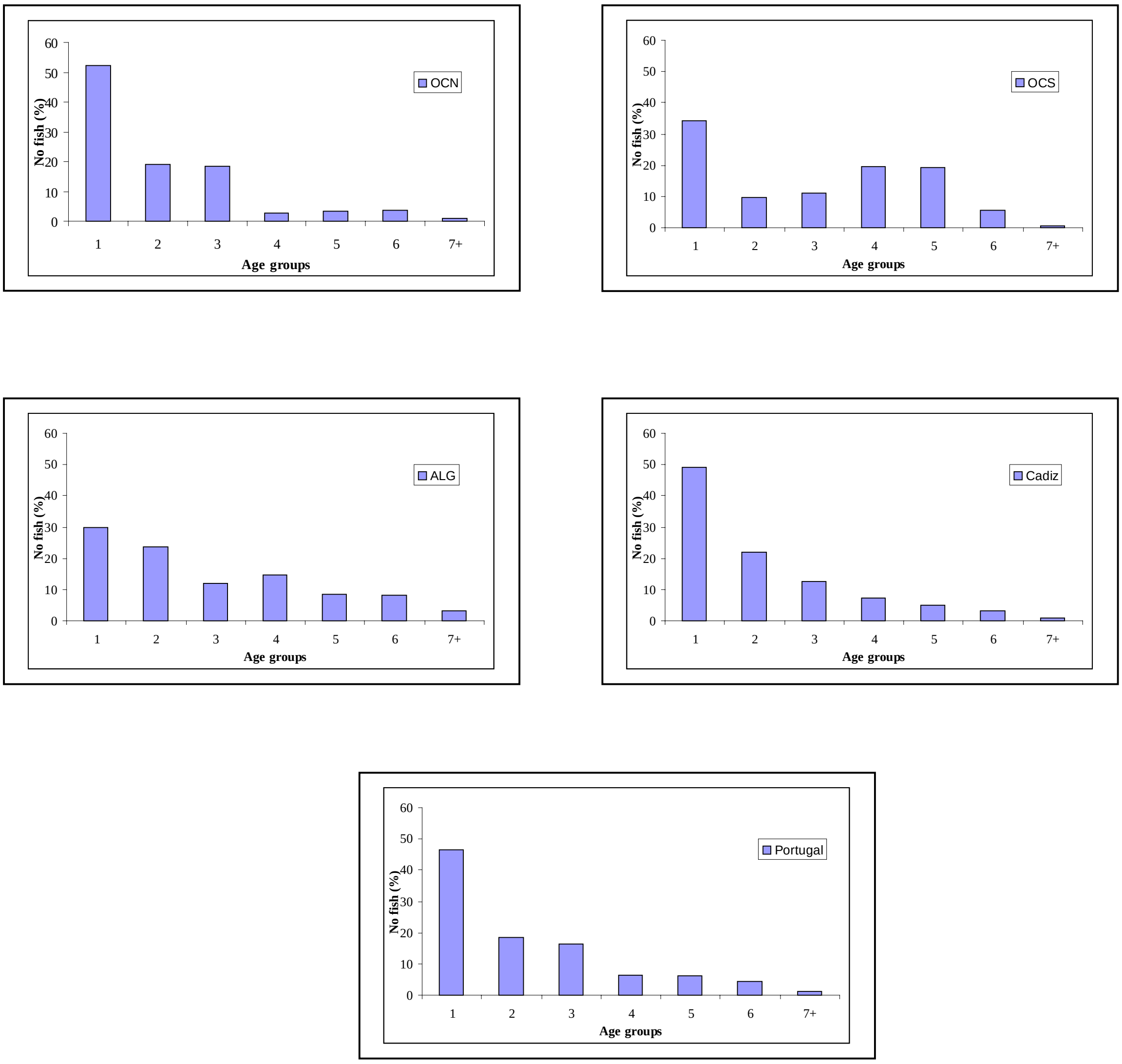


Figure 8.4.2.6: Relative abundance of sardine in number by Age Group and area during Spring Portuguese 1999 acoustic survey. Areas Ocidental Norte (OCN) and Ocidental Sur (OCS) roughly correspond to Sub-Division IXa Central North and Central South, whereas Algarve (ALG) and Cadiz correspond to IXa South-Algarve and IXa Sout-Cadiz respectively.

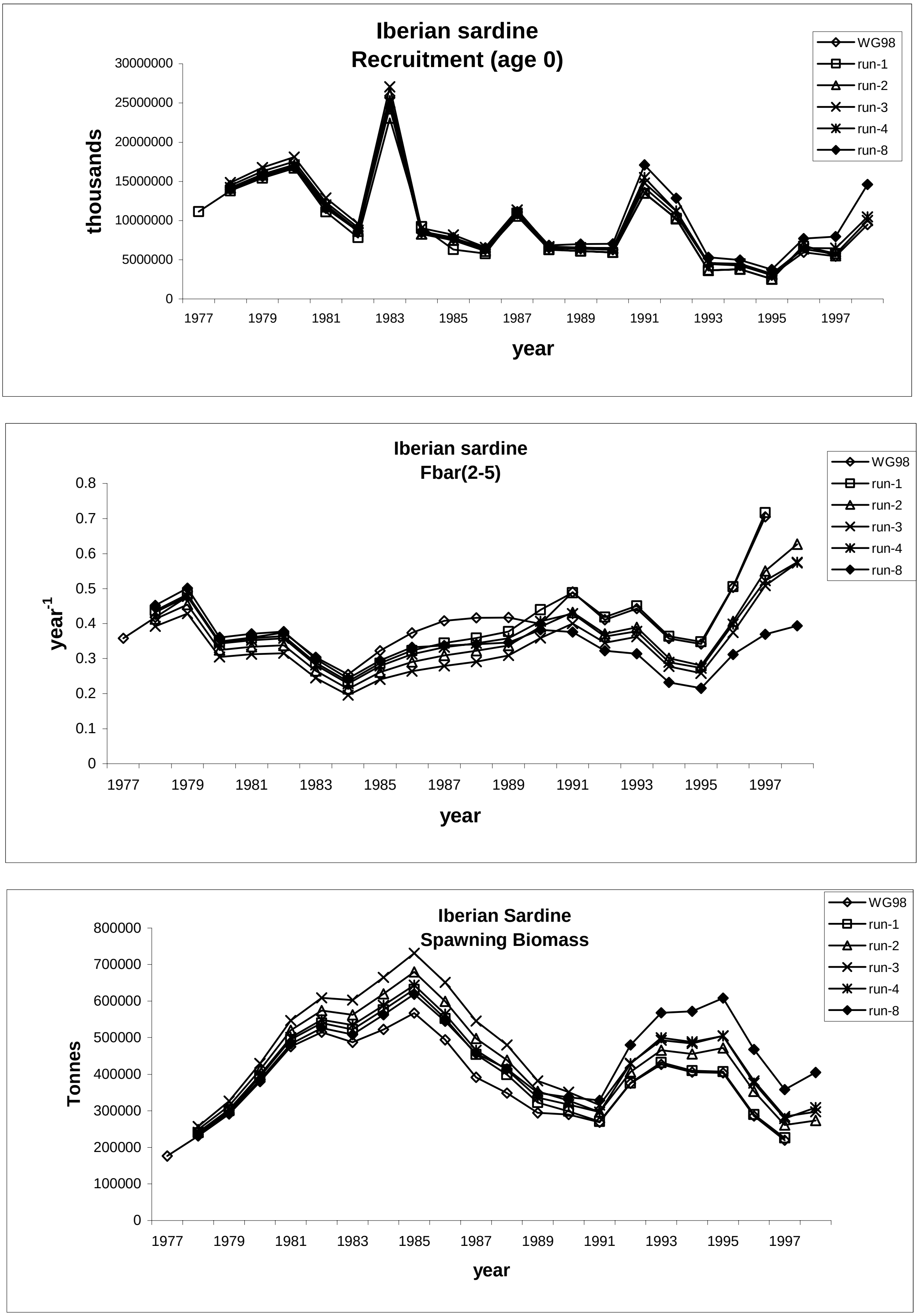
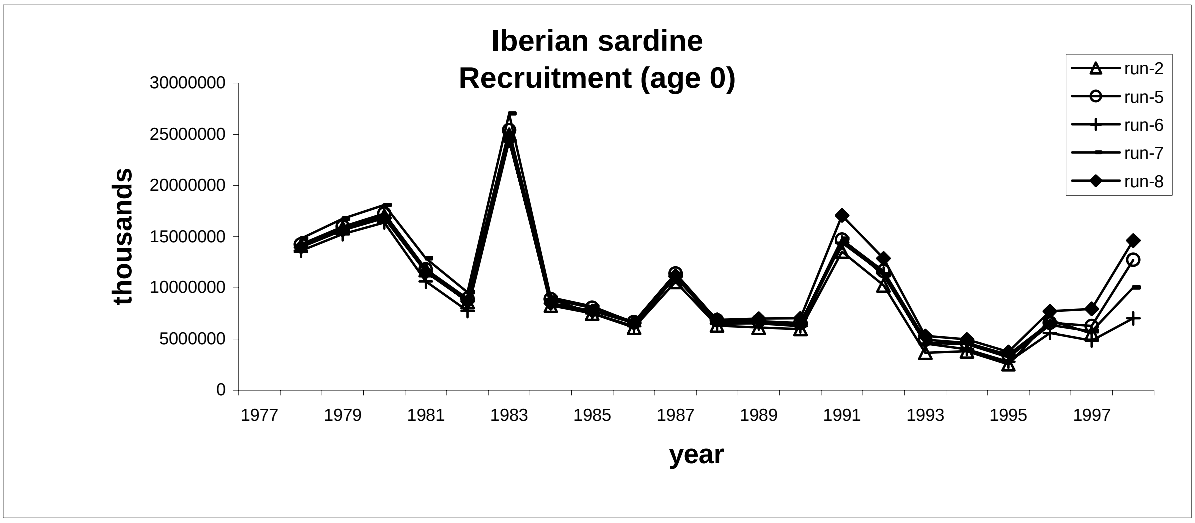
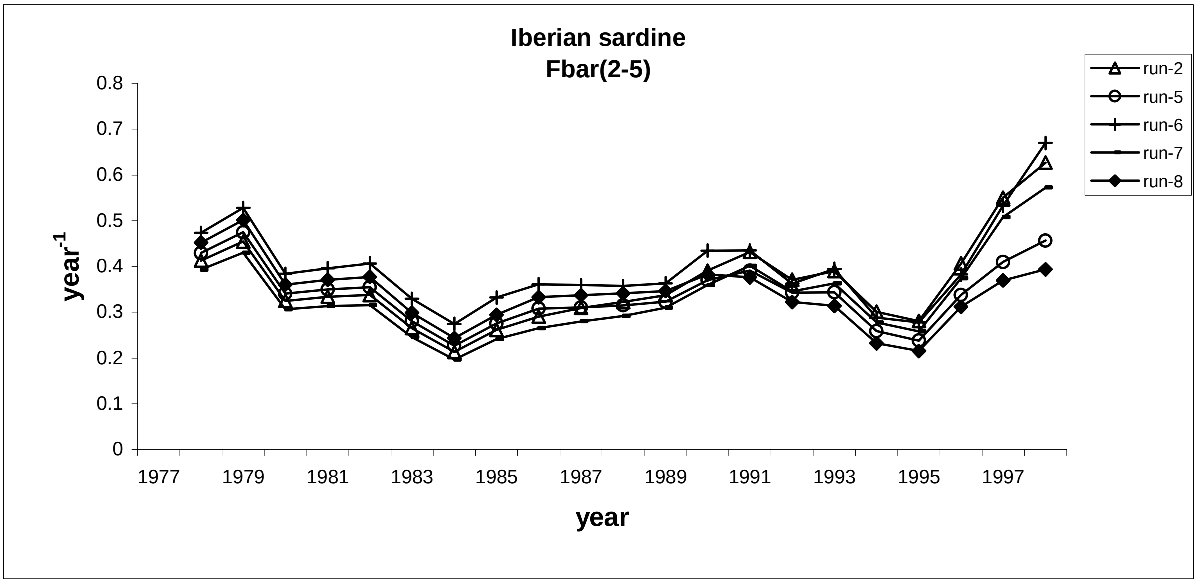


Figure 8.7.1.1 - Estimated Iberian sardine recruitment, Fbar(2-5) and spawning biomass for different runs.
WG98: assessment made in 1998.
run-1: revised data for 1978-1997.
run-2: updated data for 1998.
run-3: DEPM out.
run-4: cpue from Vigo/Ribeira and Sada out.
run-8: SP March, PT March, PT November surveys, DEPM absolute.





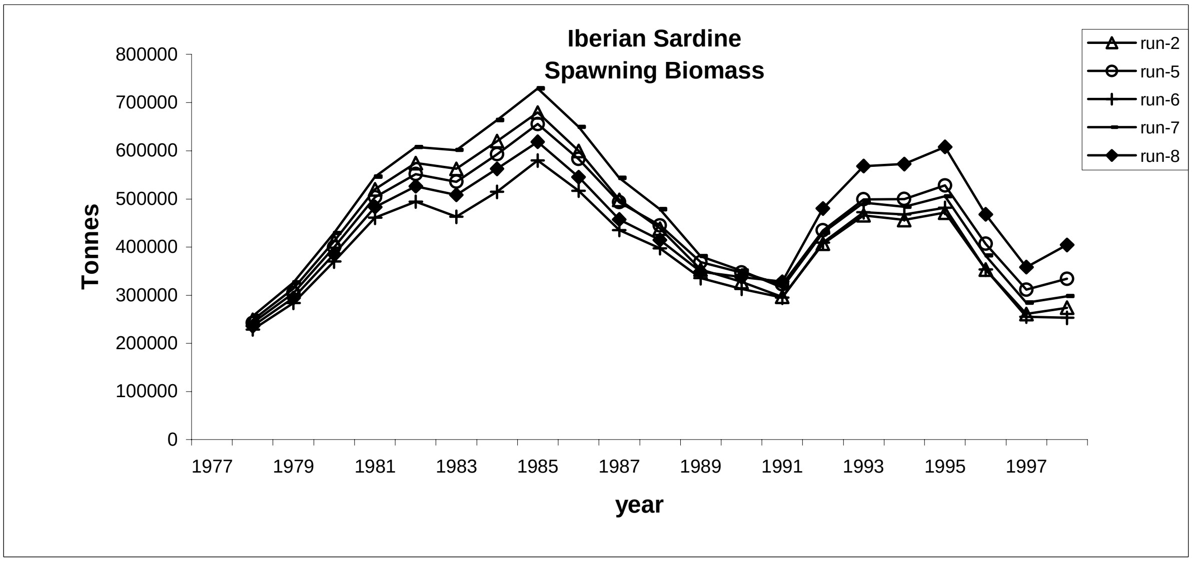


Figure 8.7.1.2 - Estimated Iberian sardine recruitment, Fbar(2-5) and spawning biomass for different runs.
run-2: updated data for 1998.
run-5: PT November acoustic survey in.
run-6: data from SP March acoustic survey only for Div. IXa.
run-7: DEPM as relative SSB abundance index.
run-8: SP March, PT March, PT November surveys, DEPM absolute.

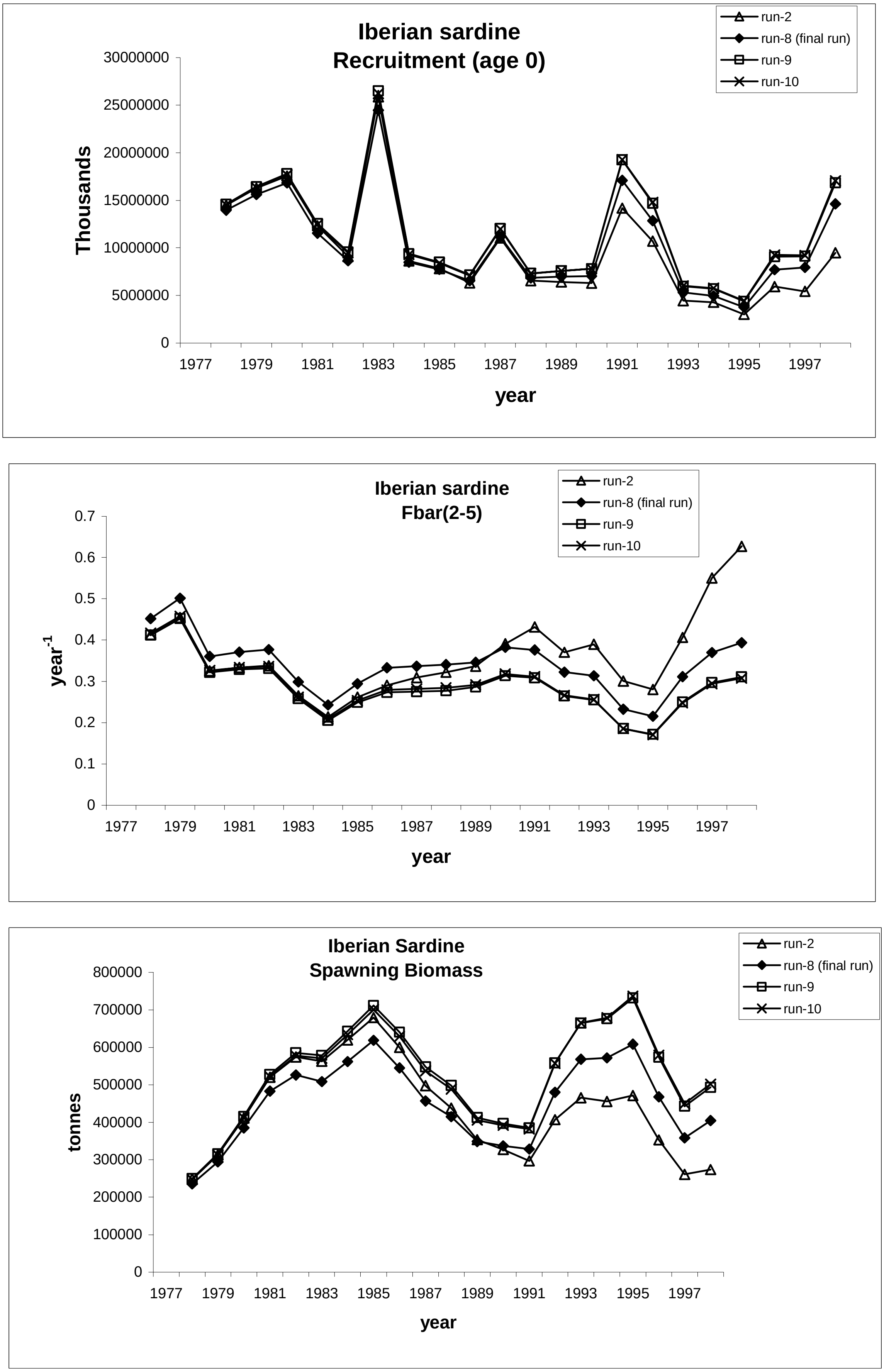


Figure 8.7.1.3 - Estimated Iberian sardine recruitment, Fbar(2-5) and spawning biomass for different runs.
run-2: updated data for 1998.
run-8: SP March, PT March, PT November surveys, DEPM absolute.
run-9: SP March, PT March, PT November surveys, DEPM relative.
run-10: SP March, PT March, PT November surveys, DEPM out.

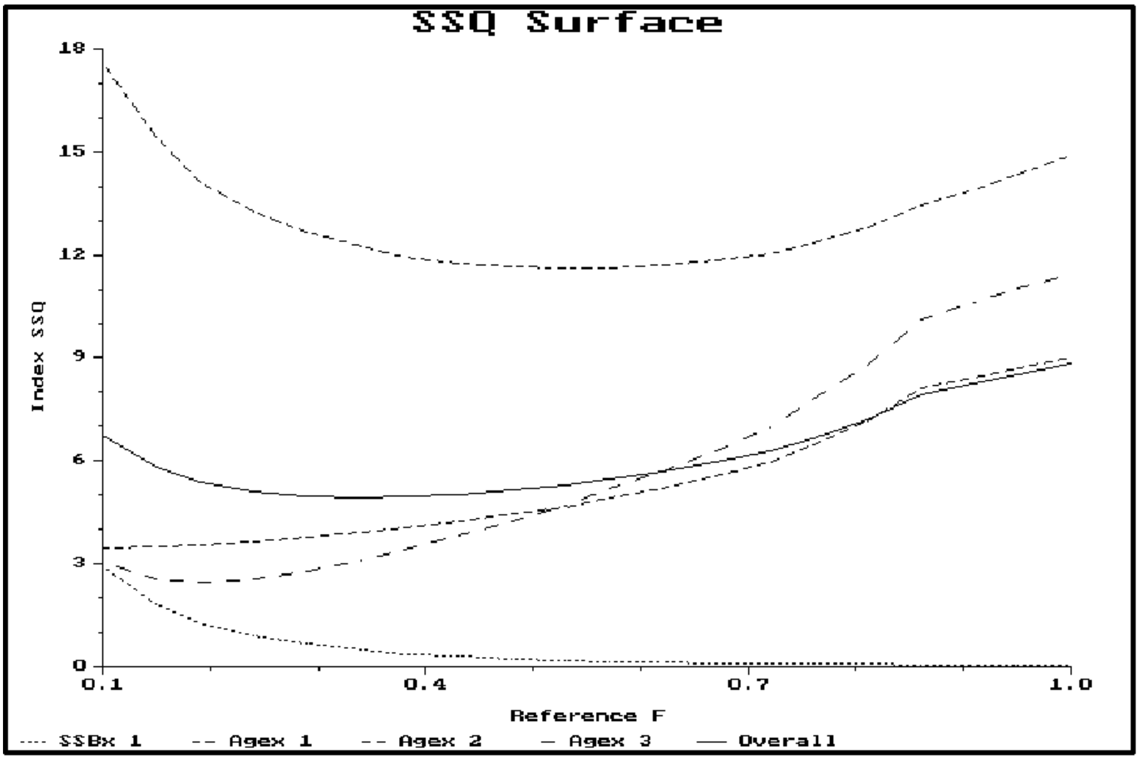
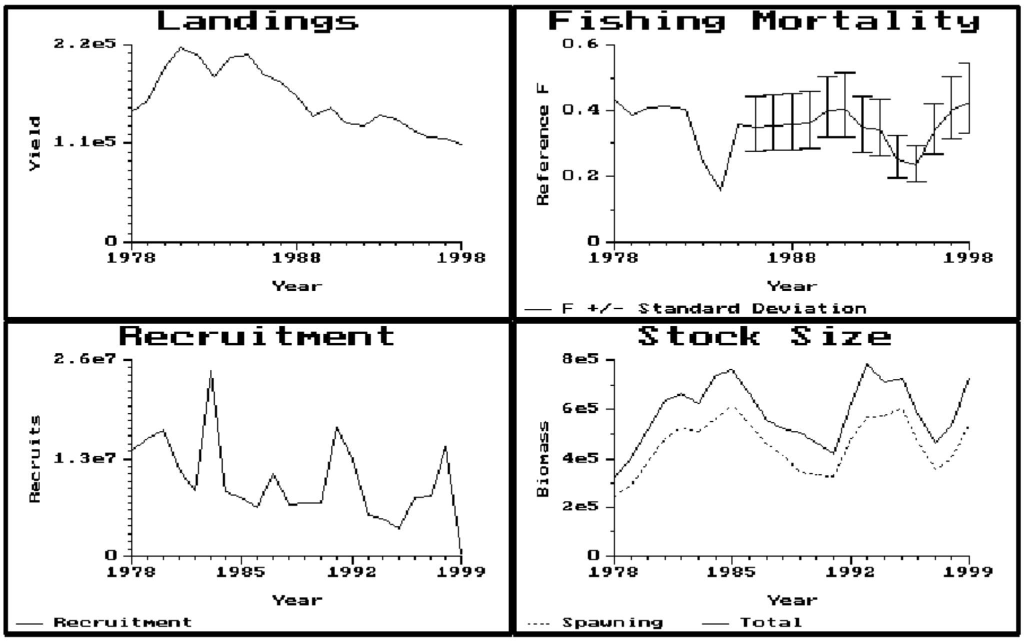


Figure 8.7.2.1 Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.

Stock Summary



Separa

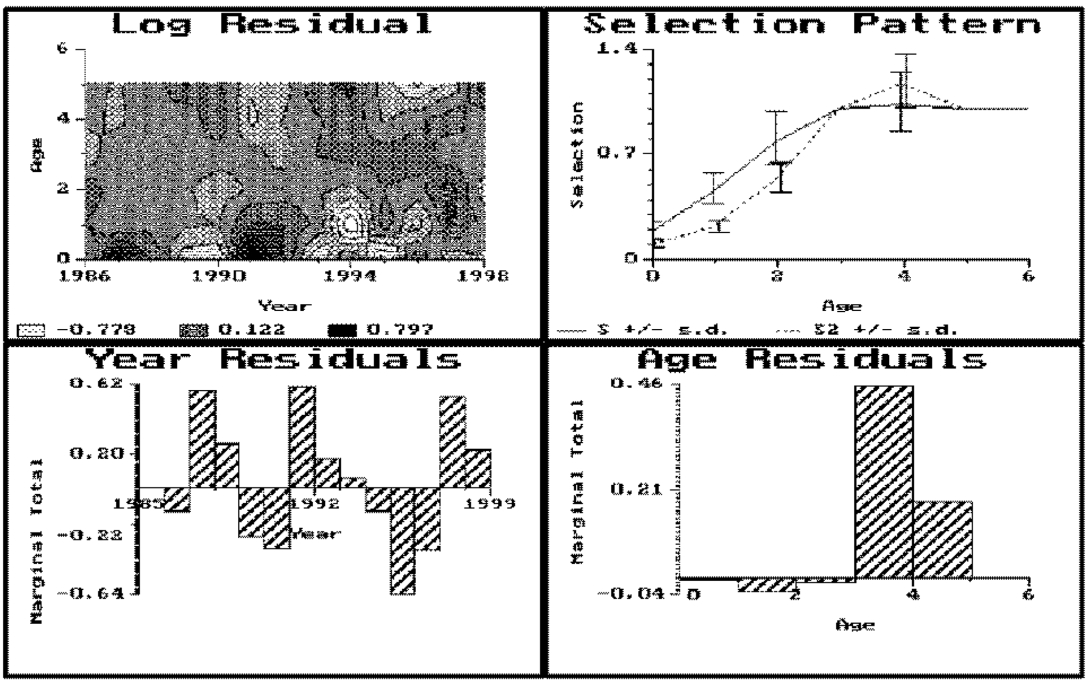
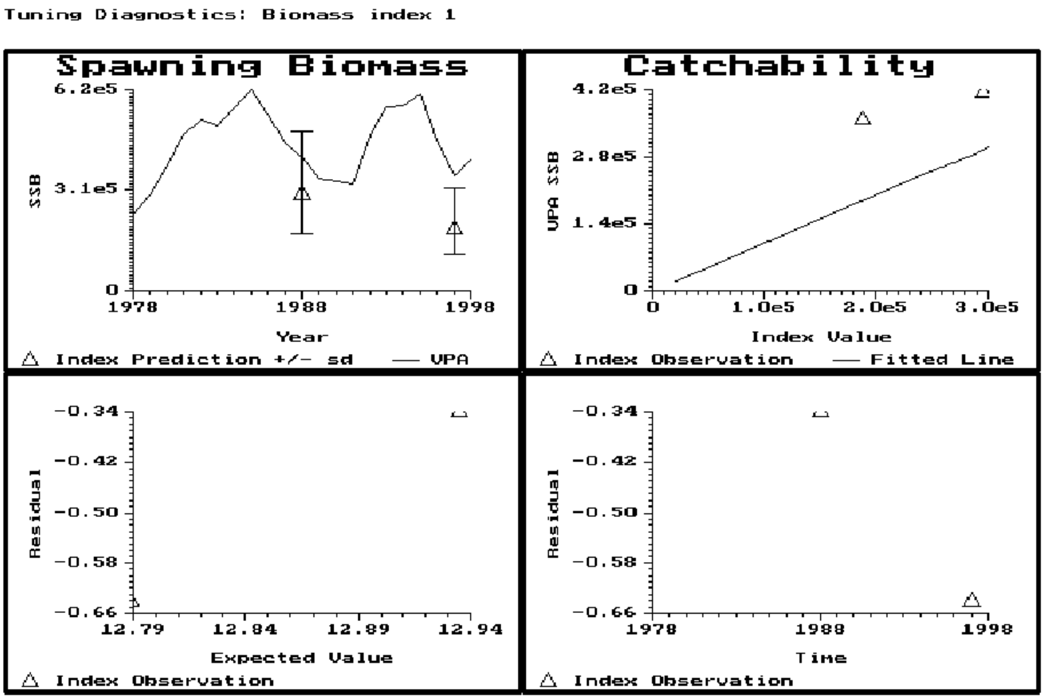


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.



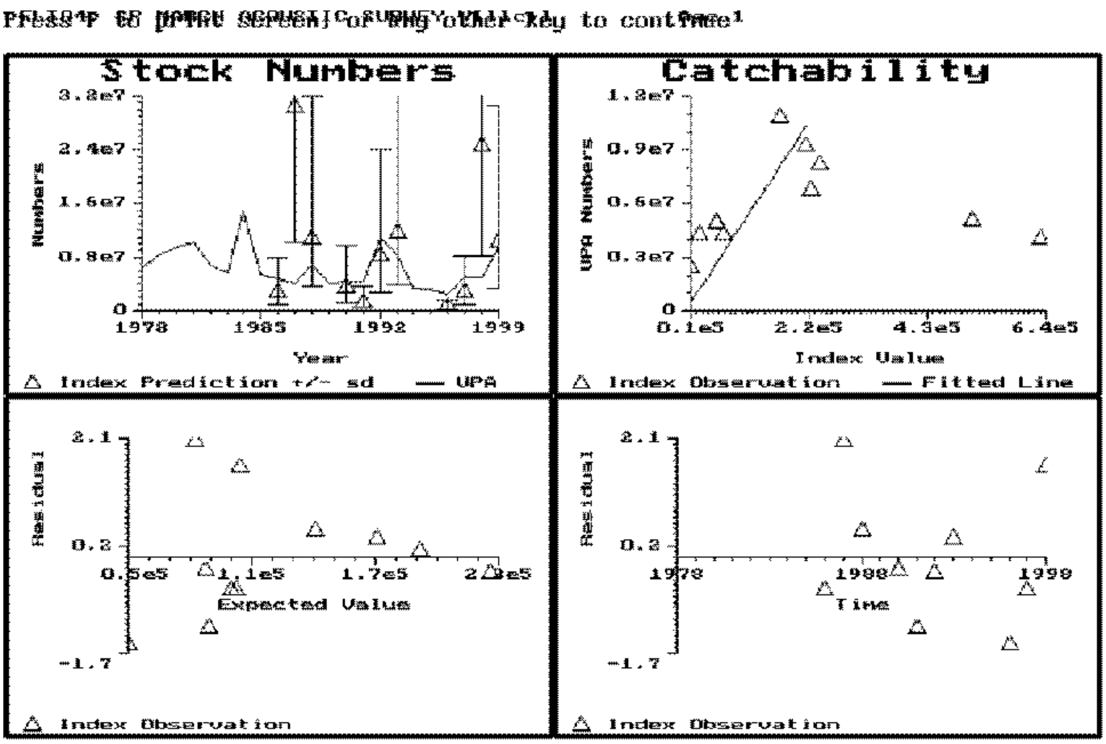


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.

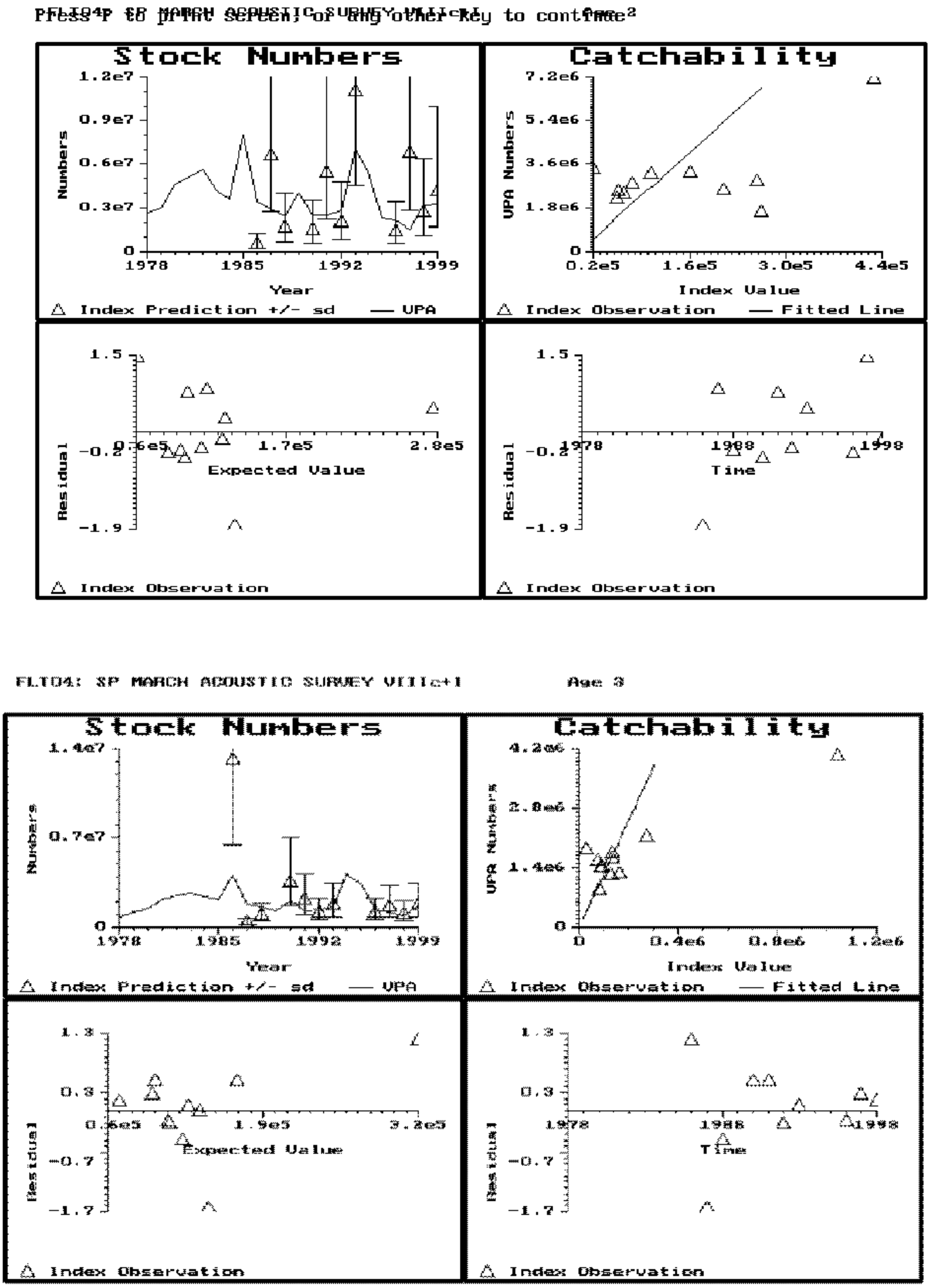
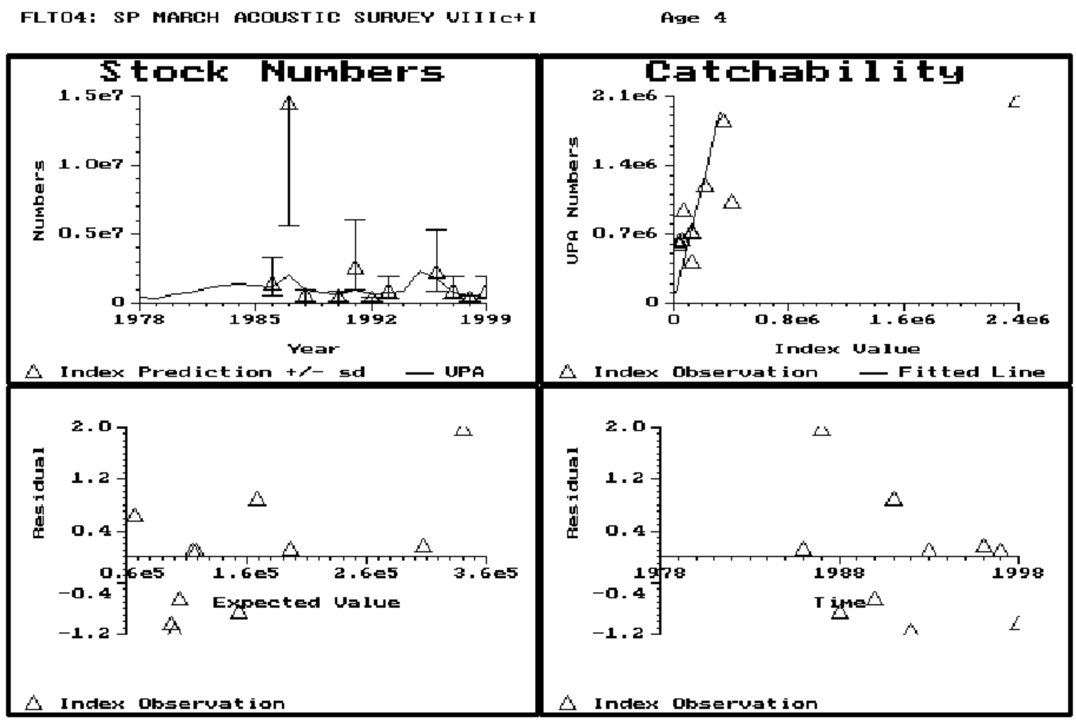


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.



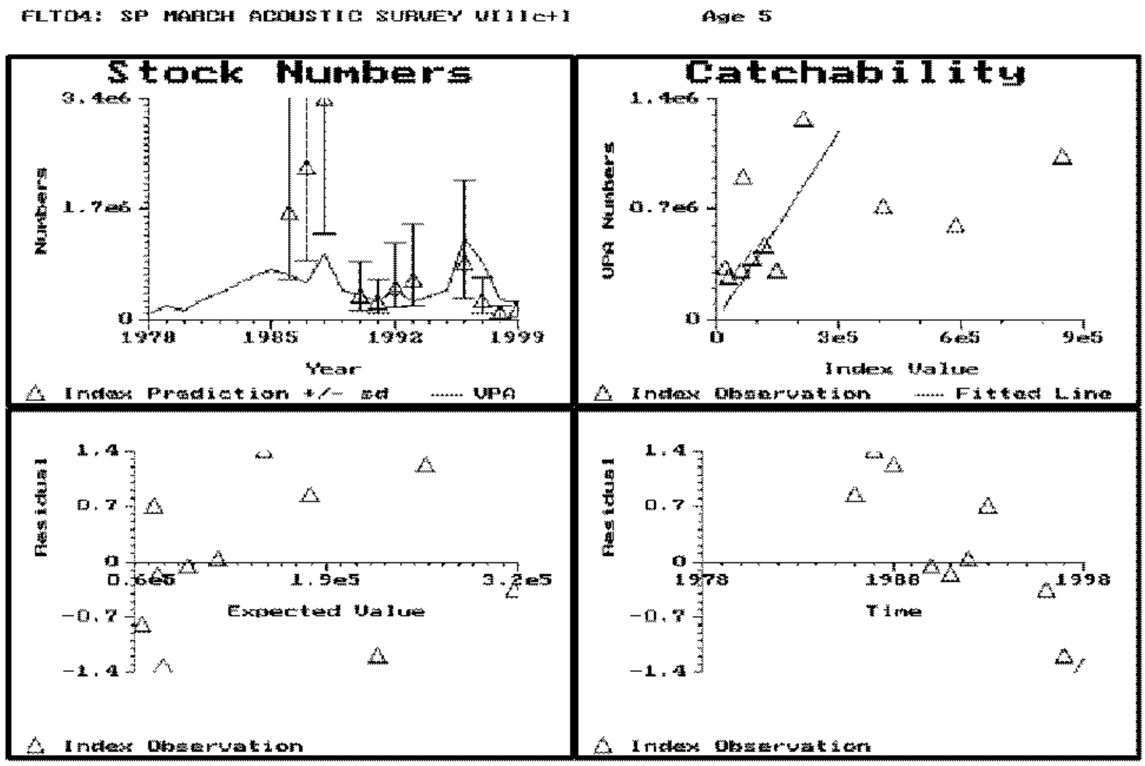
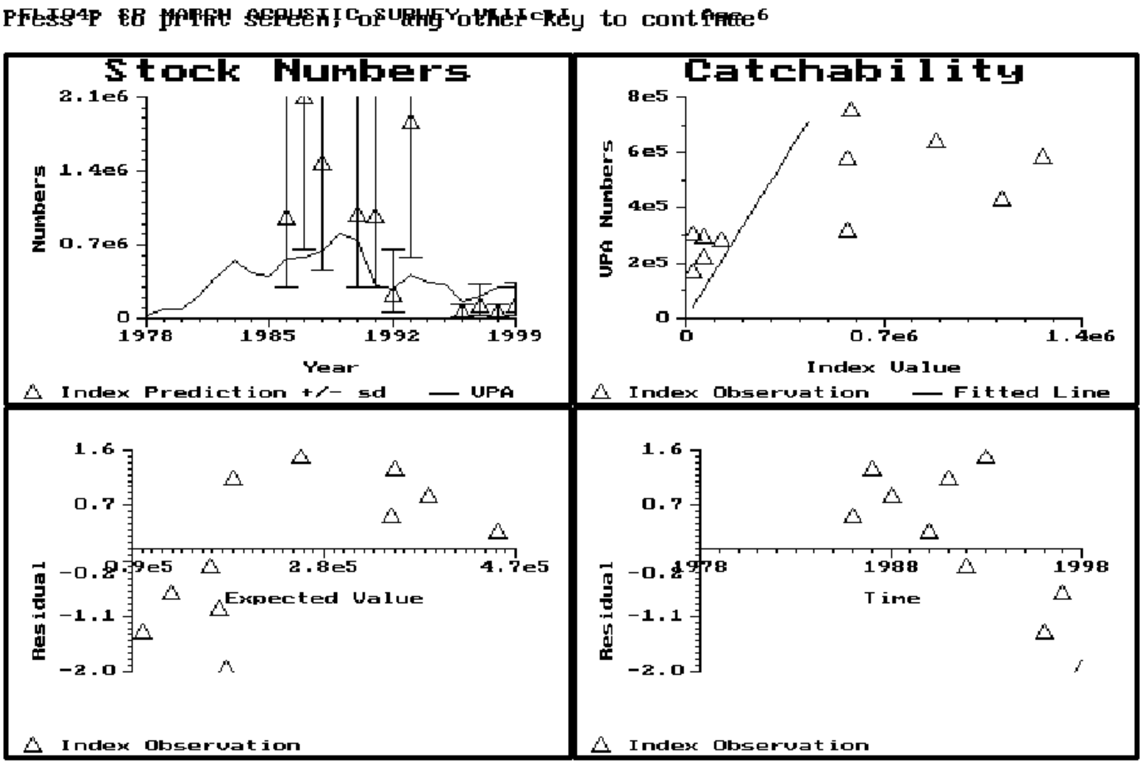


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.



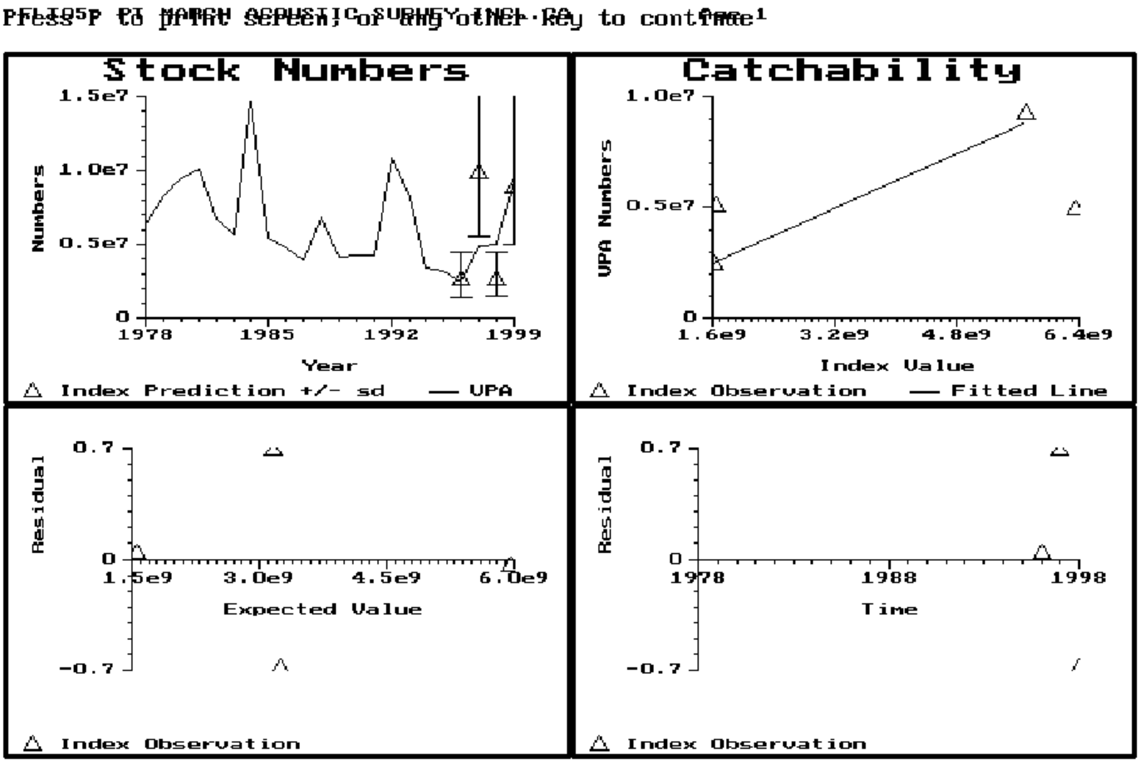
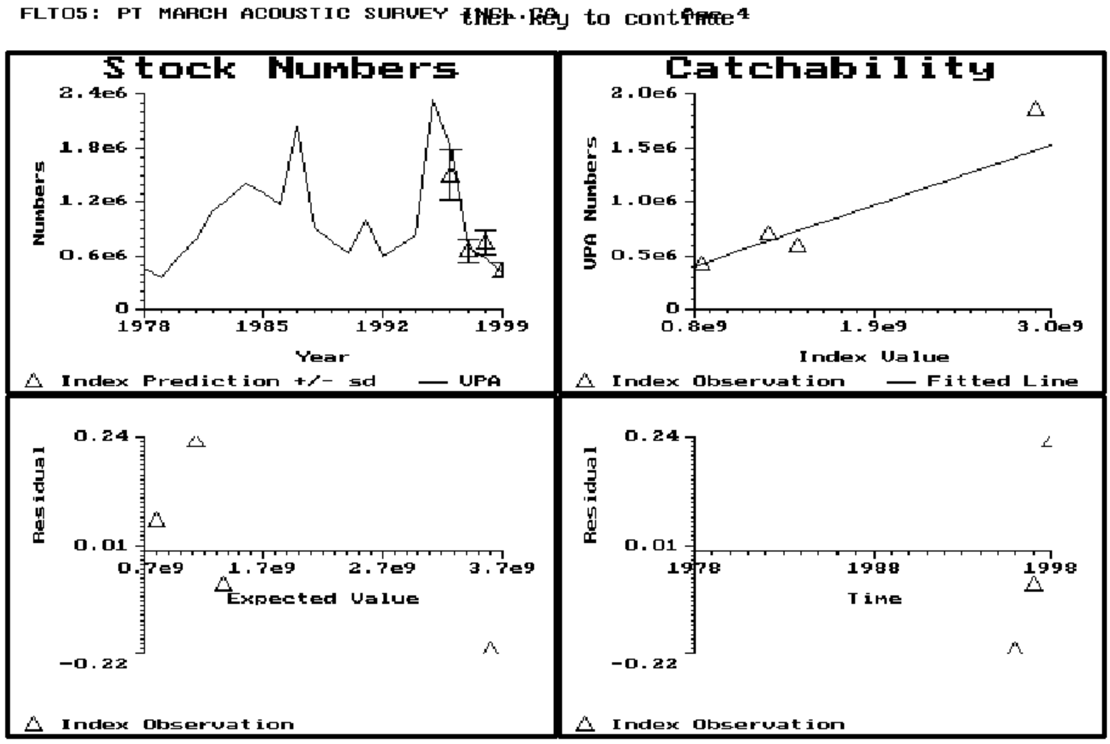


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.



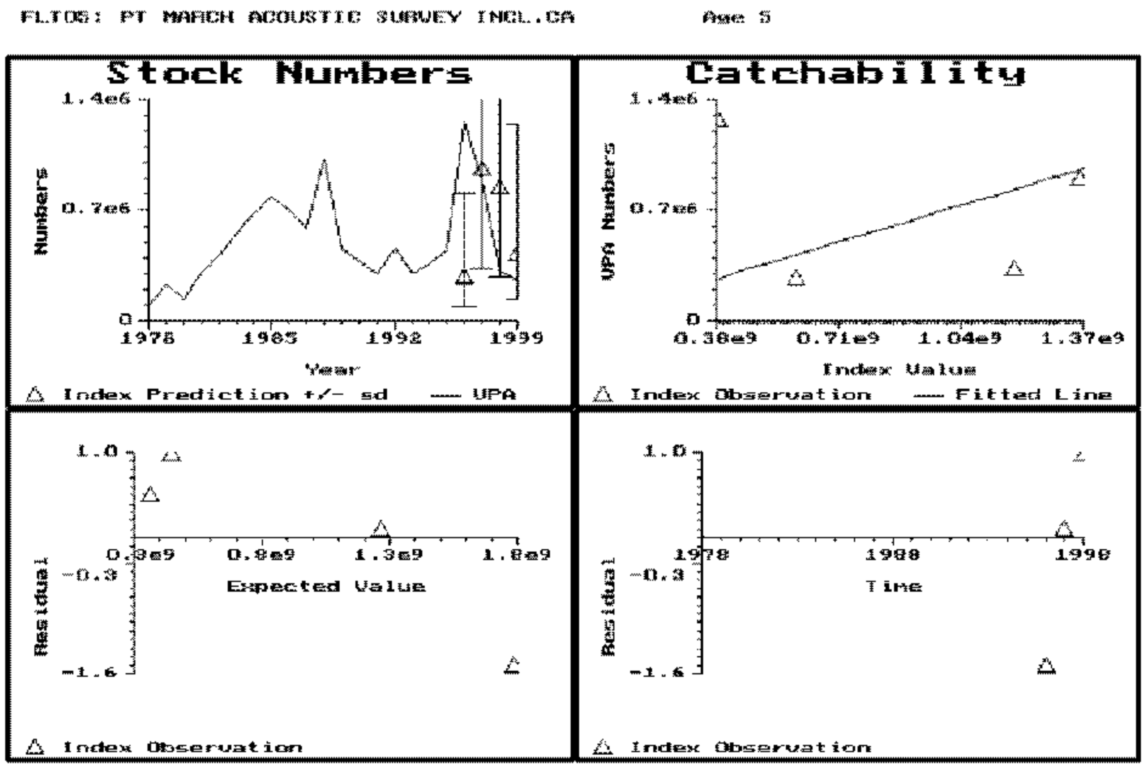
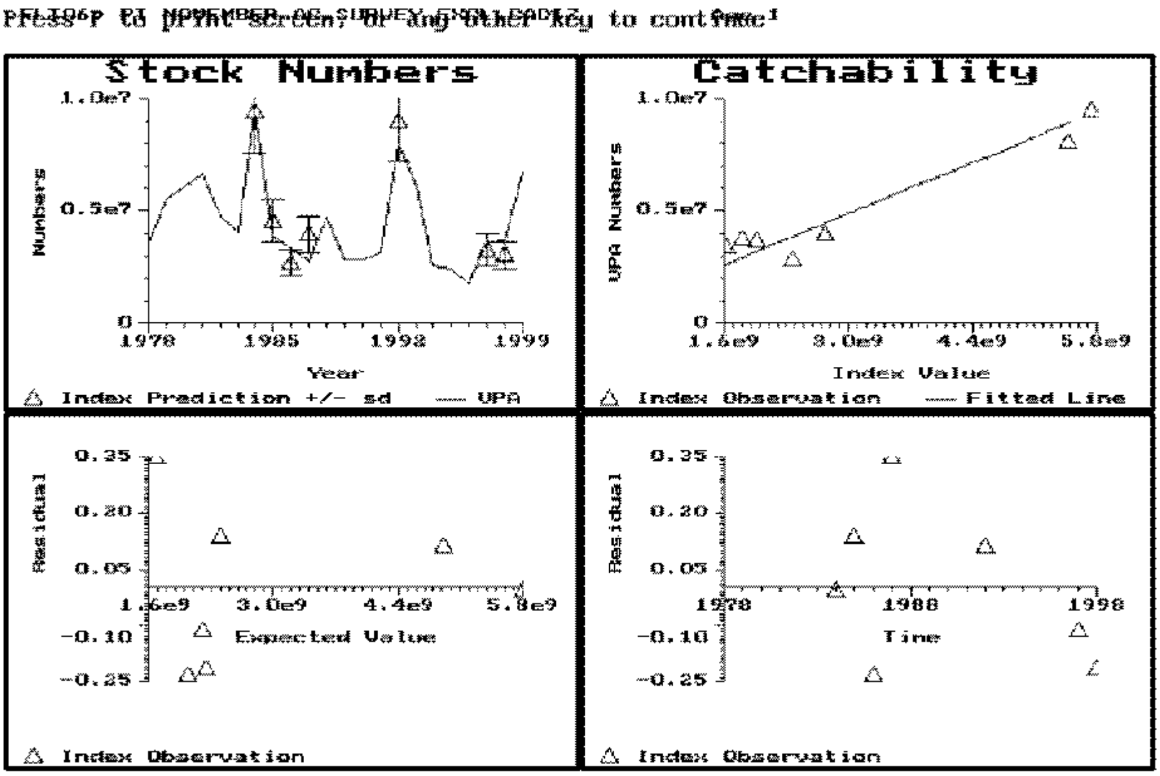


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.



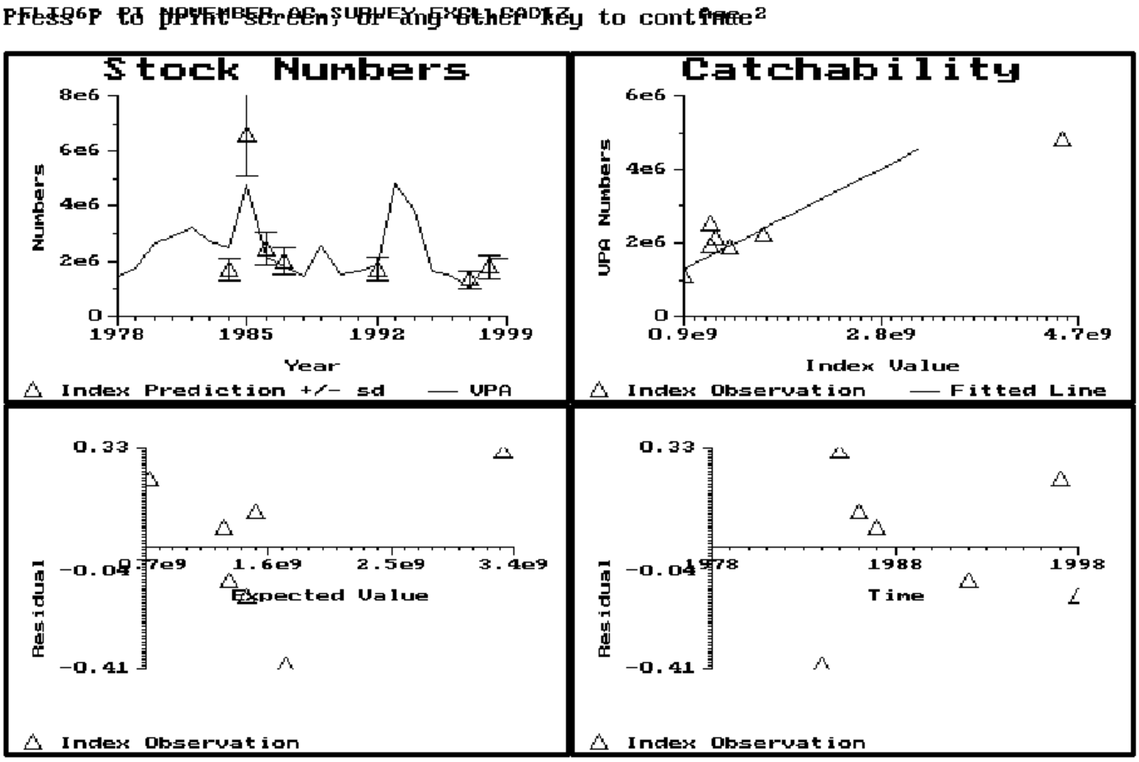
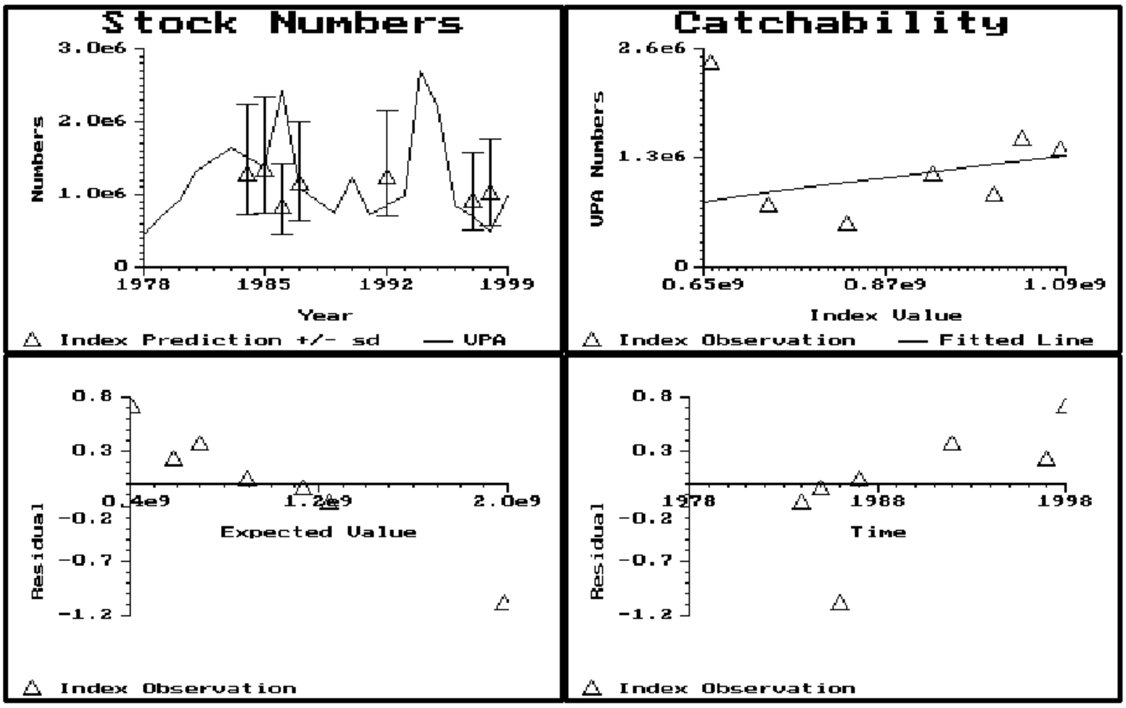


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 3



FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 4

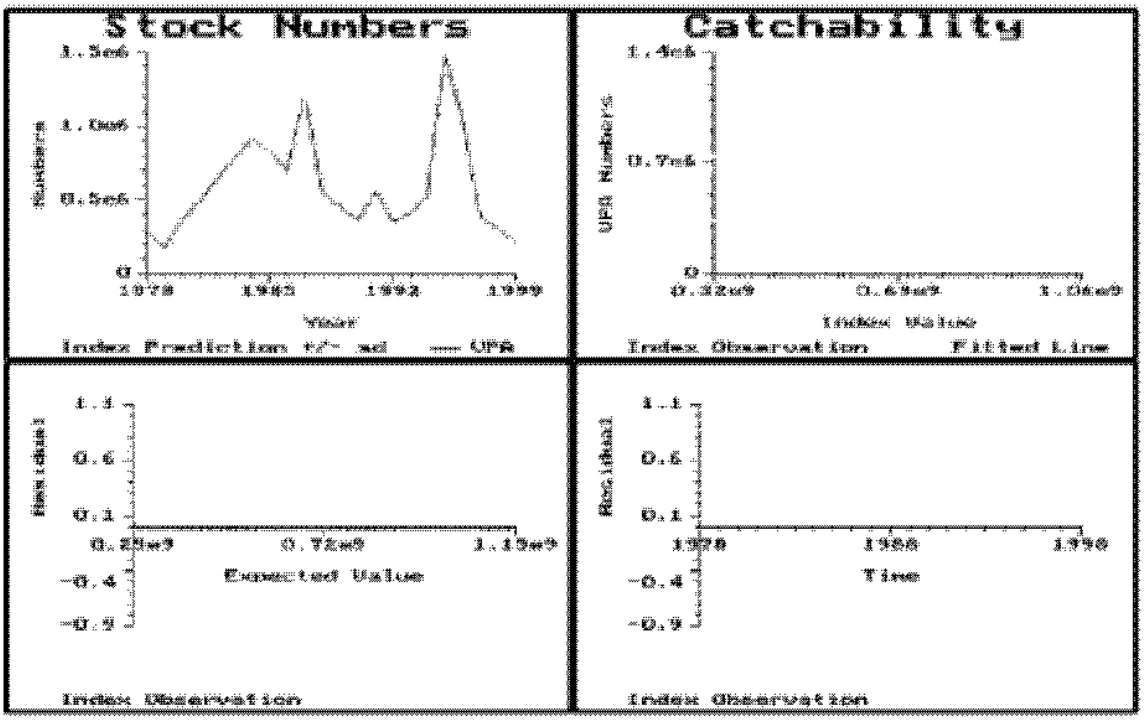


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.

