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Report of the

Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy

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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 4–13 September 2001 to address the following terms of reference, as decided at the 88th Statutory Meeting:

a) assess the status of and provide catch options for 2002 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 2002 for the sardine stock in Divisions VIIIc and IXa; Catch options for 2002 should be provided separately by division;

c) assess the status of and provide catch options for 2002 for the anchovy stocks in Sub-area VIII and Division IXa;

d) review progress in determining precautionary reference points;

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

f) identify major deficiencies in the assessments;

g) Review the layout of a Quality Handbook and prepare a workplan for writing such a document. A draft of the Quality Handbook shall be reviewed by the Working Group in 2002.

1.2 Participants

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1.3 Quality and Adequacy of Fishery and Sampling data

1.3.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. Sampling levels have decreased for mackerel by 10% (to 76%) due primarily to the absence of Russian sampling data for 2000. The proportion of the horsemackerel catch which was sampled has increased this year but is still inadequate at 56%. Sardine and anchovy stocks continue to be well sampled. A short summary of the data, similar to that presented in recent Working Group is shown for each stock. Sampling programmes by EU countries may be funded under the new EU sampling directive (Council Regulation EEC N° 1543/2000) in 2001 and it is hoped that this will lead to an improvement in sampling levels.

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

Mackerel

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
1999	608,928	86	1,109	116,978	17,432
2000	667,158	76	1,182	122,769	15,923

In 2000 76% of the total catch was covered by the sampling programmes. This represents a 10% decrease over 1999 and the lowest proportion of catch sampled to date. Although the number of samples and measured fish has increased since 1999, the sampling effort was less evenly distributed. Spain and Portugal continue to carry out extremely intensive programme on their catches however, there was no sampling from Russian catches. Denmark and Germany increased the proportion of the catch sampled over 1999, however there were decreases in the proportion of the catch sampled in England & Ireland. Norway, Portugal, Scotland, Spain and the Netherlands continue to sample the entire catch thoroughly. The countries which did not carry out any sampling programmes in 2000 included Russia, Lithuania, France, Faroes, Estonia and Sweden (these countries accounted for almost 96,000t of unsampled catches).

There were more areas than in previous years which do not appear to be adequately sampled .

- Sub area III in which 3,837 t are taken but where no sampling is carried out :
- Div Vb in which 6,151t are taken but where no sampling is carried out
- Div VIIId where 2,273t are taken but where no sampling is carried out
- Div VIIIa where 7,784t are taken but where no sampling is carried out
- Div VIIc where 1,587t are taken but inadequately sampled
- Div VIIh where 4,452t are taken but inadequately sampled
- Div IVb where 2,413t are taken but inadequately sampled
- Div IIa where 85,555t are taken but inadequately sampled

See Figure 1.3.1.1 for a map of sampling levels relative to catch.

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

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Belgium	146	0	0	0	0
Denmark	29,177	86	11	509	662
England & Wales	19,662	34	26	744	3,469
Estonia	2,673	0	0	0	0
Faroe Islands	21,023	0	0	0	0
France	19,445	0	0	0	0
Germany	22,979	77	21	596	7,964
Ireland	71,233	79	56	603	9,823
Lithuania	2,085	0	0	0	0
Norway	174,098	99	128	2,502	11,542
Portugal	2,253	100	395	934	38,002
Russia	50,772	0	0	0	0
Scotland	164,069	92	175	4,931	21,590
Spain∗	38,320	100	282	2,904	22,409
Sweden	4,994	0	0	0	0
The Netherlands	32,407	100	88	2,200	7,308
Total	617,016	82	1,182	15,923	122,769

∗Unofficial catches

Horse Mackerel

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

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	Aged
1992	436,500	45	1,803	158,447	5,797
1993	504,190	75	1,178	158,954	7,476
1994	447,153	61	1,453	134,269	6,571
1995	580,000	48	2,041	177,803	5,885
1996	460,200	63	2,498	208,416	4,719
1997	518,900	75	2,572	247,207	6,391
1998	399,700	62	2,539	245,220	6,416
1999	363,033	51	2,158	208,387	7,954
2000	272,496	56	1,610	186,825	5,874

The overall sampling levels on horse mackerel appear to have remained at about the same intensity in recent years. The large numbers of samples and measured fish are due mainly to intensive length measurement programs in the southern areas. In 2000, 84% of the horse mackerel measured were from Division IXa. The totals sampled, measured and aged are now summed correctly for 1999.

Countries that carried out comprehensive sampling programmes in 2000 were Netherlands, Portugal and Spain. Sampling intensity from Ireland was similar to 1999, that of England and Wales decreased slightly. In 2000, Germany and Norway decreased their sampling intensity considerably. France, Denmark and Scotland continue to take considerable catches but 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 2000:

Horse mackerel sampling

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Netherlands	65,956	100	75	10,640	1,875
Germany	16,737	1	2	545	0
Ireland	55,430	57	24	4,330	871
Spain*	36,016	100	558	38,859	1,292
Denmark	20,939	0	0	0	0
France	20,457	0	0	0	0
Portugal	15,349	100	948	132,178	1,612
U.K.(Scotland)	10,705	0	0	0	0
Norway	2,087	19	2	142	142
U.K.(England)	6,024	41	1	131	82
Total	249,700	56	1610	186,825	5,874

* Unofficial catches

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

The horse mackerel sampling intensity for the western fisheries was as follows:

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Netherlands	57,259	100	38	4,621	950
Germany	16,737	1	2	545	0
Ireland	55,200	57	24	4,330	871
Spain*	2,226	100	69	3,182	42
Denmark	17,346	0	0	0	0
France	20,457	0	0	0	0
UK (Scotland)	10,284	0	0	0	0
Norway	2,087	19	2	142	142
UK (England)	4,439	55	1	131	82
Total	186,035	39	136	12,951	2,087

* Unofficial catches

The horsemackerel sampling intensity for the North Sea fishery was as follows.

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Netherlands	8,697	100	37	6,019	925
Denmark	3,593	0	0	0	0
UK (England)	1,585	0	0	0	0
Total	13,875	63	37	6,019	925

The sampling intensity for the Southern fishery was as follows:

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Spain*	33,790	100	489	35,677	1,250
Portugal	15,349	100	948	132,178	1,612
Total	49,139	100	1,437	167,855	2,862

* Unofficial catches

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
1999	101,302	93	849	91,060	8,399
2000	91,718	94	777	92,517	7,753

The proportion of the catch covered by the sampling programme increased slightly in 2000.

The summarised details of individual sampling programmes in 2000 are shown below. These catches cover area VII, VIII and IXa.

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Spain∗	19,644	100	402	42,748	3,400
Portugal	66,141	100	375	49,769	4,353
U.K. (England)	3,033	0	0	0	0
Ireland	2,592	0	0	0	0
Germany	308	0	0	0	0
Total	91,718	94	777	92,517	7,753

∗ Unofficial catches

The overall sampling levels for sardine are adequate for all areas.

Anchovy

The sampling programmes carried out on anchovy in 2000 are summarised below. The programmes are shown separately for Sub area VIII and for Div. IXa. Sampling throughout Div's. VIIIa+b and VIIIc appears to be satisfactory. A full sampling programme was again carried out by France on catches in Div. VIII.

The overall sampling levels for recent years are shown below:

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	Aged
1992	40,800	92	289	17,112	3,805
1993	39,700	100	323	21,113	6,563
1994	34,600	99	281	17,111	2,923
1995	42,104	83	?	?	?
1996	38,773	93	214	17,800	4,029
1997	27,440	76	258	18,850	5,194
1998	31,617	100	268	15,520	5,181
1999	40,156	100	397	33,778	10,227
2000	39,497	99	209	18,023	4,713

The sampling programmes for France and Spain are summarised below:

Country	Division	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
France	VIIIa	12,316	100	5	191	174
France	VIIIb	5,449	100	17	721	1,441
Spain*	VIIIa, b	3,117	100	39	2,086	547
Spain*	VIII c	16,113	100	122	8,170	1,412
Total	VIII	36,995	100	183	11,168	3,574

* Unofficial catches

The level of sampling for VIIIa catches by France should be improved in the future, by increasing the number of samples.

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

Country	Division	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Spain*	IXa	2,191	100	26	6,855	1,139
Portugal	IXa	310	0	0	0	0
Total	IXa	2,502	88	26	6,855	1,139

* Unofficial catches

No catches from Portugal were sampled for length and age in Division IXa in 2000 except for Cadiz.

1.3.2 Catch data

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

For mackerel and horse mackerel it was concluded that in the southern areas the catch statistics appear to be satisfactory. In the northern areas it was concluded that since 1996 there has been a considerable improvement in the accuracy of the total landing figures, this continues to be the case. The reason for the improvement in catch statistics are given as; tighter enforcement of the management measures in respect of the national quota and increasing awareness of the importance of accurate catch figures for possible zonal attachment of some stocks. In 2000 the misreporting of catches particularly from Division IVa into VIa and IIa appears to have decreased significantly. This may be because the area is now open until 1st of February and because of the continuing trend of earlier migration out of this area (see Section 2.8.3). 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.

In France there remains a problem in relation to the collection of all fishery statistics particularly for mackerel and horse mackerel. The figures provided to this working group may be inaccurate.

Discarding information was reported to the WG this year (See Section 1.3.3. below).

1.3.3 Discards

Mackerel

Discarding of small mackerel has historically been a major problem in the mackerel fishery and was largely responsible for the introduction of the south west mackerel box. In the years prior to 1994 there was evidence of large-scale discarding and slipping of small mackerel in the fisheries in Division IIa and Sub-area IV, mainly because of the very high prices paid for larger mackerel (>600 g) 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 these areas the decrease in the price difference in 1994 and the introduction of Norwegian regulations in the early 1990's has caused a decrease in discarding 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 horsemackerel. 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. The Working Group would like to highlight the possibility that discarding of small mackerel may again become a problem in all areas, particularly if a strong year class enters the fishery.

As a result of an EU study on discard information from Norwegian and Scottish purse seine fisheries (completed in 1999) some age disaggregated data from the fisheries in the fourth quarter in area IVa was available to the working group from Scotland. This data was incorporated in the catch numbers at age and weight in the stock. Further information from an interim report on this EU study (No. 99/071) was available towards the end of the WG but was not received in time to be incorporated in the assessment. Discard data is treated confidentially by the working group and is only shown by area in the report.

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 horsemackerel, between 0.1% and 8.1% for mackerel and less than 1% for sardine.

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

Horse Mackerel

Discarding of horsemackerel is not considered to be a problem. Discarding of horsemackerel in Division IXa is unknown. Discarding of horsemackerel in Division VIIIc is not considered to be a problem.

Sardine

Discarding levels in the sardine fishery in Division IXa are unknown.

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.

1.3.4 Age-reading

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

<u>Mackerel</u>

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. There is currently an exchange of mackerel otoliths in progress and it is hoped that the results of this will continue to maintain the accuracy and precision of mackerel age readings.

<u>Horse mackerel</u>

The otolith exchange, carried out in 1996, showed a considerable bias in the age readings of the older ages. As a consequence an otolith workshop was held in Lowestoft in January 1999 (ICES 1999/G:16). Following discussion and comparisons there was improvement in the precision of age reading during the workshop. However, the underestimation of older age groups (bias), which is an accuracy error, could not be significantly improved on. The problem of underestimating the age of older fish was thoroughly investigated by an estimation of the effect of age-reading errors on the assessment (addendum of ICES 1999/G:16). It was concluded that the accuracy errors (bias) should be improved first before the precision would be improved, because both age-reading errors have an opposite effect on the estimates of fishing mortality and spawning stock biomass. The Workshop recommended to slice the whole otoliths of set K (last set used at workshop) according to the transverse sectioned otolith processing technique and to stain these with the most suitable stain before an otolith exchange would take place among the most experienced readers. The Workshop regarded that this new processing technique might increase the visibility of the outer annual rings compared to the traditional broken/burnt technique and it might therefore reduce the bias in the older ages.

A working document was presented that described the improvements in the quality of the basic horse mackerel age data within the ICES area over the last 20 years (Eltink, WD 2001). It not only reviewed the historic information on this subject but also presented new results on age reading comparisons from otoliths treated according to the traditional broken/burnt otolith processing technique and according to the stained sliced transeverse sectioned otolith processing technique. The results from the experienced age readers demonstrated that the processing technique of the sliced transverse sectioned otoliths could considerably reduce the bias in age reading and at the same time improve precision, when these were stained with the light woodstain "Honeydue" (Sadolin). The age readings from the unstained sliced otoliths resulted in worse results compared to age readings from the broken/burnt otoliths. The staining of these sliced otoliths with Neutral Red improved slightly the age reading results, but these were still worse than the age readings of the broken/burnt otoliths. It showed that some readers still need help to adapt to age reading otoliths from this new processing technique. Reading stained sliced otoliths seems to be again a major step forward in the process of getting good quality basic horse mackerel age data. In future other staining techniques should be investigated to improve age reading results even more.

The Working Group encourages the further use of this promising otolith processing method. Age readers who start to apply this new processing method should first read a reference set of otoliths of known age processed according to this new method in order to estimate their precision and accuracy (bias) in the age reading before they read large quantities of otoliths of which the ageings are used for assessment purposes. In future when more age readers apply this technical otolith exchange will be needed.

Sardine

An otolith exchange involving France, Spain and Portugal (EU Project PELASSES) has been completed and results were presented to the WG (Silva and Soares WD 2001). A further workshop will be held in Lisbon in October 2001.

Anchovy

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

In the Gulf of Cadiz the problems of interpretation of otolith readings continues. However, an otolith exchange has been carried out and intercalibrate otolith age readings for anchovy from Cadiz and sub areas VIII & IX. A workshop based on this exchange is due to take place in October 2001.

1.3.5 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. Following the recommendation of the WGMEGS in 2000 maturity samples were not taken on the 2001 egg survey as these samples would only cover part of the distribution area of the spawning stock. There is no new information on mackerel maturity in the southern area.

Horse Mackerel

There is no new information on horse mackerel maturity.

Sardine

Work on a different definition of mature fish for the Daily Egg Production Method and the calculation of maturity ogives for analytical assessment, was presented to last years WG. This work was done because of the persistence of doubts regarding the correspondence between macroscopic and microscopic maturity stage and regarding the first development stage that should be considered in the definition of mature fish in each area. It was agreed at last years WG that an intercalibration of the two maturity scales be carried out and that this serve as a basis for a common definition of mature fish. This work is currently ongoing and the results will be presented at the ICES WGDEPM which will be held in Lisbon in October 2001.

Anchovy

There are ongoing difficulties in stock identification of anchovy in Gulf of Cadiz and IXa.

1.3.6 Quality Control and Data Archiving

Current methods of compiling fisheries assessment data. Information on official, area misreported, unallocated, discarded and sampled catches are currently recorded by the national laboratories on the WG-data exchange sheet (MS Excel; for definitions see text table below) and sent to the species co-ordinators. Co-ordinators collate data using the latest version of *salloc1*, (Patterson, 1999) which produces a standard output file (*Sam.out*). However only sampled, official, WG and discards are available in this file.

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

Definitions of the different catch categories as used by the MHMSA WG:

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

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

The working group acknowledges the effort some members have made to provide “corrected” data, which in some cases differ significantly from the officially reported catches. Most of this valuable information is gathered on the basis of personal knowledge of the fishery and good relations between the responsible scientist and the fishermen. The WG is aware of the problem that this knowledge might be lost if the scientist resigns, and asks the national laboratories to ensure continuity in data provision. In addition the working group recognises and would like to highlight the inherent conflict of interest in obtaining details of unallocated catches by country and increasing the transparency of data handling by the Working Group. This issue will have to be carefully considered in light of any future development by ICES of a standard platform to store all fisheries aggregated data.

The quality and format of input data provided to the species co-ordinators is still highly variable. Table 1.3.6.1 gives an overview of possible problems by nation. From this it can be seen that some nations have none or only inadequately aged samples, others have not used the data input spreadsheet provided or not even submitted any data. This is regarded to be problematic for the Faroes, France and Russia in the case of Mackerel, Denmark, France, Germany, Scotland and Sweden in the case of Horse Mackerel, and France and Portugal in the case of Anchovy. It has to be noted that in this respect the quality of input data has deteriorated as compared to last year. This table will be updated again next year to continue to track improvements. Sardine data was provided using the WG-data spreadsheets, which is an improvement from last year. For anchovy, a complex method of catch sampling based on stratifying by commercial size-categories is used. Although a documented programme such as *sallocl* is not used to combine these data it was felt that such a programme would not improve the quality of this data.

The Working Group documents sampling coverage of the catches in two ways. Sampling effort will be tabulated against official catches by species (as in this Section). Further, maps showing total catch in relation to numbers of aged and measured fish by area give a picture of the quality of the overall sampling programme in relation to where the fisheries are taking place (Figure 1.3.1.1).

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

Prior to 1997, most of the data was handled in multiple spreadsheet systems in different formats. These are now stored in the original format, separately for each stock and catch year. Table 1.3.6.2 gives an overview on data collected by September 2001. It is the intention of the Working group that in the interim period until the proposed standard database is developed (see below) the previous years archived data will be copied over to the current year directory and updated at the working group. Thus the archive for each year will contain the complete dataset available. Further, it should be backed up on Compact Disk. The request by the WG for ICES to provide an archive folder was not carried out, therefore the WG continues to create an archive by manually copying over all previously stored disaggregated and input data to the current WG folder. **The WG recommends that only to designated members of the WGMHSA**, **should be given access to the archives folder** as it contains sensitive data

In last years WG, members were again 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), to fill in missing historical disaggregated data. However, there was little response from the national institutes. **The WG recommends that national institutes increase national efforts to gain historic data, aiming to provide an overview of which data are stored where, in which format and for what time frame.** The Working Group still sees a need to raise funds (possibly in the framework of a EU-study) for completing the collection of historic data, for verification and transfer into digital format.

Review of recommended progress and future developments. During last year's Working Group, ICES indicated that the effort to develop and establish a standard platform for the collation and processing of input data within ICES could be increased, as was suggested several times by the WG. To ease and speed up the development process, a subgroup of the WG produced a working document listing detailed requirements of this and other WGs for a database system (WD Zimmermann et al. 2000). ICES was asked to distribute this document among other WGs for reviewing as a next step.

In this respect, the WG decided to put only little effort in further developments of the input spreadsheet and *sallocl* program. Improvements made to the exchange spreadsheet used by the species co-ordinators included correction to cell formulas which calculate SOP comparison, the implementation of validation checks at the value entry point, and crosschecks on the data reported by sampled areas and disaggregated by statistical rectangle. It was noted this year that considerable difficulties were encountered with the combination of the input spreadsheet and *sallocl*. These problems were due to non printing characters which are generated when csv files are produced by MS office localised to non-english versions, and non-printing characters created from the export of data to the exchange spreadsheet from database applications. In spite of last year's recommendation, ICES has not provided a facility to store relevant documentation and the most recent version of exchange sheets and programmes used to aggregate the data, allowing the download of these items over the ICES web server.

This year, **the WG noted that ICES has failed to make any step towards the development of a standard data input platform.** The specifications which ICES has asked for and which were provided by last year's WG have not been distributed to other WGs. Further, in the light of ongoing discussions on Quality Control in ICES' advisory process, the Working Group expresses its **serious concerns** that the only currently established system to keep standardised data at ICES, IFAP, was recently abandoned without any replacement.

A presentation was made to the group of an application which could provide a solution to the problems mentioned above. As part of the EU-EMAS (Evaluation of Market Sampling) project an VBA/MS Access based open source database ("*VPAbase*") was developed which can store disaggregated fisheries data and has the functionality of the *sallocl* program (ICES CM 2001 P:23). However, this database is not fully developed and will require funding subsequent to the completion of the EMAS project.

It is the WG's opinion that a further developed database could solve not only the immediate data handling problems, but also most of the quality control issues at the data input level, as raised by ICES in the draft of a Quality Control handbook (see Section 1.4). It would also provide a solution to the archiving problem when stored on the ICES system, and data could be submitted by each country over a web-enabled version, which would overcome the problem of users working off different versions of the application. However, given the confidential nature of some of this data, the security implications of such a solution would have to be addressed.

The Working Group therefore strongly recommends that ICES takes over the responsibility to provide a database such as EMAS input database (described above) as soon as possible. Continuity of assessment input data storage on an ICES server has to be assured until the database is fully implemented.

1.4 Checklists for quality of assessments

As a step in the direction of systematic documentation of the assessment procedures and quality, checklists as suggested by the HAWG (ICES 2000) were made for some of the stocks last year and updated this year (Tables 1.4.1 – 1.4.4).

1.5 Comments on ICES Quality Control Handbook

In response to the terms of reference, the Working Group discussed the proposed ICES Quality Control handbook. As MHSA was the second to last WG asked to comment on this issue, there was little substantially new to add to the comments of other groups.

In general, the WG agreed that any kind of standardised reference guide for the handling of data and of the assessments and predictions would be very useful. The WG fully supports ICES' effort to increase transparency in the advisory process. However, some issues related to progress on this side were raised, namely

- standardisation of methods vs. flexibility to allow frequent method developments
- transparency vs. confidentiality
- additional work for compiling the requested information vs. workload and time constraints in the group

The WG acknowledges the advantages **standardised procedures** could give to transparency, and considers these useful, especially for WG's where few changes of the assessment methodology are required over the years. The WGMHSA, however, like other pelagic groups, is regarded as rather innovative and exploratory to enable the WG to deal with the sometimes highly variable nature of pelagic fish. This WG therefore asks ICES to assure that the definition of standardised software for exclusive use in the assessment process will not lead to restrictions in the flexibility of the development and use of new methods. Further the additional workload to document frequent developments not only in the report, but also in a separate quality control handbook, should be minimal.

With respect to **confidentiality vs. transparency**, the Working Group cites HAWG's comments: The Group expressed some concern with the requirements of transparency regarding the processes for deriving Working Group catches, used in the assessments, from National statistics. The problem is that total transparency would be highly detrimental to obtaining any information on misreporting in future. This would lead to further deterioration of total catch statistics. The Working Group proposes to provide only as much information on this process as is possible without jeopardising the chances of getting information on misreporting in future. In WGMHSA's opinion, ICES is responsible for the required measures to limit access to information marked as confidential by the group. This also has to be assured in the future.

At this stage, the WG cannot assess adequately how much **additional work** would be needed to compile information for the outlined Quality Control handbook. As the group prefers strongly to have the complete documentation of its work in the WG report instead of just referring to a frequently changed addendum of a separate document, it suggests that parts of the report could be produced in a standardised format. Information needed for the QC handbook could then be extracted from the various reports annually by the QC handbook authors. ACFM is encouraged to provide a list of minimal requirements and desired formats, which should give the opportunity to track changes between years. The WG considers their Assessment checklists (Section 1.4) as a good starting point for standardised report sections. Overall, this procedure would add little additional work to the WG during regular WG sessions, as members would only have to indicate (and elaborate on) changes. However, for the initial preparation of the standardised parts of report, a separate meeting of a subgroup of the WG would be needed.

WGMHSA once again states that there are important issues related to quality control other than just the documentation of data handling by the WG's. In this respect, the quality of the advice would as much profit from a standardisation of input data storage and processing as solely from the handbook (see Section 1.3.6 for further elaboration).

Table 1.3.6.1. Overview of the availability and format of data provided to the species co-ordinators and possible problems (e.g. inconsistencies, missing data)

A. Mackerel

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

B. Horse Mackerel

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

C. Sardine

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

C. Anchovy

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

Table 1.3.6.2: Available disaggregated data for the WG MHSA per Sept. 2001
X: Multiple spreadsheets(usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad and Alloc-outputs (ascii/txt)

Stock		Catchyear	Format X	Format W	Format D	Comments
Horse Mackerel: Western and North Sea						
	HOM_NS+W	1991	X			Files from Svein Iversen, April 1999
		1992	X			Files from Svein Iversen, April 1999
		1993	X			Files from Svein Iversen, April 1999
		1994	X			Files from Svein Iversen, April 1999
		1995	X			Files from Svein Iversen, April 1999
		1996	X			Files from Svein Iversen, April 1999
		1997	X	W	D	Files from Svein Iversen, April 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Svein Iversen Sept 2000
		2000	X	W	D	Files provided by Svein Iversen Sept 2001
Horse Mackerel: Southern						
	HOM_S	1992	X			WG Files on ICES system [Database.92], March 1999
		1996	X			Source?
		1997		(W)	D	WG Files on ICES system [WGFILES\HOM_SOTH], March 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Pablo Abaunza Sept 2000
		2000	X	W		Files provided by Pablo Abaunza Sept 2001
North East Atlantic Mackerel						
	NEAM	1991	X			North Sea +Western WG Files on ICES system [Database.91], March 19[9
		1992	X			North Sea +Western WG Files on ICES system [Database.92], March 19[9
		1993	X			North Sea +Western WG Files on ICES system [Database.93], March 19[9
		1997		W	D	Files from Ciaran Kelly, April 1999
		1998		W	D	Files from Ciaran Kelly, Sept 1999
		1999		W	D	Files provided by Ciaran Kelly, Sept 2000
		2000		W	D	Files provided by Ciaran Kelly, Sept 2001
	Western Mackerel subset					
		1997		(W)	D	Files from Ciaran Kelly, April 1999; (W) contained in NEAM
		1998		(W)	D	Files from Ciaran Kelly, Sept 1999; (W) contained in NEAM
		1999		(W)	D	Files provided by Ciaran Kelly, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Guus Eltink, Sept 2001; (W) contained in NEAM
	Southern Mackerel subset					
		1991	X			WG Files on ICES system [Database.91], March 1999
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1994	X			WG Files on ICES system [Database.94], March 1999
		1995	X			WG Files on ICES system [Database.95], March 1999
		1996	X			WG Files on ICES system [Database.96], March 1999
		1997	X	(W)		WG Files on ICES system [WGFILES\MAC_SOTH], March 1999
		1998	X	(W)		Files provided by Mane Martins; (W) contained in NEAM
		1999	X	(W)		Files provided by Begoña Villamor, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Begoña Villamor, Sept 2001; (W) contained in NEAM
Sardine						
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1995	X			files provided by Pablo Carrera Sept 2001
		1996	X			files provided by Pablo Carrera Sept 2001
		1997		W	D	W for Portugal only, files provided by Pablo Carrera and Kenneth Patters[on
		1998		W	D	files provided by Pablo Carrera Sept 1999
		1999		W		files provided by Pablo Carrera Sept 2000
		2000		W	D	files provided by Pablo Carrera Sept 2001
Anchovy						
	Anchovy in VIII	1987-95	X			revised data, all in one spreadsheet, provided by Andres Uriarte Sept 199[9
		1996	X			file provided by Andres Uriarte Sept 1999
		1997	X	W	D	files provided by Andres Uriarte Sept 1999
		1998	X	W		files provided by Andres Uriarte Sept 1999
		1999	X	W		files provided by Andres Uriarte Sept 2000
		2000	X	W		files provided by Andres Uriarte Sept 2001
	Anchovy in IX					
		1992	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1993	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1994	X			files provided by Begoña Villamor Sept 1999
		1995	X			files provided by Begoña Villamor Sept 1999
		1996	X			files provided by Begoña Villamor Sept 1999
		1997	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1998	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1999	X	W		W for Spain only, files provided by Begoña Villamor Sept 2000
		2000	X	W		W for Spain only, files provided by Begoña Villamor Sept 2001

Table 1.4.1. Checklist North-East Atlantic Mackerel assessments

1. General

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

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, misreporting	Catch estimation based on official landings statistics and augmented by national collected additional information on misreporting and discarding. Discard information was only available for the Netherlands until 2001 when Scotland also provided information. Discarding is considered as a major problem in the fishery. Misreporting is corrected by re-allocating catches from official reported areas to areas where catches were taken, based on additional information. Separation of the different mackerel stock components is on the basis of the spatial and temporal distribution of catches (see above).
2.2	Indices of abundance	
	Catch per unit effort	CPUE (at age) information for the Southern area only
	Gear surveys (trawl, longline)	Trawl surveys for juvenile mackerel gives recruit indices and distribution, currently not used for the assessment.
	Acoustic surveys	Experimental surveys in 1999 to 2001 by Norway, Scotland, Spain, Portugal and France. These are not currently used in the assessment.
	Egg surveys	The triennial egg survey for mackerel and horse mackerel currently provides the only fishery independent SSB estimate used in the assessment. The survey has been conducted in the western area since 1977, and in the southern area since 1992. In its present form the survey aims at covering the whole spawning time (January - July) and area (South off Portugal to West off Scotland) for both species since 1995. Applied method: Annual Egg Production Method. Similar egg surveys are also carried out on a roughly triennial basis in the North Sea, but these have only a partial spatio-temporal coverage and are not currently used in the assessment
	Larvae surveys	None
	Other surveys	Russian aerial surveys have been conducted annually in July since 1997 in international waters in the Norwegian Sea and in part of the Norwegian and Faroese waters (Div. IIa). This gives distribution and biomass estimates, not currently used in the assessment.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive in-formation	Catch at age: derived from national sampling programmes. Sampling programmes differ largely by country and sometimes by fishery. Sampling procedures applied are either separate length and age sampling or representative age sampling. Total number of samples taken (2001): 1,182; total number of fish aged: 15,923; total number of fish measured: 122,769. Weight at age in the stock: Western component; derived from the Dutch and Irish national sampling program (catches in March-May from Div. VIIj). Presented as point estimates without variances. For both other components: constant value since 1984 (start of data series). Weighted by the relative proportion of the egg production estimates of SSB for the respective components. Weight at age in the catch: derived from the total international catch at age data weighted by catch in numbers. In some countries, weight at age is derived from general length-weight relationships, others use direct measurements. Maturity at age: based on biological samples from commercial and research vessels; weighted maturity ogive according to the SSB biomass in the three components.

Table 1.4.1 (Cont'd)

2.4	Tagging information	Used as indicator for the mixing of the Southern and Western component; used to estimate total mortality; for exploratory assessment runs (AMCI).
2.5	Environmental data	Not used
2.6	Fishery information	Several scientists involved in the assessment of this stock are familiar with the fishery. A few nations have placed observers aboard the fishing vessels. Anecdotal information on the fishery may be used in the judgement of the assessment.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	*Current assessment model: ICA*
3.2	Spatially explicit or not	no
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over years and ages (M=0.15) based on tagging data. Selection at age: Reference age 5 for which selection is set at 1. Selection at final age set to 1.2. One period of 9 years of separable constraint (including the egg survey biomass estimates from 1992 onwards). Population in final year: 13 parameters. Population at final age for separable years: 9 parameters. Recruitment for survivors year: Total number of parameters: 40 Total number of observations: 111 Number of observations per parameter: 2.8
	Recruitment	No recruitment relationship fitted.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of a weighted sum of squares. Terms are weighted by manually set weights. Index for biomass from egg surveys gets a weight of 5 and each catch at age observation in the separable period contributes a weight of 1 except 0-group, which is downweighted to 0.01. The survey biomass estimate was treated as absolute up to 1998. From 1999 it was treated as an index.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Maximum likelihood estimates of parameters and 95% confidence limits are given. Total variance for the model and model components given, both weighted and unweighted. Several test statistics given (skewness, kurtosis, partial chi-square). Historic uncertainty analysis based on Monte-Carlo evaluation of the parameter distributions.
3.6	Retrospective evaluation	Currently no retrospective analysis is carried out. Two reasons: because it is not directly available within ICA and because the assumptions concerning the separable period have been very variable over recent years. It is recognised that the retrospective analysis is severely lacking. Historic realisations of assessments are routinely presented and from a direct overview on the changes in perception concerning the state of the stock. Currently only historic realisations of SSB are presented. It is recommended that also fishing mortality and recruitment plots should be presented.
3.7	Major deficiencies	• reference age not well determined • selection at final age not well determined • separable period changes often • weighting for catch data much higher than for survey data (41 to 5) • weighting for survey indices and catch data are not related to variability in the data • correlation structure of parameters not properly assessed and presented • catchability of surveys is assumed constant over the years • area misreporting of catch is a major problem • relationship between number of parameters, number of data points and total SSQ not addressed • simpler assessment models currently not evaluated

Table 1.4.1 (Cont'd)

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model, by fleet and area fished.
4.2	Spatially explicit or not	Not
4.3	Key model (input) parameters	Stock weights at age: average from last 3 years Natural mortality at age: average from last 3 years Maturity at age: : average from last 3 years Catch weights at age BY FLEET: average from last 3 years Proportion of M and F before spawning: 0.4 Fishing mortalities by age: From ICA Numbers at age: from ICA, final year in assessment; ages 2 to 12+ 0-group is GM recruitment whole period except last 3 years 1-group is GM recruitment applying mortality at age 0 Fishing mortalities by area (and age): *The exploitation pattern used in the prediction was the separable ICA F's for the final year and then re-scaled according the ratio status quo F (last 3 years) and reference F (F_{4-8}). This exploitation pattern is subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the last 3 years.*
4.4	Recruitment	Geometric mean over whole period except last 3 years.
4.5	Evaluation of uncertainty	Uncertainty in model parameters is NOT incorporated, though sometimes a limited number of sensitivity analyses may be performed, usually with regard to recruitment level.
4.6	Evaluation of predictions	Predictions are not evaluated retrospectively (this is tricky to do in terms of catches, but some evaluation in terms of population numbers at age should be done).
4.7	Major Deficiencies	*SSB estimates from egg surveys only every 3 years available.* *Assessment/Prediction mismatch: The prediction model contains more detail (by fleet) than the assessment model (not by fleet). In particular, stock estimates are based on a separable model which is then treated in a non-separable way in the short term predictions.* *Catch options: no unique solution for catches by fleet when management objectives are stated in terms of Fadult and Fjuvenile. Need to impose further constraints (eg maintain proportions of catches between fleets), to find unique solution.* *No stochasticity/uncertainty reflected in short term predictions.* Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year Software: MFDP programme

5. Prediction model(s) – MEDIUM TERM

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Age structured.
5.2	Spatially explicit or not	No

Table 1.4.1(Cont'd)		
5.3	Key model parameters	*Model parameters as in short term predictions. Exploitation pattern, numbers at age and corresponding CVs as estimated by ICA in the previous year assessment. Expected Recruitments are based on the geometric mean computed from the time-series of estimated recruitments and it's CV.*
5.4	Recruitment	An Occam stock recruitment relationship is fitted.
5.5	Evaluation of uncertainty	Stochastic forward projections are based on the Baranov catch equation incorporating uncertainty in the starting population numbers and recruitment as noted in point 2, 5.3.
5.6	Evaluation of predictions	Predictions are not evaluated post-hoc
5.7	Major Deficiencies	Medium-term predictions not carried out in 2001

Table 1.4.2. Checklist Southern Horse Mackerel Assessment

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The southern stock is distributed in Divisions VIIIc an IXa. There are still uncertainties in the delineation of horse mackerel stocks in the Northeast Atlantic. The limit line for the separation between Southern and Western horse mackerel stocks is not clear and it is supported by few biological information. With the ongoing project on horse mackerel stock identification research (HOMSIR), it is expected to clarify the horse mackerel stock structure in the Northeast Atlantic.
1.2	Stock structure	
1.3	Single/multi-species	A single species assessment is carried out

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment. Catch reports are quite good and mis-reported catches and discards are negligible. During the assessment period the level of catches has never reached the TAC of 73 000 proposed for *Trachurus spp*. until 1999 (68 000 t in 2000 and 2001). The missing of target species for the purse seiners, like anchovy and sardine, can produce an increase in the fishing mortality of the horse mackerel, as it happened in 1997, 1998 and 1999.
2.2	Indices of abundance	The following series of age disaggregated indices are available: two series of bottom trawl surveys from 1985 onwards. Another series of bottom trawl surveys from 1989 onwards. The relationship between the indices and abundance is considered to be linear. There also is an SSB estimate for 1995 based on egg surveys.
	Catch per unit effort	Three series of CPUE corresponding to three different bottom trawl fishing fleets are available. One from 1979 to 1990 and the other two from 1984 onwards. Data disaggregated by age are available from the two last ones.
	Gear surveys (trawl, longline)	Three series of Bottom trawl surveys are carried out in the distribution area (see Indices of abundance). Two of them cover the entire stock distribution area during the recruitment season (fourth quarter).
	Acoustic surveys	Information is available from acoustic surveys but not used in the assessment. Biomass estimates are considered to be underestimated, because the horse mackerel is also found close to the bottom blind area of the acoustic transducer.
	Egg surveys	Egg surveys are carried out on a triennual basis since 1995. At the moment there only is available the SSB estimate from 1995.
	Larvae surveys	Some information from the egg surveys but not used in the assessment.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches is considered to be good. Catch at age matrix is available from 1985. Age assignment is validated until age 12. There are no significant trends in the weight at age in the catch along the assessment period. Weight at age in the stock is considered to be constant over the assessment period, as it is also the case of the maturity ogive.
2.4	Tagging information	At the moment there is no available information from tagging
2.5	Environmental data	Environmental information is available from acoustic surveys and bottom trawl surveys. Satellite images can provide useful information on the dynamics of the aquatic systems based mainly in the estimation of the sea surface temperature. Preliminary multivariate analysis have shown a good fit among the recruitment strength and some environmental conditions.
2.6	Fishery information	Horse mackerel is mainly caught by purse seiners and bottom trawlers. The catches are relatively uniform over the year, although the second and third quarter show relatively higher catches.

Table 1.4.2 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	XSA. The model is tuned with two series of commercial fishing fleets and three series of bottom trawl surveys. The assessment period is from 1985 onwards.
3.2	spatially explicit or not	No
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Fishing mortality and catchability. Natural mortality is set to a constant value
	recruitment	No stock recruitment relationship is assumed. Recruitment estimates from XSA.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	No statistical formulation. Catch data is supposed error-free.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	No evaluation of assessment uncertainty
3.6	Retrospective evaluation	Yes

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Age. Using IFAP short term forecast and Y/R routines. In 2001 WG, the software MFDP and MFYPR was used for both purposes respectively.
5.2	Spatially explicit or not	No
5.3	Key model parameters	Fishing mortality
5.4	Recruitment	Geometric mean over the XSA model estimates at age 0 in the assessment period.
5.5	Evaluation of uncertainty	No
5.6	Evaluation of predictions	No

Table 1.4.3.Checklist, ANCHOVY VIII

1. General

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

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are not included but considered as negligible for the two fleets. The fishing statistics are considered accurate and the fishery is well known
2.2	Indices of abundance	Series of surveys for DEPM and acoustic since 1987 (with a gap in 1993). Acoustic surveys since 1983 (although not covering all the years)
	Catch per unit effort	There exists series of catch per unit effort for the French and Spanish fleets
	Gear surveys (trawl, longline)	Pelagic trawls to sampled the population mainly during the spawning period and in some cases (opportunistically) purse seining.
	Acoustic surveys	Series since 1989 (used in the assessment), there indexes before (in 1993 and 1993)
	Egg surveys	Daily Egg Production Method applied to estimate the SSB. Series since 1987-2000 with a gap in 1993. estimates in 1996, 99 & 2000 are based on regression models of previous DEPM SSB on P0 and SA.
	Larvae surveys	Some sampling exists to know the larvae condition.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches are considered sufficient. However, an increase of the sampling effort seems useful to have a better knowledge of the age structure of the catches during the second semester in the North of the Bay of Biscay. Age reading is considered accurate and cross reading is currently done between Spain and France. Otoliths typology is made. Indirect validation with the fluctuation of the stock (2 years old validation) is being prepared
2.4	Tagging information	No tagging program
2.5	Environmental data	There exists a lot of information, particularly on the temperature, water stratification, upwelling index, etc Motos *et al*. 1996, Borja *et al*. 1996, 98). Hydrodynamic model is currently used (Allain et al. 1999) .
2.6	Fishery information	Two main fishery. A Spanish one in Spring fishing only with purse seine and a French one mainly in winter and in autumn using mainly the pelagic trawl. A small fleet of French seiners fish in the South and in the North of the Bay of Biscay

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA is used with DEPM, Acoustic and age structure of the catches and the population
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is set fix at 1.2. It is considered variable. Catchability for the DEPM index is set to 1 because it is assumed to be an absolute indicator of Biomass. Catchability of the acoustic survey is estimated.
	Recruitment	No stock recruitment relationship is assumed. However, below 18,000 tonnes a link between recruitment and spawner abundance is assumed.

Table 1.4.3 (Cont'd)

3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Accuracy of the data are not taken into account (No observation error). Only, a weighted factor allows to translate the validity of the information used into the tuning of the assessment. Log normal errors assumed. Maximum likelihood estimates.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Asymptotic estimates of variances, by the inverse of the Hessian matrix. No explicit bootstrapping evaluation of the uncertainty
3.6	Retrospective evaluation	Not done so far (2000)

4. Prediction model(s)

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age predictions models Based on CEFAS deterministic projections (MFDP).
4.2	Spatially explicit or not	No
4.3	Key model parameters	Recruitment at age 0 in the assessment year. Fishing mortality, Catch constrain for the assessment year.
4.4	Recruitment	Geometric mean or more precautionary levels, according to the complementary information that might be available to the WG. Use of environmental indexes is on state of refinement for future use.
4.5	Evaluation of uncertainty	Short term sensitivity analysis (Cook 1993) was used in 1999.
4.6	Evaluation of predictions	Not properly.

Table 1.4.4 Checklist for Iberian Sardine

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The Iberian Sardine Stock is distributed along VIIIc and IXa ICES Divisions. A comprehensive review of the stock dynamics has been done last year. No changes in the actual stock definition were suggested. A new project aiming to understand the dynamic of the European sardine is under development.
1.2	Stock structure	Two main nursery areas located in the Gulf of Cadiz and in Ixa Central North. Adult fish are mainly located in the south of Portugal and in VIIIc. However, the number of older fish in VIIIc decreased and the relative abundance of older fish increased in the south of Portugal. Recruitment at area starts in March.
1.3	Single/multi-species	A single species assessment is carred out

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment. 99% of the catches were covered by the sampling programme. The bulk of the catches are taken by purse seiners with no discards.
2.2	Indices of abundance	Four time series of age disaggregated indices area available, Portuguese November acoustic survey, Portuguese March acoustic survey, Portuguese August acoustic survey and Spanish March acoustic survey. Daily Egg Production Method was undertook in 1988, 1990 and 1999 and estimated SSB is available.
	Catch per unit effort	
	Gear surveys (trawl, longline)	
	Acoustic surveys	Three series of acoustic surveys area presently available. None of these covers the whole distribution area of the stock. The Portuguese November acoustic started in 1984; there are two gaps, from 1988 to 1992 and from 1993 to 1997. The Portuguese March acoustic survey has continuity since 1996 covering as well the Gulf of Cadiz; other two survey covering the Portuguese area in March were undertook in 1986 and 1988. The Spanish March acoustic survey begun in 1986; no surveys for 1989 and 1994 are available. 1995 survey is no used because the different period in which it was carried out.
	Egg surveys	DEPM was conducted for the whole area in 1997 and 1999. The whole area except Cadiz was also covered in 1988. In 1990 e new survey covered only the Spanish area.
	Larvae surveys	
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological samples are done in a quarterly and ICES Sub-division basis. Data are pooled from this basis. Age groups are disaggregated up to 6+. Maturity ogive, weight at age are calculated each year. Last years, different otolith structures has been observed; this might led to a mis-allocation of age groups in younger fish. Otolith exchanges and the study of the daily otolith increments are impemented. Fish from VIIIc are in general higher than those of the IXa .
2.4	Tagging information	
2.5	Environmental data	Meteorological data are available from either satellite or fixed station. Time series of upwelling index, NAO among others are, available. Direct measurements at sea are also obtained during the different surveys.
2.6	Fishery information	Sardine is maily caught by purse seiners.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA model. Age are disaggregated up to 6+. The assessment period if from 1978 onwards.
3.2	spatially explicit or not	No
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is fixed at 0.33 for all ages. Two separable periods with different selecction pattern are assumed (from 1987 to 1993 and from 1994 onwards). Acoustic indices fitted with linear catchability. DEPM as absolute.
	recruitment	No SRR is assumed
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	No statistical formulation
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	No evaluation of uncertainty. Exploratory analysis is done for sensitivity purposes.
3.6	Retrospective evaluation	No

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Age.Using IFAP short term forecast and Y/R routines
5.2	Spatially explicit or not	Two scenarios, for the whole area and for each VIIIc and IXa Divisions.
5.3	Key model parameters	Fishing mortality from the last assessment. Weights in the stock and in the catches as the mean of the last three years. Maturity ogive from the last year. Age group 1 in 2001, estimated as the projection of geometric mean of the last 6 recruitments at age 0
5.4	Recruitment	Geometric mean of the last six years as estimated by the ICA model
5.5	Evaluation of uncertainty	No
5.6	Evaluation of predictions	No

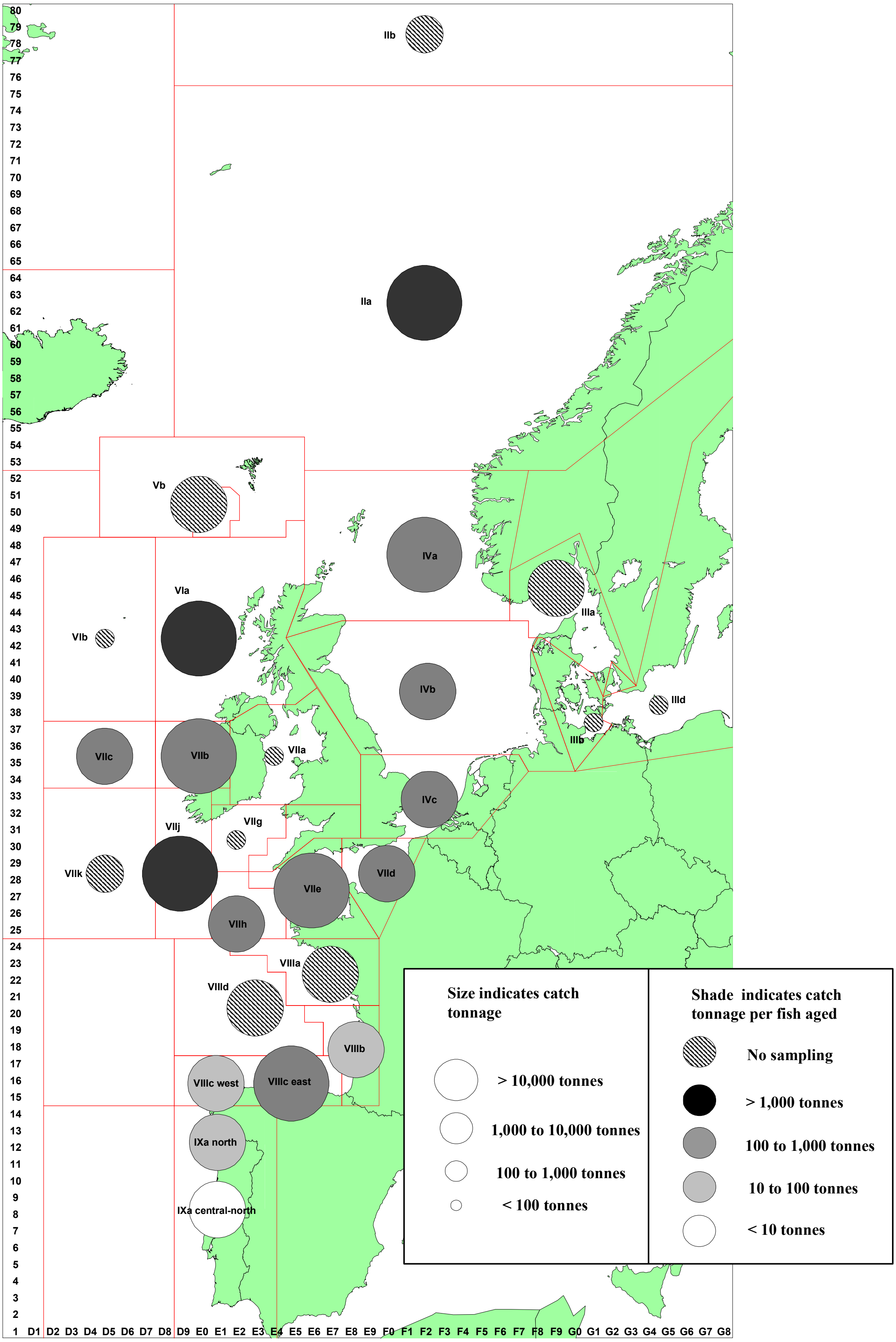


Figure 1.3.1.1 Sampling of mackerel for age in relation to tonnage landed by ICES division. Circle size indicates catch tonnage and shading indicates sampling level

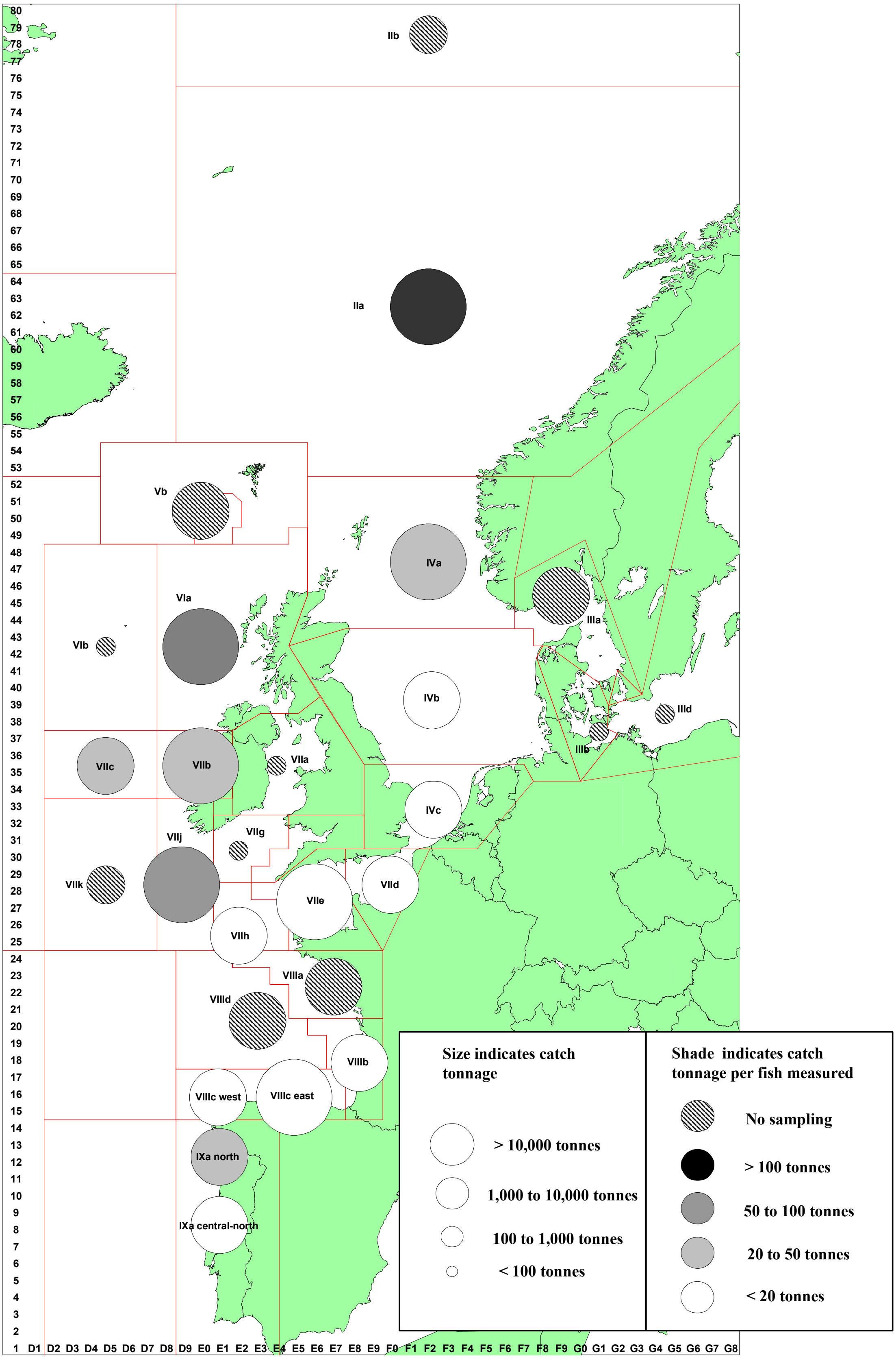


Figure 1.3.1.2 Sampling of mackerel for length in relation to tonnage landed by ICES division. Circle size indicates catch tonnage and shading indicates sampling level

2 NORTHEAST ATLANTIC MACKEREL

2.1 ICES advice applicable to 2000 and 2001

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

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

The TACs agreed by the various management authorities and the advice given by ACFM for 2000 and 2001 are given in the text table below.

Agreement	Areas and Divisions	TACs in 2000	TACs in 2001
Coastal states agreement (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	570,680[1]	574,000
NEAFC agreement	International waters of IIa, IV, Vb, VI, VII, XII, XIV	No agreement	54,050[2]
EU-NO agreement[3]	IIIa, IVa,b	1,865	1,865
EU autonomous[4]	VIIIc, IXa	39,200	40,180
Total		611,745	669,995

Stock components	ACFM advice 2000	ACFM advice 2001	Areas used for allocations	Prediction basis	Catch in 2000
North Sea	Lowest possible level	Lowest possible level	IIa, III, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV	Northern	631,084
Western	Reduce F below F_{pa} = 0.17	Reduce F below F_{pa} = 0.17			
Southern			VIIIc, IXa	Southern[5]	36,074
					667,158

1) According to the Coastal states agreement in 2000 of 560,000 t, in addition Faroes was entitled to fish 10.680 t originating from the coastal State share of the areas beyond national fisheries jurisdiction.
2) NEAFC agreement was 65,000 t including 11,050 t not fished by any party.
3) Quota to Sweden (area IVa is only applicable in 2001).
4) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.
5) Does not include the 3,000 t of Spanish catches taken in Spanish waters of VIIIb under the southern TAC.

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

For 1999, 2000 and 2001 a fishing mortality not exceeding $\mathbf{F}_{pa}$ = 0.17 was recommended, which in 2001 corresponds to a catch of less than 665.000 t.

In addition to the TACs and the national quota the following are some of the more important additional management measures which have been in force since 1998, and are again in force in 2001. 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 from 1. February to 30. June, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year;
2. Prohibition of a directed mackerel fishery in the "Mackerel Box";
3. Minimum landing size of 30 cm for Sub-area IV, Division IIIa and 20 cm for Divisions VIIIc and IXa.

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

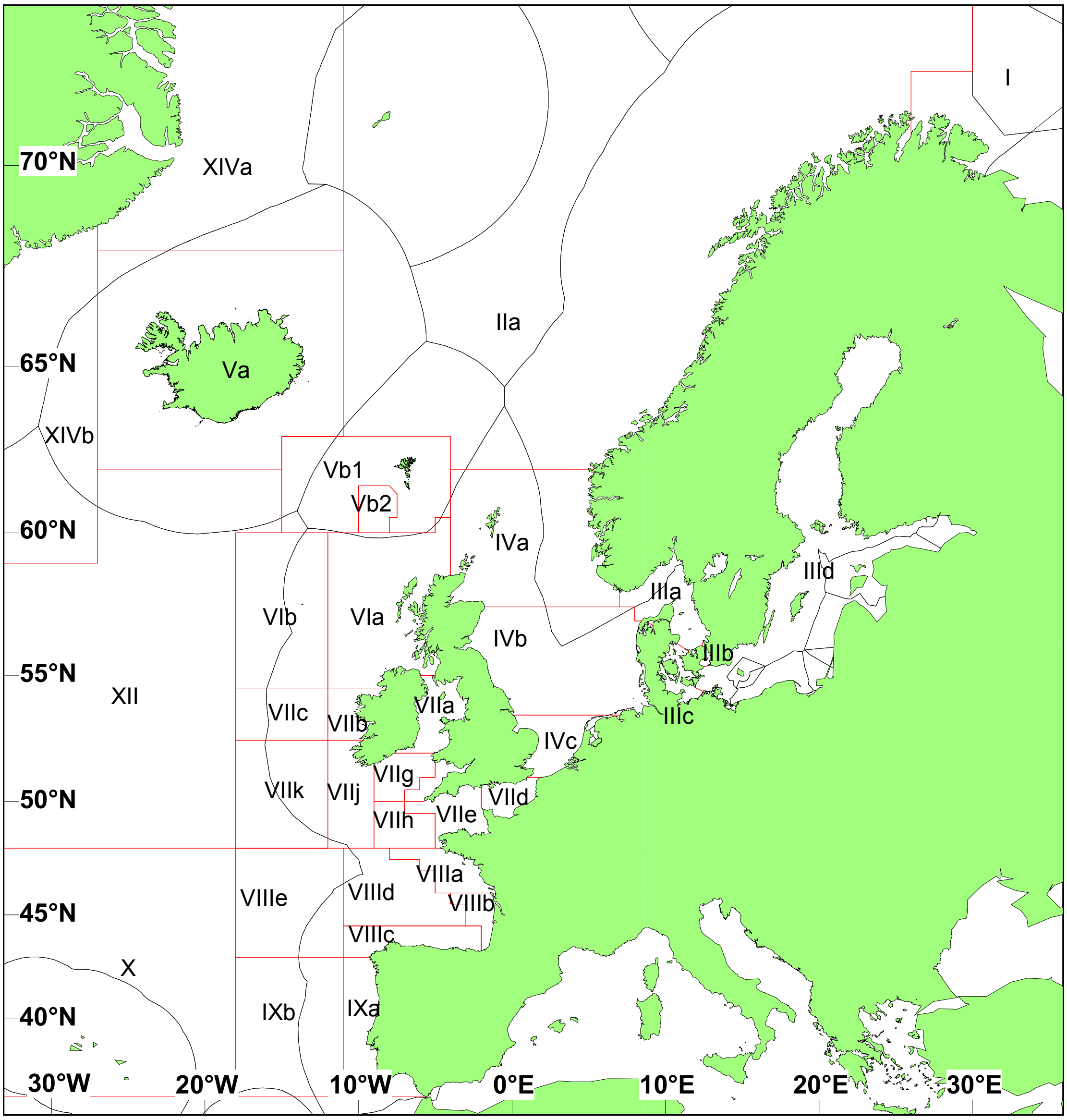


Figure 2.1.1 Map of approximate national zones and ICES Divisions and Sub-areas.

2.2 The Fishery in 2000

2.2.1 Catch Estimates

The total estimated catch in 2000 was about 670,000t, which was nearly 60,000t higher than the catch taken in 1999. The TACs set for 2000 for all those areas for which TACs were agreed amounted to 611,745t (See Section 2.1.). The corresponding TAC for 1999 was 532,215t. The increase in catches taken in 2000 appears mainly to have been as a result of an increase in catches in the Western area particularly area VI. The corresponding TACs as best ascertained by the Working Group (Section 2.1) agreed for 2001 amount to 669,995 t.

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.1.1. This table shows the development of the fisheries since 1969. The historical catches reported in this table will be re-examined intersessionally (See section 1.3). Some slight changes made during 1998 were appended to the caton file (540t). The highest catches (over 270,000t) were again taken from Sub-area IV and III with the vast majority of these being taken in Division IVa. This year for the first time catches were also reported from further east in Divisions IIIb & IIId. The catches, taken from Div Vb and Sub area II (92,557t), where the international fisheries take place, were almost 20,000t higher than recorded in 1999. Catches in this fishery were also reported from Sub area I and Division IIb. The catch taken in the fisheries in Sub-area VI showed the greatest increase with 151,000t taken in 2000 compared to 99,000t in 1999. The catch in Sub area VII and in Divisions VIIa,b,d,e was increased by almost 20,000t to 115,500t.

The catches taken in Divisions VIIIc and IXa decreased slightly from recent years from over 40,000t to about 36,000t.

The total reported misreported catch during 2000 was less than 10,000t.

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 2000 reflects the greater catches taken in the western area in the first quarter.

Percentage distribution of the total catches from 1990 - 2000

Year	Q1	Q2	Q3	Q4
1990	28	6	26	40
1991	38	5	25	32
1992	34	5	24	37
1993	29	7	25	39
1994	32	6	28	34
1995	37	8	27	28
1996	37	8	32	23
1997	34	11	33	22
1998	38	12	24	27
1999	34	9	30	27
2000	39	4	23	33

The catches per quarter by Sub-area and Division are shown in Table 2.2.1.6. These catches are shown per statistical rectangle in Figures 2.8.1.1 to 2.8.1.4 and are discussed in more detail in Section 2.8. It should be noted that these figures are based on details submitted on the official log books and may not indicate the true location of the stock. 39% 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. Only 4%of the total catch was taken in Quarter 2, most of it from Sub-area VII. This is a significant decrease in the proportion of the total catch taken at this time of the year. 23% of the total catch was taken during Quarter 3; this is again a proportional decrease in the catch taken at this time of the year. The main catches were taken from the shoals on the summer feeding areas in Division IIa and IVa. During Quarter 4, 33% of the total catch was taken mainly from Division IVa. The main catches of southern mackerel are taken in VIIIc (83%) and these are mainly taken in the first quarter. Catches from IXa which comprise 17% of southern mackerel catches are mainly taken in the first and third quarters.

National catches

The national catches recorded by the various countries for the different areas are shown in Table 2.2.1.2 - 2.2.1.5. As has been stated in previous reports these figures should not be used to study trends in national figures. This is because of the high degree of misreporting and "unallocated" catches recorded in some years due to some countries exceeding their quota. The main mackerel catching countries in recent years continue to be Norway, Scotland, Ireland, Russia, Netherlands and Spain. Significant catches were also taken by Denmark, Germany, France, England and Faroe Islands (combined catch 112,284t); of these only Denmark, England and Germany provide sampled catch data covering 49,307t of this catch.

The total catch recorded from Sub-area II and Vb (Table 2.2.1.2) in 2000 was about 92,000t which was 20,000t more than in 1999. In contrast to last year the WG was unaware of any misreporting of catches from IVa. This is similar to the situation in 1995 & 1996 when catches were about 100,000t. The total catch taken from international waters was about 49,000t which the lowest since 1996. The catches in IIb were bycatches of mackerel taken by Russian vessels fishing for herring and blue whiting (during late July between 73°30'-74°N and 5-6°E). These catches to the far north are coincident with positive anomalies in sea surface temperature in the northern parts of Norwegian and Greenland seas. Small bycatches of mackerel (600t) were also taken in the Barents Sea (Sub area I, between 70°30'-71°N and 34-35°E) during June & July. These bycatches consisted of large adult fish. In this area at the time the Norwegian and Coastal Murmansk Currents were warmer then usual.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.1.3) in 2000 was 272,000t which is over 25,000t less than in 1999. In comparison to previous years there was very little misreporting of catches taken in this area into IIa or VIa. The main catches were recorded by Norway (142,320 t), while substantial catches were also recorded by Denmark, (27,720 t) and the United Kingdom (57,110 t). Discards were again reported this year and information on the age structure of the discarded catch was provided for one fleet. An interim report on this EU study (No. 99/071) is available. There were very small reported catches from IIIb and IIId .

The total catch estimated to have been taken from the Western areas (Table 2.2.1.4) was over 266,000t. This is a significant increase over the WG catch taken last year. This increase in the WG catch appears to be commensurate with the decrease in misreported catches into IVa. The main catches continue to be taken by United Kingdom (126,620t) and Ireland (61,277t). The Netherlands (30,123t), Germany (22,901t), and France (17,857t) continue to have important fisheries in this area.

The total catch recorded from Divisions VIIIc and IXa (Table 2.2.1.5) in 2000 was 36,074 t compared with 43,796 t in 1999. The catch in 2000 has decreased from the level of about 40,000t, which had been taken for the past three years. The TAC for 2000 was 39,200 t, which is the not same as that for 1999. The decrease in catches of southern mackerel may be due to a decrease in effort by the Spanish handline fleet, which was unable to fish for extended periods in April due to bad weather.

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

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and III[3]			Sub-area I,II & Divs.Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
1969	4,800		4,800	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
1999[§]	98,666		98,666	93,821		93,821	299,798		299,798	72,848	43,796	608,929		608,929
2000	150,927	1	150,928	113,520	1,918	115,438	271,997	165	272,162	92,557	36,074	665,075	2,084	667,159

*Preliminary.

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

[2]Discards estimated only for one fleet in recent years.

[3]Divisions IIIb & IIId included in 2000 only

[§] Discards reported as part of unallocated catches

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

Table 2.2.1.2 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	1999	2000
Denmark	6,800	1,098	251			4,746	3,198	37	2,090	106	1,375
Estonia			216		3,302	1,925	3,741	4,422	7,356	3,595	2,673
Faroe Islands	3,100	5,793	3,347	1,167	6,258	9,032	2,965	5,777**	2,716	3,011	5,546
France		23	6	6	5	5	0	270			
Germany							1				
Iceland							92	925	357		
Ireland										100	
Latvia			100	4,700	1,508	389	233				
Lithuania											2,085
Netherlands							561			661	
Norway	77,200	76,760	91,900	110,500	141,114	93,315	47,992	41,000	54,477	53,821	31,778
Russia			42,440	49,600	28,041	44,537	44,545	50,207	67,201	51,003	49,100*
United Kingdom	400	514	802		1,706	194	48	938	199	662	
USSR[2]	28,900	13,631[2]									
Poland								22			
Misreported (IVa)					-109,625	-18,647			-177	-40,011	
Misreported (VIa)										-100	
Discards	2,300										
Total	118,700	97,819	139,062	165,973	72,309	135,496	103,376	103,598	134,219	72,848	92,557

[2]Russia.
*Includes small bycatches in Sub area I & IIb
** Faroese catch revised from previously reported 7,628

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

Country	1985	1986	1987	1988	1989	1990	1991	1992
Belgium		49	14	20	37		125	102
Denmark	12,424	23,368	28,217	32,588	26,831	29,000	38,834	41,719
Estonia								400
Faroe Islands	1,356				2,685	5,900	5,338	
France	322	1,200	2,146	1,806	2,200	1,600	2,362	956
Germany, Fed. Rep.	217	1,853	474	177	6,312	3,500	4,173	4,610
Iceland								
Ireland					8,880	12,800	13,000	13,136
Latvia								211
Netherlands	726	1,949	2,761	2,564	7,343	13,700	4,591	6,547
Norway	30,835	50,600	108,250	59,750	81,400	74,500	102,350	115,700
Sweden	760	1,300	3,162	1,003	6,601	6,400	4,227	5,100
United Kingdom	170	559	19857	1,002	38,660	30,800	36,917	35,137
USSR (Russia from 1990)								
Romania								
Misreported (IIa)								
Misreported (VIa)		148,000	117,000	180,000	92,000	126,000	130,000	127,000
Unallocated	-	7,391	8,948	29,630	6,461	-3,400	16,758	13,566
Discards	3,656	7,431	10,789	29,776	2,190	4,300	7,200	2,980
Total	50,466	243,700	301,618	338,316	281,600	305,100	365,875	367,164

Country	1993	1994	1995	1996	1997	1998	1999	2000[1]
Belgium	191	351	106	62	114	125	177	146
Denmark	42,502	47,852	30,891	24,057	21,934	25,326	29,353	27,720
Estonia					-	-		
Faroe Islands	11,408	11,027	17,883	13,886	3,288[2]	4,832	4,370	10,614
France	1,480	1,570	1,599	1,316	1,532	1,908	2,056	1,588
Germany, Fed. Rep.	4,940	1,479	712	542	213	423	473	78
Iceland							357	
Ireland	13,206	9,032	5,607	5,280	280	145	11,293	9,956
Latvia					-	-		
Netherlands	7,770	3,637	1,275	1,996	951	1,373	2,819	2,262
Norway	112,700	114,428	108,890	88,444	96,300	103,700	106,917	142,320
Sweden	5,934	7,099	6,285	5,307	4,714	5,146	5,233	4,994
United Kingdom	41,010	27,479	21,609	18,545	19,204	19,755	31,578	57,110
Russia					3,525	635	345	1,672
Romania		2,903			-	-		
Misreported (IIa)		109,625	18,647	-	-	-	40,000	
Misreported (VIa)	146,697	134,765	106,987	51,781	73,523	98,432	59,882	8,591
Unallocated	-	-	983	236	1,102	3,147	4,946	3,197
Discards	2,720	1,150	730	1,387	2,807	4,753		1,912
Total	390,558	472,397	322,204	212,839	231,484	269,700	299,799	272,160

[1]Includes small catches in IIIb & IIId
[2]Faroese catches revised from previously reported 1,367

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

Country	1984	1985	1986	1987	1988	1989	1990	1991
Denmark	200	400	300	100		1,000		1,573
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	4,095
Germany	11,200	11,800	7,700	13,300	15,900	16,200	18,100	10,364
Ireland	84,100	91,400	74,500	89,500	85,800	61,100	61,500	17,138
Netherlands	99,000	37,000	58,900	31,700	26,100	24,000	24,500	64,827
Norway	34,700	24,300	21,000	21,600	17,300	700		29,156
Poland								
Spain	100				1,500	1,400	400	4,020
United Kingdom	198,300	205,900	156,300	200,700	208,400	149,100	162,700	162,588
USSR	200							
Unallocated	18000	75100	49299	26000	4700	18900	11,500	-3,802
Misreported (Iva)			-148,000	-117,000	-180,000	-92,000	-126,000	-130,000
Discards	12,100	4,500			5,800	4,900	11,300	23,550
Grand Total	479,600	467,700	232,599	284,100	197,000	199,100	182,400	183,509

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	194		2,239	1,443	1,271	-	-	552	82
Estonia				361		-	-		
Faroe Islands		2,350	4,283	4,248	-	2,448[1]	3,681	4,239	4,863
France	9,109	8,296	9,998	10,178	14,347	19,114	15,927	14,311	17,857
Germany	21,952	23,776	25,011	23,703	15,685	15,161	20,989	19,476	22,901
Ireland	76,313	81,773	79,996	72,927	49,033	52,849	66,505	48,282	61,277
Netherlands	32,365	44,600	40,698	34,514	34,203	22,749	28,790	25,141	30,123
Norway		600	2,552			-	-		
Spain	2,764	3,162	4,126	4,509	2,271	7,842	3,340	4,120	4,500
United Kingdom	196,890	215,265	208,656	190,344	127,612	128,836	165,994	127,094	126,620
USSR									
Unallocated	1,472	0	4,632	28,245	10,603	4,577	8,351	9,254	0
Misreported (IVa)	-127,000	-146,697	-134,765	-106,987	-51,781	-73,523	-98,255	-59,982	-3,775
Discards	22,020	15,660	4,220	6,991	10,028	16,057	3,277		1,920
Grand Total	236,079	248,785	251,646	270,476	213,272	196,110	218,599	192,486	266,367

[1]Faroese catches revised from 2,158

Table 2.2.1.5 Landings (tonnes) of mackerel in Divisions VIIIc and IXa, 1977–2000. 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	1999	2000
Spain[1]	16,844	13,446	16,086	16,940	12,043	16,675	21,146	23,631	28,386	35,015	36,174	37,631	30,061
Portugal[2]	4,388	3,112	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080	2,897	2,002	2,253
Spain[2]	3,540	1,763	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613	5,093	4,164	3,760
Total[2]	7,928	4,875	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693	7,990	6,165	6,013
TOTAL	24,772	18,321	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708	44,164	43,796	36,074

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

Table 2.2.1.6 Catches of mackerel by Division and Sub-area in 2000.
(Data submitted by Working Group members.)

Area / Quarter	Q1	Q2	Q3	Q4	Total
I II or Vb	5,382	1,003	84,675	1,496	92,557
IIIabd	7	121	2,465	1,244	3,837
IVa	17,173	488	62,785	184,098	264,544
IVbc	0	87	1,247	2,447	3,781
VI	134,627	5,963	1,196	9,142	150,928
VII	69,530	10,797	559	19,371	100,257
VIIIabde	8,001	4,511	8	2,661	15,181
Sub total	234,721	22,970	152,934	220,459	631,084
VIIIc	22,566	6,020	863	612	30,061
IXa	1,917	903	2,215	979	6,013
Sub total	24,483	6,923	3,077	1,591	36,074
Grand Total	283,686	36,815	159,089	223,642	703,232

2.2.2 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 2.2.2.1 shows the Spanish landings by sub-division in the period 1982-2000. The total Spanish landings of *S. japonicus* in 2000 was 3527 t, increasing compared to 1999. In 2000 the catch in Division VIIIb was 344 t, lower than in 1998 and in 1999. The catch in Sub-division VIIIc East reached 1279 t in 2000, increasing compared to 1999. In Sub-division VIIIc West the catch was 626 t, much higher than in 1998 and 1999, and similar to that in 1997. In Sub-division IXa North the catch was 531 t in 2000, increasing compared 1999, but not attaining the levels reached in the period 1993-1997.

Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all Cantabrian and Galician ports. In the ports of Cantabria and Northern Galicia (Sub-division VIIIc West) catches of *S. scombrus* and *S. japonicus* are separated by species, since each of them is important in a certain season of the year. In the ports of Southern Galicia (Sub-division IXa North) the separation of the catch of the two species is not registered at all ports, for which reason the total separation of the catch is based on the monthly percentages of the ports in which they are separated and on the samplings carried out in the ports of this area. There is probably no mixed 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 748 t of *Scomber japonicus* in 2000. In the bottom trawl surveys carried out in the Gulf of Cadiz in 2000, catches of *S. scombrus* increased compared to previous years, with *S. japonicus* making up 39% and *S. scombrus* 61% 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). Since then, this proportion of the *S. scombrus* has progressively increased, accounting for 61 % in 2000. Due to the uncertainty of the proportion of *S. scombrus* in landings, these catches have never been included in the mackerel catches reported to this Working Group by Spain.

In Portugal the landings of *S. japonicus* from Division IXa (CN, CS and S) were 11,799 t, decreasing compared to 1999 (13,877 t), the highest catches since 1982. The distribution of the catches are similar in the whole period, more abundant in the southern areas than those of the north (Table 2.2.2.1). 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 probably no mixed identification of mackerel species in the Portuguese fishery in Division IXa.

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

Table 2.2.2.1: Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-2000

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427	247	778	362	1218	632	344
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2633	4416	1753	414	1279
	VIIIc west															47	610	12	3	626
Spain	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2679	5026	1765	418	1905
	IXa North												2557	7560.2	4705	5066	1727	412	104	531
	IXa South											895	800	1012.7	364	370	613	969	879	748
	Total	0	0	0	0	0	0	0	0	0	0	895	3357	8572.9	5068	5437	2340	1381	983	1279
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10902.7	7872	8894	7729	4364	2033	3527
	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481	296	146
Portugal	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414	10407	7450
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779	1578	1427	1749	2778	2796	3173	2924
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759	5408	6690	13877	10520
	Division VIIIb										487	7	4	427	247	778	362	1218	632	344
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416	1753	414	1279
	VIIIc west															47	610	12	3	626
	Division VIIIc	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026	1765	418	1905
TOTAL																				
	IXa North												2557	7560	4705	5066	1727	412	104	531
	IXa Central-North		0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481	296	146
	IXa Central-South		244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414	10407	7450
	IXa South		129	3899	4113	4177	3409	2813	4061	2547	3080	3698	2579	2591	1790	2120	3391	3764	4052	3672
	Division IXa	664	373	8059	9118	8184	8876	3816	6447	8568	10142	9876	10698	13003	8952	10195	7748	8071	14860	11799
	Total	986	627	8715	9631	8934	10026	5030	9538	10491	12131	10742	12594	15333	11756	13653	13137	11054	15909	14048

2.3 Stock Components

2.3.1 Biological evidence for stock components

No new biological evidence has been presented to assist in stock component definition for mackerel. The definitions of stock components given in the last WG report have therefore been retained.

2.3.2 Allocation of Catches to Component

Since 1987 all catches taken in the North Sea and Division IIIa have been combined with those from the rest of the Western stock component area. This 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 2000. It should be pointed out that if the North Sea stock component 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 component.

Prior to 1995 catches from Divisions VIIIc and IXa were all considered as belonging to the southern mackerel component, although no separate assessment had been carried out. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern component were combined with those from the western component. This was based on tagging studies which suggested that fish which had spawned in the southern area could be caught in the western or North Sea areas. The same procedure was carried out by the 1997 - 2000 Working Groups and again by the present Working Group, - the new population unit again being called the Northeast Atlantic mackerel stock.

The TAC for the Southern area applies to Divisions VIIIc and IXa. Since 1990, 3,000t of this TAC, which has been fixed at 39,200t, have been permitted to be taken from Division 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.

2.4 Biological data

2.4.1 Catch in numbers at age

The 2000 catches in numbers at age by quarter for NE Atlantic mackerel (Areas I,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 667,158t, which is the best estimate of the WG of total removals from the stock in 2000. 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 2-7 year old fish. These age groups constitute 79% of the total catches which is very similar to 1999. There was an even spread of ages 3 to 6 in catches, which target mackerel in the northern areas. In the southern North Sea, English Channel, northern Biscay area (IVc VIId,e & VIIIa) where mackerel is caught as a bycatch in fisheries for horsemackerel the age distribution is predominantly age group 1 and 2 fish. In the southern areas the catches were mainly comprised of age 0, 1 and 2 fish ,with VIIIc east having a catch age distribution similar to targeted mackerel catches in the northern areas.

Age distributions of catches were provided by Denmark, England, Ireland, Netherlands, Norway, Portugal, Scotland, Spain and Germany. There are still gaps in the overall sampling for age from countries which take substantial catches notably France, Faroes, and Sweden (combined catch of 45,500t) and the UK (England & Wales) who provide aged data for about less than 50% of their catches. In 2000 there were no samples available for the Russian catch (about 51,000t) which was mainly taken in IIa, the only samples available for this Sub-area were from the Norwegian purse seine fleet. In addition there were no aged samples to cover the entire catch from Sub area III, (total catch 3,800t) and some minor catches in Sub-area I and Divisions IIb, VIIa, VIIg, and VIIk. As in 1999 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 2000 catches by some of the fleets were provided by England, Ireland, Netherlands, Norway, Portugal, Scotland, Spain and Germany. The length distributions were available from most of the fishing fleets and account for almost 74% of the catches. These distributions are only intended to give a very rough indication of the size of mackerel by the various fleets and do not reflect the seasonal variations, which occur in many of the landings. More detailed information on a quarterly basis is available for some fleets on the working group files. The length distributions by country and fleet for 2000 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 2000 for the NE Atlantic mackerel 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 2000 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 mackerel are based on a relative weighting of the North Sea, Western, and Southern mackerel components (0.02, 0.73, 0.25 respectively) based on the proportion of egg production in each area from the 1998 egg survey. 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. This year Irish data was used over a slightly longer time period (February to May and included a sample from VIIc). The mean weights at age calculated from this data was very similar to last year.

2.4.4 Maturity Ogive

The maturity ogive was revised by the 1998 Working Group, taking into account new histological analyses from the Southern area. No new information was available this year, and the maturity ogive arrived at in 1998 was used also for 2000.

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 is based 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 in numbers at age (000's) for NE Atlantic mackerel

Quarters 1 to 4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa central	Ixa north	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,265	0	696	0	0	59	12	2	48	0	5,044	24,220	36,345
1	0	85	0	61	2	0	4,187	182	3,667	17	16,113	0	6	3,142	3	8,651	12,683	67	320	8,879	78	6,955	370	2,654	17,589	28	9,649	6,765	102,153
2	31	5,546	11	507	20	1	41,221	1,423	1,439	2,883	30,434	1	10	7,358	16	7,295	12,477	34	1,075	4,713	35	5,404	296	3,622	3,331	1,171	1,559	1,673	133,588
3	155	21,874	56	1,352	34	4	81,268	2,610	786	3,571	51,940	12	5	18,370	833	4,171	9,835	58	3,372	25,217	338	4,240	1,160	13,759	4,094	1,945	531	2,544	254,133
4	320	43,469	116	1,593	5	2	135,177	584	148	6,426	85,196	18	3	22,632	1,055	1,066	4,804	53	1,994	26,227	294	1,726	1,645	7,393	1,250	1,029	266	720	345,211
5	204	27,583	74	1,388	3	4	97,276	773	17	1,928	68,066	8	2	10,590	726	610	4,559	41	1,745	23,060	299	2,033	3,057	14,779	1,553	806	177	813	262,174
6	218	29,477	79	918	1	3	85,409	561	25	1,908	52,819	6	1	10,234	371	573	2,620	25	1,327	15,647	178	1,703	1,825	8,158	372	717	97	147	215,419
7	125	16,941	45	664	2	3	58,073	543	53	1,015	40,376	4	1	7,505	444	245	2,373	16	1,087	9,758	102	2,141	2,357	11,429	373	490	61	110	156,339
8	84	11,290	30	426	1	2	34,270	304	10	540	27,235	3	0	4,307	183	150	1,080	7	1,017	4,817	40	1,472	1,312	5,976	186	469	24	51	95,286
9	41	5,486	15	224	0	1	18,213	107	8	406	11,197	3	0	2,067	178	58	358	6	344	4,190	33	777	644	1,933	58	172	14	14	46,546
10	20	2,768	7	195	0	0	10,266	0	0	133	8,384	1	0	1,963	64	19	26	3	239	2,010	5	231	255	1,027	29	122	15	5	27,787
11	15	2,093	6	86	0	0	6,360	27	2	68	4,191	1	0	880	5	27	3	2	44	1,528	6	76	272	980	27	39	4	4	16,747
12	3	376	1	64	0	0	7,101	40	0	118	4,837	0	0	733	3	167	349	1	97	915	7	138	124	599	20	25	13	4	15,737
13	1	118	0	35	0	0	2,117	0	0	111	3,349	0	0	658	3	0	0	1	0	237	0	0	74	381	12	0	0	1	7,099
14	1	117	0	8	0	0	876	0	0	2	933	0	0	231	1	5	0	0	41	287	0	327	40	258	10	1	0	1	3,139
15	1	116	0	12	0	0	1,442	0	0	55	1,546	1	0	514	3	0	0	0	0	302	3	0	20	94	6	0	0	0	4,118
SOP	628	85,548	227	3,802	17	10	264,410	2,421	1,368	6,152	150,919	19	7	29,030	1,583	5,755	13,966	94	4,445	44,920	516	7,780	5,125	25,580	4,482	2,269	2,253	3,762	667,111
Catch	628	85,551	227	3,810	17	10	264,544	2,413	1,368	6,151	150,909	19	7	28,940	1,587	5,761	13,954	94	4,452	44,945	516	7,784	5,124	25,582	4,479	2,273	2,253	3,760	667,158
SOP%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Quarter 1

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	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
1	0	0	0	0	0	0	0	0	0	0	234	0	0	897	3	0	0	5	0	6,132	78	91	56	599	14,275	0	6,459	4,175	33,003
2	0	0	0	2	0	0	8,000	0	0	2,663	13,985	0	0	4,770	14	627	2,490	5	743	3,493	35	2,365	166	2,086	1,089	464	661	405	44,064
3	0	0	0	3	0	0	9,952	0	0	3,276	36,979	0	0	15,518	799	204	3,417	32	3,010	22,933	338	1,630	954	10,410	2,858	1,649	233	1,827	116,020
4	0	0	0	5	0	0	18,516	0	0	6,050	77,748	0	0	20,407	992	82	2,445	34	1,771	23,065	294	822	1,320	5,694	881	967	149	361	161,603
5	0	0	0	4	0	0	6,057	0	0	1,701	63,859	0	0	9,085	690	94	425	28	1,283	19,896	299	712	2,386	11,641	1,068	704	84	380	120,396
6	0	0	0	2	0	0	5,375	0	0	1,665	50,414	0	0	9,385	346	63	561	19	1,048	12,845	178	536	1,427	6,511	218	573	49	46	91,261
7	0	0	0	2	0	0	3,174	0	0	868	39,328	0	0	6,833	424	73	691	11	704	6,955	102	459	1,828	9,182	200	388	29	27	71,277
8	0	0	0	1	0	0	1,438	0	0	450	26,335	0	0	3,966	173	27	2	5	749	3,607	40	317	1,020	4,829	99	408	12	16	43,495
9	0	0	0	0	0	0	993	0	0	360	10,494	0	0	1,733	168	24	2	3	222	2,216	33	146	502	1,556	29	122	6	3	18,612
10	0	0	0	0	0	0	303	0	0	110	8,157	0	0	1,809	59	18	1	1	222	662	5	128	206	830	13	122	4	1	12,652
11	0	0	0	0	0	0	138	0	0	50	3,991	0	0	780	2	18	1	1	44	473	6	74	217	797	12	26	1	0	6,632
12	0	0	0	0	0	0	250	0	0	91	4,749	0	0	685	2	5	0	1	44	644	7	31	102	484	9	25	2	1	7,131
13	0	0	0	0	0	0	293	0	0	106	3,284	0	0	620	2	0	0	1	0	197	0	0	60	312	5	0	0	0	4,881
14	0	0	0	0	0	0	0	0	0	0	875	0	0	219	1	5	0	0	0	38	0	18	33	212	5	1	0	0	1,408
15	0	0	0	0	0	0	147	0	0	53	1,394	0	0	454	1	0	0	0	0	276	3	0	17	78	3	0	0	0	2,426
SOP	0	0	0	7	0	0	17,169	0	0	5,383	134,638	0	0	25,156	1,515	330	2,291	52	3,357	36,368	516	2,166	3,979	19,835	2,727	1,849	916	1,000	259,254
Catch	0	0	0	7	0	0	17,173	0	0	5,382	134,627	0	0	25,068	1,519	331	2,291	52	3,364	36,389	516	2,170	3,978	19,838	2,728	1,853	916	1,001	259,204
SOP%				100%			100%		0%	100%	100%			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Quarter2

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	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
1	0	74	0	27	0	0	49	33	16	7	0	0	0	13	0	8	132	0	0	0	0	2	4	860	1,070	11	1,729	284	4,318
2	3	1,332	0	209	0	0	879	4	119	131	985	1	2	96	3	478	312	1	14	78	0	205	20	779	1,147	694	564	212	8,267
3	14	991	0	154	0	0	635	9	53	95	4,688	12	1	1,112	34	199	195	9	111	1,586	0	869	184	3,040	1,030	289	145	515	15,969
4	29	291	0	37	0	0	146	4	12	22	6,621	18	0	2,119	64	42	122	16	111	3,132	0	836	312	1,483	275	61	69	260	16,081
5	19	45	0	0	0	0	0	0	17	0	2,230	8	0	1,200	36	70	60	9	124	3,021	0	945	662	2,959	406	102	35	366	12,312
6	20	48	0	1	0	0	0	3	25	0	1,585	6	0	817	25	98	48	6	152	2,800	0	1,157	396	1,596	130	143	22	83	9,159
7	11	27	0	2	0	0	0	4	19	0	932	4	0	652	20	70	35	5	221	2,802	0	1,669	527	2,221	157	102	10	73	9,564
8	8	18	0	0	0	0	0	0	10	0	785	3	0	320	10	42	6	2	152	1,210	0	1,145	291	1,137	81	61	8	31	5,318
9	4	9	0	0	0	0	0	0	8	0	652	3	0	324	10	34	5	2	83	1,973	0	628	142	374	27	50	8	10	4,346
10	2	4	0	0	0	0	0	0	0	0	227	1	0	153	5	0	7	1	14	1,347	0	103	49	196	15	0	10	4	2,139
11	1	3	0	0	0	0	0	0	2	0	200	1	0	99	3	9	1	1	0	1,055	0	2	55	183	14	13	3	3	1,648
12	0	1	0	0	0	0	0	0	0	0	89	0	0	48	1	0	0	0	14	271	0	103	22	114	10	0	12	3	689
13	0	0	0	0	0	0	0	0	0	0	65	0	0	39	1	0	0	0	0	40	0	0	14	69	6	0	0	1	236
14	0	0	0	0	0	0	0	0	0	0	58	0	0	11	0	0	0	0	41	249	0	309	6	46	5	0	0	1	727
15	0	0	0	0	0	0	0	0	0	0	152	1	0	60	2	0	0	0	0	27	0	0	3	16	3	0	0	0	265
SOP	57	876	0	121	0	0	490	12	74	73	5,940	19	1	2,257	68	282	241	17	399	7,530	0	3,041	1,061	5,089	931	410	445	458	29,894
Catch	57	873	0	121	0	0	488	13	74	73	5,944	19	1	2,257	68	282	238	17	399	7,535		3,040	1,060	5,089	931	410	445	458	29,893
SOP%	100%	100%		100%			100%	106%	100%	100%	100%	100%	94%	100%	100%	100%	99%	100%	100%	100%		100%	100%	100%	100%	100%	100%	100%	100%

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

Quarter 3

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	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	22	0	1,926	17,056	19,003
1	0	0	0	3	2	0	430	150	1,164	0	3,540	0	4	98	0	33	318	3	54	10	0	0	5	611	1,968	0	1,029	2,193	11,614
2	28	4,112	11	140	20	0	10,765	1,339	401	0	1,264	0	7	35	0	29	529	4	86	15	0	0	4	221	881	0	237	954	21,081
3	141	20,657	56	724	34	0	17,792	2,015	52	0	253	0	4	7	0	13	293	2	48	8	0	0	4	66	160	0	126	170	42,624
4	291	42,767	116	1,030	5	0	26,163	221	0	0	253	0	3	7	0	8	197	2	33	6	0	0	3	16	62	0	42	76	71,301
5	186	27,276	74	969	3	0	21,467	161	0	0	253	0	1	7	0	5	110	1	18	3	0	0	5	14	54	0	52	53	50,712
6	198	29,145	79	619	1	0	17,081	53	0	0	759	0	1	21	0	3	68	1	11	2	0	0	2	4	16	0	23	14	48,101
7	114	16,742	45	475	2	0	13,855	60	0	0	0	0	1	0	0	2	40	0	6	1	0	0	3	4	10	0	18	8	31,386
8	76	11,168	30	296	1	0	9,117	51	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	2	4	0	3	3	20,755
9	37	5,424	15	131	0	0	5,118	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	1	0	0	1	10,731
10	19	2,737	7	158	0	0	3,698	0	0	0	0	0	0	0	0	1	18	0	3	1	0	0	0	0	1	0	1	0	6,643
11	14	2,069	6	33	0	0	1,274	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,398
12	2	343	1	40	0	0	1,546	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,933
13	1	114	0	7	0	0	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	381
14	1	114	0	7	0	0	282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	404
15	1	114	0	11	0	0	442	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	568
SOP	571	83,873	227	2,445	17	0	62,773	952	298	0	1,200	0	5	33	0	22	415	3	68	12	0	0	8	190	675	0	529	1,687	155,998
Catch	571	83,877	227	2,448	17	0	62,785	949	298	0	1,196	0	5	33	0	22	415	3	68	12	0	0	8	190	673	0	529	1,686	156,012
SOP%	100%	100%	100%	100%	98%		100%	100%	100%		100%		91%	100%		99%	100%	93%	100%	100%			101%	100%	100%		100%	100%	100%

Quarter 4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa central	Ixa north	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,265	0	696	0	0	59	12	2	26	0	3,119	7,164	17,342
1	0	11	0	31	0	0	3,708	0	2,487	10	12,339	0	1	2,135	0	8,610	12,234	60	267	2,738	0	6,862	304	584	276	16	431	114	53,219
2	0	102	0	156	0	1	21,578	80	920	89	14,199	0	1	2,457	0	6,162	9,147	25	233	1,126	0	2,834	106	536	215	12	96	102	60,175
3	0	227	0	471	0	4	52,889	586	681	200	10,020	0	1	1,734	0	3,755	5,930	15	203	690	0	1,741	17	244	45	7	27	32	79,520
4	0	411	0	521	0	2	90,351	359	136	354	574	0	0	99	0	934	2,040	1	79	25	0	68	11	200	31	2	6	23	96,227
5	0	262	0	414	0	4	69,752	612	0	228	1,724	0	0	298	0	441	3,965	3	319	140	0	377	4	165	25	1	7	13	78,754
6	0	284	0	295	0	3	62,953	506	0	243	62	0	0	11	0	409	1,943	0	116	0	0	10	0	46	7	1	4	4	66,898
7	0	172	0	185	0	3	41,044	479	34	147	116	0	0	20	0	100	1,606	0	155	0	0	13	0	23	6	0	5	2	44,111
8	0	104	0	130	0	2	23,715	253	0	90	116	0	0	20	0	81	1,070	0	116	0	0	10	0	9	2	0	1	1	25,719
9	0	53	0	94	0	1	12,102	106	0	46	52	0	0	9	0	0	349	0	39	0	0	3	0	3	1	0	0	0	12,858
10	0	26	0	37	0	0	6,265	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6,353
11	0	21	0	54	0	0	4,949	27	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,069
12	0	32	0	25	0	0	5,305	40	0	28	0	0	0	0	0	162	349	0	39	0	0	3	0	1	0	0	0	0	5,984
13	0	5	0	28	0	0	1,564	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,602
14	0	3	0	1	0	0	594	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600
15	0	3	0	1	0	0	853	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	859
SOP	0	801	0	1,228	0	10	183,987	1,456	996	695	9,142	0	1	1,582	0	5,121	11,019	22	622	1,009	0	2,574	77	466	148	10	363	616	221,946
Catch	0	801	0	1,234	0	10	184,098	1,451	996	695	9,142	0	1	1,582	0	5,126	11,010	22	622	1,009	0	2,574	77	466	146	10	363	616	222,051
SOP%		100%		100%		100%	100%	100%	100%	100%	100%		146%	100%		100%	100%	100%	100%	100%		100%	100%	100%	98%	100%	100%	100%	100%

Table 2.4.1.2 Percentage catch numbers at age for NE Atlantic mackerel

Quarters 1-4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	0%	0%	0%	1%	3%	0%	1%	3%	60%	0%	4%	0%	20%	3%
2	3%	3%	3%	7%	29%	3%	7%	20%	23%	15%	7%	2%	34%	8%
3	13%	13%	13%	18%	50%	19%	14%	36%	13%	19%	13%	21%	18%	20%
4	26%	26%	26%	21%	7%	12%	23%	8%	2%	33%	21%	30%	11%	25%
5	17%	16%	17%	18%	5%	20%	17%	11%	0%	10%	17%	14%	7%	12%
6	18%	18%	18%	12%	1%	17%	15%	8%	0%	10%	13%	10%	5%	11%
7	10%	10%	10%	9%	3%	16%	10%	8%	1%	5%	10%	7%	3%	8%
8	7%	7%	7%	6%	1%	8%	6%	4%	0%	3%	7%	4%	1%	5%
9	3%	3%	3%	3%	0%	3%	3%	1%	0%	2%	3%	5%	0%	2%
10	2%	2%	2%	3%	0%	0%	2%	0%	0%	1%	2%	2%	1%	2%
11	1%	1%	1%	1%	0%	1%	1%	0%	0%	0%	1%	1%	0%	1%
12	0%	0%	0%	1%	0%	1%	1%	1%	0%	1%	1%	1%	0%	1%
13	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%
14	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%

Ages	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0	0%	0%	11%	0%	5%	0%	0%	0%	0%	0%	0%	0%	29%	65%	2%
1	0%	38%	22%	21%	2%	7%	5%	25%	3%	4%	61%	0%	55%	18%	6%
2	0%	32%	22%	11%	8%	4%	2%	20%	2%	5%	12%	17%	9%	5%	8%
3	21%	18%	17%	19%	25%	20%	24%	16%	9%	19%	14%	28%	3%	7%	15%
4	27%	5%	8%	17%	15%	21%	21%	6%	12%	10%	4%	15%	2%	2%	20%
5	19%	3%	8%	13%	13%	18%	21%	7%	23%	20%	5%	11%	1%	2%	15%
6	10%	2%	5%	8%	10%	12%	13%	6%	14%	11%	1%	10%	1%	0%	13%
7	11%	1%	4%	5%	8%	8%	7%	8%	18%	16%	1%	7%	0%	0%	9%
8	5%	1%	2%	2%	8%	4%	3%	5%	10%	8%	1%	7%	0%	0%	6%
9	5%	0%	1%	2%	3%	3%	2%	3%	5%	3%	0%	2%	0%	0%	3%
10	2%	0%	0%	1%	2%	2%	0%	1%	2%	1%	0%	2%	0%	0%	2%
11	0%	0%	0%	1%	0%	1%	0%	0%	2%	1%	0%	1%	0%	0%	1%
12	0%	1%	1%	0%	1%	1%	0%	1%	1%	1%	0%	0%	0%	0%	1%
13	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%
14	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
15	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 2.4.2.1	MACKEREL length distributions in 2000 catches by country and by various fleets.												
Length	Portugal			Spain			Netherlands	Ireland	Norway	Scotland	England		Germany
(cm)	artisanal	purse seine	trawl	artisanal	purse seine	trawl	pel. trawl	pel. trawl	purse seine	Pel. Trawl	hand lines	Pel. Trawl	all gears
13													
14													
15													
16													
17					1%								
18					6%								
19		0%	0%		10%	0%	1%						
20	0%	15%	1%		8%	2%	2%						
21	0%	43%	3%		8%	5%	1%	0%			0%	0%	0%
22	2%	32%	7%		4%	19%	1%	0%		0%	0%	0%	
23	1%	7%	14%		1%	12%	0%	0%		0%	0%	0%	0%
24	0%	2%	12%	0%	0%	6%	0%	0%			0%	0%	
25	0%	1%	9%	0%	0%	2%	0%	0%		0%	2%	4%	
26	1%	1%	8%	0%	1%	2%	1%	2%	0%	0%	8%	8%	0%
27	2%		6%	1%	2%	1%	2%	4%	0%	1%	14%	13%	0%
28	7%		6%	1%	4%	2%	2%	3%	0%	1%	11%	9%	0%
29	11%		8%	2%	6%	5%	3%	2%	0%	1%	8%	11%	1%
30	12%		8%	3%	4%	7%	4%	4%	1%	3%	8%	12%	2%
31	12%		6%	4%	3%	8%	5%	7%	1%	5%	9%	13%	6%
32	12%		4%	4%	3%	7%	7%	11%	3%	8%	11%	10%	8%
33	11%		3%	5%	3%	6%	9%	13%	5%	11%	11%	9%	11%
34	10%		2%	5%	3%	5%	7%	13%	8%	12%	8%	6%	13%
35	7%		1%	6%	4%	3%	9%	11%	13%	12%	5%	3%	14%
36	5%		1%	11%	4%	3%	11%	8%	16%	12%	3%	1%	13%
37	3%		0%	12%	5%	2%	10%	6%	14%	11%	1%	1%	11%
38	1%		0%	16%	6%	2%	9%	5%	14%	10%	1%	0%	9%
39	1%		0%	14%	6%	1%	6%	4%	11%	6%	0%	0%	6%
40	0%		0%	9%	4%	0%	5%	2%	7%	4%	0%	0%	3%
41	0%	0%	0%	4%	2%	0%	2%	1%	3%	2%	0%		2%
42	0%	0%	0%	2%	1%	0%	2%	1%	2%	1%	0%		1%
43	0%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%		1%
44	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%
45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		0%
46					0%	0%							
47	0%		0%		0%	0%				0%			
48	0%		0%			0%			0%				0%
49													
50													

Table 2.4.3.1 Mean length (cm)at age for NE Atlantic mackerel

Quarters 1-4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																	20.6		20.6			20.6	25.5	25.5	22.3		22.2	20.4	20.7
1		25.1		27.1	28.2		29.0	27.4	27.8	27.3	27.7		28.1	26.4	22.9	28.4	27.5	27.6	28.1	23.2	21.0	28.0	28.2	27.2	24.2	27.3	25.7	25.0	26.4
2	31.0	31.0	31.0	32.0	27.9	31.3	31.0	27.4	31.3	29.3	30.6	28.8	30.5	30.0	29.3	31.6	30.2	31.2	30.2	30.5	30.4	30.7	30.1	30.2	29.3	29.3	31.1	30.1	30.6
3	33.6	33.6	33.6	35.1	31.2	34.7	34.1	31.6	33.7	32.5	33.0	32.5	32.8	33.1	33.1	33.5	32.4	33.1	32.2	32.9	33.1	33.0	33.2	32.3	31.9	32.1	33.4	31.9	33.3
4	35.0	35.0	35.0	36.7	32.9	36.0	35.2	34.7	35.2	33.3	34.1	33.6	34.1	33.9	34.4	34.7	33.9	34.3	34.3	34.8	35.5	34.5	35.6	35.4	34.3	34.1	34.8	34.0	34.7
5	36.7	36.7	36.7	38.0	34.0	36.8	36.7	36.2	37.2	34.6	35.8	35.8	35.6	35.3	37.1	36.0	37.3	36.1	36.9	36.7	37.1	35.5	36.7	36.7	35.1	36.6	35.7	34.7	36.4
6	37.3	37.3	37.3	38.5	35.8	37.2	37.5	37.0	38.4	36.0	36.7	36.2	35.3	36.1	39.2	37.3	35.0	36.9	38.7	37.7	38.2	37.7	38.1	38.5	37.1	38.9	36.9	36.3	37.2
7	38.7	38.7	38.7	39.5	33.2	38.4	38.5	37.8	35.3	37.9	37.9	35.8	37.6	36.9	38.8	38.2	36.0	37.5	37.9	38.5	38.8	38.4	38.9	39.1	38.5	37.8	37.7	37.7	38.3
8	38.8	38.8	38.8	39.4	38.4	39.1	39.2	39.0	39.5	38.7	38.7	38.1	39.4	37.6	41.1	42.0	37.4	39.0	39.9	39.7	40.6	40.0	39.5	39.6	38.7	40.2	39.0	37.4	39.0
9	39.6	39.6	39.6	39.8	39.3	40.7	39.7	40.7	41.9	39.0	39.6	39.2	41.9	39.0	41.0	40.7	41.4	39.4	40.6	40.0	40.1	39.9	39.6	39.8	39.2	41.0	40.0	38.4	39.7
10	39.8	39.8	39.8	40.7	37.8		40.4	37.8	40.8	38.6	40.1	37.5	37.6	38.6	44.4	40.7	37.8	38.7	41.5	40.6	40.9	41.3	40.7	41.1	41.3	41.5	40.9	40.0	40.2
11	39.1	39.1	39.1	41.3	39.5	42.5	40.9	42.5	41.5	40.5	40.0	39.5	41.5	40.7	39.4	42.7	42.4	40.4	42.5	42.0	42.2	43.1	41.3	41.3	41.7	42.2	41.9	41.2	40.6
12	44.0	43.8	44.0	41.6		42.7	41.6	42.7	42.5	40.1	40.5	41.0		40.6	40.0	43.5	48.5	43.8	45.8	46.3	51.4	42.8	41.6	41.7	41.5	44.4	43.0	39.4	41.7
13	44.0	43.9	44.0	42.6			41.5			38.1	42.2	39.0		41.0	40.3			40.8		41.2			42.0	41.9	42.8			42.1	41.8
14	44.0	44.0	44.0	43.1			42.7		46.5	43.1	41.3	41.0		39.9	39.9	46.5	46.5	40.1	43.2	41.9		43.4	43.2	42.6	43.3	46.5		42.8	42.1
15	44.0	44.0	44.0	42.5			42.2			37.7	42.5	42.0		42.2	42.3			38.9		33.4	31.5		43.5	43.5	45.3			44.1	41.7

Quarter1

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																													
1											24.4			22.7	22.8			21.9		21.1	21.0	27.4	28.3	27.7	23.2		24.3	22.6	23.0
2				30.1			29.2		30.0	29.2	29.9			29.3	29.1	30.0	28.3	30.1	29.9	30.2	30.4	30.0	29.9	30.2	29.0	29.9	30.9	30.1	29.6
3				33.6			32.5		32.0	32.4	32.8			33.0	33.2	32.0	31.5	32.8	32.1	32.9	33.1	32.1	33.2	32.3	32.0	32.1	33.3	31.8	32.7
4				34.6			33.3		34.0	33.1	34.2			33.9	34.5	34.0	32.5	34.6	34.1	34.9	35.5	34.1	35.5	35.5	34.2	34.1	34.8	33.5	34.1
5				36.1			34.7		34.1	34.3	35.9			35.3	37.2	34.1	34.9	36.4	36.6	36.8	37.1	35.5	36.6	36.8	34.9	36.6	35.7	33.9	36.0
6				37.2			36.0		36.7	35.8	36.7			36.1	39.4	36.7	33.1	37.1	39.0	37.8	38.2	38.0	38.0	38.5	36.8	39.0	37.0	35.7	36.9
7				37.1			37.6		36.8	37.8	37.9			36.9	39.0	36.8	32.9	38.2	37.7	38.7	38.8	37.2	38.9	39.1	38.3	37.7	37.6	37.4	38.0
8				38.5			38.6		39.5	38.6	38.8			37.5	41.2	39.5	39.5	39.3	40.3	40.0	40.6	40.0	39.5	39.6	38.2	40.3	38.8	35.8	38.9
9							38.9		39.1	38.9	39.6			39.0	41.1	39.1	39.1	39.5	40.7	40.1	40.1	39.8	39.6	39.9	38.8	40.7	39.9	38.0	39.6
10							38.2		40.8	38.2	40.2			38.7	44.9	40.8	40.8	39.8	41.5	39.8	40.9	41.2	40.8	41.1	41.4	41.5	40.8	39.2	40.0
11							40.5		43.3	40.5	40.0			40.9	40.3	43.3	43.3	41.4	42.5	41.8	42.2	43.2	41.3	41.3	41.9	42.6	41.6	40.7	40.5
12							39.6		42.5	39.6	40.5			40.6	39.8	42.5	42.5	44.8	44.5	49.5	51.4	43.4	41.8	41.7	41.4	44.5	43.0	37.9	41.4
13							38.0			38.0	42.3			41.1	40.8			41.6		41.6			42.1	41.9	43.6			41.1	41.7
14									46.5		41.3			39.8	39.1	46.5	46.5	39.0		39.0		46.5	43.3	42.6	44.1	46.5		42.1	41.4
15							37.5			37.5	42.5			42.2	42.0			36.6		32.6	31.5		43.6	43.5	45.2			42.6	40.9

Quarter 2

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																													
1		24.5		23.8			24.5	23.4	23.6	24.5			27.2	24.0	24.0	25.5	28.3					25.5	29.5	24.3	26.9	25.5	26.6	26.7	26.2
2	31.0	31.1		31.1			31.1	31.0	28.9	31.1	29.4	28.8	28.9	30.4	30.4	28.8	30.1	28.8	27.5	28.9		28.2	29.9	29.8	28.7	28.8	30.7	28.8	29.9
3	33.6	33.2		33.2			33.2	33.0	32.6	33.2	32.5	32.5	32.5	32.9	32.9	32.5	32.6	32.5	32.4	32.5		32.4	33.3	32.2	31.6	32.5	33.1	32.5	32.5
4	35.0	34.6		34.6			34.5	35.5	34.8	34.5	33.6	33.6	34.5	34.0	34.0	34.7	33.9	33.6	34.8	34.0		34.7	35.9	35.4	34.6	34.7	34.7	34.9	34.1
5	36.7	36.7							37.2		35.6	35.8	37.1	35.9	35.9	37.2	35.6	35.8	35.6	35.9		35.6	36.9	36.7	35.6	37.2	35.8	35.5	36.1
6	37.3	37.3		35.5				35.5	38.4		35.8	36.2	38.4	36.3	36.3	38.5	35.3	36.2	37.6	37.3		37.6	38.2	38.5	37.8	38.5	37.1	36.8	37.3
7	38.7	38.7		40.5				40.5	38.4		36.0	35.8	38.1	36.1	36.1	38.2	37.1	35.8	38.7	38.1		38.7	38.8	39.0	38.8	38.2	37.7	37.9	38.1
8	38.8	38.8							39.5		37.0	38.1	39.5	38.4	38.4	39.5	39.5	38.1	40.1	39.0		40.0	39.5	39.5	39.3	39.5	39.0	38.2	39.1
9	39.6	39.6							41.9		39.5	39.2	41.9	38.9	38.9	41.9	41.9	39.2	39.8	40.0		39.9	39.4	39.8	39.7	41.9	40.0	38.4	39.8
10	39.8	39.8									37.5	37.5	37.6	37.2	37.2		37.6	37.5	41.5	41.0		41.5	40.4	41.0	41.3		40.9	40.1	40.4
11	39.1	39.1							41.5		39.6	39.5	41.5	38.7	38.7	41.5	41.5	39.5		42.1		41.5	41.1	41.3	41.6	41.5	42.0	41.3	41.4
12	44.0	44.0									41.3	41.0		40.3	40.3			41.0	42.5	38.9		42.5	40.6	41.8	41.6		42.9	39.7	40.6
13	44.0	44.0									39.0	39.0		39.5	39.5			39.0		39.0			41.8	41.9	42.2			42.3	40.2
14	44.0	44.0									41.4	41.0		41.5	41.5			41.0	43.2	42.4		43.2	42.8	42.6	42.7			42.9	42.7
15	44.0	44.0									42.0	42.0		42.6	42.6			42.0		42.0			42.9	43.6	45.5			44.2	42.3

Table 2.4.3.1 Mean length (cm)at age (continued)

Quarter 3

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																									22.0		22.4	19.8	20.1
1				27.0	28.2		27.2	28.2	27.0		26.7		28.3	26.7		27.6	28.3	28.3	28.3	28.3			27.2	28.8	29.2		30.4	29.1	28.1
2	31.0	31.0	31.0	31.5	27.9		30.7	27.1	31.2		29.1		30.9	29.1		31.0	30.8	30.9	30.9	30.9			28.9	29.7	30.0		32.0	30.1	30.4
3	33.6	33.6	33.6	35.4	31.2		34.3	30.7	33.5		31.5		32.9	31.5		32.9	32.9	32.9	32.9	32.9			31.7	31.3	31.3		33.9	31.4	33.8
4	35.0	35.0	35.0	36.9	32.9		35.9	32.6			31.5		34.1	31.5		34.1	34.1	34.1	34.1	34.1			35.2	33.6	34.1		34.8	33.6	35.3
5	36.7	36.7	36.7	38.1	34.0		37.2	33.9			35.5		35.4	35.5		35.4	35.5	35.4	35.4	35.4			36.3	34.9	35.3		35.7	35.0	36.9
6	37.3	37.3	37.3	38.5	35.8		37.8	35.6			35.2		34.2	35.2		34.2	34.5	34.6	34.2	34.2			38.0	36.7	35.9		36.5	35.6	37.5
7	38.7	38.7	38.7	39.6	33.2		38.9	32.8					37.5			37.5	37.6	37.7	37.5	37.5			38.5	38.5	37.9		37.9	37.6	38.8
8	38.8	38.8	38.8	39.4	38.4		39.2	38.5									39.5	39.1					38.9	38.8	38.5		39.5	38.0	39.0
9	39.6	39.6	39.6	39.6	39.3		39.6	39.3									41.9	40.1					39.0	39.5	38.6		40.5	38.6	39.6
10	39.8	39.8	39.8	40.7	37.8		40.5	37.8					37.6			37.6	37.6	38.3	37.6	37.6			40.0	41.0	40.1		40.7	40.3	40.2
11	39.1	39.1	39.1	41.1	39.5		41.1	39.5									41.5	42.1					40.8	41.4	41.1		42.1	41.0	39.9
12	44.0	44.0	44.0	41.2			41.2											38.9					39.8	41.4	39.9		51.5	38.7	41.7
13	44.0	44.0	44.0	43.7			43.7											39.0					41.4	42.3	41.7			41.6	43.8
14	44.0	44.0	44.0	43.1			43.1											42.3					43.5	43.6	42.2			42.4	43.4
15	44.0	44.0	44.0	42.5			42.5											42.0						44.4	43.0			43.2	42.8

Quarter 4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																	20.6		20.6			20.6	25.5	25.5	22.5		22.2	21.8	21.4
1		29.3		29.9			29.2		28.1	29.3	28.0		27.4	28.0		28.4	27.5	28.0	28.0	28.0		28.0	28.2	29.4	29.7	28.5	30.4	29.0	28.1
2		31.9		33.8		31.3	31.8	31.3	31.7	32.0	31.5		30.5	31.5		32.0	30.6	31.5	31.3	31.5		31.5	30.4	31.4	30.9	32.3	31.9	31.6	31.5
3		34.3		35.5		34.7	34.3	34.7	33.9	34.4	33.9		32.3	33.9		33.6	32.9	34.1	34.6	34.1		34.1	31.5	33.3	32.1	33.8	33.8	32.8	34.1
4		35.4		36.6		36.0	35.4	36.0	35.3	35.4	35.9		33.8	35.9		34.8	35.5	35.7	38.4	35.7		35.9	32.5	34.0	33.7	35.0	34.8	33.3	35.4
5		36.6		37.7		36.8	36.7	36.8		36.6	33.1		35.0	33.1		36.3	37.7	34.7	38.7	34.7		35.0	32.8	35.0	35.6	36.8	35.8	34.6	36.7
6		37.4		38.7		37.2	37.5	37.2		37.4	37.5		33.4	37.5		37.2	35.6		37.5			37.5	38.2	35.4	36.3	38.3	36.5	35.2	37.5
7		38.5		39.2		38.4	38.4	38.4	33.5	38.5	37.9		34.8	37.9		39.2	37.3		37.8			37.8	38.8	37.4	37.4	40.5	37.8	38.0	38.4
8		39.2		39.4		39.1	39.2	39.1		39.2	38.0		34.5	38.0		44.2	37.3		37.5			37.5	39.3	37.6	37.5	44.5	39.5	38.3	39.1
9		39.7		40.1		40.7	39.8	40.7		39.7	38.5		37.5	38.5		37.5	41.4		41.5			41.5	39.3	37.9	38.0		40.5	38.6	39.9
10		40.4		40.7			40.4			40.4													40.9	39.4	38.0		41.3	40.2	40.4
11		40.5		41.4		42.5	40.9	42.5		40.6													41.1	40.6	40.7		41.5	40.8	40.9
12		41.7		42.1		42.7	41.8	42.7		41.7						43.5	48.5		48.5			48.5	41.3	37.7	37.0	43.5		39.7	42.3
13		41.3		42.4			41.8			41.5													41.5	41.6	41.7			41.7	41.8
14		43.1		43.1			42.5			43.1													42.3	43.3	42.4			42.4	42.5
15		43.0		43.0			42.8			43.0														44.5	43.2			43.2	42.8

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

Quarters 1-4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																	0.056		0.056			0.056	0.111	0.123	0.082		0.074	0.062	0.063
1		0.122		0.170	0.190		0.199	0.173	0.173	0.162	0.149		0.168	0.129	0.078	0.168	0.158	0.154	0.159	0.088	0.054	0.160	0.155	0.152	0.097	0.142	0.116	0.116	0.135
2	0.282	0.275	0.282	0.289	0.183	0.278	0.252	0.173	0.252	0.198	0.221	0.169	0.219	0.197	0.178	0.245	0.214	0.239	0.195	0.213	0.205	0.222	0.190	0.197	0.179	0.172	0.221	0.205	0.229
3	0.383	0.380	0.383	0.402	0.266	0.384	0.354	0.283	0.337	0.279	0.286	0.257	0.279	0.270	0.294	0.301	0.273	0.285	0.241	0.268	0.275	0.276	0.262	0.237	0.222	0.234	0.287	0.224	0.308
4	0.446	0.445	0.446	0.477	0.312	0.433	0.400	0.384	0.401	0.302	0.323	0.285	0.324	0.293	0.334	0.354	0.324	0.316	0.305	0.326	0.350	0.299	0.326	0.318	0.281	0.295	0.328	0.277	0.367
5	0.538	0.537	0.538	0.532	0.357	0.469	0.467	0.445	0.371	0.350	0.384	0.349	0.368	0.338	0.425	0.398	0.449	0.382	0.411	0.393	0.412	0.339	0.360	0.356	0.303	0.393	0.365	0.294	0.429
6	0.555	0.555	0.555	0.567	0.454	0.486	0.501	0.482	0.423	0.398	0.414	0.354	0.350	0.363	0.490	0.423	0.352	0.405	0.473	0.431	0.458	0.416	0.405	0.411	0.364	0.476	0.407	0.342	0.467
7	0.624	0.623	0.624	0.609	0.287	0.538	0.549	0.509	0.339	0.472	0.463	0.353	0.441	0.391	0.501	0.448	0.394	0.434	0.426	0.458	0.485	0.413	0.432	0.430	0.406	0.418	0.444	0.385	0.504
8	0.650	0.650	0.650	0.603	0.486	0.566	0.581	0.553	0.494	0.501	0.491	0.421	0.491	0.420	0.601	0.643	0.444	0.489	0.506	0.498	0.546	0.463	0.457	0.449	0.415	0.523	0.493	0.378	0.537
9	0.676	0.675	0.676	0.638	0.541	0.650	0.613	0.650	0.592	0.513	0.531	0.471	0.592	0.469	0.587	0.539	0.665	0.489	0.528	0.487	0.512	0.475	0.459	0.460	0.432	0.544	0.538	0.407	0.570
10	0.673	0.673	0.673	0.678	0.476		0.647	0.476	0.525	0.503	0.553	0.421	0.454	0.458	0.740	0.523	0.458	0.470	0.516	0.507	0.522	0.506	0.504	0.508	0.511	0.519	0.585	0.465	0.588
11	0.543	0.544	0.543	0.692	0.549	0.747	0.670	0.745	0.544	0.591	0.551	0.477	0.544	0.546	0.467	0.642	0.612	0.540	0.656	0.571	0.651	0.680	0.524	0.515	0.525	0.620	0.646	0.512	0.597
12	0.879	0.865	0.879	0.714		0.761	0.707	0.761	0.646	0.575	0.576	0.519		0.543	0.494	0.754	0.213	0.766	0.470	0.964	1.321	0.613	0.541	0.534	0.521	0.651	0.701	0.448	0.656
13	0.750	0.749	0.750	0.751			0.688			0.469	0.648	0.451		0.557	0.509			0.564		0.586			0.556	0.542	0.571			0.546	0.642
14	0.750	0.750	0.750	0.718			0.721		0.913	0.766	0.616	0.581		0.515	0.494	0.913	0.913	0.540	0.575	0.524		0.593	0.607	0.570	0.593	0.913		0.576	0.629
15	0.800	0.800	0.800	0.727			0.714			0.452	0.662	0.541		0.617	0.591			0.475		0.300	0.235		0.619	0.609	0.685			0.630	0.647

Quarter 1

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																													
1											0.108			0.075	0.077			0.062		0.055	0.054	0.158	0.156	0.147	0.079		0.091	0.072	0.078
2				0.203			0.193		0.196	0.192	0.208			0.177	0.174	0.196	0.160	0.207	0.180	0.203	0.205	0.196	0.186	0.190	0.163	0.182	0.213	0.183	0.194
3				0.297			0.275		0.234	0.273	0.285			0.267	0.296	0.234	0.229	0.271	0.232	0.266	0.275	0.234	0.263	0.235	0.223	0.232	0.276	0.218	0.266
4				0.332			0.298		0.292	0.295	0.326			0.293	0.337	0.292	0.257	0.330	0.294	0.330	0.350	0.294	0.325	0.319	0.275	0.294	0.324	0.257	0.316
5				0.390			0.346		0.298	0.333	0.388			0.341	0.430	0.298	0.327	0.393	0.398	0.401	0.412	0.354	0.359	0.356	0.293	0.396	0.357	0.267	0.379
6				0.432			0.389		0.374	0.382	0.417			0.365	0.501	0.374	0.273	0.422	0.490	0.442	0.458	0.442	0.404	0.411	0.351	0.488	0.405	0.316	0.413
7				0.440			0.453		0.396	0.457	0.465			0.396	0.509	0.396	0.269	0.467	0.421	0.479	0.485	0.408	0.433	0.430	0.395	0.421	0.429	0.366	0.451
8				0.494			0.485		0.500	0.484	0.494			0.420	0.611	0.500	0.500	0.509	0.527	0.525	0.546	0.520	0.457	0.449	0.397	0.527	0.480	0.323	0.485
9							0.500		0.461	0.500	0.534			0.476	0.596	0.461	0.461	0.503	0.525	0.504	0.512	0.491	0.461	0.460	0.416	0.524	0.533	0.388	0.514
10							0.473		0.525	0.473	0.557			0.465	0.769	0.525	0.525	0.517	0.519	0.500	0.522	0.522	0.507	0.508	0.516	0.519	0.578	0.428	0.534
11							0.565		0.690	0.565	0.555			0.561	0.522	0.690	0.690	0.608	0.656	0.632	0.651	0.684	0.526	0.515	0.532	0.658	0.618	0.482	0.559
12							0.531		0.646	0.531	0.576			0.547	0.500	0.646	0.646	0.858	0.649	1.194	1.321	0.647	0.550	0.534	0.522	0.649	0.704	0.387	0.625
13							0.458			0.458	0.652			0.564	0.541			0.613		0.613			0.558	0.542	0.603			0.497	0.615
14									0.913		0.616			0.515	0.475	0.913	0.913	0.501		0.501		0.913	0.611	0.571	0.625	0.913		0.537	0.595
15							0.439			0.439	0.675			0.622	0.605			0.426		0.276	0.235		0.625	0.610	0.675			0.556	0.597

Quarter 2

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																													
1		0.111		0.102			0.111	0.096	0.097	0.111			0.144	0.090	0.090	0.101	0.170					0.101	0.178	0.101	0.128	0.101	0.126	0.123	0.121
2	0.282	0.256		0.256			0.256	0.244	0.165	0.256	0.185	0.169	0.166	0.196	0.196	0.163	0.207	0.169	0.137	0.166		0.150	0.185	0.186	0.156	0.163	0.207	0.158	0.200
3	0.383	0.325		0.322			0.323	0.298	0.247	0.323	0.258	0.257	0.245	0.251	0.251	0.242	0.272	0.257	0.244	0.256		0.244	0.266	0.237	0.214	0.242	0.271	0.233	0.256
4	0.446	0.392		0.374			0.375	0.360	0.315	0.375	0.285	0.285	0.308	0.281	0.281	0.307	0.313	0.285	0.298	0.291		0.298	0.334	0.317	0.286	0.307	0.321	0.292	0.294
5	0.538	0.538							0.371		0.344	0.349	0.370	0.334	0.334	0.371	0.363	0.349	0.307	0.342		0.308	0.366	0.355	0.315	0.371	0.359	0.310	0.343
6	0.555	0.555		0.387				0.387	0.423		0.347	0.354	0.422	0.347	0.347	0.425	0.348	0.354	0.403	0.381		0.403	0.409	0.411	0.381	0.425	0.408	0.350	0.384
7	0.624	0.624		0.608				0.608	0.428		0.361	0.353	0.409	0.340	0.340	0.408	0.423	0.353	0.414	0.405		0.414	0.430	0.430	0.414	0.408	0.431	0.383	0.406
8	0.650	0.650							0.494		0.390	0.421	0.494	0.417	0.417	0.494	0.494	0.421	0.447	0.417		0.447	0.455	0.448	0.432	0.494	0.489	0.394	0.432
9	0.676	0.676							0.592		0.486	0.471	0.592	0.434	0.434	0.592	0.592	0.471	0.469	0.467		0.470	0.453	0.458	0.447	0.592	0.539	0.403	0.470
10	0.673	0.673									0.421	0.421	0.454	0.379	0.379		0.454	0.421	0.487	0.511		0.487	0.491	0.507	0.506		0.585	0.463	0.490
11	0.543	0.543							0.544		0.482	0.477	0.544	0.428	0.428	0.544	0.544	0.477		0.543		0.544	0.514	0.516	0.516	0.544	0.647	0.507	0.524
12	0.879	0.879									0.540	0.519		0.485	0.485			0.519	0.616	0.419		0.616	0.501	0.536	0.520		0.696	0.454	0.502
13	0.750	0.750									0.451	0.451		0.452	0.452			0.451		0.451			0.544	0.541	0.541			0.546	0.486
14	0.750	0.750									0.606	0.581		0.531	0.531			0.581	0.575	0.528		0.575	0.586	0.568	0.560			0.571	0.560
15	0.800	0.800									0.541	0.541		0.580	0.580			0.541		0.541			0.591	0.606	0.694			0.629	0.557

Table 2.4.3.2 Mean weight (kg) at age in the catch for NEA mackerel (continued)

Quarter 3

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																									0.079		0.077	0.056	0.058
1				0.175	0.190		0.165	0.190	0.158		0.146		0.171	0.146		0.163	0.171	0.170	0.171	0.171			0.138	0.188	0.197		0.217	0.195	0.176
2	0.282	0.282	0.282	0.279	0.183		0.246	0.166	0.242		0.199		0.232	0.199		0.234	0.229	0.231	0.232	0.232			0.167	0.207	0.215		0.261	0.219	0.242
3	0.383	0.383	0.383	0.413	0.266		0.369	0.254	0.334		0.225		0.286	0.225		0.289	0.285	0.286	0.286	0.286			0.226	0.230	0.250		0.319	0.251	0.368
4	0.446	0.446	0.446	0.486	0.312		0.439	0.304			0.230		0.325	0.230		0.325	0.325	0.325	0.325	0.325			0.317	0.293	0.326		0.348	0.312	0.442
5	0.538	0.538	0.538	0.539	0.357		0.500	0.355			0.317		0.368	0.317		0.368	0.368	0.367	0.368	0.368			0.350	0.325	0.366		0.381	0.354	0.519
6	0.555	0.555	0.555	0.569	0.454		0.536	0.456			0.312		0.326	0.312		0.326	0.333	0.333	0.326	0.326			0.401	0.383	0.389		0.411	0.379	0.544
7	0.624	0.624	0.624	0.618	0.287		0.587	0.272					0.461			0.461	0.456	0.452	0.461	0.461			0.419	0.435	0.462		0.468	0.448	0.606
8	0.650	0.650	0.650	0.607	0.486		0.609	0.484									0.494	0.417					0.435	0.448	0.485		0.543	0.467	0.631
9	0.676	0.676	0.676	0.635	0.541		0.635	0.541									0.592	0.467					0.437	0.471	0.492		0.593	0.492	0.656
10	0.673	0.673	0.673	0.681	0.476		0.678	0.476					0.454			0.454	0.454	0.466	0.454	0.454			0.476	0.530	0.557		0.606	0.564	0.675
11	0.543	0.543	0.543	0.702	0.549		0.702	0.549									0.544	0.543					0.503	0.547	0.598		0.682	0.591	0.604
12	0.879	0.879	0.879	0.690			0.690											0.416					0.476	0.549	0.549		1.384	0.498	0.724
13	0.750	0.750	0.750	0.761			0.761											0.451					0.526	0.583	0.626			0.622	0.757
14	0.750	0.750	0.750	0.710			0.710											0.530					0.618	0.636	0.651			0.659	0.721
15	0.800	0.800	0.800	0.722			0.722											0.541						0.666	0.692			0.699	0.738

Quarter 4

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXa central	IXa north	Total
0																	0.056		0.056			0.056	0.111	0.123	0.085		0.073	0.076	0.067
1		0.197		0.228			0.204		0.181	0.200	0.151		0.158	0.151		0.168	0.157	0.160	0.156	0.160		0.160	0.155	0.194	0.208	0.170	0.218	0.196	0.164
2		0.274		0.344		0.278	0.277	0.278	0.267	0.277	0.237		0.228	0.237		0.257	0.228	0.249	0.234	0.249		0.248	0.198	0.237	0.236	0.261	0.257	0.253	0.253
3		0.361		0.412		0.384	0.364	0.384	0.344	0.364	0.305		0.276	0.305		0.307	0.297	0.331	0.355	0.331		0.331	0.220	0.294	0.270	0.312	0.315	0.288	0.347
4		0.413		0.469		0.433	0.410	0.433	0.409	0.415	0.377		0.324	0.377		0.362	0.404	0.365	0.551	0.365		0.383	0.242	0.318	0.316	0.369	0.347	0.303	0.409
5		0.474		0.515		0.469	0.468	0.469		0.476	0.279		0.359	0.279		0.424	0.466	0.378	0.510	0.378		0.388	0.252	0.351	0.375	0.449	0.384	0.341	0.462
6		0.504		0.564		0.486	0.502	0.486		0.506	0.442		0.308	0.442		0.430	0.375		0.434			0.434	0.409	0.365	0.401	0.466	0.411	0.364	0.497
7		0.559		0.588		0.538	0.544	0.538	0.289	0.560	0.462		0.354	0.462		0.514	0.446		0.463			0.463	0.429	0.436	0.441	0.560	0.465	0.464	0.540
8		0.587		0.593		0.566	0.577	0.566		0.588	0.463		0.342	0.463		0.768	0.444		0.449			0.449	0.447	0.444	0.442	0.783	0.543	0.480	0.571
9		0.614		0.643		0.650	0.613	0.650		0.615	0.487		0.453	0.487		0.453	0.668		0.674			0.674	0.449	0.457	0.462		0.593	0.488	0.615
10		0.646		0.663			0.637			0.647													0.512	0.504	0.465		0.635	0.559	0.638
11		0.660		0.685		0.747	0.664	0.747		0.662													0.517	0.547	0.579		0.646	0.584	0.665
12		0.721		0.751		0.761	0.721	0.761		0.721						0.758	0.212		0.212			0.212	0.529	0.442	0.427	0.758		0.541	0.689
13		0.713		0.748			0.719			0.719													0.531	0.577	0.624			0.624	0.719
14		0.766		0.766			0.727			0.766													0.565	0.616	0.659			0.659	0.727
15		0.784		0.784			0.757			0.784														0.672	0.699			0.699	0.757

Table 2.4.3.3 Calculation of mean weights in the stock for NEA for the past 3 years

YEAR 1998

weighting according egg prod. by area in 1998

AGE	WESTERN stock weight	WESTERN stock number	SOUTHERN stock weight	SOUTHERN stock number	North S. stock weight	North S. stock number
1	0.070	0.73	0.161	0.25	0.138	0.02
2	0.139	0.73	0.248	0.25	0.23	0.02
3	0.217	0.73	0.305	0.25	0.314	0.02
4	0.277	0.73	0.354	0.25	0.357	0.02
5	0.339	0.73	0.385	0.25	0.438	0.02
6	0.407	0.73	0.427	0.25	0.464	0.02
7	0.405	0.73	0.455	0.25	0.418	0.02
8	0.473	0.73	0.493	0.25	0.471	0.02
9	0.515	0.73	0.511	0.25	0.529	0.02
10	0.567	0.73	0.545	0.25	0.545	0.02
11	0.535	0.73	0.548	0.25	0.55	0.02
12	0.588	0.73	0.617	0.25	0.63	0.02
13	0.550	0.73	0.622	0.25	0.66	0.02
14	0.655	0.73	0.656	0.25	0.68	0.02
15+	0.660	0.73	0.716	0.25	0.69	0.02
			Constant 1984-NOW		**1991/H:11** constant 1984-now	

NORTH EAST ATLANTIC MACKEREL AGE	weighted mean weight	number
1	**0.094**	1
2	**0.168**	1
3	**0.241**	1
4	**0.298**	1
5	**0.353**	1
6	**0.413**	1
7	**0.418**	1
8	**0.478**	1
9	**0.514**	1
10	**0.561**	1
11	**0.539**	1
12	**0.596**	1
13	**0.570**	1
14	**0.656**	1
15+	**0.675**	1
12+	0.624	

YEAR 1999

weighting according egg prod. by area in 1998

AGE	WESTERN stock weight	WESTERN stock number	SOUTHERN stock weight	SOUTHERN stock number	North S. stock weight	North S. stock number
1	0.070	0.73	0.161	0.25	0.138	0.02
2	0.195	0.73	0.248	0.25	0.23	0.02
3	0.237	0.73	0.305	0.25	0.314	0.02
4	0.301	0.73	0.354	0.25	0.357	0.02
5	0.350	0.73	0.385	0.25	0.438	0.02
6	0.401	0.73	0.427	0.25	0.464	0.02
7	0.360	0.73	0.455	0.25	0.418	0.02
8	0.446	0.73	0.493	0.25	0.471	0.02
9	0.491	0.73	0.511	0.25	0.529	0.02
10	0.503	0.73	0.545	0.25	0.545	0.02
11	0.452	0.73	0.548	0.25	0.55	0.02
12	0.565	0.73	0.617	0.25	0.63	0.02
13	0.567	0.73	0.622	0.25	0.66	0.02
14	0.585	0.73	0.656	0.25	0.68	0.02
15+	0.611	0.73	0.716	0.25	0.69	0.02
			Constant 1984-NOW		**1991/H:11** constant 1984-now	

NORTH EAST ATLANTIC MACKEREL AGE	weighted mean weight	number
1	**0.094**	1
2	**0.209**	1
3	**0.256**	1
4	**0.315**	1
5	**0.361**	1
6	**0.409**	1
7	**0.385**	1
8	**0.459**	1
9	**0.497**	1
10	**0.514**	1
11	**0.478**	1
12	**0.579**	1
13	**0.583**	1
14	**0.605**	1
15+	**0.639**	1
12+	0.601	

YEAR 2000

weighting according egg prod. by area in 1998

AGE	WESTERN stock weight	WESTERN stock number	SOUTHERN stock weight	SOUTHERN stock number	North S. stock weight	North S. stock number
1	0.070	0.73	0.161	0.25	0.138	0.02
2	0.187	0.73	0.248	0.25	0.23	0.02
3	0.236	0.73	0.305	0.25	0.314	0.02
4	0.282	0.73	0.354	0.25	0.357	0.02
5	0.350	0.73	0.385	0.25	0.438	0.02
6	0.385	0.73	0.427	0.25	0.464	0.02
7	0.392	0.73	0.455	0.25	0.418	0.02
8	0.448	0.73	0.493	0.25	0.471	0.02
9	0.494	0.73	0.511	0.25	0.529	0.02
10	0.489	0.73	0.545	0.25	0.545	0.02
11	0.539	0.73	0.548	0.25	0.55	0.02
12	0.518	0.73	0.617	0.25	0.63	0.02
13	0.524	0.73	0.622	0.25	0.66	0.02
14	0.552	0.73	0.656	0.25	0.68	0.02
15+	0.574	0.73	0.716	0.25	0.69	0.02
			Constant 1984-NOW		**1991/H:11** constant	

NORTH EAST ATLANTIC MACKEREL AGE	weighted mean weight	number
1	**0.094**	1
2	**0.203**	1
3	**0.255**	1
4	**0.301**	1
5	**0.360**	1
6	**0.397**	1
7	**0.408**	1
8	**0.460**	1
9	**0.499**	1
10	**0.504**	1
11	**0.542**	1
12	**0.545**	1
13	**0.551**	1
14	**0.580**	1
15+	**0.612**	1
12+	0.572	

2.5 Extension of data set for the period 1972-1983

A method for extending the catch data set for the Southern area back to 1972 was presented to the WG last year. The WG found this approach promising. However, it was also realised that the data for the Western area had quite large SOP errors in the early years. Accordingly, the WG then recommended that the catches in numbers and weight in the catches for this period should be revised. So far, this has not been possible to do. To facilitate this process, the Working Group **recommends that a sub group of the Working Group on verifying catch at age and catch number data for mackerel for the early period (back to 1972) in the western area meet in Dublin for two days prior to the meeting of WGMEGS in April 2002.**

2.6 Fishery Independent information

2.6.1 Preliminary Results of the 2001 Mackerel and Horse Mackerel Egg Survey

The following represents a preliminary investigation into the results of the 2001 Mackerel egg survey in the western area. It is intended as a guide for the WGMHSA and does not represent a complete or definitive analysis of the survey.

All surveys carried out under the programme in the western area have been completed and the data checked and assimilated to the data base. The only exception is the English survey in periods 4 & 5 where the data are incomplete – approximately half the stations having been analysed. These would be expected to be those stations with the most eggs. Survey data from the southern area has yet to be analysed. Additional data from an Irish plankton survey will also be available for periods 3 & 4 later in the year.

The survey has been analysed using five contiguous periods – see table below

Period	Dates
3	11 March – 8 April
4	9 April – 13 May
5	14 May – 10 June
6	11 June – 1 July
7	2 July – 23 July

The analysis protocols followed those described in the report of WGMEGS (ICES 2000/G:01). Interpolation into unsampled rectangles was carried out manually according to the rules set down in that report. Arithmetic means were used where more than one sample per rectangle per period were collected.

Conversion to biomass was carried out using the same factors (PreSB-SSB, Fecundity and sex ratio) as in 1998.

Results

Figures 2.6.1 – 5 show the mean daily egg production for mackerel by rectangle by period. Post plots of daily egg production values were square root scaled to the maximum at a single station of 600 eggs m^{-2} d^{-1}.

- Period 3 (Fig 2.6.1) – Due to the skeletal nature of the survey there was a lot of interpolation, but this was usually well established. Outside edges were well defined except between 48 & 49°N and at 53° 45N.

- Period 4 (Fig. 2.6.2) – Good coverage, well defined edges, little interpolation.

- Period 5 (Fig. 2.6.3) – Good coverage and edge definition, except at SW edge of Porcupine Bank at 51°N.

- Period 6 (Fig 2.6.4) – A considerable amount of interpolation, but coverage and edges were good.

- Period 7 (Fig 2.6.5) – Again much interpolation, but this was well based. The southern edge of the surveyed area had the highest production in this period, and was, therefore, not well defined. However, this production was low compared to all other periods.

These data were then converted to the total annual egg production using rectangle area and the number of days per period. The annual egg production curve for the western area is presented in Figure 2.6.6, with the 1998 western data for comparison. The production curve for 2001 was more similar to earlier surveys than the somewhat unusual 1998 curve. Maximum production was in period 5 (May/June). The shape of the curve from the fixed start date through periods 3 and 4 suggests that the use of this start date is reasonable. The very low figure in Period 7 also validates the end date. Essentially the curve appeared better established than in 1998.

The following table details the integrated egg curve and the analysis through to a very preliminary biomass.

Parameters used in the calculation	
Total Annual Egg Production	$1.08842 * 10^{15}$
Realised Fecundity (eggs g female^{-1})	1002
Female fraction	0.5
Pre spawning Biomass to SSB conversion	1.08
Biomass	
Pre-spawning biomass (tonnes)	2,172,000
SSB (tonnes)	2,346,000
Decrease (tonnes)	604,000
Percent decrease	20.4

All these data should be treated with extreme caution. The egg production curve is based on incomplete data, although any additional data should result in only small adjustments. The periods used and the interpolated values may be adjusted by WGMEGS at their meeting in April 2002. The fecundity value used to convert to biomass is the value determined in 1998. This value was the subject of considerable controversy in 1998, as it was based on a small number of observations and was the lowest in the time series.

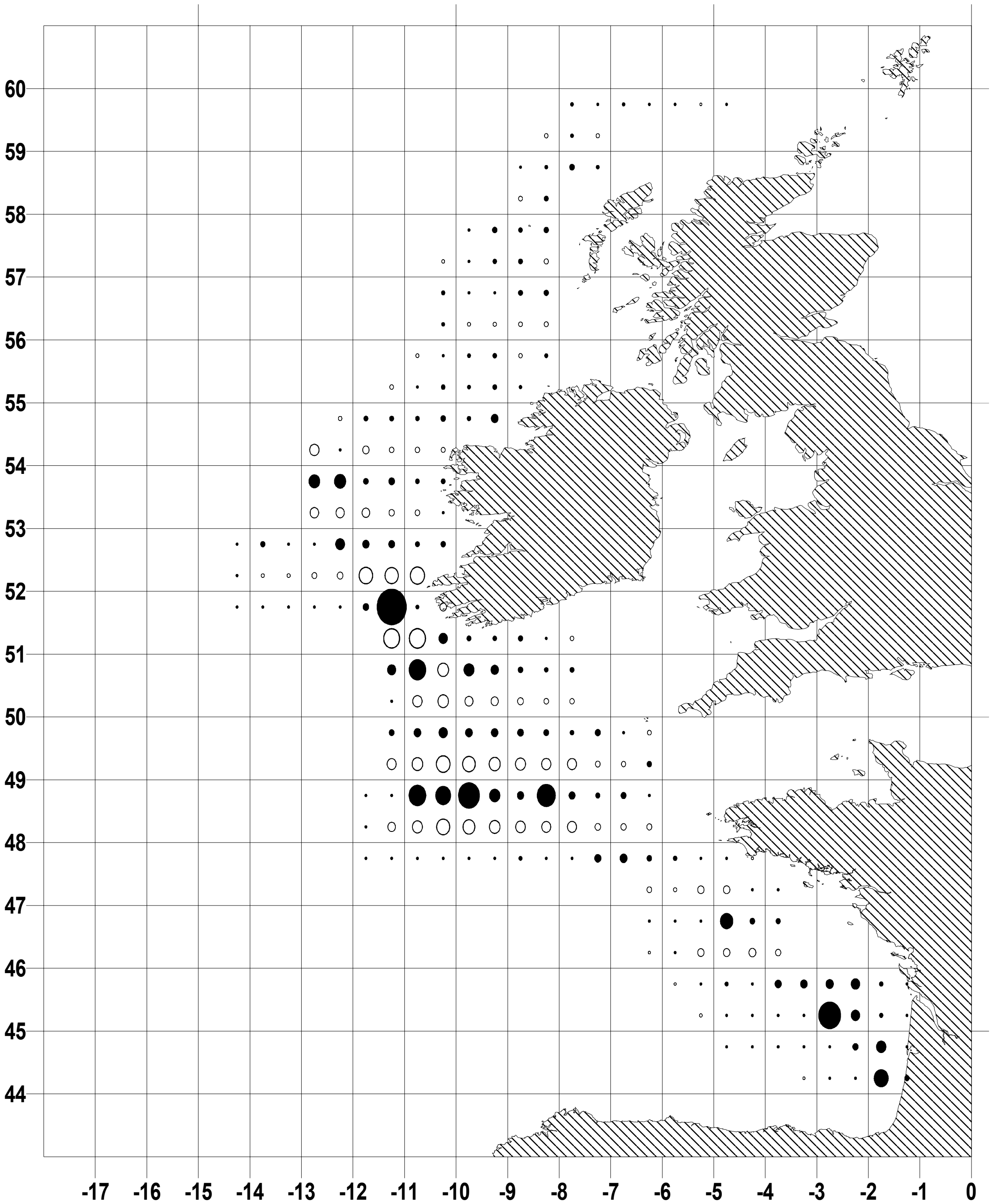


Figure 2.6.1 Daily mackerel egg production m^{-2} in period 3
(Scaled to a maximum of 600 eggs.m^{-2}.d^{-1} – the smallest circles represent zero values)

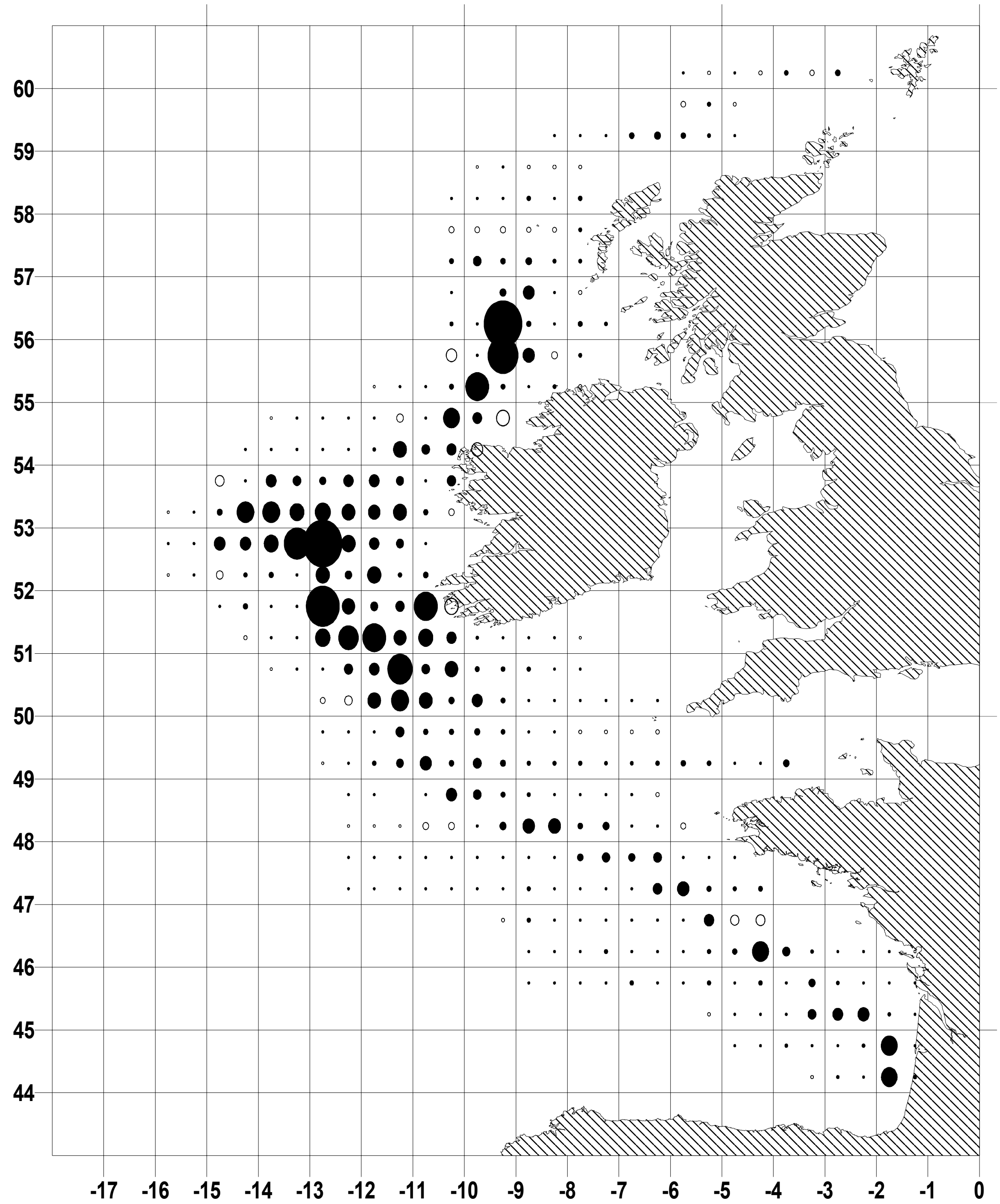


Figure 2.6.2 Daily mackerel egg production m^{-2} in period 4
(Scaled to a maximum of 600 eggs.m^{-2}.d^{-1} – the smallest circles represent zero values)

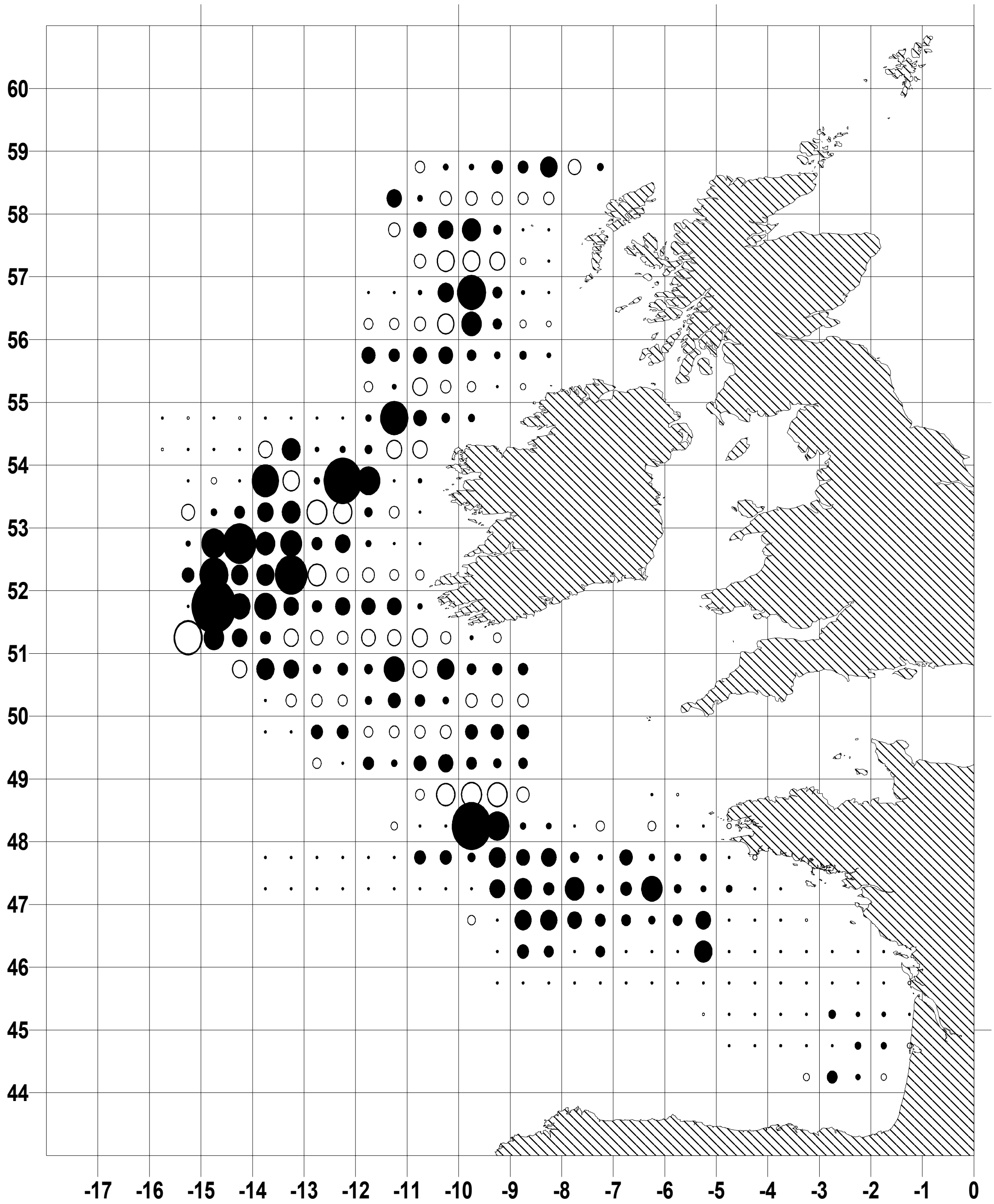


Figure 2.6.3 Daily mackerel egg production m^{-2} in period 5
(Scaled to a maximum of 600 eggs.m^{-2}.d^{-1} – the smallest circles represent zero values)

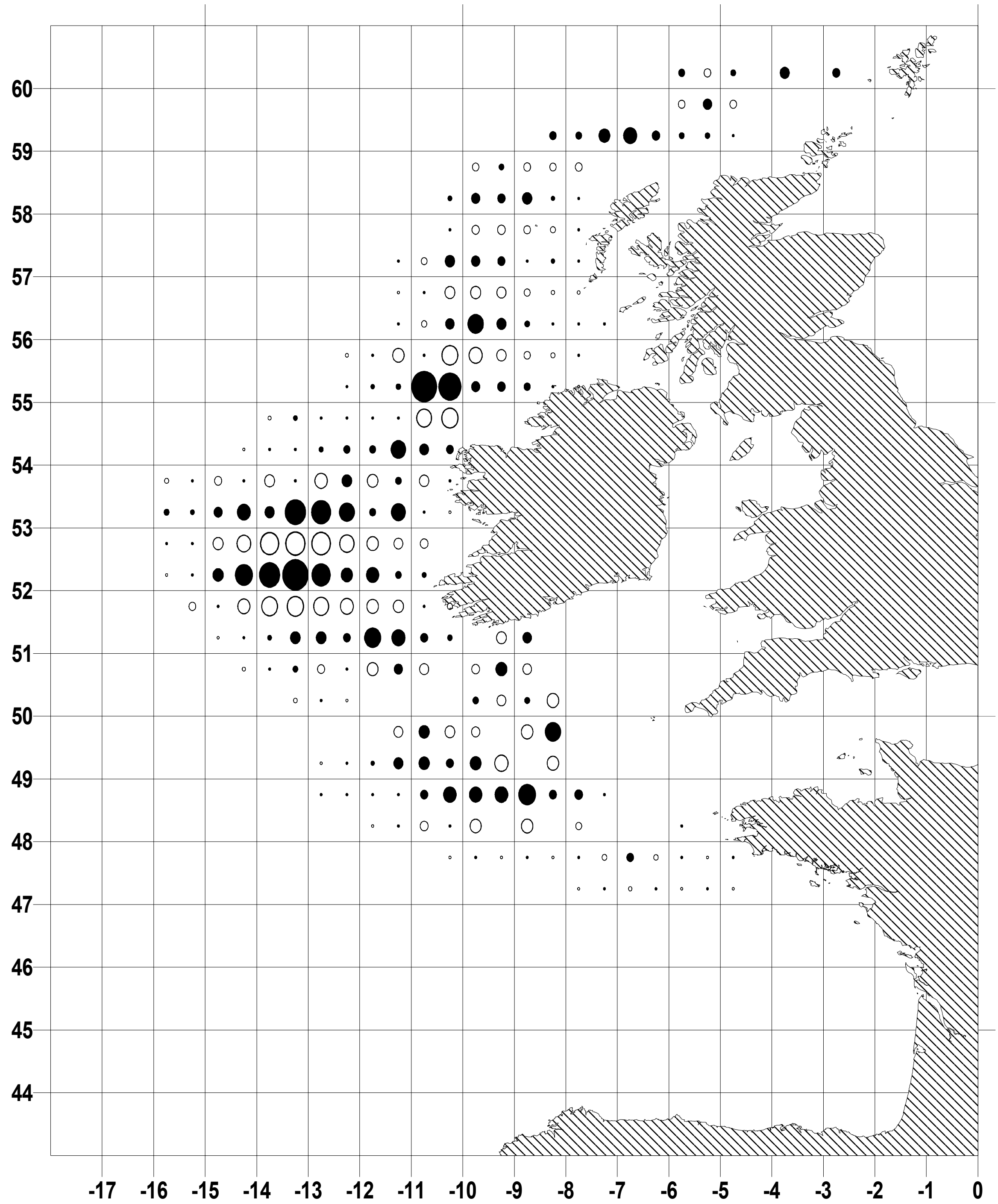


Figure 2.6.4 Daily mackerel egg production m^{-2} in period 6
(Scaled to a maximum of 600 eggs.m^{-2}.d^{-1} – the smallest circles represent zero values)

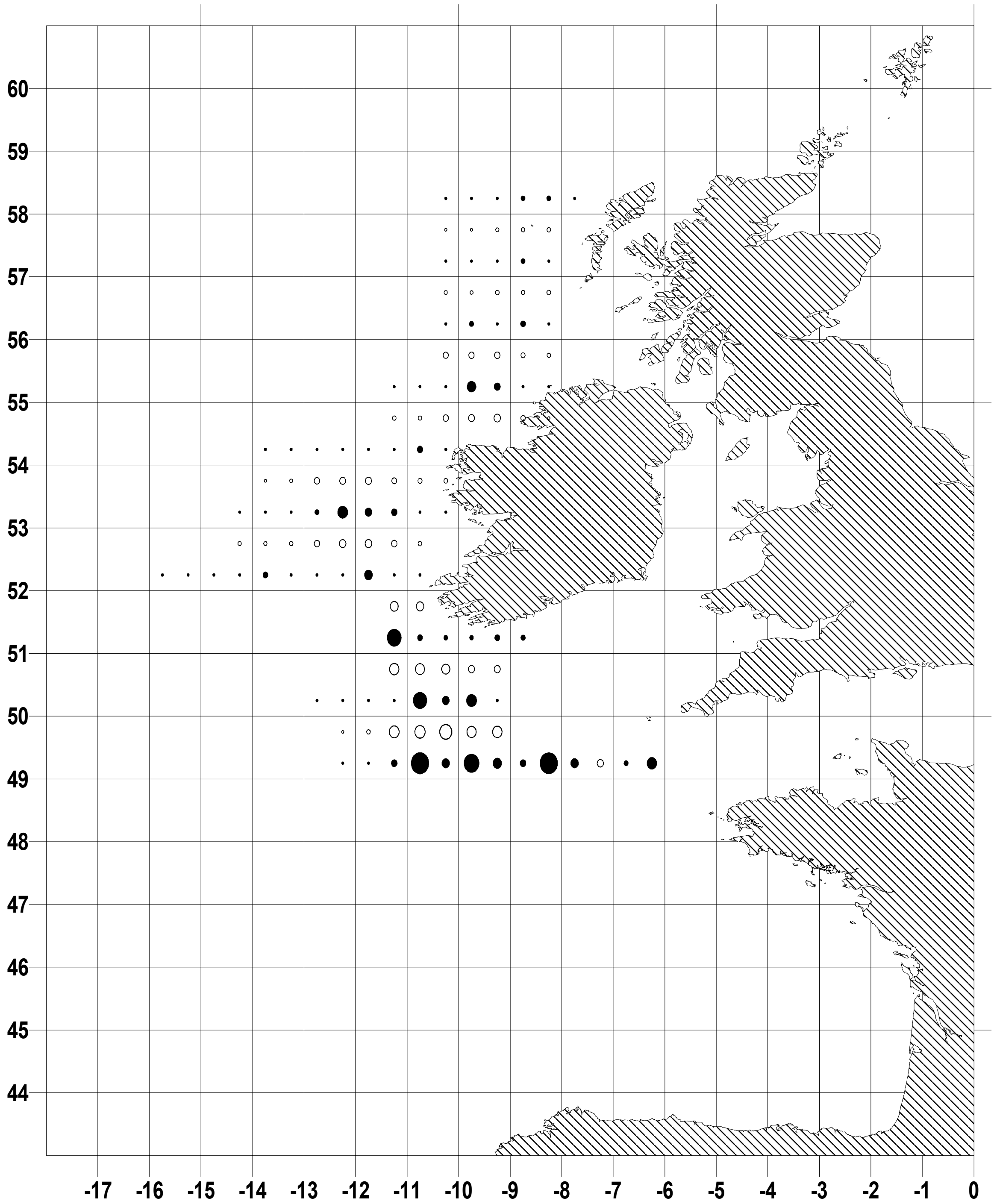


Figure 2.6.5 Daily mackerel egg production m^{-2} in period 7
(Scaled to a maximum of 600 eggs.m^{-2}.d^{-1} – the smallest circles represent zero values)

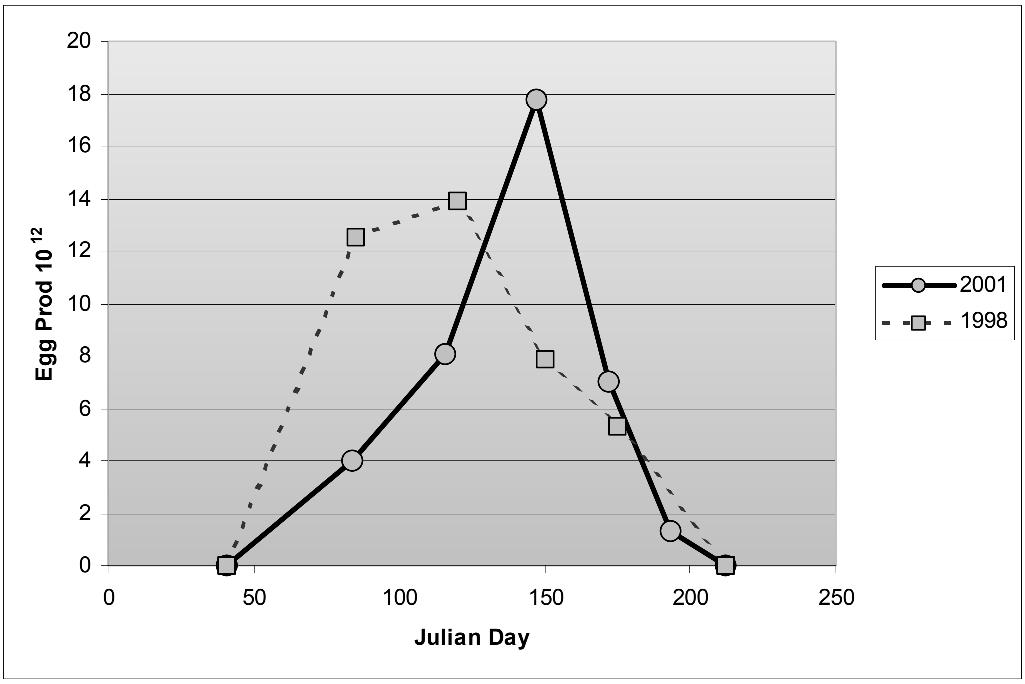


Figure 2.6.6 Mackerel daily egg production curves for the 1998 and 2001 egg surveys in the western area.

2.7 Effort and Catch per Unit Effort

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

Table 2.7.1 and Figure 2.7.1 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 2000 and from 1990 to 2000 respectively, for which mackerel is the target species from March to May. The Figure also shows the effort of the Aviles and A Coruna trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 2000. 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. The effort of the hand-line fleet increased since 1994 to 1998 but decreased in 1999 and 2000, mainly for the Santoña fleet. The effort of the trawl fleets is rather stable during the entire period. The purse-seine fleet effort fluctuated during the available period.

Portuguese Mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988 - 2000 is also included and as in Spain mackerel is a by catch. The effort for this fleet increased in 1998 in comparison to the previous years. In 1999 and 2000, the effort decreased in comparison to 1998.

Figure 2.7.2 and Table 2.7.2 show CPUE corresponding to the fleets referred to in Table 2.7.1. The CPUE trend of the Spanish hand-line fleets shows an increase since 1994 to 1999, decreasing in 2000. The CPUE for the Aviles trawl fleet has increased since 1994, in particular in 2000, and for the A Coruña trawl fleet is rather stable during the entire period. The CPUE of the Portuguese trawl fleet shows a decrease since 1992 to 1998, increasing in 1999 and 2000.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the hand-line and trawl fleets is shown in Table 2.7.3.

Table 2.7.1 SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Av. HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Nº fishing trips)	VIGO (Subdiv.IXa North) (Nº fishing trips)	(Subdiv.IXa CN,CS&S) (Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	12568	33999	-	-	20	-
1984	10815	32427	-	-	700	-
1985	9856	30255	-	-	215	-
1986	10845	26540	-	-	157	-
1987	8309	23122	-	-	92	-
1988	9047	28119	-	-	374	55178
1989	8063	29628	-	605	153	52514
1990	8492	29578	322	509	161	49968
1991	7677	26959	209	724	66	44061
1992	12693	26199	70	698	286	74666
1993	7635	29670	151	1216	-	47822
1994	9620	39590	130	1926	-	38719
1995	6146	41452	217	1696	-	42090
1996	4525	35728	560	2007	-	43633
1997	4699	35211	736	2095	-	42043
1998	5929	-	754	3022	-	86020
1999	6829	30232	739	2602	-	55311
2000	4453	30073	719	1709	-	69846

Table 2.7.2 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	-	15.4
1999	136.4	42.9	2438.0	2084.7	-	23.9
2000	311.6	65.1	1795.5	1879.7	-	24.7

Table 2.7.3. SOUTHERN MACKEREL. CPUE at age from fleets.

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

		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9
1995	1696	0	41	83	793	1001	789	1092	998	928	519	339	300	159	83	81	63
1996	2007	0	0	28	401	1234	865	701	1361	802	773	330	288	105	13	28	18
1997	2095	0	7	255	709	3475	2591	894	880	693	471	248	146	98	24	11	11
1998	3022	0	1	100	1580	2017	4456	3461	1496	1015	1006	594	428	443	155	114	296
1999	2602	0	1	230	1435	3151	2900	3697	1956	758	424	317	233	131	75	21	18
2000	1709	0	1	34	619	877	2098	1297	1822	913	282	125	122	62	42	26	9

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

		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1990	322	0	0	0	6	25	66	132	41	86	83	28	8	11	0	2	2
1991	209	0	0	5	45	96	60	39	43	14	14	23	4	1	1	1	4
1992	70	0	0	4	60	47	51	15	7	8	2	2	2	0	0	0	0
1993	151	0	0	1	2	43	26	63	33	15	15	9	5	3	3	1	2
1994	130	0	2	18	56	110	205	146	101	40	36	18	10	5	2	2	1
1995	217	0	3	33	171	168	144	225	227	222	107	70	56	22	9	11	9
1996	560	0	0	6	89	276	191	152	293	171	164	70	60	22	3	6	4
1997	736	0	0	22	170	963	754	368	472	398	328	170	100	74	18	8	10
1998	754	0	391	86	486	644	1419	1035	403	250	232	127	96	82	19	9	9
1999	739	0	24	211	668	1541	1006	1174	496	183	83	65	44	23	13	4	1
2000	719	0	0	2	110	285	781	534	777	388	133	62	58	35	21	13	3

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

		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	2	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1
1995	6146	0	9	139	261	168	125	177	156	147	74	50	44	20	10	11	9
1996	4525	0	327	126	274	527	149	81	134	70	63	27	21	8	1	2	3
1997	4699	368	786	934	183	391	167	48	49	43	37	22	14	13	3	2	5
1998	5929	0	537	1442	868	237	341	221	74	34	29	15	10	9	1	0	1
1999	6829	2	601	746	685	730	262	284	117	41	15	10	6	2	2	0	0
2000	4453.4	1	380	594	1889	629	878	268	297	128	41	16	12	10	4	2	0

Table 2.7.3. (Cont'd)

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

		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41452	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35728	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35211	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	-	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18
1999	30232	4461	444	292	409	512	314	399	220	112	85	74	59	34	20	6	17
2000	30073	40	9283	902	1932	642	781	170	158	79	24	12	11	9	5	4	3

IXa trawl fleet (Portugal) (Catch thousands)

		Catch															
Year	**Effort C(**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	55178	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	52514	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	49968	2840	5729	1967	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	44061	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	74666	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	47822	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	38719	650	1128	1447	342	125	94	65	21	4	1	2	0	1	0	0	0
1995	42090	1001	2690	983	295	99	59	46	40	25	17	16	8	5	0	0	1
1996	43633	423	1293	778	490	269	86	88	129	98	109	66	34	17	6	0	1
1997	42043	318	885	1763	181	98	125	95	59	47	20	20	6	10	0	0	0
1998	86020	1873	3950	1265	171	47	39	40	56	23	14	19	51	32	13	0	5
1999	55311	2311	3615	1384	316	94	55	32	13	2	2	1	1	1	0	0	0
2000*	69846	2730	6318	1328	424	226	135	71	40	20	9	13	4	11	0	0	0

(-) Not available
* preliminary

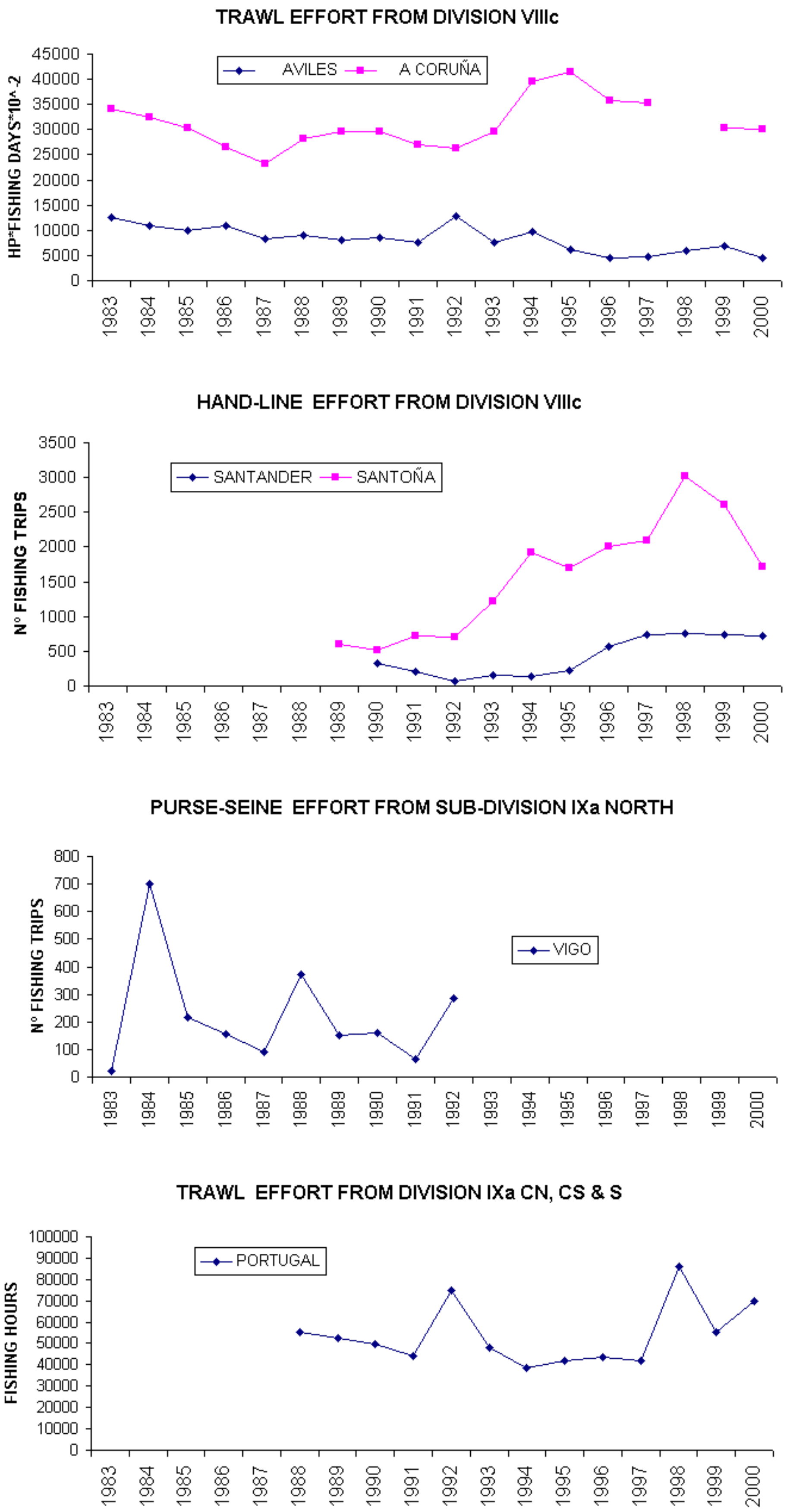
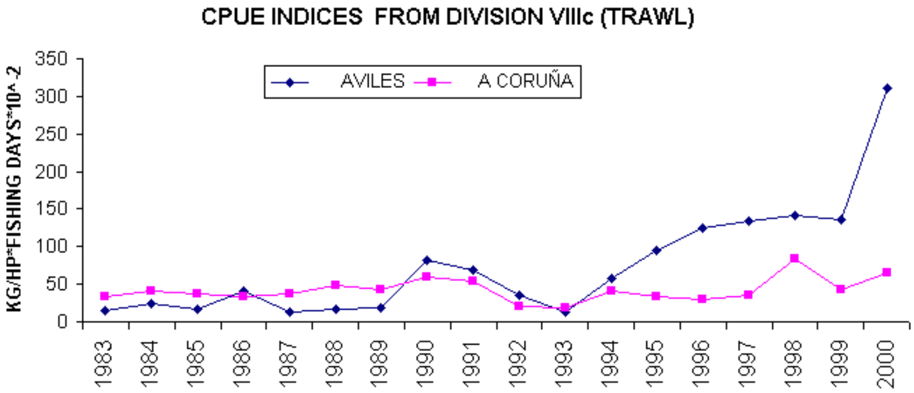
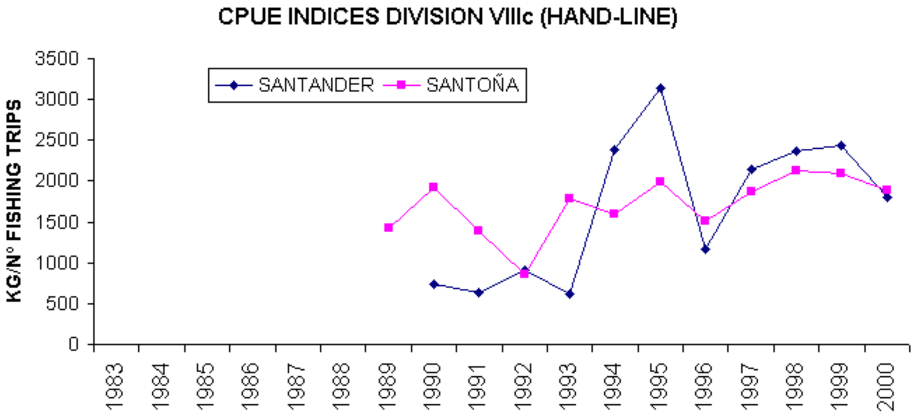
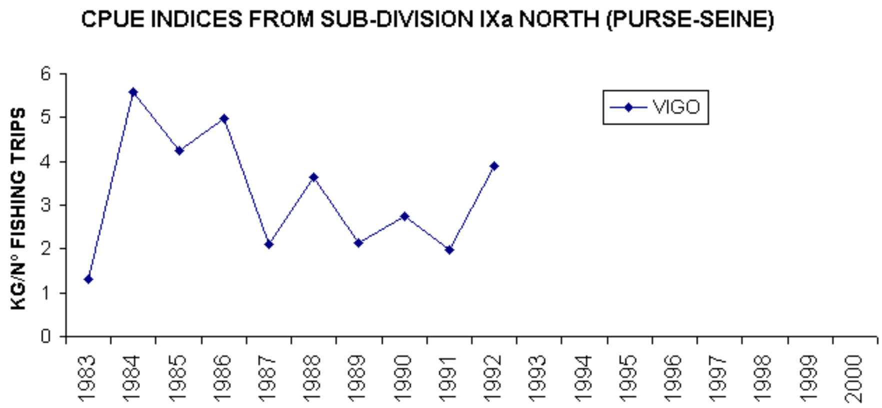


Figure 2.7.1 : SOUTHERN MACKEREL. Effort data by fleets and area







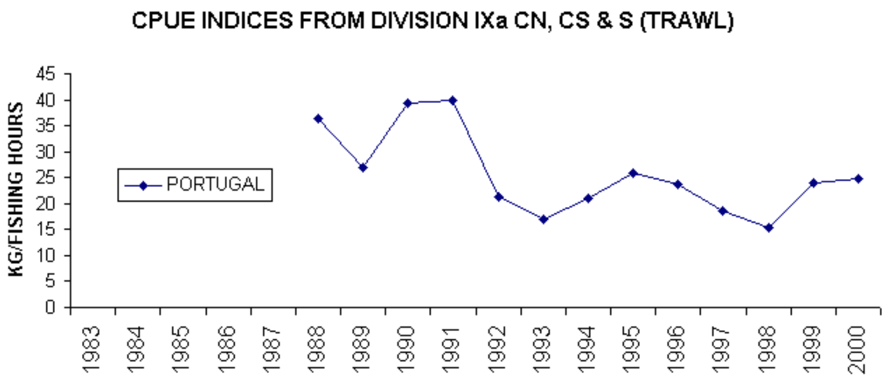


Figure 2.7.2 : SOUTHERN MACKEREL. CPUE indices by fleets and area

2.8 Distribution of mackerel in 2000 - 2001

2.8.1 Distribution of commercial catches in 2000

The distribution of the mackerel catches taken in 2000 is shown by quarter and rectangle in Figures 2.8.1.1 – 4. These data are based on catches reported by Portugal, Spain, Netherlands, Germany, Denmark, Norway, Russia, Faroes, UK, Ireland, and Sweden. In these data the Spanish catches are not based on official data. Not all official catches are included in these data. The total catches reported by rectangle were approximately 613,880 tonnes including Spanish WG data, the total official catches were approximately 619,000 tonnes.

First Quarter 2000

Catches reported by rectangle during this quarter totalled about 239,200 tonnes, up by about 20% from 1999. The perennial problem of mis-reporting between Divisions IVa and VIa, which gave large catches just west of 4° W, seemed to be increased again from 1999. However, there is some anecdotal evidence from the fishery of an early migration again out of the North Sea as was seen in 1999. The relaxation of fishing regulations in IVa in the first quarter should also have reduced the pressure to misreport. So it may be that the plot is a reasonable reflection of what was actually happening in the fishery. Otherwise, the general distribution of catches was similar to 1995 to 1999, suggesting that the pattern and timing of the pre-spawning migration remains relatively constant. Slightly less catches were apparently taken in the English channel area in 2000 than in 1999, although 1999 catches were higher than in 1998. The catch distribution is shown in Figure 2.8.1.1.

Second Quarter 2000

Catches during this quarter totalled about 19,420 tonnes, down substantially from 1999. The general distribution of catches was similar to 1999, although slightly less extensive in the North Sea and mostly absent in the English channel. The catches taken in international waters east and north of the Faroe Islands were again reduced as also happened in 1999. Similar fishing patterns to 1999 were apparent around the Iberian peninsula. The Russian fleet took 57 t in a rectangle at 70° 45N, 34° 30E.The catch distribution is shown in Figure 2.8.1.2.

Third Quarter 2000

Catches during this quarter totalled about 147,660 tonnes, down by around 20,000 tonnes from 1999. The general distribution of catches was similar to 1999, with the main catches being taken in international waters and off the Norwegian coast. There was a slight increase in catches around the Shetland Islands. The scattered catches on the western side of the British Isles were quite similar to 1999. The increased catches reported on the Dutch coast were reduced in 2000. Catches in the Iberian area were very similar to 1999, although slightly more patchy than in 1999. The Russian fleet took 571 t in a rectangle at 70° 45N, 34° 30E. The catch distribution is shown in Figure 2.8.1.3.

Fourth Quarter 2000

Catches during this quarter totalled about 207,600 tonnes, up by 40,000 tonnes from 1999. The general distribution of catches was very similar to 1998. The main catches were taken in the area west of Norway across to Shetland. There was some evidence of mis-reported catches west of 4°W, and west of 8°W near the Faroes, but this was not substantial. Only small catches were taken west of Scotland, but catches west of Ireland were similar to 1999. The increase in catches seen in the English Channel in 1999 was less apparent in 2000. The catch distribution is shown in Figure 2.8.1.4.