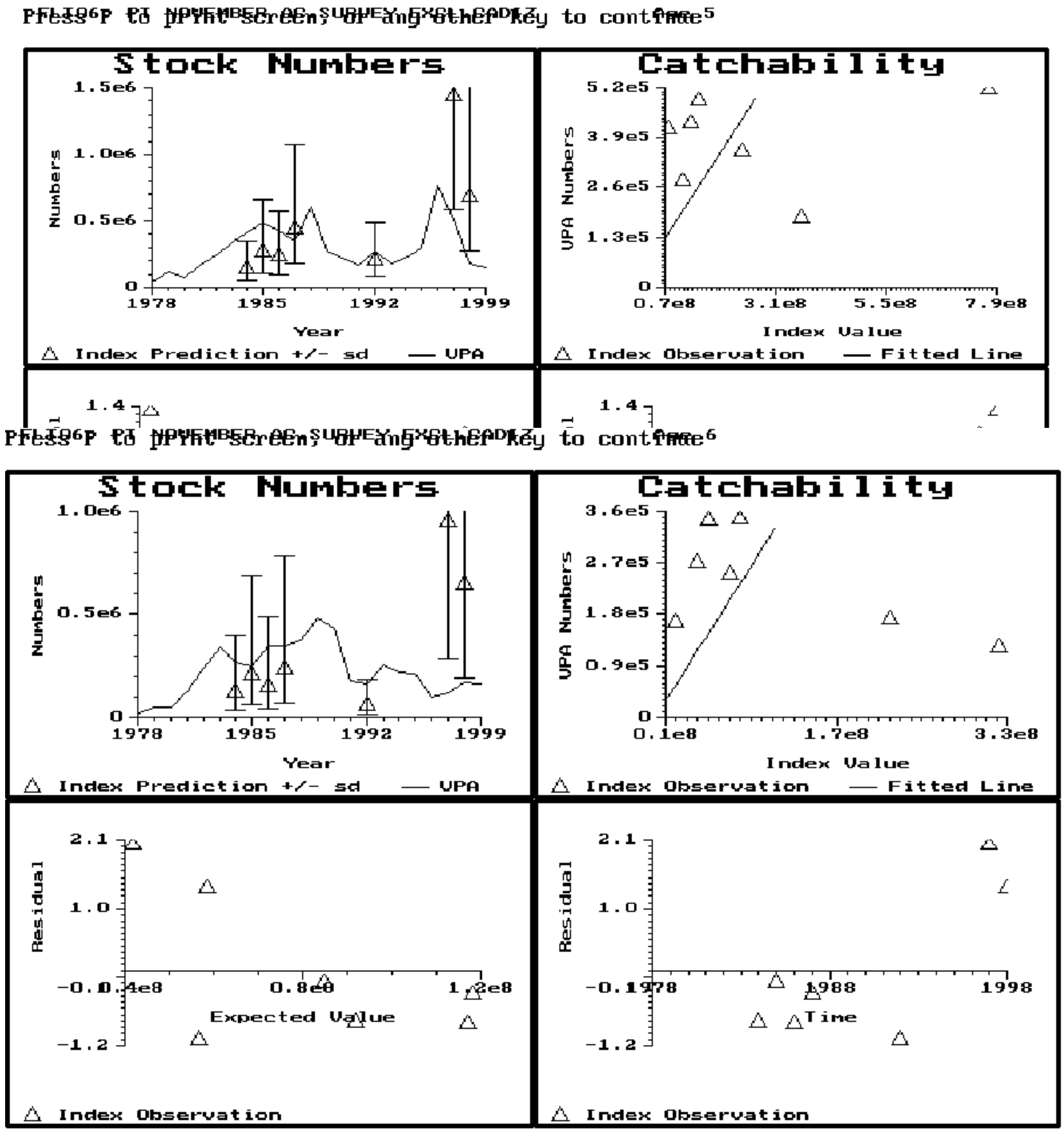


Figure 8.7.2.1 (cont.) Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the final assessment.)

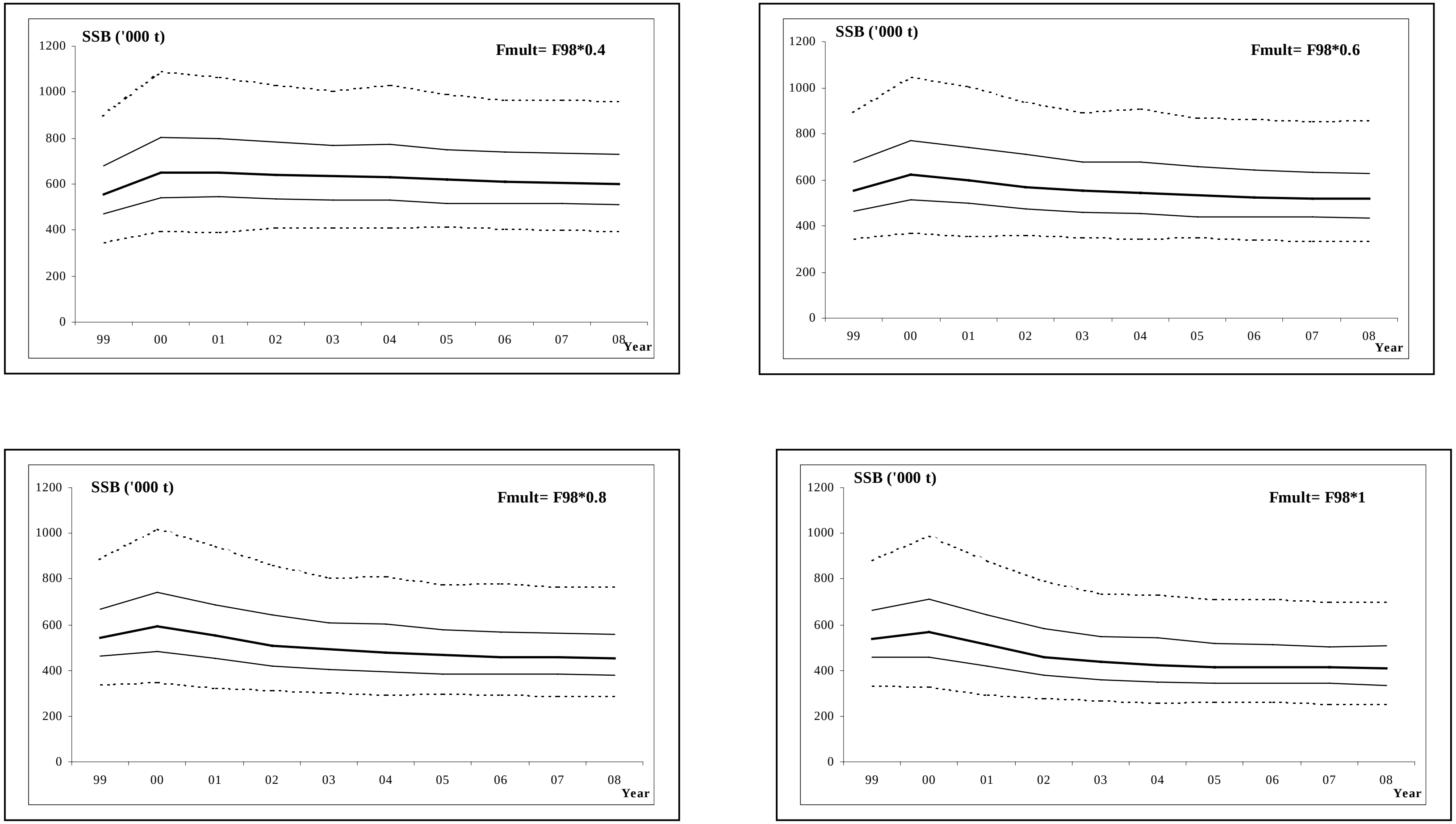


Figure 8.10.1: Expected median SSB (thick line) and its 25-75 and 5-95 (dotted line) percentiles for different scenarios of F multipliers.

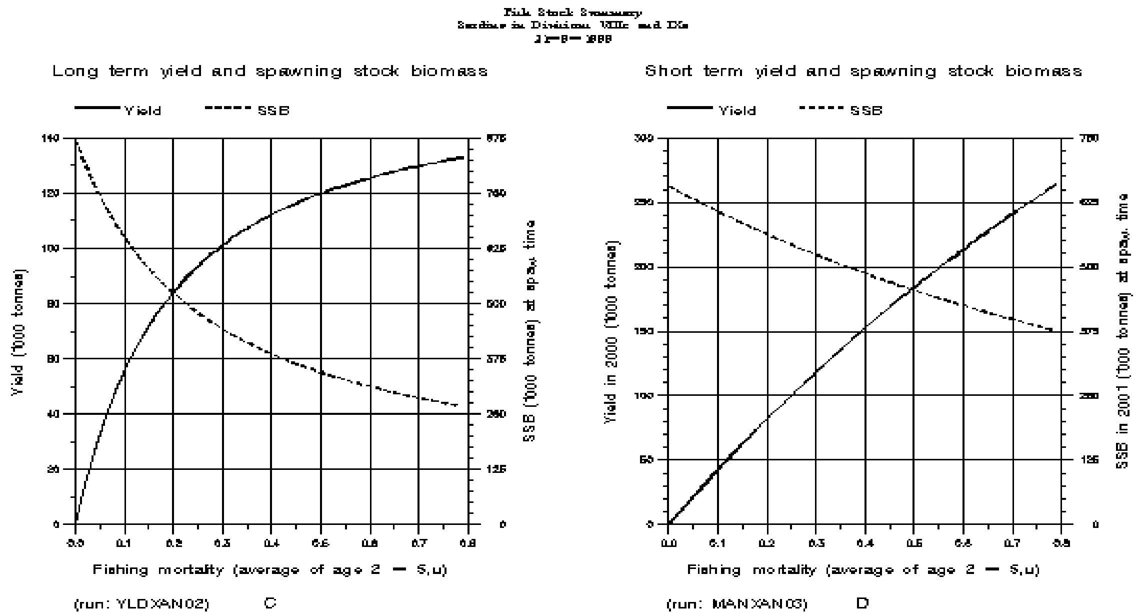
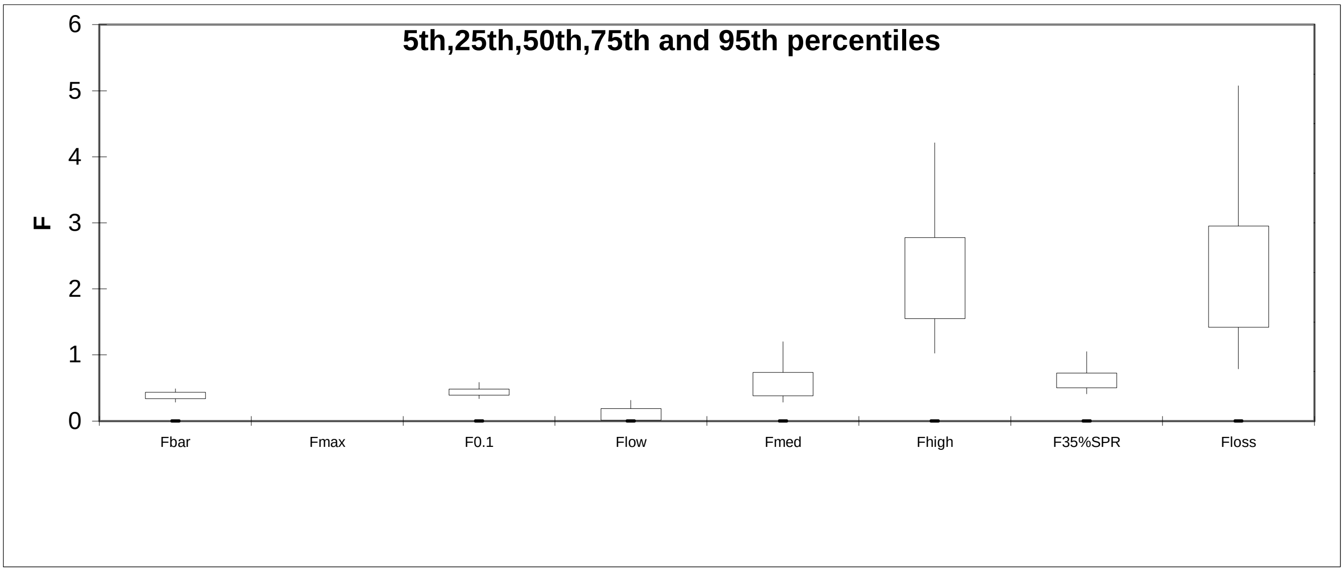


Figure 8.11.1 Sardine in Divisions VIIIc and Ixa. Plots of yield per recruit and short term predictions.



Reference point	Deterministic	Median	80th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	8507000	8507000	11150000	11606000	
MBAL	300000				9.52
Bloss	235500				
SSB90%R90%Surv	323113	328300	385200	470374	9.52
SPR%ofVirgin	44.55	44.40	49.16	53.89	
VirginSPR	0.13	0.13	0.15	0.17	
SPRloss	0.02	0.02	0.03	0.04	

	Deterministic	Median	20th percentile	5th percentile	Hist F > ref pt %
FBar	0.39	0.39	0.34	0.29	14.29
Fmax	2.94	3.12	2.07	1.60	0.00
F0.1	0.44	0.44	0.39	0.34	9.52
Flow	0.06	0.10	0.00	0.00	100.00
Fmed	0.57	0.53	0.36	0.29	0.00
Fhigh	2.32	2.13	1.48	1.03	0.00
F35%SPR	0.62	0.60	0.49	0.41	0.00
Floss	2.50	2.09	1.27	0.79	0.00

Figure 8.12.1 Biological reference points for the Iberian sardine.

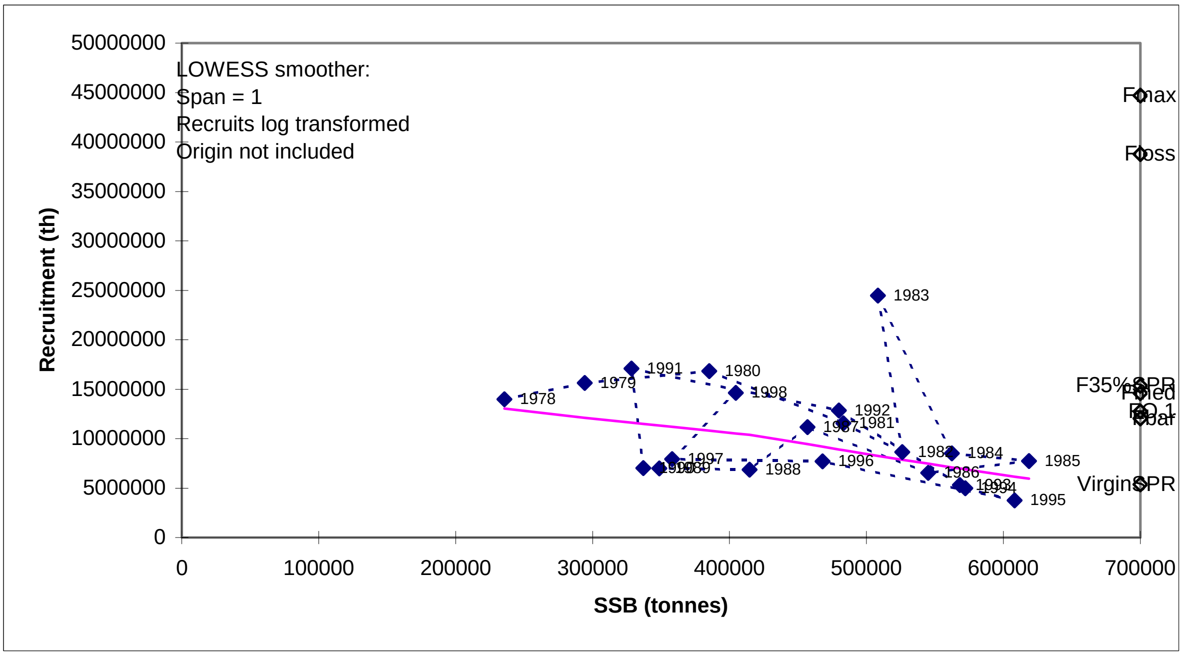


Figure 8.12.2 SSB/Recruitment relationship and reference points for the Iberian sardine.

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, and Junquera, 1993). These authors explain that the variability is reflecting the different environments in the recruitment zones where the development of larvae and juveniles took place. They suggest 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*., 1991 and 1994), the WG considers that the anchovy in this area has to be dealt with as a single management unit for assessment purposes.

The connections between the population of the anchovy in the Bay of Biscay and those from other areas, either to the North or to the South, is not clear. 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. A further increase in the fisheries would allow a better study of the dynamics of the anchovy in this area and its possible connection with anchovies from other areas.

9.2 Distribution of the Anchovy Fisheries

Due to the lack of information on the distribution of the French and Portuguese landings by statistical rectangle in 1998, the Working group prefers not to produce the maps of locations of the catch as the French fishery during this year was the main one. However, 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 1991-1998. In Sub-area VIII during the first quarter, the main fishery (predominantly by the French fleet) was located around the Gironde estuary from 44°N up to 47°N. 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 quarter, the fishery was spread in the Bay of Biscay: the Spanish one in the Center and in the South (VIIIb and c) and the French one in the Center and the North (VIIIb and a). During the fourth quarter, the two fisheries are well separated, the Spanish one in the VIIIc (close to the Spanish coast) and the French one in the North and the Center of the Bay.

In Division IXa, the Portuguese landings in 1998 were low and most of the fish was caught during the first and fourth quarter in Sub-division Central North. The decrease of Portuguese catches since the historical maximum of 1995 (7056 tonnes) is continuing in 1998, especially in IXa Central North. The Spanish fishery in 1998 was mainly located in the Bay of Cadiz. During 1998, in that area, the landings increased reaching a historical maximum for this area (8977 t) and are relatively stable throughout the year without undergoing any significant rise in spring-summer as it was usual. The decrease of Spanish catches in IXa North since the maximum level in 1995 (5,329 t) is continuing in 1998.

The distribution of fisheries in the Sub-area VIII is rather constant during this period: the main fishing areas appeared in VIIIc and VIIIb in Spring (mainly landings from the Spanish fishery) and in the VIIIb and VIIIa during the rest of the year (mainly French fishery). However, there is increase of the catches in the VIIIa, particularly during the second half of the year, since the bilateral agreement between France and Spain in 1992 (see chapter 10.2).

In 1998, the distribution of catches in Division IXa appeared to be similar to those of the 1991-1994 and 1996-1997 periods. The main fishery area is located in IXa South (Bay of Cadiz). The increase of catches recorded in IXa Central North and North in 1995 has not been observed in 1998. As the anchovy is fished as intensive as possible because of its high price at the market, the changes in the landings will probably reflect variations in the anchovy abundance in those areas (Pestana WD, 1996). Historically, catches to the West of the Iberian peninsula (from Subdivisions IXa Central and North) have shown episodic increases (Junquera, 1986 and Pestana WD 1996), probably due to environmental favourable conditions (Uriarte *et al*., 1996).

Table 9.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters and total in the period 1991-1998.

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	

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	

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	

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	

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	

- Not available

10 ANCHOVY - SUB-AREA VIII

10.1 ACFM Advice applicable to 1998 and 1999

ICES reiterated in 1998-1999 the advice given in 1996 that a reduced fishing mortality on juvenile anchovy will increase the spawning biomass without a major loss in total yield. This may be achieved by closing fishing areas with high abundance of 1-group anchovy. Fishing for anchovy should be prohibited between January and June inclusive within the area defined by the following boundaries:

- from the Spanish coast north along longitude 1.35’W to latitude 44.45’N ; west to longitude 1.45W; north to latitude 46.00’N and east to the French mainland.

No decision concerning the closing fishing areas has been taken, and a TAC of 33,000 t. for 1998 and 1999, while the international fishery caught 31,617 t in 1998. Since the 1980’s, the TAC of 30,000 t (33,000t from 1996 onwards) has been agreed but often exceeded or not reached. The allocation is 10% for France (3,300 t) and 90% for Spain (29,700 t). However, since 1992, a bilateral agreement between France and Spain modifies every year the quotas between the two countries. More precisely, 6,000 t from the Spanish quota are allocated to the French fleet for the second half of the year, if the French mid-water pelagic activity for anchovy stops during the main Spanish fishery in spring (from 20 March to 1 June). Thus, this bilateral agreement between France and Spain allowed some decrease of the fishing effort in spring when the anchovy is concentrated in the center of the Bay of Biscay for spawning. In addition to this, 6,000 t of the Portuguese quota from XIa are exchanged between Portugal and France since 1996, whereas all the French catches are made in the Bay of Biscay (Division VIII) and as such reported to this WG.

ICES proposed that B_{pa} be set at 36,000 tonnes, the SSB which allows the stock size to remain above B_{lim} in the following year in the event of a weak recruitment.

F_{pa} be established between 1.0 – 1.2, on a technical basis corresponding to an F for 50% spawning potential ratio, i.e., the F at which the SSB/R is half what it would have been it the absence of fishing.

10.2 The fishery in 1998

Two fleets operate on anchovy in the Bay of Biscay and the pattern of each fishery has not changed in recent years, however the relative amount of their catches have changed:

Spanish purse seine fleet: Operative mainly in the spring, when more than 80% of the annual catches of Spain are usually taken. This spring fishery operates at the south-eastern corner of the Bay of Biscay in Divisions VIIIc and b. Until 1995, the Spanish purse-seiners were allowed to fish 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 can fish anchovy throughout the year in Sub-area VIII with the same system of fishing licences.

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 indicate that they are supposed to be less than 5% of the total Spanish catches.

French Pelagic Trawlers: Operative in summer, autumn and winter. Until 1992, they also operated in the spring season, but due to a bilateral agreement between France and Spain the spring season is not presently used as fishing season by the pelagic trawlers. The major fishing areas are the VIIIa and b in the first half of the year and VIIIa, mainly, during the second half. The VIIIc area is prohibited to the French pelagic fleet.

There are also some French purse-seiners located in the Basque country and in the southern part of Brittany. They fish mainly in the spring season in VIIIb and for a part of them in autumn in the north of the Bay of Biscay.

10.2.1 Catch estimates for 1998.

In 1998 a total of 31,617 tonnes were caught in Subarea VIII (Table 10.2.1.1 and Figure 10.2.1.1). It is a 41.5% increase compared to the level of 1997 catches. This increase is mainly due to the French fishery that had a 91.2% increase of their landings. As the previous year, the Spanish catches were low and roughly half of those taken in 1996 and 1997, probably due again to a decrease of fish catchability in spring. As usual, the main Spanish fishery took place in Spring (80%) and the main French fishery in the second half of the year (61%) (Table 10.2.1.2) (Figure 10.2.1.2).

In 1998, as in other years, Spanish and French fisheries were well separated temporally and spatially. About 79% of the Spanish landings were caught in divisions VIIIc and VIIIb in Spring, while the French landings were caught in divisions VIIIb in Winter (26.5 %) or in Summer in division VIIIa (73%) (Table 10.2.1.3).

During the first half of 1999, total international catches reached 14,443 t (preliminary data). The Spanish fishery in Spring has produced a higher level of catches (10,400 t) than the level of 1998, whereas the French one, during the first half of the year, landed around 4,000 t (see Table 10.2.1.1).

10.2.2 Discard

It is believed than there is no discarding in the Spanish fishery and the discards have not been recorded in the French fishery.

10.3 Biological data

10.3.1 Catch in numbers at Age

The age composition of the landings of anchovy by countries and for the international total production are presented in Table 10.3.1.1. For both countries, the 1 age group largely predominates in the catches. For the international catches 1 year-old anchovies make up 80% of the landings, followed by age 2 with 19%. The 0 and 3 age groups represented respectively a very low proportions of the catches in 1998, less than 1% for each category. Approximately 25 % of the catches of anchovy (in numbers) consisted of immature fish prior to their first spawning in May.

The catches of anchovy corresponding to the Spanish live bait fishery for tuna fishing for the period 1987-1998 are given in Table 10.3.1.2. In 1998, catches at age 0 were lower than those of the previous year (roughly the half). Live bait catches of anchovy are rather variable depending on the availability of the different small pelagic species which are used as live bait by this tuna fishing.

Table 10.3.1.3 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies predominate in the catches during the both halves of most of the years. A few catches of immature, 0 age group, appeared during the second half of the year. The estimates of the catches at age on annual basis since 1987 is presented along with the inputs to the assessment in Table 10.8.2.1.

The preliminary estimates of the Spanish catch at age for the first half of 1999 reflects a majority of age 2.

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.

For the first quarter, the main fishery that is the French one, fish, medium size anchovy (grade of 50), in the central part of the Bay of Biscay (Figure 10.3.2.1).

For the second quarter, the length distribution of the French fishery showed a bimodal distribution. For the French landings, the smaller group corresponds mainly to the production of small purse-seiner and pelagic trawlers fishing close to the shore. It is not the case for the Spanish landings, which has caught larger anchovies off shore. (Figure 10.3.2.2).

For the third quarter, the French and Spanish landings had again different length distributions. The French catches show a bimodal distribution, the smaller fraction corresponds to the anchovy caught off the coast by the smaller boats (Figure 10.3.2.3)

For the fourth quarter, the size distribution of the French landings showed always this bimodality. That corresponds to productions caught off the North of the Bay of Biscay and belonging to different groups of length but of the same age group (1 year-old). The low Spanish landings, mainly 0group, were caught off VIIIc (Figure 10.3.2.4).

The series of mean weight at age in the fishery by half year from 1987 to 1997, 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 10.8.2. 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. Small errors detected in the mean values at age of 1996 in the last year WG report have been corrected as appropriate.

The values of mean weight at age for the stock appear with the inputs to the assessment in Table 10.8.2. These values are the ones estimated for the spawners during the DEPM surveys of 1990-1997 (reported in Cendrero ed., 1994 and Motos *et al*., WD 1998 and Uriarte *et al*., WD 1999). For the years 1993 and 1996, when no estimate of mean weight at age for the stock existed, the average of the rest of the years has been taken. For the years 1987 to 1989 small changes in the mean weight at age have been introduced compared to the ones used in the previous year assessment. This is due to the fact that, in the previous year, the mean values for the 1990-97 series of DEPM estimates of mean weight at age were used for 1987-89, whereas, this time, the original mean weight at age adopted for the population at age estimates of those DEPM values are being used again. The original values are higher than the mean values more accurately estimated during the more recent years. Nevertheless changing only the mean weights at age without revising the population at age estimates for those years introduce contradictory information in the assessment. Therefore, until a complete revision of the whole series will be made, the original values are retained.

10.3.3 Maturity at Age

As reported in previous years' reports, anchovies are fully mature as soon as they are 1 year old, at the following Spring after they spawn. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Motos, 1994).

10.3.4 Natural Mortality.

The natural mortality for this stock is high and probably variable. In previous WG report, estimates of natural mortality were obtained from consecutive estimates of the population in numbers at age supplied by the DEPM method and the catches taken between surveys (ICES 1992, Asses:17). For the purpose of the assessment applied in the WG, a natural mortality of 1.2, fixed value around the historical average, is adopted.

In the framework of an international project between France and Spain (Project 95/018), a statistical approach to get better estimates of natural mortality has been carried out. This approach used DEPM information and trends in CPUE of some French pelagic trawler fleet chosen as reference. In that study, we use as inputs the estimates given by the DEPM for the level of abundance of SSB. Given that level, we use as a decreasing trends the Z estimates calculated from the CPUE values of the French reference fleets. Finally, we try to appreciate the degree of convergence among the level of abundance in June of the next year calculated as indicated above and the level of SSB given by the DEPM for the next year. The main results are shown in the following table (after Prouzet et al, 1999).

Cohort	Z est.	Confidence interval of Z (90%)		F est.	Confidence interval of F (90%)		M est.	Confidence interval of M (90%)	
1986	1.16	0.75	1.57	0.59	0.34	0.97	0.57	0.13	0.98
1987	4.56	3.41	5.70	0.98	0.58	1.67	3.59	2.69	4.61
1988	1.93	1.70	2.17	0.63	0.50	0.78	1.30	1.05	1.54
1989	3.76	2.90	4.62	0.71	0.43	1.14	3.01	2.15	3.73
1990	1.94	1.68	2.21	1.2	0.87	1.67	0.74	0.36	1.05
1991	1.92	1.58	2.25	0.43	0.27	0.74	1.48	1.12	1.82
1993	2.67	2.18	3.16	1.01	0.68	1.54	1.65	1.07	2.14

From the results obtained, M (natural mortality) can vary widely among years and it seems that the assumption of a constant M use for the current management procedure is an over-simplification of the actual population dynamic. However, as the European Community has not yet approved the final report and as the principal results have not been presented in a working document to the working group members, these results have not been used for the actual assessment of the anchovy population.

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 1999, with a gap in 1993 (Table 10.4.1.1). A review of the most recent surveys since 1995 is presented in Motos *et al*. (WD 1998) and Uriarte *et al*. (for the years 1995, 1997, 1998 and 1999 in WD 1999). In 1995 and 1997 biomasses about 60,000 t of anchovy were estimated in the Bay of Biscay. These values are about the middle of the range of estimated spawning biomasses of the DEPM series. From the surveys of 1996 only the total Egg production is available. This is due to the lack of adult sampling. For 1998, an estimate of 102,000 tonnes was provided. This is the highest of the series recorded and reflects the income of a strong recruitment. For 1999, just a preliminary estimate has been made with the model defined by Uriarte *et al*., 1999 (WD 1999) and similar to the one used in the previous year working group (ICES CM1999/ACFM:6). The model is such as:

$$LN(SSB) = \alpha LN(P0) + \beta LN(A) + cste + \xi \ ,$$

With P0: daily egg production per 0.05 m^2 and A: positive spawning area. This model has a linear form (Y= ax1+bx2 + constant + residuals). The constant term gives a mean estimate of the inverse of the daily fecundity.

The regression analysis performed give a very good explanation of the variance observed (multiple $R^2 = 0.965$). The relationship obtained has the following equation:

$$LN(biomass) = 1.204*LN(A) + 0.712*LN(P0) – 2.874$$

The standard error of the estimates is equal to 0.145. That allows defining a biomass of 68,679 tons with a range of 48700 – 96870 tons for 1999. For 1996, the new estimate is 39,344 with a range of 27,190 – 56,940 tons.

The composition of the population at age was derived for the surveys from 1987 to 1997 (except for 1993 and 1996), based on the adult sampling performed during these surveys. However, in 1987 and 1988 the adult sampling did not cover the whole spawning area of anchovy and therefore some assumptions about the composition of the population in the unsampled area had been made. Consequently, the age compositions for the DEPM surveys in 1987 and 1988 are less reliable. That is probably the reason why the mean weight at age of the 1-year-old in those years differs markedly from the most recent years of estimates (see Table 10.8.2.1). The 1998 population estimates at age are new input for this year's assessment.

Since the beginning of the use of the DEPM survey to assess the status of the Bay of Biscay anchovy, the estimates provided for 1989 have been considered downward biased as suggested by their authors (Motos and Santiago, 1989) and there are no reasons why they were always raised by 1 standard deviation of the estimate. However, it seems that those values were incorrectly raised and therefore they have been appropriately corrected as agreed, in the previous years, for the assessment of this year. The text table below show the values used in the last year assessment for the 1989 population at age estimates and the one now used:

DEPM in 1989	SSB (CV)	Pop_age 1	Pop_age 2	Pop_age 3	SOP
Original	11,861 (0.41)	246	206	18	11,637
In last Year WG	15,000	246	206	18	11,637
In 1999 WG	16,724	347	290	25	16,408

The DEPM are being under revision (see Uriarte *et al*., 1999). This has to be done to account for a change in the methodology of estimating spawning frequency (Motos and Uriarte, in preparation). The years prior to 1995 might be partly biased upward by an amount of about 10 %. Revised versions were provided for the years 1995 and 1997 in Uriarte *et al.* (1999, WD) suppose reductions of 9 and 12 % respectively in comparison with the previously reported estimates. The surveys consistently show that the major fraction of the population is always the one year old anchovies and therefore the population is driven year after year by the recruitment at age 1.

10.4.2 Acoustic surveys

Data from French acoustic surveys aimed at providing estimates are available since 1983 in Table 10.4.2.1 The estimates for 1991 and 1992 were revised and updated for a FAR programme on anchovy (Cendrero ed., 1994). In 1993, 1994 and 1995, only observations concerning the ecology of anchovy, especially located close to the Gironde estuary (one of the major spawning areas for anchovy in the Bay of Biscay) were made. In 1997, a new acoustic survey was performed for anchovy in the French waters, mainly to study the behaviour of the species in the central part of the Bay (close to the Gironde estuary) and to investigate the relationships between ecology of anchovy and its environment.

Anon. 1993/ Assess:7 concluded that the acoustic values are relative indices of abundance and the values of 1983 and 1984 seems to be underestimates of the abundance.

The PEGASE98 survey has been carried out on board the RV THALASSA from 20/5 to 21/6/1998. The objectives of the first part of the survey were to study the distribution and the abundance of pelagic species present in the area, and to investigate how the distribution is associated with environmental conditions. The objective of the second part of the survey was to study the primary and secondary productions associated with environmental conditions in some study areas determined during the first part.

Acoustic data have been stored along 2500 nautical miles and echo-traces were identified by 34 fishing operations (32 with a mid-water trawl and 2 with a bottom trawl). A first calculation has been done for the area covered by Thalassa from 20/5 to 7/6/1998 for anchovy and sardine. Table 10.4.2.1 presents updated estimates for 1994 and 1998 (J. Masse pers.com.), which were not available for the last year assessment.

10.5 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 10.5.1. The French mid-water trawlers involved in the anchovy fishery has increased continuously up to 1994. Afterwards this fleet has been slightly decreasing. Therefore, it seems that after the rapid increase of the French fishing effort since 1984, we observe a certain reduction of the fishing effort for the last years, according to the slight decrease in the number of vessels involved in the fishery. The main French fishing effort is concentrated in the central and northern part of the Bay of Biscay in the second half of the year, whereas for the Spanish fishery, the main fishing season takes place during the first half of the year in the south-eastern part of the Bay.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different. The current effort may be at the level that existed in this fishery at the beginning of the 1970's (Anon. 1996/Assess:2).

CPUE of the Spanish purse-seiners during the spring fishery for anchovy is shown in Table 10.5.2. This index is spatially linked with the anchovy abundance in the southern area of the Bay of Biscay and also, although less closely, to the evolution of the biomass of the whole population in the Bay of Biscay, as measured by the daily egg production method (Uriarte and Villamor, WD 1993). The indices for the first half of 1997 and 1998 showed strong decreases of CPUE for the total catch, suggesting a decrease of the population in these two recent years. The DEPM estimates of biomass showed, however, that this was not the case. Therefore the reason for such a decrease must come from elsewhere. In 1997, the small size of anchovy caught interfered with the normal development of the fishery because the Spanish markets are not interested in buying anchovies of small sizes (only for fresh consumption). This and the bad weather conditions reduced largely the potential of catching (and selling) for the fleet. In 1998, the DEPM survey showed that anchovy concentrations at the south of the Bay of Biscay were weaker than in other years. This area is where the Spanish purse seiners mainly operate. Thus, the anchovy population may have been less available to this fleet. Therefore in these last two years the catchability of the Spanish purse seine fleet has probably been reduced.

For 1999, we noticed an increase of the global CPUE (in tons per boat per day) and particularly a large increase of the catch per unit of effort for the 2 years old, which is one of the highest, recorded on the 1987-1999 period. These levels are in agreement with the DEPM estimates made in 1998 and confirm the presence of a significant population of 2 years old in the Bay of Biscay during the first part of the year 1999. On the other hand, the CPUE at age 1 is one of the lowest of the series, suggesting a low recruitment at age 1 in that year.

A study made of the catches per unit of effort of some French pelagic fleet used as references (Prouzet *et al.*, 1999) showed good co-variation between the maximum level of the CPUE and the level of biomasses estimated by DEPM in the Bay of Biscay in June for the age group 1 and 2. These new observations confirmed the robustness of the series of SSB abundance from the DEPM used for the assessment.

10.6 Distribution of anchovy

See section 9.2

10.7 Recruitment forecasting and environment

The anchovy spawning population heavily depends upon the strength of the recruitment at age 1 produced every year. This means that the dynamics of the population directly follow those of the recruitment with very small buffer. The forecast of the fishery and the population depends therefore on the provision of an estimate of the next year anchovies at age 1. Given the absence of quantitative recruitment surveys, the only information presently available is the one concerning the influence of the environment on the recruitment of anchovy.

Northern and eastern winds of medium and low intensity blowing in Spring and early Summer in the Bay of Biscay seem to induce good levels of recruitment at age 1 for the next year to the anchovy population (Borja *et al*., 1996; 1998). This result has been demonstrated for the period 1967-1996 and the most recent assessment of this WG confirms the good relationship between the Upwelling Index for the Bay of Biscay and Recruitment for anchovy in Subarea VIII. The potential use of this index of Upwelling for forecasting the Recruitment of the Bay of Biscay anchovy has already been suggested in the previous years. In this year the index will be used for the first time to define the inputs for the projections. In last year, the variation of the index explained about 62 % of the variance of the Recruitment estimated from 1986 to 1996 in the last year assessment (by a multiplicative model). The direct linear comparison between the upwelling Index and the anchovy population at age 1 estimates of DEPM surveys show that Upwelling explained about 54 % of recruitment variation (R=0.734). The estimates of this Upwelling since 1986 are reported in Table 10.7.1, updated with the 1999 estimate).

Since this index is not an observation of recruitment abundance (as a survey would be) but a calculated environmental index, it has been considered that it should only be used to improve the projections of the fishery over 1998 and forecast for 1999 (helping for the estimations of the anchovies at age 0 in both years). Its reliability as a predictor should be evaluated from its fitting to the recruitment estimates provided by the assessment for the previous years. The *a priori* basis for a relationship between the upwelling index and anchovy recruitment is not well understood and the form of that relationship is unknown. The form or intensity of a relationships between a certain environmental index and recruitment may change according to different oceanographic regimes. Therefore the *a priori* inclusion of such an index to tune an assessment can mask or artificially increase its relationship with the recruitment. If we admit that any form of the relationship can be subject to process errors, it seems judicious to evaluate the form and the performance of the relationship after an independent assessment of past recruitments has been produced. For these reasons the upwelling index will not be included as an index of recruitment in the assessment. Instead the relationship between upwelling and recruitment will be evaluated after the assessment and will be used in forecasting recruitment *a posteriori* in order to improve the short term projections (see further explanations in section 10.8.1).

10.8 State of the stock

10.8.1 Data exploration and Models of assessment

In this stock, natural mortality is believed to be high (but variable) and close to or higher than fishing mortality. For that reason, in a VPA the strength of the year classes will be conditional on the assumed natural mortality. The assessment of the anchovy fishery performed up to now has been based on fitting a separable selection model for fishing 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. Although the CPUE of the Spanish purse seiners is available, it has never been included in the assessment because of the likely changes in the catchability of these types of fleets, possibly inversely to the size of the stock (Csirke 1989).

Potentially the current approach could be improved by moving on to a seasonal assessment of the fishery, where the different seasons and fleets could be further studied and described in their fishing patterns. However no further work has been presented since last year.

The first step to assess the anchovy population in Subarea VIII was the comparison between the last year assessment and the one produced in a similar way (same tuning indexes and weighting factors) after adding the most recent fishery and index values and correcting the small errors and inconsistencies detected in the inputs of the last year assessment (in mean weights at age in the catch and the stock and the corrections of the DEPM values for 1989, see previous sections). This is shown in Table 10.8.11 and Figure 10.8.1.1, both assessments are very consistent.

The ACFM minutes of 1998 states “ACFM appreciates the improvement in the anchovy assessment and accepted the use of the upwelling index”. However, the WG did not want to drive the assessment of past recruitment by the Upwelling index (according to the reasons explained in section 10.7) it was used with only a small weighting factor of 0.1. With such a weighting, the upwelling neither guides the assessment of past years nor influences the most recent recruitment estimates. This is clearly shown in Figure 10.8.1.1 where a comparison of the assessment with and without the upwelling indices shows that including this variable has very little effect on the estimates. Therefore, the working group considered that it was more efficient and transparent to exclude the observations concerning the variation of the intensity of upwelling to estimate the anchovy recruitment (number of age 0). The upwelling indexes will be, in fact, used to establish a relationship between its variability and those of the recruitment estimated independently of upwelling indexes by the ICA program. So, the impact of the variation of the environmental conditions could be evaluated in isolation from other effects in respect of its use for the forecast of the new recruits.

Tuning the assessment using the DEPM and acoustic indexes both as aggregated indices of biomass and as aged structured indices was already discussed last year. Although the age structured index turns out to contain the most valuable information, the WG decided to let the information provided by the surveys tune the assessment in both ways as Biomass (in tons) and age disaggregated (in number) indexes of the Spawning Population. The aggregated SSB indexes are the only figures available for the current year 1999 (and for 1996), the elimination of this type of information reduced the ability of the survey to predict 1998 onwards. For that reason, in order to counterbalance somehow the double use made of the information of each survey in the assessment, the weighting factors have been set to 0.5 for all these inputs. Since the DEPM surveys are under revision, the sensitivity of the current assessment to the use of the estimates provided by that method as absolute or relative has been compared. Table 10.8.1.2 and Figure 10.8.1.2 show the output of ICA assessment runs without the upwelling index. The first run includes the whole series as absolute. In the second run the DEPM estimates for 1995, 1997 and 1998 are taken as absolute values whereas the DEPM estimates for the previous years are taken as relative. In the third run all the DEPM series are used as relative. The major divergences appear between the latter run and the two previous runs. When the DEPM series are taken entirely as relative then recruitment and biomasses decrease and fishing mortality increases substantially. It suffices to consider a few years of the DEPM surveys as absolute (as in the second run) to scale the whole assessment. Given the fact that the most recent years are already updated and revised for this WG, those years should be at least taken as absolute and not as relative. In addition, the revision is not expected to make big differences in relation to the previously reported estimates (of about 10 %). Thus, the WG consider more reliable to use the whole series of DEPM as an absolute index than as a relative one, in order to scale the assessment.

10.8.2 Stock assessment

An Integrated Catch at Age analysis, which assumes a separable model of fishing mortality, has been used for the assessment of the anchovy in the Bay of Biscay from 1987 to 1998 (with the ICA package, Patterson and Melvin 1996).

Inputs for the final assessment are summarised in Table 10.8.2.1. The assessment uses as tuning data the DEPM (1987-1997) and the Acoustic (1989-98) figures as biomass and as population numbers at age estimates. The Acoustic and DEPM estimates are considered as relative and absolute estimates respectively and are down-weighted to 0.5. For 1996 and 1999, the DEPM SSB biomasses included in the assessment are the ones obtained from the combined log-linear model of spawning area and Daily egg production per unit area explained in section 10.4.1.

The assessment assumes a constant natural mortality of 1.2, per year around the average value estimated earlier at this working group (Anon., 1995/Assess:2). The assessment starts in 1987 when the DEPM began to be applied. The separable model of fishing mortality is applied over the whole set of years (1987-99) (12 years). However the catch data of 1987 and 1988 are down-weighted in the analysis because for those years, the French catch at age data are considered to be more unreliable than for the rest of the years. In addition, the DEPM population as numbers at age estimates for those years, were not as reliable as for the following ones.

Ages 4 and 5+ are heavily down-weighted (to 0.01) due to the small fraction of the catch they represent and to the large imprecision of the estimates. A shift of the age plus from 5+ to 4+ or even 3+ was suggested in the minutes of the ACFM (1997), given the few catches presented in these age groups. This possibility has not been tried for the assessment with the ICA package since moving the age plus to 4+ would imply fixing the selection pattern for age 3. Given that, the age 2 which is the reference age for the separable model, is already fixed. The only estimate allowed to the assessment would be that of selectivity at age 1 and 0. If the plus group were set at age 3 then none selectivity would be estimated by the assessment except that of age 0. For these reasons the age group plus has not been changed from age 5. The strong down weighting of ages 4 and 5+ should assure that they do not interfere with the assessment of the other true ages.

The model was fitted to all these inputs by a non-linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=87}^{y=98} \lambda_{a,y}\left(Ln\left(C_{a,y}\right) - Ln\left(F_y \cdot S_a . \overline{N}_{a,y}\right)\right)^2$$

$$+\lambda_{DEPM}\sum_{y=87}^{y=99}\left[\ Ln\left(SSB_{DEPM}\right) - Ln\left(\sum_{a=1}^{5} N_{a,y}\cdot O_a \cdot W_{a,y}\cdot \exp\left(-P_F F_Y \cdot S_a - P_M . M\right)\right)\ \right]^2$$

$$+\sum_{y=87}^{98}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right) - Ln\left(N_{a,y}\cdot \exp\left(-P_F \cdot F_y \cdot S_a - P_M \cdot M\right)\right)\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989,91,92,97}^{98}\left[Ln\left(SSB_{acoustic}\right) - Ln\left(Q_{acoustic}\sum_{a=1}^{5} N_{a,y}\cdot W_{a,y}\cdot \exp\left(\ -P_F F_Y \cdot S_a - P_M . M\ \right)\right)\right]^2 +$$

$$+\sum_{y=89,91,92}^{97}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right) - Ln\left(Q_{a,y}\cdot N_{a,y}\cdot \exp\left(-P_F \cdot F_Y \cdot S_a - P_M \cdot M\right)\right)\right]^2$$

with constraints on : $S_2 = S_4 = 1$ and $F_{98} = F_{97}$

and $\overline{N}$: average exploited abundance over the year

N : population abundance on the first of January

N_0 : number of 0 group anchovy

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

Q_0 catchability coefficient for the upwelling index.

K Coefficient of the power function fitted for the relationship between Upwelling and Recruitment.

$\lambda_{a,Y}$: weighting factor for the catches at age (set respectively to ages 0 to 5 at 0.1, 1, 1, 1, 0.01, 0.01)

Others λ are the weighting factor for the indices and/or ages (see last portion of table 10.8.2.1)

Results of the assessment are presented in Tables 10.8.2.2 and Figures 10.8.2.1

The assessment thus defined is almost similar to the one implemented in 1998 for the period 1987-1997, with the sole exception of the removal of the upwelling index from the assessment.

10.8.3 Reliability of the assessment and uncertainty of the estimation

In comparison with the results obtained in previous year (ICES CM1999/ACFM:6) the assessment give similar results (see Figure 10.8.1.1). The assessment is primarily driven by the Spawning Biomass estimates produced by the DEPM, this is the longest and most consistent independent estimate of the population in absolute terms. As shown in the exploratory analysis the adoption of the DEPM estimates as absolute figures allows scaling the whole analysis in the definition of recruitment, biomass and fishing mortality. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (1997). The log-variance of the populations estimates from the model versus the tuning indices seems reasonable, but the strong variations in abundance from year to year suggested by the direct DEPM estimates are not followed in parallel by the model (see Figure 10.8.2.1). The model tends to smooth annual variability in biomass. The separable model presents rather big level of absolute residuals both across years and ages, performing the best for age 1 (the most important age group in catches).

The severe changes in fishing mortality from 1997 to 1998 is certainly due to the strong reduction in the catches compared to the increase in biomass from 1997 to1998. The Spanish purse seine fishery had difficulties in 1998 to find the anchovies probably due to a more northern distribution of anchovy than usual, as reflected in the DEPM egg distribution.

It is remarkable as well how the fishing mortality varies according to the size of the stock, so as to increase strongly at low levels of biomass as e.g., show by the case of 1991 and 1996.

The WG considers that this assessment shows reasonably well the recent trends in population abundance and fishing mortality according to the information available. From the output stock summary the only reference about the stock size has to be the spawning biomass and not the total stock size because the latter includes the biomass of the age 0 group at the beginning of every year (when it does not exist). The stock summary of this assessment is presented in Figure 10.8.3.1.

Table 10.8.3.1 shows that anchovy assessments for the Bay of Biscay have been closely consistent in recent years.

10.9 Catch Prediction

For 1998, the level of recruitment used for the deterministic catch forecasts was estimated from two sources of data. The number of recruits, estimated by the ICA program independently from the observations on the intensity of upwelling in 1998, constitutes the first source. This reflects the information contained in the fishery data. The other is estimated from a relationship established between the series of recruitment given by the ICA program and the series of upwelling indexes. The parameter estimates of this relationship between the number of recruits and the intensity of upwelling are given in Table 10.9.1.and Figure 10.9.1. A Multiplicative model has been adopted for the forecast purposes of this year, although the form of the model should be revised each year. The upwelling forecast of recruitment appears as well in Table 10.9.1.

The estimate of recruitment in 1998 is the mean of the two estimates weighted by the inverse of their variances. That of 1999 is estimated solely on the basis of the upwelling index. The abundance of age 1 at the beginning of 1999 is estimated from the synthetic estimate of the Recruitment at age 0 in 1998 corrected by the total mortality estimated from the F of age 0 group in 1998 and an M of 1.2 (see table below).

	ESTIMATES of RECRUITMENT (age 0) FOR PROJECTIONS in 1998 and 1999				
Year	Source	NonLog Values	Log Values	Log Standard Error	LogVariance
1998	ICA output (Upwel_out)	2963	7.9939	0.9767	0.9540
1998	Upwelling prediction	5394	8.5930	0.4956	0.2457
				Sum of Variance	1.1996
1998	Age0_Synthesis	4774	8.4710	0.4418	0.1954
1999	Age0_Upwelling	4394	8.3880	0.5206	0.2710
1999	Age1 in 1999	1434	7.2684	0.4418	0.1954

For 2000 onwards the recruitment at age 0 is set equal to the geometric mean of those year classes estimated since 1987 (12047 millions) as reported by ICA outputs. Weights at age in the catches are the average values recorded since 1987 and weights in the stock are the average value input to the assessment since 1990 (when they began to be correctly estimated). Two projections are presented: the first assumes catches at $F_{status\ quo}$ (the mean of the last three years of fishing mortality estimates) in 1999. The second one assumes a catch constraint at 25,000 tonnes in 1999 that is believed to be rather consistent with the development of the fishery in the current year 1999 (Table 10.9.2).

The former suggested catches at 39,916 tonnes in 1999; level which seems too high due to the decrease in fishing effort observed this summer for the French fishery in the central and northern part of the Bay of Biscay. The level of 25,000 tonnes in 1999 seems to be more realistic and with this alternative constraint, the SSB expected for 2000 at $F_{status\ quo}$ is 25,178 tonnes which is lower than the B_{pa} defined by the Working group and accepted by ICES for the anchovy of the Bay of Biscay.

The uncertainties associated to this deterministic projection are strong due to the high variability of natural mortality and of the recruitment itself, before taking into account all the others uncertainties of the values of the parameters estimated by the ICA model.

10.10 Short-term risk analysis.

If medium term projections refers to the period between the assessment and the time when the most recently assessed year classes will not contribute any more to the catches of the fishery, then for the Bay of Biscay anchovy this period is probably two years including the current one. For that reason a probabilistic forecast of the fishery in 1999 and 2000 has been performed in order to check the risk for the spawning stock of falling below the Bpa of 36,000t or the B_{lim} of

18,000t. in 2000. These has been done with a simulation using the same inputs as the deterministic short term forecast (see section 10.9. and Table 10.9.2) and using the same range of F multiplier options for 2000. In addition, the F multiplier of the deterministic catch constraint of 25,000 t for 1999 has always been assumed as starting point.

The method of Cook (1993) was used with the input shows in Table 10.10.1. The results, in Figure 10.10.1, show the probability to exceed the $F_{statuquo}$ for a given catch in 2000 and the probability to reach a certain level of biomass in 2000. For example, we can see from the graph A (at the top) that a catch of 25,000t in 2000 corresponds to a probability to exceed the $F_{statuquo}$ of more than 0.8. The graph (B) shows, in case of the low level of recruitment forecasted for 1999 with the upwelling index, that the probability to be below the B_{pa} (36,000t) in 2000.is 0.9 and below the B_{lim} (18,000t) is about 0.25.

The sensitivity analysis of the short term forecast (Figure 10.10.2) shows a high sensitivity for the yield 2000 to several factors. It is negatively influenced with the increase of natural mortality of age groups 0 (K98), 1 (M1) and 2 (M2) and positively with the F multiplier in 2000 and mainly with the abundance of recruits. The variance of its estimate is mainly explained (57%) by the fluctuation of the natural mortality (parameters N0, N1, and K98) and less (19%) by the variation of fishing mortality (parameters sH1an sH3).

The SSB in the year 2000 is negatively affected with natural mortality multiplier in 1999 (K98) and the mortality of the recruits' (M0). The variance of its estimate is largely explained (62%) by the variation of the strength of recruitment in 1999 (parameter N0) and the level of natural mortality (parameter K98) and in a lesser extent to the fluctuation of fishing mortality (sH2). This observation confirms the difficulty to predict the stock biomass 2 years in advance. The SSB for 2001 will therefore strongly be dependent on the next year (2000) recruitment at age 0.

10.11 Medium term predictions

As mentioned before medium term and short term approaches to predictions are the same for this species (see section 10.10).

10.12 Long-Term Yield

Figure 10.12.1 shows the Yield and Spawning Biomass per Recruit (SBR) compared with the virgin state using the mean of the fishing mortalities at age (1-3) estimated for the period 1990-98, increased and decreased by 1 standard deviation. This figure shows that in the current situation the biomass per recruit of the population is close to be reduced (but not yet) to about half of that expected without any fishery. Therefore, the % SBR obtained for this population is slightly above 50 %, what satisfies the criteria % SBR of Macer and Sissenwine (1993) for pelagic species. In conclusion, the pattern of fishing mortality of this fishery could be sustainable from a long term point of view, provided that the risk of over-fishing at low levels of abundance is avoided by a close monitoring of the fishery coupled with an adaptive and fast managing system. From Figure 10.12.1, it can be seen that with geometric mean recruitments and current *status quo* F, catches around 30,000 t. can theoretically be expected from a long-term point of view. However this is always subject to the unavoidable recruitment fluctuations as it will be probably the case for 2000 (two consecutive low recruitments).

10.13 Reference points for management purposes

The exploitation of pelagic species should be undertaken with special care. We have to keep the exploitation of the stock at a moderate level of fishing mortality due to the risks of overfishing at low levels of biomass of this species and taking into account the historical collapses of several of these stocks (Ulltang 1980, Csirke 1988, Pitcher 1995). In this sense Macer and Sissenwine (1993) state that the higher the natural mortality the bigger should be kept the percentage of spawning biomass per recruit in relation to the virgin state (the criteria of %SBR). They also indicate that the small pelagic species could be poorly resistant to exploitation and for these species the %SBR corresponding with the F_{med} can be as high as 40 % or even in some cases 60 %. Patterson (1992) suggest that a moderate and sustainable rate of exploitation could be reached at 0.67 M. However one problem associated to these reviews is that they are based on the knowledge on medium size and not short living species as anchovy. Nevertheless at the current state of knowledge on this species, they may be taken as an indication about sustainable levels of fishing mortality.

The current levels of fishing mortality (F_{bar} for the ages 1-3 at about 0.76 since 1990) are below the likely 1.2 value for natural mortality. Therefore, it meets the criteria of Patterson (1992). The exploitation pattern indicates a negligible exploitation of the 0 group and a moderate fishing pressure on the age 1, far below the one exerted over the two and older years-old anchovies. Although the population consists mainly of 1 year-old anchovy that reach their first maturity in May-June, more than half of the fishing mortality on this age group takes place during and after the spawning season.

So a high percentage of the population is able to spawn. On the basis of these considerations, it can be said that the current exploitation pattern regarding 1 year-old anchovies is generally conservative.

The study group on the Precautionary Approach to Fisheries Management (CM1998/ACFM:10) made some suggestions concerning the Reference Points for Management Purposes made by the Working Group last year. Particularly, it suggested a reference F_{pa} for the anchovy population at the level of 50% SPR which correspond to a F_{bar} for ages 1-3 of about 1, so just at or below the average natural mortality. The current fishing levels seems to be below the F_{pa} (see Figure 10.12.1) and therefore not at a critical level.

However taking into account a) the likely variability of the natural mortality, b) the uncertainties of the assessment (specially for the latest levels of F) and c) the risk in the fisheries of small pelagic of increasing catchability at low levels of biomass, it seems that it could be difficult to manage from mortality targets to a given mortality value. In addition the changes of fishing mortality by changing the fishing effort are hardly to be implemented.

For that reason, the Working group considers that it is more efficient for the managers to have a clear and simple guideline, from the data given by the direct estimates of the spawning biomass, on the level corresponding to B_{lim} and B_{pa}.

In the last year report (ICES CM 1998/ Assess 6:), we estimate the value of B_{lim} equal to 18,000 tonnes of anchovy which correspond to the minimum biomass below which the stock has a high probability of collapse. This reference was also supported by the Study group on the Precautionary Approach (CM1998/ACFM:10). The Working Group defines another precautionary level that is the B_{pre}: precautionary biomass. This level was defined as the double of B_{lim} and set at 36,000 tonnes. This can be a level use for B_{pa} but on a short-term period (2 years).

The new observations made in 1998 and in 1999 and the knowledge gathered on this stock since 10 years makes that position stronger (see section 10.15). The only way to manage this stock from a concrete point of view is to evaluate the biomass, each year, from the direct estimation methods (DEPM or/and acoustic) and to evaluate the strength of the recruitment (environmental indices - see chapter 10.7). In any case, the fishery would be closed or strongly reduced if the biomass is around of B_{lim}. For convenience these arguments were repeated below.

B_{lim}: For anchovy this level of Biomass should be set at the minimum biomass below which the stock has a high probability of collapse. Preliminarily, it could be defined as the lowest estimated spawning stock biomass (from the assessment) over the past ten years (18,000 tonnes, in 1989, see Table 10.8.2.1). Although in this year a good recruitment was produced, this level of Spawning Biomass is small that it should not be expected good recruitments at lower biomasses. Therefore this level of Spawning Biomass should be considered as B_{lim}, below which there is a serious risk of stock collapse. The definition is consistent with the definition of MBAL previously accepted for this stock (set between 15,000 to 20,000 tonnes at the lowest DEPM estimates of Biomass, in 1989 and 1991, see Table 10.4.1.1).

B_{pre}: A useful reference for the Precautionary approach on levels of biomass should be the definition of a precautionary biomass (B_{pre}), slightly different of B_{pa} for management purposes. It is the Spawning Biomass that allows, under poor recruitment conditions, to obtain a minimum Spawning Biomass for the following year at the level of B_{lim}. In this way, the management would preserve a minimum SSB, in the next year, at least around to B_{lim} to prevent as soon as possible the collapse of the fishery. The past experience shows that a SSB between 30,000 tonnes or 40,000 tonnes give a biomass of 2 years old that allows, with a small recruitment, to have in the next Spring a biomass at the B_{lim} level. Taking into account these considerations and given the uncertainties in the assessment and the natural variability of this fishery we suggest to take a B_{pre} at a level doubled of the B_{lim}: 36,000 t. (see ICES 1999\assess:6 for further explanations).