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

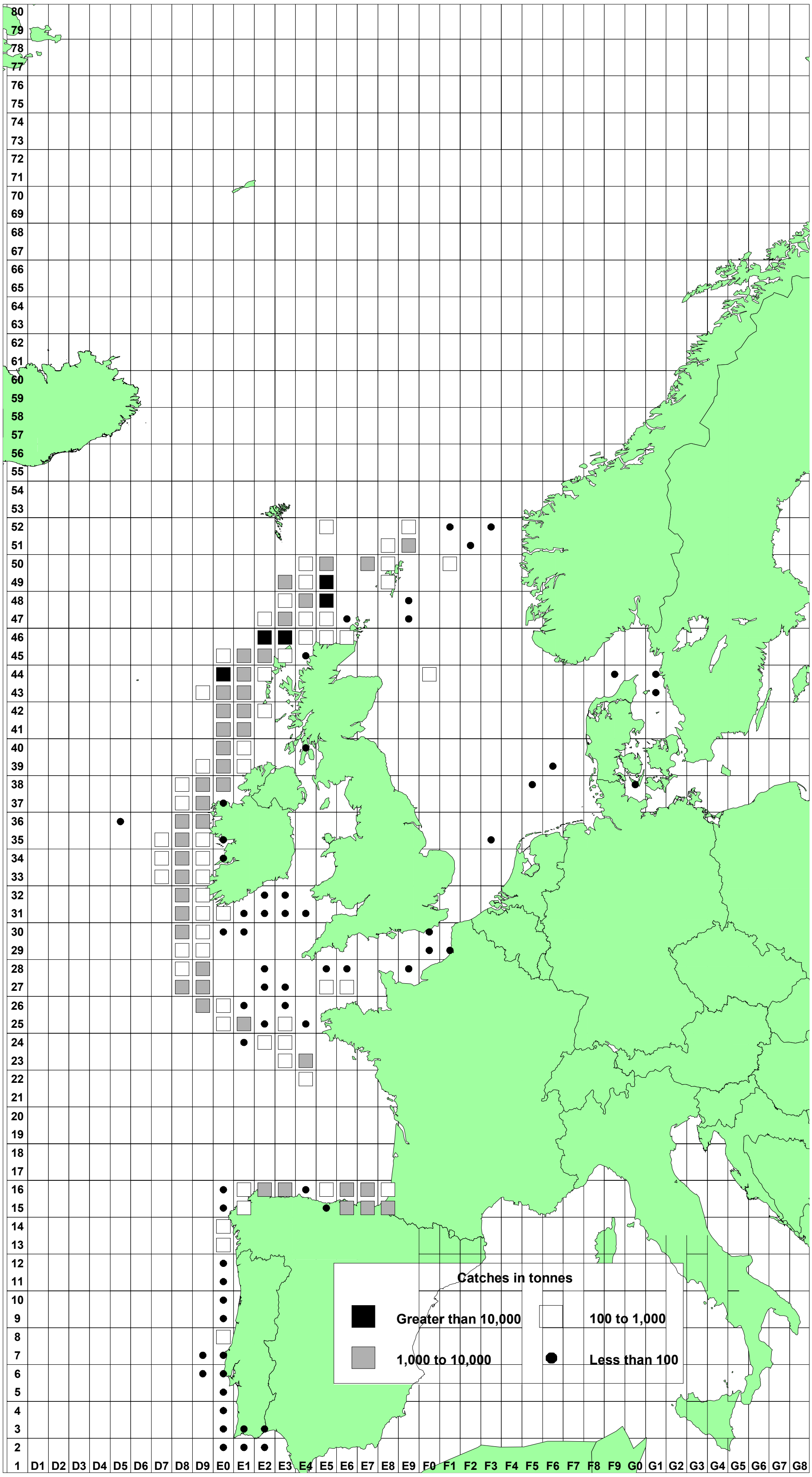


Figure 2.8.1.1. Mackerel commercial catches in quarter 1, 2000.

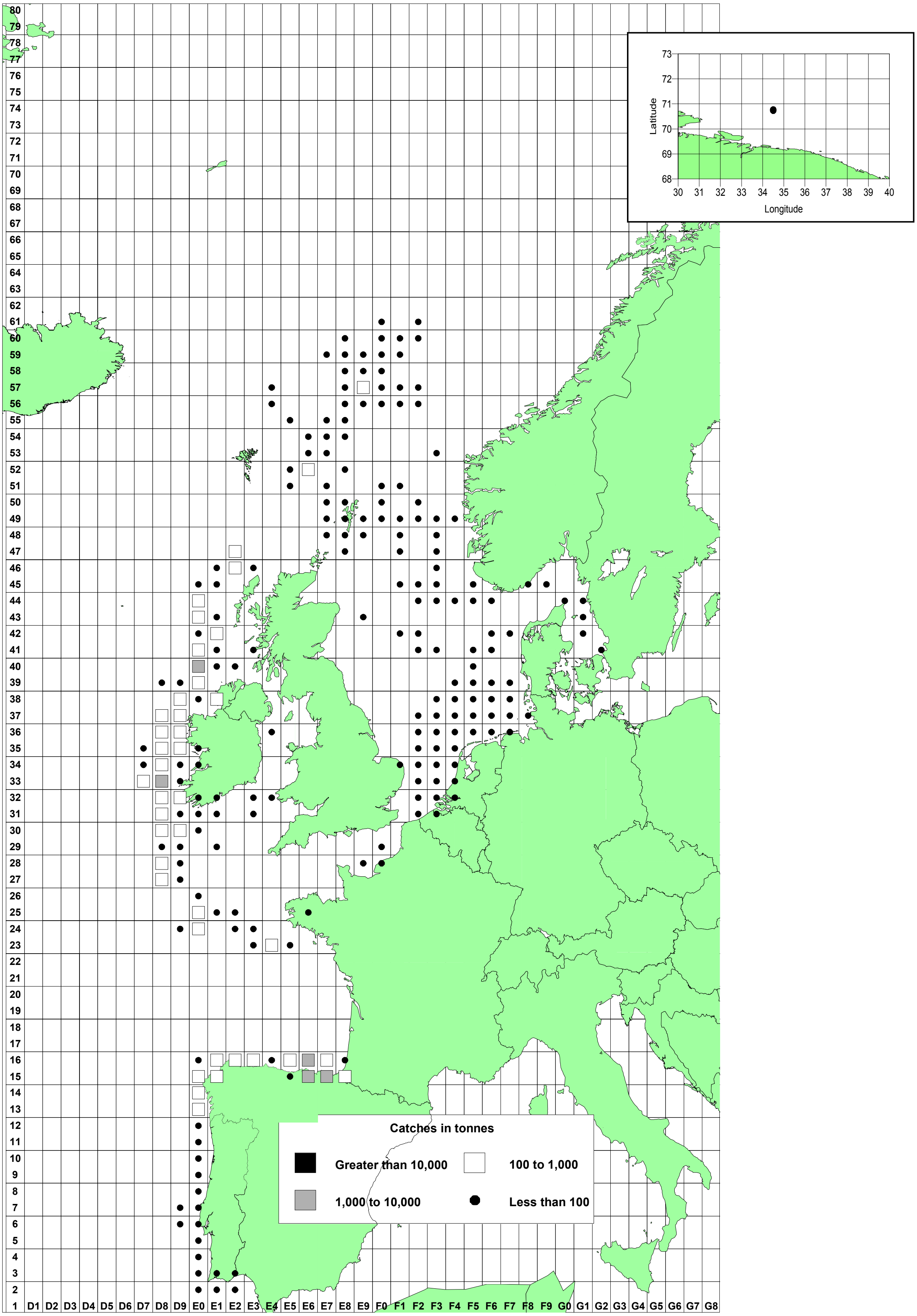


Figure 2.8.1.2. Mackerel commercial catches in quarter 2, 2000. Inset - Catches in Barents Sea.

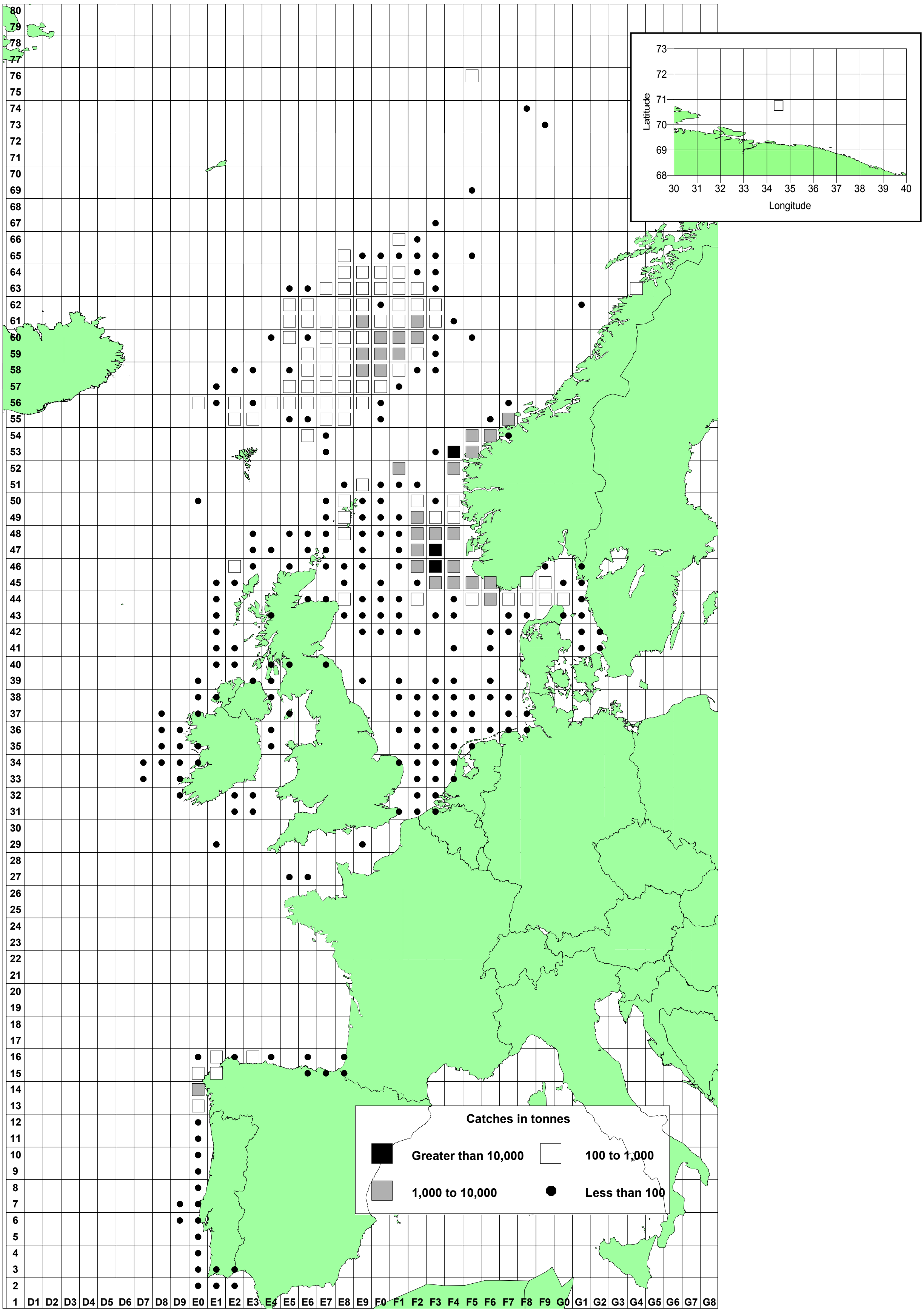


Figure 2.8.1.3. Mackerel commercial catches in quarter 3, 2000. Inset - Catches in Barents Sea.

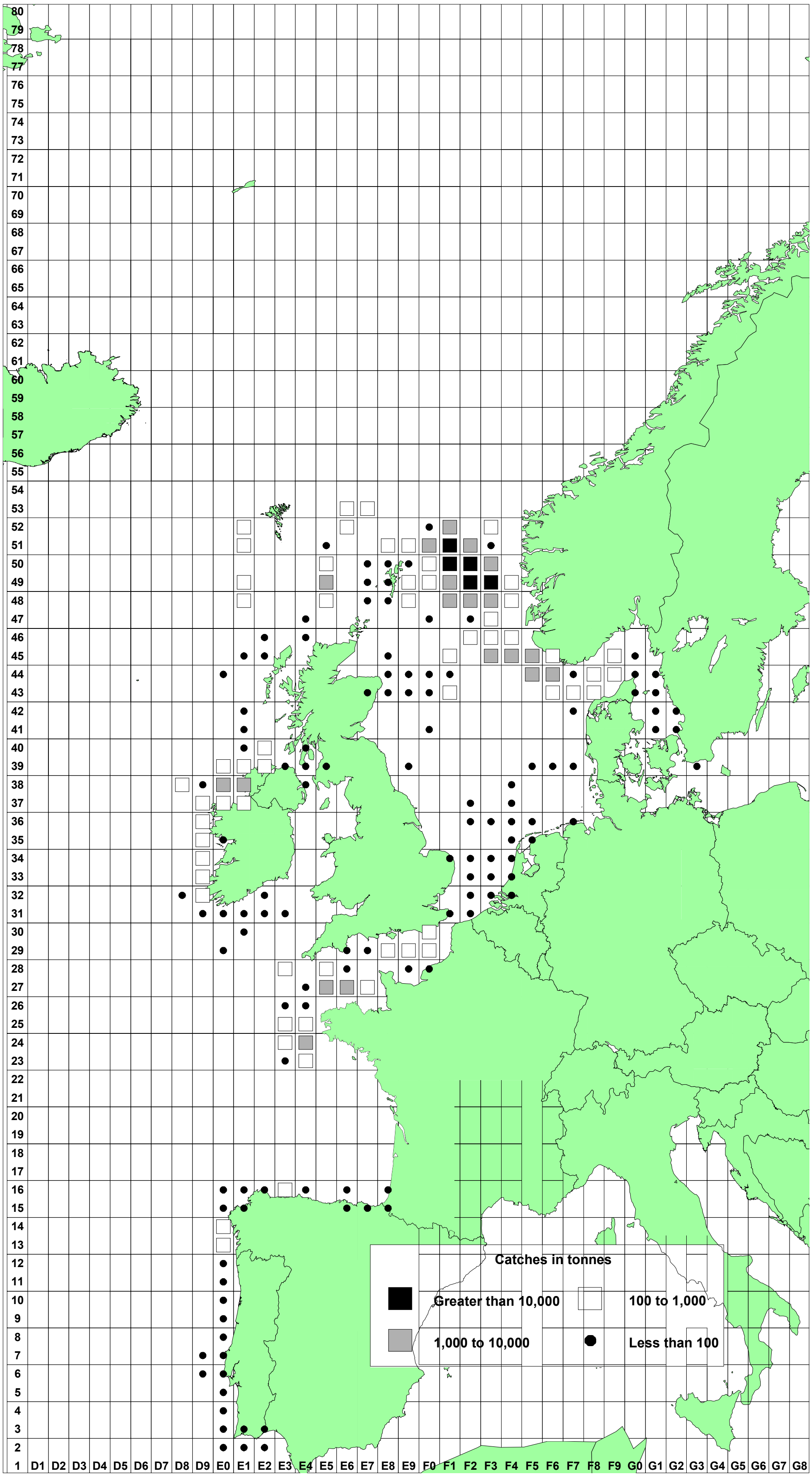


Figure 2.8.1.4. Mackerel commercial catches in quarter 4, 2000.

2.8.2 Distribution of juvenile mackerel

Surveys in winters 1999/2000 & 2000/2001

The juvenile distribution data made available to WGMHSA in 2000 were incomplete. These have now been brought up to date and the full data set available for the two winters is presented here. This presentation also allows comparison over the two years.

Fourth Quarter 1999 and 2000

Age 0 fish in 1999 (Fig 2.8.2.1 left)

- High catch rates in NW Ireland as in previous years
- High catch rates in central Biscay as previously
- Hot spot in N Portugal still apparent, but reduced from previous years
- High catch rates in the Celtic Sea not seen previously
- No good catches in Hebrides

Age 0 fish in 2000 (Fig 2.8.2.1 right)

- Much lower catches in NW Ireland than in any recent years
- High catch rates in central Biscay
- Hot spot in Portugal largely absent
- One good catch in southern Celtic Sea
- No good catches in Hebrides

Overall major reduction in age 0 fish

Age 1 fish were still reasonably abundant in both years on NW Ireland and Biscay shelf break. No major changes between 1999 and 2000 (Figure 2.8.2.2).

First quarter 2000 & 2001

Age 1 fish in 2000 (Fig 2.8.2.3 left)

- High catch rates off NW Ireland and the Hebrides as in previous years
- High catch rates and well distributed in the Celtic Sea as in previous years
- High catch rates in the north part of the North Sea – up from 1998
- Very low catch rates in central North Sea of putative North Sea component juveniles

Age 1 fish in 2001(Fig 2.8.2.3 right)

- Very low catch rates in all western areas
- High catch rates in north part of the North Sea – similar to 2000
- Better catch rates in central North sea

Overall major reduction in age 1 fish

Age 2 fish in 2000 (Fig 2.8.2.4 left)

- High catch rates in NW Ireland/Hebrides area and in Celtic Sea
- Very good catch rates in Cornish box area
- High catch rates in Northern North Sea
- Very little caught in central North Sea

Age 2 fish in 2001 (Fig 2.8.2.4 right)

- Reduced catch rates in NW Ireland/Hebrides area
- High catch rates in Celtic Sea, but mostly west and south of Cornish box
- Reasonable catch rates in northern North Sea, but down on 2000
- Slightly better than 2000, but still low catch rates in central North Sea

Distribution maps of mackerel recruits in their first and second winters

One problem with the current timing of bottom trawl surveys in the winter period is that the best coverage of the western area is in the fourth quarter while the North Sea is not covered at all. In the first quarter, the western area surveys are restricted to the area north of the Celtic Sea while there is full coverage of the North Sea. Recent tagging studies (Uriarte *et al* ICES CM 2001:O17) have shown that juvenile mackerel are most likely to remain in the same place prior to recruitment to the adult stock. Other work (Reid in progress) also suggests that average catch rates remain stable in the northern part of the western area between quarters 4 and the following quarter 1. Potentially this should allow the combination of surveys in both quarters to provide a single complete area coverage for all areas for a given winter. Examples of this are given for first winter fish in Figure 2.8.2.5 and second winter fish in Figure 2.8.2.6 for the winters 1999-2000 and 2000-2001. The same trends reported above can be seen in these maps:

For first winter fish

- Significant reduction in catch rates NW of Ireland, in the Celtic Sea, and off Portugal
- Stable catch rates in the northern North Sea and in Biscay
- Increased catch rates in the central North Sea

For second winter fish

- Reduction in catch rates NW of Ireland, Hebrides and northern North Sea.
- Little change in catch rates in the Celtic Sea, Biscay and Iberian Peninsula
- Slight increase in catch rates in the central North Sea

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

As noted in last years report, the coverage of the western area in the fourth quarter remains reasonably good. There are gaps in the area west of Ireland and in the inner part of the Celtic Sea/Western Approaches. The working group noted with approval the provisional intention of CEFAS to start up a western fourth quarter bottom trawl survey. This should fill most of the unsampled areas in the Celtic Sea area. A new bottom trawl survey series in the area of the Porcupine Bank is also planned by IEO to start in 2001. It is to be hoped that, together with the advent of the new Irish research vessel in 2003, this will allow complete coverage west of Ireland.

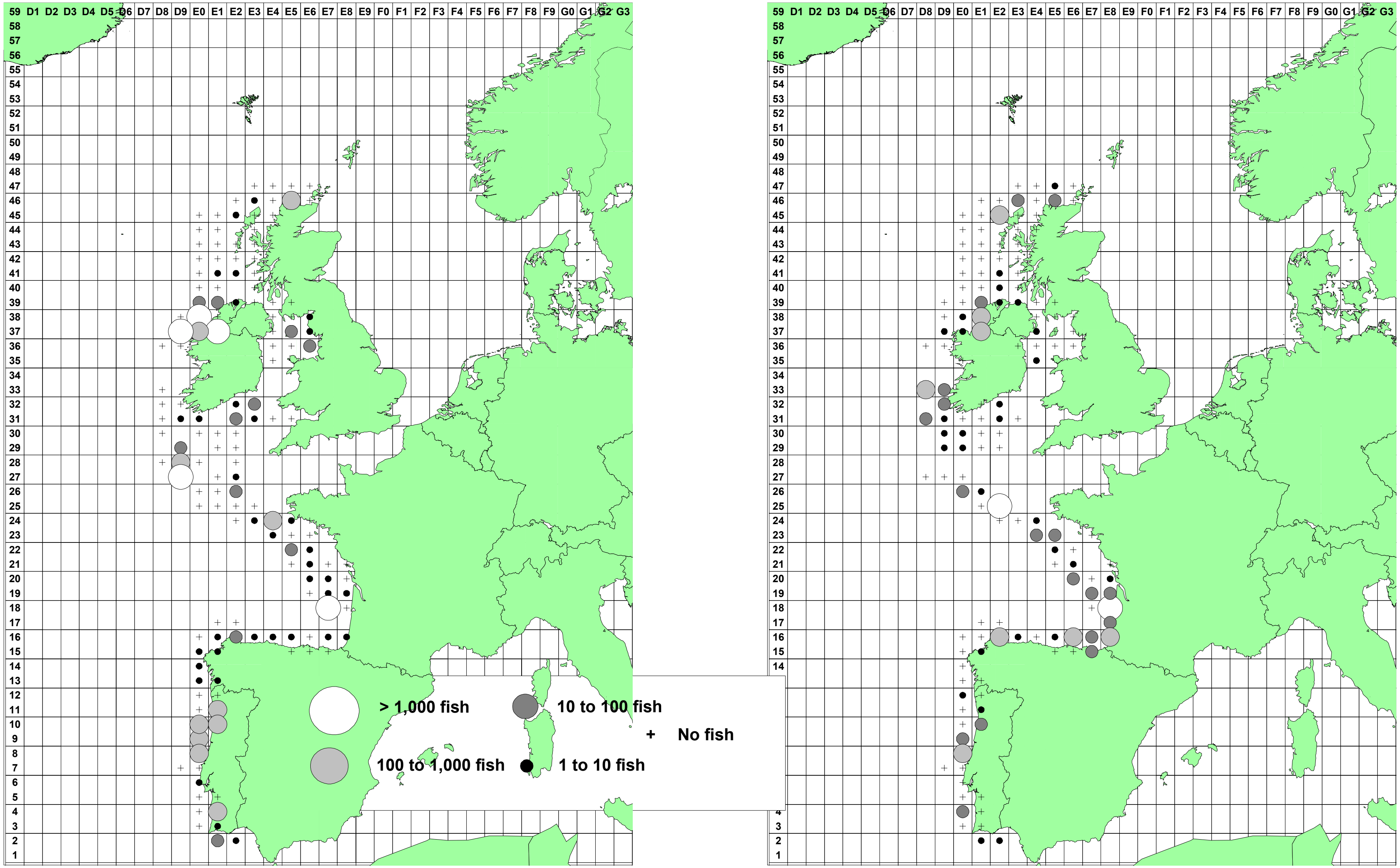


Figure 2.8.2.1. Distribution of mackerel recruits. 1999 year class age 0 in quarter 4 1999 (left) and 2000 year class age 0 in quarter 4 2000 (right). Catch rates per hour

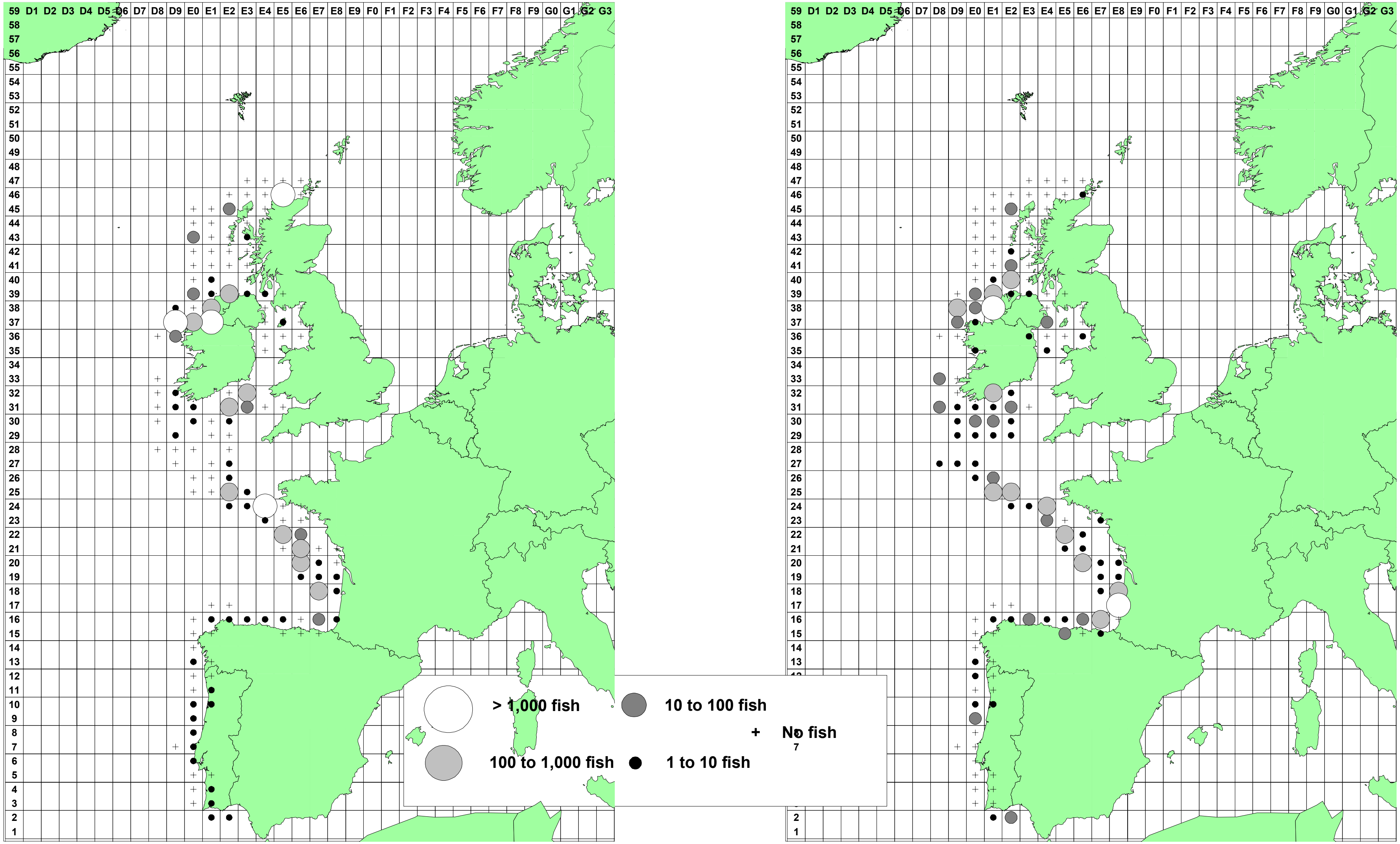


Figure 2.8.2.2. Distribution of mackerel recruits. 1998 year class age 1 in quarter 4 1999 (left) and 1999 year class age 1 in quarter 4 2000 (right). Catch rates per hour

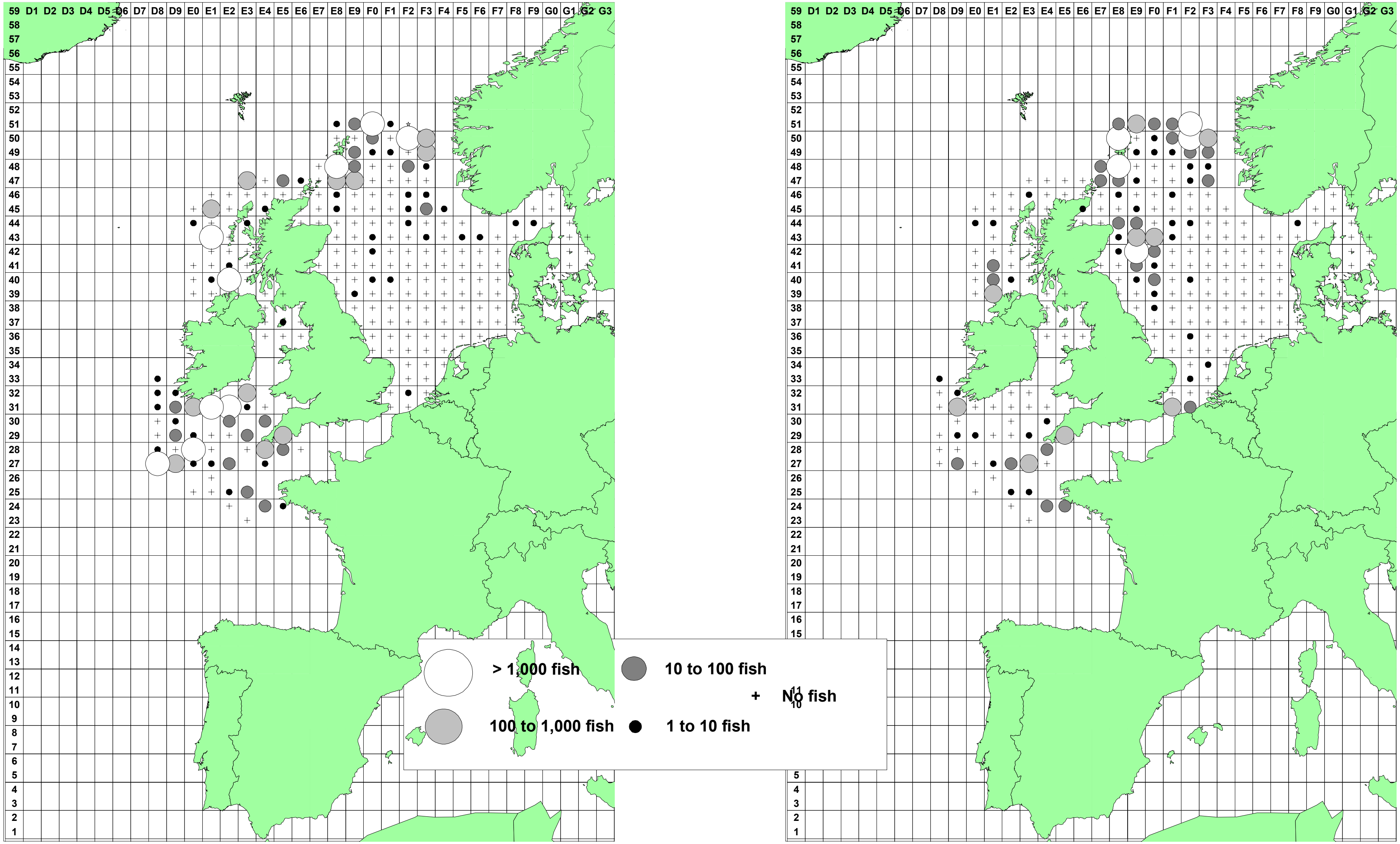


Figure 2.8.2.3. Distribution of mackerel recruits. 1999 year class age 1 in quarter 1 2000 (left) and 2000 year class age 1 in quarter 1 2001 (right). Catch rates per hour

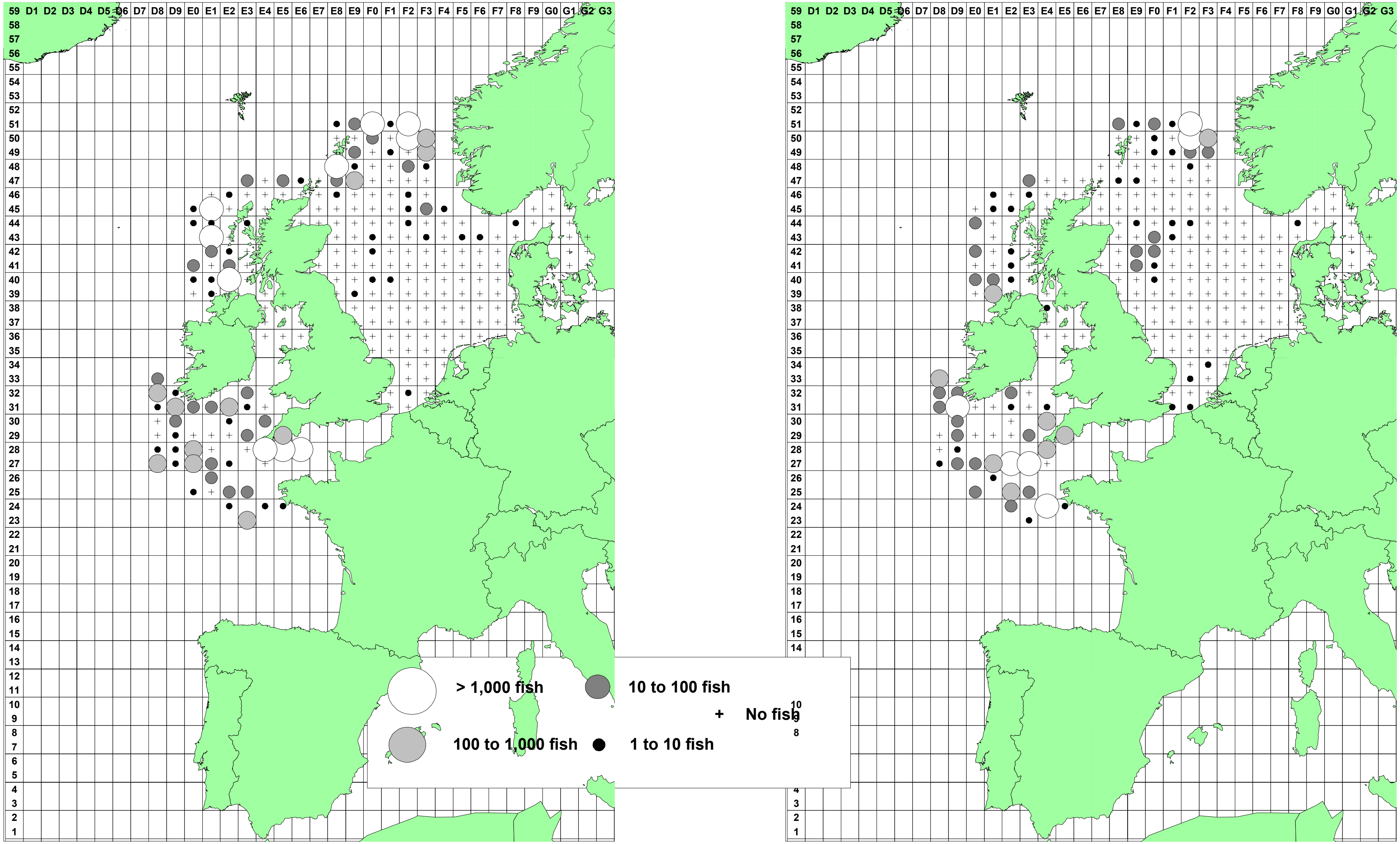


Figure 2.8.2.4. Distribution of mackerel recruits. 1998 year class age 2 in quarter 1 2000 (left) and 1999 year class age 2 in quarter 1 2001 (right). Catch rates per hour

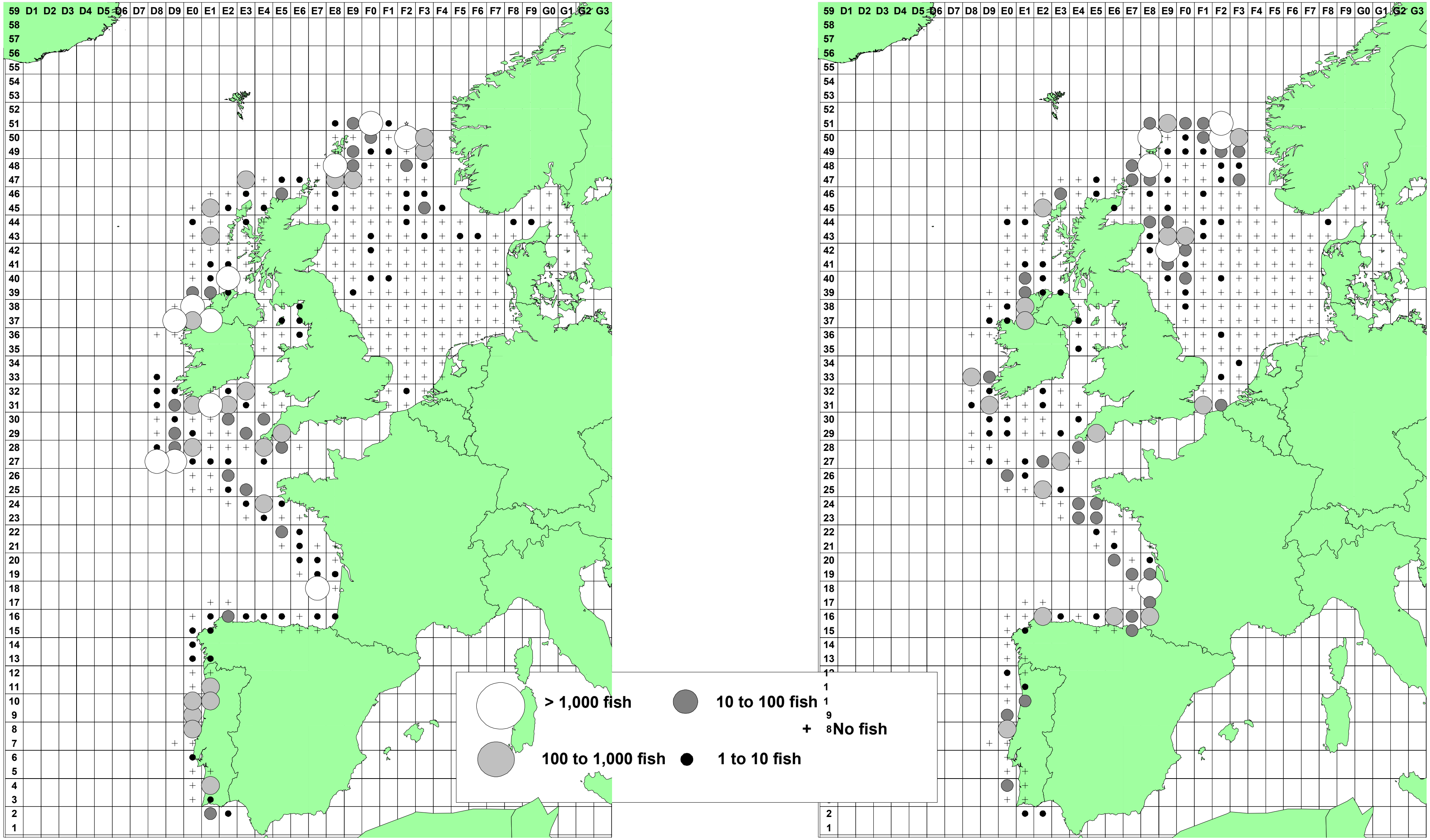


Figure 2.8.2.5. Distribution of mackerel recruits. (left) 1999 year class in 1st winter (1999/2000). (right) 2000 year class in 1st winter (2000/2001). Catch rates per hour

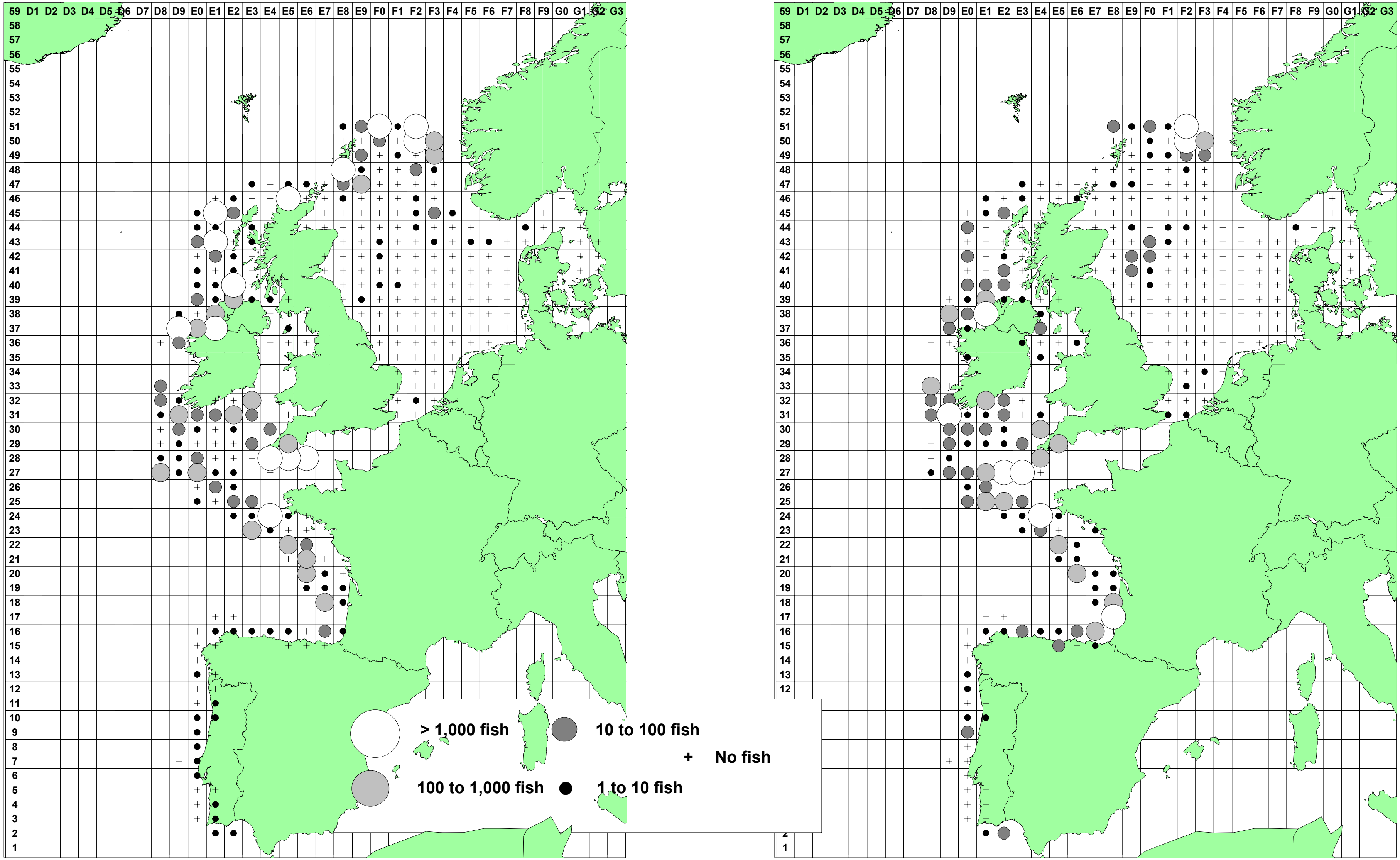


Figure 2.8.2.6. Distribution of mackerel recruits. (left) 1998 year class in 2nd winter (1999/2000). (right) 1999 year class in 2nd winter (2000/2001). Catch rates per hour

2.8.3 Distribution and migration of adult mackerel

Acoustic surveys

Four relevant acoustic surveys were carried out on mackerel and reported to this WG. These were:

- An acoustic survey by the Institute of Marine Research Bergen in October/November 2000. This mainly covered the shelf break area between the Viking and Tampen Banks but scouting surveys covered a wider area (approx 58-62^{o}N and 5^{o}E to 3^{o}W).

- An acoustic survey by IEO in ICES Sub-divisions VIIIc and IXa, in March and April 2001.

- An acoustic survey by IPIMAR in March 2001. The survey covered the Portuguese shelf and into the Gulf of Cadiz.

- An acoustic survey by IFREMER in April to June 2001. The survey covered the Biscay shelf from 43^{o} 30 to 48^{o}N.

The IMR survey showed that in the latter part of 2000, there were substantial concentrations of mackerel spread across the platform up to 30 nm from the shelf break between the Viking and Tampen Banks (approx 59^{o}N 3^{o}E to 61^{o}30N 2^{o}E). A provisional estimate of approximately 600,000 t of mackerel was made. The fish were in a very similar location to the previous year's survey. No evidence of major migration movements was seen. See Skagen & Iversen WD 2001.

The IEO survey was primarily targeted on sardine and anchovy, however, the most common species observed was mackerel. As in 1999, mackerel were ubiquitous throughout the Cantabrian Sea, but almost none were seen in the north of IXa. Far fewer juveniles were seen in this area compared to 1999. This confirms the general trend from the trawl surveys. A provisional abundance estimate of 399,000 tonnes was made. See Carrera WD 2001.

Again, the IPIMAR survey was targeted on sardine and anchovy and no estimate of mackerel was made, however, mackerel were observed in the catches, and was relatively important in the northern part of the survey area. It would be desirable if the acoustic survey data could be worked up for mackerel as well and could then be combined with that from the IEO and IFREMER surveys. See Marques & Morais WD 2001.

The IFREMER survey was targeted at all pelagic fish resources in the French Biscay area. Analysis to date has been concentrated on sardine and anchovy, however abundance estimates for mackerel will be made available. Mackerel was common in the catches throughout the area, and particularly in the north. See Masse WD 2001

Aerial Surveys

A new aerial survey for mackerel in the Norwegian Sea was carried out during July 2001 by the Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO – Murmansk, Russia). The survey was targeted on the spatial distribution of mackerel aggregations in the Norwegian Sea, as well as the thermal and hydrodynamic status of the sea surface, distribution of locations of increased bio-productivity and the availability and distribution of other marine organisms (sea mammals and birds).

The 2001 survey included the deployment of LIDAR systems for the first time but these data are not at present available. In the northern part of the survey area (north of 68^{o}N) it was possible to intercalibrate the aerial survey with an acoustic survey conducted by a Russian survey vessel "Fridtjof Nansen". The resultant biomass estimated in this area was 350,000 t. The major aggregations of feeding mackerel had a more easterly distribution than in previous years. See Shamray *et al* WD 2001. These findings were also confirmed by observations by a Norwegian research vessel (see Holst *et al* WD 2001). In 2001 the aircraft was also able to work in collaboration with Icelandic and Norwegian research vessels. See Chernook *et al* (1 & 2) WD 2001. The distribution of mackerel in 2001 seemed to be restricted due to a rather strong East Icelandic Current. The observations made by the aircraft were confirmed in areas surveyed by research and fishing vessels.

The yearly area distribution since 1997 is shown in Figure 2.8.3.1.

Inferences on migration from commercial data

No new data were available to the working group on detailed catch location and timings of commercial mackerel fishing activity. Some data has been collected at a number of institutes, but this has not as yet been collated and reported. It is hoped that this data series will be updated in 2002.

2.8.4 The development of other survey methodologies for mackerel

Under current conditions the only fishery independent stock assessment data available for mackerel are from the triennial mackerel egg surveys. This makes the annual assessments increasingly vulnerable with distance from the last egg survey year. While it is not possible to carry out more frequent egg surveys it may be possible to use other survey methodologies to provide data in the intermediate years. The two methodologies that have been investigated and show promise are acoustic and aerial surveys. Both types of survey can potentially deliver two types of information; distribution and abundance. As carried out to date both types of survey have covered only parts of the total distribution area of the stock and so are unable to provide a valid stock abundance estimate or a description of the overall distribution. The aim of this section is to detail the current scope of these surveys and the steps required to allow them to be used for stock assessment purposes.

Aerial Surveys

Aerial surveys (see 2.8.3) have been carried out by Russia in the Norwegian Sea since 1997 (see Shamray *et al.,* WD 2001). They are centred on the area of the international fishery with a small extension into Norwegian and Icelandic waters. On the 2001 survey for the first time there was also collaboration with the respective national fisheries institutes. The surveys are usually carried out in July as this provides the best weather for the aircraft operation. The registration of mackerel schools by the aircraft is currently by visual means, however, the survey in 2001 also included LIDAR apparatus which may be developed to provide more quantifiable data and observation of schools at greater depths than is currently possible. The major advantage of the method is that it can cover a very large area in a relatively short period of time. The main disadvantage is that it cannot collect biological data or confirm the species of schools observed. For this one or more vessels are required to collect these data in tandem with the aircraft.

These surveys require good weather, and they require that all the target species schools are close to the surface. Both these conditions can be satisfied in July in this area. The surveys provide valuable data on the distribution of a part of the stock (in 2001 estimated at 350 ktonnes in the area north of 68°N) but cannot currently provide a complete stock estimate. For them to be able to do so, the surveys would have to cover the full distribution area of the stock. At this time, the egg surveys have shown that some of the stock was still to be found as far south as 49°N. The southern extent of the aerial survey was 63°N. The survey was also unable to cover into the Norwegian EEZ or into UK waters in the northern North Sea area . The survey aircraft did however observe schools in both these areas.

The Working Group believes that for these surveys to provide an accurate stock assessment and abundance distribution they need to be extended over the full distribution of the stock. This is clearly beyond the capabilities of the single Russian aircraft currently deployed, and would require a minimum of one and preferably more aircraft. In the shorter term it is recommended that the aerial survey by the Russian aircraft be extended as widely as possible and that vessel collaboration should be provided in all the survey areas. Such collaboration was successfully carried out with Icelandic and Norwegian research vessels in 2001 and should be extended to include UK and Faroese vessels in future years.

Acoustic Surveys

There are two sets of acoustic surveys which have provided useful abundance and distribution data on mackerel. One of these has been carried out in the North Sea by Scotland and Norway, the other in the southern area by Portugal, Spain and France.

North Sea acoustic surveys

An intermittent series of surveys (see 2.8.3.) has been carried out by Scotland and Norway in the area of the Viking Bank in the North Sea (approximately 60°N and 1-4°E). The Scottish surveys were mostly carried out in December and January (Reid, WD 1998), the Norwegian ones in October-November (Skagen & Iversen, WD 2001). Both survey series were based on the premise that a substantial proportion of the adult stock aggregates in this area prior to migration to the spawning areas. Both surveys have included wider area scouting surveys to determine the extent of the population at this time, however, this has not been done in a systematic fashion to date. It is clear that not all of the stock can be concentrated in this area at this time. For instance, there are catches of mackerel in other areas, e.g. the

English Channel, and small catches around the Iberian Peninsula. However, it is reasonable to assume that a substantial proportion of the adult stock is found in northern waters at this time, and probably mostly in the Viking Bank area. The Scottish survey in 1995 estimated a total biomass of 1.575 million tonnes (WG SSB in 1995 was 2.25 million tonnes). The Norwegian survey in 2000 made a very preliminary estimate of 600,000 tonnes. The Working Group proposed that these surveys should be continued and that Scotland and Norway should collaborate to define the spatial and temporal limits of the stock at this time, possibly with a coordinated multi vessel survey, and to determine the optimum spatio-temporal window for these surveys.

Southern area acoustic surveys

A series of coordinated acoustic surveys have been carried out in Spanish, Portuguese and French waters for a number of years (Stratoudakis *et al.,* WD 2001, Marques & Morais, WD 2001 and Carrera, WD 2001). They extend from the Gulf of Cadiz in the south to Brittany in the north. The surveys are carried out between March and May, usually earlier in the south and later in the north. They are targeted principally at sardine and anchovy, however, they cover a large part of the mackerel distribution at this time, and a mackerel abundance estimate is produced from the IEO and IFREMER surveys.

As in the northern acoustic and aerial surveys, the problem with these surveys for mackerel stock estimation is that they do not cover the whole of the expected distribution area. Based on the egg surveys, by the time of the last acoustic survey in May, there were spawning mackerel as far north as 59°N and possibly further. For this survey to provide a full stock estimate, it would have to be extended further to the North, possibly by the inclusion of vessels from other countries. Given that a large part of the distribution area is already surveyed, it should be possible to cover the entire area with two extra surveys. One other possible drawback for these surveys is that they are carried out at the same time of year as the mackerel egg surveys, however, this also means that the extent of the population is well understood at this time, which is not the case for the aerial and northern acoustic surveys.

Next steps

All three survey sets have similar problems if they are to be useful for stock assessment purposes. None of them cover the full known distribution of the stock at the time of the surveys and so provide an estimate for an unknown fraction of the total stock. Therefore, it becomes necessary to improve the coverage to include the full distribution of the stock. For all of the surveys this will require coordination between the countries currently involved and those who might wish to become involved.

Following the observation by ACFM that the acoustic surveys should be continued and refined and that work was required on the abundance estimates from the aerial surveys, the WG therefore recommends the formation of a new Mackerel Survey Planning Group with responsibility for aerial and acoustic surveys of mackerel. In the first instance this PG should be tasked to:

- Coordinate vessels from all appropriate countries to collaborate with the Russian aerial surveys in the Norwegian Sea.
- Seek other nations willing to participate in aerial surveys and coordinate vessels with the existing survey.
- Coordinate Scottish and Norwegian acoustic surveys in the Viking Bank area to ensure full coverage and appropriate areas and timings.
- Coordinate Spanish, Portuguese and French acoustic surveys and seek potential collaborators for northern extension of these surveys.
- Utilise the findings of the EU SIMFAMI project to provide a universally applicable mackerel target strength to length relationship for use in all acoustic surveys for mackerel.

It is proposed that this Planning Group be set up under the chairmanship of E. Shamray (Russia) and meet in February 2002 in Lisbon or La Coruña.

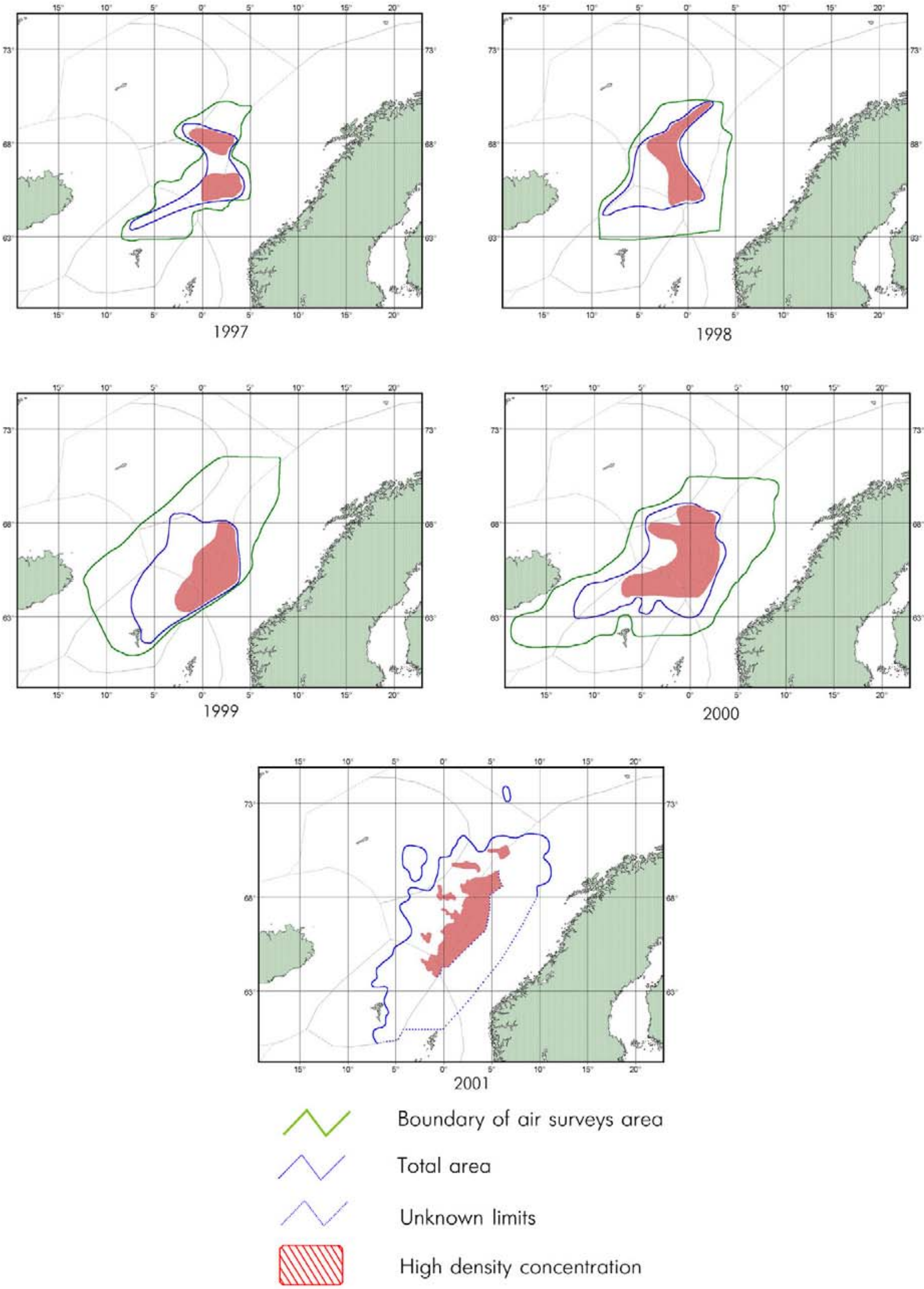


Figure 2.8.3.1 Area distribution of mackerel in Russian aerial surveys.

2.9 Recruitment forecasting

No further work was carried out on recruitment forecasting prior to this meeting.

2.10 State of the stock

2.10.1 Data exploration and Preliminary Modelling

The sensitivity of the ICA model was tested by applying different weightings to the SSB’s from egg surveys, weightings of 1 and 10 compared to a traditional weighting of 5, and by applying periods of separable constraint of 3, 5, 7 and 9 years (Figures 2.10.1.1-4). All other input parameters (Table 2.10.1.1) were kept the same as at last years WG. Only the period of separable constraint of 9 years included the whole period of SSB’s from the egg surveys as used in last years assessment. At the 1998 WG this test was also carried out and showed that the changes in weighting as well as changes in periods of separable constraint made the assessment very unstable (Anon., 1999). This was expected to be due to the absence of SSB's from the egg surveys in the two most recent years of the assessment. In this years assessment again the last two assessment years lack SSB's from egg surveys as in the assessment at the 1998 WG. However, the assessment of this year showed to be much more stable, which might be mainly due to similar signals in both the egg survey SSB's as well as the catch at age data. The SSB’s and F's in the last year differed only up to 4.1% with weightings of 1 and 10 compared to a weighting of 5. The SSB’s and F's in the last year differed up to 12.2% with periods of separable constraint of 3, 5, 7 and 4+5 years compared to the period of separable constraint of 9 years, which difference is expected to be mainly caused by excluding the 1992 or the 1992 and 1995 egg survey SSB values from the period of separable constraint.

During the WG meeting the preliminary assessment data set was revised (nearly 20 kt was added), but this was regarded not to affect the overall conclusions in this section. The same provisional data set was used for the exploratory runs of ICA, ISVPA and AMCI.

In order to outline tendencies in stock dynamics determined by catch-at-age data the ISVPA model was also applied. Since the last WG meeting when the model was applied to NEA Mackerel for the first time, it was somewhat changed and was presented in its revised version at the North Pelagic and Blue Whiting WG (Anon., 2001). Since that time the model was again extended to include an additional objective function - the absolute median deviation *AMD,* the median of the absolute deviations of model residuals from their median value, sometimes referred to as one of the most robust measures of scale (Huber, 1981).

For test runs the “effort-controlled” version of the model attributing errors to errors in catch-at-age data was used. The whole time interval (1984-2000) was considered as separable and was ascribed by single selectivity pattern. No one of the three ISVPA objective functions (SSE, MDN and AMD) revealed distinct minimum when the model was run on the whole interval of age groups (0-12+). The minimum for MDN and, especially, for AMD became apparent when 0-group, giving extremely high residuals, was excluded from analysis. The ISVPA results, corresponding to the minimum of AMD and presented in Table 2.10.1.2 and in Figure 2.10.1.5, are similar to ICA results despite the egg survey SSB estimates were not used in the ISVPA run.

The AMCI model has been presented to the Working Groups previously (ICES CM 2000/ACFM:05 and ICES CM 2001/ACFM:06), in order to include tag returns from the Norwegian tagging series in the assessment. It is also described in the report of the NPBWWG in 2001 (ICES, 2001). It has been extended recently to allow disaggregation by area and fleet (SGHEAP report 2001), and the code was partly rewritten on that occasion. These options were not used for mackerel.

A series of trial runs were made:

- A key run with a recursively updated selection pattern except for the first 4 years where the selection was fixed.
- Egg survey index as an absolute measure of SSB.
- Log sum of squares as objective function for catch numbers at age and for SSB indices.
- A Poisson likelihood- like objective function for the tag returns.
- Catches at age 0 downweighted by 0.01, and at age 1 by 0.1.

Trial runs were also made with the following deviations from the key run:

- SSB indices not used.
- Tags data not used.

- Catches downweighted by a factor of 0.1 compared to the key run.
- Stepwise parameter estimation, i.e. fishing mortality estimated using the tagging data and the log catch ratios along the cohorts with the Poisson-like objective function, followed by estimates of the year class abundances with the log sum of squares objective function for the catches and the SSB index, keeping the previously fishing mortalities fixed.

The results of the AMCI exploratory runs are shown in Figures 2.10.1.6.

Estimates of the total mortality were also made directly from the tagging data. The mortality between releases in year $y1$ and year $y2$ was estimated as $Z(y1, y2) = \log \frac{r2 * R1}{r1 * R2}$, where $R1$ and $R2$ are the numbers released in years $y1$ and $y2$, and $r1$ and $r2$ are the number recaptured from these releases in later years. The analysis was done on age-disaggregated data, considering various age groups separately. The results are shown in Figure 2.10.1.7. The trend in mortality is slightly different from that obtained with the various assessment models, in particular, the mortality seems to have been increasing in recent years. However, the value in 1995-1996 was very low, which may be caused by year to year variation in the mortality associated with the tagging.

The overall trends from the exploratory AMCI runs are the same in all options, and similar to those obtained with ICA and ISVPA with a gradual increase in SSB since the mid 1990ies and a slightly declining fishing mortality in recent years. The absolute levels vary somewhat between the options, however, and the SSBs are generally higher and the Fs lower than the results obtained with ICA. The influence of the tagging data on these estimates was relatively small, while the influence of the SSB data was to reduce the SSB and increase the fishing mortality.

The assessment results are robust to the analysis method used although the AMCI was sensitive to which supplementary data were included. Therefore the WG decided to continue to use ICA for the standard assessment. A period of separable constraint of 9 years was preferred because it includes all three SSB values from the egg surveys as used at last years WG meeting. The preliminary run with two periods of separable constraint (4+5 years) was rejected, because by adding two periods of separable constraint it increased the number of parameters without a significant reduction in the value of the objective function.

2.10.2 Stock Assessment

Tables 2.10.2.1-7 show the catches in number, the mean weights at age in the catch, the mean weights-at-age in the stock, the natural mortality, the proportion of fish spawning and the SSB index values used in the assessment.

ICA fits to the catch-at-age data and the egg production estimates were used to examine the relationship between the indices and the catch-at-age data as estimated by a separable VPA. The WG decided to use again a weighting of 5 for the SSB index and used again the index series as a relative index of abundance. The WG decided to use again only the 3 most recent SSB estimates from the egg surveys in the analysis. This is because the 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. In this years assessment the separable constraint was changed to one period of 9 years to include the SSB index time series over the period 1992-2000. 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 2.10.1.1.

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

$$\sum_{a=0}^{a=11} \sum_{y=1992}^{y=2000} \lambda_a (\ln(C_{a,y}) - \ln(F_y.S_a \cdot \overline{N}_{a,y}))^2 +$$
$$\sum_{y=1992}^{y=2000} \Sigma(\ln(EPB_y) - \ln(\mathrm{Q} \textstyle\sum_a N_{a,y} \cdot O_{a,y} . W_{a,y} . \exp(-PF.F_y.S_a - PM.M))^2$$

subject to the constraints

$S_5 = 1.0$
$S_{11} = 1.2$

where

. - 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 1992–2000, 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 2.10.2.7 and 2.10.2.8 present the estimated fishing mortalities, and population numbers-at-age. Tables 2.10.2.9 a-g and Figures 2.10.2.1–2.10.2.4 present the ICA diagnostic output. The stock summary is presented in Table 2.10.2.10.

2.10.3 Reliability of the Assessment and Uncertainty estimation

Assessment

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 in previous years as a problem in the assessment. In 2000 the proportion sampled of the total catch of the north east Atlantic mackerel was the lowest since 1992 (see Section 1.3).

The problem of assessing the stock with very little supplementary data, which also has been pointed out previously, is still serious. Three years ago, the problem was to obtain a stable stock estimate when the last independent information was far back in time, the last three years the problem relates more to the dependence of the estimate on the last data point (egg survey biomass in 1998). 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 in 1998, can only be explained by recent strong year classes coming into the spawning stock, while there is no clear evidence that this is the case. This year different weighting factors for the SSB of 1 and 10 appeared to have no significant effect on the predicted SSB in the last year.

Estimates provided by the AMCI model also uses the large data set of Norwegian tag material as a source of information about mortality. It is reassuring that it gives results that are in line with the ICA assessment. Other estimates became available for the second time from the ISVPA. These results also provide a perception of the stock which is in line with that from ICA (see section 2.10.1 Catch Predictions).

Uncertainty

The variances estimated by ICA express how well the parameters, including the present population numbers, can be estimated with the present data and model assumptions. The CV's of the stock number estimates are in the order of 11 - 17%, which is slightly better than in the last assessment done in 2000. The 1999 and 2000 year classes, for which there is little information in the data, have higher CV's.

The SSB estimates as obtained by previous Working Groups (1995 - 2000), are shown in Figure 2.10.3.1. The SSB estimates from the last three Working Groups are consistent. Although the trend in biomass is consistent, the time-series 1984-1993 were scaled down in the most recent assessments. The opposite is observed from 1994 onwards as the model is trying to fit an increasing trend driven by the 1995 and 1998 SSB estimates based on the egg surveys. The last three WG's treated the egg survey biomass as relative index, while the earlier WG's as absolute index.

According to ICA (Table 2.10.2.10) the SSB's increase from 1998 to 2001, while the 1998 and the very preliminary egg productions from the egg surveys in the western area indicate a 20% reduction in SSB over the same period (see section 2.6.1). It should be noted that analysis of the western area is incomplete and that data of fecundity could alter the 2001 SSB estimate considerably. Furthermore the contribution fo the southern spawning component is unknown.

The relative proportions of the southern and western spawning components in 1992 was based on a rough calculation of relative abundance (Anon., 1993).

There is a signal in the tagging mortality data that indicates that natural mortality might have increased (see section 2.10.1).

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 2.10.3.1 (average F), 2.10.3.2 (recruitment) and 2.10.3.3 (spawning stock biomass).

2.11 Catch Predictions

Table 2.11.1 and Table 2.11.2 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 2001 (age 0) and year class 2000 (age 1), the ICA-estimated abundances in 2001 (ages 2 – 12+) were used as the starting populations in the prediction.

The following assumptions were made regarding recruitment at age 0 and age 1 in 2001:

Age 0 No recruitment indices are available for the 2001 year class. The geometric mean was used for the 2001 recruitment. The value of 4280.5 million fish is calculated from the geometric mean (1972-1997) of recruitment to the Western mackerel, raised by the ratio (1.167) of the estimated Western and North East Atlantic mackerel recruitments for the period 1984-1997 (Table 2.11.3).

Age 1 The recruitment at age 1 is taken to be the geometric mean recruitment (4280.5 million fish) brought forward 1 year by the total mortality at age 0 in that year (see Table 2.11.1).

Recruitment at age 0 in 2002 and 2003 was also assumed to be 4280.5 million fish.

Catch forecasts have been calculated for the provision of area based TACs. Two “fleets” have been defined:

1. “Northern” area corresponding to the exploitation of the western area, including the North Sea and Division I, IIa and IIIa; “Northern” area reflects all areas except Divisions VIIIc and IXa;

2. “Southern” area including Div. VIIIc and IXa (“Southern”).

The exploitation pattern used in the prediction was the separable ICA F’s for the final year and then re-scaled according to the ratio *status quo* F (1998-2000) and reference F ($F_{4\text{-}8}$). 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 1998–2000. The calculation of partial F's at age was not correct last year, when the ratio at age was calculated from the sum of the catches in numbers for the three years combined. The effect of this improvement was estimated from this years prediction input data. The wrong partial F's appeared to cause differences less than 0.41% for the fishing mortality, less than 0.65% for the catch weight and no effect on spawning stock biomass.

Weight at age in the catch was taken as an average of the values for the period 1998–2000 for each area. Weight at age in the stock was calculated from an average (1998–2000) of weights at age for the NEA mackerel stock.

The catch for 2001 is assumed to be 670,000 t, which corresponds to the TAC in 2001 (see Section 2.1).

Predictions were calculated by the MFDP program and the result from it have been transferred to the same output sheets as used at last years WG meeting.

Eight single option summary tables are presented and summarised in the text tables below. In addition Table 2.11.4 and 2.11.5 refer to 4 options with a catch constraint of 670 kt in 2001 and to 4 options with *status quo* fishing mortality (Fsq = 0.1835) in 2001. Each of these two options for 2001 are then followed by:

F2002 = F2003 = 0.15 lower level of F of the F-range 0.15-0.20 as agreed by EU, Norway and Faroese in 2000;
F2002 = F2003 = 0.17 corresponding to F_{pa};
F2002 = F2003 = 0.1835 = Fsq corresponding to the mean fishing mortality for the period 1998–2000;
F2002 = F2003 = 0.20 upper level of F of the F-range 0.15-0.20 as agreed by EU, Norway and Faroese in 2000.

UNITS: '000 t

	Catch 2001 = 670 kt F=0.15 2002,2003			Catch 2001 = 670 kt F= F_{pa} = 0.17 2002,2003			Catch 2001 = 670 kt F= F_{sq} =0.1835 2002,2003			Catch 2001 = 670 kt F= 0.20 2002,2003		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2001	0.1682	670	4043	0.1682	670	4043	0.1682	670	4043	0.1682	670	4043
2002	0.15	625	4154	0.17	703	4126	0.1835	754	4108	0.20	816	4085
2003	0.15	644	4181	0.17	711	4092	0.1835	755	4034	0.20	806	3964

UNITS: '000 t

	Status quo (F1998-2000=0.1835) F=0.15 2002,2003			*Status quo* (F1998-2000=0.1835) F= F_{pa} = 0.17 2002,2003			*Status quo* (F1998-2000=0.1835) F= F_{sq} =0.1835 2002,2003			*Status quo* (F1998-2000=0.1835) F= 0.20 2002,2003		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2001	0.1835	726	4023	0.1835	726	4023	0.1835	726	4023	0.1835	726	4023
2002	0.15	617	4111	0.17	694	4083	0.1835	745	4064	0.20	806	4042
2003	0.15	637	4145	0.17	704	4057	0.1835	748	3999	0.20	798	3930

For options F = 0.15 the forecasts for 2002 and 2003 predict that SSB will increase compared to 2001.
For options F = 0.17 the forecasts predict that SSB will slightly increase in 2002 and 2003 compared to 2001.
For options F = $F_{status\ quo}$ = 0.1835 and F = 0.20 the forecasts predict that SSB will slightly increase in 2002 and slightly decrease in 2003 compared to 2001.

A detailed multifleet prediction table is presented in Table 2.11.6 for the $F_{status\ quo}$ =0.1835 in 2001-2003.

The MFDP programme could not produce a two multifleet management option table for the options *status quo* F in 2001 or a catch constraint of 670kt in 2001. Therefore, this was carried out by a spreadsheet, which was checked last year by comparing its results to the IFAP prediction programme results. The results of both were exactly the same including the decimals. Table 2.11.7 presents the two fleet management option table for the option of *status quo* F in 2001 and a range of F's for 2002. Table 2.11.8 presents the two fleet management option table for the option of 670kt in 2001 and a range of F's for 2002.

The forecasts of SSB in 2001 and 2002 for the two scenarios are only slightly higher compared to the predicted SSB values last year. However, a main revision is expected to take place when the SSB biomass from the 2001 egg survey will become available in 2002.

Table 2.10.1.1 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1996-2001.

Assessment year	2001	2000	1999	1998 ###	1997	1996
First data year	1984	1984	1984	1984	1984	1984
Final data year	2000	1999	1998	1997	1996	1995
No of years for separable constraint ?	9	8	7	12	11	10
Constant selection pattern model (Y/N)	S1(1992-2000)	S1(1992-1999)	S1(1992-1998)	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	1.2 / 1.2	1.0 / 1.2
Reference age for separable constraint	5	5	5	5	5	5
First age for calculation of reference F	4	4	4	4	4	4
Last age for calculation of reference F	8	8	8	8	8	8
Shrink the final populations	No	No	No	No	No	No

Tuning indices

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

Model weighting

Relative weights in catch at age matrix	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01
Survey indices weighting Egg surveys	5.0	5.0	5.0	1.0	1.0	1.0
Stock recruitment relationship fitted?	No	No	No	No	No	No
Parameters to be estimated	40	38	36	55	53	?
Number of observations	111	99	87	149	136	?

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

Table 2.10.1.2 Results of ISVPA run with ages 1-12+

Year	Total biomass	SSB	F(4-8)	Recr. (millions)
1984	2983.988	2586.834525	0.2177	2140.4440
1985	3323.994	2768.940172	0.1834	4925.9410
1986	3431.365	2842.983139	0.1728	3459.6880
1987	3401.159	2932.130226	0.2015	2792.2720
1988	3536.518	3093.721141	0.2218	3070.9840
1989	3479.062	2994.958024	0.2012	3235.6180
1990	3228.729	2788.246608	0.2169	3138.6040
1991	3547.109	3086.318851	0.2246	3200.8580
1992	3688.048	3164.245209	0.2586	3232.2990
1993	3657.625	3050.2959	0.3163	4611.0840
1994	3623.452	2918.314164	0.3133	5260.8700
1995	3960.333	3212.676098	0.2894	5395.4040
1996	4047.642	3342.656205	0.2110	5080.6790
1997	4603.577	3732.881618	0.1917	6292.8020
1998	4976.207	3988.857329	0.1936	5111.3660
1999	5480.287	4551.788434	0.1612	3923.9340
2000	5603.57	4636.060233	0.1504	5747.7820

Age	S(age)
1	0.117
2	0.272
3	0.497
4	0.729
5	0.931
6	1.023
7	1.121
8	1.195
9	1.320
10	1.303
11	1.303
12	1.303

Table 2.10.2.1 North East Atlantic Mackerel. Catch in numbers at age.

(Output Generated by ICA version 1.4)

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

Catch in Number

AGE	1999	2000
0	67.00	36.34
1	73.52	102.15
2	131.32	133.59
3	212.65	254.13
4	249.96	345.21
5	267.01	262.17
6	228.68	215.42
7	149.11	156.34
8	81.45	95.29
9	47.00	46.55
10	28.50	27.79
11	15.79	16.75
12	30.59	30.09

x 10 ^ 6

Table 2.10.2.2 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

Weights at age in the catches (Kg)

AGE	1999	2000
0	0.06200	0.06300
1	0.17600	0.13500
2	0.23600	0.22900
3	0.30700	0.30800
4	0.36100	0.36700
5	0.40600	0.42900
6	0.45400	0.46700
7	0.50100	0.50400
8	0.53700	0.53700
9	0.56900	0.57000
10	0.58700	0.58800
11	0.60900	0.59700
12	0.68800	0.64900

Table 2.10.2.3 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

Weights at age in the stock (Kg)

AGE	1999	2000
0	0.00000	0.00000
1	0.09400	0.09400
2	0.20900	0.20300
3	0.25600	0.25500
4	0.31500	0.30100
5	0.36100	0.36000
6	0.40900	0.39700
7	0.43700	0.43400
8	0.45900	0.46000
9	0.49700	0.49900
10	0.51400	0.50400
11	0.47800	0.54200
12	0.60100	0.57200

Table 2.10.2.4 North East Atlantic Mackerel. Natural mortality at age.

Natural Mortality (per year)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

Natural Mortality (per year)

AGE	1999	2000
0	0.15000	0.15000
1	0.15000	0.15000
2	0.15000	0.15000
3	0.15000	0.15000
4	0.15000	0.15000
5	0.15000	0.15000
6	0.15000	0.15000
7	0.15000	0.15000
8	0.15000	0.15000
9	0.15000	0.15000
10	0.15000	0.15000
11	0.15000	0.15000
12	0.15000	0.15000

Table 2.10.2.5 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	1997	1998
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
1	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.060	0.060	0.060
2	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.580	0.580	0.580
3	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.850	0.850	0.850
4	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.980	0.980	0.980
5	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.980	0.980	0.980
6	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 2.10.2.6 North East Atlantic Mackerel. Biomass estimates from egg surveys.

INDICES OF SPAWNING BIOMASS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	*****	*****	*****	*****	*****	*****	*****	*****	3370	*****	*****	2840	*****	*****	3750	*****	*****

x 10 ^ 3

Table 2.10.2.7 North East Atlantic Mackerel. Fishing mortality at age.

Fishing Mortality (per year)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.04239	0.02555	0.01472	0.00153	0.01603	0.01563	0.00762	0.00275	0.00680	0.00839	0.00832	0.00798	0.00588	0.00536	0.00557
1	0.02460	0.04770	0.02111	0.01438	0.03552	0.02213	0.04012	0.02167	0.02701	0.03330	0.03301	0.03166	0.02332	0.02129	0.02209
2	0.06299	0.01892	0.09163	0.07141	0.05661	0.09423	0.08865	0.07461	0.06348	0.07826	0.07759	0.07442	0.05481	0.05004	0.05193
3	0.20930	0.05199	0.04067	0.19792	0.10503	0.11285	0.16330	0.11195	0.12129	0.14953	0.14826	0.14220	0.10474	0.09562	0.09922
4	0.21395	0.19192	0.08282	0.07630	0.21928	0.12603	0.14971	0.20859	0.18520	0.22833	0.22638	0.21713	0.15992	0.14601	0.15151
5	0.26244	0.19654	0.21867	0.12821	0.11995	0.22383	0.15770	0.18627	0.22894	0.28225	0.27984	0.26841	0.19769	0.18049	0.18729
6	0.24162	0.25691	0.22739	0.21923	0.16106	0.10918	0.22846	0.17849	0.24821	0.30601	0.30341	0.29101	0.21434	0.19569	0.20306
7	0.11935	0.22288	0.29300	0.25048	0.25271	0.15237	0.12453	0.26423	0.28435	0.35057	0.34759	0.33338	0.24554	0.22418	0.23262
8	0.19666	0.13812	0.21517	0.32533	0.29651	0.21496	0.17851	0.20430	0.29655	0.36561	0.36250	0.34768	0.25608	0.23380	0.24260
9	0.21467	0.21334	0.12375	0.26809	0.32521	0.26621	0.24071	0.22095	0.32805	0.40444	0.40099	0.38461	0.28327	0.25863	0.26837
10	0.21738	0.24316	0.20607	0.26018	0.22693	0.31362	0.18844	0.30372	0.29208	0.36009	0.35703	0.34244	0.25221	0.23027	0.23894
11	0.25784	0.22405	0.21202	0.24259	0.24963	0.23292	0.24904	0.24426	0.27472	0.33870	0.33581	0.32209	0.23723	0.21659	0.22474
12	0.25784	0.22405	0.21202	0.24259	0.24963	0.23292	0.24904	0.24426	0.27472	0.33870	0.33581	0.32209	0.23723	0.21659	0.22474

Fishing Mortality (per year)

AGE	1999	2000
0	0.00481	0.00470
1	0.01908	0.01864
2	0.04484	0.04380
3	0.08567	0.08370
4	0.13082	0.12780
5	0.16171	0.15798
6	0.17533	0.17128
7	0.20086	0.19622
8	0.20947	0.20464
9	0.23172	0.22637
10	0.20631	0.20155
11	0.19405	0.18957
12	0.19405	0.18957

Table 2.10.2.8 North East Atlantic Mackerel. Population numbers at age.

Population Abundance (1 January)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	7478.7	3465.9	3575.9	5239.6	3731.3	4539.1	3437.7	3929.2	4985.5	6387.1	4946.2	5550.4	6590.7	5283.2	4787.7
1	1418.8	6169.8	2907.8	3032.9	4502.9	3160.5	3846.2	2936.4	3372.7	4261.9	5451.5	4222.0	4739.3	5639.4	4522.9
2	1522.8	1191.5	5063.0	2450.5	2573.1	3740.5	2660.7	3180.3	2473.2	2825.5	3548.1	4539.8	3520.7	3985.1	4751.6
3	3896.6	1230.7	1006.3	3976.3	1963.8	2092.8	2929.9	2095.8	2540.5	1997.8	2248.9	2825.9	3627.2	2868.6	3262.6
4	2169.5	2720.4	1005.6	831.6	2807.9	1521.7	1609.1	2141.9	1612.8	1936.9	1480.7	1668.9	2109.9	2811.5	2243.9
5	1174.0	1507.7	1932.6	796.7	663.2	1940.9	1154.7	1192.4	1496.4	1153.5	1326.8	1016.2	1156.1	1547.6	2091.2
6	492.4	777.2	1066.1	1336.7	603.2	506.3	1335.5	848.9	851.9	1024.4	748.7	863.2	668.8	816.6	1112.1
7	211.9	332.8	517.4	731.0	924.0	442.0	390.7	914.7	611.2	572.0	649.3	475.7	555.4	464.6	577.9
8	373.4	161.9	229.2	332.2	489.8	617.7	326.6	296.9	604.5	395.9	346.8	394.8	293.4	373.9	319.6
9	267.5	264.0	121.3	159.1	206.5	313.4	428.8	235.2	208.3	386.8	236.4	207.7	240.0	195.5	254.8
10	206.8	185.7	183.6	92.3	104.7	128.4	206.7	290.1	162.3	129.2	222.2	136.2	121.7	155.6	129.9
11	142.7	143.2	125.4	128.6	61.2	71.8	80.8	147.3	184.3	104.3	77.6	133.8	83.3	81.4	106.4
12	328.0	518.7	442.8	315.3	267.2	185.1	135.9	262.5	304.7	254.6	216.4	154.8	155.8	137.7	122.3

x 10 ^ 6

Population Abundance (1 January)

AGE	1999	2000	2001
0	7007.2	8355.2	(4280.5)
1	4098.0	6002.3	7157.7
2	3807.9	3460.5	5070.8
3	3882.8	3133.7	2850.8
4	2542.9	3067.6	2480.7
5	1659.8	1920.3	2323.5
6	1492.5	1215.3	1411.3
7	781.3	1078.0	881.4
8	394.2	550.1	762.5
9	215.8	275.2	385.8
10	167.7	147.3	188.9
11	88.0	117.4	103.7
12	186.3	187.2	216.9

x 10 ^ 6

Table 2.10.2.9a North East Atlantic Mackerel. Diagnostic output.

Predicted Catch in Number

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	31.40	49.55	38.05	40.96	35.86	26.25	24.68	31.20	36.34
1	83.48	129.66	164.46	122.24	101.48	110.35	91.80	71.92	102.94
2	141.37	197.70	246.23	302.63	174.50	180.75	223.43	155.13	137.80
3	269.87	258.15	288.29	348.46	335.37	243.21	286.54	296.36	233.89
4	253.79	368.20	279.34	303.30	290.14	355.32	293.50	290.02	342.28
5	285.16	264.34	301.79	222.90	193.05	237.86	332.44	230.60	261.10
6	174.42	251.75	182.63	203.13	120.13	135.10	190.26	223.37	178.03
7	140.97	157.77	177.80	125.77	112.63	86.88	111.71	132.35	178.79
8	144.59	113.08	98.36	108.13	61.75	72.60	64.12	69.36	94.77
9	54.33	120.08	72.87	61.88	55.17	41.50	55.87	41.57	51.91
10	38.31	36.43	62.22	36.84	25.27	29.81	25.72	29.10	25.04
11	41.26	27.95	20.63	34.35	16.38	14.76	19.94	14.46	18.87

x 10 ^ 6

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	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
4	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
6	1.0000	1.0000	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	1.0000	1.0000
8	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
10	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

Table 2.10.2.9b 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	1999	2000
1	*******	*******	*******	*******	*******	*******	*******	*******	3207.0	*******	*******	3106.9	*******	*******	3602.1	*******	*******

x 10 ^ 3

Table 2.10.2.9c North East Atlantic Mackerel. Diagnostic output.

Fitted Selection Pattern

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.1615	0.1300	0.0673	0.0119	0.1337	0.0698	0.0483	0.0147	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
1	0.0937	0.2427	0.0965	0.1121	0.2961	0.0989	0.2544	0.1163	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180
2	0.2400	0.0963	0.4190	0.5569	0.4720	0.4210	0.5622	0.4005	0.2773	0.2773	0.2773	0.2773	0.2773	0.2773	0.2773
3	0.7975	0.2645	0.1860	1.5436	0.8756	0.5042	1.0355	0.6010	0.5298	0.5298	0.5298	0.5298	0.5298	0.5298	0.5298
4	0.8152	0.9765	0.3788	0.5951	1.8280	0.5630	0.9493	1.1198	0.8090	0.8090	0.8090	0.8090	0.8090	0.8090	0.8090
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	0.9207	1.3072	1.0399	1.7099	1.3427	0.4878	1.4487	0.9582	1.0842	1.0842	1.0842	1.0842	1.0842	1.0842	1.0842
7	0.4548	1.1340	1.3400	1.9536	2.1068	0.6808	0.7897	1.4185	1.2421	1.2421	1.2421	1.2421	1.2421	1.2421	1.2421
8	0.7494	0.7027	0.9840	2.5374	2.4719	0.9604	1.1320	1.0968	1.2954	1.2954	1.2954	1.2954	1.2954	1.2954	1.2954
9	0.8180	1.0855	0.5659	2.0910	2.7112	1.1893	1.5264	1.1862	1.4329	1.4329	1.4329	1.4329	1.4329	1.4329	1.4329
10	0.8283	1.2372	0.9424	2.0292	1.8918	1.4011	1.1949	1.6305	1.2758	1.2758	1.2758	1.2758	1.2758	1.2758	1.2758
11	0.9825	1.1399	0.9696	1.8920	2.0811	1.0406	1.5792	1.3113	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
12	0.9825	1.1399	0.9696	1.8920	2.0811	1.0406	1.5792	1.3113	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Fitted Selection Pattern

AGE	1999	2000
0	0.0297	0.0297
1	0.1180	0.1180
2	0.2773	0.2773
3	0.5298	0.5298
4	0.8090	0.8090
5	1.0000	1.0000
6	1.0842	1.0842
7	1.2421	1.2421
8	1.2954	1.2954
9	1.4329	1.4329
10	1.2758	1.2758
11	1.2000	1.2000
12	1.2000	1.2000

Table 2.10.2.9d North East Atlantic Mackerel. Diagnostic output.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.2289	6	0.1996	0.2626	0.2135	0.2455	0.2295
2	1993	0.2822	7	0.2458	0.3241	0.2630	0.3029	0.2830
3	1994	0.2798	7	0.2412	0.3247	0.2594	0.3019	0.2806
4	1995	0.2684	8	0.2274	0.3169	0.2466	0.2921	0.2694
5	1996	0.1977	9	0.1637	0.2388	0.1795	0.2177	0.1986
6	1997	0.1805	10	0.1459	0.2232	0.1619	0.2011	0.1816
7	1998	0.1873	12	0.1464	0.2395	0.1652	0.2123	0.1888
8	1999	0.1617	14	0.1213	0.2155	0.1397	0.1872	0.1635
9	2000	0.1580	16	0.1135	0.2199	0.1334	0.1870	0.1602
Separable Model: Selection (S) by age								
10	0	0.0297	48	0.0114	0.0775	0.0182	0.0485	0.0335
11	1	0.1180	8	0.1007	0.1382	0.1088	0.1279	0.1184
12	2	0.2773	7	0.2404	0.3198	0.2578	0.2982	0.2780
13	3	0.5298	6	0.4630	0.6062	0.4946	0.5675	0.5310
14	4	0.8090	6	0.7104	0.9212	0.7571	0.8644	0.8107
	5	1.0000		Fixed : Reference Age				
15	6	1.0842	6	0.9593	1.2254	1.0186	1.1541	1.0863
16	7	1.2421	5	1.1046	1.3966	1.1699	1.3187	1.2443
17	8	1.2954	5	1.1581	1.4489	1.2234	1.3716	1.2975
18	9	1.4329	5	1.2860	1.5967	1.3560	1.5143	1.4351
19	10	1.2758	5	1.1398	1.4280	1.2045	1.3513	1.2779
	11	1.2000		Fixed : Last true age				
Separable model: Populations in year 2000								
20	0	8355166	146	471135	148171459	1926670	36232873	24509279
21	1	6002256	24	3745274	9619343	4718554	7635194	6178574
22	2	3460511	19	2344227	5108354	2836900	4221206	3529507
23	3	3133744	17	2227031	4409615	2632578	3730317	3181690
24	4	3067567	15	2270421	4144591	2630975	3576609	3103935
25	5	1920295	14	1442846	2555735	1659690	2221819	1940827
26	6	1215304	14	915037	1614102	1051488	1404642	1228109
27	7	1077999	14	812767	1429785	933342	1245077	1089248
28	8	550078	14	411321	735645	474258	638021	556162
29	9	275151	15	203607	371835	235965	320845	278418
30	10	147322	16	106932	202967	125103	173487	149304
31	11	117403	16	84180	163736	99076	139119	119106
Separable model: Populations at age								
32	1992	184311	15	137255	247498	158575	214224	186407
33	1993	104304	11	82653	131626	92629	117450	105041
34	1994	77554	10	62514	96212	69476	86571	78024
35	1995	133801	11	107755	166143	119809	149428	134620
36	1996	83261	11	66361	104465	74161	93479	83821
37	1997	81395	12	64172	103240	72097	91892	81996
38	1998	106385	13	81867	138247	93075	121599	107340
39	1999	88045	14	65631	118112	75789	102282	89039
SSB Index catchabilities								
INDEX1								
Linear model fitted. Slopes at age :								
40	1 Q	1.092	7	1.016	1.360	1.092	1.266	1.179

Table 2.10.2.9e North East Atlantic Mackerel. Diagnostic output.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.325	-0.940	-0.405	-1.021	0.057	0.316	0.907	0.764	0.000
1	0.001	-0.012	-0.110	-0.405	0.166	0.269	0.079	0.022	-0.008
2	0.100	0.062	-0.106	0.119	-0.033	0.031	0.028	-0.167	-0.031
3	0.278	0.033	0.063	-0.024	-0.006	-0.020	-0.080	-0.332	0.083
4	0.049	0.078	-0.044	-0.098	-0.038	0.064	0.096	-0.149	0.009
5	0.071	-0.079	-0.001	-0.176	-0.083	0.037	0.085	0.147	0.004
6	-0.111	0.015	0.012	-0.026	-0.221	0.000	0.087	0.024	0.191
7	-0.213	-0.051	0.066	0.124	0.062	-0.029	0.058	0.119	-0.134
8	-0.043	-0.146	0.076	0.048	-0.101	-0.088	0.126	0.161	0.005
9	-0.059	0.011	0.094	0.112	0.081	-0.051	-0.165	0.123	-0.109
10	-0.045	0.063	-0.077	0.141	0.021	-0.109	-0.053	-0.021	0.104
11	-0.007	0.039	-0.011	0.100	0.114	-0.056	-0.186	0.088	-0.119

Table 2.10.2.9f North East Atlantic Mackerel. Diagnostic output.

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	0.04958	*******	*******	-.08982	*******	*******	0.04024

	1999	2000
1	*******	*******

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 2000

Variance	0.0184
Skewness test stat.	-2.5194
Kurtosis test statistic	3.1946
Partial chi-square	0.1094
Significance in fit	0.0000
Degrees of freedom	69

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Linear catchability relationship assumed

Variance	0.0304
Skewness test stat.	-0.4919
Kurtosis test statistic	-0.5303
Partial chi-square	0.0041
Significance in fit	0.0020
Number of observations	3
Degrees of freedom	2
Weight in the analysis	5.0000

Table 2.10.2.9g North East Atlantic Mackerel. Diagnostic output.

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.9512	111	40	71	0.0697
Catches at age	4.9391	108	39	69	0.0716
SSB Indices					
INDEX1	0.0121	3	1	2	0.0061

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	1.5744	111	40	71	0.0222
Catches at age	1.2708	108	39	69	0.0184
SSB Indices					
INDEX1	0.3036	3	1	2	0.1518

Table 2.10.2.10 North East Atlantic Mackerel. 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	7478720	3388713	2645828	648084	0.2449	0.2068	100
1985	3465860	3591903	2616406	614275	0.2348	0.2013	100
1986	3575910	3580352	2632340	602128	0.2287	0.2074	103
1987	5239640	3459986	2611702	654805	0.2507	0.1999	99
1988	3731310	3626229	2687998	676288	0.2516	0.2099	103
1989	4539060	3642447	2724120	585921	0.2151	0.1653	100
1990	3437690	3438327	2580921	625611	0.2424	0.1678	99
1991	3929230	3798001	2902582	667883	0.2301	0.2084	98
1992	4985450	3913230	2938102	760351	0.2588	0.2487	99
1993	6387130	3835186	2766249	825036	0.2983	0.3066	100
1994	4946240	3756298	2611792	823477	0.3153	0.3039	100
1995	5550350	3969079	2846404	756291	0.2657	0.2915	100
1996	6590670	3958797	2932761	563585	0.1922	0.2147	100
1997	5283160	4361789	3173685	569543	0.1795	0.1960	99
1998	4787740	4619818	3300059	666678	0.2022	0.2034	100
1999	7007220	5055484	3722444	608928	0.1636	0.1756	100
2000	(4280500)	5266083	3814606	667158	0.1749	0.1716	100

No of years for separable analysis : 9
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1984 . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 40
Number of observations : 111

Conventional single selection vector model to be fitted.

Table 2.10.3.1 Assessment quality control diagram for the North East Atlantic mackerel combined (Average fishing mortality over age 4 to 8).

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	1999	2000
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		
2000	0.200	0.209	0.165	0.167	0.207	0.246	0.302	0.298	0.285	0.209	0.190	0.197	0.169	
2001	0.200	0.210	0.165	0.168	0.208	0.249	0.307	0.304	0.292	0.215	0.196	0.203	0.176	0.172

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

Table 2.10.3.2 Assessment quality control diagram for the 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	2000	2001
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			
2000	3746	4633	3421	4030	5052	6670	4861	5687	6765	5206	5124	4252 [4)]		
2001	3731	4539	3438	3929	4985	6387	4946	5550	6591	5283	4788	7007	4281 [4)]	

[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 yearclass) 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 2.10.3.3 Assessment quality control diagram for the North East Atlantic mackerel combined (Spawning stock biomass).

Assessment Quality Control Diagram 3

Date of assessment	Spawning stock biomass ('000 t)															
	Year															
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
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					
2000	2697	2735	2594	2924	2965	2803	2659	2918	3014	3262	3399	3831				
2001	2688	2724	2581	2903	2938	2766	2612	2846	2933	3174	3300	3722	3815			

[1]Forecast.

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

Table 2.11.1 INPUT PREDICTIONS FOR NORTH EAST ATLANTIC MACKEREL

UNIT: millions

Version: 08-Sep-01 13:49

Year class	AGE	Stock in numbers at 1st January 2001	
2000	**0**	4280.5	<--- geometric mean over period 1972-1997 of Western recruitment, raised by the average ratio of the estimated Western and NEA area recruitments for the period 1984-1997.
1999	**1**	3667.0	<--- corrected 1-year olds
1998	**2**	5070.8	<-- from ICA
1997	**3**	2850.8	<-- from ICA
1996	**4**	2480.7	<-- from ICA
1995	**5**	2323.5	<-- from ICA
1994	**6**	1411.3	<-- from ICA
1993	**7**	881.4	<-- from ICA
1992	**8**	762.5	<-- from ICA
1991	**9**	385.8	<-- from ICA
1990	**10**	188.9	<-- from ICA
1989	**11**	103.7	<-- from ICA
	12+	216.9	<-- from ICA

CALCULATION OF RECRUITMENT AT AGE 1	
Numbers at age **1**	7157.7
At age **0** one year earlier	8355.2
CORRECTED **1**-YEAR OLDS	3667.0

(N_age_1_in_2001 / N_age_0_in 2000) x GM recruitment

Calculation of status quo F and fishery pattern by fleet

	MAC-south catch at age			**MAC-northern catch at age**			**MAC-northern fraction**		
AGE	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**	**1998**	**1999**	**2000**
0	53123	66972	29314	8003	31	7032	0.1309	0.0005	0.1935
1	31394	13109	36657	67958	60411	65496	0.6840	0.8217	0.6412
2	22826	8634	10186	206941	122685	123401	0.9007	0.9343	0.9237
3	21466	12828	20928	243100	199824	233205	0.9189	0.9397	0.9176
4	10624	22031	9629	312562	227933	335582	0.9671	0.9119	0.9721
5	19696	17387	17322	342249	249626	244852	0.9456	0.9349	0.9339
6	15450	21849	8773	192169	206833	206646	0.9256	0.9045	0.9593
7	6584	11407	11973	111804	137701	144366	0.9444	0.9235	0.9234
8	4298	4667	6237	68448	76786	89049	0.9409	0.9427	0.9345
9	4135	2882	2018	43218	44122	44528	0.9127	0.9387	0.9566
10	2702	2330	1076	21684	26175	26711	0.8892	0.9183	0.9613
11	1990	1788	1014	14561	13998	15733	0.8798	0.8867	0.9394
12	1929	991	636	19331	28634	28694	0.8430	0.9362	0.9535
13	578	585	394						
14	420	203	269						
15+	675	172	100						

	from ICA
F(4-8)98 =	0.2034
F(4-8)99 =	0.1756
F(4-8)00 =	0.1716
	0.1835 **= Fsq (4-8) 98-00**

		Rescaling factor					
Mean F(4-8)	**0.1716**	**1.0696**		**Rescaled fishery pattern for the prediction**		**Mean of the fractions over the last three years**	
AGE	**F-values from ICA**		**Rescaled F-values**	**SOUTH**	**NORTH**	**SOUTH**	**NORTH**
0	0.00470		0.00503	**0.0045**	**0.0005**	0.8917	0.1083
1	0.01864		0.01994	**0.0057**	**0.0143**	0.2844	0.7156
2	0.04380		0.04685	**0.0038**	**0.0431**	0.0804	0.9196
3	0.08370		0.08953	**0.0067**	**0.0828**	0.0746	0.9254
4	0.12780		0.13670	**0.0068**	**0.1299**	0.0496	0.9504
5	0.15798		0.16898	**0.0105**	**0.1585**	0.0619	0.9381
6	0.17128		0.18321	**0.0129**	**0.1703**	0.0702	0.9298
7	0.19622		0.20989	**0.0146**	**0.1953**	0.0696	0.9304
8	0.20464		0.21889	**0.0133**	**0.2056**	0.0606	0.9394
9	0.22637		0.24213	**0.0155**	**0.2266**	0.0640	0.9360
10	0.20155		0.21559	**0.0166**	**0.1990**	0.0771	0.9229
11	0.18957		0.20277	**0.0199**	**0.1829**	0.0980	0.9020
12+	0.18957		0.20277	**0.0181**	**0.1847**	0.0891	0.9109
	F of WG2001						

Proportion of F and M before spawing

F	**M**
0.4	**0.4**

Table 2.11.1 (Continued)

AGE	Proportion MATURE		1998	1999	2000
0	0.00		0.00	0.00	0.00
1	0.06	NEA	0.06	0.06	0.06
2	0.58		0.58	0.58	0.58
3	0.85		0.85	0.85	0.85
4	0.98		0.98	0.98	0.98
5	0.98		0.98	0.98	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		1998	1999	2000
0	0.000		0.000	0.000	0.000
1	0.094	NEA	0.094	0.094	0.094
2	0.193		0.168	0.209	0.203
3	0.251		0.241	0.256	0.255
4	0.305		0.298	0.315	0.301
5	0.358		0.353	0.361	0.360
6	0.406		0.413	0.409	0.397
7	0.437		0.439	0.437	0.434
8	0.466		0.478	0.459	0.460
9	0.503		0.514	0.497	0.499
10	0.526		0.561	0.514	0.504
11	0.520		0.539	0.478	0.542
12+	0.599		0.624	0.601	0.572

AGE	NORTHERN Mean weight at age in the CATCH		1998	1999	2000
0	0.069		0.060	0.092	0.056
1	0.166	NORTHERN	0.165	0.184	0.150
2	0.233		0.231	0.237	0.231
3	0.314		0.317	0.310	0.314
4	0.364		0.356	0.367	0.368
5	0.418		0.411	0.408	0.435
6	0.463		0.458	0.461	0.470
7	0.495		0.465	0.509	0.511
8	0.536		0.522	0.544	0.543
9	0.569		0.558	0.575	0.575
10	0.590		0.583	0.595	0.591
11	0.609		0.605	0.619	0.602
12+	0.665		0.645	0.698	0.653

AGE	SOUTHERN Mean weight at age in the CATCH		1998	1999	2000
0	0.064		0.065	0.062	0.064
1	0.128	SOUTHERN	0.138	0.137	0.110
2	0.197		0.192	0.202	0.196
3	0.244		0.237	0.261	0.233
4	0.309		0.313	0.302	0.311
5	0.356		0.350	0.371	0.348
6	0.389		0.375	0.385	0.408
7	0.415		0.407	0.407	0.429
8	0.443		0.449	0.433	0.447
9	0.467		0.461	0.481	0.459
10	0.502		0.494	0.503	0.509
11	0.513		0.493	0.531	0.516
12+	0.553	weighted mean weight!	0.513	0.528	0.536
			0.566	0.549	0.543
			0.616	0.572	0.571
			0.643	0.594	0.614

AGE	NEA Mean weight at age in the CATCH		1998	1999	2000
0	0.063		0.065	0.062	0.063
1	0.156	NEA	0.157	0.176	0.135
2	0.231		0.227	0.236	0.229
3	0.308		0.310	0.307	0.308
4	0.361		0.354	0.361	0.367
5	0.414		0.408	0.406	0.429
6	0.458		0.452	0.454	0.467
7	0.489		0.462	0.501	0.504
8	0.531		0.518	0.537	0.537
9	0.563		0.550	0.569	0.570
10	0.583		0.573	0.587	0.588
11	0.599		0.591	0.609	0.597
12+	0.656		0.631	0.688	0.649

Table 2.11.2 North East Atlantic Mackerel. Multifleet prediction: INPUT DATA

Rundate: 8 Sep 2000

2001

	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 the stock
0	0.0005	0.069	0.0045	0.064	**4281**	0.15	0.00	0.4	0.4	0.000
1	0.0143	0.166	0.0057	0.128	**3667**	0.15	0.06	0.4	0.4	0.094
2	0.0431	0.233	0.0038	0.197	5071	0.15	0.58	0.4	0.4	0.193
3	0.0828	0.314	0.0067	0.244	2851	0.15	0.85	0.4	0.4	0.251
4	0.1299	0.364	0.0068	0.309	2481	0.15	0.98	0.4	0.4	0.305
5	0.1585	0.418	0.0105	0.356	2324	0.15	0.98	0.4	0.4	0.358
6	0.1703	0.463	0.0129	0.389	1411	0.15	0.99	0.4	0.4	0.406
7	0.1953	0.495	0.0146	0.415	881	0.15	1.00	0.4	0.4	0.437
8	0.2056	0.536	0.0133	0.443	763	0.15	1.00	0.4	0.4	0.466
9	0.2266	0.569	0.0155	0.467	386	0.15	1.00	0.4	0.4	0.503
10	0.1990	0.590	0.0166	0.502	189	0.15	1.00	0.4	0.4	0.526
11	0.1829	0.609	0.0199	0.513	104	0.15	1.00	0.4	0.4	0.520
12+	0.1847	0.665	0.0181	0.553	217	0.15	1.00	0.4	0.4	0.599
UNIT:		(kg)		(kg)	(millions)					(kg)

2002

	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 the stock
0	0.0005	0.069	0.0045	0.064	4280.5	0.15	0.00	0.4	0.4	0.000
1	0.0143	0.166	0.0057	0.128	-	0.15	0.06	0.4	0.4	0.094
2	0.0431	0.233	0.0038	0.197	-	0.15	0.58	0.4	0.4	0.193
3	0.0828	0.314	0.0067	0.244	-	0.15	0.85	0.4	0.4	0.251
4	0.1299	0.364	0.0068	0.309	-	0.15	0.98	0.4	0.4	0.305
5	0.1585	0.418	0.0105	0.356	-	0.15	0.98	0.4	0.4	0.358
6	0.1703	0.463	0.0129	0.389	-	0.15	0.99	0.4	0.4	0.406
7	0.1953	0.495	0.0146	0.415	-	0.15	1.00	0.4	0.4	0.437
8	0.2056	0.536	0.0133	0.443	-	0.15	1.00	0.4	0.4	0.466
9	0.2266	0.569	0.0155	0.467	-	0.15	1.00	0.4	0.4	0.503
10	0.1990	0.590	0.0166	0.502	-	0.15	1.00	0.4	0.4	0.526
11	0.1829	0.609	0.0199	0.513	-	0.15	1.00	0.4	0.4	0.520
12+	0.1847	0.665	0.0181	0.553	-	0.15	1.00	0.4	0.4	0.599
UNIT:		(kg)		(kg)	(millions)					(kg)

2003

	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 the stock
0	0.0005	0.069	0.0045	0.064	4280.5	0.15	0.00	0.4	0.4	0.000
1	0.0143	0.166	0.0057	0.128	-	0.15	0.06	0.4	0.4	0.094
2	0.0431	0.233	0.0038	0.197	-	0.15	0.58	0.4	0.4	0.193
3	0.0828	0.314	0.0067	0.244	-	0.15	0.85	0.4	0.4	0.251
4	0.1299	0.364	0.0068	0.309	-	0.15	0.98	0.4	0.4	0.305
5	0.1585	0.418	0.0105	0.356	-	0.15	0.98	0.4	0.4	0.358
6	0.1703	0.463	0.0129	0.389	-	0.15	0.99	0.4	0.4	0.406
7	0.1953	0.495	0.0146	0.415	-	0.15	1.00	0.4	0.4	0.437
8	0.2056	0.536	0.0133	0.443	-	0.15	1.00	0.4	0.4	0.466
9	0.2266	0.569	0.0155	0.467	-	0.15	1.00	0.4	0.4	0.503
10	0.1990	0.590	0.0166	0.502	-	0.15	1.00	0.4	0.4	0.526
11	0.1829	0.609	0.0199	0.513	-	0.15	1.00	0.4	0.4	0.520
12+	0.1847	0.665	0.0181	0.553	-	0.15	1.00	0.4	0.4	0.599
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 2.11.3 Method of estimating geometric mean recruitment for NEA MACKEREL

	NEA MACKEREL	WESTERN MACKEREL		
Year	Recruitment 1984-2000	1972-2000		
1972		2004	WESTERN GM over 72-79 3263	raised to NEA 3808
1973		4405		
1974		3423		
1975		4880		
1976		5041		
1977		953		
1978		3322		
1979		5463		
1980		5421	GM over 80-89 3663	raised to NEA 4275
1981		6983		
1982		1839		
1983		1358		
1984	7479	6520		
1985	3466	3125		
1986	3576	3151		
1987	5240	5026		
1988	3731	3341		
1989	4539	4270		
1990	3438	3106	GM over 90-97 4130	raised to NEA 4819
1991	3929	3592		
1992	4985	4380		
1993	6387	5580		
1994	4946	4157		
1995	5550	4188		
1996	6591	5023		
1997	5283	3547		
1998	4788	3240		
1999	7007	3503		
2000				

NEA mackerel	Western mackerel	Raising factor Western to NEA
4793.5	4107.6	1.167
GM over 1984-1997	GM over 1984-1997	for period 1984-1997

Western mackerel	NEA mackerel
3668.0	4280.5
GM over 1972-1997	for period 1972-1997

Table 2.11.4 NORTH EAST ATLANTIC MACKEREL. Two area prediction summary table with Fsq=0.1835 in 2001.

(Data obtained from the MFDP programme)

Fsq=0.1835 in 2001 and F=0.15 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	1.000000	0.1720	1688	682	0.0115	154	44	0.1835	1842	726	24624	5418	14229	4538	12713	4023
2002	0.817439	0.1406	1406	580	0.0094	129	37	0.1501	1535	617	23770	5357	14021	4591	12627	4111
2003	0.817439	0.1406	1425	599	0.0094	128	38	0.1501	1553	637	23319	5348	13786	4637	12393	4145
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.1835 in 2001 and F=0.17 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	1.000000	0.1720	1688	682	0.0115	154	44	0.1835	1842	726	24624	5418	14229	4538	12713	4023
2002	0.926431	0.1593	1581	652	0.0107	145	42	0.1700	1726	694	23770	5357	14021	4591	12553	4083
2003	0.926431	0.1593	1579	662	0.0107	142	42	0.1700	1721	704	23142	5279	13617	4570	12168	4057
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.1835 in 2001-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	1.000000	0.1720	1688	682	0.0115	154	44	0.1835	1842	726	24624	5418	14229	4538	12713	4023
2002	1.000000	0.1720	1698	700	0.0115	156	45	0.1835	1854	745	23770	5357	14021	4591	12503	4064
2003	1.000000	0.1720	1679	703	0.0115	152	45	0.1835	1831	748	23025	5234	13505	4526	12019	3999
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.1835 in 2001 and F=0.20 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	1.000000	0.1720	1688	682	0.0115	154	44	0.1835	1842	726	24624	5418	14229	4538	12713	4023
2002	1.089918	0.1875	1839	757	0.0126	169	49	0.2000	2008	806	23770	5357	14021	4591	12442	4042
2003	1.089918	0.1875	1797	750	0.0126	163	48	0.2000	1960	798	22882	5179	13370	4472	11840	3930
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.5 NORTH EAST ATLANTIC MACKEREL. Two area prediction summary table with <u>catch constraint of 670kt in 2001</u>.

(Data obtained from the MFDP programme)

Catch constraint of 670 kt in 2001 and F=0.15 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	0.916839	0.1577	1556	630	0.0106	142	40	0.1682	1698	670	24624	5418	14229	4538	12769	4043
2002	0.817439	0.1406	1421	587	0.0094	130	38	0.1501	1551	625	23903	5408	14146	4640	12739	4154
2003	0.817439	0.1406	1437	605	0.0094	129	39	0.1501	1566	644	23418	5390	13884	4678	12479	4181
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 670 kt in 2001 and F=0.17 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	0.916839	0.1577	1556	630	0.0106	142	40	0.1682	1698	670	24624	5418	14229	4538	12769	4043
2002	0.926431	0.1593	1598	660	0.0107	147	43	0.1700	1745	703	23903	5408	14146	4640	12664	4126
2003	0.926431	0.1593	1592	668	0.0107	143	43	0.1700	1735	711	23240	5320	13713	4610	12252	4092
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 670 kt in 2001 and Fsq=0.1835 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	0.916839	0.1577	1556	630	0.0106	142	40	0.1682	1698	670	24624	5418	14229	4538	12769	4043
2002	1.000000	0.1720	1716	708	0.0115	157	46	0.1835	1873	754	23903	5408	14146	4640	12613	4108
2003	1.000000	0.1720	1693	710	0.0115	153	45	0.1835	1846	755	23121	5274	13600	4565	12101	4034
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 670 kt in 2001 and F=0.20 in 2002-2003

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2001	0.916839	0.1577	1556	630	0.0106	142	40	0.1682	1698	670	24624	5418	14229	4538	12769	4043
2002	1.089918	0.1875	1858	766	0.0126	171	50	0.2000	2029	816	23903	5408	14146	4640	12551	4085
2003	1.089918	0.1875	1812	758	0.0126	164	48	0.2000	1976	806	22977	5218	13463	4511	11921	3964
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.6 NORTH EAST ATLANTIC MACKEREL. Two area prediction detailed table.

data obtained from MFDP output

Rundate :08/09/2001

Fsq = 0.1835 constraint for each fleet in 2001-2003

YEAR 2001 | F-factor **1.0000**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	Age	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass
2001	**0**	0.0005	2	0	0.0045	18	1	0.0050	20	1	4281	0	0	0
2000	**1**	0.0142	48	8	0.0057	19	2	0.0199	67	10	3667	345	206	19
1999	**2**	0.0430	198	46	0.0038	18	3	0.0468	216	49	5071	980	2718	526
1998	**3**	0.0828	210	66	0.0067	17	4	0.0895	227	70	2851	715	2202	552
1997	**4**	0.1300	280	102	0.0067	14	4	0.1367	294	106	2481	756	2168	660
1996	**5**	0.1586	316	132	0.0104	21	7	0.1690	337	139	2324	832	2004	718
1995	**6**	0.1703	204	95	0.0129	16	6	0.1832	220	101	1411	573	1223	497
1994	**7**	0.1955	145	72	0.0144	11	4	0.2099	156	76	881	385	763	333
1993	**8**	0.2057	131	70	0.0132	8	4	0.2189	139	74	763	355	658	306
1992	**9**	0.2263	72	41	0.0158	5	2	0.2421	77	43	386	194	330	166
1991	**10**	0.1986	31	19	0.0170	3	1	0.2156	34	20	189	99	163	86
1990	**11**	0.1826	16	10	0.0202	2	1	0.2028	18	11	104	54	90	47
1989	**12+**	0.1840	34	22	0.0188	3	2	0.2028	37	24	217	130	188	113
		0.1720	1688	682	0.0115	154	44	**0.1835**	1842	**724**	26426	5418	12713	**4023**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2002 | F-factor: **1.0000**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	Age	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass
2002	**0**	0.0005	2	0	0.0045	18	1	0.0050	20	1	4281	0	0	0
2001	**1**	0.0142	48	8	0.0057	19	2	0.0199	67	10	3666	345	205	19
2000	**2**	0.0430	121	28	0.0038	11	2	0.0468	132	30	3094	598	1659	321
1999	**3**	0.0828	307	96	0.0067	25	6	0.0895	332	102	4165	1044	3217	806
1998	**4**	0.1300	254	92	0.0067	13	4	0.1367	267	96	2244	684	1960	597
1997	**5**	0.1586	253	106	0.0104	17	6	0.1690	270	112	1862	667	1606	575
1996	**6**	0.1703	245	113	0.0129	19	7	0.1832	264	120	1689	686	1463	595
1995	**7**	0.1955	166	82	0.0144	12	5	0.2099	178	87	1011	442	876	382
1994	**8**	0.2057	106	57	0.0132	7	3	0.2189	113	60	615	286	531	247
1993	**9**	0.2263	99	56	0.0158	7	3	0.2421	106	59	527	265	451	227
1992	**10**	0.1986	43	26	0.0170	4	2	0.2156	47	28	261	137	225	119
1991	**11**	0.1826	20	12	0.0202	2	1	0.2028	22	13	131	68	114	59
1990	**12+**	0.1840	35	23	0.0188	4	2	0.2028	39	25	225	135	196	117
		0.1720	1698	700	0.0115	156	45	**0.1835**	1857	**743**	23770	5357	12503	**4064**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2003 | F-factor: **1.0000**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	Age	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass
2003	**0**	0.0005	2	0	0.0045	18	1	0.0050	20	1	4281	0	0	0
2002	**1**	0.0142	48	8	0.0057	19	2	0.0199	67	10	3666	345	205	19
2001	**2**	0.0430	121	28	0.0038	11	2	0.0468	132	30	3093	598	1658	321
2000	**3**	0.0828	187	59	0.0067	15	4	0.0895	202	63	2541	637	1963	492
1999	**4**	0.1300	371	135	0.0067	19	6	0.1367	390	141	3278	999	2864	873
1998	**5**	0.1586	229	96	0.0104	15	5	0.1690	244	101	1684	603	1453	520
1997	**6**	0.1703	196	91	0.0129	15	6	0.1832	211	97	1354	550	1173	477
1996	**7**	0.1955	199	98	0.0144	15	6	0.2099	214	104	1210	528	1048	458
1995	**8**	0.2057	121	65	0.0132	8	3	0.2189	129	68	706	329	609	284
1994	**9**	0.2263	80	45	0.0158	6	3	0.2421	86	48	425	214	364	183
1993	**10**	0.1986	59	35	0.0170	5	3	0.2156	64	38	356	187	308	162
1992	**11**	0.1826	28	17	0.0202	3	2	0.2028	31	19	181	94	157	82
1991	**12+**	0.1474	39	26	0.0102	4	2	0.1577	43	28	250	150	217	130
		0.1720	1679	703	0.0115	152	45	**0.1835**	1833	**748**	23025	5234	12019	**3999**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.7 NORTH EAST ATLANTIC MACKEREL. Two area management option table.

Spreadsheet version **Fsq = 0.1835 in 2001**

		YEAR 2001										
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass
1	0.1835	0.1719	1688	682	0.0116	154	44	0.1835	1842	726	12713	4023
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

		YEAR 2002											2003	
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time		Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
0.00	0.0000	0.0000	0	0	0.0000	0	0	0.0000	0	0	13204	4324	14263	4879
0.05	0.0092	0.0086	91	38	0.0006	8	2	0.0092	99	40	13168	4311	14139	4829
0.10	0.0184	0.0172	181	75	0.0012	16	5	0.0184	198	80	13132	4297	14016	4781
0.15	0.0275	0.0258	271	112	0.0017	25	7	0.0275	296	120	13096	4284	13894	4733
0.20	0.0367	0.0344	360	149	0.0023	33	10	0.0367	393	159	13060	4271	13774	4686
0.25	0.0459	0.0430	448	186	0.0029	41	12	0.0459	489	198	13025	4257	13655	4639
0.30	0.0551	0.0516	536	222	0.0035	49	14	0.0551	585	236	12989	4244	13537	4593
0.35	0.0642	0.0602	623	258	0.0041	57	17	0.0642	680	275	12954	4231	13421	4547
0.40	0.0734	0.0688	710	294	0.0046	65	19	0.0734	774	313	12918	4218	13306	4502
0.45	0.0826	0.0774	795	329	0.0052	72	21	0.0826	868	350	12883	4205	13192	4457
0.50	0.0918	0.0860	881	364	0.0058	80	23	0.0918	961	388	12848	4192	13080	4413
0.55	0.1009	0.0946	965	399	0.0064	88	26	0.1009	1053	425	12813	4179	12968	4369
0.60	0.1101	0.1032	1049	434	0.0070	96	28	0.1101	1145	462	12778	4166	12858	4326
0.65	0.1193	0.1118	1132	468	0.0075	103	30	0.1193	1236	498	12743	4153	12749	4284
0.70	0.1285	0.1204	1215	502	0.0081	111	32	0.1285	1326	534	12709	4140	12641	4242
0.75	0.1376	0.1290	1297	536	0.0087	119	34	0.1377	1415	570	12674	4128	12535	4200
0.80	0.1468	0.1376	1378	569	0.0093	126	37	0.1468	1504	606	12639	4115	12429	4159
0.85	0.1560	0.1461	1459	602	0.0099	134	39	0.1560	1593	641	12605	4102	12325	4118
0.90	0.1652	0.1547	1539	635	0.0104	141	41	0.1652	1680	676	12571	4090	12222	4078
0.95	0.1743	0.1633	1619	668	0.0110	148	43	0.1744	1768	711	12537	4077	12120	4038
1.00	0.1835	0.1719	1698	700	0.0116	156	45	0.1835	1854	745	12503	4065	12019	3999
1.05	0.1927	0.1805	1777	732	0.0122	163	47	0.1927	1940	779	12469	4052	11919	3960
1.10	0.2019	0.1891	1855	764	0.0128	170	49	0.2019	2025	813	12435	4040	11820	3922
1.15	0.2110	0.1977	1932	796	0.0133	178	51	0.2111	2110	847	12401	4027	11722	3884
1.20	0.2202	0.2063	2009	827	0.0139	185	53	0.2202	2194	880	12368	4015	11626	3847
1.25	0.2294	0.2149	2085	858	0.0145	192	55	0.2294	2277	913	12334	4002	11530	3810
1.30	0.2386	0.2235	2161	889	0.0151	199	57	0.2386	2360	946	12301	3990	11435	3773
1.35	0.2477	0.2321	2236	919	0.0157	206	59	0.2478	2442	979	12268	3978	11342	3737
1.40	0.2569	0.2407	2310	950	0.0162	213	61	0.2569	2524	1011	12235	3966	11249	3701
1.45	0.2661	0.2493	2384	980	0.0168	220	63	0.2661	2605	1043	12202	3954	11157	3666
1.50	0.2753	0.2579	2458	1010	0.0174	227	65	0.2753	2685	1075	12169	3942	11067	3631
1.55	0.2844	0.2665	2531	1039	0.0180	234	67	0.2845	2765	1107	12136	3929	10977	3597
1.60	0.2936	0.2751	2603	1069	0.0186	241	69	0.2937	2844	1138	12103	3917	10888	3563
1.65	0.3028	0.2837	2675	1098	0.0191	248	71	0.3028	2923	1169	12071	3905	10800	3529
1.70	0.3120	0.2923	2747	1127	0.0197	255	73	0.3120	3001	1200	12038	3893	10714	3496
1.75	0.3211	0.3009	2818	1156	0.0203	261	75	0.3212	3079	1230	12006	3882	10628	3463
1.80	0.3303	0.3095	2888	1184	0.0209	268	77	0.3304	3156	1261	11973	3870	10543	3430
1.85	0.3395	0.3181	2958	1212	0.0215	275	78	0.3395	3233	1291	11941	3858	10458	3398
1.90	0.3487	0.3267	3027	1240	0.0220	282	80	0.3487	3309	1321	11909	3846	10375	3366
1.95	0.3578	0.3353	3096	1268	0.0226	288	82	0.3579	3385	1350	11877	3834	10293	3335
2.00	0.3670	0.3439	3165	1296	0.0232	295	84	0.3671	3460	1380	11845	3823	10211	3304
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.8 NORTH EAST ATLANTIC MACKEREL. Two area management option table.

Spreadsheet version **Catch contstraint 670kt in 2001**

		YEAR 2001										
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass
0.91675	0.1683	0.1576	1556	630	0.0106	142	40	0.1683	1698	670	12769	4043
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

		YEAR 2002											2003	
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time		Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
0.00	0.0000	0.0000	0	0	0.0000	0	0	0.0000	0	0	13323	4370	14369	4923
0.05	0.0084	0.0086	92	38	0.0006	8	2	0.0092	100	41	13286	4357	14243	4874
0.10	0.0168	0.0172	183	76	0.0012	17	5	0.0184	200	81	13250	4343	14119	4825
0.15	0.0252	0.0258	274	114	0.0017	25	7	0.0275	299	121	13213	4330	13996	4776
0.20	0.0337	0.0344	364	151	0.0023	33	10	0.0367	397	161	13177	4316	13875	4728
0.25	0.0421	0.0430	453	188	0.0029	41	12	0.0459	494	200	13141	4303	13754	4681
0.30	0.0505	0.0516	542	225	0.0035	49	14	0.0551	591	239	13105	4290	13635	4634
0.35	0.0589	0.0602	630	261	0.0041	57	17	0.0642	687	278	13069	4276	13518	4588
0.40	0.0673	0.0688	717	297	0.0046	65	19	0.0734	782	316	13033	4263	13402	4542
0.45	0.0757	0.0774	804	333	0.0052	73	21	0.0826	877	355	12998	4250	13287	4497
0.50	0.0842	0.0860	890	369	0.0058	81	24	0.0918	971	392	12962	4237	13173	4452
0.55	0.0926	0.0946	975	404	0.0064	89	26	0.1009	1064	430	12927	4224	13060	4408
0.60	0.1010	0.1032	1060	439	0.0070	96	28	0.1101	1156	467	12891	4210	12949	4365
0.65	0.1094	0.1118	1144	474	0.0075	104	30	0.1193	1248	504	12856	4197	12839	4322
0.70	0.1178	0.1204	1228	508	0.0081	112	33	0.1285	1340	541	12821	4184	12730	4279
0.75	0.1262	0.1290	1310	542	0.0087	120	35	0.1377	1430	577	12786	4172	12623	4237
0.80	0.1346	0.1376	1393	576	0.0093	127	37	0.1468	1520	613	12751	4159	12516	4195
0.85	0.1431	0.1461	1474	609	0.0099	135	39	0.1560	1609	649	12717	4146	12411	4154
0.90	0.1515	0.1547	1556	643	0.0104	142	41	0.1652	1698	684	12682	4133	12307	4114
0.95	0.1599	0.1633	1636	676	0.0110	150	43	0.1744	1786	719	12647	4120	12203	4074
1.00	0.1683	0.1719	1716	708	0.0116	157	46	0.1835	1873	754	12613	4108	12101	4034
1.05	0.1767	0.1805	1795	741	0.0122	164	48	0.1927	1960	789	12579	4095	12001	3995
1.10	0.1851	0.1891	1874	773	0.0128	172	50	0.2019	2046	823	12545	4082	11901	3956
1.15	0.1935	0.1977	1952	805	0.0133	179	52	0.2111	2131	857	12511	4070	11802	3918
1.20	0.2020	0.2063	2030	837	0.0139	186	54	0.2202	2216	891	12477	4057	11704	3880
1.25	0.2104	0.2149	2107	868	0.0145	194	56	0.2294	2300	924	12443	4045	11608	3842
1.30	0.2188	0.2235	2183	899	0.0151	201	58	0.2386	2384	957	12409	4032	11512	3805
1.35	0.2272	0.2321	2259	930	0.0157	208	60	0.2478	2467	990	12375	4020	11418	3769
1.40	0.2356	0.2407	2334	961	0.0162	215	62	0.2569	2549	1023	12342	4008	11324	3733
1.45	0.2440	0.2493	2409	992	0.0168	222	64	0.2661	2631	1056	12308	3995	11232	3697
1.50	0.2525	0.2579	2483	1022	0.0174	229	66	0.2753	2713	1088	12275	3983	11140	3662
1.55	0.2609	0.2665	2557	1052	0.0180	236	68	0.2845	2793	1120	12242	3971	11049	3627
1.60	0.2693	0.2751	2630	1081	0.0186	243	70	0.2937	2873	1151	12209	3959	10960	3592
1.65	0.2777	0.2837	2703	1111	0.0191	250	72	0.3028	2953	1183	12176	3946	10871	3558
1.70	0.2861	0.2923	2775	1140	0.0197	257	74	0.3120	3032	1214	12143	3934	10783	3525
1.75	0.2945	0.3009	2847	1169	0.0203	264	76	0.3212	3110	1245	12110	3922	10697	3491
1.80	0.3029	0.3095	2918	1198	0.0209	270	77	0.3304	3188	1275	12078	3910	10611	3458
1.85	0.3114	0.3181	2989	1227	0.0215	277	79	0.3395	3266	1306	12045	3898	10526	3426
1.90	0.3198	0.3267	3059	1255	0.0220	284	81	0.3487	3342	1336	12013	3886	10442	3394
1.95	0.3282	0.3353	3128	1283	0.0226	290	83	0.3579	3419	1366	11980	3875	10358	3362
2.00	0.3366	0.3439	3197	1311	0.0232	297	85	0.3671	3494	1396	11948	3863	10276	3331
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Northeast Atlantic Mackerel

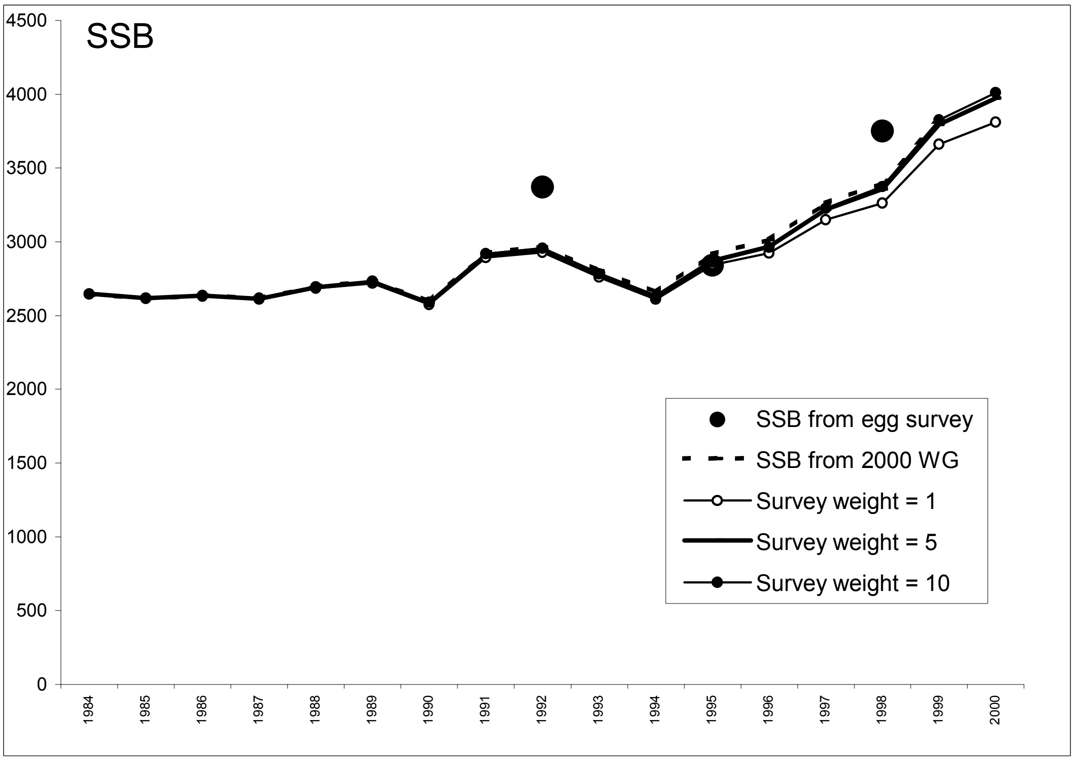


Figure 2.10.1.1 Assessments as last year except period of separable constraint increased from 8 to 9 years. Weighting of 1 results in 4.1% underestimation of 2000 SSB compared to traditional weighting of 5. Weighting of 10 results in 0.9% overestimation of 2000 SSB compared to traditional weighting of 5.

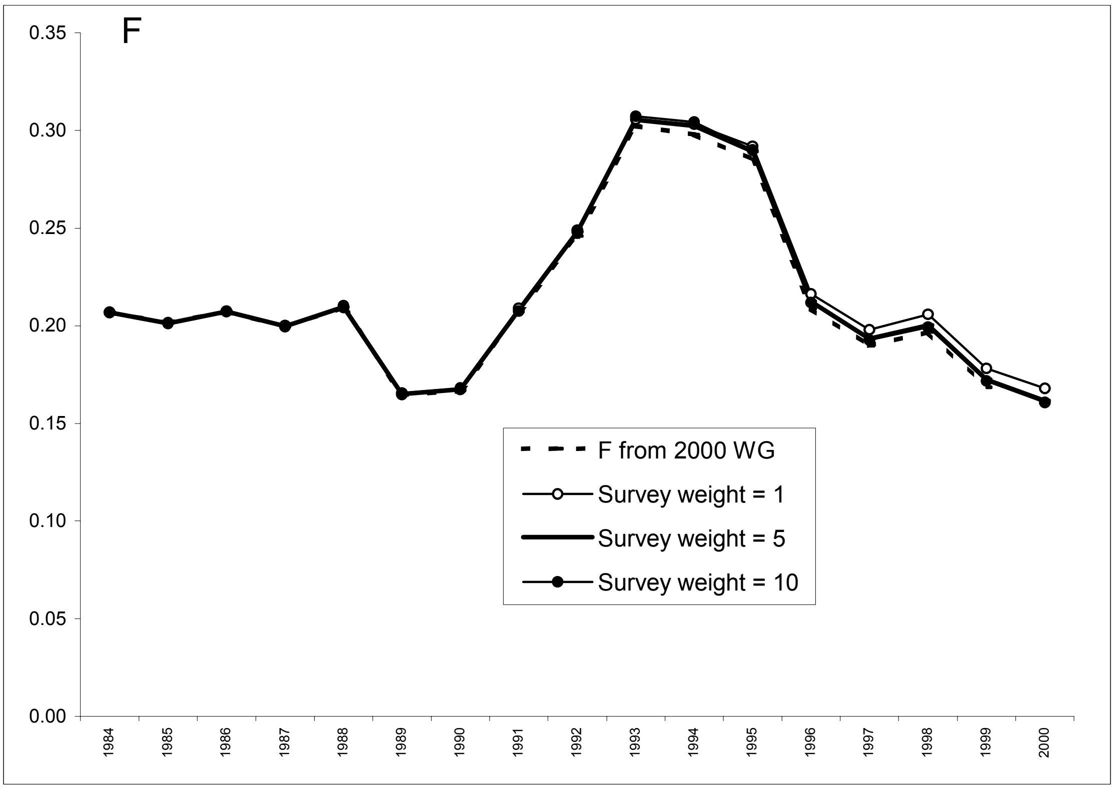


Figure 2.10.1.2 Assessments as last year except period of separable constraint increased from 8 to 9 years. Weighting of 1 results in 3.9% overerestimation of 2000 F compared to traditional weighting of 5. Weighting of 10 results in 0.6% underestimation of 2000 F compared to traditional weighting of 5.

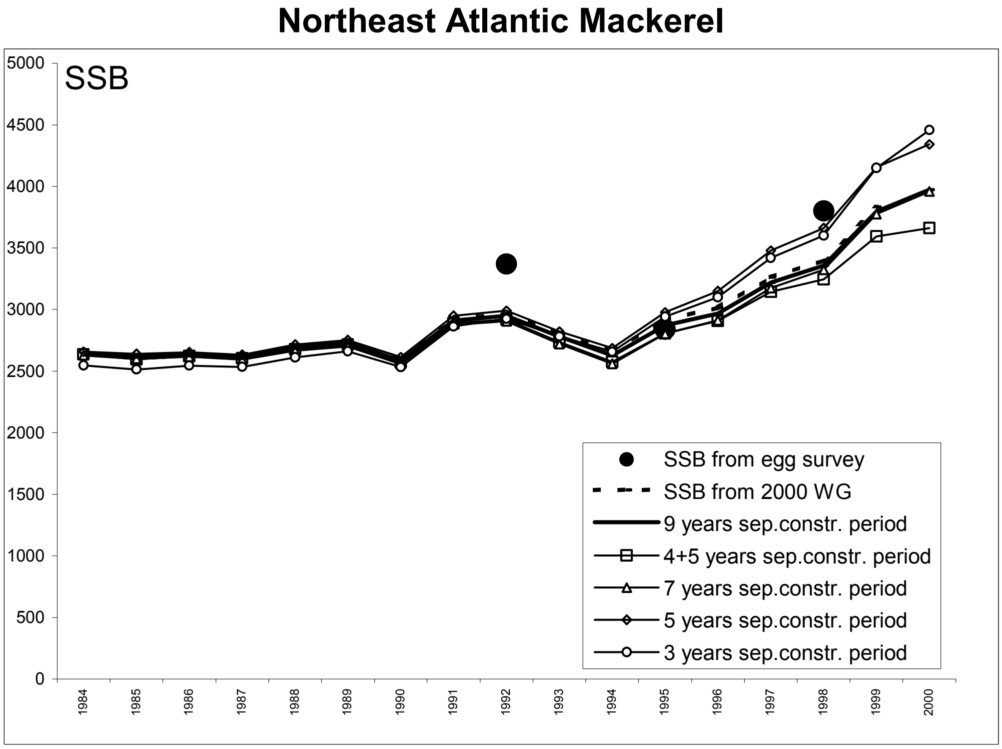


Figure 2.10.1.3 Assessments as last year except period of separable constraint varied from 3 to 9 years.
Period of sep.constraint of 4+5 years results in 7.9% undererestimation of 2000 SSB compared to period of 9 years.
Period of sep.constraint of 7 years results in 0.4% undererestimation of 2000 SSB compared to period of 9 years.
Period of sep.constraint of 3 and 5 years results in resp. 12.2% and 9.2% overerestimation of 2000 SSB compared to period of 9 years.

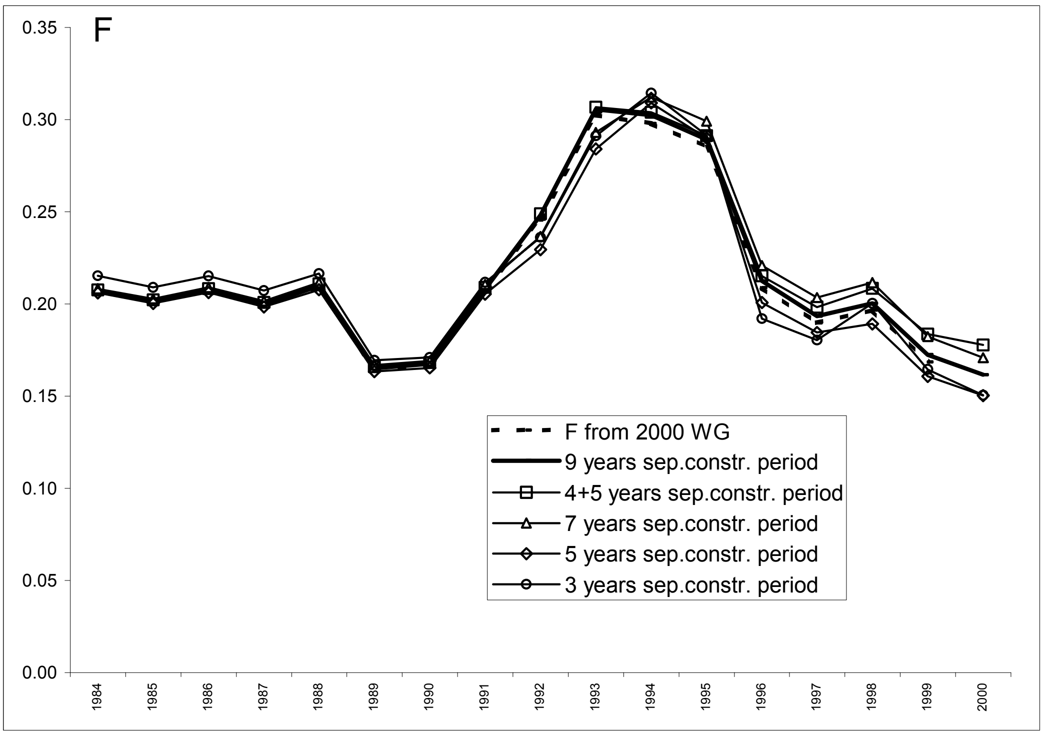


Figure 2.10.1.4 Assessments as last year except period of separable constraint varied from 3 to 9 years.
Period of sep.constraint of 4+5 years results in 10.0% overerestimation of 2000 F compared to period of 9 years.
Period of sep.constraint of 7 years results in 5.7% overerestimation of 2000 F compared to period of 9 years.
Period of sep.constraint of 3 and 5 years results in resp. 6.9% and 7.0% undererestimation of 2000 F compared to period of 9 years.

ISVPA

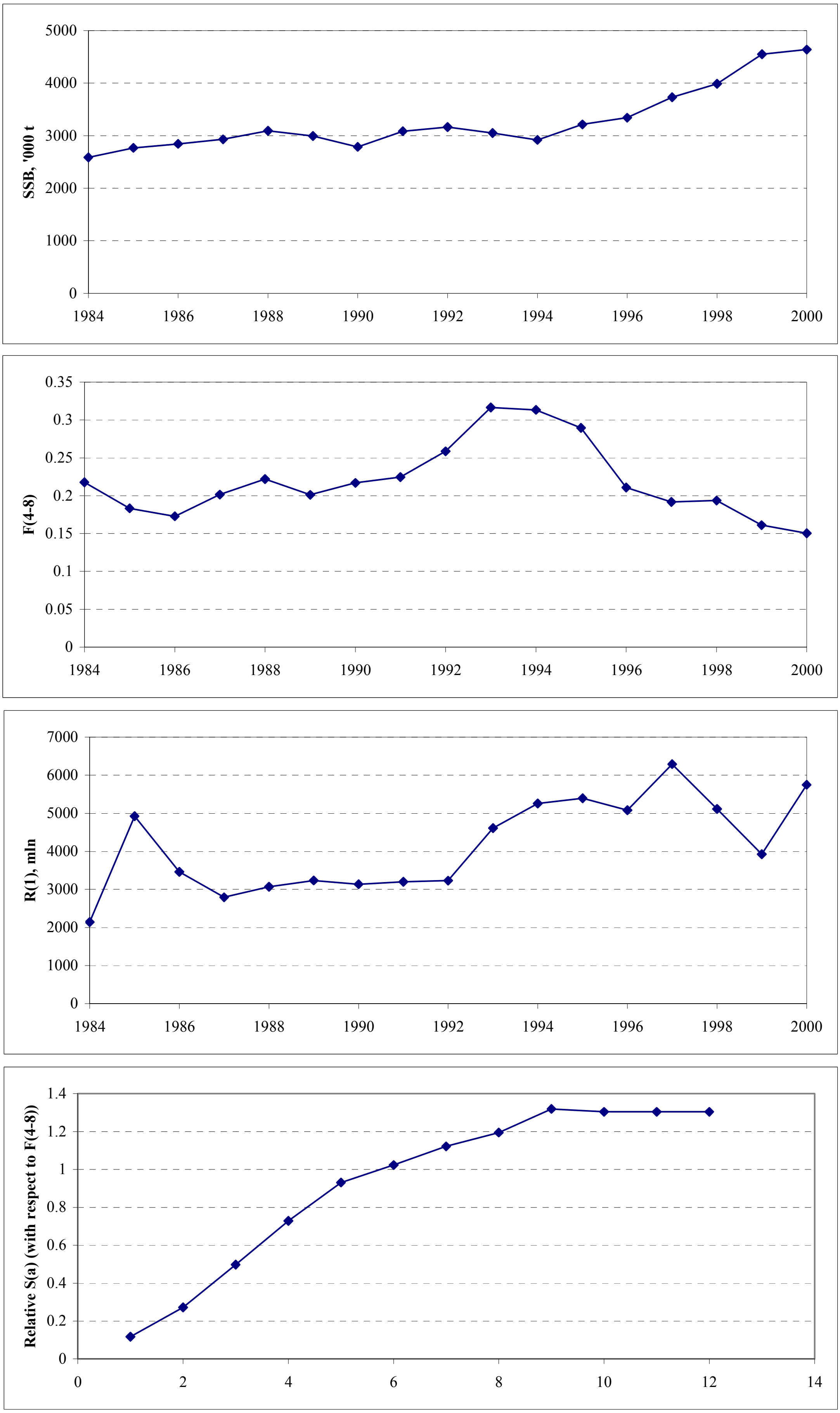


Figure 2.10.1.5 North East Atlantic Mackerel. Exploratory runs of ISVPA (ages 1-12+).

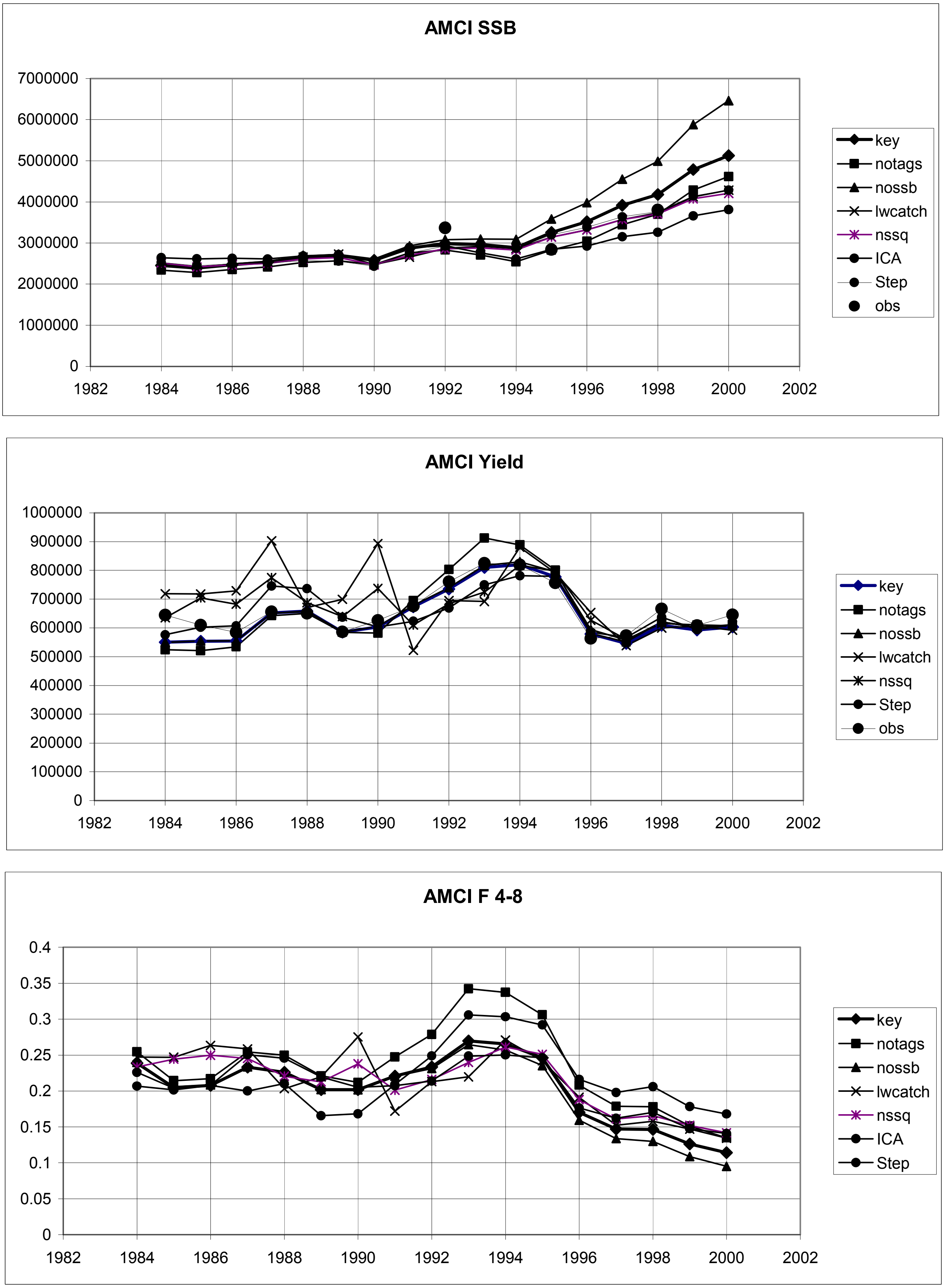


Figure 2.10.1.6 NEA Mackerel. Results from the AMCI exploratory runs

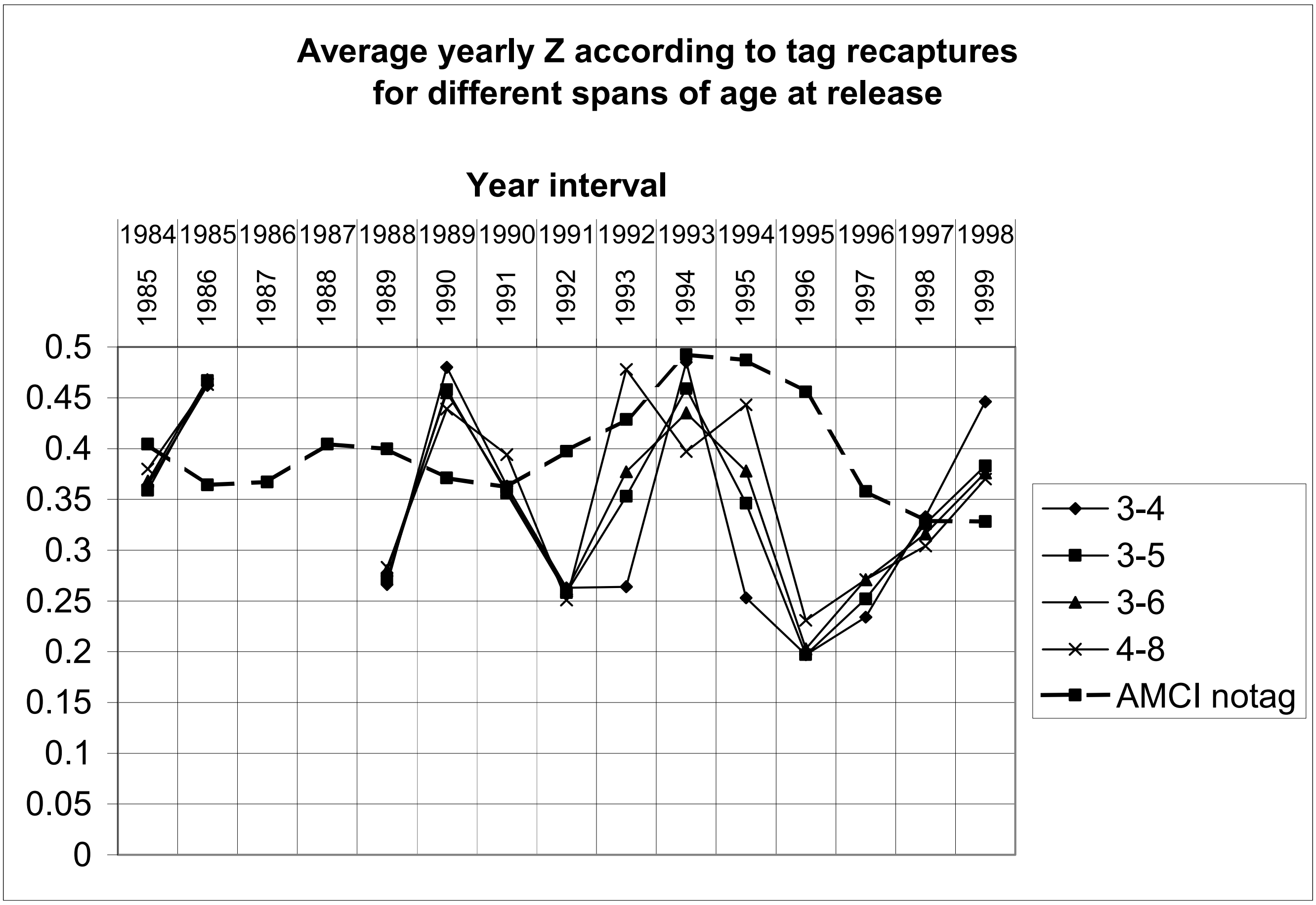


Figure 2.10.1.7 Average yearly Z according to tag recaptures for different spans of age at release.

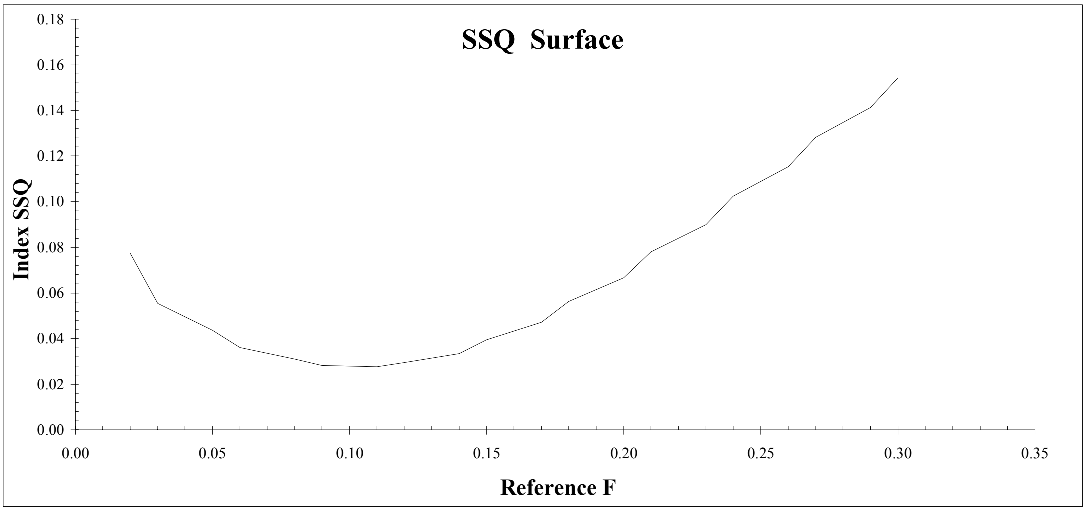


Figure 2.10.2.1 **The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (1992-2000).**

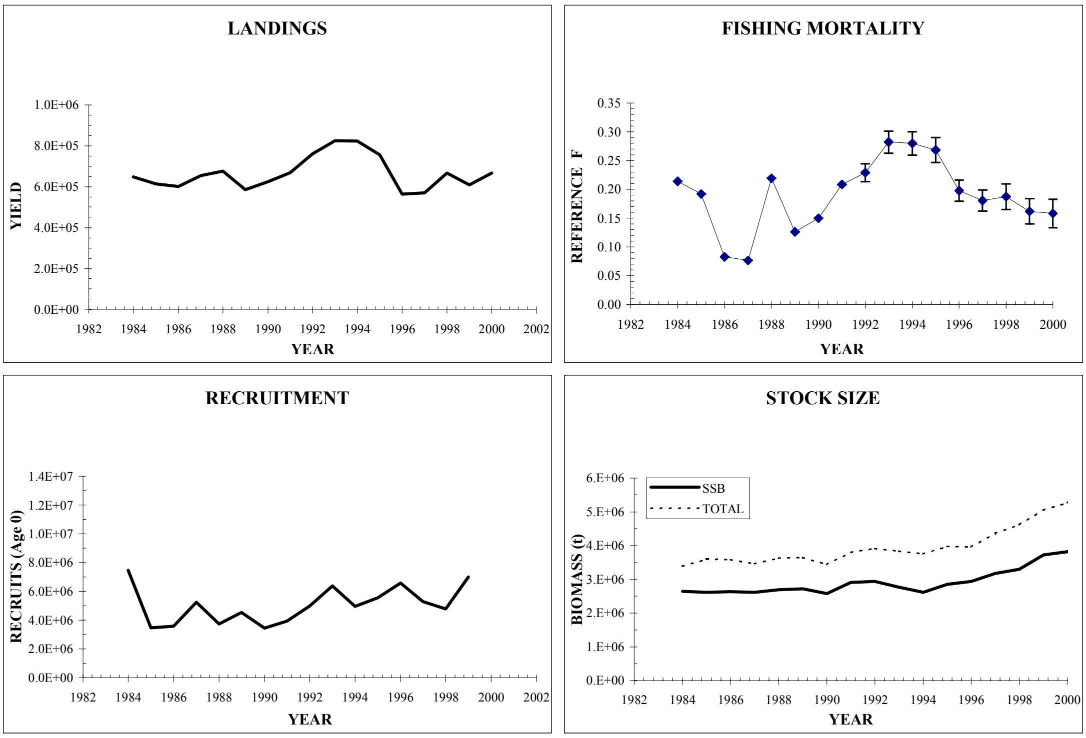


Figure 2.10.2.2 **The long term trends in stock parameters for North East Atlantic mackerel.**
Only SSB estimates from egg surveys covering the range 1992-1998 are used in the biomass index.

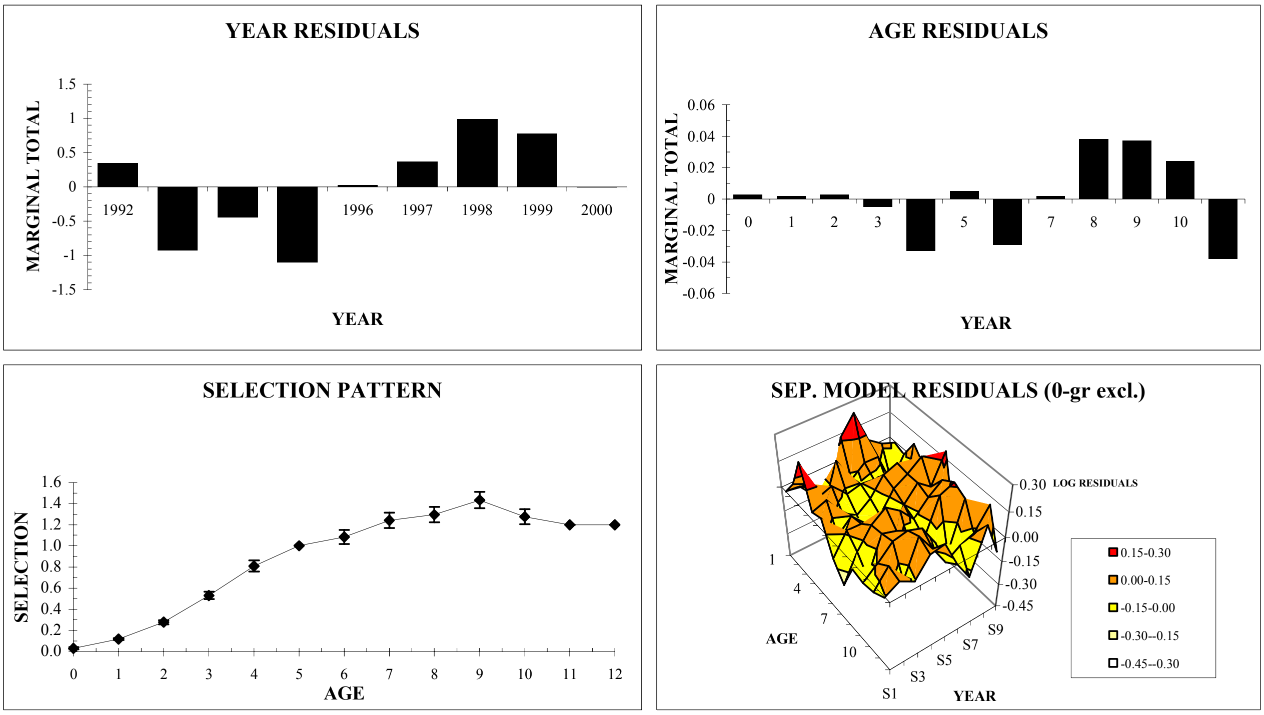


Figure 2.20.2.3 **The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data. Only SSB estimates from egg surveys covering the range 1992-1998 are used in the biomass index and there is only one period of separable constraint (1992-2000).**

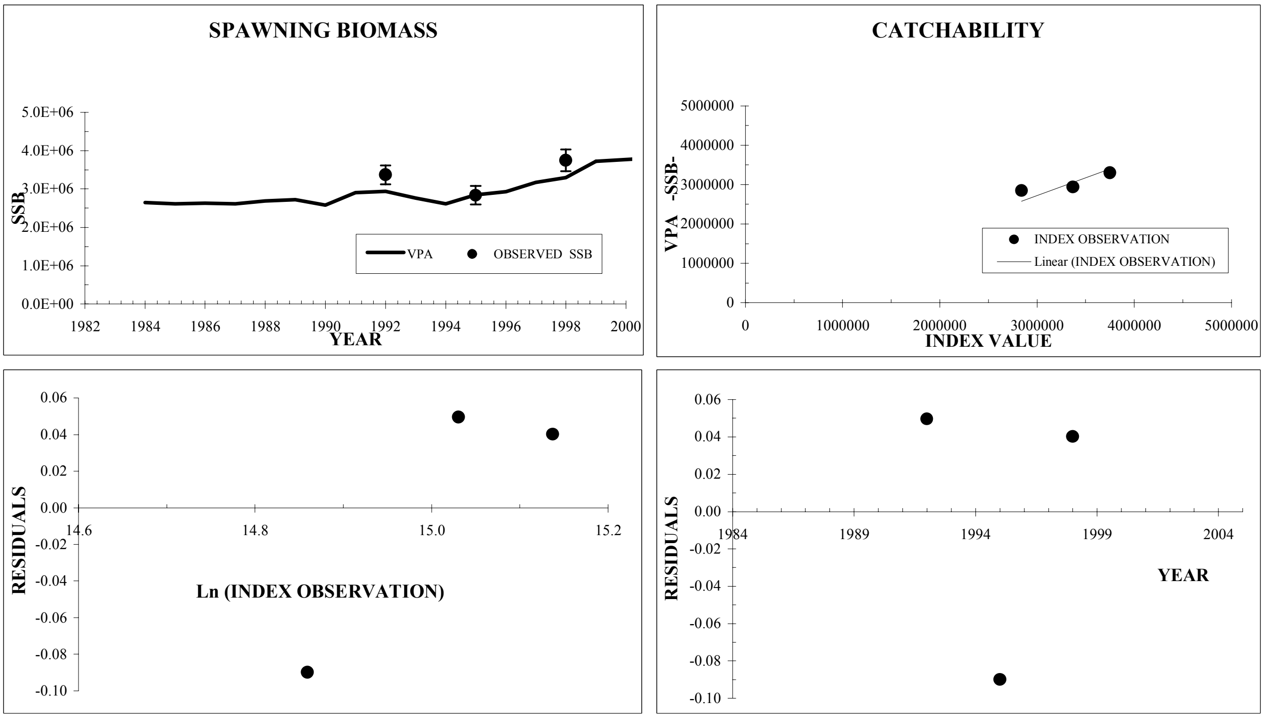


Figure 2.10.2.4 **The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel. Only SSB estimates from egg surveys covering the range 1992-1998 in the biomass index and there is only on period of separable**

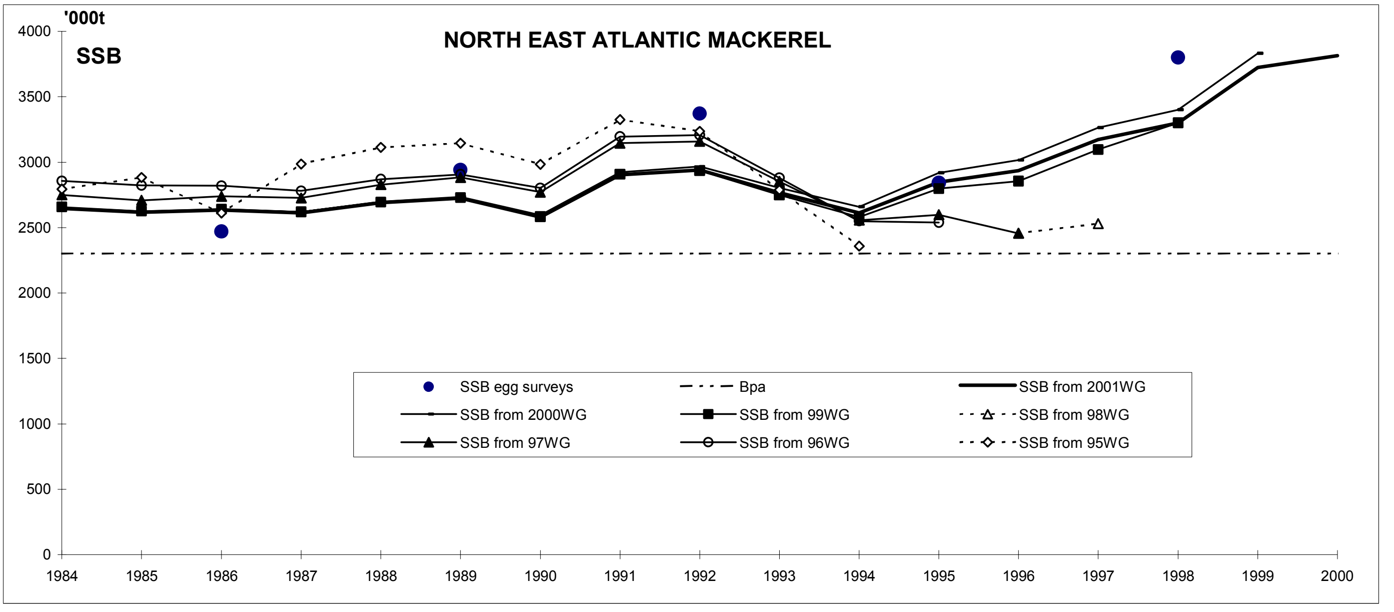


Figure 2.10.3.1 **Comparison of spawning stock biomass estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1986, 1989, 1992, 1995 and 1998 are also shown. At the 1999 - 2001 working groups only the last three biomass estimates (1992, 1995 and 1998) from the egg surveys were used. At the 1998 working group meeting the new assessment was rejected and in stead the 1997 assessment was projected one year forward.**

2.12 Medium-term predictions

Since the present state of the stock this year is more uncertain than usual because of the long time span since the last egg survey, and since there is no immediate need neither to revise harvest control rules, nor to advise on rebuilding plans, no medium term predictions were made this year.

2.13 Long-term Yield

Table 2.13.1 presents the yield per recruit forecasts for the combined North East Atlantic Mackerel stock. The multifleet yield per recruit programme (MFYPR) was not able to carry out the yield per recruit forecasts for both the Northern and Southern area as was done at earlier working group meetings. Therefore, yield per recruit forecast was carried out for the combined 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 to be 0.187.

Table 2.13.1 One area yield per recruit table for North East Atlantic Mackerel (Single recruit)

MFYPR version 2a
Run: run5
Time and date: 20:56 11/09/2001
Yield per results

FMult	F(4-8)	CatchNos Numbers	Yield kg	StockNos Numbers	Biomass kg	SpwnNosJan Numbers	SSBJan kg	SpwnNosSpwn Numbers	SSBSpwn kg
0	0.0000	0.0000	0.0000	7.1792	2.2371	4.9388	2.0685	4.6512	1.9481
0.1	0.0184	0.0715	0.0349	6.7032	1.9777	4.4654	1.8097	4.1780	1.6920
0.2	0.0367	0.1281	0.0610	6.3273	1.7765	4.0920	1.6091	3.8048	1.4940
0.3	0.0551	0.1740	0.0809	6.0224	1.6164	3.7895	1.4496	3.5025	1.3368
0.4	0.0734	0.2120	0.0963	5.7696	1.4862	3.5391	1.3199	3.2525	1.2093
0.5	0.0918	0.2441	0.1086	5.5562	1.3784	3.3282	1.2127	3.0418	1.1040
0.6	0.1101	0.2717	0.1185	5.3734	1.2877	3.1477	1.1226	2.8617	1.0157
0.7	0.1285	0.2956	0.1265	5.2147	1.2105	2.9914	1.0459	2.7057	0.9407
0.8	0.1468	0.3166	0.1331	5.0754	1.1439	2.8544	0.9798	2.5691	0.8762
0.9	0.1652	0.3353	0.1385	4.9519	1.0860	2.7333	0.9224	2.4483	0.8203
1.0	0.1835	0.3520	0.1431	4.8415	1.0350	2.6251	0.8720	2.3406	0.7713
1.1	0.2019	0.3670	0.1470	4.7421	0.9900	2.5280	0.8274	2.2438	0.7280
1.2	0.2203	0.3806	0.1502	4.6519	0.9497	2.4400	0.7877	2.1563	0.6896
1.3	0.2386	0.3931	0.1530	4.5696	0.9136	2.3599	0.7521	2.0766	0.6551
1.4	0.2570	0.4045	0.1554	4.4941	0.8810	2.2866	0.7199	2.0038	0.6241
1.5	0.2753	0.4151	0.1574	4.4245	0.8513	2.2192	0.6908	1.9368	0.5960
1.6	0.2937	0.4248	0.1592	4.3600	0.8243	2.1569	0.6642	1.8750	0.5704
1.7	0.3120	0.4339	0.1607	4.3000	0.7995	2.0991	0.6399	1.8177	0.5471
1.8	0.3304	0.4424	0.1620	4.2441	0.7766	2.0453	0.6175	1.7644	0.5256
1.9	0.3487	0.4503	0.1632	4.1917	0.7555	1.9950	0.5968	1.7146	0.5059
2.0	0.3671	0.4578	0.1642	4.1425	0.7359	1.9479	0.5777	1.6680	0.4876

Reference point	F multiplier	Absolute F
Fbar(4-8)	1	0.1835
FMax	3.8788	0.7119
F0.1	1.0159	0.1865
F35%SPR	1.2215	0.2242
Flow	0.7614	0.1398
Fmed	1.9313	0.3545
Fhigh	11.9057	2.1852

2.14 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). These values have been used by ACFM since 1998 (text table below).

ACFM 1998 reference points:

ICES considers that:	ICES proposes that:
There is no biological basis for defining $\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$ be set at 2.3 million t
$\mathbf{F}_{lim}$ is 0.26, the fishing mortality estimated to lead to potential stock collapse.	$\mathbf{F}_{pa}$ be set at 0.17. This F is considered to provide approximately 95% probability of avoiding $\mathbf{F}_{lim}$, taking into account the uncertainty in the assessments.

Technical basis:

	$\mathbf{B}_{pa}$: $\mathbf{B}_{loss}$ in Western stock raised by 15% = 2.3 million t.
$\mathbf{F}_{lim}$: $\mathbf{F}_{loss}$: 0.26	$\mathbf{F}_{pa}$ = $\mathbf{F}_{lim}$ x 0.65. $F_{0.1}$ = 0.17

$F_{0.1}$ was estimated to be 0.18 in the present assessment compared to 0.19 in 1999 and 2000.

The consideration of reference points will not be carried out until the full catch at age time series of the North East Atlantic Mackerel stock back to 1972 is available, and the new egg survey results are incorporated.

2.15 Management Measures and Considerations

The last three years assessments indicate that the combined stock is larger than predicted in the previous years and is the largest in the time series. According to this estimate, the combined stock is within safe biological limits, but until the results of the egg survey in 2001 are included in the assessment (in 2002), it is difficult to be confident about the accuracy of the assessment. The spawning stock is well above B_{pa} and is harvested just above F_{pa}. The upward trend in the present stock estimate is uncertain and the perception of a substantial increase in stock size depends on a limited number of observations of SSB. In particular, the abundance of the youngest year classes is poorly substantiated, and the predictions are sensitive to these.

The fisheries on mackerel in the Northern area are now covered within the Coastal States and the NEAFC agreements. In the Southern area an autonomous quota was set. It is expected that the complete coverage of the catches would lead to a more efficient management of the species.

In 2000 Norway, Faroese and EU have agreed on: “For 2000 and subsequent years, the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality in the range of 0.15 - 0.20 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of the fishing mortality rate.” The Working Group sees no reason to deviate from the strategy to maintain a fishing mortality of 0.17. Medium and long-term predictions made in previous Working Groups have indicated that a long term harvesting strategy with a fixed F near $F_{0.1}$ would be optimal with respect to long-term yield and low risk. ACFM has recommended F= 0.17 as F_{pa}.

The North Sea spawning component still needs the maximum possible protection and the current measures have so far failed to lead to a recovery of the stock.

Little is known about discards in the mackerel fishery. However, the sampling for discards has improved in the last year.

The forecasts of SSB in 2001 and 2002 for the two scenarios of $F_{\textit{status quo}}$ and a catch constraint of 670,000t are only slightly higher than the predicted SSB values last year. This is because the SSB obtained from the 1998 egg surveys was high and the model predicted strong year classes in the recent years. However, a major revision of SSB might take place when the SSB biomass from the 2001 egg survey will become available in 2002. The catch predictions for 2002 made this year are similar to last years prediction for 2002, since both use the same SSB from the 1998 egg survey, only updated by the catches in 2000 and the agreed TAC for 2001. Therefore, a multi-annual Harvest Control Rule might be considered for the period between the results from the egg surveys. This should only be addressed once the results from the 2001 egg survey have been fully incorporated into the assessment and the full time series of catch numbers and catch at age has been reliably established. The risks and advantages of a multi-year HCR will be considered by the WG at this time. Generally the predictions do not appear to be very sensitive to the strength of the incoming year classes (ICES CM 2001/ACFM:06), this might be due to the relatively high level of the stock.

These catch forecasts are based on the assumption that the exploitation patterns in each area as well as the partial fishing mortality levels, which are very different, will be maintained. Partial F's for each area were calculated, using the average ratio of the fleets catch at age in the “Northern” and “Southern” areas and the total catch at each age for the years 1998-2000. The drawback of the present method to split the stocks is that if the catches for various reasons change in one area due to e.g. effort changes or weather conditions, it will be reflected as a change in the basis for the calculation of future TAC's in that area. Thus, this split by area should only be regarded as an example, because the split could also be based on other criteria. If necessary, advice on other criteria on how to split the catches between “Northern” and “Southern” areas should become available from the management bodies outside ICES.

2.16 Sensitivity Analysis

A sensitivity analysis for *status quo* forecasts made using data from the North East Atlantic Mackerel stock was presented in 1999 (ICES 2000/ACFM:5). Those results revealed that the forecasts were sensitive to the accuracy of the estimated fishing mortality in 2000, apart from the fact that it is now three years since the last egg survey. Since this years assessment is just an extension of the 1999 assessment updated with catches in the 1999 and 2000, the Working Group felt that a sensitivity analysis was not needed this year and will be considered once the estimates from the egg survey are available.

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

3.1 North Sea Mackerel Component

3.1.1 ACFM Advice applicable to 2000 and 2001

Due to the depleted level of North Sea mackerel the ACFM advice for 2000 and 2001 was almost the same as that 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 February–31 July (In 1988 – 1999 this period was 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 without any explanation not repeated by ACFM in the advices for 1999 and 2000, but reappeared in 2001.

3.1.2 The Fishery in 2000

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.

3.1.3 Biological Data

The catches of North Sea mackerel are taken in the mackerel fishery that takes place in its distribution area which is assumed to be similar to what was observed when the stock component was much more abundant, 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).

3.1.4 Fishery-independent Information

3.1.4.1 Egg Surveys

The last egg survey was carried out 25 May-25 June 1999 by the Netherlands and Norway (Iversen and Eltink, WD 1999). The SSB estimates based on the egg surveys in the North Sea since 1980 are given below:

Year	1980	1981	1982	1983	1984	1986	1988	1990	1996	1999
Egg production x 10^{-12}	60	40	126	160	78	30	25	53	77	48
SSB x 10^{-3} t	86	57	180	228	111	43	36	76	110	68

The working group supports the recommendation made by WGMEGS to carry out a new egg survey in the North Sea in 2002.

3.1.4.2 Trawl Surveys

In the absence of useable genetic, morphometric, parasitological or otolith microchemistry research, it is not possible to differentiate western and North Sea juveniles in the North Sea. Therefore at present it is not possible to positively identify juvenile mackerel caught in the North Sea IBTS as belonging to the North Sea or western components.

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. This is due to the depleted level of this component and the large amount of western and southern mackerel migrating into the North Sea, mixing with the North Sea component the second half of the year. How this might have influenced the present migration pattern and thereby the distribution of the North Sea component is unknown.

3.1.7 Recruitment Forecasting

There is no information available which can be used to predict the recruitment to the North Sea. There have been no strong year classes recruited to this stock since the strong 1969 year class.

3.1.8 State of the Stock Component

The stock component is still at a historical low level, estimated at 68,000 t in 1999. The 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. However, data from the fishery in the first quarter of 2000 (Reid, WD 2000) demonstrated that the stock probably left the North Sea in December. Detailed information from the fishery is still not ready for November 2000-March 2001, but a first impression is that the mackerel might have left the North Sea a little later than last year. Therefore the Working Group will not change the advice, but keep a close look at the development of the mackerel migration during November 2001- March 2002:

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 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 and therefore the reported landings of Mackerel in Divisions IIIa and IVb,c might be seriously underestimated due to discarded by-catch.

3.2 Western Mackerel Component

3.2.1 Biological Data

The biological data used in the assessment of the western mackerel component is shown below in the following sections. As the Western mackerel component is a subset of the NEA Mackerel (see Section 2.4), data will not be given here again by quarter and area. The correction for the Russian catches (540 t in 1998) which could not be included in last year's assessment was included in the caton file for the 2001 assessment.

Catch in numbers at age

The 2000 catches in numbers at age by area for the whole year for the Western mackerel component (fished in areas II, III, IV, V, VI, VII and Divisions VIIIa and VIIIb) are shown in Table 3.2.1.a. and correspond to a total catch of 631,085 t.

The age structure of the catches of Western mackerel is predominantly 2-7 year old fish. These age groups constitute 79% of the total catches which is very similar to 1999. There was an even spread of ages 3 to 6 in catches, which target mackerel in the northern areas. In the southern North Sea, English Channel, northern Biscay area (IVc, VIId,e & VIIIa) where mackerel is caught as a bycatch in fisheries for horsemackerel the age distribution is predominantly age group 1 and 2 fish.

Age distributions of catches were provided by Denmark, England, Ireland, Netherlands, Norway, Spain, Scotland and Germany. There are still gaps in the overall sampling for age from countries which take substantial catches, notably France, Faroes and Sweden (combined catch of 45,500 t) and the UK (England & Wales) who provide aged data for less than about 50% of their catches. In 2000 there were no samples available for the Russian catch (about 51,000 t) which was mainly taken in IIa, the only samples available for this sub-area were from the Norwegian purse seine fleet. In addition there were no aged samples to cover the entire catch from sub-area III, (total catch 3,800 t) and some minor catches in Sub-area I and Divisions IIb, VIIa, VIIg and VIIk. As in 1999, 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 1.3. Details of allocations of unsampled catches to sampled age-structures are recorded in the Working Group archives.

Mean weights at age

The mean weights at age in the catches per area for the Western mackerel component are shown in Table 3.2.1.b. 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 fishing on the spawning grounds (in VIIj, March-May 2000, and in VIIb,c and VIIj, Feb-May 2000, respectively).

Mean lengths at age

The mean lengths at age per quarter for 2000 for the Western mackerel component are shown in Table 3.2.1.c. These data continue the long time series and are useful in investigating changes in relation to stock size.

Maturity Ogive

There is no new basis for a revision to the maturity ogive used for western mackerel.

3.2.2 Fishery independent information

Egg surveys

A mackerel egg survey in the western area was carried out in 2001 (see section 2.6.), but the results of this survey will not be available before spring 2002. Information on the historic time series of egg surveys which cover the area of the Western stock is given in the 1999 report of WGMHSA (ICES 2000/ACFM:5). Based on the 1998 egg survey the relative contribution of the Western area to the NE Atlantic egg survey estimates would be 0.75.

3.2.3 State of the Stock

An Integrated Catch Analysis 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. The Working Group intends to revise the catch data for the combined stock intersessionally (see Section 2.5) to do without this exercise in the future.

Table 3.2.2.a shows the input data to ICA (catches in number, mean weights at age in the catch, mean weights at age in the stock, SSB index values, proportion of fish spawning - which remains unchanged since the beginning of the time series -, and natural mortality, 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. The WG continued to use the SSB index as a relative index of abundance and to give the index series a weighting of 5. 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 1989–2000, Figure 3.2.3). 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. A list of input parameters used in assessments made since the 1997 Working Group is given in Table 3.2.3. Both selection patterns were calculated relative to the reference fishing mortality at age 5.

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

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

$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=2000}\lambda_a(\ln(C_{a,y})-\ln(F_y.S2_a.\overline{N}_{a,y}))^2+$$

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

$$\sum_{y=1989}^{y=2000}\Sigma(\ln(EPB_y)-\ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a-PM.M))^2$$

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 1989–1999, 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 estimate of biomass

Table 3.2.2.b and Figures 3.2.1 to 3.2.4 present the outputs from ICA (estimated fishing mortalities, population numbers at age, stock summary and diagnostic output). For the years prior to 1984 the values obtained for recruitment and SSB from this years' assessment are very similar to those obtained last year. Comments on the assessment of NEA mackerel, of which the western component is a subset, are given in Section 2.10.

Tab. 3.2.1: Mackerel - WESTERN stock component: Biological information from commercial catches by area, total year (quarter 1-4)

a. Catch numbers at age by area (canum) and catch (caton)

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6265	0	696	0	0	59	12	0	**7032**
1	0	85	0	61	2	0	4187	182	3667	17	16113	0	6	3142	3	8651	12683	67	320	8879	78	6955	370	28	**65496**
2	31	5546	11	507	20	1	41221	1423	1439	2883	30434	1	10	7358	16	7295	12477	34	1075	4713	35	5404	296	1171	**123401**
3	155	21874	56	1352	34	4	81268	2610	786	3571	51940	12	5	18370	833	4171	9835	58	3372	25217	338	4240	1160	1945	**233205**
4	320	43469	116	1593	5	2	135177	584	148	6426	85196	18	3	22632	1055	1066	4804	53	1994	26227	294	1726	1645	1029	**335582**
5	204	27583	74	1388	3	4	97276	773	17	1928	68066	8	2	10590	726	610	4559	41	1745	23060	299	2033	3057	806	**244852**
6	218	29477	79	918	1	3	85409	561	25	1908	52819	6	1	10234	371	573	2620	25	1327	15647	178	1703	1825	717	**206646**
7	125	16941	45	664	2	3	58073	543	53	1015	40376	4	1	7505	444	245	2373	16	1087	9758	102	2141	2357	490	**144366**
8	84	11290	30	426	1	2	34270	304	10	540	27235	3	0	4307	183	150	1080	7	1017	4817	40	1472	1312	469	**89049**
9	41	5486	15	224	0	1	18213	107	8	406	11197	3	0	2067	178	58	358	6	344	4190	33	777	644	172	**44528**
10	20	2768	7	195	0	0	10266	0	0	133	8384	1	0	1963	64	19	26	3	239	2010	5	231	255	122	**26711**
11	15	2093	6	86	0	0	6360	27	2	68	4191	1	0	880	5	27	3	2	44	1528	6	76	272	39	**15733**
12	3	376	1	64	0	0	7101	40	0	118	4837	0	0	733	3	167	349	1	97	915	7	138	124	25	**15101**
13	1	118	0	35	0	0	2117	0	0	111	3349	0	0	658	3	0	0	1	0	237	0	0	74	0	**6705**
14	1	117	0	8	0	0	876	0	0	2	933	0	0	231	1	5	0	0	41	287	0	327	40	1	**2871**
15	1	116	0	12	0	0	1442	0	0	55	1546	1	0	514	3	0	0	0	0	302	3	0	20	0	**4017**
																								12+ group:	**28694**
SOP (t)	628	85548	227	3802	17	10	264410	2421	1368	6152	150919	19	7	29030	1583	5755	13966	94	4445	44920	516	7780	5125	2269	**631010**
catch (t	628	85551	227	3810	17	10	264544	2413	1368	6151	150909	19	7	28940	1587	5761	13954	94	4452	44945	516	7784	5124	2273	**631084**

b. Mean weight at age in the catch by area (Kg) (weca)

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.000	0.056	0.000	0.000	0.056	0.111	0.000	**0.056**
1	0.000	0.122	0.000	0.170	0.190	0.000	0.199	0.173	0.173	0.162	0.149	0.000	0.168	0.129	0.078	0.168	0.158	0.154	0.159	0.088	0.054	0.160	0.155	0.142	**0.150**
2	0.282	0.275	0.282	0.289	0.183	0.278	0.252	0.173	0.252	0.198	0.221	0.169	0.219	0.197	0.178	0.245	0.214	0.239	0.195	0.213	0.205	0.222	0.190	0.172	**0.231**
3	0.383	0.380	0.383	0.402	0.266	0.384	0.354	0.283	0.337	0.279	0.286	0.257	0.279	0.270	0.294	0.301	0.273	0.285	0.241	0.268	0.275	0.276	0.262	0.234	**0.314**
4	0.446	0.445	0.446	0.477	0.312	0.433	0.400	0.384	0.401	0.302	0.323	0.285	0.324	0.293	0.334	0.354	0.324	0.316	0.305	0.326	0.350	0.299	0.326	0.295	**0.368**
5	0.538	0.537	0.538	0.532	0.357	0.469	0.467	0.445	0.371	0.350	0.384	0.349	0.368	0.338	0.425	0.398	0.449	0.382	0.411	0.393	0.412	0.339	0.360	0.393	**0.435**
6	0.555	0.555	0.555	0.567	0.454	0.486	0.501	0.482	0.423	0.398	0.414	0.354	0.350	0.363	0.490	0.423	0.352	0.405	0.473	0.431	0.458	0.416	0.405	0.476	**0.470**
7	0.624	0.623	0.624	0.609	0.287	0.538	0.549	0.509	0.339	0.472	0.463	0.353	0.441	0.391	0.501	0.448	0.394	0.434	0.426	0.458	0.485	0.413	0.432	0.418	**0.511**
8	0.650	0.650	0.650	0.603	0.486	0.566	0.581	0.553	0.494	0.501	0.491	0.421	0.491	0.420	0.601	0.643	0.444	0.489	0.506	0.498	0.546	0.463	0.457	0.523	**0.543**
9	0.676	0.675	0.676	0.638	0.541	0.650	0.613	0.650	0.592	0.513	0.531	0.471	0.592	0.469	0.587	0.539	0.665	0.489	0.528	0.487	0.512	0.475	0.459	0.544	**0.575**
10	0.673	0.673	0.673	0.678	0.476	0.000	0.647	0.476	0.525	0.503	0.553	0.421	0.454	0.458	0.740	0.523	0.458	0.470	0.516	0.507	0.522	0.506	0.504	0.519	**0.591**
11	0.543	0.544	0.543	0.692	0.549	0.747	0.670	0.745	0.544	0.591	0.551	0.477	0.544	0.546	0.467	0.642	0.612	0.540	0.656	0.571	0.651	0.680	0.524	0.620	**0.602**
12	0.879	0.865	0.879	0.714	0.000	0.761	0.707	0.761	0.646	0.575	0.576	0.519	0.000	0.543	0.494	0.754	0.213	0.766	0.470	0.964	1.321	0.613	0.541	0.651	**0.661**
13	0.750	0.749	0.750	0.751	0.000	0.000	0.688	0.000	0.000	0.469	0.648	0.451	0.000	0.557	0.509	0.000	0.000	0.564	0.000	0.586	0.000	0.000	0.556	0.000	**0.648**
14	0.750	0.750	0.750	0.718	0.000	0.000	0.721	0.000	0.913	0.766	0.616	0.581	0.000	0.515	0.494	0.913	0.913	0.540	0.575	0.524	0.000	0.593	0.607	0.913	**0.634**
15	0.800	0.800	0.800	0.727	0.000	0.000	0.714	0.000	0.000	0.452	0.662	0.541	0.000	0.617	0.591	0.000	0.000	0.475	0.000	0.300	0.235	0.000	0.619	0.000	**0.648**
																								12+ group:	**0.653**

Table 3.2.1 (Cont'd)

c. Mean length at age in the catch by area (cm)

Ages	I	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0.0	20.6	0.0	0.0	20.6	25.5	0.0	**20.6**
1	0.0	25.1	0.0	27.1	28.2	0.0	29.0	27.4	27.8	27.3	27.7	0.0	28.1	26.4	22.9	28.4	27.5	27.6	28.1	23.2	21.0	28.0	28.2	27.3	**27.2**
2	31.0	31.0	31.0	32.0	27.9	31.3	31.0	27.4	31.3	29.3	30.6	28.8	30.5	30.0	29.3	31.6	30.2	31.2	30.2	30.5	30.4	30.7	30.1	29.3	**30.7**
3	33.6	33.6	33.6	35.1	31.2	34.7	34.1	31.6	33.7	32.5	33.0	32.5	32.8	33.1	33.1	33.5	32.4	33.1	32.2	32.9	33.1	33.0	33.2	32.1	**33.4**
4	35.0	35.0	35.0	36.7	32.9	36.0	35.2	34.7	35.2	33.3	34.1	33.6	34.1	33.9	34.4	34.7	33.9	34.3	34.3	34.8	35.5	34.5	35.6	34.1	**34.7**
5	36.7	36.7	36.7	38.0	34.0	36.8	36.7	36.2	37.2	34.6	35.8	35.8	35.6	35.3	37.1	36.0	37.3	36.1	36.9	36.7	37.1	35.5	36.7	36.6	**36.4**
6	37.3	37.3	37.3	38.5	35.8	37.2	37.5	37.0	38.4	36.0	36.7	36.2	35.3	36.1	39.2	37.3	35.0	36.9	38.7	37.7	38.2	37.7	38.1	38.9	**37.2**
7	38.7	38.7	38.7	39.5	33.2	38.4	38.5	37.8	35.3	37.9	37.9	35.8	37.6	36.9	38.8	38.2	36.0	37.5	37.9	38.5	38.8	38.4	38.9	37.8	**38.2**
8	38.8	38.8	38.8	39.4	38.4	39.1	39.2	39.0	39.5	38.7	38.7	38.1	39.4	37.6	41.1	42.0	37.4	39.0	39.9	39.7	40.6	40.0	39.5	40.2	**39.0**
9	39.6	39.6	39.6	39.8	39.3	40.7	39.7	40.7	41.9	39.0	39.6	39.2	41.9	39.0	41.0	40.7	41.4	39.4	40.6	40.0	40.1	39.9	39.6	41.0	**39.7**
10	39.8	39.8	39.8	40.7	37.8	0.0	40.4	37.8	40.8	38.6	40.1	37.5	37.6	38.6	44.4	40.7	37.8	38.7	41.5	40.6	40.9	41.3	40.7	41.5	**40.2**
11	39.1	39.1	39.1	41.3	39.5	42.5	40.9	42.5	41.5	40.5	40.0	39.5	41.5	40.7	39.4	42.7	42.4	40.4	42.5	42.0	42.2	43.1	41.3	42.2	**40.5**
12	44.0	43.8	44.0	41.6	0.0	42.7	41.6	42.7	42.5	40.1	40.5	41.0	0.0	40.6	40.0	43.5	48.5	43.8	45.8	46.3	51.4	42.8	41.6	44.4	**41.7**
13	44.0	43.9	44.0	42.6	0.0	0.0	41.5	0.0	0.0	38.1	42.2	39.0	0.0	41.0	40.3	0.0	0.0	40.8	0.0	41.2	0.0	0.0	42.0	0.0	**41.8**
14	44.0	44.0	44.0	43.1	0.0	0.0	42.7	0.0	46.5	43.1	41.3	41.0	0.0	39.9	39.9	46.5	46.5	40.1	43.2	41.9	0.0	43.4	43.2	46.5	**42.1**
15	44.0	44.0	44.0	42.5	0.0	0.0	42.2	0.0	0.0	37.7	42.5	42.0	0.0	42.2	42.3	0.0	0.0	38.9	0.0	33.4	31.5	0.0	43.5	0.0	**41.6**
																								12+ group:	**41.8**

Table 3.2.2.a Mackerel, WESTERN stock component – input to ICA

Output Generated by ICA Version 1.4, Run 2, 06.09.01 (Data are a subset of the Northeast Atlantic Mackerel Stock)

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

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	0.0	7.0
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	60.4	65.5
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	122.7	123.4
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	199.8	233.2
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	227.9	335.6
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	249.6	244.9
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	206.8	206.6
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	137.7	144.4
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	76.8	89.0
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	44.1	44.5
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	26.2	26.7
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	14.0	15.7
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	28.6	28.7

x 10 ^ 6

Table 3.2.2.a (cont'd): Mackerel, WESTERN stock component – input to ICA

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

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	0.09200	0.05600
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	0.18400	0.15000
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	0.23700	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	0.31000	0.31400
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	0.36700	0.36800
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	0.40800	0.43500
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	0.46100	0.47000
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	0.50900	0.51100
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	0.54400	0.54300
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	0.57500	0.57500
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	0.59500	0.59100
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	0.61900	0.60200
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	0.69800	0.65300

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Table 3.2.2.a (cont'd): Mackerel, WESTERN stock component – input to ICA

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	1999	2000
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
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	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	0.19500	0.18700
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	0.23700	0.23600
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	0.30100	0.28200
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	0.35000	0.35000
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	0.40100	0.38500
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	0.43200	0.42700
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	0.44600	0.44800
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	0.49100	0.49400
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	0.50300	0.48900
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	0.45200	0.53900
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	0.57400	0.54300

Table 3.2.2.a (cont'd): Mackerel, WESTERN stock component – input to ICA

Natural Mortality (per year)

AGE	1972	1973	...	1997	1998	1999	2000
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

Proportion of fish spawning

AGE	1972	1973	...	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.6000	0.6000	0.6000	0.6000	0.6000	0.6000	0.6000
3	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000
4	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700
5	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700
6	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
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
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS: INDEX1 (Triennial Egg Survey)

	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	*******	*******

	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	2930.0	*******	*******	2470.0	*******	*******	2950.0	*******	*******

x 10 ^ 3

Table 3.2.2.b: Mackerel, WESTERN stock component – output from ICA

Output Generated by ICA Version 1.4, Run 2, 06.09.01 (Data are a subset of the Northeast Atlantic Mackerel Stock)

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	0.01579	0.00388	0.00592	0.00117	0.00000	0.00008	0.00000	0.00057
1	0.00256	0.02134	0.02501	0.01938	0.07427	0.03911	0.04202	0.14207	0.11942	0.06358	0.03726	0.03014	0.01413	0.04598	0.01122
2	0.00688	0.01191	0.01819	0.03581	0.08339	0.09738	0.18622	0.10321	0.26970	0.16716	0.13334	0.16792	0.06699	0.01751	0.06268
3	0.01362	0.04331	0.03542	0.08648	0.14051	0.08791	0.19145	0.29275	0.16734	0.18984	0.22530	0.18503	0.21958	0.05100	0.08068
4	0.07634	0.06460	0.09117	0.10958	0.20970	0.09467	0.18480	0.23662	0.28781	0.09354	0.22135	0.27130	0.22174	0.19995	0.09680
5	0.00000	0.11168	0.13768	0.21834	0.13561	0.08465	0.19758	0.23579	0.27338	0.19581	0.09295	0.22800	0.24887	0.20681	0.14116
6	0.00000	0.13869	0.14342	0.13763	0.19236	0.08540	0.15613	0.25989	0.23135	0.22994	0.21856	0.09712	0.23559	0.24632	0.17531
7	0.00000	0.17864	0.22024	0.49771	0.40397	0.14375	0.11916	0.27007	0.26696	0.23224	0.23042	0.21037	0.09559	0.22020	0.22580
8	0.00000	0.17843	0.21998	0.34885	0.30716	0.20494	0.17207	0.16155	0.24531	0.30324	0.29804	0.21888	0.16657	0.12947	0.22554
9	0.00000	0.13541	0.16694	0.26475	0.16444	0.16389	0.28196	0.31576	0.20373	0.24539	0.36650	0.25486	0.17144	0.18849	0.17116
10	0.00000	0.14489	0.17863	0.28328	0.17595	0.10982	0.32109	0.41365	0.31034	0.30182	0.25274	0.34133	0.19845	0.20153	0.18314
11	0.00000	0.13401	0.16522	0.26200	0.16273	0.10157	0.23710	0.50047	0.48108	0.33547	0.30989	0.30294	0.23197	0.23197	0.16939
12	0.00000	0.13401	0.16522	0.26200	0.16273	0.10157	0.23710	0.50047	0.48108	0.33547	0.30989	0.30294	0.23197	0.23197	0.16939

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.00070	0.00077	0.00069	0.00072	0.00079	0.00094	0.00121	0.00119	0.00110	0.00081	0.00075	0.00079	0.00073	0.00076
1	0.01388	0.01514	0.02050	0.02150	0.02354	0.02802	0.03590	0.03550	0.03273	0.02415	0.02225	0.02342	0.02160	0.02267
2	0.07748	0.08456	0.05839	0.06125	0.06704	0.07982	0.10226	0.10111	0.09324	0.06880	0.06337	0.06672	0.06154	0.06456
3	0.09974	0.10884	0.10491	0.11004	0.12045	0.14340	0.18372	0.18165	0.16751	0.12361	0.11385	0.11987	0.11056	0.11599
4	0.11967	0.13060	0.14995	0.15728	0.17216	0.20497	0.26260	0.25964	0.23943	0.17668	0.16272	0.17134	0.15803	0.16579
5	0.17450	0.19044	0.18541	0.19448	0.21288	0.25344	0.32470	0.32104	0.29606	0.21846	0.20121	0.21186	0.19540	0.20500
6	0.21672	0.23651	0.18817	0.19737	0.21604	0.25721	0.32953	0.32581	0.30046	0.22171	0.20420	0.21501	0.19830	0.20804
7	0.27914	0.30463	0.21001	0.22028	0.24112	0.28707	0.36778	0.36363	0.33534	0.24745	0.22790	0.23997	0.22132	0.23219
8	0.27881	0.30427	0.22504	0.23605	0.25838	0.30761	0.39410	0.38966	0.35933	0.26516	0.24422	0.25714	0.23716	0.24881
9	0.21159	0.23091	0.25797	0.27058	0.29618	0.35262	0.45176	0.44667	0.41191	0.30395	0.27995	0.29477	0.27186	0.28522
10	0.22641	0.24708	0.23861	0.25028	0.27396	0.32616	0.41787	0.41315	0.38100	0.28114	0.25894	0.27265	0.25146	0.26381
11	0.20940	0.22852	0.22249	0.23338	0.25546	0.30413	0.38965	0.38525	0.35527	0.26216	0.24145	0.25423	0.23448	0.24600
12	0.20940	0.22852	0.22249	0.23338	0.25546	0.30413	0.38965	0.38525	0.35527	0.26216	0.24145	0.25423	0.23448	0.24600

Table 3.2.2.b (cont'd): Mackerel, WESTERN stock component – output from ICA

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	2003.6	4405.0	3422.8	4880.3	5041.2	953.2	3322.1	5462.8	5421.1	6983.0	1838.9	1358.3	6520.3	3124.7	3151.2
1	5232.1	1723.1	3791.4	2944.9	4199.6	4307.3	818.6	2849.8	4628.2	4647.9	5974.9	1580.9	1169.1	5611.6	2689.5
2	1901.0	4491.8	1451.7	3182.7	2486.0	3355.9	3565.1	675.6	2128.0	3535.2	3754.0	4954.6	1320.3	992.2	4612.9
3	2340.0	1625.0	3820.3	1227.0	2643.0	1968.5	2620.4	2547.2	524.5	1398.6	2574.3	2827.8	3605.2	1062.8	839.1
4	7431.3	1986.8	1339.4	3173.8	968.6	1976.7	1551.7	1862.4	1636.0	381.8	995.7	1768.8	2022.8	2491.3	869.3
5	0.0	5926.1	1603.1	1052.3	2448.2	676.0	1547.6	1110.2	1265.2	1055.9	299.3	686.8	1160.7	1394.8	1755.7
6	0.0	0.0	4561.7	1202.3	728.1	1839.9	534.6	1093.2	754.9	828.5	747.2	234.8	470.6	778.9	976.2
7	0.0	0.0	0.0	3401.7	901.8	517.0	1454.0	393.6	725.6	515.5	566.6	516.9	183.4	320.0	524.0
8	0.0	0.0	0.0	0.0	1779.9	518.2	385.4	1110.9	258.6	478.2	351.8	387.3	360.5	143.4	221.0
9	0.0	0.0	0.0	0.0	0.0	1126.8	363.4	279.3	813.5	174.2	303.9	224.7	267.8	262.7	108.5
10	0.0	0.0	0.0	0.0	0.0	0.0	823.2	235.9	175.3	571.1	117.3	181.3	149.9	194.2	187.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	514.0	134.3	110.6	363.5	78.4	110.9	105.8	136.6
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	323.5	662.6	594.2	518.0	229.5	416.5	414.5

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	5025.6	3340.6	4270.5	3105.9	3592.3	4379.6	5579.6	4156.7	4188.3	5023.3	3546.7	3240.4	3503.0	9953.4	3266.4
1	2710.7	4322.5	2873.0	3673.1	2671.4	3089.5	3766.0	4796.6	3573.5	3601.0	4320.1	3050.4	2786.8	3012.9	8560.5
2	2289.0	2301.0	3664.5	2422.7	3094.2	2245.8	2585.7	3127.1	3984.5	2976.6	3025.4	3636.6	2564.7	2347.4	2535.1
3	3729.2	1823.3	1819.9	2975.2	1961.3	2490.5	1784.7	2009.2	2432.7	3124.2	2391.7	2444.1	2928.0	2075.7	1894.1
4	666.3	2905.0	1407.5	1410.4	2293.9	1496.6	1857.2	1278.3	1442.1	1770.9	2376.4	1837.0	1866.0	2256.4	1590.9
5	679.1	508.8	2194.3	1042.7	1037.3	1662.1	1049.4	1229.4	848.6	976.9	1277.4	1738.2	1332.2	1371.3	1645.4
6	1312.2	490.9	362.0	1569.0	738.9	721.6	1110.3	652.8	767.5	543.3	675.8	899.1	1210.4	943.1	961.5
7	705.1	909.4	333.6	258.1	1108.6	512.4	480.2	687.4	405.6	489.2	374.6	474.3	624.1	854.4	659.3
8	359.9	459.1	577.1	232.7	178.2	749.7	331.0	286.1	411.3	249.7	328.8	256.7	321.1	430.5	583.0
9	151.8	234.4	291.5	396.7	158.2	118.5	474.4	192.1	166.8	247.1	164.8	221.6	170.9	218.0	288.9
10	78.7	105.8	160.1	193.8	260.5	101.2	71.7	259.9	105.8	95.1	157.0	107.2	142.1	112.1	141.1
11	134.2	54.0	71.1	108.6	129.9	170.5	62.9	40.6	148.0	62.2	61.8	104.3	70.3	95.1	74.1
12	345.5	275.6	187.3	139.1	249.4	276.2	217.8	189.0	131.2	134.8	114.5	92.4	147.1	141.3	159.1

x 10 ^ 6

Table.3.2.2.b (cont'd): Mackerel, WESTERN stock component – output from ICA

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	2003630	4134494	3083399	170775	0.0554	0.0153	76
1973	4405000	4038128	3184063	219445	0.0689	0.1344	68
1974	3422830	4153013	3209338	298054	0.0929	0.1625	72
1975	4880290	4049472	2957247	491380	0.1662	0.2624	56
1976	5041170	3665800	2601410	507178	0.1950	0.2498	74
1977	953230	3563803	2584456	325974	0.1261	0.1227	85
1978	3322110	3546271	2765640	503913	0.1822	0.1659	80
1979	5462830	3250195	2433768	605744	0.2489	0.2328	78
1980	5421080	3022271	2069979	604761	0.2922	0.2610	75
1981	6983040	3106827	2157655	661762	0.3067	0.2110	94
1982	1838920	3002804	2048495	623819	0.3045	0.2123	89
1983	1358320	3156027	2293194	614287	0.2679	0.2051	90
1984	6520310	2933705	2290224	550929	0.2406	0.1937	97
1985	3124730	3075752	2261718	561292	0.2482	0.2005	100
1986	3151200	3092969	2288027	537615	0.2350	0.1729	100
1987	5025620	3065769	2340589	615380	0.2629	0.2138	97
1988	3340550	3308148	2466094	628000	0.2547	0.2333	100
1989	4270450	3337372	2484621	567400	0.2284	0.1917	99
1990	3105900	3103214	2331479	605937	0.2599	0.2011	100
1991	3592310	3489960	2664193	646169	0.2425	0.2201	98
1992	4379610	3620718	2694716	742305	0.2755	0.2621	99
1993	5579610	3445578	2453634	805039	0.3281	0.3357	100
1994	4156700	3234475	2217616	795723	0.3588	0.3320	99
1995	4188340	3339914	2369967	728742	0.3075	0.3061	100
1996	5023340	3197396	2374528	529464	0.2230	0.2259	100
1997	3546720	3393156	2465106	528835	0.2145	0.2081	99
1998	3240390	3325753	2484048	623411	0.2510	0.2191	100
1999	3503010	3586837	2733068	565132	0.2068	0.2020	100
2000	9953410	3467269	2636952	631085	0.2393	0.2120	100

No of years for separable analysis : 15
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1972 . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 62
Number of observations : 188

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

Table. 3.2.2.b (cont'd): Mackerel, WESTERN stock component – output from ICA

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	0.1412	15	0.1038	0.1919	0.1207	0.1651	0.1429
2	1987	0.1745	14	0.1303	0.2336	0.1504	0.2025	0.1764
3	1988	0.1904	14	0.1442	0.2514	0.1653	0.2194	0.1924
4	1989	0.1854	10	0.1496	0.2298	0.1662	0.2069	0.1865
5	1990	0.1945	10	0.1572	0.2405	0.1745	0.2168	0.1956
6	1991	0.2129	10	0.1727	0.2624	0.1913	0.2369	0.2141
7	1992	0.2534	10	0.2060	0.3117	0.2280	0.2817	0.2549
8	1993	0.3247	10	0.2640	0.3993	0.2922	0.3608	0.3265
9	1994	0.3210	10	0.2591	0.3977	0.2878	0.3581	0.3230
10	1995	0.2961	11	0.2352	0.3727	0.2633	0.3329	0.2981
11	1996	0.2185	12	0.1701	0.2806	0.1923	0.2482	0.2202
12	1997	0.2012	13	0.1538	0.2633	0.1754	0.2308	0.2031
13	1998	0.2119	15	0.1565	0.2868	0.1815	0.2473	0.2144
14	1999	0.1954	17	0.1375	0.2777	0.1633	0.2338	0.1986
15	2000	0.2050	20	0.1362	0.3086	0.1664	0.2526	0.2095
Separable Model: Selection (S1) by age 1986 1988								
16	0	0.0040	144	0.0002	0.0680	0.0010	0.0170	0.0114
17	1	0.0795	20	0.0536	0.1179	0.0650	0.0972	0.0811
18	2	0.4440	19	0.3011	0.6547	0.3642	0.5413	0.4528
19	3	0.5715	19	0.3877	0.8426	0.4689	0.6967	0.5829
20	4	0.6858	19	0.4651	1.0111	0.5625	0.8360	0.6994
	5	1.0000		Fixed : Reference Age				
21	6	1.2419	19	0.8454	1.8245	1.0206	1.5112	1.2661
22	7	1.5996	19	1.0925	2.3421	1.3169	1.9431	1.6302
23	8	1.5977	19	1.0898	2.3425	1.3144	1.9422	1.6285
24	9	1.2126	19	0.8286	1.7743	0.9985	1.4725	1.2356
25	10	1.2974	19	0.8905	1.8904	1.0708	1.5721	1.3216
	11	1.2000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1989 to 2000								
26	0	0.0037	75	0.0008	0.0163	0.0017	0.0079	0.0049
27	1	0.1106	11	0.0877	0.1393	0.0983	0.1244	0.1113
28	2	0.3149	11	0.2536	0.3911	0.2820	0.3517	0.3169
29	3	0.5658	10	0.4598	0.6962	0.5090	0.6290	0.5690
30	4	0.8087	10	0.6616	0.9886	0.7300	0.8960	0.8130
	5	1.0000		Fixed : Reference Age				
31	6	1.0148	9	0.8401	1.2260	0.9215	1.1176	1.0196
32	7	1.1327	9	0.9439	1.3592	1.0321	1.2431	1.1376
33	8	1.2137	8	1.0188	1.4459	1.1100	1.3271	1.2186
34	9	1.3913	8	1.1752	1.6472	1.2765	1.5165	1.3965
35	10	1.2869	8	1.0812	1.5318	1.1775	1.4065	1.2920
	11	1.2000		Fixed : Last true age				
Separable model: Populations in year 2000								
36	0	.9953E+07	260	.6025E+05	.1644E+10	.7351E+06	.1348E+09	.2967E+09
37	1	3012887	34	1530067	5932738	2132278	4257178	3198416
38	2	2347388	26	1384087	3981130	1792806	3073525	2434215
39	3	2075733	23	1319990	3264166	1647650	2615038	2131842
40	4	2256368	19	1524815	3338893	1847468	2755769	2301922
41	5	1371332	18	954244	1970724	1139709	1650028	1395003
42	6	943092	18	660980	1345612	786676	1130608	958728
43	7	854430	17	606543	1203625	717382	1017660	867588
44	8	430536	17	303833	610076	360394	514329	437398
45	9	218022	18	151911	312906	181319	262155	221758
46	10	112049	19	76359	164422	92137	136265	114215
47	11	95091	20	63864	141588	77613	116506	97073
Separable model: Populations at age								
48	1986	136648	28	78069	239183	102698	181823	142337
49	1987	134183	22	85779	209900	106796	168592	137725
50	1988	53988	20	36422	80027	44166	65995	55088
51	1989	71097	18	49667	101773	59206	85375	72297
52	1990	108572	16	79013	149188	92321	127683	110008
53	1991	129890	15	96431	174957	111577	151207	131398
54	1992	170462	14	129112	225056	147933	196422	172183
55	1993	62891	13	48003	82396	54794	72185	63491
56	1994	40619	14	30865	53456	35308	46728	41019
57	1995	147993	14	110788	197693	127669	171553	149617
58	1996	62192	15	46031	84026	53341	72511	62929
59	1997	61790	15	45489	83934	52851	72241	62549
60	1998	104274	16	75897	143261	88673	122620	105652
61	1999	70270	17	49395	99966	58703	84115	71415
SSB Index catchabilities : INDEX1								
Linear model fitted. Slopes at age :								
62	1 Q	1.098	4	1.047	1.271	1.098	1.212	1.155

Table 3.2.2.b (cont'd): Mackerel, WESTERN stock component – output from ICA

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	2.385	-0.278	-2.107	2.192	0.944	0.618	-0.797	0.743	-2.283	-0.135	0.630	1.202	1.219	-4.332	0.000
1	-0.081	-0.415	0.495	-0.235	0.403	-0.203	-0.056	-0.073	-0.073	-0.367	0.129	0.312	0.035	0.088	0.043
2	0.424	-0.066	-0.310	0.463	0.414	0.083	-0.059	-0.142	-0.262	0.016	-0.150	-0.068	-0.053	-0.148	-0.100
3	-0.704	0.686	0.003	0.188	0.348	-0.060	0.115	-0.054	-0.031	-0.053	-0.044	-0.028	-0.055	-0.355	0.098
4	-0.159	-0.297	0.423	-0.109	0.072	0.072	0.011	-0.031	-0.042	-0.064	-0.011	0.061	0.149	-0.107	0.045
5	0.434	-0.244	-0.211	0.031	-0.121	-0.018	-0.150	-0.123	-0.083	-0.109	-0.041	0.057	0.102	0.126	0.034
6	0.283	-0.003	-0.212	-0.230	-0.056	-0.067	0.001	-0.162	0.041	0.026	-0.097	0.100	0.171	0.020	0.226
7	0.192	-0.073	-0.217	-0.085	-0.157	-0.140	-0.063	0.054	-0.061	0.229	0.098	0.089	0.171	0.177	-0.133
8	-0.082	0.028	-0.007	-0.024	-0.013	0.274	-0.311	-0.051	0.184	-0.084	-0.088	-0.088	0.233	0.196	0.008
9	-0.358	0.202	0.137	0.077	-0.091	0.106	0.427	-0.301	0.181	0.219	-0.119	-0.077	-0.199	0.152	-0.124
10	-0.020	0.191	-0.113	-0.008	-0.238	0.155	0.303	0.492	-0.375	0.242	0.057	-0.330	-0.095	-0.117	0.098
11	0.019	0.045	0.181	0.027	-0.281	0.069	-0.047	0.396	0.481	-0.144	0.191	0.000	-0.404	0.023	-0.205

SPAWNING BIOMASS INDEX RESIDUALS: INDEX1

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.1361	*******	*******	0.0673	*******	*******	-0.0027	*******	*******	-0.1553	*******	*******	-0.0632	*******	*******

	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.0093	*******	*******	-0.0517	*******	*******	0.0789	*******	*******

Table 3.2.2.b (cont'd): Mackerel, WESTERN stock component – output from ICA

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

```
 Separable model fitted from 1986  to 2000
 Variance                            0.0628
Skewness test stat.                  1.7493
Kurtosis test statistic              2.7153
Partial chi-square                   0.6843
Significance in fit                  0.0000
Degrees of freedom                       **
```