In 1998 ICES proposed that a B_{pa} of 36,000 and a B_{lim} of 18, 000 be adopted and the Working Group does not suggest to alter these values.

10.14 Harvest Control Rules.

The Study Group on Precautionary Approach to Fisheries Management did not propose any harvest control rules, but for this stock the following suggestions could be considered.

Due to the rapid turn over of this population and the high variation of the natural mortality on the 1year old, there is no possibility to define practical and useful harvest control rules for that species without direct monitoring of the spawning stock each year. Even in the case of an important population of 1+anchovy, it is very difficult, to be sure to get the year after a SSB sufficiently important to prevent a collapse of the fishery in case of two low consecutive recruitment levels.

In the context of a continuous monitoring of that population, a partial or a total closure of that fishery would be the only practical solution to recommend to managers if the population is around B_{lim} and the environmental signals indicate a weak recruitment strength for next year. This would be the case in year 2000 if again a low recruitment would be expected according to the Upwelling index (see section 10.15.).

10.15 Management Measures and Considerations

The general framework of the anchovy management in the Bay of Biscay has been defined in the last working group report and this general framework remains presently valid. (See ICES CM1999\Assess: 6, for more details). As mentioned then, the assessment suggests that the current level of fishing mortality could be sustained in the long term provided that step towards a more conservative approach is taken when the stock is at a low level. This seems presently to be the case according to the current assessment. The actual state of the stock is of concern (see section 10.8) and suggests that it is necessary for the short-term management to be more active and to define the outlines of the fishery regulation.

The history of the exploitation of this stock in relation to the proposed precautionary reference points is shown at Figure 10.15.1. The Bay of Biscay anchovy is a short-living species that is totally mature at 1 year old. Although the Bay of Biscay anchovy constitute a small stock, catches from this resource are economically very valuable. In the last 15 years, there has been an increase in fishing effort and the catches have been recently exceeding the average level since 1960. The history of the Spanish purse seine fishery shows that a large fleet strongly dependent on anchovy and operating during a long period may not be economically profitable in the long term. Therefore, the need to regulate the fishery is

Figure 10.15.1 shows that in 1999 the stock remains in the area of the graph where the stock is above the B_{pa} and the reference F is lower than the F_{pa}. But we can observe from 1998 to 1999 a strong tendency for the state of the stock to converge towards B_{pa}, despite that the F stayed roughly the same (strong impact of the environment on the recruitment). This situation could be worse in 2000 because the upwelling index is low in 1999 and forecast a new bad recruitment (see Tables 10.7.1 and 10.9.1). So, it is possible that the stock, even at $F_{statusquo}$ may reach the level of B_{lim} or less in 2000.

A strong reduction of the spawning biomass in 2000, linked to adverse environmental conditions, seems a probable situation. For these reasons, the working group considers that it is important to reduce the fishing effort in 2000. This can be advised for the whole year or at least during the first quarter (mainly a French fishery) and the second quarter (mainly a Spanish fishery) in order to protect the spawners prior and during spawning time in 2000. In this way, all the possible regulations will have been taken in order to prevent a collapse of this stock always conceivable with this kind of short living species. After the DEPM survey in May and the estimate of the level of upwelling indexes by first September, some others management rules, more restrictive if necessary, could be defined in closed connection with the managers (strong economical impacts).

Although the stock is within safe biological limits in 1999, a strong reduction is expected (due to changes in upwelling index) such that the stock is expected to fall below Bpa in the short term because both the 1998 and 1999 year-classes are estimated as being very weak.

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	4,043	10,400		14,443 (*)
AVERAGE (1960-98)	5,433	28,530	306	34,056

(*) Preliminary data up to July for the French and Spanish fishery

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.

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	0	1113	1560	268	148	582	679	355	107	87	4899
1988	0	0	14	872	1386	776	291	1156	2002	326	0	0	6822
1989	704	71	11	331	648	11	43	56	70	273	9	28	2255
1990	0	0	16	1331	1511	127	269	1905	3275	1447	636	82	10598
1991	1318	2135	603	808	1622	195	124	419	1587	557	54	285	9708
1992	2062	1480	942	783	57	11	335	1202	2786	3165	2395	0	15217
1993	1636	1805	1537	91	343	1439	1315	2640	4057	3277	2727	47	20914
1994	1972	1908	1442	172	770	1730	663	2125	3276	2652	223	0	16934
1995	620	958	807	260	844	1669	389	1089	2150	1231	855	22	10892
1996	1084	630	614	206	150	1568	1243	2377	3352	2666	1349	0	15238
1997	2235	687	24	36	90	1108	1579	1815	1680	2050	718		12022
1998	1523	2128	783	0	237	1427	2425	4995	4250	2637	2477	103	22987
Average 87-98	1096	983	566	500	768	861	735	1697	2430	1720	963	60	12374
in percentage	8.9%	7.9%	4.6%	4.0%	6.2%	7.0%	5.9%	13.7%	19.6%	13.9%	7.8%	0.5%	100%
Average 92-98	1590	1371	878	221	356	1279	1136	2320	3079	2525	1535	29	16315
in percentage	9.7%	8.4%	5.4%	1.4%	2.2%	7.8%	7.0%	14.2%	18.9%	15.5%	9.4%	0.2%	100%

COUNTRY: SPAIN

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4133	3677	514	81	54	28	457	202	265	9864
1988	6	0	28	786	2931	3204	292	98	421	118	136	246	8266
1989	2	2	25	258	4295	795	90	510	116	198	1610	273	8173
1990	79	6	2085	1328	9947	2957	1202	3227	2278	123	16	10	23258
1991	100	40	23	1228	5291	1663	91	60	34	265	184	596	9573
1992	360	384	340	3458	13068	3437	384	286	505	63	94	89	22468
1993	102	59	1825	3169	7564	4488	795	340	198	65	546	23	19173
1994	0	9	149	5569	3991	5501	1133	181	106	643	198	74	17554
1995	0	0	35	5707	11485	1094	50	9	6	152	48	365	18951
1996	48	17	138	1628	9613	5329	1206	298	266	152	225	17	18937
1997	43	1	81	2746	2672	877	316	585	1898	331	203	185	9939
1998	35	235	493	371	4602	1083	1518	44	47	3	22	1	8455
Average 87-98	65	63	473	2532	6595	2578	596	474	492	214	290	179	14551
in percentage	0.4%	0.4%	3.2%	17.4%	45.3%	17.7%	4.1%	3.3%	3.4%	1.5%	2.0%	1.2%	100%
Average 92-98	84	101	437	3236	7571	3116	772	249	432	201	191	108	16497
in percentage	0.5%	0.6%	2.7%	19.6%	45.9%	18.9%	4.7%	1.5%	2.6%	1.2%	1.2%	0.7%	100%

COUNTRY: Total FRANCE + SPAIN

	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Average 91-98	1,674.4	1,471.5	1,315.5	3,456.6	7,926.4	4,394.6	1,907.3	2,569.3	3,510.8	2,726.6	1,725.8	136.5	32,811.3
in percentage	5.1%	4.5%	4.0%	10.5%	24.2%	13.4%	5.8%	7.8%	10.7%	8.3%	5.3%	0.4%	100%

Table 10.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 1998 (with live bait catches)

COUNTRIES	DIVISIONS	QUARTERS			CATCH (t)		
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	0	0	0	0.0%
	VIIIb	290	3840	206	0	4337	50.2%
	VIIIC	472	2215	1579	27	4294	49.8%
	TOTAL	763	6055	1785	27	8630	100.0%
	%	8.8%	70.2%	20.7%	0.3%	100.0%	
FRANCE	VIIIa	0	0	11671	5217	16888	73.5%
	VIIIb	4434	1665	0	0	6099	26.5%
	VIIIC	0	0	0	0	0	0.0%
	TOTAL	4434	1665	11671	5217	22987	100.0%
	%	19.3%	7.2%	50.8%	22.7%	100.0%	
INTERNATIONAL	VIIIa	0	0	11671	5217	16888	53.4%
	VIIIb	4725	5505	206	0	10436	33.0%
	VIIIC	472	2215	1579	27	4294	13.6%
	TOTAL	5197	7720	13456	5244	31617	100.0%
	%	16.4%	24.4%	42.6%	16.6%	100.0%	

Table 10.3.1.1: ANCHOVY catch at age in thousands for 1998 by country, division and quarter (without the catches from the live bait tuna fishing boats).

units: thousands

			1	2	3	4	Annual total
	QUARTERS		1	2	3	4	Annual total
SPAIN	**AGE**		**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**
		0	0	0	805	2,238	3,043
		1	36,586	181,124	42,698	12	260,421
		2	963	40,208	9,514	1	50,686
		3	78	3,924	8	0	4,010
		4	0	155	0	0	155
	TOTAL(n)		37,627	225,412	53,025	2,251	318,315
	W MED.		20.34	26.53	25.75	12.02	25.58
	CATCH. (t)		762.7	6055.5	1609.4	27.2	8,454.7
	SOP		765.5	5980.7	1606.5	27.1	8,379.7
	VAR. %		100.37%	98.76%	99.82%	99.61%	99.11%
FRANCE	**AGE**		**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**
		0	0	0	0	0	0
		1	164,392	61,715	345,467	194,826	766,400
		2	68,533	19,150	90,933	22,777	201,393
		3	1,028	565	3,389	0	4,983
		4	0	0	0	0	0
	TOTAL(n)		233,954	81,430	439,789	217,603	972,776
	W MED.		19.78	19.93	24.62	23.39	22.79
	CATCH. (t)		4,434.4	1,665.0	11,670.7	5,217.1	22,987.2
	SOP		4,627.1	1,623.1	10,828.8	5,089.4	22,168.4
	VAR. %		104.35%	97.48%	92.79%	97.55%	96.44%
	QUARTERS		**1**	**2**	**3**	**4**	**Annual total**
TOTAL	**AGE**		**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**
Sub-area VIII		0	0	0	805	2,238	3,043
		1	200,979	242,839	388,165	194,838	1,026,821
		2	69,496	59,359	100,447	22,778	252,079
		3	1,106	4,490	3,398	0	8,993
		4	0	155	0	0	155
	TOTAL(n)		271,581	306,842	492,814	219,854	1,291,092
	W MED.		19.86	24.78	24.74	23.27	23.48
	CATCH. (t)		5,197	7,720	13,280	5,244	31,442
	SOP		5,393	7,604	12,435	5,116	30,548
	VAR. %		103.76%	98.49%	93.64%	97.56%	97.16%

Table 10.3.1.2. 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)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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
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
2	1,461	203	1,496	139	0	0		477	209	522	58	0
3	912	3	0	0	0	0		0	0	0	0	0
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
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5
meanW (g)	14.7	4.3	13.3	12.4	13.3	12.1	12.9	10.2	15.8	13.4	9.14	10.85

Table 10.3.1.3 : Catches at age of anchovy of the fishery in the Bay of Biscay on half year basis as reported up to 1998 to ICES WGs and updated since then.

Units: Thousands The catches at age are equal to the addition of the age composition of landing and live bait catches of anchovy

(From Uriarte et al., 1997 WD updated for the 1997 AND 1998 data)

INTERNATIONAL

YEAR	1987		1983		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998	
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	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	0	49,771	0	109,173	0	133,232	0	4,075
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	522,361	189,081	683,009	456,164	471,370	439,888	443,818	598,139
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	282,301	21,771	233,095	53,156	138,183	40,014	128,854	123,225
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	76,525	90	31,092	499	5,580	195	5,596	3,398
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0	4,096	7	2,213	42	0	0	155	0
5	8,920	0	99	0	0	0	0	0	0	0	0	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	885,283	260,719	949,408	619,034	615,133	613,329	578,423	728,837
Internat Ca	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	23,479	6,637	21,024	13,349	10,704	11,443	12,918	18,700
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%	101.5%	98.2%	99.5%	100.4%	99.7%	102.1%	100.6%	94.8%
Annual Catch		15,308		15,581		10,614		34,272		19,635		37,885		40,392		34,631		30,116		34,373		22,147		31,617

SPAIN

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	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	0	52,238	0	91,400	0	4,075
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	542,127	72,763	296,261	123,011	217,711	57,847
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	163,010	12,403	74,856	9,435	41,171	9,515
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	14,461	499	1,927	195	4,002	9
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0	4,096	7	2,213	42	0	0	155	0
5	8,920	0	99	0	0	0	0	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	721,810	137,945	373,044	224,041	263,039	71,445
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	16,774	2,361	6,420	3,897	6,818	1,812
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%	99.5%	100.4%	99.5%	98.7%	98.9%	99.8%
Annual Catch		10,409		8,759		8,358		23,674		9,926		22,669		19,479		17,697		19,224		19,135		10,317		8,630

FRANCE

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 haf	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	0	56,936	0	41,832	0	0
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	140,882	383,401	175,109	316,877	226,107	540,293
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	70,085	40,753	63,327	30,579	87,683	113,710
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	16,631	0	3,653	0	1,594	3,389
4	0	0	0	0	0	0	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	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	227,598	481,089	242,089	389,288	315,384	657,392
Catch Fran	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	4,251	10,987	4,284	7,546	6,099	16,888
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%	102.8%	99.8%	100.0%	103.9%	102.5%	94.3%
Annual Catch		4,899		6,822		2,255		10,598		9,708		15,217		20,914		16,934		10,892		15,238		11,830		22,987

Table 10.3.2.1 Length distribution ('000) of anchovy in Divisions VIIIa,b,c by country, by gear, quarters and Sub-divisions in 1998

Length (half cm)	France VIIIab	Spain VIIIbc	France VIIIab	Spain VIIIbc	France VIIIa,b	Spain VIIIbc	France VIIIa,b	Spain VIIIbc
	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
3.5								
4								
4.5								
5								
5.5								
6								
6.5								
7								
7.5								
8		13						
8.5		34						
9		98	178					
9.5	1	64	325	15		17		5
10	1	103	1 875		21			8
10.5	7	68	3 332	12	3 253	45		6
11	1 783	106	3 002	40	4 965	69	347	63
11.5	693	327	2 569	76	13 871	171	2 868	287
12	3 574	1 056	4 025	642	16 600	267	13 821	633
12.5	16 602	1 607	6 971	1 171	25 976	499	22 649	653
13	29 635	3 025	8 110	3 815	32 117	880	16 114	402
13.5	50 075	4 571	10 142	8 337	21 748	795	16 505	50
14	42 999	6 590	7 142	18 245	19 839	988	12 901	54
14.5	31 784	6 665	5 413	22 671	16 192	1 725	10 276	48
15	20 288	4 682	3 096	31 744	17 295	3 596	9 946	17
15.5	13 752	2 857	4 822	42 076	31 709	7 417	20 592	18
16	14 126	2 105	7 545	37 090	42 158	11 723	30 266	3
16.5	4 419	1 199	5 608	26 775	46 515	10 250	18 619	2
17	2 277	997	4 170	17 784	57 913	8 453	17 025	1
17.5	1 650	760	1 365	7 775	53 463	3 990	16 097	1
18	497	527	950	4 377	22 871	1 808	5 849	
18.5		126	434	1 922	7 979	178	2 528	
19		46	207	767	4 161	90	981	
19.5			124	76	1 139	65	634	
20			41	2				
20.5								
21								
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number ('000)	234 161	37 627	81 446	225 412	439 784	53 025	218 018	2 251
catch (in tons)	4 434	762	1 665	6 056	11 671	1 609	5 217	27
mean length (cm)	14.4	14.7	14.2	15.8	15.6	16.3	15.2	12.7
mean weight (g)	18.8	20.3	18.4	26.5	24.9	25.8	22.8	12

Table 10.3.2.2: Mean weight at age in the national and international catches of anchovy in SubArea VIII on half year basis
Units: grams

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998	
Sources:	Anon. (1989 & 1991)		Anon. (1989)		Anon. (1991)		Anon. (1991)		Anon. (1992)		Anon. (1993)		Anon. (1995)		Anon. (1996)		Anon. (1997)		Anon. (1998)		Anon. (1999)		This 1999WG	
Periods	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf
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	0.0	15.1	0.0	12.0	0.0	11.6	0.0	10.2
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	22.5	26.9	19.1	23.2	14.4	20.3	21.8	23.7
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	32.3	31.3	29.3	27.7	26.9	30.1	24.3	27.7
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	36.4	36.4	35.0	35.7	32.0	29.7	31.9	28.7
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	37.3	29.1	46.1	39.7	0.0	0.0	31.9	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	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	26.9	25.0	22.2	21.6	17.3	19.1	22.5	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	23,830	6,520	21,066	13,139	10,672	11,687	12,996	17,727
mean weight 3-	39.3	39.2	35.0	44.5	29.7	42.7	44.8	40.8	28.2	39.0	37.7	27.4	30.5	30.5	30.7	30.0	36.5	35.9	35.8	36.0	32.0	29.7	31.9	28.7

SPAIN

Periods	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf
Age 0	0.0	11.6	0.0	4.7	0.0	12.6	0.0	5.9	0.0	14.3	0.0	13.0	0.0	12.3	0.0	14.7	0.0	16.1	0.0	11.2	0.0	10.8	0.0	10.2
1	21.4	21.0	21.3	21.7	20.6	25.3	20.6	24.4	18.5	16.4	21.5	18.2	16.4	15.5	18.7	19.6	24.8	20.1	19.9	19.3	14.1	21.1	24.2	24.7
2	33.0	39.3	32.4	35.7	29.3	36.0	29.0	28.9	28.1	22.4	32.6	24.4	29.5	26.6	29.2	25.4	35.2	33.4	31.9	29.0	28.6	27.4	32.3	35.3
3	38.0	39.2	34.6	44.5	27.3	42.7	44.9	40.8	34.4	39.0	44.5	27.4	43.3	0.0	32.0	30.0	38.2	36.4	40.2	35.7	41.7	29.7	35.3	52.1
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	37.3	29.1	46.1	39.7	0.0	0.0	31.9	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	29.0	19.1	24.2	9.4	24.7	14.9	21.4	24.6	22.4	14.9	23.4	17.9	20.5	15.0	25.0	18.6	29.4	18.0	23.1	17.6	17.1	17.2	25.6	25.3
SOP	8,841	1,628	6,811	1,814	5,222	2,966	16,555	7,234	7,900	1,555	20,904	1,629	17,352	2,276	15,424	2,467	18,703	903	16,696	2,170	6,386	3,847	6,746	1,809
mean weight 3-	39.6	39.2	35.2	44.5	27.3	42.7	44.9	40.8	34.4	39.0	44.5	27.4	43.3	43.3	32.0	30.0	38.1	35.9	41.0	36.0	41.7	29.7	35.2	52.1

FRANCE

					Old values		Old values		Old values		Old values		Old values		Old values		Old values		Old values					
Periods	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf	1st half	2nd haf
Age 0	0.0	13.0	0.0	12.1	0.0	17.0	0.0	11.0	0.0	15.6	0.0	12.3	0.0	0.0	0.0	11.6	0.0	13.5	0.0	12.7	0.0	13.4	0.0	0.0
1	20.4	22.3	19.8	24.3	16.6	24.5	20.6	23.3	18.7	27.1	13.8	23.9	13.1	21.7	14.8	26.1	17.2	27.6	15.8	23.9	14.9	20.0	19.5	23.6
2	28.7	27.2	26.1	29.0	26.0	29.6	26.5	26.1	22.9	30.0	27.5	29.8	23.2	29.8	22.6	30.3	24.5	31.1	23.3	27.3	24.9	31.0	20.6	27.1
3	35.4	0.0	34.0	0.0	31.7	0.0	29.0	0.0	27.6	0.0	27.9	0.0	27.6	0.0	27.3	0.0	31.4	0.0	30.5	0.0	26.8	0.0	23.2	28.6
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	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	23.4	22.4	21.4	23.9	21.9	22.9	21.1	23.4	21.8	26.8	16.8	23.6	17.7	22.7	18.5	26.4	20.5	26.7	19.2	22.8	17.7	20.1	19.8	24.2
SOP	2,954	1,977	3,017	3,871	1,821	469	2,961	7,518	6,768	2,984	5,361	9,867	6,962	13,981	8,016	8,975	5,127	5,617	4,370	10,969	4,286	7,840	6,250	15,918

TABLE 10.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(from MOTOS & URIARTE WD1993, MOTOS et al. 1995 and URIARTE et al. WD 1999)

YEAR		1987	1988	1989(*)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999 (Preliminary)
Period of year		2 - 7 June	21 - 28 Ma	10 - 21 Ma	4 - 15 May	6May-07Ju	6May-13Ju	No survey	7 May-3Jun	11 - 25 Ma	18 - 30 May	9 - 21 May	18 May - 8	22 May - 5 June
Positive area (km2)		23850	45384	17546	59757	24264	67796		48735	31189	28448	50133	73131	51019
Surveyed area (km2)		34934	59840	37930	79759	84032	92782		60330	51698	34294	59587	83156	61533
Po (Egg per 0.05 m^2)(A+)		4.6	5.52	2.08	3.78	2.55	4.27		4.39	4.975	4.87	2.69	3.825	3.65
Total Daily egg production		2.20	5.01	0.73	5.02	1.24	5.81		4.48	3.09	2.77	2.70	5.6	3.72
(* 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
SSB (t)		29365	63500	11861	97239	19276	90720	--	70940	54700	*39344 (**)*	51176	101976	*68679 (**)*
	C.V.	0.48	0.31	0.41	0.17	0.14	0.2		0.16	0.09		0.10	0.09	
TOTAL #		1129	2675	470	5843	965.6	5797	--	3516	2644		3737.7	6282.4	
(millions)	C.V.					0.14	0.25		0.18	0.11		0.16	0.13	
No/age:	1	656	2349	246	5613	670.5	5571		2457	2257		3242.6	5466.7	
	C.V.					0.16	0.26		0.23	0.13		0.17	0.15	
(millions)	2	331	258	206	190	290.3	209.3		1005	329		482.1	759.5	
	C.V.					0.17	0.22		0.19	0.23		0.1	0.14	
	3+	142	68	18	40	4.8	16.7		54	58		13.1	56.3	
	C.V.					0.42	0.51		0.28	0.30		0.27	0.36	

(*) Likely subestimate according to authors (Motos &Santiago,1989)
(**) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area)

Table 10.4.2.1. Evaluation of Anchovy abundance index from French acoustic surveys in the Bay of Biscay.

	1983 20/4-25/4	1984 30/4-13/5	1989 (2) 23/4-2/5	1990 12/4-25/4	1991 6/4-29/4	1992 13/4-30/4	1993	1994 15/5-27/5	1995	1996	1997 6/5-22/5	1998 20/5-7/6
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	*na*	2300(3)	*na*	*na*	1726(3)	9400 5600 (3)
Density (t/nm(**2))	15.4	10.3	3,0	14.5-32.2 (4	23.6	32.8	*na*	14.5	*na*	*na*	36.5	10.2
Biomass (t)	50,000	38,500	15,500	0-110,000 (	64,000	89,000	*na*	35,000	*na*	*na*	63000	57000
Number (10**(-6))	2,600	2,000	805	300-7,500 (	3,173	9,342	*na*	*na*	*na*	*na*	3351	*na*
Number of 1-group(10**(-6))	1,800 (1)	600	400	100-7,500 (	1,873	9,072	*na*	*na*	*na*	*na*	2481	*na*
Number of age 2-group(10**(-6))	800	1,400	405	0 -200 (4)	1,300	270	*na*	*na*	*na*	*na*	870	*na*
Anchovy mean weight	19.2	19.3	19.3	*na*	20.2	9.5	*na*	*na*	*na*	*na*	18.8	*na*

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems

Table 10.5.1: Evolution of the French and Spanish fleet 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	52	0	(1)	52	571	623
1972	35	0	(1)	35	492	527
1976	24	0	(1)	24	354	378
1980	14	n/a	(1)	14	293	307
1984	n/a	4	(1)	4	306	310
1987	9	36	(1)	45	282	327
1988	10	61	(1)	71	278	349
1989	2	51	(1)	53	215	268
1990	30	80 (2)		110	266	376
1991	30	115 (2)		145	250	395
1992	13	123 (2)		136	244	380
1993	21	138 (2)		159	253	412
1994	26	150 (2)		176	257	433
1995	26	120 (2)		146	257	403
1996	20	100 (2)		120	251	371
1997	26	136 (2)		162	267	429
1998	n/a	n/a			266	266
1999					250	250

(1) Only St. Jean de Luz and Hendaya.
(2) Maximum number of potential boats; the number of pelagic trawling gears is roughly half of this number due to the fishing in pairs of mid-water trawlers.
n/a = Not available.

TABLE 10.5.2 Catch per unit effort of anchovy from the Spanish Spring fishery in the Bay of Biscay
(Average catches per boat and fishing day) (From WG members)

YEAR	87	88	89	90	91	92	93	94	95	96	97	98	99 (Provisional)
CPUE/PERIOD	03-06	03-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06	03-06	03-06
CPUE (t)	0.9	0.7	0.8	1.5	1.2	2.5	1.7	1.6	2.6	2.2	0.8	0.9	1.4
CPUE 1 (#)	13.8	19.7	16.1	63.4	29.3	86.3	46.7	26.5	52.6	69.6	36.9	28.8	17.8
CPUE 2 (#)	12.2	5.8	13.7	4.4	20.2	16.6	29.7	32.6	29.6	21.2	9.4	5.7	31.0
CPUE 3 (#)	2.8	0.7	1.2	0.8	0.4	1.3	0.1	4.6	8.2	1.9	0.2	0.6	1.6
CPUE 4+ (#)	2.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0
CPUE 2+ (#)	17.5	6.6	14.9	5.3	20.6	17.9	29.8	37.2	38.3	23.4	9.7	4.4	32.6
CPUE 3+ (#)	5.3	0.9	1.2	0.8	0.4	1.3	0.1	4.6	8.8	2.1	0.2	0.2	1.6

in thousands

* CPUE values for the years 1988-89 are updapted acording to the revised catches at age of Spring from Uriarte et al. WD 1997

Table 10.7.1 Upwelling index from Mars to July in the Bay of Biscay as predictor of Recruitment of the anchovy in subarea VIII From Borja et al. (WD 1997, and in press), updated for 1999

years	index value
1987	508.4
1988	473.2
1989	970.9
1990	905.9
1991	1076.3
1992	1128.8
1993	570.9
1994	905.0
1995	1204.0
1996	973.0
1997	1230.5
1998	461.0
1999	402.0

Table 10.8.1.1: Comparison of the assessment made in 1999 and preliminary Assessments
ANCHOVY IN SUBAREA VIII

Type of Asses	**The 1998 Assessment**			**Run 01: Like the 1998 Assessment**			**Run 0.2: Assessment of 1999 DEPM as absolute**		
Tunning Indexes	**All indexes**			**All indexes (including revision of mean weights)**				**Without upwelling**	
Assessment	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**
Year	**Adopted 98**	**Adopted 98**	**Adopted 98**	**Like 1998 As**	**Like 1998 As**	**Like 1998 As**	**Upwelling ou**	**Upwelling ou**	**Upwelling out**
1987	7,424	0.573	30,027	7,480	0.559	30,176	7,447	0.550	37,813
1988	4,294	0.541	27,519	4,353	0.529	27,775	4,387	0.501	37,070
1989	19,052	0.617	19,112	19,084	0.603	19,370	19,082	0.581	23,389
1990	7,206	0.629	55,649	7,312	0.620	55,705	7,319	0.615	55,844
1991	27,767	1.299	28,391	28,247	1.271	28,687	28,402	1.258	28,794
1992	25,764	0.891	69,737	25,268	0.874	70,806	25,305	0.863	71,236
1993	13,877	0.574	88,690	13,229	0.572	87,320	13,334	0.566	87,618
1994	10,454	0.679	60,978	10,308	0.685	58,327	10,275	0.679	58,755
1995	14,501	0.862	45,126	13,459	0.867	43,659	13,397	0.861	43,727
1996	21,443	1.172	40,617	23,280	1.252	36,801	20,231	1.238	37,098
1997	30,950	0.414	54,783	35,520	0.486	49,815	34,648	0.486	49641
1998	3,158			3,193	0.247	116,434	2,977	0.251	118593
1999				2,228			12,047		
Mean Values	12,445	0.750	43,065	12,580	0.714	45,889	12,348	0.704	48,849
	SSQ	df	Variance	SSQ	df	Variance	SSQ	df	Variance
Tot. WSSQ	4.925	83	0.059	5.162	92	0.056	5.032	82	0.061
Separ CAGE	3.365	26	0.129	3.398	29	0.117	3.375	29	0.116
DEPM SSB	0.373	11	0.034	0.357	12	0.030	0.282	12	0.023
Acoustic SSB	0.189	4	0.047	0.392	5	0.078	0.423	5	0.085
DEPM Pop.	0.771	27	0.029	0.788	30	0.026	0.727	30	0.024
Acoust. Pop.	0.222	6	0.037	0.223	6	0.037	0.226	6	0.038
Upwelling/Recruitme	0.005	10	0.000	0.005	11	0.000			
Tot USSQ	42.383	83	0.511	43.851	92	0.477	42.997	82	0.524
Separ CAGE	31.125	26	1.197	31.680	29	1.092	32.031	29	1.105
DEPM SSB	1.494	11	0.136	1.428	12	0.119	1.127	12	0.094
Acoustic SSB	0.757	4	0.189	1.567	5	0.313	1.692	5	0.338
DEPM Pop.	6.938	27	0.257	7.093	30	0.236	6.543	30	0.218
Acoust. Pop.	1.577	6	0.263	1.584	6	0.264	1.645	6	0.274
Upwelling/Recruitme	0.493	10	0.049	0.499	11	0.045			
Selectivity _ 0	0.007	0.0054		0.007	0.0050		0.007	0.0050	
Selectivity _ 1	0.375	0.2811		0.385	0.2748		0.389	0.2736	
Selectivity _ 3	0.688	0.5164		0.665	0.4747		0.657	0.4628	
Weighting factors for the catches at age			**Model**			**Model**			**Model**
Weights 1987	0.5			0.5			0.5		
Weights 1988	0.5			0.5			0.5		
All other years	1			1			1		
Weights age 0	0.1			0.1			0.1		
Weights age 1	1			1			1		
Weights age 2	1			1			1		
Weights age 3	1			1			1		
Weights age 4	0.01			0.01			0.01		
Weights age 5	0.01			0.01			0.01		
Weights DEPM aged	0.5		Absolute	0.5		Absolute	0.5		Absolute
Weights Acoust age	0.5		Relative	0.5		Relative	0.5		Relative
Weight DEPM (SSB	0.5		Absolute	0.5		Absolute	0.5		Absolute
Weight Acoustic SSI	0.5		Relative	0.5		Relative	0.5		Relative
Upwelling/Recruitme	0.1		Linear	0.1		Linear			

Table 10.8.1.2: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning DEPM surveys

Type of Asses	**DEPM as absolute**			**Two series of DEPM 87-94, 95-98**			**Assessment with DEPM as relative**		
				The first relative the second absolute					
Tuning Indexes	Upwelling Removed			Upwelling Removed			Upwelling Removed		
Assessment	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**
Year	**Adopted**	**Adopted**	**Adopted**	**Two DEPM**	**Two DEPM**	**Two DEPM**	**DEPM relati**	**DEPM relati**	**DEPM relative**
1987	7,447	0.550	37,813	6,804	0.613	33,314	5,949	0.989	24,865
1988	4,387	0.501	37,070	4,064	0.553	32,538	3,647	0.850	26,583
1989	19,082	0.581	23,389	17,590	0.649	20,941	16,155	0.993	17,204
1990	7,319	0.615	55,844	6,771	0.676	51,187	6,190	0.947	45,727
1991	28,402	1.258	28,794	27,124	1.353	25,627	23,983	1.909	21,711
1992	25,305	0.863	71,236	23,625	0.962	68,045	21,464	1.480	57,418
1993	13,334	0.566	87,618	12,765	0.630	80,221	11,184	0.982	68,080
1994	10,275	0.679	58,755	10,204	0.735	54,449	9,204	1.108	44,006
1995	13,397	0.861	43,727	13,003	0.908	42,129	10,759	1.310	34,734
1996	20,231	1.238	37,098	19,852	1.324	36,124	14,993	2.048	27,496
1997	34,648	0.486	49641	33,165	0.514	47,724	25,528	0.995	33149
1998	2,977	0.251	118593	2,591	0.267	111,067	2,277	0.492	79572
1999	12,047			11,208			10,007		
Mean Values	12,348	0.704	48,849	11,626	0.765	45,131	10,063	1.175	36,096
	SSQ	df	Variance	SSQ	df	Variance	SSQ	df	Variance
Tot. WSSQ	5.032	82	0.061	4.684	76	0.062	4.375	78	0.056
Separ CAGE	3.375	29	0.116	3.268	29	0.113	3.121	29	0.108
DEPM SSB	0.282	12	0.023	0.020	3	0.007	0.235	11	0.021
Acoustic SSB	0.423	5	0.085	0.429	5	0.086	0.394	5	0.079
DEPM Pop.	0.727	30	0.024	0.119	9	0.013	0.417	27	0.015
Acoust. Pop.	0.226	6	0.038	0.221	6	0.037	0.209	6	0.035
Upwelling/Recruitment Index									
DEPm Relative Biomass				0.236	6	0.039			
DEPM Relative Numbers				0.391	18	0.022			
Tot USSQ	42.997	82	0.524	35.971	76	0.473	27.661	78	0.355
Separ CAGE	32.031	29	1.105	27.068	29	0.933	19.906	29	0.686
DEPM SSB	1.127	12	0.094	0.080	3	0.027	0.941	11	0.086
Acoustic SSB	1.692	5	0.338	1.717	5	0.343	1.575	5	0.315
DEPM Pop.	6.543	30	0.218	1.073	9	0.119	3.755	27	0.139
Acoust. Pop.	1.645	6	0.274	1.573	6	0.262	1.484	6	0.247
Upwelling/Recruitment Index									
DEPm Relative Biomass				0.944	6	0.157			
DEPM Relative Numbers				3.515	18	0.195			
Selectivity _ 0	0.007	0.0050		0.007	0.0055		0.006	0.0075	
Selectivity _ 1	0.389	0.2736		0.392	0.3001		0.354	0.4156	
Selectivity _ 3	0.657	0.4628		0.732	0.5604		1.185	1.3930	
Weighting factors for the catches at age			**Model**			**Model**			**Model**
Weights 1987	0.5			0.5			0.5		
Weights 1988	0.5			0.5			0.5		
All other years	1			1			1		
Weights age 0	0.1			0.1			0.1		
Weights age 1	1			1			1		
Weights age 2	1			1			1		
Weights age 3	1			1			1		
Weights age 4	0.01			0.01			0.01		
Weights age 5	0.01			0.01			0.01		
Weights DEPM a	0.5		Absolute	0.5		Absolute	0.5		Relative
Weights Acoust a	0.5		Relative	0.5		Relative	0.5		Relative
Weight DEPM (S	0.5		Absolute	0.5		Absolute	0.5		Relative
Weight Acoustic S	0.5		Relative	0.5		Relative	0.5		Relative
Upwelling/Recruitment Index				0		None	0		None

Table 10.8.2.1. Inputs for the anchovy assessment (subarea VIII)

Output Generated by ICA Version 1.4

Anchovy VIII Biscay (run: ICAAND05/I05)

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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
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
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
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
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
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

x 10 ^ 6

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	24.7	13.3	66.9	27.2	215.2	131.6	45.6	42.1	69.6	150.9	101.6	4.5
1	312.3	331.3	222.6	1016.6	698.6	2001.0	1250.7	774.4	727.4	1260.4	869.7	817.3
2	179.1	138.4	182.7	107.0	699.5	151.2	552.4	664.3	383.1	324.4	188.8	255.3
3	35.7	16.2	16.2	17.9	15.9	20.5	7.1	60.9	65.1	31.5	6.3	11.3
4	50.2	8.2	4.7	4.0	6.2	1.5	2.7	1.9	15.0	13.8	2.0	1.0

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	.012000	.005000	.013000	.007000	.014000	.013000	.012000	.015000	.015000	.012000	.012000	.010000
1	.021000	.022000	.020000	.022000	.020000	.021000	.018000	.020000	.024000	.020000	.017000	.023000
2	.032000	.030000	.029000	.028000	.025000	.031000	.027000	.027000	.032000	.031000	.028000	.026000
3	.038000	.035000	.031000	.043000	.028000	.038000	.031000	.031000	.036000	.040000	.032000	.031000
4	.041000	.038000	.027000	.041000	.041000	.041000	.041000	.041000	.037000	.046000	.041000	.032000
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000
1	.022000	.023000	.021000	.016000	.017000	.015000	.016000	.017000	.019000	.016000	.012000	.015000
2	.033000	.030000	.029000	.030000	.028000	.032000	.027000	.026000	.031000	.029000	.027000	.030000
3	.038000	.034000	.033000	.035000	.034000	.032000	.033000	.032000	.034000	.034000	.037000	.037000
4	.041000	.043000	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	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
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
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
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

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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
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
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
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
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
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

Table 10.8.2.1.(Continued)

INDICES OF SPAWNING BIOMASS

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	70.94	54.70	39.34	51.18	101.98	68.68

x 10 ^ 3

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	999990.	999990.	15500.	999990.	64000.	89000.	999990.	35000.	999990.	999990.	63000.	57000.	999990.

AGE-STRUCTURED INDICES

FLT01: ACOUSTIC SURVEYS (Catch: Unknown)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0

FLT02: DEPM SURVEYS (Catch: Unknown) (Ef

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	656.0	2349.0	346.0	5613.0	670.5	5571.0	*******	2457.0	2257.0	*******	3242.6	5466.7
2	331.0	258.0	290.5	190.0	290.3	209.3	*******	1005.0	329.0	*******	482.1	759.5
3	142.0	68.0	25.4	40.0	4.8	16.7	*******	54.0	58.0	*******	13.1	56.3

x 10 ^ 3

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.0057	0.0052	0.0060	0.0064	0.0131	0.0090	0.0059	0.0071	0.0090	0.0129	0.0050	0.0026
1	0.3132	0.2853	0.3309	0.3502	0.7168	0.4914	0.3224	0.3870	0.4907	0.7055	0.2767	0.1431
2	0.8059	0.7341	0.8515	0.9011	1.8447	1.2646	0.8297	0.9959	1.2628	1.8156	0.7120	0.3682
3	0.5298	0.4826	0.5598	0.5924	1.2127	0.8314	0.5455	0.6547	0.8301	1.1936	0.4681	0.2420
4	0.8059	0.7341	0.8515	0.9011	1.8447	1.2646	0.8297	0.9959	1.2628	1.8156	0.7120	0.3682
5	0.8059	0.7341	0.8515	0.9011	1.8447	1.2646	0.8297	0.9959	1.2628	1.8156	0.7120	0.3682

Table 10.8.2.1 Inputs for the anchovy assessment (Subarea VIII) (continued)

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	7447.	4387.	19082.	7319.	28402.	25305.	13334.	10275.	13397.	20231.	34648.	2977.	12047.
1	1935.	2230.	1314.	5713.	2190.	8443.	7554.	3993.	3073.	3999.	6016.	10383.	894.
2	515.	426.	505.	284.	1212.	322.	1556.	1648.	817.	567.	595.	1374.	2710.
3	142.	69.	62.	65.	35.	58.	27.	204.	183.	70.	28.	88.	286.
4	144.	25.	13.	11.	11.	3.	8.	5.	32.	24.	6.	5.	21.
5	26.	3.	3.	3.	2.	2.	3.	2.	2.	2.	3.	5.	2.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.0500	0.0500	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.5000	0.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.5000	0.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.5000	0.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.0050	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Predicted SSB Index Values

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	37.81	37.07	23.39	55.84	28.79	71.24	*******	58.76	43.73	37.10	49.64	118.59	59.48

x 10 ^ 3

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	*******	*******	21.87	*******	26.93	66.61	*******	54.94	*******	*******	46.42	110.90	*******

x 10 ^ 3

Predicted Age-Structured Index Values

FLT01: ACOUSTIC SURVEYS (Catch: Unknown Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	793.8	*******	1182.7	4867.1	*******	*******	*******	*******	3690.5
2	582.2	*******	940.7	345.2	*******	*******	*******	*******	654.1

FLT02: DEPM SURVEYS (Catch: Unknown) (E Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	943.2	1101.4	635.2	2735.7	881.2	3780.9	*******	1878.8	1376.6	*******	2983.1	5486.2
2	198.7	170.1	190.6	104.8	285.5	99.9	*******	580.8	253.5	*******	239.9	652.3
3	127.9	42.4	32.6	32.6	14.0	23.6	*******	87.3	80.5	*******	16.4	49.4

x 10 ^ 3

Table 10.8.2.1 Inputs for the anchovy assessment (Subarea VIII) (continued)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
1	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886	0.3886
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
3	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574	0.6574
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
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

Table 10.8.2.2. Results for the anchovy assessment (Subarea VIII)

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	7446510	168761	37813	15308	0.4048	0.5496	100
1988	4386750	124672	37070	15581	0.4203	0.5007	100
1989	19081960	292990	23389	10614	0.4538	0.5807	100
1990	7318640	175940	55844	34272	0.6137	0.6146	99
1991	28401670	498904	28794	19635	0.6819	1.2581	103
1992	25305270	442685	71236	37885	0.5318	0.8625	98
1993	13334140	324209	87618	40392	0.4610	0.5659	99
1994	10275180	271694	58755	34631	0.5894	0.6792	99
1995	13396820	252102	43727	30116	0.6887	0.8612	98
1996	20231370	326621	37098	34373	0.9265	1.2382	99
1997	34647790	505442	49641	22337	0.4500	0.4856	99
1998	2977270	236387	118593	31617	0.2666	0.2511	102

No of years for separable analysis : 12
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 1998
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 34
Number of observations : 116
Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1987	0.8059	25	0.4873	1.3330	0.6235	1.0418	0.8329
2	1988	0.7341	23	0.4636	1.1623	0.5807	0.9281	0.7546
3	1989	0.8515	18	0.5969	1.2147	0.7103	1.0207	0.8656
4	1990	0.9011	17	0.6373	1.2742	0.7552	1.0753	0.9153
5	1991	1.8447	13	1.4167	2.4020	1.6122	2.1107	1.8615
6	1992	1.2646	17	0.8932	1.7904	1.0591	1.5101	1.2847
7	1993	0.8297	18	0.5719	1.2037	0.6863	1.0032	0.8448
8	1994	0.9959	17	0.7074	1.4021	0.8364	1.1858	1.0112
9	1995	1.2628	16	0.9095	1.7533	1.0681	1.4929	1.2806
10	1996	1.8156	14	1.3605	2.4231	1.5671	2.1037	1.8354
11	1997	0.7120	21	0.4682	1.0827	0.5749	0.8818	0.7285
12	1998	0.3682	24	0.2297	0.5903	0.2894	0.4684	0.3790
Separable Model: Selection (S) by age								
13	0	0.0071	31	0.0038	0.0132	0.0052	0.0097	0.0075
14	1	0.3886	12	0.3052	0.4947	0.3435	0.4395	0.3915
	2	1.0000		Fixed : Reference Age				
15	3	0.6574	13	0.5005	0.8635	0.5720	0.7556	0.6638
	4	1.0000		Fixed : Last true age				
Separable model: Populations in year 1998								
16	0	2977275	97	440561	20120159	1123169	7892102	4788315
17	1	10383170	21	6781408	15897910	8354820	12903955	10631340
18	2	1373962	18	948181	1990938	1137076	1660198	1398785
19	3	87908	22	56282	137307	70020	110367	90213
20	4	5237	33	2709	10125	3741	7331	5542
Separable model: Populations at age								
21	1987	144260	128	11527	1805293	39742	523655	331178
22	1988	25147	55	8549	73968	14502	43606	29260
23	1989	12881	34	6579	25221	9142	18148	13660
24	1990	10600	28	6006	18708	7933	14164	11055
25	1991	10811	27	6363	18368	8249	14168	11213
26	1992	3114	32	1637	5924	2243	4323	3286
27	1993	7569	34	3865	14824	5371	10666	8027
28	1994	4781	32	2521	9065	3449	6626	5042
29	1995	31985	29	17987	56875	23845	42903	33394
30	1996	24078	31	12886	44990	17503	33124	25335
31	1997	6351	37	3018	13365	4345	9283	6826

SSB Index catchabilities
INDEX1
Absolute estimator. No fitted catchability.
INDEX2
Linear model fitted. Slopes at age :

32	2	Q	.9351	18	.7808	1.631	.9351	1.362	1.148

Age-structured index catchabilities
FLT01: ACOUSTIC SURVEYS (Catch: Unknown
Linear model fitted. Slopes at age :

33	1	Q	.9414E-03	26	.7328E-03	.2038E-02	.9414E-03	.1587E-02	.1264E-02
34	2	Q	.1796E-02	26	.1394E-02	.3921E-02	.1796E-02	.3044E-02	.2421E-02

FLT02: DEPM SURVEYS (Catch: Unknown) (E
Absolute estimator. No fitted catchability.
RESIDUALS ABOUT THE MODEL FIT

Table 10.8.2.2. Results for the anchovy assessment (Subarea VIII) (Continued)

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.433	2.427	0.990	-0.468	-0.910	-1.232	0.332	0.352	-0.335	-0.323	0.270	-0.098
1	0.081	0.428	-0.214	0.295	-0.462	-0.328	0.116	0.093	-0.022	-0.101	0.047	0.243
2	-0.045	-0.267	-0.306	0.236	-0.772	0.395	-0.038	-0.192	-0.231	-0.125	-0.058	-0.013
3	-0.080	-0.423	0.214	-0.304	0.607	-0.188	-0.288	0.035	0.162	0.002	-0.086	-0.225
4	-1.214	-1.763	-1.539	-1.384	-1.831	-0.380	-0.989	-0.656	-1.297	-1.791	-0.701	0.027

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.2529	0.5382	-0.3357	0.5546	-0.4013	0.2418	*******	0.1884	0.2239	0.0587	0.0305	-0.1509	0.1438

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	*******	*******	-0.3444	*******	0.8658	0.2897	*******	-0.4510	*******	*******	0.3054	-0.6656	*******

AGE-STRUCTURED INDEX RESIDUALS

FLT01: ACOUSTIC SURVEYS (Catch: Unknown

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.6854	*******	0.4597	0.6227	*******	*******	*******	*******	-0.3971
2	-0.3629	*******	0.3234	-0.2457	*******	*******	*******	*******	0.2852

FLT02: DEPM SURVEYS (Catch: Unknown) (E

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.363	0.757	-0.608	0.719	-0.273	0.388	*******	0.268	0.494	*******	0.083	-0.004
2	0.511	0.417	0.422	0.595	0.017	0.739	*******	0.548	0.261	*******	0.698	0.152
3	0.105	0.472	-0.250	0.205	-1.071	-0.347	*******	-0.480	-0.328	*******	-0.225	0.132

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 1998

Variance	0.1164
Skewness test stat.	-1.1652
Kurtosis test statistic	1.6976
Partial chi-square	0.2990
Significance in fit	0.0000
Degrees of freedom	29

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance

Last age is a plus-group

Variance	0.0470
Skewness test stat.	0.9816
Kurtosis test statistic	-0.5885
Partial chi-square	0.0530
Significance in fit	0.0000
Number of observations	12
Degrees of freedom	12
Weight in the analysis	0.5000

DISTRIBUTION STATISTICS FOR INDEX2

Linear catchability relationship assumed

Last age is a plus-group

Variance	0.1692
Skewness test stat.	0.3055
Kurtosis test statistic	-0.6307
Partial chi-square	0.0792
Significance in fit	0.0000
Number of observations	6
Degrees of freedom	5
Weight in the analysis	0.5000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: ACOUSTIC SURVEYS (Catch: Unknown

Table 10.8.2.2. Results for the anchovy assessment (Subarea VIII) (Continued)

Linear catchability relationship assumed

Age	1	2
Variance	0.1533	0.0472
Skewness test stat.	-0.0552	-0.0393
Kurtosis test statisti	-0.7466	-0.7842
Partial chi-square	0.0619	0.0221
Significance in fit	0.0040	0.0009
Number of observations	4	4
Degrees of freedom	3	3
Weight in the analysis	0.3750	0.3750

DISTRIBUTION STATISTICS FOR FLT02: DEPM SURVEYS (Catch: Unknown) (E

Index used as absolute measure of abundance

Age	1	2	3
Variance	0.0713	0.0797	0.0670
Skewness test stat.	0.9291	1.5686	-1.8988
Kurtosis test statisti	-0.7482	-0.9359	0.3836
Partial chi-square	0.0505	0.0659	0.0669
Significance in fit	0.0000	0.0000	0.0000
Number of observations	10	10	10
Degrees of freedom	10	10	10
Weight in the analysis	0.3333	0.3333	0.3333

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	42.9970	116	34	82	0.5244
Catches at age	32.0310	60	31	29	1.1045
SSB Indices					
INDEX1	1.1269	12	0	12	0.0939
INDEX2	1.6917	6	1	5	0.3383
Aged Indices					
FLT01: ACOUSTIC SURVEYS (Catch: Unknow	1.6045	8	2	6	0.2674
FLT02: DEPM SURVEYS (Catch: Unknown) (	6.5429	30	0	30	0.2181

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.0321	116	34	82	0.0614
Catches at age	3.3749	60	31	29	0.1164
SSB Indices					
INDEX1	0.2817	12	0	12	0.0235
INDEX2	0.4229	6	1	5	0.0846
Aged Indices					
FLT01: ACOUSTIC SURVEYS (Catch: Unknow	0.2256	8	2	6	0.0376
FLT02: DEPM SURVEYS (Catch: Unknown) (	0.7270	30	0	30	0.0242

Table 10.8.3.1

Stock: Anchovy Sub-area VIII

Assessment Quality Control Diagram 1

Average F(1-3,u)												
Date of assessment	Year											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989												
1990												
1991												
1992												
1993												
1994												
1995												
1996	0.707	1.014	0.990	0.993	1.992	1.343	0.926	0.901	0.825			
1997	0.546	0.554	0.678	0.610	1.449	0.892	0.585	0.643	0.738	0.855		
1998	0.573	0.541	0.617	0.629	1.299	0.891	0.574	0.679	0.862	1.172	1.414	
1999	0.549	0.501	0.581	0.615	1.259	0.864	0.566	0.680	0.862	1.239	0.484	0.249

Remarks: Assessments of 1996 1997 performed using ICA.

Table 10.8.3.1 (Continued)

Stock: Anchovy Sub-area VIII

Assessment Quality Control Diagram 2

Recruitment (age 0) Unit: millions												
Date of assessment	Year class											
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989												
1990												
1991												
1992												
1993												
1994												
1995												
1996	8276	3310	21395	7272	27393	27677	15551	14273	14963			
1997	8267	3641	21990	7506	28271	28003	14455	12335	14650	17065		
1998	7424	4294	19052	7206	27767	25764	13877	10454	14051	210443	30950	
1999	7455	4386	19075	7323	28272	25306	13329	10268	13384	20313	35043	2963

Remarks: Assessments of 1996 1997 performed using ICA.

Table 10.8.3.1 (Continued)

Stock: Anchovy Sub-area VIII

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)													
Date of assessment	Year												
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996	29178	16356	60886	29395	69621	93342	68487	55670					
1997	29905	17782	63438	29569	71261	95497	65521	46671	47188				
1998	27519	19112	55649	28391	69737	88690	60978	45126	40617	54783			
1999	36558	23392	56386	28590	72637	87526	58819	43723	37764	49375	117241		

Remarks: Assessments of 1996- 1999 performed using ICA.

Table 10.9.1: Fitting of anchovy recruits at age 0 versus the Upwelling index in the Bay of Biscay with a multiplicative model.