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

```
   DISTRIBUTION STATISTICS FOR   INDEX1


 Linear catchability relationship assumed

 Variance                            0.0430
Skewness test stat.                 -0.1811
Kurtosis test statistic             -0.4466
Partial chi-square                   0.0203
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	51.8737	188	62	126	0.4117
Catches at age	51.8135	180	61	119	0.4354
SSB Indices					
INDEX1	0.0601	8	1	7	0.0086

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.9718	188	62	126	0.0712
Catches at age	7.4684	180	61	119	0.0628
SSB Indices					
INDEX1	1.5034	8	1	7	0.2148

Table 3.2.3 Input parameters of the final ICA assessments of Western Mackerel for the years 1997-2001

Assessment year	2001	2000	1999	1998 #	1997
First data year	1972	1972	1972	1972	1972
Final data year	2000	1999	1998	1997	1996
No of years for separable constraint	15	14	13	-	11
Constant selection pattern model (Y/N)	No: S1(86-88); S2(89-00)	No: S1(86-88); S2(89-99)	No: S1(86-88); S2(89-98)	-	No: S1(86-88); S2(89-96)
S to be fixed on last age	1.2 / 1.2	1.2 / 1.2	1.2 / 1.2	-	1.2 / 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	77,80,83,86,89,92,95,98	77,80,83,86,89,92,95,98	77,80,83,86,89,92,95,98	-	77,80,83,86,89,92,95
	Abundance index	relative index: linear	relative index: linear	relative index: linear	-	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	5.0	5.0	-	1.0
Stock recruitment relationship fitted?		No	No	No	-	No
Parameters to be estimated		62	60	58	-	53
Number of observations		188	176	164	-	139

At the 1998 Working Group meeting no assessment was carried out, because the 1997 assessment was regarded to be more reliable

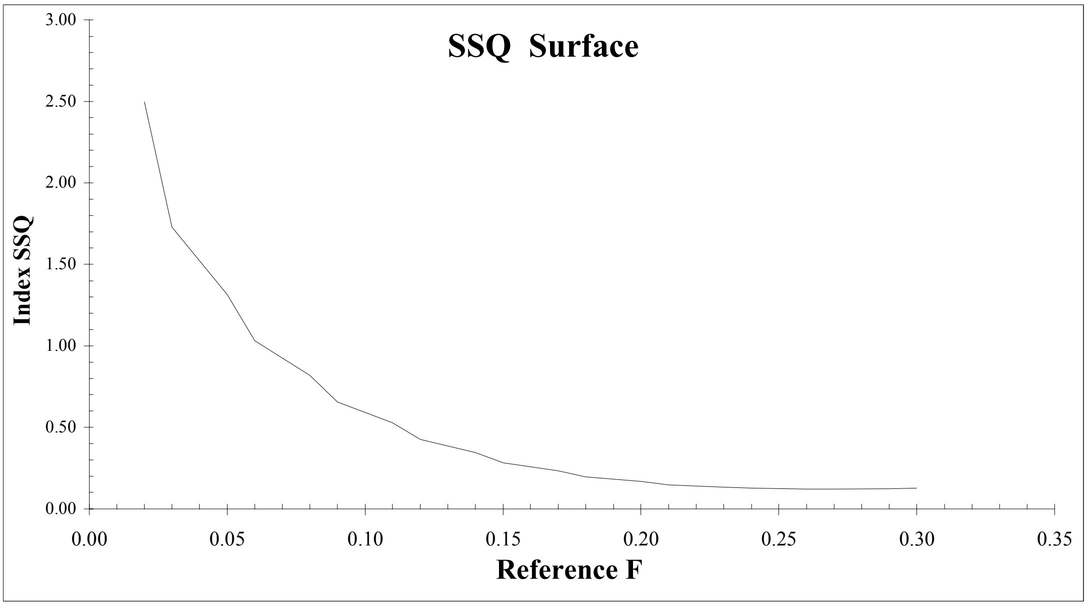


Figure 3.2.1 Sum of squares surface for the ICA separable VPA fit to the mackerel egg survey biomass estimates for the Western component (1986-2000).

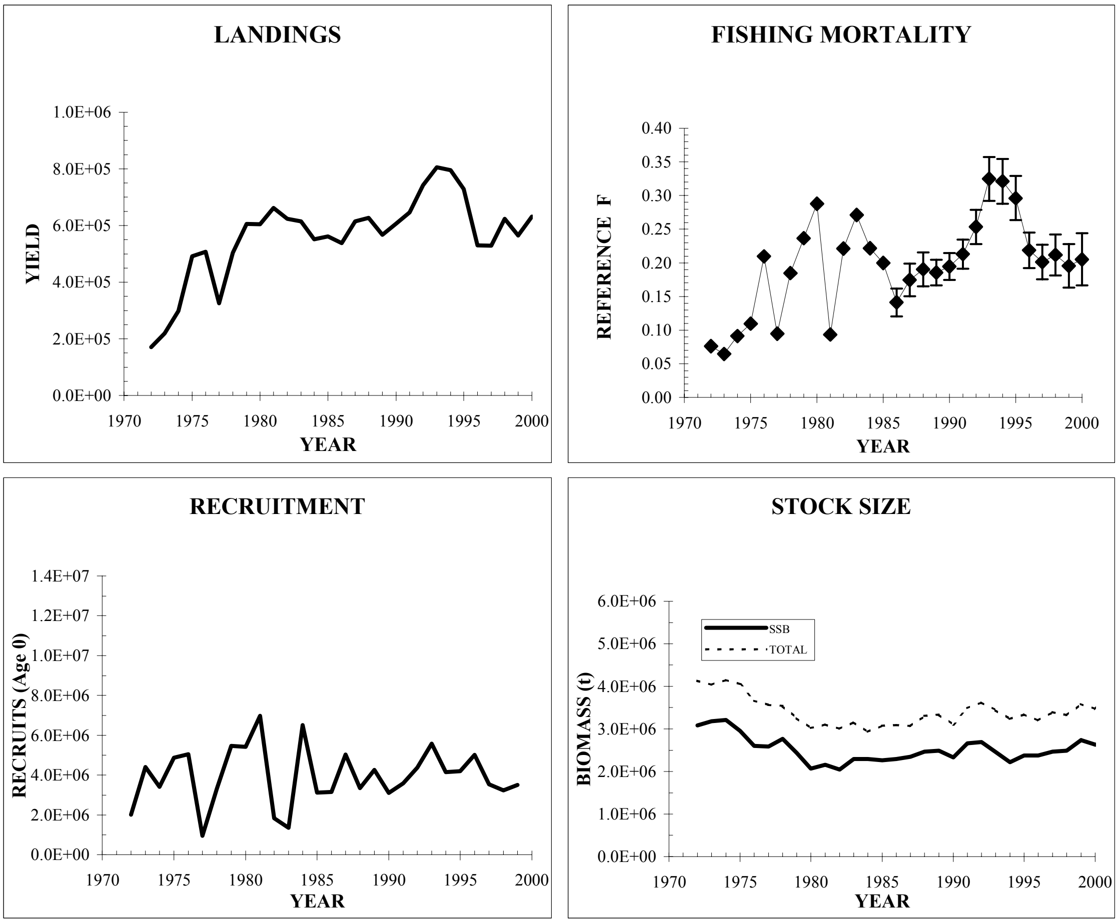


Figure 3.2.2 Long term trends in stock parameters for the Western mackerel component. SSB estimates from egg surveys covering the range 1977-1998 are used in the biomass ind

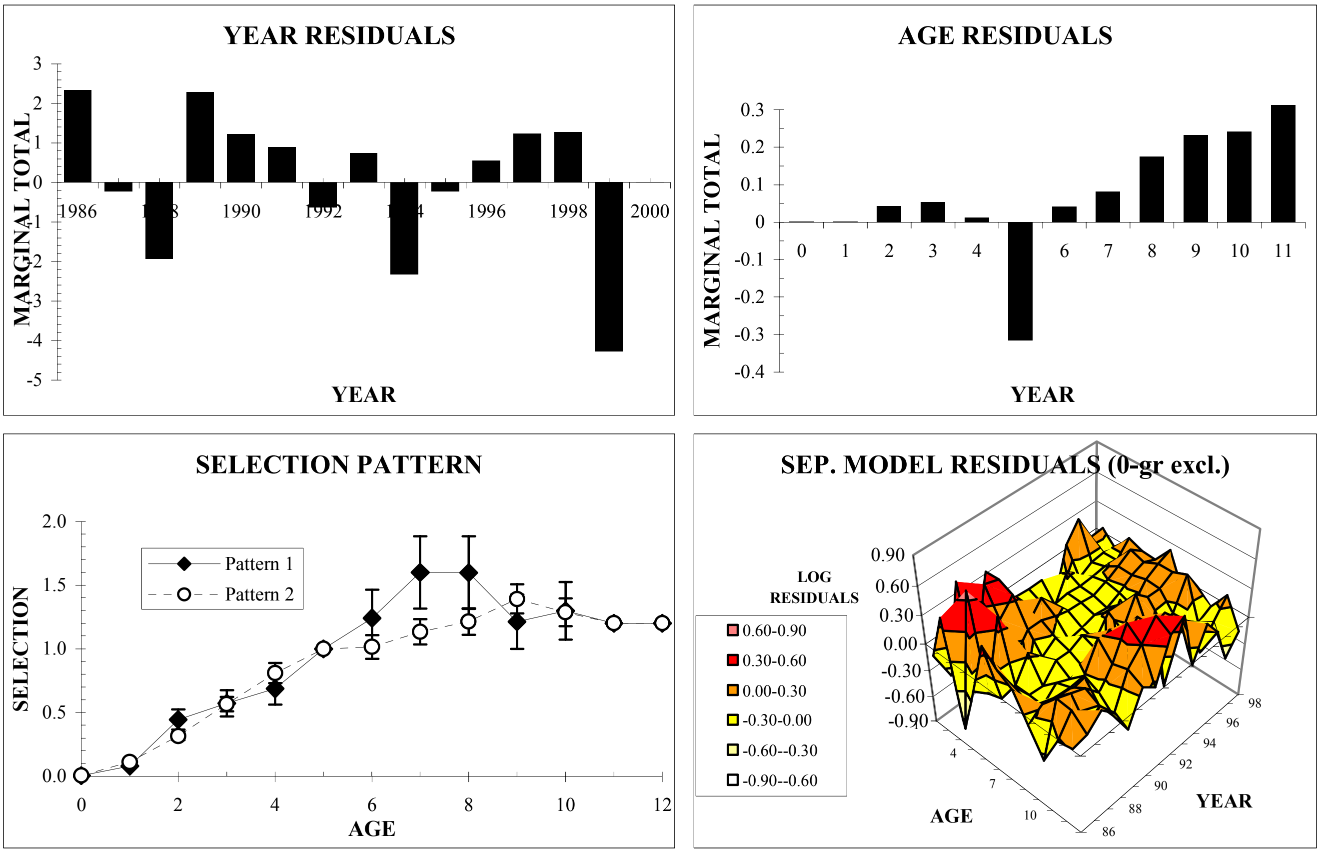


Figure 3.2.3 **Catch at age residuals and ages fitted by ICA to the Western mackerel component data. SSB estimates from egg surveys covering the range 1977-1998 are used in the biomass index; two periods of separable constraint (1986-1988;1989-2000).**

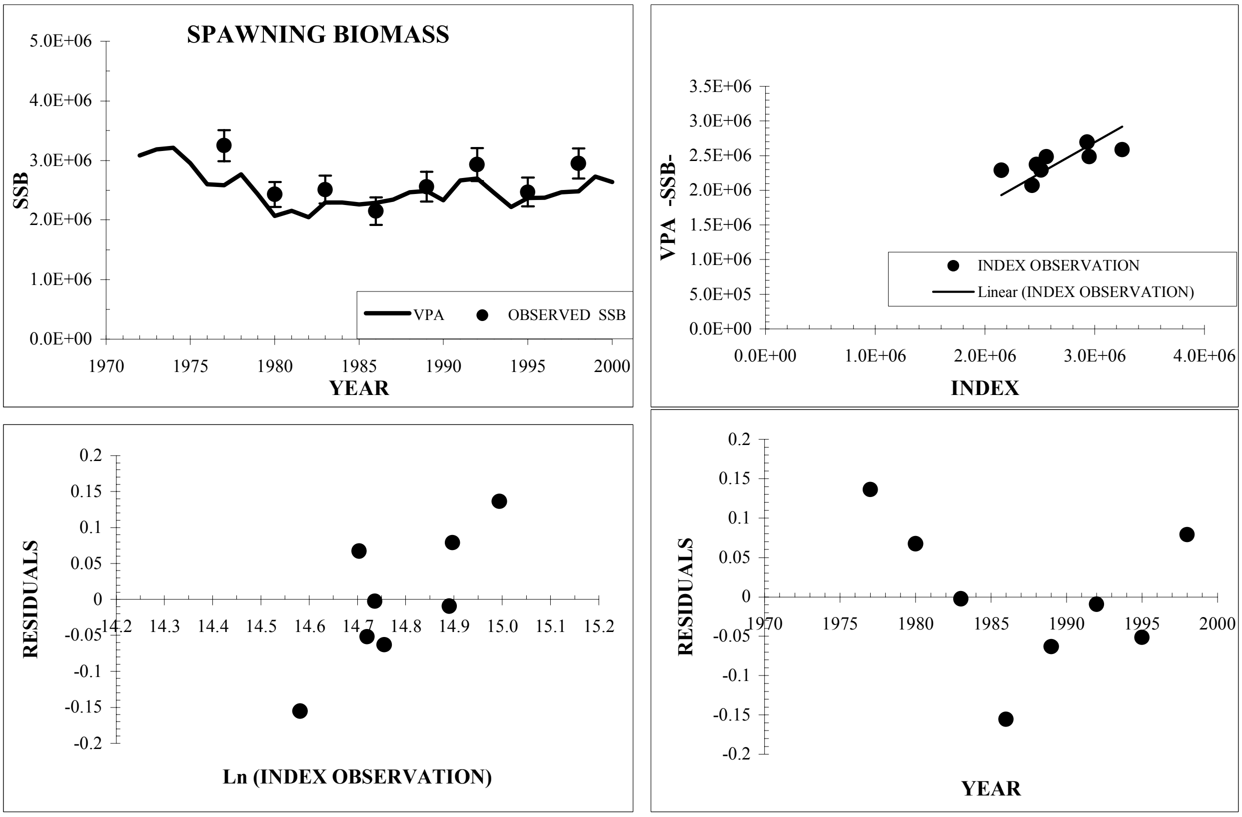


Figure 3.2.4 **Diagnostics for the egg production index as fitted by ICA to the Western mackerel component data. Only SSB estimates from egg surveys covering the range 1977-1998 are used for the biomass index; two periods of separable constraint (1986-1988;1989-2000).**

3.3 Southern Mackerel Component

3.3.1 Biological Data

Catch in numbers at age

The 2000 catches in numbers at age for Divisions VIIIc and IXa are discussed in Section 2.4.1 (Tables 2.4.1.1 and 2.4.1.2 NEA mackerel).

Mean lengths at age and mean weigths at age

The mean lengths at age and mean weights at age for Divisions VIIIc and IXa are discussed in Section 2.4.3 (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 presented in Section 2.4.3 (Table 2.4.3.3- NEA Mackerel). The matrix of mean weights at age in the Southern component was calculated in the following way: for each age, the mean weights 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 (1991-1995) was calculated for the final mean weight estimate for each age. These data will be revised and computed by year to be presented in the 2002 Working Group meeting.

Maturity ogive

No new information became available on maturity ogive since the 1999 meeting of this Working Group (ICES, 2000). In 1999 the WG changed the southern maturity ogive used in the assessment by the maturity ogive based on histological analysis. This ogive was also used for the subsequent years.

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

Egg Surveys

A new egg survey in 2001 covering all the southern area was carried out between January and June. The survey was slit into five sampling periods, allowing coverage of the expected southern spawning area (Periods 1-5). The widest area coverage is provided during the third sampling period when the distribution of mackerel spawning is most widespread in the southern area. For this period an overlap of the sampling areas was planned for the Portuguese, Spanish and German cruises, in order to ensure a complete coverage for plankton and fecundity sampling at the time of peak spawning. Two to three vessels were operating in the Cantabrian Sea and the southern part of the Bay of Biscay in the fourth and fifth period for both plankton and ovary sampling. Portugal, Spain, England, Germany and Netherlands took part in this assessment. The surveys were performed within the study financed by DGXIV 00/038: 'Mackerel and Horse Mackerel Egg surveys 2001' (EGGSURVEY).

Not preliminary data for the 2001 egg production is presented in this Working Group.

The 1998 egg production data was reviewed by the Working Group on mackerel and horse mackerel egg surveys (ICES, 2000/G:01). As a result of that review an error was found in the flow meter data on one station during sampling period 4. The estimate of egg abundance for that period was corrected resulting in a reduction in the estimate of stage I egg production for period 4. The revised value for period 4 has resulted in a reduction of 6% in the estimate of total stage I egg production in the southern area from $46.09*10^{13}$ to $43.37*10^{13}$ with a CV of 43.45%. The resultant proportion of stage I egg production in the southern area is reduced by only 1% from the original estimate of 25%.

The revised estimate of total spawning stock biomass for the southern area in 1998, is reduced from 850,000 tonnes to 800,000 tonnes with a CV of 68% and this would be taken into account in any future assessments. A comparison of this data with the 1995 biomass estimate (378,450 t) shows an increase of 111%.

Bottom trawl surveys

There are two surveys series: The Spanish September-October survey and the Portuguese October survey. The two sets of Autumn surveys covered Sub-divisions VIIIc East, VIIIc West and IXa North (Spain) from 20-500 m depth, using Baka 44/60 gear and Sub-divisions IXa Central North, Central South and South (Portugal), from 20-750 m depth, using a Norwegian Campell Trawl (NCT), that is a trawl net having a 14 m horizontal opening, rollers on the ground-roper and has been fitted with a 20 mm mesh size cod end. The same sampling methodology is used in both surveys but there were differences in the gear design. The Spanish survey used a bottom trawl gear called “Baka” (similar to the gear normally used in these waters by the commercial trawl fleet) aimed at benthic and demersal species, therefore the scope of the survey must be borne in mind, regarding the validity of the abundance indices obtained for pelagic species. In addition, no work is carried out at less than 80 m depth, which results in an imcomplete coverage of the whole area of mackerel juvenile distribution. Comparative data analysis of Baka and GOV gears are described in Section 2.8.2.

Table 3.3.2.1 shows the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 2000 in September-October and the numbers at age per hour trawl from the Portuguese bottom trawl Autumn surveys from 1986 to 2000. Both are carried out during the fourth quarter when the recruits have entered the area and the adults are very scarce in this area. The historical series of abundance indices from the Spanish trawl surveys indicates that 1992 and the period from 1996 to 2000 were those with the highest values of juvenile presence (0 and 1). The series of the Portuguese October survey shows very high values of recruitment (age 0) in 1988, 1992 and the period 1995 to 1999.

Acoustic surveys

The mackerel biomass was estimated to be 320,000 t in 1999, 706,000 t in 2000 and 399,000 t in 2001 (Carrera, WD 2001) based on the Spanish acoustic survey that took place in March in Sub-division IXa North and Division VIIIc. The biomass assessed in 2000 is considered to be overestimated due to high plankton abundance in the area (Carrera, WD 2000). In comparison with the previous years, the number of juvenile fish estimated in 2001 was lower than that observed last year, most of the fish found (90%) were higher than 33 cm. During 2001 the number of adult mackerel estimated in the Spanish area remain quite stable. There was no indication of a strong 2000 year class, and therefore the total biomass estimated in 2001 was lower than that estimated in 2000 (Carrera, WD 2001).

In 1999 another Spanish acoustic survey was carried out in August only in Division IXa North within the JUVESU Project (FAIR CT 97 3374); mackerel was the most fished species in this area and most of the mackerel fish belonged to age 0 (80%) (Carrera WD, 1999).

Further information is given in Section 2.6.2.- NEA Mackerel.

Table 3. 3.2.1 SOUTHERN MACKEREL CPUE at age from surveys.

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

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

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

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

* DIFFERENT SHIP

4 HORSE MACKEREL

4.1 Fisheries in 2000

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 2000 was 272,500 t which is the lowest catch since 1988. Netherlands, Ireland, Denmark, Germany, Scotland, England and Wales and 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 2000 are given in Table 4.1.2 and the distribution of the fisheries are given in Figure 4.1.1.a–d. The figures are based on data from Denmark, England and Wales, Scotland, Ireland, Northern Ireland, Faroe Isles, Germany, Denmark, Netherlands, Norway, Portugal and Spain covering 93 % of the total catches. The data are partly official and provided by working group members.

First quarter: 76,000 t. This is 30,000 t less than in 1999. The catches this quarter (Figure 4.1.1.a) are mainly distributed in the western and southern areas as in previous years.

Second quarter: 45,200 t. This is 1,600 t less than in 1999. 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: 44,800 t. This is 1,000 t more than in 2000, and the catches were distributed as in previous years (Figure 4.1.1.c). In the two later years there were some catches further north than usual.

Fourth quarter: 106,400 t. This is 60,000 t less than in 1999 and the distribution of the catches was mainly as in previous years (Figure 4.1.1.d). Also during this quarter some catches were taken rather far north.

Quarterly catches in 1999: In last year's working group report (ICES, 2001/ACFM:06) the figures giving quarterly catches of horse mackerel were wrong since they were the same as the quarterly distribution of the mackerel catches. The observed distribution of the horse mackerel catches in 1999 is given in Figures 4.1.2.a-d.

4.2 Stock Units

The last 11 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 a southern spawning area.

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 in some years the fishing area in Division IVa in the fourth quarter continues into neighbouring rectangles in Division IIIa. During this quarter usually no catches are taken in the east part of Division IIIa. In 2000 there was no information about where and when the Swedish catches were taken in Division IIIa (1,100 t). The Working Group decided as in most years to allocate the total catch in Division IIIa (1105 t) to the western stock.

At present the fishery is partly regulated by a TAC set by EU for EU waters in Divisions VIa, VIIa–c,e–k and VIIIa,b,d,e and western part of Division IVa. This TAC does not cover the total area where the western stock is fished. 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. All catches in Division IIIa in (1,105 t) were allocated to the western stock.

Southern stock: Divisions VIIIc and IXa. All catches from these areas are allocated to the southern stock.

The catches by stock are given in Table 4.3.1 and Figure 4.3.1. Over the years only one country has provided data about discard and the amount of discards given in Table 4.3.1 are therefore not representative for the total fishery. Since 1998 there are no data about discards available for the Working Group.

4.4 Estimates of discards

No estimates of discards are available for horse mackerel. An unknown proportion of discards is included in the unreported landings.

4.5 Species Mixing

Trachurus spp.

Three species of *Trachurus* genus, *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in 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 2001/ACFM: 06), special care was again taken to ensure that catch and length distributions and numbers at age of *T. trachurus* supplied to the Working Group did not include *T. mediterraneus* and *T. picturatus*. Spain provided data on *T. mediterraneus* and Portugal on *T. picturatus*.

Table 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 1795 t in 2000, being the lowest catches since 1989. 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 1986-2000 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 twelve years (ICES 1990/Assess:24, ICES 1991/Assess:22, ICES 1992/Assess:17, ICES 1993/Assess: 19, ICES 1995/ Assess:2, ICES 1996/Assess:7, ICES 1997/Assess:3, ICES 1998/ Assess:6, ICES 1999/ACFM:6, ICES 2000/ACFM:5; ICES 2001/ACFM:06), and as the evaluations and assessments are only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *Trachurus spp*. in general, as is the case at present. It would then be appropriate to set TACs for the other species as well.

4.6 Length Distribution by Fleet and by Country

Denmark, England and Wales, Netherlands, Norway, Germany, Ireland, Portugal and Spain provided length distribution data for parts or the total of their catches in 2000. These length distributions cover 64 % of the total landings and are shown in Table 4.6.1. This is less than in 1999 when the provided length distributions covered 84% of the catches.

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	1999	2000[1]
II + Vb	2,538	2,557	1,169
IV + IIIa	31,295	58,746	31,583
VI	35,073	40,381	20,657
VII	250,656	186,604	137,716
VIII	38,562	47,012	54,211
IX	41,574	27,733	27,160
Total	399,698	363,033	272,496

[1]Preliminary.

Table 4.1.2 Quarterly catches of HORSE MACKEREL by Division and Sub-division in 2000.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	8	12	180	969	1,169
IIIa	56	36	192	821	1,105
IVa	135	41	1,359	2,989	4,524
IVbc	4,968	295	14,274	6,417	25,954
VIId	1,995	318	53	20,105	22,471
VIa,b	4,730	488	8,922	6,517	20,657
VIIa–c,e–k	43,207	21,397	3,132	47,509	115,245
VIIIa,b,d,e	10,462	8,104	1,484	12,177	32,227
VIIIc	5,170	5,828	6,197	4,789	21,984
IXa	5,233	8,715	9,074	4,138	27,160
Sum	75,964	45,234	44,858	106,431	272,496

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	**50,956**	**436,549**
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	**5,629** [9]	759	106,911	69,546	194,188	11,044	3,935	**388,875**	24,147	28,442	**52,589**	**447,093** [9]
1995	240	7,948	30	8,666	**16,756** [10]	13,133	90,527	83,486	320,102	1,175	2,046	**510,597** [10]	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	**303,537** [9]	22,906	41,574	**64,480**	**398,517** [9]
1999	2,095 [4]	9,335		27,889	**37,224**	2,557 [7]	47,316	40,381	158,715	22,824		**273,888**	24,188	27,733	**51,921**	**363,033**
2000	1,105 [4]	25,954		22,471	**48,425**	1,169 [8]	4,524	20,657	115,245	32,227		**174,927**	21,984	27,160	**49,144**	**272,496**

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
5 Norwegian catches in IVb (1426 t) included in Western horse mackerel.
6 Includes 1937 t from Vb
7 Includes 132 t from Vb
8 Includes 250 t from Vb
9 Minor corrections applied (-60 t for 1994, -6 t for 1995) during the 2001 WG
10 Obviously, 128 t have been moved in 1995 from the North Sea to the Western Horse Mackerel catches

Table 4.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa in the period 1989-1999 and Trachurus picturatus in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2000.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	VIIIab		**-**	**-**	**-**	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988
		VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808
	VIIIc	VIIIc west	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
T. mediterraneus		Total	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808
		IXa North	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
	IXa	IXa C, N & S	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL		**-**	**-**	**-**	**3926**	**3241**	**7142**	**5927**	**6225**	**4917**	**6856**	**4618**	**3821**	**4495**	**2692**	**1795**
	IXa		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526	320	464
	X		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563
T. picturatus	**Azorean Area**																
	34.1.1		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344	646
	Madeira's area																
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**	**1672**

(-) Not available

ble 4.6.1. Length distributions (%) of HORSE MACKEREL catches by fleet and country in 2000

	England & Wales		Netherlands	Germany	Norway	Ireland	Spain				Portugal
	P. trawl	**D. trawl**	**P.trawl**	**P. trawl**	**P.seine**	**P. trawl**	**P.seine**	**D.trawl**	**Gill net**	**Hook**	**Trawl**
cm	Div. VIIef	Div. VIIef	Total	Div VIIb	Div IIa	Total	Total	Total	Total	Total	Total
5											
6											
7											
8											
9							0.01		0.09		0.00
10							0.01	0.05	0.21		0.14
11							0.18	0.12	1.99		0.29
12							1.02	0.22	10.19	1.72	0.80
13							2.48	0.94	25.47		4.16
14							5.71	2.04	58.39		7.04
15			0.00			0.00	9.40	3.20		1.29	7.83
16			0.00			0.00	8.77	2.30		1.72	6.51
17			0.18			0.18	7.11	1.51		2.15	6.83
18			1.15			1.14	6.11	1.21		0.43	4.69
19		1.08	10.14			10.08	4.44	1.38		1.29	3.02
20		2.42	14.68			14.59	1.91	0.91		0.86	3.13
21	0.76	1.81	3.75			3.73	2.17	0.19	0.01	0.43	4.74
22		3.84	3.44			3.42	3.31	0.30	0.06	0.43	8.09
23	0.76	5.15	4.26			4.24	4.67	0.76	0.09		10.29
24	1.53	11.08	8.33	0.19		8.29	7.01	2.88	0.14		8.23
25	3.82	11.91	9.64	4.08		9.60	10.63	5.00	0.27	0.43	6.32
26	19.08	9.08	7.11	12.62		7.10	9.80	6.45	0.35	0.86	4.64
27	10.69	7.20	8.79	19.03		8.77	6.84	9.93	0.34	3.43	3.68
28	17.56	6.28	7.51	24.27		7.51	3.80	9.69	0.24	8.15	2.48
29	16.79	4.56	5.17	15.53		5.17	1.90	10.97	0.31	14.59	1.83
30	7.63	5.23	3.22	10.29		3.22	1.17	9.39	0.38	11.16	1.56
31	5.34	5.92	2.18	7.38	8.45	2.23	0.63	9.51	0.33	14.16	1.25
32	6.87	6.14	2.17	4.08	16.89	2.25	0.32	7.28	0.42	8.58	0.85
33	2.29	5.80	2.53	1.36	21.14	2.62	0.17	4.59	0.31	11.16	0.64
34		5.68	2.11	0.58	25.34	2.21	0.10	3.39	0.19	6.01	0.45
35	2.29	3.02	1.78	0.39	14.79	1.83	0.13	2.25	0.10	3.00	0.23
36	1.53	2.52	1.23	0.19	8.45	1.26	0.09	1.53	0.02	4.29	0.13
37	2.29	0.72	0.28		4.95	0.30	0.05	0.97	0.03	3.00	0.06
38	0.76	0.26	0.22			0.22	0.01	0.54	0.02	0.86	0.03
39		0.31	0.02			0.02	0.00	0.19	0.00		0.02
40							0.00	0.21	0.02		0.01
41			0.02				0.00	0.05	0.00		0.00
42+			0.08				0.01	0.03	0.03		0.01
Sum	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%										

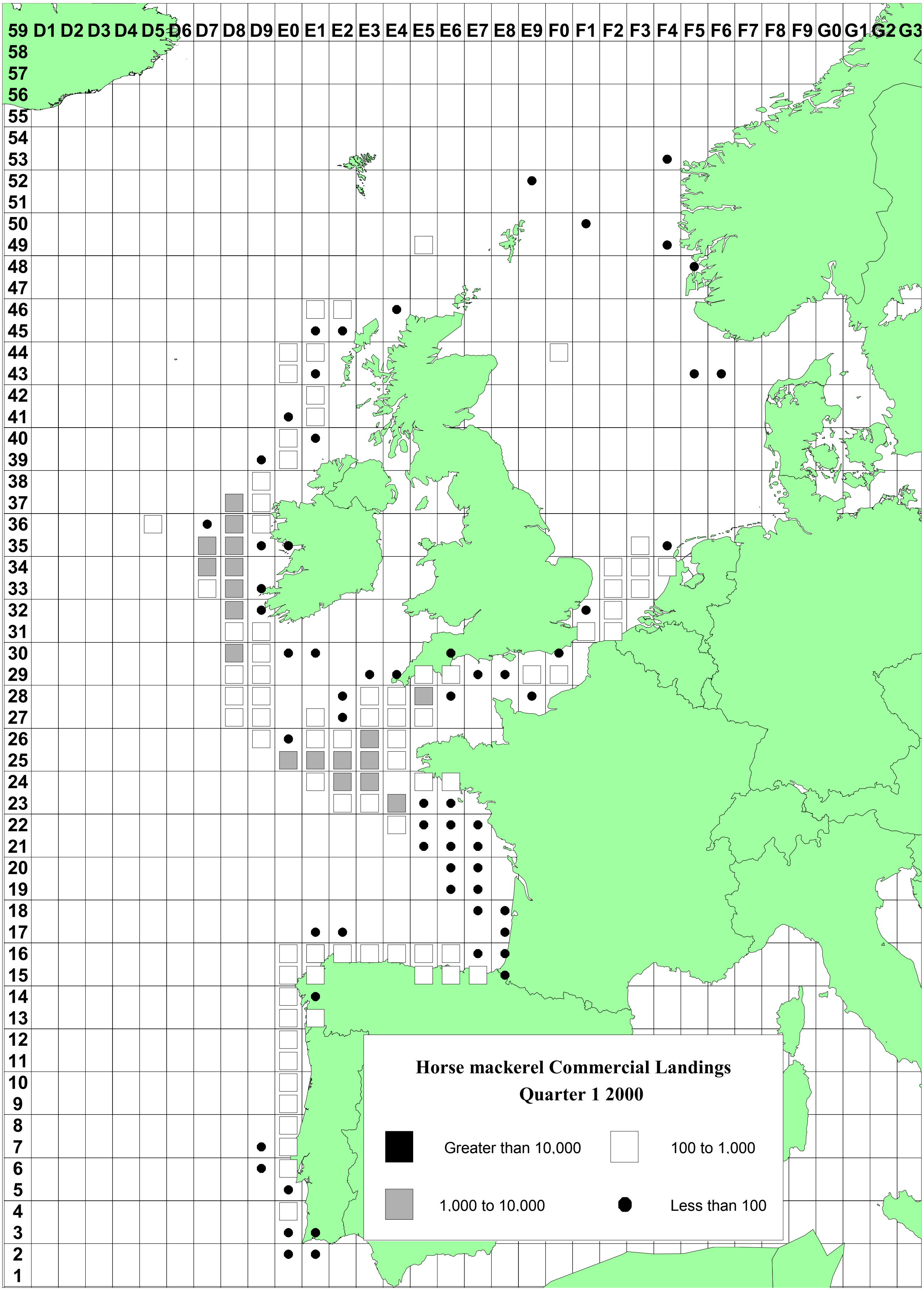


Figure 4.1.1a Horse Mackerel commercial catches in quarter 1-2000

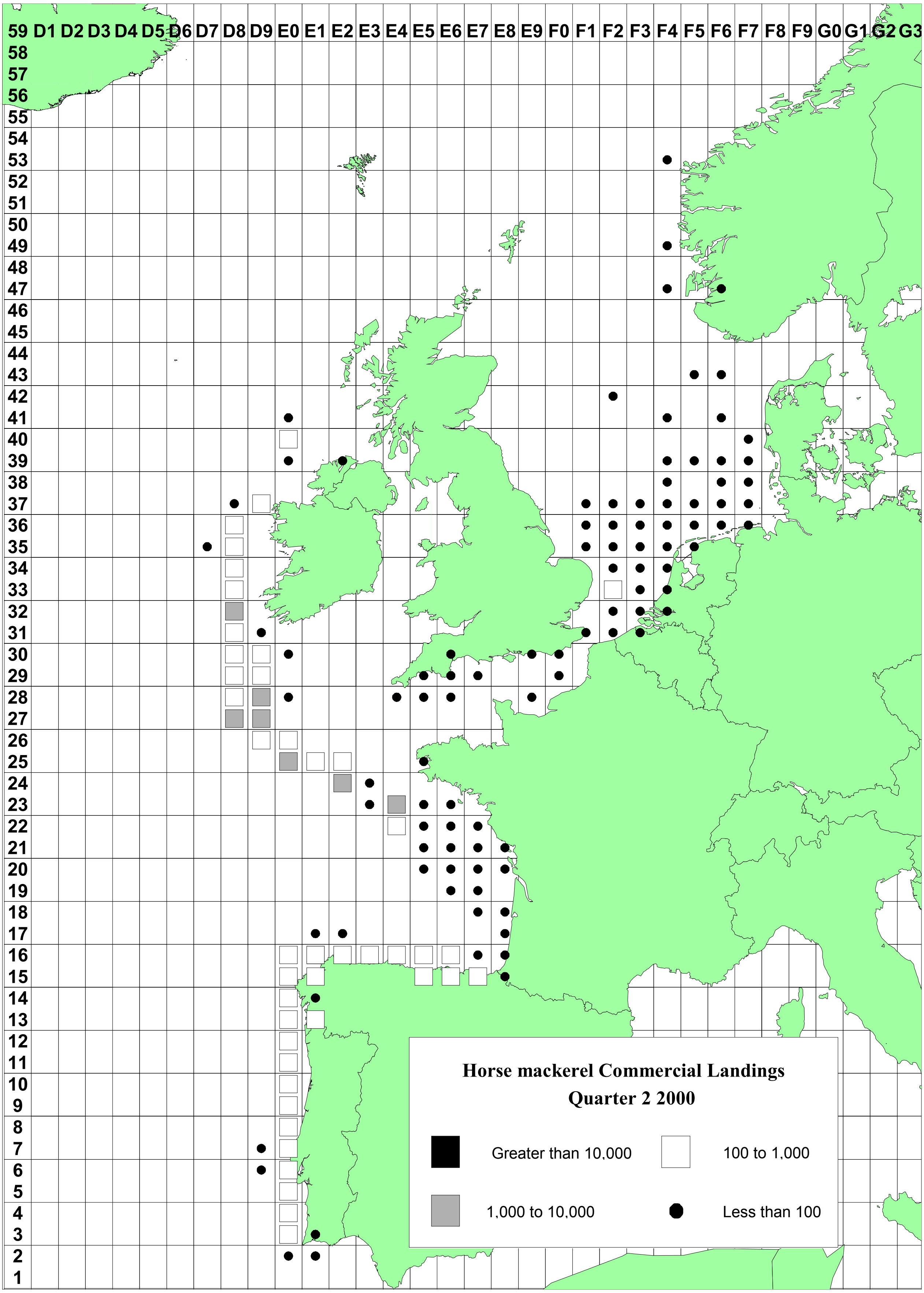


Figure 4.1.1b Horse Mackerel commercial catches in quarter 2-2000

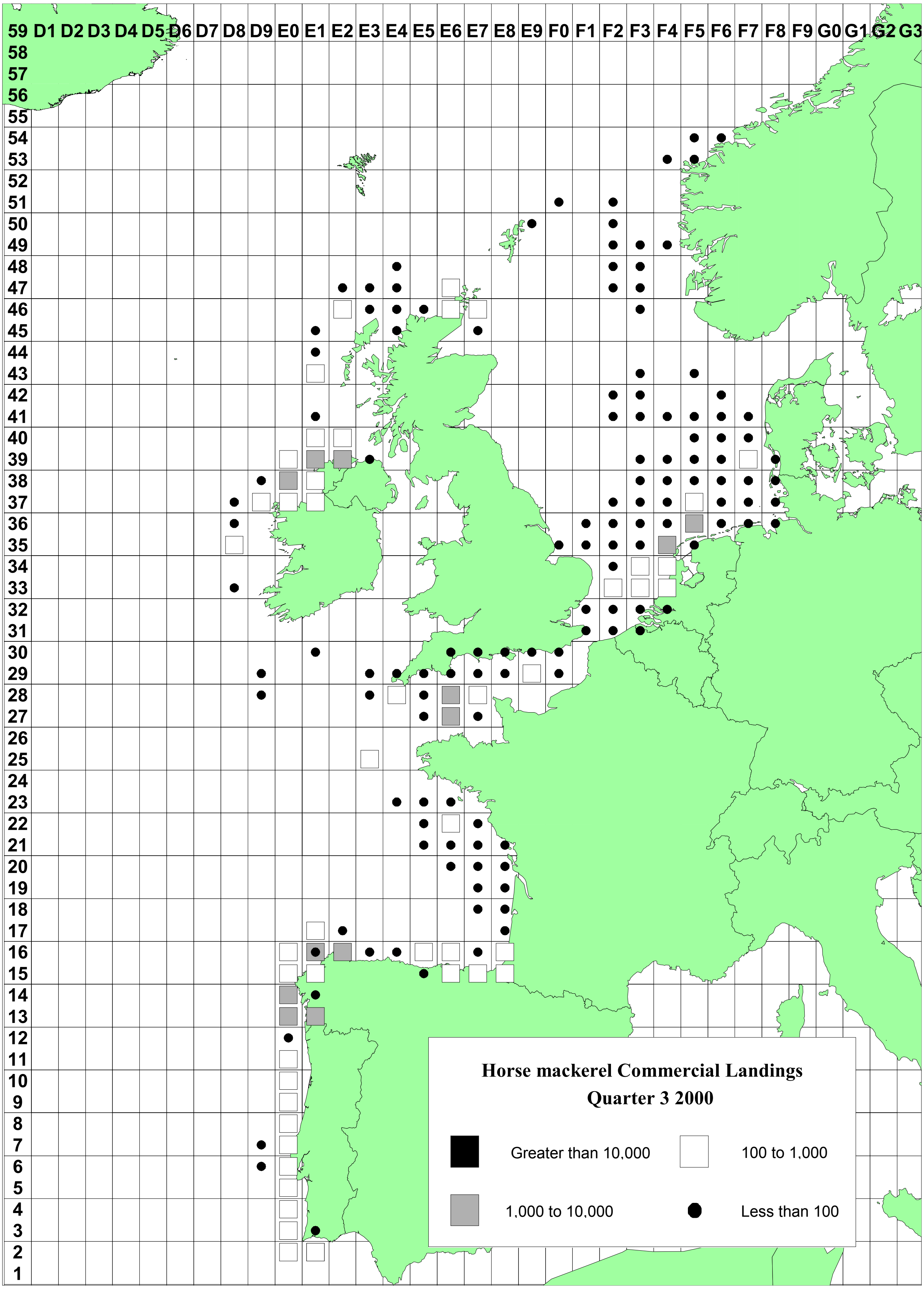


Figure 4.1.1c Horse Mackerel commercial catches in quarter 3-2000

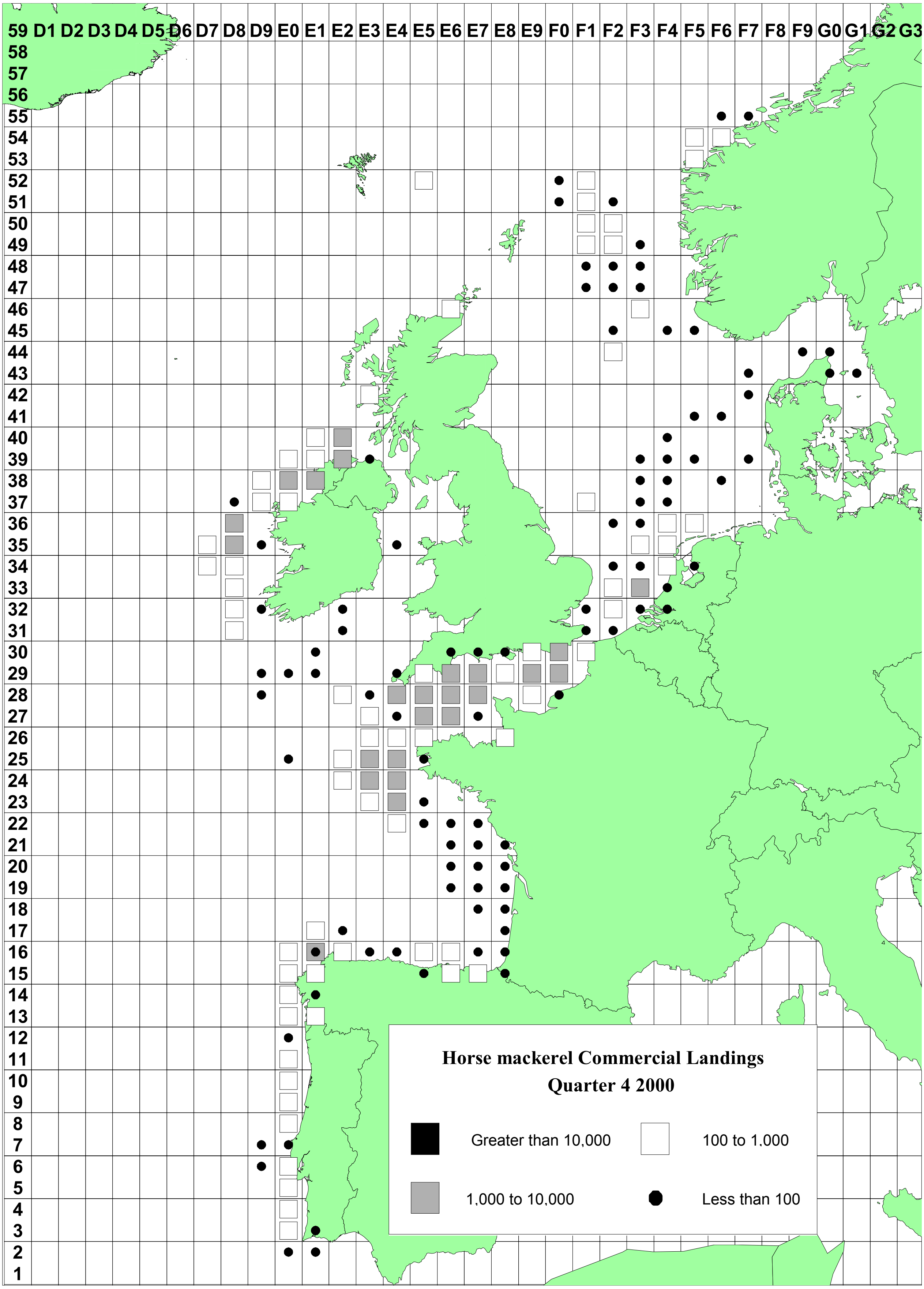


Figure 4.1.1d Horse Mackerel commercial catches in quarter 4-2000

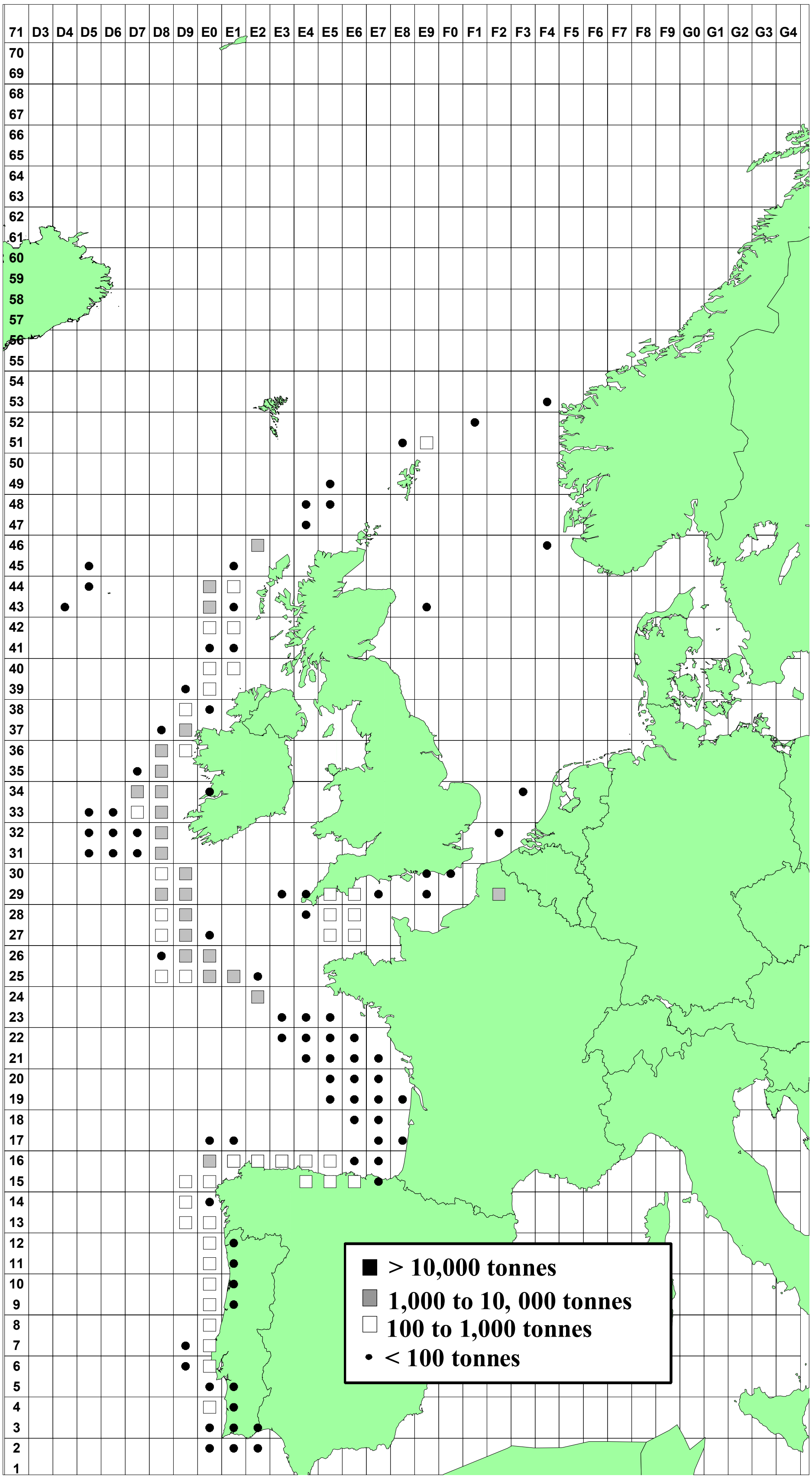


Figure 4.1.2a. Horse Mackerel commercial catches in quarter 1 – 1999

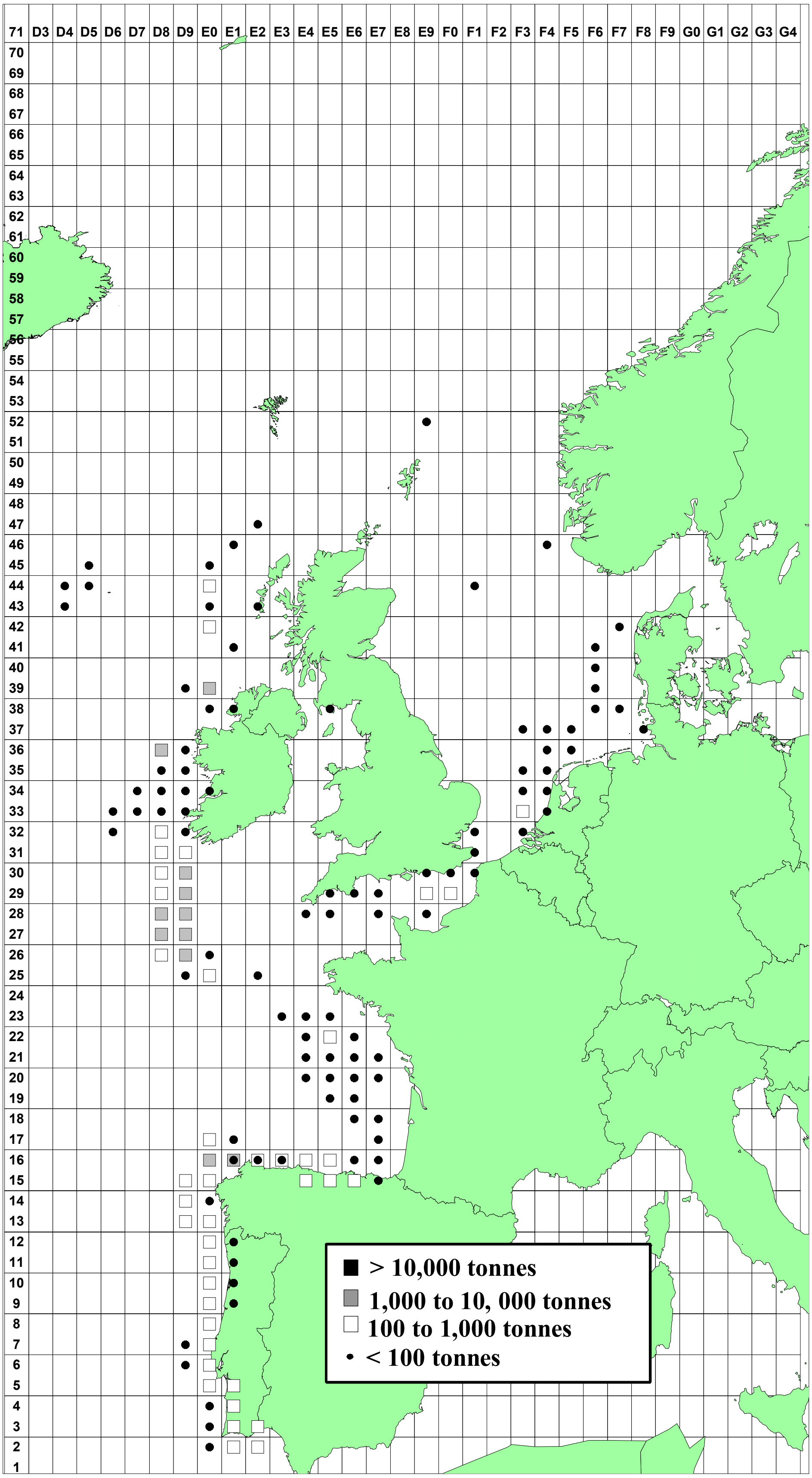


Figure 4.1.2b Horse Mackerel commercial catches in quarter 2 – 1999

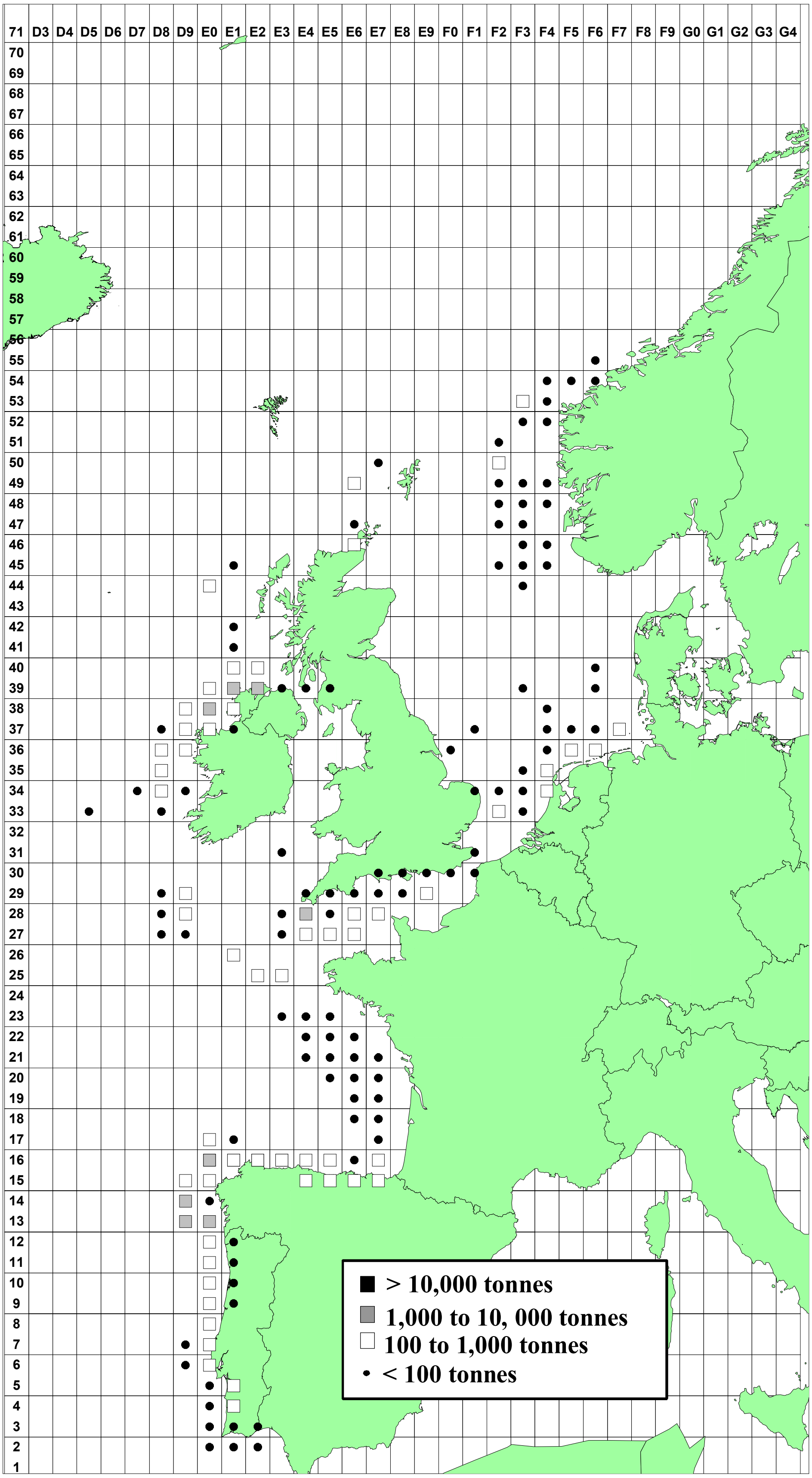


Figure 4.1.2c Horse Mackerel commercial catches in quarter 3 - 1999

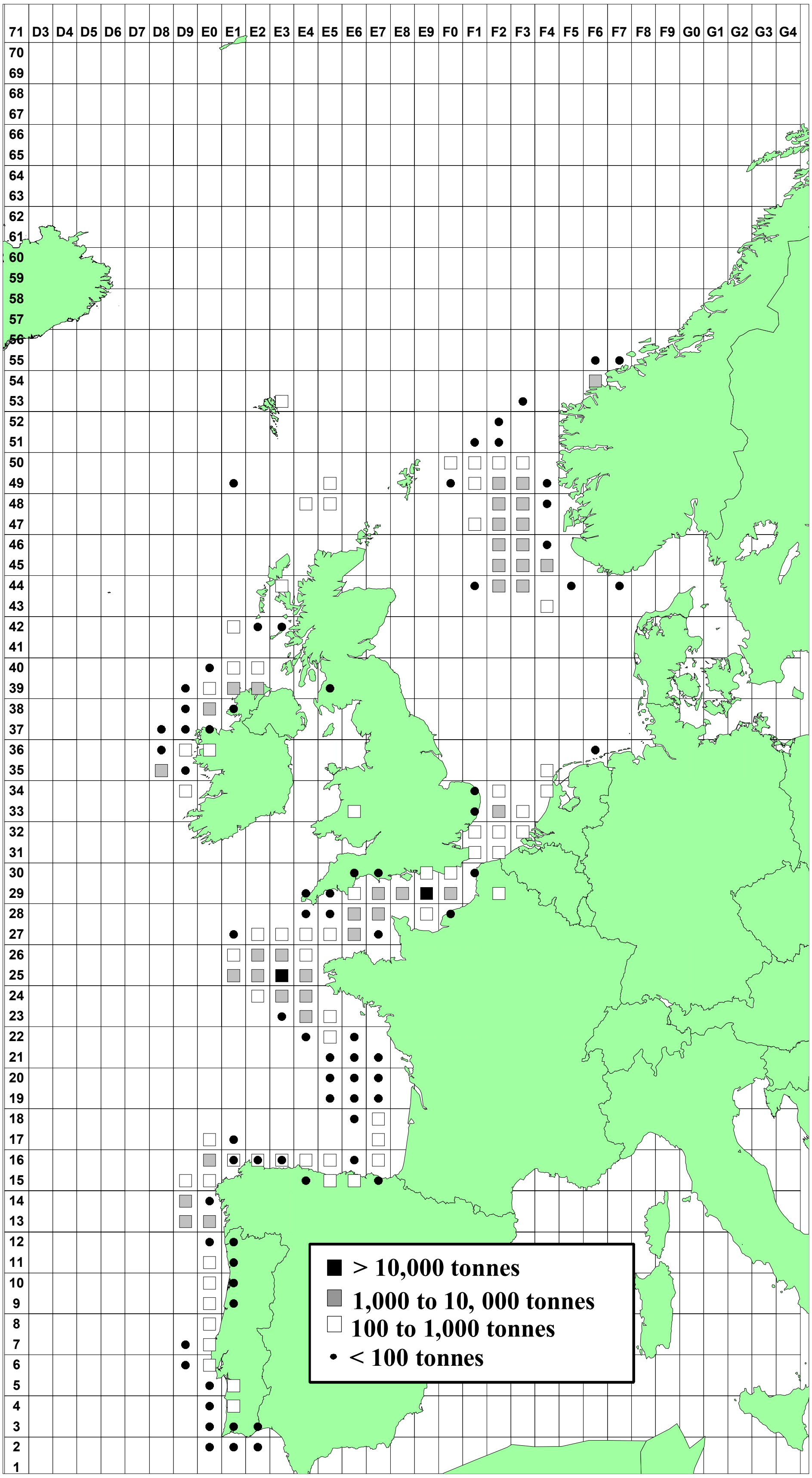


Figure 4.1.2d Horse Mackerel commercial catches in quarter 4 - 1999

5 NORTH SEA HORSE MACKEREL (DIVISIONS IIIA (EXCLUDING WESTERN SKAGERRAK), IVBC AND VIID

5.1 ACFM advice Applicable to 2000 and 2001

ACFM has not previously given TAC-advice for this stock. ACFM suggested that due to the age composition of the relatively small catches and past biomass estimates from egg-surveys, 1988-1991, the exploitation rate might have been low. From 1997 to 2000 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-area IV, which is a wider area than the North Sea stock is distributed in. This TAC has been fixed at 60,000 t for 1993-1999. In 2000 the TAC was reduced to 51 000.

5.2 The Fishery in 2000 on the North Sea stock

Catches taken in Divisions IVb, c and VIId are regarded as belonging to the North Sea horse mackerel and in some years also catches from Division IIIa - except the western part of Skagerrak (see Sections 4.2 and 4.3). Table 4.3.1 shows the catches of this stock from 1982–2000. The total catch taken from this stock in 2000 is 48 425 t, which is the largest catch on record. In previous years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId, but in recent years a large part of the catch was taken in a directed horse mackerel fishery for human consumption.

5.3 Fishery-independent Information

5.3.1 Egg Surveys

No egg surveys for horse mackerel have been carried out in the North Sea since 1991. Such surveys were carried out during the period 1988-1991 and the SSB was estimated between 217 and 255 thousand tonnes the last three survey years (Eltink, 1992).

5.3.2 Bottom trawl surveys

This year, the WG investigated the IBTS data on horse mackerel, as suggested by the ACFM.

IBTS data for North Sea horse mackerel are given only as catch rates by length group. Therefore length distributions were converted into an index of biomass, by use of a length-weight relationship.

The length-weight relationship, log(Weight) = a + b*log(Length), was derived from Table 5.3.2.1, which gave the parameters: b = 2.88 and a = - 4.26. The length-weight fit is shown in Figure 5.3.2.1.

The index of biomass was defined as

$$BiomassIndex = \sum_{Length} CPUE(Length) * \exp(a) * Length^b$$

Indices for quarters 1 and 3 are shown in Figure 5.3.2.2.

There appears to be little correlation between the index based on quarter 1 and the index based on quarter 3.

Because the stock migrates outside the area covered by the IBTS in the first quarter, this index is not representative for the stock, and consequently, it has not been used. Thus, only the IBTS index of third quarter is considered representative for the stock.

5.4 Biological Data

5.4.1 Catch in Numbers at Age

Catch in numbers at age by quarter and annual values were calculated according to Dutch samples collected in Divisions IVb and IVc from the third and fourth quarter, and in VIId from the first, third and fourth quarter. Annual catch numbers at age are given in Table 5.4.1.1 and by area for 2000 in Table 5.4.1.2. Table 5.4.1.3 shows catch number by quarter and by area in 2000.

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, and cover 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).

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 stock.

At present the sampling intensity is rather low and the quality of the catch at age data may be questionable. If a dependable analytical assessment is to be done in the future the sampling needs to be improved. This year however, a preliminary assessment was made based on data from 1995-2000. From 1995 the proportion of the catch taken for human consumption has been high (around 70% in 1995 and 96). The Dutch samples after 1996 covered all their catches, and as this catch is the largest part, the coverage has been around 70 % in recent years as shown in the text table below. The coverage for 1995-6 is not known.

	1995	1996	1997	1998	1999	2000
% of landings covered	62	55	57	66	77	71
Samples from	RV	RV+FV	FV	FV	FV	FV
(RV = Research Vessel, FV = Commercial fishing Vessels)						

5.4.2 Mean weight at age and mean length at age

Table 5.4.2.1 shows weight by quarter and by area in 2000. Table 5.4.2.2 shows length by quarter and by area in 2000. The annual average values are shown in Table 5.3.2.1.

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. However, the value, M = 0.15 was used in the preliminary assessments. This value was adopted from the Western and Southern stocks.

5.5 State of the Stock

Estimates of total age composition are available since 1995 based on Dutch samples (Table 5.4.1.1). Estimates of age composition prior to 1995 are considered unreliable, that is, not representative for the entire fishery, and should not be used for analytical assessment. During the period the catches were relatively low with an average of 18,000 t. The catch, however, has gone up considerably in recent years, and the state of the stock is unknown. In 2000 the catch level increased to the highest on record. The egg surveys in later years for mackerel in the North Sea do not cover the spawning area of horse mackerel. The present stock level is uncertain since the last SSB estimate was made in 1991. Since allocation of catches to the stock is based on the temporal and spatial distribution of the fishery it is important that catches are reported by ICES rectangle and quarters. Since there is no information of the SSB since 1991 it is not known if this stock is still exploited moderately. This year, however, it was attempted to make a first preliminary analytical assessment based on data from 1995 to 2000 . It was attempted to analyse the IBTS data to obtain an index of biomass (see Section 5.3.2).

Two preliminary assessments were made for the North Sea Horse Mackerel:

1) ISVPA
2) Ad Hoc Spread Sheet – Method, with a smaller number of parameters.

The catch-at-age appears to have changed during the period from 1995 to 2000, with a large reduction in mean age, mean length and mean weight (Figures 5.4.1.2 and 5.4.1.3). Whether this is caused by a real change in the fishing pattern, or is caused by biased samples is unknown. In years 1995 and 1996 a certain number of commercial catches were converted into age distributions by research vessel samples, which may not be representative for the commercial fishery. In recent years, however, a fishery for human consumption fishery has developed. This fishery targets at small size horse mackerel for the Japanese market (Eltink, pers. Com.). As explained in Section 5.4.1, the sampling and the coverage has improved in recent years.

The ratio between landings and the IBTS index should reflect the trend in fishing mortality. The plot is shown in Figure 5.5.0.1. It appears that fishing mortality has shown a pronounced increasing trend during the period 1995-2000.

5.5.1 ISVPA

The time series of data available was considered too short for the ISVPA. The method was nevertheless tested, but is not presented here in details. The ISVPA was run for ages (1-15+) and (2-15+).

Fishing mortality increased from a low value (0.05) in 1995 and to 0.3 in 2000 (Figure 5.5.1.1). The selection ogive shows a peak for age 5, and decreases to a very low value for ages 10-15+.(Figure 5.5.1.2).

The ISVPA method does not require any tuning data. However, the results were compared to the length based biomass index, derived from the IBTS. The IBTS for Q3 showed a fair accordance with the ISVPA (Figure 5.5.1.3). Biomasses, however, came out with very high values compared to the estimate of 217-255 thousands tons from the last egg survey in 1991 (Figure 5.5.1.4). The high biomasses should be seen in conjunction with the dome shaped selection ogive (Figure 5.5.1.2). Increasing the F on the older age groups would bring down the biomass.

5.5.2 Ad Hoc Spread Sheet – Method

This method is essentially like all the other single species assessment methods used by ICES WGs.

It is a model with a small number of parameters matching the short time series of data and a single length based biomass index available for North Sea horse mackerel.

It is a model assuming a separable fishing mortality, which uses catch at age, and biomass index as input.

Parameters are fitted by the least squares method.

It deviates from other methods in that the number of parameters is smaller, which is made possible by the introduction of a number of assumptions.

1) The selection ogive has an ascending left hand side and a descending right hand side. Here this is modelled by the product of two logistic curves (that requires 4 parameters per year).

2) The parameters in the selection ogive are assumed to be linear functions in time.

3) The effort level is assumed to be a linear function of time.

The left hand side gear selection ogive in year "y" of age group "a" is:

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

where

$Sel2_{Left}(y) = \ln(3) * L_{Left50\%}(y)/(L_{Left75\%}(y) - L_{Left50\%}(y))$

$Sel2_{Left}(y) = \ln(3)/(L_{Left75\%}(y) - L_{Left50\%}(y))$

$L_{Left50\%}(y)$ = Body Length at which 50% of the fish entering the gear are retained (ignoring the right hand side selection)
$L_{left75\%}(y)$ = Body Length at which 75 % of the fish entering the gear are retained
$L_{Left75\%}(y)$ = (Selection Range) * $L_{Left50\%}(y)$

$L_{Left50\%}(y) = A_{Left} + B_{Left}*(y - \text{First year})$

This model is a simple way of reducing the number of parameters, but it is not justified by observations.

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

and with the parameters defined as for the left-hand side selection.
The combined selection ogive thus becomes:

$$\mathrm{SEL(y,a)} = \mathrm{SEL}_{\mathrm{LEFT}}(y,a) * SEL_{RIGHT}(y,a)$$

The selection ogive is normalized so that the maximum value is 1.0.
The double logistic curve was chosen due to the findings of the ISVPA, which showed a pronounced descending slope of the selection ogive (Figure 5.5.1.2).
Thus the selection part of the separable VPA is replaced by only 4 parameters: A_{Left}, $B_{Left,}$ A_{Right} and B_{Right}.
The F-level is replace by two parameters, A_F and B_F so that fishing mortality is defined as

$$F(y,a) = (A_F + B_F(y - first\ \ year)) * SEL(y,a)$$

The assumption thus is that there is a linear trend in the fishing mortality level. This model was inspired of the plot of landings/IBTS on the year, which should indicate the trend in F.

The stock numbers in the first year were fitted to the catch numbers by the solver function of EXCEL.

As the starting point for the iteration, year 1995 was assumed to be in equilibrium, that is, N(95,a) = N(95,a-1)*exp(-Z(95,a-1)). As expected, this assumption is not met, in particular the catch number C(95,13) appears to come from a large recruitment (the outstanding 1982 year class).

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

$$\chi^2 = W_C \sum_y \sum_a \frac{(C_{Observed}(y,a) - C_{\Pr edicted}(y,a))^2}{C_{\Pr edicted}(y,a)} +$$
$$W_B \sum_y \frac{(\mathrm{Re}\,l.Bionass(y) - \mathrm{Re}\,l.IBTSIndex(y))^2}{\mathrm{Re}\,l.Biomass(y)}$$

The "relative biomass" is the biomass predicted by the model, and the relative index is the length based IBTS index for quarter 3.

The model is implemented as a conventional EXCEL spread sheet, and the minimization is made by the "solver" function of EXCEL.

The values of the weights W_c and $W_{B,}$ were selected to make the two terms in the object function approximately equal, giving the same weight to the catch at age data and to the survey index.

The program is operated from a "dashboard", contained in a single work-sheet, as shown in Figure 5.5.2.1. The cells containing with large font indicate the input parameters, which can be modified by the "Solver". It is up to the user, which parameters should be modified, and in the actual runs, only subsets of parameters were modified. With this set-up, it is easy for the user to evaluate the effect of changing parameters on selected key-output.

The results are shown in Figure 5.5.2.2.A-D, which are copies of the spreadsheets.

The results (Figure 5.5.2.2) indicate that the stock biomass has decreased from around 450 000 tons in 1995 to 150 000 tons in 2000. There is a fair correlation between the length based IBTS biomass index and the estimated biomass. Fishing mortality has increased from about 0.1 to about 0.6. The F-pattern matches the trend shown in the Figure 5.5.0.1.

All these results are in the expected range, but it should be stressed the estimation procedure is not very robust, and there are many possible interpretations of the data which gives almost the same goodness of fit.

The working group stresses that the results of this exercise are to be considered "data-exploration" rather than an assessment, due to the uncertainties of data, the short time series and the experimental nature of the model.

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 from 1993 to 1999 and 51000 in 2000. 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. 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.

No forecast for the North Sea stock has been made for 2002.

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

5.9 Recommendation

The Working Group recommends that the IBTS collects age composition samples from horse mackerel in third quarter in the area of the North Sea horse mackerel (IVbc, VIId and IIIa), to improve the fishery independent abundance indices. It is also recommended that more age composition samples be collected, covering all major components of the North Sea horse mackerel fisheries.

Table 5.3.2.1.a. Weight at age (kg), 1995-2000, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000
0	0.000	0.000	0.063	0.063	0.063	0.075
1	0.076	0.107	0.102	0.102	0.102	0.101
2	0.126	0.123	0.126	0.126	0.126	0.136
3	0.125	0.143	0.142	0.142	0.142	0.152
4	0.133	0.156	0.160	0.160	0.160	0.166
5	0.146	0.177	0.175	0.175	0.175	0.194
6	0.164	0.187	0.199	0.199	0.199	0.198
7	0.161	0.203	0.231	0.231	0.231	0.213
8	0.178	0.195	0.250	0.250	0.250	0.247
9	0.165	0.218	0.259	0.259	0.259	0.280
10	0.173	0.241	0.300	0.300	0.300	0.279
11	0.317	0.307	0.329	0.329	0.329	0.342
12	0.233	0.211	0.367	0.367	0.367	0.318
13	0.241	0.258	0.299	0.299	0.299	0.325
14	0.348	0.277	0.360	0.360	0.360	0.332
15+	0.000	0.000	0.063	0.063	0.063	0.075

Table 5.3.2.1.b. Length at age (cm) 1995-2000, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000
0	19.2	19.2	19.2	19.2	19.2	19.0
1	22.0	22.0	22.0	22.0	22.0	21.5
2	23.5	23.5	23.5	23.5	23.5	23.9
3	24.8	24.8	24.8	24.8	24.8	24.9
4	25.5	25.5	25.5	25.5	25.5	26.0
5	26.4	26.4	26.4	26.4	26.4	27.8
6	27.2	27.2	27.2	27.2	27.2	28.3
7	29.2	29.2	29.2	29.2	29.2	28.6
8	29.5	29.5	29.5	29.5	29.5	30.0
9	29.5	29.5	29.5	29.5	29.5	31.3
10	30.6	30.6	30.6	30.6	30.6	31.4
11	32.1	32.1	32.1	32.1	32.1	33.7
12	33.3	33.3	33.3	33.3	33.3	33.5
13	31.1	31.1	31.1	31.1	31.1	33.4
14	32.5	32.5	32.5	32.5	32.5	33.4
15+	19.2	19.2	19.2	19.2	19.2	19.0

Table 5.4.1.1. Catch in numbers (millions), 1995-2000, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000
0	0.00	0.00	0.00	2.30	12.42	70.23
1	1.76	4.58	12.56	22.13	31.45	77.98
2	3.12	13.78	27.24	36.69	23.13	28.41
3	7.19	11.04	14.07	38.82	17.59	21.42
4	10.32	11.87	14.93	20.79	23.12	31.27
5	12.08	9.64	14.58	12.10	26.19	19.64
6	13.16	12.49	12.38	13.99	20.64	19.47
7	11.43	7.96	10.12	10.79	21.75	9.00
8	12.64	6.60	8.64	8.26	12.91	11.50
9	7.25	1.48	2.45	4.01	8.21	8.96
10	5.87	5.31	0.75	2.72	2.14	6.98
11	0.01	0.29	0.34	0.71	0.43	3.07
12	8.84	1.28	0.25	1.81	1.40	1.61
13	0.20	8.92	0.00	0.31	3.78	0.00
14	4.37	8.01	1.38	5.11	4.03	12.22
15+	0.00	0.00	0.00	2.30	12.42	70.23

Table 5.4.1.2 Catch number, annual mean length and annual mean weight North Sea horse mackerel stock by area in 2000

North Sea Horse mackerel catch number 2000					**Mean Weight**		**For Periods 1-4**		
	Q1-4	Q1-4	Q1-4	Q1-4		Q1-4	Q1-4	Q1-4	Q1-4
Ages	IVb	IVc	VIId	Sum	Ages	IVb	IVc	VIId	Mean weight
0	0	0	0	0	0	0.000	0.000	0.000	0.000
1	14387	23498	32342	70228	1	0.075	0.075	0.075	0.075
2	19157	31784	27034	77975	2	0.102	0.102	0.098	0.101
3	9286	13455	5668	28409	3	0.136	0.136	0.138	0.136
4	7104	10553	3764	21421	4	0.154	0.153	0.145	0.152
5	8638	11964	10663	31265	5	0.169	0.168	0.163	0.166
6	3655	4178	11805	19639	6	0.186	0.185	0.200	0.194
7	4659	5081	9733	19473	7	0.200	0.199	0.196	0.198
8	1930	1881	5185	8996	8	0.205	0.204	0.220	0.213
9	2353	2733	6410	11497	9	0.251	0.250	0.244	0.247
10	1551	1515	5894	8961	10	0.274	0.273	0.284	0.280
11	985	871	5120	6976	11	0.261	0.261	0.286	0.279
12	559	484	2028	3071	12	0.320	0.320	0.354	0.342
13	291	269	1050	1610	13	0.323	0.323	0.315	0.318
14	0	0	0	0	14	0.000	0.000	0.000	
15	2368	2091	7759	12218	15	0.319	0.321	0.339	0.332

Mean Length		**For Periods 1-4**		
	Q1-4	Q1-4	Q1-4	Q1-4
Ages	IVb	IVc	VIId	Mean length
0	0.00	0.00	0.00	
1	18.07	17.85	20.16	18.96
2	21.40	21.36	21.79	21.52
3	23.81	23.81	24.50	23.95
4	24.88	24.85	24.95	24.88
5	25.89	25.88	26.20	25.99
6	27.05	27.03	28.29	27.79
7	28.29	28.22	28.27	28.26
8	28.26	28.13	28.96	28.64
9	30.10	29.97	30.03	30.03
10	31.13	30.97	31.39	31.27
11	31.21	31.21	31.53	31.45
12	33.50	33.50	33.79	33.69
13	33.47	33.43	33.48	33.47
14	0.00	0.00	0.00	
15	33.05	33.07	33.60	33.41

Table 5.4.1.3 Catch number of North Sea horse mackerel stock by quarter and by area in 2000

Catch N		For Period 1			Catch N	For Period 2			
	Q1	Q1	Q1	Q1		Q2	Q2	Q2	Q2
Ages	Ivb	IVc	VIId	Sum	Ages	IVb	IVc	VIId	Sum
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	1	5.0	0.0	0.0	5.0
2	0.0	0.0	0.0	0.0	2	8.9	12.6	16.9	38.3
3	0.0	0.0	0.0	0.0	3	13.9	26.8	35.9	76.6
4	0.0	0.0	0.0	0.0	4	26.8	55.1	74.0	155.9
5	0.0	0.0	0.0	0.0	5	61.7	131.9	177.1	370.7
6	817.7	708.5	1225.1	2751.3	6	85.5	185.3	248.8	519.5
7	1800.1	1559.7	2696.8	6056.6	7	94.9	207.1	278.2	580.2
8	1097.1	950.6	1643.6	3691.3	8	47.0	102.0	137.0	286.0
9	1107.1	959.2	1658.5	3724.8	9	53.3	116.1	155.9	325.4
10	1241.7	1075.9	1860.2	4177.8	10	11.5	25.1	33.7	70.3
11	972.4	842.6	1456.8	3271.8	11	13.0	28.3	38.1	79.4
12	558.6	484.0	836.8	1879.4	12	0.0	0.0	0.0	0.0
13	279.2	241.9	418.3	939.4	13	12.3	26.8	35.9	74.9
14	0.0	0.0	0.0	0.0	14	0.0	0.0	0.0	0.0
15	2338.6	2026.3	3503.6	7868.5	15	29.5	64.3	86.4	180.2
Catch N	For Period 3				Catch N	For Period 4			
	Q3	Q3	Q3	Q3		Q4	Q4	Q4	Q4
Ages	Ivb	IVc	VIId	Sum	Ages	IVb	IVc	VIId	Sum
0	0	0	0	0	0	0	0	0	0
1	8354.2	11601.0	79.4	20034.6	1	6028.2	11897.4	32263.0	50188.6
2	10440.5	14501.3	66.3	25008.2	2	8707.9	17270.4	26950.4	52928.7
3	7457.0	10358.1	13.8	17828.9	3	1814.8	3070.3	5618.1	10503.1
4	5071.2	7043.5	9.1	12123.7	4	2006.2	3454.1	3681.2	9141.5
5	6860.3	9529.4	25.7	16415.5	5	1715.6	2302.7	10460.6	14478.8
6	2088.2	2900.3	25.4	5013.8	6	664.0	383.8	10306.3	11354.1
7	2385.9	3314.6	16.6	5717.1	7	378.1	0.0	6741.4	7119.5
8	596.7	828.6	8.4	1433.7	8	189.1	0.0	3396.4	3585.5
9	1193.1	1657.3	11.3	2861.7	9	0.0	0.0	4584.7	4584.7
10	298.3	414.4	9.8	722.4	10	0.0	0.0	3990.6	3990.6
11	0.0	0.0	8.9	8.9	11	0.0	0.0	3616.3	3616.3
12	0.0	0.0	2.9	2.9	12	0.0	0.0	1188.3	1188.3
13	0.0	0.0	1.5	1.5	13	0.0	0.0	594.1	594.1
14	0.0	0.0	0.0	0.0	14	0.0	0.0	0.0	0.0
15	0.0	0.0	10.2	10.2	15	0.0	0.0	4159.0	4159.0

Table 5.4.2.1 Weight-at-age of North Sea horse mackerel stock by quarter and by area in 2000

Mean We		For Period 1			Mean Weight		For Period 2		
	Q1	Q1	Q1	Q1		Q2	Q2	Q2	Q2
Ages	IVb	IVc	VIId	Mean weight	Ages	IVb	IVc	VIId	Mean weight
0	0.000	0.000	0.000		0	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000		1	0.074	0.000	0.000	0.074
2	0.000	0.000	0.000		2	0.084	0.076	0.076	0.078
3	0.000	0.000	0.000		3	0.126	0.125	0.125	0.125
4	0.000	0.000	0.000		4	0.141	0.140	0.140	0.140
5	0.000	0.000	0.000		5	0.147	0.147	0.147	0.147
6	0.183	0.183	0.183	0.183	6	0.177	0.177	0.177	0.177
7	0.206	0.206	0.206	0.206	7	0.184	0.184	0.184	0.184
8	0.208	0.208	0.208	0.208	8	0.214	0.214	0.214	0.214
9	0.253	0.253	0.253	0.253	9	0.243	0.243	0.243	0.243
10	0.276	0.276	0.276	0.276	10	0.285	0.285	0.285	0.285
11	0.261	0.261	0.261	0.261	11	0.249	0.249	0.249	0.249
12	0.320	0.320	0.320	0.320	12	0.250	0.000	0.000	0.250
13	0.323	0.323	0.323	0.323	13	0.322	0.322	0.322	0.322
14	0.000	0.000	0.000		14				
15	0.319	0.319	0.319	0.319	15	0.385	0.385	0.385	0.385
Mean Weight	For Period 3				Mean Weight		For Period 4		
	Q3	Q3	Q3	Q3		Q4	Q4	Q4	Q4
Ages	IVb	IVc	VIId	Mean weight	Ages	IVb	IVc	VIId	Mean weight
0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000
1	0.072	0.072	0.075	0.072	1	0.078	0.078	0.075	0.076
2	0.105	0.105	0.098	0.105	2	0.099	0.099	0.098	0.099
3	0.136	0.136	0.138	0.136	3	0.137	0.136	0.138	0.137
4	0.156	0.156	0.145	0.156	4	0.150	0.147	0.145	0.147
5	0.169	0.169	0.163	0.169	5	0.167	0.163	0.163	0.164
6	0.185	0.185	0.203	0.185	6	0.194	0.197	0.203	0.202
7	0.196	0.196	0.193	0.196	7	0.205	0.000	0.193	0.194
8	0.198	0.198	0.225	0.198	8	0.207	0.000	0.225	0.224
9	0.249	0.249	0.241	0.249	9	0.000	0.000	0.241	0.241
10	0.263	0.263	0.287	0.263	10	0.000	0.000	0.287	0.287
11	0.000	0.000	0.297	0.297	11	0.000	0.000	0.297	0.297
12	0.250	0.000	0.377	0.376	12	0.000	0.000	0.377	0.377
13	0.000	0.000	0.309	0.309	13	0.000	0.000	0.309	0.309
14	0.000	0.000	0.000		14	0.000	0.000	0.000	
15	0.000	0.000	0.356	0.356	15	0.000	0.000	0.356	0.356

Table 5.4.2.2 Length at age of North Sea horse mackerel stock by quarter and by area in 2000

Mean Length		For Period 1			Mean Length		For Period 2		
	Q1	Q1	Q1	Q1		Q2	Q2	Q2	Q2
Ages	IVb	IVc	VIId	Mean length	Ages	IVb	IVc	VIId	Mean length
0	0.0	0.0	0.0		0	0.0	0.0	0.0	
1	0.0	0.0	0.0		1	19.2	0.0	0.0	19.2
2	0.0	0.0	0.0		2	22.1	22.5	22.5	22.4
3	0.0	0.0	0.0		3	24.4	24.5	24.5	24.5
4	0.0	0.0	0.0		4	25.3	25.3	25.3	25.3
5	0.0	0.0	0.0		5	26.3	26.3	26.3	26.3
6	27.7	27.7	27.7	27.7	6	27.4	27.4	27.4	27.4
7	29.0	29.0	29.0	29.0	7	28.2	28.2	28.2	28.2
8	28.6	28.6	28.6	28.6	8	28.8	28.8	28.8	28.8
9	30.7	30.7	30.7	30.7	9	30.2	30.2	30.2	30.2
10	31.5	31.5	31.5	31.5	10	31.5	31.5	31.5	31.5
11	31.2	31.2	31.2	31.2	11	30.9	30.9	30.9	30.9
12	33.5	33.5	33.5	33.5	12	30.5	0.0	0.0	30.5
13	33.5	33.5	33.5	33.5	13	32.8	32.8	32.8	32.8
14	0.0	0.0	0.0		14	0.0	0.0	0.0	
15	33.0	33.0	33.0	33.0	15	34.3	34.3	34.3	34.3

Mean Length		For Period 3			Mean Length		For Period 4		
	Q3	Q3	Q3	Q3		Q4	Q4	Q4	Q4
Ages	IVb	IVc	VIId	Mean length	Ages	IVb	IVc	VIId	Mean length
0	0.0	0.0	0.0		0	0.0	0.0	0.0	
1	19.0	19.0	20.2	19.0	1	16.7	16.7	20.2	18.9
2	21.6	21.6	21.8	21.6	2	21.1	21.1	21.8	21.5
3	23.8	23.8	24.5	23.8	3	23.8	23.8	24.5	24.2
4	25.0	25.0	24.9	25.0	4	24.6	24.6	24.9	24.7
5	25.9	25.9	26.2	25.9	5	25.9	25.8	26.2	26.1
6	26.8	26.8	28.4	26.8	6	27.1	27.5	28.4	28.3
7	27.9	27.9	28.0	27.9	7	27.8	0.0	28.0	28.0
8	27.5	27.5	29.1	27.5	8	28.5	0.0	29.1	29.1
9	29.5	29.5	29.8	29.5	9	0.0	0.0	29.8	29.8
10	29.5	29.5	31.3	29.5	10	0.0	0.0	31.3	31.3
11	0.0	0.0	31.7	31.7	11	0.0	0.0	31.7	31.7
12	30.5	0.0	34.0	34.0	12	0.0	0.0	34.0	34.0
13	0.0	0.0	33.5	33.5	13	0.0	0.0	33.5	33.5
14	0.0	0.0	0.0		14	0.0	0.0	0.0	
15	0.0	0.0	34.1	34.1	15	0.0	0.0	34.1	34.1

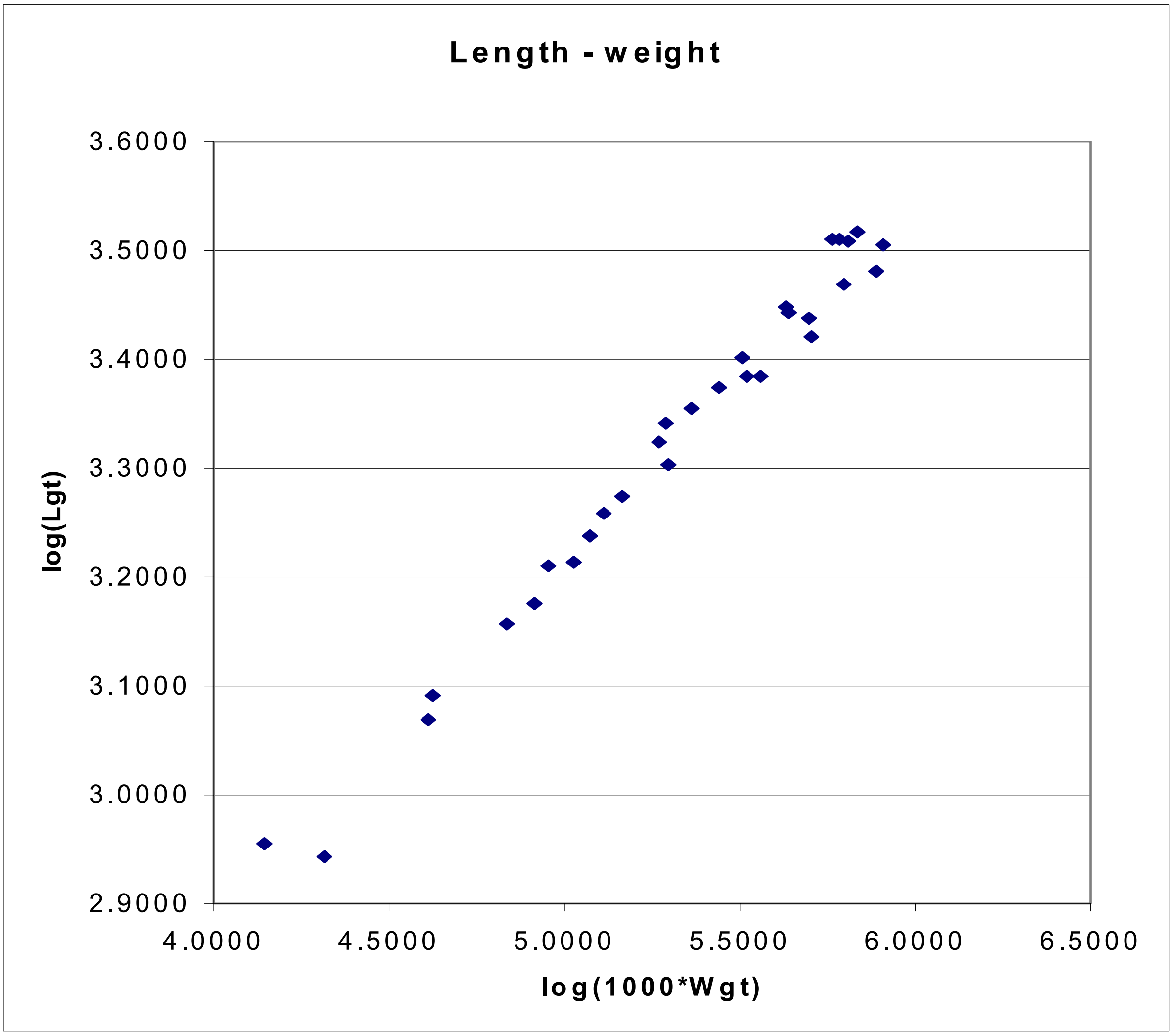


Figure 5.3.2.1 Length weight, North Sea Horse mackerel (derived from data of 1999-2000, Table 5.4.1.3).

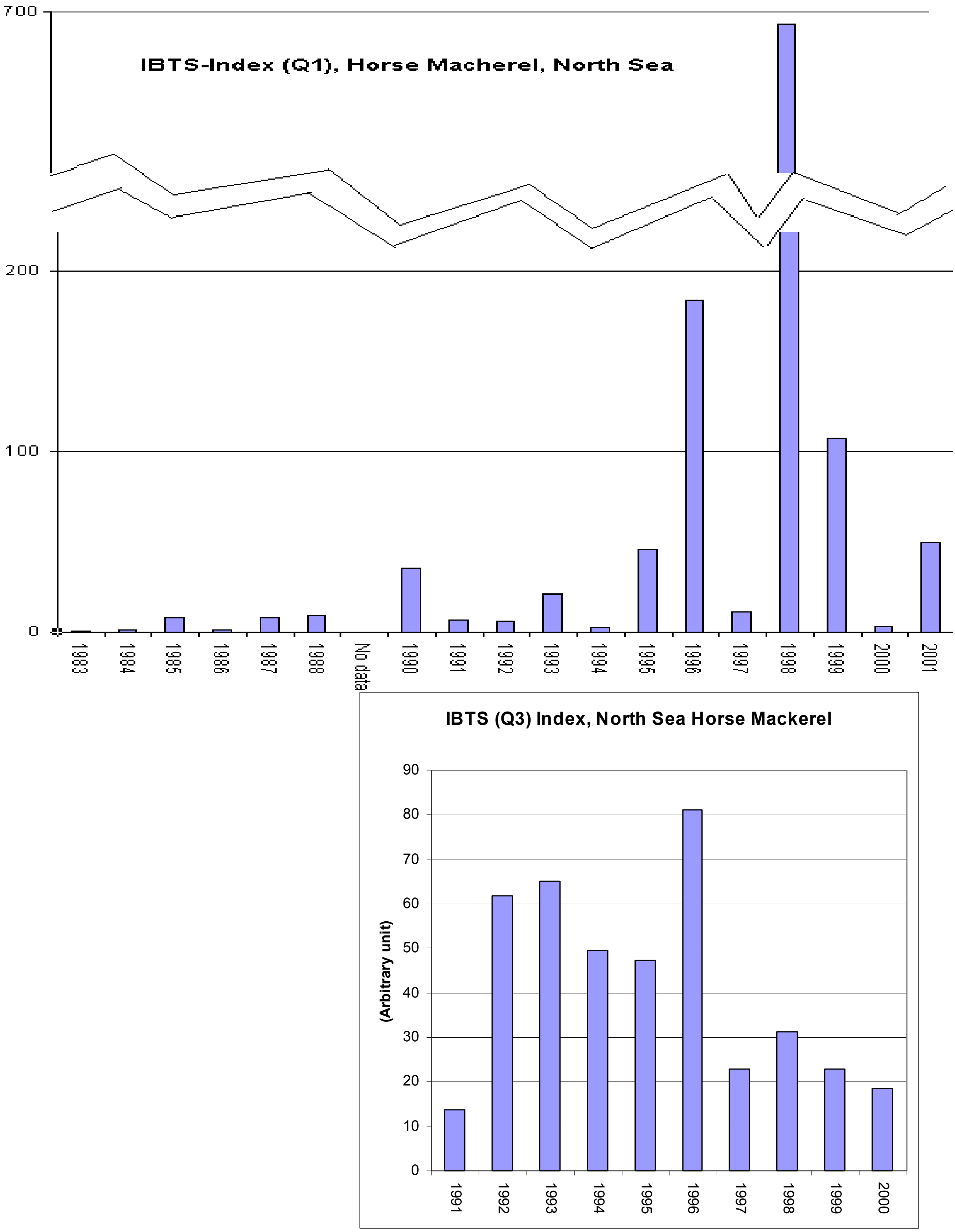


Figure 5.3.2.2 Length based biomass index for North Sea Horse Mackerel, derived from CPUE by length group from IBTS quarters 1 and 3. CPUE = numbers/hour

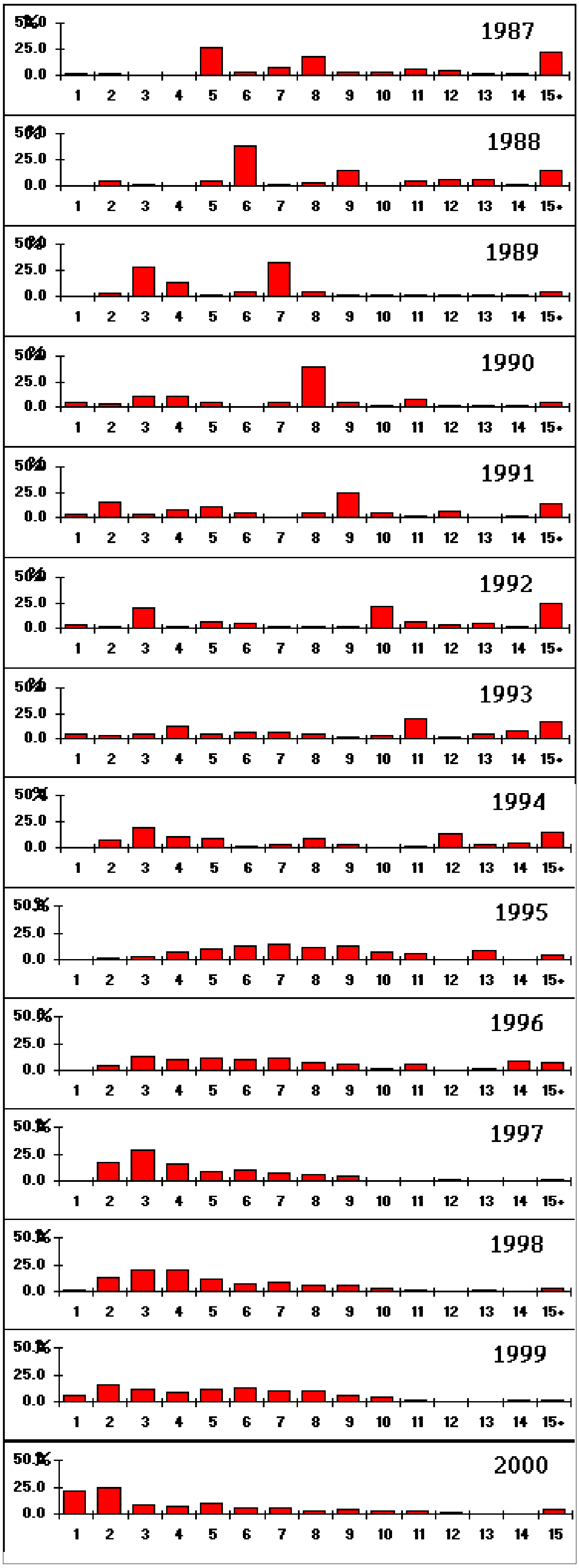
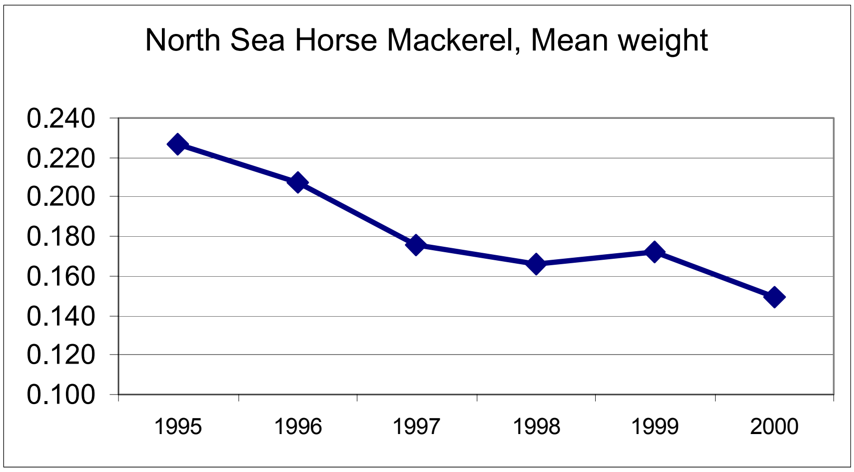


Figure 5.4.1.1. Age composition North Sea horse mackerel stock from commercial and research vessel samples, 1987-2000.



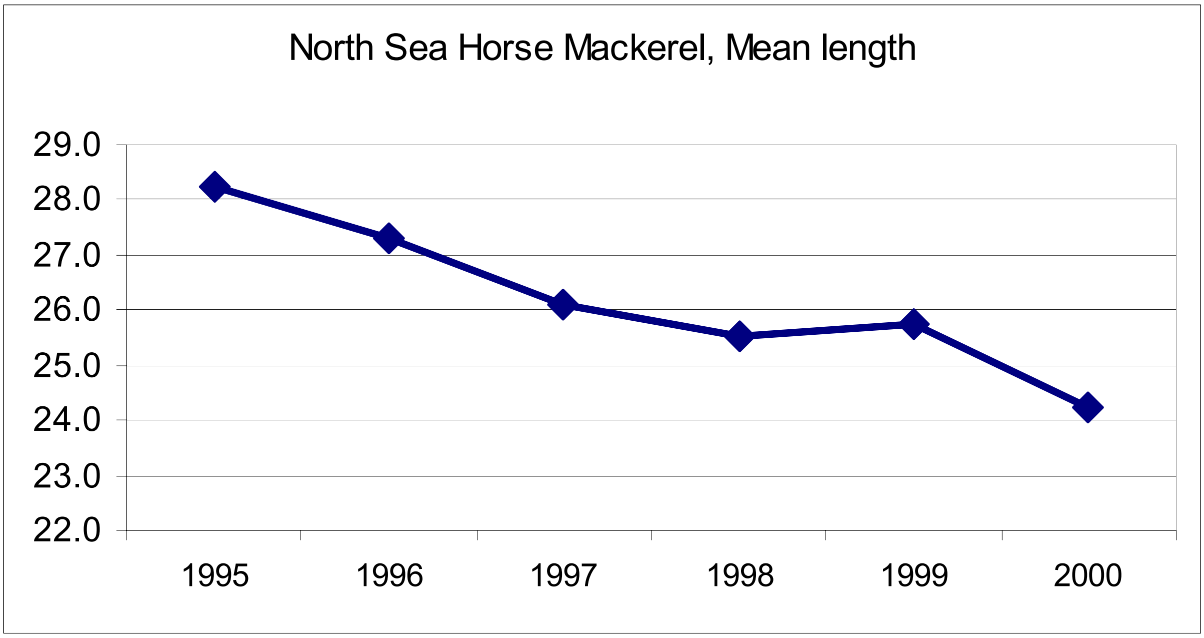


Figure 5.4.1.2 Average body weight and length in catch of North Sea Horse Mackerel, 1995-2000,

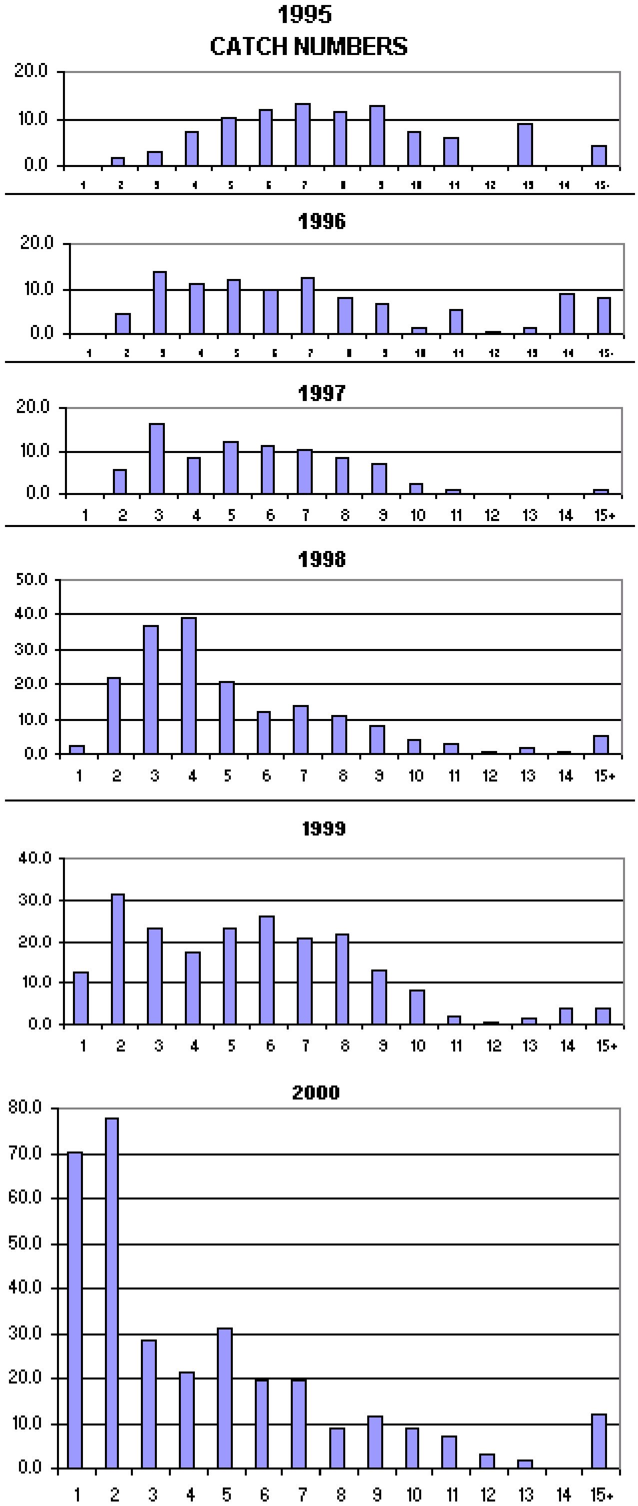


Figure 5.4.1.3. Catch at age (000'), 1995-2000. North Sea horse mackerel

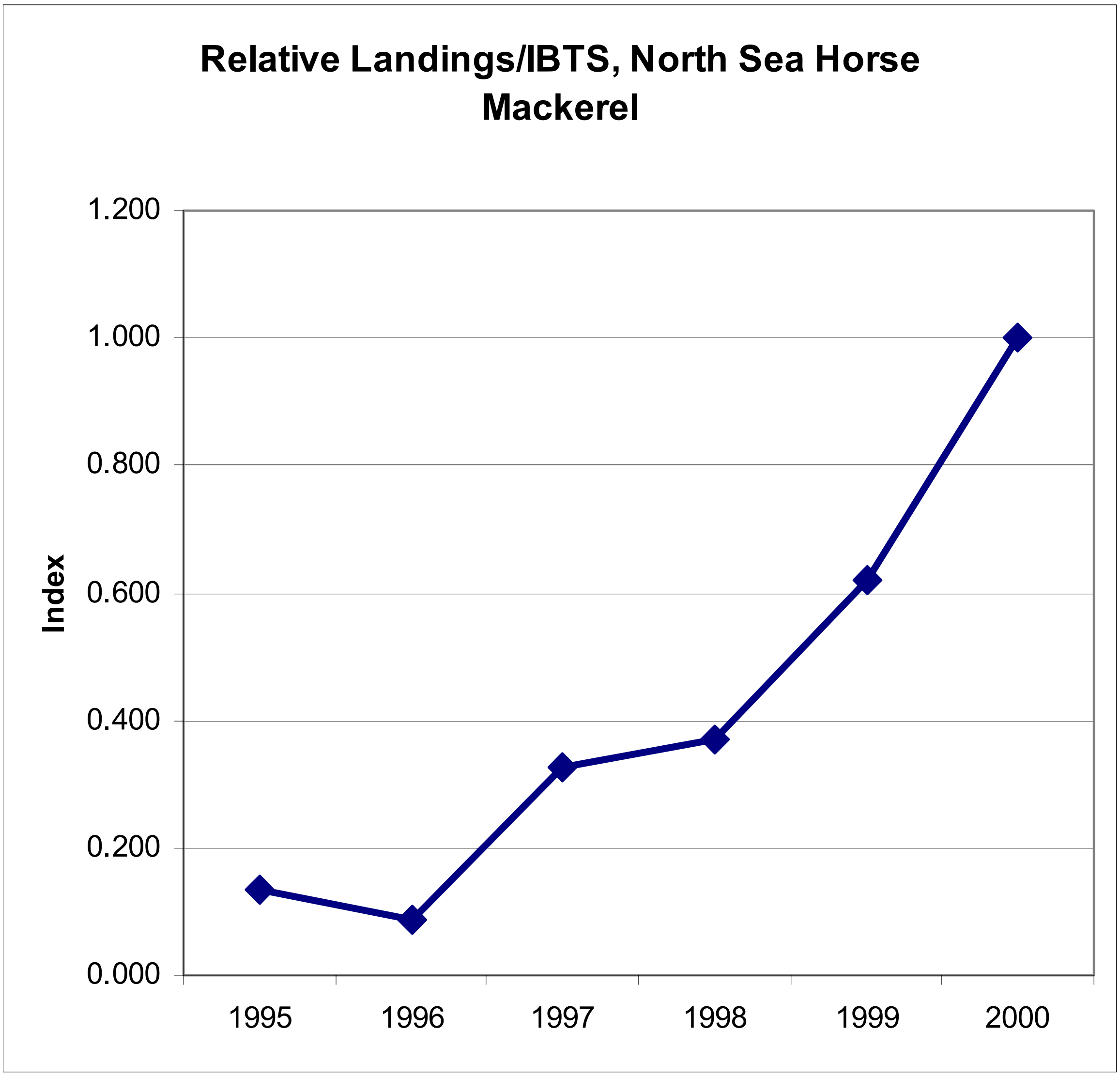


Figure 5.5.0.1. The relative trend in fishing mortality for North Sea Horse Mackerel, derived from IBTS (Q3) and landings.

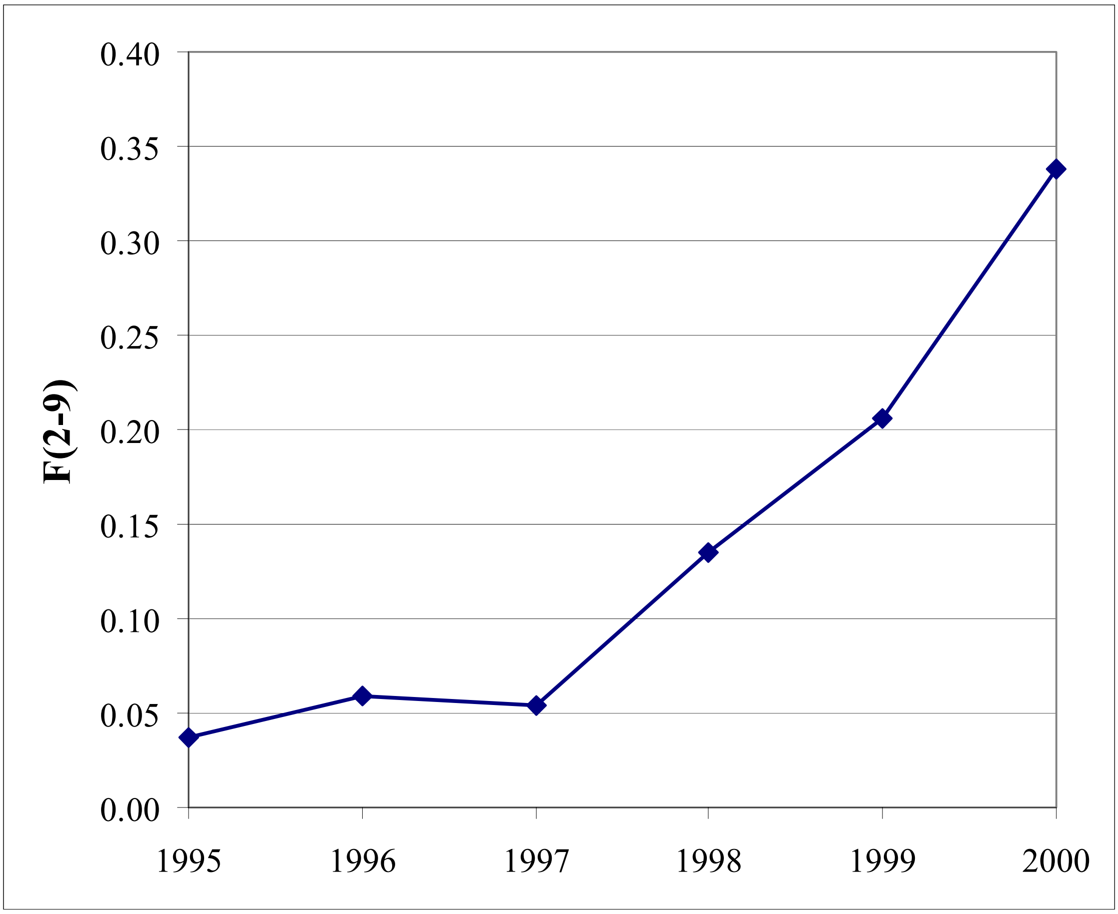


Figure 5.5.1.1. ISVPA-results for North Sea Horse Mackerel. Fishing mortality F(2-12)

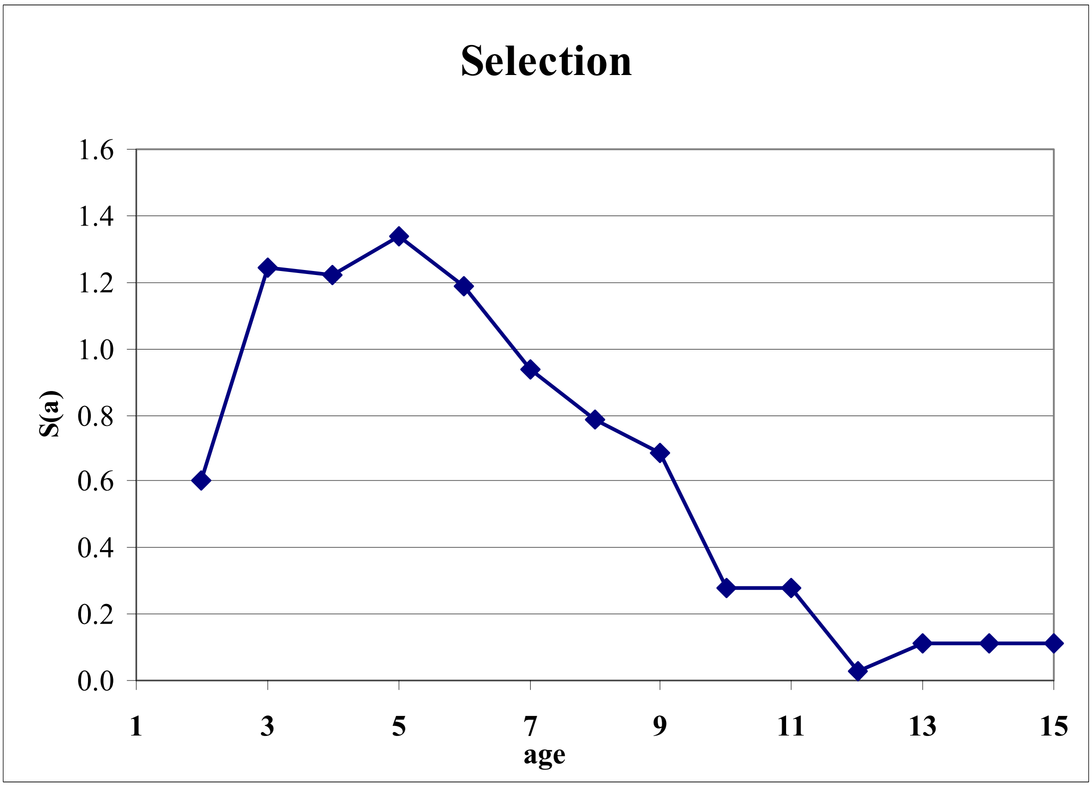


Figure 5.5.1.2. ISVPA-results for North Sea Horse Mackerel. Selection Ogive.

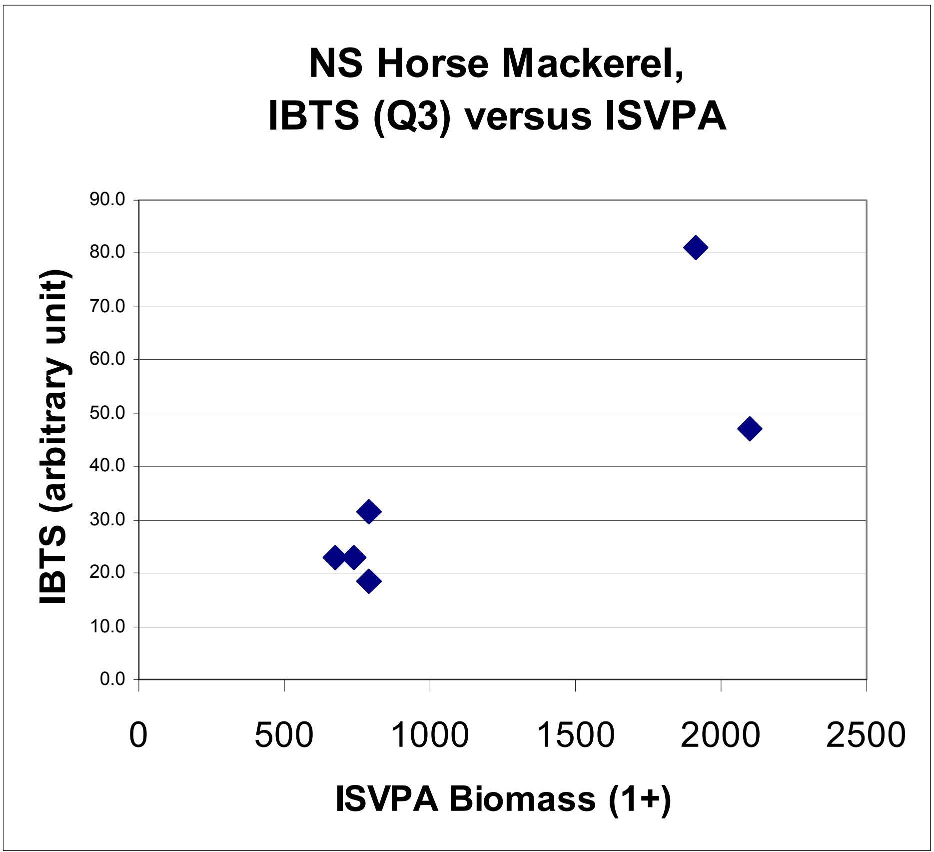


Figure 5.5.1.3 ISVPA-results for North Sea Horse Mackerel. Biomass from ISVPA compared to the IBTS for Q3.

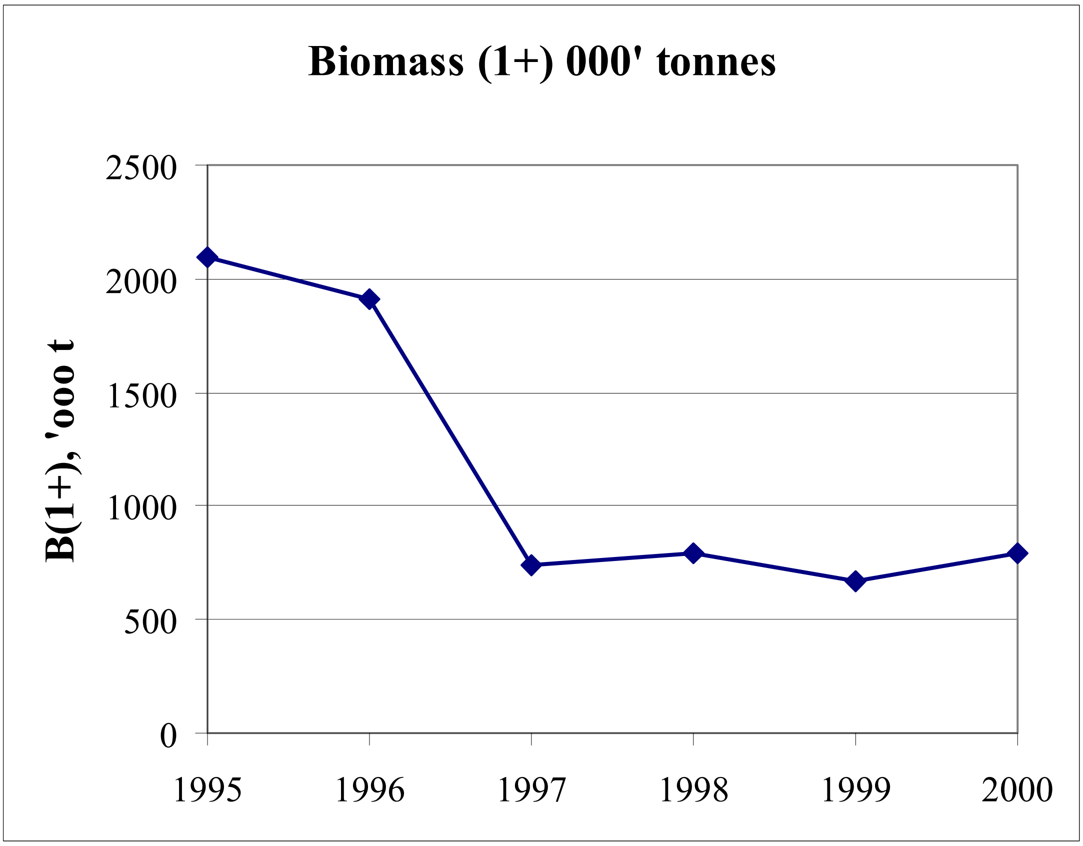


Figure 5.5.1.4. ISVPA-results for North Sea Horse Mackerel. Stock biomass

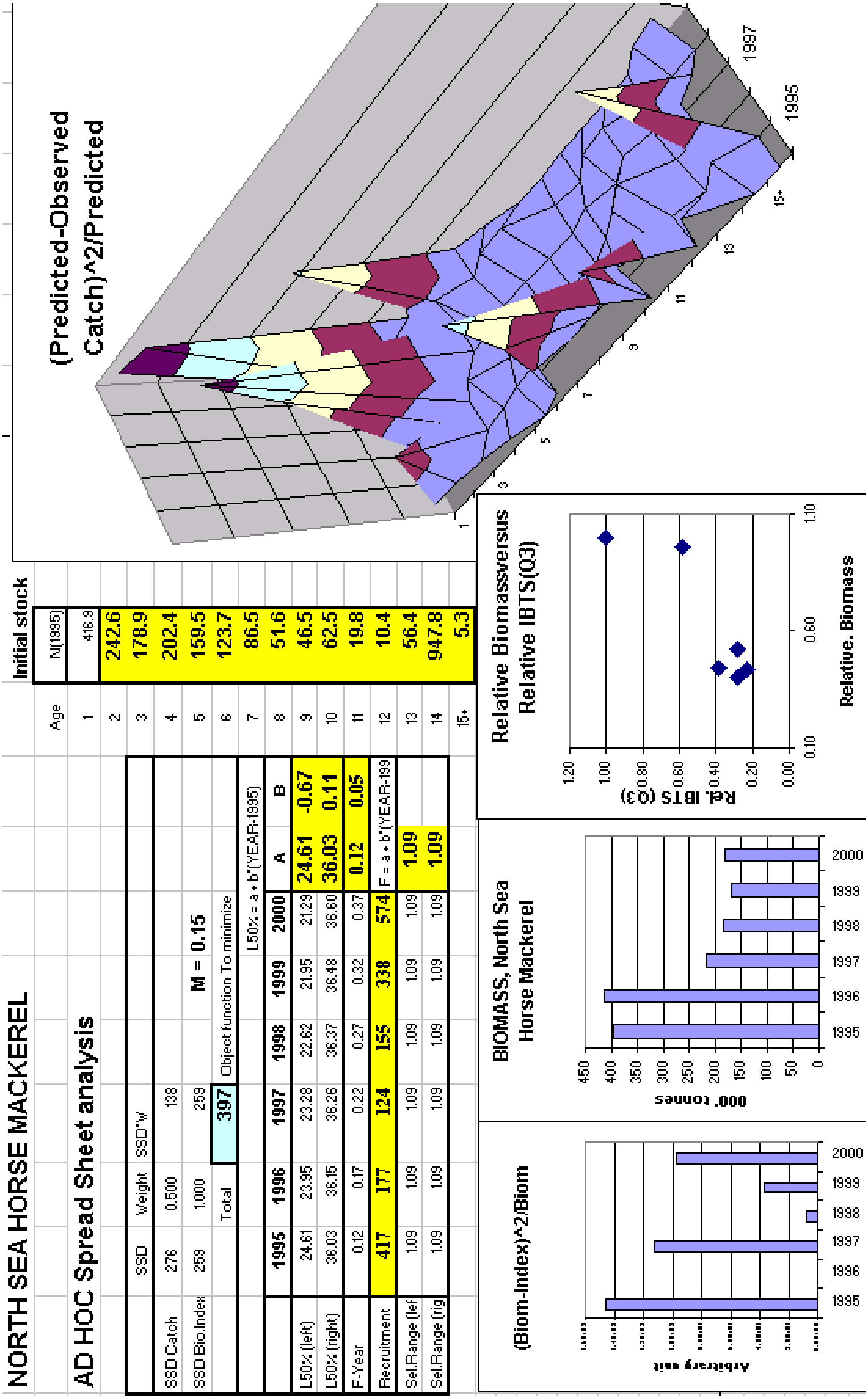


Figure 5.5.2.1. "Dashboard" for operation of the Ad Hoc spread sheet method.

NORTH SEA HORSE MACKEREL

AD HOC Spread Sheet analysis

									Age	N(1995)
								284	2	208.6
	SSD	Weight	SSD*W						3	129.5
SSD Catch	238	0.500	119						4	148.9
SSD Bio.Inde	179	1.000	179		M =	0.15			5	118.5
		Total	298	Object function To minimize					6	100.8
						L50% = a + b*(YEAR-1995)			7	74.3
	1995	1996	1997	1998	1999	2000	A	B	8	53.6
L50% (left)	24.61	23.95	23.28	22.62	21.95	21.29	24.61	-0.67	9	55.3
L50% (right)	36.03	36.15	36.26	36.37	36.48	36.60	36.03	0.11	10	65.4
F-Year	0.11	0.21	0.31	0.41	0.51	0.61	0.11	0.10	11	34.4
Recruitment	388	204	138	148	306	529	F = a + b*(YEAR-1995		12	9.9
Sel.Range (le	1.09	1.09	1.09	1.09	1.09	1.09	1.09		13	47.1
Sel.Range (ri	1.09	1.09	1.09	1.09	1.09	1.09	1.09		14	1254.8
									15+	0.0

CATCH IN NUMBERS (MILLIONS)

Age	1995	1996	1997	1998	1999	2000
1	0.000	0.0	0	2.3	12.4	70.2
2	1.760	4.6	12.6	22.1	31.5	78.0
3	3.117	13.8	27.2	36.7	23.1	28.4
4	7.190	11.0	14.1	38.8	17.6	21.4
5	10.321	11.9	14.9	20.8	23.1	31.3
6	12.082	9.6	14.6	12.1	26.2	19.6
7	13.161	12.5	12.4	14.0	20.6	19.5
8	11.426	8.0	10.1	10.8	21.8	9.0
9	12.644	6.6	8.6	8.3	12.9	11.5
10	7.247	1.5	2.4	4.0	8.2	9.0
11	5.872	5.3	0.8	2.7	2.1	7.0
12	0.010	0.3	0.3	0.7	0.4	3.1
13	8.843	1.3	0.2	1.8	1.4	1.6
14	0.202	8.9	0.0	0.3	3.8	0.0
15+	4.369	8.0	1.4	5.1	4.0	12.2

Mean weight in catch (kg)

Age	1995	1996	1997	1998	1999	2000
1	0.000	0.000	0.063	0.063	0.063	0.075
2	0.076	0.107	0.102	0.102	0.102	0.101
3	0.126	0.123	0.126	0.126	0.126	0.136
4	0.125	0.143	0.142	0.142	0.142	0.152
5	0.133	0.156	0.160	0.160	0.160	0.166
6	0.146	0.177	0.175	0.175	0.175	0.194
7	0.164	0.187	0.199	0.199	0.199	0.198
8	0.161	0.203	0.231	0.231	0.231	0.213
9	0.178	0.195	0.250	0.250	0.250	0.247
10	0.165	0.218	0.259	0.259	0.259	0.280
11	0.173	0.241	0.300	0.300	0.300	0.279
12	0.317	0.307	0.329	0.329	0.329	0.342
13	0.233	0.211	0.367	0.367	0.367	0.318
14	0.241	0.258	0.299	0.299	0.299	0.325
15+	0.348	0.277	0.360	0.360	0.360	0.332

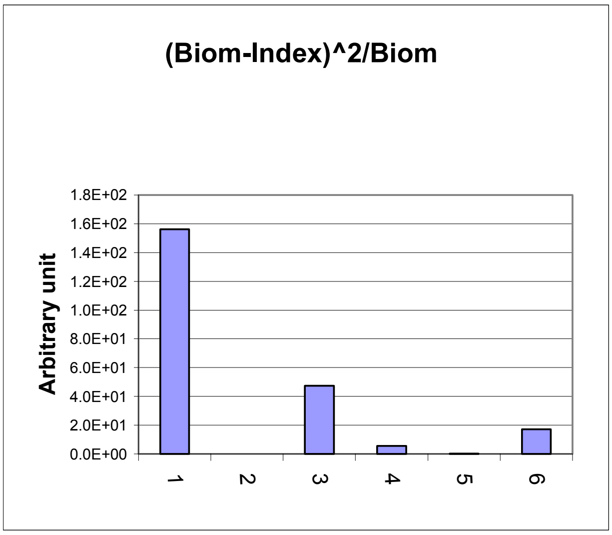
SOP (Catch number) * (weight)

Age	1995	1996	1997	1998	1999	2000
1	0.000	0.000	0.000	0.145	0.782	5.257
2	0.134	0.489	1.281	2.257	3.208	7.842
3	0.393	1.695	3.432	4.623	2.914	3.875
4	0.901	1.582	1.998	5.512	2.497	3.258
5	1.373	1.857	2.388	3.326	3.700	5.197
6	1.767	1.706	2.552	2.118	4.583	3.816
7	2.157	2.337	2.464	2.784	4.107	3.851
8	1.844	1.619	2.338	2.493	5.025	1.917
9	2.257	1.290	2.161	2.064	3.228	2.837
10	1.194	0.322	0.633	1.037	2.127	2.510
11	1.014	1.279	0.225	0.817	0.643	1.950
12	0.003	0.089	0.113	0.233	0.140	1.051
13	2.063	0.270	0.090	0.664	0.514	0.512
14	0.049	2.304	0.000	0.091	1.129	0.000
15+	1.522	2.218	0.497	1.838	1.451	4.060
Total SOP	**16.673**	**19.057**	**20.172**	**30.001**	**36.048**	**47.930**
Landings	**16756**	**18845**	**19540**	**30500**	**37224**	**48425**
Land 000'	16.756	18.845	19.540	30.500	37.224	48.425
Ratio	1.005	0.989	0.969	1.017	1.033	1.010

Figure 5.5.2.2.A. Part 1 of "Ad hoc spread sheet" 21

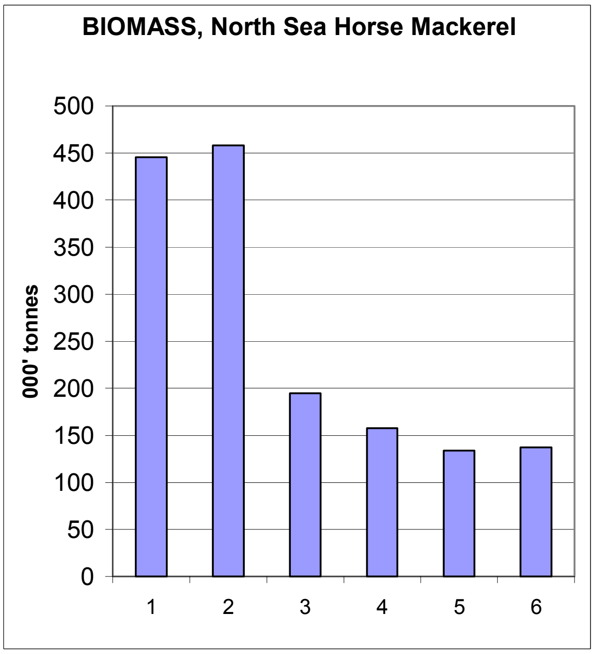
Mean Length at age (cm)

Age	1995	1996	1997	1998	1999	2000
1	19.2	19.2	19.2	19.2	19.2	19.0
2	22.0	22.0	22.0	22.0	22.0	21.5
3	23.5	23.5	23.5	23.5	23.5	23.9
4	24.8	24.8	24.8	24.8	24.8	24.9
5	25.5	25.5	25.5	25.5	25.5	26.0
6	26.4	26.4	26.4	26.4	26.4	27.8
7	27.2	27.2	27.2	27.2	27.2	28.3
8	29.2	29.2	29.2	29.2	29.2	28.6
9	29.5	29.5	29.5	29.5	29.5	30.0
10	29.5	29.5	29.5	29.5	29.5	31.3
11	30.6	30.6	30.6	30.6	30.6	31.4
12	32.1	32.1	32.1	32.1	32.1	33.7
13	33.3	33.3	33.3	33.3	33.3	33.5
14	31.1	31.1	31.1	31.1	31.1	33.4
15+	32.5	32.5	32.5	32.5	32.5	33.4



Stock Biomass

Age	1995	1996	1997	1998	1999	2000		
1	0.00	0.00	8.69	9.34	19.28	39.56		
2	15.85	35.42	17.59	11.72	12.31	24.19		
3	16.34	21.58	33.95	16.85	10.51	10.95		
4	18.67	15.34	19.54	27.99	12.71	7.64		
5	15.76	18.95	13.01	15.35	19.91	8.43		
6	14.75	16.91	15.83	9.71	10.36	13.40		
7	12.17	15.06	13.96	12.04	6.67	6.37		
8	8.65	11.97	13.50	10.70	8.35	3.85		
9	9.87	8.23	10.56	9.55	6.88	4.81		
10	10.77	9.45	7.83	7.16	5.89	4.17		
11	5.93	12.35	9.35	5.93	4.94	3.44		
12	3.14	8.28	12.16	6.75	3.91	3.09		
13	10.98	1.65	7.21	9.09	4.64	2.14		
14	302.65	9.66	1.73	4.02	4.69	2.41		
15+	0.00	273.42	9.73	1.38	2.93	2.89	Sum	
Total Biom.	**445.56**	**458.28**	**194.64**	**157.58**	**133.99**	**137.33**	**458**	Max
Relative Biom	**0.9722**	**1.0000**	**0.4247**	**0.3438**	**0.2924**	**0.2997**	**3.333**	x/Max
BTS (Q3) Inde	47.2	81.0	22.9	31.4	22.9	18.5	**81**	Max
Rel. Index	**0.5827**	**1.0000**	**0.2830**	**0.3875**	**0.2830**	**0.2278**	**2.764**	x/Max
1000*Dev.^2	1.5E+02	0.0E+00	2.0E+01	1.9E+00	8.8E-02	5.2E+00	**179**	
ev^2/Rel.Bion	1.6E+02	0.0E+00	4.7E+01	5.6E+00	3.0E-01	1.7E+01	**226**	



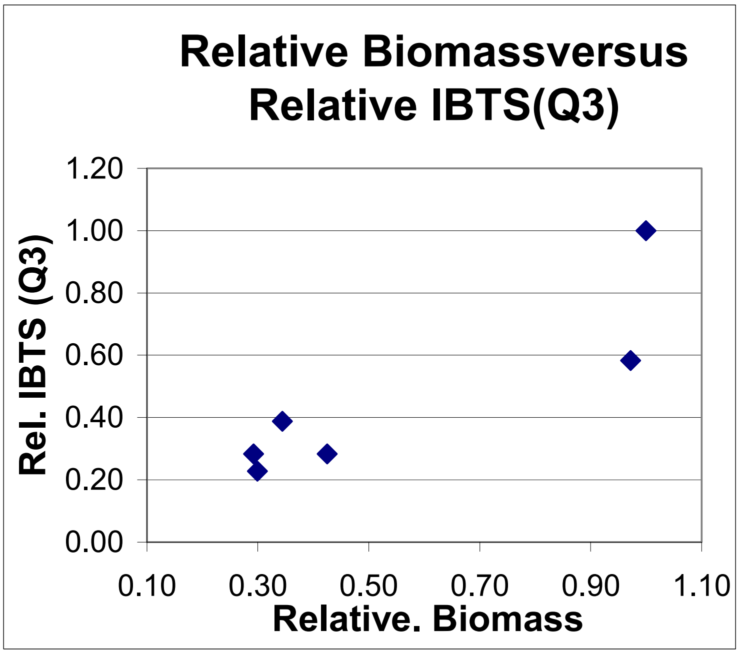


Figure 5.5.2.2.B. Part 2 of "Ad hoc spread sheet"

selection (lefthand side)

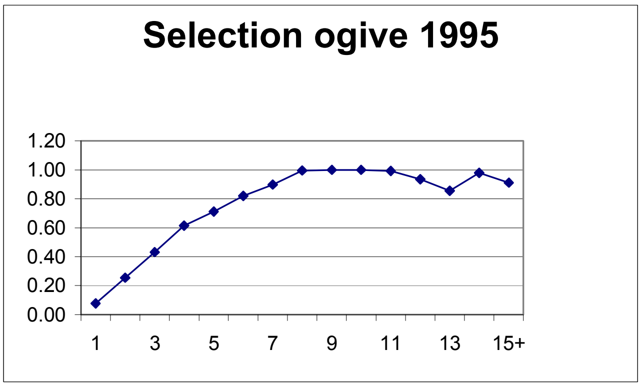
L50%	24.61	23.95	23.28	22.62	21.95	21.29
Sel.Range	1.0899	1.0899	1.0899	1.0899	1.0899	1.0899
S1	12.21	12.21	12.21	12.21	12.21	12.21
S2	-0.49622	-0.51001	-0.52459	-0.54002	-0.55640	-0.57379

Deselection (right hand side)

L50%	36.03	36.15	36.26	36.37	36.48	36.60
Sel.Range	1.087	1.087	1.087	1.087	1.087	1.087
S1	12.66	12.66	12.66	12.66	12.66	12.66
S2	-0.35127	-0.35018	-0.34909	-0.34801	-0.34694	-0.34587

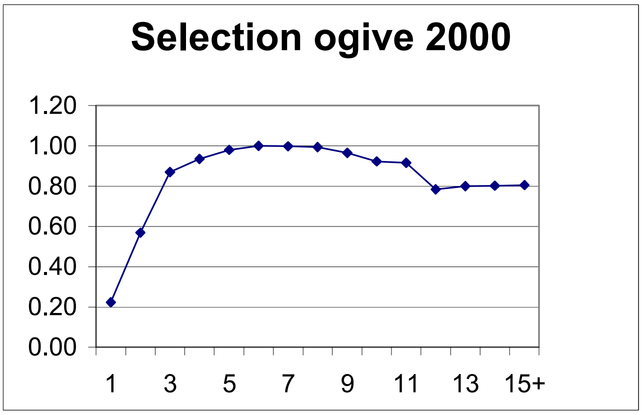
Selection * deselection

Age	1995	1996	1997	1998	1999	2000
1	0.064	0.081	0.105	0.136	0.177	0.208
2	0.213	0.268	0.336	0.415	0.503	0.531
3	0.361	0.438	0.522	0.610	0.695	0.811
4	0.513	0.596	0.677	0.751	0.816	0.872
5	0.594	0.672	0.745	0.808	0.859	0.914
6	0.685	0.753	0.811	0.859	0.895	0.932
7	0.749	0.805	0.850	0.886	0.912	0.930
8	0.831	0.860	0.882	0.898	0.910	0.926
9	0.835	0.860	0.880	0.894	0.905	0.901
10	0.835	0.860	0.880	0.894	0.905	0.860
11	0.828	0.846	0.860	0.870	0.878	0.853
12	0.780	0.792	0.802	0.811	0.818	0.731
13	0.714	0.724	0.734	0.742	0.750	0.746
14	0.817	0.832	0.844	0.854	0.861	0.748
15+	0.761	0.772	0.782	0.790	0.797	0.750
Max	0.835	0.860	0.882	0.898	0.912	0.932



Normalized Selection * deselection

Age	1995	1996	1997	1998	1999	2000
1	0.076	0.095	0.119	0.152	0.194	0.223
2	0.255	0.312	0.380	0.462	0.552	0.569
3	0.432	0.509	0.592	0.679	0.762	0.870
4	0.615	0.692	0.767	0.837	0.894	0.935
5	0.711	0.781	0.844	0.899	0.942	0.980
6	0.821	0.875	0.919	0.956	0.981	1.000
7	0.898	0.936	0.964	0.986	1.000	0.998
8	0.996	1.000	1.000	1.000	0.997	0.994
9	1.000	1.000	0.998	0.996	0.992	0.966
10	1.000	1.000	0.998	0.996	0.992	0.923
11	0.993	0.983	0.975	0.969	0.962	0.915
12	0.935	0.921	0.910	0.903	0.896	0.784
13	0.855	0.842	0.832	0.826	0.822	0.800
14	0.979	0.967	0.957	0.950	0.944	0.803
15+	0.911	0.897	0.886	0.879	0.874	0.805



Fishing mortality

F-Year	**0.1101**	**0.2111**	**0.3121**	**0.4121**	**0.5131**	**0.6131**
Age	1995	1996	1997	1998	1999	2000
1	0.007	0.017	0.033	0.056	0.091	0.128
2	0.024	0.057	0.105	0.171	0.258	0.325
3	0.040	0.092	0.163	0.251	0.357	0.498
4	0.057	0.126	0.211	0.310	0.418	0.535
5	0.066	0.142	0.232	0.333	0.441	0.561
6	0.076	0.159	0.253	0.354	0.459	0.572
7	0.083	0.170	0.265	0.365	0.468	0.570
8	0.092	0.182	0.275	0.370	0.467	0.568
9	0.092	0.182	0.274	0.369	0.464	0.552
10	0.092	0.182	0.274	0.369	0.464	0.528
11	0.091	0.179	0.268	0.359	0.450	0.523
12	0.086	0.167	0.250	0.334	0.419	0.449
13	0.079	0.153	0.229	0.306	0.384	0.458
14	0.090	0.176	0.263	0.352	0.441	0.459
15+	0.084	0.163	0.244	0.326	0.409	0.460
Mean(2-1(	**0.069**	**0.143**	**0.228**	**0.321**	**0.422**	**0.523**

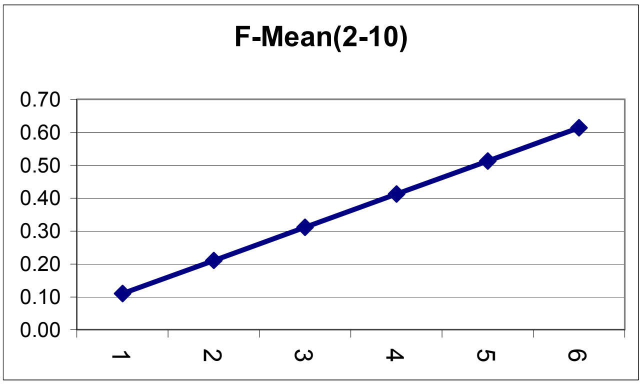
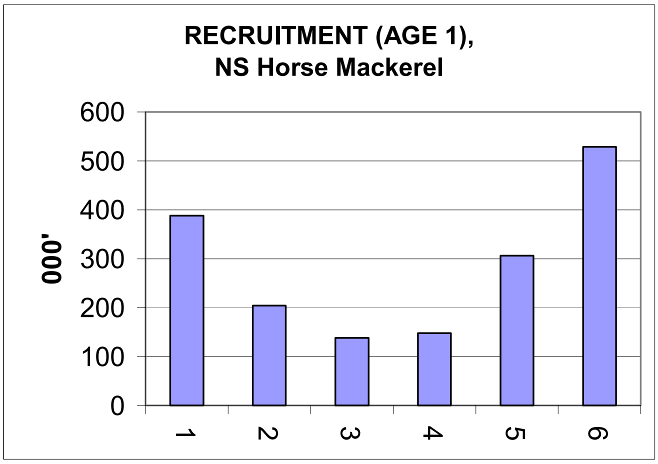


Figure 5.5.2.2.C. Part 3 of "Ad hoc spread sheet"

M = 0.15 **Predicted Stock number**

Age	1995	1996	1997	1998	1999	2000
1	**387.7**	**203.9**	**138.0**	**148.3**	**306.1**	**528.5**
2	**208.6**	331.33	172.48	114.94	120.70	240.55
3	**129.5**	175.36	269.48	133.71	83.38	80.25
4	**148.9**	107.09	137.61	197.10	89.50	50.24
5	**118.5**	121.12	81.29	95.92	124.46	50.70
6	**100.8**	95.51	90.47	55.48	59.19	68.95
7	**74.3**	80.48	70.14	60.48	33.52	32.19
8	**53.6**	58.85	58.45	46.32	36.13	18.07
9	**55.3**	42.09	42.25	38.22	27.53	19.50
10	**65.4**	43.41	30.21	27.64	22.75	14.90
11	**34.4**	51.32	31.16	19.77	16.46	12.31
12	**9.9**	26.98	36.95	20.52	11.89	9.03
13	**47.1**	7.82	19.65	24.77	12.64	6.73
14	**1254.8**	37.44	5.78	13.46	15.70	7.41
15+	**0.0**	986.82	27.03	3.82	8.15	8.69



Predicted Catch number

Age	1995	1996	1997	1998	1999	2000
1	2.52	3.22	4.12	7.52	24.75	58.91
2	4.51	16.95	15.92	16.81	25.59	62.31
3	4.70	14.39	37.67	27.70	23.33	29.40
4	7.62	11.77	24.36	48.94	28.56	19.46
5	6.98	14.90	15.67	25.33	41.41	20.34
6	6.83	13.05	18.82	15.42	20.35	28.09
7	5.48	11.70	15.21	17.26	11.70	13.09
8	4.37	9.09	13.09	13.37	12.58	7.33
9	4.53	6.50	9.44	10.99	9.55	7.74
10	5.35	6.71	6.75	7.95	7.89	5.71
11	2.79	7.81	6.82	5.56	5.57	4.69
12	0.76	3.87	7.61	5.44	3.80	3.05
13	3.31	1.03	3.74	6.08	3.77	2.31
14	100.62	5.61	1.24	3.72	5.23	2.55
15+	0.00	138.03	16.73	2.62	5.96	6.55

Dev.^2 for Catch number

Age	1995	1996	1997	1998	1999	2000
1	2.5	3.2	4.1	3.6	6.1	2.2
2	1.7	9.0	0.7	1.7	1.3	3.9
3	0.5	0.0	2.9	2.9	0.0	0.0
4	0.0	0.0	4.3	2.1	4.2	0.2
5	1.6	0.6	0.0	0.8	8.1	5.9
6	4.0	0.9	1.0	0.7	1.7	2.5
7	10.8	0.1	0.5	0.6	6.8	3.1
8	11.4	0.1	0.7	0.5	6.7	0.4
9	14.6	0.0	0.1	0.7	1.2	1.8
10	0.7	4.1	2.7	2.0	0.0	1.9
11	3.4	0.8	5.4	1.4	2.1	1.1
12	0.7	3.3	6.9	4.1	3.0	0.0
13	9.2	0.1	3.3	3.0	1.5	0.2
14	0.0	2.0	1.2	3.1	0.4	2.5
15+	0.0	0.0	14.1	2.4	0.6	4.9
TOTAL	**61.1**	**24.2**	**48.0**	**29.7**	**43.8**	**30.7**

Gr. TOT. SSD =	**238**

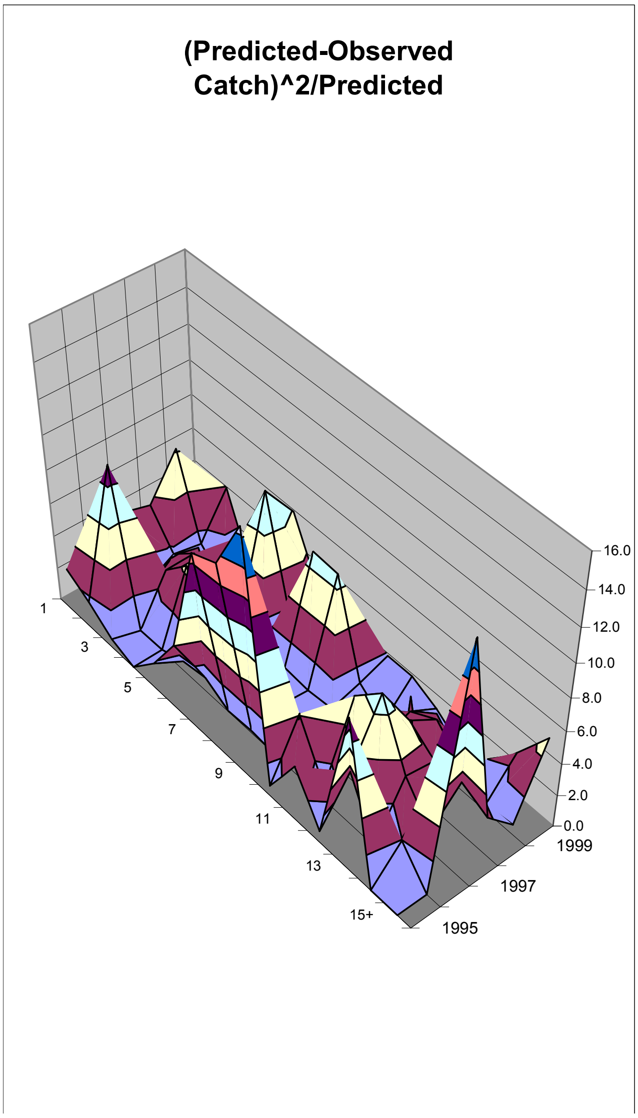


Figure 5.5.2.2.D. Part 4 of "Ad hoc spread sheet"

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 2000 and 2001

For 1999 and 2000 ICES advised 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. For 2000 ICES in addition advised to close the directed trawl fishery for horse mackerel and the industrial fisheries in Divisions VIIe,f due to relatively large catches of juvenile horse mackerel. This advice was repeated for 2001. For 2001 ICES advice to limit the catches to less than 224,000 t which corresponds to $\mathbf{F}_{0.1}$=0.15.

EU has set TACs for horse mackerel since 1987 covering 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. The TAC set by EU was reduced from 320,000 t in 1998 to 240,000 t in 2000 and to 233,000 t in 2001.

The catches of western horse mackerel in 2000 were 175,000 t. This is the first time the catch level has not exceeded the catch level recommended by ICES.

6.2 The Fishery in 2000 of the Western Stock

The fishery for western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. The national catches taken by the countries fishing in 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.

The total catch allocated to western horse mackerel in 2000 was 175,000 t (Table 4.3.1) which is almost 100,000 t less than in 1999. This was caused mainly by reduced catches in IVa and VIa by Norway and Ireland respectively.

Divisions IIa and Vb

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 3,400 t in 1996. Since then the catches have been about 2,500 t until they dropped to 1,100 t in 2000.

Sub-area IV and Division IIIa

All the catches from Divisions IVa and IIIa in 2000 were allocated to the western stock. The catches of the western stock in Division IVa has fluctuated between 11,000 t-135,000 during the period 1987-1999. These fluctuations are mainly due to the availability of western horse mackerel for the Norwegian fleet in October –November (section 6.3.2). In 2000 this availability was poor and the catches dropped to 4,500 t.

The total catches of horse mackerel in Sub area IV and Division IIIa are shown in Table 6.2.2.

Sub-area VI

The catches in this area 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). After a reduction in the catches of more than 50% in 1997 and 1998 the catches increased to 65,300 t in 1999. In 2000 the catches were reduced to the same low level as in 1990, 21,000 t. The main part of the catches is taken in a directed Irish trawl fishery for horse mackerel.

Sub-area VII

All catches from Sub area VII except Division VIId were allocated to the western stock. The catches from this area are mainly taken in directed Dutch and Irish trawl fisheries in Divisions VIIb,e,h,j. The catches of western horse mackerel increased from below 100,000 t prior to 1989 to 320,000 t in 1995 (Table 4.3.1). Since than the catches dropped to 158,000 t in 1999 and to 115,000 t in 2000.

The total catches of horse mackerel in Sub area VII are shown in Table 6.2.4.

Sub-area VIII

All catches from Sub-area except VIIIc are allocated to the western stock. The catches of western horse mackerel in these areas were less than 10,000 t in the period 1982-1988. Since then the catches have usually fluctuated between 10,000-30,000 t (Table 4.3.1) and in 2000 the catches were 32,200 t which is the highest in the period 1982-2000.

The total catches of horse mackerel in Sub-area VIII are given in Table 6.2.5.

6.3 Fishery Independent information

6.3.1 Preliminary Results of the 2001 Mackerel and Horse Mackerel Egg Survey

The following represents a preliminary investigation into the results of the 2001 Horse Mackerel egg survey. It is intended as a guide for the WGMHSA and does not represent a complete or definitive analysis of the survey.

All surveys carried out under the programme have been completed and the data checked and assimilated to the data base. The only exception is the English survey in periods 4 & 5 where the data are incomplete – approximately half the stations having been analysed. These would be expected to be those stations with the most eggs. Additional data from an Irish plankton survey will also be available for periods 3 & 4 later in the year.

The survey has been analysed using five contiguous periods – see table below:

Period	Dates
3	11 March – 8 April
4	9 April – 13 May
5	14 May – 10 June
6	11 June – 1 July
7	2 July – 23 July

The analysis protocols followed those described in the report of WGMEGS (ICES 2000/G:01). Interpolation into unsampled rectangles was carried out manually according to the rules set down in that report. Arithmetic means were used where more than one sample per rectangle per period were collected.

Conversion to biomass was carried out using the same factors (PreSB-SSB, Fecundity and sex ratio) as in 1998.

Results

Figures 6.3.1– 5 show the mean daily egg production for horse mackerel by rectangle by period. Post plots were square root scaled to the maximum at a single station of 500 eggs m^{-2} d^{-1}.

- Period 3 (Figure 6.3.1) –Due to the skeletal nature of the survey there was a lot of interpolation, but this was usually well established. Outside edges were well defined except between 48 & 49°N and at 53° 45N. Very low production in Biscay and Celtic Sea only

- Period 4 (Figure 6.3.2.) – Good coverage, well defined edges, little interpolation. Production concentrated at shelf break

- Period 5 (Figure 6.3.3.) – Good coverage and edge definition, except at SW edge of Porcupine Bank at 49 - 51°N. Production well spread along shelf break south of Porcupine Bank.

- Period 6 (Figure 6.3.4.) – A considerable amount of interpolation, but coverage and edges were good. Production concentrated at Porcupine and Sole banks.

- Period 7 (Figure 6.3.5.) – Again much interpolation, but this was well based, except at the southern edge of the surveyed area. A patchy distribution along shelf break west of Ireland

These data were then converted to the total annual egg production using rectangle area and the number of days per period. The annual egg production curve is presented in Figure 6.3.6, with the 1998 data for comparison. As with mackerel, the production curve is much better behaved than in 1998, which was characterised with a double peak and a high last period. The production curve for 2001 is more similar to earlier surveys than the somewhat unusual 1998 curve. Maximum production was in period 5 (May/June). The shape of the curve from the fixed start date through periods 3 and 4 suggests that the use of this start date is reasonable. The low figure in Period 7 also validates the end date.

The following table details the integrated egg curve and the analysis through to biomass.

Parameters used in the calculation	
Total Annual Egg Production	$0.614 * 10^{15}$
Realised Fecundity (eggs g female^{-1})	1504
Female fraction	0.5
Pre spawning Biomass to SSB conversion	1.08
Biomass	
Pre-spawning biomass (tonnes)	816,500
SSB (tonnes)	882,000
Decrease (tonnes)	518,000
Percent decrease	37

All these data should be treated with extreme caution. The egg production curve is based on incomplete data, although any additional data should result in only small adjustments. The periods used and the interpolated values may be adjusted by WGMEGGS at their meeting in April 2002. The fecundity value used to convert to biomass was the value used in 1998, itself a mean from previous surveys.

Preliminary estimates from the 2001 egg survey (D. Reid)

6.3.2 Environmental Effects

Until 1999 there were good correlations between the modeled influx of Atlantic water to the North Sea the first quarter and the horse mackerel catches taken in the Norwegian EEZ later the same year (Iversen *et al.* 1998 and Iversen *et.al*., WD 2001). However, there was no obvious correlation for 2000. The modelled influx the first quarter 2001 is the lowest since 1955.

6.4 Biological Data

6.4.1 Catch in numbers

Since 1998 there has been an increase in age readings compared with previous years. This has improved the quality of the catch at age matrix of the western horse mackerel. Since 1998 the Netherlands (Division VIa, Sub-areas IV, VII and VIII), Norway (Divisions IIa and IVa), Ireland (Division VIa and Divisions VIIbc, VIIj), Germany (Divisions VIIef) and Spain (Division VIIIab, except 1999) provided catch in numbers at age. In 2000 England and Wales provided age readings for Divs. VIIef, while Germany gave no data this year. The catch sampled for age readings in 2000 provided 56% of the total catch. Still the number of age readings are considered too low to be satisfactory.

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 specific software for calculating international catch at age (Patterson, WD 1999).

The total annual and quarterly catches in numbers for western horse mackerel in 2000 are shown in Table 6.4.1.1. The sampling intensity is discussed in Section 1.3. The catch at age matrix shows the predominance and the dominance of the 1982 year class (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

Mean length at age and mean weight at age in the catches

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 (Ireland, the Netherlands, Norway, Spain, England and Wales) 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, WD 1999). The mean weight and mean length at age in the catches by year and quarters of 2000 are shown in Tables 6.4.2.1 and 6.4.2.2.

Mean weight at age in the stock

As for previous years the mean weight at age for the two years old was given a constant weight while the weight for the older ages is based on all mature fish sampled from Dutch freezer trawlers the first and second quarter in Divisions VIIj,k (Table 6.5.1.2b).

6.4.3 Maturity ogive

There are no new data on maturity for the western horse mackerel since 1988. In 1999 the Working Group applied a maturity ogive based on the estimated maturity ogive from the Cantabrian Sea (southern area), which is close to the western area for assessment purposes of the western horse mackerel (ICES, 2000/ACFM:5). The difference between the maturity ogive as used for the years 1987-1997 and the new maturity ogive applied since 1998 is shown in the text table below:

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1987-1997	0.00	0.00	0.10	0.40	0.60	0.80	1.00
1998 onwards	0.00	0.00	0.05	0.25	0.70	0.95	1.00

6.4.4 Natural mortality

The natural mortalities applied in previous assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:6) and the Working Group admitted uncertainties in M in the range of 0.05 to 0.15. As in 2000 the Working Group applied M=0.15.

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	1985	1986	1987
Denmark	-	-	-	-	-	-	-	39
France	-	-	-	-	1	1	-[2]	-[2]
Germany, Fed.Rep	-	+	-	-	-	-	-	-
Norway	-	-	-	412	22	78	214	3,272
USSR	-	-	-	-	-	-	-	-
Total	-	+	-	412	23	79	214	3,311

	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	-	-	964[3]	1,115	9,157[3]	1,068	-	950
Denmark	-	-	-	-	-	-	-	200
France	-[2]	-	-	-	-	-	55	-
Germany, Fed. Rep.	64	12	+	-	-	-	-	-
Norway	6,285	4,770	9,135	3,200	4,300	2,100	4	11,300
USSR / Russia (1992 -)	469	27	1,298	172	-	-	700	1,633
UK (England + Wales)	-	-	17		-	-	-	-
Total	6,818	4,809	11,414	4,487	13,457	3,168	759	14,083

	1996	1997	1998	1999	2000[1]
Faroe Islands	1,598	799[3]	188[3]	132[3]	250[3]
Denmark	-	-	1,755[3]		
France	-	-	-		
Germany	-	-	-		
Norway	887	1,170	234	2304	841
Russia	881	648	345	121	84[3]
UK (England + Wales)	-	-	-		
Estonia	-	-	22		
Total	3,366	2,617	2,544	2557	1175

[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 and Division IIIa by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	8	34	7	55	20	13	13	9	10
Denmark	199	3,576	1,612	1,590	23,730	22,495	18,652	7,290	20,323
Faroe Islands	260	-	-	-	-	-	-	-	-
France	292	421	567	366	827	298	231[2]	189[2]	784[2]
Germany, Fed.Rep.	+	139	30	52	+	+	-	3	153
Ireland	1,161	412	-	-	-	-	-	-	-
Netherlands	101	355	559	2,029[3]	824	160[3]	600[3]	850[4]	1,060[3]
Norway[2]	119	2,292	7	322	[3]	203	776	11,728[4]	34,425[4]
Poland	-	-	-	2	94	-	-	-	-
Sweden	-	-	-	-	-	-	2	-	-
UK (Engl. + Wales)	11	15	6	4	-	71	3	339	373
UK (Scotland)	-	-	-	-	3	998	531	487	5,749
USSR	-	-	-	-	489	-	-	-	-
Total	2,151	7,253	2,788	4,420	25,987	24,238	20,808	20,895	62,877

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	10	13	-	+	74	57	51	28	-
Denmark	23,329	20,605	6,982	7,755	6,120	3,921	2,432	1,433	648
Estonia	-	-	-	293	-		17	-	-
Faroe Islands	-	942	340	-	360	275	-	-	296
France	248	220	174	162	302		-	-	-
Germany, Fed.Rep.	506	2,469[5]	5,995	2,801	1,570	1,014	1,600	7	7,603
Ireland	-	687	2,657	2,600	4,086	415	220	1,100	8,152
Netherlands	14,172	1,970	3,852	3,000	2,470	1,329	5,285	6,205	37,778
Norway	84,161	117,903	50,000	96,000	126,800	94,000	84,747	14,639	45,314
Poland	-	-	-	-	-	-	-	-	-
Sweden	-	102	953	800	697	2,087	-	95	232
UK (Engl. + Wales)	10	10	132	4	115	389	478	40	242
UK (N. Ireland)	-	-	350	-	-		-	-	-
UK (Scotland)	2,093	458	7,309	996	1,059	7,582	3,650	2,442	10,511
USSR / Russia (1992 -)	-	-	-						
Unallocated + discards	12,482[4]	-317[4]	-750[4]	-278[6]	-3,270	1,511	-28	136	-31,615
Total	112,047	145,062	77,904	114,133	140,383	112,580	98,452	26,125	79,161

Country	1998	1999	2000[1]
Belgium	19	21	19
Denmark	2,048	8,006	4,409
Estonia	22	-	-
Faroe Islands	28	908	24
France	379	60	49
Germany	4,620	4,071	3,115
Ireland	-	404	103
Netherlands	3,811	3,610	3,382
Norway	13,129	44,344	1,246
Poland	-	-	-
Russia	-	-	2
Sweden	3,411	1,957	1,141
UK (Engl. + Wales)	2	11	15
UK (N. Ireland)	-	-	-
UK (Scotland)	3,041	1,658	3,465
Unallocated + discards	737	-325	14613
Total	31,247	64,725	31583

[1]-Preliminary. [2] Includes Division IIa. [3] Estimated from biological sampling. [4] Assumed to be misreported. [5] Includes 13 t from the German Democratic Republic. [6] Includes a negative unallocated catch of -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	19,381	31,716	33,025	20,455	35,157	45,842

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	973	615	-	42	-	294	106	114	780
Faroe Islands	3,059	628	255	-	820	80	-	-	-
France	2	17	4	3	+	-	-	-	52
Germany, Fed. Rep.	1,162	2,474	2,500	6,281	10,023	1,430	1,368	943	229
Ireland	19,493	15,911	24,766	32,994	44,802	65,564	120,124	87,872	22,474
Netherlands	1,907	660	3,369	2,150	590	341	2,326	572	498
Norway	-	-	-	-	-	-	-	-	-
Spain	-[2]	-[2]	1	3	-	-	-	-	-
UK (Engl. + Wales)	44	145	1,229	577	144	109	208	612	56
UK (N.Ireland)	-	-	1,970	273	-	-	-	-	767
UK (Scotland)	1,737	267	1,640	86	4,523	1,760	789	2,669	14,452
USSR / Russia (1992 -)	-	44	-	-	-	-	-	-	-
Unallocated + disc.	6,493	143	-1,278	-1,940	-6,960[4]	-51	-41,326	-11,523	837
Total	34,870	20,904	34,456	40,469	53,942	69,527	83,595	81,259	40,145

Country	1998	1999	2000[1]
Denmark	-	-	-
Faroe Islands	-	-	-
France	221	25,007	-
Germany	414	1,031	209
Ireland	21,608	31,736	15,843
Netherlands	885	1,139	687
Norway	-	-	-
Russia	-	-	
Spain	-	-	-
UK (Engl. + Wales)	10	344	41
UK (N.Ireland)	1,132	-	-
UK (Scotland)	10,447	4,544	1,839
Unallocated +disc.	98	1,507	2,038
Total	34,815	65,308	20,657

[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	1985	1986	1987	1988
Belgium	-	1	1	-	-	+	+	2	-
Denmark	5,045	3,099	877	993	732	1,477[2]	30,408[2]	27,368	33,202
France	1,983	2,800	2,314	1,834	2,387	1,881	3,801	2,197	1,523
Germany, Fed.Rep.	2,289	1,079	12	1,977	228	-	5	374	4,705
Ireland	-	16	-	-	65	100	703	15	481
Netherlands	23,002	25,000	27,500[2]	34,350	38,700	33,550	40,750	69,400	43,560
Norway	394	-	-	-	-	-	-	-	-
Spain	50	234	104	142	560	275	137	148	150
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279	1,630	1,824	1,228	3,759
UK (Scotland)	1	-	-	-	1	1	+	2	2,873
USSR	-	-	-	-	-	120	-	-	-
Total	45,697	34,749	33,478	40,526	42,952	39,034	77,628	100,734	90,253

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Faroe Islands	-	28	-	-	-	-	-	-	-
Belgium	-	+	-	-	-	1	-	-	18
Denmark	34,474	30,594	28,888	18,984	16,978	41,605	28,300	43,330	60,412
France	4,576	2,538	1,230	1,198	1,001	-	-	-	27,201
Germany, Fed.Rep.	7,743	8,109	12,919	12,951	15,684	14,828	17,436	15,949	28,549
Ireland	12,645	17,887	19,074	15,568	16,363	15,281	58,011	38,455	43,624
Netherlands	43,582	111,900	104,107	109,197	157,110	92,903	116,126	114,692	81,464
Norway	-	-	-	-	-	-	-	-	-
Spain	14	16	113	106	54	29	25	33	-
UK (Engl. + Wales)	4,488	13,371	6,436	7,870	6,090	12,418	31,641	28,605	17,464
UK (N.Ireland)	-	-	2,026	1,690	587	119	-	-	1,093
UK (Scotland)	+	139	1,992	5,008	3,123	9,015	10,522	11,241	7,931
USSR / Russia (1992-)	-	-	-	-	-	-	-	-	-
Unallocated + discards	28,368	7,614	24,541	15,563	4,0103	14,057	68,644	26,795	58,718
Total	135,890	192,196	201,326	188,135	221,000	200,256	330,705	279,100	326,474

Country	1998	1999	2000[1]
Faroe Islands	-	-	550
Belgium	18	-	-
Denmark	25,492	19,223	13,946
France	24,223	-	20,401
Germany	25,414	15,247	9,692
Ireland	51,720	25,843	32,999
Netherlands	91,946	56,223	50,120
Norway	-	-	-
Russia	-	-	-
Spain	-	-	50
UK (Engl. + Wales)	12,832	8,885	2,972
UK (N.Ireland)	-	-	-
UK (Scotland)	5,095	4,994	5,152
Unallocated + discards	12,706	31,239	1,884
Total	249,446	161,654	137,766

[1]Provisional.
[2]Includes Sub-area VI.

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	1985	1986	1987	1988
Denmark	-	-	-	-	-	-	446	3,283	2,793
France	3,361	3,711	3.073	2,643	2,489	4,305	3,534	3,983	4,502
Netherlands	-	-	-	-	-[2]	-[2]	-[2]	-[2]	-
Spain	34,134	36,362	19,610	25,580	23,119	23,292	40,334	30,098	26,629
UK (Engl. + Wales)	-	+	1	-	1	143	392	339	253
USSR	-	-	-	-	20	-	656	-	-
Total	37,495	40,073	22,684	28,223	25,629	27,740	45,362	37,703	34,177

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	6,729	5,726	1,349	5,778	1,955	-	340	140	729
France	4,719	5,082	6,164	6,220	4,010	28	-	7	8,690
Germany, Fed. Rep.	-	-	80	62	-		-	-	-
Netherlands	-	6,000	12,437	9,339	19,000	7,272	-	14,187	2,944
Spain	27,170	25,182	23,733	27,688	27,921	25,409	28,349	29,428	31,081
UK (Engl. + Wales)	68	6	70	88	123	753	20	924	430
USSR/Russia (1992 -)	-	-	-	-	-	-	-	-	-
Unallocated + discards	-	1,500	2,563	5,011	700	2,038	-	3,583	-2,944
Total	38,686	43,496	46,396	54,186	53,709	35,500	28,709	48,269	40,930

Country	1998	1999	2000[1]
Denmark	1,728	4,818	2,584
France	1,844	74	7
Germany	3,268	3,197	3,760
Ireland	-	-	6,485
Netherlands	6,604	22,479	11,768
Russia	-	-	-
Spain	23,599	24,190	24,154
UK (Engl. + Wales)	9	29	112
UK (Scotland)	-	-	249
Unallocated + discards	1,884	-8658	5,093
Total	38,936	46,129	54,212

[1]Preliminary.
[2]Included in Sub-area VII.

Table 6.4.1.1. Western horse mackerel catch in numbers (1000) at age by quarter and area in 2000

1. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
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	4475	65	254	**4795**
2	0	0	0	0	0	0	0	0	0	0	3	564	0	0	6362	92	275	**7295**
3	0	0	0	0	0	0	0	0	0	0	18	3026	0	0	6277	88	196	**9605**
4	0	0	0	0	66	116	3	0	0	0	48	7888	2395	71	2346	25	34	**12991**
5	0	0	0	0	318	1137	355	0	0	0	123	20381	5907	174	7228	83	108	**35813**
6	0	0	0	0	1363	2397	55	0	46	0	98	16237	9023	420	9483	120	162	**39404**
7	0	0	0	0	4734	11221	1902	0	102	0	57	9466	10613	723	9464	127	186	**48596**
8	6	1	15	520	4877	12630	2593	0	62	0	6	1044	6628	349	6788	98	152	**35768**
9	6	1	15	520	404	1868	701	0	62	0	5	880	5722	168	3936	56	107	**14451**
10	9	1	22	780	376	662	15	0	70	0	5	745	2987	88	1814	26	48	**7648**
11	3	0	7	260	534	2150	738	0	55	0	2	328	3976	271	3059	44	87	**11514**
12	12	2	30	1040	1640	4204	846	0	32	0	5	806	2291	125	2210	31	66	**13340**
13	3	0	7	260	648	1879	464	0	16	0	0	60	4457	189	1298	19	36	**9336**
14	9	1	22	780	828	1564	97	0	0	0	0	0	3112	149	1199	17	31	**7809**
15+	105	15	252	8836	4124	11006	2385	0	132	0	3	538	16798	751	1763	25	59	**46794**

2. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
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	4501	141	923	**5565**
2	0	0	0	0	0	0	0	0	0	0	0	232	0	0	5485	159	2406	**8283**
3	0	0	0	0	0	0	0	0	1	0	0	1020	3232	0	2930	57	383	**7624**
4	0	0	0	0	1	16	0	0	2	0	0	2505	11102	0	3043	60	489	**17217**
5	0	0	0	0	1	17	0	0	5	0	0	1981	17964	0	6520	217	1857	**28561**
6	0	0	0	0	38	931	0	0	7	0	0	1090	9590	0	9453	262	2401	**23771**
7	0	0	0	0	64	1578	0	0	7	0	0	1084	13811	0	7191	224	2165	**26125**
8	4	1	5	54	59	1453	0	0	4	0	0	444	12734	0	3908	140	1399	**20205**
9	4	1	5	54	12	289	0	0	4	0	0	499	6532	0	1711	64	649	**9824**
10	6	2	7	80	5	125	0	0	1	0	0	98	2067	0	660	28	291	**3370**
11	2	1	2	27	0	0	0	0	1	0	0	111	5212	0	846	39	417	**6656**
12	8	3	9	107	10	254	0	0	0	0	0	46	1650	0	432	22	252	**2793**
13	2	1	2	27	6	138	0	0	1	0	0	150	1320	0	354	14	165	**2179**
14	6	2	7	80	6	158	0	0	0	0	0	0	1980	0	388	15	160	**2802**
15+	67	22	77	912	25	620	0	0	2	0	0	297	7921	0	348	15	200	**10507**

3. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	20	0	**98**
1	0	0	0	0	0	0	0	0	1686	17	0	0	4	0	2046	534	0	**4287**
2	0	0	0	0	0	0	0	0	4215	42	0	0	10	0	1181	308	0	**5755**
3	0	0	0	0	0	0	0	0	843	8	0	0	2	0	699	183	0	**1735**
4	0	0	0	3054	24	0	0	0	843	8	0	0	2	0	766	200	0	**4898**
5	0	0	0	1721	25	0	0	0	2248	22	0	0	6	0	935	244	0	**5201**
6	0	0	0	13921	1400	0	0	0	1124	11	0	0	3	0	1974	515	0	**18947**
7	19	18	136	17062	2373	0	0	0	843	8	0	0	2	0	1369	357	0	**22187**
8	53	50	376	12551	2186	0	0	0	843	8	0	0	2	0	624	163	0	**16855**
9	56	53	397	1081	435	0	0	0	843	8	0	0	2	0	260	68	0	**3203**
10	56	53	399	270	188	0	0	0	0	0	0	0	0	0	76	20	0	**1063**
11	15	14	104	48	0	0	0	0	0	0	0	0	0	0	64	17	0	**261**
12	63	59	446	180	382	0	0	0	0	0	0	0	0	0	18	5	0	**1153**
13	4	3	26	132	207	0	0	0	281	3	0	0	1	0	54	14	0	**724**
14	7	7	53	48	237	0	0	0	0	0	0	0	0	0	65	17	0	**434**
15+	242	229	1719	465	933	0	0	0	281	3	0	0	1	0	57	15	0	**3945**

4. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	1	2	**82**
1	0	0	0	0	0	0	0	18923	7451	0	582	7818	318	0	7736	43	147	**43018**
2	0	0	0	0	0	0	0	47309	18845	0	1456	19545	796	0	3541	42	176	**91710**
3	0	0	0	309	16	45	0	9462	4892	0	291	3909	159	0	3141	31	128	**22382**
4	0	0	0	1998	417	290	0	9462	6766	0	291	3909	159	0	3544	34	137	**27008**
5	0	0	0	1214	1037	176	0	25231	17790	0	777	10424	424	0	5639	43	167	**62922**
6	0	0	0	9605	3145	1395	0	12616	11225	0	388	5212	212	0	13687	88	319	**57892**
7	82	2	298	13237	8616	1922	0	9462	7374	0	291	3909	159	0	11136	63	219	**56771**
8	227	5	826	7342	12566	1063	0	9462	4128	0	291	3909	159	0	6232	31	102	**46344**
9	240	6	874	1988	1495	285	0	9462	4065	0	291	3909	159	0	4229	16	44	**27062**
10	241	6	878	17	0	0	0	0	287	0	0	0	0	0	1584	5	13	**3031**
11	63	1	229	28	321	0	0	0	127	0	0	0	0	0	1118	4	11	**1903**
12	270	6	982	162	1576	22	0	0	311	0	0	0	0	0	435	1	3	**3768**
13	15	0	56	103	321	10	0	3154	1265	0	97	1303	53	0	1007	3	9	**7398**
14	32	1	117	109	0	14	0	0	0	0	0	0	0	0	1843	5	11	**2132**
15+	1040	24	3781	1169	5910	152	0	3154	1449	0	97	1303	53	0	2420	6	10	**20568**

total year 2000

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	158	21	2	**181**
1	0	0	0	0	0	0	0	18923	9137	17	582	7818	322	0	18758	784	1323	**57665**
2	0	0	0	0	0	0	0	47309	23060	42	1460	20341	806	0	16568	601	2857	**113043**
3	0	0	0	309	16	45	0	9462	5736	8	310	7955	3393	0	13047	359	707	**41346**
4	0	0	0	5052	508	423	3	9462	7611	8	339	14302	13659	71	9699	319	660	**62114**
5	0	0	0	2935	1381	1330	355	25231	20042	22	900	32785	24301	174	20322	587	2131	**132496**
6	0	0	0	23526	5945	4723	55	12616	12402	11	487	22539	18827	420	34596	985	2882	**140014**
7	101	117	434	30299	15787	14721	1902	9462	8326	8	349	14459	24585	723	29160	772	2570	**153776**
8	237	327	1221	20466	19688	15147	2593	9462	5037	8	298	5398	19523	349	17552	432	1653	**119389**
9	246	346	1290	3643	2345	2442	701	9462	4974	8	297	5288	12416	168	10136	204	800	**54766**
10	251	348	1306	1147	569	787	15	0	358	0	5	844	5054	88	4134	79	352	**15337**
11	66	91	343	362	855	2150	738	0	182	0	2	439	9188	271	5087	104	514	**20393**
12	282	390	1467	1488	3608	4479	846	0	342	0	5	852	3941	125	3096	59	321	**21303**
13	19	23	91	522	1182	2027	464	3154	1563	3	97	1513	5831	189	2712	51	209	**19649**
14	41	49	199	1017	1071	1735	97	0	0	0	0	0	5092	149	3495	55	202	**13202**
15+	1144	1524	5828	11382	10992	11779	2385	3154	1864	3	100	2138	24773	751	4589	61	269	**82738**

Table 6.4.2.1. Western horse mackerel mean weight (Kg) at age in catch by quarter and area in 2000

1. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0																		
1															0.028	0.028	0.023	**0.028**
2											0.076	0.076			0.069	0.069	0.056	**0.069**
3											0.099	0.099			0.077	0.077	0.071	**0.084**
4					0.129	0.129	0.129				0.109	0.109	0.112	0.112	0.144	0.156	0.162	**0.117**
5					0.182	0.171	0.151				0.124	0.124	0.133	0.133	0.149	0.156	0.161	**0.133**
6					0.157	0.157	0.157		0.183		0.125	0.124	0.143	0.148	0.159	0.165	0.173	**0.141**
7					0.176	0.175	0.174		0.206		0.140	0.138	0.163	0.158	0.175	0.178	0.189	**0.165**
8	0.271	0.271	0.271	0.271	0.204	0.203	0.202		0.208		0.174	0.175	0.177	0.180	0.182	0.183	0.193	**0.194**
9	0.303	0.303	0.303	0.303	0.231	0.216	0.187		0.253		0.204	0.208	0.196	0.196	0.206	0.206	0.225	**0.207**
10	0.317	0.317	0.317	0.317	0.221	0.221	0.221		0.276		0.162	0.162	0.244	0.244	0.204	0.205	0.224	**0.231**
11	0.245	0.245	0.245	0.245	0.230	0.226	0.219		0.261		0.167	0.161	0.220	0.202	0.210	0.210	0.224	**0.218**
12	0.379	0.379	0.379	0.379	0.256	0.255	0.252		0.320		0.156	0.156	0.261	0.229	0.223	0.225	0.235	**0.254**
13	0.342	0.342	0.342	0.342	0.258	0.280	0.319		0.323		0.256	0.256	0.251	0.228	0.215	0.214	0.220	**0.257**
14	0.373	0.373	0.373	0.373	0.240	0.270	0.307						0.269	0.240	0.210	0.210	0.220	**0.267**
15+	0.378	0.378	0.378	0.378	0.287	0.310	0.351		0.319		0.359	0.359	0.285	0.260	0.266	0.264	0.293	**0.312**

2. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															0.027			**0.027**
1															0.037	0.026	0.027	**0.035**
2									0.076			0.083			0.076	0.064	0.045	**0.067**
3									0.125			0.099	0.087		0.104	0.106	0.107	**0.096**
4					0.126	0.126			0.140			0.109	0.107		0.127	0.136	0.140	**0.112**
5					0.126	0.126			0.147			0.126	0.137		0.134	0.137	0.140	**0.136**
6					0.161	0.161			0.177			0.163	0.182		0.139	0.142	0.147	**0.159**
7					0.168	0.168			0.184			0.174	0.179		0.149	0.153	0.157	**0.168**
8	0.271	0.271	0.271	0.271	0.187	0.187			0.214			0.211	0.202		0.160	0.162	0.166	**0.191**
9	0.303	0.303	0.303	0.303	0.183	0.183			0.243			0.238	0.200		0.178	0.177	0.189	**0.197**
10	0.317	0.317	0.317	0.317	0.205	0.205			0.285			0.285	0.241		0.184	0.181	0.189	**0.227**
11	0.245	0.245	0.245	0.245					0.249			0.249	0.213		0.192	0.192	0.203	**0.210**
12	0.379	0.379	0.379	0.379	0.194	0.194						0.254	0.266		0.224	0.219	0.229	**0.254**
13	0.342	0.342	0.342	0.342	0.208	0.208			0.322			0.286	0.285		0.204	0.206	0.212	**0.262**
14	0.373	0.373	0.373	0.373	0.203	0.203							0.304		0.209	0.192	0.206	**0.281**
15+	0.378	0.378	0.378	0.378	0.208	0.208			0.385			0.374	0.323		0.252	0.252	0.266	**0.319**

3. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															0.027	0.027		**0.027**
1									0.069	0.069	0.069		0.069		0.050	0.050		**0.058**
2									0.085	0.085	0.085		0.085		0.082	0.082		**0.084**
3									0.101	0.101	0.101		0.101		0.107	0.107		**0.104**
4				0.154	0.126				0.146	0.146	0.146		0.144		0.123	0.123		**0.146**
5				0.149	0.126				0.149	0.149	0.149		0.149		0.134	0.134		**0.145**
6				0.170	0.161				0.177	0.177	0.177		0.177		0.141	0.141		**0.166**
7	0.323	0.323	0.323	0.174	0.168				0.113	0.113	0.113		0.118		0.149	0.149		**0.170**
8	0.329	0.329	0.329	0.189	0.187				0.210	0.210	0.210		0.210		0.160	0.160		**0.192**
9	0.347	0.347	0.347	0.205	0.183				0.210	0.210	0.210		0.210		0.187	0.187		**0.224**
10	0.343	0.343	0.343	0.212	0.205								0.241		0.194	0.194		**0.272**
11	0.365	0.365	0.365	0.286									0.213		0.196	0.196		**0.298**
12	0.377	0.377	0.377	0.241	0.194								0.266		0.239	0.239		**0.292**
13	0.386	0.386	0.386	0.232	0.208				0.102	0.102	0.102		0.106		0.199	0.199		**0.178**
14	0.410	0.410	0.410	0.244	0.203								0.304		0.238	0.238		**0.246**
15+	0.395	0.395	0.395	0.251	0.208				0.800	0.800	0.800		0.746		0.246	0.246		**0.360**

4. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															0.020	0.019	0.019	**0.019**
1								0.069	0.069		0.069	0.069	0.069		0.052	0.053	0.053	**0.066**
2								0.085	0.085		0.085	0.085	0.085		0.083	0.085	0.089	**0.085**
3				0.128	0.120	0.128		0.101	0.101		0.101	0.101	0.101		0.112	0.110	0.107	**0.103**
4				0.156	0.133	0.156		0.146	0.130		0.146	0.146	0.146		0.130	0.124	0.119	**0.140**
5				0.159	0.160	0.159		0.149	0.138		0.149	0.149	0.149		0.154	0.139	0.129	**0.147**
6				0.164	0.166	0.164		0.177	0.148		0.177	0.177	0.177		0.160	0.148	0.141	**0.164**
7	0.323	0.323	0.323	0.168	0.175	0.168		0.113	0.126		0.113	0.113	0.113		0.172	0.157	0.150	**0.152**
8	0.329	0.329	0.329	0.190	0.179	0.190		0.210	0.207		0.210	0.210	0.210		0.187	0.171	0.163	**0.197**
9	0.347	0.347	0.347	0.179	0.215	0.178		0.210	0.210		0.210	0.210	0.210		0.232	0.205	0.194	**0.217**
10	0.343	0.343	0.343	0.258					0.162						0.246	0.212	0.198	**0.274**
11	0.365	0.365	0.365	0.273	0.234				0.167						0.239	0.212	0.201	**0.253**
12	0.377	0.377	0.377	0.255	0.198	0.252			0.156						0.223	0.229	0.231	**0.260**
13	0.386	0.386	0.386	0.268	0.234	0.259		0.102	0.105		0.102	0.102	0.102		0.220	0.206	0.200	**0.130**
14	0.410	0.410	0.410	0.241		0.234									0.272	0.244	0.233	**0.279**
15+	0.395	0.395	0.395	0.273	0.226	0.267		0.800	0.737		0.800	0.800	0.800		0.288	0.261	0.251	**0.441**

total year 2000

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															0.023	0.026	0.019	**0.023**
1								0.069	0.069	0.069	0.069	0.069	0.069		0.043	0.044	0.029	**0.059**
2								0.085	0.085	0.085	0.085	0.085	0.085		0.075	0.075	0.049	**0.083**
3				0.128	0.120	0.128		0.101	0.101	0.101	0.101	0.100	0.088		0.093	0.100	0.097	**0.097**
4				0.155	0.132	0.147	0.129	0.146	0.131	0.146	0.141	0.119	0.108	0.112	0.132	0.128	0.137	**0.128**
5				0.153	0.164	0.169	0.151	0.149	0.139	0.149	0.146	0.132	0.136	0.133	0.145	0.138	0.141	**0.141**
6				0.168	0.163	0.160	0.157	0.177	0.151	0.177	0.166	0.138	0.163	0.148	0.153	0.145	0.147	**0.157**
7	0.323	0.323	0.323	0.171	0.174	0.174	0.174	0.113	0.126	0.113	0.117	0.134	0.171	0.158	0.166	0.155	0.159	**0.161**
8	0.327	0.329	0.328	0.192	0.186	0.201	0.202	0.210	0.207	0.210	0.209	0.203	0.194	0.180	0.178	0.166	0.168	**0.195**
9	0.346	0.347	0.347	0.206	0.212	0.208	0.187	0.210	0.210	0.210	0.210	0.212	0.198	0.196	0.211	0.190	0.194	**0.212**
10	0.342	0.343	0.343	0.291	0.216	0.219	0.221		0.185		0.162	0.176	0.243	0.244	0.217	0.194	0.194	**0.243**
11	0.360	0.364	0.362	0.253	0.232	0.226	0.219		0.196		0.167	0.184	0.216	0.202	0.213	0.201	0.207	**0.220**
12	0.377	0.377	0.377	0.349	0.224	0.251	0.252		0.171		0.156	0.161	0.263	0.229	0.223	0.224	0.230	**0.259**
13	0.379	0.384	0.381	0.299	0.243	0.275	0.319	0.102	0.107	0.102	0.103	0.126	0.257	0.228	0.215	0.207	0.213	**0.207**
14	0.402	0.408	0.405	0.353	0.232	0.263	0.307						0.282	0.240	0.243	0.217	0.209	**0.272**
15+	0.393	0.394	0.394	0.362	0.247	0.304	0.351	0.800	0.716	0.800	0.786	0.630	0.298	0.260	0.276	0.257	0.272	**0.348**

Table 6.4.2.2. Western horse mackerel mean length (cm) at age in the catches by quarter and area in 2000

1. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0																		**0.0**
1															14.7	14.7	13.7	**14.6**
2											21.9	21.9			20.0	20.0	18.6	**20.1**
3											23.9	23.9			21.0	20.9	20.3	**21.9**
4					25.5	25.5	25.5				24.8	24.8	24.8	24.8	26.2	26.8	27.2	**25.1**
5					28.3	27.7	26.6				25.7	25.7	26.2	26.2	26.6	26.8	27.1	**26.1**
6					27.2	27.2	27.2		27.7		25.8	25.7	26.8	27.0	27.1	27.3	27.7	**26.5**
7					28.1	28.2	28.5		29.0		26.8	26.6	28.1	27.7	27.9	28.0	28.6	**27.8**
8	31.0	31.0	31.0	31.0	29.4	29.6	29.9		28.6		29.1	29.1	28.5	28.5	28.3	28.3	28.8	**29.1**
9	33.5	33.5	33.5	33.5	30.7	30.3	29.5		30.7		30.5	30.7	29.7	29.7	29.5	29.4	30.4	**29.9**
10	32.8	32.8	32.8	32.8	30.1	30.1	30.1		31.5		28.5	28.4	31.2	31.2	29.4	29.4	30.3	**30.5**
11	31.5	31.5	31.5	31.5	30.6	30.9	31.5		31.2		28.5	28.2	31.0	30.1	29.7	29.7	30.4	**30.5**
12	34.8	34.8	34.8	34.8	31.7	31.7	31.7		33.5		27.8	27.8	32.4	31.0	30.4	30.5	31.0	**31.6**
13	33.5	33.5	33.5	33.5	31.6	32.5	34.1		33.5		32.5	32.5	31.5	30.9	30.0	30.0	30.3	**31.7**
14	35.5	35.5	35.5	35.5	31.0	32.0	33.3						32.3	31.2	29.7	29.7	30.2	**32.0**
15+	35.2	35.2	35.2	35.2	32.8	33.5	34.8		33.0		37.5	37.5	33.1	32.2	32.2	32.1	33.2	**33.6**

2. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															14.5			
1															16.0	14.4	14.6	**15.7**
2									22.5			22.5			20.5	18.9	17.1	**19.5**
3									24.5			23.7	23.2		23.3	23.4	23.5	**23.3**
4					24.5	24.5			25.3			24.7	24.5		25.0	25.5	25.8	**24.6**
5					24.5	24.5			26.3			25.8	25.6		25.4	25.7	25.9	**25.6**
6					27.1	27.1			27.4			27.1	27.0		25.8	25.9	26.2	**26.4**
7					27.5	27.5			28.2			28.0	28.0		26.4	26.6	26.8	**27.4**
8	31.0	31.0	31.0	31.0	28.8	28.8			28.8			28.7	28.9		27.0	27.2	27.4	**28.4**
9	33.5	33.5	33.5	33.5	28.6	28.6			30.2			30.1	29.6		28.0	27.9	28.5	**29.2**
10	32.8	32.8	32.8	32.8	30.0	30.0			31.5			31.5	30.9		28.3	28.2	28.6	**30.2**
11	31.5	31.5	31.5	31.5					30.9			30.9	30.2		28.7	28.8	29.4	**30.0**
12	34.8	34.8	34.8	34.7	29.3	29.3						30.5	32.1		30.4	30.2	30.7	**31.5**
13	33.5	33.5	33.5	33.5	30.1	30.1			32.8			32.1	30.5		29.5	29.6	29.9	**30.4**
14	35.5	35.5	35.5	35.5	29.8	29.8							33.3		29.5	28.7	29.5	**32.4**
15+	35.2	35.2	35.2	35.2	30.1	30.1			34.3			34.2	34.3		31.6	31.6	32.2	**34.0**

3. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															14.5	14.5		**14.5**
1									19.5	19.5	19.5		19.5		18.0	18.0		**18.6**
2									20.8	20.8	20.8		20.8		21.4	21.4		**20.9**
3									21.8	21.8	21.8		21.9		23.4	23.4		**22.6**
4				26.2	24.5				24.8	24.8	24.8		24.8		24.7	24.7		**25.7**
5				25.9	24.5				25.1	25.1	25.1		25.1		25.4	25.4		**25.4**
6				27.3	27.1				27.0	27.0	27.0		27.0		25.9	25.9		**27.1**
7	31.8	31.8	31.8	27.5	27.5				22.8	22.8	22.8		23.2		26.4	26.4		**27.3**
8	32.2	32.2	32.2	28.4	28.8				28.2	28.2	28.2		28.2		27.0	27.0		**28.5**
9	32.8	32.8	32.8	29.4	28.6				27.2	27.2	27.2		27.3		28.4	28.4		**29.1**
10	32.9	32.9	32.9	29.8	30.0								30.9		28.9	28.9		**31.2**
11	33.5	33.5	33.5	33.5									30.2		28.9	28.9		**32.1**
12	33.9	33.9	33.9	31.3	29.3								32.1		31.1	31.1		**31.9**
13	34.0	34.0	34.0	30.9	30.1				22.5	22.5	22.5		22.7		29.2	29.2		**27.4**
14	34.6	34.6	34.6	31.5	29.8								33.3		31.0	31.0		**31.0**
15+	34.4	34.4	34.4	31.8	30.1				20.5	20.5	20.5		22.1		31.3	31.3		**32.0**

4. Quarter

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															12.9	12.9	12.8	**12.9**
1								19.5	19.5		19.5	19.5	19.5		18.3	18.4	18.4	**19.3**
2								20.8	20.8		20.8	20.8	20.8		21.5	21.7	22.1	**20.8**
3				25.2	24.5	25.2		21.8	22.3		21.8	21.8	21.8		23.8	23.6	23.5	**22.3**
4				26.8	25.5	26.8		24.8	24.8		24.8	24.8	24.8		25.2	24.8	24.4	**25.0**
5				26.9	27.2	26.9		25.1	25.4		25.1	25.1	25.1		26.5	25.6	25.0	**25.4**
6				27.2	27.7	27.2		27.0	26.3		27.0	27.0	27.0		27.0	26.3	25.9	**26.9**
7	31.8	31.8	31.8	27.4	28.2	27.4		22.8	24.8		22.8	22.8	22.8		27.6	26.8	26.4	**26.1**
8	32.2	32.2	32.2	28.5	28.4	28.5		28.2	28.3		28.2	28.2	28.2		28.4	27.6	27.2	**28.4**
9	32.8	32.8	32.8	28.0	30.5	27.9		27.2	27.4		27.2	27.2	27.2		30.6	29.3	28.8	**28.2**
10	32.9	32.9	32.9	31.8					28.5						31.2	29.7	29.0	**31.6**
11	33.5	33.5	33.5	32.7	31.5				28.5						30.9	29.7	29.1	**31.2**
12	33.9	33.9	33.9	31.4	29.5	31.2			27.8						30.5	30.8	30.9	**31.0**
13	34.0	34.0	34.0	32.2	31.5	31.5		22.5	22.7		22.5	22.5	22.5		30.1	29.5	29.3	**24.2**
14	34.6	34.6	34.6	30.8		30.5									32.4	31.2	30.8	**32.5**
15+	34.4	34.4	34.4	31.9	31.1	31.6		20.5	22.9		20.5	20.5	20.5		33.1	31.9	31.5	**29.2**

total year 2000

Ages	IIIa	IIa	IVa	VIa	VIIb	VIIbc	VIIc	VIIe	VIIef	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	Total
0															13.7	14.4	12.8	**13.8**
1								19.5	19.5	19.5	19.5	19.5	19.5		16.8	17.1	14.9	**18.5**
2								20.8	20.8	20.8	20.8	20.8	20.8		20.6	20.6	17.5	**20.7**
3				25.2	24.5	25.2		21.8	22.2	21.8	22.0	22.8	23.1		22.3	22.8	22.6	**22.4**
4				26.4	25.5	26.4	25.5	24.8	24.8	24.8	24.8	24.8	24.6	24.8	25.3	25.0	25.6	**25.0**
5				26.3	27.4	27.6	26.6	25.1	25.4	25.1	25.2	25.5	25.7	26.2	26.1	25.7	25.9	**25.6**
6				27.3	27.4	27.2	27.2	27.0	26.4	27.0	26.8	26.1	26.9	27.0	26.6	26.1	26.3	**26.7**
7	31.8	31.8	31.8	27.5	28.1	28.0	28.5	22.8	24.6	22.8	23.5	25.7	28.0	27.7	27.4	26.7	26.9	**27.1**
8	32.1	32.2	32.2	28.5	28.7	29.4	29.9	28.2	28.3	28.2	28.2	28.4	28.8	28.5	28.0	27.4	27.5	**28.7**
9	32.8	32.8	32.8	29.3	30.2	29.8	29.5	27.2	27.4	27.2	27.2	28.0	29.6	29.7	29.6	28.6	28.8	**28.9**
10	32.9	32.9	32.9	32.1	30.1	30.1	30.1		29.1		28.5	28.8	31.1	31.2	29.9	28.9	28.8	**30.8**
11	33.4	33.5	33.4	31.9	30.9	30.9	31.5		29.3		28.5	28.8	30.5	30.1	29.8	29.2	29.5	**30.5**
12	33.9	33.9	33.9	34.0	30.5	31.5	31.7		28.3		27.8	27.9	32.3	31.0	30.4	30.5	30.7	**31.5**
13	33.9	34.0	33.9	32.6	31.3	32.3	34.1	22.5	22.8	22.5	22.5	23.9	31.2	30.9	30.0	29.6	29.9	**28.6**
14	34.8	34.7	34.7	34.8	30.7	31.8	33.3						32.7	31.2	31.1	30.0	29.7	**32.1**
15+	34.5	34.4	34.4	34.7	31.7	33.3	34.8	20.5	23.3	20.5	21.1	26.7	33.4	32.2	32.6	31.7	32.4	**32.5**

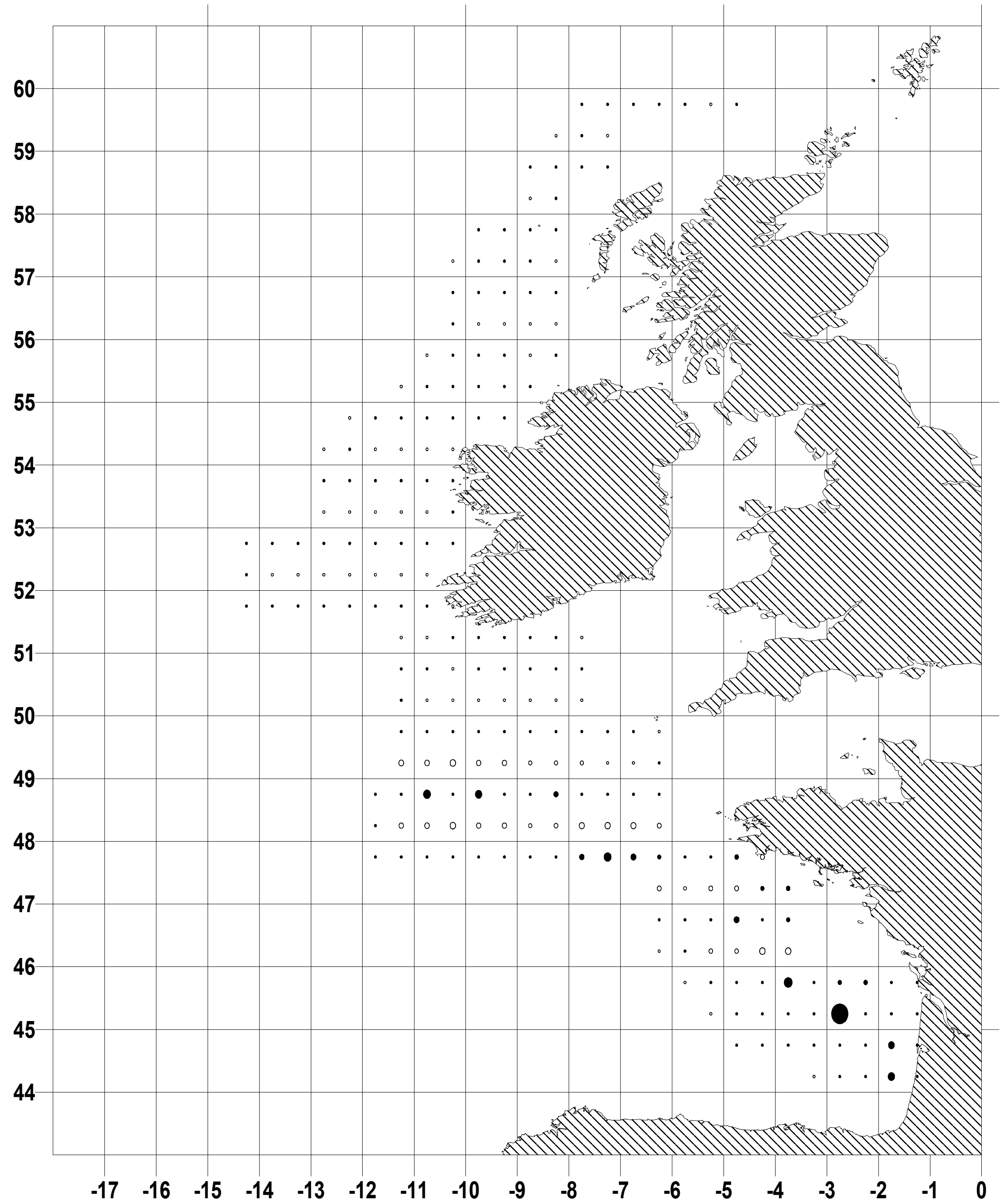


Figure 6.3.1 Daily horse mackerel egg production m^{-2} in period 3 (Scaled to a maximum of 500 $eggs.m^{-2}.d^{-1}$). The smallest rings represent 0 $eggs.m^{-2}.d^{-1}$

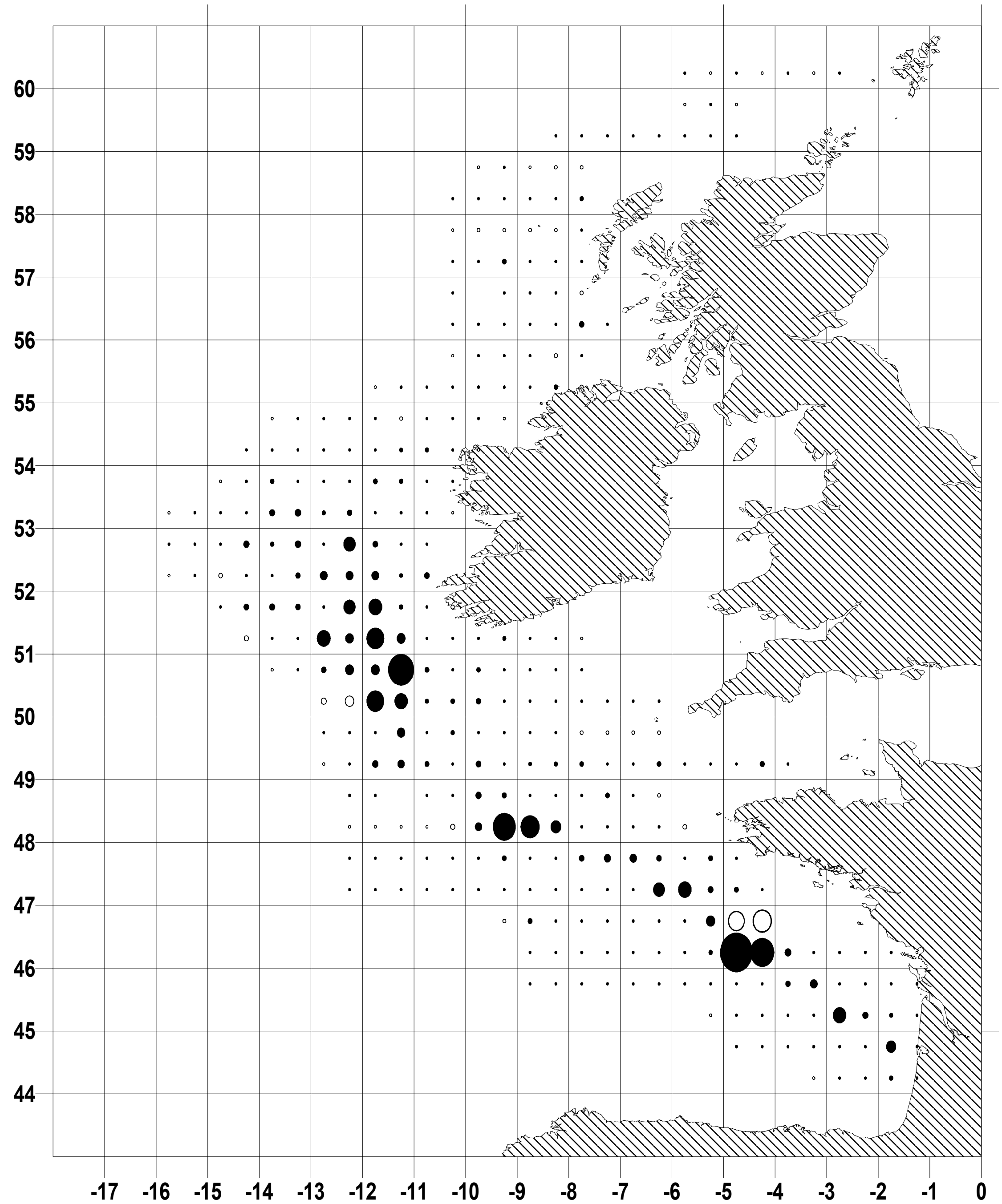


Figure 6.3.2 Daily horse mackerel egg production m^{-2} in period 4 (Scaled to a maximum of 500 eggs.m^{-2}.d^{-1}) The smallest rings represent 0 eggs.m^{-2}.d^{-1}.

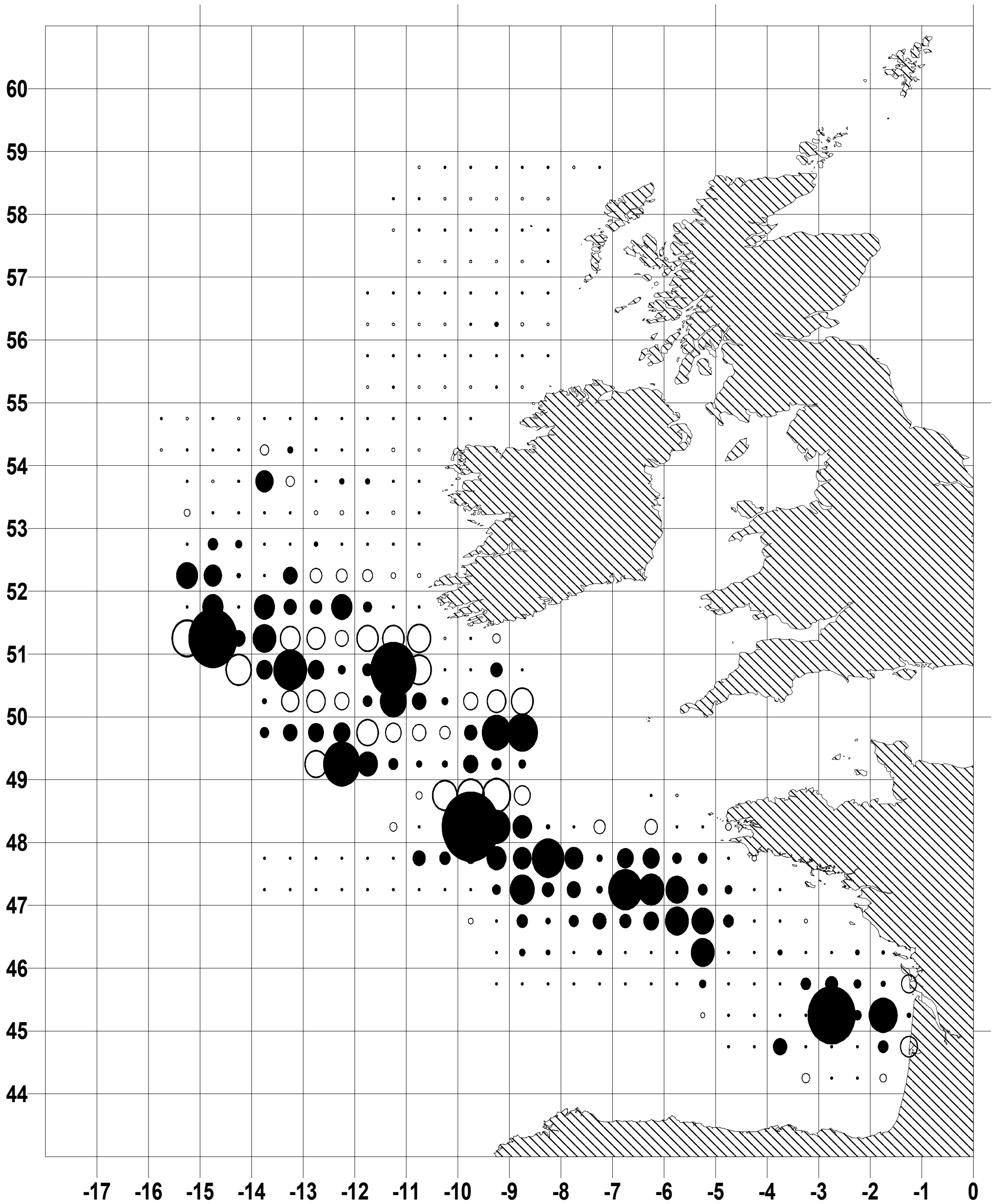


Figure 6.3.3 Daily horse mackerel egg production m^{-2} in period 5 (Scaled to a maximum of 500 $eggs.m^{-2}.d^{-1}$) The smallest rings represent 0 $eggs.m^{-2}.d^{-1}$.

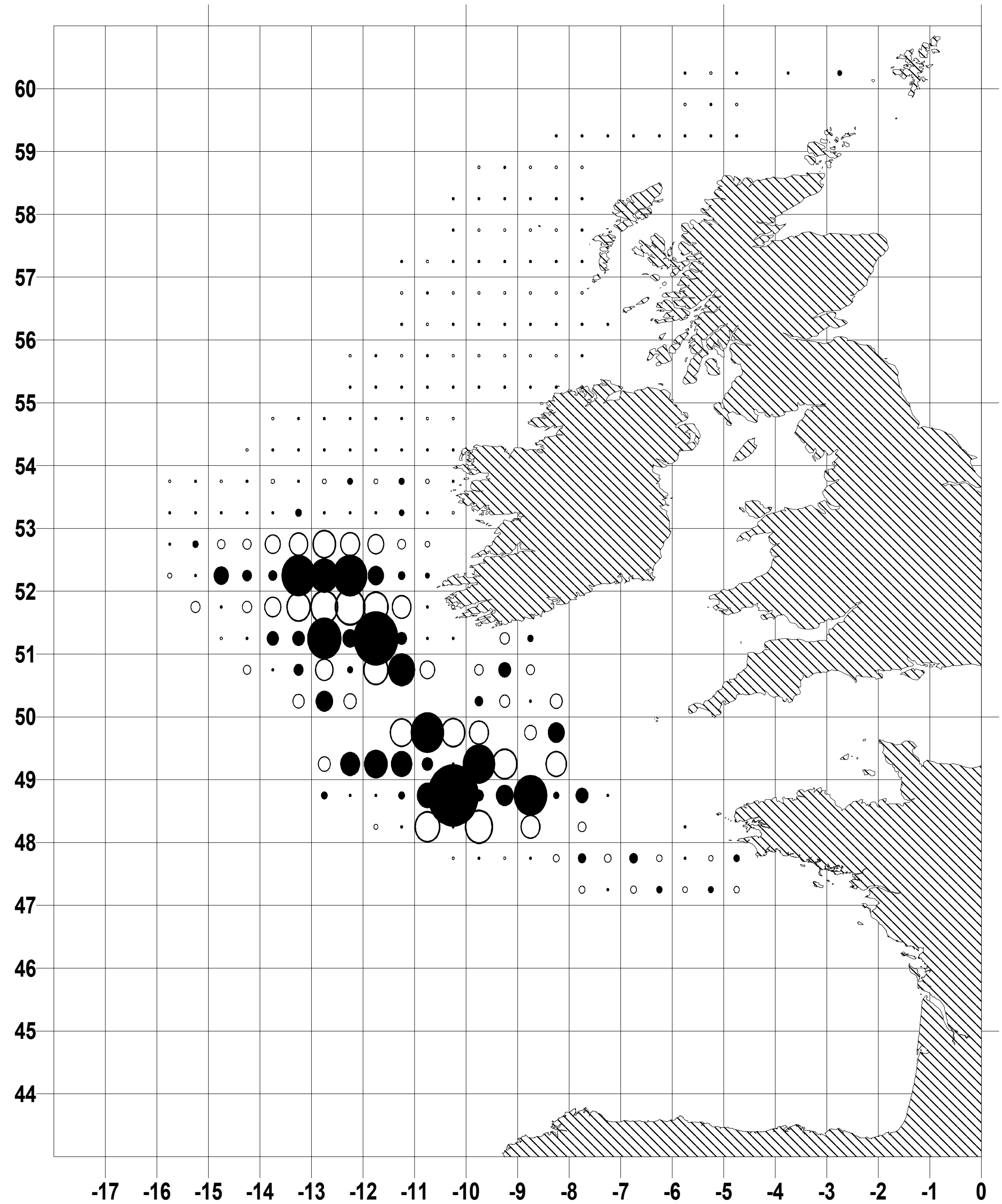


Figure 6.3.4 Daily horse mackerel egg production m^{-2} in period 6 (Scaled to a maximum of 500 eggs.m^{-2}.d^{-1}) The smallest rings represent 0 eggs.m^{-2}.d^{-1}.

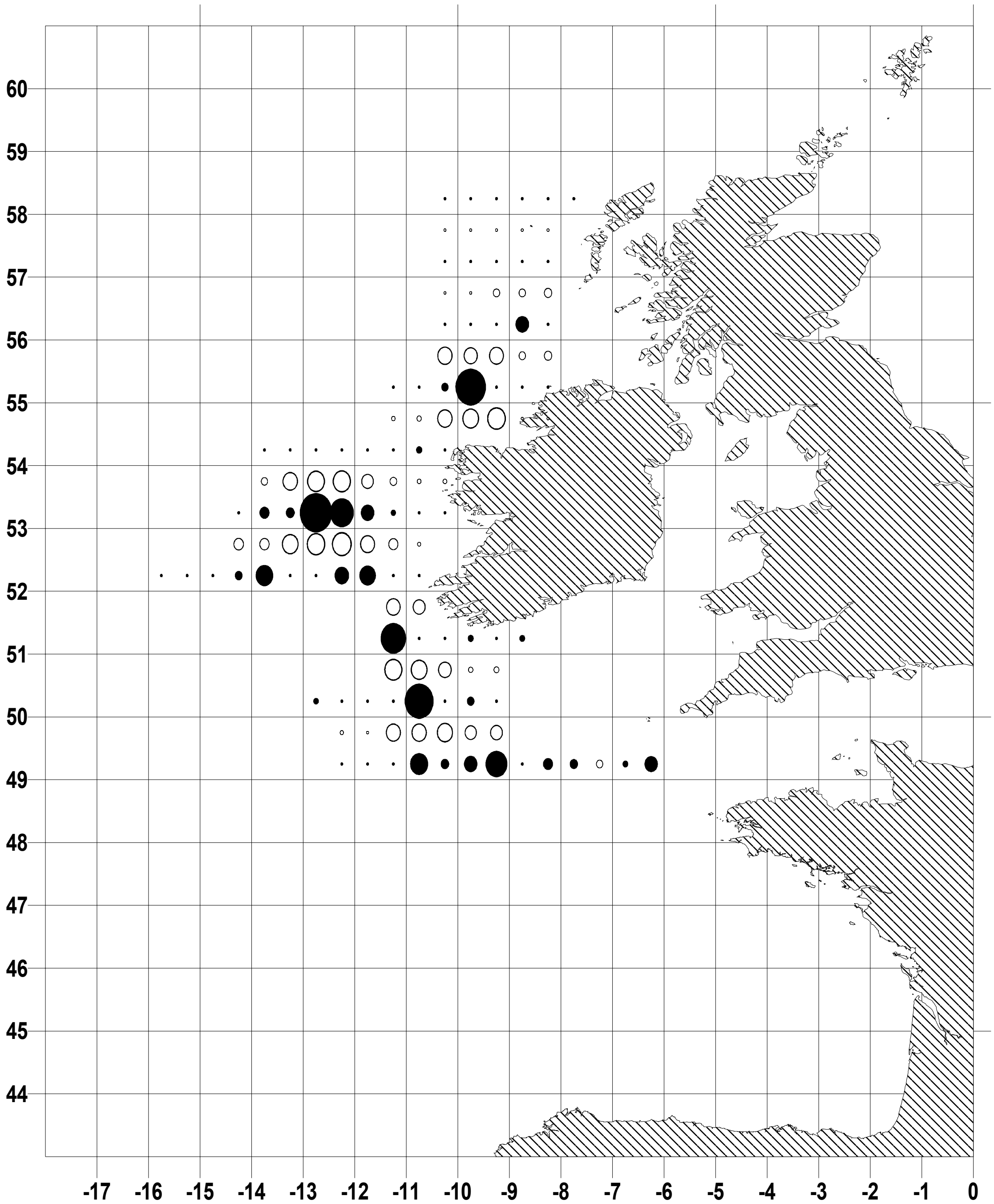


Figure 6.3.5 Daily horse mackerel egg production m^{-2} in period 7 (Scaled to a maximum of 500 eggs.m^{-2}.d^{-1}). The smallest rings represent 0 eggs.m^{-2}.d^{-1}.

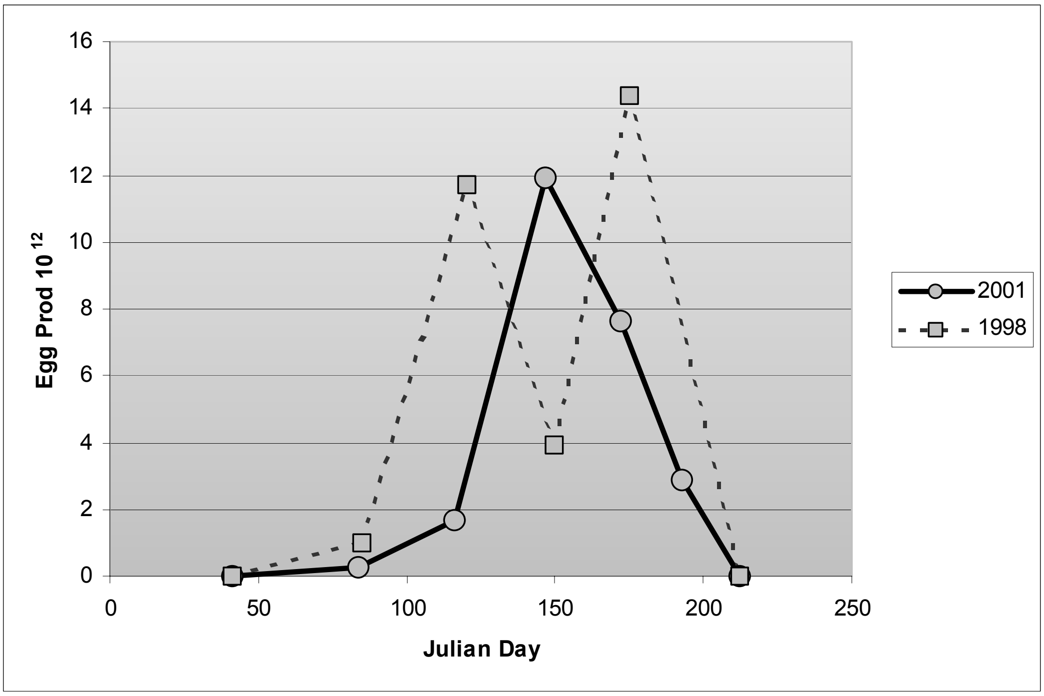


Figure 6.3.6 Horse Mackerel annual egg production curves for the 1998 and 2001 egg surveys

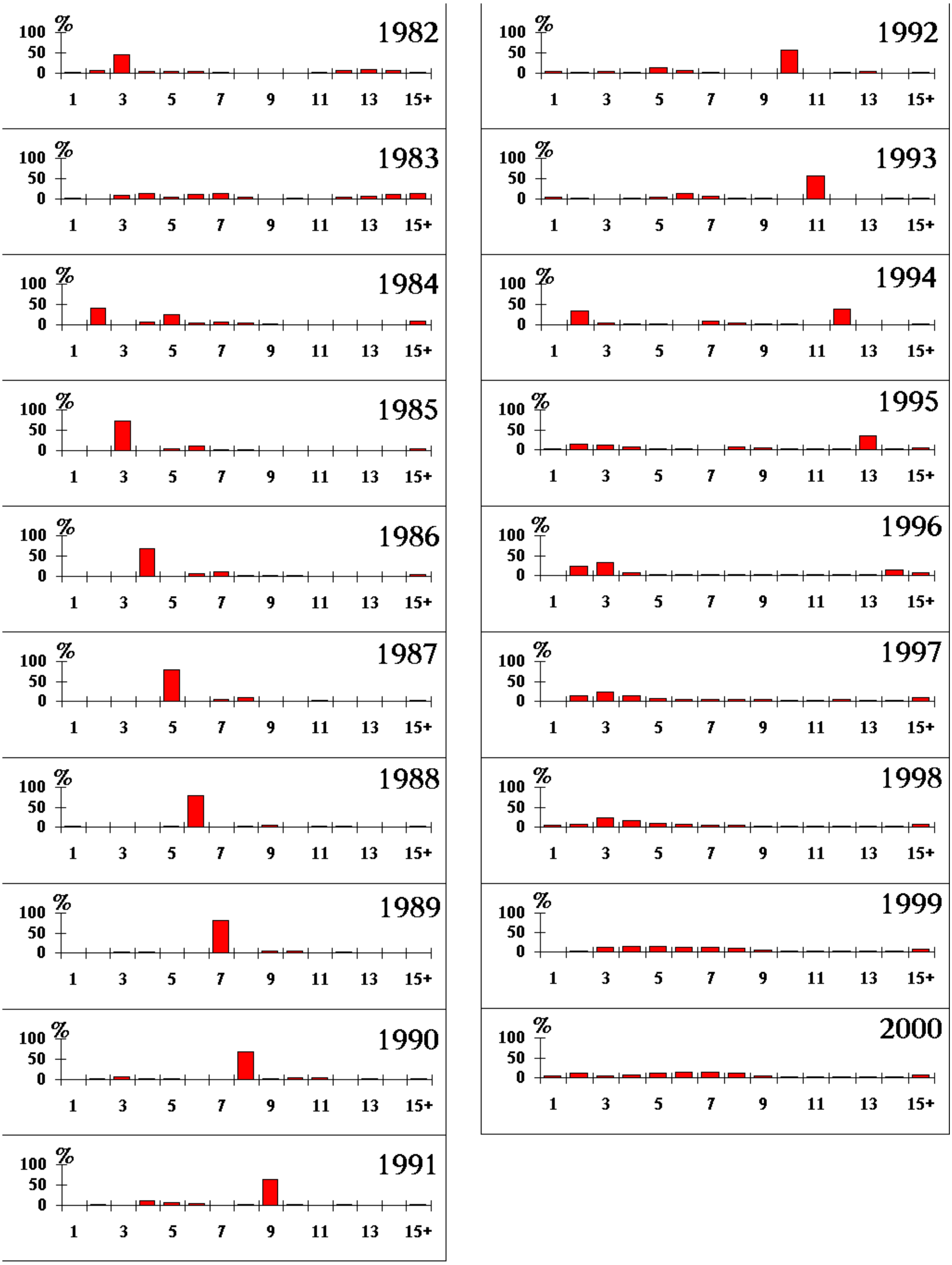


Figure 6.4.1.1 The age composition of the WESTERN HORSE MACKEREL in the international catches during 1982-2000.

6.5 State of the Stock

During last year's working group (ICES CM2001/ACFM:06), data exploration and preliminary modelling were conducted using three model structures, a VPA based 'ADAPT'-type method (Gavaris, 1988), Instantaneous Separable VPA (Kizner and Vasilyev 1997) and the SAD assessment method which combines a Separable VPA and 'ADAPT' method. The Working Group reviewed the time series of population estimates from the fitted SAD model and the limited set of diagnostics and sensitivity analyses that were available at the meeting. Although the SAD model was still at an early stage of development, the Working Group considered that the assessment structure is a more realistic representation of the dynamics of the Western Horse mackerel stock, than the estimates from the ADAPT and Bayesian models. The Working Group recommended that the State of the Stock should be based on the estimates derived from the SAD assessment method. ACFM concurred with the working group recommendation and based its advice on the results from the assessment method. Consequently at this years meeting all data exploration and preliminary modelling were conducted using that model structure.

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

Assessment models constructed for the Western Horse mackerel should take into account the particular characteristics of the catch at age data set. As has been noted in previous Assessment Working Group Reports (ICES 1996/H:2, ICES 1997/Assess:3) the stock has been dominated by a series of strong cohorts, the extremely strong 1982 and the much less abundant 1987 year classes comprising the bulk of the historic catches. In recent years there has been a change in the selection pattern towards increasing exploitation of younger fish, as the 1982 year class diminishes in importance (Figure 6.4.1.1).

The only fishery independent information currently available for calibration of the population model is a time-series of egg survey estimates of spawning biomass (ICES 1999/G:5). As no age disaggregated information is available for model calibration by means of age independent catchability; an assumption of constant selection at age is required. The assumption is valid for recent years in which there are no dominant cohorts. However, the selective nature of the fishery for the abundant 1982 year class ensures that selection at age is not constant in many of the historic years.

In the SAD model, the requirement for different structural models for recent and historic periods has been met by the fitting of linked Separable VPA and ADAPT VPA-based models. The structure is a modification of the ICA model developed by Patterson and Melvin (1996) in which a separable model is applied to recent data and linked to a VPA transformation of historic catch. In the SAD model, separable VPA derived population abundance at age is used to initiate the VPA transformation of the cohorts currently surviving in the population and an ADAPT type model structure is used to estimate the historic non-separable fishing mortalities of the earlier year classes.

Figure 6.5.1.1 presents an illustration of the model structure and the parameters estimated within the non-linear minimisation. The age structure of the assessment, 1 to 11+, aggregates the 1982 year class within the plus group for the years 1993 - 2000, removing its influence on the selection pattern estimated for the cohorts currently dominating the catches. The separable model is fitted to the catch data for the years 1998 - 2000. This is the shortest time period to which the model can be fitted and was selected after consideration of the recent changes in selection, away from the oldest ages towards young age classes ICES (2000/ACFM:5). The separable model estimates of the 1998 population abundance at age initiate a historic VPA for the cohorts exploited in that year. Apart from 1992, population abundance at the oldest age for the years 1997 and earlier is derived from the catch at age data at the oldest age and the average (un-weighted) fishing mortality at ages 7 - 9, in the same year, scaled by a ratio parameter. The ratio is estimated within the model as a parameter. Fishing mortality on the plus group is taken to be equal to that on the oldest age. The ratio parameter allows the model to increase selection at the oldest age and for the plus group, compared to the mid range ages, allowing for directed fishing of older, larger fish. In order to model the directed fishing of the dominant 1982 year class, fishing mortality on this year class at age 10 in 1992 was also estimated as a parameter within the model.

The sum of squares objective function for the model is

$$SSQ = \sum_{y=1983,1989,\ 1992,1995,\ 1998} \left[\ln(EPB_y) - \ln\left(\sum\nolimits_a N_{a,y} . O_{a,y} . W_{a,y} .\exp(-PF.\ F_y . S_a - PM.M\right)\right]^2$$
$$+ \sum_{y=1998}^{2000} \left[\ln(C_{(y,a)}) - \ln(C_{(y+1,a+1)}) - \ln\left(\frac{F_{(y+1,a+1)} \cdot S_{(y+1,a+1)} . Z_{(y,a)} \left(1 - e^{-Z(y+1,a+1)}\right) e^{-Z(y,a)}}{F_y \cdot S_a\ Z_{(y+1,a+1)} \left(1 - e^{-Z(y,a)}\right)}\right)\right]^2$$

Where : N represents the population abundance estimated by a separable VPA for the years 1998 - 2000 and from the VPA transformation for the years 1982 – 1997; F – the separable model annual fishing mortality factor; S – the separable model selection at age factor; M – natural mortality; Z – total fishing mortality (F + M); W – weights at age; O – maturity at age; EPB – the egg production estimates of SSB; PF – the proportion of fishing mortality exerted before spawning; PM – the proportion of natural mortality exerted before spawning; a and y denote age and year respectively.

The objective function does not include the residual for the egg production biomass estimate of 1986. Sensitivity tests of model estimates to the presence or absence of the survey observations (ICES CM2001/ACFM:06) established that the greatest reduction in the objective function is obtained by excluding the 1986 survey from the analysis. The effect of including this observation in the time series is to lower the trajectory of SSB such that the egg survey SSB in the years 1989 and 1992 are under estimated by the model. The over-estimation of spawning stock size by the model in the years 1986 - 1990, is consistent with the known growth pattern of the 1982 year class and has been comprehensively discussed in ICES (1998/Assess:6). There were density dependent reductions in growth and maturity within this year class and imposed by it on contemporary year classes. No data was available for the estimation of the reduced maturity at age during that period and the constant values used within the models are considered to be too high. Given the doubts about the maturity during the early years of when the 1982 year class was present in the stock, the decision was taken to exclude the 1986 survey from the data set to which the model was fitted.

The parameters, estimated by a non-linear minimisation of the sum of squares, are:

1) Fishing mortality on the reference age for the separable model (age 7).
2) The selection at the oldest age relative to that at the reference age.
3) The scaling of the fishing mortality for age 10 and the plus group relative to the average of ages 7 - 9.
4) Fishing mortality on the 1982 year class at age 10 and the corresponding plus group in 1992.

Input data for the model were as presented in Tables 6.5.1.1 and 6.5.1.2. Natural mortality (constant at age and by year at 0.15), maturity at age and stock weights at age and the proportions of F and M before spawning (0.45), are assumed to be known precisely. The egg survey SSB estimates are assumed to be absolute measures of stock abundance, a constraint imposed in order to reduce the number of estimated parameters. Figure 6.5.1.2 presents a comparison of the results from fitting the SAD model to the egg survey estimates of spawning stock biomass; the egg survey estimates of biomass are also plotted. The preliminary estimate of the egg production survey biomass for 2001 is not included in the model minimisation but is illustrated for comparison.

In order to investigate the precision of the parameter estimates derived from the fitted model, the profile of the sum of squares surface was examined. This was carried out by constraining the parameter for which the profile was required at a range of values covering the value estimated at the optimum solution and then searching for the constrained minimum with the remaining three parameters. Plots of the objective function value at the constrained minima against the range of parameter values are presented in Figure 6.5.1.3; they illustrate the curvature of the four dimensional sum of squares surface in the direction of each parameter.

Confidence limits for the estimated parameters can be obtained by making the assumption that the model conditioned on one parameter, is a sub-model of the full model with all parameters minimised (Venables and Ripley 1994). The difference in the sum of squares, scaled by the variance, has an F distribution.

$$\tau = \frac{[\,\mathrm{SSQ}(x,\phi) - \mathrm{SSQ}(\varphi)\,]}{[\,\mathrm{SSQ}(\varphi)/\mathrm{d}\,]} \quad \text{where } \tau \sim \mathbf{F(p,d)}$$

Where p is the difference in the number of parameters between the sub-model and the full model; d the degrees of freedom for the full model; SSQ(x,ϕ) the optimised sum of squares at the constrained value x of the sub-model; ϕ the parameter vector of optimised values for the unconstrained parameters; SSQ(φ) the optimised sum of squares of the full model and φ the parameter vector of optimised parameters for the full model.

The parameter value (x) that gives the F value corresponding to any required confidence interval can be read from the figures or calculated using an iterative process. The horizontal lines on each of the figures present the level of τ at which the 95% confidence interval is derived. The vertical lines indicate the estimated 95% limits for each parameter. The values are listed in the text table below which also presents the optimised parameter values.

Figure 6.5.1.3 illustrates that the τ profiles for the fishing mortality at age 10 in 1992 and the fishing mortality scaling factor at the oldest age for the years 1982 – 1997, are symmetrical about the minimum value. The τ sections for the fishing mortality at age 7 in 2000 and the selection at the oldest age in 1998 – 2000 are asymmetric which results in asymmetric estimates for the confidence intervals.

Model minimisation	Estimate	Lower 95% limit	Upper 95% limit
F at age 10 in 1992	0.19	0.17	0.22
F scaling factor for age 10	1.72	1.62	1.82
F at age 7 in 2000	0.25	0.17	0.29
Selection age 10 in 98 - 00	0.50	0.48	0.68

Table 6.5.1.3. The parameter estimates and confidence intervals calculated for the SAD assessment of the Western Horse mackerel.

During the fitting of the SAD model it was noted that the search algorithm converged to objective function minima with values similar to the optimal solution, but with different solutions for the fishing mortality at age 7 in 2000 and selection at age 10. This suggests a correlation between the parameters and in order to examine this a grid search was carried out over a range of fishing mortality and selection parameter values. A contour map of the τ surface for the two parameters is illustrated in Figure 6.5.1.4. There are indistinguishable minimum values at a reference age fishing mortality of 0.25 and selection at the oldest age of 0.5 and also 0.225 and 0.55 respectively. The surface illustrates a characteristic "banana" shape in the contours of the objective function. This indicates that the parameters are correlated and that the model is over parameterised. The extra information obtained using the egg production biomass component of the objective function has provided a minimum region within the sum of squares surface for the two parameters, but there are still insufficient constraints within the model for a unique definition of the parameter values. This finding is consistent with the observations of the sensitivity of the model results discussed at last year's working group (ICES CM2001/ACFM:06).

Analogous to the searches in one dimension illustrated in Figure 6.5.1.3, the τ surface derived by varying the two parameters can be used to calculate a two-dimensional confidence region within which the reference fishing mortality and selection at age 10 have a 95% probability of occurrence. The central region of Figure 6.5.1.5 illustrates the confidence region. This indicates that the range within which the parameter values are estimated to lie with 95% probability is 0.45 – 0.67 for selection at the oldest age and 0.17 – 0.3 for the reference fishing mortality.

The effect of the uncertainty in the estimates of the model parameters on the estimates of SSB and fishing mortality was examined by selecting a range of paired values for the two model parameters from the confidence region illustrated in Figure 6.5.1.5 and fitting an assessment model to each combination. The results for fishing mortality time series are presented in Figures 6.5.1.6 and Figure 6.5.1.7 and for SSB in Figure 6.5.1.8, in which the egg survey estimate for 2001 is presented for comparison but not included in the model minimisation. Fishing mortality has been gradually increasing since 1988 and SSB declining as the 1982 year class has been removed from the population. The uncertainty in the model parameters has an influence on the perceived trend in fishing mortality during the most recent years, which ranges between remaining stable and a slight decline. The uncertainty in the parameter effects does not change the perception of a declining spawning stock, only the rate of decline.

In a further analysis of the consistency of assessments carried out with the SAD model methodology, a retrospective analysis was performed. The results are presented in Figure 6.5.1.9 where it is seen that, apart from the assessments terminating in 1997, both series show consistency in the trends in the estimates of the stock dynamics.

6.5.2 Stock assessment

The SAD assessment model was fitted to the catch data for the years 1982 - 2000. The years 1998 - 2000 were modelled within the Separable model with a reference age for unit selection of 7 and a terminal selection estimated within the model. The ADAPT structure was applied to the years 1982 - 1997. Apart from 1992, fishing mortality at the oldest age was estimated as a scaling of the fishing mortality at ages 7 - 9 in the same year. The scaling factor was estimated as a parameter within the minimisation. After scaling, the fishing mortality at the oldest age was also used to estimate the population abundance of the plus group. The value of fishing mortality at age 10 in 1992, the oldest age of the 1982 year class (and also that of the plus group in that year), was estimated as a parameter.

The sensitivity analyses carried out in Section 6.5.1 have shown that solution space for the model parameters is not well defined and that several alternative model solutions that have equal probabilities of occurring could be presented as a "final" assessment. In order to present a summary series that shows the trends within the stock dynamics, the solution that gave the lowest sum of squares for the whole of the solution space is presented, although this is considered to be a local minimum. The assessment results for fishing mortality, population abundance at age and the stock summary time series are presented in Tables 6.5.2.1. - 6.5.2.3. The stock summary plots are presented in Figures 6.5.2.1 a - e.

The SAD estimates of SSB increased to a peak value of 2,900,000 t in 1988 following the recruitment of the 1982 year class. With the lack of recruitments of equivalent magnitude, SSB has declined steadily until 2000 (Figure 6.5.2.1e). The 2000 estimate of SSB, at 860,000t, is estimated to be above the historic low that gave rise to the 1982 year class.

Average fishing mortality (Fbar 4-10) is estimated by the model to have fluctuated within the range 0.1 - 0.3 throughout the history of the fishery. Since 1997 the trend in fishing mortality at the oldest ages (4-10) is uncertain (Figure 6.5.1.6). An increase in fishing mortality at the youngest ages has occurred progressively since 1991, but the rate of increase since 1997 is uncertain (Figure 6.5.1.7).

Apart from the strong 1982 year class, recruitment to the stock showed an increasing trend between 1991 and 1994 and is then estimated to have declined. However, the age of full recruitment to the fishery is 5 and catch at age data at the youngest ages is subject to higher relative errors. Given the additional sensitivity of the estimated recruitment to the value selection at the oldest age, recent recruitment trends should be treated with caution.

6.5.3 Reliability of the Assessment

The SAD model is at an early stage of development. The current specification of the separable model structure does not allow completely independent estimation of the selectivity at the oldest age and fishing mortality at the reference age in the final year. A formulation using similar constraints to those used in ISVPA should be considered in future developments. With the gradual reduction in the size of the 1982 year class and a consequent improvement in the assumption of the separability of fishing mortality, the assessment of this stock should become more stable. Future work should examine the sensitivity of the model to extension of the period of separability, especially back to the 1995 egg survey estimate. Estimates of the uncertainty of the parameter estimates have been calculated, but the method has not been fully tested and the influence of parameter correlation has not been fully evaluated.

6.6 Catch Prediction

A calculation of the consequences of different short-term catch options was made from the results of the SAD assessment. The biological input data for the catch predictions are given in Table 6.6.1. As discussed in section 6.5.1, the model parameter estimates derived from the separable VPA component are correlated and there is no unique solution. Therefore, in order to provide a catch prediction that reflects the uncertainty in the parameter values, pairs of values were selected from within the 95% confidence region illustrated in Figure 6.5.1.5. An assessment model was fitted to each combination and carried forward into a short term forecast for 2002 and 2003. The forecast is considered to reflect the uncertainty in the model structure in a more realistic way than a simple bootstrap procedure of the residuals about the local minimum solution. Table 6.6.1 lists the population numbers in 2001 and the fishing mortality in 2000 estimated using each parameter pairing.

The following assumptions were made for each of the fitted assessments and projections:

1. Recruitment in 2000 and the following years was taken as the geometric mean of the years 1983 - 1999, excluding the strong 1982 year class.

2. Exploitation in 2001 and later was assumed to follow the selection pattern estimated for the period 1998 – 2000, scaled to the final year.

3. Weights at age in the stock and in the catch, and maturity in years 2000 and later, were taken as the average of the years 1998 to 2000.

In addition to the deterministic forecast two fishing mortality management reference points ($\mathbf{F}_{0.1}$, F 35% SPR) were calculated using the results from each assessment, allowing comparison with the estimated average fishing mortality.

The results of the deterministic catch prediction are presented in Table 6.6.2. In order to be consistent with other prediction tables presented within ICES reports, the tables are given in the form of one short-term forecast table for each selected parameter pairing. For all parameter combinations, if the fishing mortality in 2001 is the same as in 2000 the catch will decrease below the 175000 t recorded for 2000. Continued fishing at the fishing mortality level estimated for 2000 will result in a further reduction of yield in 2001. For all parameter combinations, fishing at the forecast levels continues the decline in SSB throughout 2002 and 2003.

6.7 Short and medium term risk analysis

The assessment of this stock is currently under development. At this stage in the analysis estimates of the uncertainty associated with parameters has not been fully tested and therefore short and medium term risks have not been evaluated.

6.8 Long-Term Yield

Table 6.8.1 and Figure 6.8.1 present the yield per recruit forecasts calculated from the selection pattern estimated within the separable model and catch and stock weight, maturity and natural mortality at age averaged over the last three years of the assessment. For consistency the values are taken from the assessment at the local minimum solution of the objective function, as discussed in Section 6.5.2.

$\mathbf{F}_{max}$ is poorly defined at a combined reference F of about 0.45. However, for pelagic species $\mathbf{F}_{max}$ is generally estimated to be at levels of F well beyond sustainable levels and should not be used as a fishing mortality target.

The time series of stock and recruitment estimates for this management unit are short. The estimates of $\mathbf{F}_{med}$, $\mathbf{F}_{high}$ and $\mathbf{F}_{low}$ for short time series will be unreliable.

Predictions with a range of parameter combinations from the SAD model solution surface for the estimated parameters were used to estimate $\mathbf{F}_{0.1}$ reference points. The estimated value of $\mathbf{F}_{0.1}$ was extremely stable with a range of 0.17 – 0.18. This compares with an estimate of 0.15 from the SAD model fitted at the last working group. The average fishing mortality for 2000 (Fbar(4-10)) was estimated, using the confidence region for the model parameters, to lie in the range 0.16 – 0.25, at the same level as, or greater than $\mathbf{F}_{0.1}$. F35%SPR is estimated to be in the range 0.12 – 0.14, last year it was estimated to be 0.15.

6.9 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 $\mathbf{B}_{pa}$ 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. The egg survey biomass estimate in 1983 was 530,000 t, the current SAD assessment estimate for 1982 is 560,000. 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 500,000 t should be used as $\mathbf{B}_{pa}$.

In Section 6.5.3 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 $\mathbf{B}_{pa}$.

Fishing mortality reference points

Model development for the assessment of this stock is incomplete. Two fishing mortality reference points have been calculated from the current implementation, they are $\mathbf{F}_{0.1}$ (0.17 – 0.18) and F35%SPR (0.12 – 0.14). Both values were estimated to be 0.15 by the previous year's assessment.

ACFM has not defined any fishing mortality reference points for this stock but in its advice it has used $\mathbf{F}_{0.1}$ as the highest F that is consistent with the Precautionary Approach.

6.10 Harvest control rules

The stock is at present in a transition from harvesting the large 1982 year class to the fishing of younger ages. Given the early stage in the development cycle of the SAD model it was considered that the definition of Harvest control rules would, currently, be inappropriate. Further development work for the estimation of uncertainty and on the sensitivity of the model to the imposed structural constraints, will allow an evaluation of Harvest control rules in the near future.

6.11 Management Considerations

This stock has been dependent on the abundant 1982 year class for many years and there have been no equivalent year classes of this magnitude. 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 6.4.1.1 and Table 6.5.1.1 show a clear change in the age-structure of the catches from older to younger fish since 1996.

The Working Group expresses concern about this high exploitation rate of juvenile fish at a time when the TAC is considered too high for the long-term exploitation of the stock. Juvenile fisheries are common in many pelagic stocks and harvesting strategies have been developed that allow a balance of competing market demands (Herring WG 1999). In general the TAC for fisheries which heavily exploit juveniles, is lower than an adult fishery, to account for the inherent variability in the targeted year classes and the loss of potential yield. If the current increase in targeted juvenile mortality continues, landings will have to be reduced at a faster rate than that for an adult fishery. The Working Group recommends that a management strategy similar to that for North Sea Herring, in which both adult and juvenile mortality are independently restricted, be explored for this stock.

If the fishing mortality in 2001 is the same as in 2000 the catch will decrease below the 175 000 t recorded for 2000. For all parameter combinations continued fishing at the level estimated for 2000 will result in a further reduction of catch in 2001. The decline in SSB is estimated to continue throughout 2002 and 2003.

The 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 6.5.1.1: Western Horse Mackerel: Input to SAD

a. Catch in numbers (thousands)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0	0	0	123	0	181
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843	4036	3726	71802	11551	57665
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412	615759	417131	153811	51232	113043
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838	841304	703245	464537	166912	41346
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181	157053	390131	340241	221663	62114
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812	67924	231570	206255	233540	132496
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565	45939	112433	141961	198856	140014
7	6013	37775	29105	9808	79428	34886	10613	1159554	19305	19000	42840	124050	205842	26425	48597	120131	111607	175297	153776
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028	49091	122121	74827	136735	119389
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838	44193	103944	64746	72017	54766
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799	48439	95516	47935	33058	15337
11+	55306	92614	44421	31785	41126	52690	66659	71705	211999	132370	149030	1285690	992582	1354115	718074	585684	378334	247613	157285

b. Proportion of fish mature at start of year

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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

Table 6.5.1.2 : Western Horse Mackerel: Input to SAD

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

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	0.000	0.023
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	0.057	0.059
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	0.087	0.094	0.083
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	0.110	0.097
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	0.122	0.128
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	0.142	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	0.164	0.157
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	0.188	0.161
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	0.207	0.195
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	0.216	0.212
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	0.225	0.243
11+	0.352	0.319	0.306	0.319	0.356	0.342	0.413	0.432	0.358	0.329	0.357	0.250	0.249	0.249	0.277	0.270	0.250	0.316	0.295

b. Mean weight at age in the stock (kg)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	0.110	0.087
4	0.207	0.171	0.122	0.148	0.105	0.105	0.105	0.105	0.105	0.121	0.105	0.105	0.105	0.119	0.118	0.112	0.108	0.120	0.108
5	0.232	0.227	0.155	0.140	0.134	0.126	0.126	0.103	0.127	0.137	0.133	0.153	0.147	0.096	0.129	0.124	0.129	0.130	0.148
6	0.269	0.257	0.201	0.193	0.169	0.150	0.141	0.131	0.135	0.143	0.151	0.166	0.185	0.152	0.148	0.162	0.142	0.160	0.170
7	0.280	0.276	0.223	0.236	0.195	0.171	0.143	0.159	0.124	0.144	0.150	0.173	0.169	0.166	0.172	0.169	0.151	0.170	0.173
8	0.292	0.270	0.253	0.242	0.242	0.218	0.217	0.127	0.154	0.150	0.158	0.172	0.191	0.178	0.183	0.184	0.162	0.180	0.193
9	0.305	0.243	0.246	0.289	0.292	0.254	0.274	0.210	0.174	0.182	0.160	0.170	0.191	0.187	0.185	0.188	0.174	0.190	0.202
10	0.369	0.390	0.338	0.247	0.262	0.281	0.305	0.252	0.282	0.189	0.182	0.206	0.190	0.197	0.202	0.208	0.191	0.210	0.257
11+	0.352	0.311	0.287	0.306	0.342	0.317	0.366	0.336	0.345	0.333	0.287	0.222	0.235	0.233	0.238	0.238	0.215	0.222	0.260

Table 6.5.2.1 The fishing mortality at age estimated by the SAD assessment model for the Western Horse mackerel, at the lowest local minimum.

F	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.005	0.000	0.000	0.001	0.000	0.000	0.006	0.000	0.009
2	0.012	0.004	0.005	0.015	0.000	0.000	0.002	0.000	0.018
3	0.047	0.024	0.010	0.016	0.005	0.000	0.001	0.009	0.045
4	0.031	0.024	0.033	0.012	0.020	0.013	0.007	0.015	0.033
5	0.040	0.054	0.087	0.047	0.025	0.037	0.112	0.010	0.033
6	0.048	0.185	0.104	0.075	0.085	0.008	0.050	0.116	0.025
7	0.060	0.318	0.242	0.076	0.097	0.080	0.060	0.087	0.234
8	0.076	0.167	0.354	0.148	0.193	0.121	0.101	0.078	0.126
9	0.020	0.216	0.204	0.096	0.256	0.140	0.124	0.212	0.352
10	0.090	0.401	0.458	0.183	0.312	0.195	0.163	0.215	0.407
+gp	0.090	0.401	0.458	0.183	0.312	0.195	0.163	0.215	0.407

F	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.001	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.012	0.035	0.022	0.003	0.011	0.001	0.004	0.070	0.081	0.082
2	0.026	0.018	0.025	0.253	0.105	0.175	0.190	0.237	0.274	0.277
3	0.007	0.044	0.007	0.064	0.175	0.306	0.294	0.326	0.377	0.381
4	0.080	0.030	0.043	0.051	0.158	0.096	0.214	0.199	0.229	0.232
5	0.089	0.135	0.061	0.040	0.067	0.071	0.189	0.168	0.194	0.196
6	0.089	0.099	0.238	0.024	0.105	0.073	0.152	0.166	0.191	0.193
7	0.058	0.070	0.146	0.234	0.028	0.076	0.261	0.215	0.248	0.251
8	0.407	0.054	0.139	0.138	0.419	0.063	0.262	0.277	0.320	0.324
9	0.152	0.687	0.121	0.103	0.237	0.124	0.174	0.248	0.286	0.290
10	0.353	0.189	0.232	0.272	0.392	0.150	0.398	0.107	0.124	0.125
+gp	0.353	0.189	0.232	0.272	0.392	0.150	0.398	0.107	0.124	0.125

Table 6.5.2.2 The population numbers at age estimated by the SAD assessment model for the Western Horse mackerel, at the lowest local minimum

N	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	48822143	370110	1078406	2230104	3552464	5025940	3404399	2676167	2023982
1	511677	42021608	318557	928193	1919469	3057634	4325866	2929481	2303398
2	1273667	438064	36163075	274184	797727	1652102	2631653	3701065	2521428
3	2127737	1082970	375535	30955437	232465	686610	1421593	2260117	3185536
4	272225	1746411	910231	320092	26209648	199046	590971	1221870	1927804
5	246371	227047	1467548	757818	272294	22104818	169023	505076	1036269
6	182242	203733	185211	1157367	622163	228506	18331465	130064	430250
7	110931	149455	145721	143633	923919	491758	195072	15012706	99730
8	16440	89900	93592	98421	114527	721536	390895	158054	11845787
9	15182	13109	65453	56536	73073	81310	550315	304010	125889
10	14076	12807	9094	45917	44199	48674	60842	418504	211650
+gp	693824	300429	129433	203980	164471	319981	475402	397489	679245

N	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	3017831	5321818	6014130	5635975	3506518	1094974	513813	368437	912290	1994428	
1	1742058	2594475	4569008	5176410	4848781	3018088	942453	442243	317002	785216	1699848
2	1964817	1481247	2155312	3845142	4441160	4126215	2593948	807720	354743	251543	622448
3	2131071	1647307	1252618	1809153	2570498	3440857	2980200	1845642	548308	232184	164083
4	2621068	1821260	1356452	1070995	1460081	1857273	2181059	1912651	1146091	323820	136488
5	1605874	2082106	1520991	1118460	875925	1072843	1452865	1515313	1349457	784283	220968
6	862984	1265006	1565975	1231412	925125	704919	860388	1035655	1102466	956758	554725
7	361151	679385	986173	1062687	1034873	716880	564110	636234	755426	783959	678747
8	67928	293218	545007	733721	723694	866208	571939	374083	441729	507443	525003
9	8992137	38900	239200	408056	550094	409483	700008	378975	244048	276162	315998
10	76186	6650489	16847	182456	316849	373424	311445	506069	254517	157768	177900
+gp	477044	931585	6664730	4476851	4478645	5535752	1909716	3994226	2283823	1434072	1208541

Table 6.5.2.3 The population summary time series estimated by the SAD assessment model for the Western Horse mackerel, at the lowest local minimum

YEAR	RECRUITS Age 0	Biomass (tonnes)	SSB (tonnes)	TOTAL INT. LANDINGS(tonnes)	Fbar (4 - 10)	Fbar (2 - 6)
1982	48822143	686624	558571	41588	0.05	0.04
1983	370110	678062	564279	64862	0.19	0.06
1984	1078406	2325364	599751	73625	0.21	0.05
1985	2230104	3045671	1390655	80521	0.09	0.03
1986	3552464	3249127	1922743	105665	0.14	0.03
1987	5025940	3355162	2451866	156247	0.08	0.01
1988	3404399	3369265	2868682	188100	0.09	0.03
1989	2676167	3273254	2630778	268867	0.10	0.03
1990	2023982	2925231	2235474	373463	0.17	0.03
1991	3017831	2801163	2135225	333600	0.18	0.06
1992	5321818	2497415	1934526	368200	0.18	0.07
1993	6014130	2633786	2031935	432000	0.14	0.07
1994	5635975	2326964	1705023	347842	0.12	0.09
1995	3506518	2300034	1567332	512995	0.20	0.12
1996	1094974	2747804	1977956	396448	0.09	0.14
1997	513813	1783205	1145086	442571	0.24	0.21
1998	368437	1934829	1485965	303543	0.20	0.22
1999	912290	1381024	1092142	273888	0.23	0.25
2000		1049658	862540	174927	0.23	0.26

Table 6.6.1. The input data for the deterministic short term stock forecasts for the Western Horse mackerel. Each fishing mortality and population number vector is based on an assessment fitted using parameter values selected from the 95% confidence region of the SAD assessment model objective function parameter surface.

M	Catch weight	Stock weight	Prop of F	Prop of M	Maturity
0.15	0.012	0.000	0.45	0.45	0.00
0.15	0.052	0.000	0.45	0.45	0.00
0.15	0.088	0.050	0.45	0.45	0.07
0.15	0.103	0.096	0.45	0.45	0.30
0.15	0.121	0.112	0.45	0.45	0.67
0.15	0.141	0.136	0.45	0.45	0.90
0.15	0.161	0.157	0.45	0.45	1.00
0.15	0.174	0.165	0.45	0.45	1.00
0.15	0.195	0.178	0.45	0.45	1.00
0.15	0.207	0.189	0.45	0.45	1.00
0.15	0.227	0.219	0.45	0.45	1.00
0.15	0.287	0.232	0.45	0.45	1.00

F at age 7	0.28		0.25		0.23		0.20		0.18		0.18	
Selection	0.50		0.50		0.55		0.60		0.63		0.68	
	Staus quo F	N 2001	Staus quo F	N 2001	Staus quo F	N 2001	Staus quo F	N 2001	Staus quo F	N 2001	Staus quo F	N 2001
	0.00	1974942	0.00	1974942	0.00	2051694	0.00	2146487	0.00	2268513	0.00	2265747
	0.08	1699849	0.08	1699849	0.07	1765910	0.06	1847499	0.05	1952527	0.04	1950147
	0.28	622449	0.28	622449	0.23	757564	0.19	933972	0.16	1138151	0.15	1199687
	0.38	164083	0.38	164083	0.32	199539	0.27	245090	0.22	297663	0.21	312304
	0.23	136488	0.23	136488	0.20	167895	0.16	207875	0.14	254342	0.13	266043
	0.20	220968	0.20	220968	0.17	266813	0.14	324388	0.12	391969	0.12	406885
	0.19	554725	0.19	554725	0.17	655380	0.15	779689	0.13	927529	0.13	953304
	0.25	678748	0.25	678748	0.23	783858	0.20	911809	0.18	1067931	0.18	1084316
	0.32	525004	0.32	525004	0.30	593673	0.27	676788	0.24	783753	0.24	784167
	0.29	315998	0.29	315998	0.27	349177	0.26	390000	0.23	448645	0.24	438677
	0.13	177900	0.13	177900	0.12	189425	0.12	204818	0.11	232632	0.12	220601
	0.13	1208542	0.13	1208542	0.12	1226371	0.12	1267089	0.11	1397878	0.12	1288494

Stock numbers - thousands
Weights - kilograms

Table 6.6.2. The results of a series of deterministic short term stock forecasts for the Western Horse mackerel. Each forecast is based on an assessment fitted using parameter values selected from the 95% confidence region of the SAD assessment model objective function parameter surface.

Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.275	0.500	0.253	152572	547184	0.10	60400	442246	406208
					0.15	88383	433813	381257
					0.18	101857	429668	369451
	F0.1	0.175			0.20	114999	425570	358067
	F35%SPR	0.12			0.25	140325	417510	336500
					F2000	141923	416994	335155

Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.251	0.500	0.230	155367	612273	0.10	67227	499914	457065
					0.15	98365	490337	428942
					0.18	113356	485630	415635
	F0.1	0.175			0.20	127976	480976	402804
	F35%SPR	0.12			0.25	156147	471824	378497
					F2000	145176	475418	387898

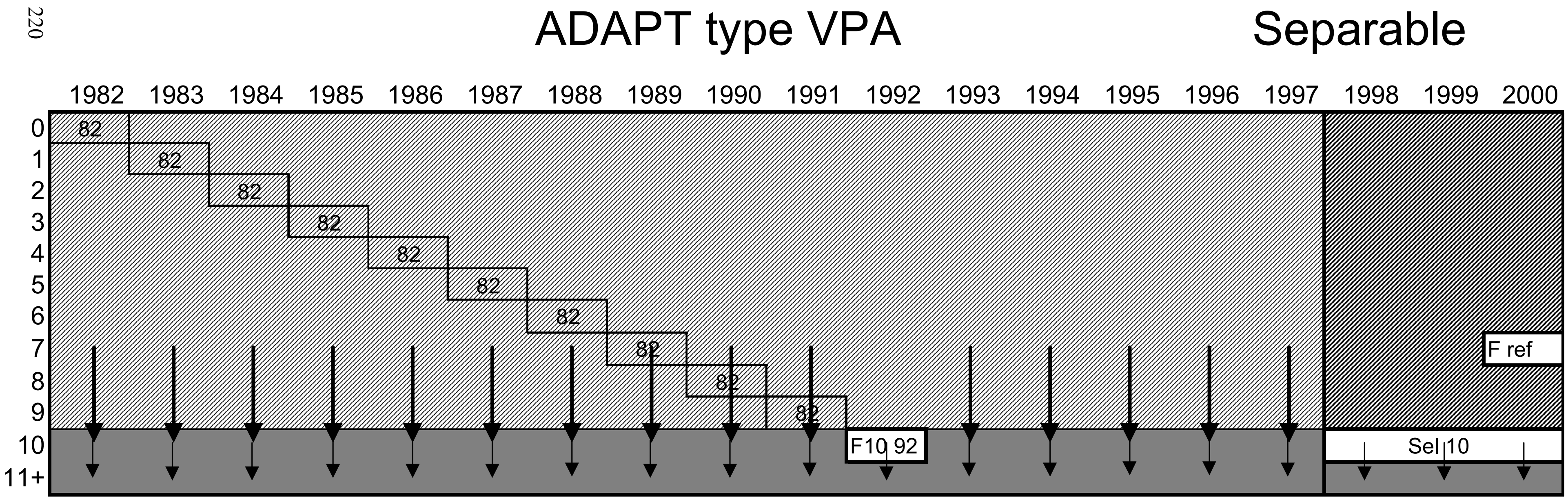
Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.225	0.550	0.208	160080	673691	0.10	76248	556347	509007
					0.15	111548	545057	476192
					0.18	128538	539511	460682
	F0.1	0.175			0.20	145105	534029	445737
	F35%SPR	0.13			0.25	177017	523257	417457
					F2000	150181	532335	441194

Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.200	0.600	0.186	164990	753942	0.10	87536	630707	577460
					0.15	128034	617292	538807
					0.18	147519	610705	520556
	F0.1	0.175			0.20	166515	604197	502984
	F35%SPR	0.13			0.25	203090	591415	469767
					F2000	155885	607850	512790

Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.175	0.675	0.165	171012	854122	0.10	102349	725405	665942
					0.15	149644	709147	619476
					0.18	172626	716525	609009
	F0.1	0.175			0.20	194546	693291	576498
	F35%SPR	0.14			0.25	237191	677827	536730
					F2000	163445	704319	606147

Parameter estimates		2001			2002			2003
F7 2000	**Selection**	**F = F2000**	**Catch**	**SSB**	**F**	**Catch**	**SSB**	**SSB**
0.175	0.625	0.163	169434	873413	0.10	102462	740543	676841
					0.15	149838	724433	630756
					0.18	172385	701170	597569
	F0.1	0.174			0.20	194837	708713	588078
	F35%SPR	0.13			0.25	237591	693374	548536
					F2000	161540	720385	619555

Table 6.8.1



Model estimated parameters

F10 92	Fishing mortality on the 1982 year class at age 10 in 1992
F ref	Fishing mortality on the reference age in 1999
	The raising factor which scales fishing mortality at age 10 relative to the avererage of ages 7 - 9

Model constraints

Sel 10	Selection at age 10 in the separable model

Figure 6.5.1.1 An illustration of the SAD model structure used for the assessment of the Western horse mackerel stock. and the parameters estimated within the least squares minimisation.

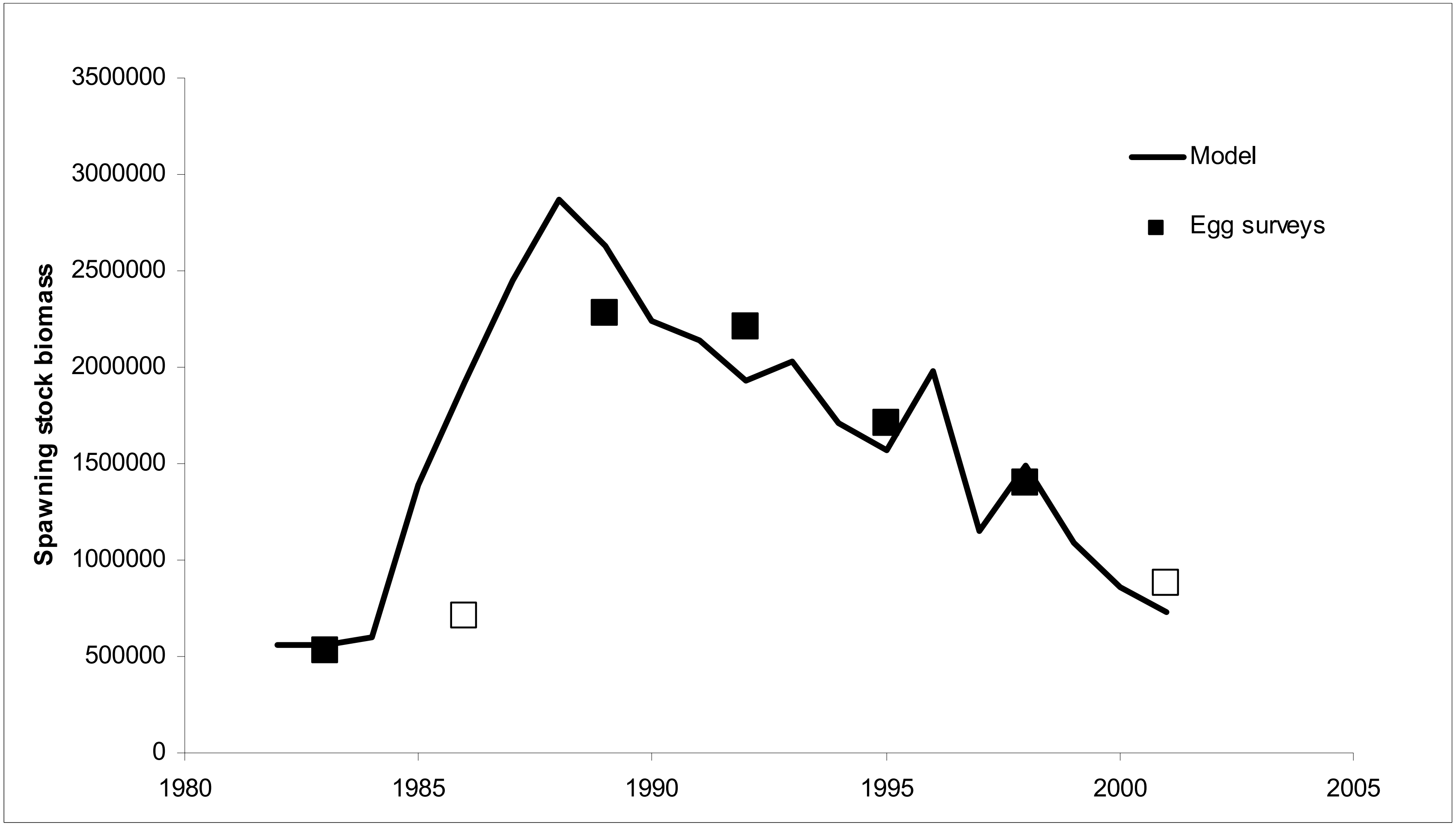


Figure 6.5.1.2 A comparison of the spawning stock biomass as estimated by the SAD assessment model at the lowest local minimum of the objective function and the triennial egg production biomass estimates. The estimates with hollow boxes are not included in the observations to which the model is fitted. The egg production estimate for 1986 is considered to be valid however data for the density dependent effects of the strong 1982 year class are not available to fit the model in that period. The estimate for 2001 is provisional.

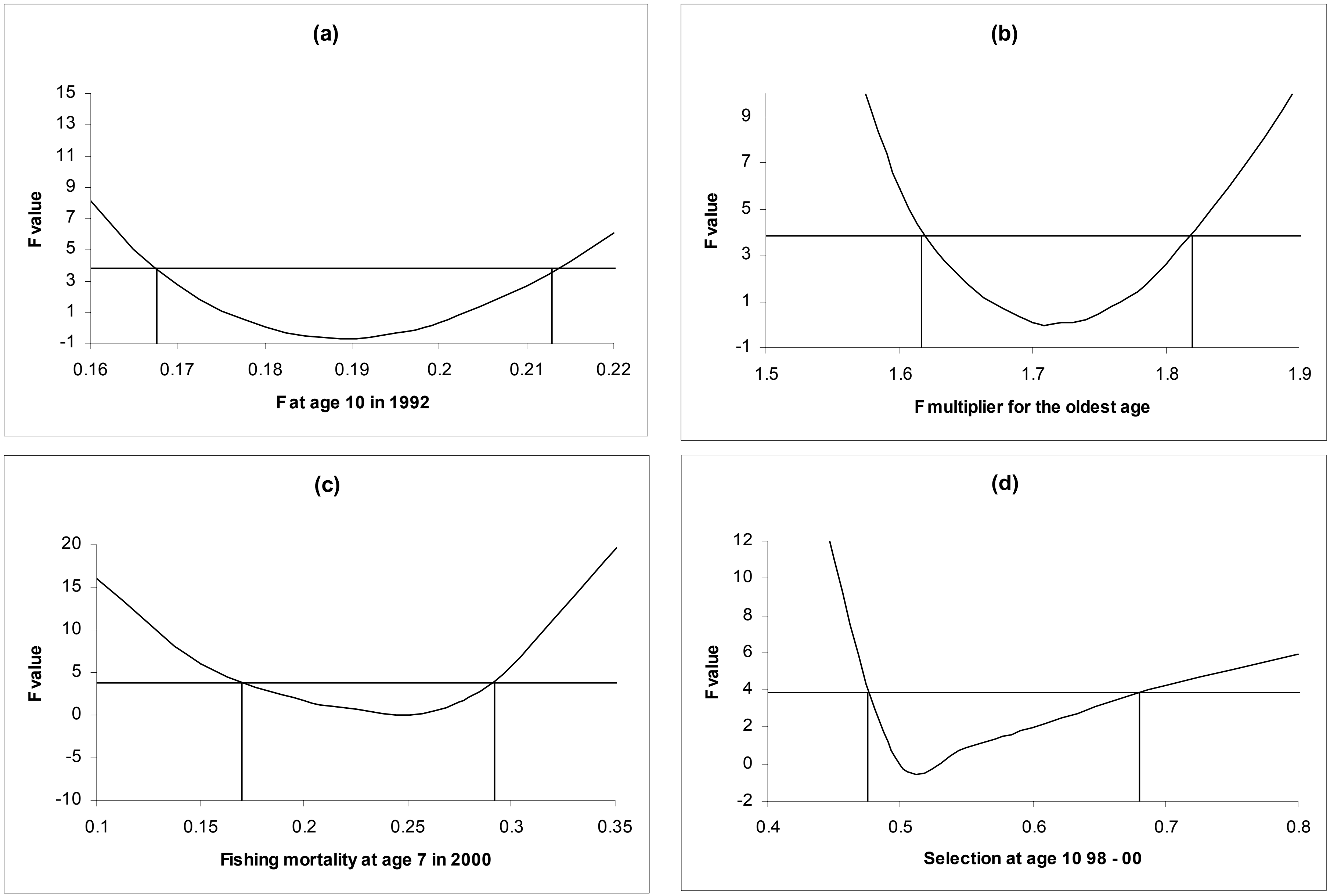


Figure 6.5.1.3 Plots of the objective function value at constrained values of the interest parameters against the parameter values.
The horizontal line represents the value of the objective function above which there is a only a 5% probability that the parameter value lies in that region. The vertical lines therefore indicate the 95% confidence limits for the parameters.

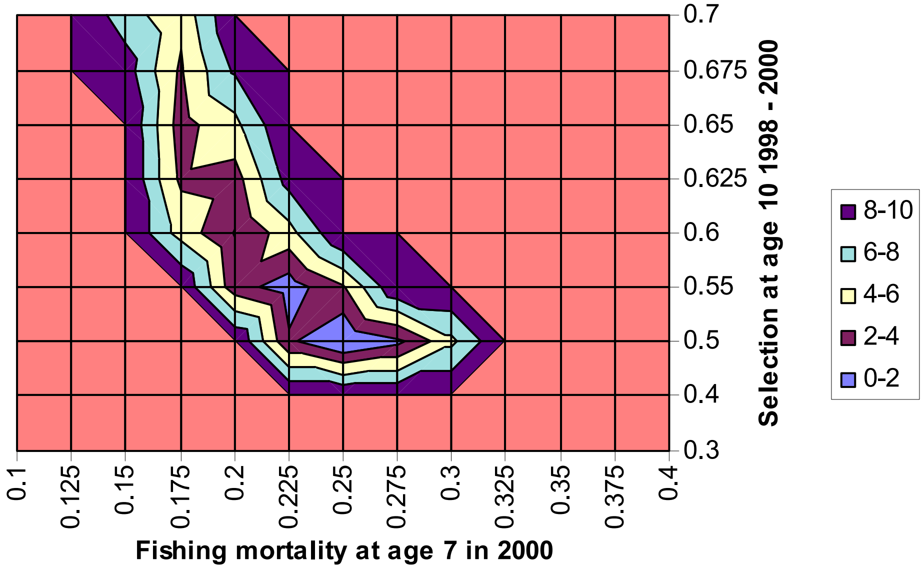


Figure 6.5.1.4 A contour map of the F statistic surface for a grid search of the SAD model objective function for the parameters of the separable model component. The curvature of the minima indicates parameter correlation.

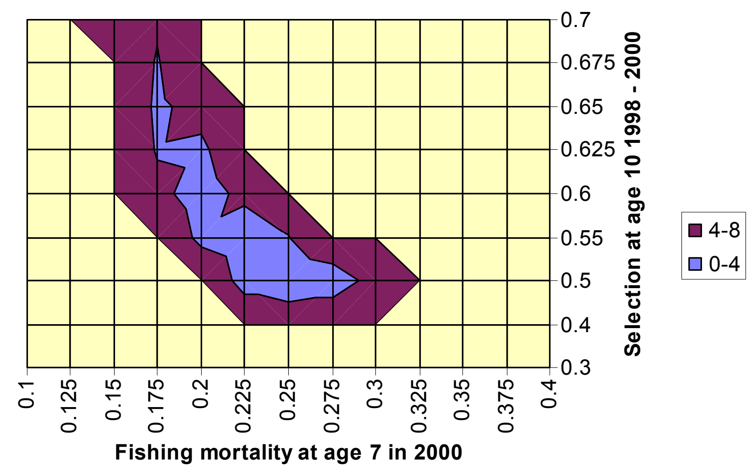
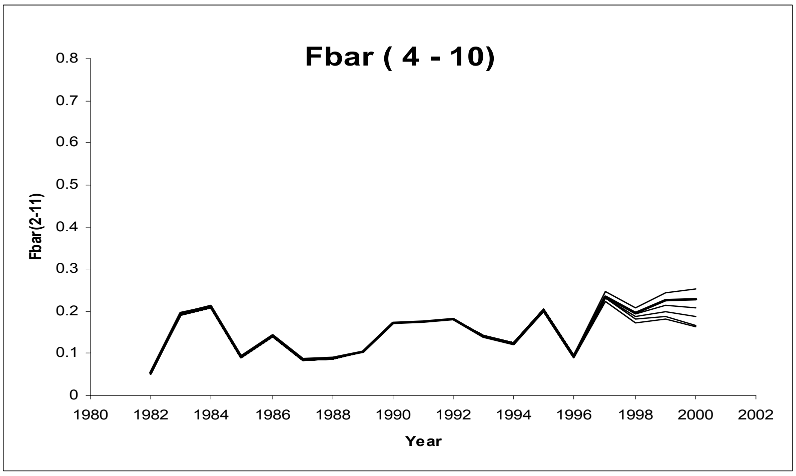
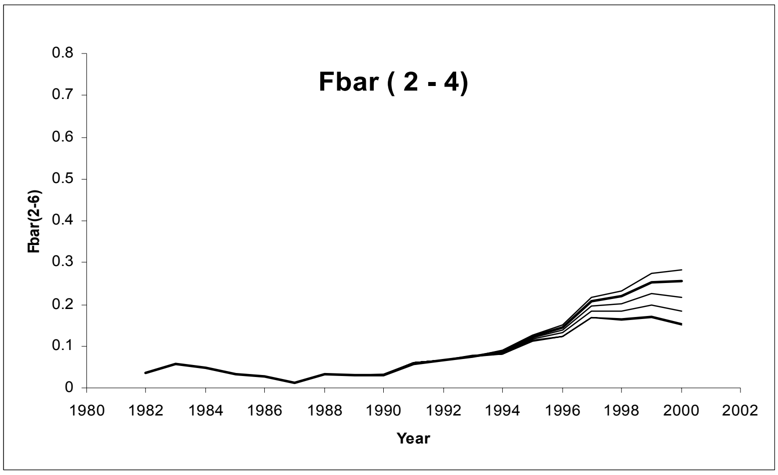
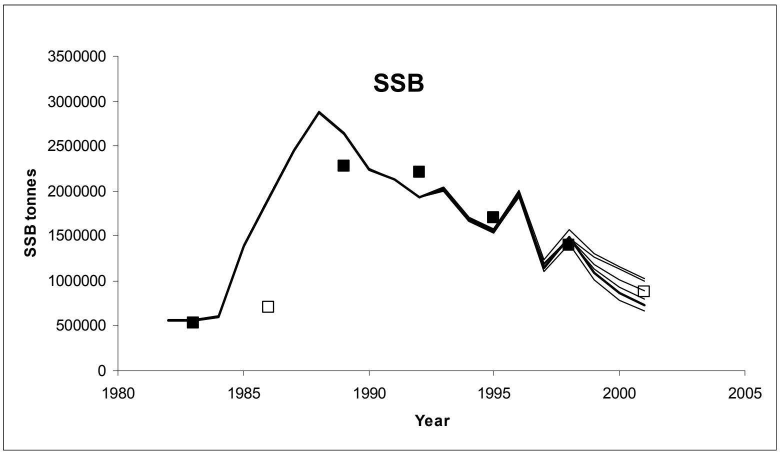


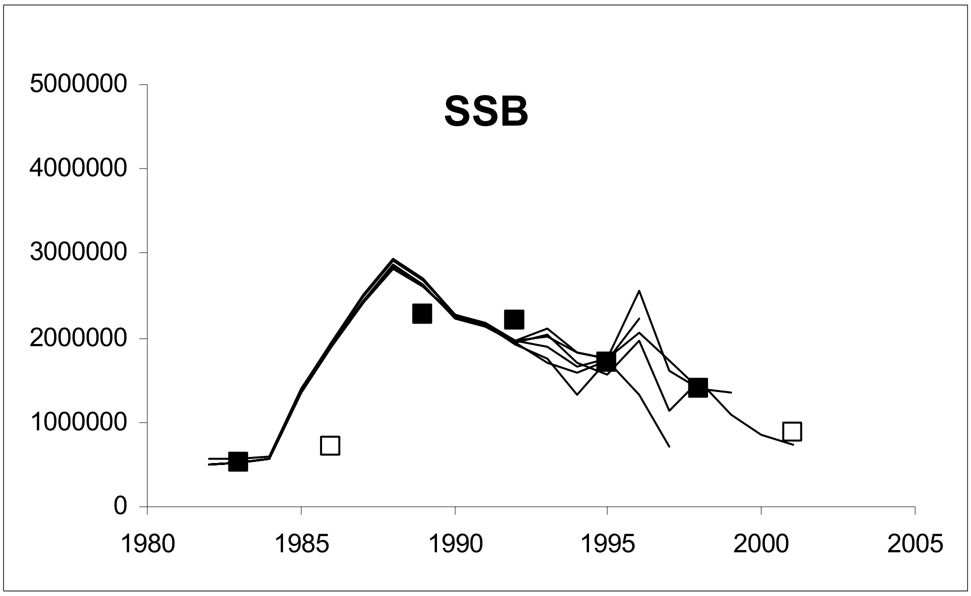
Figure 6.5.1.5 A contour map of the F statistic surface for a grid search of the SAD model objective function for the parameters of the separable model component. The central region of the surface indicates the 95% confidence interval

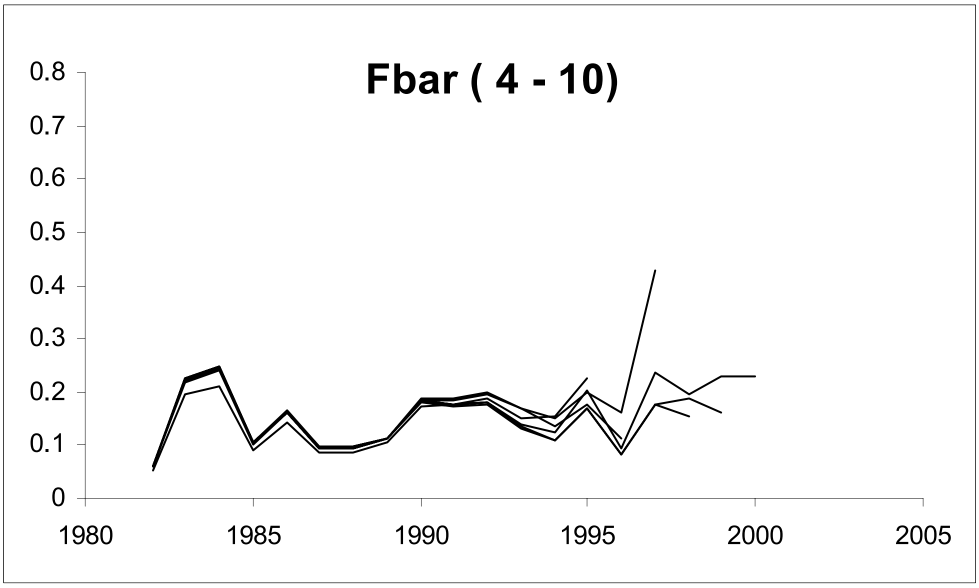






Figures 6.5.1.6 – 6.5.1.8 The time series of fishing mortality and spawning stock biomass estimates resulting from assessments performed with fishing mortality at age 7 and selection at the oldest age parameter pairs selected from the 95% confidence region of the SAD assessment model objective function surface.





Figures 6.5.1.9 – 6.5.1.10 The time series of fishing mortality and spawning stock biomass estimates resulting from retrospective assessments performed with the SAD assessment model.

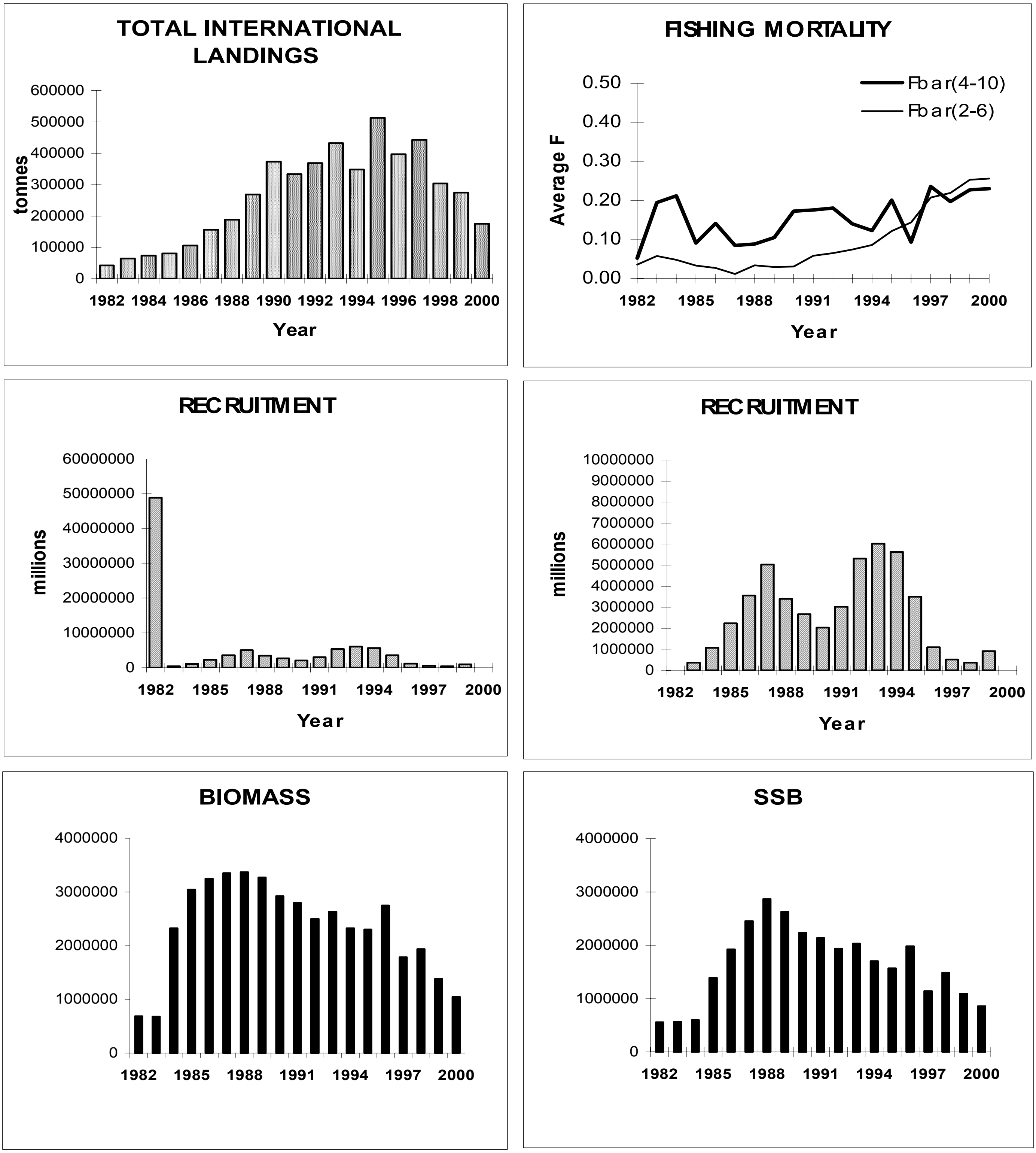
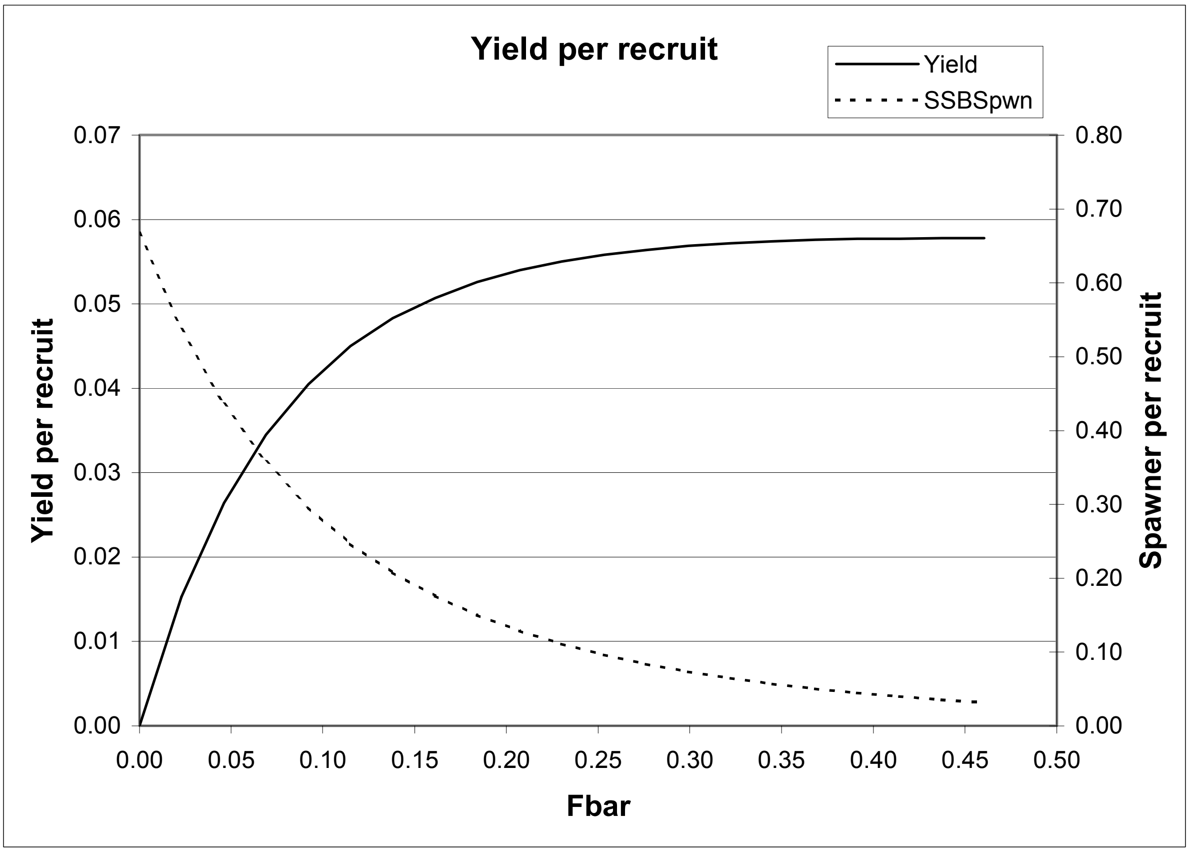


Figure 6.5.2.1 The stock summary plots for the Western Horse mackerel obtained at the SAD model lowest local minimum.

a) Landings b) Average fishing mortality ages 4 - 10 & 2 - 6.
c) Recruitment 1982 - 1999 d) Recruitment 1983 - 1999
e) Stock biomass e) Spawning stock biomass



MFYPR version 2a
Run: 2001wg
Time and date: 15:19 12/09/01

Reference point	F multiplier	Absolute F
Fbar(4-10)	1.0000	0.2302
FMax	1.9449	0.4478
F0.1	0.7603	0.1750
F35%SPR	0.5312	0.1223

Weights in kilograms

Figure 6.8.1 The results of a deterministic yield per recruit for the Western Horse mackerel stock calculated using the SAD model estimates at the lowest local minimum

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIC AND IXA)

7.1 ICES advice Applicable to 2000 and 2001

ICES stated that fishing mortality should be below $\mathbf{F}_{pa}$ (= 0.17), corresponding to landings of less than 50,000 t in 2001. ICES recommended that the TAC for this stock should only apply to *Trachurus trachurus.* The TAC for all *Trachurus* species up to 1999 was 73,000 t, and 68, 000 t in 2000 and 2001.

7.2 The Fishery

7.2.1 The Fishery in 2000

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 48,138 t in 2000 which represents a decrease of 7.3 % compared to the 1999 catches. This level of catch is in the interval of mean level of catches obtained during the period 1990-1999: 52,623 t (± 5,863). The catch by country and gear is shown in Table 7.2.1.1. The Portuguese catches show the same low level as obtained in 1999. In the Spanish catches there is a decrease of 9.9% compared to 1999 catches, due to the significative reduction in purse seiners catches (- 14.5%). The high level of Spanish catches reached on this stock during 1997, 1998 and 1999 was due to the higher catches obtained by the purse seiners. The falls in abundance of other target species, like sardine in the Spanish area, forced the purse seine fisheries to target other species like horse mackerel (ICES CM 1999/ACFM:6). The 2000 proportion of the catches by gear presents a similar pattern than in 1997-1999, 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 (55.6 % of the catches).

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 above all the third quarter show relatively higher catches (see Table 7.2.1.2).

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 moment 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).

7.2.2 The fishery in earlier years

ACFM asked to review the present perception of the state of the stock in the light of the very high catches reported in the period 1962-1978. To investigate further this question historical catches were recovered covering the period between 1927-1998 for Portugal and 1939-1998 for Spain (WD Murta & Abaunza, 2000). An attempt was also made to obtain a rough measure of abundance of stock estimating CPUE indices. Therefore, a CPUE indices was obtained from the Portuguese trawl fleet, covering the periods 1938-1955 and 1990-98. It is clear from the catch data that the current catch level is not abnormally low when compared with the catches from the 1st half of the 20th century. Instead, the catches from 1962-1978 appear exceptionally high when looking at the whole time series. More work is needed, in particular getting better effort indices and investigating the probability of the existence of one or more strong year-classes. The Working Group recommends that the work should be completed to examine effort data in the years prior to 1985, in order to understand the large fluctuations in the catches in previous years.

Table 7.2.1.1.- Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984–2000 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
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
1999	6,866	5,705	1,849	14,420	10,015	27,332	29	126	37,502	51,922
2000	7,971	4,209	2,168	15,348	10,144	23,373	59	214	33,790	49,138

[1]Estimated value. [2]Not available by gear.

Table 7.2.1.2.- Southern horse mackerel catches by quarter and area.

Country/Sub-division	Spain VIIIc-E, VIIIc-W, IXa-N		Unit:tonnes		Total
Quarter/ Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34109
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
1999	7715	9589	12027	8170	37502
2000	7405	8694	11012	6679	33790

Country/ Sub-division	Portugal IXa-CN, IXa-CS, IXa-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
1999	3479	3991	4023	2927	14420
2000	3000	5849	4258	2241	15348

7.3 Biological Data

7.3.1 Catch in numbers at age

The catch in numbers at age from all gears for 2000 are presented by quarter and area, and 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, but has almost dissappeared in the most recent years. The 1986 and 1987 year classes are strong but do not reach the extreme high level of the 1982 year class. In 2000 the catches on intermediate ages (5 to 8) are also noticeable as they were in 1998 and 1999 on 4 to 6 ages. In general the catch at age matrix is dominated by juveniles, (ages up to three years old).

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 2,862 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 1.3. 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 2000 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 old fishes in 2000 present extremely low mean weight at age values. The scarcity of big fishes in the catch (specimens greater than 37 cm), comparing with other years, could explain partially this fact. Constant mean weights at age in the stock have been used for the whole period based on data from 1985 to 1991. 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 working Group recommends that the weights-at-age in the stock should be revised to provide weights on an annual basis.

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 for 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 in the catches (ICES 1993/Assess:7; ICES 1998/Assess:6). As ACFM requested in 1992 the maturity ogive was smoothed as follows. New information on maturity ogives based on samples from Sub-divisions VIIIc East, VIIIc West and IXa North was presented to the 1999 Working Group (ICES 2000/ACFM:5). As no new information has been presented in 2001 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 at the 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 than thought before. 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.

Table 7.3.1.1a.- Southern horse mackerel catch in numbers at age (in thousands) by quarter and area in 2000

QUARTER 1

	AREA						
AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	102.500	11.450	23088.000	3623.059	2444.330	0.000	29166.839
2	114.100	63.690	897.300	6184.502	2643.075	808.008	10596.576
3	974.800	3440.000	1049.000	459.924	1886.555	1415.746	8251.225
4	1385.000	5000.000	959.600	278.624	323.001	629.837	7191.062
5	277.800	907.600	714.900	668.041	1034.779	2064.349	5389.670
6	63.190	231.200	820.600	1125.491	1562.376	2940.690	6680.357
7	19.800	86.690	773.800	1381.142	1792.253	2982.382	7016.267
8	4.253	18.350	404.700	1125.207	1461.936	2202.098	5212.291
9	4.531	17.940	550.900	1026.417	1027.363	1085.563	3708.182
10	3.869	14.630	808.700	397.103	462.771	497.069	2180.273
11	1.626	5.187	259.300	804.302	833.314	823.927	2726.030
12	1.338	3.953	122.100	661.241	637.125	536.558	1960.977
13	1.230	3.314	65.860	317.942	348.818	357.867	1093.802
14	0.941	2.544	32.160	307.031	303.085	351.555	996.375
15+	1.270	3.432	29.400	532.879	571.073	369.651	1506.435
Total	2956.248	9809.980	30576.320	18892.906	17331.854	17065.301	93676.361

QUARTER 2	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	38.810	26.700	8030.000	293.175	1340.383	3028.152	12718.410
2	65.720	43.680	8845.000	2511.532	3495.593	1412.053	16307.858
3	2061.000	6532.000	7389.000	836.966	556.532	1216.001	16530.499
4	2013.000	5331.000	2256.000	448.481	710.738	1128.132	9874.352
5	683.100	1880.000	2597.000	1120.930	2696.817	4013.373	12308.120
6	160.400	664.100	2207.000	1806.977	3488.163	4617.603	12783.843
7	104.800	392.400	1901.000	2120.536	3144.805	3765.019	11323.760
8	43.310	144.400	529.600	1715.700	2032.421	2295.848	6717.969
9	37.700	83.940	129.900	1338.749	942.743	1025.504	3520.836
10	29.570	64.490	78.230	571.957	422.812	438.792	1576.281
11	11.770	25.390	22.410	1125.562	605.266	598.396	2377.023
12	7.625	16.320	11.310	925.338	365.781	316.569	1635.318
13	4.966	10.630	3.862	482.257	239.063	208.664	944.477
14	3.506	7.504	1.613	438.320	232.285	228.700	908.422
15+	2.992	6.404	1.574	794.674	290.069	174.878	1267.599
Total	5268.269	15228.958	34003.499	16531.154	20563.470	24467.686	110794.768

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	886.030	0.001	410.932	1296.963
1	674.506	14.100	781.900	21363.092	2877.566	7898.135	32934.793
2	555.074	762.400	1331.000	1470.257	6078.606	138.610	9780.873
3	3260.493	4738.000	1873.000	792.485	3386.351	295.825	11085.661
4	2345.930	2997.000	1663.000	1037.125	3651.428	383.978	9732.531
5	752.256	887.600	1207.000	1904.344	4272.026	650.625	8921.595
6	775.003	933.700	2106.000	5189.096	8541.708	1851.058	18621.561
7	390.663	502.400	1796.000	4160.587	5721.005	1489.565	13669.557
8	134.039	186.700	1143.000	2345.210	2454.476	829.906	6959.292
9	24.534	43.520	609.600	1469.953	1003.155	368.004	3494.232
10	2.565	4.529	122.600	488.264	270.753	131.576	1017.722
11	2.607	4.486	157.900	464.323	240.915	96.417	964.040
12	1.197	1.481	70.210	126.578	65.349	30.650	294.267
13	1.076	1.160	67.510	300.860	181.469	101.576	652.575
14	0.732	0.776	46.290	693.629	220.747	122.524	1083.965
15+	0.732	0.776	46.390	831.476	191.600	110.143	1180.384
Total	8921.408	11078.628	13021.400	43523.308	39157.155	14909.521	121690.012

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	871.000	515.100	3028.000	6895.669	38.105	7.022	10483.896
1	1447.000	513.900	2108.000	3302.171	2816.888	785.662	9526.621
2	1039.000	413.300	2306.000	456.834	3386.213	106.955	6669.301
3	1337.000	1192.000	724.900	366.867	2452.157	161.242	4897.167
4	1247.000	994.800	1045.000	467.225	2640.655	197.262	5344.942
5	633.800	501.400	818.800	908.108	3207.772	433.539	5869.620
6	299.300	265.500	1048.000	2334.552	6125.002	1252.575	11025.628
7	143.100	154.200	644.900	2030.989	4211.561	1112.068	8153.719
8	57.010	85.000	357.400	1197.912	1953.239	670.979	4264.530
9	12.940	28.510	157.300	686.763	846.942	513.045	2232.560
10	8.250	24.390	154.900	216.224	249.447	200.288	845.249
11	4.223	14.360	118.300	184.210	214.812	136.714	668.396
12	1.647	7.879	63.720	65.264	50.845	57.197	244.905
13	0.151	3.942	101.800	177.410	165.000	126.545	574.697
14	0.005	2.497	104.300	226.740	210.340	242.718	786.595
15+	0.000	0.178	53.340	224.360	198.695	328.088	804.661
Total	7101.426	4716.956	12834.660	19741.299	28767.671	6331.899	72392.486

Table 7.3.1.1.b.- Total catch in numbers at age (in thousands) in 2000.

AGES	AREA IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	871.000	515.100	3028.000	7781.699	38.106	417.954	12651.858
1	2262.816	566.150	34007.900	28581.498	9479.166	11711.949	86609.479
2	1773.894	1283.070	13379.300	10623.124	15603.487	2465.627	45128.503
3	7633.293	15902.000	11035.900	2456.242	8281.596	3088.814	48397.845
4	6990.930	14322.800	5923.600	2231.456	7325.823	2339.208	39133.817
5	2346.956	4176.600	5337.700	4601.424	11211.394	7161.887	34835.960
6	1297.893	2094.500	6181.600	10456.116	19717.248	10661.925	50409.282
7	658.363	1135.690	5115.700	9693.254	14869.625	9349.035	40821.666
8	238.612	434.450	2434.700	6384.029	7902.071	5998.831	23392.694
9	79.705	173.910	1447.700	4521.882	3820.202	2992.116	13035.515
10	44.254	108.039	1164.430	1673.549	1405.783	1267.725	5663.780
11	20.226	49.423	557.910	2578.397	1894.306	1655.453	6755.715
12	11.807	29.633	267.340	1778.421	1119.099	940.975	4147.275
13	7.423	19.046	239.032	1278.470	934.351	794.652	3272.973
14	5.184	13.321	184.363	1665.719	966.457	945.498	3780.542
15+	4.994	10.790	130.704	2383.389	1251.437	982.760	4764.073
Total	24247.351	40834.522	90435.879	98688.668	105820.151	62774.407	422800.978

Table 7.3.1.2.- Southern horse mackerel. Catch in numbers at age by year (in thousands).

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
1999	51940	120035	65577	80854	85370	37711	24491	20852	18187	10835	6802	3655	2879	1046	728	3182
2000	12652	86609	45129	48398	39134	34836	50409	40822	23393	13036	5664	6756	4147	3273	3781	4764

Table 7.3.2.1a.- Southern horse mackerel mean weight at age (in kg) by quarter and area in 2000

QUARTER 1

AGE	AREA IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.032	0.025	0.027	0.024	0.023	0.032	0.026
2	0.048	0.054	0.044	0.041	0.056	0.081	0.049
3	0.085	0.087	0.072	0.088	0.071	0.082	0.091
4	0.102	0.101	0.108	0.148	0.162	0.150	0.130
5	0.120	0.120	0.133	0.167	0.161	0.152	0.154
6	0.143	0.144	0.151	0.182	0.173	0.157	0.165
7	0.166	0.167	0.171	0.205	0.189	0.168	0.181
8	0.197	0.195	0.200	0.206	0.193	0.174	0.188
9	0.208	0.208	0.215	0.242	0.225	0.189	0.218
10	0.242	0.241	0.241	0.235	0.224	0.189	0.225
11	0.288	0.286	0.279	0.233	0.224	0.198	0.224
12	0.313	0.311	0.306	0.257	0.235	0.216	0.242
13	0.344	0.344	0.331	0.231	0.220	0.210	0.227
14	0.369	0.369	0.363	0.220	0.220	0.201	0.218
15+	0.422	0.422	0.439	0.265	0.293	0.238	0.273
Total	0.096	0.100	0.057	0.118	0.140	0.161	0.111

QUARTER 2	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.046	0.043	0.034	0.028	0.027	0.025	0.031
2	0.044	0.043	0.041	0.049	0.045	0.079	0.047
3	0.088	0.086	0.063	0.084	0.107	0.106	0.089
4	0.105	0.103	0.110	0.153	0.140	0.133	0.134
5	0.123	0.125	0.131	0.163	0.140	0.134	0.143
6	0.154	0.156	0.160	0.178	0.147	0.138	0.153
7	0.210	0.205	0.210	0.199	0.157	0.149	0.175
8	0.253	0.237	0.223	0.200	0.166	0.158	0.180
9	0.312	0.311	0.307	0.230	0.189	0.167	0.209
10	0.330	0.330	0.326	0.226	0.189	0.173	0.217
11	0.365	0.365	0.362	0.225	0.203	0.182	0.213
12	0.393	0.393	0.385	0.239	0.229	0.210	0.236
13	0.436	0.436	0.418	0.223	0.212	0.201	0.221
14	0.463	0.463	0.467	0.216	0.206	0.179	0.209
15+	0.519	0.519	0.514	0.267	0.266	0.240	0.266
Total	0.109	0.108	0.078	0.173	0.132	0.127	0.122

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.024	0.027	0.026	0.025
1	0.029	0.062	0.042	0.049	0.054	0.038	0.047
2	0.081	0.085	0.070	0.070	0.084	0.073	0.085
3	0.100	0.099	0.094	0.121	0.102	0.124	0.131
4	0.115	0.114	0.125	0.135	0.120	0.134	0.149
5	0.134	0.134	0.140	0.158	0.130	0.148	0.150
6	0.158	0.159	0.163	0.157	0.138	0.152	0.155
7	0.182	0.184	0.197	0.167	0.146	0.159	0.167
8	0.203	0.207	0.228	0.182	0.158	0.166	0.184
9	0.239	0.244	0.266	0.241	0.187	0.186	0.226
10	0.307	0.302	0.298	0.246	0.196	0.187	0.232
11	0.318	0.310	0.315	0.265	0.199	0.185	0.250
12	0.330	0.328	0.335	0.240	0.244	0.223	0.264
13	0.380	0.380	0.362	0.220	0.201	0.192	0.226
14	0.399	0.399	0.383	0.302	0.247	0.206	0.284
15+	0.399	0.399	0.511	0.319	0.258	0.204	0.306
Total	0.111	0.116	0.152	0.111	0.124	0.090	0.126

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.028	0.027	0.022	0.022	0.019	0.020	0.025
1	0.039	0.035	0.040	0.040	0.053	0.052	0.050
2	0.063	0.077	0.057	0.085	0.089	0.073	0.086
3	0.094	0.095	0.089	0.125	0.107	0.118	0.129
4	0.123	0.122	0.134	0.134	0.119	0.142	0.153
5	0.132	0.132	0.143	0.159	0.129	0.172	0.153
6	0.158	0.160	0.161	0.161	0.141	0.170	0.155
7	0.171	0.177	0.178	0.172	0.150	0.181	0.165
8	0.196	0.200	0.203	0.180	0.163	0.195	0.180
9	0.224	0.228	0.230	0.210	0.194	0.241	0.214
10	0.244	0.247	0.246	0.204	0.198	0.256	0.226
11	0.242	0.256	0.267	0.213	0.201	0.248	0.228
12	0.268	0.270	0.276	0.232	0.231	0.221	0.244
13	0.290	0.311	0.316	0.204	0.200	0.224	0.228
14	0.315	0.328	0.342	0.225	0.233	0.279	0.260
15+	0.000	0.378	0.411	0.225	0.251	0.294	0.272
Total	0.084	0.100	0.091	0.096	0.127	0.178	0.123

Table 7.3.2.1b.- Total mean weight at age (in kg) in 2000.

	AREA						
AGES	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.028	0.027	0.022	0.022	0.019	0.026	0.023
1	0.036	0.036	0.030	0.045	0.042	0.036	0.037
2	0.067	0.079	0.047	0.049	0.072	0.079	0.059
3	0.094	0.091	0.071	0.103	0.097	0.097	0.089
4	0.111	0.106	0.118	0.140	0.124	0.138	0.116
5	0.129	0.127	0.135	0.161	0.135	0.143	0.139
6	0.157	0.157	0.160	0.164	0.143	0.150	0.152
7	0.184	0.189	0.196	0.181	0.155	0.160	0.169
8	0.210	0.215	0.219	0.190	0.168	0.169	0.181
9	0.269	0.270	0.246	0.233	0.199	0.190	0.215
10	0.305	0.298	0.253	0.231	0.203	0.194	0.222
11	0.327	0.320	0.290	0.234	0.212	0.195	0.224
12	0.360	0.346	0.310	0.246	0.233	0.215	0.240
13	0.410	0.391	0.335	0.222	0.211	0.208	0.225
14	0.437	0.416	0.357	0.254	0.226	0.216	0.243
15+	0.000	0.000	0.454	0.281	0.275	0.253	0.279
Total	0.101	0.107	0.083	0.120	0.129	0.133	0.114

Table 7.3.2.2a.- Southern horse mackerel mean length at age (in cm) by quarter and area in 2000

QUARTER 1

AGE	AREA IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	15.3	14.1	14.4	14.0	13.7	15.5	14.3
2	17.7	18.4	17.2	16.7	18.6	21.2	17.8
3	21.5	21.7	20.2	21.9	20.3	21.4	23.7
4	23.0	22.9	23.4	26.2	27.2	26.4	28.0
5	24.3	24.3	25.2	27.4	27.1	26.6	27.5
6	25.9	26.0	26.4	28.2	27.7	26.9	27.4
7	27.2	27.3	27.5	29.4	28.6	27.5	28.2
8	28.9	28.8	29.0	29.5	28.8	27.8	28.6
9	29.4	29.4	29.8	31.1	30.4	28.6	30.0
10	31.0	30.9	30.9	30.9	30.3	28.6	30.3
11	32.9	32.8	32.6	30.8	30.4	29.1	30.3
12	33.8	33.8	33.6	31.9	31.0	30.1	31.2
13	35.0	35.0	34.5	30.8	30.3	29.8	30.6
14	35.8	35.8	35.6	30.1	30.2	29.2	30.1
15+	37.5	37.5	37.9	32.3	33.2	31.1	32.5
Total	22.3	22.7	17.1	22.3	24.4	26.9	22.6

QUARTER 2	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	17.4	17.1	15.6	14.7	14.6	14.2	15.2
2	17.2	17.0	16.8	17.7	17.1	20.6	17.4
3	21.8	21.6	19.3	21.6	23.5	23.4	23.5
4	23.2	23.1	23.6	26.5	25.8	25.3	28.5
5	24.6	24.7	25.1	27.2	25.9	25.5	26.9
6	26.5	26.6	26.8	28.0	26.2	25.7	26.7
7	29.4	29.2	29.4	29.1	26.8	26.4	27.9
8	31.4	30.7	30.1	29.2	27.4	27.0	28.2
9	33.8	33.8	33.6	30.6	28.5	27.4	29.7
10	34.5	34.5	34.4	30.5	28.6	27.8	30.2
11	35.7	35.7	35.6	30.4	29.4	28.2	29.9
12	36.6	36.6	36.4	31.1	30.7	29.8	31.0
13	37.9	37.9	37.4	30.4	29.9	29.4	30.4
14	38.7	38.7	38.8	30.0	29.5	28.0	29.6
15+	40.2	40.2	40.2	32.3	32.2	31.1	32.3
Total	23.2	23.2	19.8	27.0	24.5	24.3	24.3

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.0	0.0	0.0	13.9	14.5	14.4	14.1
1	14.3	19.0	16.4	17.9	18.5	16.4	17.8
2	20.9	21.3	19.7	20.3	21.7	20.6	22.3
3	22.5	22.4	22.0	24.4	23.1	24.6	29.4
4	23.7	23.6	24.4	25.5	24.5	25.5	30.1
5	25.0	25.0	25.4	26.8	25.1	26.3	27.7
6	26.6	26.6	26.9	26.8	25.7	26.6	27.4
7	27.9	28.0	28.7	27.4	26.2	27.0	27.8
8	29.0	29.2	30.2	28.2	26.9	27.4	28.6
9	30.8	31.0	32.0	30.9	28.4	28.5	30.3
10	33.7	33.5	33.3	31.2	28.9	28.6	30.6
11	34.1	33.8	34.0	32.0	29.0	28.5	31.3
12	34.6	34.5	34.8	31.2	31.3	30.5	32.2
13	36.4	36.3	35.8	30.2	29.3	28.9	30.4
14	37.0	37.0	36.5	33.6	31.4	29.6	32.9
15+	37.0	37.0	40.2	34.3	31.8	29.5	33.7
Total	23.0	23.6	25.4	22.5	24.5	20.9	25.1

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	14.1	14.0	12.9	13.5	12.8	13.0	14.5
1	16.0	15.4	16.1	16.6	18.4	18.3	19.5
2	19.0	20.4	18.3	21.7	22.1	20.5	23.6
3	22.0	22.1	21.5	24.7	23.5	24.1	29.0
4	24.3	24.2	25.0	25.5	24.4	25.9	30.3
5	24.9	24.9	25.6	26.8	25.0	27.6	28.2
6	26.6	26.7	26.7	27.1	25.9	27.6	27.1
7	27.3	27.6	27.7	27.7	26.4	28.2	27.6
8	28.7	28.9	29.0	28.1	27.2	28.9	28.3
9	30.1	30.3	30.4	29.7	28.8	31.0	29.9
10	31.0	31.2	31.2	29.4	29.0	31.7	30.5
11	30.9	31.5	32.0	29.8	29.1	31.3	30.5
12	32.1	32.2	32.4	30.9	30.9	30.4	31.4
13	33.0	33.8	34.1	29.5	29.3	30.3	30.5
14	34.0	34.5	35.0	30.5	30.8	32.7	31.9
15+	0.0	36.3	37.4	30.4	31.5	33.3	32.3
Total	20.4	21.8	20.2	20.8	24.7	27.4	24.9

Table 7.3.2.2b.- Total southern horse mackerel mean length (cm) at age in 2000.

	AREA						
AGES	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	14.1	14.0	12.9	13.6	12.8	14.4	**13.5**
1	15.4	15.6	14.8	17.2	16.7	15.9	**16.0**
2	19.4	20.7	17.4	17.7	20.2	20.8	**18.8**
3	22.1	21.9	20.0	23.0	22.6	22.6	**21.7**
4	23.5	23.2	24.0	25.8	24.7	25.7	**24.0**
5	24.8	24.7	25.2	27.0	25.4	26.0	**25.6**
6	26.5	26.5	26.8	27.2	26.0	26.4	**26.5**
7	28.0	28.3	28.7	28.1	26.7	27.0	**27.4**
8	29.3	29.6	29.8	28.7	27.5	27.6	**28.1**
9	32.0	32.1	31.1	30.7	29.0	28.6	**29.8**
10	33.5	33.2	31.4	30.6	29.3	28.8	**30.1**
11	34.3	34.0	33.0	30.8	29.7	28.9	**30.2**
12	35.5	35.0	33.8	31.4	30.9	30.0	**31.1**
13	37.1	36.5	34.7	30.3	29.8	29.7	**30.4**
14	37.9	37.3	35.5	31.6	30.4	29.9	**31.1**
15+	0.0	0.0	38.5	32.8	32.5	31.7	**32.7**
Total	**22.2**	**23.0**	**19.8**	**22.9**	**24.5**	**24.5**	**22.8**

Table 7.3.2.3.- Southern horse mackerel mean weight at age in the stock and in the catch by year.

Mean weight at age in the stock

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
1999	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
2000	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

Mean weight at age in the catch

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	0.014	0.027	0.070	0.091	0.117	0.132	0.152	0.182	0.249	0.264	0.284	0.312	0.320	0.344	0.357	0.378
1986	0.016	0.029	0.055	0.076	0.104	0.137	0.185	0.194	0.209	0.290	0.301	0.319	0.329	0.339	0.349	0.349
1987	0.024	0.031	0.049	0.058	0.096	0.106	0.131	0.161	0.198	0.211	0.246	0.302	0.288	0.352	0.361	0.358
1988	0.027	0.036	0.066	0.082	0.111	0.126	0.156	0.156	0.202	0.239	0.249	0.275	0.314	0.333	0.327	0.355
1989	0.016	0.041	0.062	0.089	0.109	0.132	0.152	0.189	0.200	0.203	0.248	0.320	0.345	0.359	0.375	0.389
1990	0.016	0.035	0.047	0.076	0.124	0.130	0.155	0.170	0.182	0.214	0.260	0.272	0.316	0.345	0.368	0.388
1991	0.016	0.033	0.063	0.102	0.133	0.151	0.168	0.173	0.193	0.196	0.233	0.236	0.280	0.304	0.323	0.372
1992	0.018	0.029	0.048	0.078	0.105	0.141	0.162	0.173	0.182	0.191	0.214	0.240	0.278	0.313	0.341	0.387
1993	0.015	0.034	0.040	0.064	0.109	0.155	0.171	0.202	0.225	0.225	0.255	0.250	0.321	0.364	0.397	0.461
1994	0.021	0.036	0.058	0.069	0.097	0.142	0.182	0.205	0.226	0.250	0.276	0.299	0.295	0.343	0.363	0.391
1995	0.029	0.036	0.058	0.091	0.110	0.139	0.173	0.189	0.218	0.235	0.273	0.291	0.305	0.290	0.362	0.392
1996	0.013	0.029	0.066	0.104	0.130	0.154	0.181	0.206	0.212	0.226	0.257	0.279	0.260	0.313	0.310	0.441
1997	0.022	0.033	0.054	0.091	0.123	0.149	0.171	0.202	0.209	0.246	0.233	0.265	0.313	0.350	0.390	0.347
1998	0.025	0.038	0.062	0.093	0.122	0.152	0.173	0.195	0.208	0.226	0.257	0.260	0.266	0.306	0.335	0.387
1999	0.021	0.033	0.055	0.086	0.122	0.143	0.167	0.201	0.221	0.238	0.275	0.305	0.293	0.401	0.471	0.501
2000	0.023	0.037	0.059	0.089	0.116	0.139	0.152	0.169	0.181	0.215	0.222	0.224	0.240	0.225	0.243	0.279

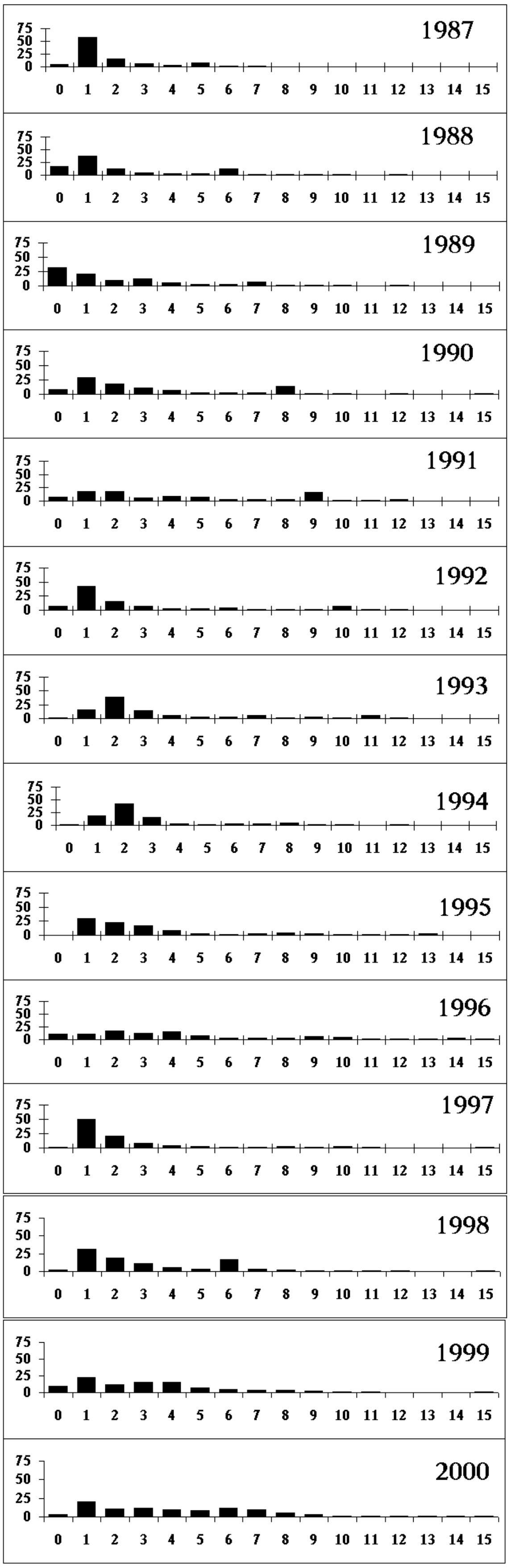


Figure 7.3.1.1.- The age composition of southern horse mackerel in the international catches from 1987-2000. Age 15 is a plus group.

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. In 1999 the two Portuguese surveys (July and October surveys) were carried out by the research vessel “Capricornio” which is very different from the one previously used, both in terms of the vessel basic performance and gear type used. There is no estimation of the calibration factor to compare the Portuguese indices obtained in 1999 from “Capricornio”, with the rest of the series and then the 1999 data were not used for the assessment. In 2000, the indices of both surveys show a significative decrease comparing with the 1998 estimates. The values obtained in 2000 are one of the lowest values in the series available (1979-2000).

Portuguese surveys show similar catch rates and variability in the data, showing the following mean and standard deviation in the time series: 23.4 (±19.5) and 20.8 (±17) for July and October surveys respectively. Both surveys present similar trends for the 1995-2000 period. The Spanish October survey biomass index shows a slight increase of 17% compared to the index obtained in 1999, and it is inside the range of the levels obtained since 1992. This series has less variability than the observed in the Portuguese series, especially since 1992, giving a mean yield of 21.2 (±11.2). Spanish surveys shows a closer agreement in yields trends with the Portuguese July surveys, excepting in the 1995-1998 period.

Table 7.4.1.2 shows the number at age from the October surveys and from the Portuguese July survey. Age disaggregated data is only available from 1985. The Spanish September/October survey and the Portuguese October survey are carried out during the fourth quarter when the recruits have entered the area. As it was explained above, in 1999 the indices obtained from the Portuguese surveys are not comparable with the rest of the series. In the Spanish October survey in 2000 the yields in the range of ages from 4 to 9 years old were noticeable, as they were in 1998 and 1999, changing the pattern observed in 1997 (Table 7.4.1.2). In this survey the 1994 yearclass is shown as a strong one. In the Portuguese July survey there is a strong fall in the observed 1995 abundance indices compared to those obtained in 1993 and 1994. Since 1995 the indices are similar (except for the groups 0 and 1 which present high variability). In this survey, in 2000, there is also an increase in the strength of the intermediate ages (5 to 8) compared to the indices obtained since 1995.

Table 7.4.1.1 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

Year	Portugal IXa (20-500 m depth) Bottom trawl (20-mm codend) Kg/h March	kg/h Jun-Jul	kg/h Oct	Spain VIIIc & IXa North (20-500m depth) kg/30 minutes Sept-Oct
1979		12.2	5.5	-
1980		20.6	2.5	-
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[1]	18.11
1994	_	49.3	12.4	21.61
1995	_	9.8	18.9	21.99
1996	_	_	23.25	26.75
1997	_	21.0	59.6	14.43
1998	_	14.3	15.4	27.99
1999	_	3.1[2]	10.1[2]	21.26
2000	_	9.4	6.7	25.60

1.- Revised
2.- In 1999 the surveys was carried out with a different vessel and different gear. There is no estimation of the calibration factor.

Table 7.4.1.2.- Southern horse mackerel. CPUE at age from surveys.

Portuguese October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	70.580	60.151	2.837	1.144	0.618	0.240	0.096	0.025	0.001	0.006	0.004	0.015	0.003	0.003	0.006	0.003
1986	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	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	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	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	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	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	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	1733.340	214.230	328.440	111.630	37.010	2.160	0.950	0.950	0.670	0.860	0.570	1.340	0.370	0.220	0.070	0.050
1994	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	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	1225.000	5.750	6.979	16.342	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	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	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
1999*	178.196	21.004	32.750	36.685	3.029	1.058	0.573	0.156	0.036	0.054	0.046	0.010	0.010	0.000	0.000	0.000
2000	3.246	15.197	15.150	21.096	11.822	6.430	3.013	1.169	0.445	0.147	0.147	0.084	0.059	0.005	0.004	0.000

Spanish October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049
1996	43.288	47.240	26.844	19.573	35.014	19.058	6.602	11.004	2.733	21.892	7.012	1.079	1.723	0.033	3.657	0.078
1997	13.866	21.891	6.529	9.419	7.730	6.327	3.911	3.995	12.424	3.947	10.330	7.708	0.506	0.350	0.109	2.585
1998	22.701	7.359	20.450	26.250	54.150	28.340	19.390	11.049	4.552	2.623	0.897	2.132	2.238	0.491	0.259	2.493
1999	30.744	50.190	17.429	3.930	19.331	18.302	10.964	13.575	11.888	8.618	4.186	0.924	1.198	0.068	0.054	0.103
2000	82.066	15.513	4.885	10.151	22.200	32.770	50.779	19.532	6.091	6.497	1.262	0.402	0.844	0.849	3.983	1.049

July Portuguese Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985																
1986																
1987																
1988																
1989	81.913	38.356	45.522	60.648	26.998	5.846	3.164	6.634	3.042	3.716	1.440	0.793	0.613	0.214	0.157	0.244
1990	82.175	51.605	69.397	26.157	12.393	5.588	3.670	3.515	7.745	3.001	1.363	0.695	0.758	0.445	0.356	0.470
1991	17.429	53.094	19.479	3.507	3.906	3.978	2.495	3.128	3.566	7.637	3.537	3.574	2.288	2.491	0.508	0.413
1992	109.178	1822.950	39.701	21.081	7.980	5.013	3.427	3.348	3.879	5.616	9.998	3.988	5.772	3.205	1.038	0.481
1993	1.810	263.390	263.800	150.040	20.840	39.560	89.150	31.340	22.690	9.530	0.520	0.640	0.050	0.020	0.000	0.000
1994	54.981	408.262	232.995	110.935	49.988	34.724	38.438	20.985	5.725	3.905	3.550	3.193	5.485	1.883	1.057	0.867
1995	5.410	38.571	16.132	23.071	26.699	12.233	5.577	2.071	0.540	0.270	0.223	0.158	0.263	0.115	0.091	0.103
1996	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
1997	29.139	330.305	71.131	8.199	11.932	4.993	1.969	1.371	0.249	0.169	0.170	0.462	0.054	0.000	0.000	0.012
1998	116.243	166.298	74.108	7.292	4.740	2.509	1.276	0.648	0.212	0.151	0.121	0.009	0.081	0.017	0.033	0.019
1999*	0.000	0.863	9.697	15.993	3.576	0.864	0.560	0.317	0.240	0.199	0.085	0.068	0.035	0.000	0.000	0.000
2000	0.842	53.711	7.391	5.146	5.572	5.044	9.953	5.577	2.210	0.784	0.122	0.122	0.041	0.070	0.056	0.056

7.4.2 Egg surveys

Some problems have been detected in the research work related with egg surveys which are an important SSB index for tuning the assessment of the stock. As it is stated in ICES (2000/G:01 Ref:D, 2000/ACFM:5) more research work is needed for the adult parameters estimation (fecundity, determinate spawning, atresia and maturity) and egg identification.

The WGMEGS (ICES 2000/G:01 Ref:D) provided a revised estimate of the 1998 egg production using mean values instead of the unusual high egg density values for two rectangles described above. Then the annual stage I egg production estimate was 17.85 x 10^{13} eggs (CV=42.2%). As only about 30% of the fecundity data were available from the area between Cadiz and Finisterra (IXa ICES Division), it was not possible to have an estimation of the SSB. These data were presented to the Working Group (WD, Costa, 2000) but unfortunately there is still no combination of these data with those already presented previously for the Division VIIIc. Thus, the Working Group recommends to obtain an estimation of the 1998 egg survey for southern horse mackerel as soon as possible. Samples from the 2001 egg survey have not yet been analysed completely.

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 (A Coruña) and in Sub-division VIIIc East (Avilés) from 1984 to 2000. A Coruña bottom trawl fleet in 2000 reached the lowest level of effort in the series, continuing with the decreasing trend that started in 1996. In 1998 there was no reliable estimation on the A Coruña bottom trawl fleet effort. The effort in Avilés bottom trawl fleet has decreased by 36% compared to the 1999 observed effort, being, as in the case of La Coruña trawl fleet, the lowest level of effort in the series. There is no estimation of effort from the purse seine fleets.

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 (A Coruña) and in Sub-division VIIIc East (Avilés) from 1983 to 2000. In 2000 both fleets show significative decreases in catch rates compared to the values obtained in 1999 (-20.8% and -11.6% respectively), constituting in both cases one of the lowest values in the series. In 1998 there was no effort estimation from A Coruña bottom trawl fleet. Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are yet not available since 1991, and the whole series needs to be revised.

Catch per unit effort at age

CPUE at age from the Galician (A 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 2000 (Table 7.5.2).

As it has been observed since 1997, the catch rates of juveniles (up to age 3) from both fleets has been maintained at the similar low levels in 2000. The A Coruña trawl fleet observed in 2000 an increase in the yields of older ages (>11 years old) compared to those obtained in 1999. A similar pattern is obtained with the Aviles trawl fleet in 2000. Moreover this fleet obtained during the period 1997- 2000 a noticeable catch rate on intermediate ages (4 – 8). There is no estimation of effort in 1998 for the A Coruña bottom trawl fleet.

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 A 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.
1999	n.a.	91.05	121.75
2000	n.a.	72.07	107.60

Table 7.5.2.- Southern horse mackerel. CPUE at age from fleets.

A Coruña bottom trawl fleet

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

Avilés bottom trawl fleet

YEAR	Effort	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	9856	1	167	613	574	13	18	16	13	17	21	14	4	4	1	4	19
1986	11000	36	223	271	174	527	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	13000	2	35	21	65	34	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
1999	6829	0	0	4	17	101	139	86	74	78	39	13	5	5	0	0	0
2000	4347	0	9	6	7	15	54	82	80	56	31	14	17	12	10	12	13

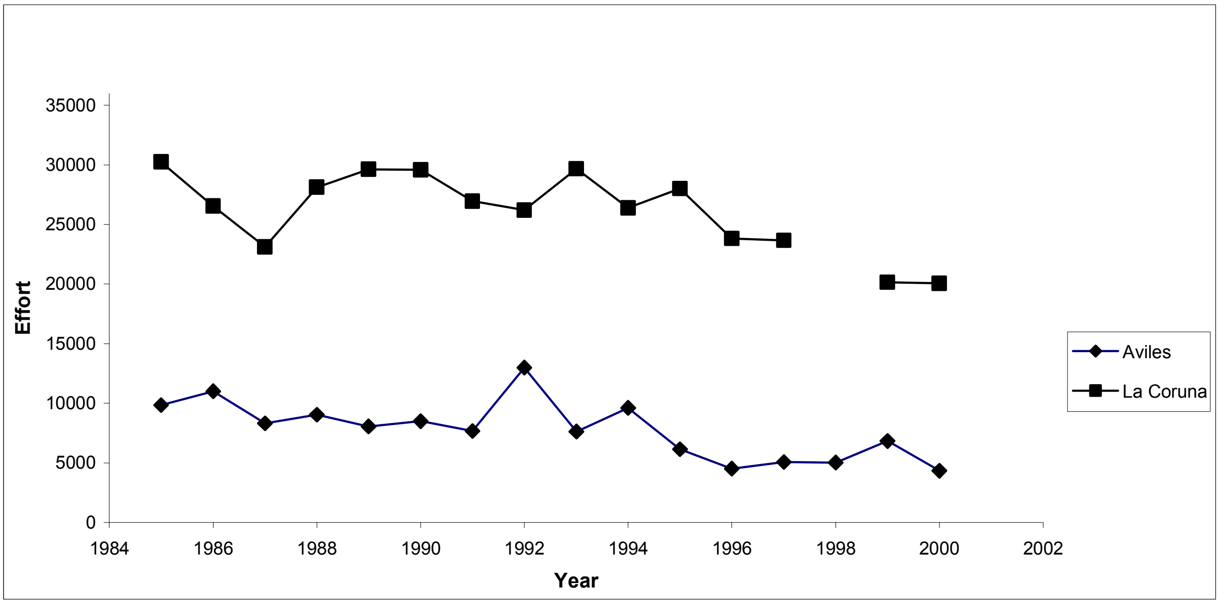


Figure 7.5.1 Effort series from two Spanish commercial bottom trawl fleets

7.6 Recruitment Forecasting

Figure 7.6.1 shows the evolution of these indices from 1985 to 2000. Both surveys present a high variability, especially in recent years. The variability in the Portuguese survey is higher than in the Spanish one, and no clear trends are evident over the whole Portuguese survey series. The abundance indices of the Spanish survey present a slight decreasing trend over the years. In 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate. From 1996 to 1999 the recruitment indices from the Portuguese survey were higher than the ones from the Spanish one, however in 2000 the Spanish survey provided higher indices. In general it seems that there exists no good agreement in trends between these surveys in the abundance index for the 0 group.

Preliminary work on recruitment forecasting using environmental variables, such as Ekman transport, upwelling and temperature is in progress (WD Moreno-Ventas *et al*., 2001). A preliminary multivariate model was presented to the WG, however further work is needed to improve the model forecast ability and to obtain more data back in time to fit the model.

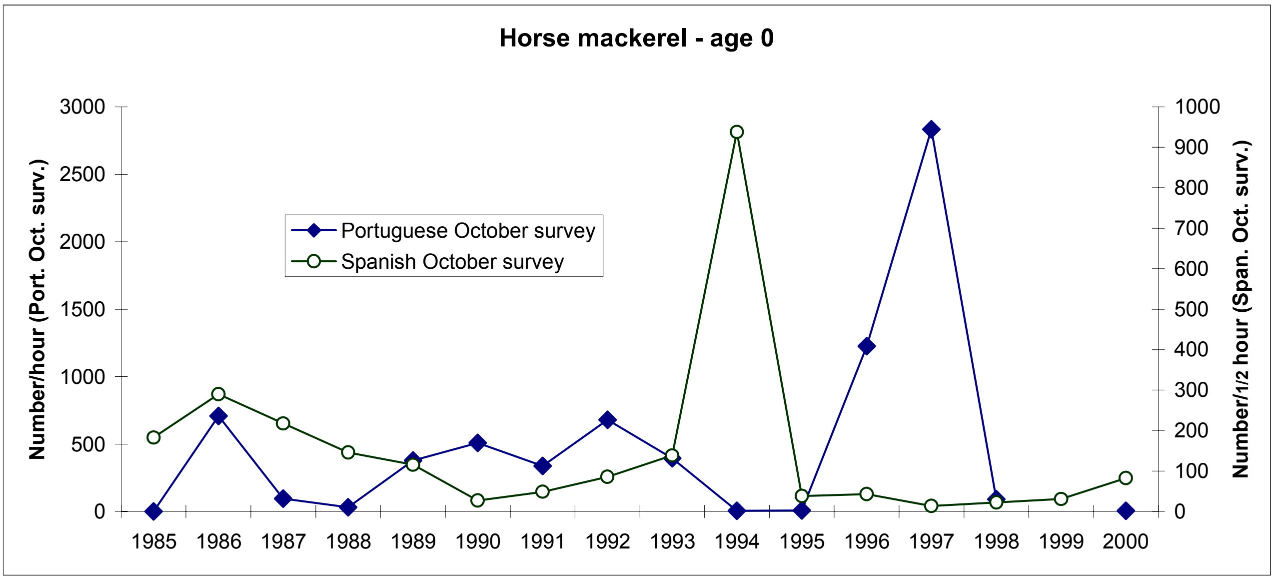


Figure 7.6.1 - Catches of age 0 horse mackerel in bottom trawl surveys used in the tuning of the VPA.

7.7 State of the Stock

7.7.1 Data exploration and preliminary modelling

Following last year's assessment using a production model, a simulation study was presented to the WG, which tested several harvest control rules under different scenarios, using for the stock assessments a Schaffer surplus model (WD Roel *et al*., 2001). Stochastic projections of the stock biomass in 1998 were performed applying the harvest control rules. Medians values of yield, relative yield and biomass, and yield inter-annual variability after 5 and 15 years were obtained. The results obtained show that the more risk prone approaches do not perform well under increased uncertainty, and the scenarios with higher uncertainty resulted in higher yields at expense of higher inter-annual variability.

An attempt was also made to apply a separable model to Southern horse mackerel data. Two versions of the ISVPA model were used: ”effort-controlled” which attributes model residuals to errors in catch-at-age data and uses model-derived fairly separable catch-at-age values in population dynamics formulae, and “catch-controlled” version which treats catch-at-age data as true and uses estimated selectivities only for calculation of terminal populations, that is for “tuning” of nonseparable cohort model. Both versions showed stable values of SSB in recent years, but the overall level of biomass for the catch-controlled version was closer to the results of XSA, which is not surprising since both models consider catch-at-data as true. Minimum of the ISVPA objective function for catch-controlled version was much less reliable than for the effort-controlled one, what nearly always take place for real (that is noisy and far from perfectly separable) data. Bothe versions of the ISVPA gave almost identical estimates of the selectivity pattern with two peaks. Results of the application of the two ISVPA versions to South horse mackerel data are shown in Figures 7.7.1.1 and 7.7.1.2.

High log-catchability residuals in the early years of some tuning data sets were thought to be creating noise in the assessment, hence runs were made only with tuning data from 1991 to the present, and without tapered time weighting. However, this procedure didn't improve the model fitting, therefore was not followed in the final run.

It was also noticed in the preliminary assessments that some ages in some fleets had a small standard error of log-catchability and could have a very high influence in the assessment. In order to balance more the weight given to other ages in the assessment, a minimum standard error for population estimates derived from each fleet was set at 0.7, instead of the default 0.3. This option didn't have a visible effect in the assessment diagnostics and was not followed in the final assessment.

All available data were used in the preliminary assessment of 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 decreasing effect on the standard errors of the log catchability (Anon. 1995/Assess:2), therefore assessments were carried out with minimum standard errors of the mean to which the survivors are shrunk of 1.0 and 2.0. Given the similarity of the results obtained with those options, a weak shrinkage weight of 1.0 was chosen, as in previous years. This ensures that the estimates are primarily derived from the data.

In order to compare the independent information provided by the different fleets, XSA was firstly run with each fleet in separate. 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: Spanish October trawl Survey during the recruitment season (Sub-division IXa North and Division VIIIc)
Fleet 5: Portuguese July Trawl Survey end of spawning season in Division IXa

In 1999 the July and October Portuguese bottom-trawl surveys were carried out in a different vessel and with a different gear. Given that a conversion factor between gears and vessels is not available, these CPUE indices for 1999 were not used in the assessment.

The log-catchability residuals and the slopes of the linear regressions between log-catchability and log-population for the ages with catchability dependent on year class strength were analysed: fleets 1, 2 and 3 presented high residuals and some negative slopes at age 0 and fleet 3 also at age 1, with a low coefficient of determination. Therefore those ages were not included in the tuning, because they were not providing any information.

Figure 7.7.1.3 compares the Fs estimated by tuning fleet. The lowest values were estimated from fleet 2 and the highest ones correspond to the estimates provided by fleet 5. SSB estimated with a fleet at a time shows opposite trends (Figure 7.7.1.4): fleet 2 shows a steep increase in SSB while this parameter decreases in time according to fleet 5. These features can be the outcome of temporal changes in catchability. Both fleets have a strong influence in the assessment: runs made without one of them resulted in a very different perception of the state of the stock. Therefore, these fleets have opposite effects in the assessment, balancing each other when both are included. These trends were noticeable in previous years, but became more marked with last year's data.

Several hypothesis can be stated to explain the behaviour of fleets 2 and 5. Fleet 2 is likely to be catching fish from different populations than the others fleets (Abaunza *et al*, 1995; Villamor *et al*, 1997). Also the way survey indices are currently calculated may not be the most appropriate for shoaling species such as horse mackerel, which may be introducing noise in the data. The hypothesis regarding fleet 2 is under investigation within the EU funded project "HOMSIR - horse mackerel stock identification research", as for the survey indices, **the WG recommends that a revision of the way indices are calculated should be done in time for the next WG meeting in 2002.**

At present there is no strong evidence that the trends shown by these fleets do not in some way correspond to reality. Since they balance each other, resulting in an assessment consistent with last year's and with the indications given by the other 3 fleets (fleets 1, 3 and 4), the WG opted to include all fleets in the final assessment. Thus, the options for the final assessment were taken in accordance with this exploratory analysis, and keeping consistency with last year's assessment.

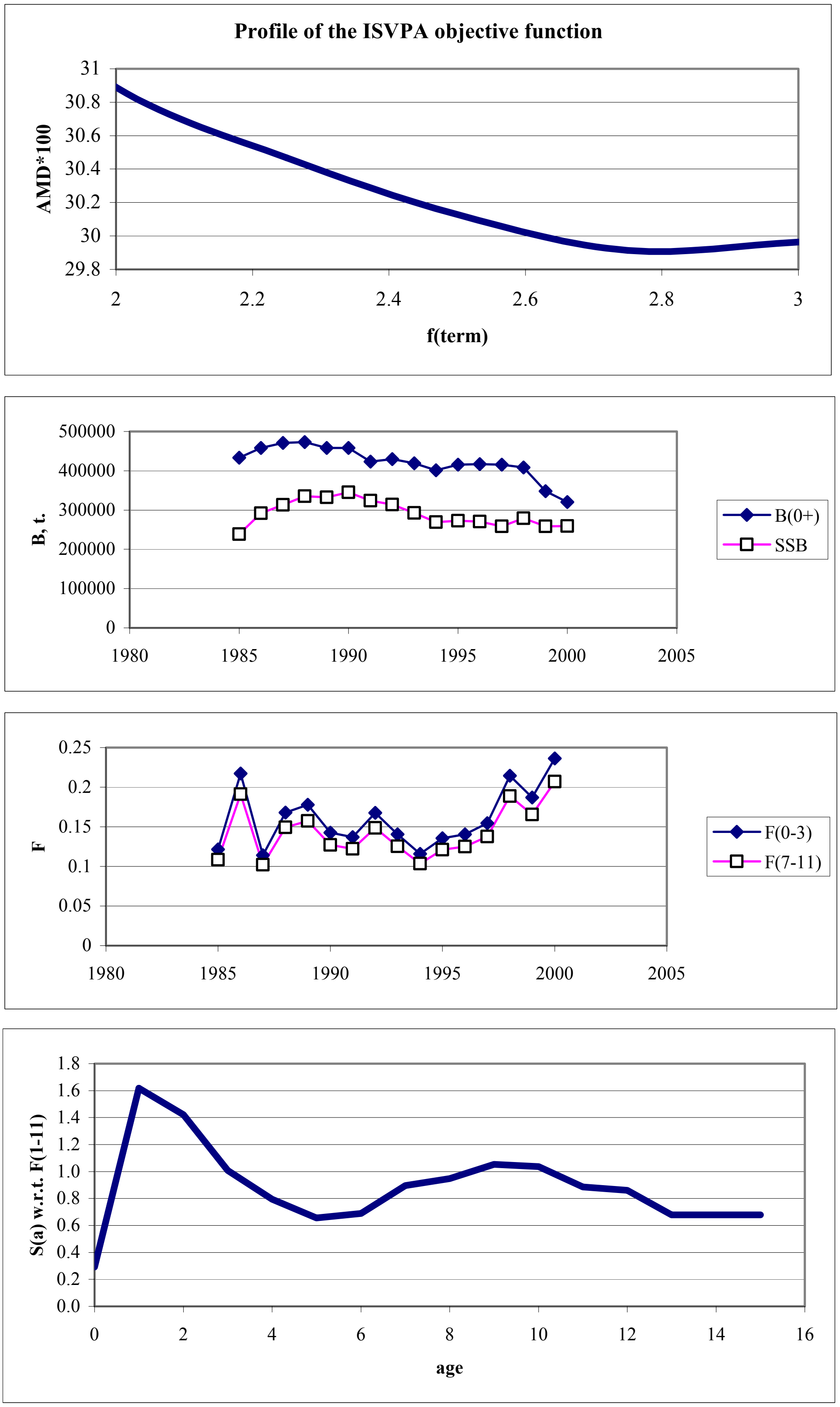


Figure 7.7.1.1.- Results of the ISVPA. Catch-controled version (Objective function, Biomass and SSB, Fishing mortality, Selection pattern) M=0.15; ages: 0-15+

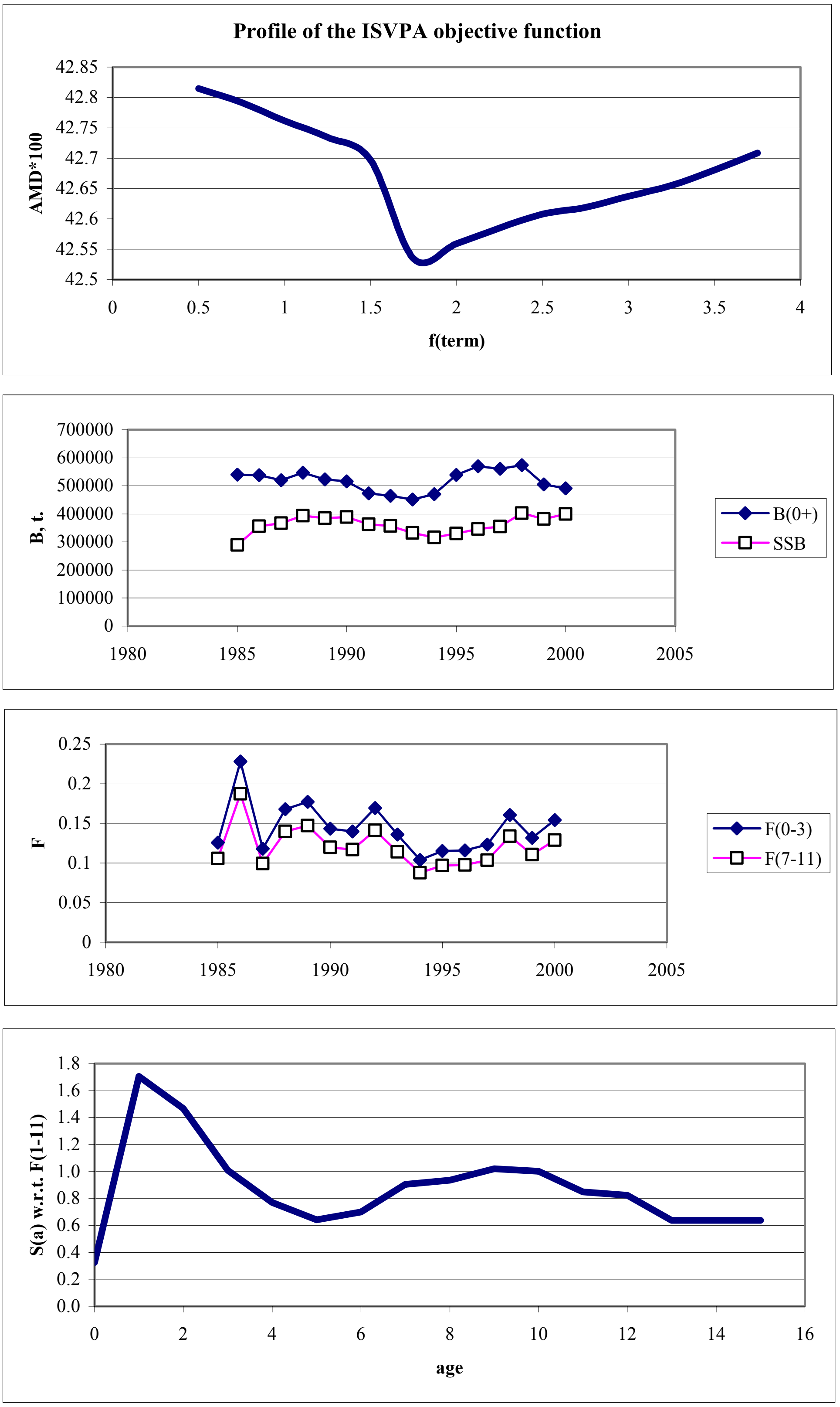


Figure 7.7.1.2.- Results of the ISVPA. Effort-controled version (Objective function, Biomass and SSB, Fishing mortality, Selection pattern) M= 0.15; ages: 0-15+

Figure 7.7.1.3.- Comparison of Fishing mortality series estimated by tuning fleet.

A) With all tuning fleets
B) A Coruna bottom trawl fleet (VIIIc West)
C) Aviles bottom trawl fleet (VIIIc East)
D) October Portuguese bottom trawl survey
E) October Spanish bottom trawl survey
F) July Portuguese bottom trawl survey

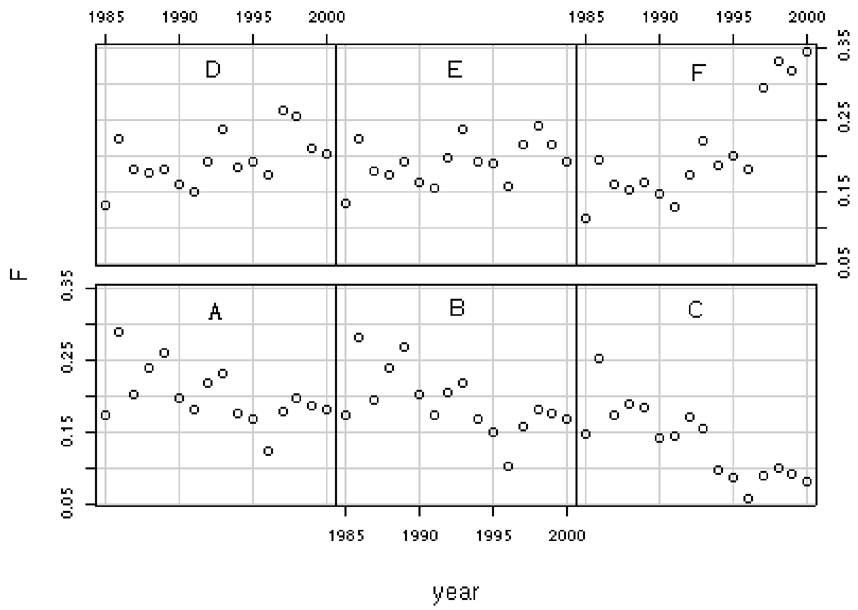
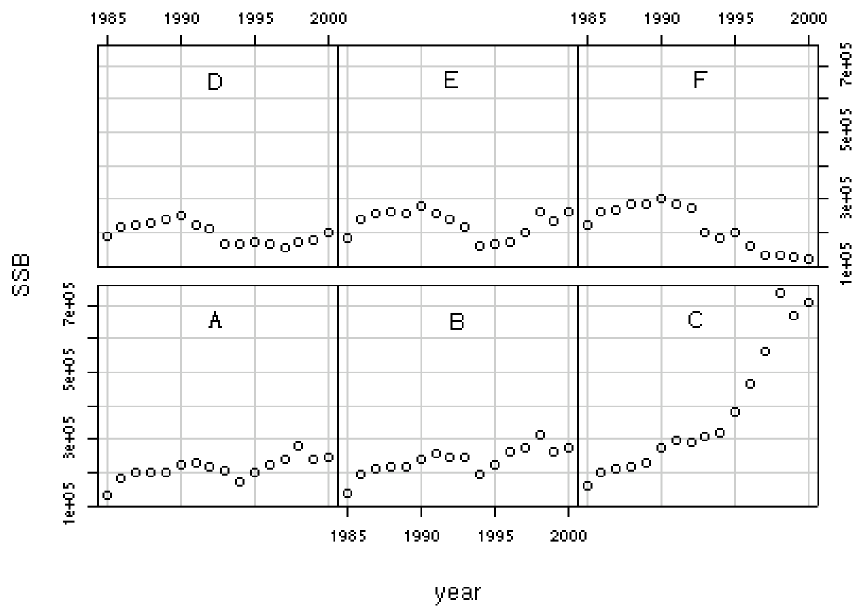


Figure 7.7.1.4.- Comparison of SSB series estimated by tuning fleet.

G) With all tuning fleets
H) A Coruna bottom trawl fleet (VIIIc West)
I) Aviles bottom trawl fleet (VIIIc East)
J) October Portuguese bottom trawl survey
K) October Spanish bottom trawl survey
L) July Portuguese bottom trawl survey



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 presents F estimates from this year and last year's assessment, which included all fleets with an F shrinkage of 1.0. It is clear that for the reference Fbar (1-11) the estimates show an extremely close agreement. Given the pattern of exploitation this stock is under a higher fishing mortality in the younger and older ages with a more reduced mortality at 4-6 years old. The estimates of Fbar (0-3) and Fbar (7-11) also show a close agreement with the assessment of last year. 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 1985-2000 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. Although most fleets provide similar views of the stock trends, 2 fleets show divergent trends. It is expected that an increase in the reliability of the assessment will take place after the recommended revisions of the input data and after the stock boundaries are well established.

Table 7.7.2.1

```
Lowestoft VPA Version 3.1    11/09/2001  11:10

 Extended Survivors Analysis

 Horse mackerel south

 CPUE data from file hom9atun.dat

 Catch data for  16 years. 1985 to 2000. Ages  0 to  12.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 8c West trawl fleet ,   1985, 2000,   0,    11,   .000,  1.000
 8c East trawl fleet ,   1985, 2000,   0,    11,   .000,  1.000
 Oct Pt Survey       ,   1985, 2000,   0,    11,   .800,   .900
 Oct Sp. survey      ,   1985, 2000,   0,    11,   .790,   .880
 Jul Pt. survey      ,   1989, 2000,   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


 Tuning had not converged after   70 iterations


 Total absolute residual between iterations
 69 and  70 =     .00150

 Final year F values
 Age         ,      0,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 69,  .0125,  .1614,  .2256,  .2547,  .2174,  .1281,  .1668,  .1869,  .1564,  .1199
 Iteration 70,  .0125,  .1614,  .2261,  .2542,  .2173,  .1281,  .1671,  .1869,  .1565,  .1199


 Age         ,     10,     11
 Iteration 69,  .1507,  .2223
 Iteration 70,  .1507,  .2223


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
```

Table 7.7.2.1 (Cont'd)

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	.020	.031	.009	.007	.003	.033	.012	.034	.074	.012
1	.108	.234	.085	.113	.152	.036	.489	.516	.381	.161
2	.168	.230	.331	.315	.165	.070	.210	.345	.233	.226
3	.089	.168	.308	.177	.164	.071	.090	.166	.298	.254
4	.085	.102	.157	.110	.121	.125	.076	.089	.226	.217
5	.077	.073	.143	.065	.096	.092	.068	.082	.094	.128
6	.121	.084	.089	.155	.081	.088	.047	.125	.084	.167
7	.176	.164	.156	.116	.154	.104	.115	.143	.105	.187
8	.283	.192	.191	.160	.134	.127	.211	.207	.127	.156
9	.206	.506	.394	.185	.135	.174	.190	.151	.207	.120
10	.397	.242	.439	.212	.283	.156	.258	.213	.159	.151
11	.299	.395	.248	.330	.360	.329	.203	.143	.149	.222

XSA population numbers (Thousands)

	AGE									
YEAR	0	1	2	3	4	5	6	7	8	9
1991	1.75E+06	7.32E+05	4.98E+05	3.05E+05	4.49E+05	4.18E+05	1.32E+05	9.74E+04	5.23E+04	3.74E+05
1992	1.60E+06	1.47E+06	5.65E+05	3.63E+05	2.40E+05	3.55E+05	3.33E+05	1.01E+05	7.03E+04	3.39E+04
1993	1.34E+06	1.34E+06	1.00E+06	3.87E+05	2.64E+05	1.87E+05	2.84E+05	2.64E+05	7.35E+04	5.00E+04
1994	1.44E+06	1.15E+06	1.06E+06	6.21E+05	2.45E+05	1.94E+05	1.39E+05	2.24E+05	1.94E+05	5.23E+04
1995	1.26E+06	1.23E+06	8.82E+05	6.63E+05	4.48E+05	1.89E+05	1.57E+05	1.03E+05	1.71E+05	1.43E+05
1996	1.26E+06	1.08E+06	9.08E+05	6.44E+05	4.84E+05	3.41E+05	1.47E+05	1.24E+05	7.58E+04	1.29E+05
1997	7.79E+05	1.05E+06	8.94E+05	7.28E+05	5.16E+05	3.68E+05	2.68E+05	1.16E+05	9.65E+04	5.74E+04
1998	4.91E+05	6.63E+05	5.54E+05	6.24E+05	5.73E+05	4.12E+05	2.96E+05	2.20E+05	8.91E+04	6.72E+04
1999	7.84E+05	4.09E+05	3.41E+05	3.38E+05	4.55E+05	4.51E+05	3.26E+05	2.25E+05	1.64E+05	6.24E+04
2000	1.10E+06	6.26E+05	2.40E+05	2.32E+05	2.16E+05	3.12E+05	3.53E+05	2.58E+05	1.74E+05	1.24E+05

Estimated population abundance at 1st Jan 2001

, 0.00E+00, 9.36E+05, 4.59E+05, 1.65E+05, 1.55E+05, 1.50E+05, 2.36E+05, 2.57E+05, 1.84E+05, 1.28E+05,

Taper weighted geometric mean of the VPA populations:

, 1.11E+06, 9.13E+05, 6.22E+05, 4.73E+05, 3.64E+05, 2.86E+05, 2.17E+05, 1.55E+05, 1.07E+05, 7.10E+04,

Standard error of the weighted Log(VPA populations) :

, .3856, .3931, .4665, .4294, .4453, .4669, .5257, .5723, .6275, .6735,

	AGE	
YEAR	10	11
1991	2.85E+04	2.36E+04
1992	2.62E+05	1.65E+04
1993	1.76E+04	1.77E+05
1994	2.90E+04	9.77E+03
1995	3.74E+04	2.02E+04
1996	1.07E+05	2.42E+04
1997	9.33E+04	7.90E+04
1998	4.09E+04	6.20E+04
1999	4.98E+04	2.84E+04
2000	4.36E+04	3.65E+04

Estimated population abundance at 1st Jan 2001

, 9.50E+04, 3.23E+04,

Taper weighted geometric mean of the VPA populations:

, 4.42E+04, 2.76E+04,

Standard error of the weighted Log(VPA populations) :

, .7396, .8477,

1

Table 7.7.2.1 (Cont'd)

Log catchability residuals.

Fleet : 8c West trawl fleet

Age	1985	1986	1987	1988	1989	1990
0	99.99	99.99	99.99	99.99	99.99	99.99
1	-.02	.88	.01	1.13	1.55	1.16
2	1.47	.69	1.46	1.43	-.10	1.45
3	1.58	2.30	2.11	1.46	1.29	.33
4	-.26	1.13	2.19	.98	.88	.27
5	.25	.32	1.43	.67	.59	-.62
6	.07	-.19	.91	.46	.14	-.39
7	-.29	-.66	.25	-.21	-.29	-.10
8	-.17	-.52	-.92	-.66	-.15	.01
9	-.08	-.61	.13	-.56	.64	-.72
10	-.30	.40	.17	-.24	1.25	-.26
11	-.65	-.04	-.03	-.22	-.22	-.83

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	-1.19	1.00	.06	.74	-.66	-1.53	-1.01	99.99	99.99	99.99
2	.28	.59	1.99	1.50	.76	-.59	-2.77	-.55	-2.04	-1.28
3	-1.86	-.35	.88	-.71	1.10	-.54	-2.60	.96	-.65	-.11
4	-.75	-.88	.66	-1.02	-.15	.50	-1.96	.76	.16	.06
5	-.62	-.10	1.02	-.50	-.29	.54	-1.46	.37	-.23	.23
6	-.33	.05	-.04	.87	-.27	.30	-1.60	.56	-.09	.17
7	.23	-.09	.30	.20	.11	.03	-.56	.34	.07	-.06
8	.36	-.02	.01	.22	.03	-.14	-.10	.59	.31	-.24
9	.08	.64	.52	-.35	-.34	.15	.03	.03	.40	-.49
10	.42	.44	-.01	-.38	-.06	.18	.14	.36	.04	-.34
11	-.22	-.13	.16	-.74	-.42	.65	.21	.07	.12	.30

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	-19.7333	-20.1628	-19.3601	-18.7561	-18.2301	-17.5835	-17.3240	-17.0072	-17.0072	-17.0072
S.E(Log q)	1.4934	1.3236	.9705	.7204	.6357	.2786	.3459	.4362	.4057	.4193

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	.54	.291	17.76	.06	13	1.16	-21.05

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	.46	1.252	16.27	.35	16	.67	-19.73
3	1.05	-.046	20.50	.09	16	1.45	-20.16
4	1.12	-.160	20.18	.14	16	1.14	-19.36
5	.99	.010	18.72	.30	16	.75	-18.76
6	1.05	-.117	18.51	.38	16	.70	-18.23
7	.91	.675	17.06	.84	16	.26	-17.58
8	.90	.658	16.74	.81	16	.32	-17.32
9	1.10	-.435	17.58	.67	16	.50	-17.01
10	.91	.625	16.33	.82	16	.37	-16.91
11	.78	2.256	15.56	.91	16	.27	-17.08

Table 7.7.2.1 (Cont'd)

```
 Fleet : 8c East trawl fleet

  Age  , 1985, 1986, 1987, 1988, 1989, 1990
     0 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     1 , -3.30, -9.72,-18.87,-15.97,-19.43, 16.46
     2 ,  2.13,  1.14,  1.62, -1.00,  -.53,  1.78
     3 ,   .83,  1.36,  1.48,  -.57,   .26,  1.28
     4 ,  1.09,   .62,   .42,  -.76,   .37,  -.17
     5 ,  -.82,  -.08,   .58,  -.53,   .24,  -.61
     6 ,  -.62,  -.71,   .37,  -.35,  -.23,  -.32
     7 ,  -.48,  -.88,  -.56,  -.78,  -.74,   .01
     8 ,  -.16,  -.68, -1.17,  -.71,  -.62,  -.11
     9 ,  -.20,  -.87,  -.27,   .04,   .41,  -.74
    10 ,  -.16,  -.75,  -.54,   .67,  1.22,  -.27
    11 ,  -.75, -1.76,  -.70,   .47, -1.25,  -.63


  Age  , 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000
     0 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     1 ,-34.13, 15.80,-12.66, 16.05,-14.74,-26.77, 11.27, 99.99, 99.99, 16.65
     2 ,  2.62, -1.72,  1.35,  1.38,  1.58,  2.13, -2.01, -3.07, -2.25, -1.05
     3 ,   .18,   .04,   .69, -1.94,   .90,  1.10, -1.27,  -.26,  -.58,  -.66
     4 ,   .26,  -.50,   .17, -2.00,   .31,  1.73,  -.38,  -.48,   .60,  -.11
     5 ,  -.44,  -.61,  -.39, -1.00,   .13,  1.22,  -.07,   .22,   .62,   .51
     6 , -1.00,  -.61, -1.19,   .67,  -.05,   .57,  -.04,   .85,   .35,   .71
     7 ,  -.87,  -.90,  -.61,   .34,   .47,   .08,   .75,   .87,   .20,   .63
     8 ,  -.73, -1.00, -1.51,   .38,   .53,   .25,  1.26,  1.07,   .33,   .40
     9 ,  -.93,  -.15,  -.39,  -.18,   .28,   .34,   .68,   .31,   .44,  -.07
    10 , -1.37,  -.53, -1.27,  -.16,   .86,   .09,  1.03,   .28,  -.45,   .20
    11 , -1.63, -1.33,  -.80,  -.56,   .57,   .49,   .58,  -.17,  -.86,   .60


 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, -17.7471, -17.9280, -17.6625, -17.4096, -17.3026, -16.9241, -16.6738, -16.4738, -16.4738, -16.4738,
 S.E(Log q),   1.9719,   1.0107,    .8834,    .6321,    .6633,    .6520,    .8470,    .4784,    .7775,    .8965,


 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,  -26.30,    -.697,    -89.40,     .00,     14,   35.13,  -17.76,

 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,     .41,    1.115,     15.17,     .27,     16,     .81,  -17.75,
  3,     .91,     .136,     17.48,     .18,     16,     .96,  -17.93,
  4,     .61,    1.070,     15.77,     .43,     16,     .54,  -17.66,
  5,     .61,    1.680,     15.52,     .65,     16,     .36,  -17.41,
  6,     .93,     .193,     16.94,     .42,     16,     .64,  -17.30,
  7,     .85,     .491,     16.18,     .52,     16,     .57,  -16.92,
  8,     .65,    1.373,     14.89,     .61,     16,     .53,  -16.67,
  9,    1.05,    -.219,     16.75,     .64,     16,     .53,  -16.47,
 10,     .86,     .512,     15.67,     .56,     16,     .69,  -16.51,
 11,     .81,     .764,     15.60,     .63,     16,     .68,  -16.83,
```

Table 7.7.2.1 (Cont'd)

Fleet : Oct Pt Survey

Age	1985	1986	1987	1988	1989	1990
0	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
2	-9.21	.94	-.06	-.21	-.32	-.03
3	-11.11	1.93	.11	.57	-.24	-.27
4	-8.93	-1.28	.43	.65	-.14	-.02
5	-7.34	-.22	-1.26	.91	.29	1.17
6	-7.13	-1.53	-.11	.85	1.27	.27
7	99.99	-.28	-.68	2.29	-1.04	.53
8	99.99	.31	.08	1.09	.33	-.14
9	99.99	.17	.79	1.21	-.08	2.22
10	99.99	-.04	.41	1.25	1.22	1.88
11	99.99	.91	.12	-1.11	2.16	2.15

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	-.86	1.60	.20	.16	.88	-2.29	.61	1.70	99.99	-.05
3	.15	.98	.74	.72	.87	-.41	-.42	-1.67	99.99	1.02
4	-.03	.72	.03	.92	.61	.24	1.10	-2.27	99.99	.62
5	-.16	.22	-1.89	.35	.87	.26	2.29	-1.65	99.99	.15
6	1.01	.50	-2.68	.32	.66	.26	1.83	-1.09	99.99	-.20
7	.89	1.93	-2.48	-.79	-.35	-.76	2.50	-.52	99.99	-.74
8	1.82	2.03	-1.33	-.61	-.98	-1.10	2.07	-.94	99.99	-1.15
9	-.28	2.89	-.40	.38	-1.00	-1.91	2.85	-2.72	99.99	-1.83
10	1.80	.78	.27	.17	.08	-1.98	1.36	-3.15	99.99	-.76
11	.99	1.64	-1.35	1.14	.59	-.88	-1.61	-3.71	99.99	-1.08

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	-9.3011	-9.9801	-10.1238	-10.7082	-11.2066	-11.2770	-11.4676	-11.5854	-11.5854	-11.5854
S.E(Log q)	1.6997	1.7943	1.5747	1.5720	1.5648	1.4674	1.3244	1.8940	1.5481	1.7869

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	.93	.056	9.57	.07	15	1.67	-9.30
3	-.69	-2.224	15.23	.16	15	1.04	-9.98
4	2.77	-.567	5.42	.01	15	4.52	-10.12
5	1.23	-.164	10.29	.06	15	2.03	-10.71
6	1.07	-.063	11.14	.09	15	1.76	-11.21
7	-1.85	-2.238	13.16	.07	14	2.29	-11.28
8	3.42	-1.063	11.26	.02	14	4.50	-11.47
9	-2.60	-1.787	10.17	.03	14	4.44	-11.59
10	1.37	-.402	11.82	.12	14	2.21	-11.52
11	-2.00	-3.403	7.10	.13	14	2.46	-11.80

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Table 7.7.2.1 (Cont'd)

Fleet : Oct Sp. survey

Age	1985	1986	1987	1988	1989	1990
0	.22	.01	.39	.62	.36	-.29
1	1.35	.53	.41	-1.01	-1.41	-.37
2	3.98	.67	1.15	.05	-1.77	-.78
3	3.21	.88	.94	1.02	1.08	-.83
4	.57	.55	1.70	.29	.21	.55
5	.50	.24	-.44	.90	1.54	.38
6	.26	.20	.29	.70	1.60	.64
7	.48	1.19	.52	.27	.73	.64
8	.50	.68	.36	.06	.61	.71
9	.24	.96	.94	.65	.79	-.24
10	.29	1.15	.84	1.41	2.71	.39
11	-.42	.66	.84	.73	-.10	-.15

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-.64	-.24	.18	1.16	-.45	-.37	-.52	.22	-.06	.10
1	-.65	-.04	-.46	.50	1.56	.14	-.26	-.99	1.50	-.43
2	-.31	-2.32	-1.27	.47	.01	.67	-.61	1.12	1.35	.42
3	-3.08	-1.24	-1.70	-1.54	.04	1.03	.19	1.43	.26	1.54
4	-1.69	-2.47	-.68	-1.02	-.27	1.46	-.16	1.69	1.01	-.42
5	-1.69	-1.39	.09	-.60	-.12	.88	-.32	1.08	.56	-.76
6	-1.77	-.89	.40	.13	.21	.32	-.84	.73	.03	-.75
7	-1.91	-.03	.36	-.08	.73	.63	-.30	.10	.25	-1.76
8	-.43	.17	-.11	-.17	.16	-.69	.65	-.28	.00	-.70
9	-.20	.71	.09	-.71	-.18	.56	-.33	-.93	.38	-.66
10	1.03	.69	1.04	-.58	.06	-.41	.20	-1.45	-.15	-1.23
11	1.15	1.34	.31	.09	.14	-.65	.03	-1.06	-1.11	-2.14

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	-17.8201	-18.1515	-17.6682	-17.3781	-17.0417	-16.6601	-16.2117	-15.8801	-15.8801	-15.8801
S.E(Log q)	1.2153	1.4495	1.2218	.9084	.8098	.8673	.4758	.6079	1.0613	.9888

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	.54	1.119	15.30	.38	16	.52	-16.46
1	1.11	-.151	17.25	.16	16	.94	-16.90

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	3.91	-.937	30.87	.01	16	4.78	-17.82
3	.60	.626	16.13	.20	16	.90	-18.15
4	.47	1.435	15.08	.42	16	.54	-17.67
5	1.73	-.699	20.90	.08	16	1.61	-17.38
6	1.25	-.410	18.23	.22	16	1.05	-17.04
7	1.13	-.247	17.29	.25	16	1.03	-16.66
8	.95	.238	15.96	.66	16	.47	-16.21
9	1.41	-1.076	17.83	.41	16	.85	-15.88
10	1.50	-.757	18.20	.19	16	1.60	-15.71
11	1.31	-.667	17.86	.31	16	1.32	-16.03

Table 7.7.2.1 (Cont'd)

Fleet : Jul Pt. survey

Age	1985	1986	1987	1988	1989	1990
0	99.99	99.99	99.99	99.99	-1.24	-.92
1	99.99	99.99	99.99	99.99	-.28	-.22
2	99.99	99.99	99.99	99.99	-.33	.67
3	99.99	99.99	99.99	99.99	.74	.07
4	99.99	99.99	99.99	99.99	1.22	-.42
5	99.99	99.99	99.99	99.99	.19	.13
6	99.99	99.99	99.99	99.99	.07	.01
7	99.99	99.99	99.99	99.99	-.91	.70
8	99.99	99.99	99.99	99.99	1.09	-.12
9	99.99	99.99	99.99	99.99	1.37	1.38
10	99.99	99.99	99.99	99.99	1.35	.79
11	99.99	99.99	99.99	99.99	1.82	1.25

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-.39	-1.69	1.58	-1.06	.82	99.99	.03	-.56	99.99	2.35
1	-.21	.61	-.14	.20	-.85	99.99	.29	.47	99.99	-.04
2	-.73	-.11	1.27	1.09	-1.49	99.99	.01	.61	99.99	-.93
3	-1.30	.37	2.35	1.49	-.15	99.99	-1.32	-1.24	99.99	-.55
4	-1.42	-.07	.83	1.75	.53	99.99	-.44	-1.46	99.99	-.25
5	-1.13	-.74	2.01	1.80	.80	99.99	-.78	-1.57	99.99	-.57
6	-.41	-1.04	2.38	2.29	.20	99.99	-1.40	-1.89	99.99	.01
7	.30	.33	1.60	1.34	-.18	99.99	-.73	-2.11	99.99	-.09
8	1.46	1.19	2.92	.55	-1.70	99.99	-1.86	-1.94	99.99	-.29
9	.12	2.39	2.46	1.41	-2.30	99.99	-1.83	-2.12	99.99	-1.11
10	2.04	.77	.62	1.91	-1.07	99.99	-2.27	-1.81	99.99	-1.90
11	2.18	2.70	-1.59	2.96	-.75	99.99	-1.13	-4.86	99.99	-1.68

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	-9.2360	-9.9330	-10.0979	-10.2983	-10.3040	-10.4582	-10.8004	-10.7108	-10.7108	-10.7108
S.E(Log q)	.9373	1.2689	1.0663	1.2579	1.4703	1.1416	1.6749	1.9329	1.6994	2.5981

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	-.75	-1.325	16.20	.08	10	1.44	-10.85
1	.42	1.095	11.55	.35	10	.47	-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	.56	1.106	11.04	.49	10	.52	-9.24
3	1.06	-.046	9.75	.09	10	1.44	-9.93
4	-1.48	-2.102	16.70	.10	10	1.31	-10.10
5	-.56	-4.108	13.71	.52	10	.40	-10.30
6	-36.45	-.841	83.50	.00	10	54.67	-10.30
7	1.28	-.307	10.01	.15	10	1.56	-10.46
8	5.78	-.875	6.66	.01	10	9.84	-10.80
9	-3.54	-1.342	13.09	.01	10	6.52	-10.71
10	2.54	-.731	11.09	.03	10	4.44	-10.85
11	-1.12	-2.673	9.69	.19	10	2.17	-10.86

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Table 7.7.2.1 (Cont'd)

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	1.,	.000,	.000,	.00,	0,	.000,	.000
8c East trawl fleet ,	1.,	.000,	.000,	.00,	0,	.000,	.000
Oct Pt Survey ,	1.,	.000,	.000,	.00,	0,	.000,	.000
Oct Sp. survey ,	1035329.,	.541,	.000,	.00,	1,	.302,	.000
Jul Pt. survey ,	9818483.,	1.760,	.000,	.00,	1,	.029,	.000
P shrinkage mean ,	912929.,	.39,,,,				.580,	.013
F shrinkage mean ,	369027.,	1.00,,,,				.090,	.031

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
935794.,	.30,	.33,	4,	1.104,	.012

Age 1 Catchability dependent on age and year class strength

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	1.,	.000,	.000,	.00,	0,	.000,	.000
8c East trawl fleet ,	**********,	41.800,	.000,	.00,	1,	.000,	.000
Oct Pt Survey ,	1.,	.000,	.000,	.00,	0,	.000,	.000
Oct Sp. survey ,	393350.,	.484,	.158,	.33,	2,	.282,	.186
Jul Pt. survey ,	441861.,	.519,	.000,	.00,	1,	.259,	.167
P shrinkage mean ,	621715.,	.47,,,,				.377,	.122
F shrinkage mean ,	216145.,	1.00,,,,				.082,	.316

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
458909.,	.27,	.15,	6,	.558,	.161

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	45801.,	1.555,	.000,	.00,	1,	.060,	.649
8c East trawl fleet ,	57970.,	2.053,	.000,	.00,	1,	.034,	.544
Oct Pt Survey ,	156781.,	1.776,	.000,	.00,	1,	.046,	.237
Oct Sp. survey ,	275525.,	.463,	.353,	.76,	3,	.493,	.141
Jul Pt. survey ,	69928.,	.855,	.150,	.18,	2,	.185,	.469
F shrinkage mean ,	183778.,	1.00,,,,				.182,	.205

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
164719.,	.36,	.26,	9,	.714,	.226

Table 7.7.2.1 (Cont'd)

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	66233.,	1.038,	.937,	.90,	2,	.096,	.518
8c East trawl fleet ,	60764.,	.940,	.598,	.64,	2,	.123,	.553
Oct Pt Survey ,	428672.,	1.875,	.000,	.00,	1,	.032,	.100
Oct Sp. survey ,	168089.,	.475,	.577,	1.21,	4,	.307,	.237
Jul Pt. survey ,	193502.,	.471,	.293,	.62,	3,	.297,	.209
F shrinkage mean ,	261723.,	1.00,,,,				.145,	.158

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
155371.,	.30,	.25,	13,	.844,	.254

Age 4 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
8c West trawl fleet ,	111955.,	.675,	.231,	.34,	4,	.167,	.281
8c East trawl fleet ,	94779.,	.668,	.418,	.62,	4,	.185,	.324
Oct Pt Survey ,	389579.,	1.262,	.498,	.39,	2,	.050,	.089
Oct Sp. survey ,	134448.,	.459,	.253,	.55,	5,	.246,	.239
Jul Pt. survey ,	180573.,	.479,	.227,	.47,	3,	.236,	.183
F shrinkage mean ,	265986.,	1.00,,,,				.116,	.128

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
149638.,	.27,	.14,	19,	.543,	.217

Age 5 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
8c West trawl fleet ,	223832.,	.499,	.453,	.91,	5,	.222,	.135
8c East trawl fleet ,	328415.,	.472,	.287,	.61,	5,	.258,	.094
Oct Pt Survey ,	190750.,	1.050,	.624,	.59,	3,	.048,	.157
Oct Sp. survey ,	196864.,	.393,	.306,	.78,	6,	.289,	.152
Jul Pt. survey ,	164643.,	.653,	.365,	.56,	4,	.110,	.179
F shrinkage mean ,	357092.,	1.00,,,,				.074,	.087

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
236485.,	.23,	.15,	24,	.673,	.128

Age 6 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
8c West trawl fleet ,	223613.,	.394,	.346,	.88,	6,	.247,	.190
8c East trawl fleet ,	346560.,	.388,	.340,	.88,	6,	.258,	.127
Oct Pt Survey ,	75852.,	.874,	.578,	.66,	4,	.048,	.480
Oct Sp. survey ,	443505.,	.382,	.351,	.92,	7,	.235,	.100
Jul Pt. survey ,	101632.,	.433,	.205,	.47,	5,	.161,	.379
F shrinkage mean ,	525641.,	1.00,,,,				.051,	.085

Table 7.7.2.1 (Cont'd)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
256842.,	.19,	.18,	29,	.925,	.167

Age 7 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
8c West trawl fleet ,	168009.,	.240,	.188,	.78,	7,	.432,	.203
8c East trawl fleet ,	273000.,	.338,	.170,	.50,	7,	.204,	.130
Oct Pt Survey ,	135551.,	.768,	.512,	.67,	5,	.037,	.246
Oct Sp. survey ,	176209.,	.339,	.339,	1.00,	8,	.177,	.195
Jul Pt. survey ,	137091.,	.394,	.352,	.89,	6,	.118,	.244
F shrinkage mean ,	285537.,	1.00,,,,				.032,	.125

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
184268.,	.15,	.12,	34,	.757,	.187

Age 8 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
8c West trawl fleet ,	121601.,	.201,	.173,	.86,	8,	.489,	.164
8c East trawl fleet ,	214041.,	.320,	.202,	.63,	8,	.175,	.097
Oct Pt Survey ,	120925.,	.700,	.570,	.81,	6,	.035,	.165
Oct Sp. survey ,	106371.,	.294,	.215,	.73,	9,	.206,	.186
Jul Pt. survey ,	91716.,	.419,	.319,	.76,	7,	.069,	.212
F shrinkage mean ,	123710.,	1.00,,,,				.026,	.162

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
128100.,	.14,	.10,	39,	.743,	.156

Age 9 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
8c West trawl fleet ,	98033.,	.186,	.206,	1.11,	9,	.471,	.116
8c East trawl fleet ,	122596.,	.274,	.231,	.84,	9,	.216,	.094
Oct Pt Survey ,	105523.,	.682,	.468,	.69,	7,	.030,	.108
Oct Sp. survey ,	72145.,	.275,	.169,	.61,	10,	.205,	.155
Jul Pt. survey ,	81799.,	.446,	.484,	1.09,	8,	.055,	.138
F shrinkage mean ,	64494.,	1.00,,,,				.022,	.172

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
94970.,	.13,	.10,	44,	.830,	.120

Table 7.7.2.1 (Cont'd)

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	30777.,	.174,	.166,	.95,	10,	.500,	.158
8c East trawl fleet ,	46024.,	.266,	.207,	.78,	10,	.207,	.108
Oct Pt Survey ,	44148.,	.626,	.456,	.73,	8,	.034,	.112
Oct Sp. survey ,	25512.,	.274,	.181,	.66,	11,	.181,	.187
Jul Pt. survey ,	28050.,	.429,	.450,	1.05,	9,	.054,	.172
F shrinkage mean ,	21961.,	1.00,,,,				.024,	.215

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
32303.,	.12,	.10,	49,	.796,	.151

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
8c West trawl fleet ,	26360.,	.164,	.063,	.38,	11,	.529,	.213
8c East trawl fleet ,	28529.,	.259,	.185,	.71,	11,	.199,	.199
Oct Pt Survey ,	22869.,	.615,	.511,	.83,	9,	.032,	.242
Oct Sp. survey ,	19289.,	.272,	.275,	1.01,	12,	.172,	.281
Jul Pt. survey ,	19855.,	.447,	.386,	.86,	10,	.043,	.274
F shrinkage mean ,	36968.,	1.00,,,,				.025,	.157

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
25170.,	.12,	.08,	54,	.721,	.222

Table- 7.7.2.2

Run title : Horse mackerel south
At 11/09/2001 11:12
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
0,	.2868,	.2831,	.0414,	.1479,	.2605,	.0592,
1,	.4446,	.5399,	.4815,	.2868,	.2758,	.2667,
2,	.2261,	.2384,	.4037,	.1169,	.1057,	.2672,
3,	.0516,	.2545,	.2405,	.1436,	.1531,	.1175,
4,	.1266,	.0991,	.1623,	.1139,	.1867,	.0767,
5,	.0975,	.1805,	.0834,	.1577,	.1720,	.0958,
6,	.0715,	.1170,	.2007,	.1231,	.2497,	.1064,
7,	.1546,	.3515,	.1177,	.2277,	.0902,	.2062,
8,	.1131,	.3838,	.1069,	.1762,	.2171,	.1742,
9,	.1686,	.2665,	.1873,	.3108,	.3364,	.2689,
10,	.1936,	.3270,	.1322,	.5869,	.6175,	.2291,
11,	.2632,	.4179,	.1161,	.3826,	.4453,	.3696,
+gp,	.2632,	.4179,	.1161,	.3826,	.4453,	.3696,
0 FBAR 1-11,	.1737,	.2887,	.2029,	.2388,	.2591,	.1980,
FBAR 0- 3,	.2523,	.3290,	.2918,	.1738,	.1988,	.1776,
FBAR 7-11,	.1786,	.3493,	.1320,	.3368,	.3413,	.2496,

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**
AGE											
0,	.0198,	.0312,	.0086,	.0071,	.0030,	.0333,	.0119,	.0340,	.0741,	.0125,	.0402,
1,	.1080,	.2339,	.0853,	.1126,	.1525,	.0361,	.4890,	.5156,	.3806,	.1614,	.3525,
2,	.1678,	.2299,	.3312,	.3150,	.1653,	.0702,	.2104,	.3445,	.2325,	.2261,	.2677,
3,	.0894,	.1677,	.3083,	.1766,	.1645,	.0714,	.0900,	.1656,	.2981,	.2542,	.2393,
4,	.0848,	.1018,	.1573,	.1100,	.1215,	.1255,	.0758,	.0895,	.2260,	.2173,	.1776,
5,	.0768,	.0735,	.1434,	.0652,	.0959,	.0921,	.0676,	.0823,	.0945,	.1281,	.1016,
6,	.1209,	.0842,	.0886,	.1554,	.0805,	.0884,	.0470,	.1251,	.0844,	.1671,	.1255,
7,	.1759,	.1644,	.1556,	.1162,	.1541,	.1038,	.1149,	.1430,	.1054,	.1869,	.1451,
8,	.2826,	.1917,	.1914,	.1595,	.1340,	.1270,	.2109,	.2069,	.1272,	.1565,	.1635,
9,	.2056,	.5055,	.3938,	.1854,	.1355,	.1736,	.1897,	.1508,	.2073,	.1199,	.1593,
10,	.3965,	.2419,	.4394,	.2120,	.2831,	.1557,	.2579,	.2131,	.1593,	.1507,	.1744,
11,	.2991,	.3952,	.2478,	.3296,	.3598,	.3289,	.2026,	.1433,	.1491,	.2223,	.1716,
+gp,	.2991,	.3952,	.2478,	.3296,	.3598,	.3289,	.2026,	.1433,	.1491,	.2223,	
0 FBAR 1-11,	.1825,	.2173,	.2311,	.1761,	.1679,	.1248,	.1778,	.1981,	.1877,	.1809,	
FBAR 0- 3,	.0963,	.1657,	.1833,	.1528,	.1213,	.0528,	.2003,	.2650,	.2463,	.1635,	
FBAR 7-11,	.2719,	.2998,	.2856,	.2005,	.2133,	.1778,	.1952,	.1714,	.1497,	.1673,	

Table 7.7.2.3

Run title : Horse mackerel south

At 11/09/2001 11:12

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,	1989,	1990,
AGE						
0,	1702128,	2690280,	1418792,	955838,	1139949,	902226,
1,	893379,	1099786,	1744707,	1171698,	709558,	756151,
2,	452076,	492948,	551692,	927809,	757023,	463540,
3,	1712968,	310352,	334294,	317115,	710488,	586228,
4,	237417,	1400286,	207097,	226217,	236424,	524695,
5,	170219,	180043,	1091533,	151541,	173742,	168829,
6,	110498,	132903,	129374,	864325,	111407,	125908,
7,	55399,	88543,	101764,	91105,	657747,	74700,
8,	40124,	40852,	53622,	77862,	62446,	517276,
9,	43570,	30842,	23954,	41476,	56191,	43257,
10,	28251,	31684,	20336,	17097,	26162,	34548,
11,	14971,	20035,	19665,	15335,	8182,	12144,
+gp,	44524,	44122,	54487,	46050,	35032,	39634,
TOTAL,	5505525,	6562675,	5751316,	4903468,	4684351,	4249135,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	GMST 85-98
AGE												
0,	1746939,	1601784,	1344551,	1437281,	1255421,	1261660,	779452,	491284,	783824,	1100975,	0,	1242705,
1,	731929,	1474115,	1336336,	1147322,	1228326,	1077292,	1050346,	662945,	408706,	626457,	935794,	1036086,
2,	498484,	565458,	1004193,	1056191,	882354,	907731,	894343,	554386,	340720,	240415,	458909,	682439,
3,	305425,	362761,	386720,	620657,	663457,	643731,	728321,	623720,	338096,	232422,	164719,	525082,
4,	448638,	240410,	264015,	244548,	447726,	484439,	515881,	572940,	454904,	215990,	155371,	368842,
5,	418274,	354758,	186887,	194169,	188568,	341287,	367788,	411604,	450926,	312338,	149638,	263551,
6,	132039,	333406,	283719,	139370,	156571,	147461,	267889,	295872,	326289,	353129,	236485,	188848,
7,	97435,	100703,	263797,	223500,	102690,	124338,	116177,	219995,	224720,	258118,	256842,	130642,
8,	52315,	70339,	73533,	194342,	171272,	75761,	96463,	89136,	164127,	174073,	184268,	86425,
9,	374054,	33943,	49980,	52268,	142606,	128924,	57430,	67242,	62383,	124393,	128100,	59892,
10,	28453,	262111,	17622,	29015,	37373,	107190,	93282,	40890,	49774,	43641,	94970,	38615,
11,	23648,	16473,	177125,	9775,	20203,	24235,	78956,	62038,	28440,	36530,	32303,	23375,
+gp,	42252,	40648,	27684,	52593,	77121,	90711,	83491,	192285,	60795,	85999,	84435,	
TOTAL,	4899885,	5456908,	5416162,	5401029,	5373684,	5414759,	5129820,	4284337,	3693705,	3804482,	2881835,	

Table 7.7.2.4

Run title : Horse mackerel south ,

At 11/09/2001 11:12

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,	1702128,	309387,	133674,	43535,	.3257,	1.0238,	.1737,	.2523,	.1786,
1986,	2690280,	343825,	184334,	71258,	.3866,	1.0190,	.2887,	.3290,	.3493,
1987,	1418792,	353013,	199877,	52747,	.2639,	.9882,	.2029,	.2918,	.1320,
1988,	955838,	348349,	202824,	55888,	.2755,	.9782,	.2388,	.1738,	.3368,
1989,	1139949,	341295,	202474,	56396,	.2785,	.9860,	.2591,	.1988,	.3413,
1990,	902226,	352368,	221905,	49207,	.2217,	1.0057,	.1980,	.1776,	.2496,
1991,	1746939,	345981,	226600,	45511,	.2008,	1.0123,	.1825,	.0963,	.2719,
1992,	1601784,	355379,	215283,	50956,	.2367,	.9935,	.2173,	.1657,	.2998,
1993,	1344551,	364648,	206786,	57428,	.2777,	1.0001,	.2311,	.1833,	.2856,
1994,	1437281,	334626,	174170,	52588,	.3019,	1.0003,	.1761,	.1528,	.2005,
1995,	1255421,	364236,	198507,	52681,	.2654,	.9997,	.1679,	.1213,	.2133,
1996,	1261660,	389345,	221262,	44690,	.2020,	1.0075,	.1248,	.0528,	.1778,
1997,	779452,	410754,	238176,	56770,	.2384,	.9940,	.1778,	.2003,	.1952,
1998,	491284,	422681,	279463,	64480,	.2307,	.9867,	.1981,	.2650,	.1714,
1999,	783824,	341612,	238302,	51922,	.2179,	.9893,	.1877,	.2463,	.1497,
2000,	1100975,	339928,	246863,	49138,	.1990,	1.0212,	.1809,	.1635,	.1673,
Arith. Mean ,	1288274,	357339,	211906,	53450,	.2577		.2003,	.0000,	.2325,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),					

1

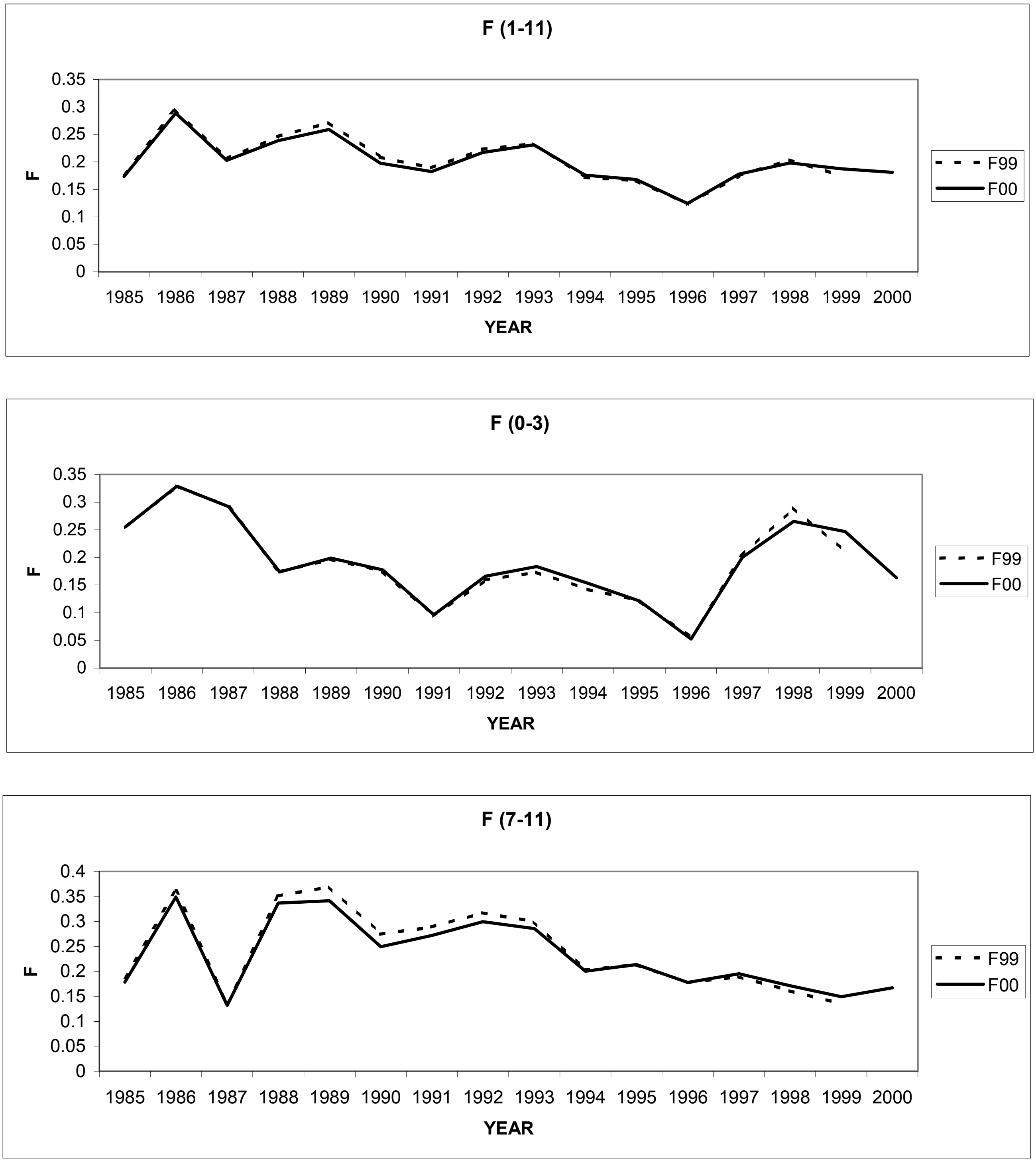


Figure 7.7.2.1.- Comparison of the 1999 and 2000 assessments for different F's bar from the final VPA figure.

Figure 7.7.2.2

Figure 7.7.2.3

7.8 Catch Predictions

The terminal population in 2000 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 1985-1998. 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-b and Figure 7.8.1 show the results of the short-term predictions of the catch and spawning stock biomass.

At F *status-quo* (Fbar 1998-2000) the predicted catch in weight for 2001 is 52,486 t. In 2002, assuming the same recruitment level, the catch at F *status quo* is predicted to be 53,719 t. The spawning stock biomass is predicted to decrease from 221,482 t at the beginning of 2001 to 203,153 t in 2002 (Table 7.8.2.a) at F *status quo*. Assuming F status quo in 2002, the spawning stock biomass is predicted to decrease in 2003 to 189,023 t.

Table 7.8.1.- Input data for predictions
Run: hom9aproj1
Time and date: 15:17 12/09/01
Fbar age range: 1-11

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	1242705	0.15	0.00	0.25	0.25	0.000	0.040	0.023
1	935794	0.15	0.00	0.25	0.25	0.032	0.353	0.036
2	458909	0.15	0.04	0.25	0.25	0.055	0.268	0.059
3	164719	0.15	0.27	0.25	0.25	0.075	0.239	0.089
4	155371	0.15	0.63	0.25	0.25	0.105	0.178	0.120
5	149638	0.15	0.81	0.25	0.25	0.127	0.102	0.144
6	236485	0.15	0.90	0.25	0.25	0.154	0.126	0.164
7	256842	0.15	0.95	0.25	0.25	0.176	0.145	0.188
8	184268	0.15	0.97	0.25	0.25	0.213	0.164	0.203
9	128100	0.15	0.98	0.25	0.25	0.240	0.159	0.226
10	94970	0.15	0.99	0.25	0.25	0.269	0.174	0.251
11	32303	0.15	1.00	0.25	0.25	0.304	0.172	0.263
12	84435	0.15	1.00	0.25	0.25	0.355	0.172	0.337

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	1242705	0.15	0.00	0.25	0.25	0.000	0.040	0.023
1	.	0.15	0.00	0.25	0.25	0.032	0.353	0.036
2	.	0.15	0.04	0.25	0.25	0.055	0.268	0.059
3	.	0.15	0.27	0.25	0.25	0.075	0.239	0.089
4	.	0.15	0.63	0.25	0.25	0.105	0.178	0.120
5	.	0.15	0.81	0.25	0.25	0.127	0.102	0.144
6	.	0.15	0.90	0.25	0.25	0.154	0.126	0.164
7	.	0.15	0.95	0.25	0.25	0.176	0.145	0.188
8	.	0.15	0.97	0.25	0.25	0.213	0.164	0.203
9	.	0.15	0.98	0.25	0.25	0.240	0.159	0.226
10	.	0.15	0.99	0.25	0.25	0.269	0.174	0.251
11	.	0.15	1.00	0.25	0.25	0.304	0.172	0.263
12	.	0.15	1.00	0.25	0.25	0.355	0.172	0.337

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	1242705	0.15	0.00	0.25	0.25	0.000	0.040	0.023
1	.	0.15	0.00	0.25	0.25	0.032	0.353	0.036
2	.	0.15	0.04	0.25	0.25	0.055	0.268	0.059
3	.	0.15	0.27	0.25	0.25	0.075	0.239	0.089
4	.	0.15	0.63	0.25	0.25	0.105	0.178	0.120
5	.	0.15	0.81	0.25	0.25	0.127	0.102	0.144
6	.	0.15	0.90	0.25	0.25	0.154	0.126	0.164
7	.	0.15	0.95	0.25	0.25	0.176	0.145	0.188
8	.	0.15	0.97	0.25	0.25	0.213	0.164	0.203
9	.	0.15	0.98	0.25	0.25	0.240	0.159	0.226
10	.	0.15	0.99	0.25	0.25	0.269	0.174	0.251
11	.	0.15	1.00	0.25	0.25	0.304	0.172	0.263
12	.	0.15	1.00	0.25	0.25	0.355	0.172	0.337

Input units are thousands and kg - output in tonnes

Table 7.8.2a.- Prediction with management option table
Run: hom9aproj1
Horse mackerel south
Time and date: 15:17 12/09/01
Fbar age range: 1-11

2001				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
319822	221482	1	0.1889	52486

2002					2003	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
311403	211474	0	0	0	366436	233052
.	210626	0.1	0.0189	5897	359588	228204
.	209782	0.2	0.0378	11669	352894	223461
.	208941	0.3	0.0567	17321	346349	218821
.	208104	0.4	0.0756	22853	339951	214281
.	207271	0.5	0.0945	28271	333694	209839
.	206440	0.6	0.1134	33575	327576	205492
.	205613	0.7	0.1322	38770	321594	201240
.	204790	0.8	0.1511	43857	315743	197079
.	203970	0.9	0.17	48839	310020	193007
.	203153	1	0.1889	53719	304423	189023
.	202339	1.1	0.2078	58499	298947	185125
.	201529	1.2	0.2267	63182	293591	181310
.	200723	1.3	0.2456	67769	288350	177577
.	199919	1.4	0.2645	72263	283223	173923
.	199119	1.5	0.2834	76666	278206	170348
.	198322	1.6	0.3023	80981	273297	166849
.	197528	1.7	0.3212	85209	268493	163425
.	196738	1.8	0.3401	89353	263791	160074
.	195951	1.9	0.359	93413	259190	156794
.	195167	2	0.3779	97393	254685	153584

Input units are thousands and kg - output in tonnes

Table 7.8.2b.- Prediction with management option table
Run: hom9aproj1
Time and date: 15:17 12/09/01
Fbar age range: 1-11

Year:	**2001**	**F multiplier:**	**1**	**Fbar:**	**0.1889**				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0.0402	45493	1046	1242705	0	0	0	0	0
1	0.3525	259309	9335	935794	29945	0	0	0	0
2	0.2677	100421	5891	458909	25240	18356	1010	16536	909
3	0.2393	32651	2917	164719	12354	44474	3336	40350	3026
4	0.1776	23530	2824	155371	16314	97884	10278	90187	9470
5	0.1016	13446	1941	149638	19004	121207	15393	113817	14455
6	0.1255	25948	4255	236485	36419	212837	32777	198669	30595
7	0.1451	32272	6067	256842	45204	244000	42944	226647	39890
8	0.1635	25867	5260	184268	39249	178740	38072	165265	35201
9	0.1593	17556	3973	128100	30744	125538	30129	116196	27887
10	0.1744	14142	3554	94970	25547	94020	25291	86697	23321
11	0.1716	4739	1246	32303	9820	32303	9820	29808	9062
12	0.1716	12388	4176	84435	29982	84435	29982	77913	27666
Total		607761	52486	4124539	319822	1253794	239031	1162083	221482

Year:	**2002**	**F multiplier:**	**1**	**Fbar:**	**0.1889**				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0.0402	45493	1046	1242705	0	0	0	0	0
1	0.3525	284710	10250	1027461	32879	0	0	0	0
2	0.2677	123889	7268	566152	31138	22646	1246	20401	1122
3	0.2393	59906	5352	302219	22666	81599	6120	74032	5552
4	0.1776	16901	2028	111602	11718	70309	7382	64781	6802
5	0.1016	10061	1452	111968	14220	90694	11518	85165	10816
6	0.1255	12766	2094	116348	17918	104713	16126	97743	15052
7	0.1451	22558	4241	179532	31598	170555	30018	158425	27883
8	0.1635	26841	5458	191208	40727	185472	39505	171489	36527
9	0.1593	18457	4177	134674	32322	131981	31675	122159	29318
10	0.1744	14000	3519	94017	25291	93077	25038	85827	23088
11	0.1716	10074	2649	68662	20873	68662	20873	63358	19261
12	0.1716	12417	4185	84636	30053	84636	30053	78099	27732
Total		658073	53719	4231184	311403	1104345	219555	1021478	203153

Year:	**2003**	**F multiplier:**	**1**	**Fbar:**	**0.1889**				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0.0402	45493	1046	1242705	0	0	0	0	0
1	0.3525	284710	10250	1027461	32879	0	0	0	0
2	0.2677	136024	7980	621610	34189	24864	1368	22399	1232
3	0.2393	73905	6602	372845	27963	100668	7550	91332	6850
4	0.1776	31010	3721	204763	21500	129001	13545	118856	12480
5	0.1016	7227	1043	80426	10214	65145	8273	61173	7769
6	0.1255	9552	1567	87059	13407	78353	12066	73137	11263
7	0.1451	11098	2086	88328	15546	83911	14768	77943	13718
8	0.1635	18762	3815	133654	28468	129644	27614	119870	25532
9	0.1593	19152	4335	139746	33539	136951	32868	126760	30422
10	0.1744	14719	3699	98842	26589	97854	26323	90232	24272
11	0.1716	9973	2623	67973	20664	67973	20664	62722	19068
12	0.1716	16306	5496	111143	39465	111143	39465	102558	36417
Total		677931	54264	4276554	304423	1025508	204505	946984	189023

Input units are thousands and kg - output in tonnes

Figure 7.8.1

7.9 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 7.9.1 presents the yield per recruit summary table. F 0.1 is estimated to be 0.11, and $\mathbf{F}_{max}$ to be 0.19 (in fact 0.1879), at the reference age (1-11).

7.10 Reference Points for Management Purpose

The SSB historic series for this stock has a narrow range without a clear trend, implying that the lowest observed SSB may be a suitable value for $\mathbf{B}_{pa}$. Also $\mathbf{F}_{pa}$, which was derived from $\mathbf{B}_{lim}$, has been in most years below F. Moreover, F and SSB have been relatively stable in time, suggesting that the current stock exploitation level is sustainable. A data revision is planned for next year, which may change the perception of the history of the stock. The WG considers that the reference points should be revisited after the survey data is revised.

7.11 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.

7.12 Management Considerations

In the year 2000 the TAC was revised to 68000 tonnes, which is in close agreement with recommendation from this working group. This TAC has never been reached during the assessment period. In 2000, F increased to a level above $\mathbf{F}_{pa}$ (F2000 = 0.1879).

Table 7.9.1.- Yield per recruit summary table

MFYPR version 2a
Run: hom9aypr1
Time and date: 15:46 12/09/01
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	7.1792	1.0241	3.7744	0.8767	3.6355	0.8444
0.1	0.0189	0.1088	0.0139	6.4556	0.8429	3.1471	0.704	3.0191	0.6753
0.2	0.0378	0.1969	0.0233	5.87	0.7033	2.6512	0.5721	2.5333	0.5467
0.3	0.0567	0.2695	0.0298	5.3876	0.5938	2.2526	0.4698	2.1438	0.447
0.4	0.0756	0.3302	0.0342	4.9843	0.5064	1.9275	0.3891	1.8272	0.3688
0.5	0.0945	0.3817	0.0372	4.643	0.4359	1.6594	0.3247	1.5667	0.3065
0.6	0.1134	0.4258	0.0392	4.3512	0.3784	1.436	0.2727	1.3504	0.2565
0.7	0.1322	0.4638	0.0405	4.0995	0.3309	1.2484	0.2304	1.1693	0.2159
0.8	0.1511	0.497	0.0412	3.8806	0.2913	1.0897	0.1957	1.0165	0.1826
0.9	0.17	0.526	0.0416	3.6891	0.2582	0.9546	0.167	0.8869	0.1552
1	0.1889	0.5516	0.0416	3.5204	0.2302	0.839	0.1431	0.7763	0.1325
1.1	0.2078	0.5744	0.0416	3.371	0.2063	0.7395	0.1231	0.6814	0.1136
1.2	0.2267	0.5946	0.0413	3.2382	0.1859	0.6536	0.1063	0.5998	0.0977
1.3	0.2456	0.6127	0.041	3.1195	0.1684	0.5791	0.0921	0.5292	0.0843
1.4	0.2645	0.6291	0.0406	3.013	0.1532	0.5143	0.0801	0.4679	0.073
1.5	0.2834	0.6438	0.0402	2.917	0.14	0.4577	0.0698	0.4146	0.0634
1.6	0.3023	0.6571	0.0397	2.8303	0.1285	0.4081	0.061	0.3681	0.0551
1.7	0.3212	0.6692	0.0393	2.7517	0.1185	0.3646	0.0534	0.3274	0.0481
1.8	0.3401	0.6803	0.0388	2.6802	0.1096	0.3263	0.0469	0.2917	0.0421
1.9	0.359	0.6904	0.0383	2.6149	0.1017	0.2926	0.0413	0.2603	0.0369
2	0.3779	0.6997	0.0379	2.5553	0.0948	0.2627	0.0364	0.2327	0.0324

Reference point	F multiplier	Absolute F
Fbar(1-11)	1	0.1889
FMax	0.9944	0.1879
F0.1	0.5867	0.1108
F35%SPR	0.5202	0.0983

Weights in kilograms

8 SARDINE GENERAL

Sardine (*Sardina pilchardus*, Walb 1792) is an important pelagic fish species with a wide distribution area around NE Atlantic waters and adjacent areas (i.e. Black Sea in the eastern Part and Açores in the western part). Northern and southern limits seem to be related to the average water temperature, being located within 10ºC and 20ºC isotherme (Furnestin, 1945). Nevertheless, several authors have hypothesised that sardine distribution and abundance are dependent on oceanographic regime (Barkova *et al*, 2001; Kifani, 1998; Carrera and Porteiro, 2001, in press). High abundance, wide geographic distributions, feeding/spawning migrations and high fishery productivity are all associated with favourable "regimes" (Lluch-Belda *et al*. 1992, Schwartzlose *et al*. 1999).

Off the African coast, Kifani (op. cit.) analysed landings from the Morocco area. The main fisheries began around the mid-20th Century. From this period, catches increased and peaked in the seventies (Figure 8.1). During this earlier period, important fluctuations were observed. During the eighties catches dropped but in the nineties there has been a general increase in catches, to around one million tonnes of fish. In this area, although sardine was earlier separated into three stock units, recent studies stated that two populations are distributed off Moroccan waters, which can be distinguished by the different growth rate and longevity and meristic characters (Barkova *et al*, op. cit).

North of the Iberian peninsula there are no fisheries targeted on sardine, although catches are routinely reported from these areas. In addition no extensive studies have been undertaken in this zone but some studies on sardine distribution and ichthyoplankton have been undertaken in ICES Divisions VIIIa,b and VIIe,f,h.

Acoustic surveys in Division VIIIa, b

During May 2001, an acoustic survey was carried out off the French coast within the framework of the EU DG XIV Study PELASSES. This survey, targeted on anchovy and sardine, also covered the distribution area of other pelagic fish species. It was co-ordinated with the Portuguese and Spanish surveys to cover the southern part of the European Atlantic waters (Massé WD 2001).

A biomass of 205 thousand tonnes of sardine was estimated, which was mainly located in the northern part. Juveniles, of which there were few, were only seen in shallow waters (Figure 8.2). As it was also observed during the Spanish survey, juvenile fish remained within the influence of river plumes, in low salty waters whilst the adult fish occurred in pure oceanic waters. The area distribution was different to that observed last year when sardine was found over the continental shelf.

The fishery

Data were provided by German and UK (England and Wales) and yielded 3 341 tonnes, which is similar to that of the last year (3 711 tonnes). Nevertheless, as shown in Table 8.1, some catches were reported from ICES Division IVc. Most of the catches occurred in Division VII (3 298 tonnes), mainly in Division VIIe,f with 2 916 tonnes. The fishery is mainly located in winter, as in previous years. Catches from the first and fourth quarter represent up to 97% of the total catches.

Table 8.1: Annual catches of sardine by ICES Sub-Division

DIVISION	1983	1984	1985	1986	1987	1988	1989	1990	1991
IVc									
Total IV									
VIId	211	147	465	512	67	29	93	64	170
VIIe,f	590	661	1 624	2 058	682	438	91	808	4 687
VIIg	-	1	-						
VIIh	2	-			216	2 119	957	235	110
Total VII	**803**	**809**	**2 089**	**2 570**	**965**	**2 586**	**1 141**	**1 107**	**4 968**
VIIIa	6 013	4 472	8 090	10 186	7 631	7 770	8 885	8 381	9 113
VIIIb	454	19	79	77	77	38	85	104	482
Total VIIIab	**6 467**	**4 491**	**8 169**	**10 263**	**7 708**	**7 808**	**8 970**	**8 485**	**9 595**

DIVISION	1992	1993	1994	1995	1996	1997	1998	1999	2000
IVc									5
Total IV									**5**
VIId	153	127	2 086	1 621	179	71	103	247	209
VIIe,f	19 635	5 304	20 985	13 787	8 278	2 584	4 223	3 415	2916
VIIg									
VIIh	4	71	-	1 439	1 350	1 058	101	11	173
Total VII	**19 793**	**5 502**	**23 071**	**16 846**	**9 807**	**3 713**	**4 427**	**3 711**	**3298**
VIIIa	8 565	4 703	7 164		8 180	11 361	10 674		38
VIIIb	141	548	119		526	160	7 749		
Total VIIIab	**8 706**	**5 251**	**7 283**		**8 706**	**11 521**	**18 423**	**17 730**	**38**

1983-90 only French data was available for Sub-Area VII

Table 8.2: Sardine landings in 2000 by country. Below, quarterly distributic of the German and UK catches.

Division	Germany	UK	France	Total
IVc		5		**5**
VIId	65	144		**209**
VIIef	39	2877		**2916**
VIIg				
VIIh	166	7		**173**
VIIj				
VIIIab	38			**38**
Total	**308**	**3033**		**3341**

Country	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Germany			2	306	**308**
UK	1473	6	103	1451	**3033**
Total	**1473**	**6**	**105**	**1757**	**3341**

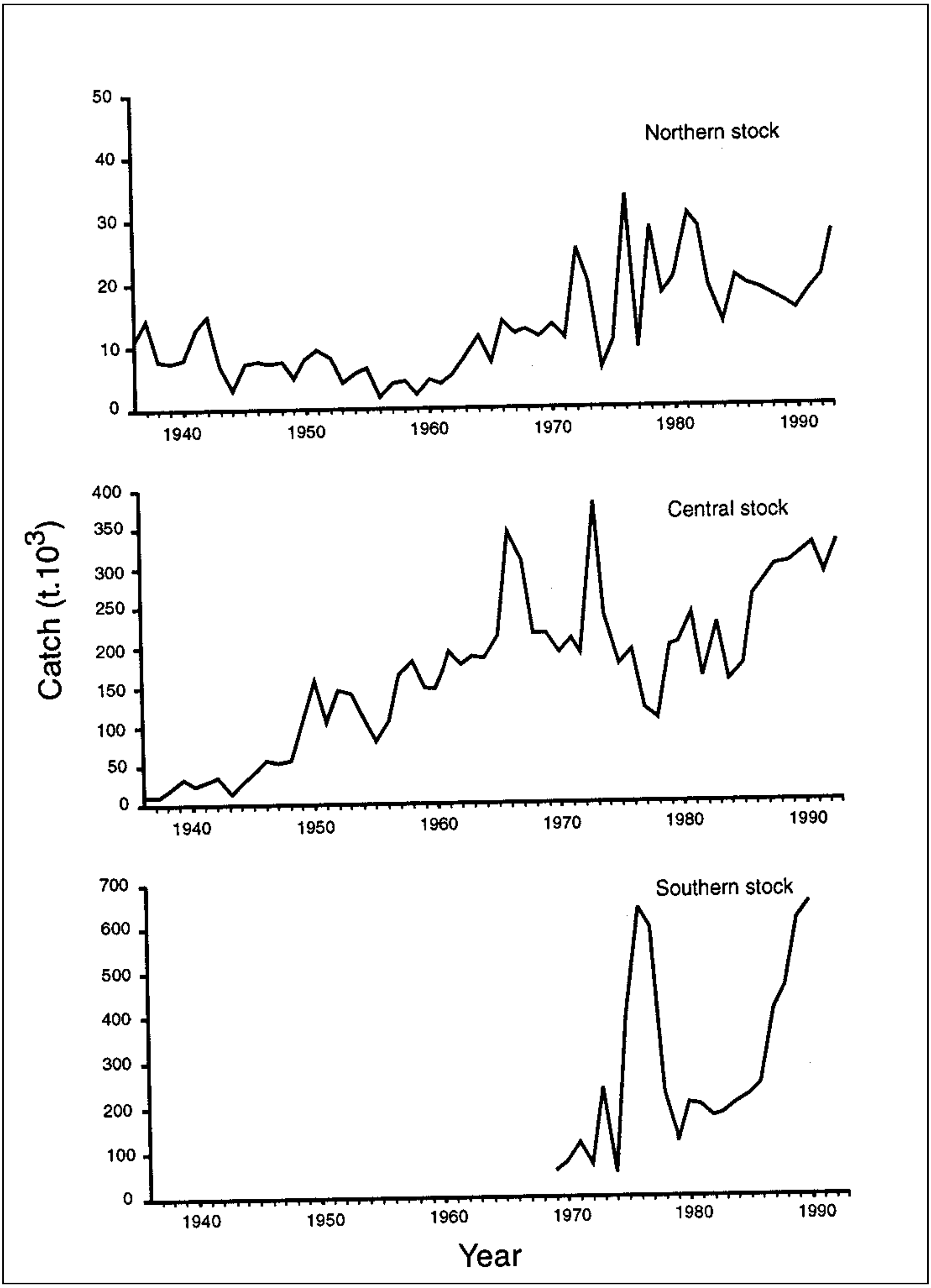


Figure 8.1: Annual catch of sardine from Morocco (adapted from Kifani, 1998). Northern stock is distributed from Gibraltar (35º50'N) to 33º15'N Moroccan coastal waters; central stock from 33º15'N to 26º45'N; and south stock from 26º45'N to 21ºN approximately.

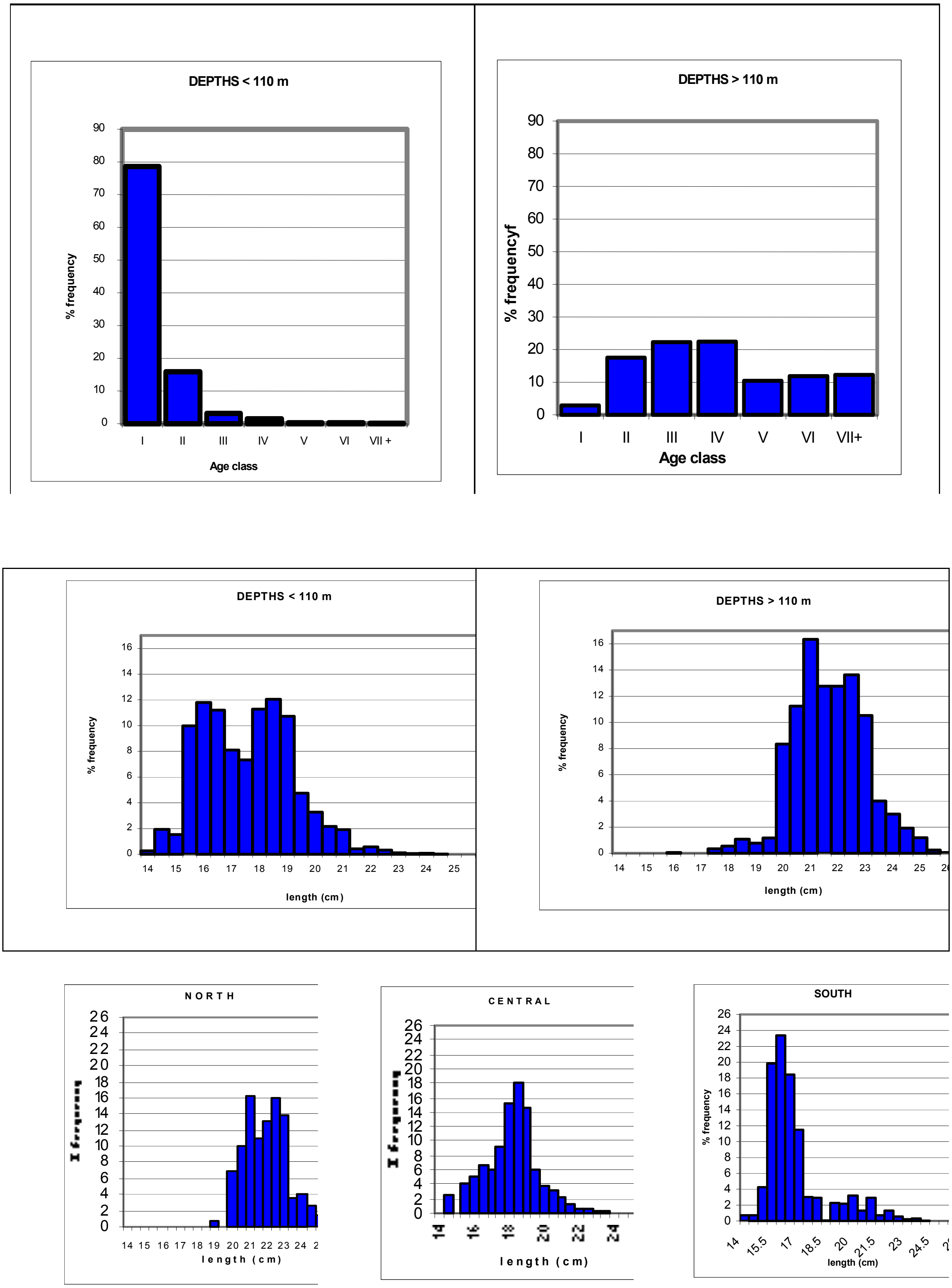


Figure 8.2 : Age and Length distribution of sardine during the PEL2001 survey in Division VIIIa, b.

9 SARDINE IN VIIIC AND IXA

9.1 ACFM Advice Applicable to 2000 and 2001

Based on new data provided by ICES CM 2001/ACFM:06, ACFM considered that at present the spawning biomass of this stock is considered to be low, similar to that observed in 1990. In addition, fishing mortality decreased last year. Management measures taken on a national basis by both Portugal and Spain contributed to this reduction. Nevertheless, changes in stock abundance in different areas remain a matter of concern. The biological relationship between the different areas and the general stock definitions is still unclear. This may imply a vulnerability of the fishery at both a local and a global level. Therefore, close monitoring of this stock is still needed, as well as a better understanding of the stock structure and behaviour. For 2001, ACFM recommended that "fishing mortality be reduced below F=0.20, corresponding to a catch of less than 88 000 t in order to prevent short-term decline in stock size and promote recovery of the stock".

9.2 The fishery in 2000

Different management measures were implemented in each country. A minimum landing size of 11 cm (EU reg. 850/98) has been in force since 1999 in all EU waters. In Spain, from 15th February to 31st March there was a ban for the purse seine fishery and sardine catches were not allowed. In Spain, a maximum allowable catch of 7,000 Kg per fishing day and a per week limitation in the number of fishing days (4 in Galicia, 5 in the rest of Spain) was also implemented. In Portugal regulations have been gradually implemented since 1997. In 2000 management measures included: (1) an overall limitation in the number of fishing days (180 days per year, and a weekend ban), (2) an overall quota reduction of about 10 % per year since 1997, (3) a closure of the purse-seine fishery in the northern part of the Portuguese area from the 15th of February to 15th of April and finally, (4) a yearly quota reduction for all fishermen organisations (which some organisations have distributed in daily catch limits by boat). Daily catch limitations were imposed for the first time in 1999.

As estimated by the Working Group, catches in divisions VIIIc and IXa were 85,786 t (19,644 t from Spain and 66,141 t from Portugal). The bulk of the landings (99%) were made by purse seiners. Table 9.2.1 summarises the quarterly landings by ICES Sub-Division. There was a decrease in landings in both countries (8% in Portugal and 13% in Spain). In Sub-division VIIIc-East, catches were 7,547 t which remained at the same level as in 1999. As it was previously observed, most of the catches were taken during the first and the fourth quarter, outside the main anchovy and tuna fishing periods. In VIIIc-W, catches were 4,149 t , similar to 1999 landings. In IXa-N, sardine catches were similar to 1999 figures (2,866 tonnes), much lower than the yields during the eighties in this area (52,000 tonnes as a mean). In IXa-CN, landings dropped 35%, from 31,574 tonnes achieved in 1999 to 23,311 tonnes. This decrease occurred from March until the end of the year, and mostly in the middle of the year. In IXa-CS, catches increased slightly (23,701 t). In addition, in IXa S, there was also a small increasing in sardine landings (19,129 tonnes). On the contrary, in the Gulf of Cadiz (IXa-Cadiz) catches decreased by 54%, from 7,846 tonnes to 5,081 tonnes.

Annual catches from both Spain and Portugal are available from 1940 (Figure 9.2.1 and Table 9.2.2). Declining trends are observed in northern areas (from IXa-CN to VIIIc) whereas in the most southern areas, catches have shown a slight increasing trend.

Table 9.2.1: Quarterly distribution of sardine landings (t) by ICEs Sub-Division. Above absolute values; below, relative numbers

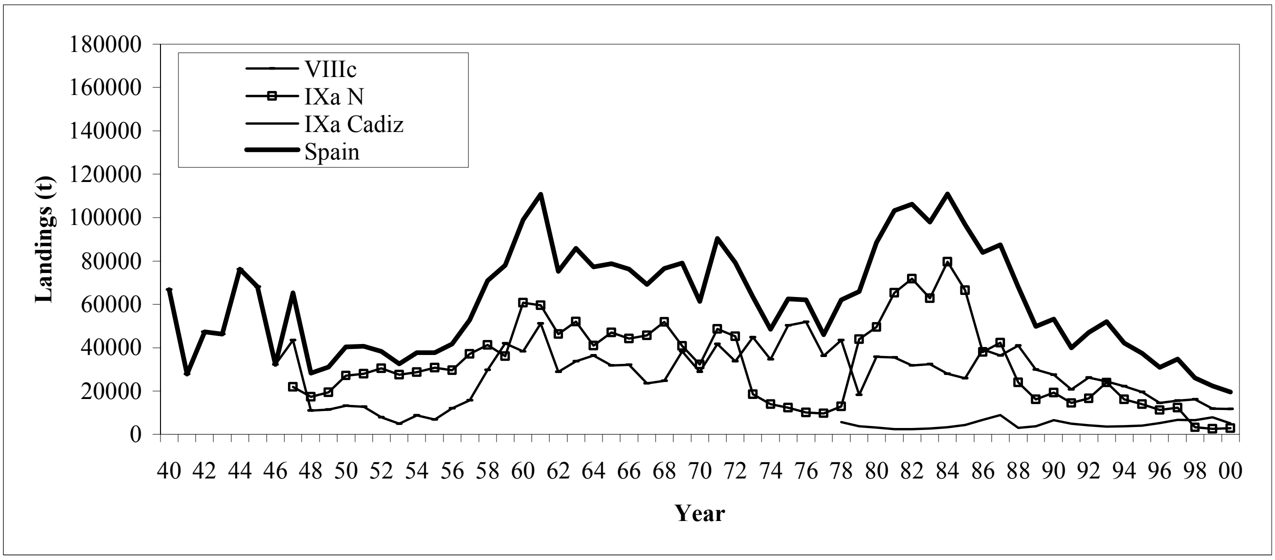
Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2953	2020	974	1601	**7547**
VIIIc-W	239	2040	1088	783	**4149**
IXa-N	77	574	1885	331	**2866**
IXa-CN	2905	3838	10009	6560	**23311**
IXa-CS	6436	4469	6312	6483	**23701**
IXa-S (A)	3516	4280	6413	4920	**19129**
IXa-S (C)	1562	663	1336	1520	**5081**
Total	**17687**	**17884**	**28016**	**22198**	**85786**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3.44	2.35	1.14	1.87	**8.80**
VIIIc-W	0.28	2.38	1.27	0.91	**4.84**
IXa-N	0.09	0.67	2.20	0.39	**3.34**
IXa-CN	3.39	4.47	11.67	7.65	**27.17**
IXa-CS	7.50	5.21	7.36	7.56	**27.63**
IXa-S (A)	4.10	4.99	7.48	5.74	**22.30**
IXa-S (C)	1.82	0.77	1.56	1.77	**5.92**
Total	**20.62**	**20.85**	**32.66**	**25.88**	

Table 9.2.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2000.

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

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



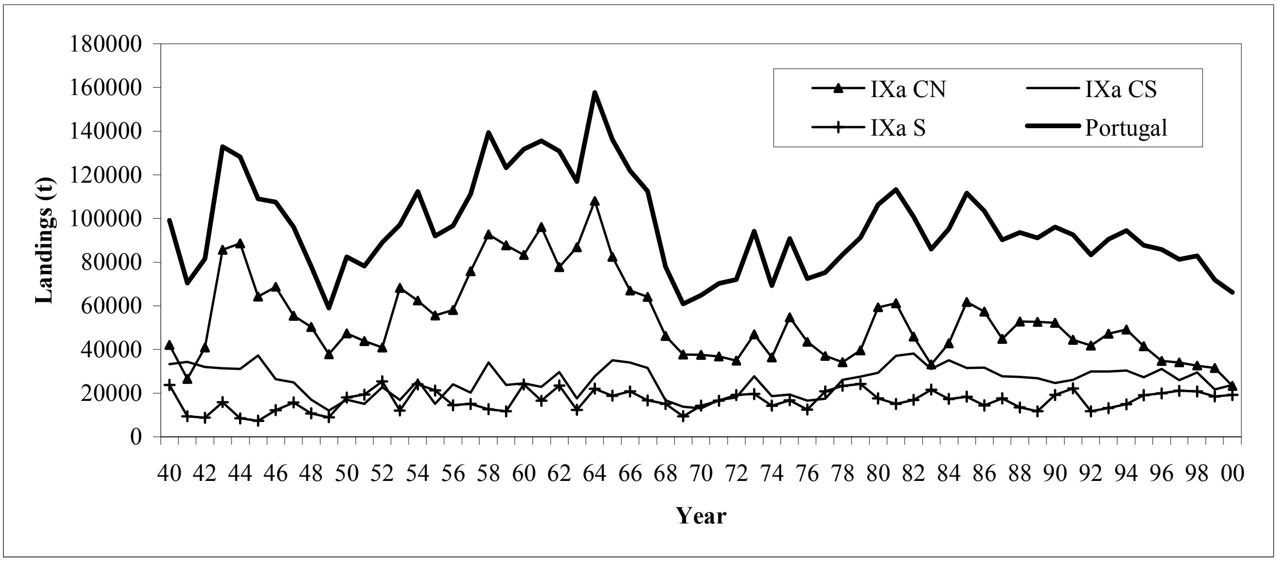


Figure 9.2.1: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

9.3 Fishery independent information

9.3.1 Egg surveys

During 2000 and 2001 no DEPM egg surveys were performed. Nevertheless, during the acoustic surveys carried out in this area, continuous records of surface sardine and anchovy eggs were provided from CUFES (Continuous Underwater Fish Egg Sampler). In addition, Calvet stations (whole column sampler) were also performed on a regular grid aiming to set up CUFES as quantitative egg sampler, once this device is calibrated. This task is still in progress. As stated in the previous Working Group Report, egg distribution derived from CUFES matched the adult distribution derived from the acoustic records quite well.

9.3.2 Acoustic surveys

Acoustic activities undertaken in this area are co-ordinated within the framework of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII (ICES CM 1999/G:13). Spring surveys were undertaken within the framework of the EU DG XIV project 99/010 PELASSES. Within this project, the French survey was carried out using the same methodology. This consists of the use of two acoustic frequencies (38 and 120 kHz) and a continuous sampling of pelagic eggs at 3-5 m depth using CUFES among other common systems.

Two Working Documents were presented (Marques and Morais, WD 2001; Carrera WD 2001), which summarise the main results of the surveys performed between autumn 2000 and spring 2001. In addition the whole Portuguese acoustic surveys time series was analysed in Stratoudakis *et al* (WD 2001).

Portuguese November 2000 Acoustic Survey

As usually, the survey was carried out on board R/V ‘Noruega’. Sardine mainly occurred in the northern part (Figure 9.3.2.1). No sardine have been seen off the southwest coast as in previous years. Sardine were also distributed in the Gulf of Cadiz and Algarve area. On the other hand some schools were observed offshore in the northern part, which was not usual in the recent surveys.

Sardine abundance during this survey was estimated to be 36 015 million fish, corresponding to 710 thousand tonnes, which is the highest abundance ever estimated in this area. As was already shown in the fish distribution, the north part contributed up to 82% of the total abundance (29 399 million fish, corresponding to 555 thousand tonnes). In contrast in the Algarve area the estimated abundance was very low and only reached 723 million fish, corresponding to 31 thousand tonnes. In IXa-CS, fish were estimated at 2 984 million fish, corresponding to 40 thousand tonnes. In Cadiz, 81 thousand tonnes of sardine were assessed, corresponding to 2,909 million fish. Table 9.3.2.1 and Figure 9.3.2.2 shows the sardine assessment by age group and area. Overall age group 0 represents 92% of the total fish abundance estimation, which is driven by the huge abundance detected in the northern area. Age group 0 estimated in the northern coast represents 84% of the total abundance of this cohort in the whole area. By areas, age group 0 represents 94% in the northern coast, 93% in the southwest, 51% in Algarve and 79% in Cadiz.

In conclusion, this survey is characterised by:

- The exceptional abundance of age group 0, the highest ever reported in this time series.
- 84% of age group 0 sardine were found in the northern area.
- An important decrease of sardine biomass in both Ocidental Sul (roughly, IXa-CS) and Algarve (IXa-S) as compared with previous years.

During the acoustic survey performed in November 1998, a total of 21 169 million fish were estimated, most of them (66%) belonging to age group 0, which indicated a strong year class in this year. Besides the difference in the magnitude of the abundance, the main difference between the two years is the location of the recruitment area. Whilst in 1998 the recruitment was distributed in the northern area (40% of the total age group 0) and in the Gulf of Cadiz (with a 38 % of this age group), in 2000 the recruitment was mainly located in the northern area (84% of the total age group). The strength of the 1998 year class was not confirmed by the subsequent March surveys and the 1998 sardine cohort, as estimated by the assessment model (see further sections), does not appear to be as strong as originally suggested.

Portuguese March 2001 Acoustic Survey

A small part of the area (around 10% of the Ocidental South area) was not covered due to bad weather conditions.

No important changes in fish distribution in Portuguese waters were observed between November 2000 and March 2001, as shown in Figure 9.2.2.3 In the northern part (Ocidental Norte), sardine was seen in shallower waters than during the November survey.

In March 2001 the sardine abundance was estimated to be 20 770 million fish, corresponding to 496 000 t. Most of the fish were seen in the northern part (13 023 million fish, corresponding to 344 thousand tonnes). In the rest of Portugal (i.e. Ocidental Sul and Algarve, which roughly corresponds to IXa-CS and IXa-S), sardine biomass decreased from previous years (3 093 million fish, corresponding to 40 000 t in Ocidental Sul, and 1 107 million fish, corresponding to 24 thousand tonnes in Algarve). In the Bay of Cadiz, a slight increase in sardine was observed from the previous survey (88 thousand tonnes, corresponding to 3 547 million fish).

Table 9.3.2.2 and Figure 9.3.2.4 show the sardine acoustic estimate by age group and area. The 2000 year class, as in the November 2000 survey, was predominant and represented 92% of the total fish estimated. Nevertheless, the distribution of this year class spread throughout the west Portuguese coast up to Lisbon, while in the southern areas (Algarve and Cadiz) the appearance of a smaller modal length (also belonging to age 1) suggests a later recruitment period. During the November survey up to 84% of this year class was located in the north, while in March 2001, only 65% of this year class was estimated over the same area. The contribution of the age group 1 in each area ranged from 73% to 94% (from 51% to 94% in November 2000) of the total fish.

Thus, this survey was characterised by:

- Confirmation of the strength of the 2000 year class. Nevertheless, an important decrease of the strength of this year class from November 2000 to March 2001 (from 3 317 million fish to 1 868 million fish, or 44%) should be noted.

- The decrease in adult fish occurred off Portugal (49%) whilst increased in the Gulf of Cadiz (57%). Overall decrease in adult fish was 27%.

Stratoudakis *et al* (WD 2001) analysed the whole acoustic survey time series from Portugal. Because this document examines changes in both stock structure and distribution in this area, major conclusions of this document are discussed in Section 9.16.

Spanish April 2001 Acoustic Survey

In April 2001 the Spanish acoustic survey, carried out on board R/V 'Thalassa', covered i) an area in north Portugal; ii) the Spanish area; and iii) a small area in south France (Carrera, WD 2001). Together with the acoustic and CUFES sampling, extensive studies on plankton and primary production were undertaken along the surveyed area. Weather conditions were unfavourable during the first part of the survey. In spite of the predominance of SW wind component, the Poleward current called 'Navidad' was not observed, at least from the TS-diagram obtained during the survey. Therefore, oceanographic conditions found during the survey were typical of spring, with warmer water in the south part (but not with higher salinity), presence of haline fronts close to the mouth of rivers, and upwelling events in the Cantabrian forced by the change of the wind direction from SW to NE occurring during the second part of the survey.

Sardine distribution, as derived from the acoustic records, is shown in Figure 9.3.2.5. Two main areas with sardine were seen. In the Atlantic waters, sardine occurred in thick and dense schools close to the coast, although some sardines were also observed further offshore in the Portuguese area. Sardine in this area were restricted to less saline waters, inside a haline front which separated oceanic waters from the river plumes. In the Cantabrian Sea sardine were mainly found on the continental shelf, reaching the slope. Sardine mainly occurred in layers, close to the bottom and probably mixed with mackerel, rather than in isolated, well defined pelagic schools. Moreover, in the Atlantic waters, sardine had lower mean length (around 15 cm) than those found in the Cantabrian Sea (22 cm).

Table 9.3.2.3 and Figure 9.3.2.6 show the sardine acoustic estimate. In northern Portugal, sardine abundance was estimated to be 6 779 million fish, corresponding to 183 000 t. The bulk of the fish (97%) belonged to age group 1, similar to that estimated during the Portuguese acoustic survey. In IXa-N, 19 000 t of sardine were estimated, corresponding to 644 million fish. In this area earlier assessments gave estimations lower than 10 thousand tonnes of sardine. The abundance estimated in 2001 is similar to that observed in the earlier nineties. In addition, as in the

Portuguese area, most of the fish belonged to age group 1. No fish older than 2 was found in this area. Age group 1 was also abundant in VIIIc-W and represented 61% of the total fish, although age groups up to 10 year old were also found in the northernmost area. Eighteen thousand tonnes of sardine, corresponding to 475 million fish were estimated in this area. In VIIIc-E Age Group 1 was scarce, being only found in the western part (VIIIc-Ew) representing 3% of the total abundance. In this area, age group 3 was predominant (34%) over a total of 475 million fish corresponding to 41 thousand tonnes. In the inner part of the Bay of Biscay (i.e. VIIIc-Ee), sardine occurred in the western part whilst the eastern part, close to the French waters sardine were scarce. In the same way, although the south of France was surveyed, almost no sardine were seen and, therefore no sardine estimate for this area was made. In VIIIc-Ee age group 5 was predominant, and some fish larger than 25 cm were also observed. In this area, 139 million fish corresponding to 13 000 t were assessed.

Main conclusions on sardine from this survey can be summarised as follows:

- Sardine distribution area was wider than that observed in 2000. In addition the number of fish estimated was higher than that estimated during 2001. Major changes occurred in IXa-N and VIIIc-W where most of the fish seen belonged to age group 1. The same situation was found in Portugal.

- Age structure found in 2001, with younger fish mainly located in Atlantic waters and an age gradient pattern through the inner part of the Bay of Biscay where the oldest fish are predominant, reflects the “normal age structure” found in the earlier nineties and eighties.

- The sardine estimates in IXa-N give a similar abundance to those assessments performed earlier in the nineties. In addition, although the number of sardine detected in VIIIc is still lower compared with that observed at the beginning of nineties, the distribution area is larger than that observed during the late nineties and similar to that observed in the earlier nineties.

- In contrast to previous years, in the inner part of the Bay of Biscay and in the southern part of the French continental shelf sardine were scarce. This observation agreed with the results obtained during the French survey over this area.

Given the low number of younger fish (age group 0) caught during 2000 in the Spanish Atlantic waters (VIIIc-W and IXa-N) and the results of the Portuguese November 2000 survey, most of the younger fish found in Spanish Atlantic waters during this survey could have been recruited from northern Portuguese waters. From this area, this cohort appears to have spread southward and northward, along the northwest coast of the Iberian Peninsula.

It seems that the sardine distribution and abundance is now reversing and the situation found during the spring 2001 off Spanish waters was similar to that observed during the late eighties/earlier nineties.

Table 9.3.2.1: Sardine Assessment from the 2000 Portuguese November acoustic survey

AREA		0	1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	483194	61391	5649	1216	1981	1332	264		**555027**
	%	87.06	11.06	1.02	0.22	0.36	0.24	0.05		
	Mean Weight	17.42	41.58	49.04	63.83	72.69	71.36	91.81		
	No fish	2773924	147660	11518	1905	2725	1866	287		**2939885**
	%	94.35	5.02	0.39	0.06	0.09	0.06	0.01		
	Mean Length	13.1	17.4	18.3	19.9	20.7	20.6	22.3		
Oc. Sul	**Biomass**	32301	3350	3922	1369	986	385	310	113	**42736**
	%	75.58	7.84	9.18	3.20	2.31	0.90	0.73	0.26	
	Mean Weight	11.68	38	46.98	58.71	71.88	73.57	80.49	86.48	
	No fish	276492	8817	8349	2331	1372	523	385	131	**298400**
	%	92.66	2.95	2.80	0.78	0.46	0.18	0.13	0.04	
	Mean Length	11.1	17.5	19	19.9	20.6	20.9	21.3		
Algarve	**Biomass**	9208	2092	2541	2763	5413	4970	2753	1654	**31394**
	%	29.33	6.66	8.09	8.80	17.24	15.83	8.77	5.27	
	Mean Weight	25.09	40.93	52.98	58.11	66.89	70.92	71.79	82.35	
	No fish	36692	5112	4795	4756	8093	7008	3835	2008	**72299**
	%	50.75	7.07	6.63	6.58	11.19	9.69	5.30	2.78	
	Mean Length	14.9	17.4	18.8	19.3	20.2	20.5	20.6	21.5	
Cadiz	**Biomass**	49176	4731	15861	3642	4564	2086	714	700	**81474**
	%	60.36	5.81	19.47	4.47	5.60	2.56	0.88	0.86	
	Mean Weight	21.37	42.71	50.32	58.42	65.13	67.44	72.22	83.08	
	No fish	230093	11076	31521	6233	7008	3093	989	843	**290856**
	%	79.11	3.81	10.84	2.14	2.41	1.06	0.34	0.29	
	Mean Length	14.2	17.6	18.5	19.3	20	20.2	20.7	21.6	
Portugal	**Biomass**	524703	66833	12112	5348	8380	6687	3327	1767	**629157**
	%	83.40	10.62	1.93	0.85	1.33	1.06	0.53	0.28	
	Mean Weight	17.1	41.4	48.6	59.7	67.7	68.6	74.5	83.3	
	No fish	3087108	161589	24662	8992	12190	9397	4507	2139	**3310584**
	%	93.25	4.88	0.74	0.27	0.37	0.28	0.14	0.06	
	Mean Length	12.9	17.4	18.6	19.6	20.2	20.3	20.9	20.3	
Whole	**Biomass**	573879	71564	27973	8990	12944	8773	4041	2467	**710631**
Area	**%**	80.76	10.07	3.94	1.27	1.82	1.23	0.57	0.35	
	Mean Weight	17.5	41.5	49.6	59.2	66.8	68.3	74.1	83.2	
	No fish	3317201	172665	56183	15225	19198	12490	5496	2982	**3601440**
	%	92.11	4.79	1.56	0.42	0.53	0.35	0.15	0.08	
	Mean Length	13.0	17.4	18.5	19.5	20.1	20.3	20.8	20.7	

Table 9.3.2.2: Sardine Assessment from the 2001 Portuguese Spring acoustic survey

AREA		1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	301274	19865	11554	8494	2626	168		**343981**
	%	87.58	5.78	3.36	2.47	0.76	0.05		
	Mean Weight	24.66	45.17	61.24	62.92	68.31	75.56		
	No fish	1221923	43973	18868	13501	3844	223		**1302332**
	%	93.83	3.38	1.45	1.04	0.30	0.02		
	Mean Length	15.1	18.4	20.3	20.5	21	21.8		
Oc. Sul	**Biomass**	34332	2540	1213	851	685	423	77	**40121**
	%	85.57	6.33	3.02	2.12	1.71	1.05	0.19	
	Mean Weight	11.52	45.84	54	56.19	54.25	61.66	73.73	
	No fish	297941	5540	2246	1514	1262	687	105	**309295**
	%	96.33	1.79	0.73	0.49	0.41	0.22	0.03	
	Mean Length	11.7	18.5	19.5	19.7	19.5	20.3	21.6	
Algarve	**Biomass**	13226	3495	1768	1236	1741	1402	752	**23620**
	%	55.99	14.80	7.49	5.23	7.37	5.94	3.18	
	Mean Weight	14.87	36.67	47.63	56.51	59.08	62.9	64.26	
	No fish	88945	9532	3711	2187	2947	2228	1171	**110721**
	%	80.33	8.61	3.35	1.98	2.66	2.01	1.06	
	Mean Length	11.7	17.2	18.7	19.8	20.1	20.5	20.6	
Cadiz	**Biomass**	39780	7535	12474	8626	11064	6359	2443	**88281**
	%	45.06	8.54	14.13	9.77	12.53	7.20	2.77	
	Mean Weight	15.32	40.94	46.69	52.18	56.74	62.87	63.62	
	No fish	259625	18404	26719	16531	19500	10114	3840	**354733**
	%	73.19	5.19	7.53	4.66	5.50	2.85	1.08	
	Mean Length	11.7	17.8	18.6	19.3	19.8	20.5	20.5	
Portugal	**Biomass**	348832	25900	14535	10581	5052	1993	829	**407722**
	%	85.56	6.35	3.56	2.60	1.24	0.49	0.20	
	Mean Weight	23.0	44.7	58.9	61.1	62.4	63.7	64.6	
	No fish	1608809	59045	24825	17202	8053	3138	1276	**1722348**
	%	93.41	3.43	1.44	1.00	0.47	0.18	0.07	
	Mean Length	14.3	18.3	20.0	20.3	20.3	20.5	20.6	
Whole Area	**Biomass**	388612	33435	27009	19207	16116	8352	3272	**496003**
	%	78.35	6.74	5.45	3.87	3.25	1.68	0.66	
	Mean Weight	22.2	43.8	53.2	57.1	58.5	63.1	63.9	
	No fish	1868434	77449	51544	33733	27553	13252	5116	**2077081**
	%	89.95	3.73	2.48	1.62	1.33	0.64	0.25	
	Mean Length	13.9	18.2	19.3	19.8	20.0	20.5	20.5	

Table 9.3.2.3: Sardine Assessment from the 2001 Spanish Spring acoustic survey

AREA		1	2	3	4	5	6	7	8	9	10	Total
VIIIc-Ee	**Biomass**		130	1113	2609	4372	2222	1390	965	494	99	**13394**
(>3°30')	**%**		1.0	8.3	19.5	32.6	16.6	10.4	7.2	3.7	0.7	
	Mean Weight		70.6	79.2	89.1	97.7	101.7	102.4	110.7	108.9	110.7	
	No fish		1824	13941	29093	44432	21679	13541	8639	4529	888	**138566**
	%		1.3	10.1	21.0	32.1	15.6	9.8	6.2	3.3	0.6	
	Mean Length		20.7	21.5	22.3	22.9	23.2	23.2	23.8	23.7	23.8	
VIIIc-Ew	**Biomass**	611	9371	14487	10146	5012	1150	280	182	31	11	**41282**
(<3°30')	**%**	1.5	22.7	35.1	24.6	12.1	2.8	0.7	0.4	0.1	0.0	
	Mean Weight	41.8	69.1	90.1	98.9	102.5	110.3	122.0	112.6	133.1	134.8	
	No fish	14513	134412	160181	102296	48648	10386	2289	1607	234	81	**474646**
	%	3.1	28.3	33.7	21.6	10.2	2.2	0.5	0.3	0.0	0.0	
	Mean Length	17.7	20.6	22.3	23.0	23.2	23.8	24.5	23.9	25.2	25.3	
VIIIc-W	**Biomass**	11063	4381	987	999	552	142	51	24	6	1	**18206**
	%	60.8	24.1	5.4	5.5	3.0	0.8	0.3	0.1	0.0	0.0	
	Mean Weight	32.6	40.2	79.2	86.1	93.5	99.7	104.7	108.2	117.3	118.0	
	No fish	336264	107096	12417	11540	5865	1421	486	223	50	8	**475371**
	%	70.7	22.5	2.6	2.4	1.2	0.3	0.1	0.0	0.0	0.0	
	Mean Length	16.4	17.5	21.5	22.0	22.6	23.0	23.4	23.6	24.2	24.3	
IXa-N	**Biomass**	17829	698									**18527**
	%	96.2	3.8									
	Mean Weight	28.1	35.5									
	No fish	624825	19551									**644**
	%	97.0	3.0									
	Mean Length	15.7	16.8									
Spain	**Biomass**	29502	14580	16587	13754	9936	3515	1721	1171	531	111	**91408**
	%	32.3	16.0	18.1	15.0	10.9	3.8	1.9	1.3	0.6	0.1	
	Mean Weight	29.8	53.4	88.5	95.8	99.8	104.3	105.1	111.0	110.1	112.7	
	No fish	975603	262883	186538	142929	98945	33486	16317	10469	4813	977	**1732959**
	%	56.3	15.2	10.8	8.2	5.7	1.9	0.9	0.6	0.3	0.1	
	Mean Length	16.0	19.1	22.2	22.8	23.0	23.4	23.4	23.8	23.7	23.9	
North Portugal	**Biomass**	174630	6859	652	397		223					**182761**
	%	95.6	3.8	0.4	0.2		0.1					
	Mean Weight	26.3	40.0	62.9	67.9		76.4					
	No fish	6589169	170346	10242	5849		2924					**6778530**
	%	97.2	2.5	0.2	0.1		0.0					
	Mean Length	15.4	17.5	20.0	20.5		21.3					

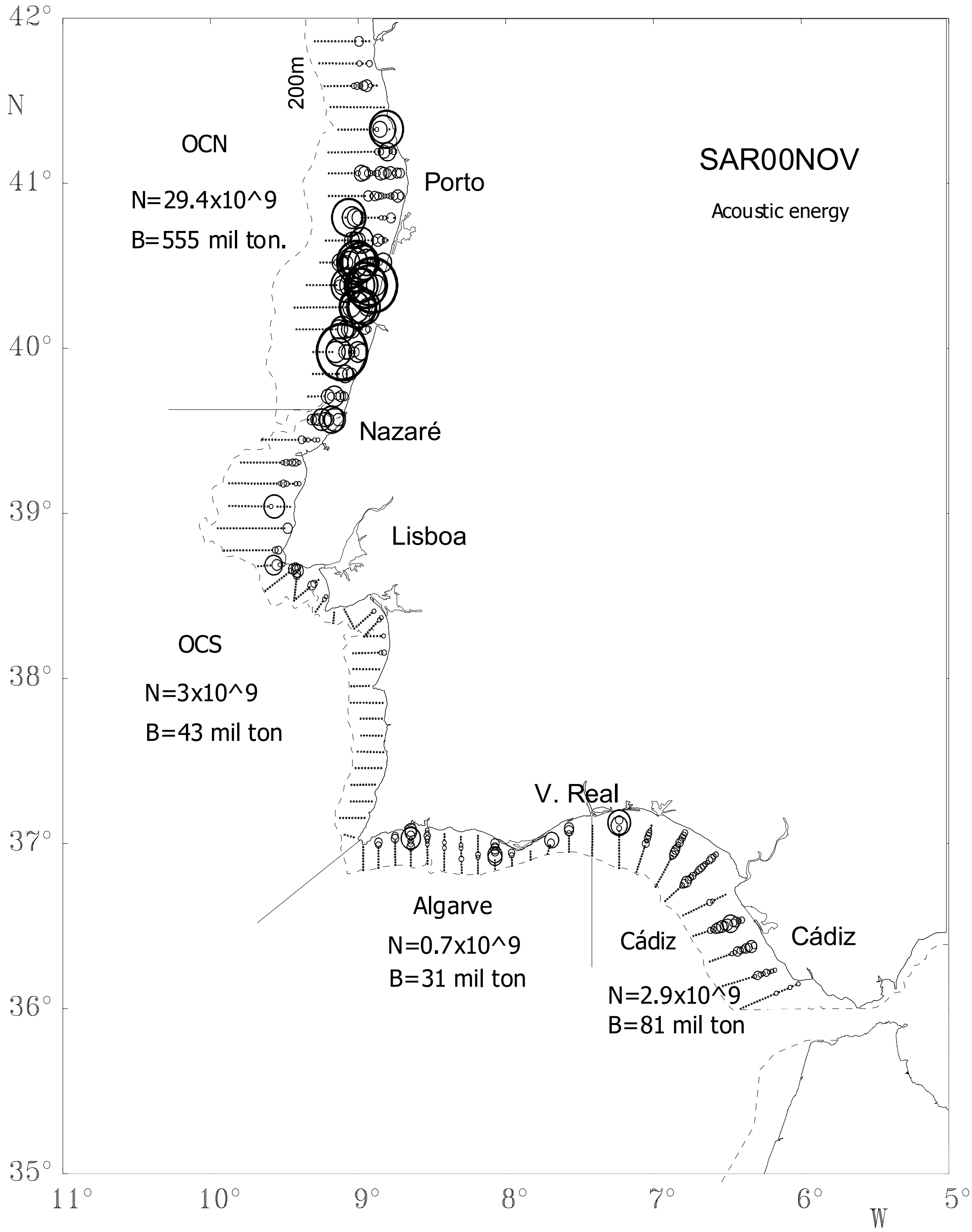


Figure 9.3.2.1: Sardine distribution as derived from the acoustic records during the Portuguese November Acoustic survey 2000. Circle diameter is proportional to the square root of the acoustic energy (SA).

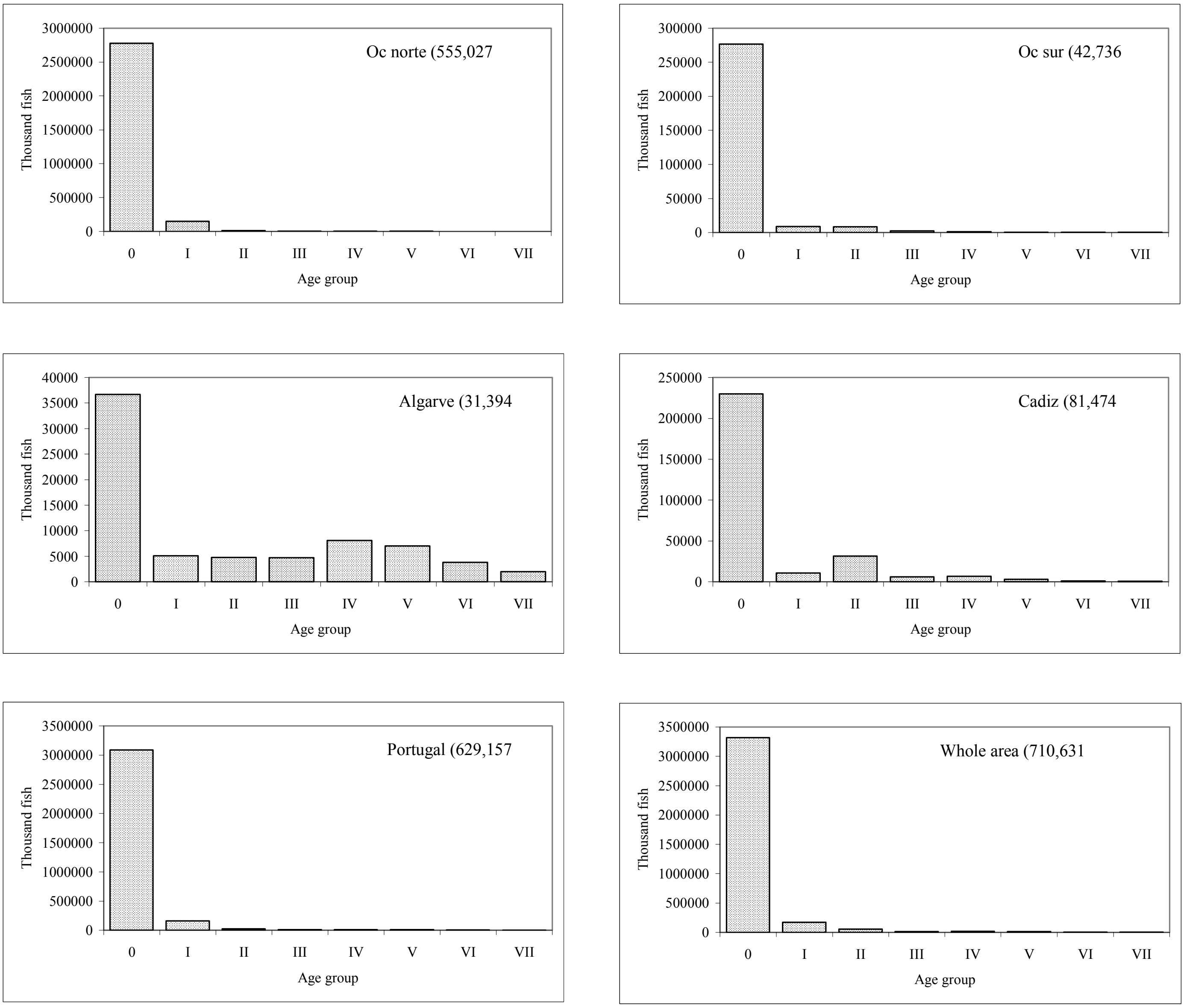


Figure 9.3.2.2: Estimated fish number of sardine (thousands) by area for the Portuguese November Acoustic survey 2000.

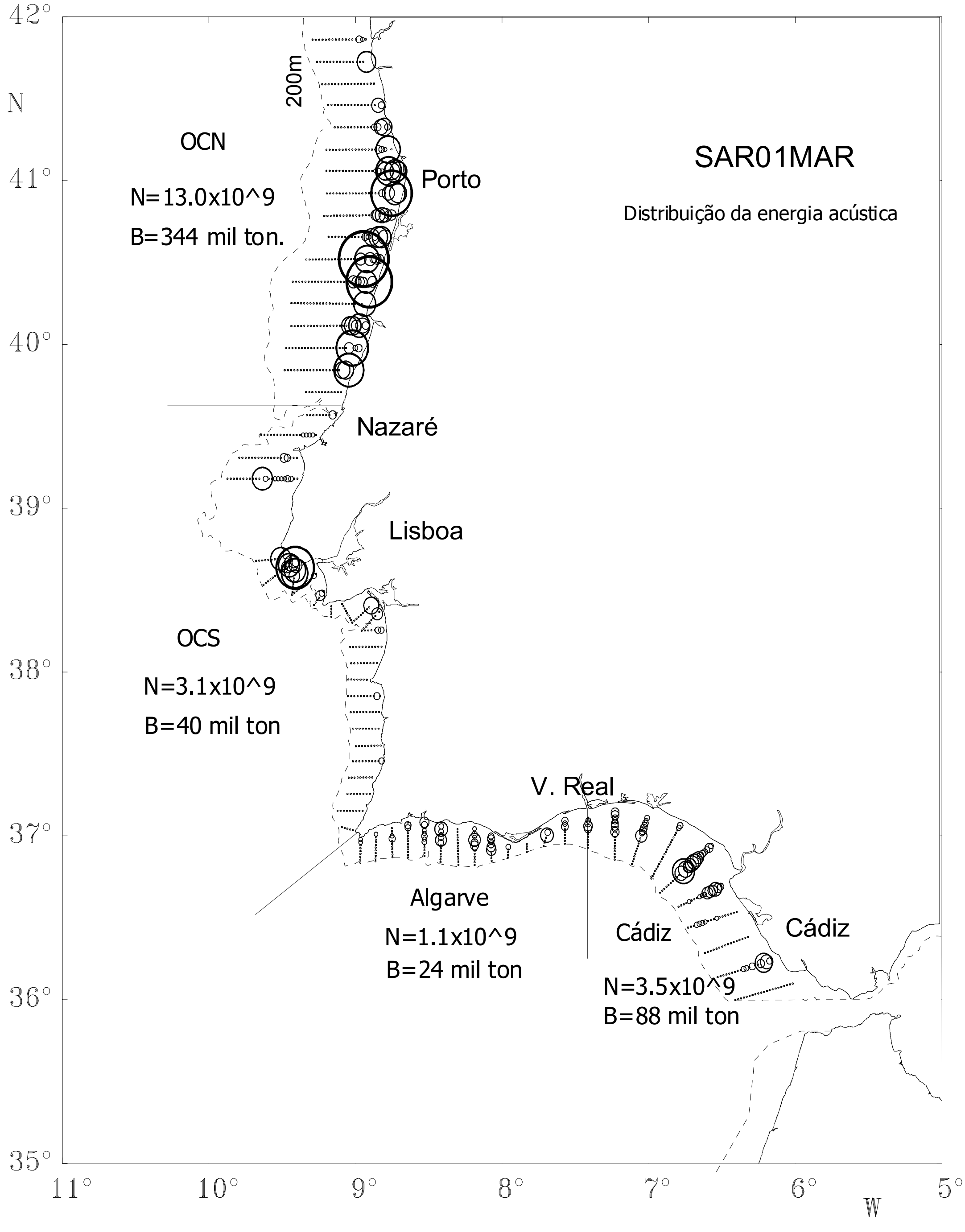


Figure 9.3.2.3 Sardine distribution as derived from the acoustic records during the Portuguese Spring Acoustic survey 2001. Circle diameter is proportional to the square root of the acoustic energy (SA).

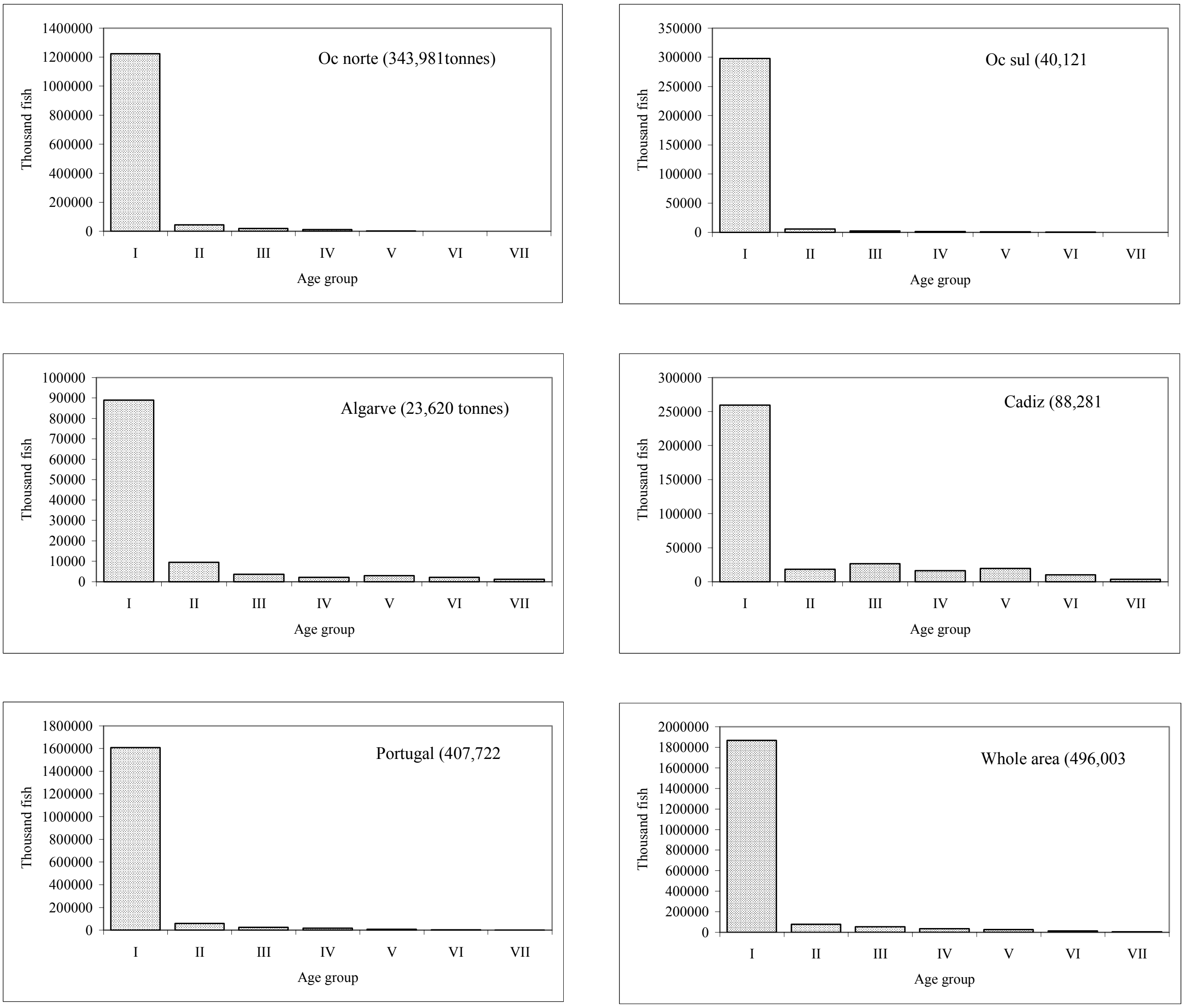


Figure 9.3.2.4: Estimated fish number of sardine (thousands) by area for the Portuguese Spring Acoustic survey 2001.

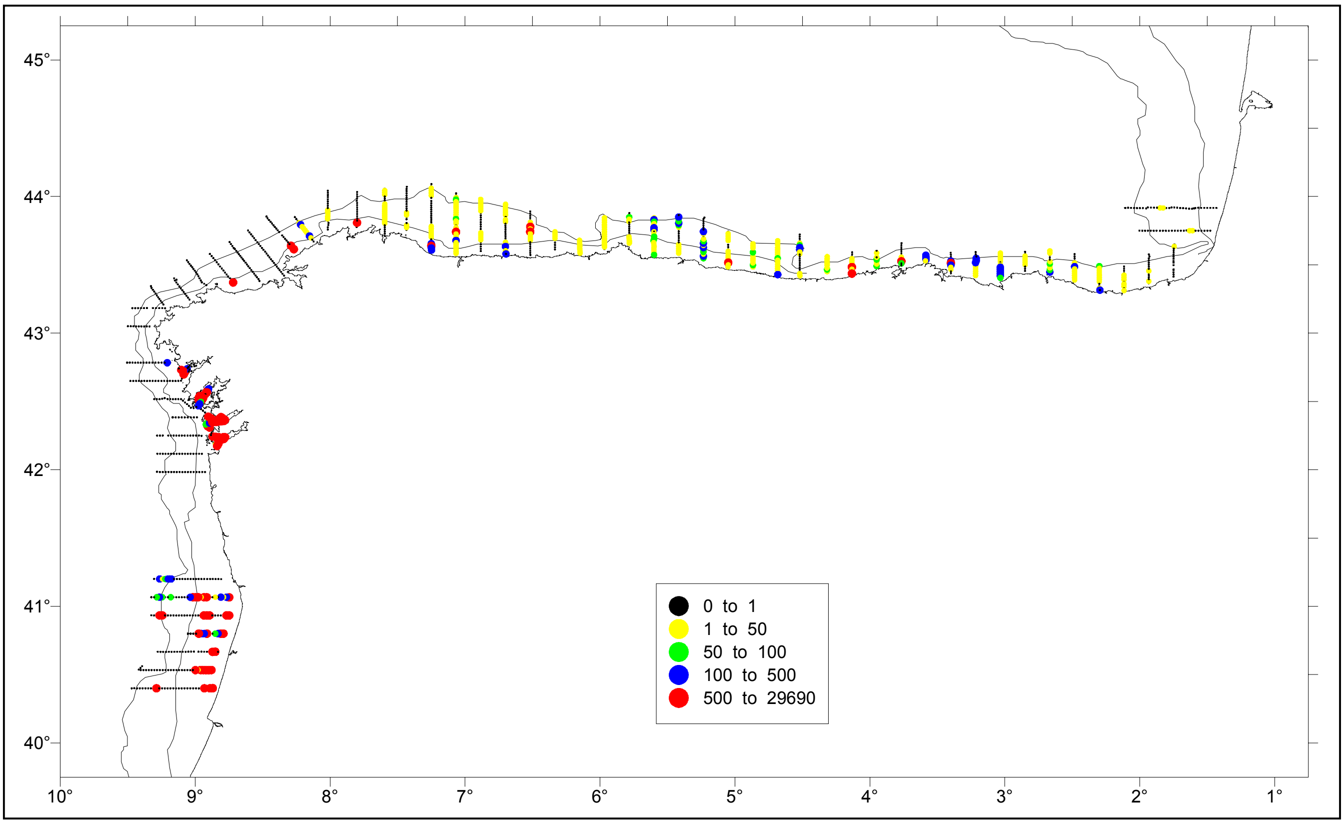


Figure 9.3.2.5: Sardine distribution as derived from the acoustic records during the Spanish Spring Acoustic survey 2001.

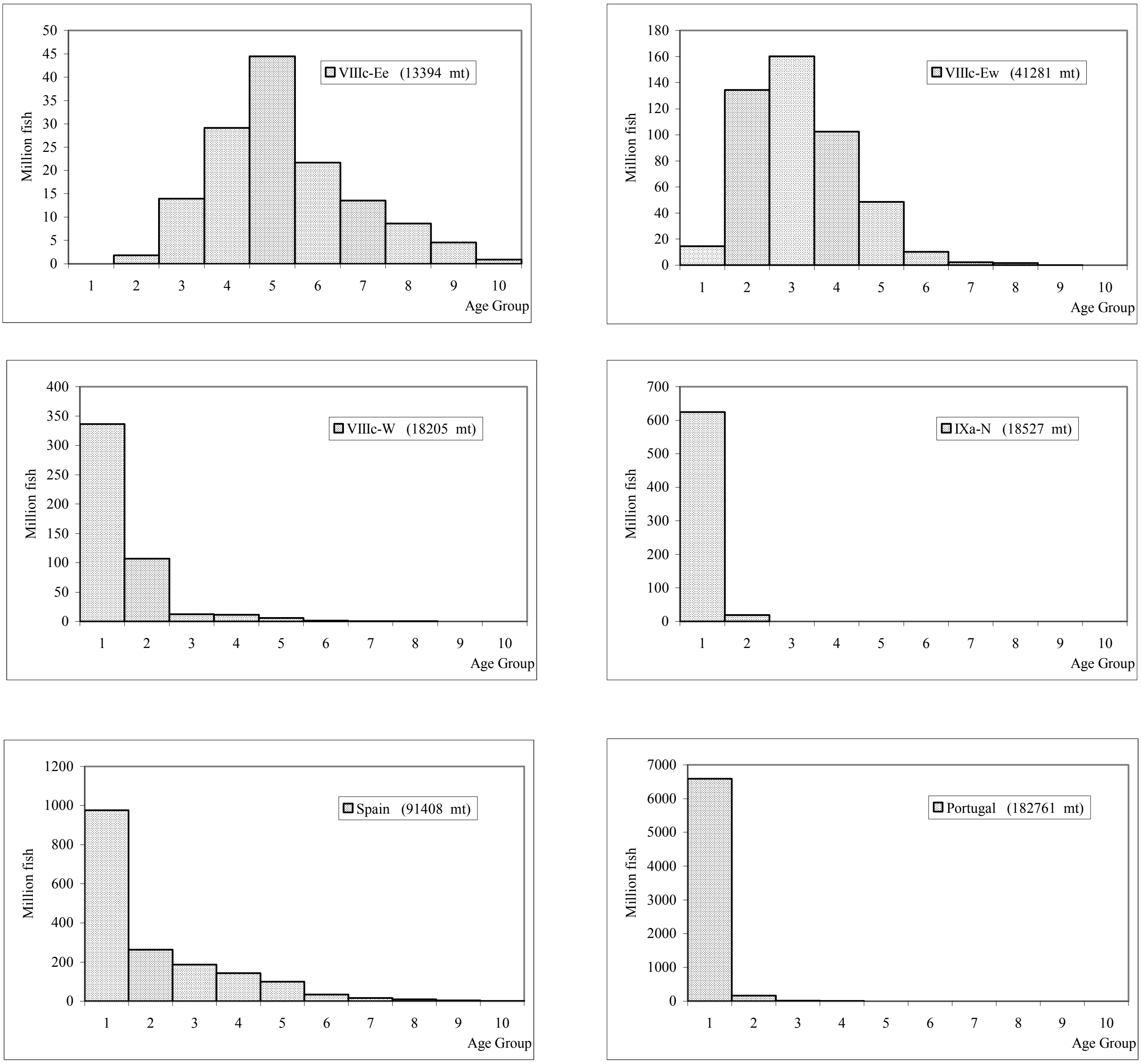


Figure 9.3.2.6: Estimated fish number of sardine (millions) by area for the Spanish Spring Acoustic survey 2001.

9.4 Biological data

Biological data were provided by Spain and Portugal. In Spain samples for ALK were pooled on a half year basis for each Sub-Division while the length/weight relationship was calculated for each quarter. In Portugal both ALK and L/W relationship were compiled on a quarterly and Sub-Division basis (ALK's for the 3rd and 4th quarter in Sub-Division IXa-South were pooled). Data from Cadiz were obtained using the length distribution of the Spanish landings and the ALK and L/W from IXa South-Algarve.

9.4.1 Catch numbers at age

Landings were grouped by length classes (0.5 cm) and later applied on a quarterly basis to the ALK of each Sub-Division. Table 9.4.1.1 shows the quarterly length distribution. Mean length from the Cantabrian Sea (VIIIc) is the highest in the area whilst in IXa-CS and IXa-S had also higher mean length than the surrounding areas. As in previous years, the smallest fish were caught in IXa-CN.

Table 9.4.1.2 shows the catch-at-age in numbers for each quarter and Sub-Division. In Table 9.4.1.3, the relative contribution of each age group in each Sub-Division is shown as well as their relative contribution to the catches.

Total sardine catch was 1,770 million fish, which remains more or less at the same level of the previous years. Age group 0 represented 28 % of the total catch in number (Table 9.4.1.3) and 67% of this age group was caught in IXa-CN. In addition, 65% of the age group 1 was caught in this area. The older fish (i.e. 2+) were taken in IXa-CS and IXa-S. Age group 0 was only predominant in IXa-N, IXa-CN and IXa Cadiz with 38, 48 and 37% respectively of the total catches in number in these areas.

Since 1978 the contribution of younger fish (i.e. age groups 0, 1 and 2) on the total catch in number followed a decreasing trend reaching the minimum in 1995 when most of the fish caught were older than 2. Since then, there has been an increasing trend and the younger fish provided 60 % of the total fish caught during 2000, still far from the 80% achieved at the beginning of the time series.

9.4.2 Mean length and mean weight at age

Mean length and mean weight at age by quarter and Sub-Division are shown in Tables 9.4.2.1 and 9.4.2.2. As previously observed, higher mean length for each age group and quarter occurred in the Cantabrian Sea (VIIIc) followed by those obtained in IXa-S. In the same way, mean weights at age were consistently higher in VIIIc.

9.4.3 Maturity at age

The maturity ogive for 2000 was based on biological samples collected during the spawning period. In the Portuguese area samples were taken during the acoustic survey undertaken in November 1999. Age groups were shifted one year. In the Spanish area, samples were also collected during the acoustic survey performed in 2000. Samples for each country were weighted according to the results of the acoustic surveys, giving a mean weighted factor for the Portuguese samples of about 90 %. The maturity ogive is presented below:

Age	0	1	2	3	5	5	6+
% mature fish	0	25.7	91.0	94.7	95.0	100	100

It should be noted that the very low maturity of the age group 1 is only comparable to that calculated for the age group 1 in 1989. In order to check whether this proportion of mature fish at age 1 calculated in November 1999 was consistent, a new ogive was calculated from samples obtained during the Portuguese acoustic survey undertook in March 2000. This new ogive gave similar results, with a high proportion of fish belonging to age group 1 which were still virgin.

9.4.4 Natural mortality

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

Table 9.4.1.1: Length composition (thousands) by quarted and ICES Sub-Division

				First Quarter				
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10			4					4
10.5			1					1
11	17		5	1				23
11.5	17		10	4	32		11	74
12	34		25	62	43		16	180
12.5	85		19	203	136		90	533
13	355	0	69	1183	61		132	1801
13.5	391		37	1513	72		195	2208
14	385		39	5345	207		583	6558
14.5	194	0	30	7733	416		1208	9581
15	37	1	30	7451	1110	5	1086	9719
15.5	77	3	40	11930	698		800	13547
16	60	3	44	7263	1884	71	832	10157
16.5	5	23	30	6569	1734	269	1288	9918
17	190	41	42	5492	2621	883	2015	11285
17.5	168	75	61	5131	5482	2551	3717	17186
18	767	43	24	2571	8422	5971	4704	22501
18.5	556	33	32	4504	13071	9813	5012	33020
19	1007	46	28	2315	22107	12271	5705	43480
19.5	1599	43	13	1993	23499	11815	3792	42753
20	3227	143	32	956	21887	11141	2126	39512
20.5	4446	234	65	546	11969	5722	738	23720
21	5799	363	126	311	5061	2783	112	14555
21.5	7144	654	165	197	1689	1039	55	10943
22	6508	465	167	6	602	299		8048
22.5	3969	439	159	2	116	87		4772
23	1921	301	19	1	31	37		2310
23.5	801	85	7					893
24	612	42	1		58	6		719
24.5	47	36						82
25	26	7				14		47
25.5	5							5
26	10							10
Total	40460	3080	1325	73282	123007	64777	34214	340147
Mean l	21.2	21.7	19.2	16.4	19.4	19.5	18.2	18.9
sd	1.95	1.51	3.48	1.71	1.30	1.00	1.62	2.11
Catch	**2953**	**239**	**77**	**2905**	**6436**	**3516**	**1562**	**17687**

Table 9.4.1.1: Cont'd

				Second Quarter				
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8								
8.5								
9				22				22
9.5				194				194
10				876				876
10.5				2500				2500
11	0		93	5057				5150
11.5	0		98	7988				8086
12	0		107	6296	221			6625
12.5	1		60	6893	472			7426
13	3	1	12	1193	664			1873
13.5	6		39	796	613			1454
14	9		146	2011	794			2960
14.5	11	4	245	7657	1113			9031
15	36	9	480	8331	1793		58	10707
15.5	66	7	773	11446	3120		144	15557
16	67	10	1105	12373	4678		558	18791
16.5	177	22	1295	14433	5535	91	1747	23299
17	192	46	1613	11733	7839	401	3081	24904
17.5	368	146	1712	8876	8577	1108	2409	23195
18	456	327	1680	4903	7713	5665	1185	21930
18.5	995	680	1080	2979	8512	11695	827	26769
19	2054	609	967	2142	8673	16747	544	31734
19.5	2129	880	683	1398	8208	15831	514	29643
20	3200	1118	364	1002	10089	16080	1023	32877
20.5	3821	1649	171	999	5307	9155	580	21682
21	4007	2782	108	277	3304	4495	257	15231
21.5	3933	3505	28	46	1026	1349	133	10020
22	2670	4478	66	65	392	234		7906
22.5	2033	4042	68		123	68		6334
23	740	2536	9			41		3326
23.5	326	966		1	32			1325
24	119	466						585
24.5	7	77						84
25	5	15						20
25.5								
26		22.46735						22
Total	27431	24399	13005	122485	88800	82959	13059	372138
Mean l	20.9	21.8	17.5	15.5	18.4	19.7	18.1	18.1
sd	1.43	1.38	1.80	2.43	1.86	0.90	1.37	2.78
Catch	**2020**	**2040**	**574**	**3838**	**4469**	**4280**	**663**	**17884**

Table 9.4.1.1 Cont'd

				Third Quarter				
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8			49					49
8.5			84					84
9			115	85				199
9.5			127	56				183
10			294	728			37	1059
10.5			553	3245			149	3946
11	9		1020	7660			929	9619
11.5	9		973	11720			2230	14932
12	18		1194	22506	73		818	24610
12.5	50		1245	20106	308		74	21783
13	200		1220	29790	404		223	31837
13.5	223		1560	20951	338		669	23741
14	231		1696	22214	132	58	1449	25780
14.5	113		2441	14252	334	162	1771	19074
15	32		2459	9409	529	2015	953	15396
15.5	23		2200	4382	846	2772	592	10815
16	1		1625	4382	1749	3348	544	11650
16.5	1		1886	5547	1733	1420	808	11395
17	11	6	2635	9846	2146	578	1849	17071
17.5	19	9	1988	16184	4072	1314	2456	26042
18	7	100	2471	13459	6847	6789	1784	31458
18.5	21	335	2905	15198	8892	10523	1757	39632
19	164	1157	3719	13661	10685	17799	2557	49742
19.5	407	1778	3461	11998	13815	21302	2511	55273
20	1198	1767	2751	11179	18078	18302	2397	55672
20.5	1556	1976	1559	4964	13141	9191	1234	33620
21	2177	1702	833	2333	7155	3866	778	18845
21.5	1797	1171	136	539	1882	1190	325	7038
22	1544	973	34	133	338	455	25	3501
22.5	979	1004	10	40	53	61		2147
23	557	539			8			1103
23.5	157	352	1		14			524
24	44	131	1		11			186
24.5	34	48						83
25	8							8
25.5	0							0
26	0							0
Total	11590	13049	43245	276567	93584	101146	28917	568098
Mean l	20.9	21.0	16.7	15.4	19.5	19.3	17.0	17.2
sd	2.29	1.32	2.91	2.91	1.52	1.39	3.00	3.14
Catch	**974**	**1088**	**1885**	**10009**	**6312**	**6413**	**1336**	**28016**

Table 9.4.1.1: Cont'd

	Fourth Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8								
8.5								
9								
9.5			4					4
10			4	295				299
10.5			7	651				658
11		45	24	948				1018
11.5		128	29	2052	76			2285
12	5	157	104	4375	238		276	5156
12.5	8	269	155	7620	759		459	9270
13	5	351	281	14303	1375		2092	18408
13.5	27	369	505	15747	2922	63	4545	24177
14	24	385	1138	20698	7686		6378	36309
14.5	8	246	1569	22885	10143	145	4298	39293
15	3	178	1418	23434	12891	464	2743	41131
15.5	3	56	902	19903	9946	620	1544	32975
16	6	35	462	14957	12338	2407	965	31169
16.5		28	212	5968	6759	3362	1117	17446
17	13	8	202	5921	5534	3697	2159	17532
17.5	11	1	177	6989	4956	2800	2354	17288
18	124		195	7787	5319	2984	2869	19276
18.5	127	6	252	5786	5294	7130	3216	21811
19	236	10	343	5983	6991	11868	2105	27535
19.5	649	208	219	5272	7725	14203	1416	29693
20	1600	462	261	4990	10075	16036	823	34247
20.5	2890	1260	115	3278	9157	8781	250	25731
21	2937	1191	154	1796	7047	3282	75	16482
21.5	3418	1179	112	616	3785	1271		10382
22	2737	1107	102	120	2117	211		6393
22.5	1890	1316	80	53	786	17		4142
23	1013	653	47		164			1877
23.5	454	498	22		117			1091
24	102	108	11					221
24.5	93	39						133
25	14	2						16
25.5	7							7
26	11							11
Total	18417	10296	9107	202426	134199	79341	39682	493468
Mean l	21.5	20.1	16.0	15.7	17.6	19.4	16.1	17.1
sd	1.23	3.55	2.44	2.22	2.53	1.38	2.19	2.77
Catch	**1601**	**783**	**331**	**6560**	**6483**	**4920**	**1520**	**22198**

Table 9.4.1.2: Catch in numbers ('000) at age by quarter and by SubDivision in 1999

	First Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	2277	123	425	50052	6221	5432	13253	77782
2	6633	406	216	25468	33604	13294	7581	87203
3	11432	812	65	6909	35190	13408	6088	73905
4	11152	919	201	3717	22123	13270	4087	55468
5	5670	519	119	339	10919	10792	2175	30534
6	2086	202	282	98	8267	8018	1008	19962
7	941	91		12	2143	738	22	3948
8	267	7	18		661	107		1060
9								
10								
11								
Total	40460	3080	1325	86595	119129	65058	34214	349862
Catch	2953	239	77	2905	6436	3516	1562	17687

	Second Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	1082	663	5911	107017	25970	1599	4979	147222
2	7405	3414	5387	12298	24578	18175	4909	76166
3	7993	6277	733	2989	17255	19870	1136	56254
4	6546	7177	791	2266	14682	14937	886	47286
5	2914	4430	64	263	5850	8621	648	22789
6	968	1720	103	398	949	5066	378	9581
7	392	704				1571	124	2790
8	131	15	15					162
9								
10								
11								
Total	27431	24399	13005	125232	89285	69841	13059	362251
Catch	2020	2040	574	3838	4469	4280	663	17884

	Third Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	916	10	18696	166585	3853	12077	14923	217061
1	1191	2904	8014	55049	11766	1372	1222	81518
2	3667	5731	11778	34979	17750	21895	3580	99380
3	2541	1764	3114	21520	26430	21239	3159	79767
4	2006	1409	1542	6219	24846	17840	2516	56378
5	827	754	34	1438	4592	14429	2105	24180
6	292	273	68	213	2585	5844	867	10142
7	122	144		67	206	2174	355	3068
8	28	59				772	189	1048
9								
10								
11								
Total	11590	13049	43245	286070	92030	97643	28917	572543
Catch	974	1088	1885	10009	6312	6413	1336	28016

	Fourth Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	96	2256	6423	160079	63571	12022	28328	272774
1	2000	834	821	19761	21017	2310	1557	48301
2	5883	2475	1045	9150	13309	14756	4603	51222
3	4396	1736	316	7705	13412	15494	2538	45597
4	3540	1552	230	3475	10788	13937	1503	35024
5	1592	890	87	963	3824	11995	838	20189
6	578	321	185		891	5035	225	7237
7	254	149			721	1924	70	3119
8	78	83			1408	666	20	2255
9								
10								
11								
Total	18417	10296	9107	201133	128941	78141	39682	485718
Catch	1601	783	331	6560	6483	4920	1520	22198

	Whole Year							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1012	2267	25119	326664	67424	24100	43251	489836
1	6549	4524	15171	231879	64975	10713	21011	354822
2	23588	12026	18426	81895	89242	68121	20673	313972
3	26362	10589	4227	39124	92287	70012	12921	255523
4	23245	11057	2763	15676	72439	59984	8993	194156
5	11004	6593	304	3003	25185	45838	5765	97693
6	3925	2516	639	709	12693	23964	2477	46922
7	1708	1088		79	3071	6407	572	12925
8	505	165	33		2069	1545	209	4526
9								
10								
11								
Total	97899	50824	66682	699030	429385	310683	115872	1770374
Catch	7547	4149	2866	23311	23701	19129	5081	85786

Table 9.4.1.3: Relative distribution of sardine catches. Upper pannel, relative contribution of each age group within each Sub-Division Lower pannel, relative contribution of each Sub-Division within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1.03	4.46	**37.67**	**46.73**	15.70	7.76	**37.33**	**27.67**
1	6.69	8.90	22.75	33.17	15.13	3.45	18.13	20.04
2	24.09	23.66	27.63	11.72	20.78	21.93	17.84	17.73
3	**26.93**	20.84	6.34	5.60	**21.49**	**22.53**	11.15	14.43
4	23.74	**21.75**	4.14	2.24	16.87	19.31	7.76	10.97
5	11.24	12.97	0.46	0.43	5.87	14.75	4.98	5.52
6+	6.27	7.42	1.01	0.11	4.15	10.27	2.81	3.64

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca
0	0.21	0.46	5.13	**66.69**	13.76	4.92	8.83
1	1.85	1.27	4.28	**65.35**	18.31	3.02	5.92
2	7.51	3.83	5.87	26.08	**28.42**	21.70	6.58
3	10.32	4.14	1.65	15.31	**36.12**	27.40	5.06
4	11.97	5.69	1.42	8.07	**37.31**	30.89	4.63
5	11.26	6.75	0.31	3.07	25.78	**46.92**	5.90
6+	9.54	5.85	1.05	1.22	27.70	**49.58**	5.06

Table 9.4.2.1: Mean length at age by quarter and ICES Sub-Division

	First Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	15.2	17.6	14.7	15.2	16.4	17.7	16.6	15.7
2	20.0	20.1	19.4	17.5	18.5	18.8	18.7	18.4
3	21.4	21.6	20.5	19.0	19.6	19.2	19.1	19.7
4	21.8	22.1	21.4	19.7	20.2	19.8	19.7	20.4
5	22.3	22.5	21.8	20.8	20.4	20.3	20.1	20.7
6	22.6	22.7	22.5	20.9	20.7	20.8	20.5	21.0
7	23.1	23.2		20.8	21.4	21.8	21.5	21.9
8	22.9	24.8	21.3		21.9	23.2		22.3
9								
10								
11								
Total	21.2	21.7	19.2	16.4	19.4	19.5	18.2	18.8

	Second Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	17.6	18.5	16.3	14.9	16.3	18.3	17.0	15.4
2	19.8	20.2	18.2	18.0	18.3	18.8	17.9	18.6
3	21.1	21.6	19.3	19.3	19.3	19.5	19.3	19.9
4	21.6	22.2	20.0	20.1	20.2	20.1	20.2	20.7
5	22.1	22.6	21.3	20.6	20.8	20.6	20.7	21.2
6	22.4	22.8	22.6	21.5	21.8	21.0	20.9	21.6
7	22.6	23.3				21.0	21.0	21.8
8	22.8	24.8	21.3					22.8
9								
10								
11								
Total	20.9	21.8	17.5	15.5	18.4	19.7	18.1	18.0

	Third Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	13.9	17.5	13.9	13.2	15.1	16.4	14.7	13.6
1	20.5	20.0	17.6	17.4	17.7	18.0	17.5	17.6
2	21.0	20.4	19.2	19.0	19.0	19.1	19.0	19.2
3	21.7	21.9	20.2	19.8	20.0	19.6	19.5	19.9
4	22.1	22.5	20.6	20.5	20.3	19.9	19.9	20.3
5	22.5	22.7	22.0	20.6	20.8	20.3	20.3	20.6
6	22.9	23.2	22.0	21.0	21.2	20.6	20.7	20.9
7	23.0	23.3		22.6	22.6	20.8	20.9	21.1
8	23.8	23.8				21.3	21.2	21.5
9								
10								
11								
Total	20.9	21.0	16.7	15.4	19.5	19.3	17.0	17.2

	Fourth Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	14.2	13.7	14.7	14.8	15.4	16.9	14.9	15.1
1	20.3	20.7	17.3	17.7	18.0	17.5	17.6	18.0
2	21.0	21.1	19.0	19.2	19.8	19.3	18.7	19.6
3	21.8	22.1	20.4	20.2	20.4	19.6	19.2	20.2
4	22.1	22.5	21.2	21.0	20.9	20.0	19.5	20.7
5	22.6	22.9	22.6	20.8	21.3	20.4	19.8	20.8
6	23.0	23.1	22.7		22.0	20.6	20.2	21.1
7	23.2	23.1			21.5	20.8	20.3	21.3
8	23.8	23.8			22.6	21.3	21.1	22.3
9								
10								
11								
Total	21.5	20.1	16.0	15.7	17.6	19.4	16.1	17.1

	Whole Year							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	13.9	13.8	14.1	14.0	15	17	14.9	14.4
1	18.1	19.9	17.0	15.8	17.1	17.8	16.8	16.3
2	20.3	20.5	18.9	18.4	18.7	19.0	18.6	18.9
3	21.4	21.7	20.0	19.7	19.7	19.5	19.2	19.9
4	21.8	22.3	20.5	20.4	20.3	19.9	19.8	20.5
5	22.3	22.6	21.9	20.7	20.7	20.4	20.2	20.8
6	22.6	22.9	22.5	21.3	21.0	20.7	20.6	21.1
7	23.0	23.2		22.3	21.5	20.9	20.9	21.5
8	23.0	23.9	21.3		22.4	21.5	21.2	22.1
9								
10								
11								
Total	21.1	21.2	16.8	15.6	18.7	19.5	17.2	17.6

Table 9.4.2.2: Mean weight at age by quarter and ICES Sub-Division

	First Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	0.028	0.042	0.025	0.026	0.033	0.042	0.035	0.029
2	0.061	0.062	0.056	0.040	0.046	0.048	0.049	0.046
3	0.074	0.076	0.065	0.052	0.055	0.051	0.052	0.057
4	0.079	0.081	0.074	0.059	0.060	0.056	0.057	0.063
5	0.083	0.086	0.078	0.069	0.062	0.060	0.061	0.066
6	0.087	0.089	0.086	0.071	0.065	0.063	0.065	0.067
7	0.093	0.095		0.069	0.071	0.072	0.074	0.077
8	0.090	0.113	0.072		0.077	0.085		0.081
9								
10								
11								
Total	0.073	0.078	0.058	0.034	0.054	0.054	0.047	0.051

	Second Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	0.044	0.051	0.035	0.027	0.035	0.052	0.039	0.030
2	0.062	0.066	0.048	0.046	0.048	0.055	0.046	0.051
3	0.075	0.081	0.058	0.056	0.056	0.060	0.058	0.063
4	0.081	0.087	0.064	0.064	0.064	0.064	0.065	0.070
5	0.086	0.092	0.077	0.068	0.069	0.068	0.071	0.075
6	0.090	0.096	0.092	0.078	0.079	0.071	0.073	0.079
7	0.092	0.101				0.071	0.074	0.082
8	0.094	0.121	0.076					0.095
9								
10								
11								
Total	0.074	0.084	0.044	0.031	0.050	0.061	0.048	0.049

	Third Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	0.022	0.045	0.023	0.019	0.030	0.045	0.028	0.022
1	0.076	0.071	0.047	0.046	0.050	0.056	0.046	0.048
2	0.082	0.076	0.062	0.061	0.062	0.064	0.060	0.064
3	0.092	0.095	0.072	0.070	0.073	0.067	0.065	0.071
4	0.097	0.103	0.078	0.077	0.078	0.070	0.069	0.076
5	0.103	0.107	0.095	0.079	0.084	0.073	0.074	0.078
6	0.109	0.114	0.095	0.084	0.089	0.075	0.078	0.081
7	0.111	0.115		0.106	0.111	0.077	0.081	0.083
8	0.124	0.123				0.082	0.085	0.086
9								
10								
11								
Total	0.084	0.083	0.044	0.035	0.069	0.066	0.046	0.049

	Fourth Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	0.023	0.021	0.026	0.026	0.030	0.042	0.027	0.028
1	0.072	0.075	0.043	0.048	0.051	0.046	0.045	0.050
2	0.080	0.081	0.059	0.062	0.069	0.062	0.055	0.066
3	0.089	0.094	0.073	0.075	0.077	0.065	0.059	0.073
4	0.094	0.100	0.082	0.086	0.083	0.068	0.062	0.078
5	0.101	0.105	0.100	0.083	0.089	0.072	0.066	0.079
6	0.107	0.109	0.102		0.099	0.074	0.070	0.082
7	0.110	0.109			0.091	0.077	0.071	0.084
8	0.119	0.118			0.108	0.082	0.080	0.101
9								
10								
11								
Total	0.087	0.076	0.036	0.033	0.050	0.063	0.036	0.045

	Whole Year							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	0.022	0.021	0.024	0.022	0.030	0.043	0.028	0.025
1	0.053	0.068	0.041	0.033	0.043	0.046	0.038	0.037
2	0.069	0.074	0.057	0.052	0.053	0.058	0.051	0.056
3	0.079	0.085	0.070	0.067	0.063	0.062	0.057	0.066
4	0.083	0.091	0.074	0.073	0.070	0.065	0.062	0.071
5	0.088	0.095	0.086	0.078	0.072	0.069	0.068	0.074
6	0.092	0.099	0.093	0.079	0.073	0.070	0.071	0.075
7	0.097	0.104		0.100	0.079	0.075	0.078	0.081
8	0.097	0.120	0.074		0.098	0.082	0.085	0.093
9								
10								
11								
Total	0.077	0.082	0.043	0.033	0.055	0.062	0.043	0.048

9.5 Effort and catch per unit effort

Data on fishing effort and CPUE have been regularly provided in this section both for the Portuguese purse-seine fleet and Spanish purse-seine fleets from Sada and Vigo-Ribeira. However, it was recognised that the effort measure used in these CPUE series did not take into account the searching time, a factor that may influence effort estimates for pelagic fish. Furthermore, there was some indication that the Spanish fleets have gradually changed their target species to other pelagic species (mainly horse mackerel) and there is some indication that this might have also happened in Portugal during a short period in 1999 due to the large abundance of Spanish mackerel in the central area. These changes are probably impossible to evaluate.

Since it was not possible to get new information on fishing effort that enables the improvement of the estimates, effort and CPUE estimates will not be provided for 2000.

9.6 Recruitment forecasting and Environmental effects

Previous works have suggested that year class strength of the Iberian sardine is affected by hydroclimatic conditions in the North Atlantic (Borges *et al*., 1997; Santos *et al*., 1997, Cabanas and Porteiro, 1999 in press, Borges *et al*., 2000). The hypothesis of a negative impact of winter upwelling on sardine recruitment, possibly through the induction of offshore transport of larvae to areas with unfavourable feeding conditions, has been suggested by Santos et al. (1997). Strong winter north winds appear to have a negative impact on sardine recruitment but when winds are weak other factors become important in recruitment strength. Dependence of recruitment on both large and meso-scale (local) oceanographic events has been explored further (Porteiro *et al*., WD 2001) and the main results are presented in Section 9.16.

The spawning period of sardine is broad and different peaks occur at different locations and periods (Southern part, Central part –North Portugal- and Cantabrian Sea). Therefore, the recruitment process in sardine is the outcome of a large time/spatial integral that accounts for different oceanographic regimes along the Atlantic waters of the Iberian peninsula. Off the northern coast, spring upwelling may be a determinant of recruitment strength, however in the southern area or in the Cantabrian sea there could be other oceanographic processes which determine recruitment strength. These areas, especially the Gulf of Cadiz and surrounded area, may show strong recruitments in distinct years further suggesting distinct relations with environmental factors. In addition, the changes observed in both stock age structure and distribution, makes it difficult to establish a single relationship between sardine recruitment and a particular environmental event. Therefore, these relationships will possibly have to be analysed at a finer spatial scale than the whole stock area.

9.7 State of the stock

9.7.1 Data exploration

Last year, a series of preliminary analyses were carried out aiming to assess i) the effect of the different tuning data in the assessment model and, ii) the effect of the separable period in the assessment model. The above exploration indicated that the model is sensitive to which tuning fleets are included, namely because they cover parts of the stock which were shown to follow different trajectories along the time series (evident also in catch-at-age data). The assessment model showed less sensitivity to the choice of the separable period and the model fit was improved when the change in the selection pattern was set to 1993. A model constructed with 13 years of separable period (divided from 1987 to 1993 and from 1994 to 1999 with an abrupt change in selection between periods) including all the available tuning fleets as relative indices (Spanish March, Portuguese March and Portuguese November acoustic surveys) and DEPM spawning biomass as an absolute estimator was adopted as the most appropriate to represent the dynamic of this stock.

Considering the different signals given by the acoustic surveys covering different parts of the stock, the hypothesis of combining data from the two March acoustic surveys (Spanish and Portuguese), which would then represent the total stock area, was discussed this year. The smaller number of years available for the Portuguese series (7 years) than for the Spanish series (13 years) would require six years of data to be discarded from the latter series, leading to a different set of input data with large gaps in the earlier period. The WG decided not to pursue this approach but considered that it would be worthwhile exploring in the future when more common years are available for the two survey series.

Input data, including catch-at-age and abundance at age from the acoustic surveys was updated to 2000 and the assessment model was run with the same options as in the previous year. Since no conclusive information on population structure or migration dynamics were available to the WG which could provide a basis to change the previous assessment, and that the assessment model was extensively checked in the last two years to explore the sensitivity to different assumptions and input data (ICES CM 2000/ACFM:5, ICES CM 2001/ACFM:6), the WG decided to accept the above model as the most appropriate to represent the dynamic of this stock.

9.7.2 Stock assessment

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:

$$\sum_{0}^{6+}\sum_{1987}^{1993}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{1,a}\cdot\overline{N}_{ay}\right)\right]^2+\sum_{0}^{6+}\sum_{1994}^{2000}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{2,a}\cdot\overline{N}_{ay}\right)\right]^2+$$

$$+\sum_{1987}^{1993}\left[\ln\left(DEPM_y\right)-\ln\left(\sum\nolimits_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{1,a}-PM\cdot M)\right)\right]^2+$$

$$\sum_{1994}^{2000}\left[\ln\left(DEPM_y\right)-\ln\left(\sum\nolimits_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{2,a}-PM\cdot M)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

$$+\sum_{1987}^{1993}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

With constraints on $S_{13} = S_{15} = S_{23} = S_{25}=1.0$

and $\overline{N}$ average exploited abundance over the year

N: population abundance on 1st January
Oa,y: maturity ogive
M: 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 1987–1993 and 1994–2000 respectively
DEPM: SSB estimation from the daily egg production method
Q_{ANP}, Q_{ASP}, Q_{ASS}: Catchability of the linear indices from Portuguese (P) March, November (N) 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 9.7.2.1 and Figure 9.7.2.1. CV's expressed in % of the parameter estimates are similar to previous assessments and are mainly in the range 15-30%. In general, the range and the pattern of residuals both for the separable model and for the tuning fleets are similar to those of last year's assessment. Large negative residuals appear in the last year of data for the Portuguese acoustic surveys (2000 in November and 2001 in March) mainly for age groups 2-4 while the age group corresponding to the 2000 year-class shows a positive residual. Both the Portuguese and the Spanish acoustic surveys indicate a strong 2000 recruitment although not reflected with a similar strength as 0-group catches. The Portuguese surveys also estimate one of the lowest absolute and relative abundances of adult fish in the whole time series with percentages of 7% in November (age groups 1-6+) and 11% in March (age groups 2-6+), suggesting either increased mortality or that the distribution of these fish was such that their accessibility to the surveys was decreased.

Figure 9.7.2.2 shows the estimated recruitment, F2–5 and SSB for the whole time series showing a general similarity in the trajectories provided by the models fitted this year and in the assessment made in 2000. Lower estimates of recruitment are provided for the three most recent years (1997-1999) and there is no indication of an above average recruitment in 1998 as previously conjectured. Strong year classes are observed in 1983 and 1991/1992 but with decreasing strength in that order and a large 2000 year-class is clearly indicated although its magnitude is still uncertain (a 40% CV is attached to this estimate). Fishing mortality shows a decrease of 17% in 2000 relative to 1999, possibly partly influenced by a decrease in the fleet effort due to bad weather conditions in the last four months of the year. The lower SSB estimated this year for 1999 is mainly due to the lower 1998 estimate of recruitment. Estimated SSB again shows two clear periods of higher abundance (1981–87 and 1992–96) and seems to be stable after a declining period up to 1997. At present the stock is considered to be at a low level, similar to that observed in 1990, although the indications of an above average recruitment in 2000 increase the expectations of a short-term recovery of the SSB.

9.7.3 Reliability of the assessment model

Current knowledge on sardine stock dynamics (WD's in ICES 2000, Stratoudakis *et al*, WD 2001, Porteiro *et al*., WD 2001) indicates important changes in sardine distribution, abundance and population structure have taken place since the early nineties. A change of the sardine distribution towards southern areas and a reduction of the overall sardine distribution area combined with low recruitment values in recent years have influenced both the catch distribution by areas and the age composition of the catches in each area. The combination of these changes leads to a different perception of the stock depending on the area considered and, as a consequence, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if geographic/temporal differences are not considered. The large variability in recruitment, which shows good correlations with several environmental indices but little dependence on stock size (Porteiro *et al*., WD 2001), adds noise to the performance of the model and makes it difficult to conform to the separability assumption.

The WG considers that previous exploratory analyses improved the fit of the model and the precision of the parameter estimates to acceptable levels, taking into account the available input data and the inability of the model to incorporate all the characteristics of the dynamic of this stock. The present model is shown to be robust (both in relation to goodness-of fit and stock trajectory) to the addition of new input data but uncertainties about accuracy of estimates and therefore of absolute stock levels still remain. Little confidence can be attached to the large 2000 recruitment estimate (1.3 times higher than the maximum of the series, with a 41% CV), although the auxiliary information points to an above average year class.

Table 9.7.2.1a: Input values for the assessment model

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	1999	2000
0	120.8	30.5	277.1	208.6	449.1	246.0	489.8
1	60.2	189.1	101.3	548.6	366.2	475.2	354.8
2	542.2	280.7	347.7	453.3	501.6	361.5	314.0
3	1094.4	829.7	514.7	391.1	352.5	339.7	255.5
4	272.5	472.9	652.7	337.3	233.7	177.2	194.2
5	112.6	70.2	197.2	225.2	178.7	105.5	97.7
6	72.1	64.5	46.6	70.3	105.9	72.2	64.4

x 10 ^ 6

Table 9.7.2.1a (cont): Input values for the assessment model

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994
0	634.7	395.3	401.8	409.8	752.3	502.7	212.6	102.6
1	537.0	897.4	564.5	612.2	454.0	969.6	711.2	153.0
2	622.6	545.0	919.7	614.9	488.7	427.9	1008.2	538.8
3	552.6	472.4	417.5	746.1	367.9	351.6	341.8	794.2
4	685.4	289.2	249.8	233.6	306.8	184.7	197.2	209.9
5	189.3	326.3	139.1	127.1	87.2	140.1	94.3	99.4

x 10 ^ 6

Predicted Catch in Number

AGE	1995	1996	1997	1998	1999	2000
0	79.8	168.2	176.9	266.7	235.2	760.4
1	152.0	181.0	311.7	295.0	335.3	302.3
2	235.9	354.0	339.1	520.4	374.5	441.0
3	606.3	392.8	459.1	384.1	452.6	346.3
4	494.5	556.1	271.3	270.8	173.0	222.5
5	93.7	328.3	276.4	114.6	86.5	60.6

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 9.7.2.1a (cont): Input values for the assessment model

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.02000	0.02500	0.01900	0.02200	0.02400	0.02500	0.02500
1	0.03600	0.04700	0.03800	0.03300	0.04000	0.04200	0.03700
2	0.05800	0.05900	0.05100	0.05200	0.05500	0.05600	0.05600
3	0.06200	0.06600	0.05800	0.06200	0.06100	0.06500	0.06600
4	0.07000	0.07100	0.06100	0.06900	0.06400	0.07000	0.07100
5	0.07600	0.08200	0.07100	0.07300	0.06700	0.07300	0.07400
6	0.10000	0.10000	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

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.03100	0.02900	0.03600	0.02500	0.02300	0.02000	0.01700
2	0.04000	0.05000	0.04700	0.05000	0.04100	0.03900	0.04300
3	0.04900	0.06200	0.06100	0.05800	0.05300	0.05400	0.05900
4	0.06000	0.07200	0.06900	0.06800	0.06100	0.06200	0.06400
5	0.06700	0.07900	0.07500	0.07400	0.06700	0.06800	0.06700
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Table 9.7.2.1a (cont): Input values for the assessment model

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

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000
0	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
2	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
4	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
6	0.33000	0.33000	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

Table 9.7.2.1a (cont): Input values for the assessment model

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

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.8000	0.7300	0.8300	0.7270	0.7200	0.6190	0.2570
2	0.8900	0.9800	0.8900	0.9180	0.9240	0.9110	0.9100
3	0.9600	0.9700	0.9200	0.9500	0.9560	0.9870	0.9470
4	0.9600	0.9900	0.9600	0.9720	0.9870	0.9950	0.9500
5	0.9700	1.0000	1.0000	0.9930	0.9950	1.0000	1.0000
6	1.0000	1.0000	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	*******	*******	*******	*******	*******	*******	*******	147.90

x 10 ^ 3

INDEX1

	1998	1999
1	*******	215.50

x 10 ^ 3

Table 9.7.2.1a (cont): Input values for the assessment model

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	2000	2001
1	*******	*******	10.6	56.5	509.8	214.5	91.7	975.6
2	*******	*******	54.2	263.1	103.1	160.4	285.8	262.9
3	*******	*******	90.5	125.7	80.4	134.6	435.4	186.5
4	*******	*******	350.8	123.3	33.8	124.3	242.2	142.9
5	*******	*******	213.8	65.7	20.6	28.4	188.9	98.9
6	*******	*******	24.8	61.0	25.4	64.0	68.1	66.1

x 10 ^ 3

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

AGE	1996	1997	1998	1999	2000	2001
1	1625.	6344.	1636.	5712.	6581.	18684.
2	2082.	3238.	4015.	2553.	2170.	774.
3	2415.	1552.	2191.	1461.	1222.	515.
4	2906.	1260.	1434.	844.	757.	337.
5	386.	1360.	1185.	596.	532.	276.
6	12.	203.	980.	469.	613.	184.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	2957.	2063.	2493.	3715.	999990.	999990.	999990.	999990.
1	5733.	2744.	1612.	2379.	999990.	999990.	999990.	999990.
2	1152.	4548.	1670.	1344.	999990.	999990.	999990.	999990.
3	1037.	1083.	658.	929.	999990.	999990.	999990.	999990.
4	528.	839.	323.	666.	999990.	999990.	999990.	999990.
5	76.	144.	127.	236.	999990.	999990.	999990.	999990.
6	40.	70.	50.	80.	999990.	999990.	999990.	999990.

x 10 ^ 6

Table 9.7.2.1a (cont): Input values for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	6349.	999990.	999990.	999990.	999990.	2425.	8680.	3697.
1	5481.	999990.	999990.	999990.	999990.	1961.	1809.	798.
2	1157.	999990.	999990.	999990.	999990.	906.	1215.	646.
3	1003.	999990.	999990.	999990.	999990.	729.	823.	391.
4	437.	999990.	999990.	999990.	999990.	1041.	396.	459.
5	108.	999990.	999990.	999990.	999990.	772.	367.	382.
6	19.	999990.	999990.	999990.	999990.	322.	220.	165.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	2000
0	30871.
1	1616.
2	247.
3	90.
4	122.
5	94.
6	66.

x 10 ^ 6

Table 9.7.2.1b: Output values for the assessment model

Fishing Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07698	0.05287	0.06238	0.11405	0.00822	0.05257	0.01519	0.04040
1	0.45074	0.21792	0.25730	0.22479	0.13940	0.11261	0.26273	0.10702
2	0.44887	0.40080	0.41952	0.42426	0.41092	0.25309	0.15059	0.35448
3	0.45903	0.44502	0.31785	0.37908	0.35831	0.36257	0.26731	0.24480
4	0.37438	0.72390	0.33465	0.31251	0.40510	0.32046	0.25941	0.28702
5	0.63886	0.55957	0.46557	0.45743	0.41748	0.32586	0.34266	0.32108
6	0.63886	0.55957	0.46557	0.45743	0.41748	0.32586	0.34266	0.32108

Fishing Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.05342	0.06603	0.06574	0.06612	0.07135	0.05523	0.04900	0.04749
1	0.17548	0.14445	0.14382	0.14465	0.15608	0.12083	0.10720	0.10390
2	0.33454	0.24794	0.24686	0.24828	0.26791	0.20740	0.18401	0.17833
3	0.26130	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367
4	0.31935	0.36944	0.36783	0.36994	0.39920	0.30903	0.27418	0.26572
5	0.36762	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367
6	0.36762	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.02217	0.02100	0.03074	0.03723	0.04085	0.03362	0.02802
1	0.04989	0.04724	0.06916	0.08376	0.09192	0.07565	0.06304
2	0.12254	0.11603	0.16986	0.20572	0.22576	0.18580	0.15483
3	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354
4	0.28293	0.26791	0.39219	0.47498	0.52126	0.42900	0.35750
5	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354
6	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354

Population Abundance (1 January)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	13749.	15354.	16603.	11140.	8893.	24496.	9187.	7939.
1	7341.	9152.	10470.	11215.	7146.	6341.	16709.	6505.
2	3036.	3363.	5291.	5820.	6439.	4469.	4073.	9237.
3	930.	1393.	1619.	2501.	2737.	3070.	2494.	2519.
4	509.	423.	642.	847.	1231.	1375.	1536.	1373.
5	102.	251.	147.	330.	446.	590.	718.	852.
6	40.	97.	93.	242.	439.	582.	469.	436.

x 10 ^ 6

Table 9.7.2.1b (cont): Output values for the assessment model

Population Abundance (1 January)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	6851.	11641.	7281.	7360.	6973.	16413.	12325.	5375.
1	5481.	4669.	7834.	4902.	4953.	4668.	11166.	8437.
2	4202.	3306.	2905.	4878.	3049.	3046.	2974.	7211.
3	4659.	2162.	1855.	1632.	2736.	1677.	1780.	1779.
4	1418.	2579.	1092.	939.	824.	1344.	898.	985.
5	741.	741.	1281.	544.	466.	397.	709.	491.
6	631.	669.	742.	957.	909.	480.	408.	626.

x 10 ^ 6

Population Abundance (1 January)

AGE	1994	1995	1996	1997	1998	1999	2000	2001
0	5492.	4508.	6518.	5679.	7813.	8343.	32285.	9046.
1	3685.	3862.	3173.	4544.	3934.	5392.	5800.	22569.
2	5467.	2520.	2648.	2129.	3005.	2580.	3594.	3915.
3	4338.	3477.	1613.	1606.	1246.	1724.	1540.	2213.
4	992.	2452.	1991.	831.	772.	575.	861.	817.
5	543.	538.	1349.	967.	372.	329.	269.	433.
6	394.	370.	191.	246.	343.	275.	286.	295.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994
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	1995	1996	1997	1998	1999	2000
0	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
2	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
4	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

Table 9.7.2.1b (cont): Output values for the assessment model

Predicted SSB Index Values

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	437.09	*******

x 10 ^ 3

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	363.60

x 10 ^ 3

INDEX1

	1998	1999
1	*******	293.20

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	115.04	98.63	165.52	*******	104.36	99.10	237.72	179.75
2	159.30	127.65	112.19	*******	117.23	118.60	116.37	282.50
3	352.38	160.42	137.69	*******	201.79	125.95	134.60	134.76
4	201.88	363.42	153.98	*******	115.40	191.74	129.04	141.82
5	164.43	164.94	285.51	*******	103.21	89.60	160.99	111.56
6	277.42	295.07	327.44	*******	398.66	214.06	183.35	281.86

x 10 ^ 3

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	68.10	97.23	84.02	115.56	124.63	484.98
2	*******	*******	103.92	82.92	116.54	100.90	141.49	154.12
3	*******	*******	120.22	117.93	90.72	127.58	115.46	165.92
4	*******	*******	279.24	114.59	105.31	80.07	121.60	115.46
5	*******	*******	301.64	213.11	81.25	73.18	60.62	97.40
6	*******	*******	84.79	107.29	148.64	120.90	127.58	131.41

x 10 ^ 3

Table 9.7.2.1b (cont): Output values for the assessment model

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Predicted

AGE	1996	1997	1998	1999	2000	2001
1	2593.	3702.	3199.	4400.	4746.	18468.
2	2011.	1605.	2255.	1953.	2738.	2983.
3	1391.	1365.	1050.	1476.	1336.	1920.
4	2283.	937.	861.	655.	994.	944.
5	1621.	1145.	437.	393.	326.	523.
6	160.	203.	281.	229.	241.	249.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	4372.	3687.	3143.	5276.	999990.	999990.	999990.	999990.
1	5174.	2339.	1846.	1620.	999990.	999990.	999990.	999990.
2	1356.	2528.	1172.	1002.	999990.	999990.	999990.	999990.
3	808.	833.	1517.	645.	999990.	999990.	999990.	999990.
4	720.	627.	628.	1089.	999990.	999990.	999990.	999990.
5	240.	290.	242.	245.	999990.	999990.	999990.	999990.
6	98.	93.	129.	138.	999990.	999990.	999990.	999990.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	5678.	999990.	999990.	999990.	999990.	2646.	3627.	3901.
1	4014.	999990.	999990.	999990.	999990.	1671.	1435.	1998.
2	959.	999990.	999990.	999990.	999990.	672.	930.	830.
3	579.	999990.	999990.	999990.	999990.	456.	341.	508.
4	415.	999990.	999990.	999990.	999990.	317.	281.	229.
5	256.	999990.	999990.	999990.	999990.	305.	113.	108.
6	92.	999990.	999990.	999990.	999990.	48.	65.	56.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	2000
0	15175.
1	2175.
2	1191.
3	482.
4	367.
5	93.
6	62.

x 10 ^ 6

Table 9.7.2.1b (cont): Output values for the assessment model

Fitted Selection Pattern

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.1677	0.1188	0.1963	0.3009	0.0229	0.1450	0.0568	0.1650
1	0.9819	0.4897	0.8095	0.5930	0.3891	0.3106	0.9829	0.4372
2	0.9779	0.9006	1.3199	1.1192	1.1468	0.6981	0.5633	1.4480
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.8156	1.6267	1.0529	0.8244	1.1306	0.8839	0.9705	1.1725
5	1.3917	1.2574	1.4647	1.2067	1.1651	0.8988	1.2819	1.3116
6	1.3917	1.2574	1.4647	1.2067	1.1651	0.8988	1.2819	1.3116

Fitted Selection Pattern

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.2044	0.1872	0.1872	0.1872	0.1872	0.1872	0.1872	0.1872
1	0.6716	0.4096	0.4096	0.4096	0.4096	0.4096	0.4096	0.4096
2	1.2803	0.7030	0.7030	0.7030	0.7030	0.7030	0.7030	0.7030
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2222	1.0475	1.0475	1.0475	1.0475	1.0475	1.0475	1.0475
5	1.4069	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.4069	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
1	0.2077	0.2077	0.2077	0.2077	0.2077	0.2077	0.2077
2	0.5101	0.5101	0.5101	0.5101	0.5101	0.5101	0.5101
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.1778	1.1778	1.1778	1.1778	1.1778	1.1778	1.1778
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

Table 9.7.2.1b (cont): Output values for the assessment model

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	13748910	315401	228162	145609	0.6382	0.4803	83
1979	15354210	388340	283937	157241	0.5538	0.5323	96
1980	16603470	499371	372471	194802	0.5230	0.3844	95
1981	11140240	614886	466477	216517	0.4642	0.3933	89
1982	8892810	641229	506191	206946	0.4088	0.3980	96
1983	24496160	604113	488610	183837	0.3762	0.3155	104
1984	9186950	723400	550170	206005	0.3744	0.2550	95
1985	7938500	763091	616981	208440	0.3378	0.3018	94
1986	6850950	678284	556537	187363	0.3367	0.3207	97
1987	11641250	585364	479231	177695	0.3708	0.3307	100
1988	7281170	550658	437094	161530	0.3696	0.3292	102
1989	7359780	532719	370538	140962	0.3804	0.3311	96
1990	6973470	501860	365941	149430	0.4083	0.3573	104
1991	16412880	462634	370031	132587	0.3583	0.2766	99
1992	12324890	642892	500935	130249	0.2600	0.2454	99
1993	5375280	772938	569446	142495	0.2502	0.2379	98
1994	5491690	680734	552506	136581	0.2472	0.2215	98
1995	4507750	709605	592137	125280	0.2116	0.2097	98
1996	6518300	594811	478631	116736	0.2439	0.3070	101
1997	5679010	465911	363595	115814	0.3185	0.3718	98
1998	7812650	386011	300651	108925	0.3623	0.4080	97
1999	8343200	387063	293197	94091	0.3209	0.3358	98
2000	32285420	445768	308469	85786	0.2781	0.2799	98

No of years for separable analysis : 14
Age range in the analysis : 0 . . . 6
Year range in the analysis : 1978 . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 3

Parameters to estimate : 60
Number of observations : 264

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1993
Abrupt change in selection specified.

Table 9.7.2.1b (cont): Output values for the assessment model

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	0.3527	22	0.2272	0.5474	0.2818	0.4414	0.3617
2	1988	0.3511	23	0.2232	0.5525	0.2786	0.4425	0.3607
3	1989	0.3532	23	0.2215	0.5632	0.2783	0.4481	0.3633
4	1990	0.3811	23	0.2411	0.6025	0.3017	0.4814	0.3916
5	1991	0.2950	23	0.1866	0.4664	0.2335	0.3727	0.3032
6	1992	0.2617	22	0.1680	0.4079	0.2087	0.3282	0.2685
7	1993	0.2537	22	0.1624	0.3962	0.2021	0.3185	0.2603
8	1994	0.2402	24	0.1497	0.3854	0.1888	0.3057	0.2473
9	1995	0.2275	23	0.1443	0.3586	0.1803	0.2869	0.2337
10	1996	0.3330	21	0.2167	0.5116	0.2675	0.4146	0.3411
11	1997	0.4033	21	0.2665	0.6103	0.3265	0.4982	0.4124
12	1998	0.4426	21	0.2912	0.6726	0.3575	0.5479	0.4528
13	1999	0.3642	22	0.2350	0.5647	0.2912	0.4555	0.3735
14	2000	0.3035	23	0.1910	0.4823	0.2397	0.3844	0.3121
Separable Model: Selection (S1) by age 1987 1993								
15	0	0.1872	24	0.1164	0.3011	0.1469	0.2386	0.1928
16	1	0.4096	19	0.2783	0.6028	0.3363	0.4988	0.4176
17	2	0.7030	18	0.4873	1.0143	0.5831	0.8476	0.7154
	3	1.0000		Fixed : Reference Age				
18	4	1.0475	16	0.7608	1.4423	0.8898	1.2332	1.0615
	5	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1994 to 2000								
19	0	0.0923	25	0.0555	0.1535	0.0712	0.1197	0.0955
20	1	0.2077	20	0.1384	0.3117	0.1688	0.2555	0.2122
21	2	0.5101	19	0.3496	0.7443	0.4207	0.6185	0.5197
	3	1.0000		Fixed : Reference Age				
22	4	1.1778	16	0.8557	1.6211	1.0006	1.3863	1.1935
	5	1.0000		Fixed : Last true age				
Separable model: Populations in year 2000								
23	0	32285421	41	14204122	73383513	21235952	49084138	35246379
24	1	5799805	28	3328728	10105283	4369033	7699127	6037251
25	2	3593908	22	2310879	5589291	2868898	4502139	3686299
26	3	1540070	20	1039977	2280644	1260498	1881651	1571283
27	4	860800	20	574611	1289525	700401	1057930	879297
28	5	269372	24	167986	431949	211699	342756	277304
Separable model: Populations at age								
29	1987	740574	35	370179	1481579	519897	1054920	788404
30	1988	1281468	28	729499	2251078	961323	1708228	1335519
31	1989	543634	28	311330	949277	409066	722471	566070
32	1990	466183	26	275729	788188	356609	609425	483221
33	1991	397442	26	238150	663280	306050	516125	411244
34	1992	709149	24	435686	1154254	553091	909240	731394
35	1993	490565	24	304118	791317	384371	626098	505381
36	1994	542788	24	337182	873769	425733	692027	559040
37	1995	537580	25	328931	878579	418405	690699	554731
38	1996	1348729	24	826750	2200265	1050705	1731286	1391439
39	1997	967074	23	605228	1545256	761399	1228307	995120
40	1998	371731	23	232905	593306	292841	471874	382459
41	1999	329364	24	204881	529483	258515	419631	339169

Table 9.7.2.1b (cont): Output values for the assessment model

```
 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 :
   42   1  Q  .2334E-01  25 .1822E-01 .5007E-01 .2334E-01 .3909E-01 .3122E-01
   43   2  Q  .4359E-01  25 .3407E-01 .9314E-01 .4359E-01 .7281E-01 .5822E-01
   44   3  Q  .8564E-01  25 .6674E-01 .1848     .8564E-01 .1440     .1149
   45   4  Q  .1632      27 .1256     .3658     .1632     .2816     .2225
   46   5  Q  .2571      29 .1941     .6108     .2571     .4613     .3594
   47   6  Q  .5090      27 .3901     1.156     .5090     .8859     .6978


                                             FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

 Linear model fitted. Slopes at age :
   48   1  Q  888.7      38 613.3     2789.     888.7     1925.     1409.
   49   2  Q  843.6      37 586.5     2588.     843.6     1799.     1324.
   50   3  Q  991.1      37 689.1     3038.     991.1     2113.     1554.
   51   4  Q  1334.      38 918.1     4228.     1334.     2908.     2125.
   52   5  Q  1382.      41 929.8     4684.     1382.     3152.     2272.
   53   6  Q  963.0      39 657.3     3125.     963.0     2133.     1551.