Multiple Regression Analysis

Dependent variable: Log(Asess_0)

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-0.596874	2.512	-0.237609	0.8170
log(Upwelling)	1.49837	0.372817	4.01905	0.0024

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	2.92566	1	2.92566	16.15	0.0024
Residual	1.81124	10	0.181124		
Total (Corr.)	4.7369	11			

R-squared = 61.7631 percent
R-squared (adjusted for d.f.) = 57.9394 percent
Standard Error of Est. = 0.425587
Mean absolute error = 0.349438
Durbin-Watson statistic = 2.25847

Table 10.9.2 Catch predictions

12:46 Tuesday, September 21, 1999

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table: Input data

Year: 1999								
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	4394.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0068	11.642
1	1434.200	1.2000	1.0000	0.4000	0.3750	15.922	0.3751	20.667
2	2710.000	1.2000	1.0000	0.4000	0.3750	28.703	0.9653	28.892
3	286.000	1.2000	1.0000	0.4000	0.3750	34.178	0.6346	34.433
4	21.000	1.2000	1.0000	0.4000	0.3750	40.500	0.9653	38.658
5	2.000	1.2000	1.0000	0.4000	0.3750	42.000	0.9653	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12047.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0068	11.642
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3751	20.667
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9653	28.892
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.6346	34.433
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.9653	38.658
5	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9653	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12047.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0068	11.642
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3751	20.667
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9653	28.892
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.6346	34.433
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.9653	38.658
5	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9653	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND02
Date and time: 21SEP99:14:11

Table 10.9.2 Catch predictions (continued)

Anchovy in Sub-area VIII (Bay of Biscay) 12:46 Tuesday, September 21, 1999

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.6583	166012	51484	39916	0.0000	0.0000	191944	26797	0	226482	48819
.	.	.	.	.	0.2000	0.1317	.	25571	3103	224492	45703
.	.	.	.	.	0.4000	0.2633	.	24410	5913	222727	42960
.	.	.	.	.	0.6000	0.3950	.	23310	8465	221158	40531
.	.	.	.	.	0.8000	0.5267	.	22268	10791	219758	38364
.	.	.	.	.	1.0000	0.6583	.	21280	12917	218504	36418
.	.	.	.	.	1.2000	0.7900	.	20343	14867	217379	34659
.	.	.	.	.	1.4000	0.9217	.	19454	16661	216366	33060
.	.	.	.	.	1.6000	1.0533	.	18610	18315	215452	31598
.	.	.	.	.	1.8000	1.1850	.	17809	19845	214623	30253
.	.	.	.	.	2.0000	1.3167	.	17048	21264	213871	29009
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND02
Date and time : 21SEP99:14:11
Computation of ref. F: Simple mean, age 1 - 3
Basis for 1999 : F factors

Anchovy in Sub-area VIII (Bay of Biscay) 12:46 Tuesday, September 21, 1999

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.5466	0.3598	166012	59484	25000	0.0000	0.0000	200095	31994	0	229358	50653
.	.	.	.	.	0.2000	0.1317	.	30476	3752	226984	47181
.	.	.	.	.	0.4000	0.2633	.	29040	7138	224889	44153
.	.	.	.	.	0.6000	0.3950	.	27682	10204	223034	41493
.	.	.	.	.	0.8000	0.5267	.	26396	12988	221388	39140
.	.	.	.	.	1.0000	0.6583	.	25178	15524	219921	37045
.	.	.	.	.	1.2000	0.7900	.	24024	17841	218612	35166
.	.	.	.	.	1.4000	0.9217	.	22931	19964	217440	33470
.	.	.	.	.	1.6000	1.0533	.	21895	21915	216387	31929
.	.	.	.	.	1.8000	1.1850	.	20913	23713	215439	30521
.	.	.	.	.	2.0000	1.3167	.	19981	25375	214583	29226
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

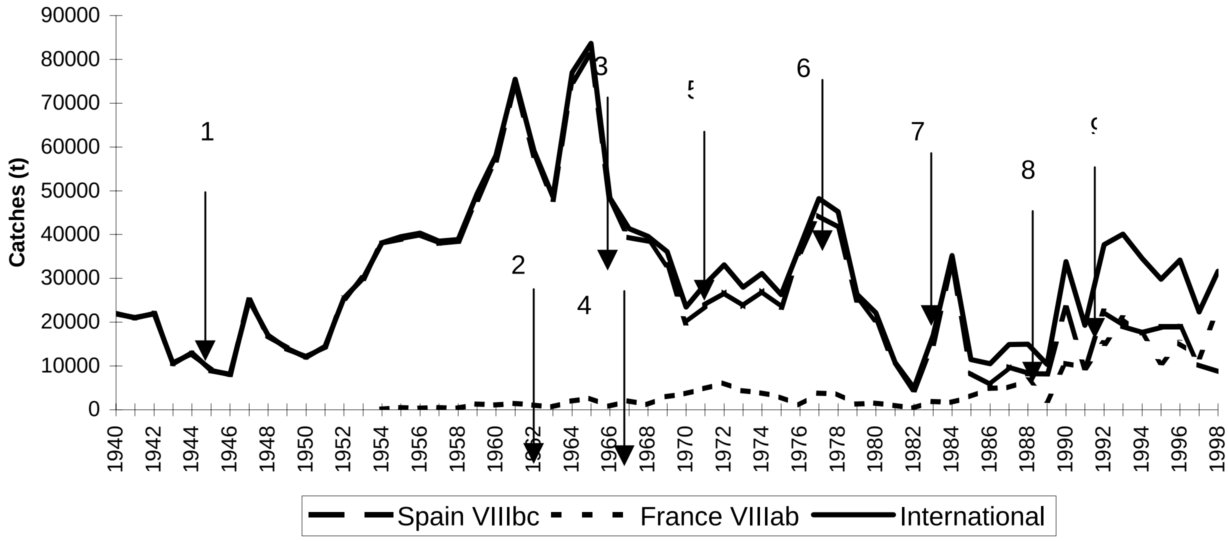
Notes: Run name : MANAND02
Date and time : 21SEP99:14:11
Computation of ref. F: Simple mean, age 1 - 3
Basis for 1999 : TAC constraints

Table 10.10.1: Input to short term sensitivity analysis for the Bay of Biscay anchvovy

3

PARAMETERS	Code	Input Estimates	CV
Population at age 0 in 1999 (from upwelling)	'N0'	4394000	0.52
Population at age 1 in 1999 (synthetic estimate)	'N1'	1434000	0.52
Population at age 2 in 1999 (from ICA ouput)	'N2'	2710000	0.22
Population at age 3 in 1999 (from ICA ouput)	'N3'	286000	0.22
Population at age 4 in 1999 (from ICA ouput)	'N4'	21200	0.33
Population at age 5 in 1999 (from ICA ouput)	'N5'	2000	0.33
Fishing Mortality mean 1996-98 at age 0	'sH0'	0.0068	0.44
Fishing Mortality mean 1996-98 at age 1	'sH1'	0.375	0.44
Fishing Mortality mean 1996-98 at age 2	'sH2'	0.9653	0.44
Fishing Mortality mean 1996-98 at age 3	'sH3'	0.6346	0.44
Fishing Mortality mean 1996-98 at age 4	'sH4'	0.9653	0.44
Fishing Mortality mean 1996-98 at age 5	'sH5'	0.9653	0.44
Weight in the catch at age 0	'WH0'	0.01164	0.08
Weight in the catch at age 1 (mean 87-98)	'WH1'	0.02066	0.14
Weight in the catch at age 2 (mean 87-98)	'WH2'	0.02889	0.09
Weight in the catch at age 3 (mean 87-98)	'WH3'	0.03443	0.14
Weight in the catch at age 4 (mean 87-98)	'WH4'	0.03866	0.18
Weight in the catch at age 5 (mean 87-98)	'WH5'	0.042	0.14
Weight in the stock at age 0 (mean 90-98)	'WS0'	0.01244	0.18
Weight in the stock at age 1 (mean 90-98)	'WS1'	0.01592	0.16
Weight in the stock at age 2 (mean 90-98)	'WS2'	0.0287	0.06
Weight in the stock at age 3 (mean 90-98)	'WS3'	0.0342	0.06
Weight in the stock at age 4 (mean 90-98)	'WS4'	0.0405	0.15
Weight in the stock at age 5 (mean 90-98)	'WS5'	0.042	0.15
Natural Mortality at age 0	'M0'	1.2	0.1
Natural Mortality at age 1	'M1'	1.2	0.1
Natural Mortality at age 2	'M2'	1.2	0.1
Natural Mortality at age 3	'M3'	1.2	0.1
Natural Mortality at age 4	'M4'	1.2	0.1
Natural Mortality at age 5	'M5'	1.2	0.1
Maturity at age 0	'MT0'	0	0
Maturity at age 1	'MT1'	1	0
Maturity at age 2	'MT2'	1	0
Maturity at age 3	'MT3'	1	0
Maturity at age 4	'MT4'	1	0
Maturity at age 5	'MT5'	1	0
Recruitment at age 0 in 2000	'R00'	12046000	0.64
Recruitment at age 0 in 2001	'R01'	12046000	0.64
Fishing mortality multiplier for 1999 (to fit 25000 t catch)	'HF99'	0.5466	0.12
Fishing mortality multiplier for 2000	'HF00'	1	0.12
Fishing mortality multiplier for 2001	'HF01'	1	0.12
Natural mortality multiplier for 1999	'K98'	1	0.1
Natural mortality multiplier for 2000	'K99'	1	0.1
Natural mortality multiplier for 2001	'K20'	1	0.1

Figure 10.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940



1. Goniometer
2. Echosounder ; anchovy disappeared from the coast of Galicia
3. Minimum landing size: 9 cm
4. Power block
5. 8 tonnes per boat and 5 days per week for the Spanish fleet;
   the Spanish fleet is not allowed to come into the French 6 nautical miles
6. Radar and sonar
7. 6 tonnes per boat for the Spanish fleet
8. Minimum landing size 12 cm: increase of the French pelagic fleet
9. Bilateral agreement between Spain and France in 1992: the pelagic fleet is not
   allowed to fish anchovy from the end of March to the end of June

Figure 10.2.1.2: Mean monthly catches (1992-1998) for the French and Spanish anchovy fisheries in Sub-area VIII

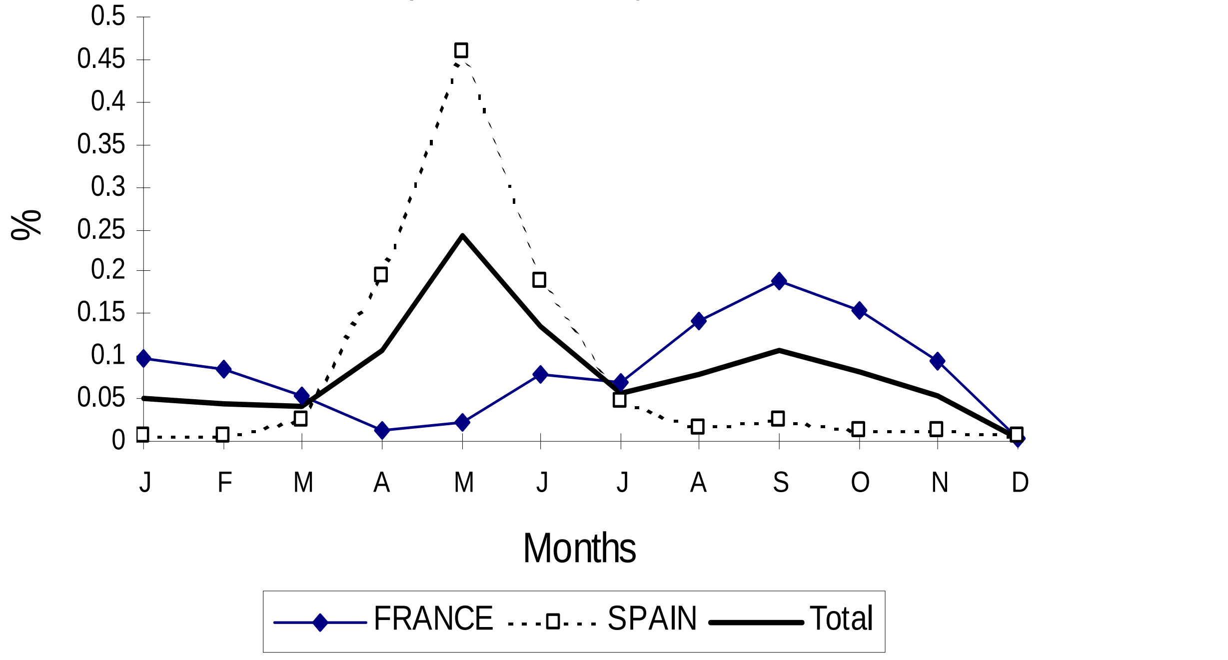


Figure 10.3.2.1: Length Distributions of Spanish and French anchovy catches for the first quarter

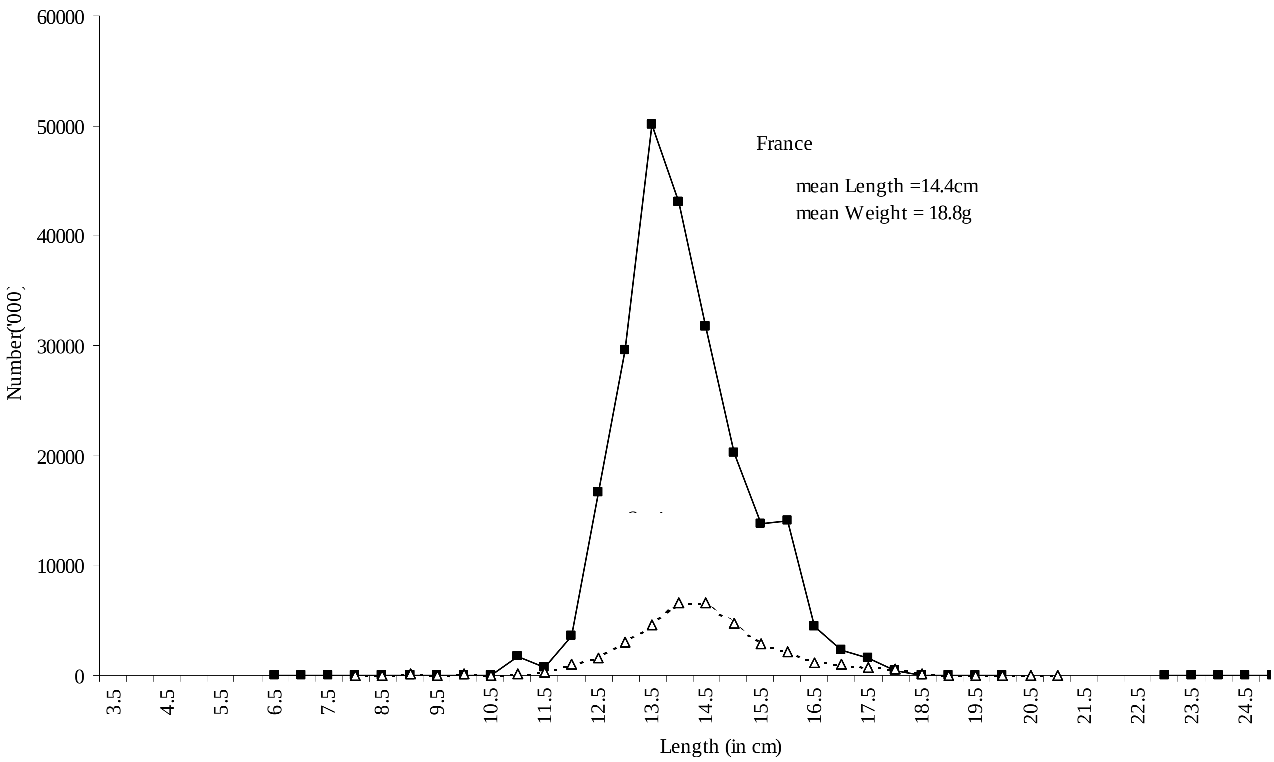


Figure 10.3.2.2: Length Distributions of Spanish and French anchovy catches for the second quarter

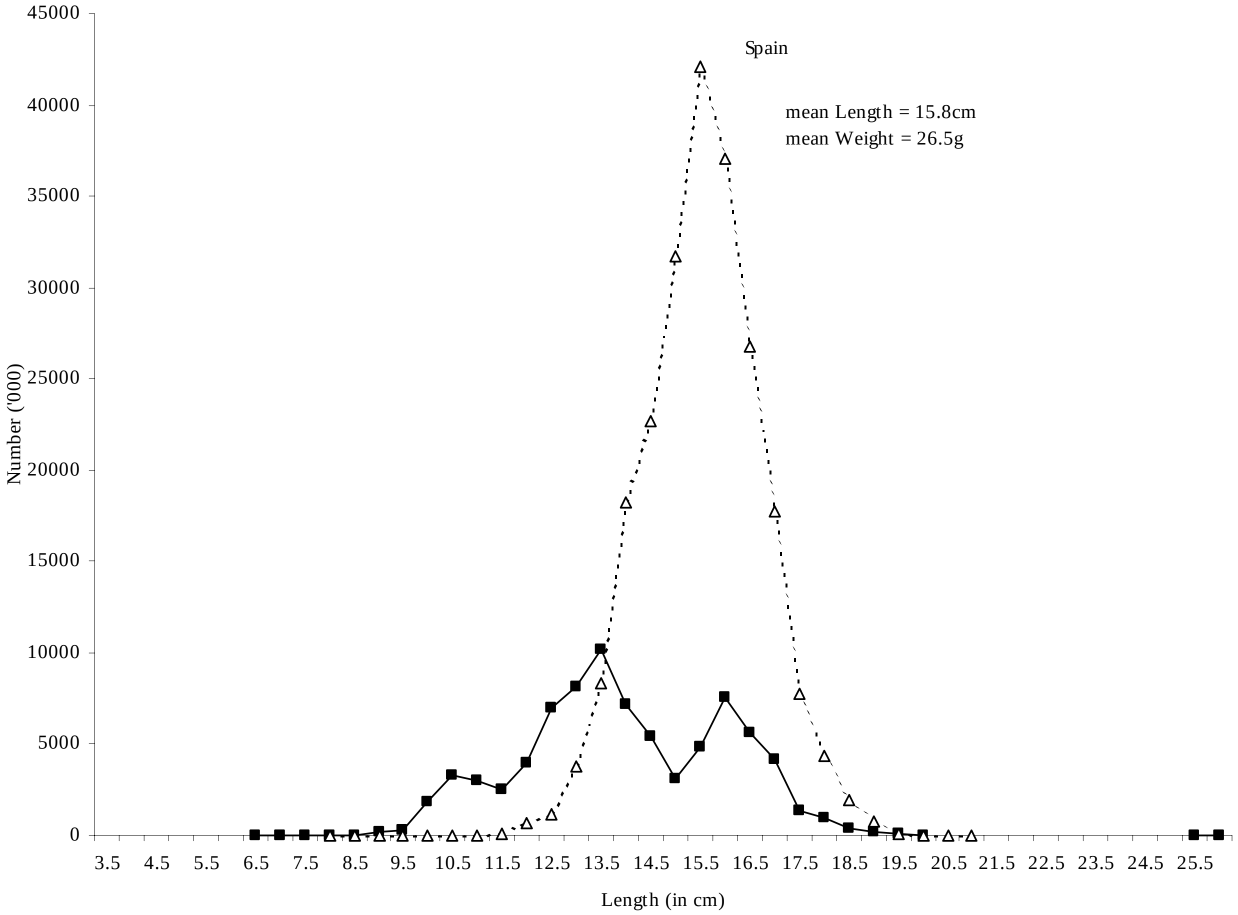


Figure 10.3.2.3.: Length Distributions of Spanish and French anchovy catches for the third quarter

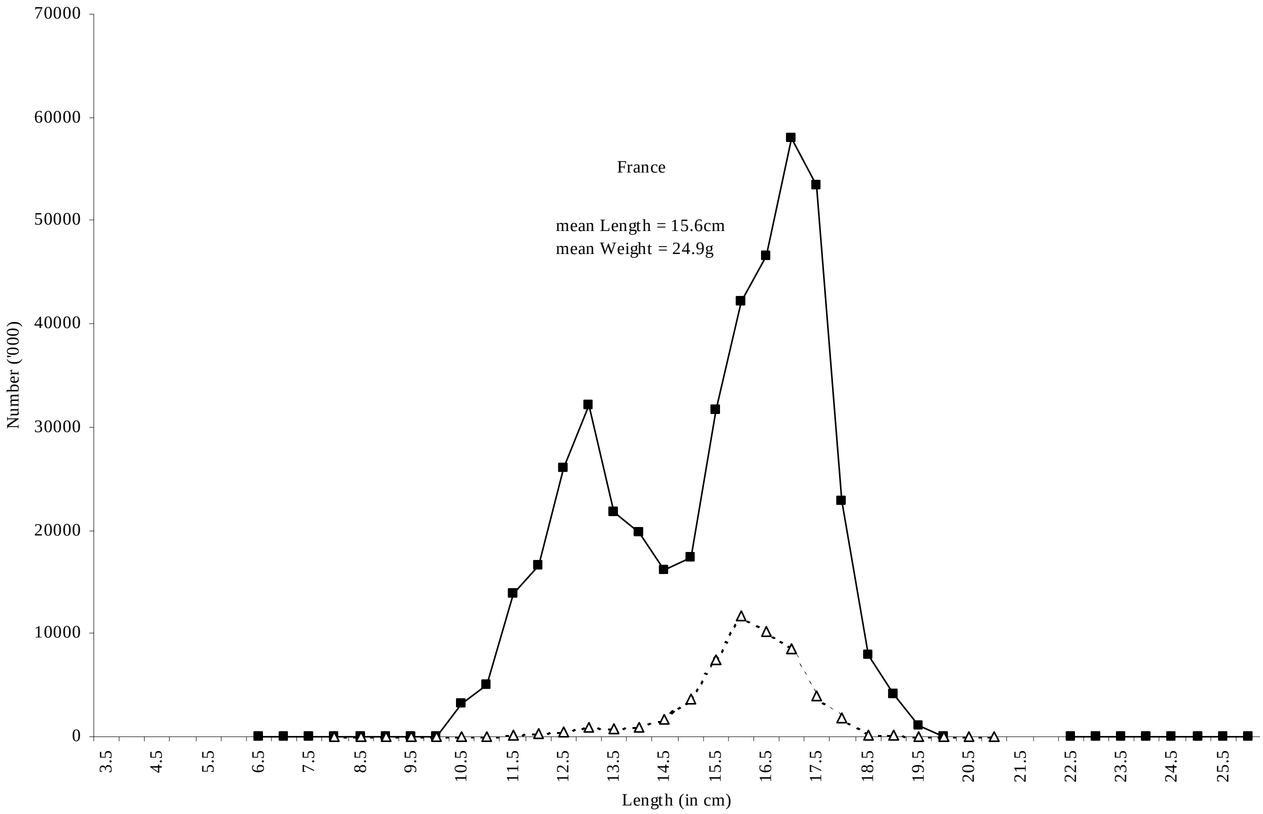


Figure 10.3.2.4.: Length Distributions of Spanish and French anchovy catches for the fourth quarter

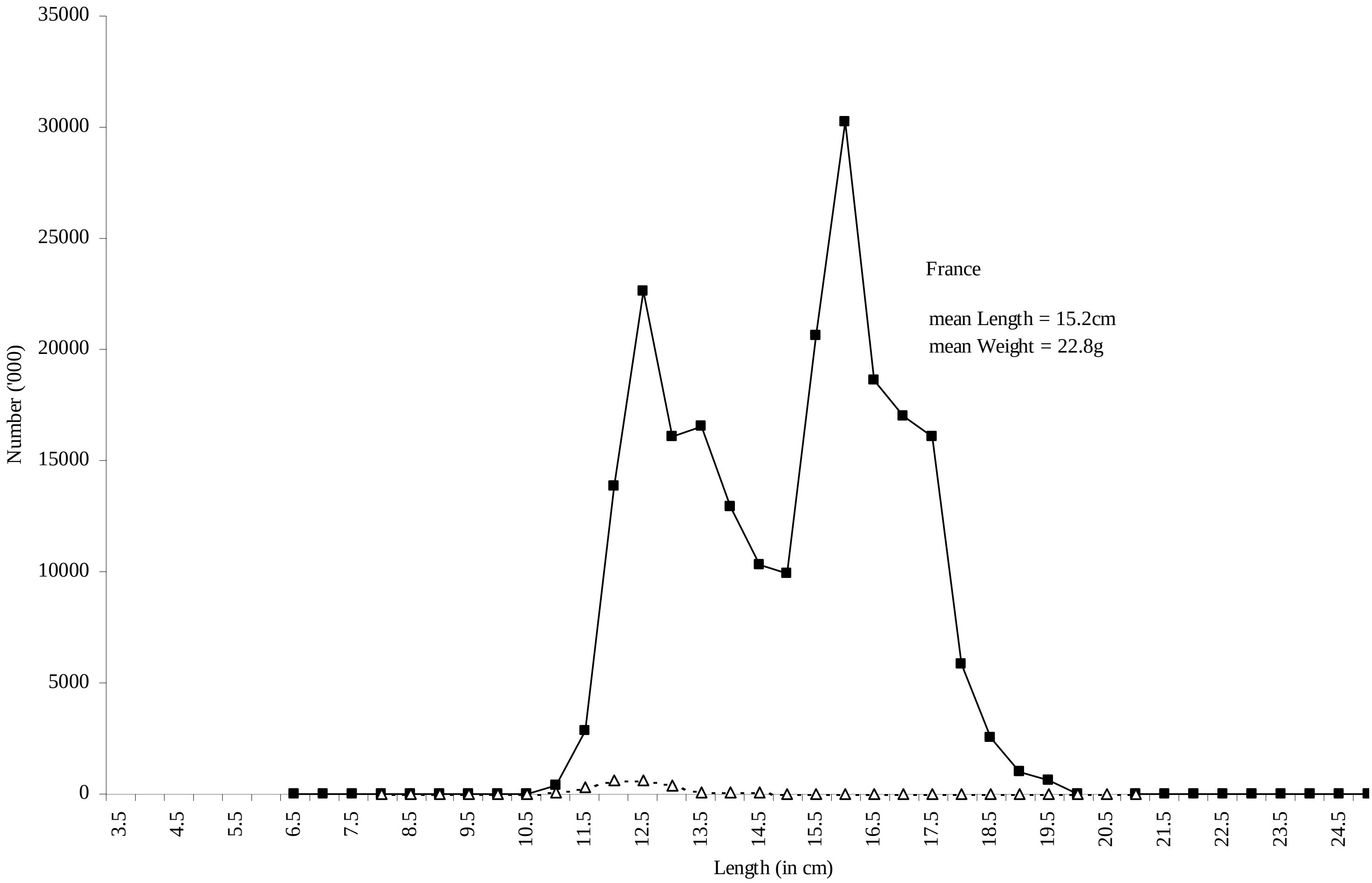
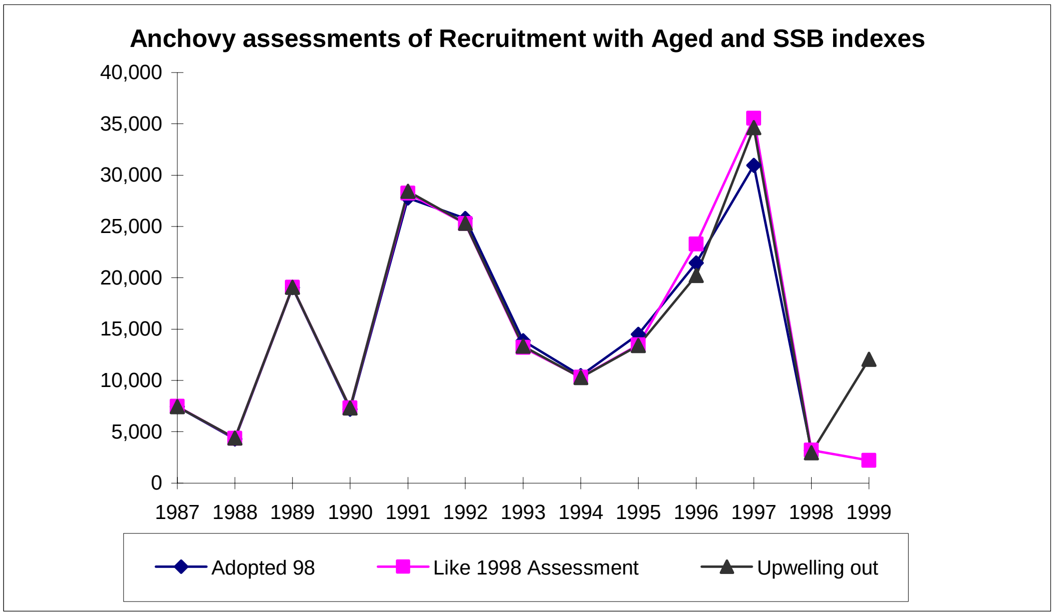
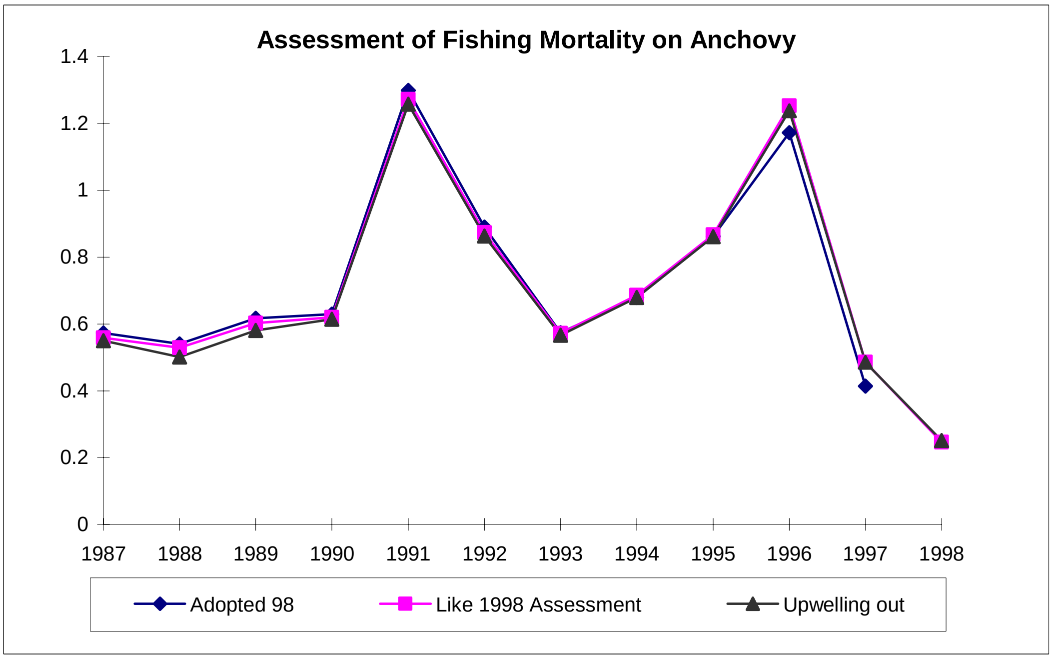


Figure 10.8.1.1: Comparison of last year and preliminary assessments in 1999(anchovy in Subarea VIII)





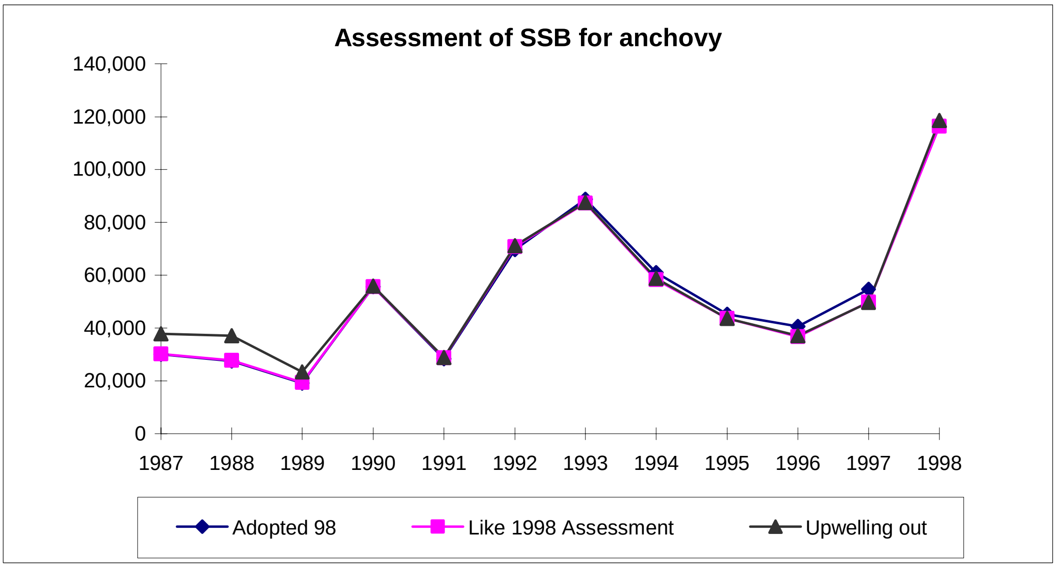
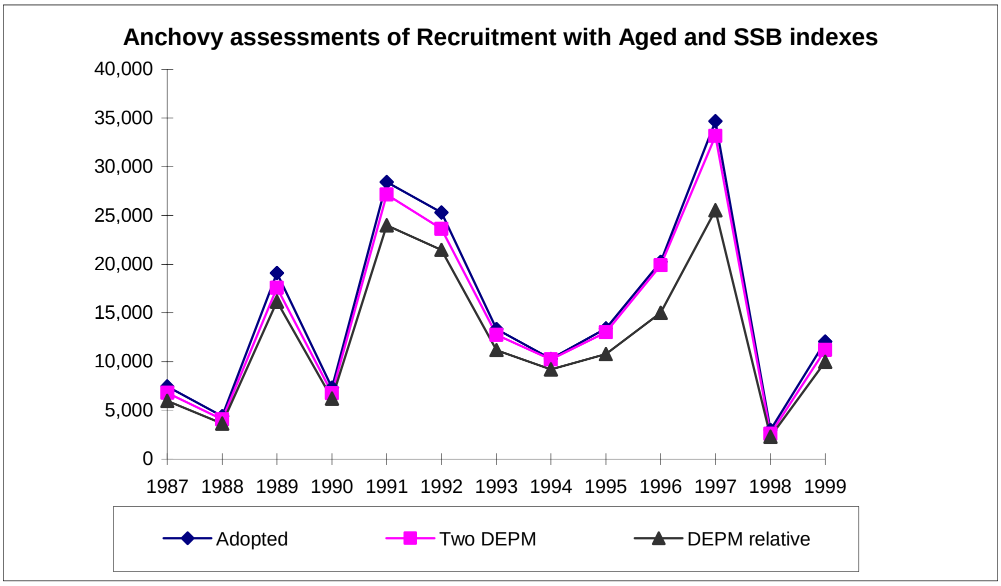
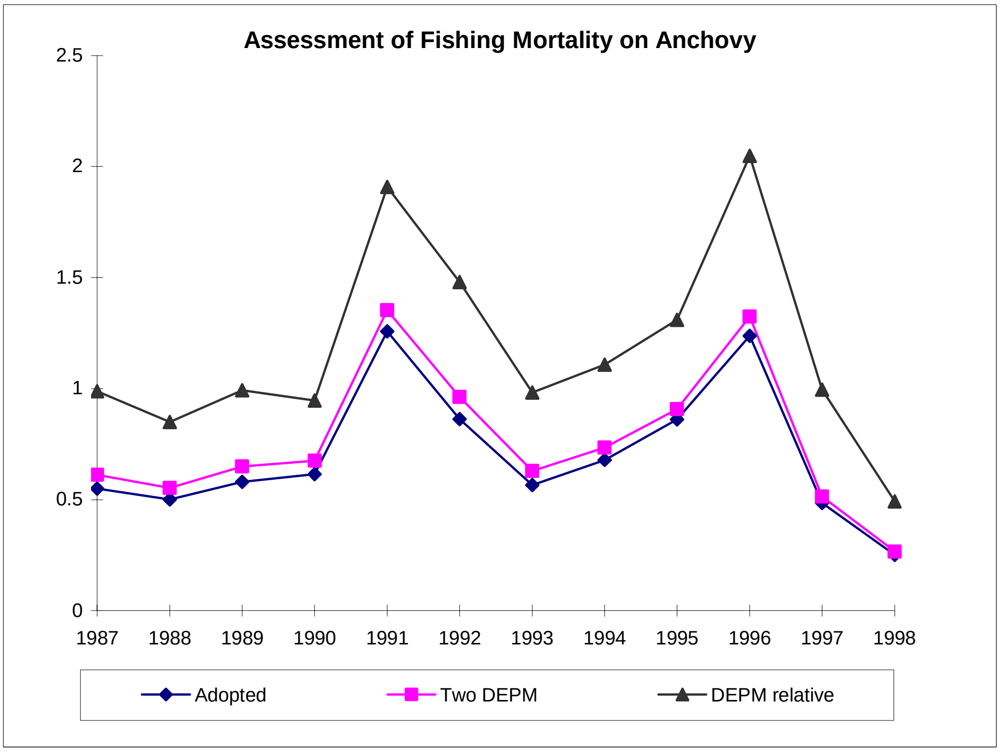


Figure 10.8.1.2: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VII Concerning the tunning of the DEPM





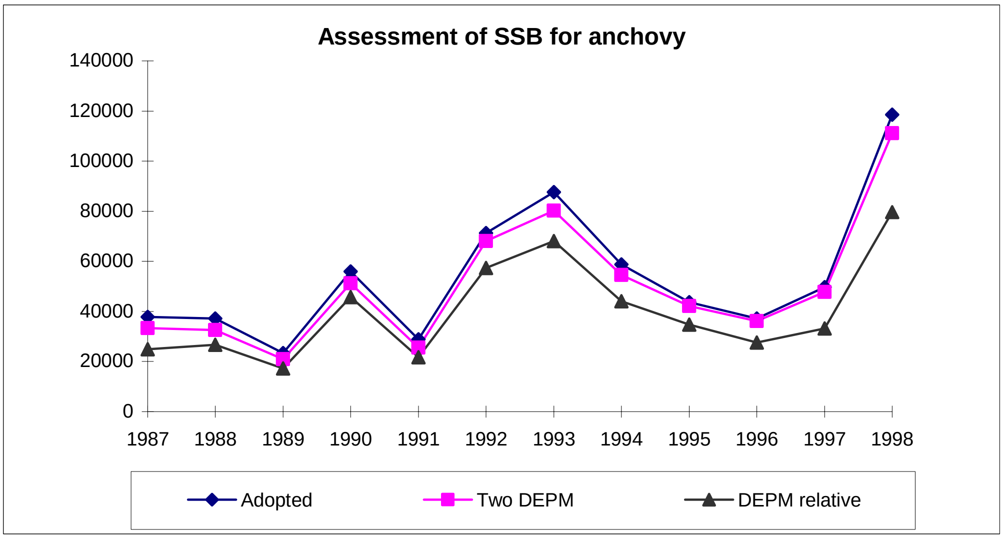
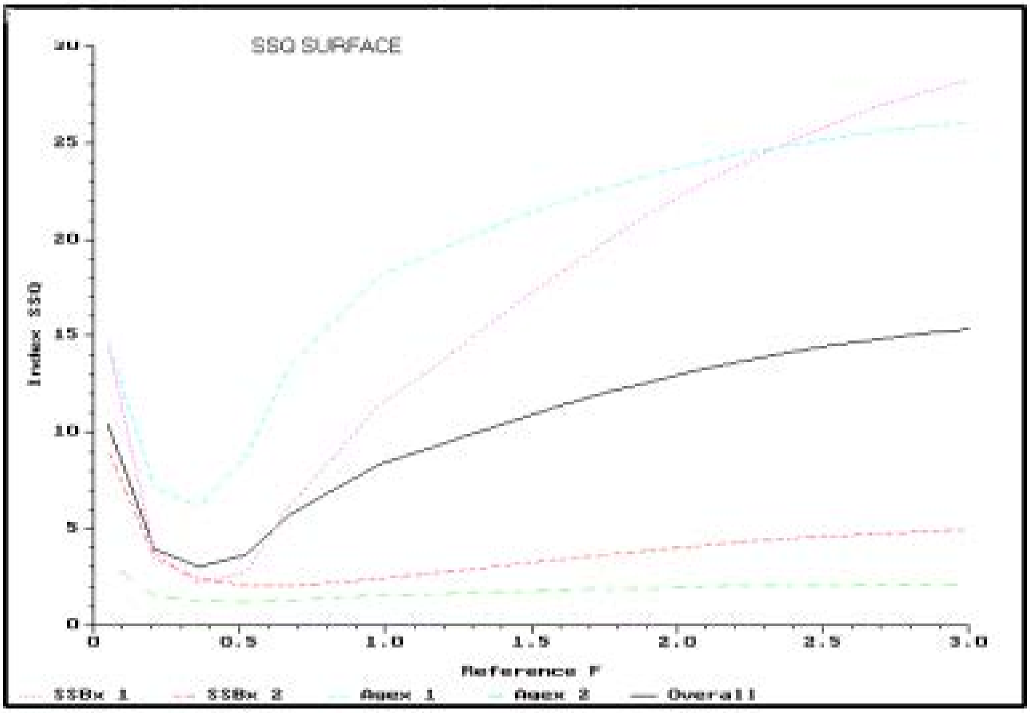


Figure 10.8.2.1 Results of the assessment on the Bay of Biscay anchovy.



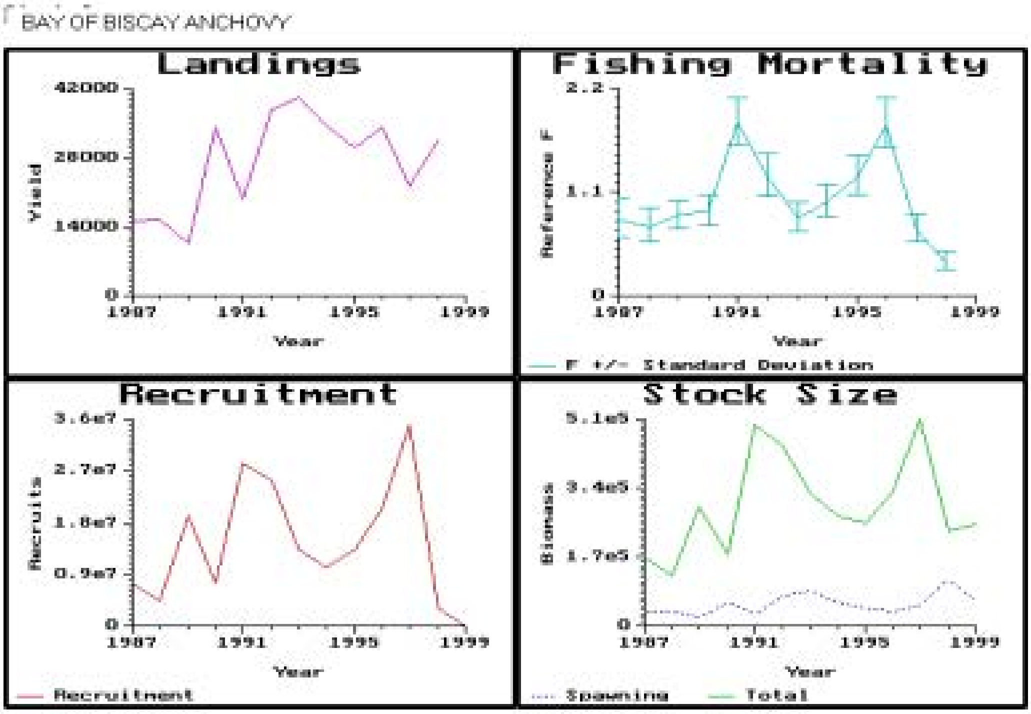
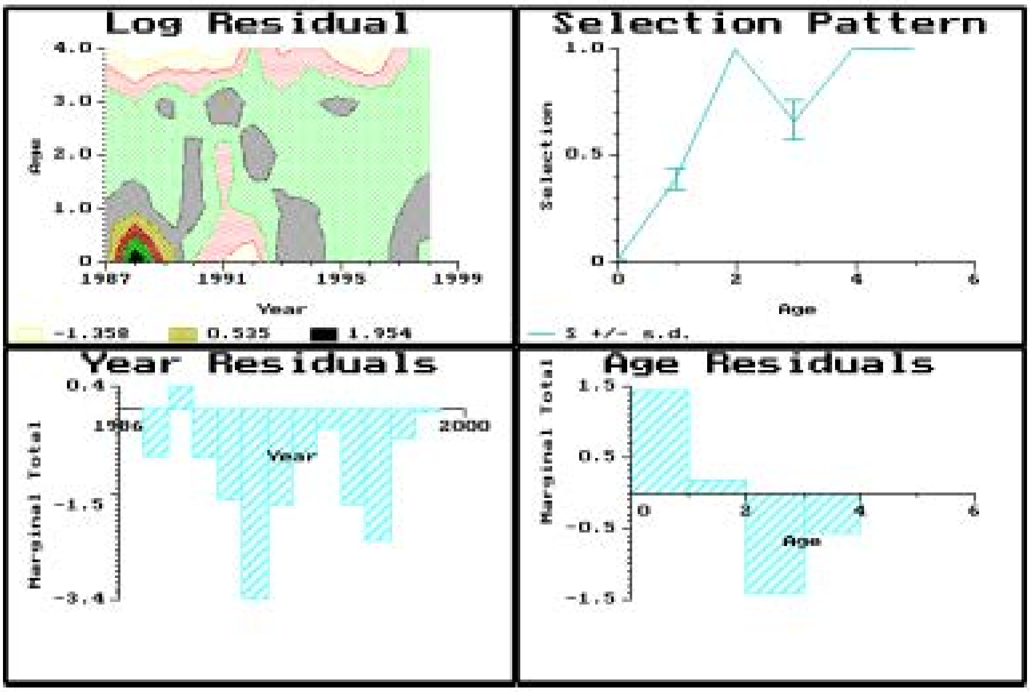


Figure 10.8.2.1 Results of the assessment on the Bay of Biscay anchovy (Cont…)

Separable Model Diagnostics



DEPM SURVEYS IN Biomass

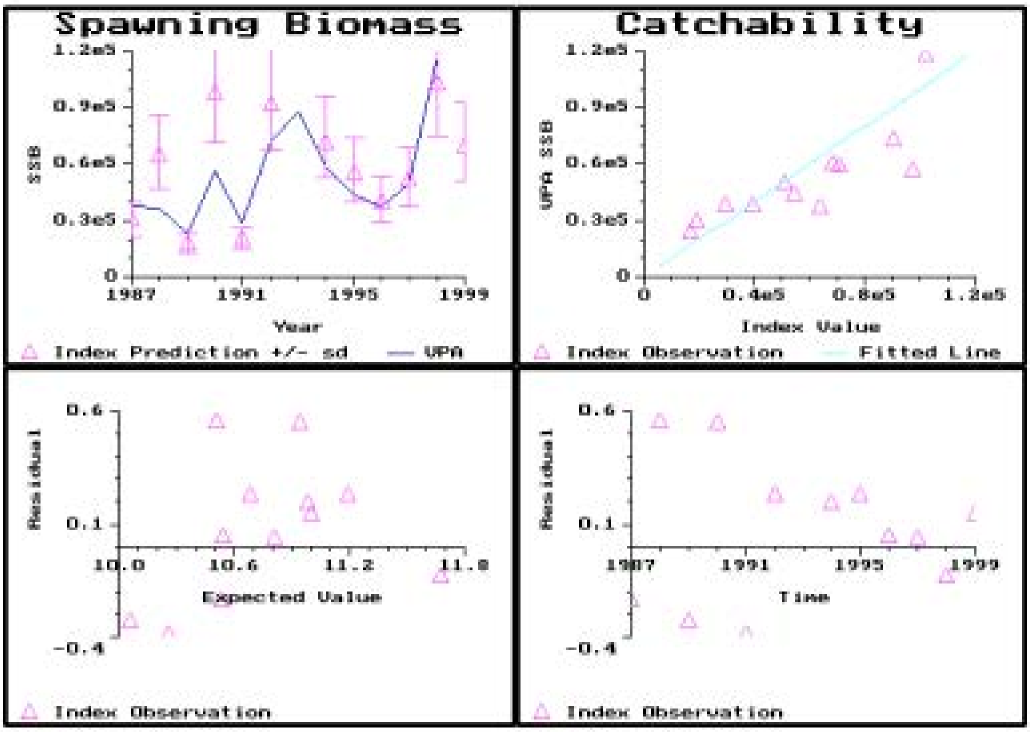
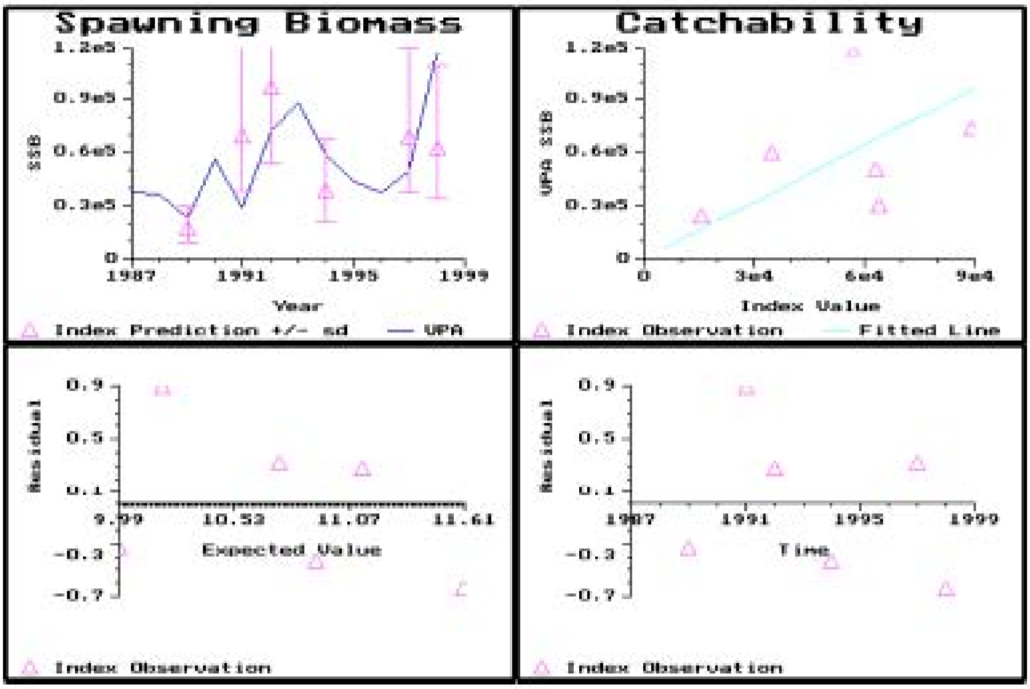


Figure 10.8.2.1 Results of the assessment on the Bay of Biscay anchovy (Cont…)

ACOUSTIC SURVEYS (BIOMASS)



Age 1

DEPM SURVEYS

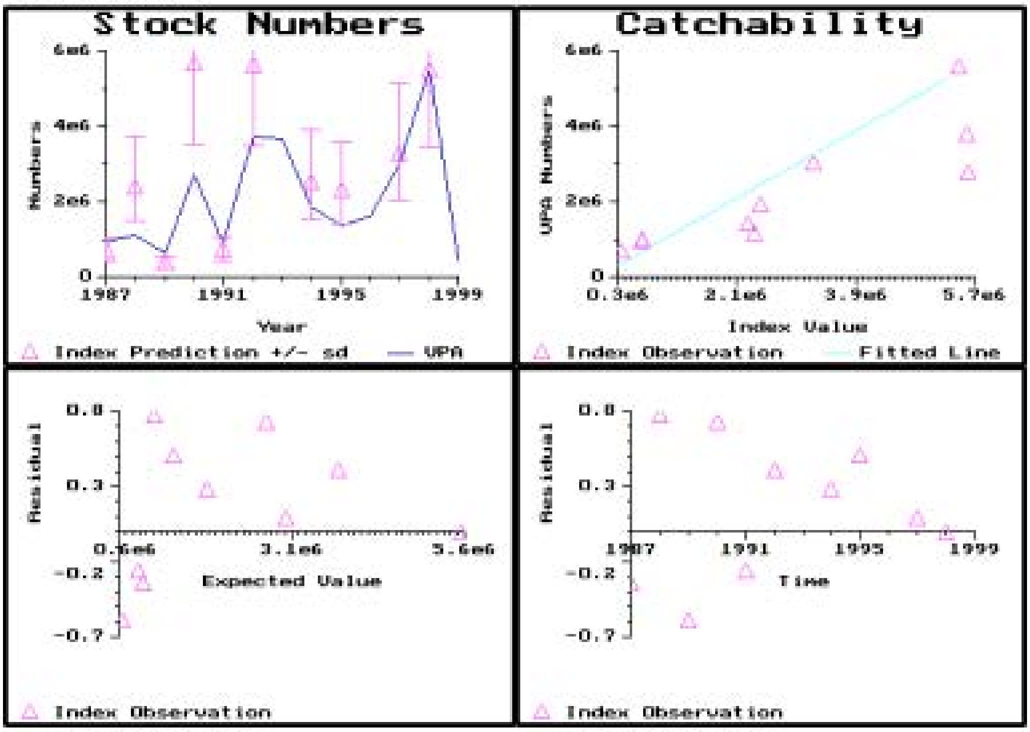
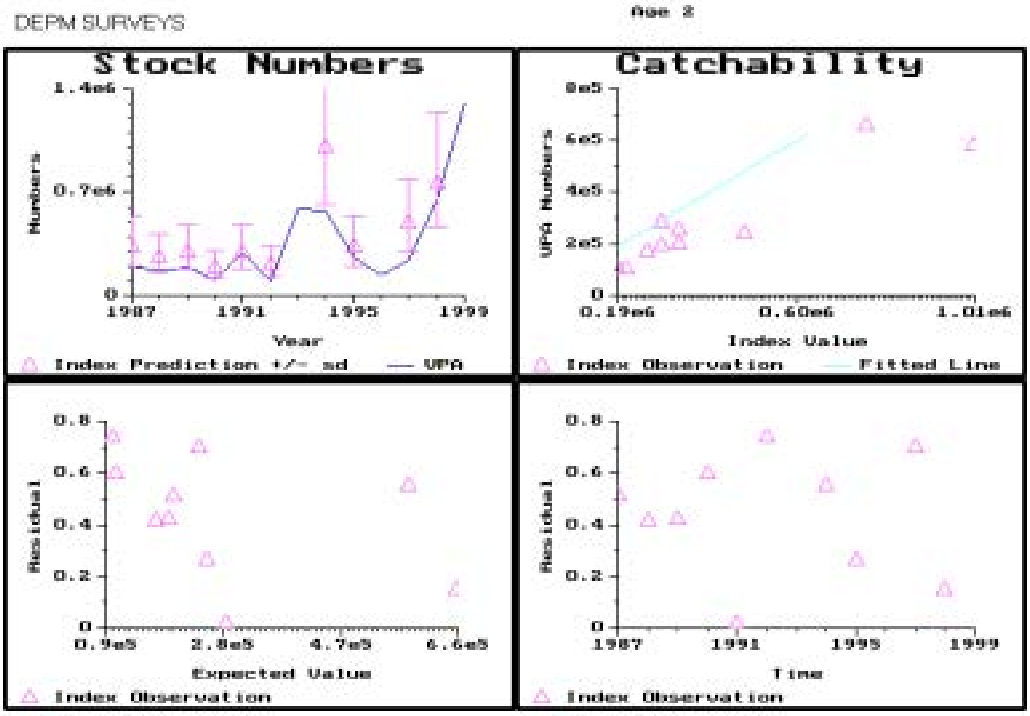


Figure 10.8.2.1 Results of the assessment on the Bay of Biscay anchovy (Cont…)



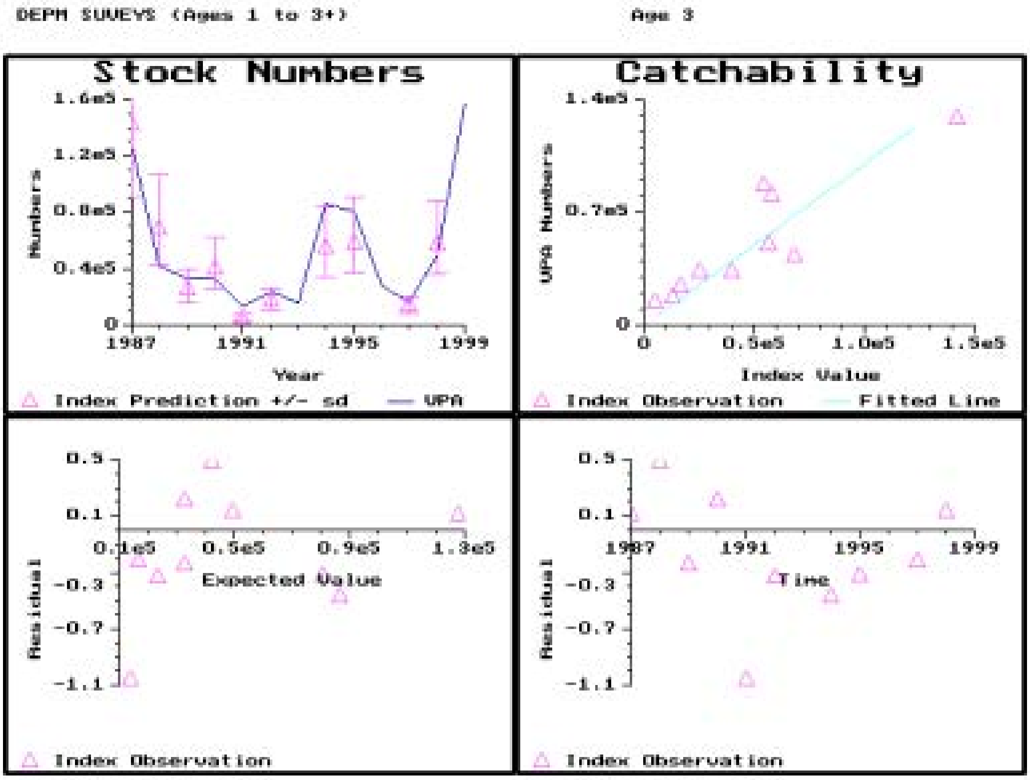
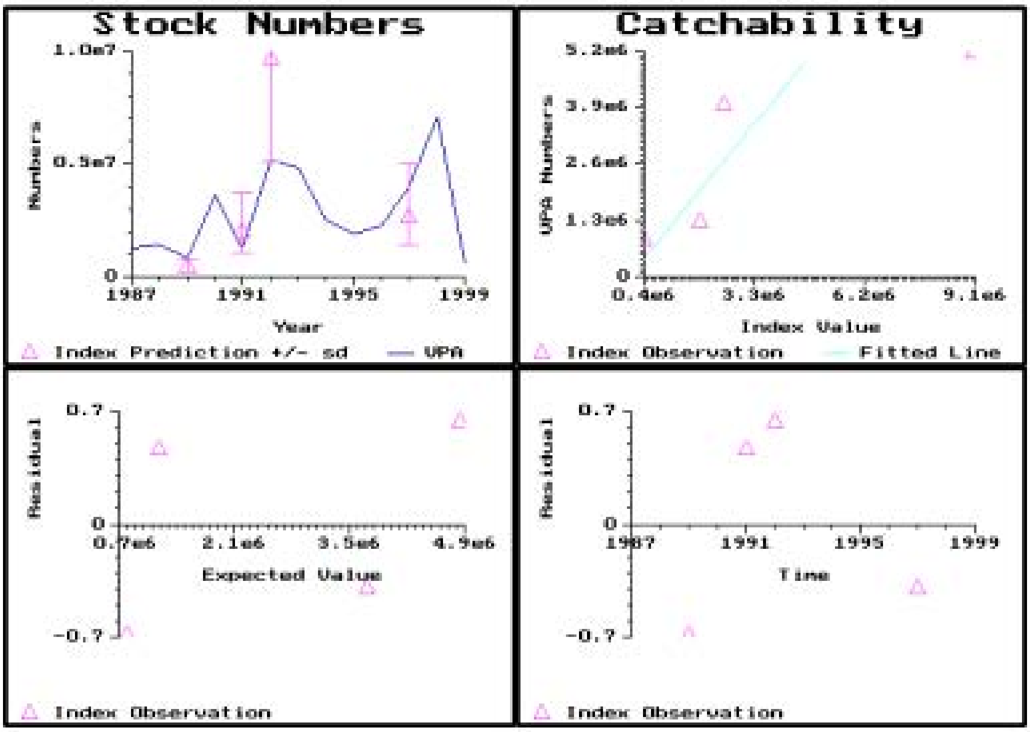
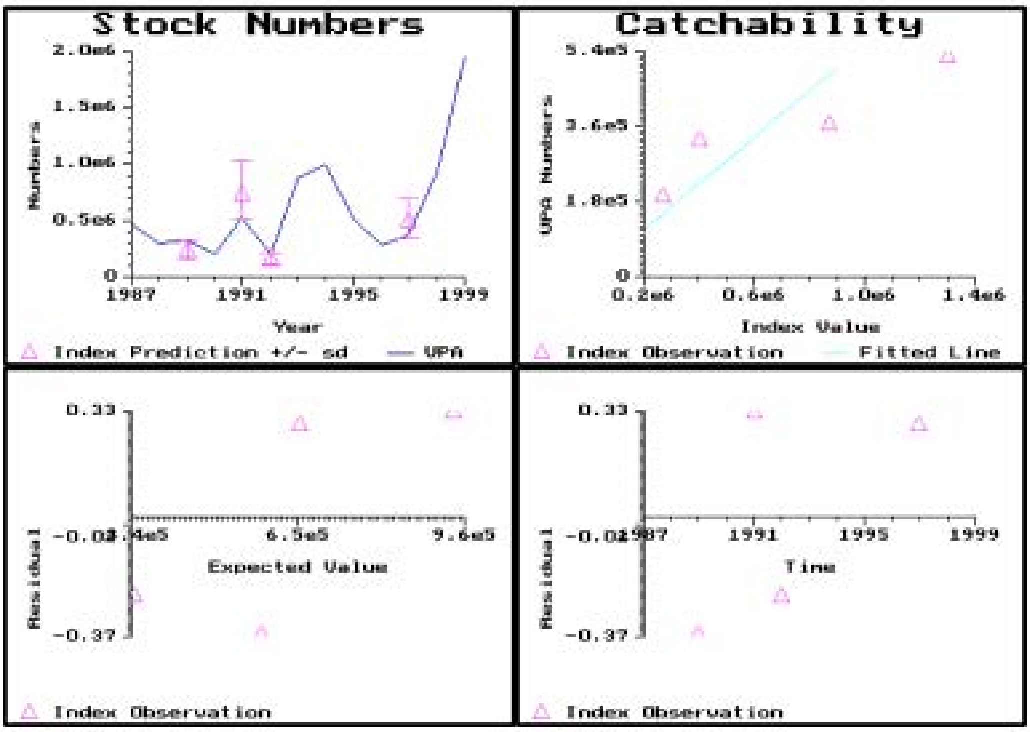


Figure 10.8.2.1 Results of the assessment on the Bay of Biscay anchovy (Cont…)

ACOUSTIC SURVEY at AGE 1



ACOUSTIC SURVEYS AGE 2



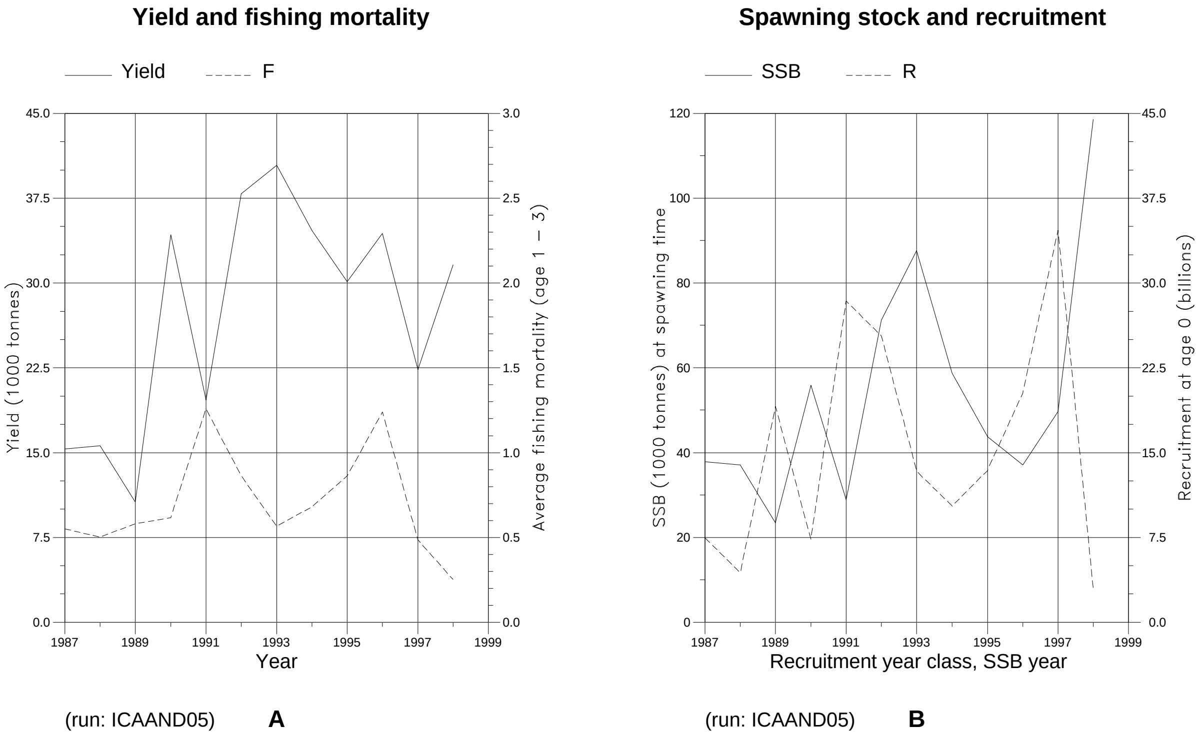


Figure 10.8.3.1 Fish Stock Summary – Anchovy in Sub-area VIII (Bay of Biscay)

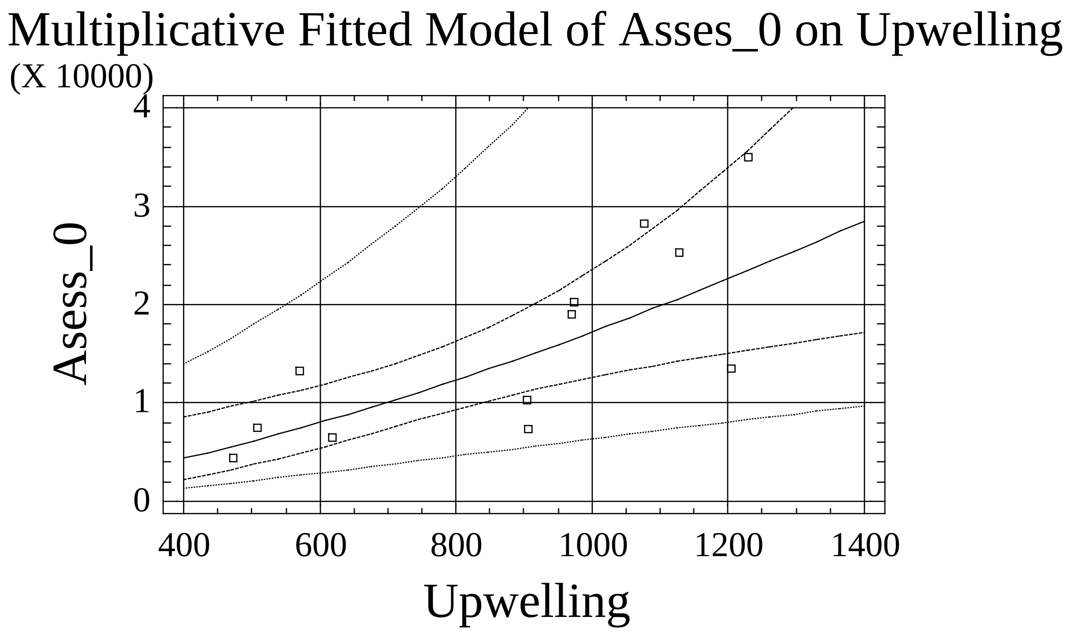


Figure 10.9.1: Multiplicative model fitted between the Upwelling and the Recruitment at age 0 estimated by the assessment of the Bay of Biscay anchovy for the period 1987-97 (excluding the estimate for 1998 and including an estimate deduced for the recruitment in 1986 --- see section 10.9).

Figure 10.10.1 Anchovy,,,Area VIII,,. Probability profiles for short term forecast.