                                             FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

 Linear model fitted. Slopes at age :
   54   0  Q  662.8      32 483.2     1757.     662.8     1281.     972.7
   55   1  Q  547.0      32 400.1     1435.     547.0     1049.     798.9
   56   2  Q  528.0      32 386.4     1382.     528.0     1012.     770.5
   57   3  Q  574.5      32 418.7     1524.     574.5     1111.     843.4
   58   4  Q  826.0      33 597.1     2246.     826.0     1624.     1226.
   59   5  Q  637.1      34 455.6     1792.     637.1     1282.     960.5
   60   6  Q  397.9      33 287.2     1087.     397.9     784.6     591.9


 RESIDUALS ABOUT THE MODEL FIT
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        Separable Model Residuals
        -------------------------
```

Age	1987	1988	1989	1990	1991	1992	1993	1994
0	0.8172	0.2761	-0.4825	-0.4627	0.7424	-0.0088	-0.8844	0.1628
1	0.0111	0.0982	0.0027	-0.0168	0.0501	0.0327	-0.2279	-0.9327
2	0.0688	-0.0185	-0.0117	-0.1734	-0.1139	0.0534	0.0705	0.0062
3	0.0293	-0.0733	-0.0708	-0.0539	0.1008	-0.0326	0.4223	0.3207
4	-0.2477	0.0498	-0.1223	0.2336	-0.1436	0.0082	0.2659	0.2609
5	-0.2063	-0.1111	0.3631	0.1720	-0.1542	-0.2334	0.1889	0.1252

Table 9.7.2.1b (cont): Output values for the assessment model

Separable Model Residuals

Age	1995	1996	1997	1998	1999	2000
0	-0.9617	0.4990	0.1645	0.5212	0.0450	-0.4397
1	0.2189	-0.5805	0.5653	0.2162	0.3487	0.1601
2	0.1738	-0.0179	0.2904	-0.0368	-0.0352	-0.3397
3	0.3137	0.2704	-0.1603	-0.0860	-0.2870	-0.3039
4	-0.0448	0.1601	0.2179	-0.1474	0.0239	-0.1364
5	-0.2891	-0.5096	-0.2050	0.4444	0.1987	0.4781

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	-0.3932	*******

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	-0.8995

INDEX1

	1998	1999
1	*******	-0.3079

Table 9.7.2.1b (cont): Output values for the assessment model

AGE-STRUCTURED INDEX RESIDUALS

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-0.737	1.858	0.303	*******	-0.413	-1.361	-0.347	0.283
2	-2.048	0.698	-0.564	*******	-0.739	0.562	-0.407	0.414
3	1.083	-1.767	-0.626	*******	0.302	0.262	-0.421	0.009
4	0.064	1.884	-0.875	*******	-0.772	0.738	-1.428	-0.118
5	0.911	1.268	1.089	*******	-0.165	-0.362	-0.320	0.268
6	0.723	1.451	0.995	*******	0.379	0.987	-0.401	1.378

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-1.857	-0.543	1.803	0.619	-0.307	0.699
2	*******	*******	-0.650	1.155	-0.122	0.463	0.703	0.534
3	*******	*******	-0.283	0.063	-0.121	0.054	1.327	0.117
4	*******	*******	0.228	0.074	-1.138	0.440	0.689	0.213
5	*******	*******	-0.344	-1.177	-1.373	-0.948	1.137	0.016
6	*******	*******	-1.230	-0.565	-1.766	-0.636	-0.627	-0.688

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Age	1996	1997	1998	1999	2000	2001
1	-0.467	0.539	-0.671	0.261	0.327	0.012
2	0.035	0.702	0.577	0.268	-0.233	-1.348
3	0.551	0.128	0.736	-0.011	-0.090	-1.315
4	0.241	0.296	0.510	0.254	-0.273	-1.029
5	-1.434	0.172	0.998	0.415	0.490	-0.642
6	-2.596	-0.001	1.248	0.718	0.932	-0.303

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.391	-0.581	-0.232	-0.351	*******	*******	*******	*******
1	0.103	0.159	-0.135	0.385	*******	*******	*******	*******
2	-0.163	0.587	0.354	0.293	*******	*******	*******	*******
3	0.250	0.262	-0.835	0.365	*******	*******	*******	*******
4	-0.310	0.292	-0.665	-0.492	*******	*******	*******	*******
5	-1.143	-0.703	-0.641	-0.035	*******	*******	*******	*******
6	-0.891	-0.284	-0.951	-0.548	*******	*******	*******	*******

Table 9.7.2.1b (cont): Output values for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.112	*******	*******	*******	*******	-0.087	0.873	-0.054
1	0.311	*******	*******	*******	*******	0.160	0.232	-0.918
2	0.188	*******	*******	*******	*******	0.299	0.266	-0.251
3	0.548	*******	*******	*******	*******	0.468	0.882	-0.262
4	0.052	*******	*******	*******	*******	1.188	0.342	0.695
5	-0.861	*******	*******	*******	*******	0.929	1.180	1.267
6	-1.589	*******	*******	*******	*******	1.897	1.220	1.076

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	2000
0	0.710
1	-0.297
2	-1.575
3	-1.678
4	-1.103
5	0.006
6	0.069

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 2000	
Variance	0.1517
Skewness test stat.	-1.6289
Kurtosis test statistic	1.5159
Partial chi-square	0.5285
Significance in fit	0.0000
Degrees of freedom	47

Table 9.7.2.1b (cont): Output values for the assessment model

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	0.3528
Skewness test stat.	-0.9197
Kurtosis test statistic	-0.4098
Partial chi-square	0.0826
Significance in fit	0.0062
Number of observations	3
Degrees of freedom	3
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	0.1981	0.1245	0.0958	0.1330	0.1324	0.1808
Skewness test stat.	0.3231	-1.3426	-0.6451	0.3592	0.0687	-0.0449
Kurtosis test statisti	-0.3925	0.2589	0.6913	-0.1294	-0.8741	-0.9120
Partial chi-square	0.2078	0.1267	0.0958	0.1317	0.1354	0.1788
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	13	13	13	13	13	13
Degrees of freedom	12	12	12	12	12	12
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Table 9.7.2.1b (cont): Output values for the assessment model

DISTRIBUTION STATISTICS FOR FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.0378	0.0924	0.0866	0.0535	0.1302	0.3258
Skewness test stat.	-0.3954	-1.0132	-0.9981	-1.1099	-0.6415	-1.1536
Kurtosis test statisti	-0.6822	-0.0667	-0.0005	-0.0899	-0.4233	0.0344
Partial chi-square	0.0086	0.0213	0.0204	0.0129	0.0317	0.0856
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Number of observations	6	6	6	6	6	6
Degrees of freedom	5	5	5	5	5	5
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear catchability relationship assumed

Age	0	1	2	3	4	5	6
Variance	0.0349	0.0234	0.0593	0.0918	0.0732	0.1217	0.1938
Skewness test stat.	0.9565	-1.7001	-2.1867	-1.3522	0.1292	0.3583	0.4229
Kurtosis test statisti	-0.4112	0.5850	1.3171	0.0780	-0.5258	-0.8961	-0.6946
Partial chi-square	0.0125	0.0087	0.0227	0.0365	0.0296	0.0513	0.0858
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

Table 9.7.2.1b (cont): Output values for the assessment model

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	127.2309	264	60	204	0.6237
Catches at age	8.6334	84	41	43	0.2008
SSB Indices					
INDEX1	1.0585	3	0	3	0.3528
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	62.2571	78	6	72	0.8647
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	21.7885	36	6	30	0.7263
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	33.4934	63	7	56	0.5981

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	10.6005	264	60	204	0.0520
Catches at age	6.5239	84	41	43	0.1517
SSB Indices					
INDEX1	1.0585	3	0	3	0.3528
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	1.7294	78	6	72	0.0240
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	0.6052	36	6	30	0.0202
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	0.6835	63	7	56	0.0122

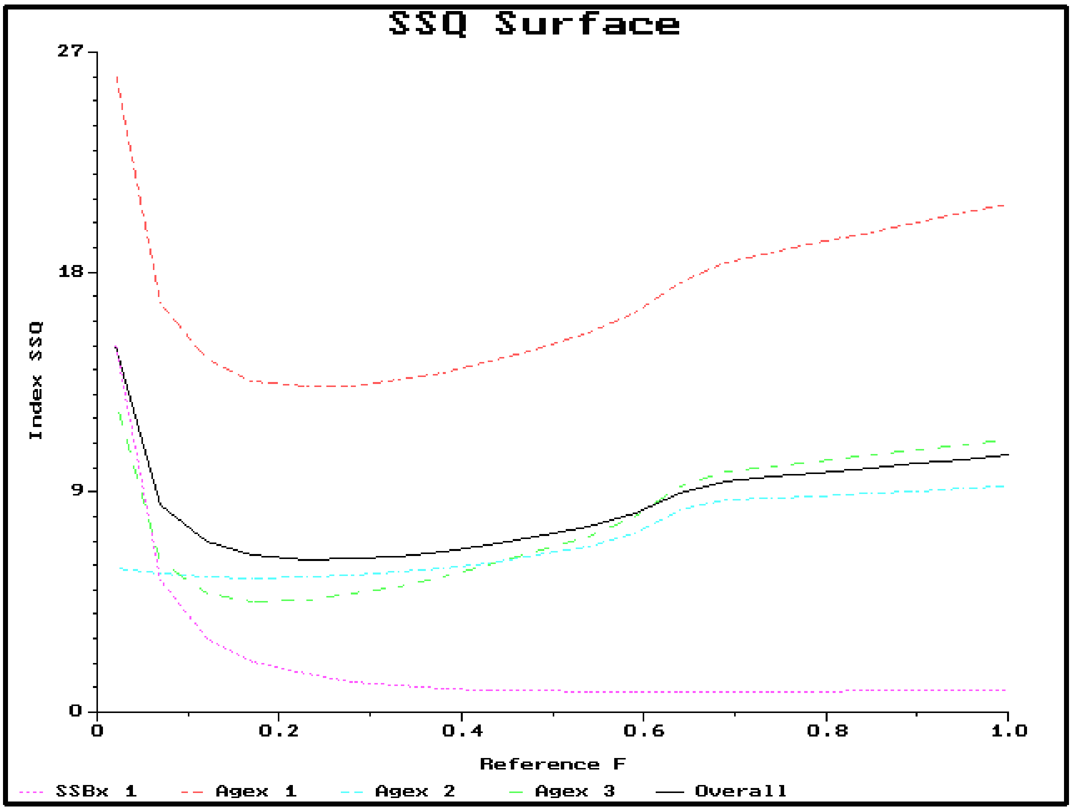
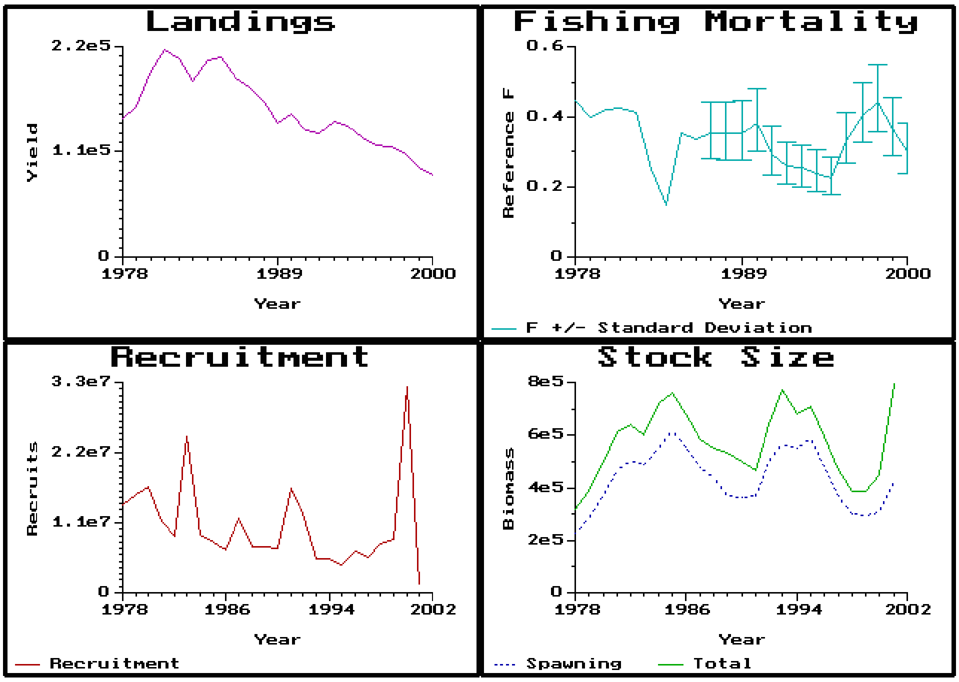


Figure 9.7.2.1 Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model. (SSBx1 is DEPM –absolute estimator-; Agex 1 is the Spanish Spring Acoustic survey time series –linear estimator-; Agex 2 is the Portuguese Spring Acoustic survey time series –linear estimator-; Agex 3 is the Portuguese Fall Acoustic survey time series –linear estimator-)

Stock Summary



Separable Model Diagnostics

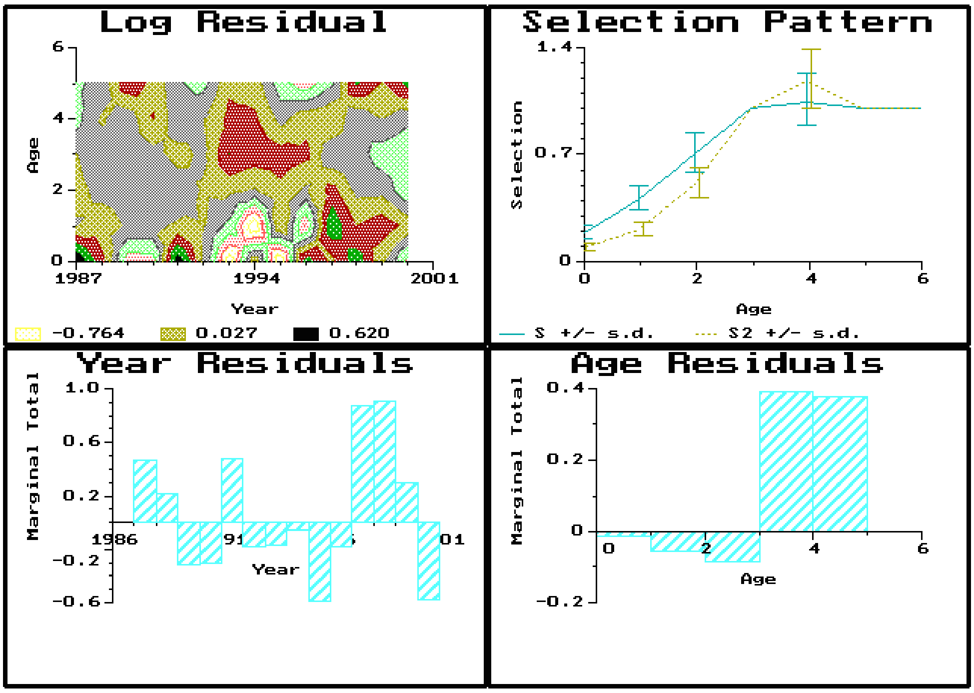


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

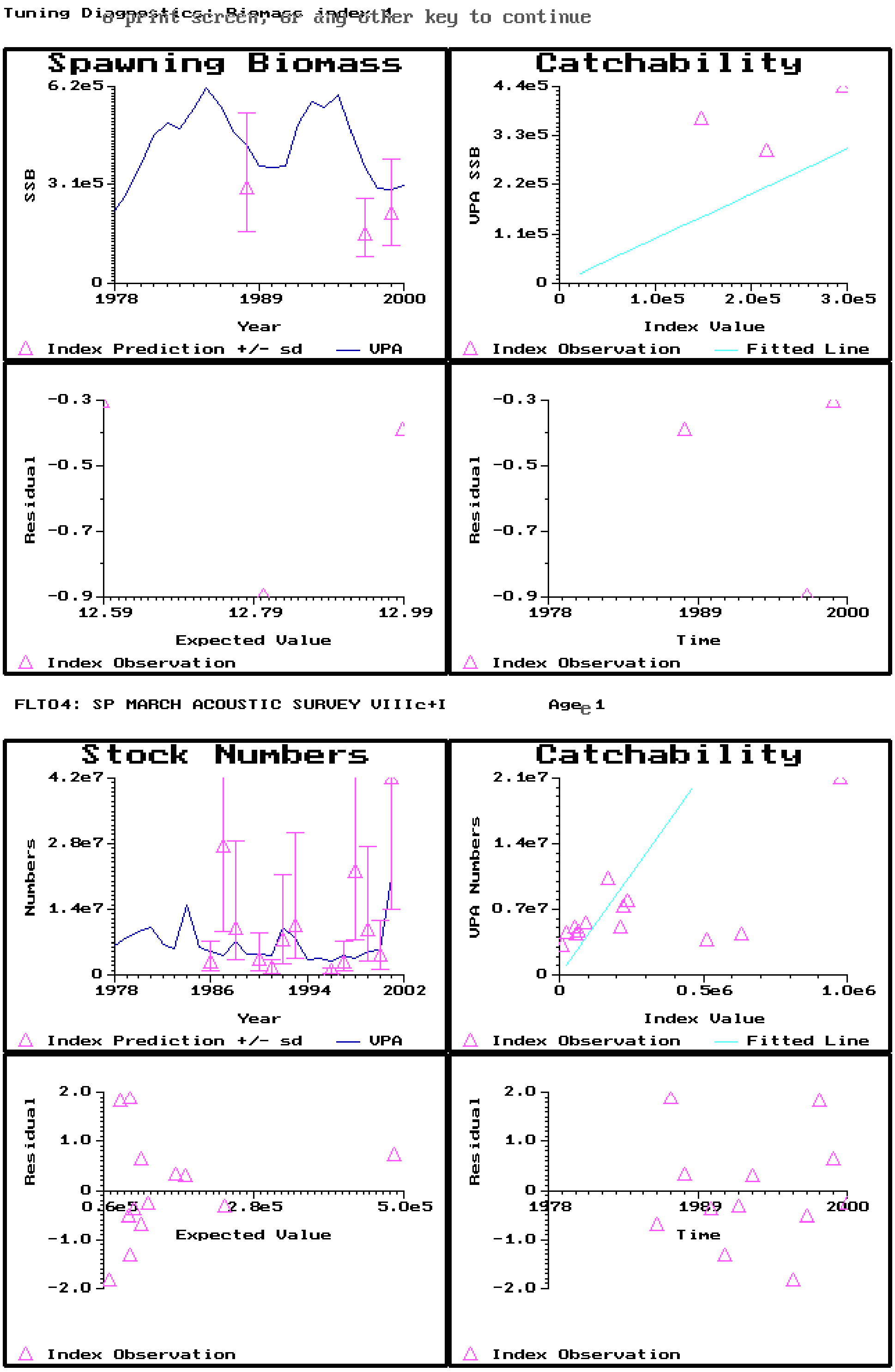


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

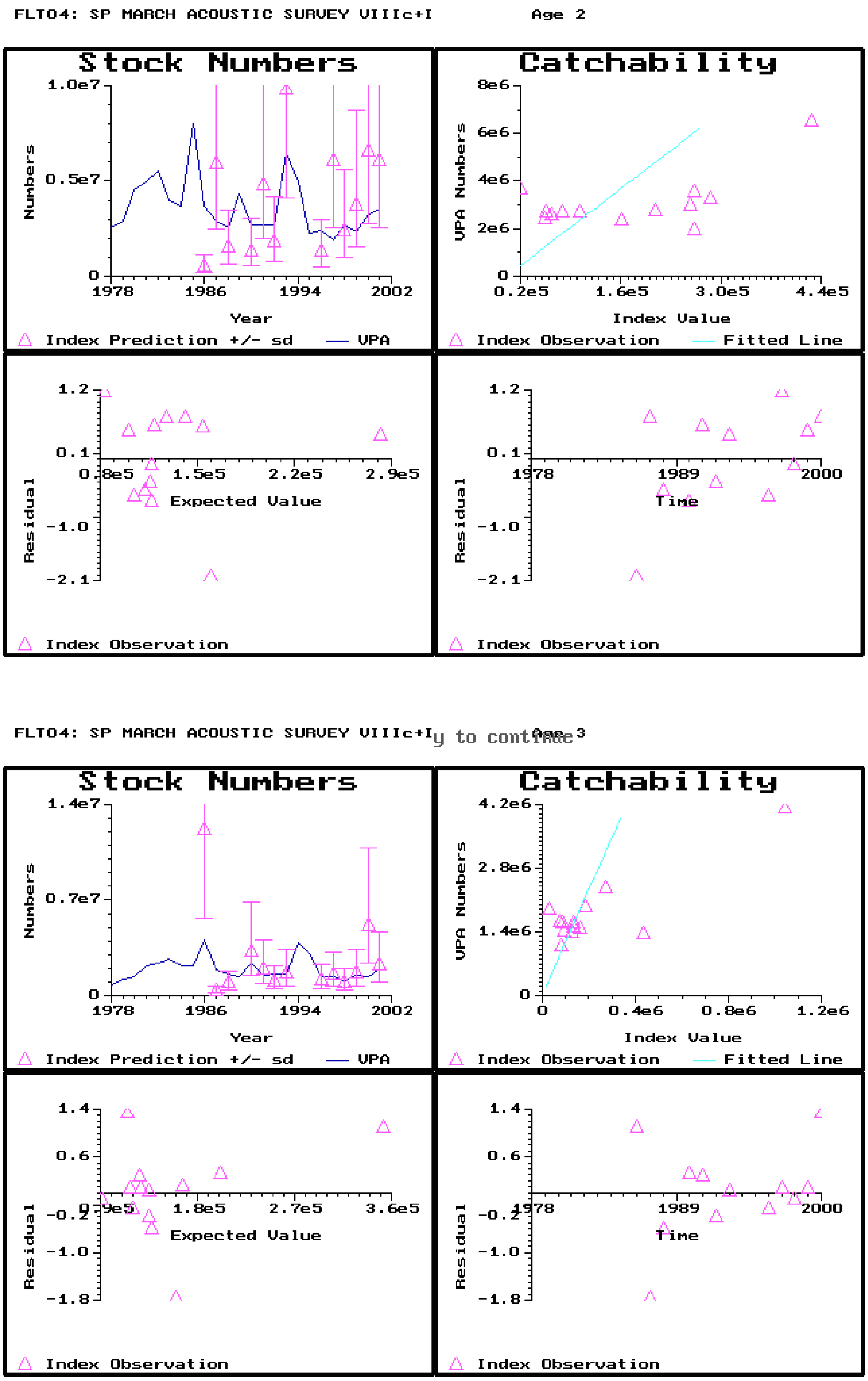
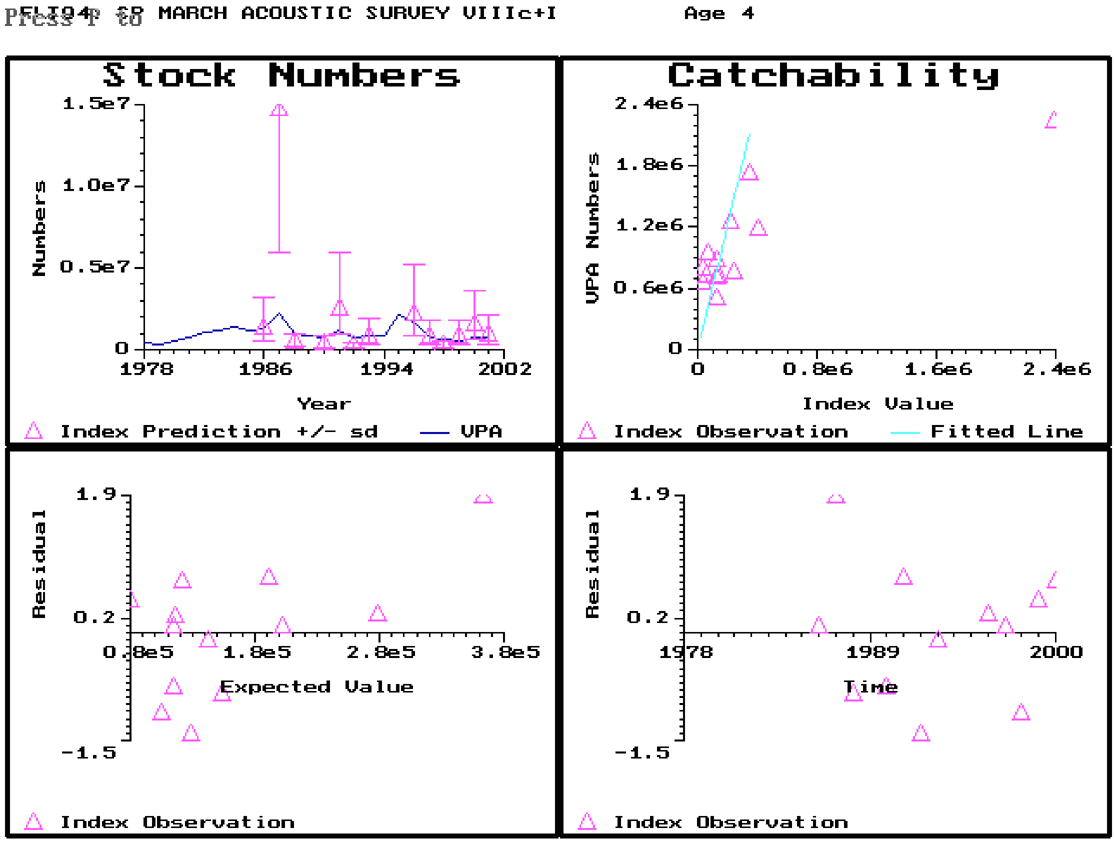


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



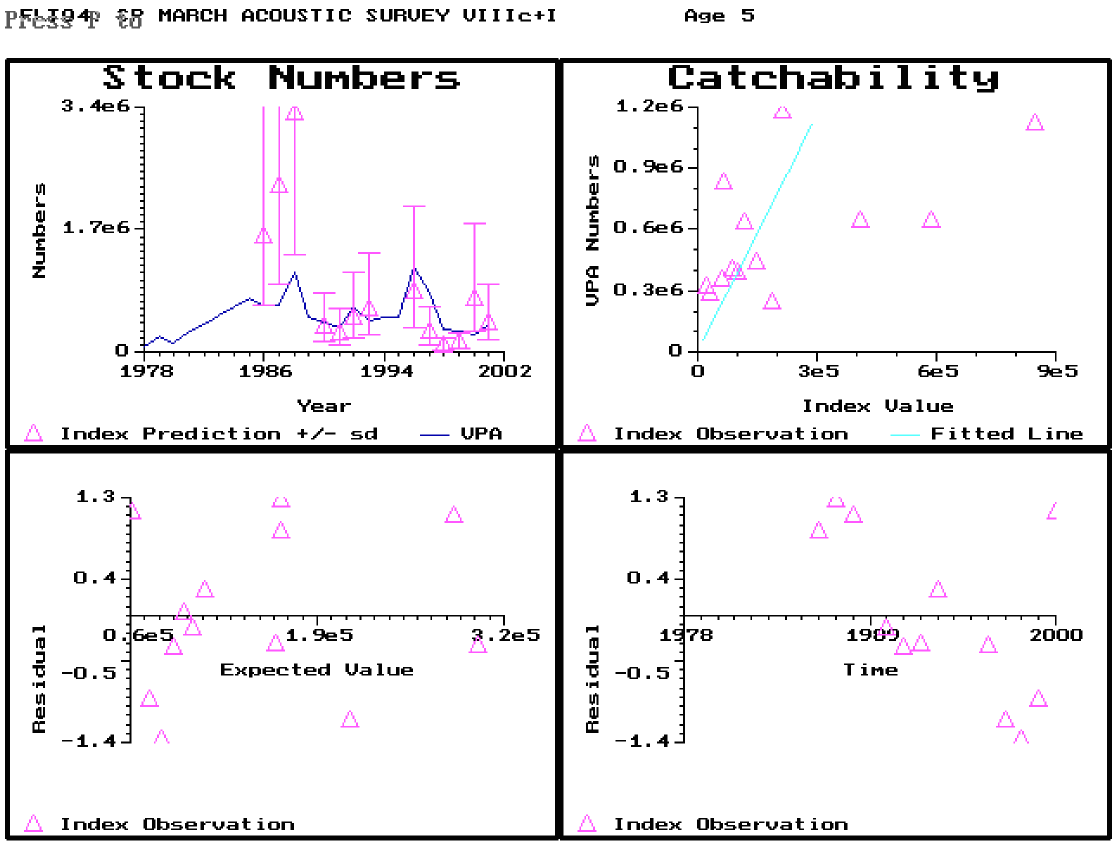
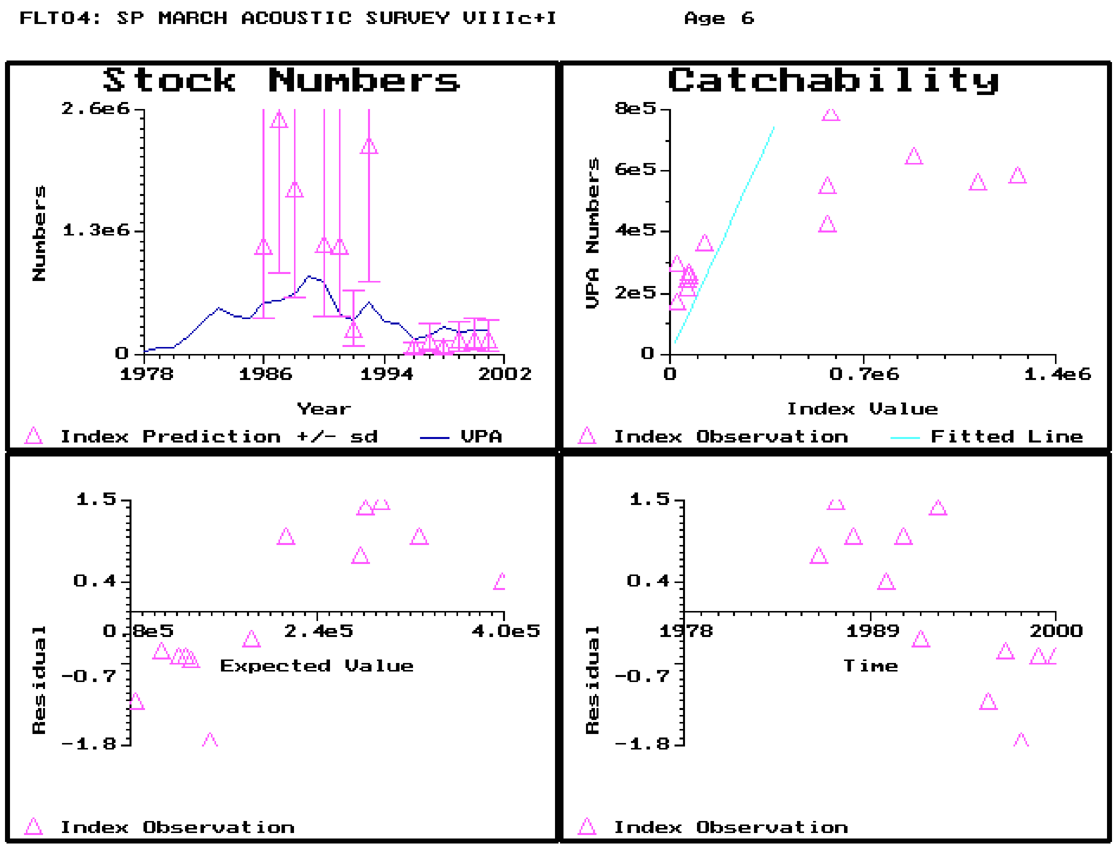


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



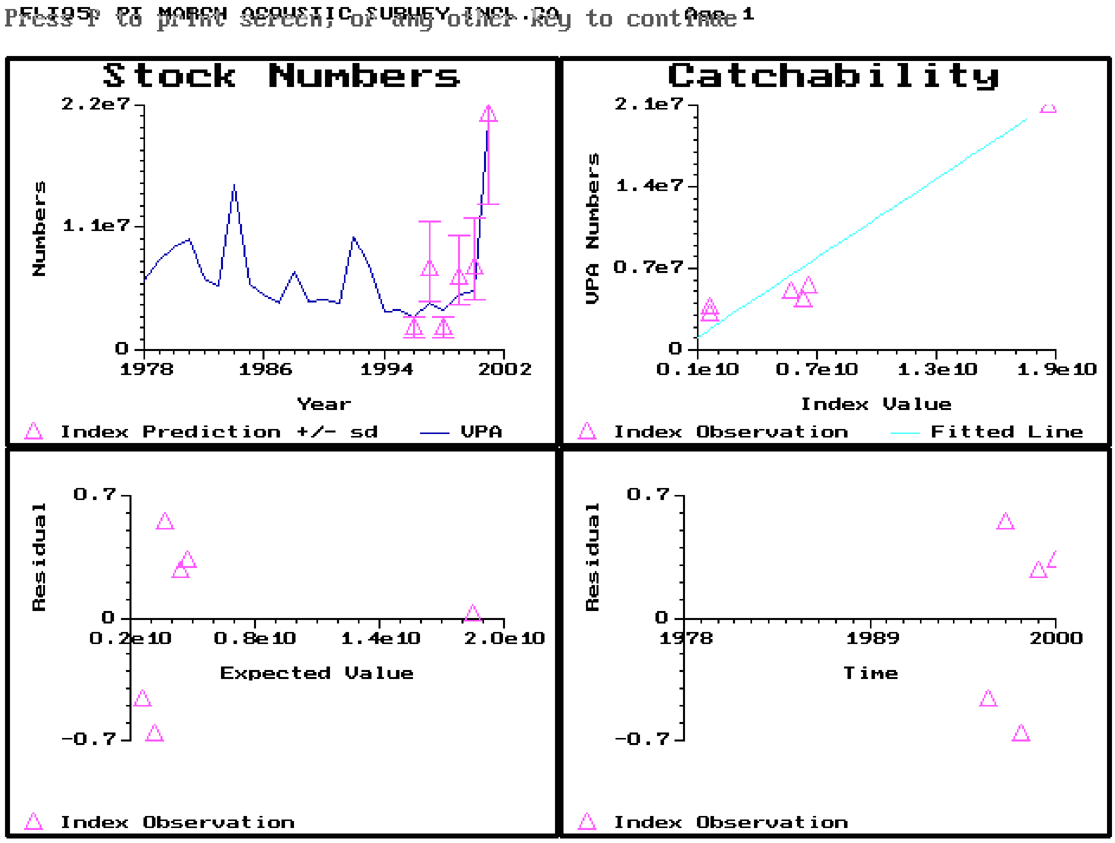
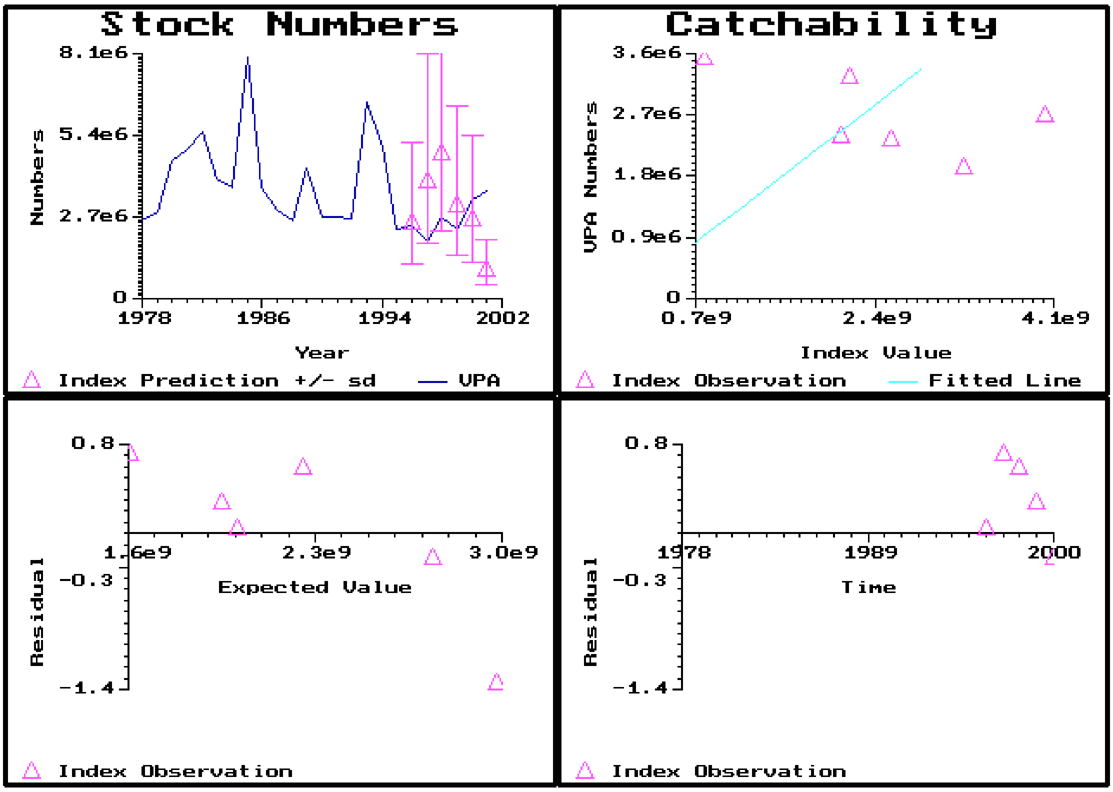


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 2



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FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 3

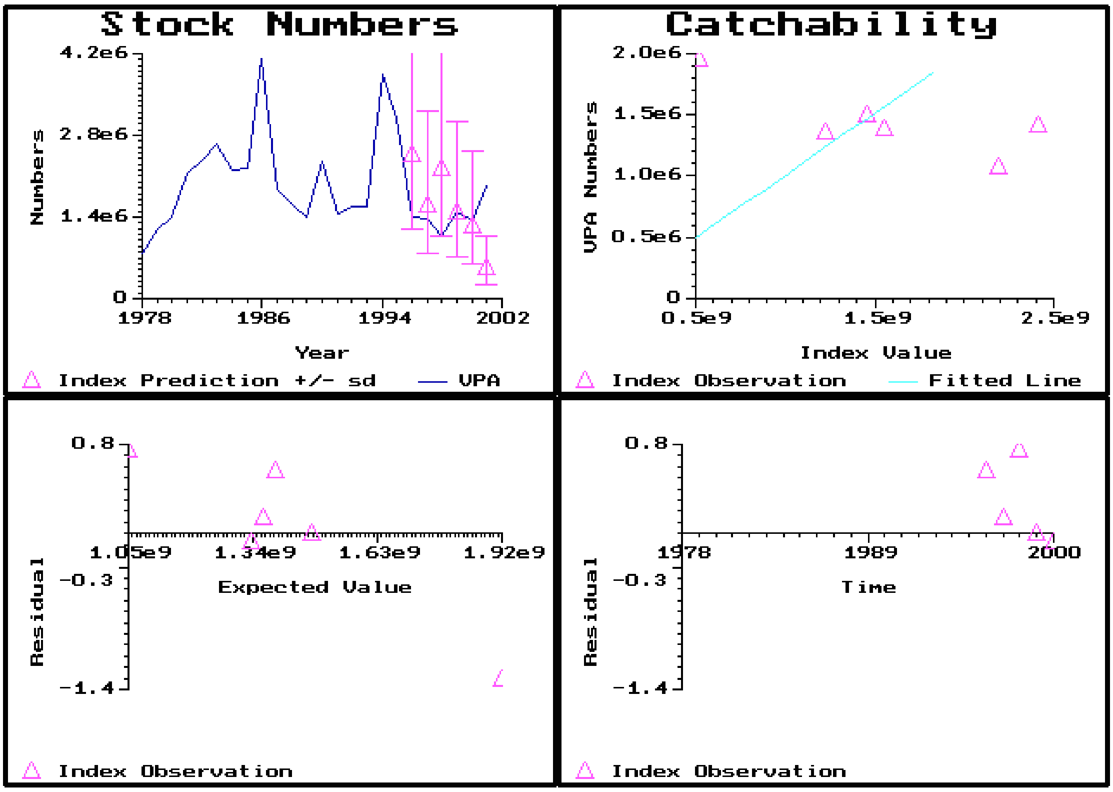
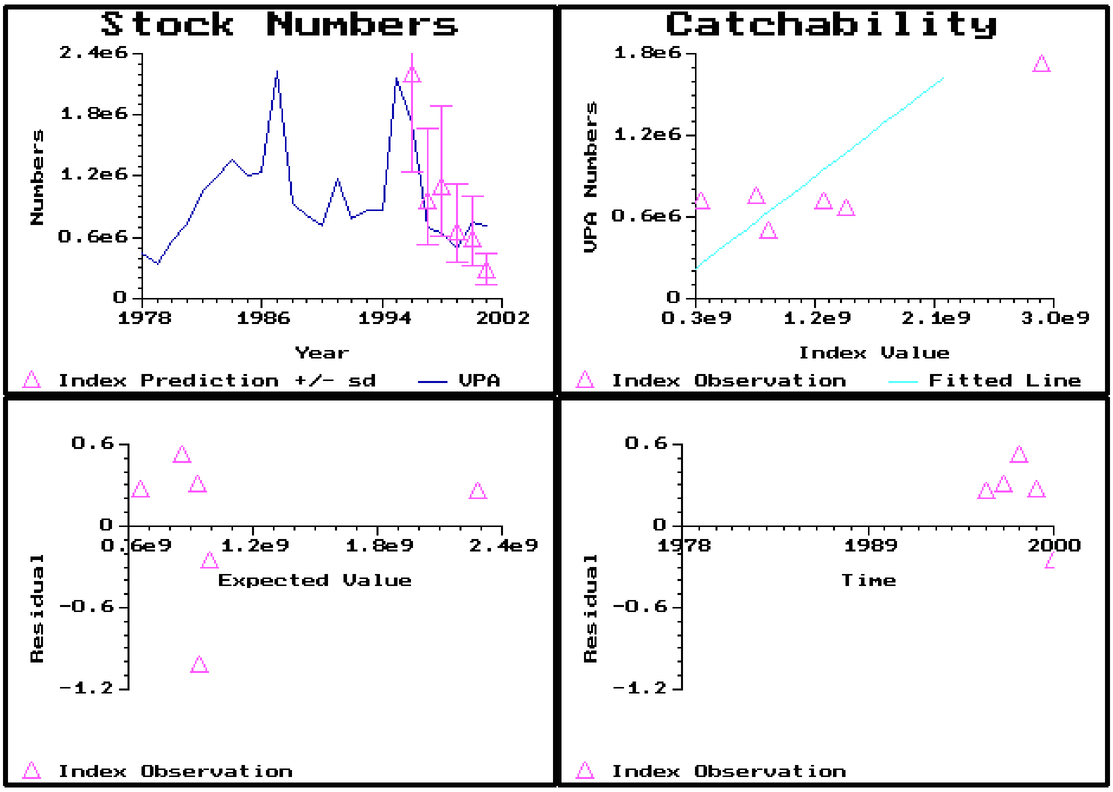


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 4

Press P to print screen, or any other key to continue



FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 5

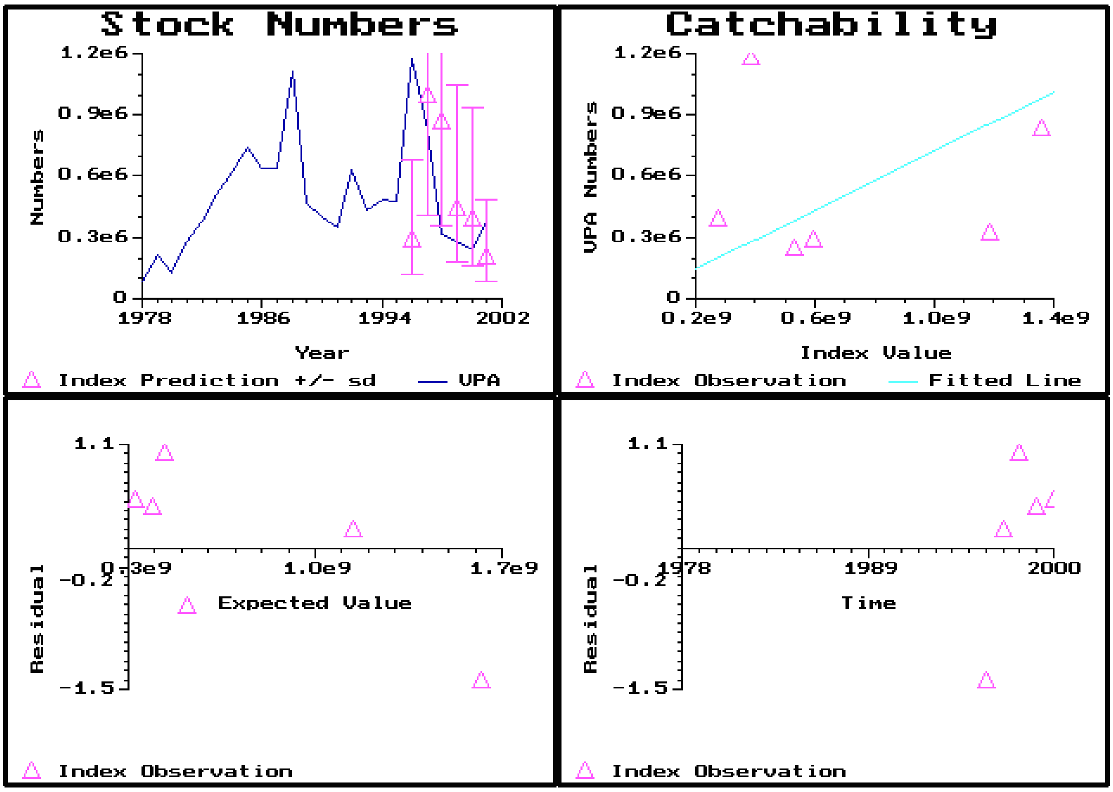
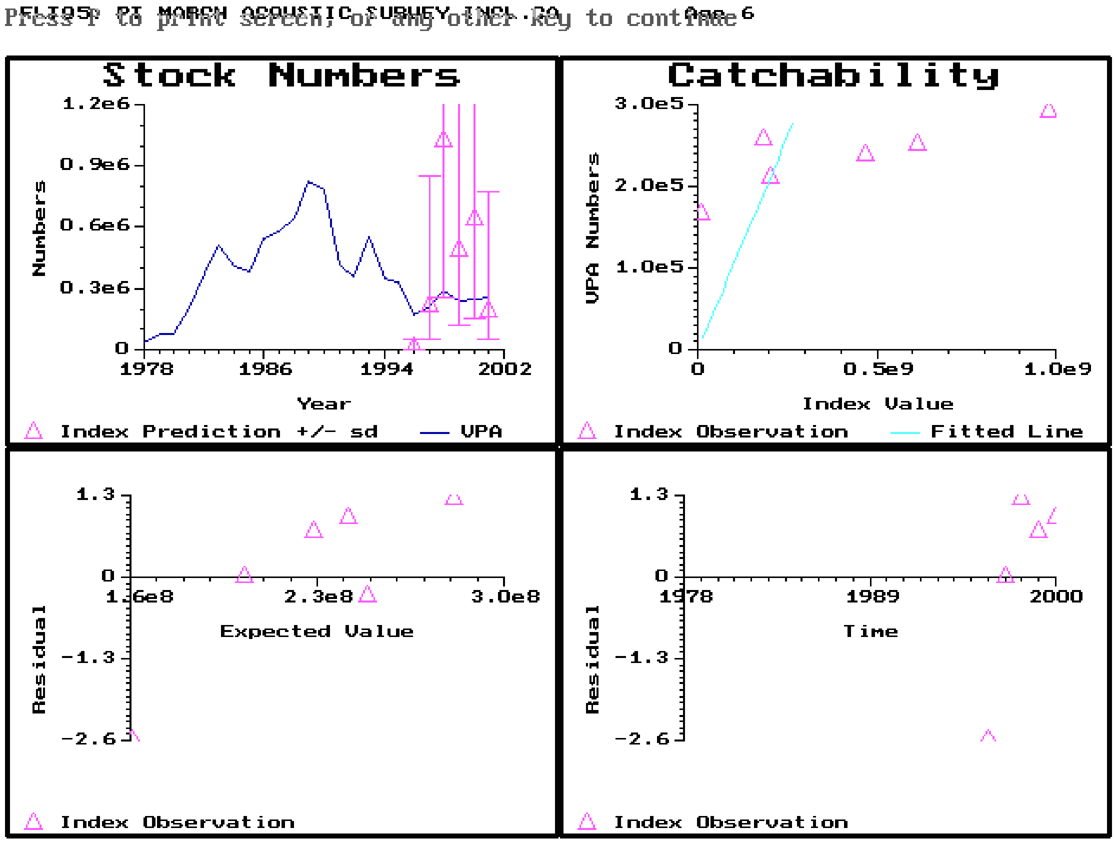


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



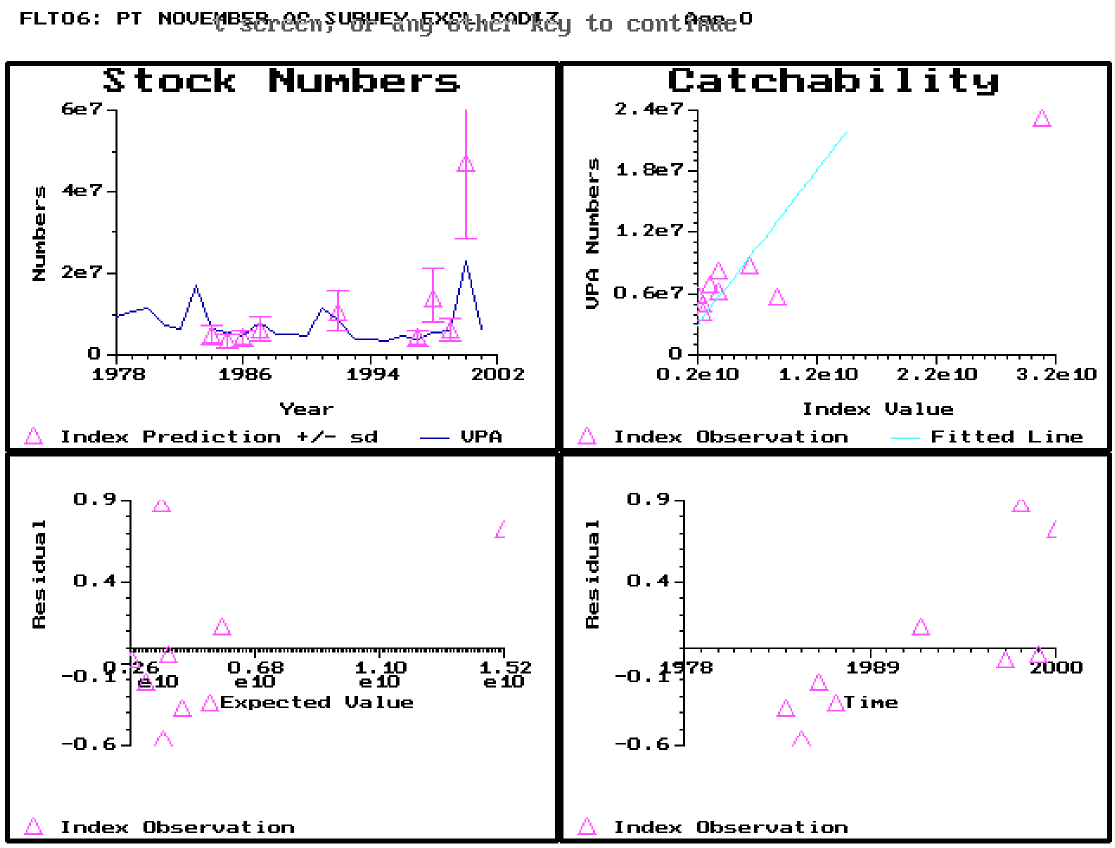


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 1

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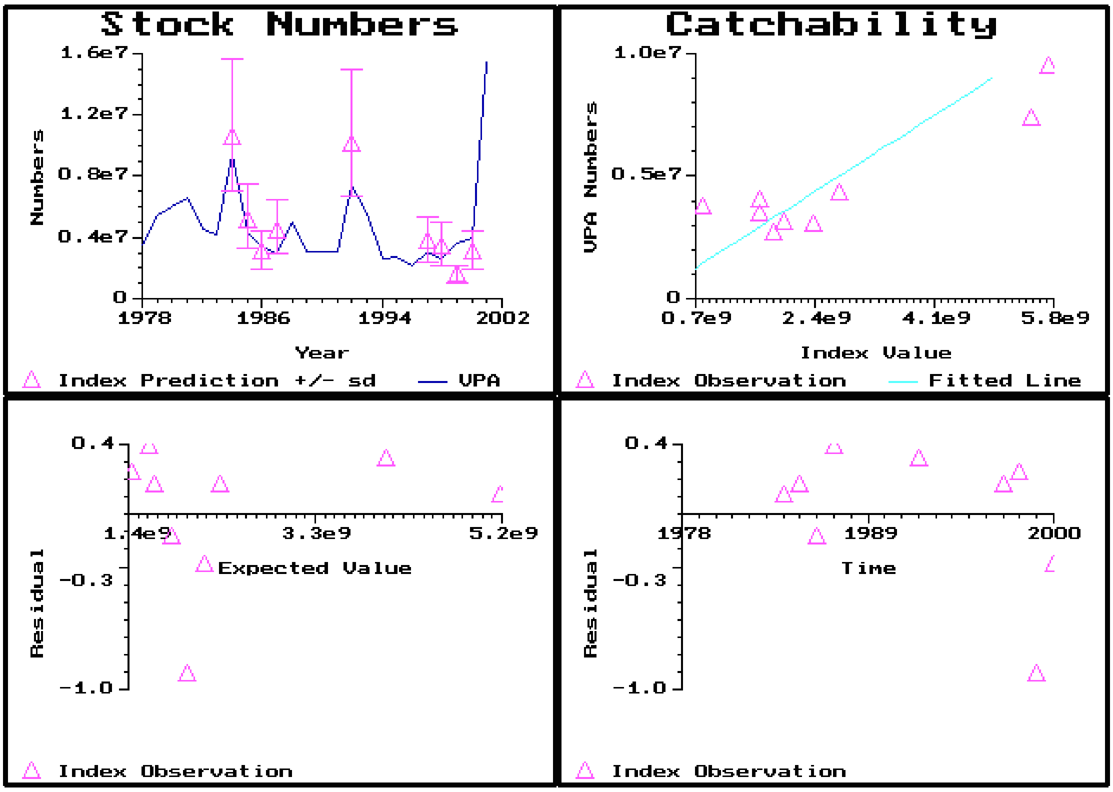


FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 2

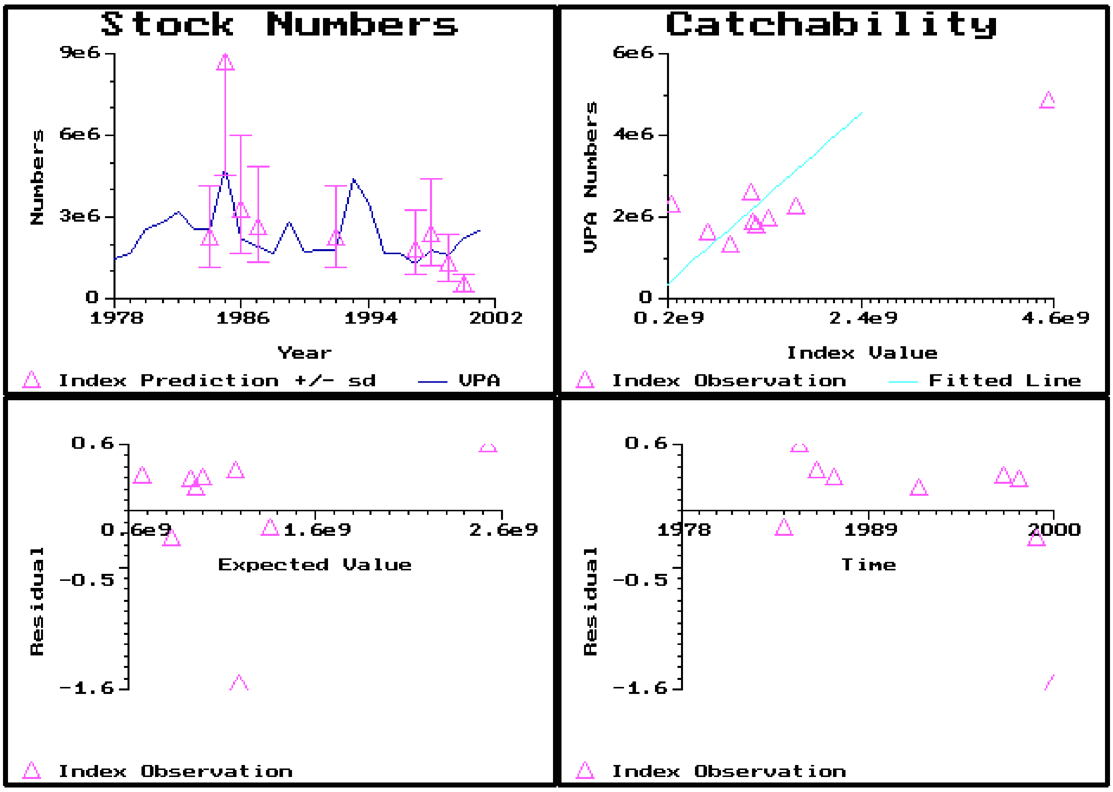


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

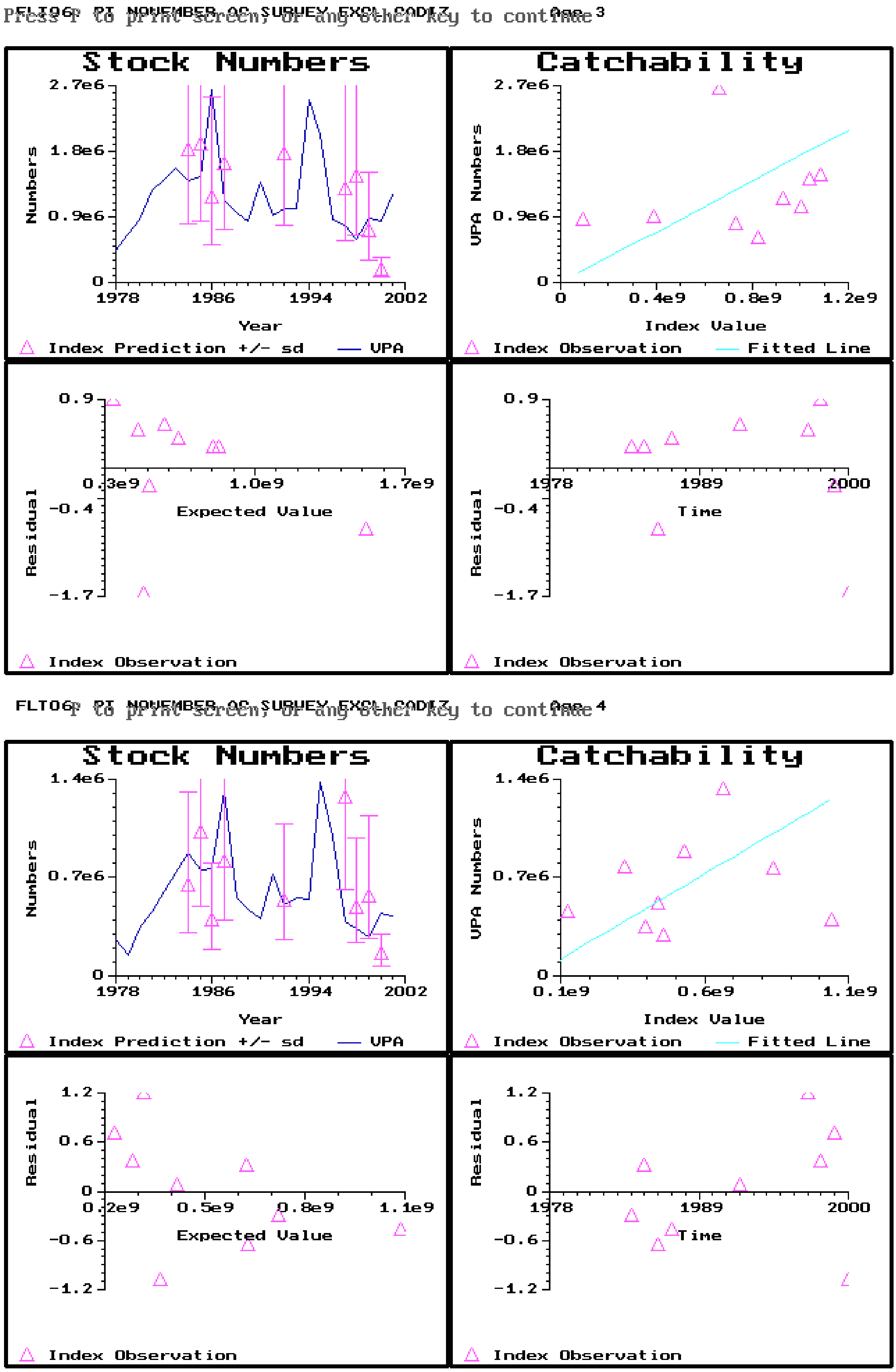
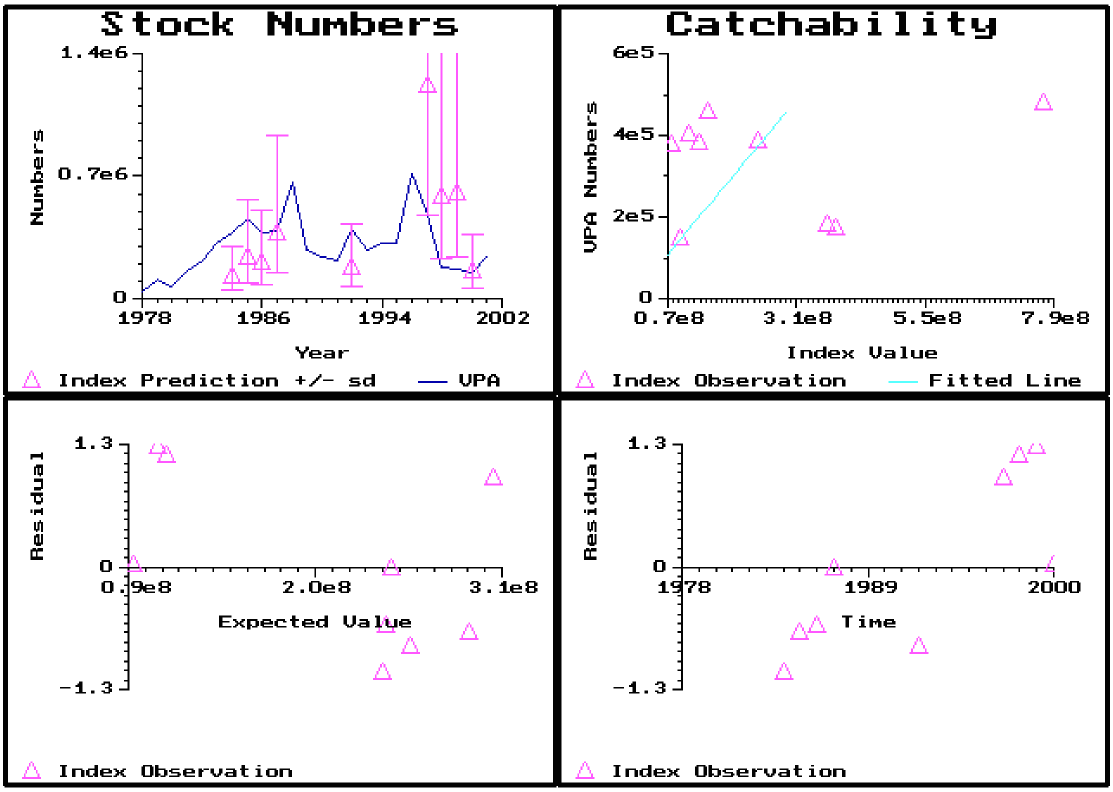


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT06: PT NOVEMBER AC SURVEY EXCL CADIZ Age 5

Press P to print screen, or any other key to continue



FLT06: PT NOVEMBER AC SURVEY EXCL CADIZ Age 6

Press P to print screen, or any other key to continue

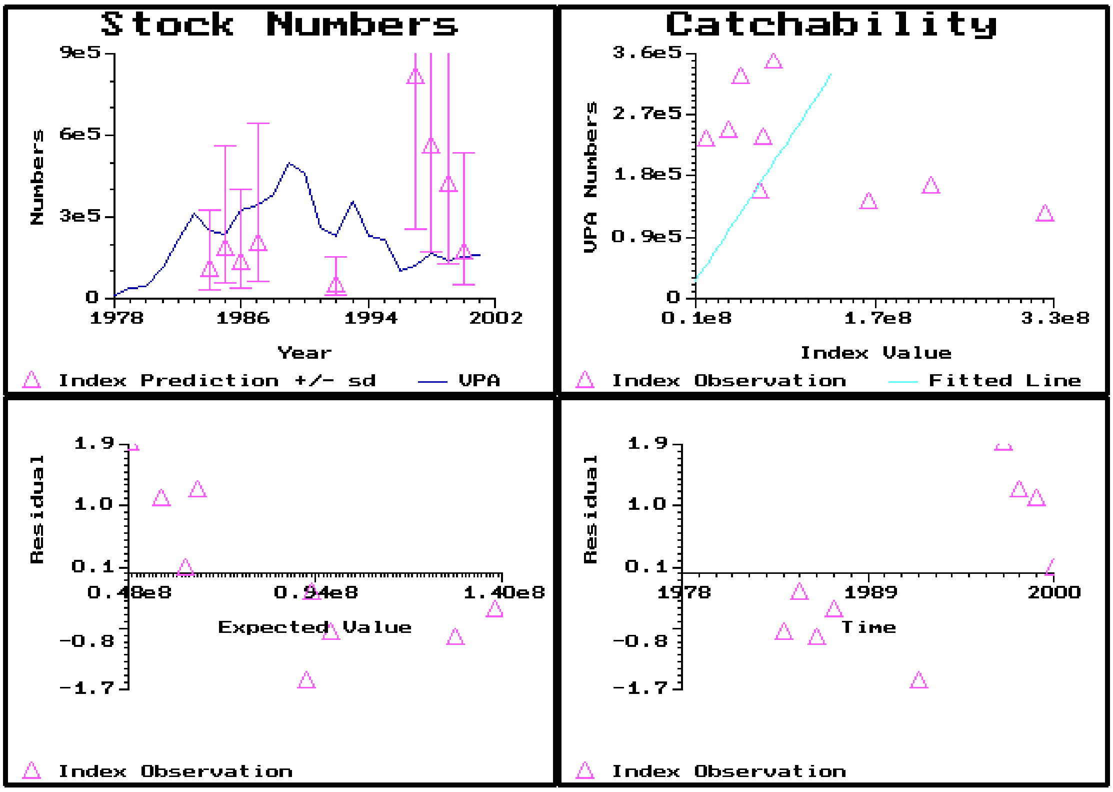


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

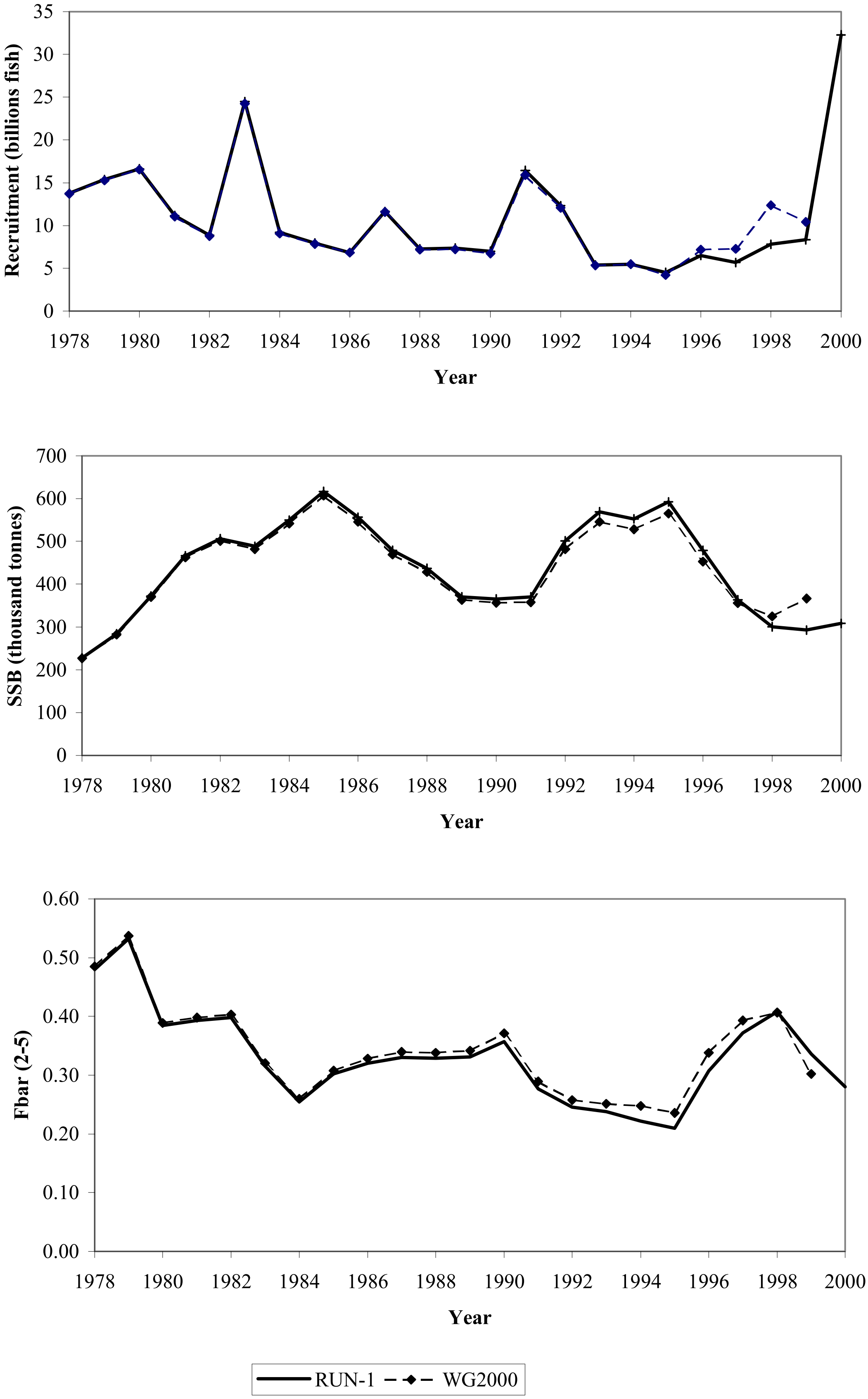


Figure 9.7.2.2: Recruitment, SSB and Fbar(2-5) trajectories for sardine as estimated by the assessment model accepted this year (RUN-1) and last year (WG2000).

9.8 Catch predictions

9.8.1 Divisions VIIIc and IXa combined

The WG discussed the value of recruitment that should be used for short term catch predictions since little confidence can be attached to the large 2000 recruitment estimated by the assessment model (1.3 times larger than the maximum of the series, with a 41% CV). Acoustic surveys indicate an exceptional 2000 year class (also predicted by the recruitment model including environmental effects proposed by Porteiro *et al.*, WD 2001), occuring at a low stock level and restricted to a small part of the stock distribution area. Indications of strong year classes in the recent history of the stock were later shown to be over-optimistic when more data was available. The SSB is considered to be at a low level and this was corroborated by the decrease in the abundance of adult fish off the western Iberian coast.

Last year, a "low level" recruitment corresponding to a geometric mean of the six previous recruitment estimates was used in short term predictions. The WG decided to explore the results of assuming an "average level" recruitment in view of the signals of a good 2000 year class. To evaluate the risk of predicting with average recruitment if a low recruitment is actually observed, a forecast was made considering a catch constraint equal to the catch predicted with the "average level" recruitment.

The scenarios explored were:

- "average level" recruitment, fixed at 9082 million fish, corresponding to the geometric mean of the period 1978-1999. This value is lower than the two highest recruitments estimated during the nineties (1991 and 1992 year classes).

- A catch constraint of 105 thousand tonnes, corresponding to the 2001 catch predicted in the first scenario, in a prediction with a "low level" recruitment, fixed at 6252 million fish (the geometric mean of the period 1994-1999). This value is lower than the recruitment estimated for 1998 and 1999.

For each scenario, weights at age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (1998-2000). The maturity ogive and the exploitation pattern corresponded to the 2000 values. 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. The number of fish at age 1 in the beginning of 2001 resulted from the projection of the 2000 recruitment assumed in each scenario and the numbers for ages 2-6+ were based on the population estimated by the assessment model.

Input values and results for the first scenario are shown in Tables 9.8.1.1 and 9.8.1.2. At F_{sq} equal to $F_{(2-5)} = 0.2799$, predicted yield in 2001 is 105 002 tonnes and SSB would increase by 26% in 2002. For 2002 catches of 118 391 tonnes are expected while the SSB would increase by 37% in 2003 comparatively to that estimated in 2000.

Tables 9.8.1.3 and 9.8.1.4 show the input values and the results for the second scenario. A 7% increase in fishing mortality is expected under this scenario for 2001. At $F_{sq} = F_{(2-5)} = 0.2799$, in 2002 landings will be 118 391 tonnes and the SSB in 2003 will only increase 7% with respect to that estimated in 2000. However, the SSB estimated for 2003 is lower than that estimated for 2002.

Considering the results of these analyses, the WG decided to adopt the lowest possible risk in order to prevent further decline in SSB in short term. The recruitment calculated as the geometric mean of the period 1994-1999 is considered to be a conservative option for the recruitment of this species taking into account the stock trajectory in the last decade. Results for this forecast are shown in Table 9.8.1.6. Predictions indicate about 16% increase in the catches and 10% increase in the SSB in 2001 at F_{sq}. However, keeping the fishing mortality will result in a decreasing trend in the SSB during the rest of the period. On account of the management measures adopted by both Spain and Portugal, catches for the next years would be close to the yield achieved in 1999 and 2000 and should be considered as a plausible harvest target. A reduction of 20% of current fishing mortality to F=0.22 provides an increase in SSB until 2003 while maintaining the catch level (around 85 000 tonnes). The predicted SSB value for 2003 is comparable to the SSB level observed in 89-91.

9.8.2 Catch predictions by area for Divisions VIIIc and IXa

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. Partial exploitation patterns for each area were calculated by splitting the exploitation pattern for the total area in 2000 according to the proportion of catches in each area. Input values for the mean weight at age in the catch by sub-division was taken as the average of 1998–2000.

Catch forecasts for each Division are shown in Table 9.8.2.2. Considering a fishing mortality equal to F_{sq} ($F_{sq}=F_{(2-5)}=0.2799$), SSB will decrease in 2003 and predicted catches will be higher than the yields attained since the national management measures were implemented. Considering F_{sq} for 2001 and F=0.8 Fsq in 2002, catches are expected to remain in both areas in 2001 and 2002 at the same level of that achieved in 2000 and SSB shows an increasing trend until 2003.

Catch predictions by area were calculated on the basis of the estimated parameters in the assessment model for 2000 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 and stable partial fishing mortality levels. Partial Fs for each area were calculated, using the average ratio of the fleets catch at age and the total catch at each age for the years 1998–2000. There is no scientific evidence to forecast catches according to ICES Divisions, and this was corroborated by the distribution of the 2000 cohort, mainly recruited in IXa-CN and spread later in the northern Iberian coast (Sub-division VIIIc-W). This split by area should only be regarded as an example, because the split could also be based on other criteria**.** If necessary, advice on other criteria on how to split the catches between "Northern" and "Southern" areas should become available from the management bodies outside ICES.

Table 9.8.1.1: Input table for short term deterministic projections

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	6349000	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3914900	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213100	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817330	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432840	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294900	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.2: Sardine management option table assuming a fixed recruitment at 9082 million f

2001				
Biomass	SSB	FMult	FBar	Landings
519531	348755	1	0.2799	105002

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
575589	406233	0.5	0.1399	62496	657496	475188
.	405011	0.55	0.1539	68367	652546	469612
.	403793	0.6	0.1679	74174	647654	464121
.	402578	0.65	0.1819	79916	642821	458715
.	401369	0.7	0.1959	85595	638044	453391
.	400163	0.75	0.2099	91212	633324	448148
.	398961	0.8	0.2239	96768	628658	442985
.	397764	0.85	0.2379	102262	624048	437900
.	396571	0.9	0.2519	107697	619491	432892
.	395382	0.95	0.2659	113073	614987	427961
.	394197	1	0.2799	118391	610536	423103
.	393016	1.05	0.2938	123651	606136	418318
.	391839	1.1	0.3078	128854	601787	413606
.	390666	1.15	0.3218	134002	597488	408963
.	389497	1.2	0.3358	139094	593239	404391
.	388333	1.25	0.3498	144133	589038	399886
.	387172	1.3	0.3638	149117	584885	395448
.	386015	1.35	0.3778	154049	580780	391076
.	384862	1.4	0.3918	158928	576722	386769
.	383714	1.45	0.4058	163756	572709	382526
.	382569	1.5	0.4198	168533	568742	378345

Input units are thousands and kg - output in tonnes

Table 9.8.1.3: Input table for short term deterministic projections with a fixed recruitment of 6252 million fish and a catch of 105 000 tonnes in 2001.

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	4370730	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3914900	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213100	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817330	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432840	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294900	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.4: Sardine management option table assuming a fixed recruitment of 6252 million f
a catch constraint of 105 000 tonnes in 2001.

2001				
Biomass	SSB	FMult	FBar	Landings
479965	338219	1.0652	0.2981	105000

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
476455	347943	0.5	0.1399	54236	508126	374960
.	346830	0.55	0.1539	59309	503839	370169
.	345721	0.6	0.1679	64322	499607	365456
.	344615	0.65	0.1819	69275	495429	360820
.	343514	0.7	0.1959	74171	491303	356258
.	342417	0.75	0.2099	79008	487229	351770
.	341324	0.8	0.2239	83789	483206	347355
.	340235	0.85	0.2379	88514	479234	343010
.	339149	0.9	0.2519	93184	475311	338735
.	338068	0.95	0.2659	97799	471437	334529
.	336990	1	0.2799	102360	467612	330390
.	335916	1.05	0.2938	106869	463834	326318
.	334846	1.1	0.3078	111325	460103	322310
.	333780	1.15	0.3218	115730	456418	318366
.	332718	1.2	0.3358	120084	452778	314485
.	331659	1.25	0.3498	124389	449184	310665
.	330604	1.3	0.3638	128644	445633	306905
.	329553	1.35	0.3778	132850	442127	303205
.	328506	1.4	0.3918	137008	438663	299563
.	327463	1.45	0.4058	141119	435242	295979
.	326423	1.5	0.4198	145184	431862	292450

Input units are thousands and kg - output in tonnes

Table 9.8.1.5: Input table for short term deterministic projections with a fixed recruitment of 6252 million fish

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	4370730	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3915010	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213192	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817293	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432938	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294544	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.6: Sardine management option table assuming a fixed recruitment at 6252 million f

2001				
Biomass	SSB	FMult	FBar	Landings
479943	339519	1	0.2799	99262

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
481270	351940	0.5	0.1399	54865	511709	378055
.	350812	0.55	0.1539	59996	507372	373208
.	349688	0.6	0.1679	65067	503091	368441
.	348568	0.65	0.1819	70077	498863	363751
.	347452	0.7	0.1959	75028	494689	359137
.	346340	0.75	0.2099	79920	490568	354597
.	345232	0.8	0.2239	84755	486498	350131
.	344128	0.85	0.2379	89533	482480	345737
.	343028	0.9	0.2519	94255	478512	341414
.	341931	0.95	0.2659	98922	474593	337160
.	340839	1	0.2799	103535	470724	332975
.	339751	1.05	0.2938	108093	466902	328856
.	338667	1.1	0.3078	112599	463129	324803
.	337586	1.15	0.3218	117053	459402	320815
.	336509	1.2	0.3358	121456	455721	316890
.	335437	1.25	0.3498	125807	452086	313028
.	334368	1.3	0.3638	130109	448496	309227
.	333302	1.35	0.3778	134361	444949	305486
.	332241	1.4	0.3918	138565	441447	301804
.	331184	1.45	0.4058	142721	437987	298180
.	330130	1.5	0.4198	146830	434569	294613

Input units are thousands and kg - output in tonnes

Table 9.8.2.1: Input values for sardine two area management option table

	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 the stock
0	0.0002	0.029	0.028	0.025	6252.3	0.33	0.00	0.25	0.25	0.000
1	0.0020	0.059	0.061	0.038	4370.7	0.33	0.26	0.25	0.25	0.020
2	0.0176	0.074	0.137	0.054	3915.0	0.33	0.91	0.25	0.25	0.041
3	0.0439	0.081	0.260	0.061	2213.2	0.33	0.95	0.25	0.25	0.055
4	0.0632	0.086	0.294	0.065	817.3	0.33	0.95	0.25	0.25	0.062
5	0.0547	0.092	0.249	0.068	432.9	0.33	1.00	0.25	0.25	0.067
6+	0.0467	0.100	0.257	0.100	294.5	0.33	1.00	0.25	0.25	0.100
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 9.8.2.2 IBERIAN SARDINE Two area management option table.

Spreadsheet version **Fsq=0.2799 in 2001-2002**

		YEAR 2001										
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass
1	0.280	0.045	199.762	16.170	0.235	1528.240	83.412	0.280	1728.003	99.582	7237.717	339.424
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

		YEAR 2002											2003	
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time		Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
0.00	0.000	0.000	-	-	0.000	-	-	0.000	-	-	7370	363	8367.567	431.052
0.05	0.014	0.002	11.942	0.983	0.012	85.521	4.824	0.014	97.463	5.807	7349.092	362.153	8274.579	425.334
0.10	0.028	0.004	23.726	1.952	0.024	170.130	9.591	0.028	193.856	11.543	7328.245	360.989	8183.025	419.710
0.15	0.042	0.007	35.355	2.908	0.035	253.841	14.301	0.042	289.195	17.209	7307.468	359.828	8092.879	414.179
0.20	0.056	0.009	46.830	3.852	0.047	336.665	18.955	0.056	383.495	22.807	7286.762	358.671	8004.117	408.739
0.25	0.070	0.011	58.155	4.782	0.059	418.615	23.555	0.070	476.770	28.337	7266.126	357.519	7916.714	403.389
0.30	0.084	0.013	69.331	5.700	0.071	499.702	28.100	0.084	569.033	33.800	7245.559	356.371	7830.645	398.127
0.35	0.098	0.016	80.360	6.606	0.082	579.940	32.592	0.098	660.299	39.198	7225.063	355.227	7745.888	392.952
0.40	0.112	0.018	91.245	7.500	0.094	659.338	37.031	0.112	750.583	44.531	7204.636	354.087	7662.418	387.862
0.45	0.126	0.020	101.987	8.382	0.106	737.909	41.418	0.126	839.896	49.800	7184.278	352.951	7580.214	382.854
0.50	0.140	0.022	112.590	9.252	0.118	815.664	45.755	0.140	928.254	55.006	7163.989	351.819	7499.253	377.929
0.55	0.154	0.025	123.054	10.110	0.129	892.615	50.040	0.154	1015.668	60.150	7143.769	350.691	7419.513	373.084
0.60	0.168	0.027	133.381	10.957	0.141	968.771	54.276	0.168	1102.152	65.233	7123.617	349.567	7340.973	368.318
0.65	0.182	0.029	143.575	11.793	0.153	1044.144	58.463	0.182	1187.719	70.256	7103.533	348.448	7263.611	363.629
0.70	0.196	0.031	153.637	12.617	0.165	1118.745	62.602	0.196	1272.381	75.219	7083.517	347.332	7187.407	359.017
0.75	0.210	0.034	163.568	13.431	0.176	1192.583	66.693	0.210	1356.151	80.123	7063.569	346.221	7112.341	354.479
0.80	0.224	0.036	173.371	14.234	0.188	1265.670	70.737	0.224	1439.041	84.970	7043.688	345.113	7038.393	350.014
0.85	0.238	0.038	183.047	15.026	0.200	1338.016	74.734	0.238	1521.063	89.760	7023.874	344.009	6965.543	345.622
0.90	0.252	0.040	192.598	15.808	0.212	1409.630	78.686	0.252	1602.228	94.493	7004.128	342.909	6893.772	341.300
0.95	0.266	0.043	202.027	16.579	0.223	1480.522	82.593	0.266	1682.549	99.172	6984.447	341.814	6823.061	337.047
1.00	0.280	0.045	211.334	17.340	0.235	1550.702	86.455	0.280	1762.037	103.795	6964.834	340.722	6753.392	332.863
1.05	0.294	0.047	220.523	18.091	0.247	1620.180	90.274	0.294	1840.703	108.365	6945.286	339.634	6684.747	328.746
1.10	0.308	0.049	229.593	18.833	0.259	1688.965	94.049	0.308	1918.558	112.882	6925.804	338.550	6617.107	324.694
1.15	0.322	0.052	238.548	19.565	0.270	1757.067	97.782	0.322	1995.614	117.346	6906.389	337.470	6550.456	320.708
1.20	0.336	0.054	247.388	20.287	0.282	1824.493	101.472	0.336	2071.881	121.759	6887.038	336.393	6484.777	316.784
1.25	0.350	0.056	256.115	20.999	0.294	1891.255	105.121	0.350	2147.370	126.121	6867.753	335.321	6420.052	312.923
1.30	0.364	0.058	264.732	21.703	0.306	1957.360	108.730	0.364	2222.092	130.432	6848.532	334.252	6356.265	309.123
1.35	0.378	0.061	273.239	22.397	0.317	2022.817	112.298	0.378	2296.056	134.695	6829.377	333.188	6293.400	305.383
1.40	0.392	0.063	281.639	23.082	0.329	2087.634	115.826	0.392	2369.273	138.908	6810.285	332.127	6231.442	301.702
1.45	0.406	0.065	289.932	23.758	0.341	2151.822	119.315	0.406	2441.753	143.074	6791.258	331.069	6170.373	298.080
1.50	0.420	0.067	298.120	24.426	0.353	2215.386	122.766	0.420	2513.507	147.192	6772.295	330.016	6110.180	294.514
1.55	0.434	0.070	306.205	25.084	0.364	2278.337	126.178	0.434	2584.542	151.263	6753.396	328.966	6050.847	291.004
1.60	0.448	0.072	314.189	25.735	0.376	2340.682	129.553	0.448	2654.870	155.288	6734.560	327.921	5992.360	287.549
1.65	0.462	0.074	322.072	26.377	0.388	2402.428	132.891	0.462	2724.500	159.267	6715.788	326.879	5934.703	284.148
1.70	0.476	0.076	329.856	27.010	0.400	2463.585	136.192	0.476	2793.441	163.202	6697.079	325.840	5877.864	280.799
1.75	0.490	0.078	337.543	27.636	0.411	2524.159	139.457	0.490	2861.702	167.093	6678.432	324.805	5821.827	277.503
1.80	0.504	0.081	345.133	28.253	0.423	2584.159	142.687	0.504	2929.292	170.940	6659.848	323.774	5766.580	274.259
1.85	0.518	0.083	352.629	28.863	0.435	2643.591	145.881	0.518	2996.221	174.744	6641.326	322.747	5712.108	271.064
1.90	0.532	0.085	360.032	29.464	0.447	2702.464	149.041	0.532	3062.496	178.505	6622.867	321.723	5658.399	267.919
1.95	0.546	0.087	367.343	30.058	0.458	2760.785	152.166	0.546	3128.127	182.225	6604.469	320.703	5605.439	264.822
2.00	0.560	0.090	374.563	30.645	0.470	2818.560	155.258	0.560	3193.122	185.903	6586.133	319.687	5553.217	261.773
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

9.9 Short-Term risk analysis

Not considered to be relevant.

9.10 Medium-term projections

Not considered to be relevant.

9.11 Long-term Yield

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 (Table 9.8.1.5). Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. Population numbers used in the projection are those used for short term predictions. Results are shown in Table 9.11.1 and Figure 9.11.1.

Table 9.11.1.: Sardine yield per recruit table.

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	3.5578	0.1348	2.1574	0.1252	1.9865	0.1152
0.1	0.0280	0.0445	0.0030	3.4242	0.1234	2.0258	0.1138	1.8547	0.1041
0.2	0.0560	0.0823	0.0055	3.3108	0.1139	1.9144	0.1044	1.7430	0.0948
0.3	0.0840	0.1150	0.0075	3.2133	0.1059	1.8188	0.0964	1.6472	0.0871
0.4	0.1119	0.1434	0.0092	3.1283	0.0991	1.7358	0.0897	1.5639	0.0805
0.5	0.1399	0.1685	0.0107	3.0535	0.0932	1.6629	0.0839	1.4908	0.0748
0.6	0.1679	0.1908	0.0119	2.9871	0.0881	1.5984	0.0788	1.4260	0.0699
0.7	0.1959	0.2108	0.0130	2.9277	0.0836	1.5408	0.0744	1.3682	0.0656
0.8	0.2239	0.2288	0.0139	2.8741	0.0797	1.4890	0.0705	1.3162	0.0618
0.9	0.2519	0.2452	0.0147	2.8254	0.0761	1.4421	0.0671	1.2692	0.0585
1	0.2799	0.2602	0.0154	2.7809	0.0730	1.3994	0.0640	1.2263	0.0555
1.1	0.3078	0.2740	0.0160	2.7401	0.0702	1.3603	0.0612	1.1871	0.0528
1.2	0.3358	0.2868	0.0165	2.7025	0.0676	1.3244	0.0587	1.1511	0.0504
1.3	0.3638	0.2986	0.0170	2.6676	0.0653	1.2912	0.0565	1.1178	0.0482
1.4	0.3918	0.3096	0.0175	2.6352	0.0632	1.2605	0.0544	1.0869	0.0462
1.5	0.4198	0.3200	0.0179	2.6049	0.0612	1.2318	0.0525	1.0582	0.0444
1.6	0.4478	0.3296	0.0183	2.5765	0.0595	1.2050	0.0508	1.0314	0.0427
1.7	0.4757	0.3387	0.0186	2.5498	0.0578	1.1799	0.0492	1.0063	0.0412
1.8	0.5037	0.3473	0.0189	2.5246	0.0563	1.1564	0.0477	0.9827	0.0398
1.9	0.5317	0.3554	0.0192	2.5008	0.0548	1.1341	0.0463	0.9604	0.0385
2	0.5597	0.3632	0.0195	2.4783	0.0535	1.1131	0.0451	0.9394	0.0372

Reference point	F multiplier	Absolute F
Fbar(2-5)	1	0.2799
FMax	12.224	3.4209
F0.1	1.6461	0.4607
F35%SPR	1.7606	0.4927

Weights in kilograms

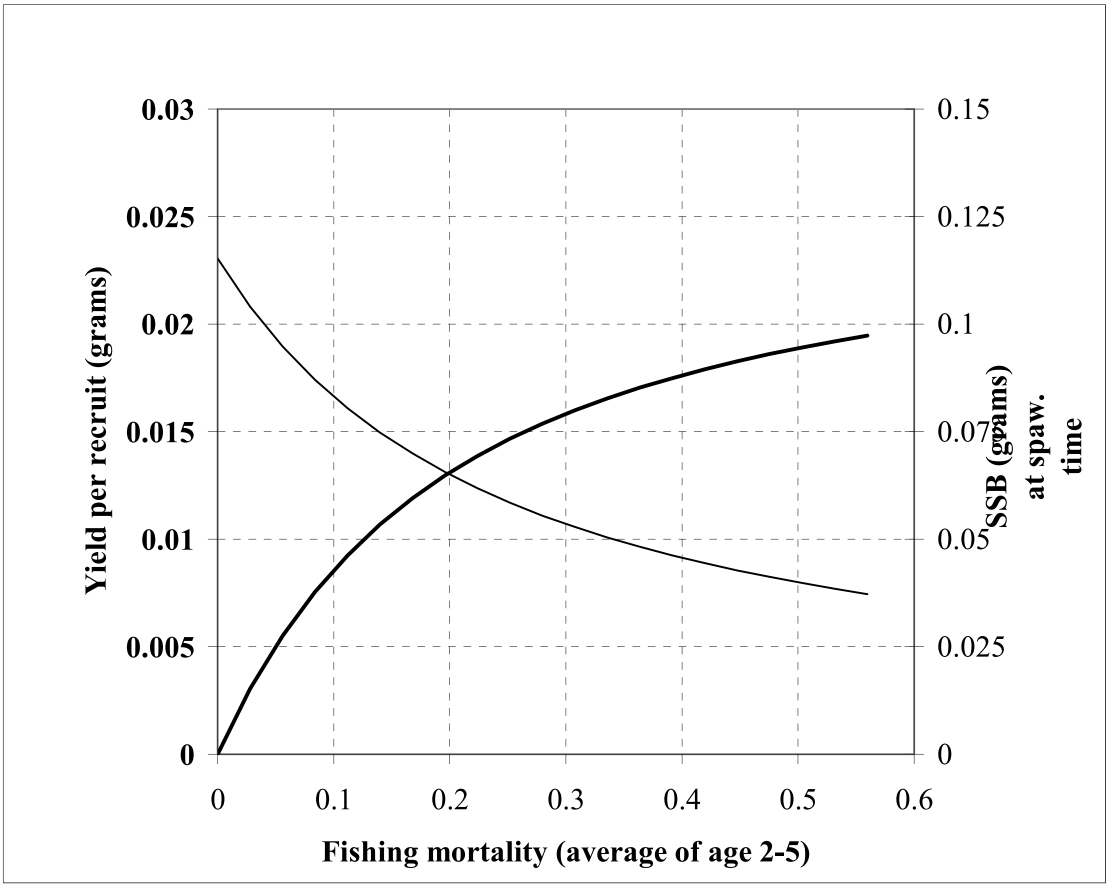


Figure 9.11.1: Sardine Yield per recruit

9.12 Uncertainty in assessment

Not considered to be relevant.

9.13 Reference points for management purposes

The Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) did not consider any reference points for sardine. In addition, ACFM concluded that since the state of the stock in relation to precautionary reference points is considered to be unknown, no precautionary approach reference points are proposed.

The absolute size of this stock still remains uncertain. Nevertheless, as it was already stated, the perception of this stock from the different assessment models analysed gave similar fluctuations in SSB, $Fbar_{(2\text{-}5)}$ and recruitment.

The state of the stock in the earlier part of the time series remains unclear. Therefore the Working Group concluded that no reference points for management purposes should be suggested.

9.14 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).

The lack of stability in the assessment model makes it difficult to adopt a harvest control rule. Nevertheless, given the similar trends observed in the different models, some form of rule adapted to the most recent assessment could be suggested. Accordingly, to prevent further decrease of the stock in the short term, a harvest control rule in which the estimation of the last assessment is observed as relative could be adopted. As it was stated last year, the fishing mortality for this stock should be adapted according to the perception of the stock size.

9.15 Management considerations

At present the Spawning Stock Biomass of this stock is considered to be low. The current assessment model estimated a SSB in 2000 lower than that observed in 1990. Fishing mortality increased from 1995 to 1998 where it reached the highest value since 1980. Nevertheless, fishing mortality shows a decrease in the last two years. Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches and possibly a decrease in the fishing effort in 2000 (due to prevalence of rough weather conditions in the last four months of the year) may have contributed to this decrease.

The apparently good 2000 year-class is expected to change the stock level in the short-term. However, previous indications of strong year classes were observed either to have disappeared gradually when new information was available (as the 1998 year class) or had a short-term influence in stock biomass (as the 1991 year class). In addition, 2000 recruitment mostly occurred in north Portugal as observed during the Portuguese acoustic survey. However, in Spring 2001, the 2000 year class spread out and was found along the western coast of the Iberian Peninsula, whilst in the southern area (IXa Cadiz and IXA-S) a new pulse belonging to this year class but with lower mean length was detected during spring. The WG considers that the 2000 year class must be monitored and its strength evaluated by future data before it can be fully included in the assessment of the stock.

At present, the SSB is close to its historical lowest level, therefore close monitoring of this stock is still needed.

9.16 Stock identification, composition, distribution and migration in relation to climatic effects

Research in stock identification has progressed during 2000 with the collection of fifteen sardine samples across a wide distribution area (Celtic Sea to Atlantic Morocco, Azores and the Spanish Mediterranean coast) from sampling opportunities provided by Spring surveys prosecuted within the framework of the EU Project 'PELASSES'. The study of morphometric and genetic markers from these samples is under way, the analysis of otolith microchemistry and life history properties will be carried out in the near future. Preliminary results are available from the comparison of samples from four dispersed locations: Gulf of Biscay, northern Portugal, south-western Mediterranean and the Azores (Silva *et al*.,WD 2001). Morphometric results show the Azores sample is clearly separated from a group including the Mediterranean and northern Portugal, while fish from the Gulf of Biscay overlap considerably with the coastal Atlantic and Mediterranean samples. The analysis of three DNA microsatellite loci show a high degree of heterogeneity between samples with all sample pairs (except the Azores-Mediterranean pair) showing significant differences. The similarity between these two samples may reflect the recent evolutionary origin of the Azorean fish from those from the south-western Mediterranean. The differences between the results from morphometric and genetic studies may simply reflect the different nature of the two types of marker, the latter reflecting mainly the evolutionary history and degree of isolation while the former being highly susceptible to environmental conditions.

Information on sardine abundance, distribution and population structure off the Portuguese coast has been reviewed and synthesised from the analysis of data from twenty-six acoustic surveys carried out during the past two decades (Stratoudakis *et al*., WD 2001). A thorough description of survey methodology and the main changes observed through time is provided. The results of comparisons between the two decades (80's and 90's) essentially complement and substantiate previous studies presented in recent years (ICES 2000, 2001). The extent of the sardine distribution area off Portugal decreased by around 25% in the 90's when seasonal differences became less perceptible and a declining trend with time became evident. The reduction is almost exclusively due to a large reduction in the northern area (~41%) (where there are also indications of changes in the maturation cycle) and these results are corroborated by similar trends in the mean depth of fishing hauls with sardine over time. Sardine abundance shows no clear trends over time, but is marked by the dominance of young fish in recent years and also by the strong 2000 year class in northern Portugal.

The recent failure in the Galician sardine fishery (IXa-N and southwestern part of VIIIc-W) has been analysed in Carrera and Porteiro (2001). Available information on sardine (i.e. acoustic and ichthyoplankton surveys and landings) was reviewed. The decrease in sardine landings was explained by two main factors: a) the shrinkage of the sardine distribution, especially off north Portugal which affected the juvenile fishery in South Galicia (IXa-N) and b) a change in the age structure pattern of sardine along the Iberian coast together with an overall decrease in the stock size which might have affected the migration patterns of adult fish and hence, the adult fishery in North Galicia.

Dependence of the sardine recruitment process on both large and meso-scale (local) oceanographic events has been explored further by modelling recruitment strength as a linear function of several oceanographic indices (NAO-Spring, NAO-Winter and Gulf Stream current as large indices and upwelling and Ekman transport as local indices) together with the estimated spawning stock biomass (Porteiro *et al*., WD 2001). Both local and large-scale oceanographic events seem to have influence on the strength of the recruitment. In addition, the size of the parental stock appears to have influence on the strength of the recruitment. Since younger sardine mainly occur in the recruitment areas, a previous good recruitment could be acting as a negative partial effect either on intra-specific competition between the larvae and young fish or on egg predation by young sardines. The model is significant and explains 54% of the variability found in the recruitment time series. The prediction of an above average recruitment in 2000 was according to observed data. However, the performance (both in explanatory and predictive power) of the model has to be tested further before it can be used as a quantitative tool.

Although progress has been made during 2000, the WG continues to recognise the need to develop an integrated approach to these issues. To this end a proposal for a project 'SARDYN' was submitted to the EU-Quality of Life Program in October 2000. Funding was not granted and the project will be re-submitted in October 2001. The main objectives of the project are to describe the stock structure and dynamics of sardine in the Northeast Atlantic in order to propose alternatives for analytical assessment. The study area covers the eastern Atlantic from France to Morocco, and includes the Spanish Mediterranean. The studies planned include: the identification of spawning areas, and seasons and description of spawning dynamics; stock identification using complementary techniques (genetics, morphometrics, otolith chemistry, life history properties); direct and indirect evidence of fish movements; links between sardine distribution and abundance with primary and secondary productivity; analysis of possible mechanisms of larval drift; development of appropriate assessment models.

8 SARDINE GENERAL

Sardine (*Sardina pilchardus*, Walb 1792) is an important pelagic fish species with a wide distribution area around NE Atlantic waters and adjacent areas (i.e. Black Sea in the eastern Part and Açores in the western part). Northern and southern limits seem to be related to the average water temperature, being located within 10ºC and 20ºC isotherme (Furnestin, 1945). Nevertheless, several authors have hypothesised that sardine distribution and abundance are dependent on oceanographic regime (Barkova *et al*, 2001; Kifani, 1998; Carrera and Porteiro, 2001, in press). High abundance, wide geographic distributions, feeding/spawning migrations and high fishery productivity are all associated with favourable “regimes” (Lluch-Belda *et al*. 1992, Schwartzlose *et al*. 1999).

Off the African coast, Kifani (op. cit.) analysed landings from the Morocco area. The main fisheries began around the mid-20th Century. From this period, catches increased and peaked in the seventies (Figure 8.1). During this earlier period, important fluctuations were observed. During the eighties catches dropped but in the nineties there has been a general increase in catches, to around one million tonnes of fish. In this area, although sardine was earlier separated into three stock units, recent studies stated that two populations are distributed off Moroccan waters, which can be distinguished by the different growth rate and longevity and meristic characters (Barkova *et al*, op. cit).

North of the Iberian peninsula there are no fisheries targeted on sardine, although catches are routinely reported from these areas. In addition no extensive studies have been undertaken in this zone but some studies on sardine distribution and ichthyoplankton have been undertaken in ICES Divisions VIIIa,b and VIIe,f,h.

Acoustic surveys in Division VIIIa, b

During May 2001, an acoustic survey was carried out off the French coast within the framework of the EU DG XIV Study PELASSES. This survey, targeted on anchovy and sardine, also covered the distribution area of other pelagic fish species. It was co-ordinated with the Portuguese and Spanish surveys to cover the southern part of the European Atlantic waters (Massé WD 2001).

A biomass of 205 thousand tonnes of sardine was estimated, which was mainly located in the northern part. Juveniles, of which there were few, were only seen in shallow waters (Figure 8.2). As it was also observed during the Spanish survey, juvenile fish remained within the influence of river plumes, in low salty waters whilst the adult fish occurred in pure oceanic waters. The area distribution was different to that observed last year when sardine was found over the continental shelf.

The fishery

Data were provided by German and UK (England and Wales) and yielded 3 341 tonnes, which is similar to that of the last year (3 711 tonnes). Nevertheless, as shown in Table 8.1, some catches were reported from ICES Division IVc. Most of the catches occurred in Division VII (3 298 tonnes), mainly in Division VIIe,f with 2 916 tonnes. The fishery is mainly located in winter, as in previous years. Catches from the first and fourth quarter represent up to 97% of the total catches.

Table 8.1: Annual catches of sardine by ICES Sub-Division

DIVISION	1983	1984	1985	1986	1987	1988	1989	1990	1991
IVc									
Total IV									
VIId	211	147	465	512	67	29	93	64	170
VIIe,f	590	661	1 624	2 058	682	438	91	808	4 687
VIIg	-	1	-						
VIIh	2	-			216	2 119	957	235	110
Total VII	**803**	**809**	**2 089**	**2 570**	**965**	**2 586**	**1 141**	**1 107**	**4 968**
VIIIa	6 013	4 472	8 090	10 186	7 631	7 770	8 885	8 381	9 113
VIIIb	454	19	79	77	77	38	85	104	482
Total VIIIab	**6 467**	**4 491**	**8 169**	**10 263**	**7 708**	**7 808**	**8 970**	**8 485**	**9 595**

DIVISION	1992	1993	1994	1995	1996	1997	1998	1999	2000
IVc									5
Total IV									**5**
VIId	153	127	2 086	1 621	179	71	103	247	209
VIIe,f	19 635	5 304	20 985	13 787	8 278	2 584	4 223	3 415	2916
VIIg									
VIIh	4	71	-	1 439	1 350	1 058	101	11	173
Total VII	**19 793**	**5 502**	**23 071**	**16 846**	**9 807**	**3 713**	**4 427**	**3 711**	**3298**
VIIIa	8 565	4 703	7 164		8 180	11 361	10 674		38
VIIIb	141	548	119		526	160	7 749		
Total VIIIab	**8 706**	**5 251**	**7 283**		**8 706**	**11 521**	**18 423**	**17 730**	**38**

1983-90 only French data was available for Sub-Area VII

Table 8.2: Sardine landings in 2000 by country. Below, quarterly distributic of the German and UK catches.

Division	Germany	UK	France	Total
IVc		5		**5**
VIId	65	144		**209**
VIIef	39	2877		**2916**
VIIg				
VIIh	166	7		**173**
VIIj				
VIIIab	38			**38**
Total	**308**	**3033**		**3341**

Country	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Germany			2	306	**308**
UK	1473	6	103	1451	**3033**
Total	**1473**	**6**	**105**	**1757**	**3341**

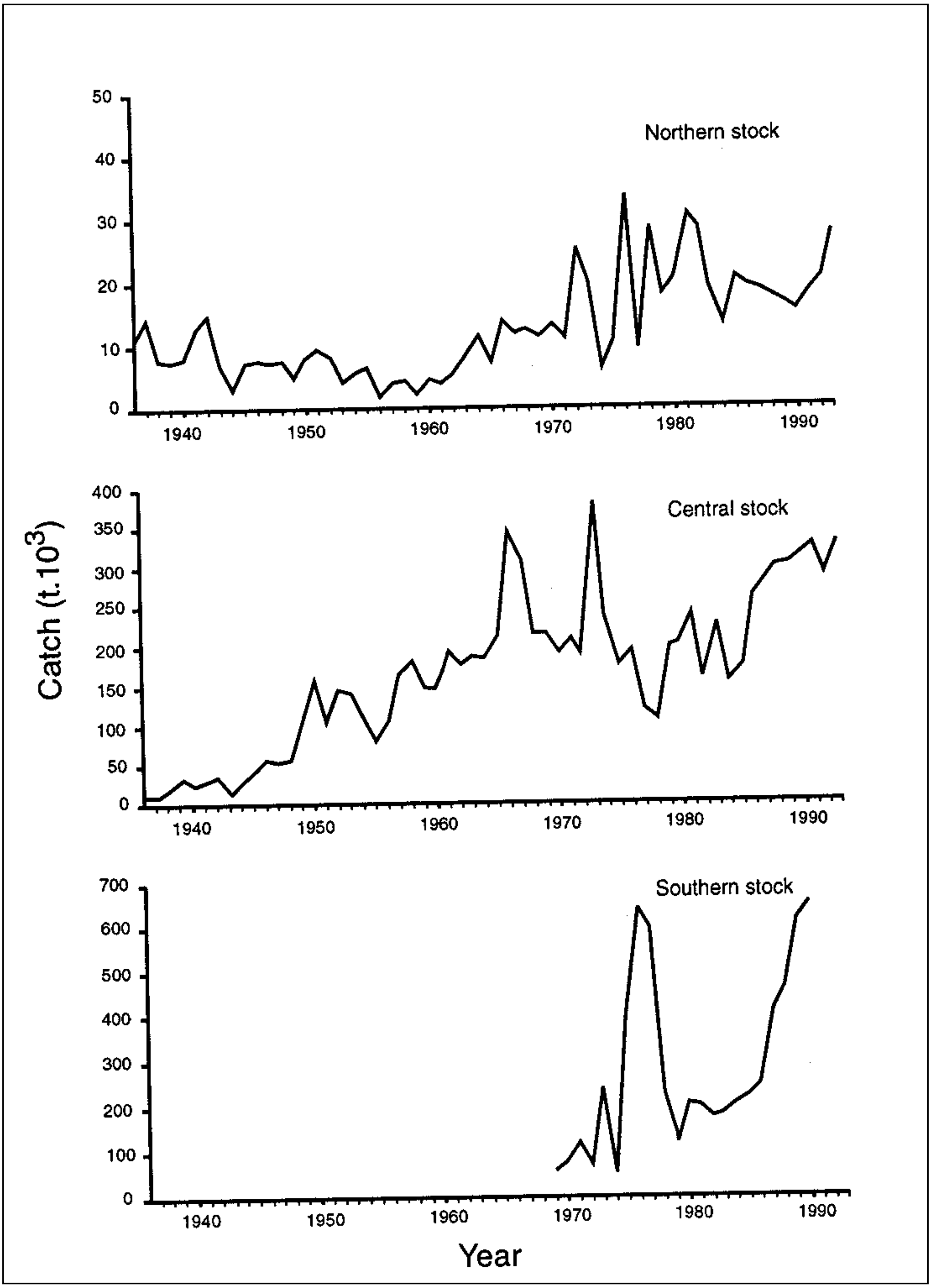


Figure 8.1: Annual catch of sardine from Morocco (adapted from Kifani, 1998). Northern stock is distributed from Gibraltar (35º50'N) to 33º15'N Moroccan coastal waters; central stock from 33º15'N to 26º45'N; and south stock from 26º45'N to 21ºN approximately.

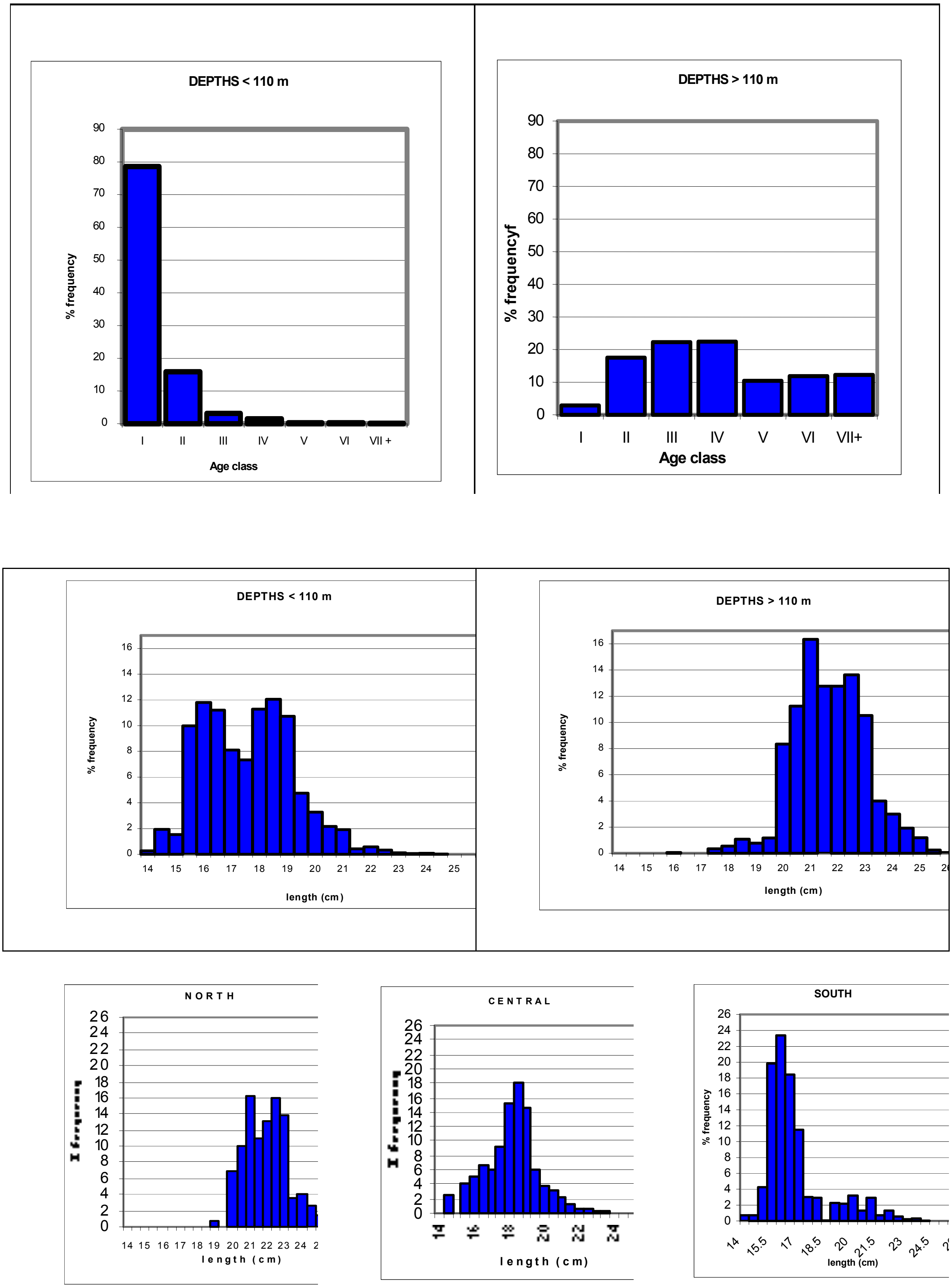


Figure 8.2 : Age and Length distribution of sardine during the PEL2001 survey in Division VIIIa, b.

9 SARDINE IN VIIIC AND IXA

9.1 ACFM Advice Applicable to 2000 and 2001

Based on new data provided by ICES CM 2001/ACFM:06, ACFM considered that at present the spawning biomass of this stock is considered to be low, similar to that observed in 1990. In addition, fishing mortality decreased last year. Management measures taken on a national basis by both Portugal and Spain contributed to this reduction. Nevertheless, changes in stock abundance in different areas remain a matter of concern. The biological relationship between the different areas and the general stock definitions is still unclear. This may imply a vulnerability of the fishery at both a local and a global level. Therefore, close monitoring of this stock is still needed, as well as a better understanding of the stock structure and behaviour. For 2001, ACFM recommended that "fishing mortality be reduced below F=0.20, corresponding to a catch of less than 88 000 t in order to prevent short-term decline in stock size and promote recovery of the stock".

9.2 The fishery in 2000

Different management measures were implemented in each country. A minimum landing size of 11 cm (EU reg. 850/98) has been in force since 1999 in all EU waters. In Spain, from 15th February to 31st March there was a ban for the purse seine fishery and sardine catches were not allowed. In Spain, a maximum allowable catch of 7,000 Kg per fishing day and a per week limitation in the number of fishing days (4 in Galicia, 5 in the rest of Spain) was also implemented. In Portugal regulations have been gradually implemented since 1997. In 2000 management measures included: (1) an overall limitation in the number of fishing days (180 days per year, and a weekend ban), (2) an overall quota reduction of about 10 % per year since 1997, (3) a closure of the purse-seine fishery in the northern part of the Portuguese area from the 15th of February to 15th of April and finally, (4) a yearly quota reduction for all fishermen organisations (which some organisations have distributed in daily catch limits by boat). Daily catch limitations were imposed for the first time in 1999.

As estimated by the Working Group, catches in divisions VIIIc and IXa were 85,786 t (19,644 t from Spain and 66,141 t from Portugal). The bulk of the landings (99%) were made by purse seiners. Table 9.2.1 summarises the quarterly landings by ICES Sub-Division. There was a decrease in landings in both countries (8% in Portugal and 13% in Spain). In Sub-division VIIIc-East, catches were 7,547 t which remained at the same level as in 1999. As it was previously observed, most of the catches were taken during the first and the fourth quarter, outside the main anchovy and tuna fishing periods. In VIIIc-W, catches were 4,149 t , similar to 1999 landings. In IXa-N, sardine catches were similar to 1999 figures (2,866 tonnes), much lower than the yields during the eighties in this area (52,000 tonnes as a mean). In IXa-CN, landings dropped 35%, from 31,574 tonnes achieved in 1999 to 23,311 tonnes. This decrease occurred from March until the end of the year, and mostly in the middle of the year. In IXa-CS, catches increased slightly (23,701 t). In addition, in IXa S, there was also a small increasing in sardine landings (19,129 tonnes). On the contrary, in the Gulf of Cadiz (IXa-Cadiz) catches decreased by 54%, from 7,846 tonnes to 5,081 tonnes.

Annual catches from both Spain and Portugal are available from 1940 (Figure 9.2.1 and Table 9.2.2). Declining trends are observed in northern areas (from IXa-CN to VIIIc) whereas in the most southern areas, catches have shown a slight increasing trend.

Table 9.2.1: Quarterly distribution of sardine landings (t) by ICEs Sub-Division. Above absolute values; below, relative numbers

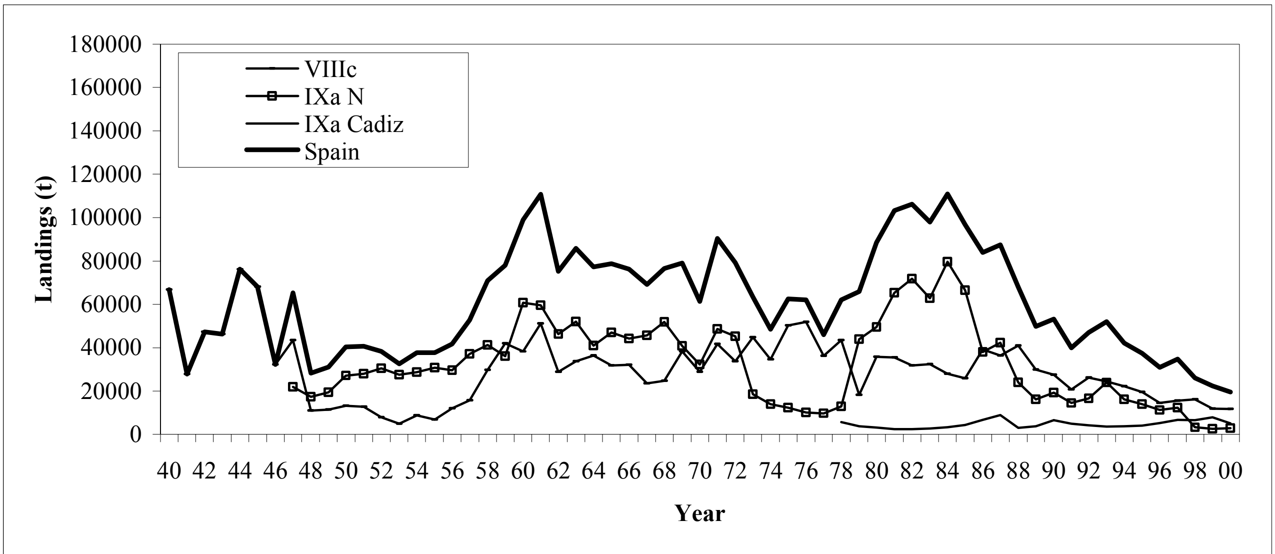
Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2953	2020	974	1601	**7547**
VIIIc-W	239	2040	1088	783	**4149**
IXa-N	77	574	1885	331	**2866**
IXa-CN	2905	3838	10009	6560	**23311**
IXa-CS	6436	4469	6312	6483	**23701**
IXa-S (A)	3516	4280	6413	4920	**19129**
IXa-S (C)	1562	663	1336	1520	**5081**
Total	**17687**	**17884**	**28016**	**22198**	**85786**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3.44	2.35	1.14	1.87	**8.80**
VIIIc-W	0.28	2.38	1.27	0.91	**4.84**
IXa-N	0.09	0.67	2.20	0.39	**3.34**
IXa-CN	3.39	4.47	11.67	7.65	**27.17**
IXa-CS	7.50	5.21	7.36	7.56	**27.63**
IXa-S (A)	4.10	4.99	7.48	5.74	**22.30**
IXa-S (C)	1.82	0.77	1.56	1.77	**5.92**
Total	**20.62**	**20.85**	**32.66**	**25.88**	

Table 9.2.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2000.

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

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



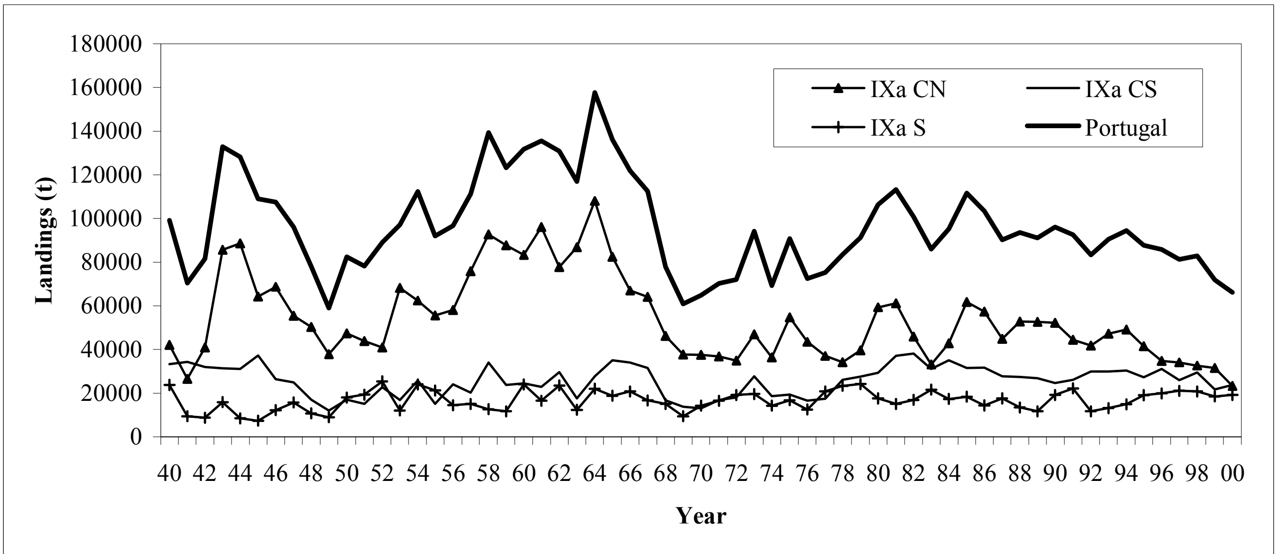


Figure 9.2.1: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

9.3 Fishery independent information

9.3.1 Egg surveys

During 2000 and 2001 no DEPM egg surveys were performed. Nevertheless, during the acoustic surveys carried out in this area, continuous records of surface sardine and anchovy eggs were provided from CUFES (Continuous Underwater Fish Egg Sampler). In addition, Calvet stations (whole column sampler) were also performed on a regular grid aiming to set up CUFES as quantitative egg sampler, once this device is calibrated. This task is still in progress. As stated in the previous Working Group Report, egg distribution derived from CUFES matched the adult distribution derived from the acoustic records quite well.

9.3.2 Acoustic surveys

Acoustic activities undertaken in this area are co-ordinated within the framework of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII (ICES CM 1999/G:13). Spring surveys were undertaken within the framework of the EU DG XIV project 99/010 PELASSES. Within this project, the French survey was carried out using the same methodology. This consists of the use of two acoustic frequencies (38 and 120 kHz) and a continuous sampling of pelagic eggs at 3-5 m depth using CUFES among other common systems.

Two Working Documents were presented (Marques and Morais, WD 2001; Carrera WD 2001), which summarise the main results of the surveys performed between autumn 2000 and spring 2001. In addition the whole Portuguese acoustic surveys time series was analysed in Stratoudakis *et al* (WD 2001).

Portuguese November 2000 Acoustic Survey

As usually, the survey was carried out on board R/V 'Noruega'. Sardine mainly occurred in the northern part (Figure 9.3.2.1). No sardine have been seen off the southwest coast as in previous years. Sardine were also distributed in the Gulf of Cadiz and Algarve area. On the other hand some schools were observed offshore in the northern part, which was not usual in the recent surveys.

Sardine abundance during this survey was estimated to be 36 015 million fish, corresponding to 710 thousand tonnes, which is the highest abundance ever estimated in this area. As was already shown in the fish distribution, the north part contributed up to 82% of the total abundance (29 399 million fish, corresponding to 555 thousand tonnes). In contrast in the Algarve area the estimated abundance was very low and only reached 723 million fish, corresponding to 31 thousand tonnes. In IXa-CS, fish were estimated at 2 984 million fish, corresponding to 40 thousand tonnes. In Cadiz, 81 thousand tonnes of sardine were assessed, corresponding to 2,909 million fish. Table 9.3.2.1 and Figure 9.3.2.2 shows the sardine assessment by age group and area. Overall age group 0 represents 92% of the total fish abundance estimation, which is driven by the huge abundance detected in the northern area. Age group 0 estimated in the northern coast represents 84% of the total abundance of this cohort in the whole area. By areas, age group 0 represents 94% in the northern coast, 93% in the southwest, 51% in Algarve and 79% in Cadiz.

In conclusion, this survey is characterised by:

- The exceptional abundance of age group 0, the highest ever reported in this time series.
- 84% of age group 0 sardine were found in the northern area.
- An important decrease of sardine biomass in both Ocidental Sul (roughly, IXa-CS) and Algarve (IXa-S) as compared with previous years.

During the acoustic survey performed in November 1998, a total of 21 169 million fish were estimated, most of them (66%) belonging to age group 0, which indicated a strong year class in this year. Besides the difference in the magnitude of the abundance, the main difference between the two years is the location of the recruitment area. Whilst in 1998 the recruitment was distributed in the northern area (40% of the total age group 0) and in the Gulf of Cadiz (with a 38 % of this age group), in 2000 the recruitment was mainly located in the northern area (84% of the total age group). The strength of the 1998 year class was not confirmed by the subsequent March surveys and the 1998 sardine cohort, as estimated by the assessment model (see further sections), does not appear to be as strong as originally suggested.

Portuguese March 2001 Acoustic Survey

A small part of the area (around 10% of the Ocidental South area) was not covered due to bad weather conditions.

No important changes in fish distribution in Portuguese waters were observed between November 2000 and March 2001, as shown in Figure 9.2.2.3 In the northern part (Ocidental Norte), sardine was seen in shallower waters than during the November survey.

In March 2001 the sardine abundance was estimated to be 20 770 million fish, corresponding to 496 000 t. Most of the fish were seen in the northern part (13 023 million fish, corresponding to 344 thousand tonnes). In the rest of Portugal (i.e. Ocidental Sul and Algarve, which roughly corresponds to IXa-CS and IXa-S), sardine biomass decreased from previous years (3 093 million fish, corresponding to 40 000 t in Ocidental Sul, and 1 107 million fish, corresponding to 24 thousand tonnes in Algarve). In the Bay of Cadiz, a slight increase in sardine was observed from the previous survey (88 thousand tonnes, corresponding to 3 547 million fish).

Table 9.3.2.2 and Figure 9.3.2.4 show the sardine acoustic estimate by age group and area. The 2000 year class, as in the November 2000 survey, was predominant and represented 92% of the total fish estimated. Nevertheless, the distribution of this year class spread throughout the west Portuguese coast up to Lisbon, while in the southern areas (Algarve and Cadiz) the appearance of a smaller modal length (also belonging to age 1) suggests a later recruitment period. During the November survey up to 84% of this year class was located in the north, while in March 2001, only 65% of this year class was estimated over the same area. The contribution of the age group 1 in each area ranged from 73% to 94% (from 51% to 94% in November 2000) of the total fish.

Thus, this survey was characterised by:

- Confirmation of the strength of the 2000 year class. Nevertheless, an important decrease of the strength of this year class from November 2000 to March 2001 (from 3 317 million fish to 1 868 million fish, or 44%) should be noted.

- The decrease in adult fish occurred off Portugal (49%) whilst increased in the Gulf of Cadiz (57%). Overall decrease in adult fish was 27%.

Stratoudakis *et al* (WD 2001) analysed the whole acoustic survey time series from Portugal. Because this document examines changes in both stock structure and distribution in this area, major conclusions of this document are discussed in Section 9.16.

Spanish April 2001 Acoustic Survey

In April 2001 the Spanish acoustic survey, carried out on board R/V ‘Thalassa’, covered i) an area in north Portugal; ii) the Spanish area; and iii) a small area in south France (Carrera, WD 2001). Together with the acoustic and CUFES sampling, extensive studies on plankton and primary production were undertaken along the surveyed area. Weather conditions were unfavourable during the first part of the survey. In spite of the predominance of SW wind component, the Poleward current called ‘Navidad’ was not observed, at least from the TS-diagram obtained during the survey. Therefore, oceanographic conditions found during the survey were typical of spring, with warmer water in the south part (but not with higher salinity), presence of haline fronts close to the mouth of rivers, and upwelling events in the Cantabrian forced by the change of the wind direction from SW to NE occurring during the second part of the survey.

Sardine distribution, as derived from the acoustic records, is shown in Figure 9.3.2.5. Two main areas with sardine were seen. In the Atlantic waters, sardine occurred in thick and dense schools close to the coast, although some sardines were also observed further offshore in the Portuguese area. Sardine in this area were restricted to less saline waters, inside a haline front which separated oceanic waters from the river plumes. In the Cantabrian Sea sardine were mainly found on the continental shelf, reaching the slope. Sardine mainly occurred in layers, close to the bottom and probably mixed with mackerel, rather than in isolated, well defined pelagic schools. Moreover, in the Atlantic waters, sardine had lower mean length (around 15 cm) than those found in the Cantabrian Sea (22 cm).

Table 9.3.2.3 and Figure 9.3.2.6 show the sardine acoustic estimate. In northern Portugal, sardine abundance was estimated to be 6 779 million fish, corresponding to 183 000 t. The bulk of the fish (97%) belonged to age group 1, similar to that estimated during the Portuguese acoustic survey. In IXa-N, 19 000 t of sardine were estimated, corresponding to 644 million fish. In this area earlier assessments gave estimations lower than 10 thousand tonnes of sardine. The abundance estimated in 2001 is similar to that observed in the earlier nineties. In addition, as in the

Portuguese area, most of the fish belonged to age group 1. No fish older than 2 was found in this area. Age group 1 was also abundant in VIIIc-W and represented 61% of the total fish, although age groups up to 10 year old were also found in the northernmost area. Eighteen thousand tonnes of sardine, corresponding to 475 million fish were estimated in this area. In VIIIc-E Age Group 1 was scarce, being only found in the western part (VIIIc-Ew) representing 3% of the total abundance. In this area, age group 3 was predominant (34%) over a total of 475 million fish corresponding to 41 thousand tonnes. In the inner part of the Bay of Biscay (i.e. VIIIc-Ee), sardine occurred in the western part whilst the eastern part, close to the French waters sardine were scarce. In the same way, although the south of France was surveyed, almost no sardine were seen and, therefore no sardine estimate for this area was made. In VIIIc-Ee age group 5 was predominant, and some fish larger than 25 cm were also observed. In this area, 139 million fish corresponding to 13 000 t were assessed.

Main conclusions on sardine from this survey can be summarised as follows:

- Sardine distribution area was wider than that observed in 2000. In addition the number of fish estimated was higher than that estimated during 2001. Major changes occurred in IXa-N and VIIIc-W where most of the fish seen belonged to age group 1. The same situation was found in Portugal.

- Age structure found in 2001, with younger fish mainly located in Atlantic waters and an age gradient pattern through the inner part of the Bay of Biscay where the oldest fish are predominant, reflects the "normal age structure" found in the earlier nineties and eighties.

- The sardine estimates in IXa-N give a similar abundance to those assessments performed earlier in the nineties. In addition, although the number of sardine detected in VIIIc is still lower compared with that observed at the beginning of nineties, the distribution area is larger than that observed during the late nineties and similar to that observed in the earlier nineties.

- In contrast to previous years, in the inner part of the Bay of Biscay and in the southern part of the French continental shelf sardine were scarce. This observation agreed with the results obtained during the French survey over this area.

Given the low number of younger fish (age group 0) caught during 2000 in the Spanish Atlantic waters (VIIIc-W and IXa-N) and the results of the Portuguese November 2000 survey, most of the younger fish found in Spanish Atlantic waters during this survey could have been recruited from northern Portuguese waters. From this area, this cohort appears to have spread southward and northward, along the northwest coast of the Iberian Peninsula.

It seems that the sardine distribution and abundance is now reversing and the situation found during the spring 2001 off Spanish waters was similar to that observed during the late eighties/earlier nineties.

Table 9.3.2.1: Sardine Assessment from the 2000 Portuguese November acoustic survey

AREA		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**Total**
Oc. Norte	**Biomass**	483194	61391	5649	1216	1981	1332	264		**555027**
	%	87.06	11.06	1.02	0.22	0.36	0.24	0.05		
	Mean Weight	17.42	41.58	49.04	63.83	72.69	71.36	91.81		
	No fish	2773924	147660	11518	1905	2725	1866	287		**2939885**
	%	94.35	5.02	0.39	0.06	0.09	0.06	0.01		
	Mean Length	13.1	17.4	18.3	19.9	20.7	20.6	22.3		
Oc. Sul	**Biomass**	32301	3350	3922	1369	986	385	310	113	**42736**
	%	75.58	7.84	9.18	3.20	2.31	0.90	0.73	0.26	
	Mean Weight	11.68	38	46.98	58.71	71.88	73.57	80.49	86.48	
	No fish	276492	8817	8349	2331	1372	523	385	131	**298400**
	%	92.66	2.95	2.80	0.78	0.46	0.18	0.13	0.04	
	Mean Length	11.1	17.5	19	19.9	20.6	20.9	21.3		
Algarve	**Biomass**	9208	2092	2541	2763	5413	4970	2753	1654	**31394**
	%	29.33	6.66	8.09	8.80	17.24	15.83	8.77	5.27	
	Mean Weight	25.09	40.93	52.98	58.11	66.89	70.92	71.79	82.35	
	No fish	36692	5112	4795	4756	8093	7008	3835	2008	**72299**
	%	50.75	7.07	6.63	6.58	11.19	9.69	5.30	2.78	
	Mean Length	14.9	17.4	18.8	19.3	20.2	20.5	20.6	21.5	
Cadiz	**Biomass**	49176	4731	15861	3642	4564	2086	714	700	**81474**
	%	60.36	5.81	19.47	4.47	5.60	2.56	0.88	0.86	
	Mean Weight	21.37	42.71	50.32	58.42	65.13	67.44	72.22	83.08	
	No fish	230093	11076	31521	6233	7008	3093	989	843	**290856**
	%	79.11	3.81	10.84	2.14	2.41	1.06	0.34	0.29	
	Mean Length	14.2	17.6	18.5	19.3	20	20.2	20.7	21.6	
Portugal	**Biomass**	524703	66833	12112	5348	8380	6687	3327	1767	**629157**
	%	83.40	10.62	1.93	0.85	1.33	1.06	0.53	0.28	
	Mean Weight	17.1	41.4	48.6	59.7	67.7	68.6	74.5	83.3	
	No fish	3087108	161589	24662	8992	12190	9397	4507	2139	**3310584**
	%	93.25	4.88	0.74	0.27	0.37	0.28	0.14	0.06	
	Mean Length	12.9	17.4	18.6	19.6	20.2	20.3	20.9	20.3	
Whole Area	**Biomass**	573879	71564	27973	8990	12944	8773	4041	2467	**710631**
	%	80.76	10.07	3.94	1.27	1.82	1.23	0.57	0.35	
	Mean Weight	17.5	41.5	49.6	59.2	66.8	68.3	74.1	83.2	
	No fish	3317201	172665	56183	15225	19198	12490	5496	2982	**3601440**
	%	92.11	4.79	1.56	0.42	0.53	0.35	0.15	0.08	
	Mean Length	13.0	17.4	18.5	19.5	20.1	20.3	20.8	20.7	

Table 9.3.2.2: Sardine Assessment from the 2001 Portuguese Spring acoustic survey

AREA		1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	301274	19865	11554	8494	2626	168		**343981**
	%	87.58	5.78	3.36	2.47	0.76	0.05		
	Mean Weight	24.66	45.17	61.24	62.92	68.31	75.56		
	No fish	1221923	43973	18868	13501	3844	223		**1302332**
	%	93.83	3.38	1.45	1.04	0.30	0.02		
	Mean Length	15.1	18.4	20.3	20.5	21	21.8		
Oc. Sul	**Biomass**	34332	2540	1213	851	685	423	77	**40121**
	%	85.57	6.33	3.02	2.12	1.71	1.05	0.19	
	Mean Weight	11.52	45.84	54	56.19	54.25	61.66	73.73	
	No fish	297941	5540	2246	1514	1262	687	105	**309295**
	%	96.33	1.79	0.73	0.49	0.41	0.22	0.03	
	Mean Length	11.7	18.5	19.5	19.7	19.5	20.3	21.6	
Algarve	**Biomass**	13226	3495	1768	1236	1741	1402	752	**23620**
	%	55.99	14.80	7.49	5.23	7.37	5.94	3.18	
	Mean Weight	14.87	36.67	47.63	56.51	59.08	62.9	64.26	
	No fish	88945	9532	3711	2187	2947	2228	1171	**110721**
	%	80.33	8.61	3.35	1.98	2.66	2.01	1.06	
	Mean Length	11.7	17.2	18.7	19.8	20.1	20.5	20.6	
Cadiz	**Biomass**	39780	7535	12474	8626	11064	6359	2443	**88281**
	%	45.06	8.54	14.13	9.77	12.53	7.20	2.77	
	Mean Weight	15.32	40.94	46.69	52.18	56.74	62.87	63.62	
	No fish	259625	18404	26719	16531	19500	10114	3840	**354733**
	%	73.19	5.19	7.53	4.66	5.50	2.85	1.08	
	Mean Length	11.7	17.8	18.6	19.3	19.8	20.5	20.5	
Portugal	**Biomass**	348832	25900	14535	10581	5052	1993	829	**407722**
	%	85.56	6.35	3.56	2.60	1.24	0.49	0.20	
	Mean Weight	23.0	44.7	58.9	61.1	62.4	63.7	64.6	
	No fish	1608809	59045	24825	17202	8053	3138	1276	**1722348**
	%	93.41	3.43	1.44	1.00	0.47	0.18	0.07	
	Mean Length	14.3	18.3	20.0	20.3	20.3	20.5	20.6	
Whole	**Biomass**	388612	33435	27009	19207	16116	8352	3272	**496003**
Area	**%**	78.35	6.74	5.45	3.87	3.25	1.68	0.66	
	Mean Weight	22.2	43.8	53.2	57.1	58.5	63.1	63.9	
	No fish	1868434	77449	51544	33733	27553	13252	5116	**2077081**
	%	89.95	3.73	2.48	1.62	1.33	0.64	0.25	
	Mean Length	13.9	18.2	19.3	19.8	20.0	20.5	20.5	

Table 9.3.2.3: Sardine Assessment from the 2001 Spanish Spring acoustic survey

AREA		1	2	3	4	5	6	7	8	9	10	Total
VIIIc-Ee	**Biomass**		130	1113	2609	4372	2222	1390	965	494	99	**13394**
(>3°30')	**%**		1.0	8.3	19.5	32.6	16.6	10.4	7.2	3.7	0.7	
	Mean Weight		70.6	79.2	89.1	97.7	101.7	102.4	110.7	108.9	110.7	
	No fish		1824	13941	29093	44432	21679	13541	8639	4529	888	**138566**
	%		1.3	10.1	21.0	32.1	15.6	9.8	6.2	3.3	0.6	
	Mean Length		20.7	21.5	22.3	22.9	23.2	23.2	23.8	23.7	23.8	
VIIIc-Ew	**Biomass**	611	9371	14487	10146	5012	1150	280	182	31	11	**41282**
(<3°30')	**%**	1.5	22.7	35.1	24.6	12.1	2.8	0.7	0.4	0.1	0.0	
	Mean Weight	41.8	69.1	90.1	98.9	102.5	110.3	122.0	112.6	133.1	134.8	
	No fish	14513	134412	160181	102296	48648	10386	2289	1607	234	81	**474646**
	%	3.1	28.3	33.7	21.6	10.2	2.2	0.5	0.3	0.0	0.0	
	Mean Length	17.7	20.6	22.3	23.0	23.2	23.8	24.5	23.9	25.2	25.3	
VIIIc-W	**Biomass**	11063	4381	987	999	552	142	51	24	6	1	**18206**
	%	60.8	24.1	5.4	5.5	3.0	0.8	0.3	0.1	0.0	0.0	
	Mean Weight	32.6	40.2	79.2	86.1	93.5	99.7	104.7	108.2	117.3	118.0	
	No fish	336264	107096	12417	11540	5865	1421	486	223	50	8	**475371**
	%	70.7	22.5	2.6	2.4	1.2	0.3	0.1	0.0	0.0	0.0	
	Mean Length	16.4	17.5	21.5	22.0	22.6	23.0	23.4	23.6	24.2	24.3	
IXa-N	**Biomass**	17829	698									**18527**
	%	96.2	3.8									
	Mean Weight	28.1	35.5									
	No fish	624825	19551									**644**
	%	97.0	3.0									
	Mean Length	15.7	16.8									
Spain	**Biomass**	29502	14580	16587	13754	9936	3515	1721	1171	531	111	**91408**
	%	32.3	16.0	18.1	15.0	10.9	3.8	1.9	1.3	0.6	0.1	
	Mean Weight	29.8	53.4	88.5	95.8	99.8	104.3	105.1	111.0	110.1	112.7	
	No fish	975603	262883	186538	142929	98945	33486	16317	10469	4813	977	**1732959**
	%	56.3	15.2	10.8	8.2	5.7	1.9	0.9	0.6	0.3	0.1	
	Mean Length	16.0	19.1	22.2	22.8	23.0	23.4	23.4	23.8	23.7	23.9	
North Portugal	**Biomass**	174630	6859	652	397		223					**182761**
	%	95.6	3.8	0.4	0.2		0.1					
	Mean Weight	26.3	40.0	62.9	67.9		76.4					
	No fish	6589169	170346	10242	5849		2924					**6778530**
	%	97.2	2.5	0.2	0.1		0.0					
	Mean Length	15.4	17.5	20.0	20.5		21.3					

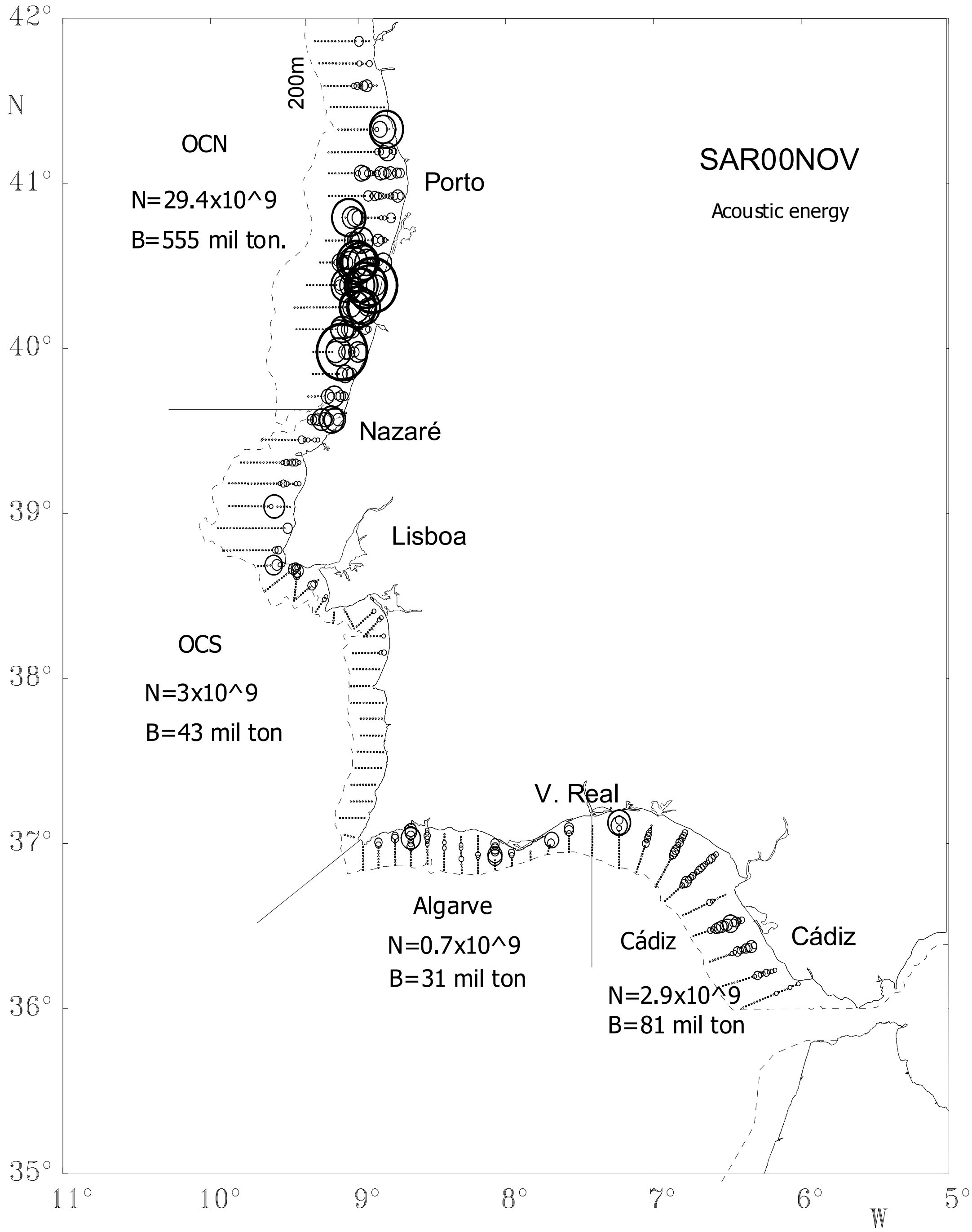


Figure 9.3.2.1: Sardine distribution as derived from the acoustic records during the Portuguese November Acoustic survey 2000. Circle diameter is proportional to the square root of the acoustic energy (SA).

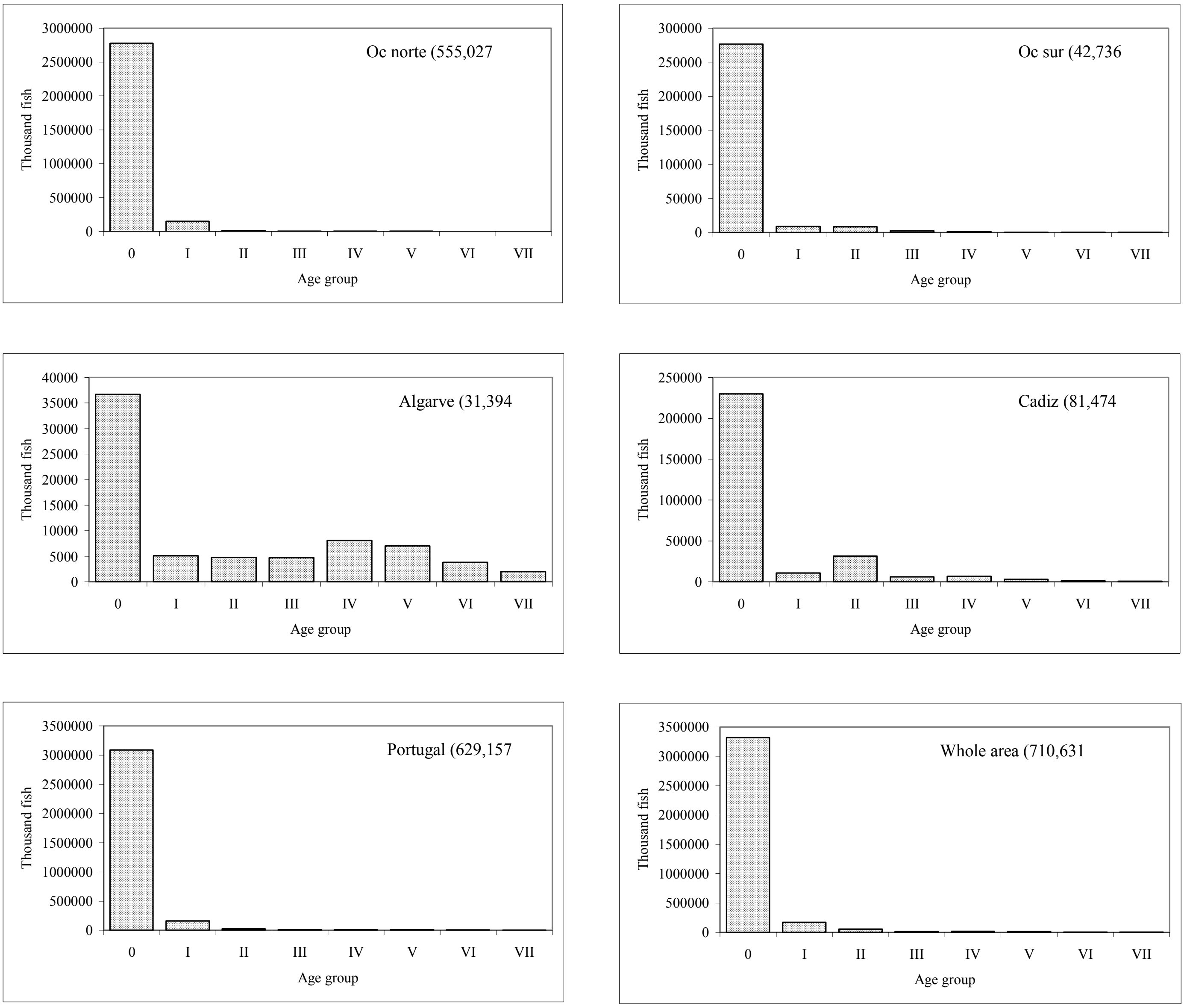


Figure 9.3.2.2: Estimated fish number of sardine (thousands) by area for the Portuguese November Acoustic survey 2000.

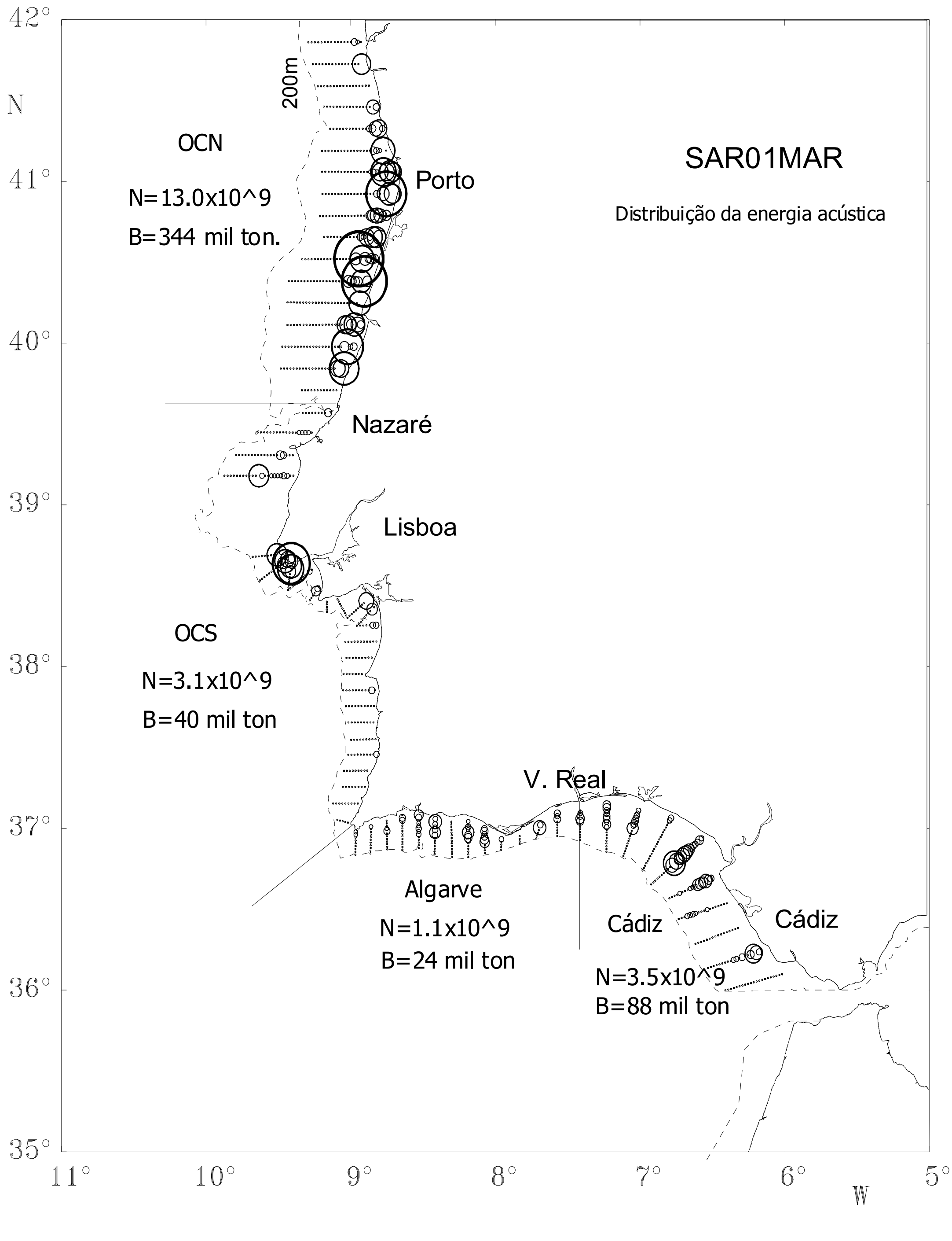


Figure 9.3.2.3 Sardine distribution as derived from the acoustic records during the Portuguese Spring Acoustic survey 2001. Circle diameter is proportional to the square root of the acoustic energy (SA).

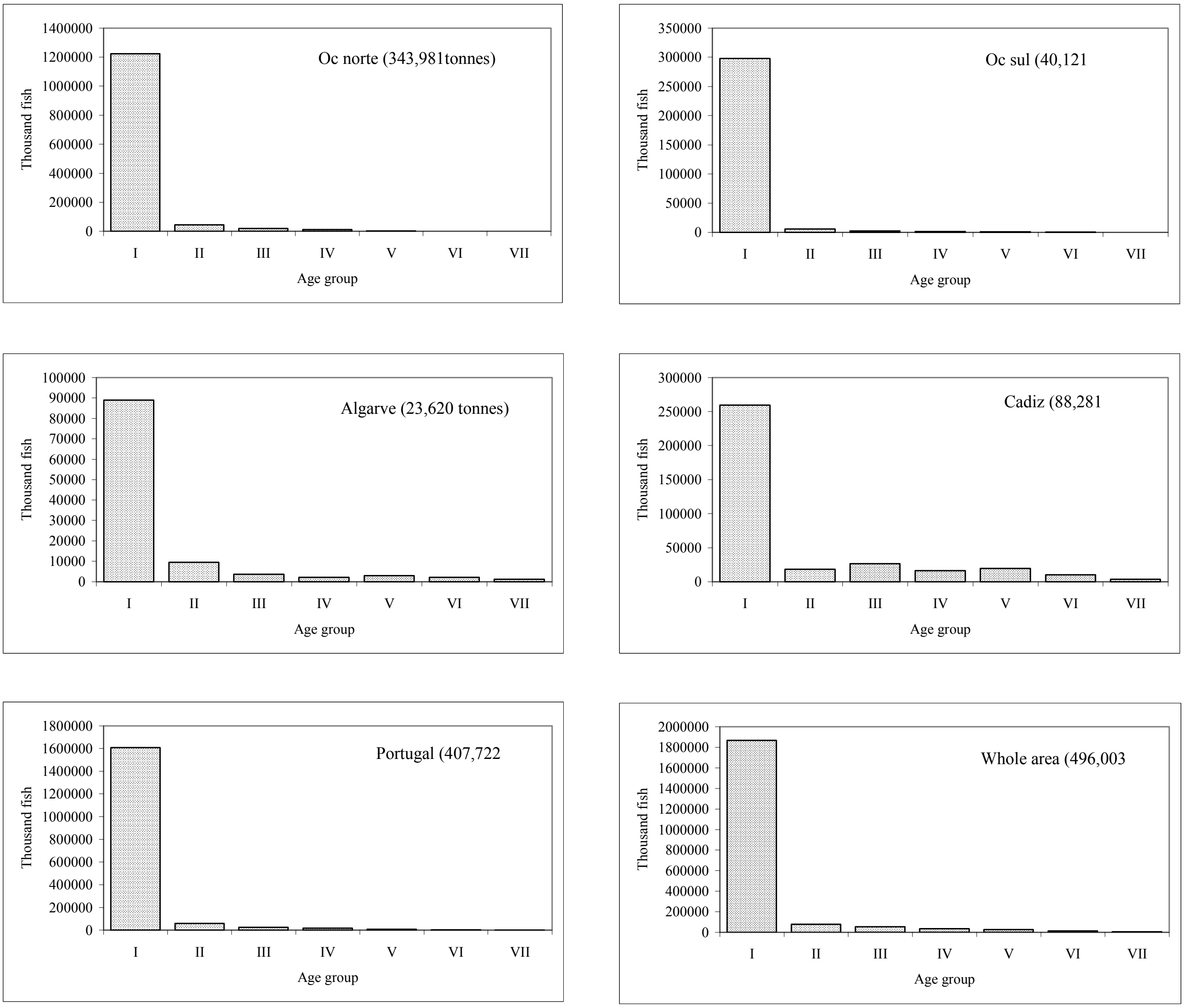


Figure 9.3.2.4: Estimated fish number of sardine (thousands) by area for the Portuguese Spring Acoustic survey 2001.

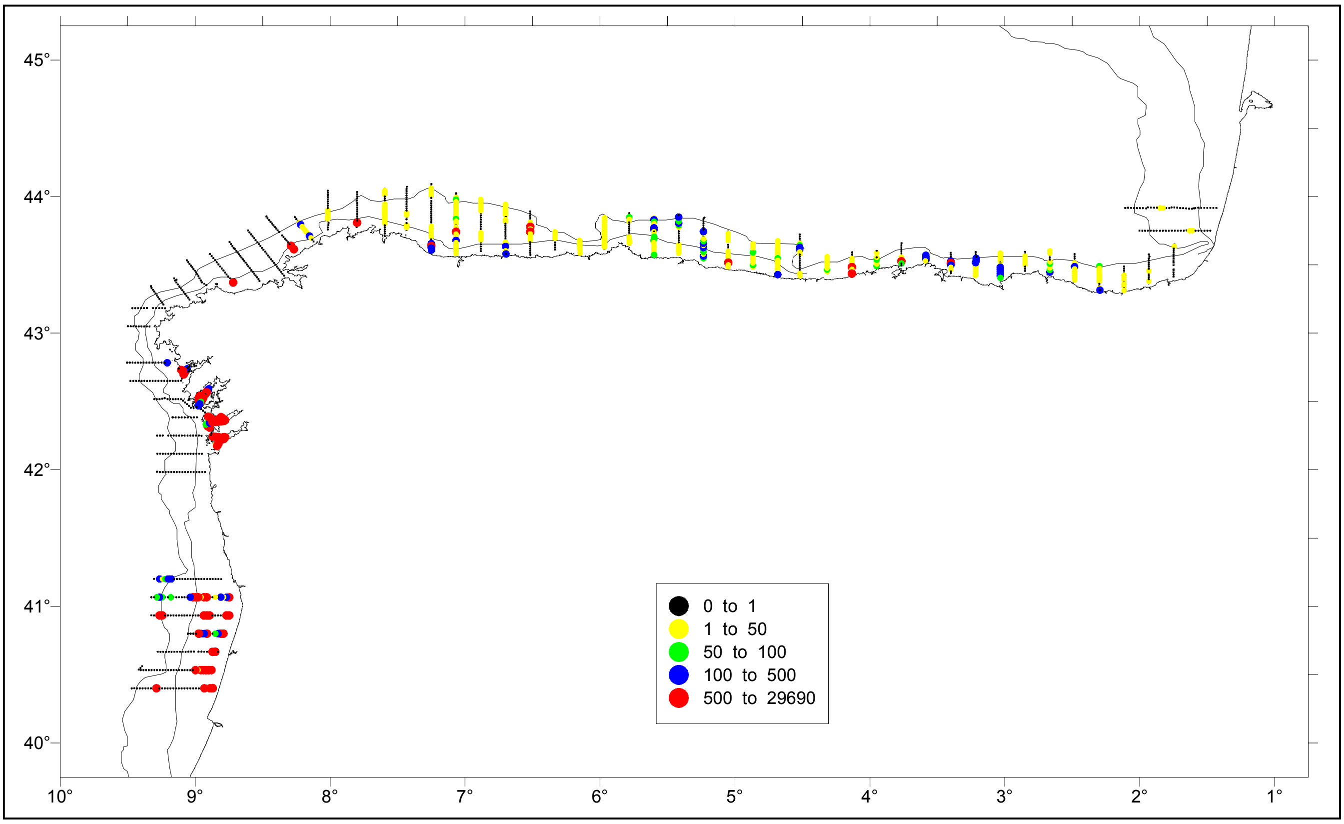


Figure 9.3.2.5: Sardine distribution as derived from the acoustic records during the Spanish Spring Acoustic survey 2001.

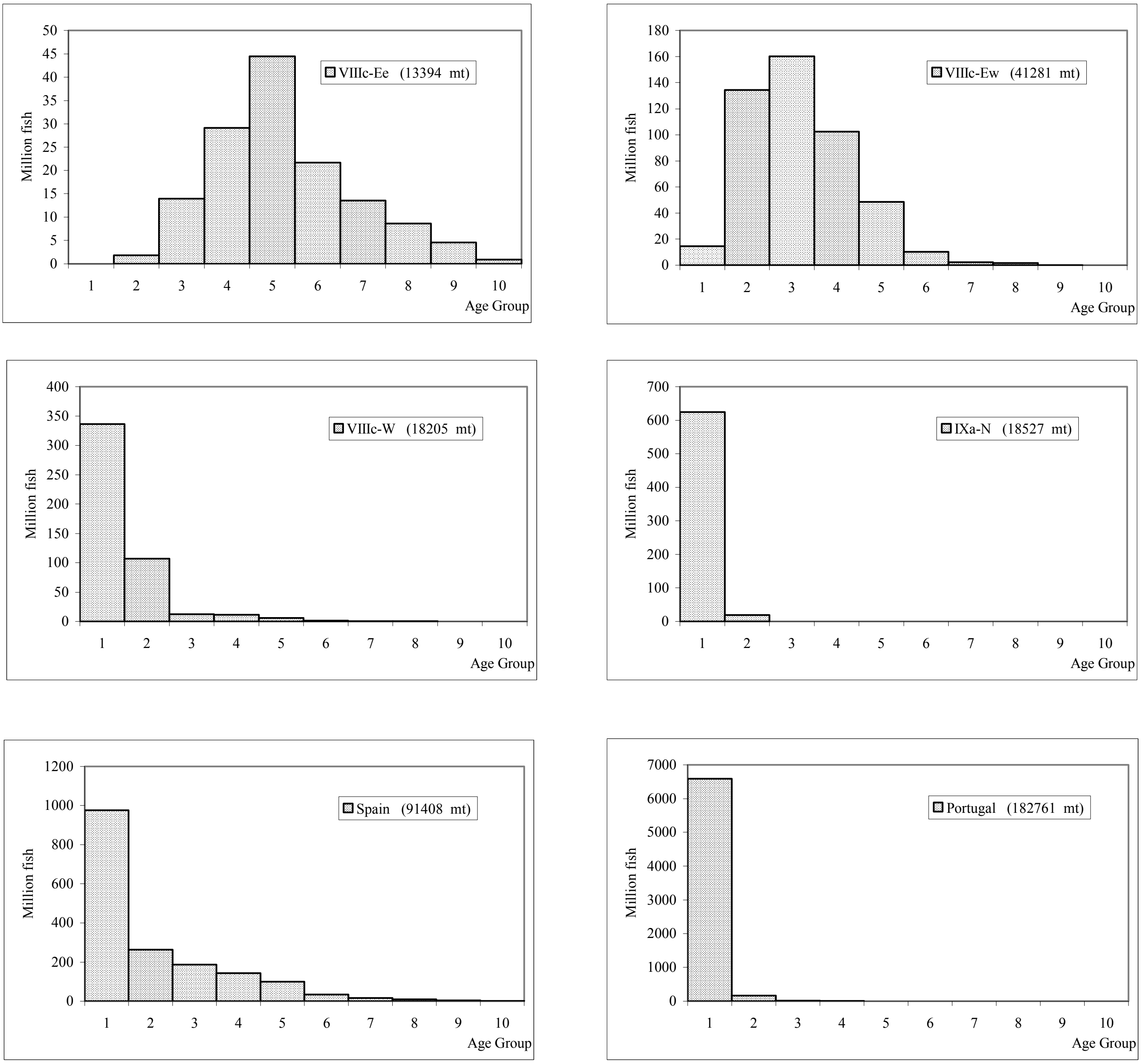


Figure 9.3.2.6: Estimated fish number of sardine (millions) by area for the Spanish Spring Acoustic survey 2001.

9.4 Biological data

Biological data were provided by Spain and Portugal. In Spain samples for ALK were pooled on a half year basis for each Sub-Division while the length/weight relationship was calculated for each quarter. In Portugal both ALK and L/W relationship were compiled on a quarterly and Sub-Division basis (ALK's for the 3rd and 4th quarter in Sub-Division IXa-South were pooled). Data from Cadiz were obtained using the length distribution of the Spanish landings and the ALK and L/W from IXa South-Algarve.

9.4.1 Catch numbers at age

Landings were grouped by length classes (0.5 cm) and later applied on a quarterly basis to the ALK of each Sub-Division. Table 9.4.1.1 shows the quarterly length distribution. Mean length from the Cantabrian Sea (VIIIc) is the highest in the area whilst in IXa-CS and IXa-S had also higher mean length than the surrounding areas. As in previous years, the smallest fish were caught in IXa-CN.

Table 9.4.1.2 shows the catch-at-age in numbers for each quarter and Sub-Division. In Table 9.4.1.3, the relative contribution of each age group in each Sub-Division is shown as well as their relative contribution to the catches.

Total sardine catch was 1,770 million fish, which remains more or less at the same level of the previous years. Age group 0 represented 28 % of the total catch in number (Table 9.4.1.3) and 67% of this age group was caught in IXa-CN. In addition, 65% of the age group 1 was caught in this area. The older fish (i.e. 2+) were taken in IXa-CS and IXa-S. Age group 0 was only predominant in IXa-N, IXa-CN and IXa Cadiz with 38, 48 and 37% respectively of the total catches in number in these areas.

Since 1978 the contribution of younger fish (i.e. age groups 0, 1 and 2) on the total catch in number followed a decreasing trend reaching the minimum in 1995 when most of the fish caught were older than 2. Since then, there has been an increasing trend and the younger fish provided 60 % of the total fish caught during 2000, still far from the 80% achieved at the beginning of the time series.

9.4.2 Mean length and mean weight at age

Mean length and mean weight at age by quarter and Sub-Division are shown in Tables 9.4.2.1 and 9.4.2.2. As previously observed, higher mean length for each age group and quarter occurred in the Cantabrian Sea (VIIIc) followed by those obtained in IXa-S. In the same way, mean weights at age were consistently higher in VIIIc.

9.4.3 Maturity at age

The maturity ogive for 2000 was based on biological samples collected during the spawning period. In the Portuguese area samples were taken during the acoustic survey undertaken in November 1999. Age groups were shifted one year. In the Spanish area, samples were also collected during the acoustic survey performed in 2000. Samples for each country were weighted according to the results of the acoustic surveys, giving a mean weighted factor for the Portuguese samples of about 90 %. The maturity ogive is presented below:

Age	0	1	2	3	5	5	6+
% mature fish	0	25.7	91.0	94.7	95.0	100	100

It should be noted that the very low maturity of the age group 1 is only comparable to that calculated for the age group 1 in 1989. In order to check whether this proportion of mature fish at age 1 calculated in November 1999 was consistent, a new ogive was calculated from samples obtained during the Portuguese acoustic survey undertook in March 2000. This new ogive gave similar results, with a high proportion of fish belonging to age group 1 which were still virgin.

9.4.4 Natural mortality

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

Table 9.4.1.1: Length composition (thousands) by quarted and ICES Sub-Division

First Quarter

Length	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Total
7								
7.5								
8								
8.5								
9								
9.5								
10			4					4
10.5			1					1
11	17		5	1				23
11.5	17		10	4	32		11	74
12	34		25	62	43		16	180
12.5	85		19	203	136		90	533
13	355	0	69	1183	61		132	1801
13.5	391		37	1513	72		195	2208
14	385		39	5345	207		583	6558
14.5	194	0	30	7733	416		1208	9581
15	37	1	30	7451	1110	5	1086	9719
15.5	77	3	40	11930	698		800	13547
16	60	3	44	7263	1884	71	832	10157
16.5	5	23	30	6569	1734	269	1288	9918
17	190	41	42	5492	2621	883	2015	11285
17.5	168	75	61	5131	5482	2551	3717	17186
18	767	43	24	2571	8422	5971	4704	22501
18.5	556	33	32	4504	13071	9813	5012	33020
19	1007	46	28	2315	22107	12271	5705	43480
19.5	1599	43	13	1993	23499	11815	3792	42753
20	3227	143	32	956	21887	11141	2126	39512
20.5	4446	234	65	546	11969	5722	738	23720
21	5799	363	126	311	5061	2783	112	14555
21.5	7144	654	165	197	1689	1039	55	10943
22	6508	465	167	6	602	299		8048
22.5	3969	439	159	2	116	87		4772
23	1921	301	19	1	31	37		2310
23.5	801	85	7					893
24	612	42	1		58	6		719
24.5	47	36						82
25	26	7				14		47
25.5	5							5
26	10							10
Total	40460	3080	1325	73282	123007	64777	34214	340147
Mean l	21.2	21.7	19.2	16.4	19.4	19.5	18.2	18.9
sd	1.95	1.51	3.48	1.71	1.30	1.00	1.62	2.11
Catch	**2953**	**239**	**77**	**2905**	**6436**	**3516**	**1562**	**17687**

Table 9.4.1.1: Cont'd

	Second Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8								
8.5								
9				22				22
9.5				194				194
10				876				876
10.5				2500				2500
11	0		93	5057				5150
11.5	0		98	7988				8086
12	0		107	6296	221			6625
12.5	1		60	6893	472			7426
13	3	1	12	1193	664			1873
13.5	6		39	796	613			1454
14	9		146	2011	794			2960
14.5	11	4	245	7657	1113			9031
15	36	9	480	8331	1793		58	10707
15.5	66	7	773	11446	3120		144	15557
16	67	10	1105	12373	4678		558	18791
16.5	177	22	1295	14433	5535	91	1747	23299
17	192	46	1613	11733	7839	401	3081	24904
17.5	368	146	1712	8876	8577	1108	2409	23195
18	456	327	1680	4903	7713	5665	1185	21930
18.5	995	680	1080	2979	8512	11695	827	26769
19	2054	609	967	2142	8673	16747	544	31734
19.5	2129	880	683	1398	8208	15831	514	29643
20	3200	1118	364	1002	10089	16080	1023	32877
20.5	3821	1649	171	999	5307	9155	580	21682
21	4007	2782	108	277	3304	4495	257	15231
21.5	3933	3505	28	46	1026	1349	133	10020
22	2670	4478	66	65	392	234		7906
22.5	2033	4042	68		123	68		6334
23	740	2536	9			41		3326
23.5	326	966		1	32			1325
24	119	466						585
24.5	7	77						84
25	5	15						20
25.5								
26		22.46735						22
Total	27431	24399	13005	122485	88800	82959	13059	372138
Mean l	20.9	21.8	17.5	15.5	18.4	19.7	18.1	18.1
sd	1.43	1.38	1.80	2.43	1.86	0.90	1.37	2.78
Catch	**2020**	**2040**	**574**	**3838**	**4469**	**4280**	**663**	**17884**

Table 9.4.1.1 Cont'd

	Third Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8			49					49
8.5			84					84
9			115	85				199
9.5			127	56				183
10			294	728			37	1059
10.5			553	3245			149	3946
11	9		1020	7660			929	9619
11.5	9		973	11720			2230	14932
12	18		1194	22506	73		818	24610
12.5	50		1245	20106	308		74	21783
13	200		1220	29790	404		223	31837
13.5	223		1560	20951	338		669	23741
14	231		1696	22214	132	58	1449	25780
14.5	113		2441	14252	334	162	1771	19074
15	32		2459	9409	529	2015	953	15396
15.5	23		2200	4382	846	2772	592	10815
16	1		1625	4382	1749	3348	544	11650
16.5	1		1886	5547	1733	1420	808	11395
17	11	6	2635	9846	2146	578	1849	17071
17.5	19	9	1988	16184	4072	1314	2456	26042
18	7	100	2471	13459	6847	6789	1784	31458
18.5	21	335	2905	15198	8892	10523	1757	39632
19	164	1157	3719	13661	10685	17799	2557	49742
19.5	407	1778	3461	11998	13815	21302	2511	55273
20	1198	1767	2751	11179	18078	18302	2397	55672
20.5	1556	1976	1559	4964	13141	9191	1234	33620
21	2177	1702	833	2333	7155	3866	778	18845
21.5	1797	1171	136	539	1882	1190	325	7038
22	1544	973	34	133	338	455	25	3501
22.5	979	1004	10	40	53	61		2147
23	557	539			8			1103
23.5	157	352	1		14			524
24	44	131	1		11			186
24.5	34	48						83
25	8							8
25.5	0							0
26	0							0
Total	11590	13049	43245	276567	93584	101146	28917	568098
Mean l	20.9	21.0	16.7	15.4	19.5	19.3	17.0	17.2
sd	2.29	1.32	2.91	2.91	1.52	1.39	3.00	3.14
Catch	**974**	**1088**	**1885**	**10009**	**6312**	**6413**	**1336**	**28016**

Table 9.4.1.1: Cont'd

	Fourth Quarter							
Length	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Total**
7								
7.5								
8								
8.5								
9								
9.5			4					4
10			4	295				299
10.5			7	651				658
11		45	24	948				1018
11.5		128	29	2052	76			2285
12	5	157	104	4375	238		276	5156
12.5	8	269	155	7620	759		459	9270
13	5	351	281	14303	1375		2092	18408
13.5	27	369	505	15747	2922	63	4545	24177
14	24	385	1138	20698	7686		6378	36309
14.5	8	246	1569	22885	10143	145	4298	39293
15	3	178	1418	23434	12891	464	2743	41131
15.5	3	56	902	19903	9946	620	1544	32975
16	6	35	462	14957	12338	2407	965	31169
16.5		28	212	5968	6759	3362	1117	17446
17	13	8	202	5921	5534	3697	2159	17532
17.5	11	1	177	6989	4956	2800	2354	17288
18	124		195	7787	5319	2984	2869	19276
18.5	127	6	252	5786	5294	7130	3216	21811
19	236	10	343	5983	6991	11868	2105	27535
19.5	649	208	219	5272	7725	14203	1416	29693
20	1600	462	261	4990	10075	16036	823	34247
20.5	2890	1260	115	3278	9157	8781	250	25731
21	2937	1191	154	1796	7047	3282	75	16482
21.5	3418	1179	112	616	3785	1271		10382
22	2737	1107	102	120	2117	211		6393
22.5	1890	1316	80	53	786	17		4142
23	1013	653	47		164			1877
23.5	454	498	22		117			1091
24	102	108	11					221
24.5	93	39						133
25	14	2						16
25.5	7							7
26	11							11
Total	18417	10296	9107	202426	134199	79341	39682	493468
Mean l	21.5	20.1	16.0	15.7	17.6	19.4	16.1	17.1
sd	1.23	3.55	2.44	2.22	2.53	1.38	2.19	2.77
Catch	**1601**	**783**	**331**	**6560**	**6483**	**4920**	**1520**	**22198**

Table 9.4.1.2: Catch in numbers ('000) at age by quarter and by SubDivision in 1999

	First Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	2277	123	425	50052	6221	5432	13253	77782
2	6633	406	216	25468	33604	13294	7581	87203
3	11432	812	65	6909	35190	13408	6088	73905
4	11152	919	201	3717	22123	13270	4087	55468
5	5670	519	119	339	10919	10792	2175	30534
6	2086	202	282	98	8267	8018	1008	19962
7	941	91		12	2143	738	22	3948
8	267	7	18		661	107		1060
9								
10								
11								
Total	40460	3080	1325	86595	119129	65058	34214	349862
Catch	2953	239	77	2905	6436	3516	1562	17687

	Second Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	1082	663	5911	107017	25970	1599	4979	147222
2	7405	3414	5387	12298	24578	18175	4909	76166
3	7993	6277	733	2989	17255	19870	1136	56254
4	6546	7177	791	2266	14682	14937	886	47286
5	2914	4430	64	263	5850	8621	648	22789
6	968	1720	103	398	949	5066	378	9581
7	392	704				1571	124	2790
8	131	15	15					162
9								
10								
11								
Total	27431	24399	13005	125232	89285	69841	13059	362251
Catch	2020	2040	574	3838	4469	4280	663	17884

	Third Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	916	10	18696	166585	3853	12077	14923	217061
1	1191	2904	8014	55049	11766	1372	1222	81518
2	3667	5731	11778	34979	17750	21895	3580	99380
3	2541	1764	3114	21520	26430	21239	3159	79767
4	2006	1409	1542	6219	24846	17840	2516	56378
5	827	754	34	1438	4592	14429	2105	24180
6	292	273	68	213	2585	5844	867	10142
7	122	144		67	206	2174	355	3068
8	28	59				772	189	1048
9								
10								
11								
Total	11590	13049	43245	286070	92030	97643	28917	572543
Catch	974	1088	1885	10009	6312	6413	1336	28016

	Fourth Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	96	2256	6423	160079	63571	12022	28328	272774
1	2000	834	821	19761	21017	2310	1557	48301
2	5883	2475	1045	9150	13309	14756	4603	51222
3	4396	1736	316	7705	13412	15494	2538	45597
4	3540	1552	230	3475	10788	13937	1503	35024
5	1592	890	87	963	3824	11995	838	20189
6	578	321	185		891	5035	225	7237
7	254	149			721	1924	70	3119
8	78	83			1408	666	20	2255
9								
10								
11								
Total	18417	10296	9107	201133	128941	78141	39682	485718
Catch	1601	783	331	6560	6483	4920	1520	22198

	Whole Year							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1012	2267	25119	326664	67424	24100	43251	489836
1	6549	4524	15171	231879	64975	10713	21011	354822
2	23588	12026	18426	81895	89242	68121	20673	313972
3	26362	10589	4227	39124	92287	70012	12921	255523
4	23245	11057	2763	15676	72439	59984	8993	194156
5	11004	6593	304	3003	25185	45838	5765	97693
6	3925	2516	639	709	12693	23964	2477	46922
7	1708	1088		79	3071	6407	572	12925
8	505	165	33		2069	1545	209	4526
9								
10								
11								
Total	97899	50824	66682	699030	429385	310683	115872	1770374
Catch	7547	4149	2866	23311	23701	19129	5081	85786

Table 9.4.1.3: Relative distribution of sardine catches. Upper pannel, relative contribution of each age group within each Sub-Division Lower pannel, relative contribution of each Sub-Division within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1.03	4.46	**37.67**	**46.73**	15.70	7.76	**37.33**	**27.67**
1	6.69	8.90	22.75	33.17	15.13	3.45	18.13	20.04
2	24.09	23.66	27.63	11.72	20.78	21.93	17.84	17.73
3	**26.93**	20.84	6.34	5.60	**21.49**	**22.53**	11.15	14.43
4	23.74	**21.75**	4.14	2.24	16.87	19.31	7.76	10.97
5	11.24	12.97	0.46	0.43	5.87	14.75	4.98	5.52
6+	6.27	7.42	1.01	0.11	4.15	10.27	2.81	3.64

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca
0	0.21	0.46	5.13	**66.69**	13.76	4.92	8.83
1	1.85	1.27	4.28	**65.35**	18.31	3.02	5.92
2	7.51	3.83	5.87	26.08	**28.42**	21.70	6.58
3	10.32	4.14	1.65	15.31	**36.12**	27.40	5.06
4	11.97	5.69	1.42	8.07	**37.31**	30.89	4.63
5	11.26	6.75	0.31	3.07	25.78	**46.92**	5.90
6+	9.54	5.85	1.05	1.22	27.70	**49.58**	5.06

Table 9.4.2.1: Mean length at age by quarter and ICES Sub-Division

	First Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	15.2	17.6	14.7	15.2	16.4	17.7	16.6	15.7
2	20.0	20.1	19.4	17.5	18.5	18.8	18.7	18.4
3	21.4	21.6	20.5	19.0	19.6	19.2	19.1	19.7
4	21.8	22.1	21.4	19.7	20.2	19.8	19.7	20.4
5	22.3	22.5	21.8	20.8	20.4	20.3	20.1	20.7
6	22.6	22.7	22.5	20.9	20.7	20.8	20.5	21.0
7	23.1	23.2		20.8	21.4	21.8	21.5	21.9
8	22.9	24.8	21.3		21.9	23.2		22.3
9								
10								
11								
Total	21.2	21.7	19.2	16.4	19.4	19.5	18.2	18.8

	Second Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	17.6	18.5	16.3	14.9	16.3	18.3	17.0	15.4
2	19.8	20.2	18.2	18.0	18.3	18.8	17.9	18.6
3	21.1	21.6	19.3	19.3	19.3	19.5	19.3	19.9
4	21.6	22.2	20.0	20.1	20.2	20.1	20.2	20.7
5	22.1	22.6	21.3	20.6	20.8	20.6	20.7	21.2
6	22.4	22.8	22.6	21.5	21.8	21.0	20.9	21.6
7	22.6	23.3				21.0	21.0	21.8
8	22.8	24.8	21.3					22.8
9								
10								
11								
Total	20.9	21.8	17.5	15.5	18.4	19.7	18.1	18.0

	Third Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	13.9	17.5	13.9	13.2	15.1	16.4	14.7	13.6
1	20.5	20.0	17.6	17.4	17.7	18.0	17.5	17.6
2	21.0	20.4	19.2	19.0	19.0	19.1	19.0	19.2
3	21.7	21.9	20.2	19.8	20.0	19.6	19.5	19.9
4	22.1	22.5	20.6	20.5	20.3	19.9	19.9	20.3
5	22.5	22.7	22.0	20.6	20.8	20.3	20.3	20.6
6	22.9	23.2	22.0	21.0	21.2	20.6	20.7	20.9
7	23.0	23.3		22.6	22.6	20.8	20.9	21.1
8	23.8	23.8				21.3	21.2	21.5
9								
10								
11								
Total	20.9	21.0	16.7	15.4	19.5	19.3	17.0	17.2

	Fourth Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	14.2	13.7	14.7	14.8	15.4	16.9	14.9	15.1
1	20.3	20.7	17.3	17.7	18.0	17.5	17.6	18.0
2	21.0	21.1	19.0	19.2	19.8	19.3	18.7	19.6
3	21.8	22.1	20.4	20.2	20.4	19.6	19.2	20.2
4	22.1	22.5	21.2	21.0	20.9	20.0	19.5	20.7
5	22.6	22.9	22.6	20.8	21.3	20.4	19.8	20.8
6	23.0	23.1	22.7		22.0	20.6	20.2	21.1
7	23.2	23.1			21.5	20.8	20.3	21.3
8	23.8	23.8			22.6	21.3	21.1	22.3
9								
10								
11								
Total	21.5	20.1	16.0	15.7	17.6	19.4	16.1	17.1

	Whole Year							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	13.9	13.8	14.1	14.0	15	17	14.9	14.4
1	18.1	19.9	17.0	15.8	17.1	17.8	16.8	16.3
2	20.3	20.5	18.9	18.4	18.7	19.0	18.6	18.9
3	21.4	21.7	20.0	19.7	19.7	19.5	19.2	19.9
4	21.8	22.3	20.5	20.4	20.3	19.9	19.8	20.5
5	22.3	22.6	21.9	20.7	20.7	20.4	20.2	20.8
6	22.6	22.9	22.5	21.3	21.0	20.7	20.6	21.1
7	23.0	23.2		22.3	21.5	20.9	20.9	21.5
8	23.0	23.9	21.3		22.4	21.5	21.2	22.1
9								
10								
11								
Total	21.1	21.2	16.8	15.6	18.7	19.5	17.2	17.6

Table 9.4.2.2: Mean weight at age by quarter and ICES Sub-Division

	First Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	0.028	0.042	0.025	0.026	0.033	0.042	0.035	0.029
2	0.061	0.062	0.056	0.040	0.046	0.048	0.049	0.046
3	0.074	0.076	0.065	0.052	0.055	0.051	0.052	0.057
4	0.079	0.081	0.074	0.059	0.060	0.056	0.057	0.063
5	0.083	0.086	0.078	0.069	0.062	0.060	0.061	0.066
6	0.087	0.089	0.086	0.071	0.065	0.063	0.065	0.067
7	0.093	0.095		0.069	0.071	0.072	0.074	0.077
8	0.090	0.113	0.072		0.077	0.085		0.081
9								
10								
11								
Total	0.073	0.078	0.058	0.034	0.054	0.054	0.047	0.051

	Second Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	0.044	0.051	0.035	0.027	0.035	0.052	0.039	0.030
2	0.062	0.066	0.048	0.046	0.048	0.055	0.046	0.051
3	0.075	0.081	0.058	0.056	0.056	0.060	0.058	0.063
4	0.081	0.087	0.064	0.064	0.064	0.064	0.065	0.070
5	0.086	0.092	0.077	0.068	0.069	0.068	0.071	0.075
6	0.090	0.096	0.092	0.078	0.079	0.071	0.073	0.079
7	0.092	0.101				0.071	0.074	0.082
8	0.094	0.121	0.076					0.095
9								
10								
11								
Total	0.074	0.084	0.044	0.031	0.050	0.061	0.048	0.049

	Third Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.022	0.045	0.023	0.019	0.030	0.045	0.028	0.022
1	0.076	0.071	0.047	0.046	0.050	0.056	0.046	0.048
2	0.082	0.076	0.062	0.061	0.062	0.064	0.060	0.064
3	0.092	0.095	0.072	0.070	0.073	0.067	0.065	0.071
4	0.097	0.103	0.078	0.077	0.078	0.070	0.069	0.076
5	0.103	0.107	0.095	0.079	0.084	0.073	0.074	0.078
6	0.109	0.114	0.095	0.084	0.089	0.075	0.078	0.081
7	0.111	0.115		0.106	0.111	0.077	0.081	0.083
8	0.124	0.123				0.082	0.085	0.086
9								
10								
11								
Total	0.084	0.083	0.044	0.035	0.069	0.066	0.046	0.049

	Fourth Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.023	0.021	0.026	0.026	0.030	0.042	0.027	0.028
1	0.072	0.075	0.043	0.048	0.051	0.046	0.045	0.050
2	0.080	0.081	0.059	0.062	0.069	0.062	0.055	0.066
3	0.089	0.094	0.073	0.075	0.077	0.065	0.059	0.073
4	0.094	0.100	0.082	0.086	0.083	0.068	0.062	0.078
5	0.101	0.105	0.100	0.083	0.089	0.072	0.066	0.079
6	0.107	0.109	0.102		0.099	0.074	0.070	0.082
7	0.110	0.109			0.091	0.077	0.071	0.084
8	0.119	0.118			0.108	0.082	0.080	0.101
9								
10								
11								
Total	0.087	0.076	0.036	0.033	0.050	0.063	0.036	0.045

	Whole Year							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.022	0.021	0.024	0.022	0.030	0.043	0.028	0.025
1	0.053	0.068	0.041	0.033	0.043	0.046	0.038	0.037
2	0.069	0.074	0.057	0.052	0.053	0.058	0.051	0.056
3	0.079	0.085	0.070	0.067	0.063	0.062	0.057	0.066
4	0.083	0.091	0.074	0.073	0.070	0.065	0.062	0.071
5	0.088	0.095	0.086	0.078	0.072	0.069	0.068	0.074
6	0.092	0.099	0.093	0.079	0.073	0.070	0.071	0.075
7	0.097	0.104		0.100	0.079	0.075	0.078	0.081
8	0.097	0.120	0.074		0.098	0.082	0.085	0.093
9								
10								
11								
Total	0.077	0.082	0.043	0.033	0.055	0.062	0.043	0.048

9.5 Effort and catch per unit effort

Data on fishing effort and CPUE have been regularly provided in this section both for the Portuguese purse-seine fleet and Spanish purse-seine fleets from Sada and Vigo-Ribeira. However, it was recognised that the effort measure used in these CPUE series did not take into account the searching time, a factor that may influence effort estimates for pelagic fish. Furthermore, there was some indication that the Spanish fleets have gradually changed their target species to other pelagic species (mainly horse mackerel) and there is some indication that this might have also happened in Portugal during a short period in 1999 due to the large abundance of Spanish mackerel in the central area. These changes are probably impossible to evaluate.

Since it was not possible to get new information on fishing effort that enables the improvement of the estimates, effort and CPUE estimates will not be provided for 2000.

9.6 Recruitment forecasting and Environmental effects

Previous works have suggested that year class strength of the Iberian sardine is affected by hydroclimatic conditions in the North Atlantic (Borges *et al*., 1997; Santos *et al*., 1997, Cabanas and Porteiro, 1999 in press, Borges *et al*., 2000). The hypothesis of a negative impact of winter upwelling on sardine recruitment, possibly through the induction of offshore transport of larvae to areas with unfavourable feeding conditions, has been suggested by Santos et al. (1997). Strong winter north winds appear to have a negative impact on sardine recruitment but when winds are weak other factors become important in recruitment strength. Dependence of recruitment on both large and meso-scale (local) oceanographic events has been explored further (Porteiro *et al*., WD 2001) and the main results are presented in Section 9.16.

The spawning period of sardine is broad and different peaks occur at different locations and periods (Southern part, Central part –North Portugal- and Cantabrian Sea). Therefore, the recruitment process in sardine is the outcome of a large time/spatial integral that accounts for different oceanographic regimes along the Atlantic waters of the Iberian peninsula. Off the northern coast, spring upwelling may be a determinant of recruitment strength, however in the southern area or in the Cantabrian sea there could be other oceanographic processes which determine recruitment strength. These areas, especially the Gulf of Cadiz and surrounded area, may show strong recruitments in distinct years further suggesting distinct relations with environmental factors. In addition, the changes observed in both stock age structure and distribution, makes it difficult to establish a single relationship between sardine recruitment and a particular environmental event. Therefore, these relationships will possibly have to be analysed at a finer spatial scale than the whole stock area.

9.7 State of the stock

9.7.1 Data exploration

Last year, a series of preliminary analyses were carried out aiming to assess i) the effect of the different tuning data in the assessment model and, ii) the effect of the separable period in the assessment model. The above exploration indicated that the model is sensitive to which tuning fleets are included, namely because they cover parts of the stock which were shown to follow different trajectories along the time series (evident also in catch-at-age data). The assessment model showed less sensitivity to the choice of the separable period and the model fit was improved when the change in the selection pattern was set to 1993. A model constructed with 13 years of separable period (divided from 1987 to 1993 and from 1994 to 1999 with an abrupt change in selection between periods) including all the available tuning fleets as relative indices (Spanish March, Portuguese March and Portuguese November acoustic surveys) and DEPM spawning biomass as an absolute estimator was adopted as the most appropriate to represent the dynamic of this stock.

Considering the different signals given by the acoustic surveys covering different parts of the stock, the hypothesis of combining data from the two March acoustic surveys (Spanish and Portuguese), which would then represent the total stock area, was discussed this year. The smaller number of years available for the Portuguese series (7 years) than for the Spanish series (13 years) would require six years of data to be discarded from the latter series, leading to a different set of input data with large gaps in the earlier period. The WG decided not to pursue this approach but considered that it would be worthwhile exploring in the future when more common years are available for the two survey series.

Input data, including catch-at-age and abundance at age from the acoustic surveys was updated to 2000 and the assessment model was run with the same options as in the previous year. Since no conclusive information on population structure or migration dynamics were available to the WG which could provide a basis to change the previous assessment, and that the assessment model was extensively checked in the last two years to explore the sensitivity to different assumptions and input data (ICES CM 2000/ACFM:5, ICES CM 2001/ACFM:6), the WG decided to accept the above model as the most appropriate to represent the dynamic of this stock.

9.7.2 Stock assessment

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:

$$\sum_{0}^{6+}\sum_{1987}^{1993}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{1,a}\cdot \overline{N}_{ay}\right)\right]^2+\sum_{0}^{6+}\sum_{1994}^{2000}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{2,a}\cdot \overline{N}_{ay}\right)\right]^2+$$

$$+\sum_{1987}^{1993}\left[\ln\left(DEPM_y\right)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{1,a}-PM\cdot M)\right)\right]^2+$$

$$\sum_{1994}^{2000}\left[\ln\left(DEPM_y\right)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{2,a}-PM\cdot M)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

$$+\sum_{1987}^{1993}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{2000}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

With constraints on $S_{13} = S_{15} = S_{23} = S_{25}=1.0$

and $\overline{N}$ average exploited abundance over the year

N: population abundance on 1st January
Oa,y: maturity ogive
M: 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 1987–1993 and 1994–2000 respectively
DEPM: SSB estimation from the daily egg production method
Q_{ANP}, Q_{ASP}, Q_{ASS}: Catchability of the linear indices from Portuguese (P) March, November (N) 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 9.7.2.1 and Figure 9.7.2.1. CV's expressed in % of the parameter estimates are similar to previous assessments and are mainly in the range 15-30%. In general, the range and the pattern of residuals both for the separable model and for the tuning fleets are similar to those of last year's assessment. Large negative residuals appear in the last year of data for the Portuguese acoustic surveys (2000 in November and 2001 in March) mainly for age groups 2-4 while the age group corresponding to the 2000 year-class shows a positive residual. Both the Portuguese and the Spanish acoustic surveys indicate a strong 2000 recruitment although not reflected with a similar strength as 0-group catches. The Portuguese surveys also estimate one of the lowest absolute and relative abundances of adult fish in the whole time series with percentages of 7% in November (age groups 1-6+) and 11% in March (age groups 2-6+), suggesting either increased mortality or that the distribution of these fish was such that their accessibility to the surveys was decreased.

Figure 9.7.2.2 shows the estimated recruitment, F2–5 and SSB for the whole time series showing a general similarity in the trajectories provided by the models fitted this year and in the assessment made in 2000. Lower estimates of recruitment are provided for the three most recent years (1997-1999) and there is no indication of an above average recruitment in 1998 as previously conjectured. Strong year classes are observed in 1983 and 1991/1992 but with decreasing strength in that order and a large 2000 year-class is clearly indicated although its magnitude is still uncertain (a 40% CV is attached to this estimate). Fishing mortality shows a decrease of 17% in 2000 relative to 1999, possibly partly influenced by a decrease in the fleet effort due to bad weather conditions in the last four months of the year. The lower SSB estimated this year for 1999 is mainly due to the lower 1998 estimate of recruitment. Estimated SSB again shows two clear periods of higher abundance (1981–87 and 1992–96) and seems to be stable after a declining period up to 1997. At present the stock is considered to be at a low level, similar to that observed in 1990, although the indications of an above average recruitment in 2000 increase the expectations of a short-term recovery of the SSB.

9.7.3 Reliability of the assessment model

Current knowledge on sardine stock dynamics (WD's in ICES 2000, Stratoudakis *et al*, WD 2001, Porteiro *et al*., WD 2001) indicates important changes in sardine distribution, abundance and population structure have taken place since the early nineties. A change of the sardine distribution towards southern areas and a reduction of the overall sardine distribution area combined with low recruitment values in recent years have influenced both the catch distribution by areas and the age composition of the catches in each area. The combination of these changes leads to a different perception of the stock depending on the area considered and, as a consequence, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if geographic/temporal differences are not considered. The large variability in recruitment, which shows good correlations with several environmental indices but little dependence on stock size (Porteiro *et al*., WD 2001), adds noise to the performance of the model and makes it difficult to conform to the separability assumption.

The WG considers that previous exploratory analyses improved the fit of the model and the precision of the parameter estimates to acceptable levels, taking into account the available input data and the inability of the model to incorporate all the characteristics of the dynamic of this stock. The present model is shown to be robust (both in relation to goodness-of fit and stock trajectory) to the addition of new input data but uncertainties about accuracy of estimates and therefore of absolute stock levels still remain. Little confidence can be attached to the large 2000 recruitment estimate (1.3 times higher than the maximum of the series, with a 41% CV), although the auxiliary information points to an above average year class.

Table 9.7.2.1a: Input values for the assessment model

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	1999	2000
0	120.8	30.5	277.1	208.6	449.1	246.0	489.8
1	60.2	189.1	101.3	548.6	366.2	475.2	354.8
2	542.2	280.7	347.7	453.3	501.6	361.5	314.0
3	1094.4	829.7	514.7	391.1	352.5	339.7	255.5
4	272.5	472.9	652.7	337.3	233.7	177.2	194.2
5	112.6	70.2	197.2	225.2	178.7	105.5	97.7
6	72.1	64.5	46.6	70.3	105.9	72.2	64.4

x 10 ^ 6

Table 9.7.2.1a (cont): Input values for the assessment model

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994
0	634.7	395.3	401.8	409.8	752.3	502.7	212.6	102.6
1	537.0	897.4	564.5	612.2	454.0	969.6	711.2	153.0
2	622.6	545.0	919.7	614.9	488.7	427.9	1008.2	538.8
3	552.6	472.4	417.5	746.1	367.9	351.6	341.8	794.2
4	685.4	289.2	249.8	233.6	306.8	184.7	197.2	209.9
5	189.3	326.3	139.1	127.1	87.2	140.1	94.3	99.4

x 10 ^ 6

Predicted Catch in Number

AGE	1995	1996	1997	1998	1999	2000
0	79.8	168.2	176.9	266.7	235.2	760.4
1	152.0	181.0	311.7	295.0	335.3	302.3
2	235.9	354.0	339.1	520.4	374.5	441.0
3	606.3	392.8	459.1	384.1	452.6	346.3
4	494.5	556.1	271.3	270.8	173.0	222.5
5	93.7	328.3	276.4	114.6	86.5	60.6

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 9.7.2.1a (cont): Input values for the assessment model

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.02000	0.02500	0.01900	0.02200	0.02400	0.02500	0.02500
1	0.03600	0.04700	0.03800	0.03300	0.04000	0.04200	0.03700
2	0.05800	0.05900	0.05100	0.05200	0.05500	0.05600	0.05600
3	0.06200	0.06600	0.05800	0.06200	0.06100	0.06500	0.06600
4	0.07000	0.07100	0.06100	0.06900	0.06400	0.07000	0.07100
5	0.07600	0.08200	0.07100	0.07300	0.06700	0.07300	0.07400
6	0.10000	0.10000	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

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.03100	0.02900	0.03600	0.02500	0.02300	0.02000	0.01700
2	0.04000	0.05000	0.04700	0.05000	0.04100	0.03900	0.04300
3	0.04900	0.06200	0.06100	0.05800	0.05300	0.05400	0.05900
4	0.06000	0.07200	0.06900	0.06800	0.06100	0.06200	0.06400
5	0.06700	0.07900	0.07500	0.07400	0.06700	0.06800	0.06700
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Table 9.7.2.1a (cont): Input values for the assessment model

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

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000
0	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
2	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
4	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
6	0.33000	0.33000	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

Table 9.7.2.1a (cont): Input values for the assessment model

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

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.8000	0.7300	0.8300	0.7270	0.7200	0.6190	0.2570
2	0.8900	0.9800	0.8900	0.9180	0.9240	0.9110	0.9100
3	0.9600	0.9700	0.9200	0.9500	0.9560	0.9870	0.9470
4	0.9600	0.9900	0.9600	0.9720	0.9870	0.9950	0.9500
5	0.9700	1.0000	1.0000	0.9930	0.9950	1.0000	1.0000
6	1.0000	1.0000	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	*******	*******	*******	*******	*******	*******	*******	147.90

x 10 ^ 3

INDEX1

	1998	1999
1	*******	215.50

x 10 ^ 3

Table 9.7.2.1a (cont): Input values for the assessment model

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	2000	2001
1	*******	*******	10.6	56.5	509.8	214.5	91.7	975.6
2	*******	*******	54.2	263.1	103.1	160.4	285.8	262.9
3	*******	*******	90.5	125.7	80.4	134.6	435.4	186.5
4	*******	*******	350.8	123.3	33.8	124.3	242.2	142.9
5	*******	*******	213.8	65.7	20.6	28.4	188.9	98.9
6	*******	*******	24.8	61.0	25.4	64.0	68.1	66.1

x 10 ^ 3

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

AGE	1996	1997	1998	1999	2000	2001
1	1625.	6344.	1636.	5712.	6581.	18684.
2	2082.	3238.	4015.	2553.	2170.	774.
3	2415.	1552.	2191.	1461.	1222.	515.
4	2906.	1260.	1434.	844.	757.	337.
5	386.	1360.	1185.	596.	532.	276.
6	12.	203.	980.	469.	613.	184.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	2957.	2063.	2493.	3715.	999990.	999990.	999990.	999990.
1	5733.	2744.	1612.	2379.	999990.	999990.	999990.	999990.
2	1152.	4548.	1670.	1344.	999990.	999990.	999990.	999990.
3	1037.	1083.	658.	929.	999990.	999990.	999990.	999990.
4	528.	839.	323.	666.	999990.	999990.	999990.	999990.
5	76.	144.	127.	236.	999990.	999990.	999990.	999990.
6	40.	70.	50.	80.	999990.	999990.	999990.	999990.

x 10 ^ 6

Table 9.7.2.1a (cont): Input values for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	6349.	999990.	999990.	999990.	999990.	2425.	8680.	3697.
1	5481.	999990.	999990.	999990.	999990.	1961.	1809.	798.
2	1157.	999990.	999990.	999990.	999990.	906.	1215.	646.
3	1003.	999990.	999990.	999990.	999990.	729.	823.	391.
4	437.	999990.	999990.	999990.	999990.	1041.	396.	459.
5	108.	999990.	999990.	999990.	999990.	772.	367.	382.
6	19.	999990.	999990.	999990.	999990.	322.	220.	165.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	2000
0	30871.
1	1616.
2	247.
3	90.
4	122.
5	94.
6	66.

x 10 ^ 6

Table 9.7.2.1b: Output values for the assessment model

Fishing Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07698	0.05287	0.06238	0.11405	0.00822	0.05257	0.01519	0.04040
1	0.45074	0.21792	0.25730	0.22479	0.13940	0.11261	0.26273	0.10702
2	0.44887	0.40080	0.41952	0.42426	0.41092	0.25309	0.15059	0.35448
3	0.45903	0.44502	0.31785	0.37908	0.35831	0.36257	0.26731	0.24480
4	0.37438	0.72390	0.33465	0.31251	0.40510	0.32046	0.25941	0.28702
5	0.63886	0.55957	0.46557	0.45743	0.41748	0.32586	0.34266	0.32108
6	0.63886	0.55957	0.46557	0.45743	0.41748	0.32586	0.34266	0.32108

Fishing Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.05342	0.06603	0.06574	0.06612	0.07135	0.05523	0.04900	0.04749
1	0.17548	0.14445	0.14382	0.14465	0.15608	0.12083	0.10720	0.10390
2	0.33454	0.24794	0.24686	0.24828	0.26791	0.20740	0.18401	0.17833
3	0.26130	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367
4	0.31935	0.36944	0.36783	0.36994	0.39920	0.30903	0.27418	0.26572
5	0.36762	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367
6	0.36762	0.35268	0.35115	0.35316	0.38109	0.29501	0.26174	0.25367

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.02217	0.02100	0.03074	0.03723	0.04085	0.03362	0.02802
1	0.04989	0.04724	0.06916	0.08376	0.09192	0.07565	0.06304
2	0.12254	0.11603	0.16986	0.20572	0.22576	0.18580	0.15483
3	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354
4	0.28293	0.26791	0.39219	0.47498	0.52126	0.42900	0.35750
5	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354
6	0.24023	0.22747	0.33299	0.40329	0.44258	0.36425	0.30354

Population Abundance (1 January)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	13749.	15354.	16603.	11140.	8893.	24496.	9187.	7939.
1	7341.	9152.	10470.	11215.	7146.	6341.	16709.	6505.
2	3036.	3363.	5291.	5820.	6439.	4469.	4073.	9237.
3	930.	1393.	1619.	2501.	2737.	3070.	2494.	2519.
4	509.	423.	642.	847.	1231.	1375.	1536.	1373.
5	102.	251.	147.	330.	446.	590.	718.	852.
6	40.	97.	93.	242.	439.	582.	469.	436.

x 10 ^ 6

Table 9.7.2.1b (cont): Output values for the assessment model

Population Abundance (1 January)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	6851.	11641.	7281.	7360.	6973.	16413.	12325.	5375.
1	5481.	4669.	7834.	4902.	4953.	4668.	11166.	8437.
2	4202.	3306.	2905.	4878.	3049.	3046.	2974.	7211.
3	4659.	2162.	1855.	1632.	2736.	1677.	1780.	1779.
4	1418.	2579.	1092.	939.	824.	1344.	898.	985.
5	741.	741.	1281.	544.	466.	397.	709.	491.
6	631.	669.	742.	957.	909.	480.	408.	626.

x 10 ^ 6

Population Abundance (1 January)

AGE	1994	1995	1996	1997	1998	1999	2000	2001
0	5492.	4508.	6518.	5679.	7813.	8343.	32285.	9046.
1	3685.	3862.	3173.	4544.	3934.	5392.	5800.	22569.
2	5467.	2520.	2648.	2129.	3005.	2580.	3594.	3915.
3	4338.	3477.	1613.	1606.	1246.	1724.	1540.	2213.
4	992.	2452.	1991.	831.	772.	575.	861.	817.
5	543.	538.	1349.	967.	372.	329.	269.	433.
6	394.	370.	191.	246.	343.	275.	286.	295.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994
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	1995	1996	1997	1998	1999	2000
0	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
2	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
4	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

Table 9.7.2.1b (cont): Output values for the assessment model

Predicted SSB Index Values

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	437.09	*******

x 10 ^ 3

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	363.60

x 10 ^ 3

INDEX1

	1998	1999
1	*******	293.20

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	115.04	98.63	165.52	*******	104.36	99.10	237.72	179.75
2	159.30	127.65	112.19	*******	117.23	118.60	116.37	282.50
3	352.38	160.42	137.69	*******	201.79	125.95	134.60	134.76
4	201.88	363.42	153.98	*******	115.40	191.74	129.04	141.82
5	164.43	164.94	285.51	*******	103.21	89.60	160.99	111.56
6	277.42	295.07	327.44	*******	398.66	214.06	183.35	281.86

x 10 ^ 3

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	68.10	97.23	84.02	115.56	124.63	484.98
2	*******	*******	103.92	82.92	116.54	100.90	141.49	154.12
3	*******	*******	120.22	117.93	90.72	127.58	115.46	165.92
4	*******	*******	279.24	114.59	105.31	80.07	121.60	115.46
5	*******	*******	301.64	213.11	81.25	73.18	60.62	97.40
6	*******	*******	84.79	107.29	148.64	120.90	127.58	131.41

x 10 ^ 3

Table 9.7.2.1b (cont): Output values for the assessment model

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Predicted

AGE	1996	1997	1998	1999	2000	2001
1	2593.	3702.	3199.	4400.	4746.	18468.
2	2011.	1605.	2255.	1953.	2738.	2983.
3	1391.	1365.	1050.	1476.	1336.	1920.
4	2283.	937.	861.	655.	994.	944.
5	1621.	1145.	437.	393.	326.	523.
6	160.	203.	281.	229.	241.	249.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	4372.	3687.	3143.	5276.	999990.	999990.	999990.	999990.
1	5174.	2339.	1846.	1620.	999990.	999990.	999990.	999990.
2	1356.	2528.	1172.	1002.	999990.	999990.	999990.	999990.
3	808.	833.	1517.	645.	999990.	999990.	999990.	999990.
4	720.	627.	628.	1089.	999990.	999990.	999990.	999990.
5	240.	290.	242.	245.	999990.	999990.	999990.	999990.
6	98.	93.	129.	138.	999990.	999990.	999990.	999990.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	5678.	999990.	999990.	999990.	999990.	2646.	3627.	3901.
1	4014.	999990.	999990.	999990.	999990.	1671.	1435.	1998.
2	959.	999990.	999990.	999990.	999990.	672.	930.	830.
3	579.	999990.	999990.	999990.	999990.	456.	341.	508.
4	415.	999990.	999990.	999990.	999990.	317.	281.	229.
5	256.	999990.	999990.	999990.	999990.	305.	113.	108.
6	92.	999990.	999990.	999990.	999990.	48.	65.	56.

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Predicted

AGE	2000
0	15175.
1	2175.
2	1191.
3	482.
4	367.
5	93.
6	62.

x 10 ^ 6

Table 9.7.2.1b (cont): Output values for the assessment model

Fitted Selection Pattern

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.1677	0.1188	0.1963	0.3009	0.0229	0.1450	0.0568	0.1650
1	0.9819	0.4897	0.8095	0.5930	0.3891	0.3106	0.9829	0.4372
2	0.9779	0.9006	1.3199	1.1192	1.1468	0.6981	0.5633	1.4480
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.8156	1.6267	1.0529	0.8244	1.1306	0.8839	0.9705	1.1725
5	1.3917	1.2574	1.4647	1.2067	1.1651	0.8988	1.2819	1.3116
6	1.3917	1.2574	1.4647	1.2067	1.1651	0.8988	1.2819	1.3116

Fitted Selection Pattern

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.2044	0.1872	0.1872	0.1872	0.1872	0.1872	0.1872	0.1872
1	0.6716	0.4096	0.4096	0.4096	0.4096	0.4096	0.4096	0.4096
2	1.2803	0.7030	0.7030	0.7030	0.7030	0.7030	0.7030	0.7030
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2222	1.0475	1.0475	1.0475	1.0475	1.0475	1.0475	1.0475
5	1.4069	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.4069	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	1994	1995	1996	1997	1998	1999	2000
0	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
1	0.2077	0.2077	0.2077	0.2077	0.2077	0.2077	0.2077
2	0.5101	0.5101	0.5101	0.5101	0.5101	0.5101	0.5101
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.1778	1.1778	1.1778	1.1778	1.1778	1.1778	1.1778
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

Table 9.7.2.1b (cont): Output values for the assessment model

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	13748910	315401	228162	145609	0.6382	0.4803	83
1979	15354210	388340	283937	157241	0.5538	0.5323	96
1980	16603470	499371	372471	194802	0.5230	0.3844	95
1981	11140240	614886	466477	216517	0.4642	0.3933	89
1982	8892810	641229	506191	206946	0.4088	0.3980	96
1983	24496160	604113	488610	183837	0.3762	0.3155	104
1984	9186950	723400	550170	206005	0.3744	0.2550	95
1985	7938500	763091	616981	208440	0.3378	0.3018	94
1986	6850950	678284	556537	187363	0.3367	0.3207	97
1987	11641250	585364	479231	177695	0.3708	0.3307	100
1988	7281170	550658	437094	161530	0.3696	0.3292	102
1989	7359780	532719	370538	140962	0.3804	0.3311	96
1990	6973470	501860	365941	149430	0.4083	0.3573	104
1991	16412880	462634	370031	132587	0.3583	0.2766	99
1992	12324890	642892	500935	130249	0.2600	0.2454	99
1993	5375280	772938	569446	142495	0.2502	0.2379	98
1994	5491690	680734	552506	136581	0.2472	0.2215	98
1995	4507750	709605	592137	125280	0.2116	0.2097	98
1996	6518300	594811	478631	116736	0.2439	0.3070	101
1997	5679010	465911	363595	115814	0.3185	0.3718	98
1998	7812650	386011	300651	108925	0.3623	0.4080	97
1999	8343200	387063	293197	94091	0.3209	0.3358	98
2000	32285420	445768	308469	85786	0.2781	0.2799	98

No of years for separable analysis : 14
Age range in the analysis : 0 . . . 6
Year range in the analysis : 1978 . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 3

Parameters to estimate : 60
Number of observations : 264

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1993
Abrupt change in selection specified.

Table 9.7.2.1b (cont): Output values for the assessment model

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	0.3527	22	0.2272	0.5474	0.2818	0.4414	0.3617
2	1988	0.3511	23	0.2232	0.5525	0.2786	0.4425	0.3607
3	1989	0.3532	23	0.2215	0.5632	0.2783	0.4481	0.3633
4	1990	0.3811	23	0.2411	0.6025	0.3017	0.4814	0.3916
5	1991	0.2950	23	0.1866	0.4664	0.2335	0.3727	0.3032
6	1992	0.2617	22	0.1680	0.4079	0.2087	0.3282	0.2685
7	1993	0.2537	22	0.1624	0.3962	0.2021	0.3185	0.2603
8	1994	0.2402	24	0.1497	0.3854	0.1888	0.3057	0.2473
9	1995	0.2275	23	0.1443	0.3586	0.1803	0.2869	0.2337
10	1996	0.3330	21	0.2167	0.5116	0.2675	0.4146	0.3411
11	1997	0.4033	21	0.2665	0.6103	0.3265	0.4982	0.4124
12	1998	0.4426	21	0.2912	0.6726	0.3575	0.5479	0.4528
13	1999	0.3642	22	0.2350	0.5647	0.2912	0.4555	0.3735
14	2000	0.3035	23	0.1910	0.4823	0.2397	0.3844	0.3121
Separable Model: Selection (S1) by age 1987 1993								
15	0	0.1872	24	0.1164	0.3011	0.1469	0.2386	0.1928
16	1	0.4096	19	0.2783	0.6028	0.3363	0.4988	0.4176
17	2	0.7030	18	0.4873	1.0143	0.5831	0.8476	0.7154
	3	1.0000		Fixed : Reference Age				
18	4	1.0475	16	0.7608	1.4423	0.8898	1.2332	1.0615
	5	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1994 to 2000								
19	0	0.0923	25	0.0555	0.1535	0.0712	0.1197	0.0955
20	1	0.2077	20	0.1384	0.3117	0.1688	0.2555	0.2122
21	2	0.5101	19	0.3496	0.7443	0.4207	0.6185	0.5197
	3	1.0000		Fixed : Reference Age				
22	4	1.1778	16	0.8557	1.6211	1.0006	1.3863	1.1935
	5	1.0000		Fixed : Last true age				
Separable model: Populations in year 2000								
23	0	32285421	41	14204122	73383513	21235952	49084138	35246379
24	1	5799805	28	3328728	10105283	4369033	7699127	6037251
25	2	3593908	22	2310879	5589291	2868898	4502139	3686299
26	3	1540070	20	1039977	2280644	1260498	1881651	1571283
27	4	860800	20	574611	1289525	700401	1057930	879297
28	5	269372	24	167986	431949	211699	342756	277304
Separable model: Populations at age								
29	1987	740574	35	370179	1481579	519897	1054920	788404
30	1988	1281468	28	729499	2251078	961323	1708228	1335519
31	1989	543634	28	311330	949277	409066	722471	566070
32	1990	466183	26	275729	788188	356609	609425	483221
33	1991	397442	26	238150	663280	306050	516125	411244
34	1992	709149	24	435686	1154254	553091	909240	731394
35	1993	490565	24	304118	791317	384371	626098	505381
36	1994	542788	24	337182	873769	425733	692027	559040
37	1995	537580	25	328931	878579	418405	690699	554731
38	1996	1348729	24	826750	2200265	1050705	1731286	1391439
39	1997	967074	23	605228	1545256	761399	1228307	995120
40	1998	371731	23	232905	593306	292841	471874	382459
41	1999	329364	24	204881	529483	258515	419631	339169

Table 9.7.2.1b (cont): Output values for the assessment model