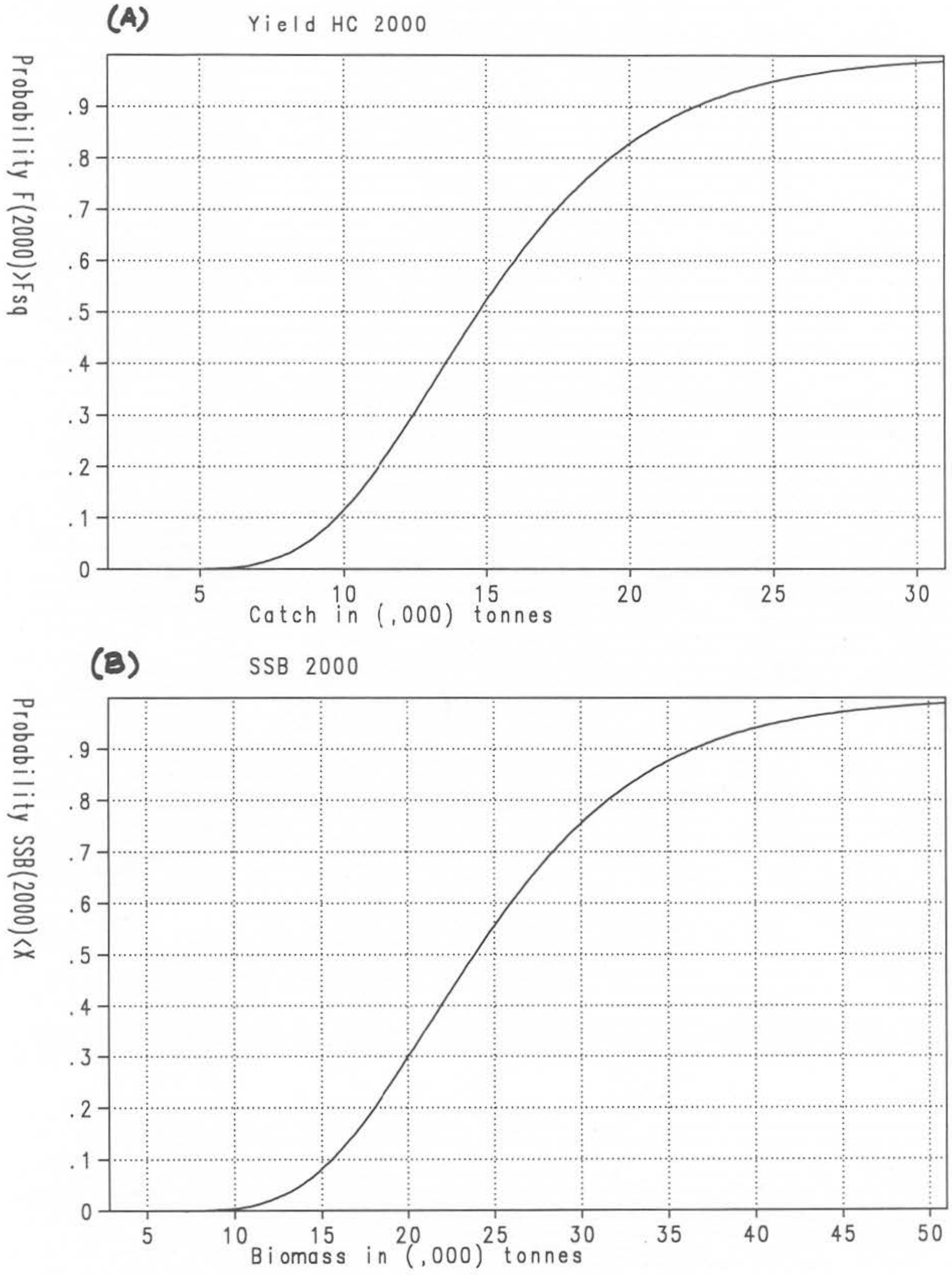


Figure 10.10.2 Anchovy,,,Area VIII,,. Sensitivity analysis of short term forecast.

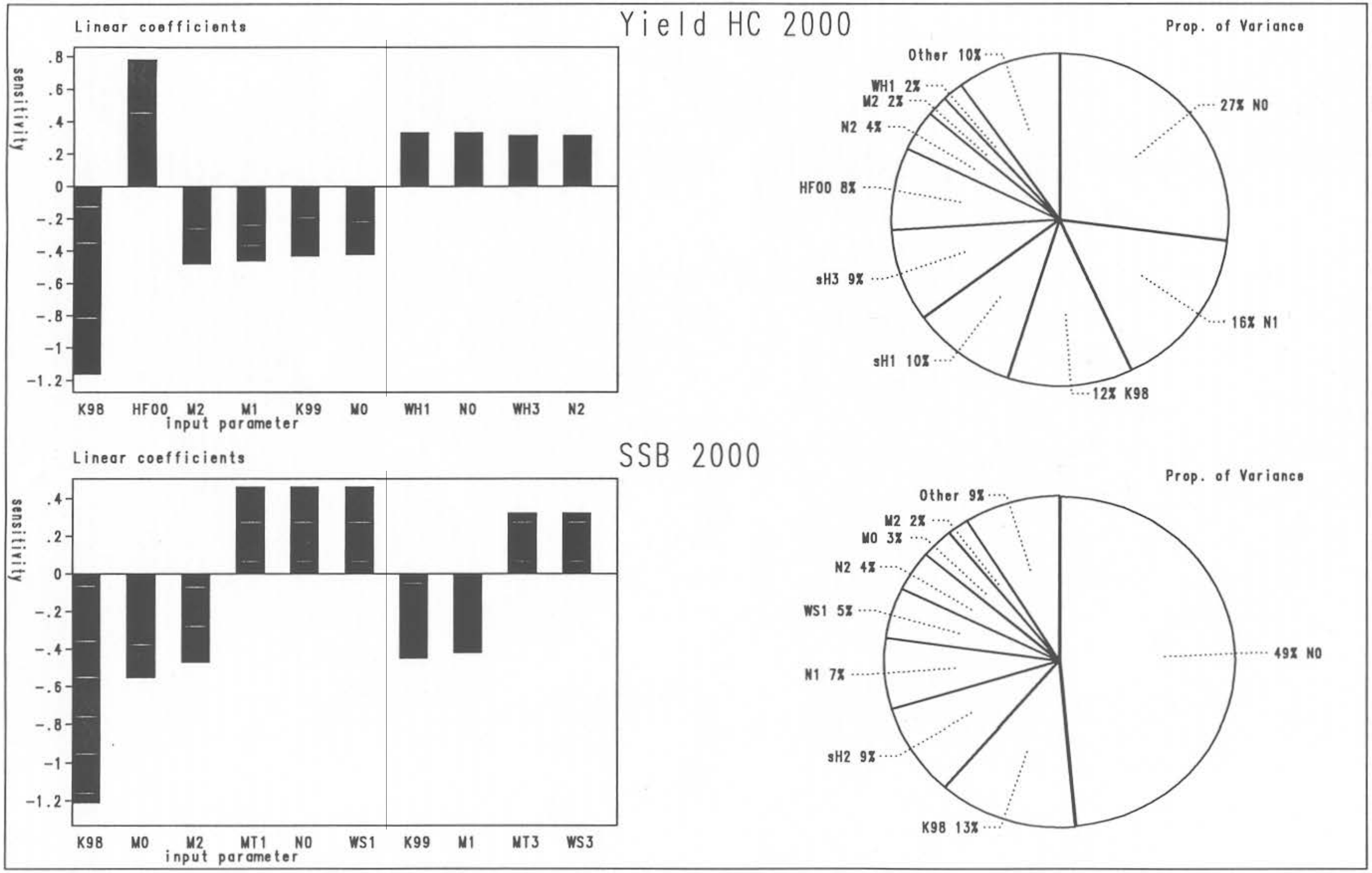
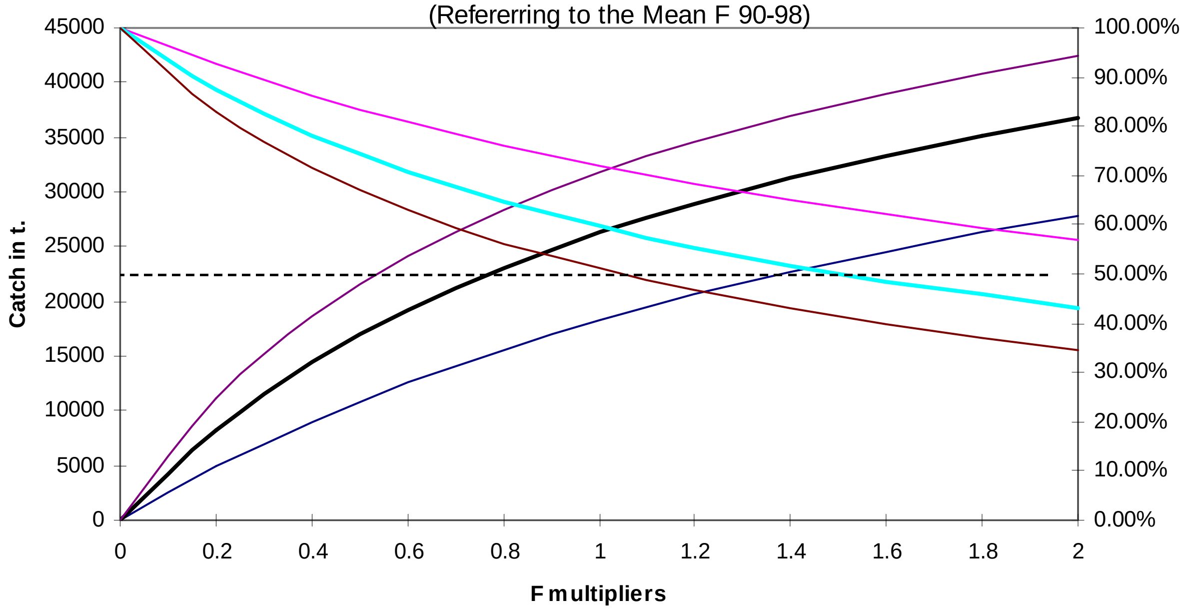


Figure 10. 12.1 Long term yield and %SSBR with R=Geometric mean considering the uncertainties in the estimates of the separable annual F (+/- 1 s.e.)
(Refererring to the Mean F 90-98)



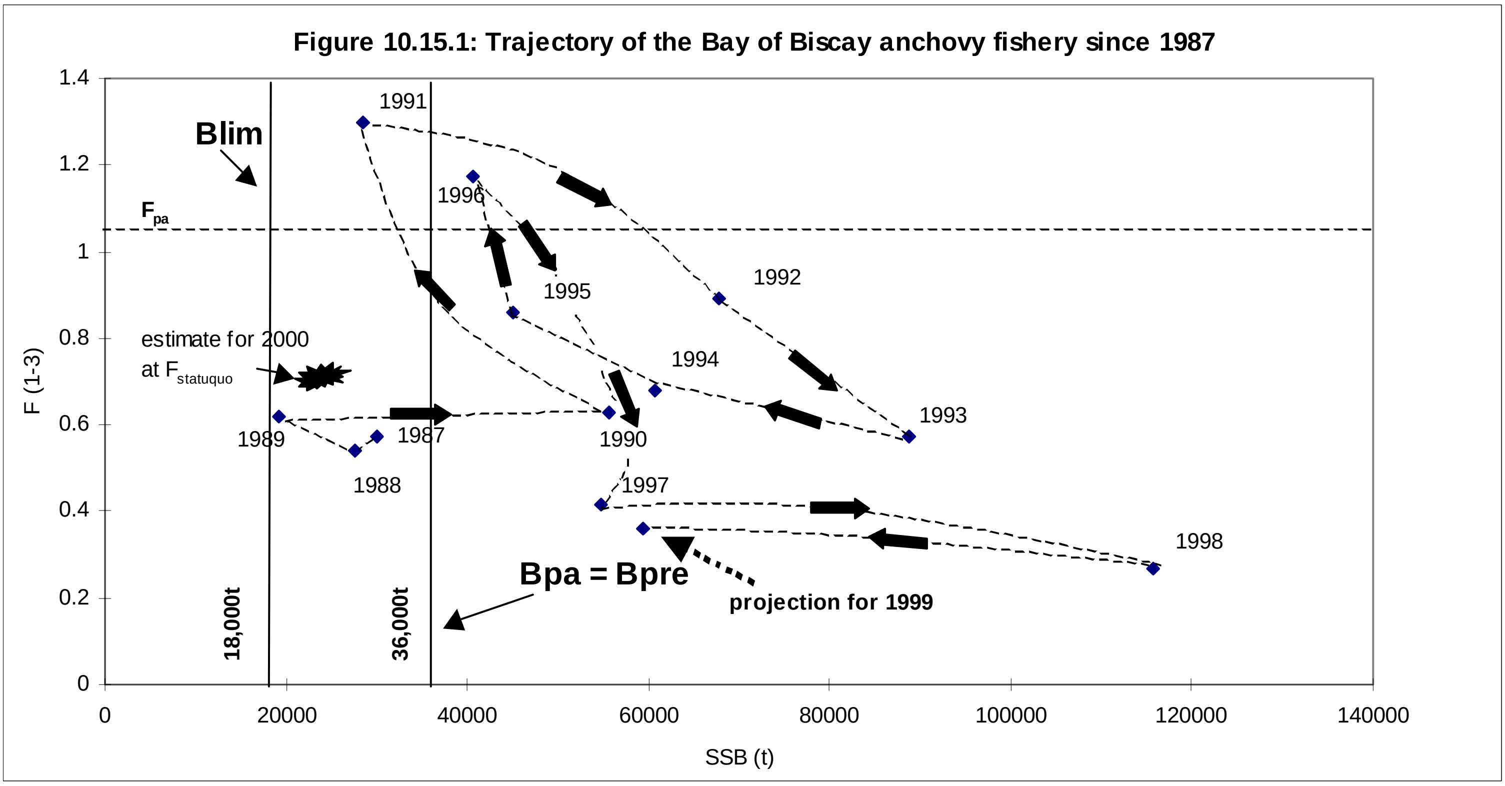


Figure 10.15.1: Trajectory of the Bay of Biscay anchovy fishery since 1987
Blim
Fpa
estimate for 2000
at Fstatuquo
Bpa = Bpre
projection for 1999
18,000t
36,000t
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
F (1-3)
SSB (t)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
20000
40000
60000
80000
100000
120000
140000

11 ANCHOVY IN DIVISION IXA

11.1 ACFM Advice Applicable to 1998 and 1999

The advice given by ACFM was the following: If a traditional TAC is required it should be set at the average landings since 1988 excluding 1995, that is, 4 600 t. The agreed TAC for anchovy in Division IXa was 12 000 tonnes for 1998 and 13 000 tonnes for 1999.

No management objectives have been set for this stock. The current TAC is believed to exceed the sustainable catch potential. A traditional TAC management system may not be appropiate for this short-lived species, in which variations in recruitment are largely driven by environmental factors. Lack of biological information for this stock hampers the provision of advice on more appropriate management measures. Monitoring of the stock would require regular sampling together with information from a series of acoustic and egg surveys.

11.2 The Fishery in 1998

In 1998 the anchovy fishery in Division IXa was once more concentrated in the Gulf of Cadiz (Sub-division IXa South) as usual. The exception is 1995, when the fishery was mainly found in the northern part of Division IXa (Figure 11.2.1.1). Anchovy is the target species of the Spanish purse-seine fleet in the Gulf of Cadiz. The Spanish and Portuguese purse-seine fleets in the northern part of Division IXa target anchovy when abundance is high, due to high market prices, as occurred in 1995 (ICES 1997/ Assess:3). In 1998 anchovy fishery in the northern part of Division IXa was low, as is usual in this area.

The increase in anchovy abundance in the northern part of Division IXa in 1995 may have been due to changed thermohaline conditions in the coastal waters northwest of the Iberian Peninsula, less saline and warmer than in preceding years (Diaz del Río *et al*., 1996 and ICES 1997/C:3), thus creating more favourable conditions for reproduction and larval survival. In other years lower temperatures and increased salinity were registered (ICES 1997/C:3, ICES 1998/C:8 and ICES 1999/?).

The Spanish fleet in the Gulf of Cadiz is mainly purse-seiners, though there is also trawlers in the area. Trawlers usually target prawn. Some of these trawlers switch to targeting anchovy in years when the yield of prawns is low. The Spanish fleet in the west of Galicia is composed of purse-seiners. The Portuguese fleet is mainly, purse-seiners, with some trawlers and artisanal ships, which catch a very small quantity of anchovies. (Table 11.2.1.2)

11.2.1 Landings in Division IXa

The total catch in 1998 was 10,962 t, similar to the level of 1995 (12,956 t). The catch in 1998 is far higher to the mean catch registered in this area since 1988 (excluding 1995). These high catches in 1998 are explained by the catches of the Spanish fleet in the Gulf of Cadiz (Sub-division IXa South), as opposed to what occurred in 1995 in which the high catches came mainly from the northern part of Division IXa, and were obtained by the Spanish and Portuguese fleets.

The Spanish catch increased in 1998 (9,349 t) compared to 1996 (4,664 t) due to the increase in catches in the Gulf of Cadiz (Sub-division IXa South). The catch in 1998 in the Gulf of Cadiz increased to 8,977 t, reaching a historical maximum for this area. The mean catch in the Gulf of Cadiz between 1988 and 1997 is of around 3,600 t. The Spanish catch in Sub-division IXa North increases slightly with respect to 1996 and 1997, with a great drop in comparison with 1995, the catch remaining at the low levels usually found in the area. The Portuguese catch in 1998 (1,613 t) increased with respect to 1997 (632 t) and fell compared to 1995 (7,056 t). (Table 11.2.1. 1 and Figure 11.2.1.1).

Table 11.2.1.2 shows catch by fishing gear and by country. In both countries the main part of the catch was taken using purse-seine, this gear accounting for 84% in the Spanish and 96% in the Portuguese fisheries. In 1998 in the Gulf of Cadiz catches corresponding to the trawl fleet increase considerably, from 190 t in 1997 to 1148 t in 1998, although this only makes up 13% of the total catch in this area.

From 1943 to 1987 data of catches were only provided by Portugal, and during this period catches varied between 23 t and 12,610 t (Table 11.2.1.1). The Portuguese annual landings alternate between periods of high catches (1936-1940, 1942-1948, 1955-1957, 1962-1966 and 1995) and periods of very low catch levels (1927-1936, 1966-1976, 1979-1984 and 1987-1994) (Pestana, 1996). Data of Spanish catches in the Gulf of Cadiz (Sub-division IXa South) for this period cannot be given since they have been combined with anchovy catches in the area of Morocco, and catches in Galician waters (Sub-division IXa North) are not available.

11.2.2 Landings by Subdivision

Since 1988 the anchovy fishery in Division IXa was situated in the Gulf of Cadiz (Sub-division IXa South), except in 1995, when it was mainly found in the northern part of Division IXa (Sub-division IXa North and Central-North).

The distribution of Spanish catches in 1998 was similar to that of the years 1988-1994 and 1996-1997 (ICES 1992/Assess:17,ICES 1993/Assess: 19, ICES 1995/Assess: 2, ICES 1996/Assess: 7, ICES 1998/Assess: 6 and ICES 1999/ACFM:6) and completely different to that of 1995 (ICES 1997/Assess: 3). In 1998, the greatest catches (96%) were found in Sub-division IXa South (Gulf of Cadiz), and the rest (4%) in Sub-division IXa North (West of Galicia). Catches in the Gulf of Cadiz take place throughout the year, usually increasing in spring and summer, but in 1998 catches are relatively stable throughout the year without undergoing any significant rise in spring-summer. The small catches in Sub-division IXa North came about mainly in the first and fourth quarters.(Table 11.2.2.1).

The greatest contribution to Portuguese annual landings came from IXa South during the period 1943-1967 (mean value 4,526 t).Thereafter, landings decreased to 386 t (mean value) from 1968 to 1983 and to 32 t (mean value) from 1984 to 1991. From 1992 to 1995 landings were less than 1 tonne, in 1996-1997 they were 32 t (mean value) and in 1998 landings increases to 566 t. In Sub-division IXa Central-North there were alternate periods of relatively high and low landings. After 1984 landings of Sub-division IXa Central-North made the greatest contribution to total annual landings (mean value 1,116 t). The mean percentage of landings by Sub-division (1970-1995) is 70% of the total in IXa Central-North, 5% in IXa Central-South and 20% in IXa South. The same landing pattern occurs in Sub-divisons IXa Central-North and Central-South during the period from 1970-1994 and in 1995 (Pestana, WD 1996). In 1996-1998, catches in Sub-division IXa Central-North and Central-South fell, but maintained the same pattern of catches as in the period 1970-1995.

Most of the Portuguese landings were made between May and October (mean 1927-1994). The 1995 landings show a different evolution with two very important periods, from April to June and from August to December. (Pestana, 1996). In 1996-1998 catches are taken mainly in the first and fourth quarters (Table 11.2.2.1)

11.3 Biological Data

11.3.1 Catch Numbers at Age

Catches at age of anchovy in Division IXa are not available. Catches at age were only provided for the Spanish fishery in Sub-division IXa North in 1995 and these catches were made up of age 1 anchovies (ICES 1997/Assess:3).

Catches at age of anchovy in Sub-division IXa North are not normally available due to the catch being insignificant, thus rendering it impossible to carry out biological sampling of commercial catches. In 1998 a few otolith samples were collected, but catches at age in Sub-division IXa North are not presented owing to the small number of otoliths and their failure to cover the whole length range. They were not considered representative of the population. Spanish sample, 68.5% were found to be age 1, 30.8% age 2 and 0.7% age 3 (B. Villamor, pers. comm.).

As in previous years, catches at age for anchovy are also unavailable in the Gulf of Cadiz, due to problems in the interpretation of otolith readings for this area. In 1997 and 1998 an otolith exchange for anchovy in the Gulf of Cadiz was carried out within the International Project co-funded by the European Commission, entitled European Fish Ageing Network (EFAN), to solve the difficulties involved in age reading. The results of the exhange are described in the report of the anchovy otolith exhange (M.T. García Santamaría, 1998). The main conclusions of this exchange were the following:

- Despite the level of agreement between modal ages and readings reached by all readers combined in samples both from Set A and B (79% and 77% respectively), in only 105 of the 378 observed otoliths did all readers interpret the same age.

- Most of the readers have attributed low reability to their readings.

- Two readers have a tendency to overestimate first age classes. Nevertheless, these readers are those who have better detected ages 3 and 4. The remaining readers tend to underestimate the age.

- A high disparity of criteria was detected among readers when determining the nature of the otolith edge (hyaline or opaque).

- Results indicate an incorrect interpretation of annual rings and false rings among participating readers.

- The age-length key prepared using the modal ages provides mean values of lengths at age that fit quite well to the reality, at least in relation to the most abundant and representative ages in the catch (0 and 1).

- The low reliability in assigning age and especially the discrepancies in the criteria followed by the readers to interpret the nature of the otolith edge make it necessary to consider a Workshop to establish standardised principles for age interpretation in anchovy.

11.3.2 Mean Length at Age and Mean Weight at Age

Mean weights at age and mean lengths at age in Division IXa are not available for 1998 for the same reasons as those explained previously.

Using the few data we have to get some idea of the situation, in 1995 mean length and mean weight at age 1 in the catch of Sub-division IXa North were 15.6 cm and 26.0 g respectively (ICES 1997/Assess:3). From the small sample of otoliths obtained in Sub-division IXa North in 1998, mean lengths were 15.3 cm, 17.7 cm and 17.8 cm for ages 1, 2 and 3 respectively (B. Villamor, pers. comm.). From the sample of otoliths used in the otolith exchange carried out in Sub-division IXa South, mean lengths were 9.3 cm for age 0, 12.4 cm for age 1, 13.7 cm for age 2, 15.0 cm for age 3 and 15.5 for age 4 (M.T. García Santamaría, 1999)

Length Distributions by fleet

Annual length compositions of landings of Anchovy in Division IXa are provided only by Spain, from 1988 to 1998 for Sub-division IXa South and from 1995 to 1998 for Sub-division IXa North. Portugal have not provided length distributions of landings in Division IXa.

Table 11.3.2.1 and Figure 11.3.2.1 show anchovy length distributions in 1998 in Division IXa by quarter and Sub-division and Table 11.3.2.2 shows annual length distributions from 1988 to 1998. Figure 11.3.2.2 compares length distributions in Sub-divisions IXa South and IXa North from 1995 to 1998.

In 1998, as in previous years, a large number of juveniles are captured (individuals with a length of less than 10 cm) in Sub-division IXa South during the first and second halves of the year (Table 11.3.2.1 and Figure 11.3.2.1). The mean length and weight in the catch in Sub-division IXa South are smaller than those recorded from Sub-division IXa North (Table 11.3.2.2 and Figures 11.3.2.1 and 11.3.2.2).

11.3.3 Maturity at Age

Over a four-year period (1989-1992) in the Gulf of Cadiz (Sub-division IXa South) the spawning season extends from late winter to early autumn. Peak spawning time for the whole population occurs from June to August. Maturity is reached at a total length of 11.09 cm in males and 11.20 cm in females. However, there are inter-annual variations in this size, suggesting a high plasticity in the reproductive characteristics as a response to environmental factors regulating reproductive success. (M. Millán, 1999)

11.3.4 Natural mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Sub-area VIII, natural mortality must be high.

11.4 Fishery-Independent Information

11.4.1 Acoustic Surveys

A Spanish acoustic survey was carried out in the Gulf of Cadiz (Sub-division IXa South) in 1993 to estimate anchovy abundance. The total biomass estimated was 6,569 t (ICES 1995/Assess:2). Since then, no acoustic surveys have been conducted in this area by Spain. In Sub-division IXa North, Spain has been conducting acoustic surveys aimed at sardine since 1983, but no anchovy schools were detected (Carrera *et al.*, WD 1999) .

Information on anchovy from the Portuguese sardine egg and acoustic surveys relating to Division IXa is not available as there is no research project for anchovy in Portugal.

11.5 Effort and Catch per Unit Effort

Data provided on fishing effort and CPUE indices of anchovy in Division IXa refer to the Spanish purse-seine fleet in the Gulf of Cadiz from 1988 to 1998 and to the Spanish purse-seine fleet in Sub-division IXa North from 1995 to 1998 (Table 11.5.1 and 11.5.2). No Portuguese data are available.

Effort measured as the number of effective fishing trips made by the five fleets of the Gulf of Cadiz and the CPUE series shows a declining trend to 1995 in all fleets. Since 1996 an increase in effort is observed in the Barbate single-purpose and San Lucar fleets, with a considerable increase in CPUE in the Barbate single-purpose fleet (Figure 11.5.1). In Sub-division IXa North very high effort and CPUE in 1995 are observed, the year in which there was a great abundance of anchovy in this area. Since 1996 there has been a great fall in effort and CPUE, corresponding to years of low anchovy abundance (Figure 11.5.2).

11.6 Recruitment Forecasting

Recruitment forecasting of Anchovy in Division IXa is unknown. By analogy with the anchovy stock in Sub-area VIII, recruitment may have wide variations driven by environmental factors.

11.7 State of the Stock

No assessment of this stock can be made for the reasons described last year; on one hand the differences in length distributions between IXa South and North suggest that the populations inhabiting these areas may have different biological characteristics, and on the other there is a lack of independent information from the fishery (ICES CM 1999/ACFM:6). Furthermore, mean lengths at age are different between the Southern and Northern areas (see section 11.3.2) based on the otolith samples, which supports the suggestion that populations inhabiting these areas must have different dynamics.

Anchovy biomass in the Gulf of Cadiz was estimated as 6,569 t in an acoustic survey in 1993.

Because of the lack of biological information, the state of the stock is unknown. By analogy with the anchovy stock in Sub-area VIII, it seems that this stock will fluctuate widely due to variations in recruitment largely driven by environmental factors.

11.8 Catch Preditions

No catch preditions have been estimated for this stock.

11.9 Medium-Term Predictions

No medium-term predictions have been estimated for this stock.

11.10 Long-Term Yield

No long-term yield predictions have been estimated for this stock.

11.11 Reference Points for Management Purposes

Based on available information it is not possible to determine limit and precautionary reference points.

11.12 Harvest Control Rules

Harvest control rules are not available as reference points are not determined.

11.13 Management Considerations

The regulatory measures were the same as for the previous year and are summarised by Millan and Villamor (WD 1992). It must be pointed out that the purse-seine fleet in the Gulf of Cadiz did not observe the habitual voluntary stoppage of three months in this area in 1997 and 1998 (ICES 1992/Assess:17, ICES 1993/Assess:19, ICES

1995/Assess: 2, ICES 1996/Assess: 7, ICES 1997/Assess: 3 and ICES 1998/Assess: 6). The fleet probably went ahead with fishing activity due to the higher anchovy abundance.

Given the reduced knowledge of the biology and dynamic of this population, it is recommended that the precautionary TAC at the level of recent catches (excluding 1995 and 1998) would be appropriate to avoid an increase in effort. The official TAC is almost three times higher that the average of the catches of the recent years (excluding 1995 and 1998).

Table 11.2.1.1 Portuguese and Spanish annual landings 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	5336	5454	5950
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	3036	3153	3389
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

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

Table 11.2.1.2 ANCHOVY IXa. Catches (t) by gear and by country in 1988-1998.

Country/ Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998
SPAIN	4263	5454	5946	5712	3028	1961	3153	5900	1823	4664	9349
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371
Purse seine IXa South	4242	5270	5666	5656	2995	1630	2884	496	1556	4410	7830
Trawl IX a South	21.0	66.0	60.0	41.0	0.0	330	152	75	224	190	1148
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613
Trawl					4	9	1		56	46	37
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541
Artisanal					1	1	3		94	7	35
Total	4721	5950	6487	5922	3303	1984	3390	12956	4594	5295	10962

* Portugal data without separate the catch by gear

Table 11.2.2.1: Anchovy catches (t) in Division IXa by country and Subdivisions in 1998.

		QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANUAL	
COUNTRY	SUBDIVISIONS	C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
SPAIN	IXa North	192	51.8	51	13.6	5	1.4	123	33.2	371	4.0
	IXa South	1773	19.7	2113	23.5	2514	28.0	2579	28.7	8977	96.0
	TOTAL	1965	21.0	2163	23.1	2519	26.9	2702	28.9	9349	
PORTUGAL	IXa Central North	424	47.4	191	21.4	49	5.4	231	25.8	894	55.4
	IXa Central South	109	70.8	0	0.0	12	8.1	32	21.0	153	9.5
	IXa South	9	1.6	63	11.1	363	64.2	131	23.2	566	35.1
	TOTAL	541	33.5	254	15.7	424	26.3	394	24.4	1613	
TOTAL	IXa North	192	51.8	51	13.6	5	1.4	123	33.2	371	3.4
	IXa Central North	424	47.4	191	21.4	49	5.4	231	25.8	894	8.2
	IXa Central South	109	70.8	0	0.0	12	8.1	32	21.0	153	1.4
	IXa South	1782	18.7	2175	22.8	2877	30.1	2710	28.4	9543	87.1
	TOTAL	2506	22.9	2417	22.0	2943	26.8	3096	28.2	10962	

Table 11.3.2.1: Length distribution ('000) of ANCHOVY in Division IXa by country and Sub-divisions in 1998.

	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
Length (cm)	SPAIN IXa North	PORTUGAL IXa C,CN,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa C,CN,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa C,CN,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa C,CN,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa C,CN,S	SPAIN IXa South
3.5		-			-			-			-			-	
4		-			-			-			-			-	
4.5		-			-	2415		-	850		-	1986		-	5251
5		-			-	11270		-	7649		-	10257		-	29176
5.5		-	3764		-	24149		-	14448		-	22367		-	64729
6		-	12798		-	30931		-	16997		-	33257		-	93984
6.5		-	29737		-	25326		-	9065		-	24433		-	88562
7		-	25053		-	15246		-	6799		-	31383		-	78482
7.5		-	9273		-	10289		-	5293		-	23812		-	48668
8		-	14167		-	7737		-	3877		-	9996		-	35776
8.5		-	18911		-	15798		-	2954		-	11844		-	49506
9		-	23551		-	31364		-	2379	156	-	21895	156	-	79188
9.5		-	28843		-	42590		-	4234	367	-	31125	367	-	106792
10		-	46034		-	37817		-	12498	754	-	36022	754	-	132371
10.5		-	42529		-	33981		-	25805	1486	-	48225	1486	-	150540
11		-	30525		-	37797		-	38267	2047	-	51688	2047	-	158277
11.5		-	22110		-	32173		-	41559	1477	-	36856	1477	-	132697
12	61	-	12224		-	22780		-	36445	1206	-	26857	1267	-	98307
12.5	207	-	15660		-	10513		-	29267	971	-	19562	1178	-	75001
13	912	-	6437		-	4455		-	22328	1826	-	10790	2737	-	44010
13.5	1159	-	3032		-	2836		-	13139	1244	-	5479	2403	-	24486
14	2505	-	1540		-	1004		-	6957	533	-	2071	3038	-	11573
14.5	2798	-	498		-	159	15	-	3207		-	1723	2813	-	5586
15	1920	-			-	59	56	-	1385		-	587	1976	-	2031
15.5	636	-		183	-		71	-	521		-	42	890	-	563
16	123	-		384	-		54	-	134		-		560	-	134
16.5	9	-		311	-		10	-			-		330	-	
17		-		438	-			-			-		438	-	
17.5		-		311	-			-			-		311	-	
18		-			-			-			-			-	
18.5		-			-			-			-			-	
19		-			-			-			-			-	
19.5		-			-			-			-			-	
20		-			-			-			-			-	
20.5		-			-			-			-			-	
21		-			-			-			-			-	
21.5		-			-			-			-			-	
22		-			-			-			-			-	
Total N	10330	-	346687	1626	-	400688	207	-	306055	12068	-	462258	24231	-	1515689
Catch (T)	192	541	1773	51	254	2113	5	424	2514	123	394	2579	371	1613	8977
Lavg (cm)	14.5	-	9.7	16.8	-	9.4	15.7	-	10.8	12.0	-	9.6	13.4	-	9.8
Wavg (g)	18.6	-	5.1	31.1	-	5.3	24.4	-	8.2	10.2	-	5.6	15.3	-	5.9

Table 11.3.2.2: Annual Length distribution ('000) of ANCHOVY in Division IXa from 1988 to 1998.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998	
Length (cm)	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South
3.5											3956				
4			4011	258	1						24394				
4.5		127	16601	3306	26	22					94385		1430		5251
5	128	452	29122	43814	80	22					105300		11709		29176
5.5	170	813	43716	77144	345	66					75573		39261		64729
6		994	39979	43378	921	180					45352		55532		93984
6.5		1207	37909	24724	2337	611	5488				33572		54737		88562
7	255	2391	29592	15470	3567	1862	12009				26691		70869		78482
7.5	351	5764	27140	16574	5993	3561	18391		439		20643		47881		48668
8	3163	24708	24315	16633	12777	4083	23533		439		23701		47887		35776
8.5	8073	62795	33427	15724	18240	2626	22031		447		32814		37785		49506
9	12602	52082	46239	19735	14461	3843	20272		3108		29383		20476	156	79188
9.5	21594	42387	74823	30742	20684	6848	14835		9805		15933		13702	367	106792
10	34293	67553	95844	39474	31524	7100	23726		11823		8743		8824	754	132371
10.5	49922	69793	96132	71062	31870	9496	27521		14966		8435		11914	1486	150540
11	63848	68387	72419	83835	31776	9401	28394		8575		18322		22139	2047	158277
11.5	55186	55528	63427	81931	31150	11636	33602		7105		22440		26800	1477	132697
12	60928	41099	44273	77372	34504	24713	26439	74	4565		18131		38491	1267	98307
12.5	37457	34212	28509	51932	29185	32918	30192	711	3606		10112		44784	1178	75001
13	22608	17989	15263	43309	17040	26293	15732	3049	1855	8	4207	374	46325	2737	44010
13.5	8149	11505	10619	25316	5725	12681	8517	3381	1544	12	1974	997	37851	2403	24486
14	4270	7747	4689	17842	3378	5318	5719	14998	935	258	1385	2004	18885	3038	11573
14.5	474	3190	1206	5211	2180	2535	4763	25944	135	335	967	422	11136	2813	5586
15	3896	2245	605	1987	315	943	3612	46371	138	375	637	48	6269	1976	2031
15.5	2436	1671	318	944	922	510	874	42244	6	226	511	40	3734	890	563
16	2126	4676	340	1533	355	56	813	44171		227	165	33	2203	560	134
16.5	1690	7271	565	2087	271		368	14369		151		10	294	330	
17	1096	4349	373	1655	95		182	8378		104		10		438	
17.5	209	1241	199	558	19			778		94		13		311	
18		571	143	79				236		24					
18.5			19							21					
19										1					
19.5															
20															
20.5															
21															
21.5															
22															
Total N	394923	592750	841818	813628	299743	167322	327014	204705	69491	1835	627727	3951	680916	24231	1515689
Catch (T)	4263	5336	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977
Lavg (cm)	11.6	10.9	9.6	10.1	10.8	12.0	10.8	15.6	11.0	15.6	7.1	14.2	9.6	13.4	9.8
W avg (g)	10.8	8.9	6.9	7.0	10.0	11.8	9.3	26.0	9.6	23.7	2.9	16.1	6.8	15.3	5.9

Table 11.5.1 ANCHOVY in Division IXa. Effort data : Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) number of fishing trips.

Year	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE Single purpose	BARBATE Multi purpose	SAN LUCAR Multi purpose	I. CRISTINA Single purpose	I.CRISTINA Multi purpose	VIGO	RIVEIRA
	No. fishing trip					No. fishing trip	
1988	3958	17	210	-	-	-	-
1989	4415	39	234	-	-	-	-
1990	4622	92	660	-	-	-	-
1991	3981	40	919	-	-	-	-
1992	3450	116	583	-	-	-	-
1993	2152	5	225	-	-	-	-
1994	1625	69	899	196	28	-	-
1995	528	17	377	22	17	1537	252
1996	1595	89	1659	76	55	32	3
1997	2207	115	1738	75	13	31	23
1998	2153	-	2234	177	30	134	269

Table 11.5.2: ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) CPUE series ir commercial fisheries.

Year	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE Single purpose	BARBATE Multi purpose	SAN LUCAR Multi purpose	I. CRISTINA Single purpose	I.CRISTINA Multi purpose	VIGO	RIVEIRA
	kg/No. fishing trip					kg/No. fishing trip	
1988	1047	461	420	-	-	-	-
1989	1139	534	943	-	-	-	-
1990	1128	287	643	-	-	-	-
1991	1312	339	456	-	-	-	-
1992	819	173	300	-	-	-	-
1993	641	268	225	-	-	-	-
1994	1326	262	398	204	174	-	-
1995	377	134	166	52	25	2509	2286
1996	497	315	246	137	157	847	4
1997	1580	306	288	134	163	1068	639
1998	3144	-	221	242	197	1489	512

Figure 11.2.1.1: Portuguese and Spanish annual landings of Anchovy in Division IXa since 1943

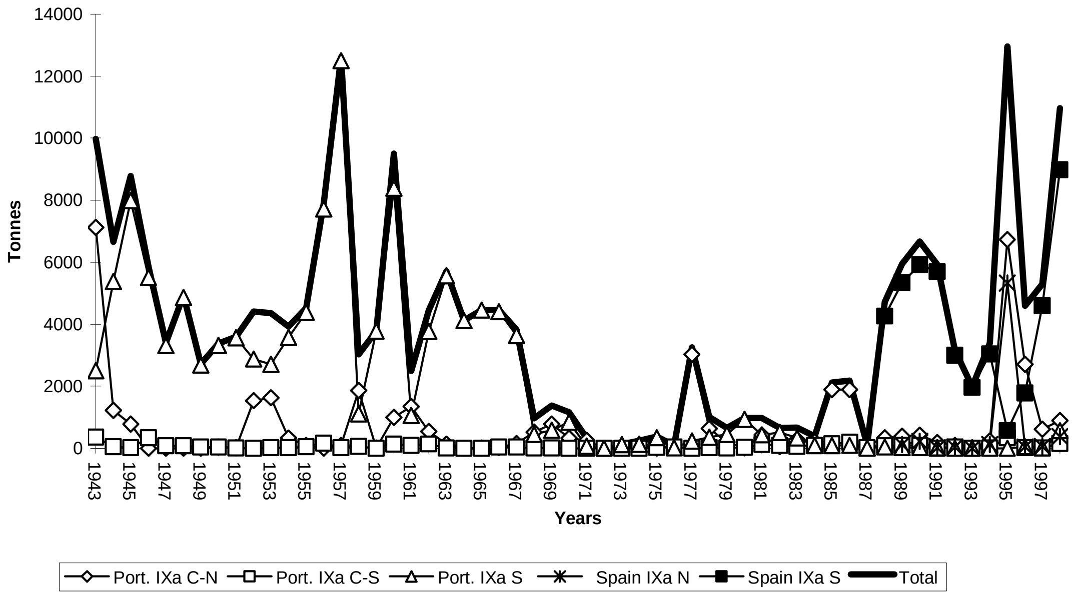


Figure 11.3.2.1: Length distribution ('000) of landings of ANCHOVY in Sub-divisions IXa South(Gulf of Cadiz) and IXa North (Western Galicia) by quarter in 1998

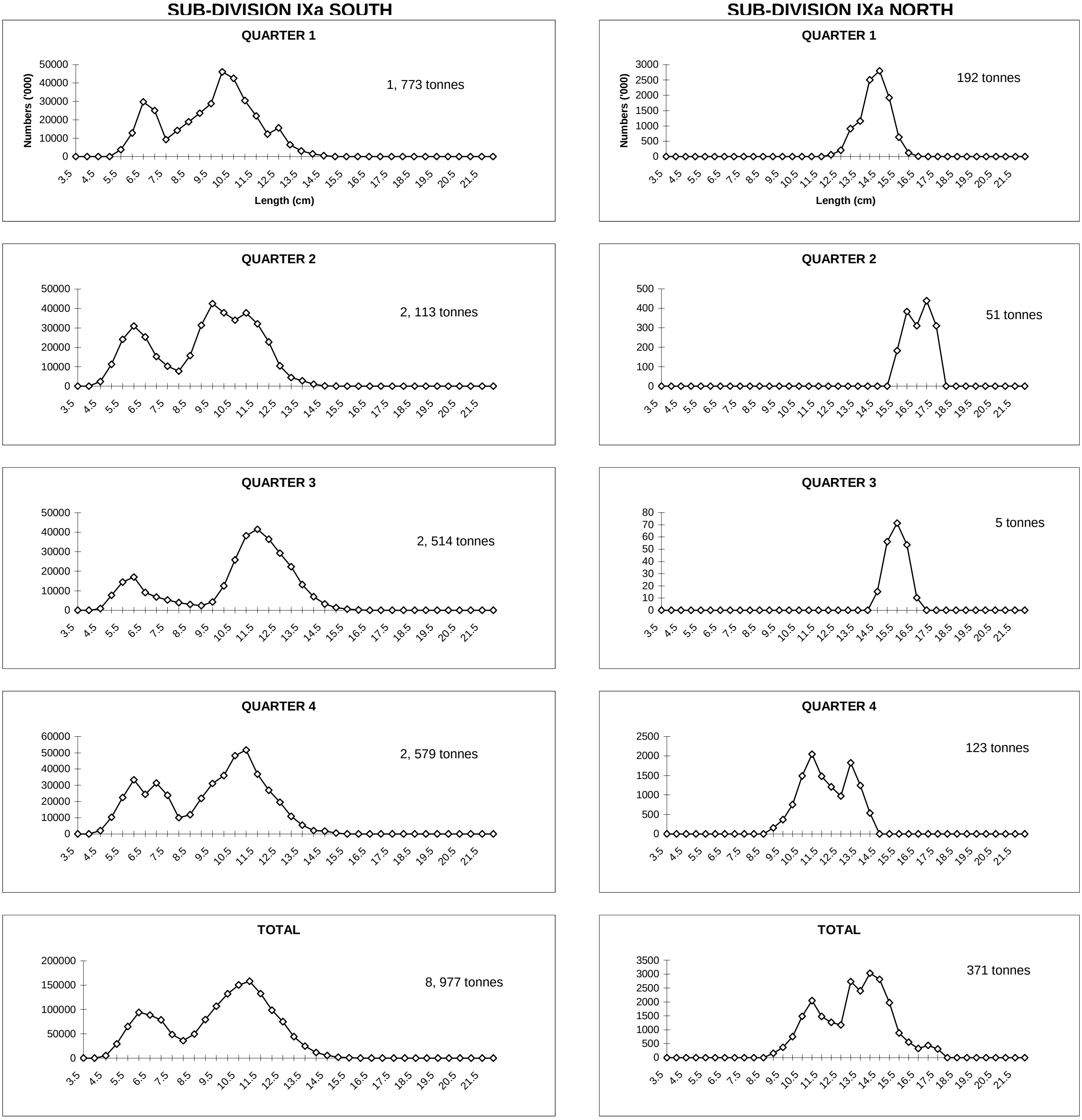
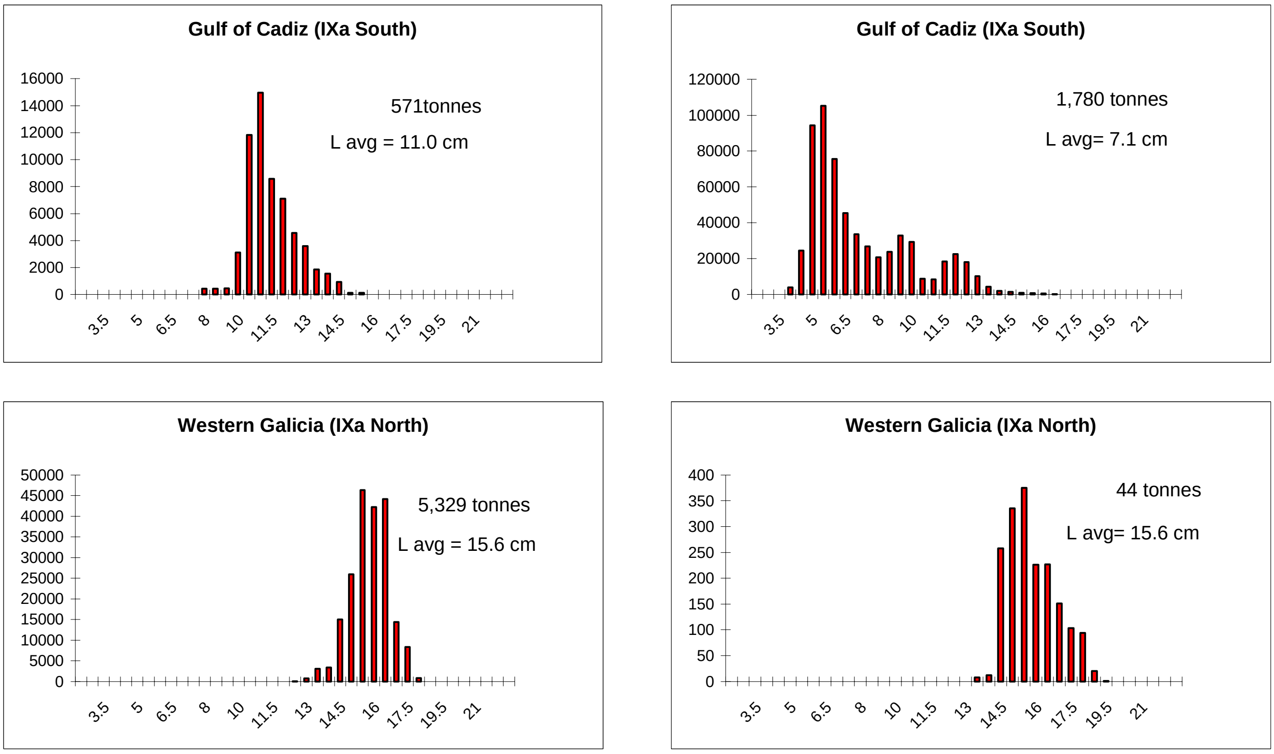


Figure 11.3.2.2: Length distribution ('000) of Anchovy in Sub-division IXa South and IXa North. 1995-1998

1995 **1996**



1997 **1998**

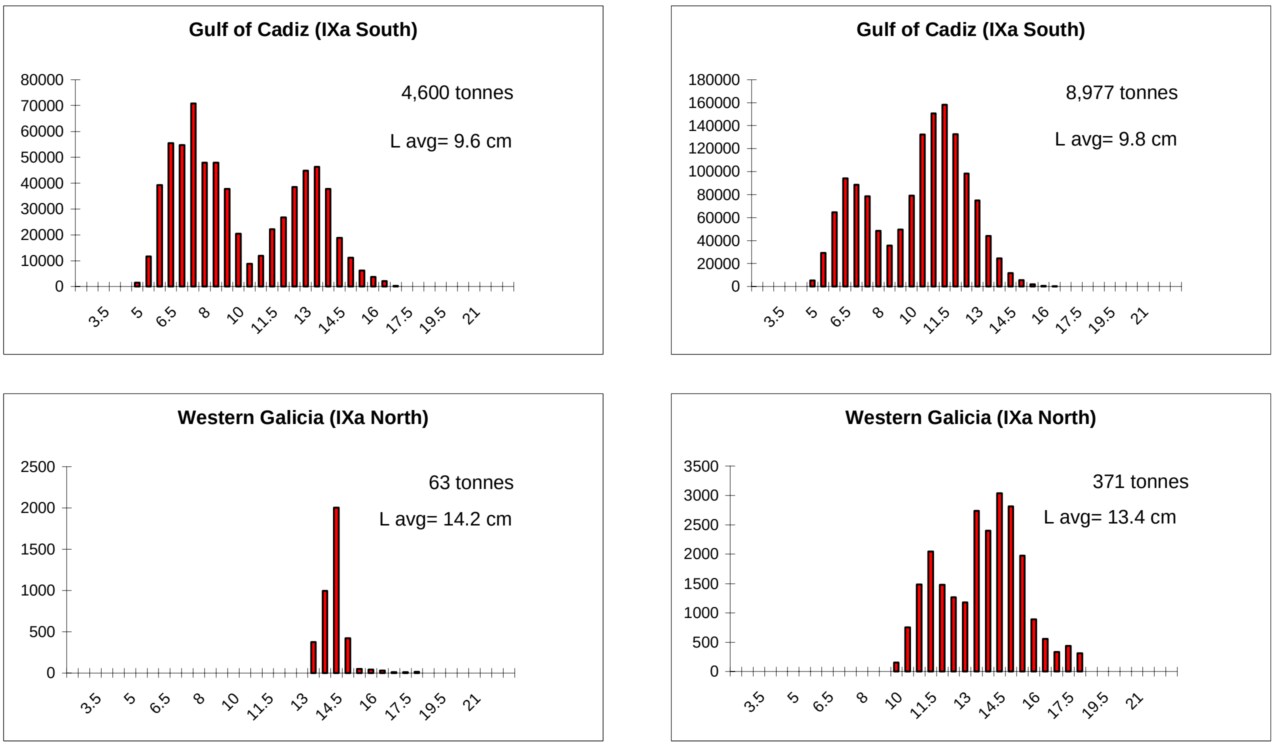
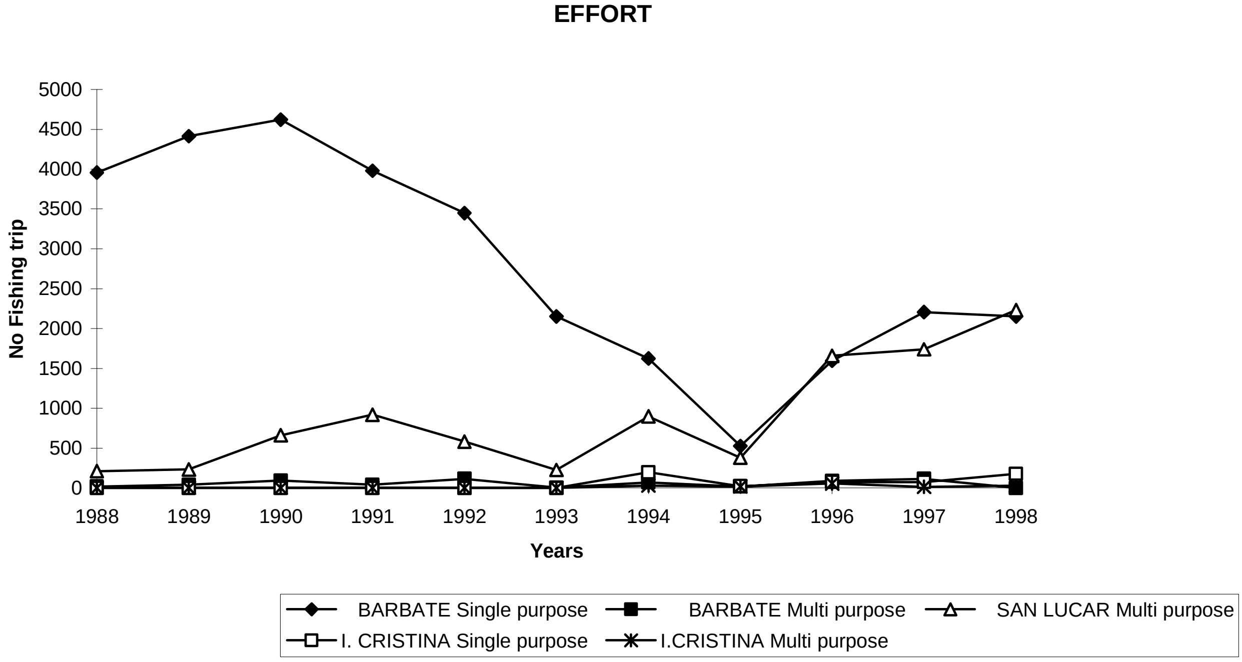


Figure 11.5.1 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) Effort and CPUE series in comercial fisheries.



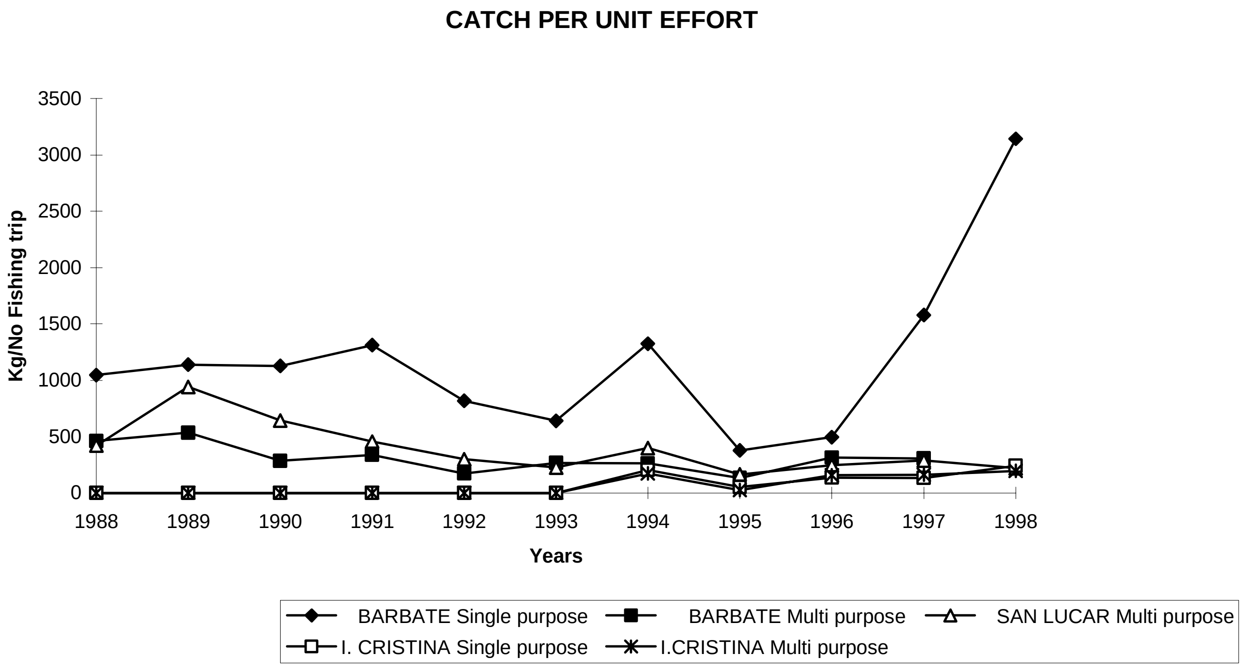
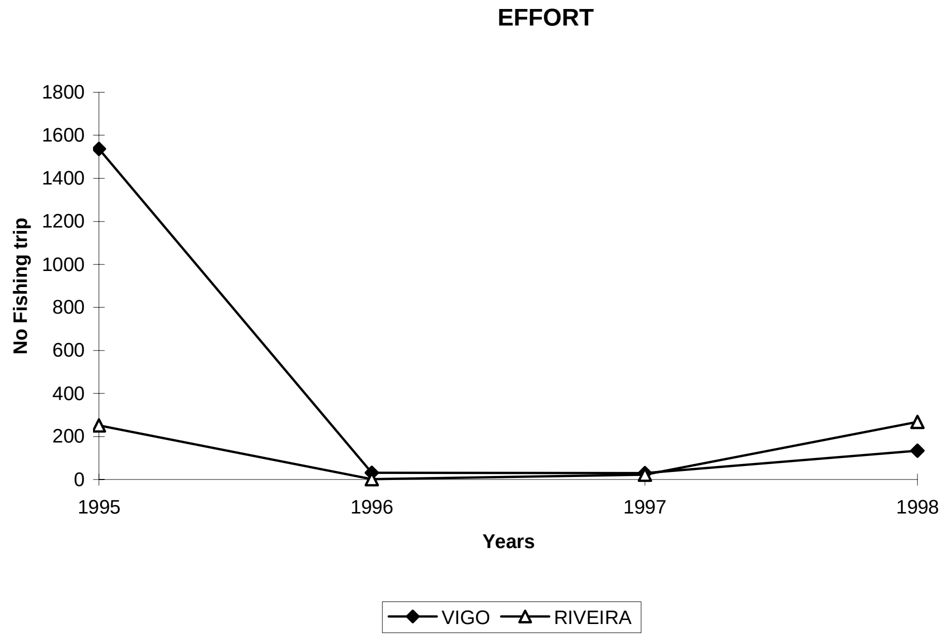
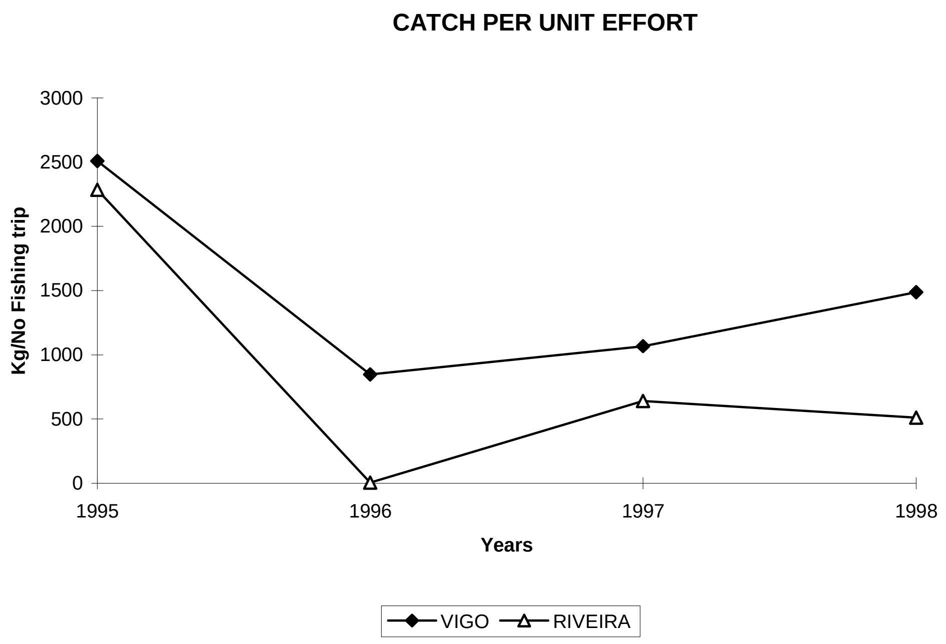


Figure 11.5.2: ANCHOVY in Division IXa. Spain IXa North (Galician West) Effort and CPUE series in comercial fisheries.





12 DATA REQUESTED BY THE MULTI-SPECIES WORKING GROUP

12.1 Mackerel

The catch of mackerel belonging to the North Sea stock has been included in the catches of the western stock since 1987.

12.1.1 Catch in numbers at age by quarter for the North Sea mackerel stock

The working group assumes that no new data is available to give catch in number at age by quarter. The total catch of North Sea mackerel of 10,000 tonnes can be assumed.