```
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 :
  42   1  Q  .2334E-01  25 .1822E-01 .5007E-01 .2334E-01 .3909E-01 .3122E-01
  43   2  Q  .4359E-01  25 .3407E-01 .9314E-01 .4359E-01 .7281E-01 .5822E-01
  44   3  Q  .8564E-01  25 .6674E-01 .1848     .8564E-01 .1440     .1149
  45   4  Q  .1632      27 .1256     .3658     .1632     .2816     .2225
  46   5  Q  .2571      29 .1941     .6108     .2571     .4613     .3594
  47   6  Q  .5090      27 .3901     1.156     .5090     .8859     .6978


                                         FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Linear model fitted. Slopes at age :
  48   1  Q  888.7      38 613.3     2789.     888.7     1925.     1409.
  49   2  Q  843.6      37 586.5     2588.     843.6     1799.     1324.
  50   3  Q  991.1      37 689.1     3038.     991.1     2113.     1554.
  51   4  Q  1334.      38 918.1     4228.     1334.     2908.     2125.
  52   5  Q  1382.      41 929.8     4684.     1382.     3152.     2272.
  53   6  Q  963.0      39 657.3     3125.     963.0     2133.     1551.


                                         FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear model fitted. Slopes at age :
  54   0  Q  662.8      32 483.2     1757.     662.8     1281.     972.7
  55   1  Q  547.0      32 400.1     1435.     547.0     1049.     798.9
  56   2  Q  528.0      32 386.4     1382.     528.0     1012.     770.5
  57   3  Q  574.5      32 418.7     1524.     574.5     1111.     843.4
  58   4  Q  826.0      33 597.1     2246.     826.0     1624.     1226.
  59   5  Q  637.1      34 455.6     1792.     637.1     1282.     960.5
  60   6  Q  397.9      33 287.2     1087.     397.9     784.6     591.9