12.1.2 Weight at age in the stock

New data from Norway is available for the North Sea stock (pers.com. Iversen) Data on weight at age in the stock from 1999 egg survey in the North Sea are presented in Table 12.1.

12.1.3 Stock distribution by quarter

Although there appears to be some evidence suggesting a change in the distribution of mackerel in the North Sea, the working group did not have sufficient information to justify altering the distributions presented (Table 12.2) in previous reports (Anon. CM 1997/Assess:3).

12.2 Horse Mackerel

12.2.1 Catch in numbers and weight at age by quarter for the North Sea horse mackerel stock

Details of the catch in numbers and the weight at age are given in Table 5.4.1.1

12.2.2 Stock distribution by quarter

The North Sea Horse Mackerel stock are known to migrate south to the Channel during the 4th quarter and to be back in the North Sea by the 2nd quarter of each year. The Working Group therefore suggests that a value of 50% and 10 % of the stock can be assumed to be available in the North Sea during the 4th and 1st quarter respectively.(Table 12.3).

There is still no information about the numbers of western horse mackerel which migrate into the northern North Sea during the 3rd and 4th quarters of the year. From 1982 to 1986 catches of horse mackerel in Division IVa were low (<1,000 tonnes) indicating very little migration. However, since then catches have increased to a maximum of 113,000 t in 1990, which was about 30% of the total western stock catch. Since 1994 catches have declined and in 1998 the provisional catch in Division IVa was about 17 ,000 t (Table 4.1.2) or about 17% of the total western stock catch.

In 1997 due to decreasing catches by Norway in Division IVa and a reduction in the modelled inflow of Atlantic water to the North Sea in 1996 (Iversen, et al: WD 1997) the Working Group suggests that a value of 10% of the adult stock of the Western Horse Mackerel can be assumed to be available in Division IVa in the fourth quarter, and 1% in the first quarter of the year.

Table 12.1 North Sea Mackerel mean weight in the stock

Age	W(g)
1	110
2	207
3	281
4	326
5	425
6	447
7	-
8	595

Table 12.2 Percentage of each mackerel stock assumed to be present in the North Sea, by quarter, in 1998.

	North Sea Stock (%)				Western Stock (%)[1]			
Quarter	1	2	3	4	1	2	3	4
1	100	100	100	100	-	20	30	30
2	80	100	100	80	10	10	50	70
>2	90	100	50	70	10	+	50	70

Table 12.3 Percentage of each horse mackerel stock assumed to be present in the North Sea, by quarter, in 1998.

	North Sea Stock (%)				Western Stock (%)			
Quarter	1	2	3	4	1	2	3	4
1-4	10	100	100	50	0	0	0	0
5+	10	100	100	50	1	0	0	10

[1] There is evidence from tagging studies that fish from the Southern component also migrates along with western component fish.

13 RESPONSE TO EU REQUEST ON NORTH SEA MACKEREL

The European Commission has requested ACFM to consider:

Question 1: *Is it at present possible to positively identify mackerel or mackerel spawning products caught in the North Sea as originating from the North Sea spawning component from the North East Atlantic mackerel stock?*

Question 2*: If not, what is the basis for the recommendations relating to seasonal and geographical closures for fishing mackerel in ICES Sub-area IV and ICES Division IIIa repeated by ICES since 1987?*

Question 3: *If so, and recalling that managers have been unable to agree on conditions in strict compliance with these recommendations, is there reason to consider alternative and/or augmented recommendations?*

13.1 Basis for current ACFM Advice

The original recommendation in full from the 1988 ICES mackerel working Group report (ICES C.M. 1988/Assess:12) was:

On the assumption of the North Sea stock remaining on a low level, the Working Group retains the view that fishing should not be allowed. This, however, creates problems since mackerel of this stock only occur completely separated from Western mackerel at the time of spawning. At other times, when important fisheries take place, the two stocks mix. The ratios of mixing by time and area in recent years cannot be determined with certainty, but the general distribution and migration pattern are outlined in Figure 3.2.

It is reasonable to assume that mackerel occurring in Divisions IIIa, IVb and IVc are predominantly North Sea stock at all times of the year. Mackerel in Division IVa can be of mixed origin, but Western mackerel dominate in the northern part during the July-October period.

Based on this, the Working Group recommends that fishing for mackerel be prohibited in Divisions IIIa, IVb and IVc at any time of the year and in Division IVa from 1 January - 31 July. This might, however, leave a proportion of the North Sea stock vulnerable to fishing in the southern part of Division IVa.

13.2 Discreteness of North Sea Mackerel Population

Mackerel in the North Sea was considered by ICES as an independent stock and assessments (VPA) for this stock was carried out until 1984 (ICES, 1985/Assess:7). The catches in the North Sea and Norwegian Sea were allocated to the western and North Sea stocks according to recovery rates of internal tags inserted in mackerel in the western areas in May and in July-August in the Skagerrak and North Sea. As time passed the North Sea mackerel stock declined (collapsed) and the western and later also the so called southern stock were shown to migrate extensively into the Norwegian Sea and North Sea after the spawning season. They stay in these areas for feeding until migrating back to the spawning area. The tagging in the North Sea was terminated since both western and North Sea fish were present at the same time in the tagging area.. Since the basis for dividing the catches into North Sea and western mackerel thereby disappeared all mackerel catches in the North Sea and Skagerrak have since been allocated to the western stock. However, the biomass of the North Sea mackerel has never been included in the tuning of VPA and ICA. Since it is impossible to allocate catches by stocks or components the catches of mackerel in southern, western and North Sea areas have since 1995 (ICES 1996/Assess:7) been included in the ICA assessment of the so called North East Atlantic mackerel stock. So far the ICA has been tuned according to spawning biomasses estimated from egg surveys in the western and southern areas. The estimated biomass spawning in the North Sea has not been included. Thereby the ICA has been tuned to a to low biomass. However, due to the low biomass spawning in the North Sea the Northeast Atlantic mackerel stock is underestimated by about 3%.

13.2.1 Implications from Egg Surveys

Mackerel usually spawn in the North Sea and Skagerrak in May to late July early August in temperatures usually above 10^{o} C (Iversen, 1973, Johansen, 1925, and Dannevig 1948). The spawning takes place in the surface and over 90% of the eggs are observed in the upper 12-13 m (Iversen, 1973).

Johnson (1977) reviewed mackerel larvae sampled by the continuous plankton recording (CPR) program in the North Sea during the two periods 1948-1956 and 1958-1968 and showed that the main concentrations were observed well inside the North Sea, east of 1^{o} W and between 54^{o} and 59^{o} N.

The Institute of Marine Research (IMR) has carried out mackerel egg surveys in the North Sea since 1968. These surveys were carried out once each spawning season until 1979 (Iversen, 1973, 1977). Since 1980 the spawning area was covered several times to estimate the total egg production and SSB. Since 1982 usually other countries as the Netherlands, Scotland, Denmark as well as Norway participated in the surveys.

The main spawning usually takes place centrally in the North Sea, with no or low numbers of eggs observed in the north western part and in the Channel. The spawning usually starts mid May and ends towards the end of July but low egg production has also been observed as late as 10 August (Iversen 1981). The main spawning is usually during second half of June (Figure 3.1.4.1.4).

Three egg surveys were carried out in the North Sea in 1999 (Figure 3.1.4.1.1-3.1.4.1.3, section 3.1.4.1) by Netherlands and Norway and the SSB was estimated at 68,000 tons. During the period 1980 to 1999 SSB has been estimated nine times (Iversen WD 1999) and the spawning stock has varied between 25,000 tons (1988) and 160,000 tons (1983) (text table in section 3.1.4.1). The spawning area in the North Sea is well defined and separated from the western spawning area.

13.2.2 Implications from Tagging

Several tagging surveys were made during the sixties and the seventies on North Sea mackerel (Bolster, 1974; Hamre, 1978; Lindquist and Hannerz, 1974). Based on these surveys Hamre (1980) summerised a general pattern of seasonal migration of the North Sea stock (see Section 3.1.6). The rest of the Northeast Atlantic mix with the North Sea Mackerel during July-January/February when mackerel from the southern and western areas migrate into Divisions Vb, IIa and IVa. Uriarte & Lucio (in press) and a recent international tagging program carried out in 1997 and 1998 (Uriarte et al. WD99) endorses the previous finding of the tagging studies about the strong mixing of components, including the southern component, in Division IV during the second half of the year. The tagging studies showed that some mackerel from southern and western areas remain in Division IVa even during the first part of the first quarter of the year (Figure 2.3.2.1).

13.2.3 Implications from Commercial Fishery Information

Historical information from commercial vessels.

Confidential information on catch locations was collected from a number of commercial vessels from a number of countries as part of the EU funded SEFOS project to allow a wider temporal scale picture of the migration pattern to be developed than was possible from acoustic surveys alone (see Section 13.2.7.). The fishing locations for January 1994 are given in Figure 13.2.3.1. From this evidence the mackerel were migrating out of the North Sea and west of 4°W around the last week of January. A wider scale impression is given in Figure 13.2.3.2. which shows the catch locations for the three main months of the fishery. Most catches in December were taken along the edge of the Norwegian deeps. By the beginning of January, the catches were further west, but only moved west of 4°W at the end of January.

New information from commercial vessels.

No new survey information is available since December 1996. However, information was available on a confidential basis from a number of fishing vessels from a number of countries. This allowed a follow up to the SEFOS data detailed above. This information covered catch location, and date, and in some cases tonnages. Where tonnages were not available a nominal catch of 0.1 tonnes was assumed. This data was made available for the fishing seasons 1997-99 and for the months of January to March. The catch locations and dates are summarised on the map in Figure 13.2.3.3. It is clear from this that during January the commercial fishing activity is concentrated between 0 and 4°E. There were a few catches taken further west in the second half of January. These occurred only in 1999, when a series of large schools were tracked by the fleet moving to the west. By the end of January 1999, these fish had disappeared and most vessels returned to the area north and east of Shetland. In the first half of February the fishing remained east of 4°W. In the second half of February the fishery starts to move westwards into area VIa. Thereafter the fishery continued to shift rapidly south along the shelf break. The split between east and west of 4°W by half month in terms of catches made and tonnages caught are summarised in Figures 13.2.3.4 & 5. Again it is clear that in the first three periods the fishery is concentrated to the east of this latitude and rapidly shifts to the west during the second half of February.

Data from commercial sources must always be treated with caution. While the data plotted can be considered as reliable in itself, the activity of the fleet cannot be considered as a perfect indicator of where the fish are. Vessels are constrained by the location of their home ports, landing ports and by management measures. Most mackerel in this period would have been landed into Norway. Comparison between the pattern in 1994 (Figs.13.2.3.1 & 2) and 1997-99 (Fig. 13.2.3.3) would suggest that the mackerel are migrating out of the North Sea later in recent years. In 1994 the fishery was mainly located on the shelf break west of 8°W by the beginning of February. In the later period, the fishery was still firmly in the North Sea in the first half of February and only began to move west in the second half. The fishery was generally clear of the North Sea by the beginning of March, approximately a month later than in 1994.

It is not possible to determine how much of the catch taken in IVa is made up of North Sea component mackerel.

13.2.4 Implications from genetic studies

Earlier studies using protein polymorphism did not detect any structuring among the North East Atlantic mackerel (Jamison and Smith, 1987). This was probably a result of low levels of resolution of the markers used, and the fact that sampling in these studies did not concentrate on spawning individuals. Nesbø et. al (1999) analysed two regions in mtDNA (D-loop and cytb) and microsatellites in combination with coalescent and frequency based statistical approaches and thereby provided evidence for population differentiation among southern, western and North Sea spawning stocks. The highest levels of diversity were associated with the southern stock. This probably reflects that this population is the oldest.

When comparing fatty acid profiles from hearth tissue from spawning mackerel, Grahl-Nielsen and Mjaavatten (pers. comm.) found differences between mackerel spawning west of Ireland and mackerel spawning in the North Sea.

13.2.5 Implications from trawl surveys

Bottom trawl surveys are carried out in the North Sea in all quarters but particularly the first quarter when complete coverage is achieved. Juvenile mackerel are regularly caught in these surveys. One example of this is given in Figure 13.2.5.1. for the first quarter of 1998 and for age 1 fish. The major problem is determining which of these fish are derived from the N. Sea component, and which are from the western component. In Figure 13.2.5.1. there is a group of larger catches concentrated in the western part of the central N. Sea. It can be speculated that these may be N.Sea component juveniles, as this is the area where the bulk of the N. Sea component spawn. However there is no direct evidence to substantiate this conclusion.

In some years large concentrations of young fish have been found in the NW part of the N. Sea in the first quarter (see Figure 13.2.5.2.). Given that no corresponding increase was seen later in the N. Sea stock (1999 egg surveys), the WG has agreed that these fish were most likely to be western component juveniles.

Occasional catches are made of young mackerel in the southern part of the N. Sea. It is currently believed that these are probably western component fish, which enter the N Sea through the English Channel.

The question of the derivation of juveniles caught in the N. Sea should be resolved by further genetic or otolith microchemistry based studies. These should be made a priority for further research.

13.2.6 Implications from parasitology, and otolith L_1 measurements

MacKenzie (1981) found that the plerocercus larvae of a trypoanorynch cestode, (Grillotia angeli Dollfus), appeared to meet the requirements for a parasite which could be used to estimate the proportions of western stock mackerel in adult populations of mixed stock composition. Because of differences in prevalence it was possible to differentiate between North Sea and western mackerel. The parasite infects mackerel up to the age of two years and survives thereafter as an encysted plerocercus for as long as the mackerel lives. The infestation rate in the Celtic area was about 15% and less than 1% in the North Sea. This difference was thought to be used to allocate catches to stocks. However the prevalence fell drastically in 1978 (Mackenzie and Mehl, 1984). The method is therefore only applicable for year classes 1977 and older.

Eltink (1988) investigated the Anisakis larvae infestation rates in mackerel from ICES sub-areas IV, VI, VII and VIII for the two periods 1970-1971 and 1982-1984. He found that the Anisakis abundance in western mackerel was about half of the infestation in the North Sea mackerel. It seems that mackerel are infested by Anisakis larvae until they are 3-4 years old. As most of the western mackerel at present every year spend about 6 months in the North Sea and Norwegian Sea it is likely that the infestation rate is more evenly distributed in Western and North Sea mackerel.

Dawson (1983, 1986) found significant differences in L_1 measurements in otoliths taken from mackerel spawning in the Celtic Sea and the North Sea. L_1 is the maximum diameter between the outer margins of the first hyaline ring, measured across the centre of the nucleus of the otolith. Based on these findings both Dawson (1983,1986) and Lockwood (1988) concluded that mackerel spawning in the North Sea is a separate population from that which spawn west of the British Isles. They also suggested that L_1 measurements could be used to allocate catches to stocks.

13.2.7 Implications from Acoustic Surveys

Four combined acoustic, fishing and hydrographic surveys were carried out as part of the SEFOS project (Shelf Edge Fisheries and Oceanography Study) between January 1994 and December 1996 to study the spatio-temporal pattern of the mackerel spawning migration and its relationship to the hydrography of the area.

The first survey was aimed at mapping the distribution and migration in the northern North Sea and west of Shetland in January 1994. Figure 13.2.7.1 shows the distribution of the fish seen on the survey. The mackerel were actively migrating at this time, but large quantities of fish were seen still inside IVa. The timings of the observations (Figure 13.2.7.2.) suggests that some of the stock were migrating into VIa by the end of January (Walsh *et al* 1995).

The second survey in January 1995 covered the same area and again found large quantities of mackerel migrating through the area. Figure 13.2.7.3 shows the area in which the mackerel were found on this survey. Again the fish were found east of 4°W throughout the period (Reid *et al* 1997).

In both these surveys it was clear that the mackerel were actively migrating westwards. Schools were recorded high in the water column and were tracked moving west.

Based on these surveys and reports from commercial fishermen it was determined that the western mackerel were assembling prior to migration in the area west of the Norwegian Deeps, around Viking Bank. The third survey was designed to target and map these concentrations.

The third survey was carried out in December 1995 (Reid *et al* 1996). Large concentrations of mackerel were identified in deep water along the shelf break east of Viking Bank (see figure 13.2.7.4). The biomass of the mackerel seen was calculated using standard acoustic survey techniques and calculated to be approximately 1.6 million tonnes (Reid: WGMHMSA WD 1998). This figure must be regarded as approximate as the survey was not designed explicitly as an assessment survey. However, the value is a good indicator that the bulk of the stock was to be found in this area at this time. The distribution of the mackerel biomass is given in Figure 13.2.7.5. A similar survey was carried out in December 1996, in this case it was not possible to carry out a stock estimate due to the presence of herring in the areas, however, again there were large amounts of mackerel in the same area. In both December surveys, the mackerel were seen in dense schools on the seabed. There was no evidence that the schools were moving away from the area.

It was not possible to determine whether any of the mackerel seen belonged to the N. Sea component.

It can be concluded that at this time the bulk of the western mackerel remained in the Viking Bank area until at least the end of January. Migration appeared to commence in January

13.3 Mixing with western and southern component fish

As stated elsewhere in this chapter no reliable methodology has yet been deployed to separate catches (both adult and juvenile) into N. Sea component fish and those of the southern and western components.

Based on tagging studies, acoustic surveys and fishery distribution data, it can be concluded that the N. Sea component mackerel are found mixed with the remainder of the NEA mackerel from July to February inclusive. During the spawning season the fish are definitely found in different areas. After July, the western/southern fish migrate into the North and Norwegian Seas. Historically the N. Sea fish have a similar distribution. From October until mid February the bulk of the western/southern fish now overwinter in the Viking Bank area in the N. Sea and in the Norwegian Trench. Again this is the historic overwintering area for the N. Sea fish. By the end of February, in recent years, the western/southern fish have probably migrated out of the N. Sea again towards their spawning areas and the two groups will again be separate.

In brief, the components are probably mixed to some degree from July until the end of February – a period of eight months.

The likely proportions of the fish from the three components in the main fisheries is currently impossible to determine without further studies aimed at the characterisation of these components beyond their spawning locations.

The situation is even more difficult to assess for juvenile fish. There is a probable N. Sea component juvenile area in the west central N. Sea (see 13.2.5.) in the first and fourth quarters. In some years large numbers of western juveniles enter the northern part of the N. Sea in the first quarter. There is also evidence of western fish entering the southern N. Sea through the English Channel. Whether and to what degree these juveniles mix is currently unknown.

13.4 Effect of Current Management Measures

The Working Group reviewed the current management measures on the North Sea Component, bearing in mind that the component is likely to have been below 100,000 t for at least 13 years and that the likely level of catches in recent years has been assumed to be about 10,000 t.

Since 1993 ICES have advised that the maximum protection should be afforded to the stock and that closed areas and seasons and a minimum size limit should be in operation. The current management measures in operation are:

- A TAC of 62,500 t has been fixed for Sub area IV, Divisions IIIa, IIIb,c,d, (EU zone) and Division IIa (EU zone). In addition under the EU/Norwegian agreements flexibility clauses, 65,000 t of fish can be taken in Div.IVa (EU zone) during the fourth quarter and a further 60,000 t of IIa mackerel can also be taken in the North Sea. This is fact means that a total of over 187,500 t of mackerel may be legally taken in areas where the North Sea component may be located. These catch restrictions have not led to recovery of the North Sea component.

- In theory maximum protection, as advised by ICES for the North Sea component, can only be achieved by a complete ban on fishing on the North Sea component at all times of the year. Obviously this cannot be achieved because of the effect that it would have on fishing the Western and Southern components.

- A complete ban on directed fishing for mackerel has been in operation for Divisions IVb and IVc for all the year and for Division IVa for the first three quarters. These seasonal and area closures are designed to protect the adults and juveniles of the North Sea component. In addition they also provide some protection to juveniles of the Western component, which are present in the North Sea in some years in considerable quantities. Vessels engaged in other directed fisheries are permitted to take a 10% by- catch of mackerel. This has resulted in large scale discarding of mackerel particularly in the directed fishery for horsemackerel. ICES have pointed out in 1998 that the reported landings of mackerel in Divisions IIIa and IVb,c, may be seriously underestimated. It would be desirable to reduce this discarding. However it is not clear how this could be achieved. The Working Group therefore reiterates the recommendation that observers should be placed on board vessels in those fisheries in which discarding is perceived to be a problem.

- A minimum size limit of 30 cm is in operation for mackerel in the North Sea. The measure was originally introduced to prevent large quantities of juvenile mackerel being landed for industrial purposes. If it is not possible to reduce discards levels to zero then this measure should be rigorously enforced and should be extended to cover all areas in which mackerel are caught.

The Working Group emphasises that the available biological information is inadequate to permit the questions posed by the EU to be answered in full. It will not be possible to clarify the question of stock mixing without comprehensive tagging programmes on the adult and juvenile components and genetic studies on the spawning populations.

13.5 Conclusions

The WG was asked to assist ACFM with the following questions.

Q1. Is it at present possible to positively identify mackerel or mackerel spawning products caught in the North Sea as originating from the North Sea spawning component of the North East Atlantic mackerel stock ?

Q2. If not, what is the basis for the recommendations relating to seasonal and geographical closures for fishing mackerel in ICES Sub-area IV and ICES Division IIIa repeated by ICES since 1987?

Q3. If so, and recalling that managers have been unable to agree on conditions in strict compliance with these recommendations, is there reason to consider alternative and/or augmented recommendations?

Question 1.

It is possible to identify a discrete and repeatable area of mackerel spawning in the North Sea. This spawning area has been surveyed a number of times in recent years (1999, 1996, 1990). Spawning is mostly concentrated in the western part of the central N. Sea and indicates a small but relatively consistent stock level.

No recent survey data for larvae are available, however, CPR (Continuous Plankton Recorder) data from the 1950s and 60s indicate a wide spread of larvae in the central N. sea which is discrete from larvae in the western area.

It is possible to identify concentrations of juvenile mackerel in the west part of the central N.Sea which may derive from spawning in the same area. However, there is no direct evidence to confirm this interpretation.

It is not possible to identify the distribution and migrations of the adult fish. It can be assumed that the adults are in the spawning area during April to July. Historic data would suggest that they overwinter at the edge of the Norwegian Deeps close to Viking Bank. There is no recent evidence to confirm that this pattern has been maintained. It is important to note that a large fraction of the western component also now overwinters in this area and is the target of a substantial fishery. Research work to identify the involvement of the N Sea component in the winter fishery in area IVa should be a priority.

Some work on biometrics, parasitology and otolith structure (see 13.2.6.) has been carried out to identify the N. Sea component. While most of this work was limited in scope and should be expanded and enhance, it was able to show some differences between the fish from the two components which could be exploited for identification purposes.

It can be concluded that there is still a N. Sea mackerel component, which spawns separately from the western component, which may have a nursery area in the western N. Sea and which may share it's winter range with the western component.

Question 2.

Given the proven existence of the North Sea stock this question is not directly relevant, however, the subject of geographical and seasonal closures is dealt with in response to question 3.

Question 3.

On the basis of survey work in 1994-96 and confidential commercial data, it is clear that the western mackerel component migrates out of the N. Sea (ICES area IVa) during the first quarter of the year, while in the 1980s this migration took place between October and November. Prior to the migration the main concentration of mackerel remains in the NE part of the N. Sea in the area of Viking Bank from early October. The existing advice is for a complete ban on mackerel fishing in areas IVb & IVc, and for a closure of IVa after the first of January. It is recommended that the closure of areas IVb & IVc be maintained. It is further recommended that the closing date for mackerel fishing in IVa be changed to the 1st of February. This recommendation is made considering that:

" The observations that the western component fish remain in the N. Sea at least until mid February.
" The previous recommendation for closure was based on the western mackerel having migrated out of IVa by the end of December
" The timing of this closure was intended to allow fishing in this area while "*Western mackerel dominate*".
" The pattern of migration has changed substantially in recent years and may continue to change.

The WG agreed that this subject should be kept under review.

The WG also recommended that research should be carried out to determine the migration and distribution pattern of the North Sea mackerel and to what extent it is subject to the winter fishery in area IVa. Such research should include tagging, genetic and otolith studies, as well as examination of the distribution patterns and migrations.

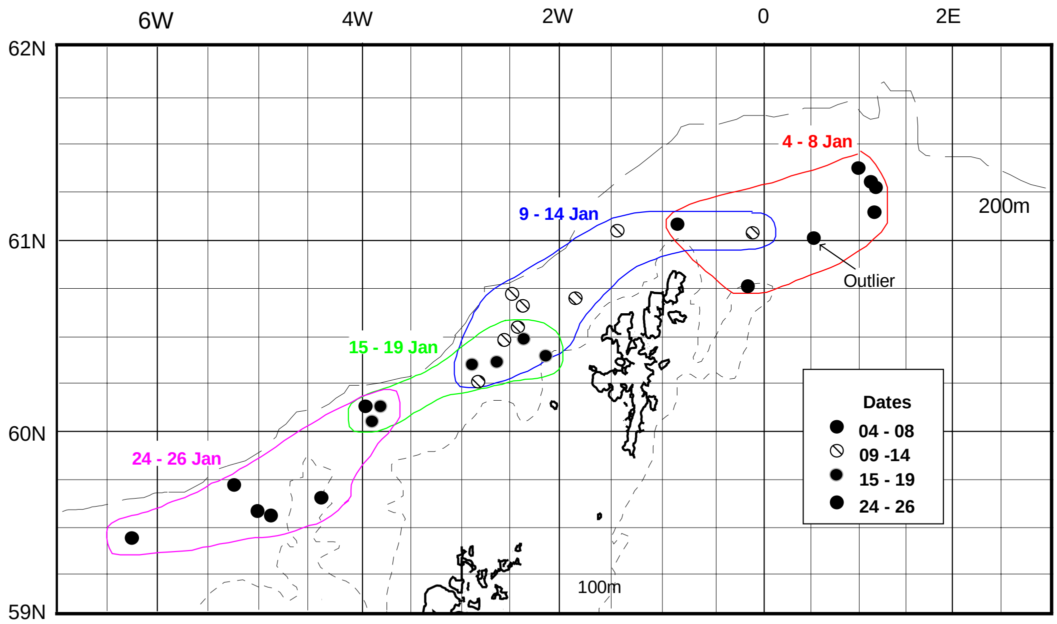


Figure 13.2.3.1. Location of commercial fishing operations in four time periods in January 1994

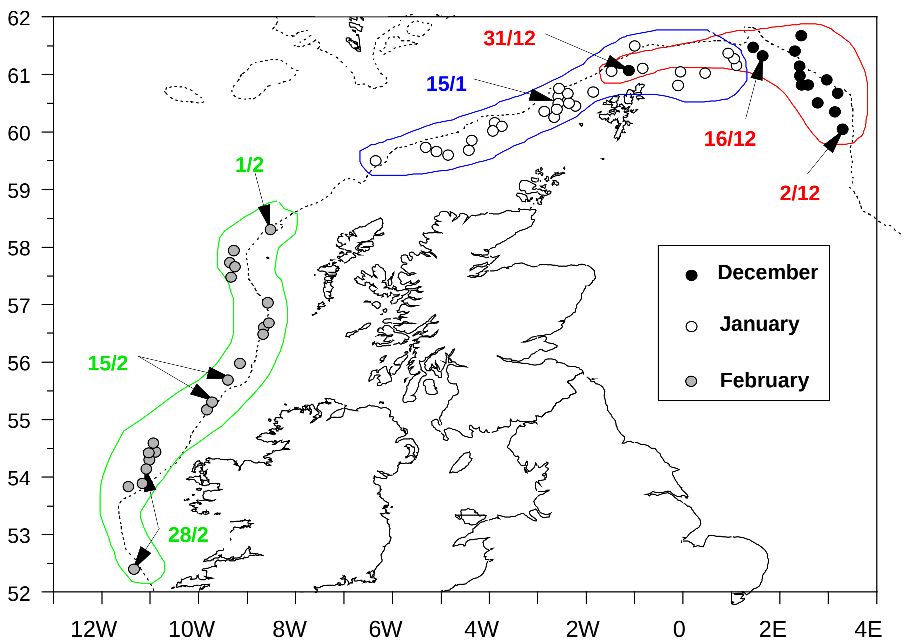


Figure 13.2.3.2. Location of commercial fishing operations December 1993 - February 1994

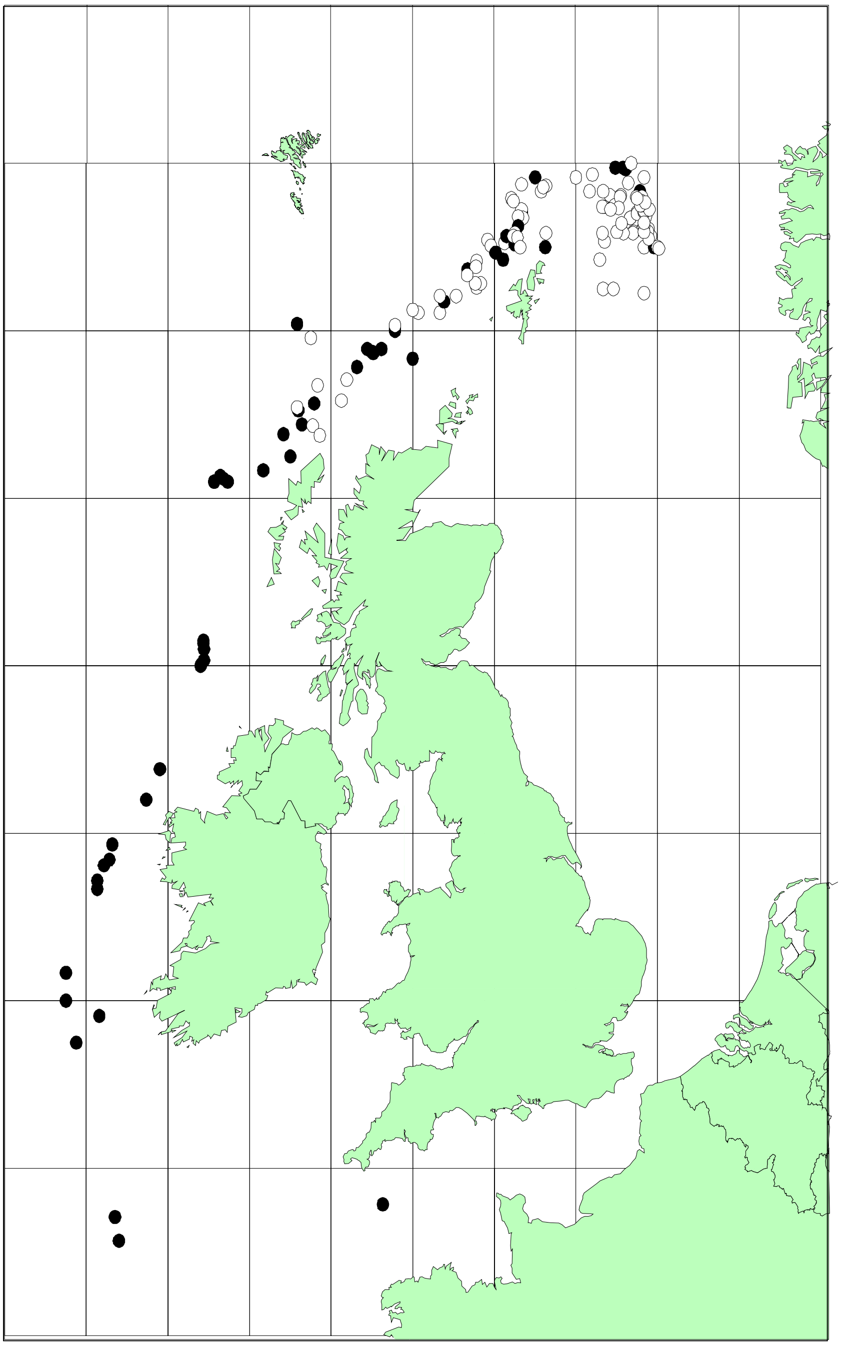


Figure 13.2.3.3. Commercial catch locations January to March 1997-99
Open circles – 1st January to 14th February
Closed circles – 15th February to 31st March

Figure 13.2.3.4. Number of catches East and West of 4W

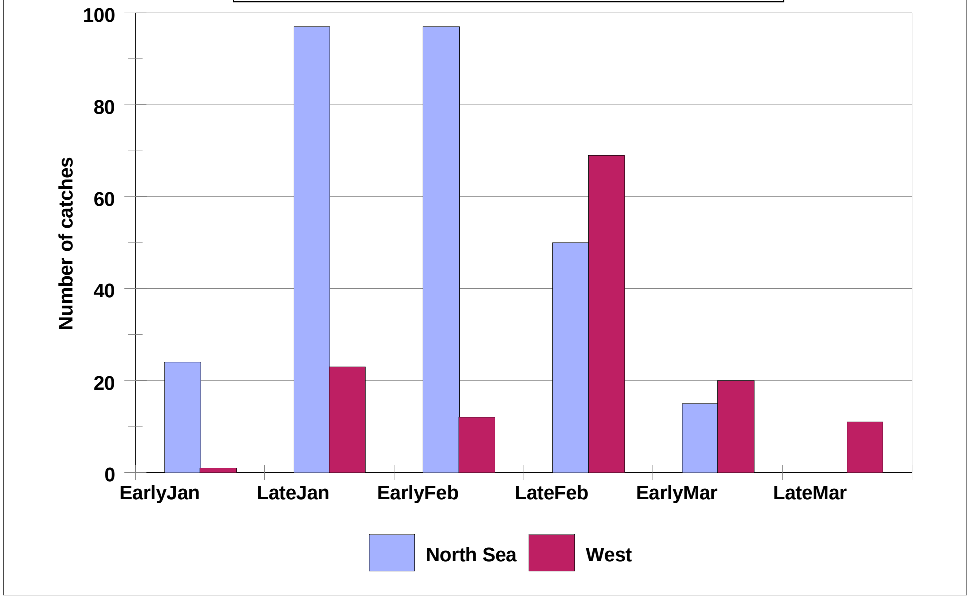


Figure 13.2.3.5. Tonnages of catches East and West of 4W#

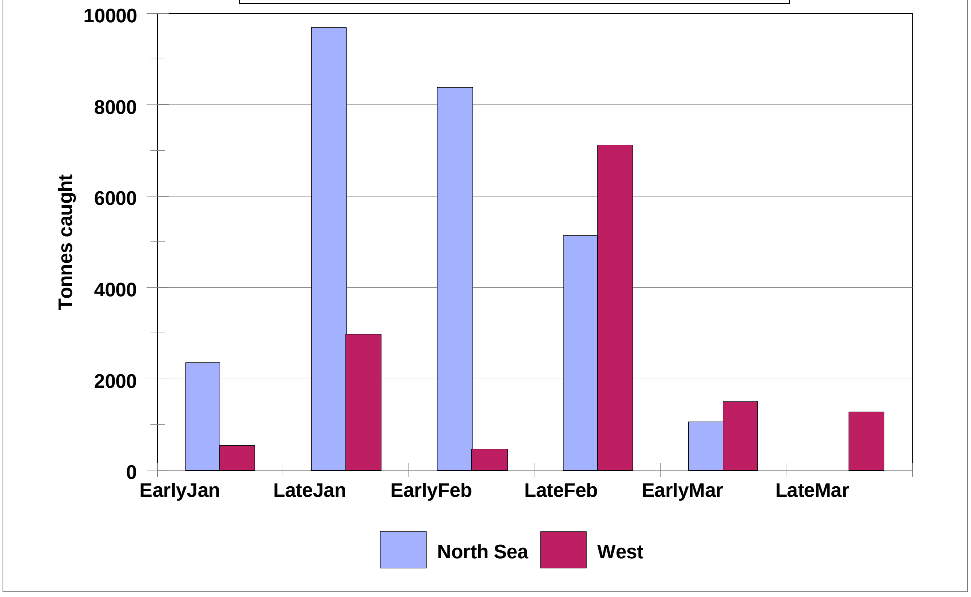


Figure 13.2.5.1. Distribution of mackerel recruits. Quarter 1 – Age 1 – 1998 (Catch rates per hour)

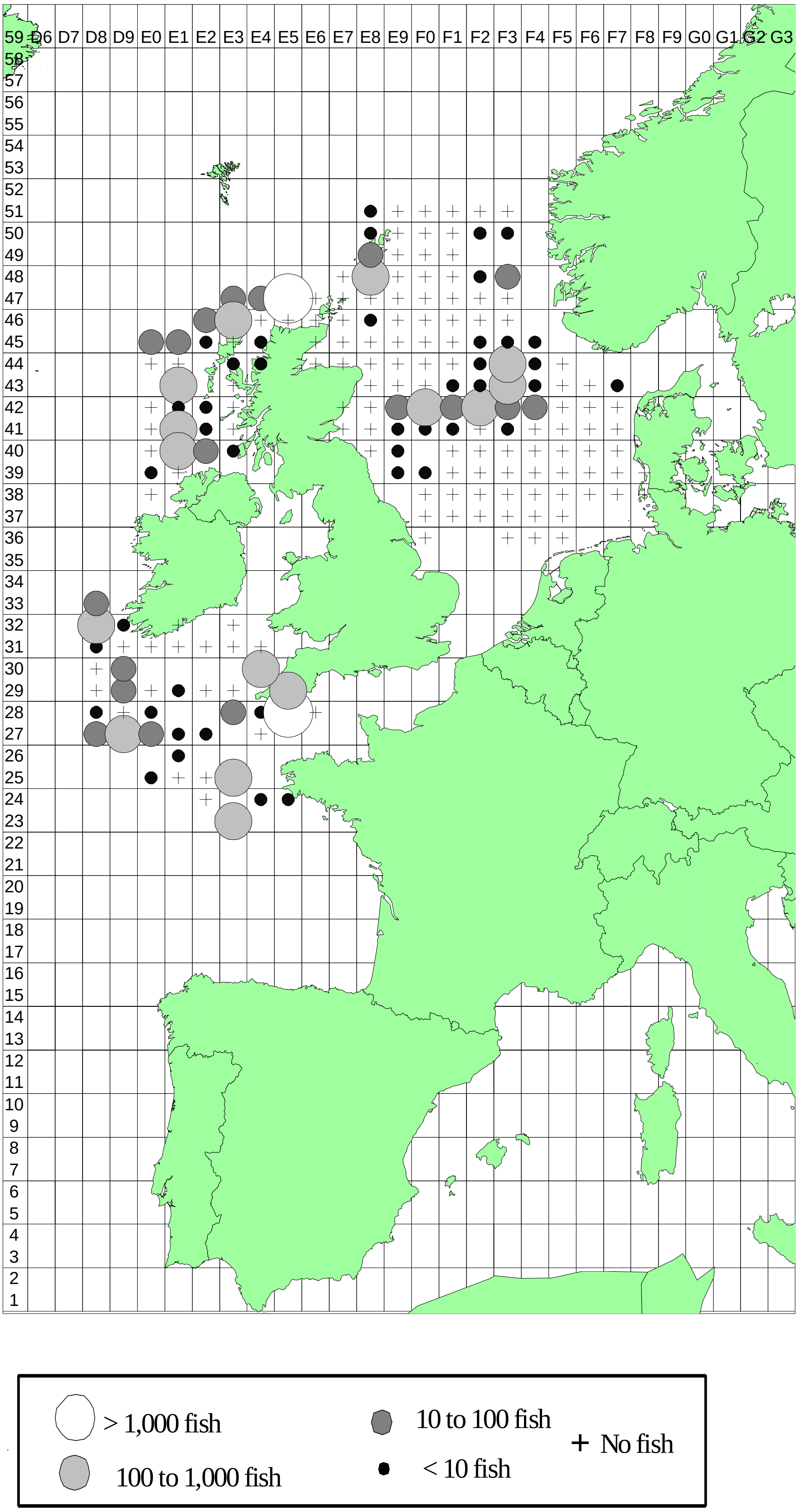
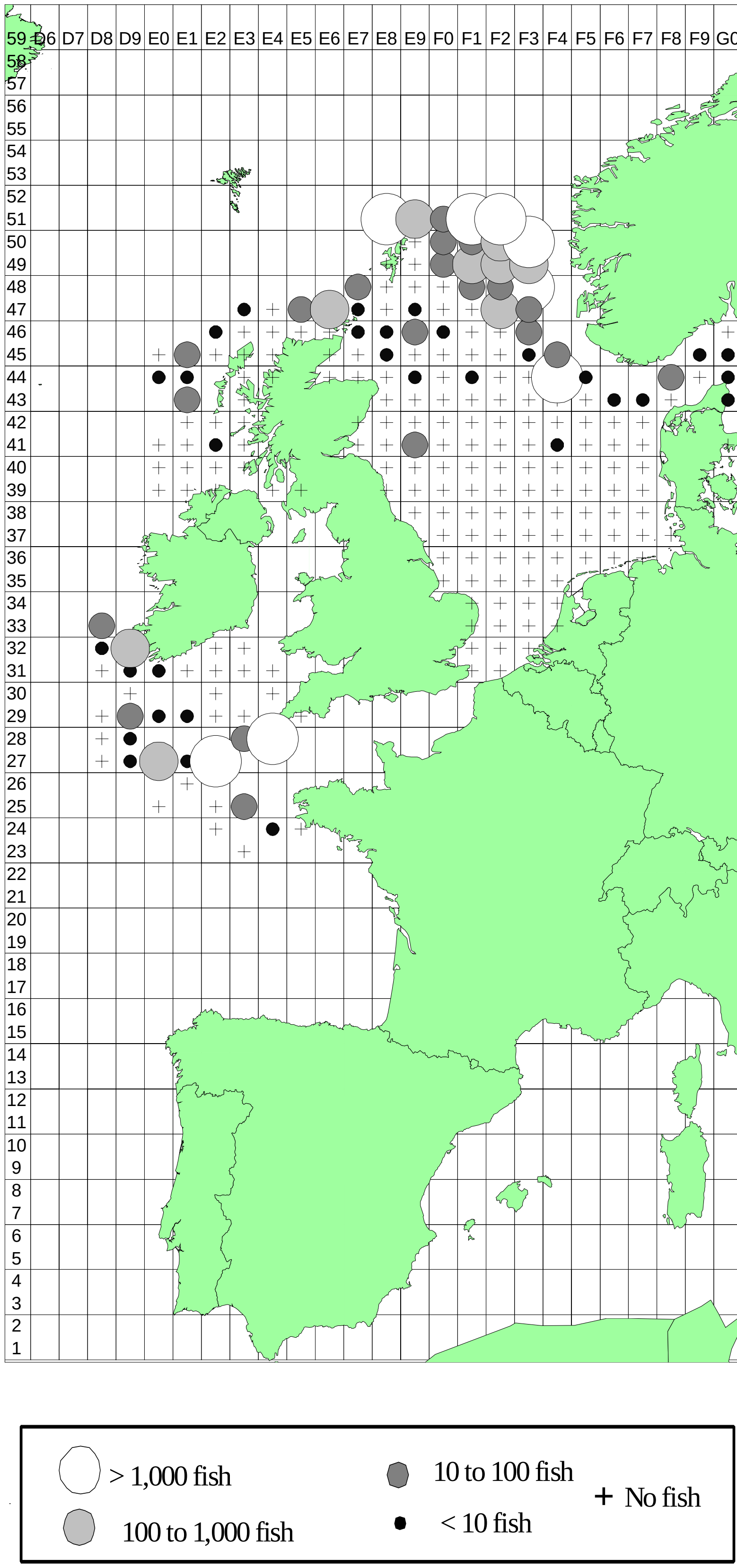


Figure 13.2.5.2. Distribution of mackerel recruits. Quarter 1 – Age 1 – 1997 (Catch rates per hour)



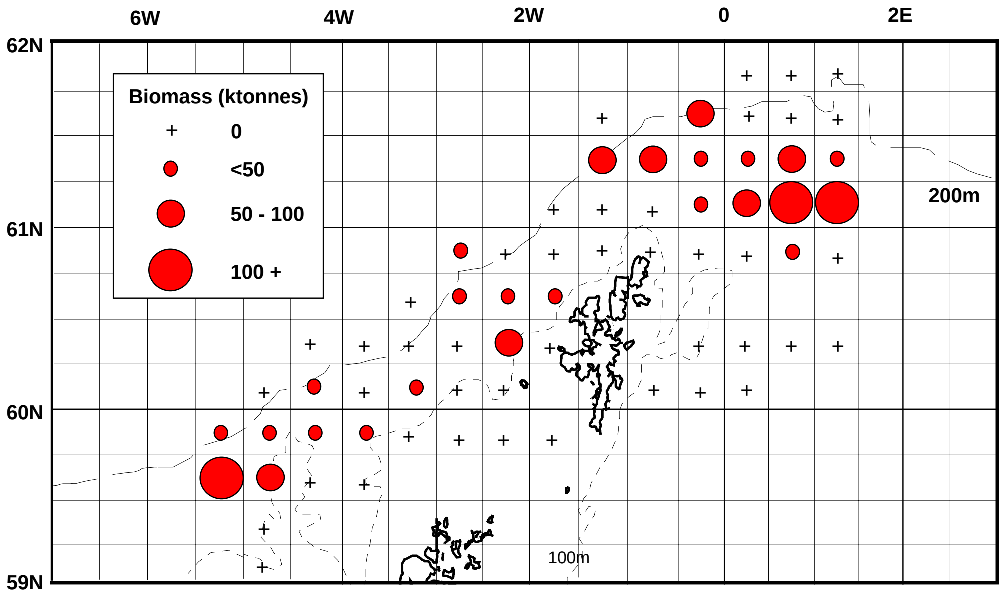


Figure 13.2.7.1. Circle plot of mackerel biomass distribution by quarter ICES rectangle in four categories

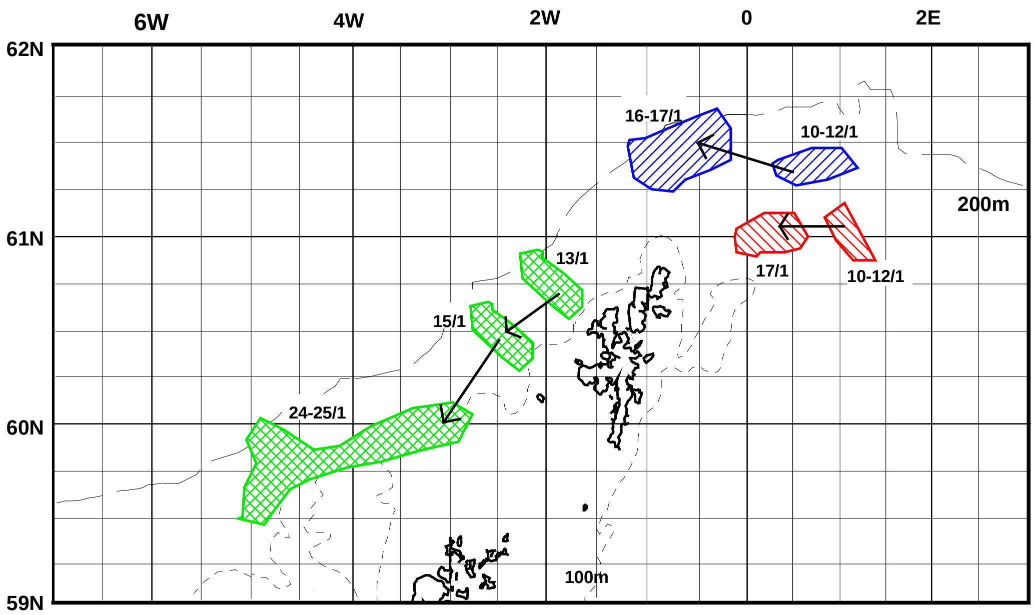


Figure 13.2.7.2 Locations of mackerel concentrations - January 1994

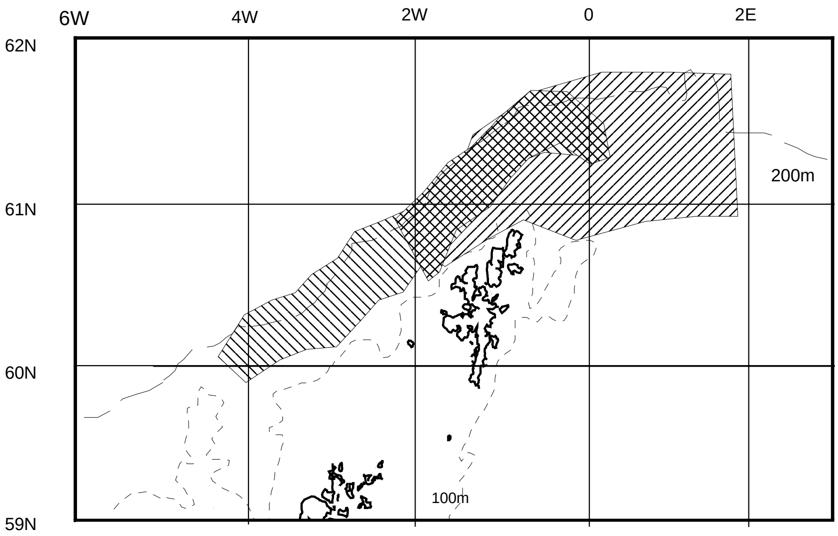


Figure 13.2.7.3. Survey Areas January 1995

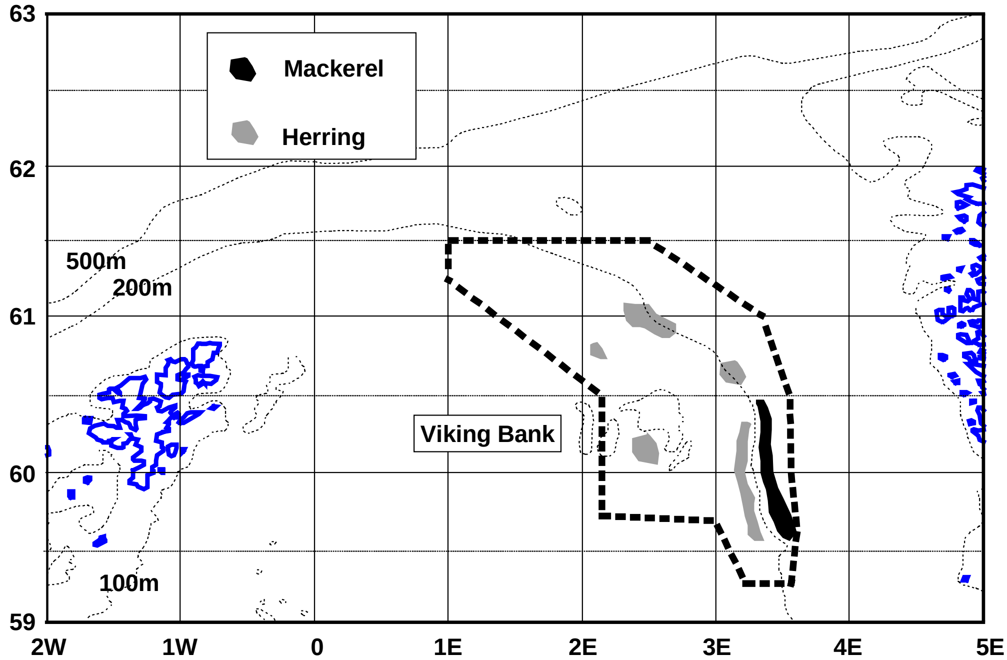


Figure 13.2.7.4. Fish concentrations from the acoustic survey December 1995

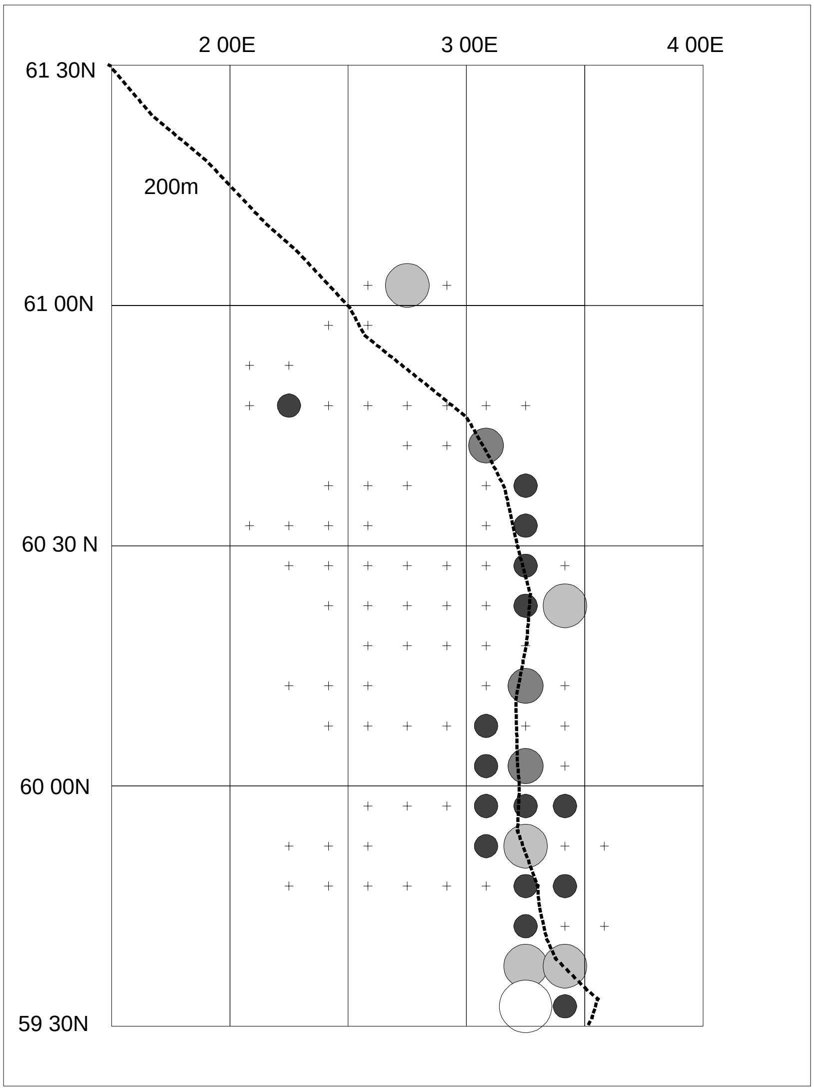
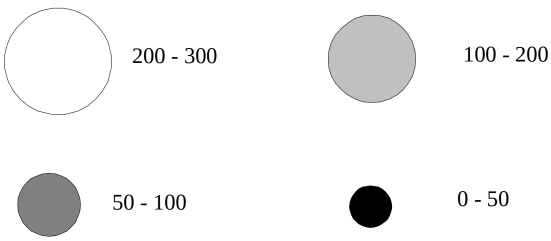


Figure 13.2.7.5. Estimated mackerel abundance by 10' rectangles (KTonnes)
Crosses represent rectangles surveyed with no fish seen



14 REVIEW OF SARDINESTOCK IDENTITY

14.1 Basis for Current Assumptions about Stock Identity

Sardine assessment currently considers a stock unit that includes the ICES divisions VIIIc and IXa. In the first attempt to delimit a sardine stock for management purposes within European waters (1977), the French part of the Gulf of Biscay was also included in what is now considered the Atlanto-Iberian stock (Pestana 1989). However, in the absence of directed sardine fisheries in French waters, the current limits have been adopted since 1980. The initial reasons for considering areas VIIIc and IXa together were administrative simplification and similarities in exploitation between the Spanish and Portuguese fishing fleets targeting sardine (Pestana 1989). Throughout the 1980s, biological and fisheries information did not raise serious concerns in relation to the selection of the above stock unit.

A series of changes in the distribution and exploitation of sardine during the 1990s raised again the question of sardine stock identity within European waters. This was discussed during a recent sardine study group (Vigo, 4–8 May 1998). The group concluded that:

“In relation to the northern boundary: “the appropriate definition of stock units for sardine remains unclear, given that significant abundances of this species exist in the Bay of Biscay and extending northwards at least until as far as the Celtic Sea.”

“In relation to possible divisions within the current stock delimitation: “insufficient information is available to advise on a re-definition of stock units and to address the question of sardine stock in VIIIc and IXa as a separate entity until further investigation provide sufficient evidence for a redefinition of stock units”

In this chapter we summarise recent information on the distribution of sardine and its fishery, together with recent changes in environmental conditions over the area. This information should help in addressing questions related to sardine stock identity. A synthesis of the new findings and overall conclusions are presented in the final section.

To facilitate the following presentation, it is worth stating how stock unit is currently perceived by ACFM:

“management advice is intended to be based on biological units that would be self-sustainable if harvested in a proper manner. However, not all assessment units currently used correspond to self-sustaining units: some include several relatively separate biological units, while others include only part of a larger unit. If the assessment unit comprises more than one biological unit, and if the management unit correspond to the management unit or is larger, there is scope for individual biological units to be overexploited, and possibly severely depleted, therefore threatening the productivity of the resource. When the biological unit is split between several assessment and management units, the effectiveness of management measures will be jeopardised unless the same management measures are applied in all units.”

14.2 Climatic Changes Likely to Affect Sardine Distribution

Sardine and anchovy species support important fisheries in most temperate upwelling zones of the world (Lluch-Belda et al 1989). High abundance, wide geographic distribution, feeding/spawning migrations and high fishery productivity are all associated with favourable “regimes“. Regimes are prolonged periods (a decade or longer) of favourable environmental conditions over large geographic areas (Lluch-Belda et al 1989). Low abundance, reduced geographic distributions and low fishery productivity are associated with unfavourable regimes. In the California sardine an abrupt regime shift occurred in about 1978 when sea surface temperatures increased (MacCall and Prager 1988) and sardine biomass (about 5 000 tonnes in the late 1970’s) began to increase at rates that averaged 28% per year during 1983–1995 (Deriso *et al.* 1996). During unfavourable regimes associate with cold 3–5 year average sea surface temperatures, maximum sustainable yield is near zero (Jacobson and MacCall 1995).

In the North-east Atlantic, the large-scale atmospheric pressure field is dominated by the Azores anticyclone in spring-summer and, to a smaller extent, by the Iceland low pressure Fiúza *et al*., (1982). In the western Iberian area, the atmospheric circulation associated with the Azores anticyclone corresponds to weak mean westerly-southwesterly winds in winter and to relatively strong mean winds from the north and the northwest during the summer. Meteorological conditions in the North of the Iberian Peninsula (Santander Meteorological Centre) follow a warming tendency in the last period, mainly since the 80`s. During 1998 the annual average air temperature was 14.8ºC, 0.44ºC higher than the mean for years 1961–1998. A correlation of 0.56 is found between the NAO index and the Annual air temperature anomalies (Lavin.A and Cabanas, J.M., 1999)

Peliz and Fiúza (1999) describe seasonal patterns of phytoplankton pigment concentrations, based on Nimbus-7 satellite data. Moderate to high concentrations occur in all coastal waters of the Iberian area in winter, and extend well offshore beyond the shelf break; the highest offshore concentrations lie along the Galicia front, and these are present almost year round. During the upwelling season, pigment concentrations are lower than in winter and are confined to the inner shelf, except in the Gulf of Cadiz, which is pigment rich all year. Margalef (1956) identified marked changes in the phytoplankton composition in Galicia waters during 1950s sardine crisis there. For example, *Thalassiosira rotula* abundance increases with poor sardine yields. There are not reports to indicate whether this diatom became less abundant when the fishery recovered after 1957, but there have been significant changes in phytoplankton composition in recent decades.

Sea surface temperature increased off the Iberian Peninsula during recent years (Lavin *et al.* 1996; Dias *et al* 1996; Anon. 1997). Increased temperatures imply intensification of winter winds that may transport sardine larvae away from favourable feeding grounds and increase their mortality (Dias 1994). There is some evidence that these changes in the upwelling pattern fit within a broader pattern of climate changes. Santos *et al.* (1998), Santos 1999 WD, identified two cycles in the annual sardine catch time series; one in the period before the late 1960's corresponding to an high catch cycle, and the other a low catch cycle during the most recent 25 years. These catch cycles coincide with the alternate phases exhibited by the NAO index.

14.3 Distribution of commercial catches

The evolution of sardine catches in biomass for the Spanish and Portuguese sub-areas are shown in Figures 8.2.1.2 and 8.2.1.3 respectively. Catches at age in number are analysed by sub-area along the period 1978–1998 (Table 14.3.1 and Azevedo, WD 1999). Total catch in number from Division VIIIc decreased from 1300 million fish in 1978 to 217 million fish in 1998. No clear trend or change in the exploitation pattern is observed along the time series for Division VIIIc. Although from 1978 to 1983 catches were consistently dominated by age groups 0–3, in the following years dominance is observed both in young and old age groups, the latter reflecting the contribution to the catches of stronger year classes that occurred in previous years. This is also reflected in the contribution to the catches of age group-6+ that increases from an average of 5% in 1978–1987 to 17% in 1989–1998.

A sharp decrease in the total catch in number in sub-area IXa North is observed along the time series, from 1499 million sardines in 1980 to 77 million in 1998. Besides the exceptional years of 1995 and 1996, when age group-4 dominated in the catches (29 and 33% of those years total catch number), catches in sub-area IXa North from 1978–1998 are mainly dominated from age groups 0–3, the highest contributions of these age groups ranging between 20–80% of the total catches in number. Changes in the exploitation pattern along the time series are imperceptible.

With respect to sub-area IXa Central-North, total catch remained almost always between 1000–1400 million fish until 1991, decreasing after to around 780 million sardines in 1998. Exploitation pattern analysis does not show any consistent change over time in sub-area IXa Central-North.

Total catch in sub-area IXa Central-South has remained rather stable since 1978, at around 700 million sardines. During the 1990s a shift in the exploitation pattern towards older sardines is observed from the catches.

In sub-area IXa South-Algarve total catch in number sharply decreased between late 70s and 1980 but have remained around 400 million fish since then. Catch at age from this sub-area also clearly indicates a shift in the exploitation pattern towards older sardines after 1990. Most of the catches during the 1990s come from older individuals (age 3 and older) by contrast with the early years when the contribution to annual catches was mainly from younger ages.

Total catch in number in sub-area IXa South-Cadiz have remained stable along the time series, being at present around the 1978–1979 level (between 100–200 million fish). An exploitation pattern shift towards older individuals was also observed during the 1990s.

Overall, the analysis of catch data indicates:

- large decrease in catches during the 1990s in the areas where the bulk of sardine was caught during the 1980s (Ixa North and Central north, division VIIIc), though the reduction is considerably larger in the Spanish waters
- there is an overall stability in the catches of the southern areas (IXa Central-South, IXa South-Algarve and IXa South-Cadiz)
- there are changes in the exploitation pattern for the southern areas in the 1990s, which are not related to gear modifications

14.4 Distribution of Spawning Areas

To investigate the distribution of sardine spawning areas in Spain and Portugal and their evolution over time, egg presence/absence data from all available ichthyoplankton surveys were analysed. Although the analysis does not strictly refer to the actual spawning areas but to areas covered with eggs, the short duration of egg phase (3–4 days means that the two should be closely related in the absence of strong advection. For this analysis, Stratoudakis (WD 1999) considered information from 14 surveys in Portuguese waters between 1985 and 1999 (Table 14.4.1) and Bernal (WD 1999) from 3 surveys in Spanish waters between 1988 and 1997.

For the Spanish surveys, spawning area estimates by region are shown in Table 14.4.2 and Figure 14.4.1. GAM based estimates (Bernal WD 1999) are similar to those assumed in the traditional method, but consistently smaller (84, 75 and 83% of the traditional estimates in 1988, 1990 and 1997 respectively). In the Portuguese DEPM surveys, the model based estimates of spawning area are consistently, and considerably, smaller than the traditional estimates in the DEPM survey (54, 64 and 75% of the traditional estimates in 1988, 1997 and 1999 respectively). It is clear that the traditionally assumed spawning areas are positively biased, because areas without eggs are included within the assumed area of spawning.

Comparing the results by region (as delimited in Figure 8.4.1.3) over time (Figure 14.4.1), spawning area in Region I shows a drastic reduction from about 7 000 km^2 in 1988 and 1990 to only 523 km^2 in 1997. More over, zero probabilities of presence in the Atlantic coast of Region I were predicted in that year. Region II also shows a drastic reduction from more than 10 000 km^2 in 1988 and 1990 to about 3 000 km^2 in 1997. Nevertheless, Region III estimates only show a significant decline from 1988 to 1990 (4 600 km^2 to 2 985 km^2), while the changes between 1990 and 1997 are very small (2 985 km^2 to 2 321 km^2).

The distribution of the predicted surfaces of egg presence for the different surveys off the Spanish coast is shown in Figure 8.4.1.2. Spawning areas were confined to the continental shelf in 1988 and 1997, but not in 1990, where areas with probabilities of presence as high as 50% where found at very large depths (near 4000 meters). The marginal effect of depth for each of the surveys is shown in Figure 14.4.1 (Bernal WD 1999). All surveys show a step drop in the probability of presence near the shelf edge, but in 1990 a secondary peak of probability appears for large depths. The same trend is observed in the cumulative plot of abundance in relation to depth (Figure 14.4.2). In 1988, the spawning area estimate for each Region is larger than the shelf, except for Region I. In 1990, the spawning area estimate largely exceeds the shelf area for each of the regions. A drastic reduction of the estimates is shown in 1997, when only Region III spawning area slightly exceeds the shelf area.

For the 8 Portuguese ichthyoplankton surveys considered adequate for modelling the probability of egg presence (shown in bold in Table 14.4.1), Table 14.4.3 gives the estimates of spawning area by region and year, including 95% confidence intervals, and the results are also plotted in Figure 14.4.1. Estimates of total area are significantly higher in the 1980s than in the 1990s, the late 1980s estimates being almost double those at the late 1990s. Estimates in the early 1990s were generally intermediate, with the noticeable exception of 1993. Closer inspection of the model fitted to the 1993 survey indicates potential positive bias due to the presence of a pure region effect (Hastie and Tibshirani 1990).

Figure 14.4.3 shows trends in the absolute and relative regional contribution of the spawning areas within Portugal. There is a clear decline in the total area of sardine spawning off Portugal which is exclusively due to a large reduction in the northern region. Estimates of spawning area after 1990 are consistently higher in the southwestern region than in the north. Relative contribution in the north dropped from 61% to 36% between 1990 and 1991. Spawning area in the southern region appears stable throughout the study period, which is reflected as a mild relative increase due to the overall net reduction. It is also worth commenting that the maximum values of spawning area by region seem to be very close to the area of the regional continental shelf.

Although not shown in Table 14.4.3, spawning area in the Cadiz region was estimated for the two most recent DEPM surveys. In 1997, the estimated area was 4.3 thousand km^2 (95% confidence interval between 3.7 - 4.9), while in 1999 the estimate was slightly higher (4.7 thousand km^2) but with confidence limits (4.2 – 5.3 thousand km^2) overlapping with those of 1997. These results are in accordance with area and abundance acoustic estimates from the most recent years, both suggesting considerable presence of mature sardines in the Cadiz region. The two DEPM surveys suggest that spawning area in the Cadiz was 61% and 64% of the spawning area in Portugal during March 1997 and January 1999 respectively. The percentages for acoustic area estimates give similar indications: 60% for March 1997, 22% for March 1998 and 116% for November 1998, while the contribution in abundance for the same surveys were 34%, 25% and 52% respectively.

Overall, the analysis of the Spanish and Portuguese egg data suggests a drastic change in spawning area and its regional distribution, probably from the early 1990s onwards. Total spawning area in Iberian waters are considerably reduced during the 1990s, while the main spawning areas are now situated in the south. Up to 1990, egg distribution was almost continuous from the southern border of Portugal to the Franco-Spanish border (information for Cadiz not available). In that time the largest spawning areas were observed in northern Portugal (north to the Canyon of Nazaré), the Galician and the Western Cantabrian coast. In the late 1990s, spawning areas were less than half of those in late 1980s, due to a considerable reduction of spawning activity in the three areas mentioned above. Interestingly, in the recent years information from the Cadiz region has become available, suggesting it to be the largest area with sardine eggs, contributing a quarter of the total spawning area of sardine in the Atlantic waters of the Iberian peninsula.

14.5 Distribution from acoustic surveys

To analyse the distribution of sardine in acoustic surveys, information from 1984 to 1999 was considered (Morais *et al.* WD 1999). Portuguese data include 3 sets of surveys, one in March (late spawning season), one in August (feeding) and another in November (early spawning and recruitment). To investigate temporal patterns, mean values (Table 14.5.1) for the 1980s (10 surveys) and the 1990s (9 surveys), as well as for the autumn series (Table 14.5.2 - 2 in the 1980s and 4 in the 1990s) and the spring series (Table 14.5.3 - 4 in the 1980s and 3 in the 1990s) separately, were compared. The variables considered where distribution area (nm^2), overall abundance (in numbers), density (numbers/nm^2), "juvenile" abundance (fish up to 16 cm) and "adult" abundance. It should be kept in mind that methodological modifications (change in acoustic and fishing gears, etc.) took place within the study period and that, when each seasonal set of surveys is considered alone, the number of observations is very small.

Figure 14.5.1 shows the distribution area (nm^2) of sardine by Portuguese region. Overall, there is an indication of a small reduction in area during the 1990s, which is due to a considerable decline (around 25%) in northern Portugal (north to the Canyon of Nazaré). In the southwestern and southern regions there is a net increase in area (15%) during the 1990s. Similar patterns are observed in relation to sardine abundance (Figure 14.5.2). Again, there is a small overall decline (5%) during the 1990s, which is exclusively due to a 15% decline in the northern region. In the southwest there is no evidence of change, while there is a net increase in the south. The decline in overall abundance is slightly smaller than the decline in area and this is depicted as a very small net increase in sardine density during the 1990s (Figure 14.5.3). When the size composition of the fish is taken into account (Figure 14.5.4), there is a 15% reduction in juveniles from 1980s to 1990s which is partly compensated by a small increase in adults. As with distribution area and overall abundance, there is a clear regional difference in the pattern of temporal changes for younger and older fish. In the north there is a mild (10%) increase in juveniles in the 1990s and a larger decrease in adults (30%), while the reverse is seen in the southwestern and southern regions.

When the spring series is considered alone, there is a clear reduction (35%) in distribution area and abundance (both juvenile and adult) during the 1990s. The reduction in juveniles (45%) is more marked than in the adults (25%). The changes in the spring series are uniform throughout the regions, although the decline is more pronounced in the north. On the other hand, the autumn series shows no temporal change in distribution area over time and a net increase (ca. 25%) in abundance during the 1990s. The overall increase is due to a large increase in juveniles (ca. 70%) while there is a small reduction in adults. Unlike the spring survey, big differences in temporal evolution are observed between regions. Distribution area reduces by 20% in the north during the 1990s, but this is compensated by an increase of a similar order in the other two areas. Overall abundance increases in the north (35%) and southwest (25%) but slightly reduces in the south. The increase in the north is exclusively due to a very large increase in small fish (190%), which is partly dampened by a reduction for adult fish (45%). The pattern is different in the southwest, where there is a 50% increase for adult fish, and in the south where there is a big reduction in juveniles (40%) and a small increase in adults (15%).

Comparing the autumn and spring surveys over time, there is an indication of a shift in importance from spring to autumn as we move from the 1980s to the 1990s. In the 1980s distribution areas in March were larger than in November, both regionally and overall, while the reverse is observed in the 1990s. Also, the area contraction during the 1990s in the north is less prominent in November (20%) than in March (55%). When abundances are compared, there is again an indication of a seasonal reversal from the 1980s to the 1990s. In the 1980s, overall abundance was 20% higher during March, while in the 1990s it is about 25% higher in November. The reversal is obvious in all regions, although most prominent in the north. In that region there is also a noticeable reversal in juvenile abundance, with large increases during the 1990s in the autumn series and large reductions in the spring series. In the southern region there is a loss of juveniles both in autumn and spring in the recent years, while in the southwest there is a large increase during spring.

The above analysis did not consider the Cadiz region because information there is only available in the 1990s. However, it is worth mentioning that for the 6 surveys where the Cadiz region was sampled, its contribution to the total sardine abundance (numbers) in the Portuguese survey ranged from 20% (November 92 and March 98) to 47% (March 99). The age composition of the fish in Cadiz appear to be more similar to those in Portugal during the autumn than during spring.

The Spanish Spring acoustic survey time series was analysed in Carrera et al (1999b WD). This time series started in 1986 and presents gaps in 1989 and 1994. In late 1980s sardine was distributed throughout the surveyed area. In Sub-Division IXa North sardine was mostly located inside the Rias (five bays at the mouth of rivers with approximately 20 nmi long and 7 nmi large) and close to the coast. In VIIIc the distribution reached as far as the shelf break (180 m water depth). Major concentration occurred near Cape Ortegal (7º20'W), Cape Peñas (5º50'W) and Cape Ajo (3º40'W). This situation was stable until 1990. From 1990 the occupied area shrunk in the western part of Division VIIIc and in Sub-Division IXa North. In the middle of Division VIIIc the decrease was lower: Figure 14.5.5 shows the occupied area since 1991. The increase of the area in 1993 in Sub-Division VIIIc-W and in the western part of VIIIc-E seems to be related with the strength of the 1991 and 1992 recruitment. In Sub-Division IXa North and in the inner part of the Bay of Biscay no significant changes were detected. In 1995 and 1996 the occupied area was extremely low as a whole. In 1998 the area in sub-Division VIIIc-West (middle Cantabrian Sea) was higher but the fish density was low. In addition, the number of sardine schools found in the survey track decreased since 1992 and they are found closer to the coast (the EU-FAIR Project Cluster).

Overall, the analysis of the acoustic data suggests:

- a reduction in distribution area during the 1990s in the Spanish waters and the IXa Central north
- a reduction in distribution area and abundance during the 1990s in all areas covered by the Portuguese March surveys
- increased or stable distribution areas and abundances in the southern areas covered by the Portuguese November surveys
- a large contribution of IXa-Cadiz to the total distribution area and abundance during 96–99 (no prior information availale)
- distribution area and abundance are higher in the Portuguese November series than in the Portuguese March series during the 1990s (both regionally and overall), while the reverse was observed in the 1980s.

It should be noted that the above findings are in general accordance with the results from the analysis of spawning areas and catch data.

14.6 Morphometrics

A review of the literature on the structure of the Atlantic sardine population provided an extensive list of references, published between the beggining of the century and the 1960s. These studies focused mainly on the comparison of meristic characters (number of vertebrae and gillrakers) between areas. The studies of Fage (1920), Furnestin (1952) and several others mainly concluded the existence of a cline on those characters and propose a division on races that could be distinguished by mean values of those characters. This divisions were later questioned by Ruivo (1950) and Andreu (1969) on the argument that relationships between meristic characters and fish length or environmental factors were not being taken into account. No agreement was, therefore, attained regarding the structure of sardine populations based on these studies.

A study on sardine morphometry was carried out, based on samples collected during the 98/99 spawning season between the Gulf of Biscay and the Gulf of Cadiz (Silva, WD 1999). The results indicate a cline in morphometry and no clear separation of groups in the study area. There is, however, some indication of grouping of samples from Southwest and South Iberian waters (south of Lisbon). Furthermore, distance between the Northwest and South-Southwest groups seems smaller than distance between these groups and the Northern one.

Extension of the sampling to areas further North and further South, a more even coverage of the study area and the analysis of samples collected at different times of the year, were identified as necessary to provide firm conclusions on this subject.

14.7 Inferences from population structure

Year class contribution to the catch at age in number was analysed by sub-area for the period 1978-1998 (Azevedo, WD 1999). These data were compared with information provided by Spanish March, Portuguese March and Portuguese November acoustic surveys (Tables 14.7.1 and 14.7.2).

Table 14.7.1 summarizes strong year classes in each area in the catch-at-age data and in the survey data. Only the 1983 year class could be followed in catches throughout all the age groups and sub-areas as a strong year class. Nevertheless, year classes 1987, 1991 and 1992 also appear as strong year classes for most of the age groups in most of the areas. This information is also reflected on the acoustic surveys. However, the strong 1987 year class is not depicted by the acoustic survey information which suggests a strong 1986 year class in sub-areas VIIIc, IXa North and IXa Central-South.

In Division VIIIc year class 1991 showed below average values at age group-0 and year class 1992 at age group-0 and 1. However, the contribution to the catches at older ages after 1994 became rather strong. On the other hand, in sub-area IXa North and Ixa Central-North, a high contribution of year classes 1991 and 1992 (1.7 to 3.6 the age average) at age group-0 and 1 was observed.

The 1998 year class appears in the catches in sub-area IXa North, IXa Central-North and sub-area IXa South-Cadiz. In subarea IXa Central-North this year class is estimated to be the second highest along the time series and above twice the age average.In IXa South-Cadiz it was observed that in 1998 the catch at age group-0, 129 million sardines, was the highest of the time series and represented around 58% of the total annual catch in number, i.e, four times the age average proportion along the time period. According to the survey data, recruitment in 1998 appears to be stronger in the sub-areas from IXa Central-North to Cadiz waters.

It is also worth noting that when the cohort strengths are reconstructed from Spanish and Portuguese catch data separately (summing up catches at ages 0–4 for each cohort while assuming an annual natural mortality of 0.33), there appears a good correlation between year class strength in Portuguese and Spanish waters (Figure 14.7.1).

Overall, it seems that strong year classes in the 1980s (1983 and 1987) were immediately observed as above average contributions at age in most subareas of the stock unit, both in the catch data and the acoustic surveys. Although strong year classes have also entered the fishery in the 1990s (1991, 1992 and 1998), these have not been detected immediately in some areas, where above average catches at age only appeared 1–2 years later (at ages 1–2) for the particular cohorts. These data are in overall agreement with the analysis on egg and acoustic data, suggesting a reduction in distribution area during the 1990s. They also do not provide evidence of clear discontinuities within the area of the currently delimited stock unit.

14.8 Synthesis

As mentioned in section 14.1, the main reasons for defining the current stock unit in 1980 were associated with practical, rather than biological justifications. However, the analysis presented in sections 14.2 – 14.7 does not provide strong evidence to support proposals for concrete changes on biological grounds. Nevertheless, it improves our knowledge in relation to sardine dynamics within the current stock unit, and confirms that considerable changes in distribution have occurred in the 1990s. It also highlights the need for more information in relation to sardine dynamics in the northern and southern boundaries of the current stock unit.

Table 14.3.1 - Sardine catch at age proportion standardised by the age average (age range: 0-6+, period: 1978-1998). Mean age proportion (mean prop.) is presented as reference

Sub-area VIIIc

	Age group						
Year class	0	1	2	3	4	5	6+
1978	**2.9**	**1.1**	**1.1**	0.7	0.3	0.2	0.1
1979	0.9	**1.5**	**1.2**	**1.3**	0.8	0.6	0.2
1980	**1.4**	**1.9**	**1.6**	0.6	0.3	0.2	0.1
1981	**1.4**	**1.2**	**1.8**	0.8	0.4	0.3	0.3
1982	0.2	0.9	**1.6**	**1.4**	**1.2**	0.7	0.6
1983	**2.7**	0.1	0.8	**1.2**	0.9	0.6	0.7
1984	0.0	**3.8**	0.4	0.6	0.6	0.6	0.4
1985	0.2	0.2	**3.1**	0.6	0.9	**1.1**	0.5
1986	0.4	0.9	0.9	**2.0**	0.7	**1.1**	1.0
1987	**3.9**	0.2	0.3	0.3	**1.3**	0.5	0.7
1988	0.3	**1.6**	0.4	0.8	0.7	**2.5**	**1.4**
1989	**1.6**	0.3	**1.3**	0.6	0.5	0.8	**2.2**
1990	**1.2**	1.0	0.4	**1.5**	0.5	0.6	**1.9**
1991	0.9	1.0	0.5	0.4	**1.7**	0.6	**2.4**
1992	0.6	**2.3**	0.4	0.6	0.4	**1.6**	**1.4**
1993	0.9	0.9	**1.2**	0.9	0.7	0.8	**1.8**
1994	0.4	0.1	**1.3**	**2.1**	0.7	1.0	**1.3**
1995	0.1	0.3	0.4	**1.8**	**2.6**	0.9	**1.4**
1996	0.2	0.2	0.5	0.6	**3.0**	**3.0**	0.8
1997	0.8	0.4	0.8	0.9	**1.6**	**2.2**	**1.1**
1998	0.1	**1.1**	**1.1**	**1.3**	**1.1**	**1.2**	1.0
mean prop.	15	17	19	16	13	9	12

Sub-area IXa North

	Age group						
Year class	0	1	2	3	4	5 6+	
1978	**2.0**	0.9	1.0	0.8	0.4	0.3	0.1
1979	0.6	**1.3**	**1.1**	**1.3**	1.0	0.9	0.3
1980	0.9	**1.6**	**1.5**	0.6	0.5	0.2	0.2
1981	1.0	1.0	**1.7**	0.9	0.5	0.5	0.5
1982	0.1	0.8	**1.4**	**1.5**	**1.6**	**1.1**	**1.1**
1983	**1.8**	0.1	0.7	**1.2**	**1.2**	0.9	**1.1**
1984	0.0	**3.3**	0.4	0.7	0.8	0.9	0.6
1985	0.1	0.1	**2.8**	0.6	**1.2**	**1.6**	0.8
1986	0.2	0.7	0.8	**2.1**	**1.0**	**1.7**	**1.7**
1987	**2.6**	0.1	0.3	0.3	**1.7**	0.7	**1.2**
1988	0.2	**1.4**	0.4	0.9	1.0	**3.7**	**2.4**
1989	1.0	0.3	**1.1**	0.6	0.7	**1.2**	**3.9**
1990	0.8	0.8	0.4	**1.6**	0.6	0.9	**3.3**
1991	**3.6**	0.7	0.1	0.1	0.2	0.1	0.2
1992	**2.5**	**1.7**	0.2	0.2	0.1	0.4	0.3
1993	0.1	**1.7**	**1.8**	1.0	0.4	0.5	0.7
1994	0.2	0.3	**2.1**	**2.3**	0.5	0.4	0.5
1995	0.1	0.5	0.6	**2.4**	**3.0**	0.7	0.8
1996	0.3	0.4	**1.0**	0.7	**3.4**	**2.9**	0.5
1997	**1.2**	**1.4**	0.9	0.6	0.8	**1.1**	0.4
1998	**1.6**	**1.7**	0.8	0.5	0.4	0.4	0.3
mean prop.	22	20	21	15	10	6	7

Table 14.3.1 (Continued)

Sub-area IXa Central-North

	Age group						
year	0	1	2	3	4	5	6+
1978	0.3	**2.3**	0.9	0.1	0.1	0.1	0.0
1979	**1.2**	**1.7**	**1.1**	0.1	0.1	0.0	0.0
1980	0.9	**1.6**	**1.2**	0.3	0.2	0.2	0.0
1981	**1.3**	**1.4**	1.0	0.5	0.3	0.3	0.1
1982	0.0	0.6	**2.2**	0.8	0.5	0.2	0.3
1983	**1.5**	0.7	0.9	**1.4**	1.0	0.8	0.6
1984	0.2	**2.5**	0.3	0.5	0.5	0.5	0.6
1985	0.7	0.4	**2.1**	0.7	0.5	0.3	0.3
1986	0.5	0.8	**1.3**	**1.3**	**1.2**	0.9	0.3
1987	**1.7**	0.7	0.7	**1.1**	**1.6**	**1.4**	**1.8**
1988	0.9	**1.2**	0.8	0.7	**1.6**	**1.3**	**1.3**
1989	0.2	0.7	**1.6**	0.8	0.9	**3.2**	**1.6**
1990	0.3	1.0	0.7	**1.7**	**1.2**	**1.9**	**5.7**
1991	**4.7**	0.4	0.3	0.5	0.8	0.8	1.0
1992	**1.6**	**1.6**	0.5	0.5	0.9	0.5	0.1
1993	0.0	0.8	**1.7**	1.0	0.9	**1.1**	0.4
1994	0.1	0.0	0.7	**3.7**	**1.6**	0.9	0.9
1995	0.0	0.5	0.6	**2.6**	**2.5**	1.0	**2.2**
1996	**1.9**	0.1	0.5	**1.5**	**3.4**	**2.2**	**1.8**
1997	0.6	**1.1**	0.8	0.9	**1.2**	**2.9**	**1.6**
1998	**2.4**	1.0	1.0	0.4	0.3	0.4	0.3
mean prop.	13	30	29	17	7	3	1

Sub-area IXa Central-South

	Age group						
year	0	1	2	3	4	5	6+
1978	0.4	**2.6**	0.9	0.1	0.1	0.1	0.0
1979	**1.7**	**1.9**	**1.1**	0.1	0.0	0.0	0.0
1980	**1.2**	**1.8**	**1.2**	0.2	0.1	0.1	0.0
1981	**1.7**	**1.6**	1.0	0.5	0.2	0.2	0.1
1982	0.0	0.7	**2.2**	0.7	0.3	0.1	0.2
1983	**2.0**	0.7	0.9	**1.3**	0.7	0.6	0.6
1984	0.2	**2.7**	0.3	0.4	0.3	0.3	0.6
1985	0.9	0.5	**2.1**	0.6	0.4	0.2	0.2
1986	0.7	0.9	**1.3**	**1.2**	0.8	0.6	0.2
1987	**2.3**	0.8	0.7	0.9	**1.1**	0.9	**1.6**
1988	**1.3**	**1.3**	0.8	0.7	**1.1**	0.9	**1.2**
1989	0.0	0.7	**1.1**	**1.4**	**1.3**	**2.2**	**1.4**
1990	0.2	0.3	1.0	**1.6**	**1.8**	**1.8**	**3.2**
1991	**3.9**	0.5	0.7	1.0	0.6	0.4	0.2
1992	0.0	**1.1**	**1.1**	**1.2**	**1.1**	0.8	0.2
1993	0.5	0.7	**1.1**	**1.2**	**1.4**	**1.5**	**1.1**
1994	**1.3**	0.2	0.7	**2.1**	**1.3**	**1.5**	0.9
1995	0.5	0.4	0.6	**2.1**	**2.2**	0.9	0.2
1996	**1.2**	0.2	0.4	**1.3**	**3.3**	**2.7**	1.0
1997	0.4	0.9	0.7	**1.2**	**1.8**	**2.5**	**1.1**
1998	0.4	0.5	**1.1**	**1.2**	**1.1**	**2.8**	**6.7**
mean prop.	10	27	29	19	11	4	1

Table 14.3.1 (Continued)

Sub-area IXa South-Algarve

	Age group						
year	0	1	2	3	4	5	6+
1978	0.7	**2.5**	0.6	0.3	0.4	0.2	0.2
1979	**2.7**	**1.8**	0.7	0.3	0.2	0.0	0.0
1980	**1.8**	**1.8**	1.0	0.4	0.2	0.1	0.0
1981	1.0	1.0	**1.1**	**1.1**	0.5	**1.1**	0.7
1982	0.3	**1.6**	**1.2**	0.7	0.6	0.4	0.3
1983	**1.4**	**1.3**	**1.2**	0.7	0.3	0.5	0.1
1984	**1.9**	**1.1**	0.9	0.8	0.7	0.8	**1.1**
1985	0.9	**1.5**	**1.2**	0.5	0.4	0.9	**1.2**
1986	**1.6**	0.9	**1.2**	0.6	1.0	0.9	0.9
1987	0.6	0.7	**1.4**	**1.3**	0.6	0.7	0.4
1988	**4.4**	0.7	0.6	0.9	0.3	0.5	0.8
1989	0.7	**2.0**	0.7	0.5	0.7	0.7	0.6
1990	**1.4**	1.0	0.9	0.8	**1.1**	**1.2**	**1.8**
1991	0.6	0.7	**1.2**	**1.3**	**1.3**	1.0	0.1
1992	0.0	**1.2**	**1.1**	**1.1**	**1.1**	1.0	0.6
1993	0.0	0.2	**2.1**	**1.1**	**1.1**	0.7	**1.5**
1994	0.0	0.0	1.0	**2.3**	**1.4**	**1.8**	0.9
1995	0.0	0.0	0.4	**2.7**	**2.2**	0.5	0.1
1996	0.0	0.2	**1.2**	**1.5**	**2.7**	0.7	0.2
1997	0.5	0.6	0.8	1.0	**1.8**	**2.6**	**2.5**
1998	0.4	0.2	0.4	**1.1**	**2.5**	**4.8**	**7.0**
mean prop.	10	27	24	22	12	5	1

Sub-area IXa South-Cadiz

				Age group			
year	0	1	2	3	4	5	6+
1978	0.4	**2.4**	0.7	0.3	0.4	0.2	0.3
1979	**1.7**	**1.7**	0.8	0.4	0.2	0.0	0.0
1980	**1.1**	**1.7**	**1.1**	0.4	0.2	0.1	0.0
1981	0.6	1.0	**1.1**	**1.3**	0.6	**1.4**	**1.2**
1982	0.2	**1.7**	**1.2**	0.7	0.5	0.5	0.0
1983	0.9	**1.4**	**1.3**	0.7	0.3	0.5	0.0
1984	0.8	**1.1**	1.0	1.0	0.8	**1.2**	**1.9**
1985	0.7	**1.4**	**1.3**	0.6	0.4	**1.2**	**2.8**
1986	**2.3**	1.0	0.9	0.4	0.5	0.3	0.7
1987	**1.2**	0.6	**1.2**	**1.3**	0.7	**1.1**	0.7
1988	**4.6**	0.3	0.4	0.5	0.1	0.3	0.0
1989	0.3	**2.2**	0.7	0.5	0.6	0.7	**1.5**
1990	1.0	1.0	0.8	0.9	**1.2**	**1.7**	**1.8**
1991	0.5	0.8	**1.4**	**1.4**	0.9	0.9	0.0
1992	0.6	0.7	**1.4**	**1.3**	**1.1**	**1.0**	0.0
1993	0.0	0.2	**1.9**	**1.4**	**1.6**	**1.2**	**3.8**
1994	0.0	0.0	1.0	**2.7**	**1.5**	**2.5**	**2.0**
1995	0.0	0.1	0.4	**2.1**	**3.9**	**1.1**	0.0
1996	0.0	0.2	**1.2**	**1.7**	**2.8**	**1.2**	0.2
1997	0.2	0.8	0.8	**1.1**	**2.1**	**3.3**	**3.4**
1998	**3.7**	0.7	0.3	0.4	0.5	0.6	0.6
mean prop.	15	28	23	20	11	3	1

Table 14.4.1. List of surveys considered for the analysis of the spatial distribution of sardine eggs along the Portuguese coast. In surveys operated with a double sampler, mesh size refers to the sampler used in this study. In March 1992, some stations from the 335 µm sampler were not available, and this information was obtained from the 500 µm sampler. Survey period in bold indicates surveys considered for binomial modelling.

Period	Net type	Mesh (µm)	Stations	Survey Details
November 1985	Ring	500	72	Ré *et a*l. (1990)
January 1986	Ring	500	127	Ré *et al*. (1990)
March 1986	Ring	500	127	Ré *et al*. (1990)
March 1988	CALVET	200	317	Cunha *et al* (1992)
October 1989	Bongo	500	66	Lopes P. (per.com.)
November 1990	Bongo	500	86	Afonso and Lopes (1994)
October 1991	Bongo	500	84	Lopes and Afonso (1995)
March 1992	Bongo	335/500	88	Cardador (1995)
October 1992	Bongo	335	39	Cardador (1995)
February 1993	Bongo	500	87	Cardador (1995)
March 1995	WP2	200	69	Farinha A. (per. com.)
March 1997	CALVET	150	373	Cunha *et al*. (1997)
January 1998	Bongo	335	71	Farinha A. (per. com.)
January 1999	CALVET	150	417	Cunha *et al*. (1999)

Table 14.4.2. Area estimates of the traditional method and the presence/absence GAM, together with their 95% confidence intervals and coefficient of variation (C.V.) for the Spanish DEPM surveys.

AREA OF EGG PRESENCE			
Year	**Region**	**Traditional estimate**	**GAM estimate [95% conf. interval] (C.V. %)**
1988	Region I	6915	6345 [5478,7502] (7.84)
	Region II	13829	11241 [10099, 12259] (5.19)
	Region III	5680	4657 [3725, 5761] (11.11)
	Total	**26424**	**22243 [20395, 24258] (3.75)**
1990	Region I	10165	7746 [6092, 9990] (12.28)
	Region II	17554	12082 [10247, 15732] (11.33)
	Region III	2840	2985 [1802, 4623] (25.10)
	Total	**30559**	**22813 [19938, 28398] (9.22)**
1997	Region I	0*	523 [170, 1234] (51.31)
	Region II	4519	3268 [2288, 4243] (15.78)
	Region III	2857	2321 [1664, 3147] (16.26)
	Total	**7377**	**6112 [4769, 7586] (12.18)**

Table 14.4.3. Estimates of areas (´000 Km^2) with sardine eggs by year and region for the 8 Portuguese ichtyoplankton surveys used in modelling the probability of egg presence. Values in square brackets indicate 95% confidence interval.

Year	Occident North	Occident South	Algarve	Total Portugal
1986	8.3 [7.4 - 9.0]	3.8 [3.1 – 4.4]	2.1 [1.5 – 2.4]	14.2 [12.7 – 15.1]
1988	8.2 [7.5 – 8.9]	2.6 [2.0 – 3.2]	1.3 [0.7 – 1.5]	12.1 [11.0 – 12.9]
1990	5.6 [5.1 – 6.2]	2.5 [1.7 – 2.6]	2.0 [1.6 – 2.2]	10.1 [8.9 – 10.6]
1991	3.6 [3.0 – 4.3]	3.9 [3.1 – 4.5]	1.1 [0.7 – 1.5]	8.6 [7.6 – 9.6]
1992	4.5 [3.7 – 5.1]	5.1 [4.4 – 5.7]	1.9 [1.5 – 2.1]	11.5 [10.3 – 12.3]
1993	6.4 [5.6 – 7.0]	7.2 [6.7 – 7.8]	2.9 [2.4 – 3.2]	16.5 [15.4 – 17.3]
1997	1.6 [1.2 – 2.2]	3.4 [2.8 – 4.1]	2.1 [1.5 – 2.3]	7.1 [6.1 – 7.8]
1999	3.1 [2.5 – 3.8]	3.2 [2.5 – 3.8]	1.2 [0.7 – 1.5]	7.5 [6.3 – 8.4]

Table 14.5.1 Mean estimates (overall and regional) and percentage difference for sardine distribution area, abundance and density between the 1980s and 1990s as obtained from all Portuguese acoustic surveys.

Portugal	**1984-1988** (n=10)	**1992, 95-1999** (n=9)	**Variation (%)**
Distribution Area (mn^2)	2400	2232	- 7.0
Number (million)	9575	9137	- 4.6
Density (million mn^{-2})	4.0	4.1	+2.6
Number fish ≤ 16 cm (million)	4127	3602	-12.7
Number fish > 16 cm (million)	5448	5535	+1.6

OCN	**1984-1988** (n=10)	**1992, 95-1999** (n=9)	**Variation (%)**
Distribution Area (mn^2)	1296	967	-25.4
Number (million)	4943	4267	-13.7
Density (million mn^{-2})	3.8	4.4	+15.7
Number fish ≤ 16 cm (million)	2117	2352	+11.1
Number fish > 16 cm (million)	2826	1915	-32.2

OCS	**1984-1988** (n=10)	**1992, 95-1999** (n=9)	**Variation (%)**
Distribution Area (mn^2)	713	820	+15.0
Number (million)	3055	3088	+1.1
Density (million mn^{-2})	4.3	3.8	-12.1
Number fish ≤ 16 cm (million)	1236	1052	-14.9
Number fish > 16 cm (million)	1819	2036	-11.9

Algarve	**1984-1988** (n=10)	**1992, 95-1999** (n=9)	**Variation (%)**
Distribution Area (mn^2)	391	445	+13.8
Number (million)	1577	1782	+13.0
Density (million mn^{-2})	4.0	4.0	-0.7
Number fish ≤ 16 cm (million)	774	198	-74.4
Number fish > 16 cm (million)	803	1583	+97.1

Table 14.5.2 Mean estimates (overall and regional) and percentage difference for sardine distribution area, abundance and density between the 1980s and 1990s as obtained from autumn (November/December) Portuguese acoustic surveys.

Portugal	**1984-1988** (n=4)	**1992, 95-1999** (n=3)	**Variation (%)**
Distribution Area (mn^2)	2617	2571	-1.8
Number (million)	9824	12074	+22.9
Density (million mn^{-2})	3.8	4.7	+25.1
Number fish ≤ 16 cm (million)	3941	6603	+67.6
Number fish > 16 cm (million)	5883	5471	-7.0

OCN	**1984-1988** (n=4)	**1992, 95-1999** (n=3)	**Variation (%)**
Distribution Area (mn^2)	1471	1204	-18.2
Number (million)	4694	6226	+32.7
Density (million mn^{-2})	3.2	5.2	+62.1
Number fish ≤ 16 cm (million)	1520	4409	+190.1
Number fish > 16 cm (million)	3174	1817	-42.7

OCS	**1984-1988** (n=4)	**1992, 95-1999** (n=3)	**Variation (%)**
Distribution Area (mn^2)	747	913	+22.2
Number (million)	3322	4116	+23.9
Density (million mn^{-2})	4.4	4.5	+1.4
Number fish ≤ 16 cm (million)	1805	1836	+1.6
Number fish > 16 cm (million)	1518	2283	+50.5

Algarve	**1984-1988** (n=4)	**1992, 95-1999** (n=3)	**Variation (%)**
Distribution Area (mn^2)	399	454	+13.8
Number (million)	1804	1731	-4.3
Density (million mn^{-2})	4.5	3.8	-15.9
Number fish ≤ 16 cm (million)	616	361	-41.4
Number fish > 16 cm (million)	1192	1370	+15.0

Table 14.5.3 Mean estimates (overall and regional) and percentage difference for sardine distribution area, abundance and density between the 1980s and 1990s as obtained from spring (February/March) Portuguese acoustic surveys.

Portugal	**1984-1988** (n=2)	**1996-1999** (n=4)	**Variation (%)**
Distribution Area (mn^2)	3145	2088	-33.6
Number (million)	11874	7901	-33.5
Density (million mn^{-2})	3.8	3.8	+0.2
Number fish ≤ 16 cm (million)	5366	2954	-45.0
Number fish > 16 cm (million)	6508	4947	-24.0

OCN	**1984-1988** (n=2)	**1996-1999** (n=4)	**Variation (%)**
Distribution Area (mn^2)	1667	763	-54.2
Number (million)	6796	3748	-44.8
Density (million mn^{-2})	4.1	4.9	+20.5
Number fish ≤ 16 cm (million)	4270	1834	-57.0
Number fish > 16 cm (million)	2526	1914	-24.2

OCS	**1984-1988** (n=2)	**1996-1999** (n=4)	**Variation (%)**
Distribution Area (mn^2)	899	863	-4.0
Number (million)	3179	2603	-18.1
Density (million mn^{-2})	3.5	3.0	-14.7
Number fish ≤ 16 cm (million)	455	959	+110.7
Number fish > 16 cm (million)	2724	1644	-39.6

Algarve	**1984-1988** (n=2)	**1996-1999** (n=4)	**Variation (%)**
Distribution Area (mn^2)	579	463	-20.0
Number (million)	1898	1549	-18.4
Density (million mn^{-2})	3.3	3.4	+2.2
Number fish ≤ 16 cm (million)	641	160	-75.0
Number fish > 16 cm (million)	1257	1389	+10.4

Table 14.7.1 - Year classes with high contribution to the catch at age by sub-area between 1978 and 1998)
(x - from age group-0, o - years latter

Year classes	Sub-area: VIIIc	IXa North (1)	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz	Portugal	Spain 1)
1978	x	x				o	x	x
1979	o	o			x	x	x	x
1980	x	o	o	x			x	x
1981								
1982								
1983	x	x	x	x	x		x	x
1984			o		x		x	
1985								
1986								
1987	x	x	x	x			x	x
1988					x	x		
1989					o	o		
1990					x	o		
1991	o	x	x	x	o	o	x	x
1992	o	x	x	o	o	o	x	x
1993							x	
1994								
1995								
1996			x					
1997		x						
1998		x	x			x	x	x
Source:	Table 2 and Table 1	Table 3A	Table 4	Table 5	Table 6	Table 7	Table 8	Table 9

1) proportion at age from VIIIc catch at age applied to IXa North landings (1978-1990)
Portugal: IXa Central North + IXa Central-South + IXa South-Algarve
Spain: VIIIc + IXa North 1) + IXa South-Cadiz

Table 14.7.2 - Strong year classes by sub-area from the Spanish and Portuguese Spring and Autumn survey series.

Year classes	Sub-area: VIIIc	IXa North	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz
1983	x	x	x	x	x	
1984				x	x	
1985					x	
1986	x	x		x		
1987	x		x			
1988						
1989						
1990						
1991		x	x	x		
1992		x	x	x	x	
1993						
1994						
1995						
1996			x	x		x
1997	x	x				
1998			x	x	x	x
Survey series	Spring:	86-88 90-93 95-99	Spring: Autumn:	86, 88 96-99 84-87 92 97-98		96-99

Acoustic surveys used:
Portuguese Spring and Autumn series by sub-area (Cadiz from Spring series)
Spanish Spring series by sub-area (VIIIc and IXa North)

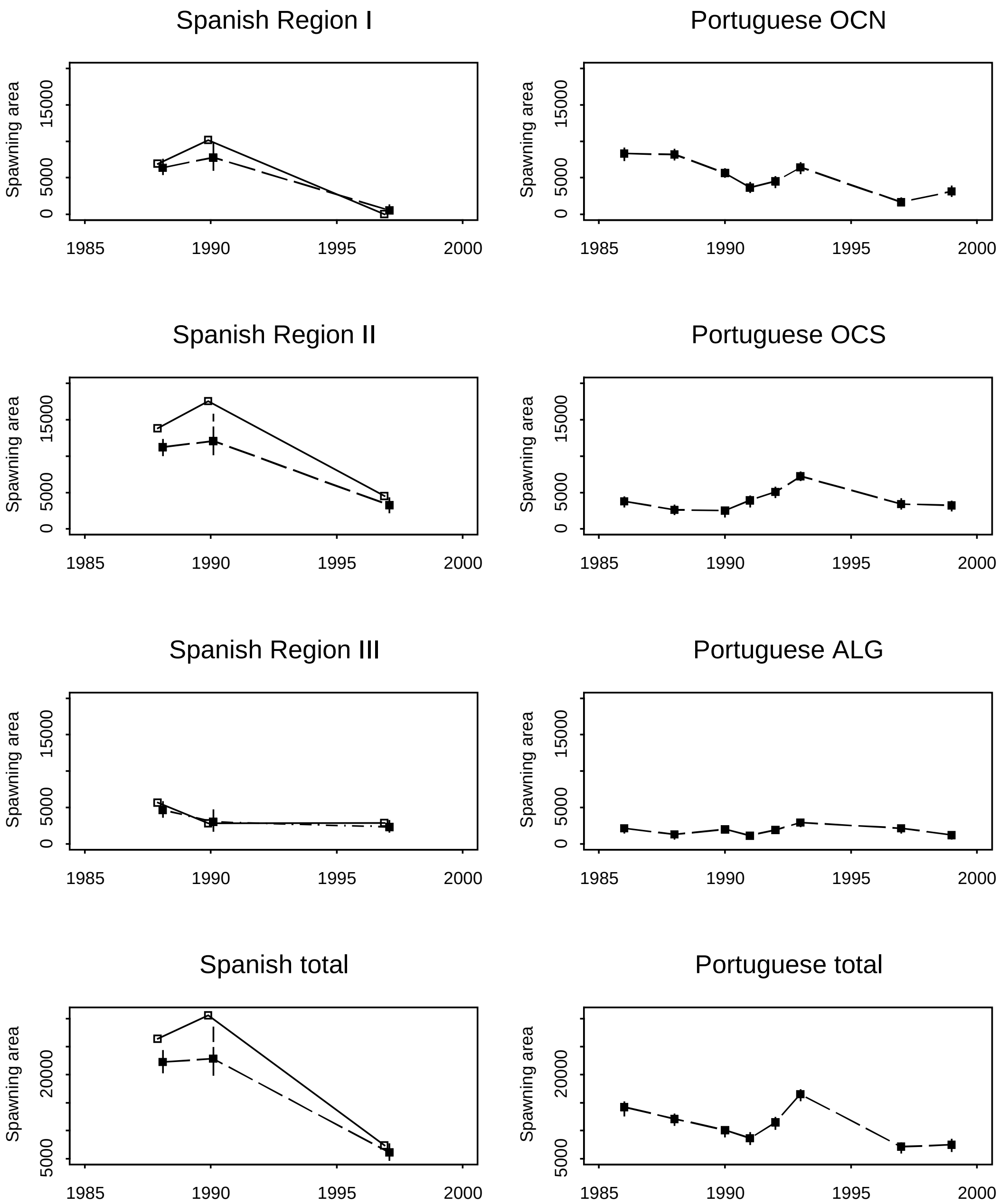


Figure 14.4.1: Spawning area estimates (Km^2) by region and year for Spanish and Portuguese ichthyoplankton surveys. The solid line indicates the traditional method (for Spanish regions only) and the broken line indicates GAM estimates.

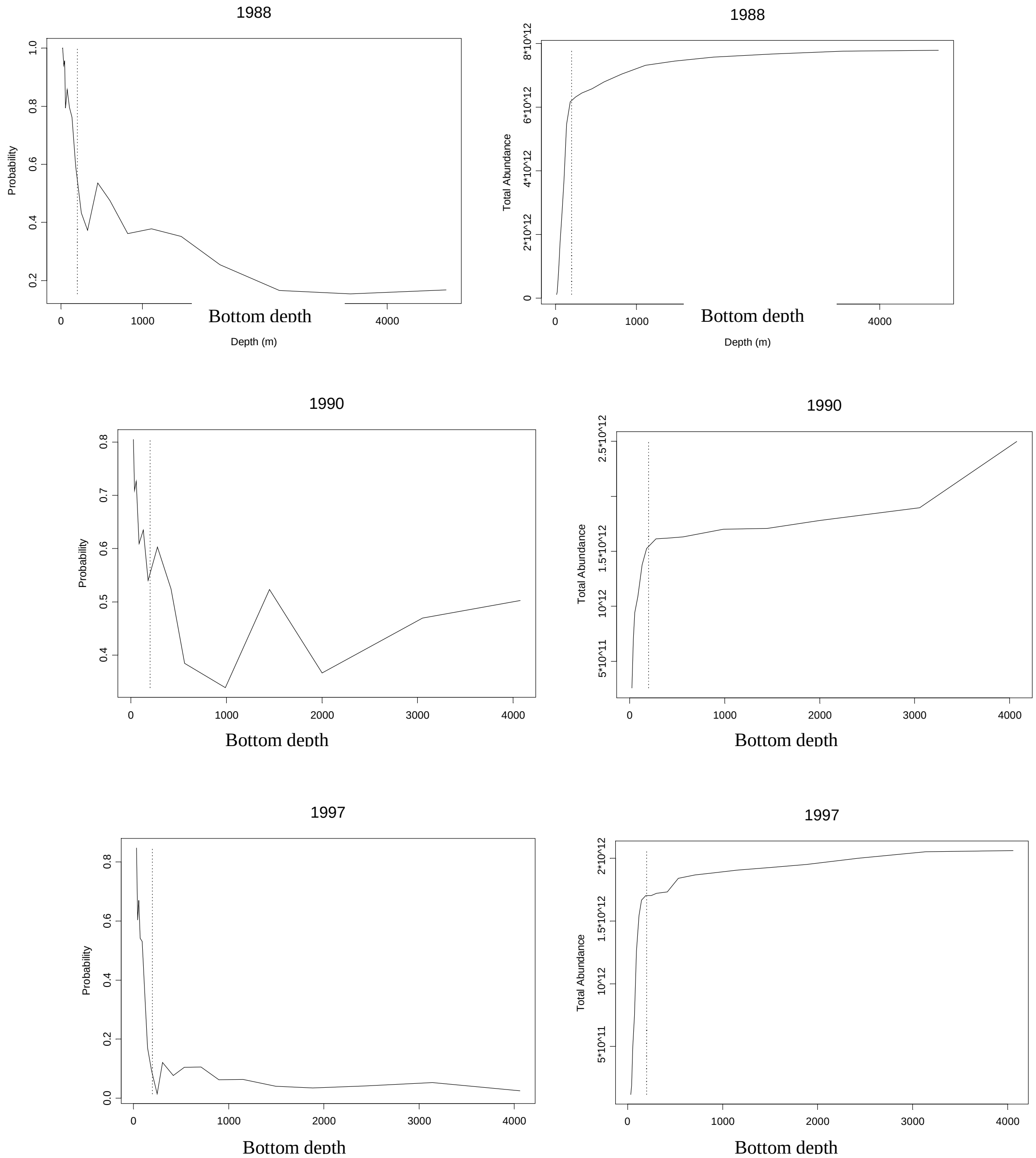


Figure 14.4.2: Fitted probability of presence (left panels) and fitted cumulative abundance (right panels) of eggs in relation with the depth. The dashed line represents the 200 m depth limit.

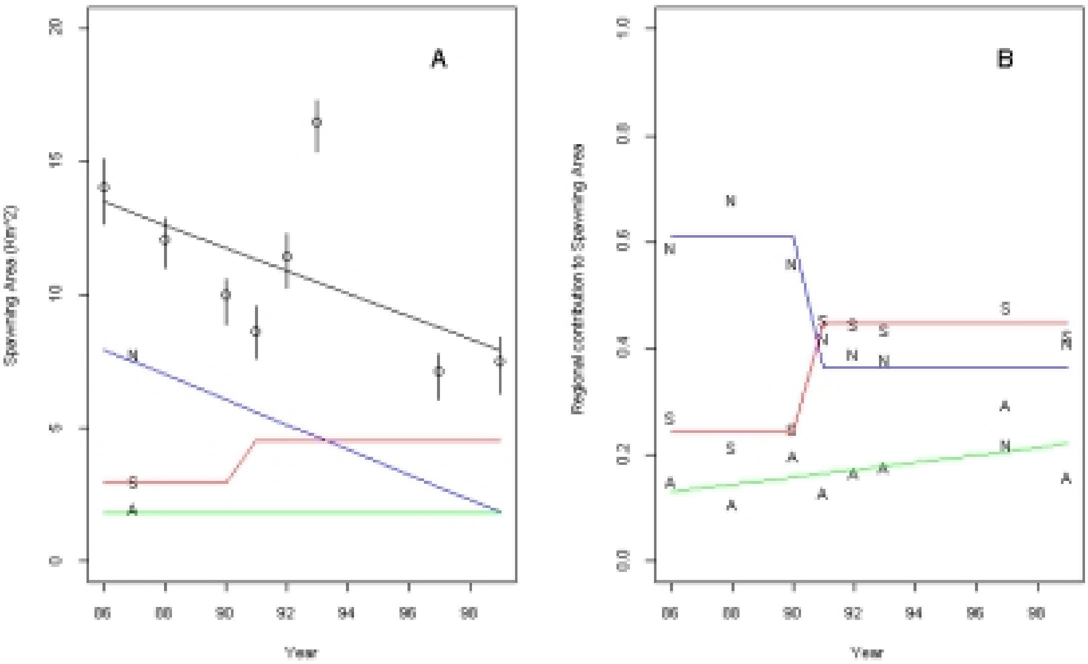


Figure 14.4.3. A – Estimated spawning area (,000 Km^2) overall for Portugal (with 95% confidence interval) and separately for the northern (N), southwestern (S) and southern (A) regions; B – Proportional contribution of spawning area by region. In both panels, plotted lines correspond to the best fit among a null, step, linear or smooth function of year.

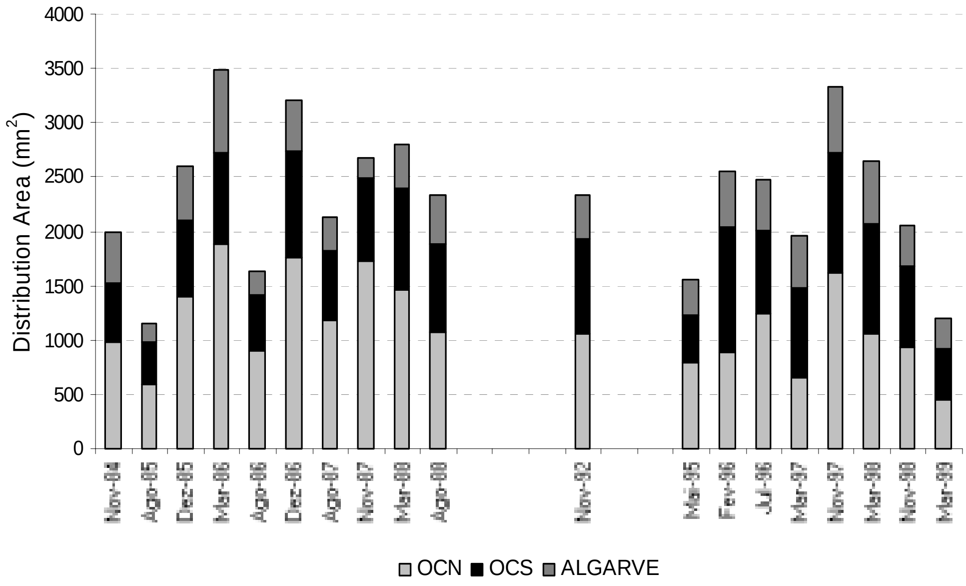


Figure 14.5.1 Sardine distribution area (nm^2) by region estimated from Portuguese acoustic surveys between 1984 and 1999.

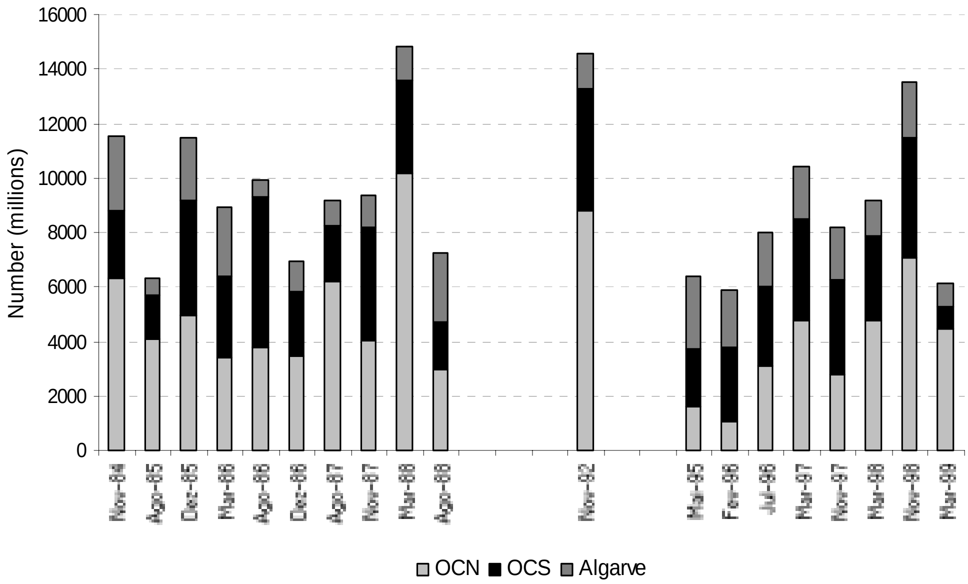


Figure 14.5.2 Sardine abundance (10^6 fish) by region estimated from Portuguese acoustic surveys between 1984 and 1999.

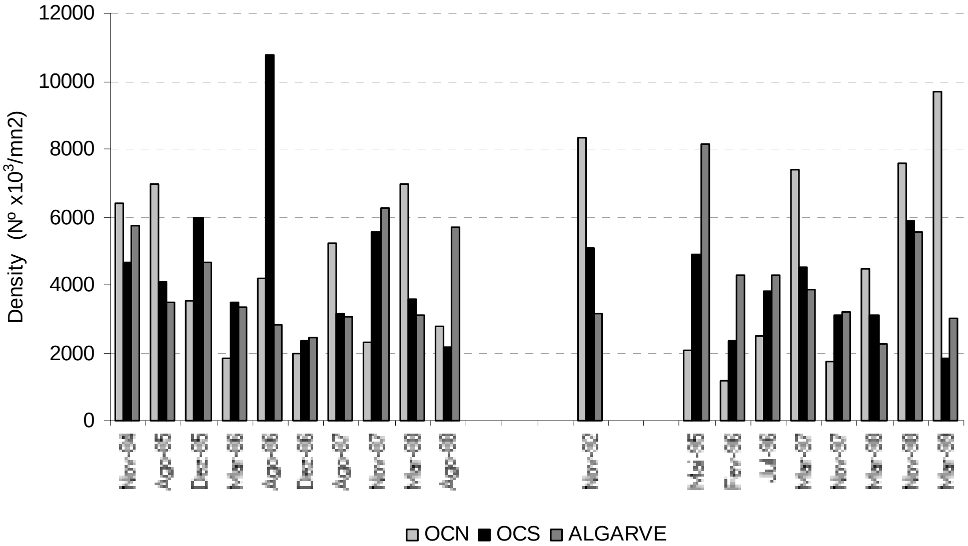


Figure 14.5.3 Sardine density (10^6 fish/nm^2) by region estimated from Portuguese acoustic surveys between 1984 and 1999.

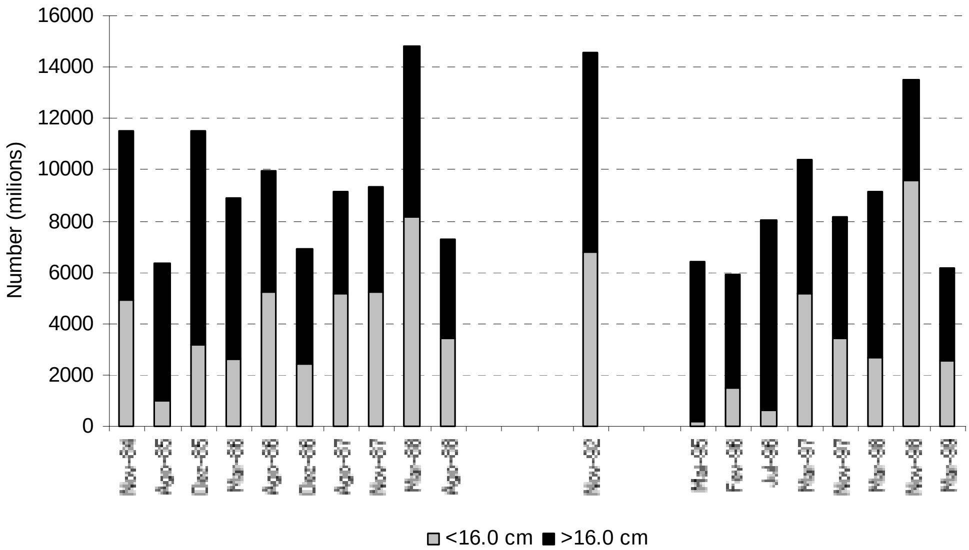


Figure 14.5.4 Sardine abundance (10^6 fish) for juveniles and adults estimated from Portuguese acoustic surveys between 1984 and 1999.

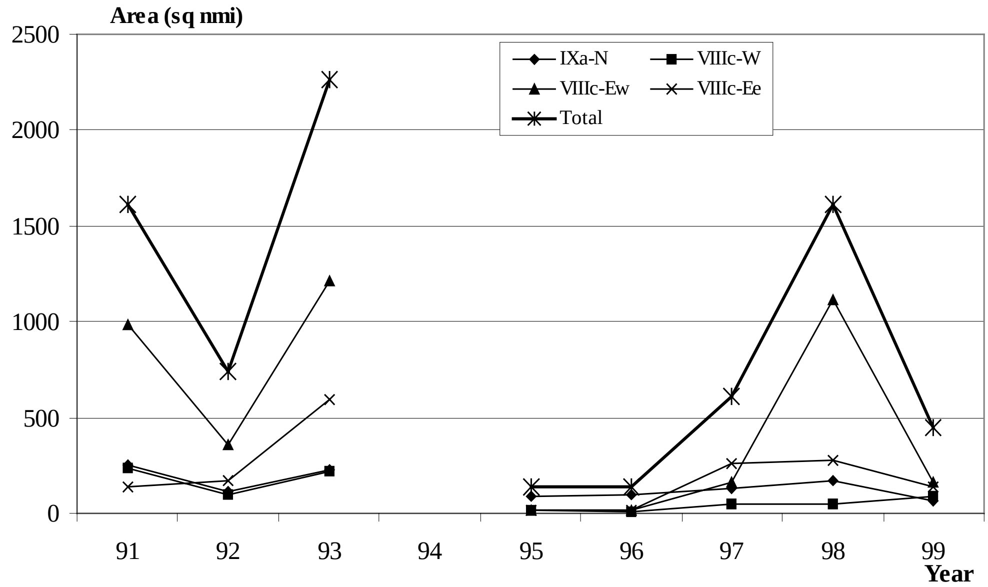
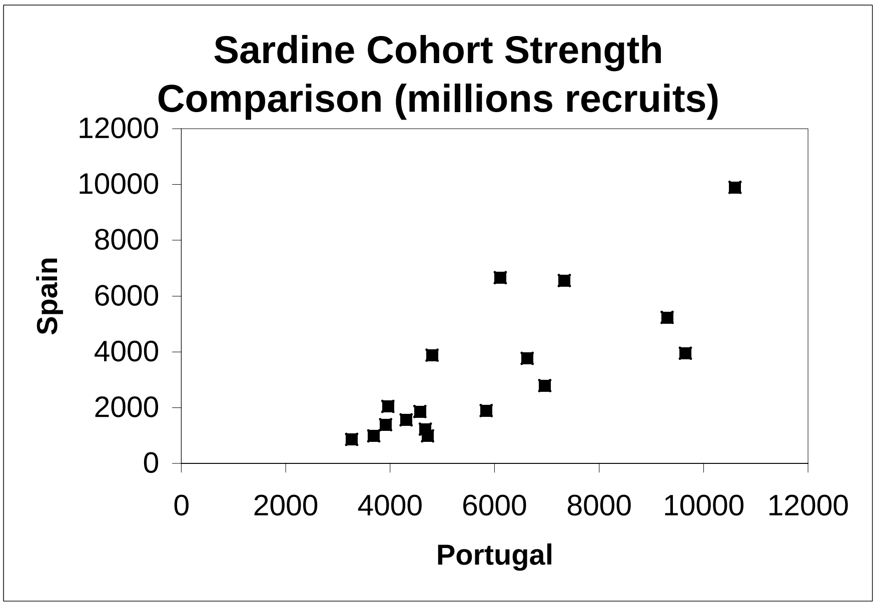


Figure 14.5.5: Occupied area of sardine expressed as square nautical miles since 1991 in the Spanish area according to the results of the Spanish Spring Acoustic surveys



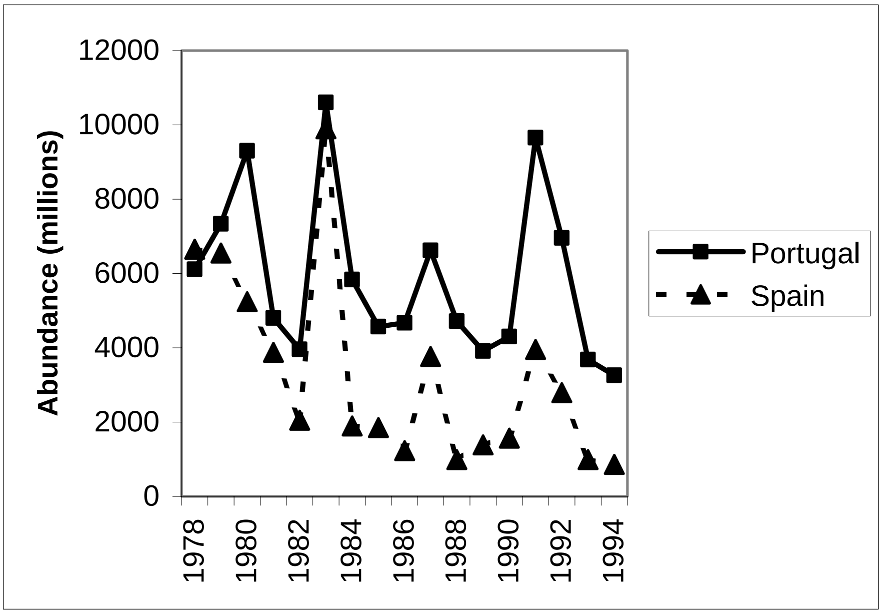


Figure 14.7.1 Comparison of sardine cohort strengths estimated from Spanish and Portuguese catch data. Time series were constructed by summing up the catch at ages 0-4 along each cohort, assuming an annual natural mortality of 0.33. Data from Azevedo WD 1999 Tables 8,9.

15 RESPONSE TO THE REQUEST BY THE GOVERNMENT OF PORTUGAL RELATING TO SARDINE ASSESSMENT AND CATCH FORECASTS

15.1 The VIIIc+IXa Assessment in relation to New Perceptions of Stock Identity

Section 14 relates the basis for current assumptions about Stock Identity as stated in Anon (1998 Vigo meeting). However, changes in spatial distribution (Stratoudakis, 1999 WD, as well as the sharp decrease in catches in Sub-Divisions VIIIc-West and IXa-N during 1998 (Carrera *et al*, 1999 WD) and the analysis performed in Azevedo (1999 WD), led the Working Group to discuss whether the actual definition of the stock is appropriate.

The Working Group considers that the distribution pattern of sardine around Atlantic waters has changed in recent years with a reduction in abundance in the north part and a stable situation in the south. However, the estimated SSB in 1999 from the assessment model indicates that the size of this stock is well above of the B_{pa} as established in the May 1998 ACFM meeting. On the other hand, the perception of the stock status is robust to the inclusion or exclusion of Divisions VIIIc.

Nevertheless, the Working Group considers that the updated information about sardine in VIIIc and IXa did not provided conclusive evidence to redefine the actual stock unit. Therefore the Working Group decided to assess the Iberian sardine as comprising a stock unit in Division VIIIc+IXa.

As a response to the request by the government of Portugal the Working Group calculated the catch forecasts for the year 2000 separately for Division VIIIc and Ixa.

15.2 Biological data in IXa

15.2.1 Catch in number at age

Table 15.2.1.1 presents the catch at age for Division IXa in the period 1978–1998. Annual catch number at age ranged between 3000–4000 million fish between 1978 and 1987. The catches decreased and in 1998 the annual catch was of around 1800 million fish. As referred in Azevedo (1999 WD) during the 1990s there was a selection pattern shift towards older individuals in the sub-areas from IXa Central-South to IXa South-Cadiz. When pooling the catch at age for the Division IXa, this selection pattern shift is also perceived. Figure 15.2.1.1 shows the annual selection pattern relative to age 3 from 1991 to 1998.

15.2.2 Mean weight at age

Table 15.2.2.1 presents the mean weight at age in the catches of Division IXa, for the period 1994–1998. It was not possible to update the information for the early years. There is no evidence for weight at age changes in the recent years.

15.3 Biological data in VIIIc

15.3.1 Catch at age in number

Table 15.3.1.1 presents the catch at age for Division VIIIc in the period 1978–1998. Annual catch number at age were the highest in 1978, 1300 million fish, and have decreased since then to 173 million fish in 1996. In 1998 the annual catch was 217 million fish. In this Division there is no evidence of a change in the selection pattern along the time series. Figure 15.3.1.1 shows the annual selection pattern relative to age 3 from 1991 to 1998.

15.3.2 Mean weight at age

Table 15.3.2.1 presents the mean weight at age in the catches of Division VIIIc, for the period 1994–1998. It was not possible to update the information for the early years. There is no evidence for weight at age changes in the recent years.

15.4 Catch prediction by area

Table 15.4.1 presents the input data. The fishing mortality at age for 1991–1998, as estimated in the assessment for Division VIIIc+IXa, was used as the basis to obtain the exploitation pattern separately for each Division. Partial fishing mortality was calculated as proportional to the catch number at age of each area. In Division IXa the exploitation pattern increased from 1995 to 1998 towards the oldest ages while in Division VIIIc no changes were observed. Therefore, it was considered appropriate to use the 1998 as the input data for catch predictions. Input values for the mean weight at age in the catch by sub-area was taken as the average of 1996–1998. The stock size, natural mortality, maturity ogive, proportion of F and M before spawning and also mean weight at age in the stock were the same as used for the catch predictions for Division VIIIc+IXa.

Catch forecasts for each Division are shown in Table 15.4.2. In Division VIIIc and at Fsq (0.051) the catches in 2000 are estimated to be 22 thousand tonnes whereas in IXa and at Fsq (0.34) the catches in 2000 are estimated to be 131 thousand tonnes.

Catch prediction by area were calculated on the basis of the estimated parameters in the assessment model for 1998 and partial catches by areas. It should be clearly stated that this forecast is based on the assumption of no changes in the spatial distribution of the population. As it has been stated in section 14, changes in the spatial distribution have being observed in this stock. Therefore, if these changes continue, catch prediction by Division, as calculated in this section, would be partly biased.

Table 15.2.1.1 Sardine catch numbers (millions) at age for area IXa.

year	age 0	age 1	age 2	age 3	age 4	age 5	age 6+	Total
1978	298	1908	646	125	75	18	6	3076
1979	576	1352	820	320	138	66	26	3297
1980	620	1646	1212	269	107	31	18	3903
1981	865	1770	1463	564	153	80	52	4948
1982	47	688	1700	580	270	96	92	3472
1983	836	540	754	687	258	108	96	3279
1984	109	2895	425	424	245	141	91	4330
1985	248	514	2080	414	237	153	77	3722
1986	202	600	874	670	256	123	86	2811
1987	945	489	562	479	385	114	108	3082
1988	411	806	475	344	243	149	89	2517
1989	119	481	766	331	180	158	105	2141
1990	160	495	455	577	250	120	156	2213
1991	1537	407	377	360	191	57	25	2953
1992	455	827	392	279	155	50	13	2172
1993	38	504	964	447	211	83	38	2285
1994	104	56	454	955	234	80	27	1909
1995	29	175	256	729	362	48	27	1627
1996	273	91	308	470	560	147	30	1879
1997	176	508	398	331	262	166	39	1880
1998	304	342	433	273	185	148	80	1766

Table 15.2.2.1 Mean weights (g) at age in Division IXa

Age	1994	1995	1996	1997	1998	Av.96-98	Cv(96-98)
0	21	26	19	22	26	**22**	**0.14**
1	35	46	39	33	38	**37**	**0.13**
2	56	58	52	51	53	**52**	**0.05**
3	60	65	58	61	58	**59**	**0.05**
4	68	68	63	67	61	**64**	**0.05**
5	73	80	69	71	64	**68**	**0.08**
6+	100	100	100	100	100	**100**	**0.00**
Average	**58**	**63**	**53**	**51**	**50**	57	**0.10**

Table 15.3.1.1 Sardine catches in number (millions) at age for area VIIIc

	Age group							
year class	age 0	age 1	age 2	age 3	age 4	age 5	age 6+	Total
1978	556	237	267	156	52	22	10	1300
1979	67	127	115	103	49	27	10	499
1980	222	351	330	103	48	16	12	1082
1981	156	150	257	102	39	22	24	749
1982	13	81	154	121	80	34	37	521
1983	225	13	84	108	64	32	43	569
1984	0	394	45	64	50	35	25	613
1985	10	13	263	43	53	44	24	451
1986	36	102	113	233	66	71	80	701
1987	456	23	53	41	136	33	62	804
1988	28	173	50	84	60	142	100	637
1989	125	31	129	50	35	40	139	548
1990	74	67	33	103	25	22	90	414
1991	36	50	27	20	64	15	81	293
1992	35	158	31	38	20	58	68	408
1993	49	59	87	56	34	27	80	392
1994	17	4	73	104	28	27	44	297
1995	2	11	16	68	78	19	38	232
1996	4	6	16	16	67	46	16	173
1997	28	14	33	34	47	45	28	230
1998	3	42	45	47	31	24	25	217

Table 15.3.2.1 Mean weights (g) at age in Division VIIIc

Age	**1994**	**1995**	**1996**	**1997**	**1998**	**Av.96-98**	**Cv(96-98)**
0	13	28	21	26	27	**25**	**0.28**
1	63	72	54	43	59	**52**	**0.18**
2	73	79	69	58	71	**66**	**0.11**
3	76	80	81	69	77	**76**	**0.06**
4	83	84	86	78	83	**82**	**0.03**
5	86	89	88	81	86	**85**	**0.03**
6+	100	100	100	100	100	**100**	**0.00**
Average	**77**	**84**	**83**	**69**	**76**	**69**	**0.08**

Table 15.4.1 Input data for the catch forecasts for Division IXa and VIIIc.

The SAS System 16:06 Thursday, September 23, 1999

Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table: Input data

1999	VIIIc		IXa							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0003	0.025	0.0414	0.022	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0089	0.052	0.0818	0.037	10080000	0.3300	0.7590	0.2500	0.2500	0.032
2	0.0208	0.066	0.2060	0.052	3606000.0	0.3300	0.9110	0.2500	0.2500	0.049
3	0.0592	0.076	0.3651	0.059	2027000.0	0.3300	0.9420	0.2500	0.2500	0.059
4	0.0679	0.082	0.4306	0.064	482000.00	0.3300	0.9730	0.2500	0.2500	0.067
5	0.0569	0.085	0.3674	0.068	302000.00	0.3300	1.0000	0.2500	0.2500	0.073
6+	0.0983	0.100	0.3259	0.100	341000.00	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2000	VIIIc		IXa							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0003	0.025	0.0414	0.022	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0089	0.052	0.0818	0.037	.	0.3300	0.7590	0.2500	0.2500	0.032
2	0.0208	0.066	0.2060	0.052	.	0.3300	0.9110	0.2500	0.2500	0.049
3	0.0592	0.076	0.3651	0.059	.	0.3300	0.9420	0.2500	0.2500	0.059
4	0.0679	0.082	0.4306	0.064	.	0.3300	0.9730	0.2500	0.2500	0.067
5	0.0569	0.085	0.3674	0.068	.	0.3300	1.0000	0.2500	0.2500	0.073
6+	0.0983	0.100	0.3259	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2001	VIIIc		IXa							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0003	0.025	0.0414	0.022	6676000.0	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0089	0.052	0.0818	0.037	.	0.3300	0.7590	0.2500	0.2500	0.032
2	0.0208	0.066	0.2060	0.052	.	0.3300	0.9110	0.2500	0.2500	0.049
3	0.0592	0.076	0.3651	0.059	.	0.3300	0.9420	0.2500	0.2500	0.059
4	0.0679	0.082	0.4306	0.064	.	0.3300	0.9730	0.2500	0.2500	0.067
5	0.0569	0.085	0.3674	0.068	.	0.3300	1.0000	0.2500	0.2500	0.073
6+	0.0983	0.100	0.3259	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

Notes: Run name : MANPCL04
Date and time: 23SEP99:16:07

Table 15.4.2 Results from the catch forecasts for Division IXa and VIIIc.

The SAS System 16:06 Thursday, September 23, 1999

Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table

Year: 1999								
VIIIc			IXa			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.0512	19254	1.0000	0.3423	112395	131648	707287	525769
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2000									Year: 2001	
VIIIc			IXa			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	703017	579979	782928	656088
0.0500	0.0026	1261	0.0500	0.0171	7474	8735	.	577955	774613	646050
0.1000	0.0051	2502	0.1000	0.0342	14837	17339	.	575940	766429	636217
0.1500	0.0077	3722	0.1500	0.0513	22092	25813	.	573933	758373	626583
0.2000	0.0102	4922	0.2000	0.0685	29240	34161	.	571935	750442	617143
0.2500	0.0128	6102	0.2500	0.0856	36283	42385	.	569946	742634	607895
0.3000	0.0154	7263	0.3000	0.1027	43223	50486	.	567965	734946	598832
0.3500	0.0179	8405	0.3500	0.1198	50062	58467	.	565992	727377	589950
0.4000	0.0205	9529	0.4000	0.1369	56802	66331	.	564028	719924	581247
0.4500	0.0230	10634	0.4500	0.1540	63444	74079	.	562072	712586	572716
0.5000	0.0256	11722	0.5000	0.1711	69991	81713	.	560125	705359	564355
0.5500	0.0282	12792	0.5500	0.1883	76444	89236	.	558186	698243	556160
0.6000	0.0307	13845	0.6000	0.2054	82804	96649	.	556255	691234	548127
0.6500	0.0333	14881	0.6500	0.2225	89073	103954	.	554332	684331	540251
0.7000	0.0358	15901	0.7000	0.2396	95253	111154	.	552418	677532	532530
0.7500	0.0384	16904	0.7500	0.2567	101346	118250	.	550511	670836	524960
0.8000	0.0410	17892	0.8000	0.2738	107353	125244	.	548613	664240	517537
0.8500	0.0435	18863	0.8500	0.2909	113275	132138	.	546723	657742	510259
0.9000	0.0461	19820	0.9000	0.3080	119114	138934	.	544840	651340	503121
0.9500	0.0486	20761	0.9500	0.3252	124872	145633	.	542966	645034	496122
1.0000	0.0512	21688	1.0000	0.3423	130549	152237	.	541100	638821	489257
1.0500	0.0538	22600	1.0500	0.3594	136147	158747	.	539241	632699	482523
1.1000	0.0563	23498	1.1000	0.3765	141668	165166	.	537391	626668	475918
1.1500	0.0589	24382	1.1500	0.3936	147113	171495	.	535548	620724	469439
1.2000	0.0614	25252	1.2000	0.4107	152484	177736	.	533713	614867	463083
1.2500	0.0640	26109	1.2500	0.4278	157780	183889	.	531886	609096	456848
1.3000	0.0666	26953	1.3000	0.4450	163005	189957	.	530066	603407	450730
1.3500	0.0691	27783	1.3500	0.4621	168158	195942	.	528254	597801	444726
1.4000	0.0717	28601	1.4000	0.4792	173242	201843	.	526450	592276	438836
1.4500	0.0742	29407	1.4500	0.4963	178258	207664	.	524653	586830	433055
1.5000	0.0768	30200	1.5000	0.5134	183205	213405	.	522864	581462	427381
1.5500	0.0794	30981	1.5500	0.5305	188087	219068	.	521083	576170	421813
1.6000	0.0819	31750	1.6000	0.5476	192903	224653	.	519308	570953	416348
1.6500	0.0845	32508	1.6500	0.5648	197656	230164	.	517542	565810	410983
1.7000	0.0870	33254	1.7000	0.5819	202345	235599	.	515783	560739	405717
1.7500	0.0896	33989	1.7500	0.5990	206973	240962	.	514031	555740	400547
1.8000	0.0922	34713	1.8000	0.6161	211539	246253	.	512286	550810	395470
1.8500	0.0947	35427	1.8500	0.6332	216046	251473	.	510549	545949	390487
1.9000	0.0973	36130	1.9000	0.6503	220494	256624	.	508819	541156	385593
1.9500	0.0998	36822	1.9500	0.6674	224885	261707	.	507097	536429	380787
2.0000	0.1024	37504	2.0000	0.6846	229218	266722	.	505381	531768	376067
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPCL04
Date and time : 23SEP99:16:07
Computation of ref. F: VIIIc: Simple mean, age 2 - 5
IXa: Simple mean, age 2 - 5
Basis for 1999 : F factors

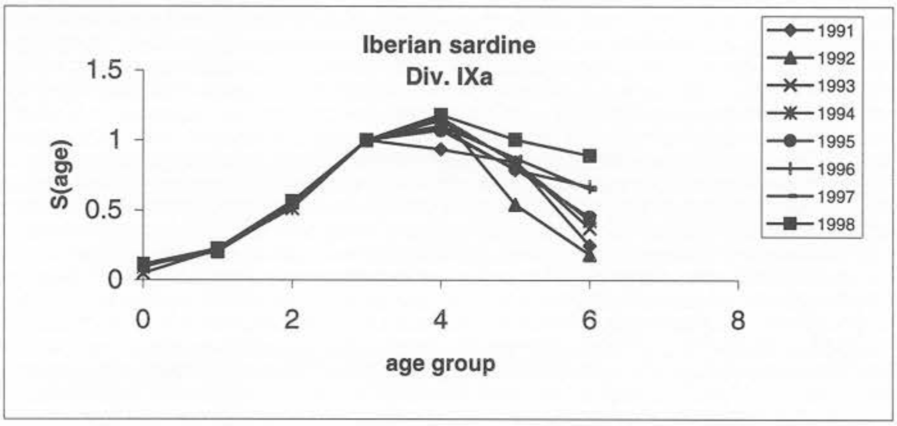


Figure 15.2.1.1 Annual selection pattern for Division IXa between 1991-1998 (reference age 3).

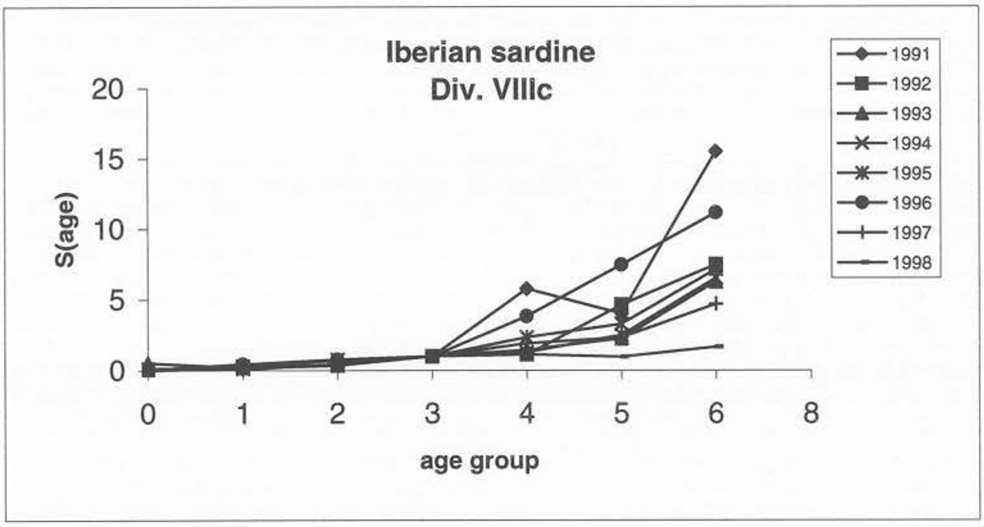


Figure 15.3.1.1 Annual selection pattern for Division VIIIc between 1991-1998 (reference age 3).

16 RECOMMENDATIONS

General

ICES is requested to provide a secure long-term electronic data storage facility to allow the Working Group to build a long-term database.

The Working Group recommends again that all national catch data is provided on the agreed Excel input spreadsheets, that these include to the maximum possible extent information on misreporting and unallocated catches, and that the data are carefully checked before they are sent to the species co-ordinator. A list of future developments of the input forms and programs is given in Section 1.6.

The Working Group recommends an increase in national effort to gain historic data. It should be possible to provide within the next year an overview of the extent of stored data. This overview should then provide the basis to raise funds (possibly in the framework of a EU-study) for the collection of historic data and for verification and transfer into digital format.

The Working Group recommends that further studies regarding modelling of uncertainty assessment and predictions, including the problem of bias in predictions, be undertaken.

Mackerel and Horse Mackerel

The Working Group recommends that observers should be placed on board vessels in those areas in which discarding of mackerel may be a problem. This observer programme, which commenced in 1998, should be expanded to cover all directed fisheries for mackerel and horse mackerel and non directed fisheries in which mackerel is take as a by catch. Information on discard levels should be presented to the Working Group as soon as possible.

The Working Group recommend that research should be carried out to determine the migration and distribution pattern of the North Sea mackerel and to what extent it is subject to the winter fishery in area IVa. This research should include tagging, genetic and otolith micro-chemistry studies and parasitology studies, as well as examination of the distribution patterns and migrations. The main aim of this work should be to determine to what extent the N. Sea component fish are caught in the fishery, and whether western fish at all life history stages can join the N. Sea component.

The Working Group recommends that ICES and NEAFC agree on access to the NEAFC database on mackerel.

The Working Group recommends further studies on the structure of the population of Northeast atlantic mackerel components specially those concerning migration pattern (tagging) and spawning components (genetics).

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 when a TAC is set for a stock, it should apply to those areas where the stock is fished, i.e., Divisions IVb,c, VIId, and eastern part of Division IIIa.

The Working Group recommends that updated maturity ogives for Southern Horse mackerel from Division IXa be presented.

The Working Group recommends that an evaluation should take place on the effects of catches of juvenile hors mackerel in divisions VIId and VIIe on the exploitation pattern and that appropriate management measures should be introduced if found necessary.

The WG recommends that simulation studies should be undertaken to evaluate the management implications of decreasing the frequency of North-East Atlantic mackerel stock assessments from the current annual regime to a biannual or triennial regime.

The Working Group recommends that the WGMHMEGG notes the comments of this WG in relation to the problem of collection of adult parameters, particularly in relation to the disproportionate division of effort, and plan appropriately for the proposed 2001 surveys.

The WG notes the substantial differences in the mackerel maturity ogive, based on either histological or macroscopic examination of the ovaries, in the southern area. The WG recommends that a mackerel maturity ogive based on histological examination of the ovaries is established for the western area.

The Working Group recommends that the issue of determinate vs indeterminate spawning for horse mackerel is clarified since it has strong implications on whether the annual egg production is appropriate for estimating spawning biomass.

Since the last egg survey to estimate the SSB of North Sea horse mackerel was carried out in 1991, the Working Group recommends that a new egg survey should be carried out in near future.

The Working Group recommends that the development of assessment methodology that can make use of tagging information is continue.

The Working Group recommends that research should be carried out on horse mackerel stock identify and migrations.

Sardine

The Working Group recommends be carry out surveys using the application of the Daily Egg Production Method (DEPM) in Divisions VIIIc and IXa according to the sardine peak of spawning season in each of these areas. The egg survey (DEPM) should be carried out earlier in the Division IXa than in the VIIIc.

The Working Group recommends that Portugal continues to perform the November acoustic survey which coincides with the spawning aggregation of sardine in the Portuguese area of Division IXa.

The Working Group also recommends to the continuation of joint acoustic surveys covering the in Divisions VIIIc and IXa each year in March-April. In order to understand the population distribution of sardine these surveys also must investigate the adjacent areas, mainly the French coast.

The Working Group recommends that all the member countries should make available the information of sardine in their waters concerning surveys, catch compositions and eggs and larvae distribution.

The Working Group recommends the implementation of studies on daily increments on age rings of sardine otoliths due to the occurrence of changes in the structure of younger sardine otoliths. This raised problems in allocation in the appropriate age groups.

The Working Group recommends the revision the maturity at age and weight at age.

The Working Group recommends Sardine DEPM 1999 estimates be presented at the next Egg Survey Working Group.

The Working Group recommends that morphometric and genetic studies for sardine be continued.

The Working Group recommends that an Workshop on Sardine Biological Sampling procedures for maturity at-age and weight-at age be held.

The Working Group recommends that an exchange of sardine otolith be carried out routinely each year and that an Workshop be held in 2000.

Anchovy

The Working Group recommends to collect all anchovy information available from the Portuguese acoustic surveys carried out in Division IXa.

The Working Group recommends the continuation of the direct surveys aimed at the assessment of the stock of anchovy in Division VIII, because this stock requires close monitoring of the population on annual basis.

The Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. This observer programme should be continued.

17 ABSTRACTS OF WORKING DOCUMENTS

Azevedo M.

Exploratory data analysis for Iberian Sardine (Sardina pilchardus). WD 1999.

Document available from: Manuela Azevedo, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: mazevedo@ipimar.pt

The Iberian sardine catch at age data for the period 1978-1990 is split by sub-area. These matrices were extended to 1998. The yearclass contribution to the catches and the relative exploitation pattern is analysed along the historical data series by sub-area. A shift in the exploitation pattern since 1990 towards older sardines (age 3 and older) is observed, but that happened only in Sub-areas IXa Central South, IXa South-Algarve and IXa South-Cadiz. The survey data supports an abundance increase of the adult sardines in these sub-areas during the 90s. Exploratory runs with ICA are performed for a unit stock comprising the ICES Division IXa and age –range 0-6+ updated to 1998. These are intended to be illustrative of the results of a sock unit defined as for Division IXa. The acoustic Spanish March survey series was split in VIIIc an IXa areas. The Portuguese November and March acoustic surveys were updated. It is estimated that the 1991 and 1992 yearclasses are stronger in comparison with the estimates of last year's assessment (WG98) to VIIIc+IXa. This is in agreement both with the catch at age and the surveys information in Division IXa. Year classes 1983 and 1987 are slightly downweighted since these year classes were better evidenced in Division VIIIc, which is not included in this assessment. Recruitment in 1998 (14.178 million) is estimated to be as strong as in 1992 (15. 852). The estimated spawning biomass shows similar values in comparison to VIIIc+IXa (WG98) from 1978-1991. This sharp increase from 1991-1995 (333 to 765 thousand tonnes), is mostly driven by the strong contribution of the 1991-1992 year classes. The fishing mortality is estimated to be relatively high in 1979 (0.46), decreasing to 0.14 in 1995. Since then an increasing trend is observed as in previous WG assessments but the estimated fishing mortality in 1997 is 0.25 whereas in WG98 assessment for VIIIc+IXa this was estimated around 0.7.

Bernal M.

Preliminary results on a two stage modelling of sardine (*Sardina pilchardus*, Walb.) egg presence and abundance off the Spanish coast and its implication for stock assessment. WD 1999.

Document available from: Miguel Bernal, Instituto Español de Oceanografía, Apdo 240, 39080 Santander, Spain. Email: miguel.bernal@st.ieo.es

Information from three sardine DEPM surveys off the Spanish coast was modelled using a two stage process of first modelling egg presence and then abundance given presence. Results from the presence/absence models were used to estimate areas of egg presence over three different regions off the Spanish coast, and results from the abundance models were used to estimate egg production for the same regions. Also the predictions from the models were used to draw distribution maps of the presence and abundance of sardine eggs along the coast and over the different years. Preliminary results indicate that the method yield comparative results to those obtained with traditional methods, while obtaining more reliable estimates of the variance of each of the parameter estimates. Results of the application of the method to the sardine surveys indicate an abrupt drop of both egg production and area of egg presence between the first surveys in 1988 and 1990 and the last survey in 1997. Comparing by areas, from the 1988 and 1990 surveys to the 1997 survey, the estimated production of eggs drops to zero values in the Atlantic coast of Spain, while in the Cantabric coast the areas of higher production seems to move from the West to the East regions.

Carrera P.

Acoustic survey JUVESU 0899: preliminary results. WD 1999.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

The main goal of the EU Project JUVESU is to check the feasibility of the aircraft borne devices for the assessment and the study of the relationship between of the juvenile phase of the pelagic fish species and the environmental conditions. For this purpose, a series of survey were programmed in preferential areas of juveniles around the Atlantic waters of the Iberian Peninsula and in the Bay of Biscay. Traditional ship borne devices such as echo-sounder, sonar and hydrography records (both continuos and cast) will be compared with those obtained by aircraft borne devices (mainly LIDAR and DAEDALUS sensors). In this paper a short description of the main results of the 1999 survey is given.

Carrera P.

Short note on the maturity ogive of sardine fitted logistic models during PELACUS 0399 acoustic survey. WD 1999.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

The aim of this paper is to describe the sexual maturity of sardine by length class during the spawning period. First analysis were carried out in late 80'ties (Figueiredo and Santos, 1988; Pérez et al, 1985).

Carrera P., Villamor B. and Abaunza P.

Report of the acoustic survey PELACUS 0399: results on sardine, mackerel, horse mackerel and anchovy. WD 1999.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

Following the recommendations of the Planning Group for Pelagic Acoustic Surveys in ICES Sub-Areas VIII and IX (ICES CM 1999/G:8). As well as the Spanish Atlantic waters (from the Miño river to Bidasoa), three work areas were identified in the southern part of the French continental shelf. These areas were chosen according to the French experience in this area. Finally as in previous years, the survey was conducted on board R/V Thalassa along March. In addition, this survey was coordinated with that of ichthyoplankton performed by R/V Cornide de Saavedra. The main objective for this survey was to assess the SSB of sardine.

Carrera P., Porteiro C., Jacobson L., Abad R. and Muiño R.

Stock dynamic of Iberian Sardine (Sardina Pilchardus, W.) and its implication on the stock assessment. WD 1999.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

Stock area and distribution are correlated with abundance for sardines and anchovies. Geographic distributions of all major sardine stocks in the all of current systems expand when abundance is high and contract when abundance is low. In addition, the center of distribution for many sardine stocks changes during high and low abundance periods. During high abundance periods many stocks undertake feeding and spawning migrations. High abundance, wide geographic distributions, feeding/spawning migrations and high fishery productivity are all associated with favourable regimes. Low abundance, reduced geographic distributions and low fishery productivity are associated with unfavourable regimes. MacCall's "basin" model was developed for northern anchovy but is useful for explaining relationships between stock area and abundance in sardines. MacCall's model describes the habitat of pelagic fish as a basin with area measuring geographic distribution and depth measuring fish density or carrying capacity at each point. Area and distribution of sardine stocks in the Canary current system expands when abundance increases and contracts when abundance decreases. This pattern likely holds for the Iberoatlantic sardine stock. Environmental conditions probably effected sardine productivity in this stock during recent years. Sea surface temperatures increased off the Iberian Peninsula during recent years. Increased temperatures imply intensification of winter winds that may transport sardine larvae away from favourable feeding grounds and increase their mortality. Recent declines in recruitment of sardine may be due to variation in the northerly winter current or increase in upwelling events. In order to know whether the long-term and short-term fluctuations of this fish stock agrees with the overall picture shown in similar fish species, both fishery and independent information from the fishery activity has been analysed. In addition, this paper analyses the implication of these fluctuations in achieving an assessment model for this stock.

Cunha M. E., Lopes P. and Santos A.

Sardine (Sardina pilchardus) daily egg production in ICES Division IXa (Lat. 41° 50'N, 36° 00'N) January 1999 – Methods and estimation. WD 1999.

Document available from: Emilia Cunha,, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: ecunha@ipimar.pt

Following the recommendations of the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy, the spawning biomass of Iberian Atlantic sardine was determined by means of the Daily Egg Production Method (DEPM) during the 1999 spawning season. This paper presents the methods and the final estimation of the daily egg production in ICES Division IXa The timing of the DEPM survey in 1999 was changed to January two months earlier than in 1998. This is because the fish spawning time in Portugal is proved to be from November to March (Soares, 1999 WD) and March is too late to succed on the DEPM method in the Portuguese area.

Darby C. D.

A note on the calculation of the eggs per gram parameter used for the estimation of spawning stock biomass from egg production surveys. WD 1999.

Document available from: Chris D. Darby, CEFAS Fisheries Laboratory, Pakefield Road, LOWESTOFT, Suffolk, United Kingdom. Email: c.d.darby@cefas.co.uk

The ICES Mackerel Working Groups 'tune' the North East Atlantic Mackerel (Scomber scombrus) and Western Horse mackerel VPA's by minimising the residuals between the VPA generated spawning stock biomasses, and SSB estimates derived from triennial international egg surveys of the spawning grounds. This paper examines the use of one of the biological parameters critical to the conversion of the survey egg abundance to fish spawning stock biomass, the number of eggs produced per gram of female body weight or fecundity. Questions are raised as to the appropriateness of the model currently used to estimate the parameter, the sampling strategy used to estimate the value and the sensitivity of the estimated SSB values to model and measurement errors. An alternative formulation for the fecundity model is suggested. However, this is not appropriate for the current tuning procedure, which would require modification.

Eltink A.

Atresia in ovaries of Western Horse mackerel in 1998. WD 1999.

Document available from: Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands. Email: guus@rivo.dlo.nl

The histological slides were prepared, but the scoring, stading and measuring of the histological slides of horse mackerel ovaries was not carried out in time before the meeting of the Mackerel / Horse Mackerel Egg Survey WG, which met in April 1999 in Hamburg. Therefore a working document on the atresia analysis was presented on this WG. A mean number of 4 atretic oocytes per gram female in the population was calculated for the 1998, compared with 12 atretic oocytes for the 1995 egg survey. A relative intensity of atresia indicates that the potential fecundity is hardly reduced by atresia and that the realised fecundity is very close to the potential fecundity as estimated at the start of the spawning season.

Eltink A.

Maturity at age of Western Horse mackerel. WD 1999.

Document available from: Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands. Email: guus@rivo.dlo.nl

The histological slides were prepared, but the scoring, stading and measuring of the histological slides of horse mackerel ovaries was not carried out in time before the meeting of the Mackerel / Horse Mackerel Egg Survey WG, which met in April 1999 in Hamburg. Therefore a working document with the maturity analysis was presented on this WG. The minimum value of proportion mature at age is obtained from samples from the juvenile area, while the maximum value of proportion mature at age is obtained from samples along the edge of the continental shelf. The actual proportion mature at age of the western mackerel is somewhere in between. Only a rough guess can be made about the proportion mature at age of western horse mackerel, because of the absence of a weiting factor by area (the actual distribution at age by rectangle is unknown).

Iversen S.A.

Biological evidence for a separate spawning stock (component) of mackerel in the North Sea. WD 1999.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: sveini@imr.no

Mackerel in the North Sea was considered by ICES as an independent stock and assessments for this stock was carried out until 1984. The catches in the North Sea and Norwegian Sea were allocated to the western and North Sea stocks according to recovery rates of internal tags inserted in mackerel in the western areas, in the Skagerrak and North Sea depends from period. As time passed the North Sea mackerel stock declined and the western and later also the southern stock were shown to migrate extensively into the Norwegian Sea and North Sea after the spawning season and the tagging program in the North sea was terminated. Since the basis for dividing the catches by stock disappeared all mackerel catches in the Norwegian Sea, the North Sea and Skagerrak have been allocated to the western stock. However, the biomass of the North Sea mackerel has never been included in the tuning of the western mackerel VPA and later ICA. For practical reasons catches of mackerel in southern, western and North Sea areas have since 1995 been included in the ICA assessment of the so called North East Atlantic mackerel stock. In ICES terminology the mackerel in later years have been assessed as one stock, the North East Atlantic stock, which consists of three spawning components (the southern-, western and the North Sea component). Earlier ICES called these spawning components for spawning stocks. The WD shows that the spawning in the North Sea is separate from the western spawning area. Parasitological studies, L1 analysis and new genetic studies also support that North Sea mackerel is a separate stock.

Iversen S. A. and Eltink A.

Egg production and spawning stock size of mackerel in the North Sea in 1999. WD 1999.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: sveini@imr.no and Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands. Email: guus@rivo.dlo.nl

During the period May-June 1999 Netherlands and Norway carried out egg surveys in the North Sea to estimate the spawning stock biomass of mackerel. During this period the spawning area was covered three times. The last time the North Sea was covered several times during the spawning season was in 1996. Usually the mackerel spawn in the North Sea during the period from mid May towards the end of July. During the egg surveys about 95 ship days were spent in 1990 while only 30 ship days were spent in 1996 (Denmark and Norway) and 1999. The surveys did not cover the total spawning area and period. The last survey gave the highest egg production. This was expected according to results from previous investigations. However, if the third survey was carried out previous to the peak of spawning in 1999, the egg production might be underestimated. However, this is not likely since the peak has not been observed that late in previous years.

Iversen S. A., Skogen M. and Svendsen E.

Prediction of the Norwegian fishery of horse mackerel in 2000. WD 1999.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: sveini@imr.no

Norway has since 1987 been the main fishing nation for horse mackerel in the northern part of the North Sea and Norwegian Sea. This fishery is carried out in the Norwegian economical zone in the second half of the year. This fishery is considered to exploit the western stock. It is shown that there is good correlation between the modelled winter influx of Atlantic water to the North Sea and the Norwegian horse mackerel fishery the following autumn. Predicted Norwegian catches in 1999 will be of the same level as in 1998.

Kolody D., Patterson K.

Evaluation of NE Atlantic Mackerel Stock Assessment Models on the Basis of Simulated Long-Term Management Performance. WD 1999.

Document available from: Dale Kolody, Marine Laboratory, P.O.Box 101, Victoria Road, Aberdeen AB11 9DB, Scotland, United Kingdom. Email: d.kolody@marlab.ac.uk

Monte Carlo simulations of the NE Atlantic mackerel fishery were used to compare stock assessment models and regimes on the basis of long-term management performance. We examined the following ICA assessment options: an absolute or relative abundance survey index, biomass survey weighting, fishing selectivity estimated for one aggregated or two separate time periods, the number of years of catch data to use (6-15) to estimate fishing selectivity. Additionally, the management performance of the current annual ICA assessment regime was compared with triennial ICA assessment and triennial assessment based on a simple delay-difference model. The different assessment models and regimes were challenged with operating models contrived to emphasize possible performance differences over 20 years of simulated data collection, assessment and management by TAC. Differences in assessment model performance were generally found to be smaller than expected, given the sensitivity observed during annual assessments. This suggests that the assessment variability that arises during routine assessments is more a consequence of noisy data than model mis-specification. The WD recommend the following ICA assessment options: relative abundance survey model, biomass survey weighting of 5 relative to catch, fitting two fishery selectivity patterns and maintaining 12 years for the separable constraint. Management performance of annual ICA, triennial ICA and triennial delay-difference model assessment were generally similar.

Morais A., Borges M.F. and Marques, V.

Changes on Sardine Distribution Pattern and Trends of Recruitment, Spawning Stock Abundance in the Portuguese Area as Directly Estimated by Acoustic Surveys from 1984-1999. WD 1999.

Document available from: Maria de Fatima Borges Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: mfborges@ipimar.pt

This paper provides the Sardine abundance and biomass historical time series as directly estimated by nineteen Portuguese acoustic surveys. Abundance at age estimates from the three survey time series carried out, during November, March and August were recovered and updated to 1998-1999. In the Northern area, during the recruitment time, which in Portugal occurs in the autumn and is measured by the November survey series, the mean abundance of juveniles increased substantially, by 190%, from the period of the eighties to the nineties due to the 1997 and 1998 strong yearclasses. Adult abundance fluctuated over the period around 4 billion fish with no overall trend from the 80’s to the 90’s. Analysis of the area of fish distribution and fish density time series disaggregated by smaller areas indicate that important changes in the Sardine seasonal and spatial distribution pattern have occurred during the nineties as compared with the earlier pattern observed during the eighties in the Portuguese area.

Marques V., Morais A. and Soares E.

Sintesis of the Portuguese Acoustic Surveys in the ICES Sub-Area IXa, carried out in November 1998 and March 1999. WD 1999.

Document available from: Vítor Marques, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: vmarques@ipimar.pt

This paper presents the main results of the Portuguese acoustic surveys carried out during November 1998 and March 1999. These surveys covered the Portuguese shelf and the Gulf of Cadiz waters, and show increase at younger ages and decrease at older ages with respect to 1997.

Milligan S.P.

Estimation of the beginning of spawning of the Western component of mackerel (Scomber scombrus) in 1998. WD 1999.

Document available from: S.P.Milligan, CEFAS Lowestoft Laboratory, Lowestoft NR 33OHT, United Kingdom. Email: s.p.milligan@cefas.co.uk

At the mackerel and horse mackerel egg production working group meeting there was some discussion regarding the start of mackerel spawning in the western area in 1998. There was evidence to suggest an early start to spawning in 1998. Similar evidence from the 1995 egg survey led to a start date of 10 February being chosen. It was therefore decided to use the same start date for the 1998 survey. Prior to 1995, the beginning of mackerel spawning in this area had been determined as 19 February. The first egg survey in the western area in 1998 was carried out in period 3 (15 March - 6 April). The results from this survey show that mackerel spawning was already well underway in the western area, with daily egg production 90% of that occurring at the peak of spawning (period 4, 16 April - 15 May). With such high daily egg production on the first survey, it was important that the start of spawning was accurately estimated. Small changes in the date of first spawning could produce significant differences in the estimates of annual egg production and consequently Spawning Stock Biomass. Unfortunately there was no sampling of plankton or of adult fish in the western area before the beginning of March. There was, however, some additional plankton sampling carried out in the Celtic Sea during March which could provide further evidence of early spawning of mackerel in 1998.

Nichols J.H. and Warnes S.

SW Mackerel Box Survey, November 1998. WD 1999.

Document available from: John H. Nichols, CEFAS Lowestoft Laboratory, Lowestoft NR 33OHT, United Kingdom. Email: j.h.nichols@cefas.co.uk

The current restrictions on fishing for mackerel inside the regulated area known as the 'mackerel box' are described in Council Regulation (EC) No 894/97 Article 9. They are imposed in order to reduce the fishing effort on juvenile mackerel, which are considered to be abundant in the area. The only targeted mackerel fishing permitted is by quota-regulated vessels using gill nets or handlines. Mackerel may also be taken legally inside the box as a by-catch in fisheries targeted at other species. The last surveys to determine the proportion and abundance of juvenile mackerel inside the restricted area were carried out during December 1995 and January 1996 on the commercial mid-water trawler. Previously, surveys were carried out in January/February 1990 and in January 1991. In addition, mackerel landed into ports in the southwest of England have also been regularly sampled. In November 1998 CEFAS commissioned a pair team of mid-water trawlers to fish commercially for mackerel inside the mackerel box. The survey showed that the trawl catch of mackerel inside the box continues to have a high proportion of juvenile mackerel in it. Whilst the proportion of the number of juveniles in the catch was lower in 1998 (69%) than in the comparable survey period in 1995 (76%), the proportion by weight at age was very similar (61% in 1998: 60% in 1995). The main reason for the differences by number was the absence, in the 1998 survey catches, of a cohort of '0' group fish between 19cm and 22cm in length, which were present in the catches in 1995. The reason for their absence in the 1998 catches is not known at present but may reflect a poorer year class in 1998. More information on the size of this year class will become available when the results of international surveys are presented to the assessment working group in September 1999.

Panterne P., Sánchez F., Fernández A. and Abaunza P.

Horse mackerel and mackerel conversion coefficients between RV Thalassa using GOV 36/47 gear and RV Cornide de Saavedra using Baka 44/60 gear from overlapping experiments. WD 1999.

Document available from: P. Panterne, IFREMER, La Rochelle, France. Email:

From the end of the 70's and the beginning of the 80's, IFREMER, IPIMAR and IEO research Institutes, have been carrying out bottom trawl surveys in Autumn, from the South of Ireland to the Strait of Gibraltar. Until now these surveys were conducted independently. To be able to describe the distribution of the whole populations considered in these surveys, and also to study if some changes in some components of the stocks are following the same patterns to SESITS project has been carried out. This project was based in two main tasks: co-ordination and standardisation of the methodology, and analysis of the data of the four bottom trawl surveys. The two overlapping experiences between surveys planned in the project for 1997 and 1998 were conducted (Northern and Southern experiments). These experiments took place during the national Autumn surveys. The main objectives of the overlapping experiments were: to compare catches in number, weight and the population structures by length classes between different research vessels/gears, and to estimate coefficient conversions by species. The target species were: hake, blue whiting, megrims, anglerfishes, horse mackerel and Norway lobster. Also, mackerel, Spanish mackerel, red shrimp and rose shrimp were added to these in the Southern overlapping. An additional study was carried out about mackerel for Northern overlapping, since it was not a target species for the SESITS project. This document sums up the results of the analysis of the data of mackerel and horse mackerel in the Northern experiment and presents the conversion coefficients for different vessels/gears.

Perez J.R., Abaunza P. and Villamor B.

Maturity ogive of the Southern Horse Mackerel (Trachurus trachurus L.) using histological and macroscopic methods. WD 1999.

Document available from: José Ramón Perez, Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Aptdo 1552, 36290 Vigo, Spain. Email:

Observations on maturation stages of horse mackerel females in ICES Sub-divisions VIII and IXa North were analyzed to examine relationships between fish size or age and maturity. Histological sections of ovaries and macroscopical criteria were used to describe gonadal development. Age at first maturity was derived by fitting the logistic model to the observed maturity proportions. Analyses were restricted to the samples collected during the Spanish acoustic survey in March 1998. The maturity ogives obtained by each method (microscopic and macroscopic) and that used in the Working Group, were compared and the results were discussed in terms of implications for the current estimation of spawning stock biomass.

Perez J.R., Villamor B. and Abaunza P.

Maturity ogive of the Northeast Atlantic mackerel (Scomber scombrus L.) from the southern area using histological and macroscopic methods. WD 1999.

Document available from: José Ramón Perez, Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Aptdo 1552, 36290 Vigo, Spain. Email:

Observations on maturation stages of mackerel females in the ICES Sub-divisions VIII and IXa North were analysed to examine relationships between fish size or age and maturity. Histological sections of ovaries and macroscopical criteria were used to describe the gonadal development. Ages at first maturity were derived by fitting the logistic model to the observed proportions. Analysis were restricted to the samples collected during the Spanish acoustic survey in March of 1998. The maturity ogives obtained by each method (microscopic and macroscopic) and that used in the Working Group, were compared and the results were discussed in terms of implications for the current estimation of spawning stock biomass.

Pestana G., Jardim E. and Godinho S.

The Catch per Unit Effort of Sardine (Portuguese Coast) as an index of abundance. WD 1999.

Document available from: Graça Pestana, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: gpestana@ipimar.pt

During the 80’s and 90’s there have been relatively large variations in stock abundance of Sardine. In order to improve the stock assessment, it was analysed the purse seine catches of sardine from the Portuguese commercial vessels. The available data come from the national sampling programme carried out in the auction market and the estimated catches per unit effort were investigated by quarters, from 1986 to 1998, and by subdivisions of the ICES Division IXa in the Portuguese coast and total coast. For the same period and areas this data was compared with estimates of absolute abundance obtained in acoustic surveys and with the commercial landings in order to investigate its validity as an index of stock abundance. A relatively poor correlation was obtained using these estimated commercial landings per unit effort.

Reid D. and Eltink A.

Recent changes in the timing and pattern of the migration of western mackerel from the North Sea from surveys and commercial data and its impact on management measures. WD 1999.

Document available from: David G. Reid, Marine Laboratory, P.O.Box 101, Victoria Road, Aberdeen AB11 9DB, Scotland, United Kingdom. Email: reiddg@marlab.ac.uk

The question was raised at the 1998 meeting of the WGMHMSA of the validity of continuing to recommend a prohibition on mackerel fishing in ICES area IVa during the first and second quarters.

In brief, the advice from the WG was formulated on the basis that:

I. Fishing should be prevented on the North Sea stock as long as it remains at a low level

II. The degree of mixing at times other than the spawning season cannot be determined

III. Western mackerel dominate in the area from July to October.

This WD presents a synopsis of the evidence available on the timing of the pre-spawning migration of the western mackerel, and establishes the best current picture of when that migrations starts and when the fish leave the N. Sea.

The major evidence is based on a series of acoustic surveys carried out between 1994 and 1996 which, together, showed that migration started in the NE N. Sea in January at that time, and left the N. Sea by the end of January. This was supported by confidential data on fishing locations from commercial vessels from a number of countries. To establish the current position, commercial data was again obtained, confidentially, from commercial vessels from a number of countries. These data showed that the migration was occurring later in recent years (97-99) with the fish leaving the N. Sea during the last half of February.

It was concluded that the current regulation closing IVa to mackerel fishing from the 1st January was out of date and that the closure should be moved to the 1st March.

Santos A.M.P.

Climate changes off Portugal during the spawning season of sardine (Winter) in the last decades. WD 1999.

Document available from: A. Miguel P. Santos, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: amsantos@ipimar.pt

The location of the Portuguese west coast at the eastern boundary of the subtropical North Atlantic determines many of its atmospheric and oceanographic characteristics, namely the occurrence of coastal upwelling during summer in response to the intensification and steadiness of favorable equatorward winds. The reproductive strategies of some pelagic fish adapted to coastal upwelling ecosystems, such as sardine on the Portuguese continental shelf, appear to be settled in order to minimise Ekman offshore transport effects to assure inshore transport and larval retention. In fact, the maximum intensity of sardine spawning off Portugal is referred to be predominantly in the winter. In the last years there are some evidences that changes in upwelling pattern off Portugal have occurred, more specifically. These conditions can lead to the increase of favorable conditions for offshore transport during the spawning season of sardine off Portugal and probably to the increase in the mortality of larvae. There are some evidences that these changes in the upwelling patterns off Portugal fit within a broader pattern of climate changes.

Silva A.

Morphometric study of Sardine from the Iberian waters. WD 1999.

Document available from: Alexandra Silva, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: asilva@ipimar.pt

This working document reports preliminary results of the analysis of the morphometry of sardine from the Atlantic Iberian waters. A short overview of previous studies on the substructure of the species Sardina pilchardus is also presented. A total of 537 individuals from samples collected between the Gulf of Biscay to the Gulf of Cadiz in November 1998 and March 1999 are analysed, using two sets of morphometric variables. One set of 23 variables from a truss network protocol and one set of 6 variables describing head length, eye diameter, inter-orbital width and fins length. Variables were corrected for fish size. An ordination of the sample centroids with Multidimensional Scaling and a Principal Components Analysis of the var-cov matrix were carried out to investigate sample clustering and variability patterns in a reduced space. Results from these analyses provided some evidence of grouping of Southwestern and Southern Iberia samples and of a gradual North-South change in sardine morphometry. However, separation of groups with geographic coherence was not clearly observed suggesting that different combinations of contiguous samples may be comparably pooled and discriminated, based on the current set of variables and samples. Results of discriminant analysis based on two different grouping of samples are presented mainly to illustrate that small changes in the composition of the a-priori groups will have negligible effects on the discrimination.

Skagen D. W.

A fish stock assessment method combining information from several sources (AMCI). WD 1999.

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Fish stock assessment is essentially to translate indirect information about the state of the stock into estimates of stock abundance and mortalities. The information can be catch numbers at age, survey indices, and other measures that have some relation to the state of the stock. The information from the different sources is sometimes incongruent, and the right way to combine this is not fully understood. Here, a program is described which offers a range of options for combining different kinds of information from different sources, into an assessment of a fish stock. It does not solve the problem of how this should be done, but offers the user the opportunity to explore different alternatives. The program includes a self contained parametric model for the population, functions for describing the relations between the population and the observations, and a selection of measures of the deviations of modelled data from the observations. The present program is in many ways similar to ICA, but it differs on the following aspects in particular. An objective function for tag recapture data and allowing for gradual change in the selections pattern. The model is structured by age, and the basic time scale is quarters. Data can be compared after aggregation over years and there is a range of objective functions for each type of data. Survey indices are generally referred to the mean population numbers in the quarter when the survey takes place, and spawning biomass is computed from the mean population numbers in the quarter stated as the spawning quarter.

Soares E.

Reproductive Biology of Sardine (S. pilchardus, Walb.) off Portuguese Coast: Seasonal Evolution of Sexual Maturity, Condition Factor and Gonadosomatic Index in 1991-1998. WD 1999.

Document available from: Eduardo Soares, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: esoares@ipimar.pt

The study of reproductive biology and behaviour of sardine is an important tool to understand the possible causes of the fluctuations in the abundance of the Atlantic Iberian stock (ICES Div.VIIIc and IXa). This document presents an analysis on the monthly evolution of sardine sexual maturity, gonadosomatic index and condition factor in three main regions off Portuguese coast during 1991-98, in order to perceive sardine reproductive biology in this area. Changes in the timing of spawning in recent years were observed.

Stratoudakis Y.

Temporal changes in estimated spawning area and distribution of sardine (Sardina pilchardus) eggs off Portugal. WD 1999.

Document available from: Yorgos Stratoudakis, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: yorgos@ipimar.pt

In this document information from 14 egg surveys was used to compare the distribution of sardine eggs off Portugal in the last 15 years (1985-1999). Despite disparities between surveys, exploratory analysis suggests a gradual decline in the proportion of stations with sardine eggs over time, and a sudden change in the relative regional contribution in the early 90s. In the main part of the analysis, binomial models are fitted to data from 8 surveys and spawning areas are estimated with confidence limits. These estimates suggest that spawning area off Portugal was significantly larger in the late 1980s than in the late 1990s, with intermediate values in the early 90s. However, the pattern of change is not uniform along the Portuguese coast, leading to an abrupt change in the relative regional contribution between 1990 and 1991. The overall decline is exclusively due to a drastic reduction of spawning area north to the Canyon of Nazaré. There is no evidence of temporal changes in the Algarve, whereas in the southwestern occidental coast there is a net increase within the study period. Spawning area in the southwest has remained the largest off Portugal throughout the 90s, when the northern contribution reduced from 60% to 35%. Sampling in the Cadiz during 1997 and 1999 (years with the lowest Portuguese estimates) indicated large areas of sardine spawning (around 60% of the total in Portugal). Data from acoustic surveys suggest similar patterns in the areas occupied with sardine, while the same trends in proportional regional contribution are also retrieved from commercial catch data. In contrast to the above, sardine abundance estimates from the acoustic surveys do not show any indication of temporal changes.

Uriarte A. (Coordinator), Alvarez P., Iversen S., Myklevoll S., Molloy J., Martíns M.M. and Villamor B.

Spatial Pattern Of Migration And Recruitment of North East Atlantic Mackerel. September 1999. WD 1999.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

The project 96-035 entitled: “Spatial Pattern of migration and recruitment of North east Atlantic mackerel” had the objectives of clarifying the migration pattern of adult mackerel from the southern and western areas and determining the recruitment spatial pattern of juveniles from two nursery areas, different from the current Mackerel box. With that purpose, an International tagging program on both adult and young mackerel was implemented in 1997 by Portugal, Spain, Ireland and Norway. The two former countries performed the tagging in southern areas, whereas the two later tagged in north-western areas. Some additional surveys not initially planned were made in 1998. A total of 161,115 mackerel were tagged along the European Atlantic coasts, 119,913 of them in 1997 and 41,202 extras in 1998. Fishermen and Research Institutes of almost all Atlantic European coastal countries from Norway to Portugal were contacted and informed about the tagging program through a mailing performed by the participants. Up to January of 1999 a total of 704 recaptures have been so far reported. 606 recaptures originate from the 1997 tagging surveys and 98 from the 1998 surveys. Recaptures of adults show that almost all adult mackerel follow the same northward migration in late spring and summer time from the spawning grounds along the west of the British Islands to the north of Faroes, Norwegian sea and northern part of the North Sea. The northward migration often extends in summer time into the north-eastern areas of the Faeroes EEZ and further north to the International waters. From September to December mackerel from all areas are mainly found in Norwegian Sea and northern part of North Sea. At the end of the year and during wintertime those mackerel migrate towards the spawning grounds through the west of the British islands in a southward progression. These observations on migration behaviour of adults are consistent with the results obtained from previous tagging experiments and the analysis of location of fishery catches. A strong presence of southern adult mackerel during spring in the western spawning grounds was observed in 1998. The mixing of mackerel from the southern and western areas throughout most of the year and their cohabitation in the western spawning grounds cast doubts on the reliability of the assumption of separate spawning components in these areas. Recaptures of tagged juveniles suggest that in general, juveniles remain closer to the areas where they were tagged. It is evident that it may take several years for some of the young tagged mackerel to recruit to the adult population and therefore to join the general migration. This will take place once they become 3 years old and will occur after the end of the current project. Therefore an important part of the results from this project may not become apparent until the future. For that reason it is important that the recapture programmes and analysis should be continued and finished at a future date.

Uriarte A., Motos L., Santos M., Alvarez P. And Prouzet P.

Assessment update for the Bay of Biscay Anchovy (Engraulis encrasicolus). Spawning biomass in 1995, 1996, 1997, 1998 and preliminary results of the 1999 survey. WD 1999.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

This document revise the results of the 1995-1999 DEPM surveys for the assessment of the Bay of Biscay Anchovy. Assessment of the Bay of Biscay Anchovy spawning biomass in 1995-1997 along with the preliminary estimates for 1998 were presented during the 1998 WG. However the procedure to estimate the spawning frequency for the Bay of Biscay Anchovy is under revision and new more accurate estimates have been produced for the current ICES WG concerning the previously reported results for 1995-1997. In addition, the carrent WD includes the definitive estimates for SSB in 1998, along with the preliminary estimates arising from the 1999 May survey. Biomass estimates for 1996 and 1999 are derived from the spawning area/biomass relationship using the extension of the positive spawning area found in these two DEPM surveys.

Witthames P.R.

On the relative timing and magnitude of individual female egg production in the western mackerel spawning component during the 1995 and 1998 triennial surveys. WD 1999.

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A comparison of mean oocyte volume in ovaries used in 1995 and 1998 for estimating potential fecundity indicated fish were less mature in 1998 at the time of collection. In these circumstances there was not a greater likelihood of including spawning fish in the fecundity estimate of 1998 compared to 1995. A simple independent method based on observations on ovary condition and spawning activity was used to assess the relative timing and magnitude of egg production per female during the 1995 and 1998 triennial surveys. Comparing fish, collected by Walther Herwig, in 1995 and 1998 ovary condition and spawning activity in the later survey indicating daily egg production per fish was much lower in 1998. Over the whole spawning season evidence was found to suggest egg production assessed in fish was more bimodal but much lower overall in 1998 compared to 1995.

Zimmermann C.

Western Horse Mackerel: Short and Medium-Term Predictions by ADAPT. WD 1999.

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The aim of this working document is to document the short and medium term projections for this stock using the ADAPT-method, as these data are not included in the Working Group report. The same was done in last year (WD Sparre & Zimmermann, WG MHSA 1998). The agreed predictions for the Western Horse Mackerel were calculated using the Bayesian approach and are given in Sec. 6.5 of the WG report.

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