RESIDUALS ABOUT THE MODEL FIT
------------------------------

       Separable Model Residuals
       -------------------------
------+-----------------------------------------------------------------
Age   |    1987    1988    1989    1990    1991    1992    1993    1994
------+-----------------------------------------------------------------
  0   |  0.8172  0.2761 -0.4825 -0.4627  0.7424 -0.0088 -0.8844  0.1628
  1   |  0.0111  0.0982  0.0027 -0.0168  0.0501  0.0327 -0.2279 -0.9327
  2   |  0.0688 -0.0185 -0.0117 -0.1734 -0.1139  0.0534  0.0705  0.0062
  3   |  0.0293 -0.0733 -0.0708 -0.0539  0.1008 -0.0326  0.4223  0.3207
  4   | -0.2477  0.0498 -0.1223  0.2336 -0.1436  0.0082  0.2659  0.2609
  5   | -0.2063 -0.1111  0.3631  0.1720 -0.1542 -0.2334  0.1889  0.1252
------+-----------------------------------------------------------------
```

Table 9.7.2.1b (cont): Output values for the assessment model

Separable Model Residuals

Age	1995	1996	1997	1998	1999	2000
0	-0.9617	0.4990	0.1645	0.5212	0.0450	-0.4397
1	0.2189	-0.5805	0.5653	0.2162	0.3487	0.1601
2	0.1738	-0.0179	0.2904	-0.0368	-0.0352	-0.3397
3	0.3137	0.2704	-0.1603	-0.0860	-0.2870	-0.3039
4	-0.0448	0.1601	0.2179	-0.1474	0.0239	-0.1364
5	-0.2891	-0.5096	-0.2050	0.4444	0.1987	0.4781

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	-0.3932	*******

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	-0.8995

INDEX1

	1998	1999
1	*******	-0.3079

Table 9.7.2.1b (cont): Output values for the assessment model

AGE-STRUCTURED INDEX RESIDUALS

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-0.737	1.858	0.303	*******	-0.413	-1.361	-0.347	0.283
2	-2.048	0.698	-0.564	*******	-0.739	0.562	-0.407	0.414
3	1.083	-1.767	-0.626	*******	0.302	0.262	-0.421	0.009
4	0.064	1.884	-0.875	*******	-0.772	0.738	-1.428	-0.118
5	0.911	1.268	1.089	*******	-0.165	-0.362	-0.320	0.268
6	0.723	1.451	0.995	*******	0.379	0.987	-0.401	1.378

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-1.857	-0.543	1.803	0.619	-0.307	0.699
2	*******	*******	-0.650	1.155	-0.122	0.463	0.703	0.534
3	*******	*******	-0.283	0.063	-0.121	0.054	1.327	0.117
4	*******	*******	0.228	0.074	-1.138	0.440	0.689	0.213
5	*******	*******	-0.344	-1.177	-1.373	-0.948	1.137	0.016
6	*******	*******	-1.230	-0.565	-1.766	-0.636	-0.627	-0.688

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Age	1996	1997	1998	1999	2000	2001
1	-0.467	0.539	-0.671	0.261	0.327	0.012
2	0.035	0.702	0.577	0.268	-0.233	-1.348
3	0.551	0.128	0.736	-0.011	-0.090	-1.315
4	0.241	0.296	0.510	0.254	-0.273	-1.029
5	-1.434	0.172	0.998	0.415	0.490	-0.642
6	-2.596	-0.001	1.248	0.718	0.932	-0.303

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.391	-0.581	-0.232	-0.351	*******	*******	*******	*******
1	0.103	0.159	-0.135	0.385	*******	*******	*******	*******
2	-0.163	0.587	0.354	0.293	*******	*******	*******	*******
3	0.250	0.262	-0.835	0.365	*******	*******	*******	*******
4	-0.310	0.292	-0.665	-0.492	*******	*******	*******	*******
5	-1.143	-0.703	-0.641	-0.035	*******	*******	*******	*******
6	-0.891	-0.284	-0.951	-0.548	*******	*******	*******	*******

Table 9.7.2.1b (cont): Output values for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.112	*******	*******	*******	*******	-0.087	0.873	-0.054
1	0.311	*******	*******	*******	*******	0.160	0.232	-0.918
2	0.188	*******	*******	*******	*******	0.299	0.266	-0.251
3	0.548	*******	*******	*******	*******	0.468	0.882	-0.262
4	0.052	*******	*******	*******	*******	1.188	0.342	0.695
5	-0.861	*******	*******	*******	*******	0.929	1.180	1.267
6	-1.589	*******	*******	*******	*******	1.897	1.220	1.076

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	2000
0	0.710
1	-0.297
2	-1.575
3	-1.678
4	-1.103
5	0.006
6	0.069

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 2000	
Variance	0.1517
Skewness test stat.	-1.6289
Kurtosis test statistic	1.5159
Partial chi-square	0.5285
Significance in fit	0.0000
Degrees of freedom	47

Table 9.7.2.1b (cont): Output values for the assessment model

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	0.3528
Skewness test stat.	-0.9197
Kurtosis test statistic	-0.4098
Partial chi-square	0.0826
Significance in fit	0.0062
Number of observations	3
Degrees of freedom	3
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	0.1981	0.1245	0.0958	0.1330	0.1324	0.1808
Skewness test stat.	0.3231	-1.3426	-0.6451	0.3592	0.0687	-0.0449
Kurtosis test statisti	-0.3925	0.2589	0.6913	-0.1294	-0.8741	-0.9120
Partial chi-square	0.2078	0.1267	0.0958	0.1317	0.1354	0.1788
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	13	13	13	13	13	13
Degrees of freedom	12	12	12	12	12	12
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Table 9.7.2.1b (cont): Output values for the assessment model

DISTRIBUTION STATISTICS FOR FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.0378	0.0924	0.0866	0.0535	0.1302	0.3258
Skewness test stat.	-0.3954	-1.0132	-0.9981	-1.1099	-0.6415	-1.1536
Kurtosis test statisti	-0.6822	-0.0667	-0.0005	-0.0899	-0.4233	0.0344
Partial chi-square	0.0086	0.0213	0.0204	0.0129	0.0317	0.0856
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Number of observations	6	6	6	6	6	6
Degrees of freedom	5	5	5	5	5	5
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear catchability relationship assumed

Age	0	1	2	3	4	5	6
Variance	0.0349	0.0234	0.0593	0.0918	0.0732	0.1217	0.1938
Skewness test stat.	0.9565	-1.7001	-2.1867	-1.3522	0.1292	0.3583	0.4229
Kurtosis test statisti	-0.4112	0.5850	1.3171	0.0780	-0.5258	-0.8961	-0.6946
Partial chi-square	0.0125	0.0087	0.0227	0.0365	0.0296	0.0513	0.0858
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

Table 9.7.2.1b (cont): Output values for the assessment model

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	127.2309	264	60	204	0.6237
Catches at age	8.6334	84	41	43	0.2008
SSB Indices					
INDEX1	1.0585	3	0	3	0.3528
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	62.2571	78	6	72	0.8647
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	21.7885	36	6	30	0.7263
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	33.4934	63	7	56	0.5981

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	10.6005	264	60	204	0.0520
Catches at age	6.5239	84	41	43	0.1517
SSB Indices					
INDEX1	1.0585	3	0	3	0.3528
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	1.7294	78	6	72	0.0240
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	0.6052	36	6	30	0.0202
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	0.6835	63	7	56	0.0122

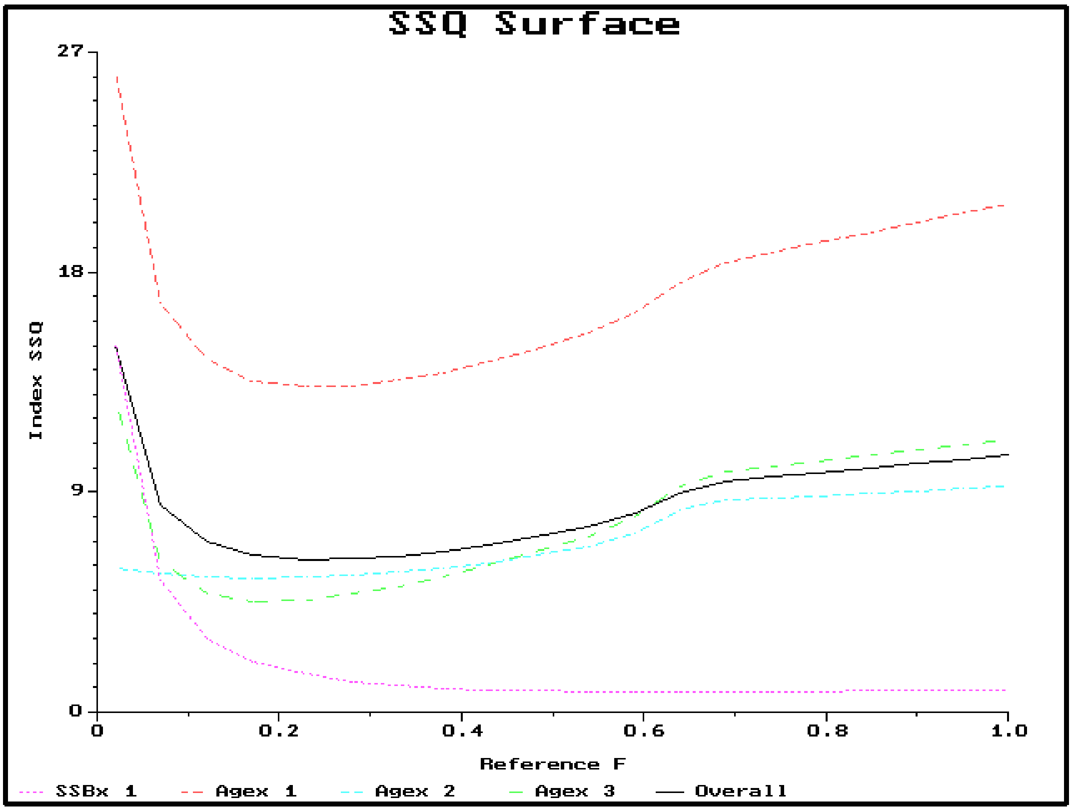
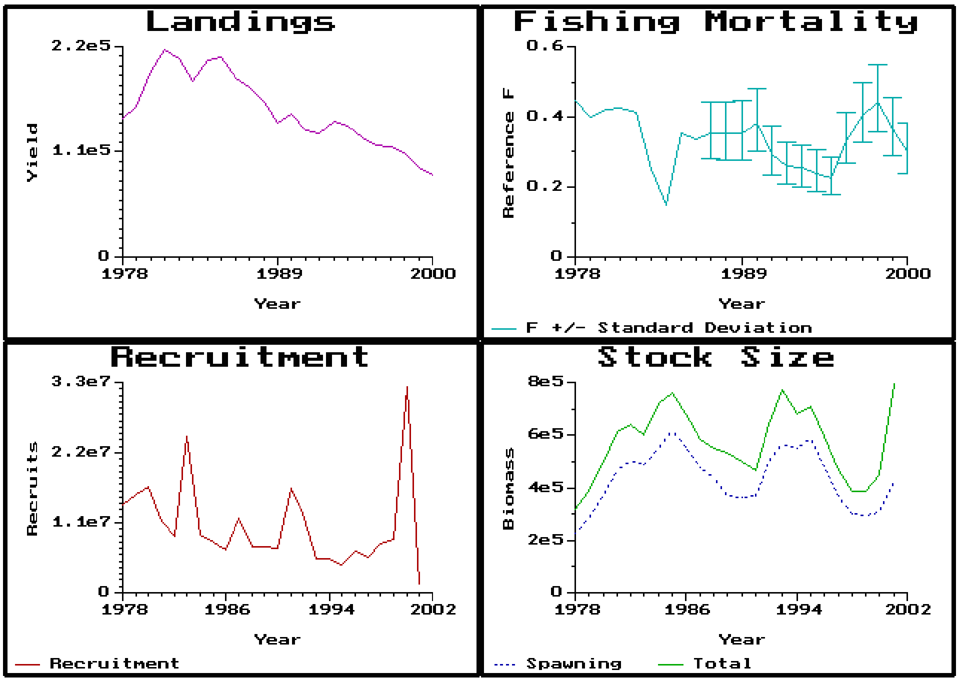


Figure 9.7.2.1 Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model. (SSBx1 is DEPM –absolute estimator-; Agex 1 is the Spanish Spring Acoustic survey time series –linear estimator-; Agex 2 is the Portuguese Spring Acoustic survey time series –linear estimator-; Agex 3 is the Portuguese Fall Acoustic survey time series –linear estimator-)

Stock Summary



Separable Model Diagnostics

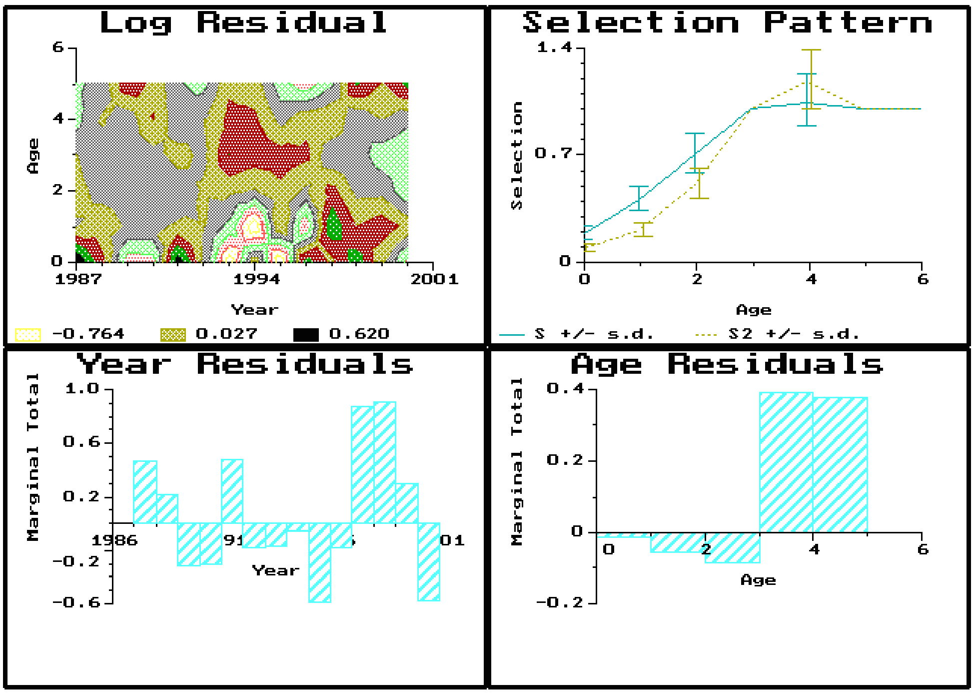


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

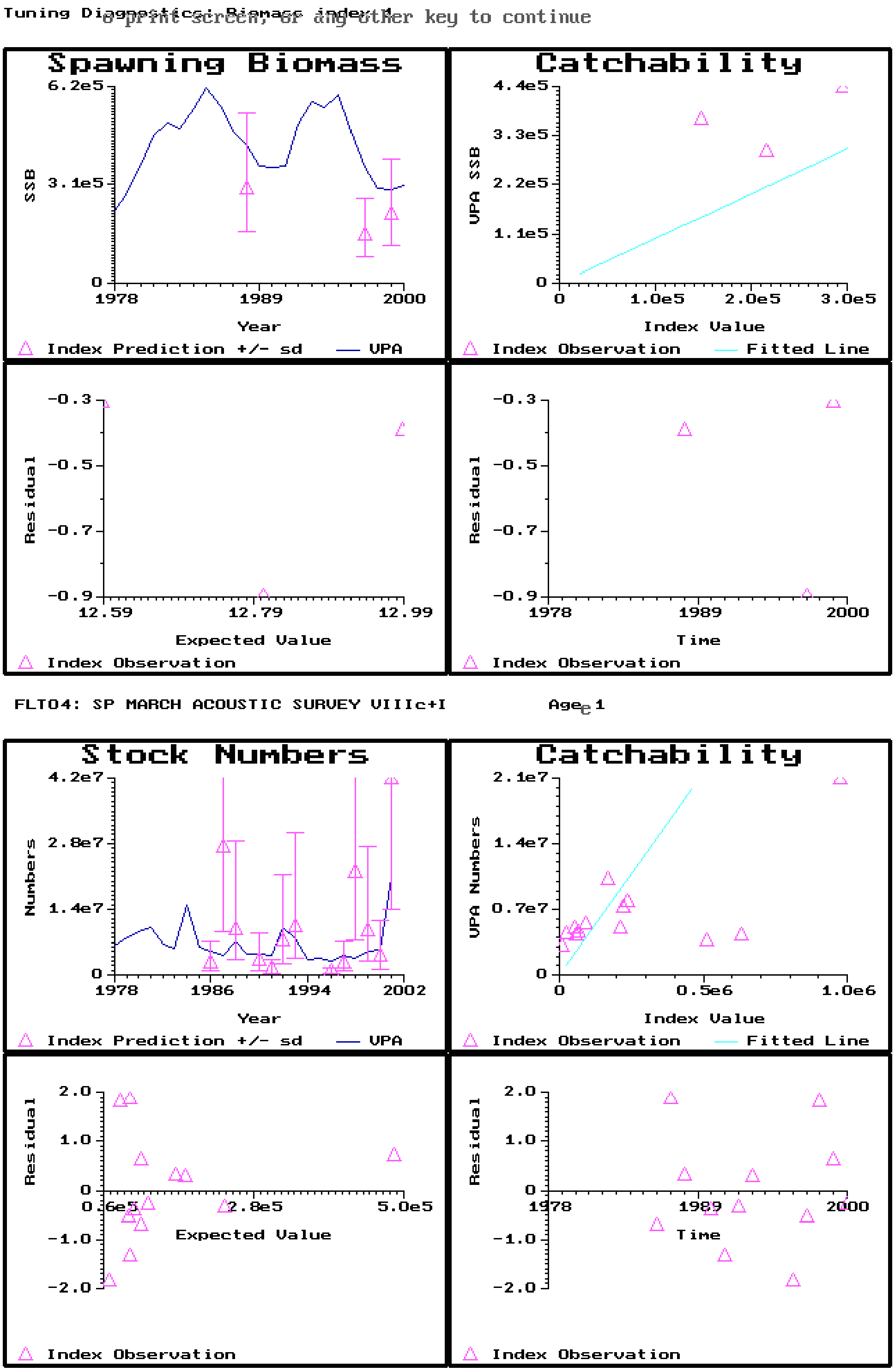
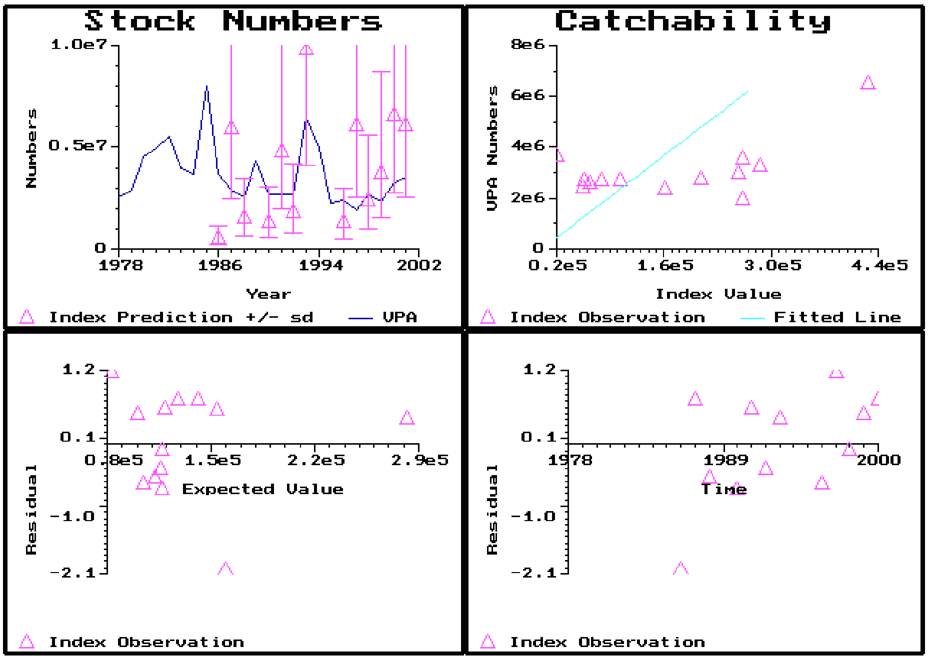


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Age 2



FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+I Age 3

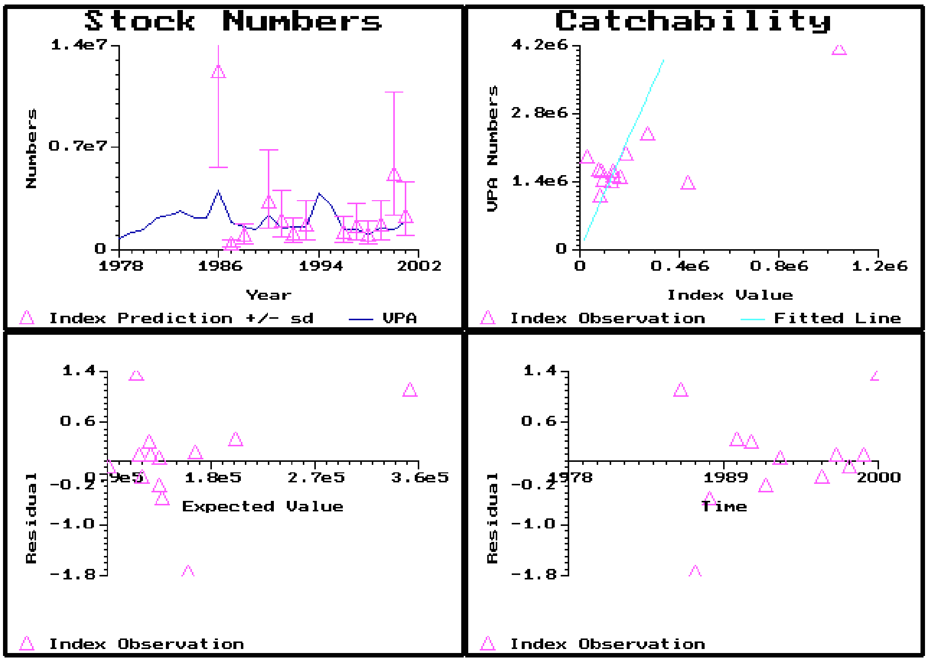
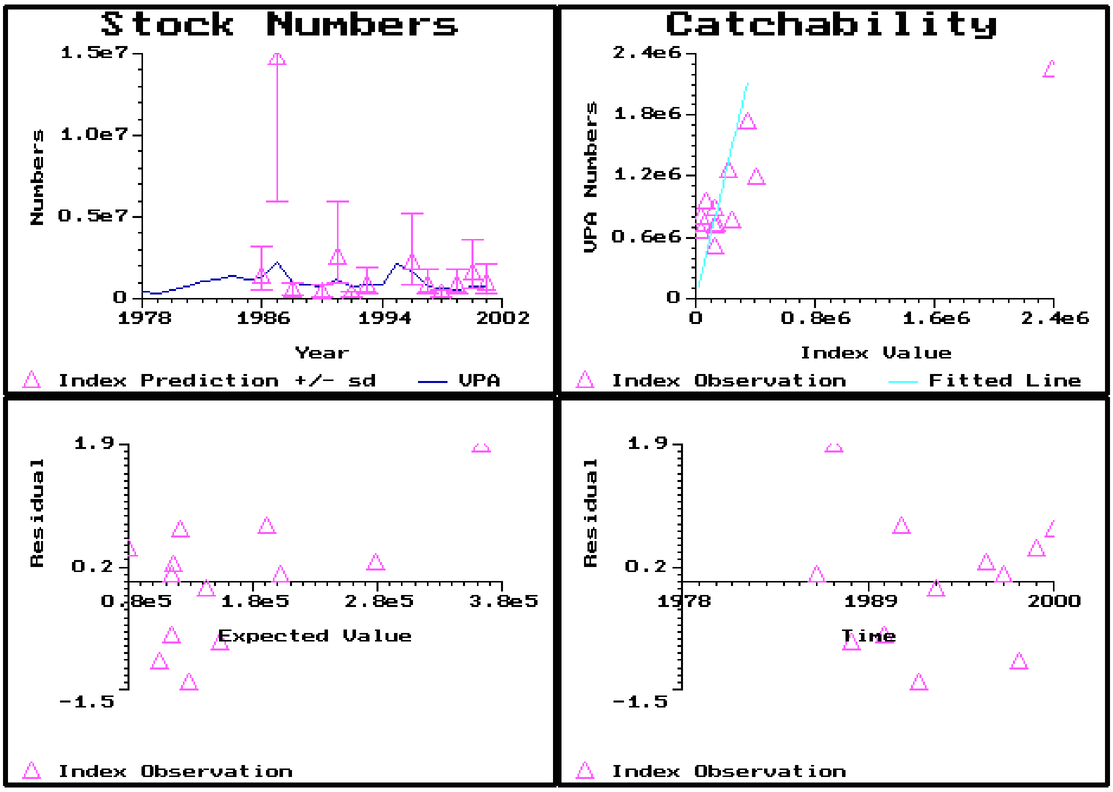


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

PFLI94P SB MARCH ACOUSTIC SURVEY VIIIc+I   Age 4



PFLI94P SB MARCH ACOUSTIC SURVEY VIIIc+I   Age 5

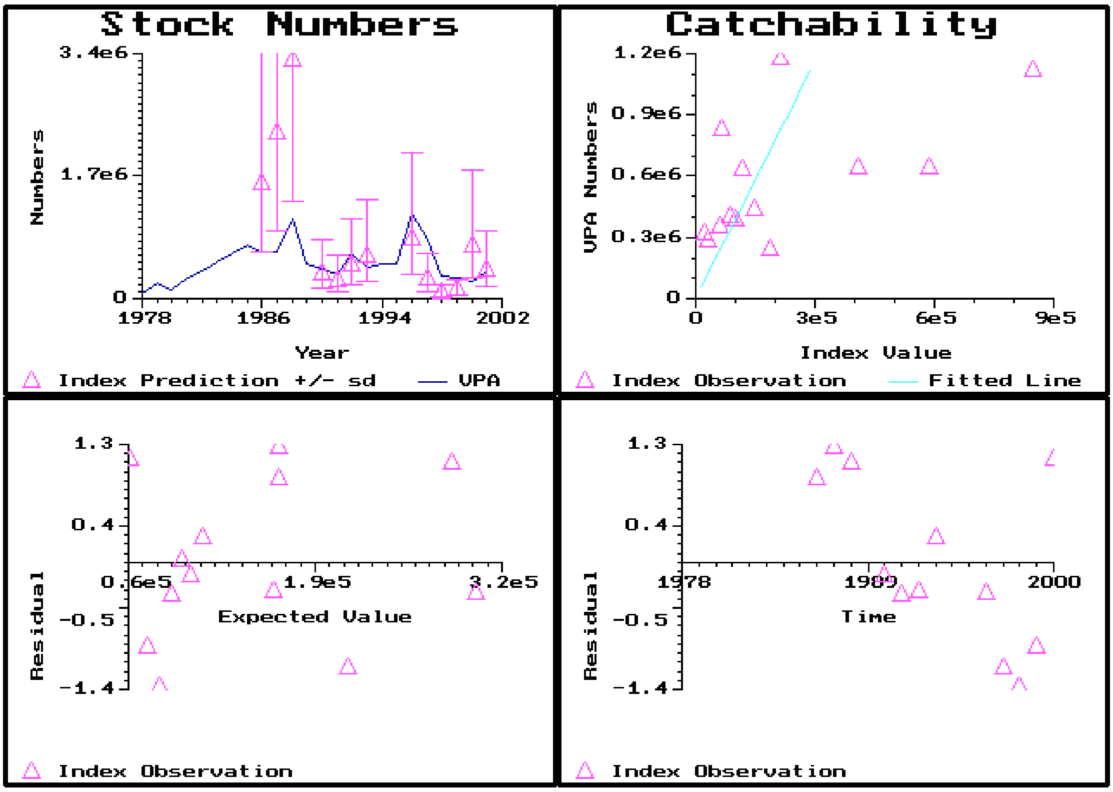
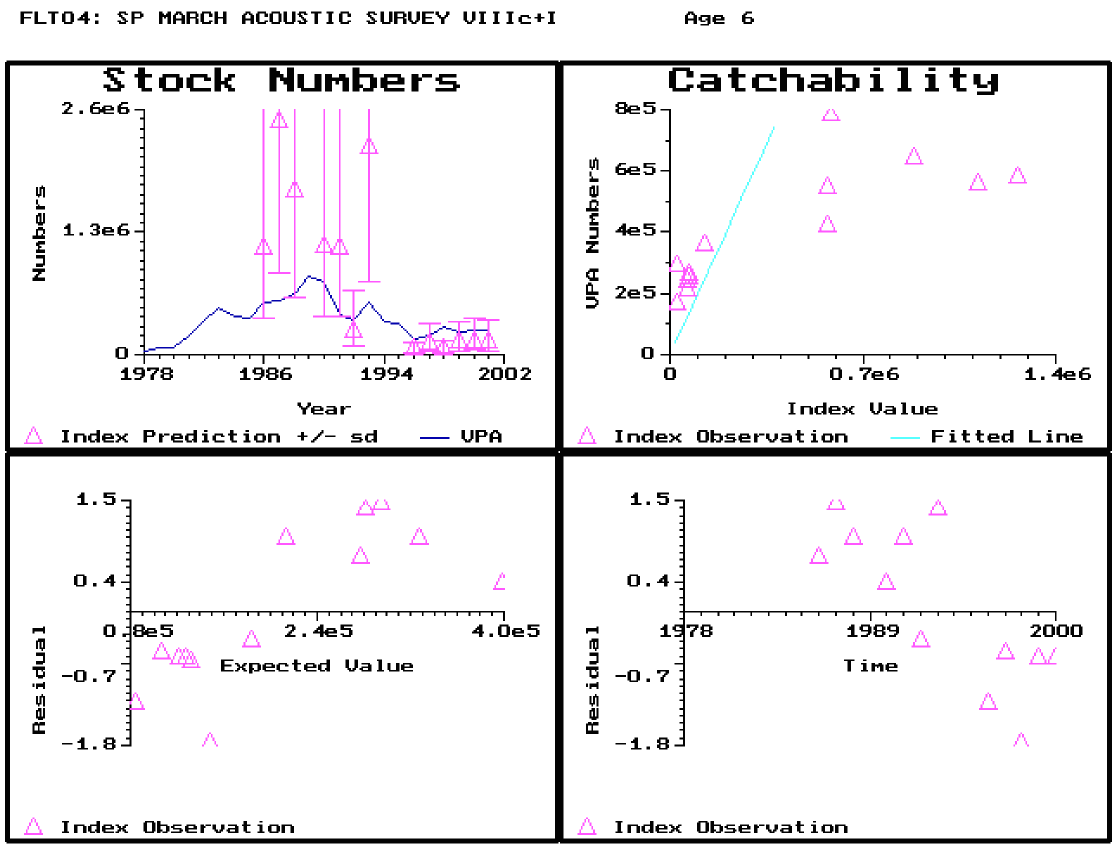


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



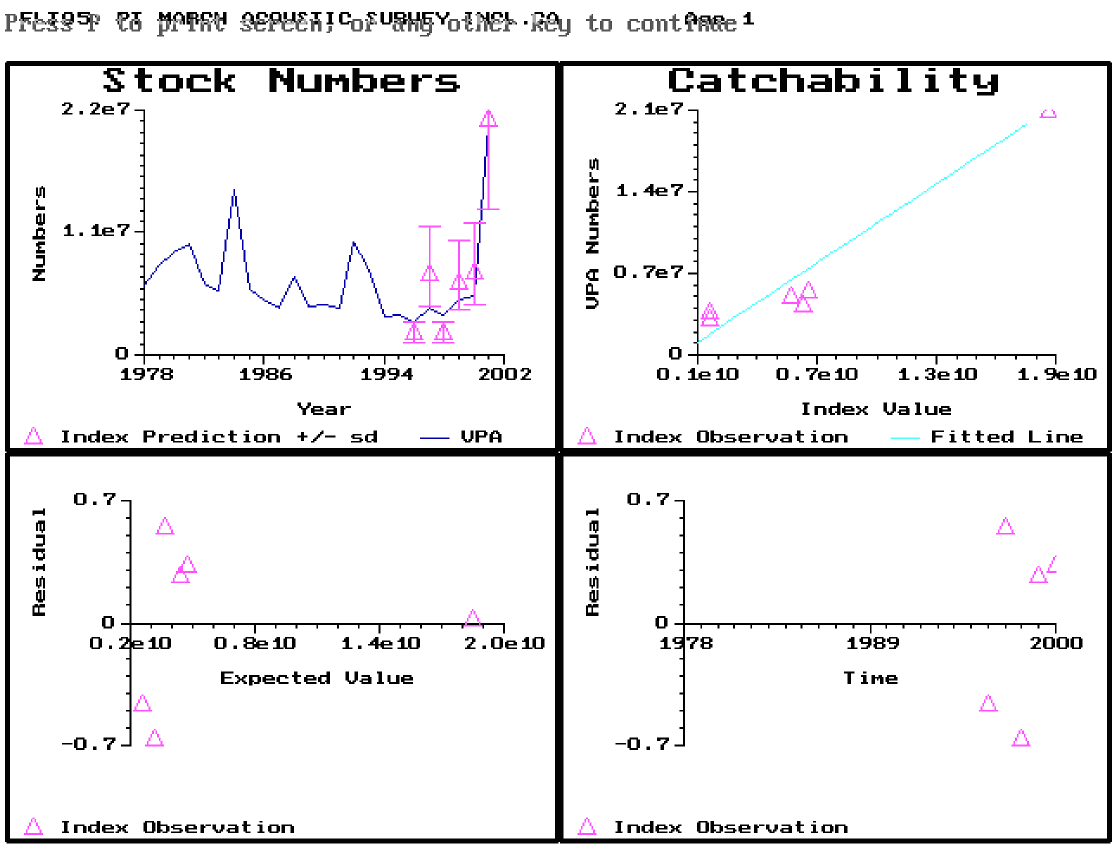


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

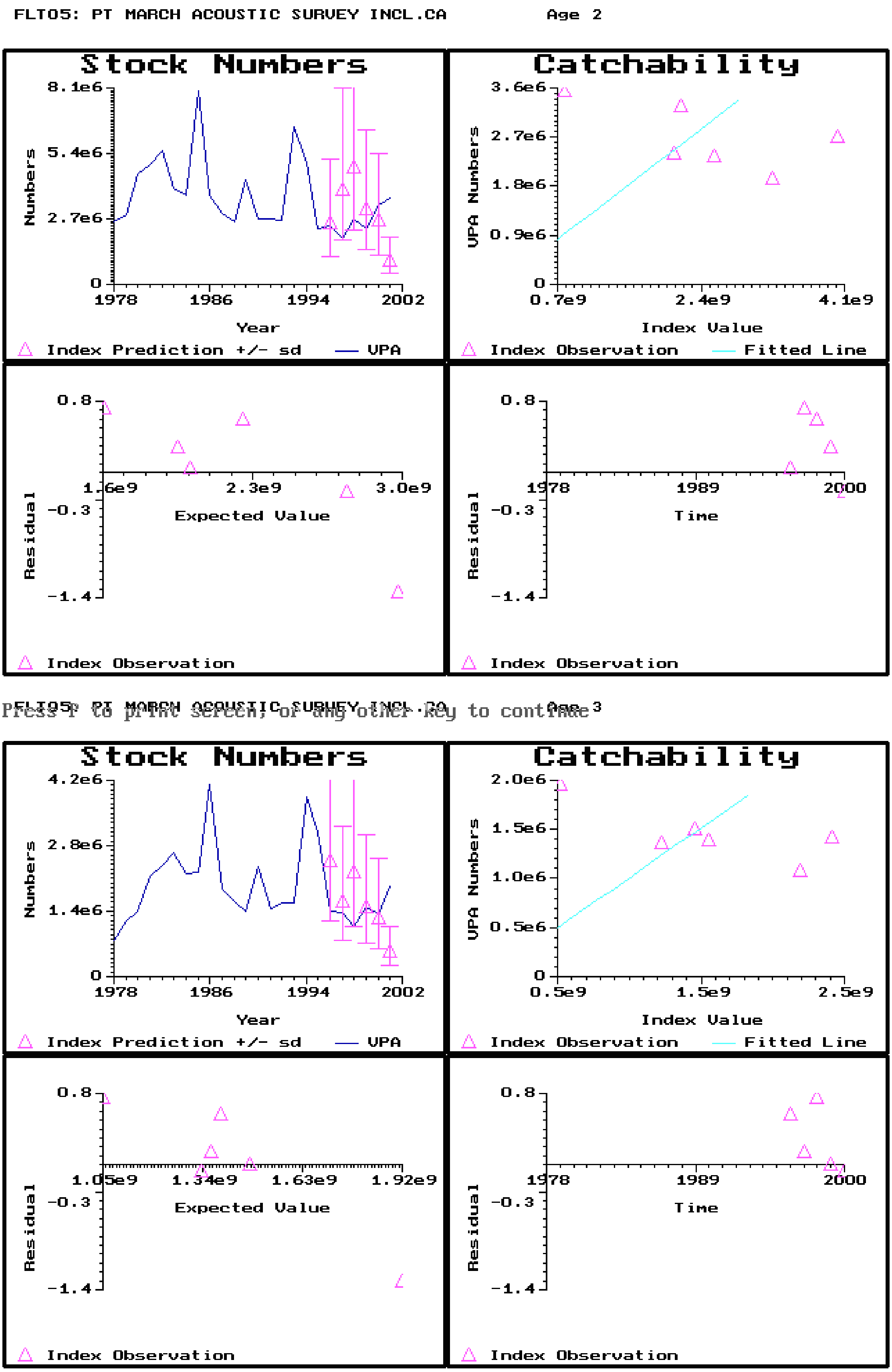
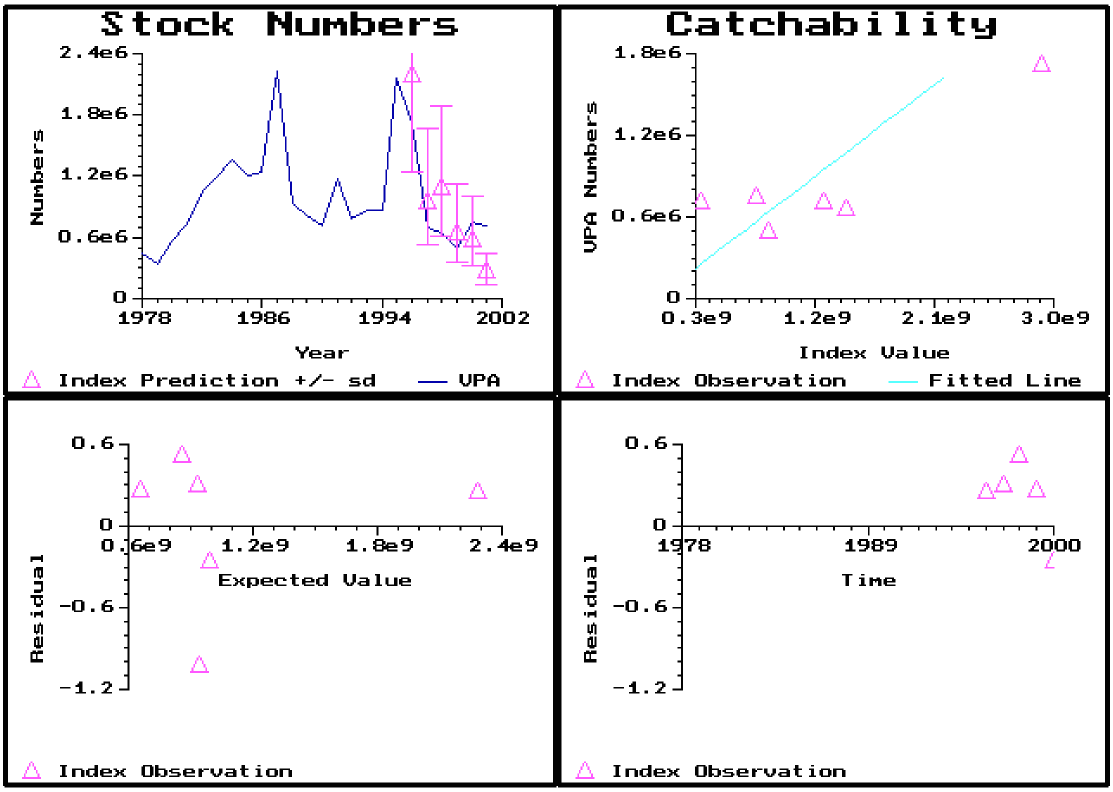


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 4
Press P to print screen, or any other key to continue



FLT05: PT MARCH ACOUSTIC SURVEY INCL.CA Age 5

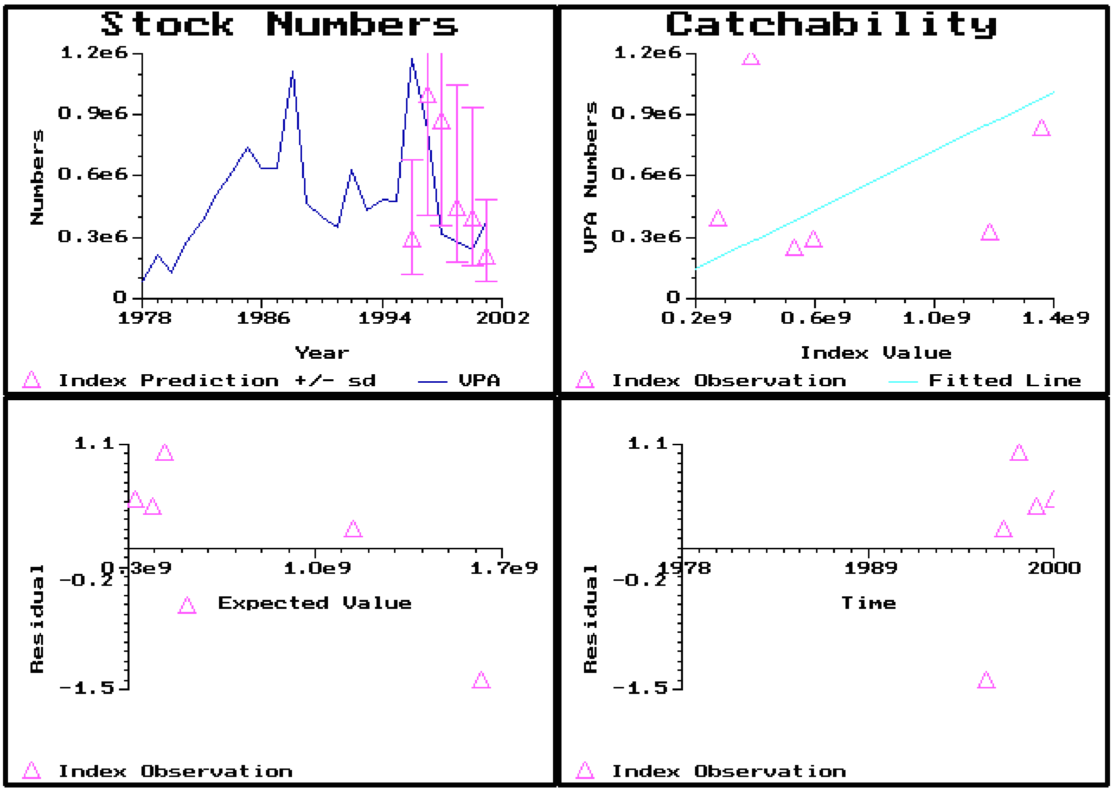
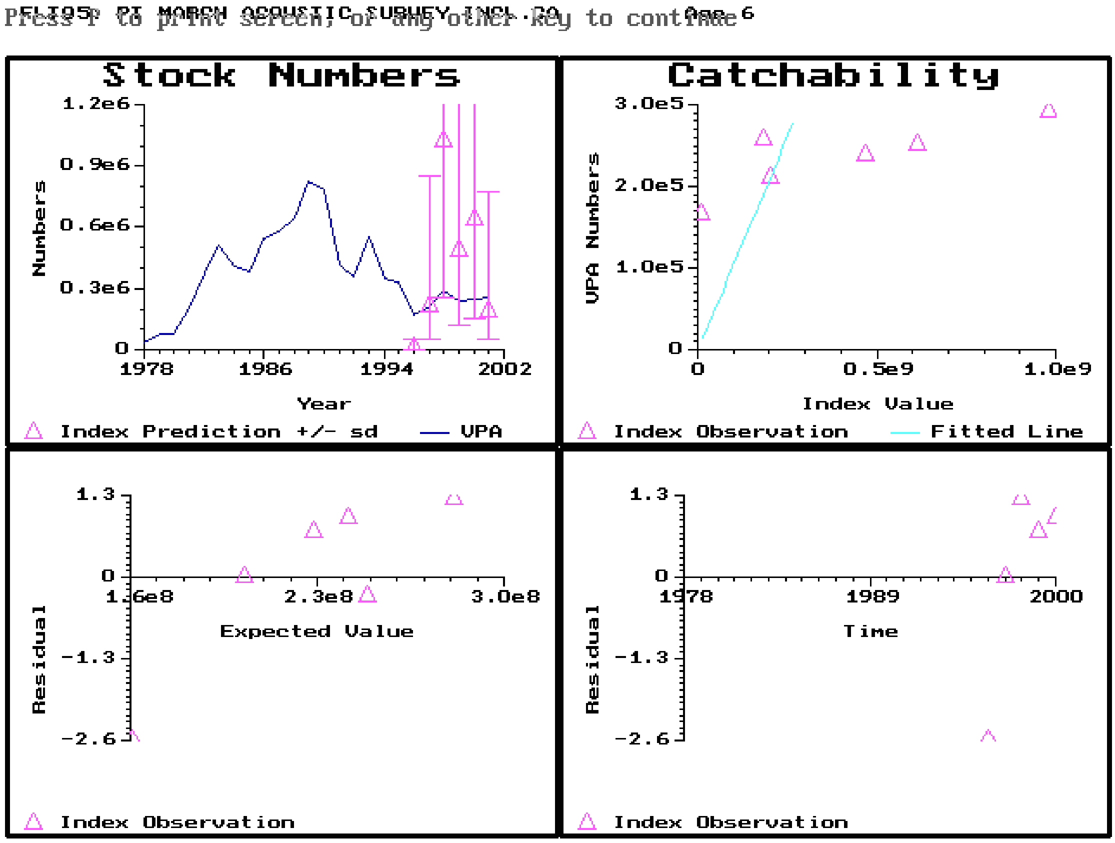


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



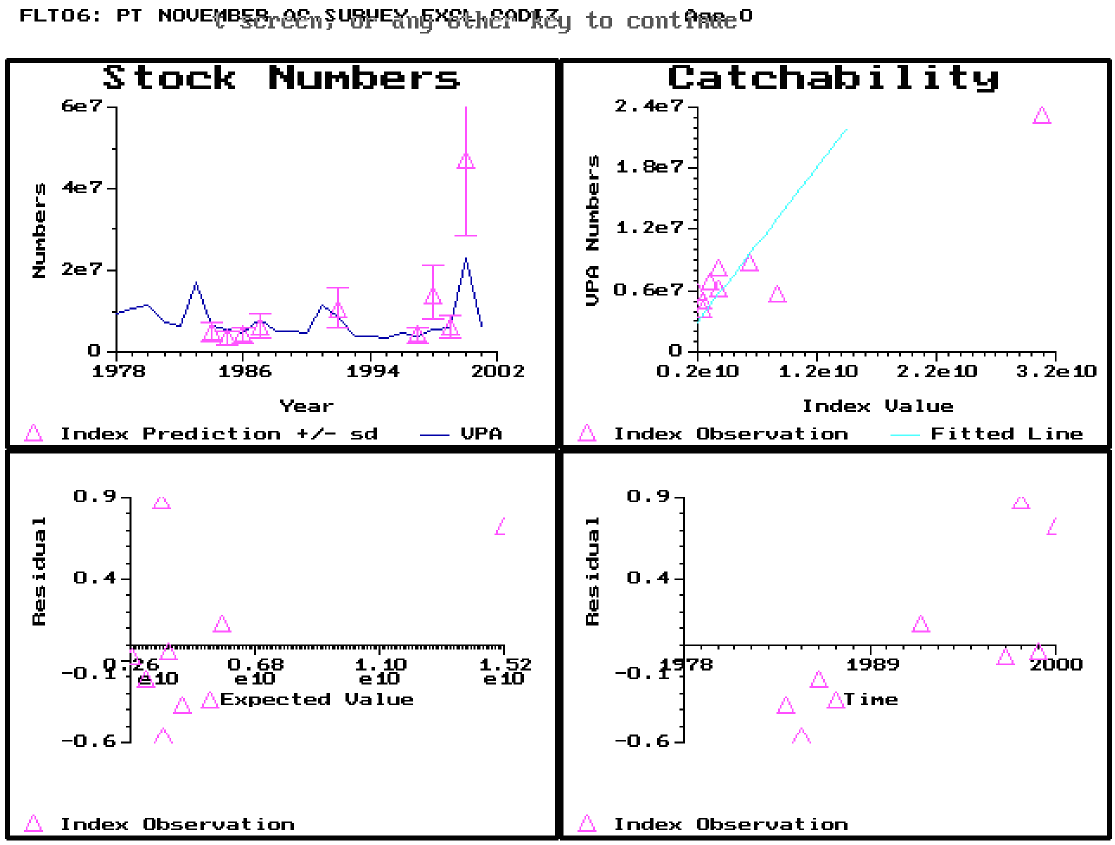
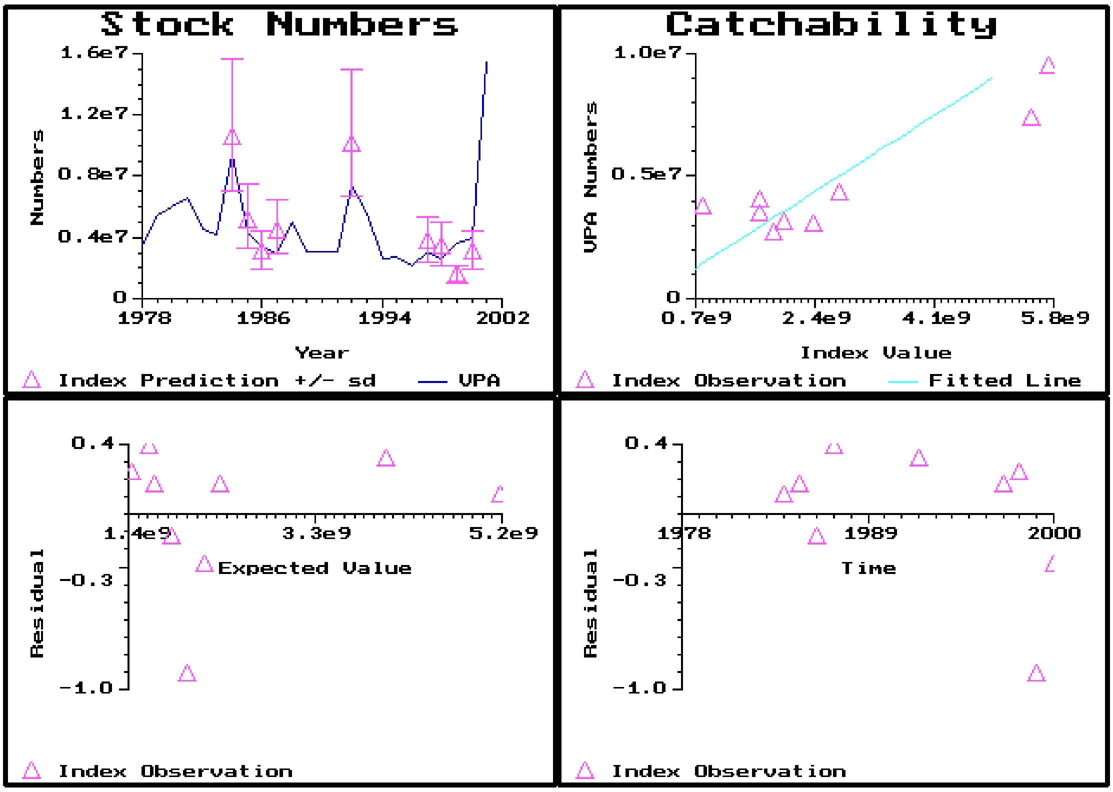


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 1



FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 2

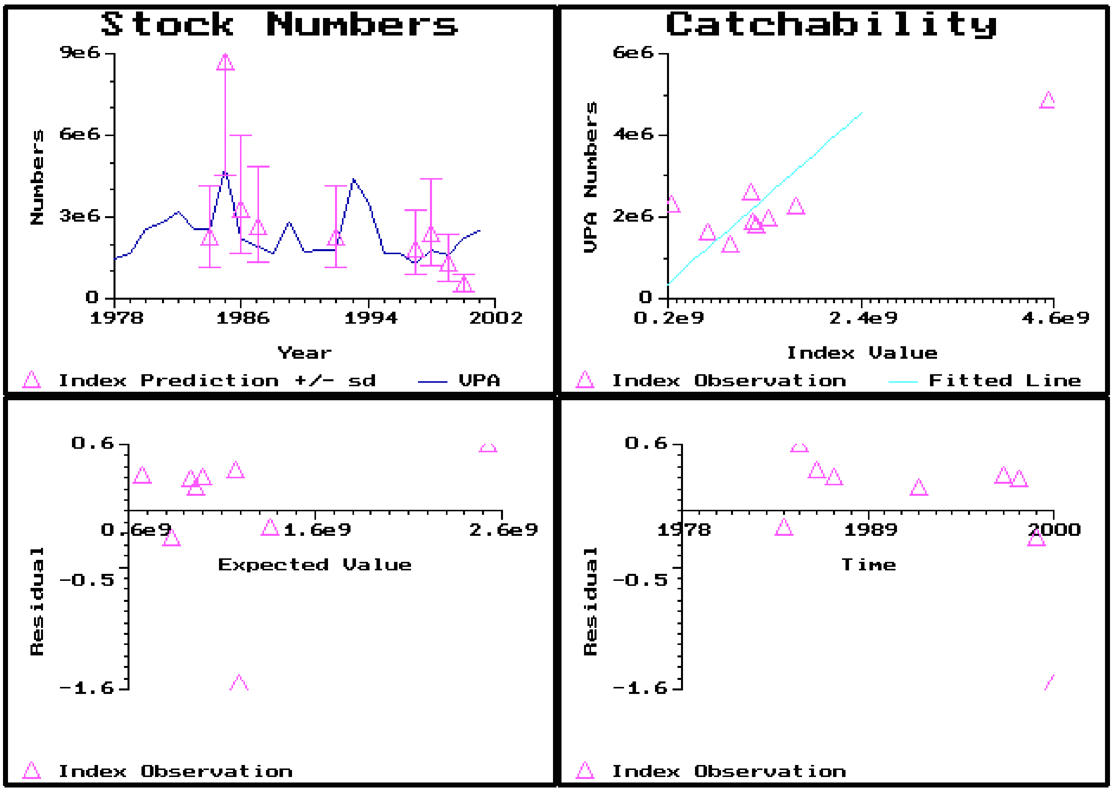
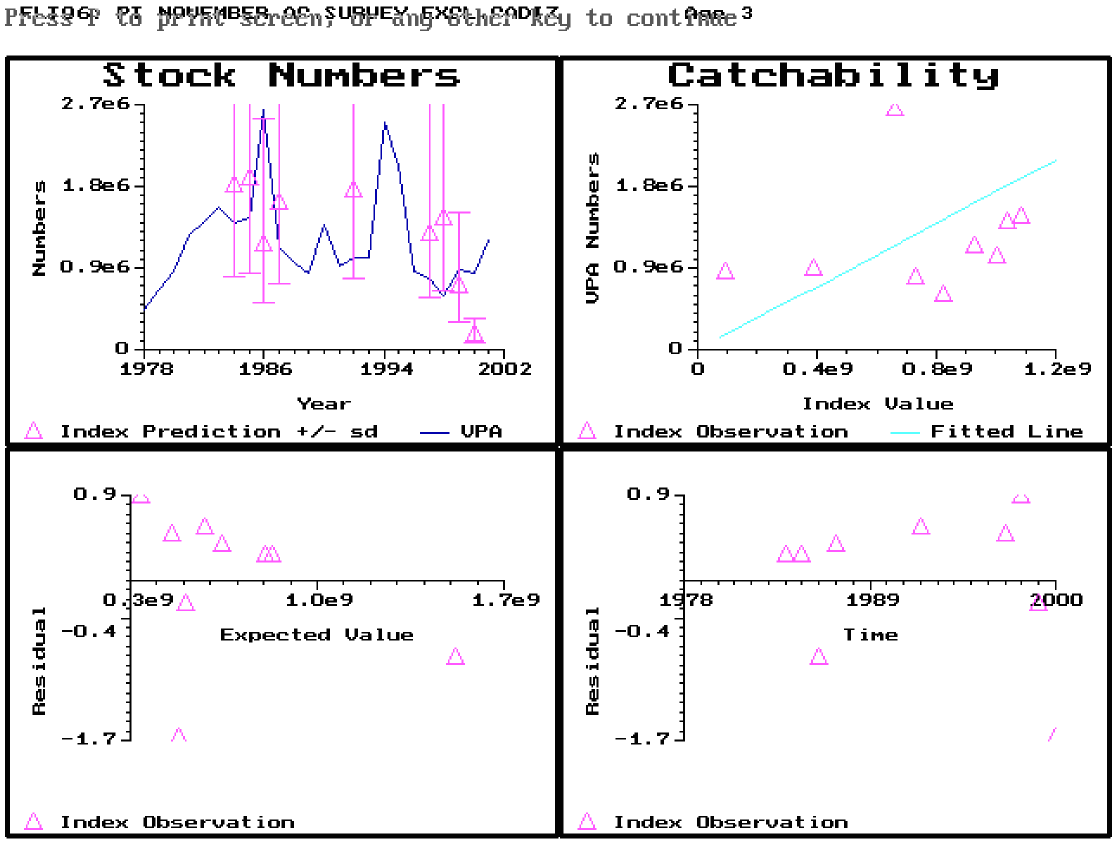


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model



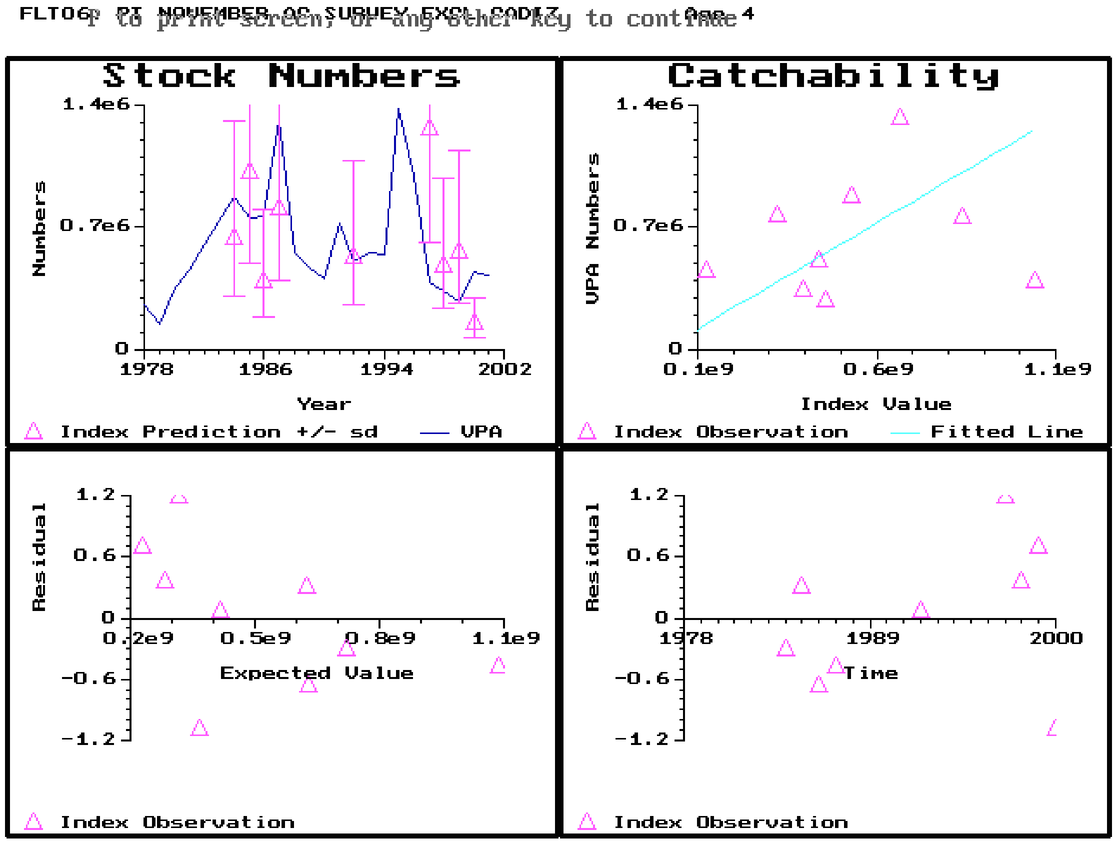


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

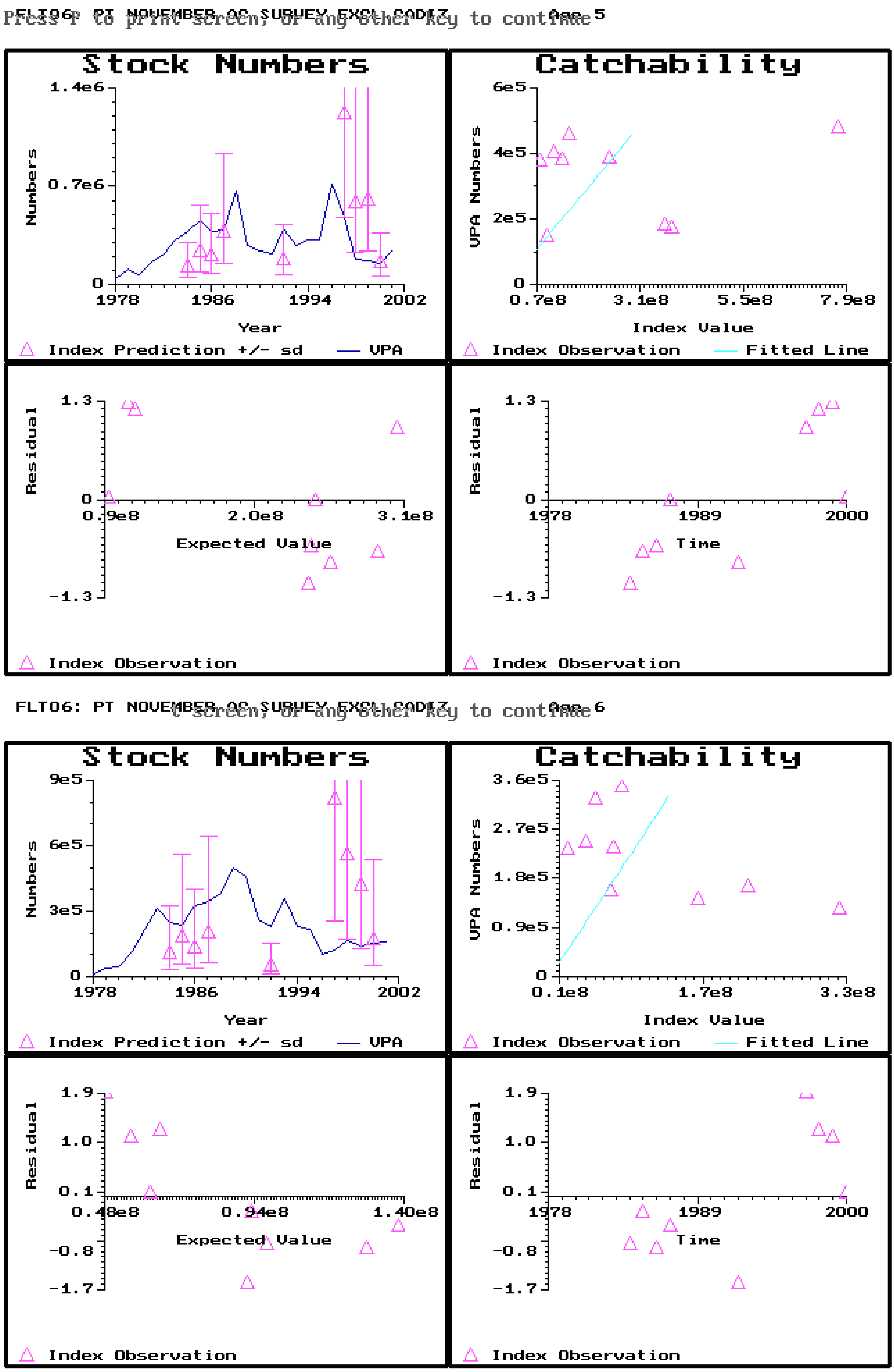


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model

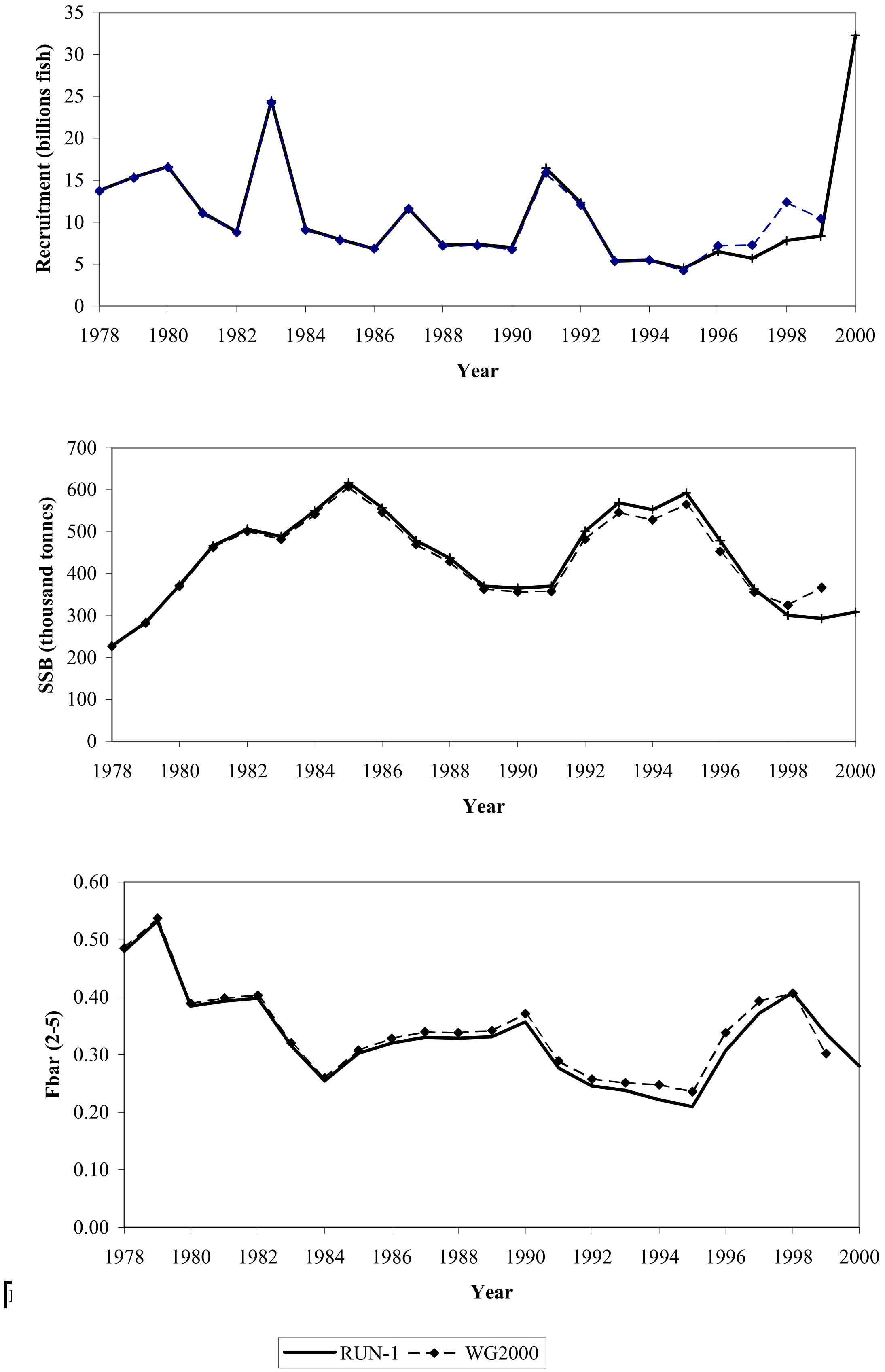


Figure 9.7.2.2: Recruitment, SSB and Fbar(2-5) trajectories for sardine as estimated by the assessment model accepted this year (RUN-1) and last year (WG2000).

9.8 Catch predictions

9.8.1 Divisions VIIIc and IXa combined

The WG discussed the value of recruitment that should be used for short term catch predictions since little confidence can be attached to the large 2000 recruitment estimated by the assessment model (1.3 times larger than the maximum of the series, with a 41% CV). Acoustic surveys indicate an exceptional 2000 year class (also predicted by the recruitment model including environmental effects proposed by Porteiro *et al.*, WD 2001), occuring at a low stock level and restricted to a small part of the stock distribution area. Indications of strong year classes in the recent history of the stock were later shown to be over-optimistic when more data was available. The SSB is considered to be at a low level and this was corroborated by the decrease in the abundance of adult fish off the western Iberian coast.

Last year, a "low level" recruitment corresponding to a geometric mean of the six previous recruitment estimates was used in short term predictions. The WG decided to explore the results of assuming an "average level" recruitment in view of the signals of a good 2000 year class. To evaluate the risk of predicting with average recruitment if a low recruitment is actually observed, a forecast was made considering a catch constraint equal to the catch predicted with the "average level" recruitment.

The scenarios explored were:

- "average level" recruitment, fixed at 9082 million fish, corresponding to the geometric mean of the period 1978-1999. This value is lower than the two highest recruitments estimated during the nineties (1991 and 1992 year classes).

- A catch constraint of 105 thousand tonnes, corresponding to the 2001 catch predicted in the first scenario, in a prediction with a "low level" recruitment, fixed at 6252 million fish (the geometric mean of the period 1994-1999). This value is lower than the recruitment estimated for 1998 and 1999.

For each scenario, weights at age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (1998-2000). The maturity ogive and the exploitation pattern corresponded to the 2000 values. 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. The number of fish at age 1 in the beginning of 2001 resulted from the projection of the 2000 recruitment assumed in each scenario and the numbers for ages 2-6+ were based on the population estimated by the assessment model.

Input values and results for the first scenario are shown in Tables 9.8.1.1 and 9.8.1.2. At F_{sq} equal to $F_{(2-5)} = 0.2799$, predicted yield in 2001 is 105 002 tonnes and SSB would increase by 26% in 2002. For 2002 catches of 118 391 tonnes are expected while the SSB would increase by 37% in 2003 comparatively to that estimated in 2000.

Tables 9.8.1.3 and 9.8.1.4 show the input values and the results for the second scenario. A 7% increase in fishing mortality is expected under this scenario for 2001. At $F_{sq} = F_{(2-5)} = 0.2799$, in 2002 landings will be 118 391 tonnes and the SSB in 2003 will only increase 7% with respect to that estimated in 2000. However, the SSB estimated for 2003 is lower than that estimated for 2002.

Considering the results of these analyses, the WG decided to adopt the lowest possible risk in order to prevent further decline in SSB in short term. The recruitment calculated as the geometric mean of the period 1994-1999 is considered to be a conservative option for the recruitment of this species taking into account the stock trajectory in the last decade. Results for this forecast are shown in Table 9.8.1.6. Predictions indicate about 16% increase in the catches and 10% increase in the SSB in 2001 at F_{sq}. However, keeping the fishing mortality will result in a decreasing trend in the SSB during the rest of the period. On account of the management measures adopted by both Spain and Portugal, catches for the next years would be close to the yield achieved in 1999 and 2000 and should be considered as a plausible harvest target. A reduction of 20% of current fishing mortality to F=0.22 provides an increase in SSB until 2003 while maintaining the catch level (around 85 000 tonnes). The predicted SSB value for 2003 is comparable to the SSB level observed in 89-91.

9.8.2 Catch predictions by area for Divisions VIIIc and IXa

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. Partial exploitation patterns for each area were calculated by splitting the exploitation pattern for the total area in 2000 according to the proportion of catches in each area. Input values for the mean weight at age in the catch by sub-division was taken as the average of 1998–2000.

Catch forecasts for each Division are shown in Table 9.8.2.2. Considering a fishing mortality equal to F_{sq} ($F_{sq}=F_{(2-5)}=0.2799$), SSB will decrease in 2003 and predicted catches will be higher than the yields attained since the national management measures were implemented. Considering F_{sq} for 2001 and F=0.8 Fsq in 2002, catches are expected to remain in both areas in 2001 and 2002 at the same level of that achieved in 2000 and SSB shows an increasing trend until 2003.

Catch predictions by area were calculated on the basis of the estimated parameters in the assessment model for 2000 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 and stable partial fishing mortality levels. Partial Fs for each area were calculated, using the average ratio of the fleets catch at age and the total catch at each age for the years 1998–2000. There is no scientific evidence to forecast catches according to ICES Divisions, and this was corroborated by the distribution of the 2000 cohort, mainly recruited in IXa-CN and spread later in the northern Iberian coast (Sub-division VIIIc-W). This split by area should only be regarded as an example, because the split could also be based on other criteria**.** If necessary, advice on other criteria on how to split the catches between "Northern" and "Southern" areas should become available from the management bodies outside ICES.

Table 9.8.1.1: Input table for short term deterministic projections

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	6349000	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3914900	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213100	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817330	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432840	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294900	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	9082000	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.2: Sardine management option table assuming a fixed recruitment at 9082 million f

2001				
Biomass	SSB	FMult	FBar	Landings
519531	348755	1	0.2799	105002

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
575589	406233	0.5	0.1399	62496	657496	475188
.	405011	0.55	0.1539	68367	652546	469612
.	403793	0.6	0.1679	74174	647654	464121
.	402578	0.65	0.1819	79916	642821	458715
.	401369	0.7	0.1959	85595	638044	453391
.	400163	0.75	0.2099	91212	633324	448148
.	398961	0.8	0.2239	96768	628658	442985
.	397764	0.85	0.2379	102262	624048	437900
.	396571	0.9	0.2519	107697	619491	432892
.	395382	0.95	0.2659	113073	614987	427961
.	394197	1	0.2799	118391	610536	423103
.	393016	1.05	0.2938	123651	606136	418318
.	391839	1.1	0.3078	128854	601787	413606
.	390666	1.15	0.3218	134002	597488	408963
.	389497	1.2	0.3358	139094	593239	404391
.	388333	1.25	0.3498	144133	589038	399886
.	387172	1.3	0.3638	149117	584885	395448
.	386015	1.35	0.3778	154049	580780	391076
.	384862	1.4	0.3918	158928	576722	386769
.	383714	1.45	0.4058	163756	572709	382526
.	382569	1.5	0.4198	168533	568742	378345

Input units are thousands and kg - output in tonnes

Table 9.8.1.3: Input table for short term deterministic projections with a fixed recruitment of 6252 million fish and a catch of 105 000 tonnes in 2001.

2001

Age	N	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	4370730	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3914900	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213100	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817330	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432840	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294900	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.4: Sardine management option table assuming a fixed recruitment of 6252 million f
a catch constraint of 105 000 tonnes in 2001.

2001				
Biomass	SSB	FMult	FBar	Landings
479965	338219	1.0652	0.2981	105000

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
476455	347943	0.5	0.1399	54236	508126	374960
.	346830	0.55	0.1539	59309	503839	370169
.	345721	0.6	0.1679	64322	499607	365456
.	344615	0.65	0.1819	69275	495429	360820
.	343514	0.7	0.1959	74171	491303	356258
.	342417	0.75	0.2099	79008	487229	351770
.	341324	0.8	0.2239	83789	483206	347355
.	340235	0.85	0.2379	88514	479234	343010
.	339149	0.9	0.2519	93184	475311	338735
.	338068	0.95	0.2659	97799	471437	334529
.	336990	1	0.2799	102360	467612	330390
.	335916	1.05	0.2938	106869	463834	326318
.	334846	1.1	0.3078	111325	460103	322310
.	333780	1.15	0.3218	115730	456418	318366
.	332718	1.2	0.3358	120084	452778	314485
.	331659	1.25	0.3498	124389	449184	310665
.	330604	1.3	0.3638	128644	445633	306905
.	329553	1.35	0.3778	132850	442127	303205
.	328506	1.4	0.3918	137008	438663	299563
.	327463	1.45	0.4058	141119	435242	295979
.	326423	1.5	0.4198	145184	431862	292450

Input units are thousands and kg - output in tonnes

Table 9.8.1.5: Input table for short term deterministic projections with a fixed recruitment of 6252 million fish

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	4370730	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	3915010	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	2213192	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	817293	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	432938	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	294544	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	6252305	0.33	0	0.25	0.25	0	0.0280	0.0247
1	.	0.33	0.2570	0.25	0.25	0.0200	0.0630	0.0397
2	.	0.33	0.9100	0.25	0.25	0.0410	0.1548	0.0557
3	.	0.33	0.9470	0.25	0.25	0.0553	0.3035	0.0640
4	.	0.33	0.9500	0.25	0.25	0.0623	0.3575	0.0683
5	.	0.33	1.0000	0.25	0.25	0.0673	0.3035	0.0713
6	.	0.33	1.0000	0.25	0.25	0.1000	0.3035	0.1000

Input units are thousands and kg - output in tonnes

Table 9.8.1.6: Sardine management option table assuming a fixed recruitment at 6252 million f

2001				
Biomass	SSB	FMult	FBar	Landings
479943	339519	1	0.2799	99262

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
481270	351940	0.5	0.1399	54865	511709	378055
.	350812	0.55	0.1539	59996	507372	373208
.	349688	0.6	0.1679	65067	503091	368441
.	348568	0.65	0.1819	70077	498863	363751
.	347452	0.7	0.1959	75028	494689	359137
.	346340	0.75	0.2099	79920	490568	354597
.	345232	0.8	0.2239	84755	486498	350131
.	344128	0.85	0.2379	89533	482480	345737
.	343028	0.9	0.2519	94255	478512	341414
.	341931	0.95	0.2659	98922	474593	337160
.	340839	1	0.2799	103535	470724	332975
.	339751	1.05	0.2938	108093	466902	328856
.	338667	1.1	0.3078	112599	463129	324803
.	337586	1.15	0.3218	117053	459402	320815
.	336509	1.2	0.3358	121456	455721	316890
.	335437	1.25	0.3498	125807	452086	313028
.	334368	1.3	0.3638	130109	448496	309227
.	333302	1.35	0.3778	134361	444949	305486
.	332241	1.4	0.3918	138565	441447	301804
.	331184	1.45	0.4058	142721	437987	298180
.	330130	1.5	0.4198	146830	434569	294613

Input units are thousands and kg - output in tonnes

Table 9.8.2.1: Input values for sardine two area management option table

	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 the stock
0	0.0002	0.029	0.028	0.025	6252.3	0.33	0.00	0.25	0.25	0.000
1	0.0020	0.059	0.061	0.038	4370.7	0.33	0.26	0.25	0.25	0.020
2	0.0176	0.074	0.137	0.054	3915.0	0.33	0.91	0.25	0.25	0.041
3	0.0439	0.081	0.260	0.061	2213.2	0.33	0.95	0.25	0.25	0.055
4	0.0632	0.086	0.294	0.065	817.3	0.33	0.95	0.25	0.25	0.062
5	0.0547	0.092	0.249	0.068	432.9	0.33	1.00	0.25	0.25	0.067
6+	0.0467	0.100	0.257	0.100	294.5	0.33	1.00	0.25	0.25	0.100
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 9.8.2.2 IBERIAN SARDINE Two area management option table.

Spreadsheet version **Fsq=0.2799 in 2001-2002**

		YEAR 2001										
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass
1	**0.280**	0.045	199.762	16.170	0.235	1528.240	83.412	0.280	1728.003	99.582	7237.717	339.424
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

		YEAR 2002											2003	
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time		Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
0.00	**0.000**	0.000	-	-	0.000	-	-	0.000	-	-	7370	363	8367.567	431.052
0.05	**0.014**	0.002	11.942	0.983	0.012	85.521	4.824	0.014	97.463	5.807	7349.092	362.153	8274.579	425.334
0.10	**0.028**	0.004	23.726	1.952	0.024	170.130	9.591	0.028	193.856	11.543	7328.245	360.989	8183.025	419.710
0.15	**0.042**	0.007	35.355	2.908	0.035	253.841	14.301	0.042	289.195	17.209	7307.468	359.828	8092.879	414.179
0.20	**0.056**	0.009	46.830	3.852	0.047	336.665	18.955	0.056	383.495	22.807	7286.762	358.671	8004.117	408.739
0.25	**0.070**	0.011	58.155	4.782	0.059	418.615	23.555	0.070	476.770	28.337	7266.126	357.519	7916.714	403.389
0.30	**0.084**	0.013	69.331	5.700	0.071	499.702	28.100	0.084	569.033	33.800	7245.559	356.371	7830.645	398.127
0.35	**0.098**	0.016	80.360	6.606	0.082	579.940	32.592	0.098	660.299	39.198	7225.063	355.227	7745.888	392.952
0.40	**0.112**	0.018	91.245	7.500	0.094	659.338	37.031	0.112	750.583	44.531	7204.636	354.087	7662.418	387.862
0.45	**0.126**	0.020	101.987	8.382	0.106	737.909	41.418	0.126	839.896	49.800	7184.278	352.951	7580.214	382.854
0.50	**0.140**	0.022	112.590	9.252	0.118	815.664	45.755	0.140	928.254	55.006	7163.989	351.819	7499.253	377.929
0.55	**0.154**	0.025	123.054	10.110	0.129	892.615	50.040	0.154	1015.668	60.150	7143.769	350.691	7419.513	373.084
0.60	**0.168**	0.027	133.381	10.957	0.141	968.771	54.276	0.168	1102.152	65.233	7123.617	349.567	7340.973	368.318
0.65	**0.182**	0.029	143.575	11.793	0.153	1044.144	58.463	0.182	1187.719	70.256	7103.533	348.448	7263.611	363.629
0.70	**0.196**	0.031	153.637	12.617	0.165	1118.745	62.602	0.196	1272.381	75.219	7083.517	347.332	7187.407	359.017
0.75	**0.210**	0.034	163.568	13.431	0.176	1192.583	66.693	0.210	1356.151	80.123	7063.569	346.221	7112.341	354.479
0.80	**0.224**	0.036	173.371	14.234	0.188	1265.670	70.737	0.224	1439.041	84.970	7043.688	345.113	7038.393	350.014
0.85	**0.238**	0.038	183.047	15.026	0.200	1338.016	74.734	0.238	1521.063	89.760	7023.874	344.009	6965.543	345.622
0.90	**0.252**	0.040	192.598	15.808	0.212	1409.630	78.686	0.252	1602.228	94.493	7004.128	342.909	6893.772	341.300
0.95	**0.266**	0.043	202.027	16.579	0.223	1480.522	82.593	0.266	1682.549	99.172	6984.447	341.814	6823.061	337.047
1.00	**0.280**	0.045	211.334	17.340	0.235	1550.702	86.455	0.280	1762.037	103.795	6964.834	340.722	6753.392	332.863
1.05	**0.294**	0.047	220.523	18.091	0.247	1620.180	90.274	0.294	1840.703	108.365	6945.286	339.634	6684.747	328.746
1.10	**0.308**	0.049	229.593	18.833	0.259	1688.965	94.049	0.308	1918.558	112.882	6925.804	338.550	6617.107	324.694
1.15	**0.322**	0.052	238.548	19.565	0.270	1757.067	97.782	0.322	1995.614	117.346	6906.389	337.470	6550.456	320.708
1.20	**0.336**	0.054	247.388	20.287	0.282	1824.493	101.472	0.336	2071.881	121.759	6887.038	336.393	6484.777	316.784
1.25	**0.350**	0.056	256.115	20.999	0.294	1891.255	105.121	0.350	2147.370	126.121	6867.753	335.321	6420.052	312.923
1.30	**0.364**	0.058	264.732	21.703	0.306	1957.360	108.730	0.364	2222.092	130.432	6848.532	334.252	6356.265	309.123
1.35	**0.378**	0.061	273.239	22.397	0.317	2022.817	112.298	0.378	2296.056	134.695	6829.377	333.188	6293.400	305.383
1.40	**0.392**	0.063	281.639	23.082	0.329	2087.634	115.826	0.392	2369.273	138.908	6810.285	332.127	6231.442	301.702
1.45	**0.406**	0.065	289.932	23.758	0.341	2151.822	119.315	0.406	2441.753	143.074	6791.258	331.069	6170.373	298.080
1.50	**0.420**	0.067	298.120	24.426	0.353	2215.386	122.766	0.420	2513.507	147.192	6772.295	330.016	6110.180	294.514
1.55	**0.434**	0.070	306.205	25.084	0.364	2278.337	126.178	0.434	2584.542	151.263	6753.396	328.966	6050.847	291.004
1.60	**0.448**	0.072	314.189	25.735	0.376	2340.682	129.553	0.448	2654.870	155.288	6734.560	327.921	5992.360	287.549
1.65	**0.462**	0.074	322.072	26.377	0.388	2402.428	132.891	0.462	2724.500	159.267	6715.788	326.879	5934.703	284.148
1.70	**0.476**	0.076	329.856	27.010	0.400	2463.585	136.192	0.476	2793.441	163.202	6697.079	325.840	5877.864	280.799
1.75	**0.490**	0.078	337.543	27.636	0.411	2524.159	139.457	0.490	2861.702	167.093	6678.432	324.805	5821.827	277.503
1.80	**0.504**	0.081	345.133	28.253	0.423	2584.159	142.687	0.504	2929.292	170.940	6659.848	323.774	5766.580	274.259
1.85	**0.518**	0.083	352.629	28.863	0.435	2643.591	145.881	0.518	2996.221	174.744	6641.326	322.747	5712.108	271.064
1.90	**0.532**	0.085	360.032	29.464	0.447	2702.464	149.041	0.532	3062.496	178.505	6622.867	321.723	5658.399	267.919
1.95	**0.546**	0.087	367.343	30.058	0.458	2760.785	152.166	0.546	3128.127	182.225	6604.469	320.703	5605.439	264.822
2.00	**0.560**	0.090	374.563	30.645	0.470	2818.560	155.258	0.560	3193.122	185.903	6586.133	319.687	5553.217	261.773
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

9.9 Short-Term risk analysis

Not considered to be relevant.

9.10 Medium-term projections

Not considered to be relevant.

9.11 Long-term Yield

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 (Table 9.8.1.5). Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. Population numbers used in the projection are those used for short term predictions. Results are shown in Table 9.11.1 and Figure 9.11.1.

Table 9.11.1.: Sardine yield per recruit table.

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	3.5578	0.1348	2.1574	0.1252	1.9865	0.1152
0.1	0.0280	0.0445	0.0030	3.4242	0.1234	2.0258	0.1138	1.8547	0.1041
0.2	0.0560	0.0823	0.0055	3.3108	0.1139	1.9144	0.1044	1.7430	0.0948
0.3	0.0840	0.1150	0.0075	3.2133	0.1059	1.8188	0.0964	1.6472	0.0871
0.4	0.1119	0.1434	0.0092	3.1283	0.0991	1.7358	0.0897	1.5639	0.0805
0.5	0.1399	0.1685	0.0107	3.0535	0.0932	1.6629	0.0839	1.4908	0.0748
0.6	0.1679	0.1908	0.0119	2.9871	0.0881	1.5984	0.0788	1.4260	0.0699
0.7	0.1959	0.2108	0.0130	2.9277	0.0836	1.5408	0.0744	1.3682	0.0656
0.8	0.2239	0.2288	0.0139	2.8741	0.0797	1.4890	0.0705	1.3162	0.0618
0.9	0.2519	0.2452	0.0147	2.8254	0.0761	1.4421	0.0671	1.2692	0.0585
1	0.2799	0.2602	0.0154	2.7809	0.0730	1.3994	0.0640	1.2263	0.0555
1.1	0.3078	0.2740	0.0160	2.7401	0.0702	1.3603	0.0612	1.1871	0.0528
1.2	0.3358	0.2868	0.0165	2.7025	0.0676	1.3244	0.0587	1.1511	0.0504
1.3	0.3638	0.2986	0.0170	2.6676	0.0653	1.2912	0.0565	1.1178	0.0482
1.4	0.3918	0.3096	0.0175	2.6352	0.0632	1.2605	0.0544	1.0869	0.0462
1.5	0.4198	0.3200	0.0179	2.6049	0.0612	1.2318	0.0525	1.0582	0.0444
1.6	0.4478	0.3296	0.0183	2.5765	0.0595	1.2050	0.0508	1.0314	0.0427
1.7	0.4757	0.3387	0.0186	2.5498	0.0578	1.1799	0.0492	1.0063	0.0412
1.8	0.5037	0.3473	0.0189	2.5246	0.0563	1.1564	0.0477	0.9827	0.0398
1.9	0.5317	0.3554	0.0192	2.5008	0.0548	1.1341	0.0463	0.9604	0.0385
2	0.5597	0.3632	0.0195	2.4783	0.0535	1.1131	0.0451	0.9394	0.0372

Reference point	F multiplier	Absolute F
Fbar(2-5)	1	0.2799
FMax	12.224	3.4209
F0.1	1.6461	0.4607
F35%SPR	1.7606	0.4927

Weights in kilograms

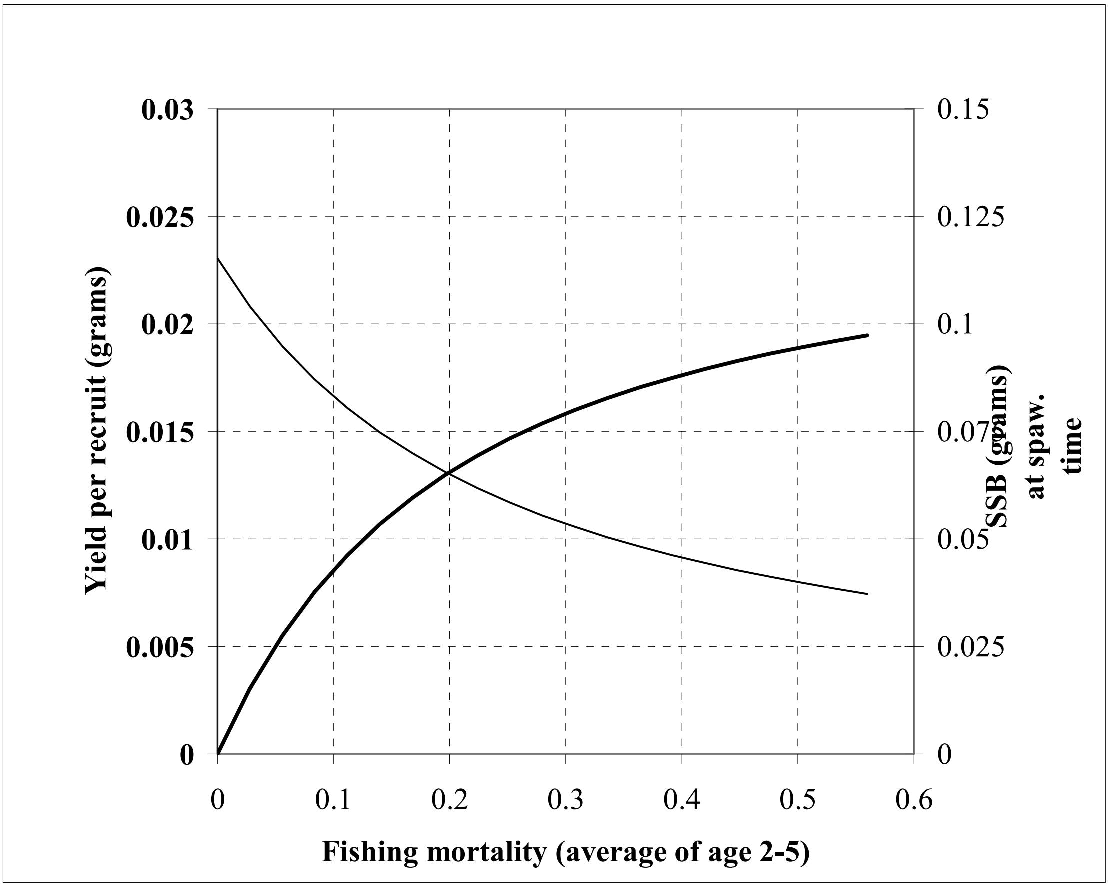


Figure 9.11.1: Sardine Yield per recruit

9.12 Uncertainty in assessment

Not considered to be relevant.

9.13 Reference points for management purposes

The Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) did not consider any reference points for sardine. In addition, ACFM concluded that since the state of the stock in relation to precautionary reference points is considered to be unknown, no precautionary approach reference points are proposed.

The absolute size of this stock still remains uncertain. Nevertheless, as it was already stated, the perception of this stock from the different assessment models analysed gave similar fluctuations in SSB, $Fbar_{(2-5)}$ and recruitment.

The state of the stock in the earlier part of the time series remains unclear. Therefore the Working Group concluded that no reference points for management purposes should be suggested.

9.14 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).

The lack of stability in the assessment model makes it difficult to adopt a harvest control rule. Nevertheless, given the similar trends observed in the different models, some form of rule adapted to the most recent assessment could be suggested. Accordingly, to prevent further decrease of the stock in the short term, a harvest control rule in which the estimation of the last assessment is observed as relative could be adopted. As it was stated last year, the fishing mortality for this stock should be adapted according to the perception of the stock size.

9.15 Management considerations

At present the Spawning Stock Biomass of this stock is considered to be low. The current assessment model estimated a SSB in 2000 lower than that observed in 1990. Fishing mortality increased from 1995 to 1998 where it reached the highest value since 1980. Nevertheless, fishing mortality shows a decrease in the last two years. Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches and possibly a decrease in the fishing effort in 2000 (due to prevalence of rough weather conditions in the last four months of the year) may have contributed to this decrease.

The apparently good 2000 year-class is expected to change the stock level in the short-term. However, previous indications of strong year classes were observed either to have disappeared gradually when new information was available (as the 1998 year class) or had a short-term influence in stock biomass (as the 1991 year class). In addition, 2000 recruitment mostly occurred in north Portugal as observed during the Portuguese acoustic survey. However, in Spring 2001, the 2000 year class spread out and was found along the western coast of the Iberian Peninsula, whilst in the southern area (IXa Cadiz and IXA-S) a new pulse belonging to this year class but with lower mean length was detected during spring. The WG considers that the 2000 year class must be monitored and its strength evaluated by future data before it can be fully included in the assessment of the stock.

At present, the SSB is close to its historical lowest level, therefore close monitoring of this stock is still needed.

9.16 Stock identification, composition, distribution and migration in relation to climatic effects

Research in stock identification has progressed during 2000 with the collection of fifteen sardine samples across a wide distribution area (Celtic Sea to Atlantic Morocco, Azores and the Spanish Mediterranean coast) from sampling opportunities provided by Spring surveys prosecuted within the framework of the EU Project 'PELASSES'. The study of morphometric and genetic markers from these samples is under way, the analysis of otolith microchemistry and life history properties will be carried out in the near future. Preliminary results are available from the comparison of samples from four dispersed locations: Gulf of Biscay, northern Portugal, south-western Mediterranean and the Azores (Silva *et al.*,WD 2001). Morphometric results show the Azores sample is clearly separated from a group including the Mediterranean and northern Portugal, while fish from the Gulf of Biscay overlap considerably with the coastal Atlantic and Mediterranean samples. The analysis of three DNA microsatellite loci show a high degree of heterogeneity between samples with all sample pairs (except the Azores-Mediterranean pair) showing significant differences. The similarity between these two samples may reflect the recent evolutionary origin of the Azorean fish from those from the south-western Mediterranean. The differences between the results from morphometric and genetic studies may simply reflect the different nature of the two types of marker, the latter reflecting mainly the evolutionary history and degree of isolation while the former being highly susceptible to environmental conditions.

Information on sardine abundance, distribution and population structure off the Portuguese coast has been reviewed and synthesised from the analysis of data from twenty-six acoustic surveys carried out during the past two decades (Stratoudakis *et al*., WD 2001). A thorough description of survey methodology and the main changes observed through time is provided. The results of comparisons between the two decades (80's and 90's) essentially complement and substantiate previous studies presented in recent years (ICES 2000, 2001). The extent of the sardine distribution area off Portugal decreased by around 25% in the 90's when seasonal differences became less perceptible and a declining trend with time became evident. The reduction is almost exclusively due to a large reduction in the northern area (~41%) (where there are also indications of changes in the maturation cycle) and these results are corroborated by similar trends in the mean depth of fishing hauls with sardine over time. Sardine abundance shows no clear trends over time, but is marked by the dominance of young fish in recent years and also by the strong 2000 year class in northern Portugal.

The recent failure in the Galician sardine fishery (IXa-N and southwestern part of VIIIc-W) has been analysed in Carrera and Porteiro (2001). Available information on sardine (i.e. acoustic and ichthyoplankton surveys and landings) was reviewed. The decrease in sardine landings was explained by two main factors: a) the shrinkage of the sardine distribution, especially off north Portugal which affected the juvenile fishery in South Galicia (IXa-N) and b) a change in the age structure pattern of sardine along the Iberian coast together with an overall decrease in the stock size which might have affected the migration patterns of adult fish and hence, the adult fishery in North Galicia.

Dependence of the sardine recruitment process on both large and meso-scale (local) oceanographic events has been explored further by modelling recruitment strength as a linear function of several oceanographic indices (NAO-Spring, NAO-Winter and Gulf Stream current as large indices and upwelling and Ekman transport as local indices) together with the estimated spawning stock biomass (Porteiro *et al*., WD 2001). Both local and large-scale oceanographic events seem to have influence on the strength of the recruitment. In addition, the size of the parental stock appears to have influence on the strength of the recruitment. Since younger sardine mainly occur in the recruitment areas, a previous good recruitment could be acting as a negative partial effect either on intra-specific competition between the larvae and young fish or on egg predation by young sardines. The model is significant and explains 54% of the variability found in the recruitment time series. The prediction of an above average recruitment in 2000 was according to observed data. However, the performance (both in explanatory and predictive power) of the model has to be tested further before it can be used as a quantitative tool.

Although progress has been made during 2000, the WG continues to recognise the need to develop an integrated approach to these issues. To this end a proposal for a project 'SARDYN' was submitted to the EU-Quality of Life Program in October 2000. Funding was not granted and the project will be re-submitted in October 2001. The main objectives of the project are to describe the stock structure and dynamics of sardine in the Northeast Atlantic in order to propose alternatives for analytical assessment. The study area covers the eastern Atlantic from France to Morocco, and includes the Spanish Mediterranean. The studies planned include: the identification of spawning areas, and seasons and description of spawning dynamics; stock identification using complementary techniques (genetics, morphometrics, otolith chemistry, life history properties); direct and indirect evidence of fish movements; links between sardine distribution and abundance with primary and secondary productivity; analysis of possible mechanisms of larval drift; development of appropriate assessment models.

10 ANCHOVY – GENERAL

10.1 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.,* 1994), the WG considers that the anchovy in this area has to be dealt with as a single management unit for assessment purposes.

Some new observations made in 2000 during the Pelasses survey in winter suggest the presence of anchovy in the Celtic Sea (Carrera, 2000). So far, this information does not affect our perception of one stock on the Bay of Biscay area. Anchovy found in the Celtic sea area is probably linked to the population of anchovy found in the Channel in spring by the professional fisheries.

Junquera (1993) suggested that anchovy in the Central and Western part of Division VIIIc may be more closely related to the anchovy found off the Western Galician coasts than with the anchovy at the South-east corner of the Bay of Biscay (where the major fishery takes place). Morphological studies, as mentioned previously, are influenced by environmental conditions and further investigations, especially on genetic characteristics, are necessary in order to be more certain. The WG considers that for assessment and management purposes the anchovy population along the Atlantic Iberian coasts (Division IXa) should be dealt with as a management unit independent of the one in the Bay of Biscay.

There is a need for further studies on the dynamics on the anchovy in IXa and its possible connection with anchovies from other areas. The differences found between areas in length distributions, mean length- and mean weight at age, and maturity-length ogives, which were estimated from both fishery data and acoustic surveys, support the view that the populations inhabiting IXa may be not entirely homogeneus, showing different biological characteristics and dynamics (ICES 2001/ACFM:06). The recent catch distribution of anchovy along Division IXa confirms that anchovy fishery is mainly concentrated in the Spanish waters of the Gulf of Cadiz (more than 80% of total landings), which is also corroborated by direct estimates of the stock biomass (about 90% of total biomass). Such data seem to suggest the existence of a stable anchovy population in the Gulf of Cadiz which may be relatively independent of the remaining populations in Division IXa. These others populations seem to be latent ones, which only develop when suitable environmental conditions take place, as occurred in 1995. (See section 12 and Ramos *et al*., WD 2001).

10.2 Distribution of the Anchovy Fisheries

The observations collected by the members of the Working group allowed to define the principal areas of fishing according to quarters. Table 10.2.1 shows the distribution of catches of anchovy by quarters for the period 1991-2000.

In Sub-area VIII during the first quarter in 2000, 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 (VIIIb) and in the South (VIIIc) and, as in the last two years in the North (VIIIa) as well, whereas the French fishery is located in the North (VIIIa). During the fourth quarter, the main fishery is located in the North of the Bay of Biscay (VIIIa) and some Spanish purse seiners stayed to fish in the North, but the main production remained the French one.

In Division IXa, the Portuguese landings in 2000 were low and most of the fish were caught during the first and fourth quarter in Sub-division South. The Portuguese catches peaked at 1995 (7056 tonnes) and since then they remained low. The Spanish fishery in 2000 was mainly located in the Bay of Cadiz. During 2000, in that area, the landings decreased to a lower level than the historical maximum for this area (8977 t) observed in 1998 and are relatively stable throughout the year, rising in spring-summer. The decrease of Spanish catches in IXa North since the maximum level in 1995 (5,329 t) is continuing in 2000.

Historically, catches to the West of the Iberian Peninsula (from Sub-divisions 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 10.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters and total in the period 1991-2000.

Q 1	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	1049	2	6	1	126	0	36	2797	1259	-
1992	1125	0	26	0	0	187	756	3666	958	-
1993	767	0	3	1	0	69	1605	4147	1143	-
1994	690	0	0	0	0	5	62	4601	786	27
1995	185	1	203	12	0	0	35	2380		
1996	41	0	1289	11	116	61	9	2345	0	-
1997	908	6.0	164	2	12	43	58	1548	925	-
1998	1782	109	424	192	472			4725	0	
1999	1638	65	91	76	65			4008	0	0
2000	416	61	41	0	88			4003	0	0

Q 2	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	3692	0	10	14	90	295	5848	3923	650	-
1992	1368	0	10	0	11	457	17532	2538	275	-
1993	921	0	6	0	25	24	10157	6230	658	-
1994	2055	0	0	0	1	79	11326	6090	163	75
1995	80	7	1989	1233	23	36	14843	6153		
1996	807	1	227	6	1	404	9366	8723	0	-
1997	1110	2	49	4	0	81	4375	3065	598	-
1998	2175	0	191	51	2215			5505	0	
1999	1995	0	4	7	7138			4169	0	0
2000	668	0	5	1	14690			3755	0	0

Q 3	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	703	0	0	0	24	15	145	386	1744	-
1992	499	0	4	27	192	390	632	191	4108	-
1993	167	0	0	0	1	8	1206	1228	6902	-
1994	210	8	29	1	61	6	1358	2341	3703	15
1995	148	52	1817	4043	1	10	55	3620		
1996	586	0	189	22	134	146	1362	171	6930	-
1997	2007	0	44	2	202	3	735	4189	2651	-
1998	2877	12	49	5	1579			205	11671	0
1999	1617	0	139	318	949			351	5750	0
2000	673	0	0	7	1238			211	8804	0

Q 4	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	274	0	171	0	205	692	148	91	805	-
1992	4	1	96	6	8	18	204	27	5533	-
1993	105	1	13	0	0	0	574	1005	5106	-
1994	80	0	198	116	6	13	895	341	2520	14
1995	157	271	2716	42	398	148	18	2080		
1996	398	12	1002	5	21	12	158	204	4016	-
1997	589	0	353	54	93	83	530	1225	1354	-
1998	2710	32	231	123	27			1	5217	0
1999	692	30	723	12	98			0	4266	0
2000	603	0	25	2	98			266	3843	0

TOTAL	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	5717	3	187	15	445	1003	6177	7197	4458	-
1992	2996	1	136	33	211	1053	19122	6422	10874	-
1993	1960	1	22	1	26	101	13542	12609	13809	-
1994	3035	8	227	117	68	103	13641	13373	7172	130
1995	571	331	6725	5329	421	194	14951	14233		
1996	1831	13	2707	44	272	623	10895	11442	10946	-
1997	4614	8	610	62	307	210	5698	10027	5528	-
1998	9543	153	894	371	4294			10436	16888	0
1999	5942	96	957	413	8249			8529	10016	0
2000	2360	61	71	10	16113			8235	12647	0

- Not available

11 ANCHOVY - SUB-AREA VIII

11.1 ACFM Advice and STECF recommendations applicable to 2001

ICES advice from ACFM in November 2000 states: "ICES recommends a preliminary TAC for 2001 is set to 18000t. *This is based on the conservative assumption that recruitment in 2000 and beyond is 8.1 billion (mean of the 8 poorest year classes), and that the fishing mortality is the average of that of recent years (F=0.71). This TAC should be revised in the middle of the year 2001, based on the results of the fishery and of acoustic and egg surveys in May-June".*

STECF in November 2000 agreed with the ICES advice but considered that: "*a provisional TAC for Anchovy in the Bay of Biscay and an in-year revision is only necessary if spawning stock biomass in the assessment year is below a predefined level. If spawning stock is estimated to be above this predefined level, STECF considers that it would be appropriate to set a final annual TAC.*

Since spawning stock biomass in 2000 (50 000 t) is well above $\boldsymbol{B}_{pa}$ *(36 000 t), a provisional TAC of 18000 t advised by ICES may not be appropriate. <u>STECF recommends that a final annual TAC for anchovy in the Bay of Biscay be set for 2001 to avoid the need to re-evaluate the stock status after the surveys in 2001</u>.*"·

Finally, the European Fishery Commission decided to set an annual TAC at a precautionary level of 33,000 t, as traditionally had been done.

11.2 The fishery in 2000

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. For the first time in 1999, a part of the fleet came to fish in the VIIIa during summer and autumn and landed significant amounts of fish. This was the case in 2000 as well (**see** Table 11.2.1.3).

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 north of the VIIIb 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.

11.2.1 Catch estimates for 2000

In 2000 a total of 36994 tonnes were caught in Sub-area VIII (Table 11.2.1.1 and Figure 11.2.1.1). It is a 35.7% increase compared to the level of 1999 catches. The two fisheries increased their landings close to their respective quotas. As usual, the main Spanish fishery took place in the second quarter (88.2%) and the main French fishery in the second half of the year (69.3 %) (Table 11.2.1.2 and Figure 11.2.1.2).

In 2000, as in other years, Spanish and French fisheries were well separated temporally and spatially. About 90% of the Spanish landings were caught in divisions VIIIc and VIIIb in Spring, while the French landings were caught in divisions VIIIb in Winter (22.4 %) or in Summer and autumn in division VIIIa (69.3%) (Table 11.2.1.3). As in 1999 some Spanish purse seines went to fish for anchovy in VIIIa during the second half of the years, although catches were low.

During the first half of 2001, total international catches reached 23,198 t (preliminary data) which is a similar level than the one reached for the same period in 2000 due to large landings of the Spanish fleet in Spring. (see Tables 11.2.1.1 and 2).

11.2.2 Discards

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.

Table 11.2.1.1: Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII) As estimated by the Working Group members.

COUNTRY	FRANCE	SPAIN	SPAIN	INTERNATIONAL
YEAR	VIIIab	VIIIbc, Landings	Live Bait Catches	VIII
1960	1,085	57,000	n/a	58,085
1961	1,494	74,000	n/a	75,494
1962	1,123	58,000	n/a	59,123
1963	652	48,000	n/a	48,652
1964	1,973	75,000	n/a	76,973
1965	2,615	81,000	n/a	83,615
1966	839	47,519	n/a	48,358
1967	1,812	39,363	n/a	41,175
1968	1,190	38,429	n/a	39,619
1969	2,991	33,092	n/a	36,083
1970	3,665	19,820	n/a	23,485
1971	4,825	23,787	n/a	28,612
1972	6,150	26,917	n/a	33,067
1973	4,395	23,614	n/a	28,009
1974	3,835	27,282	n/a	31,117
1975	2,913	23,389	n/a	26,302
1976	1,095	36,166	n/a	37,261
1977	3,807	44,384	n/a	48,191
1978	3,683	41,536	n/a	45,219
1979	1,349	25,000	n/a	26,349
1980	1,564	20,538	n/a	22,102
1981	1,021	9,794	n/a	10,815
1982	381	4,610	n/a	4,991
1983	1,911	12,242	n/a	14,153
1984	1,711	33,468	n/a	35,179
1985	3,005	8,481	n/a	11,486
1986	2,311	5,612	n/a	7,923
1987	4,899	9,863	546	15,308
1988	6,822	8,266	493	15,581
1989	2,255	8,174	185	10,614
1990	10,598	23,258	416	34,272
1991	9,708	9,573	353	19,634
1992	15,217	22,468	200	37,885
1993	20,914	19,173	306	40,393
1994	16,934	17,554	143	34,631
1995	10,892	18,950	273	30,115
1996	15,238	18,937	198	34,373
1997	12,020	9,939	378	22,337
1998	22,987	8,455	176	31,617
1999	13,649	13,145	465	27,259
2000	17,765	19,230	n/a	36,994
2001	*2,548*	*20,650*		23,198
AVERAGE (1960-00)	5,934	27,927	318	33,962

Provisional estimate for the first half of the year

Table 11.2.1.2. 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
1999	2080	1333	574	55	68	948	1015	922	3138	1923	1592	0	13649
2000	2200	948	825	5	58	1412	2190	2720	3629	2649	1127	0	17765
Average 87-00	1245	1006	585	433	667	906	859	1714	2566	1801	1019	50	12850
in percentage	9.7%	7.8%	4.6%	3.4%	5.2%	7.1%	6.7%	13.3%	20.0%	14.0%	7.9%	0.4%	100%
Average 92-00	1713	1320	839	179	291	1257	1239	2209	3146	2472	1496	22	16180
in percentage	10.6%	8.2%	5.2%	1.1%	1.8%	7.8%	7.7%	13.7%	19.4%	15.3%	9.2%	0.1%	100%

COUNTRY: SPAIN

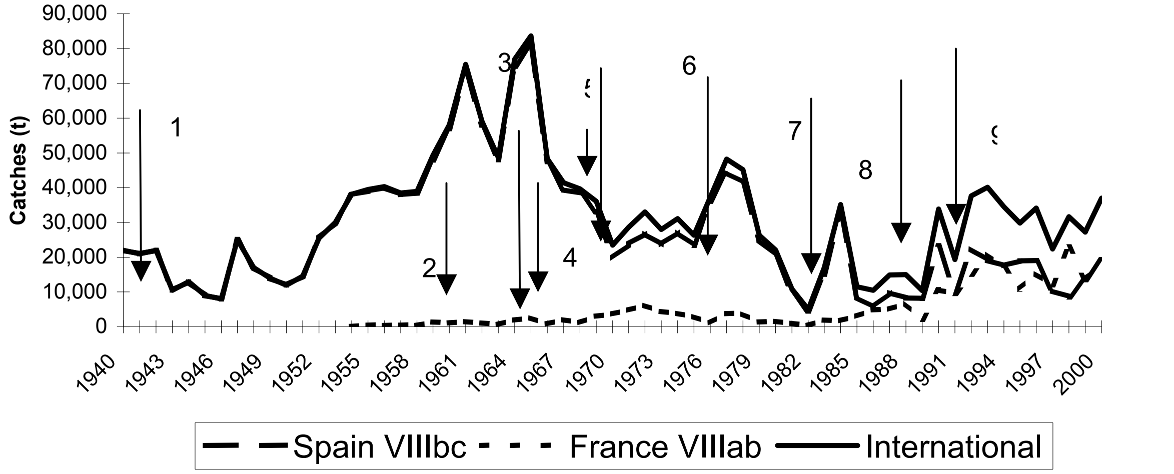
YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4133	3677	514	81	54	28	457	202	265	9864
1988	6	0	28	786	2931	3204	292	98	421	118	136	246	8266
1989	2	2	25	258	4295	795	90	510	116	198	1610	273	8173
1990	79	6	2085	1328	9947	2957	1202	3227	2278	123	16	10	23258
1991	100	40	23	1228	5291	1663	91	60	34	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
1999	8	26	52	4626	4214	1396	1037	26	911	207	615	27	13144
2000	18	0	99	1952	11864	3153	958	342	413	346	83	0	19230
Average 87-00	57	56	416	2640	6801	2535	654	433	516	223	299	155	14785
in percentage	0.4%	0.4%	2.8%	17.9%	46.0%	17.1%	4.4%	2.9%	3.5%	1.5%	2.0%	1.0%	100%
Average 92-00	68	81	357	3247	7675	2929	822	235	483	218	226	87	16428
in percentage	0.4%	0.5%	2.2%	19.8%	46.7%	17.8%	5.0%	1.4%	2.9%	1.3%	1.4%	0.5%	100%

Table 11.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 2000 (without live bait catches)

COUNTRIES	DIVISIONS	QUARTERS				CATCH (t)	
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	264	66	330	1.7%
	VIIIb	30	2280	211	266	2787	14.5%
	VIIIc	88	14690	1238	98	16113	83.8%
	TOTAL	118	16969	1713	429	19230	100
	%	0.6%	88.2%	8.9%	2.2%	100.0%	
FRANCE	VIIIa	0	0	8540	3777	12317	69.3%
	VIIIb	3973	1475	0	0	5448	30.7%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	3973	1475	8540	3777	17765	100.0%
	%	22.4%	8.3%	48.1%	21.3%	100.0%	
INTERNATIONAL	VIIIa	0	0	8804	3843	12647	34.2%
	VIIIb	4003	3755	211	266	8235	22.3%
	VIIIc	88	14690	1238	98	16113	43.6%
	TOTAL	4091	18444	10253	4206	36995	100.0%
	%	11.1%	49.9%	27.7%	11.4%	100.0%	

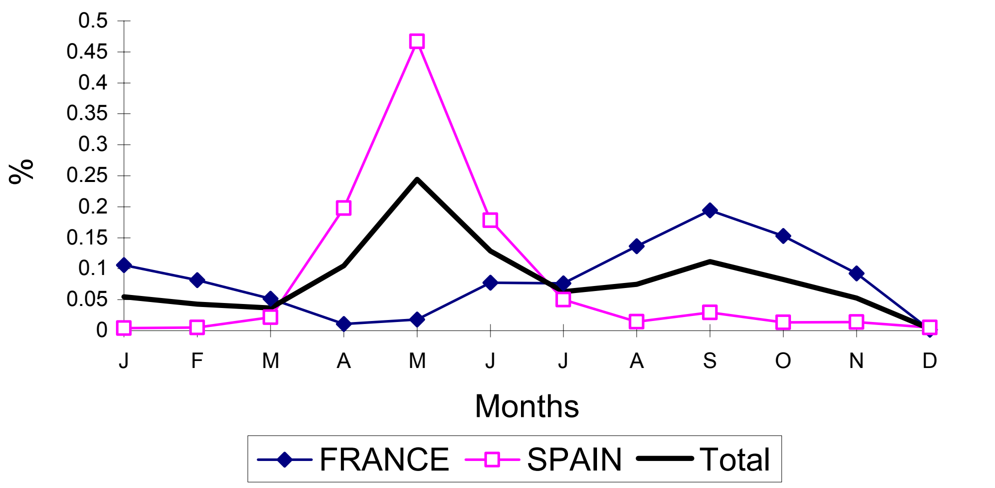
The separation of Spanish catches during the second half of the year between VIIIa and VIIIb are only approximate estimat

Figure 11.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940



1. Goniometer
2. Echosounder ; anchovy disappeared from the coast of Galicia
3. Minimun 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. Minimun 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 11.2.1.2: Mean monthly catches (1992-2000) for the French and Spanish anchovy fisheries in Sub-area VIII



11.3 Biological data

11.3.1 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 11.3.1.1. For both countries, the 1 age group largely predominates in the catches even during the first semester. For the international catches, 1 year-old anchovies make up 68.4 % of the landings followed by age 2 with 23.8%. As usually, the 0 and 3 age groups represented respectively a low proportion of the catches in 2000, respectively 0.4 and 7.4% for each category. Approximately 15% 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 were not available in 2000. The Table 11.3.1.2 gives the data available for the period 1987 – 1999. These are traditionally catches of small anchovy, mainly of 0 and 1 year old groups, amounting to about 5 hundred tonnes or less.

Table 11.3.1.3 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies predominate largely in the catches during the both halves of most of the years (except for the years 1991, 1994 and 1999). A few catches of immature, 0 age group, appear during the second half of the year. The estimates of the catches at age on an annual basis since 1987 is presented along with the inputs to the assessment in Table 11.7.2.1.

11.3.2 Mean length-at-age and mean weight-at-age

Table 11.3.2.1 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 11.3.2.1).

For the second quarter, the length distribution of the Spanish fishery, the main one showed a unimodal distribution. For the French landings, we observed a bimodal distribution for the catches, the smaller group corresponds mainly to the production of small purse-seiner and pelagic trawlers fishing close to the shore. On average, the anchovies landed by the French fleet are smaller than those caught by the Spanish one in the second quarter (Figure 11.3.2.**2**).

For the third quarter, on average the French anchovy catches had a mean size higher than the Spanish one (Figure 11.3.2.3).

For the fourth quarter, the size distribution of the French and Spanish landings were similar (Figure 11.3.2.4).

The series of mean weight at age in the fishery by half year, from 1987 to 2000, is shown in Table 11.3.2.**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 11.7.2.1. These annual values for the fishery represent the weighted averages of the half-year values per country, according to their respective catches in numbers at age.

The values of mean weight at age for the stock appear with the inputs to the assessment in Table 11.7.2.1**.** These values are the ones estimated for the spawners during the DEPM surveys of 1990-1998 (reported in Cendrero ed., 1994 and Motos *et al.,* WD 1998 and Uriarte *et al*., WD 1999). For the years 1993, 1996 and 1999 onwards, when no estimate of mean weight-at-age for the stock existed, the average of the rest of the years was taken.

11.3.3 Maturity-at-age

As reported in previous years' reports, anchovies are fully mature as soon as they reach 1 year old, at the following Spring after they spawn. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Motos, 1994).

11.3.4 Natural Mortality

For the purpose of the assessment applied in the WG, a constant natural mortality of 1.2 is used. However, the natural mortality for this stock is high and probably variable. The main results concerning natural mortality estimates (after Prouzet *et al*, 1999) were:

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 used for the current management procedure is a strong simplification of the actual population dynamic.

Table 11.3.1.1: ANCHOVY catch at age in thousands for 2000 by country, division and quarter (without the catches from the live bait tuna fishing boats).

units: thousands

	QUARTERS		**1**	**2**	**3**	**4**	**Annual total**
SPAIN	**AGE**		**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**
		0	0	0	225	214	439
		1	5,073	384,443	57,603	13,944	461,063
		2	731	198,503	7,700	940	207,873
		3	396	50,438	1,649	436	52,919
		4	0	0	0	0	0
	TOTAL(n)		6,199	633,383	67,176	15,535	722,294
	W MED.		19.27	27.09	25.65	27.93	26.91
	CATCH. (t)		117.9	16969.2	1713.3	429.3	19,229.8
	SOP		119.5	17158.7	1716.8	433.9	19,428.9
	VAR. %		101.28%	101.12%	100.20%	101.08%	101.04%
FRANCE	**AGE**		**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**
		0	0	0	0	4,859	4,859
		1	112,983	57,435	222,090	103,323	495,832
		2	59,407	9,714	44,592	11,480	125,193
		3	29,696	3,907	16,528	0	50,131
		4	0	0	0	0	0
	TOTAL(n)		202,087	71,055	283,210	119,662	676,015
	W MED.		20.38	18.56	30.02	28.81	
	CATCH. (t)		3,973.4	1,475.2	8,540.0	3,775.9	17,765
	SOP		4,118.1	1,318.9	8,501.5	3,447.4	17,386
	VAR. %		103.64%	89.40%	99.55%	91.30%	97.87%
	QUARTERS		**1**	**2**	**3**	**4**	**Annual total**
TOTAL	**AGE**		**VIIIabc**	**VIIIabc**	**VIIIabc**	**VIIIabc**	**VIIIabc**
Sub-area VIII		0	0	0	225	5,073	5,298
		1	118,056	441,877	279,694	117,267	956,895
		2	60,138	208,216	52,292	12,420	333,066
		3	30,092	54,345	18,177	436	103,050
		4	0	0	0	0	0
	TOTAL(n)		208,286	704,439	350,387	135,197	1,398,309
	W MED.		20.34	26.23	29.18	28.71	13.90
	CATCH. (t)		4,091	18,444	10,253	4,205	36,994
	SOP		4,238	18,478	10,218	3,881	36,815
	VAR. %		103.57%	100.18%	99.66%	92.30%	99.51%

Table 11.3.1.2. 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	1999	2000
0	10,020	97,581	6,114	11,999	12,716	2,167	3,557	7,872	10,154	8,102	33,078	1,032	17,230	n/a
1	24,675	17,353	6,320	21,540	13,736	14,268	20,160	5,753	10,885	6,100	8,238	15,136	20,784	n/a
2	1,461	203	1,496	139	0	0		477	209	522	58	0	810	n/a
3	912	3	0	0	0	0		0	0	0	0	0	0	n/a
Total	37,068	115,140	13,930	33,677	26,452	16,435	23,717	14,102	21,248	14,724	41,375	16,169	38,825	n/a
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5	465.126	n/a
meanW (g)	14.7	4.3	13.3	12.4	13.3	12.1	12.9	10.2	15.8	13.4	9.14	10.85	11.98	n/a

Table 11.3.1.3 : 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 without live bait catches of anchovy
(From Uriarte et al., 1997 WD updated for the 1997 AND 1998 data)

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
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	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	0	54,357	0	5,298
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	220,067	243,306	559,934	396,961
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	380,012	142,904	268,354	64,712
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	17,761	525	84,437	18,613
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	108	0	0	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	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	617,948	441,092	912,725	485,584
Internat Catches	11,718	3,590	10,003	5,579	7,153	3,460	19,386	14,886	15,025	4,610	26,381	11,504	24,058	16,334	23,214	11,417	23,479	6,637	21,024	13,349	10,704	11,443	12,918	18,700	15,381	11,878	22,536	14,458
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%	102.0%	103.0%	100.8%	97.6%
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		27,259		36,994

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	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	0	29,057	0	439
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	134,411	87,191	389,515	71,547
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	231,384	37,644	199,233	8,640
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	10,051	525	50,834	2,085
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	108	0	0	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	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	375,954	154,416	639,583	82,711
Catch Spain	8,777	1,632	6,955	1,804	5,377	2,981	16,401	7,273	8,343	1,583	21,047	1,621	17,206	2,272	15,219	2,478	18,322	902	16,774	2,361	6,420	3,897	6,818	1,812	10,323	3,287	17,087	2,143
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%	102.1%	101.7%	101.1%	100.7%
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		13,610		19,230

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 half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	2,688	0	8,419	0	5,282	0	4,985	0	5,111	0	25,313	0	0	0	912	0	18,670	0	56,936	0	41,832	0	0	0	25,300	0	4,859
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	85,656	156,115	170,418	325,413
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	148,628	105,260	69,121	56,072
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	7,710	0	33,603	16,528
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
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
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	241,994	286,676	273,142	402,873
Catch France	2,941	1,958	3,048	3,775	1,776	479	2,985	7,613	6,682	3,027	5,334	9,883	6,851	14,062	7,994	8,939	5,157	5,735	4,251	10,987	4,284	7,546	6,099	16,888	5,058	8,591	5,449	12,316
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%	101.7%	103.4%	99.8%	97.0%
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		13,649		17,765

Table 11.3.2.1. Length distribution ('000) of anchovy in Divisions VIIIa,b,c by country, by year, quarters and Sub-divisions in 2000.

	France	Spain	France	Spain	France	Spain	France	Spain
	VIIIab	VIIIbc	VIIIab	VIIIbc	VIIIab	VIIIbc	VIIIab	VIIIbc
Length (half cm)	**QUARTER 1**		**QUARTER 2**		**QUARTER 3**		**QUARTER 4**	
3.5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
5.5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0
9	0	20	42	11	0	0	0	0
9.5	2	55	83	27	0	0	0	0
10	5	90	400	31	0	0	0	0
10.5	366	284	1255	67	89	0	0	0
11	2022	512	3021	86	360	0	0	0
11.5	6270	728	3543	200	1508	25	0	9
12	11917	649	5252	1242	1572	186	0	12
12.5	13470	411	5621	3233	1224	865	80	45
13	16823	322	2320	13836	2061	2386	1083	153
13.5	25786	231	4577	29311	4399	4775	2019	261
14	28294	393	5773	52178	13639	5736	1860	1062
14.5	25825	549	6314	78922	18125	5993	5649	1250
15	14092	576	4825	96796	25861	9141	7793	2760
15.5	16542	449	6197	81267	39976	9496	13083	2520
16	16104	416	6806	91210	46546	10532	17489	2147
16.5	11480	189	6713	62731	39418	8831	19786	2114
17	6415	141	3479	59175	28269	5486	18081	1625
17.5	4667	39	2629	30667	20347	2113	16417	886
18	1261	19	1727	18595	17898	1203	10355	471
18.5	627	6	474	8284	7139	351	4527	155
19	186	4	38	2650	6226	122	1297	41
19.5	0	4	19	1775	2881	51	0	23
20	0	31	0	763	2508	21	0	2
20.5	0	15	0	274	2508	0	0	0
21	0	61	0	52	651	0	0	0
21.5	0	26	0	0	0	0	0	0
22	0	27	0	0	0	0	0	0
22.5	0	30	0	0	0	0	0	0
23	0	8	0	0	0	0	0	0
23.5	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
24.5	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0
25.5	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0
Number ('000)	202155	6285	71109	633383	283206	67312	119518	15535
Catch (t)	3973	118	1475	16969	8540	1713	3776	429
Mean Length (cm)	14.55	13.86	14.65	15.81	16.42	15.65	16.70	16.00
Mean Weight (g)	20.38	19.27	18.56	27.09	30.02	25.65	28.81	27.93

Table 11.3.2.2.: 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	
Sources:	Anon. (1989 & 1991)		Anon. (1989)		Anon. (1991)		Anon. (1991)		Anon. (1992)		Anon. (1993)		Anon. (1995)	
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
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
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
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
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
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
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
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
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
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

YEAR	1994		1995		1996		1997		1998		1999		2000	
Sources:	Anon. (1996)		Anon. (1997)		Anon. (1998)		Anon. (1999)		Anon (2000)		WG data		WG data	
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
Age 0	0.0	14.7	0.0	15.1	0.0	12.0	0.0	11.6	0.0	10.2	0.0	15.7	0.0	19.3
1	16.8	25.3	22.5	26.9	19.1	23.2	14.4	20.3	21.8	23.7	17.1	27.0	21.7	28.2
2	26.8	28.1	32.3	31.3	29.3	27.7	26.9	30.1	24.3	27.7	29.8	33.5	29.1	33.0
3	30.7	30.0	36.4	36.4	35.0	35.7	32.0	29.7	31.9	28.7	34.7	38.9	32.8	36.9
4	0.0	0.0	37.3	29.1	46.1	39.7	0.0	0.0	31.9	0.0	55.9	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
Total	22.3	24.3	26.9	25.0	22.2	21.6	17.3	19.1	22.5	24.3	25.4	27.7	24.9	29.0
SOP	23,440	11,442	23,830	6,520	21,066	13,139	10,672	11,687	12,996	17,727	15,686	12,229	22,715	14,106
mean weight 3+	30.7	30.0	36.5	35.9	35.8	36.0	32.0	29.7	31.9	28.7	35.3	38.9	32.6	36.9

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
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
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
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
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
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
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
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
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
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

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
Age 0	0.0	14.7	0.0	16.1	0.0	11.2	0.0	10.8	0.0	10.2	0.0	10.4	0.0	14.0
1	18.7	19.6	24.8	20.1	19.9	19.3	14.1	21.1	24.2	24.7	18.6	21.3	23.6	25.8
2	29.2	25.4	35.2	33.4	31.9	29.0	28.6	27.4	32.3	35.3	33.0	31.0	31.2	28.2
3	32.0	30.0	38.2	36.4	40.2	35.7	41.7	29.7	35.3	52.1	40.6	38.9	36.8	28.2
4	0.0	0.0	37.3	29.1	46.1	39.7	0.0	0.0	31.9	0.0	55.9	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
Total	25.0	18.6	29.4	18.0	23.1	17.6	17.1	17.2	25.6	25.3	28.0	21.7	27.0	26.1
SOP	15,424	2,467	18,703	903	16,696	2,170	6,386	3,847	6,746	1,809	10,544	3,344	17,278	2,157
mean weight 3+	32.0	30.0	38.1	35.9	41.0	36.0	41.7	29.7	35.2	52.1	41.1	38.9	36.4	28.2

FRANCE

					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
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
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
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
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
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
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
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
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

	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
Age 0	0.0	11.6	0.0	13.5	0.0	12.7	0.0	13.4	0.0	0.0	0.0	21.8	0.0	19.8
1	14.8	26.1	17.2	27.6	15.8	23.9	14.9	20.0	19.5	23.6	14.6	30.2	17.2	28.7
2	22.6	30.3	24.5	31.1	23.3	27.3	24.9	31.0	20.6	27.1	24.8	34.3	23.2	33.6
3	27.3	0.0	31.4	0.0	30.5	0.0	26.8	0.0	23.2	28.6	27.1	0.0	26.8	38.0
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
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
Total	18.5	26.4	20.5	26.7	19.2	22.8	17.7	20.1	19.8	24.2	21.2	31.0	19.9	29.7
SOP	8,016	8,975	5,127	5,617	4,370	10,969	4,286	7,840	6,250	15,918	5,142	8,885	5,437	11,949

Actualizacion: Completa hasta 2000 inclusive el 3/09/01 por I. Rico (de Cage00.xls)

Figure 11.3.2.1 Size distribution-First Quarter-

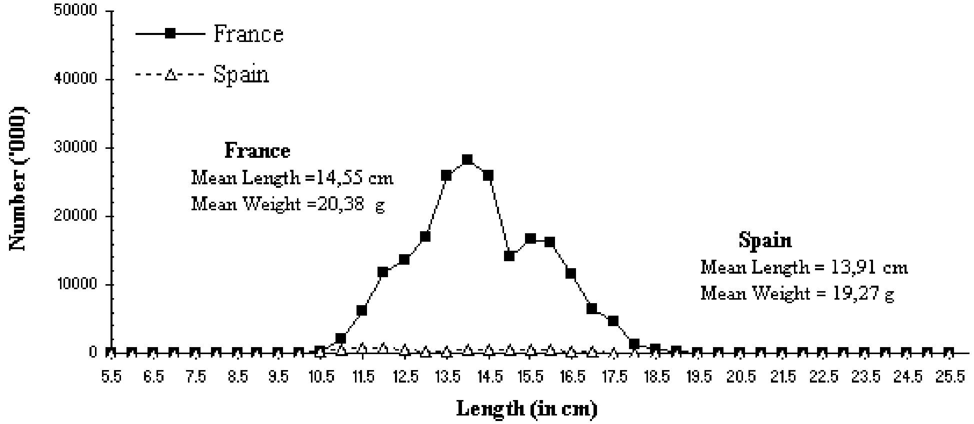


Figure 11.3.2.2 Size distribution - Second Quarter

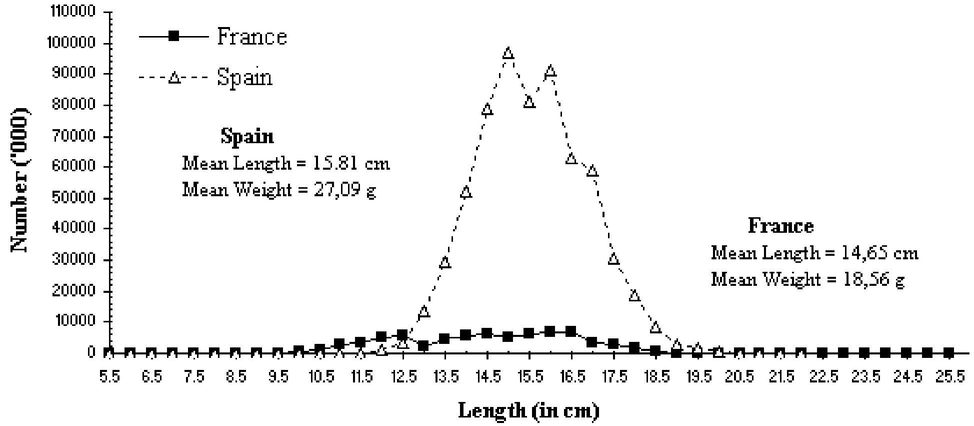


Figure 11.3.2.3 Size distribution-Third Quarter-

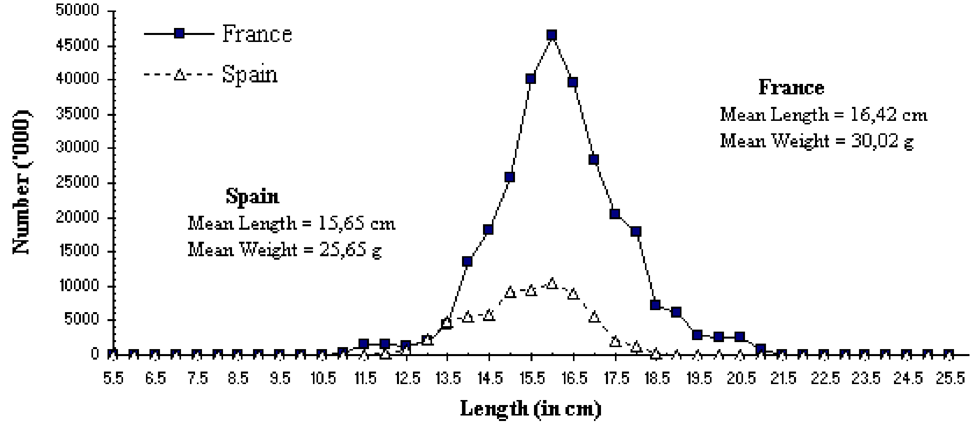
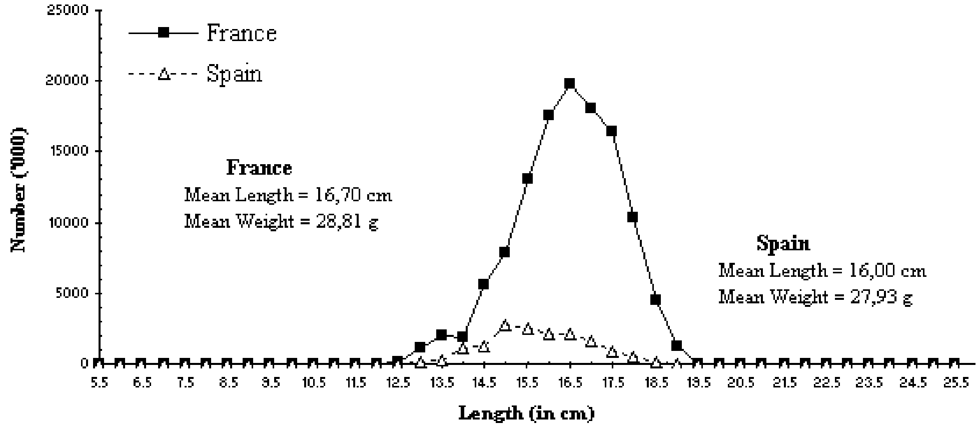


Figure 11.3.2.4 Size distribution -Fourth Quarter-



11.4 Fishery-Independent Information

11.4.1 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 2001, with a gap in 1993 (Table 11.4.1.1). The map of egg abundance and the positive spawning area for 2001 is shown in Figure 11.4.1.1. The largest spawning area of the whole series of DEPM surveys was recorded in 2001. The biomass estimate for year 2001 (WD Uriarte *et al*, 2001) ranges from 100,000 t to about 140,000 t, depending on the regression model used to infer it. As no estimate of Daily Fecundity is available, the biomass estimate was initially based on a regression on Daily Egg production (P0) and Spawning Area (SA) as was done in 1996, 1999 and 2000 when the problem was of that nature.

The WG revised the regression procedures for 2001. The spawning biomass (SSB) data used for the regressions are listed in Table 11.4.1. Uriarte *et al*. (WD2001) proposed to include temperature as a third covariate, but further examination of the results from initial trials indicated that the Julian day of the middle of the survey dates performed better and resulted in a better fit to the data.

The regression model is:

$$LN(SSB) = Constant + \alpha LN(P0) + \beta LN(SA) + \delta \cdot Julian\text{-}day + \xi$$

where P0 is the daily egg production per 0.05 m2 and SA is the positive spawning area.

The regression statistics and the forecast for 2001 are presented in Table 11.4.1.2 and Figure 11.4.1.2. The log predictions were transformed to the original scale including a bias correction factor for the $SSB = \exp(\hat{y} + \frac{1}{2}\sigma^2)$.

Based on this model the estimate would be about 128,000 t, with a CV=14% according to the predictive estimator of the biomass. As P0 and SA are taken as predictors without their measurement error, the CV above is probably an underestimate. In addition, it should be taken into account that the current estimate is based on an extrapolation out of the previous range of observations of P0 and SA. On the other hand, there seems to be an increasing trend of the residuals at high expected estimates (despite the log transformation of the data) (Figure 11.4.1.2). Nevertheless this is only a preliminary estimate that will be revised when the Daily fecundity estimates will be available at the end of the year. The current preliminary estimate is within the range of the estimates given by the models considered in Uriarte *et al* (WD 2001) and is consistent with the acoustic preliminary estimate of biomass for 2001 of about 130,000 t. This 2001 estimate indicates a substantial increase in Biomass most likely related to the recruitment of a strong year class (at age 1).

11.4.2 Acoustic surveys

The French acoustic surveys estimates available from 1983 to date are shown in Table 11.4.2.1. The figures 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, 1998, 99 and 2000 new acoustic surveys were performed for anchovy in the French waters. The acoustic values are considered to be relative indices of abundance (Anon. 1993/ Assess:7).

Within the frame of the EU Study Project PELASSES, a series of co-ordinated acoustic surveys were planned in 2000 and 2001, covering the continental shelf of the south-western part of Europe (from Gibraltar to the English Channel). The main objective of these cruises was the abundance estimation using the echo-integration method of the pelagic fish species present off the Portuguese, Spanish and French coasts. Surveys were conducted in spring, using two research vessels: R/V Noruega for the southern area (from Gibraltar to Miño river) and R/V Thalassa for the northern area (North Spain and France).

The acoustic survey in 2001 (PEL2001) took place from 27th of April to 6th of June, along systematic parallel transects perpendicular to the French coast (see Figure 11.4.2.1). A total of 4000 nautical miles were covered and 66 hauls were performed (Masse WD, 2001). The survey area was stratified according to coherent multi-species communities, depth, strata and latitude (Figure 11.4.2.2) resulting in 7 strata. An unusual presence of anchovy was observed in the coastal area at the latitude of 47°30N. These individuals were not mature and represented an approximative biomass of 20 000 tonnes.

The main results from the acoustic assessment is shown in the text table below:

	Area prospected (nM²)	Biomass(tons)
Northern offshore area	3 500	0
Northern Coastal area	2 200	20 400
Centre offshore area	3 900	500
Centre Coastal area	3 100	2 100
Southern offshore area	3 300	4100
Southern Coastal area	4 600	105,200
Southern area	700	4,900
TOTAL	21,300	137,200

Although the above table points out to a total biomass of 137,200, that value results from a minor change reported at the end of the WG (Masse, pers. comm.). The value that was used for the assessment in 2001 was just 132,800 tonnes, which corresponds to the original figure reported to this WG. That difference is negligible for the current assessment and projections.

The Figure 11.4.2.3 gives the length distributions of the anchovy sampled in the main areas. From these distributions we can infer that at least 90 % of the spawning stock biomass consists of 1 year olds.

Revision of the 2000 biomass estimates (PEL2000)

After revision of the data base and of the acoustic software, the biomass estimate from the survey PEL 2000 (18th of april – 14th of May) presented at the STCF meeting in Brussels (Anonymous, 2000) was revised and subsequently a final biomass was estimated (Masse WD, 2001) :

	Area (nM²)	Biomass
Gironde	1400	53 830
Offshore	2268	15 563
Centre	785	1 327
South	2328	27 764
TOTAL	6781	98 484

The new biomass estimate is much higher than the former one, estimated in 47,700 tonnes (ICES CM 2001/ ACFM: 06).

TABLE 11.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(From ICES2001/ACFM06 updated for the 2001 preliminary estimate, and June surveys in 1989 and 1990 from Uriarte et al. WD2001)

YEAR		1987	1988	1989(*)	1989(*)	1990	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 (preliminary)
Period of year		2 - 7 June	21 - 28 May	10 - 21 May	14-24 June	4 - 15 May	29 May- 15 June	16May- 07Jun	16May- 13Jun	No survey	17 May- 3June.	11 - 25 May	18 - 30 May	9 - 21 May	18 May - 8 June	22 May - 5 June	2 May - 20 May	14 May - 8 June
Julian Mid Day		155	145	136	171	130	158	148	151		146	138	144	135	149	149	131	147
Positive area (km2)		23850	45384	17546	27917	59757	69471	24264	67796		48735	31189	28448	50133	73131	51019	37883	72022
Surveyed area (km2)		34934	59840	37930	-	79759	-	84032	92782		60330	51698	34294	59587	83156	61533	63192	92376
Po (Egg per 0.05 m^2)(A+)		4.6	5.52	2.08	1.50	3.78	5.21	2.55	4.27		3.93	4.975	4.87	2.69	3.825	3.65	3.45	5.885
Total Daily egg production		2.20	5.01	0.73	0.83	5.02	7.24	1.24	5.81		3.83	3.09	2.77	2.70	5.6	3.72	2.61	
(* Exp(-12))	C.V.	0.39	0.24	0.4	-	0.15	-	0.06	0.14		0.14	0.07	0.16	0.07	0.05	0.09	0.19	
SSB (t)		29365	63500	11861	10058	97239	77254	19276	90720	–	60062	54700	39545	51176	101976	69074	44973	127800
	C.V.	0.48	0.31	0.41	-	0.17	-	0.14	0.2		0.17	0.09	0.16	0.10	0.09	0.15	0.15	
TOTAL #		1129	2675	470		5843		965.6	5797	–	2954	2644		3737.7	6282.4			
(millions)	C.V.							0.14	0.25		0.19	0.11		0.16	0.13			
No/age:	1	656	2349	246		5613		670.5	5571		2030	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		874	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		49.3	58		13.1	56.3			
	C.V.							0.42	0.51		0.3	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 11.4.1.2: Parameter estimates and fitting statistics for the regression model of the DEPM Spawning Biomass on the Daily Egg production P0, Spawning area SA and Julian day. And forecast for year 2000 is included.

Multiple Regression - Log(Biomass)

Multiple Regression Analysis

Dependent variable: Log(Biomass)

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.0394341	0.980814	0.0402054	0.9689
Log(P0)	0.81194	0.107849	7.52848	0.0001
Log(SA)	1.12067	0.0878779	12.7525	0.0000
Julian Day	-0.015406	0.00329994	-4.66859	0.0016

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	7.09971	3	2.36657	159.41	0.0000
Residual	0.118763	8	0.0148454		
Total (Corr.)	7.21847	11			

R-squared = 98.3547 percent
R-squared (adjusted for d.f.) = 97.7378 percent
Standard Error of Est. = 0.121842
Mean absolute error = 0.0822074
Durbin-Watson statistic = 2.11147 (P=0.4562)
Lag 1 residual autocorrelation = -0.188031

Correlation matrix for coefficient estimates

	CONSTANT	Log(P0)	Log(SA)	Julian Day
CONSTANT	1.0000	0.2480	-0.8480	-0.4587
Log(P0)	0.2480	1.0000	-0.5090	0.1985
Log(SA)	-0.8480	-0.5090	1.0000	-0.0660
Julian Day	-0.4587	0.1985	-0.0660	1.0000

Regression Results for Log(Biomass)

	Fitted Value	Stnd. Error for Forecast	Lower 95.0% CL for Forecast	Upper 95.0% CL for Forecast	Lower 95.0% CL for Mean	Upper 95.0% CL for Mean
2001	11.7485	0.137441	11.4316	12.0655	11.6019	11.8952

No Log result: 127, 765 t with an approximate CV of 13.8%

Unusual Residuals

Year	Y	Predicted Y	Residual	Studentized Residual
June 1990	11.2549	11.4394	-0.184535	-2.31

Table 11.4.2.1. 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	1994 15/5-27/5	1997 6/5-22/5	1998 20/5-7/6	2000 18/04 - 14/05	2001 27/04 - 6/06
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	2300(3)	1726(3)	9400 5600 (3)	6781	21300
Density (t/nm(**2))	15.4	10.3	3,0	14.5-32.2 (4)	23.6	32.8	14.5	36.5	10.2		
Biomass (t)	50,000	38,500	15,500	60-110,000 (4)	64,000	89,000	35,000	63000	57000	98,484	137200 (5)
Number (10**(-6))	2,600	2,000	805	4,300-7,500 (4)	3,173	9,342	*na*	3351	*na*		
Number of 1-group (10**(-6))	1,800 (1)	600	400	4,100-7,500 (4)	1,873	9,072	*na*	2481	*na*		
Number of age 2-group (10**(-6	800	1,400	405	0 -200 (4)	1,300	270	*na*	870	*na*		
Anchovy mean weight	19.2	19.3	19.3	*na*	20.2	9.5	*na*	18.8	*na*		

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems
(*) area where anchovy shools have been detected
(5) For the assessment performed in the WG of year 2001 the value used for 2001 biomass was 132800t becouse the definitive figure from the survey arrived too late to the WG

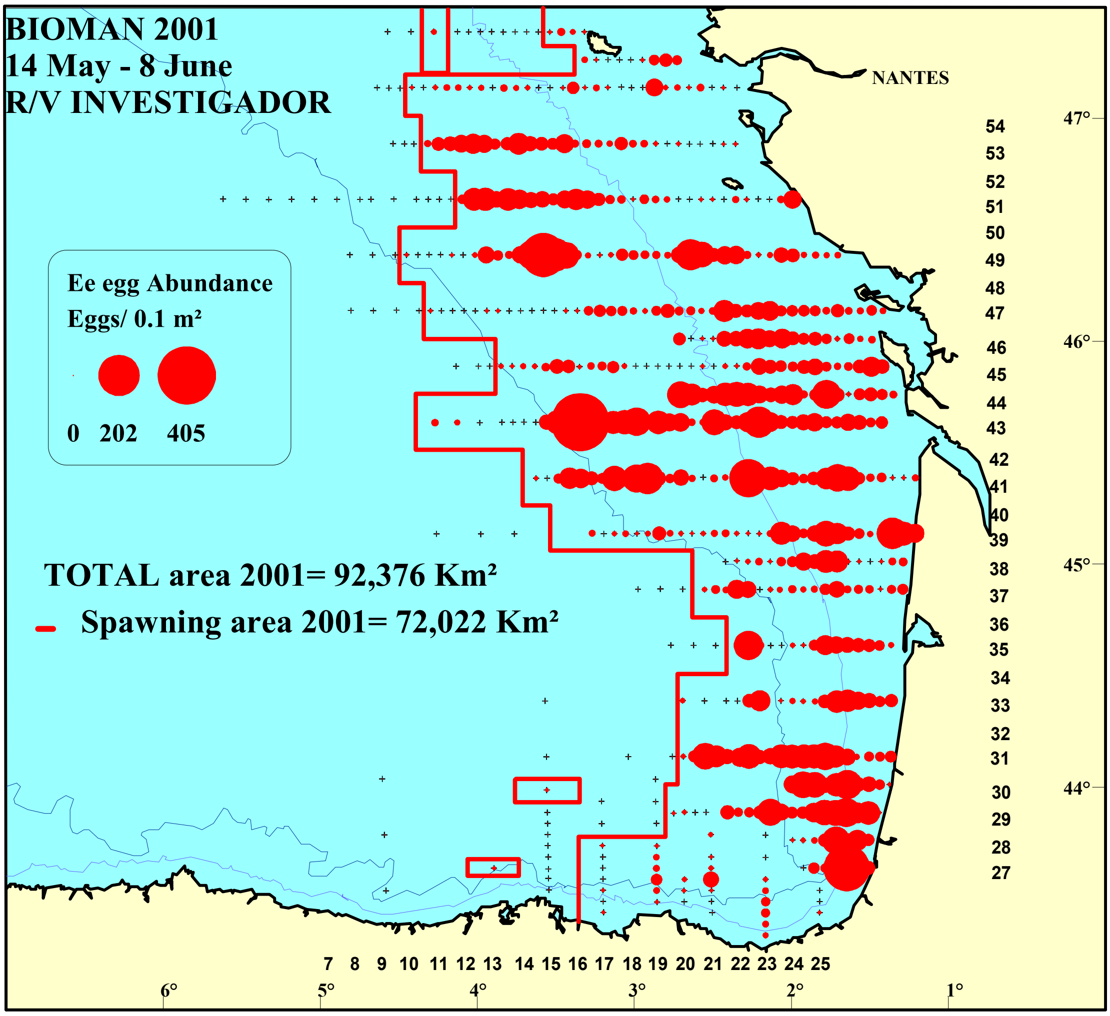


Figure 11.4.1.1: Anchovy Egg/0.1m² distribution found during BIOMAN 2001.
Solid line encloses the positive spawning area.

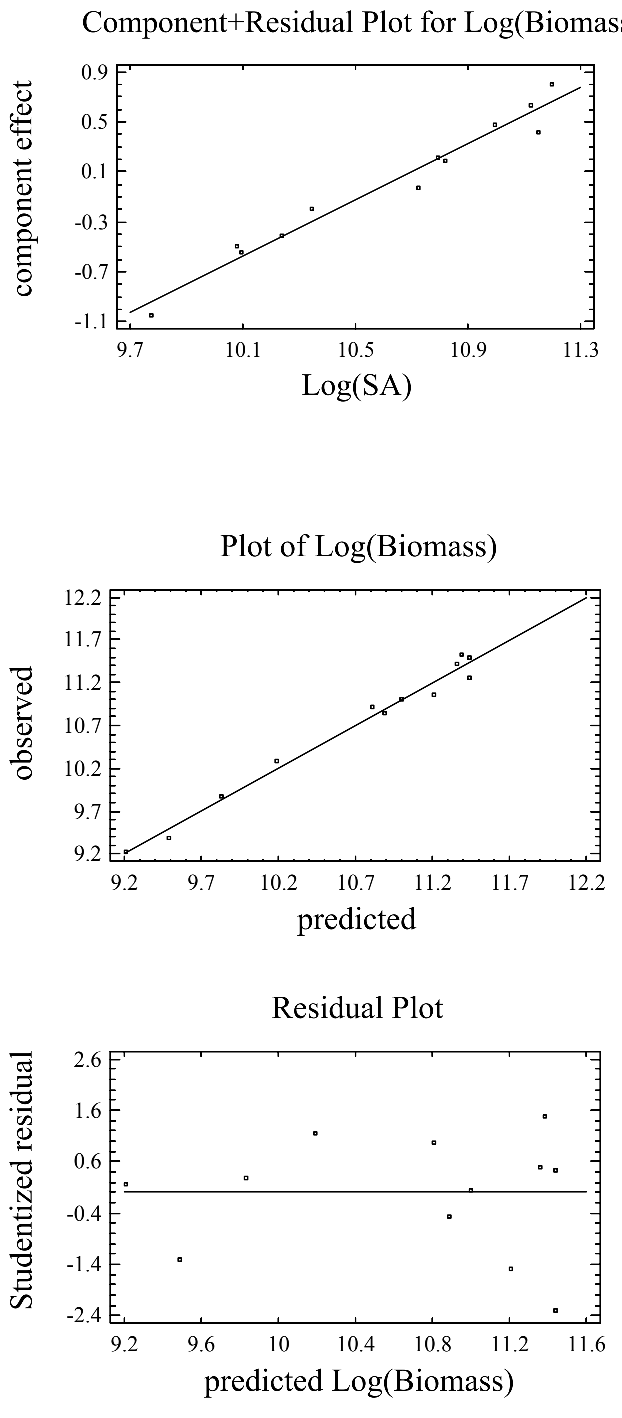


Figure 11.4.1.2 Fitting statistics for the regression model of the DEPM Spawning Biomass on the Daily Egg production P0, Spawning area SA and Julian day

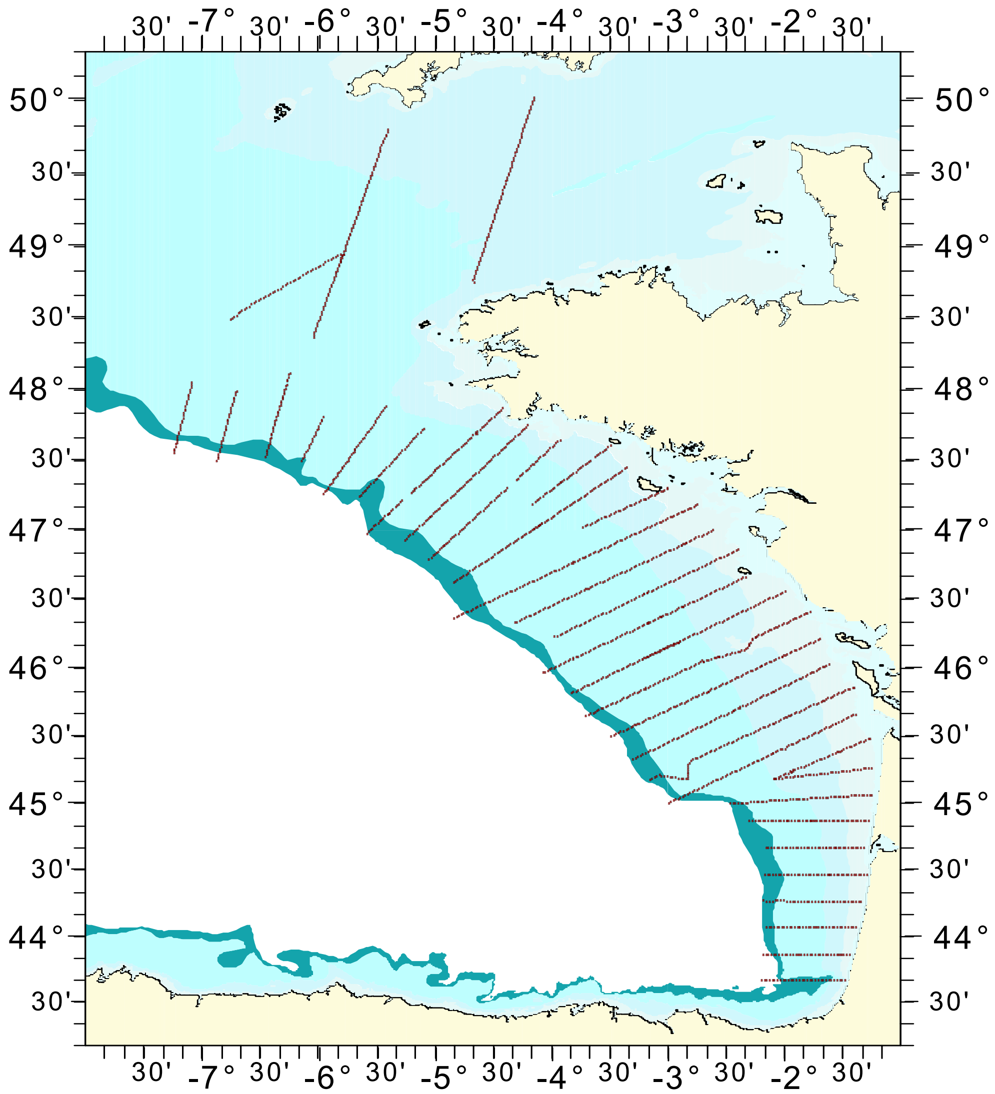


Figure 11.4.2.1. Transects prospected during PEL2001 acoustic survey (27 April – 6 June)

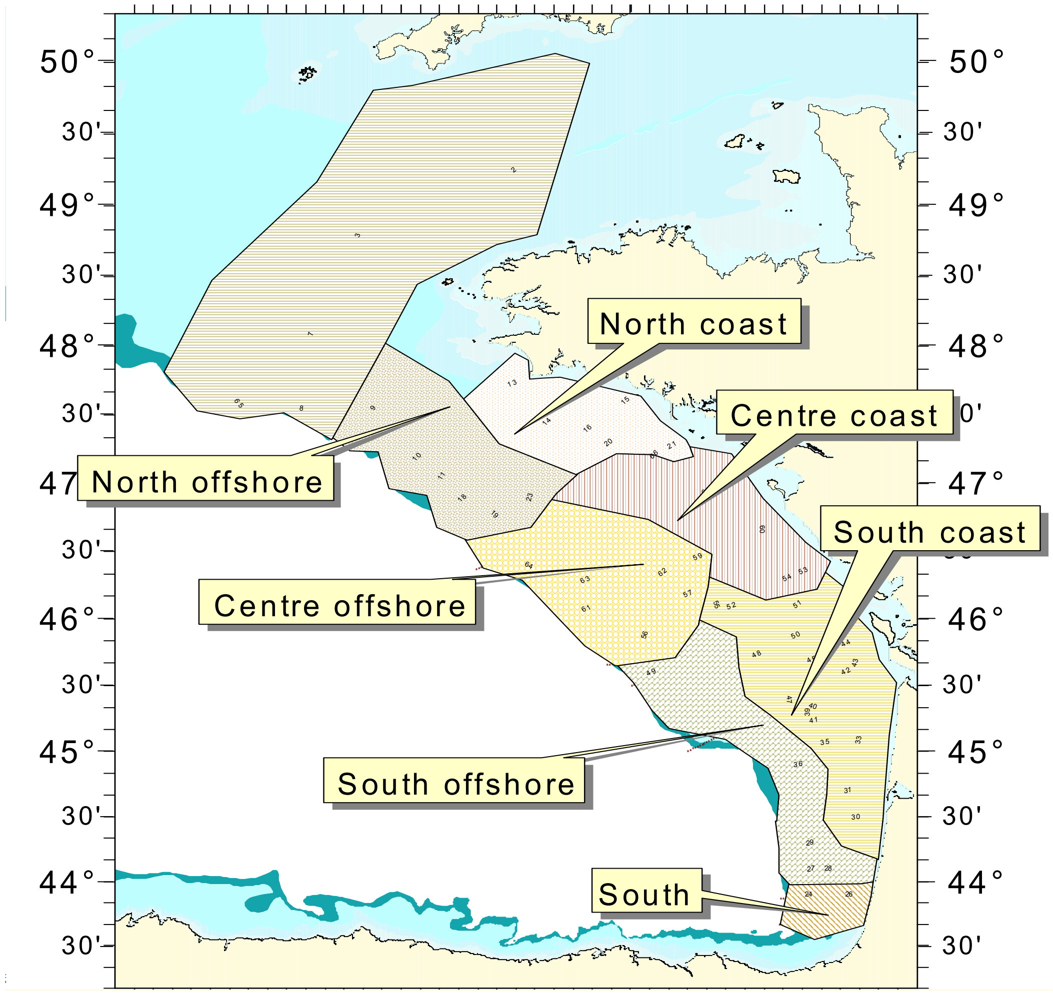


Figure 11.4.2.2: Areas considered for biomass estimates from acoustic survey PEL2001

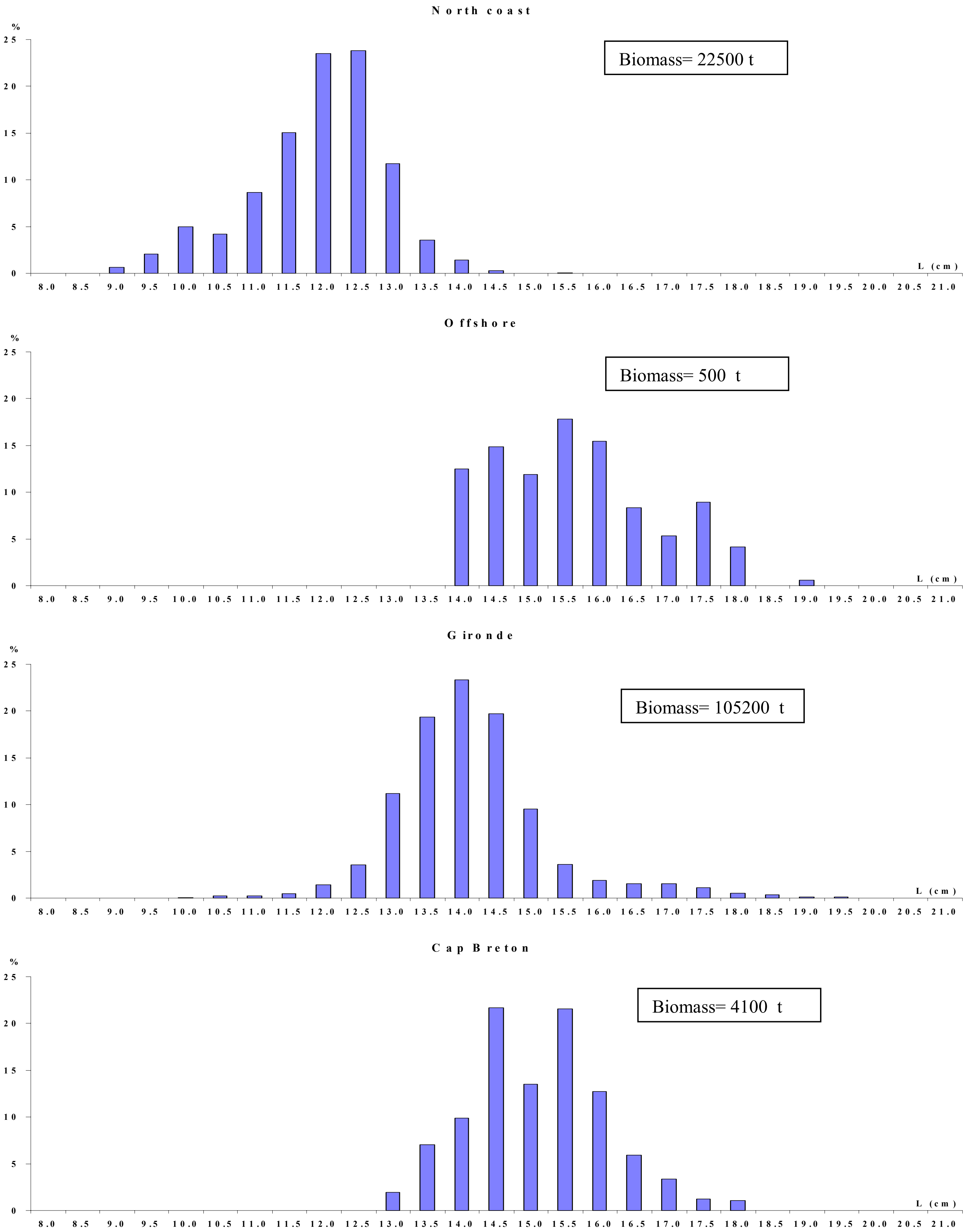


Figure 11.4.2.3. Anchovy length distribution by area for the PEL2001 survey and approximate estimates of biomasses.

11.5 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 11.5.**1.** The number of French mid-water trawlers involved in the anchovy fishery 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 decrease in the number of vessels involved in the fishery.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different, mainly since 1992 when the French Pelagic Fleet stopped the Fishery in spring during the spawning season of anchovy in the Bay of Biscay. The current effort may be at the level that existed in this fishery at the beginning of the 1970's (Anon. 1996/Assess:2), but the stop of the French pelagic fleet in spring prevents a catch of a too large number of fish before their first spawning.

The CPUE of the Spanish purse-seiners during the spring fishery for anchovy is shown in Table 11.5.2. This index is spatially linked with the anchovy abundance in the southern area of the Bay of Biscay and also with its catchability (availability of the anchovy close to the surface in Spring). It seems less closely related 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). Some observations have been made on the variation of landing per trip during the first quarter for the French pelagic fleet from 1988 to 1998 in order to see if the variation of that index followed the fluctuation of the biomass estimates by the DEPM method. The results given in a STECF WD (Prouzet and Lissardy, 2000) from a regression analysis using a Generalized Linear Model and summarised in the last year report (Anonymous, 2001) showed that 81% of the deviance of the DEPM biomass is explained by the variation of the mean catch per trip.

Table 11.5.1: Evolution of the French and Spanish fleets for ANCHOVY in Subarea VIII (from Working Group members). Units: Numbers of boats.

Year	France			Spain		total
	P. seiner	P. trawl	Total	P. seiner		
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	26	100 (2)	126	266		392
1999	26	100 *	126	250		376
2000	26	100 *	126	250	(3, 4)	328
2001			0	250	(3, 4)	

* provisional
(1) Only St. Jean de Luz and Hendaya.
(2) Maximun 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.
(3) Provisional figure according to the number of licences for purse seining in European Community Wate
(4) Provisional estimate

TABLE 11.5.2 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) 2000	2001
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	04-06	04-06
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	2.1	n/a
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	44.9	n/a
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	27.1	n/a
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	7.6	n/a
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	0.0	n/a
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	34.7	n/a
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	7.6	n/a

\# 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

11.6 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 a 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.

Two environmental indices are available to this WG (Borja *et al*. WD2000, Petitgas *et al*. WD2001) (Table 11.6.1):

One is the upwelling index of Borja *et al*. (1996; 1998) on which the prediction made in 1999 was based. This index shows the positive influence of the northern and eastern winds of medium and low intensity blowing in spring and early summer in the Bay of Biscay for the on set of good levels of recruitment at age 1 for the next year for the anchovy population. This index was built up with a long series of recruitment based on CPUE data for the period 1967-1996 and the most recent assessments of this WG confirmed that relationship. The estimates of this upwelling since 1986 are reported in Table 11.6.1**,** updated with the 2001 estimate.

The second index relating environment with the recruitment of anchovy is provided by Petitgas *et al*. (WD2001). They used a 3D hydrodynamic physical model (IFREMER Brest) that simulates processes occurring over the Biscay French continental shelf to construct environmental variables that relate directly to the physical processes that occur in the sea. According to R^2 criterion, the best linear regression is built from 2 physical factors (Allain *et al*., 1999):

1. Upwelling index (UPW), which is the summed positive "vertical speed" over the period March-July along the Landes coast (SW France). Vertical speed corresponds to the weekly mean vertical current from the bottom to the surface (tide effects have been filtered). This variable is therefore rather similar to the one produced by Borja et al. (1996, 1998) on the sole basis of wind data and has also a positive effect.

2. Stratification breakdown index (SBD), which is a binary variable describing stratification breakdown events in June or July concerning the waters above the whole continental shelf. These events are linked with periods of strong westerly winds (>15 m/s) in June or July which last several days and could have caused important larvae mortality (after the peak spawning).

In comparison to Borja *et al*. (1998) which did not identify turbulence (monthly average of the cube of the wind) as a significative factor on recruitment, Allain *et al*. (1999) were able to evidence a stratification breakdown at the scale of the whole shelf in July under major westerly gales and at a time scale of a week. Table 11.6.1 gives the environmental indices supplied by Petitgas *et al*. since 1986.

Last year the WG tested both environmental indices against the recruitment estimates from the 2000 assessment and they both stand up as significant: Borja's index explained about 55 % and the Allain's two parameter model explained about 65% of the interannual variability (see also Petitgas *et al*. 2001WD). For 2000 they predicted about 6,000 and 15,300 millions of recruits at age 0 respectively, far below the current estimate from the assessment of about 38,400 millions obtained. This failure and the current new series of recruitment estimates compared with those refitted models reduced the variance explained by these models to 5.5% for Borja's index (not significant) and to 48.5 % for Allain's index (or to 40% when adjusted for d.f.) (being still significant).

Allain's model has 2 covariates, Upwelling (UPW)) with a positive effect and SBD with a negative one, therefore low R is mainly due to SDB. In the summer periods of 1998-2000 UPW was low and no SBD appeared, therefore, Petitgas' model predicted average recruitment values. For year 2001 UPW is still below average and in addition an SBD event took place. The combination of both events lead to a low recruitment forecast at age 1 for 2002 (at about 1850 millions of age 1, or about 6170 millions recruiting at age 0 in 2001, among the 4 lowest previous recruitment estimates of the series). Nevertheless, Petitgas *et al*. (WD2001) commented that due to the higher than normal spawning surface area, the recruitment may not be so conditioned by the SDB events which were only recorded in the southern half of the Bay of Biscay.

The information environmental indexes contain is imprecise, so it would not be advisable to rely on these environmental indices to forecast recruitment. However, the WG recognises that in the case of the anchovy fishery, a reliable environmental index would be invaluable. Investigations should definitely be continued into these indices with the aim of improving their reliability and forecasting power.

Tabla 11.6.1: Series of Upwelling indexes from Borja et al. (WD2000 and pers. Comm.) and Petitgas et al (WD2001) including the Destratification variable (SDB)

	WD2000	WD2000		Recruitment assessment		Assessme in year Y+	Updated from WD2001 Prediction of P.Petitgas	
	Borja's et al. (1996,00)	Petitgas et al. (WD2000)		WG2000	WG2001	WG2001	Fitted for the period 86-99	
Year	Upwelling	Upwelling	SBD	2,000	2,001	ge_1 Serie	Adjusted	
1986	617.5	20.49	0	5845.1	5836.8	1751.0	3237	
1987	508.4	47.25	1	8702.5	8,507	2553.0	2101	
1988	473.2	35.88	1	3473.2	3,461	1038.0	1465	
1989	970.9	45.45	0	19651.7	19,288	5788.0	4631	
1990	905.9	50	1	7586.5	7,456	2229.0	2254	
1991	1,076.3	110.74	0	27632.0	27,443	8213.0	8279	
1992	1,128.8	47.16	0	24102.8	24,011	7186.0	4727	
1993	570.9	53.03	0	12789.1	12,717	3811.0	5055	
1994	905.0	29.2	0	10405.3	10,405	3117.0	3724	
1995	1,204.0	74.99	0	14513.7	14,254	4267.0	6282	
1996	973.0	50.17	0	18197.0	18,262	5454.0	4895	
1997	1,230.5	100.04	0	25830.1	28,812	8647.0	7681	
1998	461.0	58.49	0	7841.4	13,387	4022.0	5360	
1999	402.0	32.68	0	12582.4	18,419	5533.0	3918	
2000	391.0	51.21	0		38,397	11518	*4953*	*Prediction*
2001	418.0	42.63	1				*1842*	*Prediction*

Coeff.Determination for age 1:
From the assessment performed in this WG

	Borja's Index	Petitga's Multiple Index		
1986-1999	38.3%	70.4%		
1986-2000	5.5%	48.5%	40.0%	adjusted for d.f.

11.7 State of the stock

11.7.1 Data exploration and Models of assessment

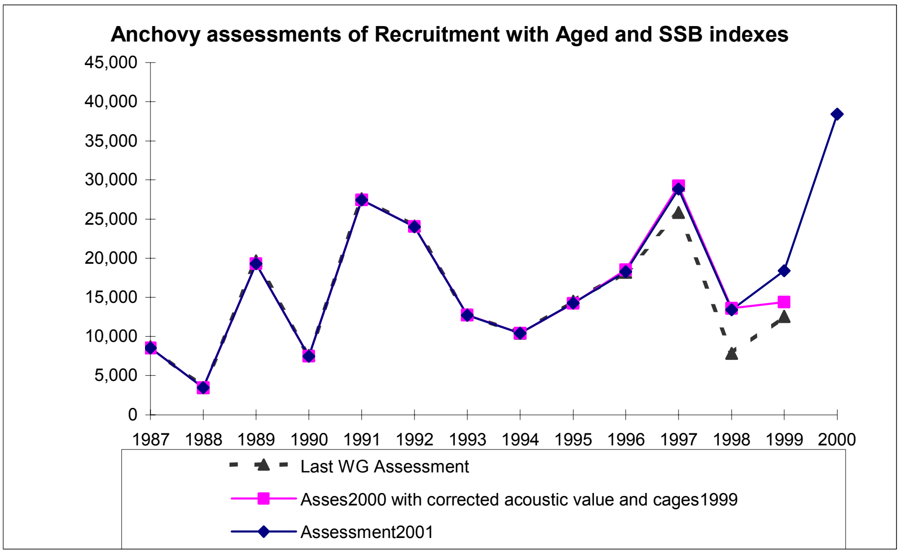
Natural mortality is believed to be high (but variable) for this stock and close to or higher than fishing mortality. The assessment of the anchovy fishery performed up to now has been based on fitting a separable selection model for fishing mortality, assuming a constant natural mortality, with the auxiliary information provided by the direct estimates of biomass and population in numbers at age. The acoustic and egg surveys performed by France and Spain have allowed such analysis. 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).

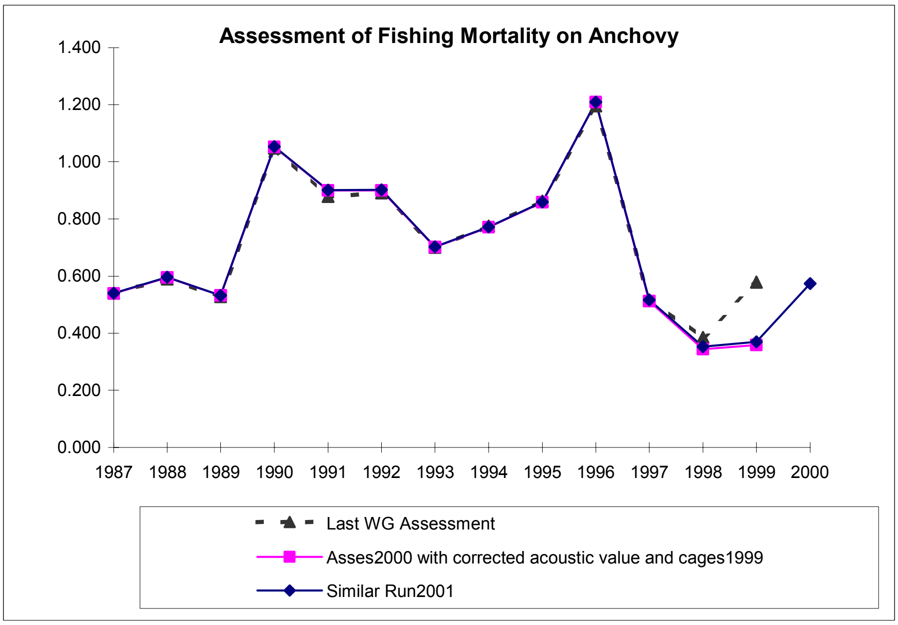
A careful selection of the appropriate weighting factors for the catches at age in the estimation process for the assessment was undertaken last year (ICES CM2001/ACFM:06). It showed that the fitting to the separable model can be improved by downweighting ages 0 and 3, which can be considered marginal ages in terms of their percentage in the catch. Therefore the WG adopted the assessment based on down weighting ages 0 and 3 to 0.01 and 0.1 respectively. In addition catch at age 3 in 1991 was found to be an outlier and was strongly down-weighted to 0.0001.

Tuning the assessment using the DEPM and acoustic indexes both as aggregated indices of biomass and as aged structured indices was already discussed and accepted in previous years (ICES CM1999, ICES CM 2001). In addition the assessment uses the DEPM indexes as absolute estimators of the population abundance, which strongly influences the levels of Biomass and Fishing mortalities resulting from the assessment. This relies on the assumption that the DEPM surveys are unbiased and absolute estimators of biomass and its value and robustness should prevail over the assumption of separable fishing model.

This year the WG detected that the catches at age used in the last year for the assessment did not include the small catches of anchovy made by the live bait tuna fishing boats in 1999. In addition, a revision of the 2000 acoustic estimate of biomass (doubling the preliminary estimate to 98,480 t) was reported to the WG. The influence of these two modifications on the assessment performed in year 2000 are shown in Figure 11.7.1.1. Using the revised catches at age of 1999 did not alter substantially the outputs of the assessment made in 2000. Correcting the preliminary 2000 acoustic estimate resulted in a substantial increase in the recruitment and biomass for the most recent years and led to a downwards revision of the fishing mortalities in 1999.

There are several missing values in the matrix of catches at age for which the sensitivity to the actual values used to fill them as inputs for the assessment was checked. The result was that filling them with 5 instead of 1 (as the default procedure) has a negligible impact on the result of the assessment.





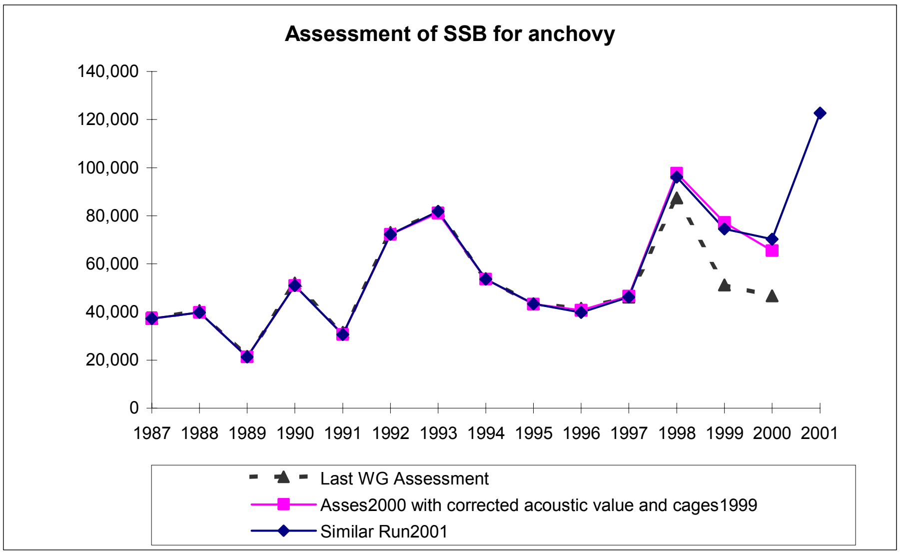


Figure 11.7.1.1: Review of the assessment made in 2000 according to the new info available for that year Concerning Anchovy in Subarea VIIII
Assessment 2000 completing the catches of 1999 and changing the acoustic estimate comparison with the assessment resulting in 2001

11.7.2 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 for the period from 1987 to 2000 (with the ICA package, Patterson and Melvin 1996), as in previous years.

Inputs for the final assessment are summarised in Table 11.7.2.**1**. The assessment uses as tuning data the DEPM (1987-2001) and the Acoustic (1989-2001) estimates both as biomass and as population numbers at age indices (the latter's ending in 1998 due to a lack of adult samples taken in the DEPM surveys). The Acoustic estimates are treated as relative and DEPM as absolute and both are down-weighted to 0.5 (because of the double use made of the indexes). For 1996, 1999, 2000 and 2001 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 (see Section 11.4.1). Catch-at-age data on an annual basis are presented in the Table 11.7.2.1.

The assessment performed used similar settings to the ones chosen for the 2000 assessment. The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier (Anon., 1995/Assess:2, Prouzet *et al.* 1999). The separable model of fishing mortality is applied over the period of 14 years considered (1987-2000). However the catch data of 1987 and 1988 are down-weighted in the analysis because the French 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 based on reliable information, therefore they were also down-weighted.

Catches for ages 0 and 4 are down-weighted to 0.01 in the assessment because they represent about 3% for age 0 and less than 1% for age 4 of the total catch. Age 3 is down-weighted to 0.1 because it also represents a small percentage in the catch around 3% and down-weighting results in an improvement in the fitting of the separable model to ages 1 and 2.

The assessment was achieved by a non-linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=87}^{y=00}\lambda_{a,y}\left(Ln\left(C_{a,y}\right)-Ln\left(F_y\cdot S_a.\overline{N}_{a,y}\right)\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1987}^{y=2001}\left[Ln\left(SSB_{DEPM}\right)-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2$$

$$+\sum_{y=87}^{98}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right)-Ln\left(N_{a,y}\cdot\exp\left(-P_F\cdot F_y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989,91,92,94}^{97,98,00,01}\left[Ln\left(SSB_{acoustic}\right)-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2+$$

$$+\sum_{y=89,91,92}^{97}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right)-Ln\left(Q_{a,y}\cdot N_{a,y}\cdot\exp\left(-P_F\cdot F_Y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

with constraints on : $S_2 = S_4 = 0.79$ and $F_{2001} = F_{2000}$

and $\overline{N}$: average exploited abundance over the year

N : population abundance on the first of January

O : maturity ogive, percentage of maturity

M : Natural Mortality

F_Y : Annual fishing mortality for the separable model

S_a : selection at age for the separable model

P_F and P_M : respective proportion of *F* and *M* occurring until mid spawning time

$C_{a,Y}$: catches at age *a* the year *Y*

Q_a and $Q_{a,Y}$: catchability coefficients for the acoustic survey

SSB_{DEPM} and SSB_{acoust} : Spawning Biomass estimates from DEPM and Acoustic methods

SP_{DEPM} and SP_{acoust} : Spawning populations at age from DEPM and acoustic methods

$\lambda_{a,Y}$: weighting factor for the catches at age (set respectively to ages 0 to 5 at 0.01, 1, 1, 0.1, 0.01, 0.01)

Other λ are the weighting factors for the indices and/or ages (all equal a priori to 0.5)(see last portion of Table 11.7.2.2)

Results of the assessment are presented in Table 11.7.2.2 and Figure 11.7.2.1. The stock summary of this assessment is presented in Figure 11.7.2.2.

Table 11.7.2.1: INPUTs for the Bay of Biscay anchovy assessment

Anchovy in subarea VIII WG2001- Bay of

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	38.1	150.3	180.1	17.0	86.6	38.4	63.5	59.9	49.8	109.2	133.2	4.1	54.4	5.3
1	338.8	508.3	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2	911.3	1042.0	463.4	956.9
2	171.2	106.0	134.5	135.5	323.2	224.6	531.6	548.3	304.1	286.3	178.2	252.1	522.9	333.1
3	33.0	10.6	20.1	13.2	29.2	17.0	5.3	63.0	76.6	31.6	5.8	9.0	18.3	103.0
4	14.9	1.4	1.0	1.0	1.0	1.0	1.0	1.0	4.1	2.3	1.0	1.0	1.1	1.0
5	8.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.015700	.019300
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.022300	.024400
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030800	.029900
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800	.033600
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900	.040500
5	.042000	.042000	.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	1999	2000
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000	.012000	.012000
1	.021700	.022600	.021000	.016200	.016800	.015400	.015900	.017100	.019000	.015900	.011900	.014600	.015900	.015900
2	.033000	.029800	.029000	.029500	.028000	.031700	.028700	.025800	.031100	.028700	.026600	.029900	.028700	.028700
3	.038000	.034100	.033000	.034600	.034000	.031700	.034400	.032300	.034100	.034400	.037400	.036900	.034400	.034400
4	.041000	.042500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Table 11.7.2.1 Cont…

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
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

Table 11.7.2.1 Cont…

INDICES OF SPAWNING BIOMASS

DEPM

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97	127.80

Acoustic

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
*******	*******	15.50	*******	64.00	89.00	*******	35.00	*******	*******	63.00	57.00	*******	98.48	132.80

x 10 ^ 3

AGE-STRUCTURED INDICES

DEPM SUVEYS (Ages 1 to 3+)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	656.0	2349.0	346.9	5613.0	670.5	5571.0	*******	2030.1	2257.0	*******	3242.6	5466.7
2	331.0	258.0	290.5	190.0	290.3	209.3	*******	874.3	329.0	*******	482.1	759.5
3	142.0	68.0	25.4	40.0	4.8	16.7	*******	49.3	58.0	*******	13.1	56.3

ACOUSTIC SURVEYS (ages 1 to 2+)

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

x 10 ^ 3

Table 11.7.2.2: Outputs for the Bay of Biscay anchovy assessment: Output Generated by ICA Version 1.4

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	18.8	8.5	42.1	32.1	101.3	88.6	36.6	32.9	50.1	90.4	61.0	19.4	27.9	90.3
1	273.9	436.0	160.5	1589.1	540.4	1991.4	1414.3	812.8	726.5	1304.9	821.4	920.8	447.5	914.5
2	194.4	133.7	173.5	115.4	438.2	183.7	574.6	599.4	327.6	311.6	201.1	279.7	505.6	328.3
3	52.3	27.1	14.7	36.7	7.0	35.7	12.6	64.6	62.0	35.0	9.5	19.5	47.5	115.3
4	22.4	8.9	3.7	3.8	3.0	0.7	3.2	1.8	8.5	8.6	1.4	1.1	3.9	12.9

x 10 ^ 6

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0038	0.0042	0.0038	0.0074	0.0064	0.0064	0.0050	0.0054	0.0061	0.0085	0.0036	0.0025	0.0026	0.0040
1	0.3022	0.3341	0.2984	0.5900	0.5052	0.5053	0.3936	0.4328	0.4815	0.6779	0.2897	0.1977	0.2073	0.3217
2	0.7147	0.7902	0.7057	1.3953	1.1948	1.1951	0.9309	1.0236	1.1388	1.6032	0.6851	0.4676	0.4903	0.7610
3	0.6008	0.6643	0.5933	1.1730	1.0044	1.0046	0.7826	0.8605	0.9573	1.3477	0.5759	0.3931	0.4122	0.6397
4	0.5646	0.6243	0.5575	1.1023	0.9439	0.9441	0.7354	0.8086	0.8997	1.2666	0.5412	0.3694	0.3874	0.6011
5	0.5646	0.6243	0.5575	1.1023	0.9439	0.9441	0.7354	0.8086	0.8997	1.2666	0.5412	0.3694	0.3874	0.6011

age Population Abundance (1 January)

age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	8507.	3461.	19288.	7456.	27443.	24011.	12717.	10405.	14254.	18262.	28812.	13387.	18419.	38394.	13477.
1	1751.	2553.	1038.	5788.	2229.	8213.	7186.	3811.	3117.	4267.	5454.	8647.	4022.	5533.	11517.
2	611.	390.	550.	232.	966.	405.	1493.	1460.	745.	580.	653.	1230.	2137.	985.	1208.
3	188.	90.	53.	82.	17.	88.	37.	177.	158.	72.	35.	99.	232.	394.	139.
4	84.	31.	14.	9.	8.	2.	10.	5.	23.	18.	6.	6.	20.	46.	63.
5	34.	3.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	5.	4.	8.

x 10 ^ 6

Table 11.7.2.2 Cont…

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0050	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	0.5000	0.5000	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	0.5000	0.5000	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	0.0500	0.0500	0.1000	0.1000	0.0001	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
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	0.0100	0.0100

Predicted SSB Index Values

DEPM x 10 ^ 3

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	37.19	39.81	21.27	51.03	30.64	72.24	*******	53.64	43.31	39.82	46.14	96.06	74.55	70.32	122.77

Acoustic x 10 ^ 3

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	******	*******	22.37	*******	32.24	76.01	*******	56.44	*******	*******	48.54	101.07	*******	73.99	129.18

Table 11.7.2.2 Cont…

Predicted Age-Structured Index Values

DEPM SUVEYS (Ages 1 to 3+) Predicted x 10 ^ 3

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	858.0	1231.7	509.5	2473.2	991.7	3653.7	*******	1754.9	1402.4	*******	2687.8	4451.5
2	246.1	151.5	222.6	67.6	309.8	129.9	*******	507.8	245.2	*******	266.5	556.8
3	130.8	51.7	30.4	30.3	9.8	32.5	*******	69.7	66.0	*******	19.3	51.9

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted x 10 ^ 3

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	678.9	*******	1373.1	5058.9	*******	*******	*******	*******	3575.9
2	580.3	*******	803.3	405.9	*******	*******	*******	*******	653.6

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
1	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228	0.4228
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406	0.8406
4	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900
5	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900

Table 11.7.2.2 Cont…

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	8507240	180763	37187	15308	0.4116	0.5392	99
1988	3460910	118836	39812	15581	0.3914	0.5962	100
1989	19287970	290989	21265	10614	0.4991	0.5325	100
1990	7456310	178456	51031	34272	0.6716	1.0528	99
1991	27443140	477161	30641	19634	0.6408	0.9015	101
1992	24011310	430443	72241	37885	0.5244	0.9017	100
1993	12716740	311491	81905	40293	0.4919	0.7024	99
1994	10405430	264977	53638	34631	0.6456	0.7723	99
1995	14254180	259847	43310	30115	0.6953	0.8592	99
1996	18262000	306942	39816	34373	0.8633	1.2096	100
1997	28812110	429708	46136	22337	0.4842	0.5169	99
1998	13386580	327763	96063	31617	0.3291	0.3528	102
1999	18419290	355327	74552	27259	0.3656	0.3700	97
2000	38393820	592548	70323	36994	0.5261	0.5741	100
2001			122770		0.5261	0.5741	

No of years for separable analysis : 14
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 2000
Number of indices of SSB : 2
Number of age-structured indices : 2

Parameters to estimate : 38
Number of observations : 130

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. istrib.
Separable model : F by year								
1	1987	0.7147	23	0.4480	1.1400	0.5632	0.9069	0.7352
2	1988	0.7902	22	0.5100	1.2245	0.6320	0.9881	0.8102
3	1989	0.7057	18	0.4921	1.0121	0.5872	0.8483	0.7178
4	1990	1.3953	16	1.0029	1.9413	1.1790	1.6514	1.4153
5	1991	1.1948	16	0.8669	1.6468	1.0144	1.4073	1.2109
6	1992	1.1951	18	0.8327	1.7151	0.9939	1.4369	1.2155
7	1993	0.9309	18	0.6504	1.3325	0.7753	1.1178	0.9466
8	1994	1.0236	17	0.7290	1.4373	0.8608	1.2171	1.0391
9	1995	1.1388	18	0.7924	1.6366	0.9465	1.3703	1.1585
10	1996	1.6032	15	1.1834	2.1720	1.3732	1.8718	1.6226
11	1997	0.6851	18	0.4735	0.9911	0.5674	0.8271	0.6973
12	1998	0.4676	21	0.3088	0.7082	0.3784	0.5779	0.4782
13	1999	0.4903	23	0.3082	0.7800	0.3869	0.6214	0.5043
14	2000	0.7610	28	0.4359	1.3285	0.5726	1.0112	0.7923
Separable Model: Selection (S) by age								
15	0	0.0053	66	0.0014	0.0197	0.0027	0.0104	0.0067
16	1	0.4228	9	0.3509	0.5095	0.3845	0.4650	0.4247
	2	1.0000	Fixed : Reference Age					
17	3	0.8406	23	0.5253	1.3452	0.6614	1.0685	0.8652
	4	0.7900	Fixed : Last true age					

Table 11.7.2.2 Cont…

Separable model: Populations in year 2000

18	0	38393823	30	21065341	69976823	28265378	52151634	40237277
19	1	5533335	24	3437075	8908097	4339881	7054986	5699062
20	2	984562	23	625049	1550858	780845	1241427	1011376
21	3	394195	24	244813	634727	309145	502644	406011
22	4	46272	25	28071	76274	35857	59712	47801

Separable model: Populations at age

23	1987	84291	198	1738	4087998	11633	610727	598974
24	1988	31024	80	6413	150079	13880	69342	42872
25	1989	13957	33	7308	26654	10033	19415	14738
26	1990	8867	27	5167	15216	6732	11680	9210
27	1991	7628	31	4121	14120	5572	10444	8014
28	1992	1908	32	1016	3584	1383	2632	2009
29	1993	9717	33	5088	18557	6986	13517	10261
30	1994	5085	34	2606	9921	3616	7151	5389
31	1995	22573	30	12469	40864	16676	30556	23632
32	1996	18271	33	9549	34957	13122	25440	19300
33	1997	5619	42	2435	12965	3667	8608	6154
34	1998	5952	32	3167	11186	4314	8212	6269
35	1999	20139	23	12585	32225	15844	25597	20726

SSB Index catchabilities

DEPM

Absolute estimator. No fitted catchability.

Acoustic

Linear model fitted. Slopes at age :

36	2	Q	1.052	13	.9226	1.578	1.052	1.384	1.218

Age-structured index catchabilities

DEPM SUVEYS (Ages 1 to 3+)

Absolute estimator. No fitted catchability.

ACOUSTIC SURVEYS (ages 1 to 2+)

Linear model fitted. Slopes at age :

37	1	Q	1.010	20	.8270	1.870	1.010	1.531	1.271
38	2	Q	1.616	21	1.318	3.031	1.616	2.472	2.044

Table 11.7.2.2 Cont…

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.706	2.878	1.454	-0.636	-0.157	-0.836	0.551	0.599	-0.007	0.189	0.781	-1.559	0.666	-2.836
1	0.213	0.153	0.113	-0.152	-0.205	-0.323	-0.007	0.045	-0.021	-0.136	0.104	0.124	0.035	0.045
2	-0.127	-0.232	-0.255	0.160	-0.304	0.201	-0.078	-0.089	-0.075	-0.085	-0.121	-0.104	0.034	0.014
3	-0.461	-0.939	0.313	-1.022	1.426	-0.743	-0.864	-0.025	0.211	-0.103	-0.495	-0.773	-0.954	-0.112
4	-0.406	-1.850	-1.299	-1.341	-1.087	0.298	-1.151	-0.573	-0.728	-1.317	-0.365	-0.104	-1.287	-2.557

SPAWNING BIOMASS INDEX RESIDUALS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.2362	0.4669	-0.2402	0.6447	-0.4635	0.2278	*******	0.1131	0.2335	-0.0068	0.1037	0.0597	-0.0763	-0.4470	0.0402

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-0.3671	*******	0.6857	0.1578	*******	-0.4778	*******	*******	0.2607	-0.5728	*******	0.2859	0.0277

AGE-STRUCTURED INDEX RESIDUALS

DEPM SUVEYS (Ages 1 to 3+)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.268	0.646	-0.384	0.820	-0.391	0.422	*******	0.146	0.476	*******	0.188	0.205
2	0.297	0.532	0.266	1.033	-0.065	0.477	*******	0.543	0.294	*******	0.593	0.310
3	0.082	0.275	-0.182	0.279	-0.710	-0.667	*******	-0.346	-0.130	*******	-0.387	0.082

Table 11.7.2.2 Cont…

Age | ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.5290	*******	0.3105	0.5841	*******	*******	*******	*******	-0.3655
2	-0.3596	*******	0.4813	-0.4077	*******	*******	*******	*******	0.2859

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 2000

Variance	0.0413
Skewness test stat.	-4.1043
Kurtosis test statistic	-0.5124
Partial chi-square	0.1324
Significance in fit	0.0000
Degrees of freedom	35

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR DEPM

Index used as absolute measure of abundance

Last age is a plus-group

Variance	0.0465
Skewness test stat.	0.6947
Kurtosis test statistic	-0.2827
Partial chi-square	0.0608
Significance in fit	0.0000
Number of observations	14
Degrees of freedom	14
Weight in the analysis	0.5000

DISTRIBUTION STATISTICS FOR Acoustic

Linear catchability relationship assumed

Last age is a plus-group

Variance	0.0955
Skewness test stat.	0.0442
Kurtosis test statistic	-0.6699
Partial chi-square	0.0620
Significance in fit	0.0000
Number of observations	8
Degrees of freedom	7
Weight in the analysis	0.5000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR DEPM SUVEYS (Ages 1 to 3+)

Index used as absolute measure of abundance

Age	1	2	3
Variance	0.0655	0.0857	0.0478
Skewness test stat.	1.3116	1.8134	-1.7064
Kurtosis test statisti	-0.6624	-0.4601	-0.3631
Partial chi-square	0.0458	0.0724	0.0480
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

Table 11.7.2.2 Cont…

DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)

Linear catchability relationship assumed

Age	1	2
Variance	0.1064	0.0761
Skewness test stat.	0.0672	0.0709
Kurtosis test statisti	-0.7245	-0.7637
Partial chi-square	0.0220	0.0172
Significance in fit	0.0009	0.0006
Number of observations	4	4
Degrees of freedom	3	3
Weight in the analysis	0.3750	0.3750

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	62.9504	130	38	92	0.6842
Catches at age	52.8812	70	35	35	1.5109
SSB Indices					
DEPM	1.3028	14	0	14	0.0931
Acoustic	1.3367	8	1	7	0.1910
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	5.9698	30	0	30	0.1990
ACOUSTIC SURVEYS (ages 1 to 2+)	1.4600	8	2	6	0.2433

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	2.9753	130	38	92	0.0323
Catches at age	1.4468	70	35	35	0.0413
SSB Indices					
DEPM	0.3257	14	0	14	0.0233
Acoustic	0.3342	8	1	7	0.0477
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	0.6633	30	0	30	0.0221
ACOUSTIC SURVEYS (ages 1 to 2+)	0.2053	8	2	6	0.0342

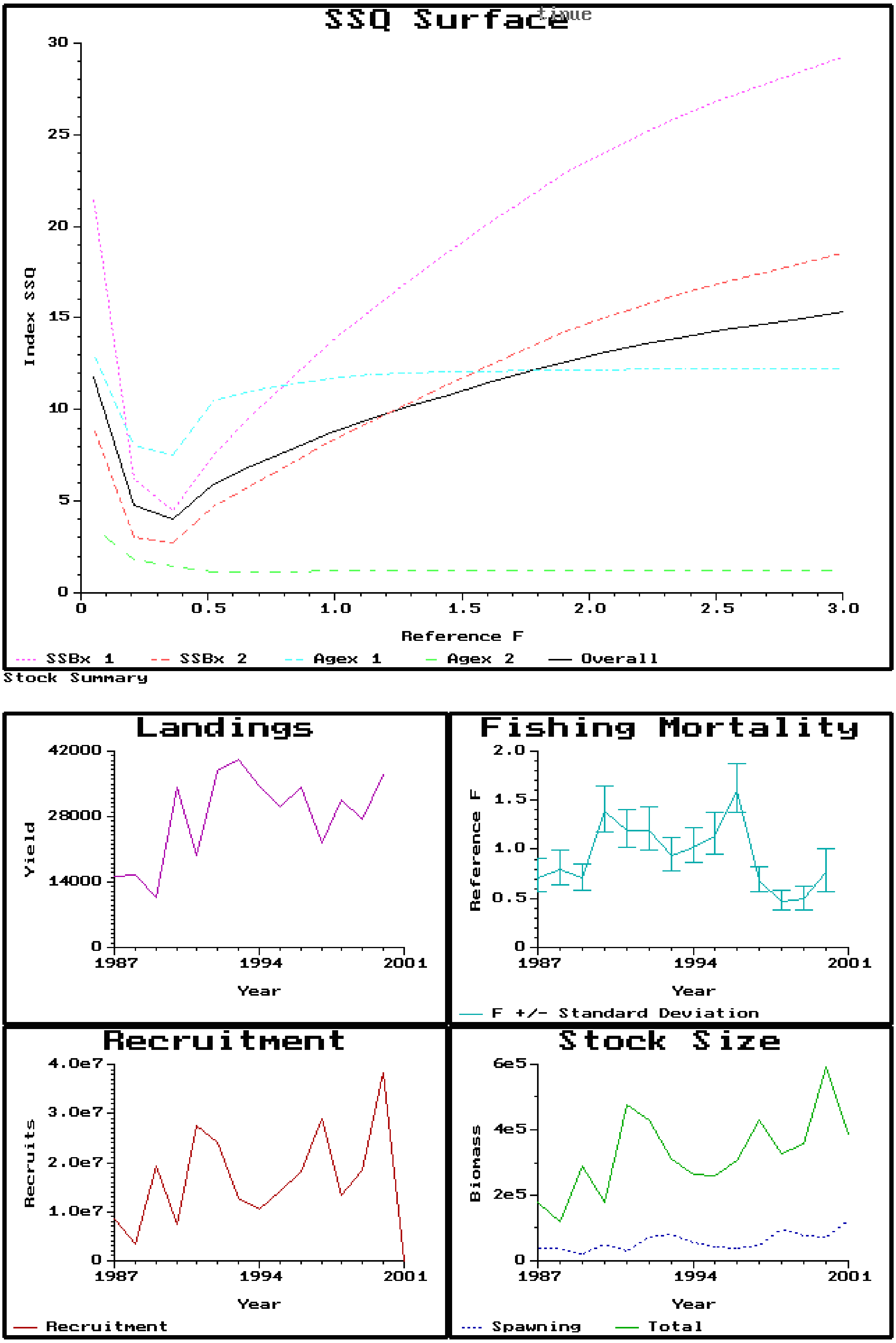
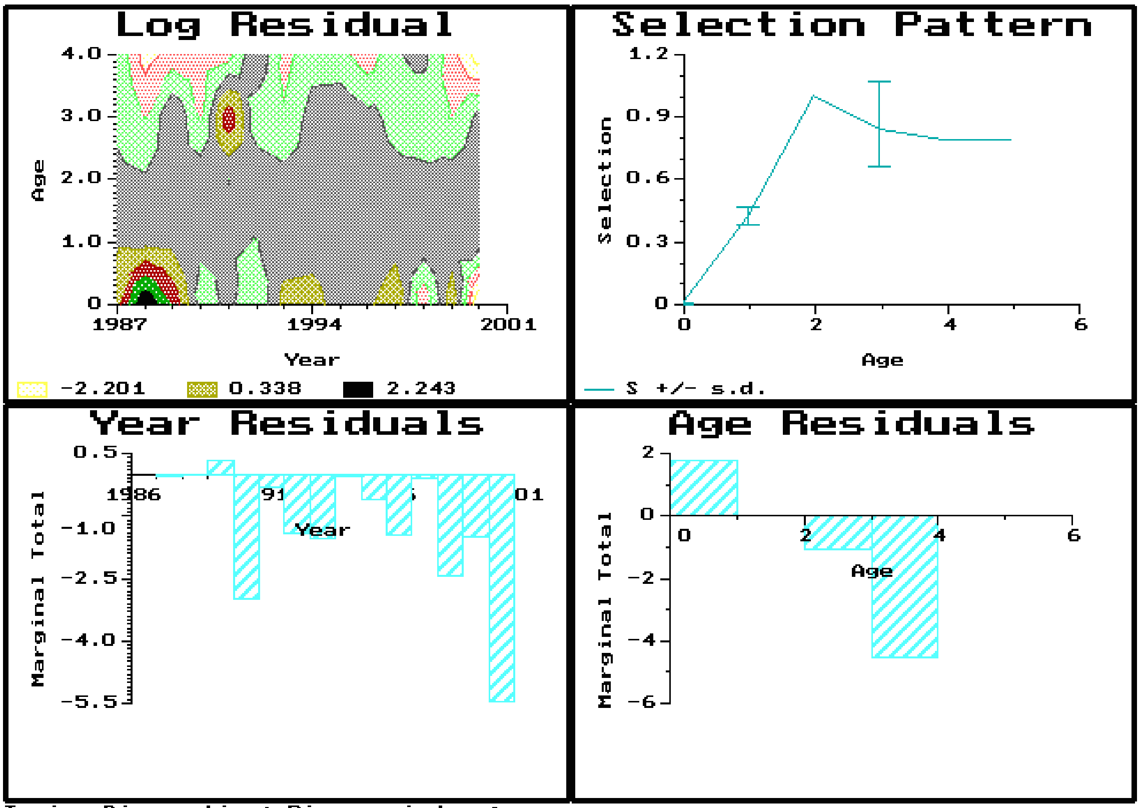


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy.

Separable Model Diagnostics ue



Tuning Diagnostics: Biomass index 1 nue

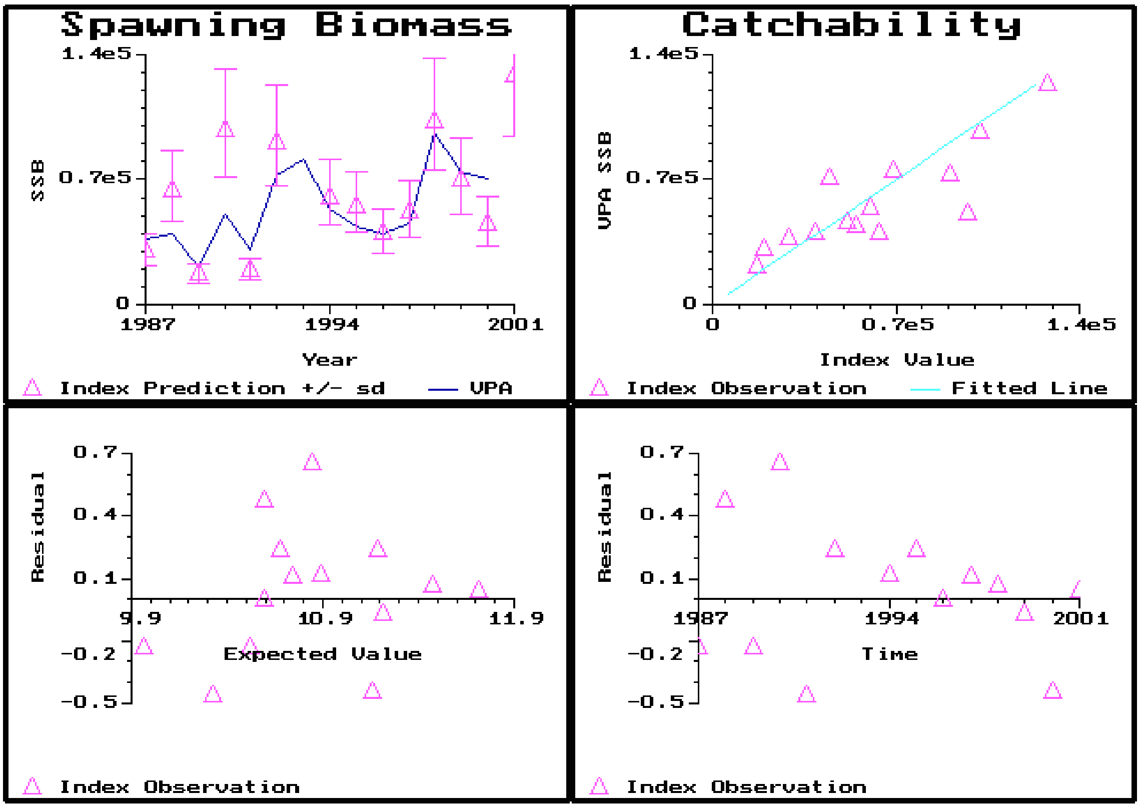


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy. (Continued)

Tuning Diagnostics: Biomass index 2

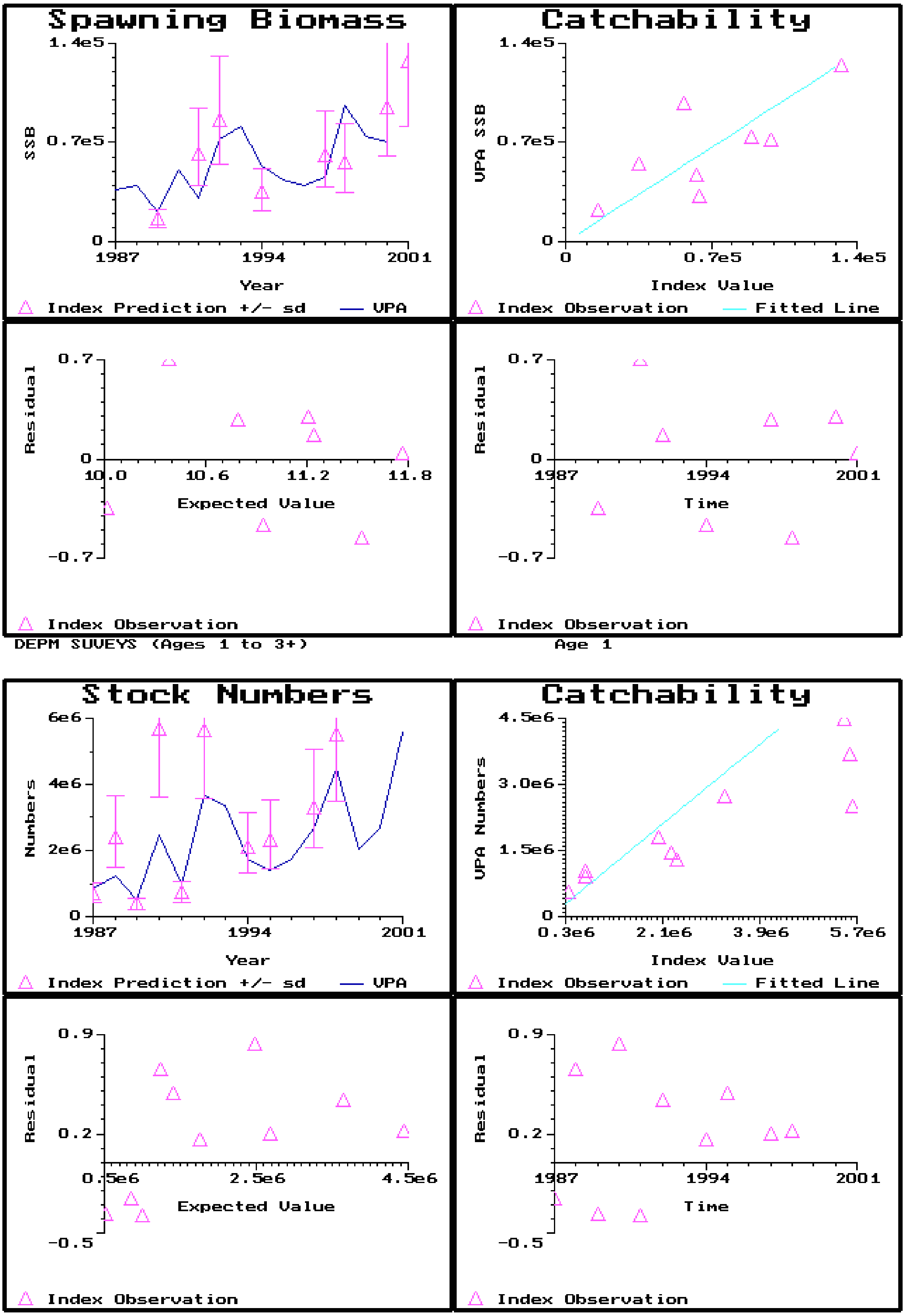


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy. (Continued)

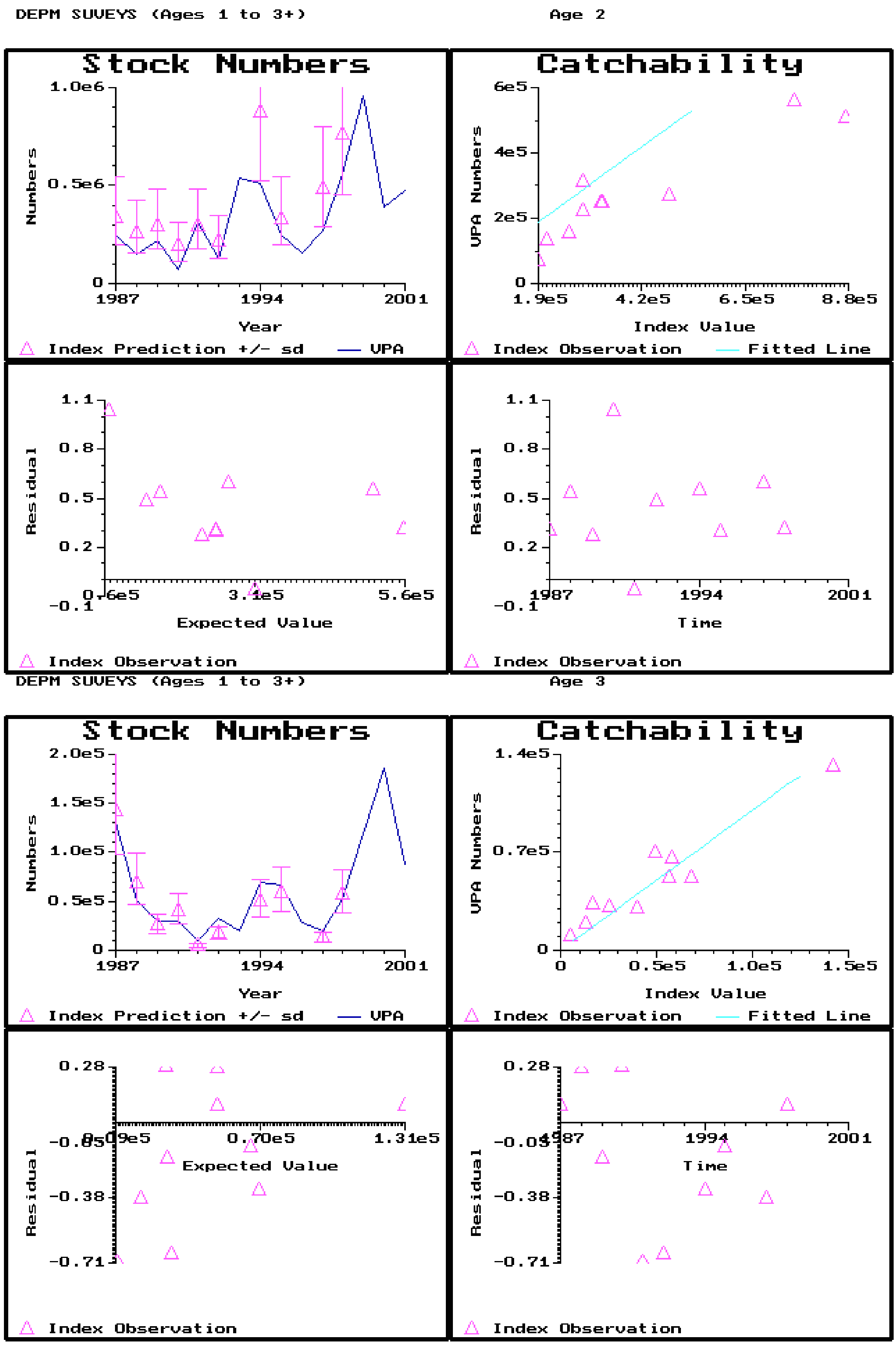
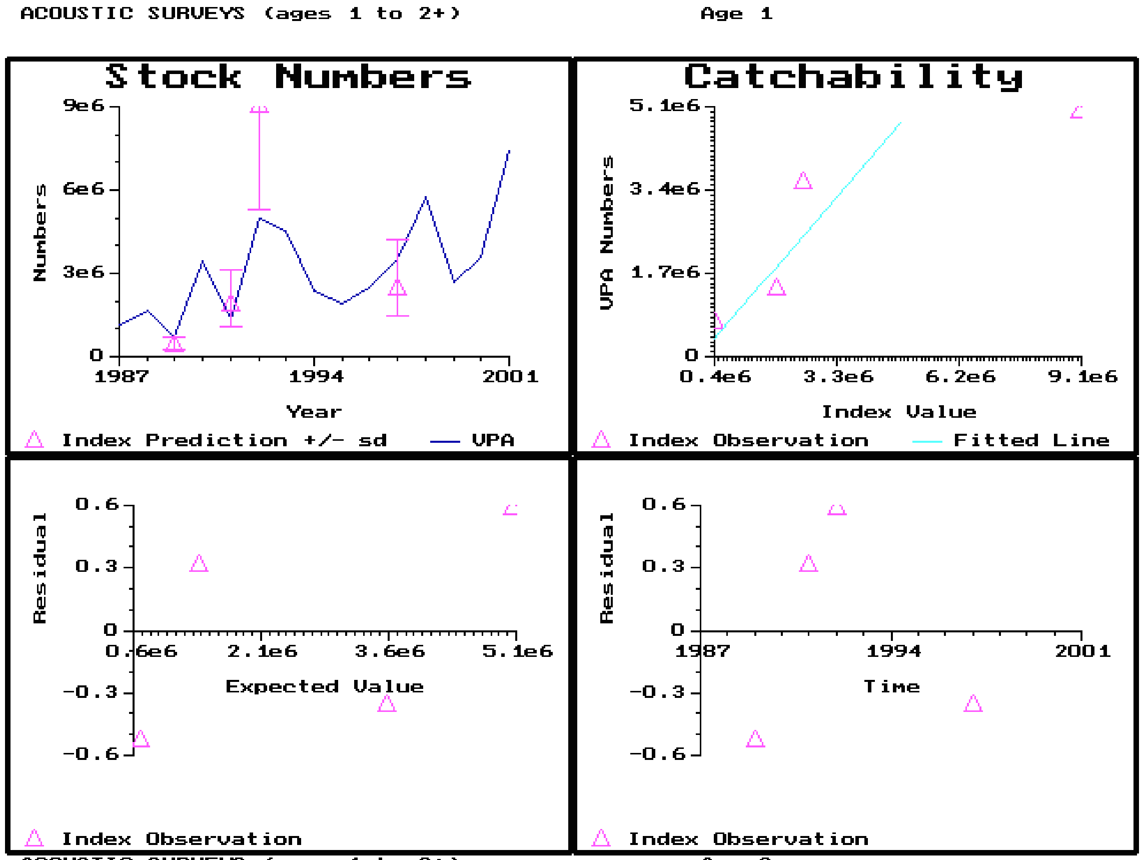


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy. (Continued)



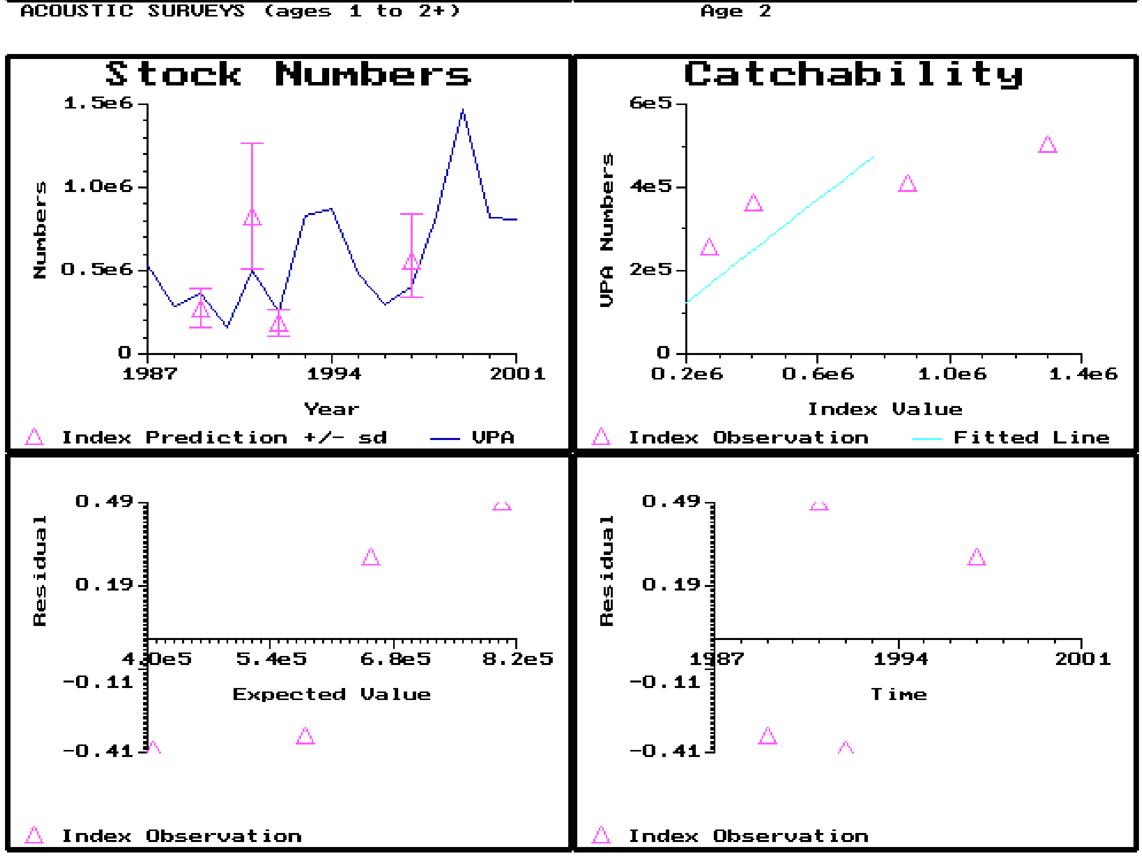
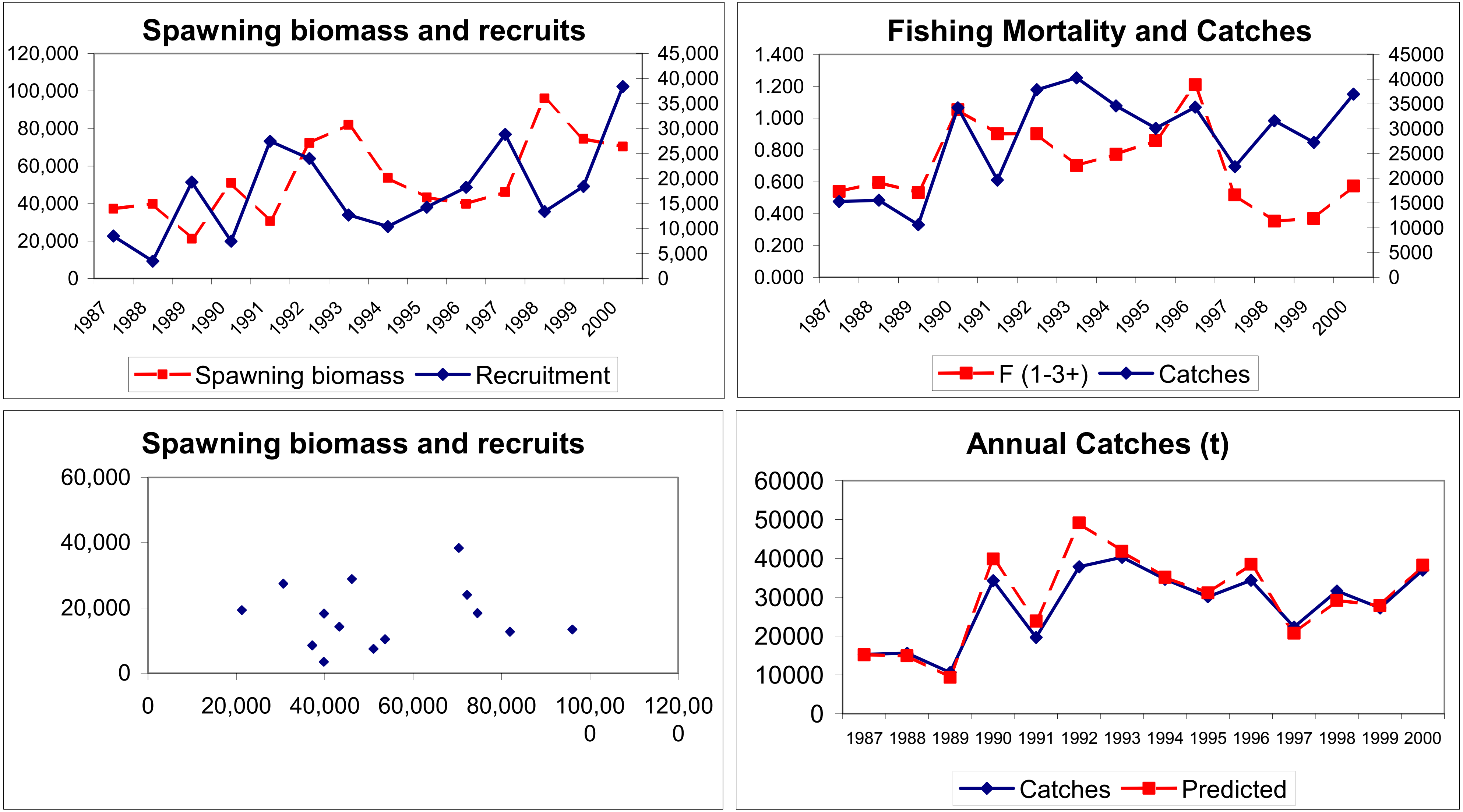


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy. (Continued)

Figure 11.7.2.2 Summary of the Assessment of the Bay of Biscay anchovy



11.7.3 Reliability of the assessment and uncertainty of the estimation

The assessment is heavily influenced by the Spawning Biomass estimates produced by the DEPM. This is the longest and most consistent independent estimate of the population and it is used as an absolute estimate of biomass. The adoption of the DEPM estimates as absolute scales the results from the analysis. The model fits well the aggregated indices of biomass (DEPM and acoustic), without any skewness or kurtosis and no clear trends in the log-residuals (Table 11.7.2.2 and Figure 11.7.2.1). The DEPM disaggregated indices seem to overestimate high recruitments, although that information has not been available since 1998 and therefore those estimates have little influence on the current perception of the population. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (2000). The absolute residuals from the separable model are high both across years and ages, particularly for ages 0 and 3, which are the ones down-weighted in the assessment. The best fit is achieved for ages 1 and 2 which are the most important age groups in the catches.

Table 11.7.3.1 shows that some changes arise between the output of the assessment performed in year 2000 and the current assessment (Figure 11.7.1.1**)**. The biomass for 2000 (estimated that year at 46,750 t.) is now being estimated at about 70,300 t. This change results from the revision of the 2000 acoustic survey estimate of biomass. The ICA estimate of biomass in year 2001 is 122,800 t. This increase in biomass is related to the large recruitment at age 1 in 2001. The appearance of such a strong recruitment is well supported by the length distribution of the population recorded during the acoustic survey in May 2001. The model fits the surveys estimates of biomass for 2001 projecting the biomass under fishing mortality equal to the one estimated for 2000.

The WG considers that this assessment reflects current perceptions regarding trends in population abundance and fishing mortality.

Table 11.7.3.1: Stock: Anchovy Sub-area VIII Historical quality of the assessment.

Assessment Quality Control Diagram 1

Average F(1-3,u)															
Date of assessment	Year														
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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	0.414				
1999	0.549	0.501	0.581	0.615	1.258	0.863	0.565	0.679	0.861	1.238	0.486	0.251			
2000	0.541	0.589	0.527	1.048	0.8787	0.892	0.700	0.775	0.863	1.195	0.517	0.385	0.577		
2001	0.539	0.596	0.533	1.053	0.901	0.902	0.702	0.772	0.859	1.210	0.517	0.353	0.370	0.574	
2002															

Remarks: Assessments of 1996-1999 performed using ICA.

Table 11.7.3.1 (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	1999	2000
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	7447	4387	19082	7319	28402	25305	13334	10275	13397	20231	34647	2977		
2000	8703	3473	19652	7587	27632	24103	12789	10405	14514	18197	25830	7841	12582	
2001	8507	3461	19288	7456	27443	24011	12717	10405	14254	18262	28812	13387	18419	38397

Remarks: Assessments of 1996-1999 performed using ICA.

Table 11.7.3.1 (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	2001	2002
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	37070	23389	55844	28794	71236	87618	58755	43727	37098	49641	118593				
2000	40585	21582	51966	31476	72975	81638	53953	43316	41558	46158	87436	51230	(46750)		
2001	39812	21265	51031	30641	72241	81905	53638	43310	39816	46136	96063	74552	70323	(95352)	

Remarks: Assessments of 1996-1999 performed using ICA.

11.8 Catch Prediction

The population and the fishery in the prediction year depends largely on the incoming recruitment, which takes place in the interim year of the assessment. As the level of recruitment is unknown, two scenarios have been defined by the WG for the fishery projections in 2002:

- A. a precautionary approach, assuming for recruitment (age 0) in year 2001 the geometric mean of those below the average of the historical series .

- B. standard approach, taking the geometric mean recruitment of the historical series.

Both catch predictions are possible and the Working Group considered that it is difficult to propose to the managers a choice owing to the fact that in case of a low recruitment, the first scenario will be more appropriate.

The inputs for these two scenarios for projections are given in Tables 11.8.1 and 11.8.3. The population at age 1 in 2001 has not been taken directly from the assessment output (11,517 millions, the highest of the series), due to it being too dependent on the preliminary biomass estimates from the surveys. Instead the average of the three previous best recruitments were taken as a representative of a strong year class, resulting in 8,015 millions age 1, which suggests a reduction by 30% of the ICA output estimate. For scenario A, the geometric mean for the years 1987, 88, 90, 93, 94 and 98 was chosen, resulting in 8,543 millions of 0 year-olds in 2001. For scenario B, the recruitment at age 0 in the subsequent year would be the geometric mean 1987 to 1999 (13,839 millions of age 0).

Weights at age in the catch correspond to the average values recorded since 1987 (14 years). Weights at age in the stock correspond to the average from 1990 (the first year of accurate assessment of this parameter, 11 years in total) as in the assessment input.

For each of the two scenarios A and B, projections were performed with a catch constraint for 2001 of 33,000 tonnes. The *status quo* fishing mortality was set equal to the average of the last 6 years (1995-2000) instead of only the last 3 years, due to the significant inter-annual fluctuations of the fishing mortality in this fishery.

The outputs for these two scenarios for projections are given in Tables 11.8.2 and 11.8.4. For both scenarios the predicted catch for 2002 will be at or above 33,000 (the precautionary TAC usually adopted) and the Spawning Biomass is expected to be above 36,000 t, the proposed $\mathbf{B}_{pa}$.

Table 11.8.1 CATCH PREDICTION FOR THE ANCHOVY IN DIVISION VIII FOR 2002

PRECAUTIONARY APPROACH Geometric mean of recruitments below average

Fishery mortality pattern is the average of the period 1995-2000

INPUTS FOR PREDICTIONS TO 2001 AND 2002

MFDP	version	1a		
Run:	CautionaryProject02			
Time	and	date:	12:38	12/09/01
Fbar	age	range:	01-Mar	

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	8,543,400	1.2	0	0.4	0.375	0.0124	0.0046	0.0125
1	8,015,000	1.2	1	0.4	0.375	0.0159	0.3626	0.0211
2	1,208,100	1.2	1	0.4	0.375	0.0289	0.8577	0.0291
3	138,550	1.2	1	0.4	0.375	0.0344	0.7210	0.0344
4	62,625	1.2	1	0.4	0.375	0.0405	0.6776	0.0400
5	8,233	1.2	1	0.4	0.375	0.0420	0.6776	0.0420

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	8,543,400	1.2	0	0.4	0.375	0.0124	0.0046	0.0125
1	.	1.2	1	0.4	0.375	0.0159	0.3626	0.0211
2	.	1.2	1	0.4	0.375	0.0289	0.8577	0.0291
3	.	1.2	1	0.4	0.375	0.0344	0.7210	0.0344
4	.	1.2	1	0.4	0.375	0.0405	0.6776	0.0400
5	.	1.2	1	0.4	0.375	0.0420	0.6776	0.0420

Table 11.8.2 –Catch option prediction for the anchovy fishery in SubArea VIII in 2002. Precautionary Option
Geometric mean of recruitments below average
Fishery mortality pattern is the average of the period 1995-2000

MFDP version 1a
Run: CautionaryProject02
Anchovy in subarea VIII WG2001- Bay of Biscay anchovy Exploratory run
Time and date: 12:38 12/09/01
Fbar age range: 1-3

2001				
Biomass	SSB	FMult	FBar	Landings
275357	95344	0.668	0.4322	33000

2002	2002	2002	2002	2002	2003	2003
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
209696	66357	0	0	0	191410	54697
.	64652	0.1	0.0647	4163	188776	51806
.	62996	0.2	0.1294	8098	186317	49151
.	61388	0.3	0.1941	11820	184021	46708
.	59827	0.4	0.2588	15344	181875	44460
.	58310	0.5	0.3235	18683	179869	42386
.	56837	0.6	0.3883	21848	177992	40473
.	55407	0.7	0.453	24850	176235	38704
.	54017	0.8	0.5177	27701	174589	37066
.	52667	0.9	0.5824	30410	173047	35548
.	51355	1	0.6471	32985	171601	34140
.	50080	1.1	0.7118	35435	170244	32830
.	48842	1.2	0.7765	37768	168970	31611
.	47638	1.3	0.8412	39992	167773	30475
.	46468	1.4	0.9059	42112	166648	29414
.	45332	1.5	0.9706	44135	165589	28422
.	44227	1.6	1.0354	46067	164593	27493
.	43153	1.7	1.1001	47913	163655	26622
.	42109	1.8	1.1648	49679	162771	25803
.	41094	1.9	1.2295	51368	161937	25033
.	40107	2	1.2942	52986	161150	24307

Input units are thousands and kg - output in tonnes

Table 11.8.3 INPUT FOR CATCH PREDICTION FOR THE ANCHOVY IN DIVISION VIII FOR 2002
GEOMETRIC MEAN
Fishery mortality pattern is the average of the period 1995-2000

MFDP version 1a
Run: GeometricMean01
Time and date: 10:44 13/09/01
Fbar age range: 1-3

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	13,838,700	1.2	0	0.4	0.375	0.0124	0.0046	0.0125
1	8,015,000	1.2	1	0.4	0.375	0.0159	0.3626	0.0211
2	1,208,100	1.2	1	0.4	0.375	0.0289	0.8577	0.0291
3	138,550	1.2	1	0.4	0.375	0.0344	0.7210	0.0344
4	62,625	1.2	1	0.4	0.375	0.0405	0.6776	0.0400
5	8,233	1.2	1	0.4	0.375	0.0420	0.6776	0.0420

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	13,838,700	1.2	0	0.4	0.375	0.0124	0.0046	0.0125
1	.	1.2	1	0.4	0.375	0.0159	0.3626	0.0211
2	.	1.2	1	0.4	0.375	0.0289	0.8577	0.0291
3	.	1.2	1	0.4	0.375	0.0344	0.7210	0.0344
4	.	1.2	1	0.4	0.375	0.0405	0.6776	0.0400
5	.	1.2	1	0.4	0.375	0.0420	0.6776	0.0420

Table 11.8.4 –Catch option prediction for the anchovy fishery in SubArea VIII in 2002. Geometric Mean

Geometric mean

Fishery mortality pattern is the average of the period 1995-2000

MFDP version 1a
Run: GeometricMean01
Anchovy in subarea VIII WG2001- Bay of Biscay anchovy Exploratory run
Time and date: 10:44 13/09/01
Fbar age range: 1-3

2001				
Biomass	SSB	FMult	FBar	Landings
340826	95393	0.6653	0.4305	33000

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
300477	82497	0	0	0	296040	79667
.	80559	0.1	0.0647	4880	292900	75935
.	78673	0.2	0.1294	9513	289954	72482
.	76839	0.3	0.1941	13913	287187	69284
.	75054	0.4	0.2588	18096	284586	66319
.	73317	0.5	0.3235	22075	282141	63566
.	71628	0.6	0.3883	25863	279841	61007
.	69983	0.7	0.453	29471	277675	58625
.	68383	0.8	0.5177	32911	275635	56404
.	66825	0.9	0.5824	36193	273712	54332
.	65309	1	0.6471	39326	271898	52395
.	63833	1.1	0.7118	42318	270186	50582
.	62396	1.2	0.7765	45180	268569	48883
.	60996	1.3	0.8412	47916	267042	47289
.	59634	1.4	0.9059	50537	265597	45790
.	58307	1.5	0.9706	53046	264230	44380
.	57015	1.6	1.0354	55452	262937	43050
.	55756	1.7	1.1001	57760	261711	41796
.	54530	1.8	1.1648	59975	260549	40610
.	53335	1.9	1.2295	62102	259447	39488
.	52172	2	1.2942	64146	258401	38424

Input units are thousands and kg - output in tonnes

11.9 Reference points for management purposes

Reference points, $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$, have been defined for this stock by ACFM (ICES CM 1998/ Assess 6:).

$\mathbf{B}_{lim}$ was defined as the level of biomass below which the stock has a high probability of collapse. The Working Group estimated a value of $\mathbf{B}_{lim}$ equal to 18,000 tonnes for anchovy (ICES CM 1998/ Assess 6:), which corresponded to the minimum spawning biomass estimated by the assessment model over the previous ten years (Table 10.1.6 in WG report CM1998/Assess: 6).

$\mathbf{B}_{pa}$**:** defined as a biomass level at which some management action to protect the stock needs to be taken. Originally, a $\mathbf{B}_{pa}$ = 36,000 t of anchovy was estimated and defined as the SSB level which could withstand two successive poor recruitments. Although that $\mathbf{B}_{pa}$ level was not thoroughly evaluated it was adopted by ACFM. Recent simulation work (Uriarte & Rueda WD01) test the validity of this reference limit for the interim year (assessment year) to prevent the stock to fall below $\mathbf{B}_{lim}$ the prediction year (the next one) under an F *status quo* strategy. The simulation results showed that if the SSB is equal or greater than 36,000 t and recruitment is randomly distributed around its geometric mean or is randomly distributed below average, the probability of the biomass of falling below $\mathbf{B}_{lim}$ the next year is less than 5%. However, if the recruitment is distributed in the lowest third of the observed historical series the risk of falling below $\mathbf{B}_{lim}$ the next year is 10 % or more. Conclusion of that work is that 36,000 t may not be an appropriate value for $\mathbf{B}_{pa}$ as it is not robust under all feasible recruitment scenarios. On that basis and taking into account the difficulties in managing a stock with such a short life-span, the WG recommends that further simulation work is undertaken to estimate appropriate reference points for this stock. The same simulation framework may be used to evaluate management regimes as explained in the sections that follow.

11.10 Harvest Control Rules

One of the major problems for the fishery management of the Bay of Biscay anchovy is the strong and short-term fluctuations in biomass linked to variability in recruitment strongly influenced by environmental factors. The Spawning Stock Biomass is determined by the abundance level of the incoming year class which cannot be determined with sufficient accuracy to recommend an annual TAC at the beginning of the fishing season (January). For that reason the WG believes that a two stages management is the best solution if the fishery was to be regulated by TAC. The two stages may consist of a provisional annual TAC which would be revised in the middle of next year once a new survey estimate is available.

The Working Group considered this approach useful and proposed a simulation study to be undertaken in the course of the coming year to evaluate alternative management regimes. Guidelines for such study follows:

An age structured operating model may be used to project forward the population for a fixed period (i.e. 20 years). An annual assessment, the TAC recommendation and implementation processes should also be included in the simulation framework. Management scenarios to be compared should include:

1) Single stage TAC regime resulting in an annual TAC recommended at the beginning or at the middle of the season. TAC options considered:

- fixed TAC
- TAC estimated based on $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ considerations (current approach).

2) Two stages TAC regime consisting of an initial TAC at the beginning of the season and a revised TAC after the survey. Options:

- The 2 stages regime is only applied under exceptional circumstances (i.e. when the biomass is below a certain threshold);
- always applied: initial TAC is fixed from year to year and then revised after the survey by applying a pre-agreed harvest control rule;
- always applied: initial TAC is set as a conservative proportion of the estimated biomass and then revised upwards by applying a harvest control rule if the survey estimates a good spawning biomass.

Performance of the various management regimes considered should be compared by estimating key statistics such as: risk for the stock of falling a certain level, expected average catches and biomass level at the end of the simulation period.

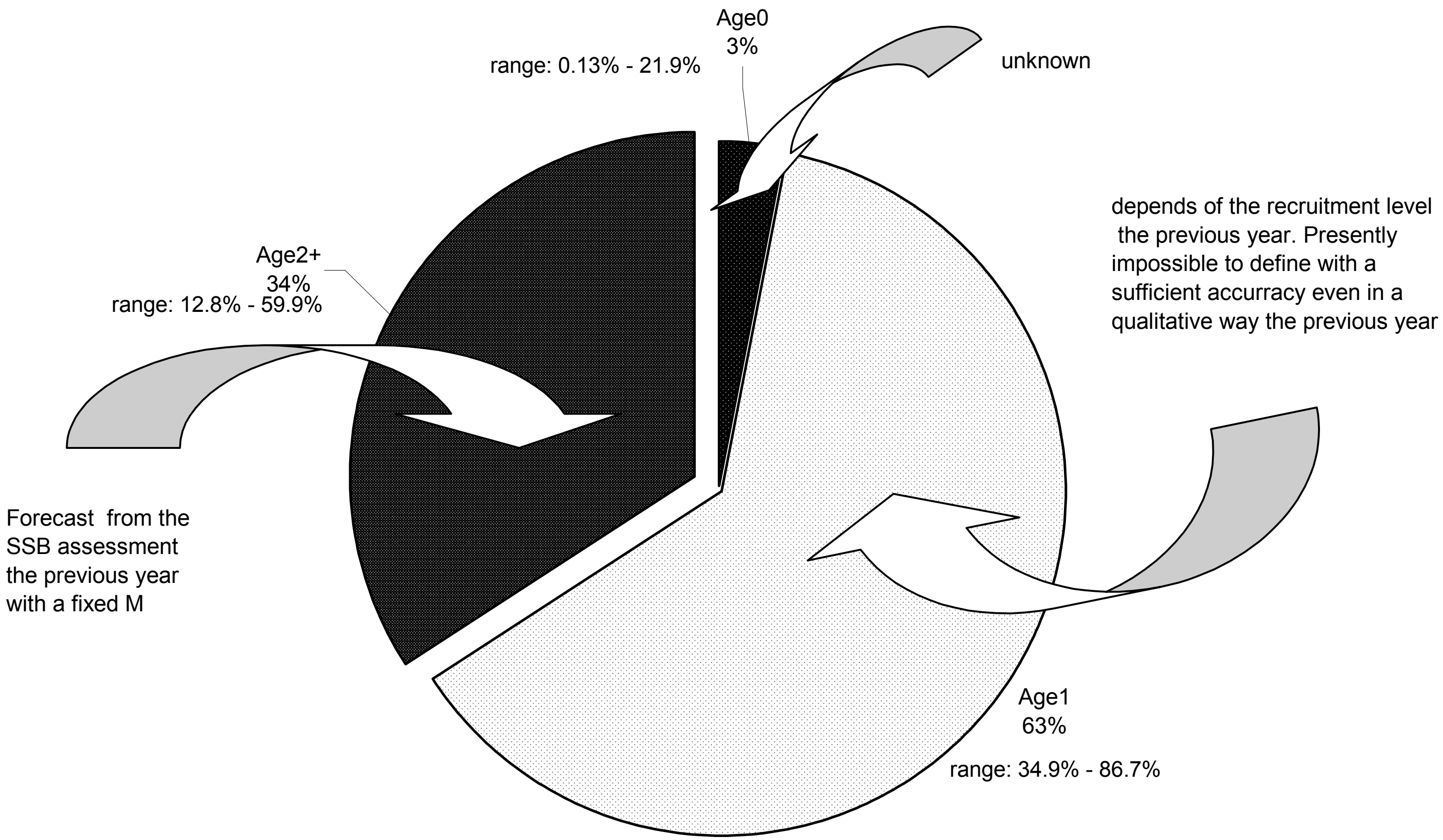
11.11 Management Measures and Considerations

The population dynamics of anchovy, characterised by a very short life and with the spawning stock and catch consisting mainly of ages 1 and 2, makes this stock difficult to manage. In particular, management by annual TACs is not appropriate because most of the stock (in some years over 90%) in the TAC year consists of year classes that are unknown at the time of the advice. This is illustrated in Figure 11.11.1, which shows the age composition of the catches in recent years. In 2001 the population is within safe biological limits (Figure 11.11.2), but dependence on recruitment results in rapid population changes.

Last year, ACFM proposed a two-stages advisory scheme, with a provisional TAC set at the start of the year based on an assumption of future recruitment, which could be revised when the results from the surveys (DEPM and acoustic surveys) became available. To avoid the possibility of advising a TAC that could turn out to be too high, resulting in excessive fishing mortality, the incoming recruitment will have to be assumed at a relatively low level. This would result in a cautious primary advice, but would allow an increase in the TAC in the second half of the year if a mid-year revision showed that the stock could sustain it. This would be in accordance with the precautionary approach, but would lead to under-utilisation, and sometimes to unduly restrictive advice if the initial TAC was too conservative.

Scientific advice for the management of the fishery through TACs will have to rely on assumptions about future recruitment unless recruitment estimates (through direct surveys) or some indirect forecasts of the recruitment are timeously available. A two-stage regime, which would be less dependent on a recruitment forecast than annual TACs, appears to be problematic from a management point of view for a variety of reasons. STECF in November (STCEF2000) suggested that a two-stage regime might be implemented only if the spawning biomass was below some threshold value. The Working Group considers that a fully operative model to evaluate alternative management regimes, including the one proposed by STEFC, needs to be developed (see 11.10 above). However, such a task could not be undertaken by the Working Group during this meeting, but it is recommended that it is undertaken in the near future.

Figure 11.11.1 - mean age distribution of anchovy catches during the period 1987-2000 and elements of knowledge for their forecast



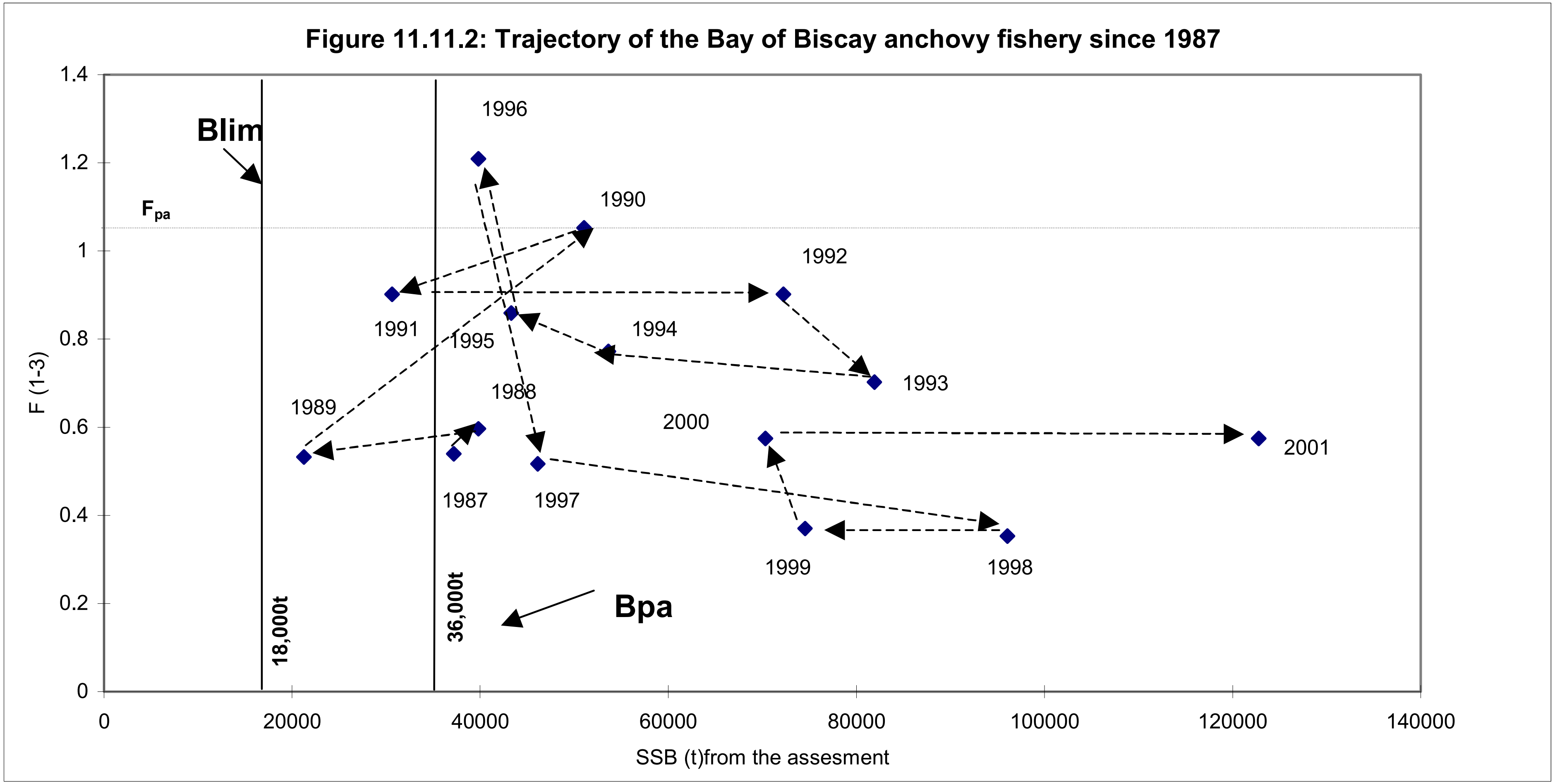


Figure 11.11.2: Trajectory of the Bay of Biscay anchovy fishery since 1987
Blim
Fpa
Bpa
18,000t
36,000t
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
F (1-3)
SSB (t)from the assesment
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
20000
40000
60000
80000
100000
120000
140000

12 ANCHOVY IN DIVISION IXA

12.1 ACFM Advice Applicable to 2000 and 2001

For 1999 and 2000, ACFM advised that catches should be restricted to 4,600 t (*i.e.*, at the level of the mean catches from the period 1988-1998, excluding 1995 and 1998). For 2001, ACFM found no basis to change the previous advice and recommended that catches were restricted to 4,900 t (mean catches from 1988-1999, excluding 1995 and 1998). This level should be kept until the response of the stock to the fishery is known. ACFM also recommended that a management plan, including monitoring of the development of the stock and of the fishery with corresponding regulations, should be developed and implemented.

The agreed TAC for anchovy (for Sub-areas IX and X and CECAF 34.1.1) was 13,000 t for 1999 and 10,000 t for 2000 and 2001. Anchovy catches in Division IXa in 1999 and 2000 were 7,408 t and 2,498 t, respectively.

No explicit management objectives have been articulated for this stock. It is recognised that the state of the resource can change quickly, and therefore an in-year monitoring and management could be appropriate. At present, the many unknowns regarding key features of the stock prevents the advice of more appropriate management measures.

12.2 The Fishery in 2000

12.2.1 Landings in Division IXa

The historical series of annual catches from Division IXa dates back to 1943, but only containing information on the Portuguese fishery. Before 1988, Spanish catches landed in the Gulf of Cadiz ports (Sub-division IXa South) and fished in Moroccan and Spanish waters were mixed in statistics, whereas those from Galician waters (Sub-division IXa North) are not available. A complete record of annual landings for the whole Division is only available since 1988.

Portuguese landings throughout the historical series have varied between 23 t (1993) and 12,610 t (1957), but showing alternate periods of high (1936-1940, 1942-1948, 1955-1957, 1962-1966 and 1995) and very low catch levels (1927-1936, 1966-1976, 1979-1984 and 1987-1994) (Pestana, 1996). Since 1988, Spanish catches from this Division have ranged between 1,824 t (1996) and 9,349 t (1998).

The total catch in 2000 was 2,502 t (Table 12.2.1.1 and Figure 12.2.1.1), which represents a 66% decrease compared to the level of 1999 catches (7,408 t), and a 49% decrease in relation to the average catch levels recorded in this Division since 1988 (4,900 t, excluding 1995 and 1998). Furthermore, the catch level attained in 2000 was very close to the lowest record of catches in the historical series with complete data for the whole Division (1,984 t in 1993). This reduction in landings in relation to those in 1999 occurred in all Sub-divisions, the most remarkable decreases being recorded in Sub-divisions IXa North and Central-North (reduction in catches higher than 90%).

Table 12.2.1.2 shows the catch by fishing gear and country. In both countries the bulk of anchovy catches (about 95%) was taken by purse-seiners. Unlike the Spanish Gulf of Cadiz fleet, which targets on anchovy in a coastal fishery (≤ 100 m depth), purse-seiners (both Spanish and Portuguese) in the northern part of Division IXa only target on anchovy when its abundance is high, due to its high market prices, as occurred in 1995. Spanish trawl catches of anchovy from the Gulf of Cadiz decreased from 993 t in 1999 to 104 t in 2000, also showing a decrease in their relative importance in the whole anchovy fishery in this area (from 18% in 1999 to 5% in 2000). Portuguese trawlers and artisanal vessels also catch the species, although in very small quantities.

Table 12.2.1.1 **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
1999	957	96	355	1408	413	5587	6000	7408
2000	71	61	178	310	10	2182	2191	2502

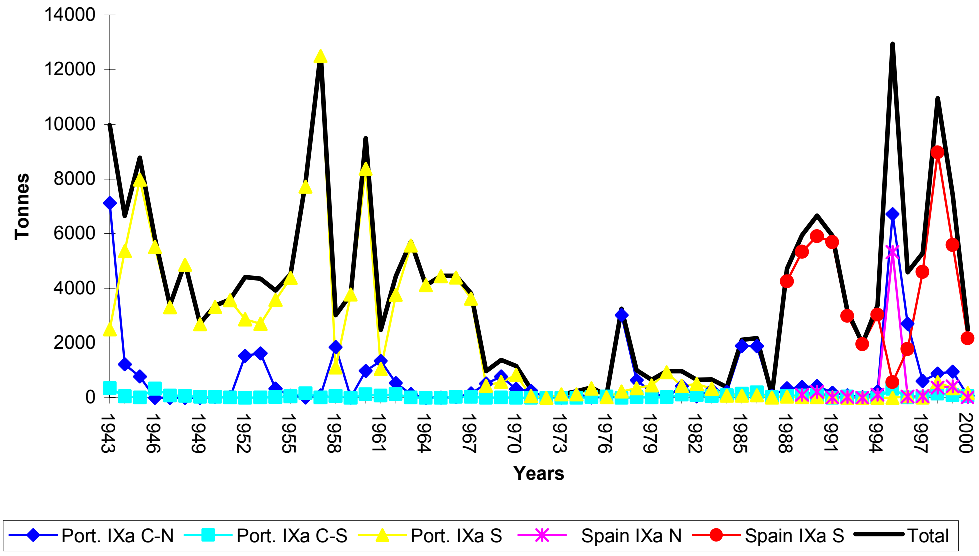
(-) Not available
(0) Less than 1 tonne

Table 12.2. 1.2 ANCHOVY IXa. Catches (t) by gear and by country in 1988-2000.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413	10
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078
Trawl IX a South						330	152	75	224	190	1148	993	104
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310
Trawl					4	9	1		56	46	37	43	6
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297
Artisanal					1	1	3		94	7	35	20	7
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502

* Portugal data without separate the catch by gear

Figure 12.2.1.1: Portuguese and Spanish annual landings of Anchovy in Division IXa since 1943



12.2.2 Landings by Sub-division

In 2000, the anchovy fishery in Division IXa was situated in the Spanish Gulf of Cadiz (Sub-division IXa South), as is usual in recent years except for 1995. In that year, favourable environmental conditions in the northwestern coastal waters of the Iberian Peninsula seemed to favour an increased level of anchovy abundance in these areas, which was reflected in a shift of the usual distribution pattern of the fishery towards the Sub-divisions IXa North and Central-North (ICES CM 1997/C:3; ICES CM 1997/Assess:3).

The distribution pattern of Spanish catches in 2000 follows that observed in recent years: catches from Sub-division IXa North were almost insignificant (10 t), whereas the bulk of Spanish catches were taken in the Gulf of Cadiz (2,182 t; *i.e*., 87.2% of total catches in Division IXa), although they experienced a 61% reduction with respect to 1999. These decreased catches may be partially explained by a strong decrease in the fishing effort exerted by the purse-seine fleet of higher relative fishing power in the area (*i.e*., the Barbate single-purpose fleet; see Section 12.5).

The greatest contribution to Portuguese annual landings in 2000 (178 t, 57% of total Portuguese catches) came from IXa South (Algarve), a situation similar to that observed during the period 1943-1967 (but with a mean value of 4,526 t). Nevertheless, from 1968 to 1997, landings in this Sub-division have experienced a consistent decreasing trend, which culminated in the years 1992-1995, with catches lower than 1 tonne. In 1998, Portuguese landings from IXa South increased to 566 t, but they fell again to the present catch levels.

In Sub-division IXa Central-North there were alternate periods of relatively high and low landings. After 1984, landings in this Sub-division 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 1996-1999, catches in Sub-division IXa Central-North and Central-South fell, but maintained the same pattern of catches as in the period 1970-1995. The above decreasing trend still persists in 2000 for both Sub-divisions, although showing a similar contribution to the total Portuguese catches (20% and 23 %).

Seasonal distribution of catches by country and Sub-divisions in 2000 is shown in Table 12.2.2.1. Catches in IXa North occurred mainly in the third quarter. In the Gulf of Cadiz, catches took place throughout the year, although they attained higher levels since the second quarter onwards. In Portuguese waters, first and fourth quarters showed the higher catches, as is usual in the last years.

Table 12.2. 1.2 ANCHOVY IXa. Catches (t) by gear and by country in 1988-2000.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413	10
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078
Trawl IX a South						330	152	75	224	190	1148	993	104
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310
Trawl					4	9	1		56	46	37	43	6
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297
Artisanal					1	1	3		94	7	35	20	7
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502

* Portugal data without separate the catch by gear

Table 12.2.2.1 Anchovy catches (t) in Division IXa by country and Subdivisions in 2000.

COUNTRY	SUBDIVISIONS	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANUAL	
		C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
SPAIN	IXa North	0	0.7	1	8.6	7	70.4	2	20.3	10	0.4
	IXa South	329	15.1	660	30.3	655	30.0	537	24.6	2182	99.6
	TOTAL	329	15.0	661	30.2	662	30.2	539	24.6	2191	
PORTUGAL	IXa Central North	41	58.2	5	6.6	0	0.0	25	35.2	71	22.9
	IXa Central South	61	99.2	0	0.0	0	0.3	0	0.5	61	19.7
	IXa South	87	48.6	8	4.4	18	10.0	66	37.0	178	57.4
	TOTAL	189	60.8	13	4.0	18	5.8	91	29.4	310	
TOTAL	IXa North	0	0.7	1	8.6	7	70.4	2	20.3	10	0.4
	IXa Central North	41	58.2	5	6.6	0	0.0	25	35.2	71	2.8
	IXa Central South	61	99.2	0	0.0	0	0.3	0	0.5	61	2.4
	IXa South	416	17.6	668	28.3	673	28.5	603	25.6	2360	94.3
	TOTAL	518	20.7	673	26.9	680	27.2	630	25.2	2502	

12.3 Fishery-Independent Information

12.3.1 Acoustic Surveys

In June 1993, a Spanish acoustic survey to estimate anchovy abundance was carried out by the Spanish waters of the Gulf of Cadiz (Sub-division IXa South). The total biomass estimated was 6,569 t (ICES 1995/Assess:2). Since then, no Spanish acoustic surveys have been conducted in this area. Spain has been conducting acoustic surveys aimed at sardine in Sub-division IXa North since 1983, but no anchovy schools were detected (Carrera *et al*., WD 1999; Carrera, WD 1999 and WD 2001).

Results on anchovy distribution and abundance from Portuguese acoustic surveys in November 2000 and March 2001 have been provided to this WG (Marques and Morais, WD 2001). Anchovy data from previous Portuguese acoustic surveys are currently under revision. The surveyed area in these surveys included the waters of the Portuguese continental shelf and those of Spanish Gulf of Cadiz (Sub-divisions IXa Central-North, Central-South and South), between 20 and 200 m depth (Figure 12.3.1.1 and 12.3.1.2).

The estimates of anchovy biomass for the total surveyed area were 34,248 t in November 2000, and 25,281 t in March 2001 and they are at the same levels attained in November 1998 and March 1999 (Table 12.3.1.1, Figures 12.3.1.3 and 12.3.1.4). As observed in previous surveys, the biggest concentrations of anchovy occurred in the Gulf of Cadiz in depths between 50 and 90 m, which accounted for 99% and 88% of the total estimated biomass in both surveys (33,909 t and 22,352 t, respectively). In the Portuguese shelf, only low concentrations were detected in small areas.

Large differences in population size composition were detected in the November 2000 survey, smaller size classes being more apparent in southern areas (Figure 12.3.1.5). Thus, about 89% of the total number of individuals estimated in the Gulf of Cadiz were ≤12 cm total length. Conversely, the population size structure along Division IXa was more uniform in March 2001, this fact being more evident within Sub-division IXa South, where 97% of Algarve and 84% of Gulf of Cadiz anchovy were between 9 and 13 cm long.

Table 12.3.1.1. Estimated abundance in number (millions) and biomass (tonnes) from Portuguese acoustic surveys by area and total.

		Portugal				Spain	TOTAL
		Central-North	Central-South	South (Algarve)	Total	South (Cadiz)	
November 1998	Number	30	122	50	203	2346	2549
	Biomass	313	1951	603	2867	30092	32959
March 1999	Number	22	15	*	37	2079	2116
	Biomass	190	406	*	596	24763	25359
November 2000	Number	4	20	*	23	4970	4994
	Biomass	98	241	*	339	33909	34248
March 2001	Number	25	13	285	324	2415	2738
	Biomass	281	87	2561	2929	22352	25281

* Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to sub-area Algarve was included in Cadiz.

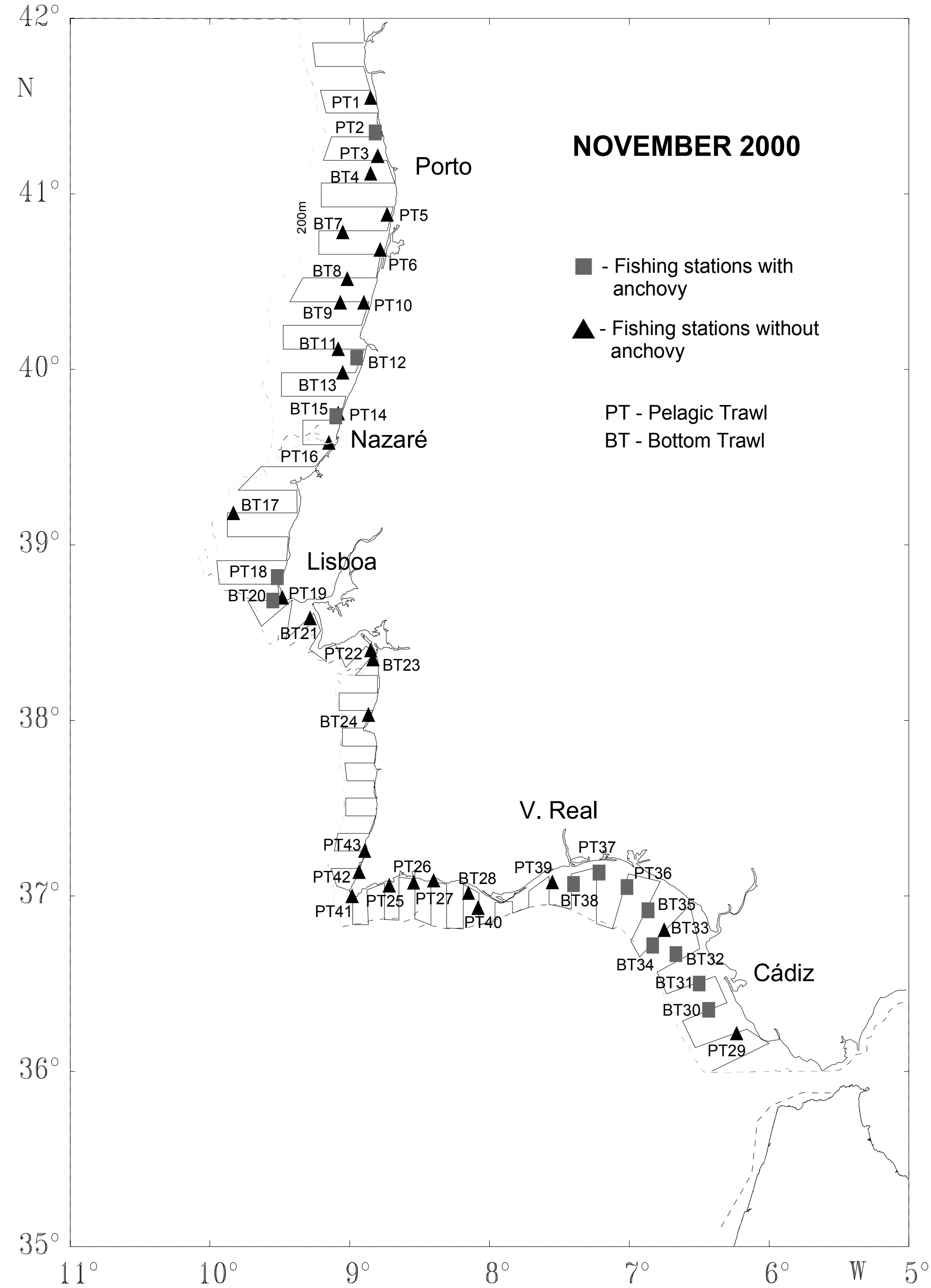


Figure 12.3.1.1. Survey track design and location of trawl stations (with and without anchovy) in November 2000 acoustic survey.

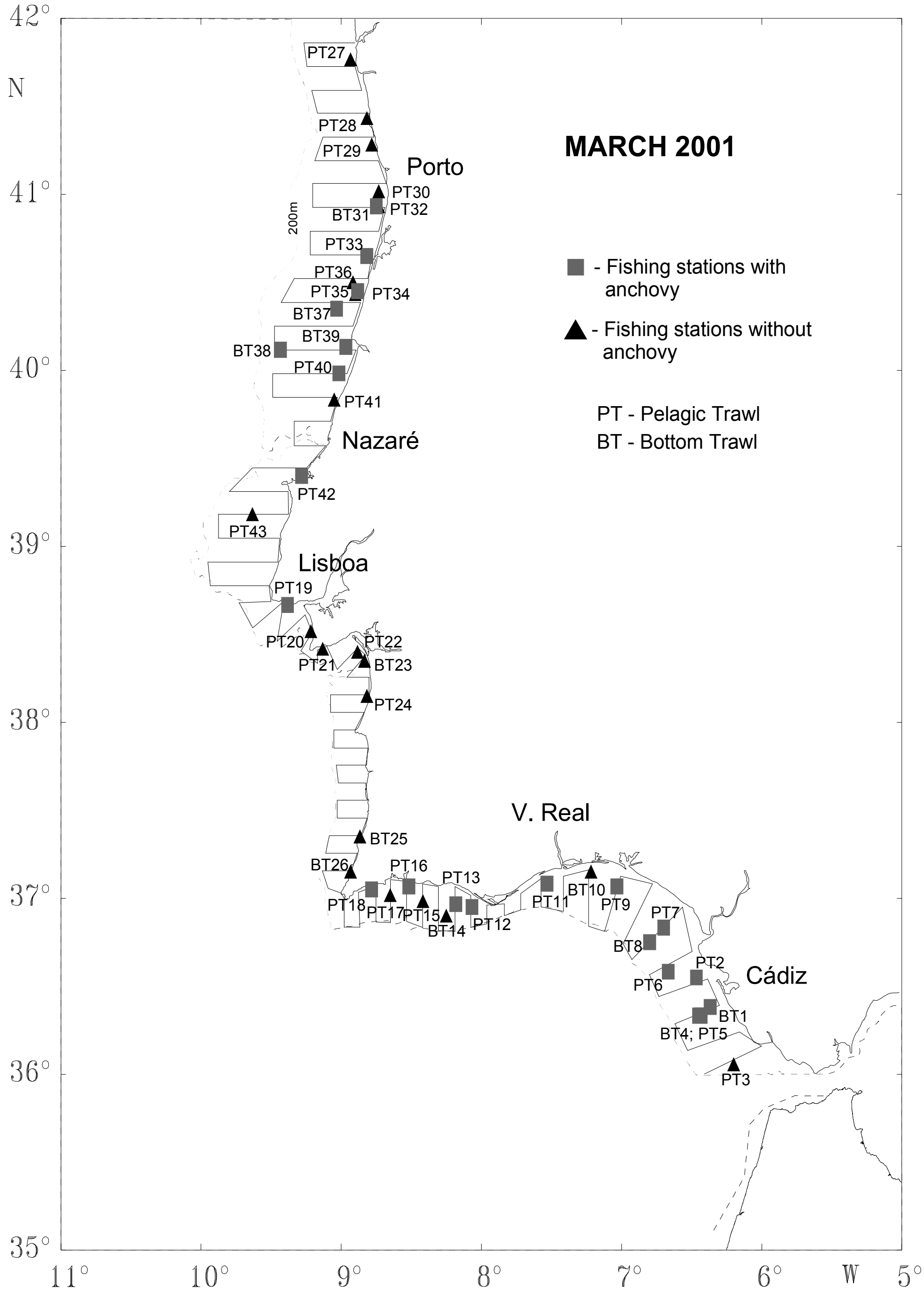


Figure 12.3.1.2. Survey track design and location of trawl stations (with and without anchovy) in March 2001 acoustic survey.

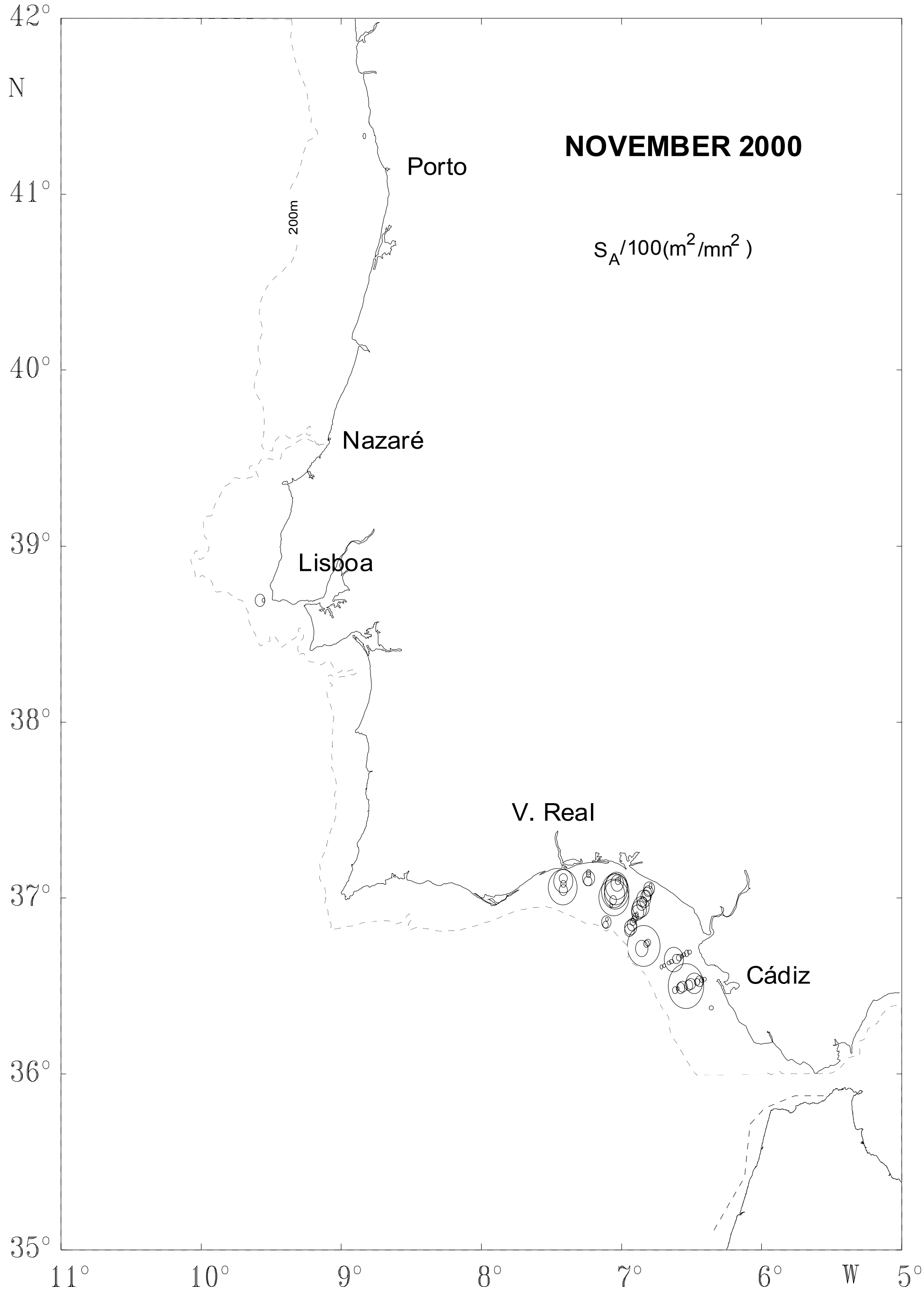


Figure 12.3.1.3. Anchovy: Acoustic energy distribution per nautical mile during the November 2000 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

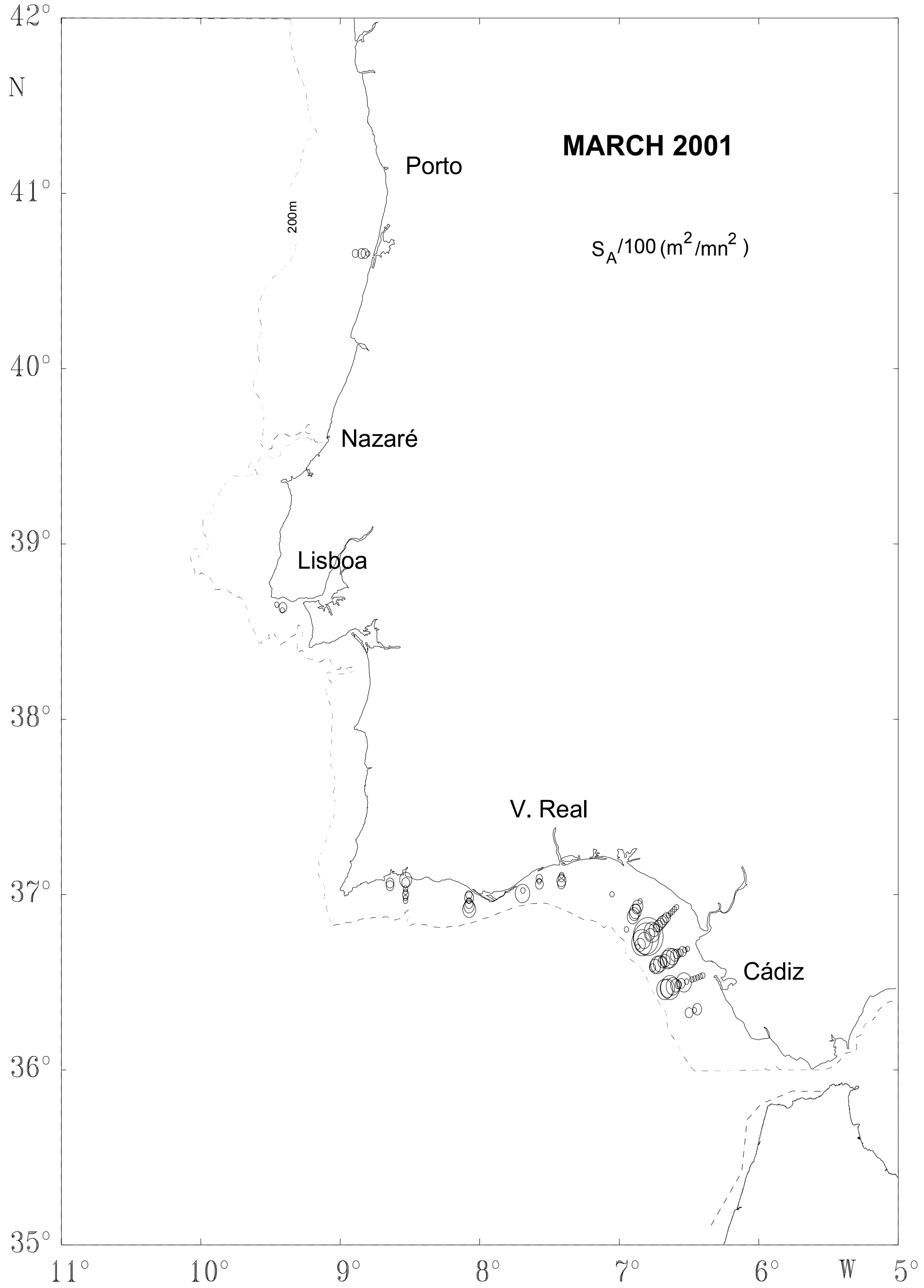


Figure 12.3.1.4. Anchovy: Acoustic energy distribution per nautical mile during the March 2001 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

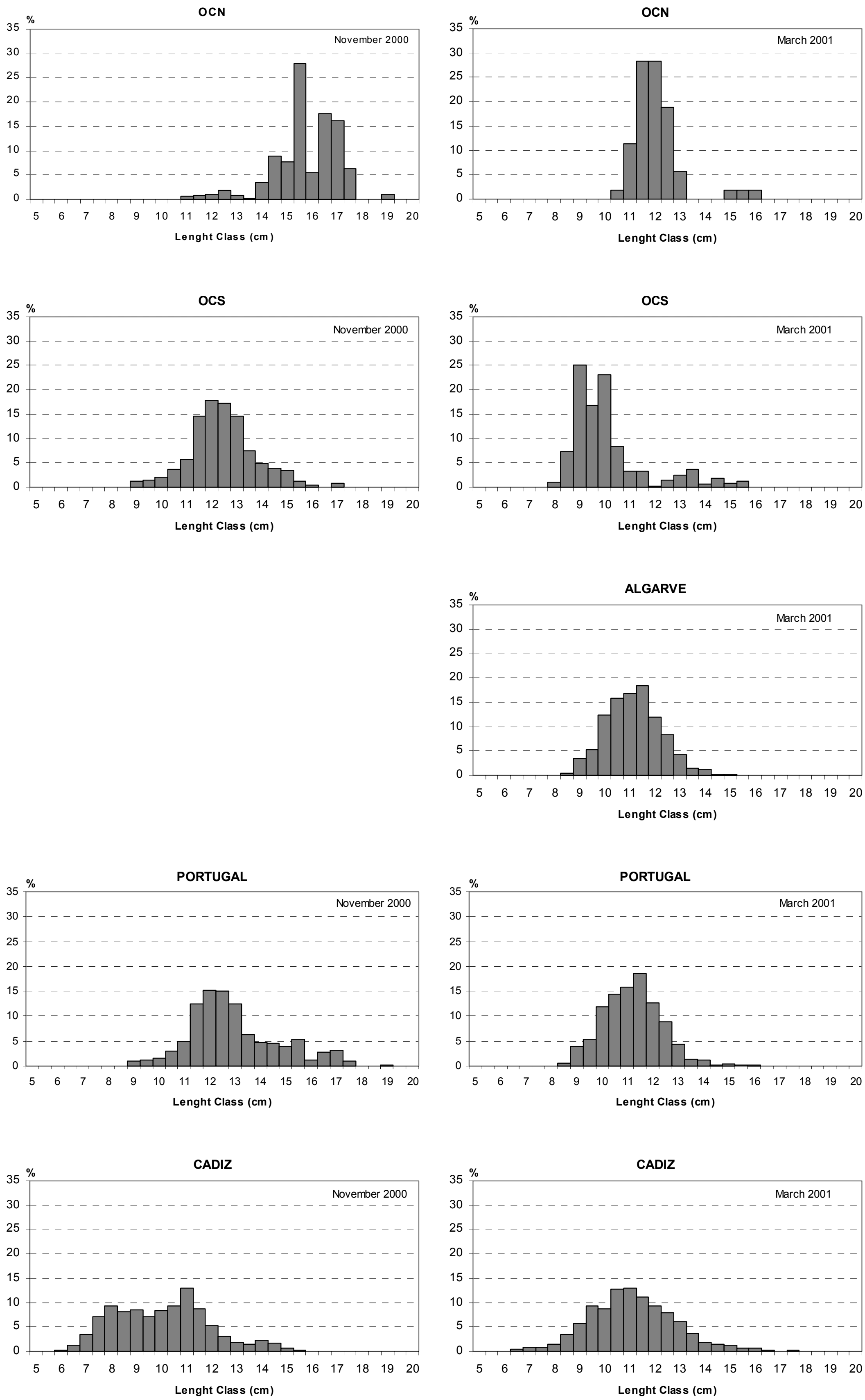


Figure 12.3.1.5. Anchovy: Distribution of length class frequency (%) by region during the November 2000 and March 2001 acoustic surveys.

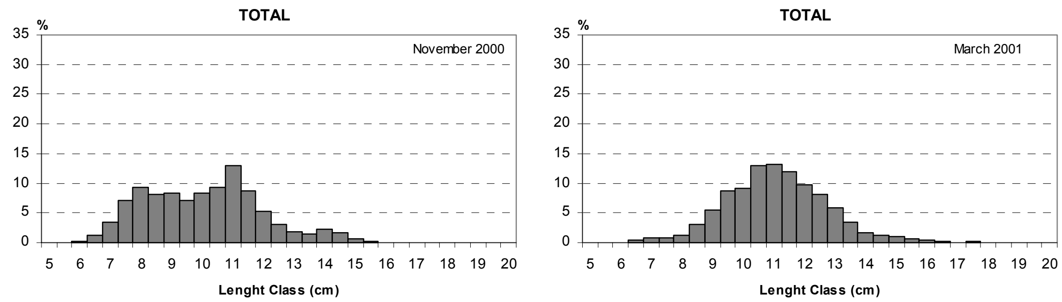


Figure 12.3.1.5. (cont.). Anchovy: Distribution of length class frequency (%) for the total area during the November 2000 and March 2001 surveys.

12.4 Biological Data

12.4.1 Catch Numbers at Age

Catch at age data from the whole Division IXa are only available from the Spanish Gulf of Cadiz fishery (Sub-division IXa South). These estimates for the period 1996-1999 were presented for the first time the last year (ICES CM 2001/ACFM:06). In the present year, this catch at age series has been extended backwards up to 1991, although with information gaps for the whole 1994 and second half in 1995 since there are no otolith collections from these periods.

Catch at age data from the Spanish fishery in Sub-division IXa North are not usually available since commercial landings used to be insignificant. The exception was in 1995 due to the aforementioned increased catches in the northernmost areas of the Division. In that year, anchovy catches consisted of age 1 individuals (ICES CM 1997/Assess:3). Additional otolith samples from this Sub-division were analysed in 1998 and 1999, but they were incomplete and not shown as representative of the fished population. Nevertheless, 58.8% of anchovies in the 1999 samples were found to be age 1, 40.0% age 2 and 1.2% age 3 (ICES CM 2001/ACFM:06).

Portugal has not provided estimates of length or age composition of anchovy landings in Sub-divisions IXa Central (north and south) and South (Algarve).

The age composition of the Gulf of Cadiz anchovy landings from 1991 to 2000 is presented in Table 12.4.1.1 and Figure 12.4.1.1. The updating of the catch-at-age series confirms that the Gulf of Cadiz anchovy fishery is supported by the 0, 1 and 2 age-groups and that the success of this fishery largely depends on the abundance of 1 year-old anchovies. Thus, the contribution of age-2 anchovies usually accounts for less than 1% of the total annual catch (excepting 1997 and 1999, with contributions of 7% and 5%). Likewise, age-3 anchovies only occurred in the first quarter in 1992 but their importance in the total annual catch that year was insignificant. The relative importance of 0- and 1-age groups in the fishery has experienced some changes through the years with available data. Thus, 1 year-old anchovies constituted almost the whole of anchovy landed in the period 1991-1993 (with percentages higher than 80%). In the following available data set (1996-2000), the contribution of this age group was, respectively, 25 % and 42% in 1996 and 1997, whereas since 1998 onwards the relative importance of 1 year old anchovies was increased again, although up to percentages between 60-75%. Since 1996, the contribution of age group 0 followed a decreasing trend, with the lowest contribution occurring in 1999 (20%), but this declining trend seems to have changed in 2000 showing a slight increase (37%).

Total catch in the Gulf of Cadiz in 2000 was 320 millions fish which represents a decrease of 49% compared to the previous year (629 millions). The most important decreases were observed in age groups 1 and 2, showing reductions of 58% and 88%, respectively.

Landings of the 0 age-group anchovies are generally restricted to the second half of the year, whereas 1 and 2 year-old catches are present throughout the year, although they tend to be lower in the fourth quarter (Table 12.4.1.1).

12.4.2 Mean Length- and Mean Weight-at-Age

Length Distributions by fleet

Annual length compositions of anchovy landings in Division IXa are provided only by Spain, from 1988 to 2000 for Sub-division IXa South, and from 1995 to 1999 for Sub-division IXa North. Portugal has not provided length distributions of landings in Division IXa.

Anchovy length distributions in 2000 in Division IXa by quarter and Sub-division are shown in Table 12.4.2.1 and Figure 12.4.2.1. Table 12.4.2.2 shows annual length distributions since 1988. Figure 12.4.2.2 compares length distributions in Sub-divisions IXa South and IXa North since 1995. Note that, with the exception of 1998, the fish caught in the North are longer than 12.5 cm.

In 2000, as in previous years, a large number of juveniles were captured (individuals less than 10 cm long) in Sub-division IXa South (Gulf of Cadiz) during the first and second halves of the year (Table 12.4.2.1 and Figure 12.4.2.1). The mean length and mean weight in the annual catch in this area were estimated at 9.8 cm and 6.8 g (Table 12.4.2.2, Figures 12.4.2.1 and 12.4.2.2). Smaller mean sizes and weights were recorded in the first and fourth quarters as is usual.

Mean Length- and Mean Weight-at-Age in Landings

In 2000, mean length- and mean weight-at-age data are only available for Gulf of Cadiz anchovy catches. Furthermore, the Spanish data series for these estimates have been completed until 1991, but with the aforementioned gaps for years 1994 and 1995 (Tables 12.4.2.3 and 12.4.2.4). The analysis of small samples of otoliths from Sub-division IXa North in 1998 and 1999 rendered estimates of mean sizes at ages 1, 2 and 3 of 15.5 cm, 17.6 cm and 17.9 cm respectively (ICES CM 2000/ACFM:05; ICES CM 2001/ACFM:06). Comparisons of these estimates with those ones from the Gulf of Cadiz anchovy indicate that southern anchovies attain smaller sizes at age.

Seasonally, 0 age-group anchovies off the Gulf of Cadiz are larger and heavier in the fourth quarter. The 1 and 2 year-old anchovies exhibit a clear and persistent pattern through the years, showing the larger mean length and heavier mean weight in the second half in the year.

12.4.3 Maturity at Age

Results from a four-year biological study (1989-1992) on Gulf of Cadiz anchovy (Sub-division IXa South) indicate that its spawning season extends from late winter to early autumn (Millán, 1999). Peak spawning time for the whole population occurs from June to August. Maturity is attained at a total length of 11.09 cm in males and 11.20 cm in females. However, size at maturity varies between years, suggesting a high plasticity in the reproductive process in response to environmental changes (Millán, 1999).

Annual maturity ogives for Gulf of Cadiz anchovy have been estimated from the data series available (since 1991) and are shown in Table 12.4.3. These ogives are based on the biological samples collected during the spawning period (*i.e.*, the second and third quarters).

Results from the Portuguese acoustic surveys in November 1998 and March 1999 indicated that 45% of anchovies in November 1998 and 78% in March 1999 were mature in the Algarve-Gulf of Cádiz area (ICES CM 2001/ACFM:06, Morais, WD 2000). In the Sub-division IXa Central percentages of mature fish found in both surveys were 1% and 79%, respectively. Estimates of length at maturity were also available from these Portuguese acoustic surveys. For the whole Sub-division IXa South (Algarve and Gulf of Cadiz), length at first maturity in November 1998 was estimated at 12,90 cm TL in both sexes, whereas in March 1999 this size was attained at 11,32 cm in males and at 11,57 cm in females. For the Sub-division IXa Central (northern and southern areas combined) those estimates were only calculated for the March 1999 survey. The estimates were 14,93 cm TL in males and 14,22 cm TL in females, contrasting with the smaller values described above for the southernmost anchovies.

12.4.4 Natural mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Sub-area VIII, natural mortality is probably high (M=1.2 is used for the data exploration, see Section 12.7.1).

Table 12.4.1.1. Spanish catch in number at age (in thousands) of Gulf of Cadiz anchovy (Sub-division IXa-South, 1991-2000) on a quarterly(Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 not available.

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	11537	45411	0	56948	56948
	1	351314	334722	36156	1189	686036	37345	723381
	2	0	4053	1591	376	4053	1968	6021
	3	0	0	0	0	0	0	0
	Total (n)	351314	338775	49284	46977	690089	96261	786350
	Catch (t)	1049	3673	701	273	4722	975	5697
	SOP	1035	3638	696	271	4672	968	5640
	VAR.%	101	101	101	101	101	101	101

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	2415	0	0	2415	2415
	1	159677	147523	42707	86	307200	42793	349993
	2	182	0	861	41	182	902	1084
	3	63	0	0	0	63	0	63
	Total (n)	159922	147523	45983	127	307445	46110	353555
	Catch (t)	1125	1367	499	4	2492	503	2995
	SOP	1120	1364	498	4	2484	502	2986
	VAR.%	100	100	100	100	100	100	100

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	13797	23517	0	37314	37314
	1	73104	81486	12120	2025	154590	14145	168735
	2	576	649	0	12	1225	12	1237
	3	0	0	0	0	0	0	0
	Total (n)	73680	82135	25917	25555	155815	51472	207287
	Catch (t)	767	921	167	105	1688	272	1960
	SOP	761	914	166	105	1675	271	1946
	VAR.%	101	101	100	100	101	100	101

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	n.a.	n.a.	0	n.a.	n.a.
	1	19579	6928	n.a.	n.a.	26508	n.a.	n.a.
	2	189	0	n.a.	n.a.	189	n.a.	n.a.
	3	0	0	n.a.	n.a.	0	n.a.	n.a.
	Total (n)	19769	6928	n.a.	n.a.	26697	n.a.	n.a.
	Catch (t)	185	80	148	157	265	305	571
	SOP	184	79	n.a.	n.a.	264	n.a.	n.a.
	VAR.%	101	101	n.a.	n.a.	101	n.a.	n.a.

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	413465	71074	0	484540	484540
	1	12772	130880	11550	7281	143652	18832	162483
	2	13	882	826	333	894	1159	2053
	3	0	0	0	0	0	0	0
	Total (n)	12785	131761	425842	78688	144546	504530	649076
	Catch (t)	41	807	585	348	848	933	1780
	SOP	36	743	621	306	779	926	1706
	VAR.%	114	109	94	113	109	101	104

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	237283	96475	0	333758	333758
	1	67055	123878	69278	19430	190933	88708	279641
	2	22601	9828	11649	745	32429	12394	44823
	3	0	0	0	0	0	0	0
	Total (n)	89656	133706	318211	116650	223362	434860	658223
	Catch (t)	906	1110	2006	578	2016	2584	4600
	SOP	844	1273	1923	596	2117	2519	4635
	VAR.%	107	87	104	97	95	103	99

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	75708	360599	0	436307	436307
	1	325407	384529	220869	84729	709936	305599	1015535
	2	11066	879	1316	0	11944	1316	13260
	3	0	0	0	0	0	0	0
	Total (n)	336473	385408	297893	445329	721881	743221	1465102
	Catch (t)	1773	2113	2514	2579	3885	5092	8977
	SOP	1923	2127	2599	2654	4050	5254	9304
	VAR.%	92	99	97	97	96	97	96

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	40549	84234	0	124784	124784
	1	249922	115218	86931	20276	365140	107207	472348
	2	10982	18701	2450	146	29683	2596	32279
	3	0	0	0	0	0	0	0
	Total (n)	260904	133919	129931	104656	394823	234587	629410
	Catch (t)	1335	1983	1582	687	3318	2269	5587
	SOP	1330	1756	1391	673	3087	2064	5150
	VAR.%	100	113	114	102	107	110	108

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	41028	77780	0	118808	118808
	1	75141	65947	46460	9949	141088	56409	197497
	2	638	2670	523	14	3307	537	3844
	3	0	0	0	0	0	0	0
	Total (n)	75779	68617	88011	87743	144395	175755	320150
	Catch (t)	329	660	655	537	989	1193	2182
	SOP	327	659	666	535	986	1201	2187
	VAR.%	101	100	98	100	100	99	100

Table 12.4.2.1: Length distribution ('000) of ANCHOVY in Division IXa by country and Sub-divisions in 2000.

	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
Length (cm)	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South
3.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
4	-	-	0	-	-	0	-	-	0	-	-	114	-	-	114
4.5	-	-	104	-	-	0	-	-	556	-	-	196	-	-	856
5	-	-	3226	-	-	46	-	-	1430	-	-	304	-	-	5006
5.5	-	-	6888	-	-	213	-	-	1750	-	-	540	-	-	9391
6	-	-	7641	-	-	698	-	-	2787	-	-	1835	-	-	12961
6.5	-	-	6157	-	-	542	-	-	3197	-	-	1550	-	-	11446
7	-	-	4986	-	-	365	-	-	5097	-	-	1306	-	-	11754
7.5	-	-	10240	-	-	649	-	-	7795	-	-	1702	-	-	20386
8	-	-	8194	-	-	1481	-	-	7474	-	-	2555	-	-	19704
8.5	-	-	5931	-	-	2643	-	-	4654	-	-	5362	-	-	18590
9	-	-	2301	-	-	2833	-	-	3735	-	-	10566	-	-	19435
9.5	-	-	2011	-	-	6439	-	-	4363	-	-	14584	-	-	27397
10	-	-	1665	-	-	9467	-	-	4970	-	-	17947	-	-	34049
10.5	-	-	1990	-	-	7888	-	-	6326	-	-	9999	-	-	26203
11	-	-	2038	-	-	6832	-	-	7379	-	-	5565	-	-	21814
11.5	-	-	2185	-	-	6344	-	-	6744	-	-	3573	-	-	18846
12	-	-	2767	-	-	5007	-	-	8170	-	-	2790	-	-	18734
12.5	-	-	2757	-	-	3245	-	-	5964	-	-	2772	-	-	14738
13	-	-	2684	-	-	2522	-	-	4825	-	-	1810	-	-	11841
13.5	-	-	1377	-	-	3019	-	-	3352	-	-	1449	-	-	9197
14	-	-	504	-	-	3403	-	-	2311	-	-	642	-	-	6860
14.5	-	-	88	-	-	2152	-	-	1034	-	-	439	-	-	3713
15	-	-	46	-	-	2011	-	-	660	-	-	95	-	-	2812
15.5	-	-	0	-	-	626	-	-	330	-	-	27	-	-	983
16	-	-	0	-	-	97	-	-	182	-	-	15	-	-	294
16.5	-	-	0	-	-	0	-	-	0	-	-	4	-	-	4
17	-	-	0	-	-	97	-	-	0	-	-	0	-	-	97
17.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
18	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
18.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
22	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
Total N	-	-	75780	-	-	68619	-	-	95085	-	-	87741	-	-	327225
Catch (T)	0	189	329	1	13	660	7	18	655	2	91	537	10	310	2182
L avg (cm)	-	-	8.2	-	-	11.1	-	-	10.0	-	-	9.8	-	-	9.8
W avg (g)	-	-	4.3	-	-	9.6	-	-	7.6	-	-	6.1	-	-	6.8

Table 12.4.2.2: Annual Length distribution ('000) of ANCHOVY in Division IXa from 1988 to 2000.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999		2000
Length	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**	**SPAIN**
(cm)	**IXa South**	**IXa South**	**IXa South**	**IXa South**	**IXa South**	**IXa South**	**IXa South**	**IXa North**	**IXa South**	**IXa North**	**IXa South**	**IXa North**	**IXa South**	**IXa North**	**IXa South**	**IXa North**	**IXa South**	**IXa South**
3.5											1349							
4			4011	258	1						12677						1831	114
4.5		127	16601	3306	26	22					67819		1333		4656		17055	856
5	128	452	29122	43814	80	22					160894		11492		25825		41100	5006
5.5	170	813	43716	77144	345	66					129791		38722		57086		36181	9391
6		994	39979	43378	921	180					52812		53185		82442		19366	12961
6.5		1207	37909	24724	2337	611	5488				33640		50275		76694		20421	11446
7	255	2391	29592	15470	3567	1862	12009				32469		62492		68074		17749	11754
7.5	351	5764	27140	16574	5993	3561	18391		439		19088		42120		43197		19089	20386
8	3163	24708	24315	16633	12777	4083	23533		439		8949		45120		32964		20835	19704
8.5	8073	62795	33427	15724	18240	2626	22031		447		11776		36200		47796		15724	18590
9	12602	52082	46239	19735	14461	3843	20272		3108		12007		20009	156	78561		14937	19435
9.5	21594	42387	74823	30742	20684	6848	14835		9805		6844		13611	367	106350		17487	27397
10	34293	67553	95844	39474	31524	7100	23726		11823		4887		8951	754	132106		23530	34049
10.5	49922	69793	96132	71062	31870	9496	27521		14966		7156		12231	1486	150718		31482	26203
11	63848	68387	72419	83835	31776	9401	28394		8575		17343		22647	2047	158806		33604	21814
11.5	55186	55528	63427	81931	31150	11636	33602		7105		21738		27353	1477	133585		40004	18846
12	60928	41099	44273	77372	34504	24713	26439	74	4565		17855		39131	1267	99586		55614	18734
12.5	37457	34212	28509	51932	29185	32918	30192	711	3606		11544		45267	1178	76285		66384	14738
13	22608	17989	15263	43309	17040	26293	15732	3049	1855	8	6450	374	46852	2737	44979		52625	11841
13.5	8149	11505	10619	25316	5725	12681	8517	3381	1544	12	4468	997	38183	2403	25038	92	38719	9197
14	4270	7747	4689	17842	3378	5318	5719	14998	935	258	3880	2004	19127	3038	11847	246	22962	6860
14.5	474	3190	1206	5211	2180	2535	4763	25944	135	335	1990	422	11268	2813	5712	497	13247	3713
15	3896	2245	605	1987	315	943	3612	46371	138	375	790	48	6370	1976	2080	1075	6811	2812
15.5	2436	1671	318	944	922	510	874	42244	6	226	703	40	3764	890	579	1160	2422	983
16	2126	4676	340	1533	355	56	813	44171		227	159	33	2224	560	138	1658	889	294
16.5	1690	7271	565	2087	271		368	14369		151		10	296	330		2430	246	4
17	1096	4349	373	1655	95		182	8378		104		10		438		2221		97
17.5	209	1241	199	558	19			778		94		13		311		1717		
18		571	143	79				236		24						1045		
18.5			19							21						397		
19										1						317		
19.5																138		
20																		
20.5																		
21																		
21.5																		
22																		
Total N	394923	592750	841818	813628	299743	167322	327014	204705	69491	1835	649078	3951	658223	24231	1465102	12993	630315	327225
Catch (T)	4263	5336	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587	2182
L avg (cm)	11.6	10.9	9.6	10.1	10.8	12.0	10.8	15.6	11.0	15.6	6.6	14.2	9.4	13.4	9.7	16.8	10.1	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	2.6	16.1	7.0	15.3	6.3	31.8	8.1	6.8

Table 12.4.2.3. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1991-2000) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 not available.

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			10.7	9.4		9.7	9.7
	1	7.2	11.5	13.1	16.1	9.3	13.2	9.5
	2		14.9	17.1	17.1	14.9	17.1	15.6
	3							
	Total	7.2	11.5	12.7	9.7	9.3	11.2	9.6

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.5			9.5	9.5
	1	10.0	11.1	12.0	15.9	10.5	12.0	10.7
	2	16.3		15.7	16.7	16.3	15.7	15.8
	3	16.9						16.9
	Total	10.0	11.1	12.0	16.2	10.5	12.0	10.7

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			6.3	7.7		7.2	7.2
	1	11.5	11.7	12.2	13.8	11.6	12.4	11.7
	2	14.7	14.9		16.5	14.8	16.5	14.8
	3							
	Total	11.5	11.8	9.1	8.2	11.6	8.6	10.9

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			*n.a.*	*n.a.*		*n.a.*	*n.a.*
	1	11.3	11.8	*n.a.*	*n.a.*	11.5	*n.a.*	*n.a.*
	2	14.7		*n.a.*	*n.a.*	14.7	*n.a.*	*n.a.*
	3			*n.a.*	*n.a.*		*n.a.*	*n.a.*
	Total	11.4	11.8	*n.a.*	*n.a.*	11.5	*n.a.*	*n.a.*

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			5.6	7.3		5.8	5.8
	1	7.4	8.5	12.9	13.7	8.4	13.2	8.9
	2	14.0	13.9	15.2	15.6	13.9	15.3	14.7
	3							
	Total	7.4	8.5	5.8	7.9	8.4	6.1	6.6

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.1		7.4	7.4
	1	10.0	10.5	13.1	13.0	10.3	13.0	11.2
	2	13.4	14.0	15.0	15.1	13.6	15.0	14.0
	3							
	Total	10.9	10.8	8.7	8.9	10.8	8.8	9.5

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.8		8.5	8.5
	1	9.5	9.2	11.9	12.2	9.3	12.0	10.1
	2	13.2	14.0	15.0		13.3	15.0	13.5
	3							
	Total	9.6	9.2	10.7	9.5	9.4	10.0	9.7

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.3		8.8	8.8
	1	8.2	12.2	12.7	12.5	9.5	12.7	10.2
	2	13.4	14.1	15.2	14.9	13.8	15.2	13.9
	3							
	Total	8.4	12.5	11.2	10.0	9.8	10.6	10.1

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.5		8.9	8.9
	1	8.2	10.9	11.9	12.5	9.4	12.0	10.2
	2	14.1	15.0	15.4	16.1	14.9	15.5	15.0
	3							
	Total	8.2	11.1	10.0	9.8	9.6	9.9	9.8

Table 12.4.2.4. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1991-2000) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 not available.

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.008	0.005		0.006	0.006
	1	0.003	0.011	0.015	0.027	0.007	0.016	0.007
	2		0.024	0.036	0.033	0.024	0.035	0.028
	3							
	Total	0.003	0.011	0.014	0.006	0.007	0.010	0.007
1992	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.005			0.005	0.005
	1	0.007	0.009	0.011	0.029	0.008	0.011	0.008
	2	0.027		0.024	0.033	0.027	0.024	0.025
	3	0.030						0.030
	Total	0.007	0.009	0.011	0.030	0.008	0.011	0.008
1993	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.002	0.003		0.003	0.003
	1	0.010	0.011	0.012	0.016	0.011	0.012	0.011
	2	0.021	0.021		0.028	0.021	0.028	0.021
	3							
	Total	0.010	0.011	0.006	0.004	0.011	0.005	0.009

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			*n.a.*	*n.a.*		*n.a.*	*n.a.*
	1	0.009	0.011	*n.a.*	*n.a.*	0.010	*n.a.*	*n.a.*
	2	0.021		*n.a.*	*n.a.*	0.021	*n.a.*	*n.a.*
	3			*n.a.*	*n.a.*		*n.a.*	*n.a.*
	Total	0.009	0.011	*n.a.*	*n.a.*	0.010	*n.a.*	*n.a.*
1996	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.001	0.003		0.001	0.001
	1	0.003	0.006	0.014	0.015	0.005	0.015	0.006
	2	0.018	0.017	0.023	0.023	0.017	0.023	0.020
	3							
	Total	0.003	0.006	0.001	0.004	0.005	0.002	0.003
1997	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.003	0.003		0.003	0.003
	1	0.007	0.009	0.015	0.013	0.008	0.015	0.010
	2	0.016	0.019	0.023	0.021	0.017	0.023	0.018
	3							
	Total	0.009	0.010	0.006	0.005	0.009	0.006	0.007
1998	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.003	0.005		0.004	0.004
	1	0.005	0.005	0.011	0.011	0.005	0.011	0.007
	2	0.014	0.019	0.022		0.014	0.022	0.015
	3							
	Total	0.006	0.006	0.009	0.006	0.006	0.007	0.006
1999	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.003	0.005		0.005	0.004
	1	0.005	0.012	0.014	0.012	0.007	0.013	0.008
	2	0.015	0.020	0.023	0.020	0.018	0.023	0.018
	3							
	Total	0.005	0.013	0.011	0.006	0.008	0.009	0.008
2000	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.003	0.005		0.005	0.005
	1	0.004	0.009	0.011	0.012	0.006	0.011	0.008
	2	0.018	0.024	0.025	0.027	0.023	0.025	0.023
	3							
	Total	0.004	0.010	0.008	0.006	0.007	0.007	0.007

Table 12.4.3. Maturity ogive (ratio of mature fish at age) for Gulf of Cadiz anchovy (Sub-division IXa South), based on biological samples collected during the spawning period (second+third quarters).

Year	Age			Observations
	0	1	2+	
1991	0	0.82	1	
1992	0	0.65	1	
1993	0	0.84	1	
1994	-	-	-	Otoliths not available.
1995	0	0.57	1	Only from April+May samples.
1996	0	0.83	1	
1997	0	0.82	1	
1998	0	0.77	1	
1999	0	0.78	1	
2000	0	0.84	1	

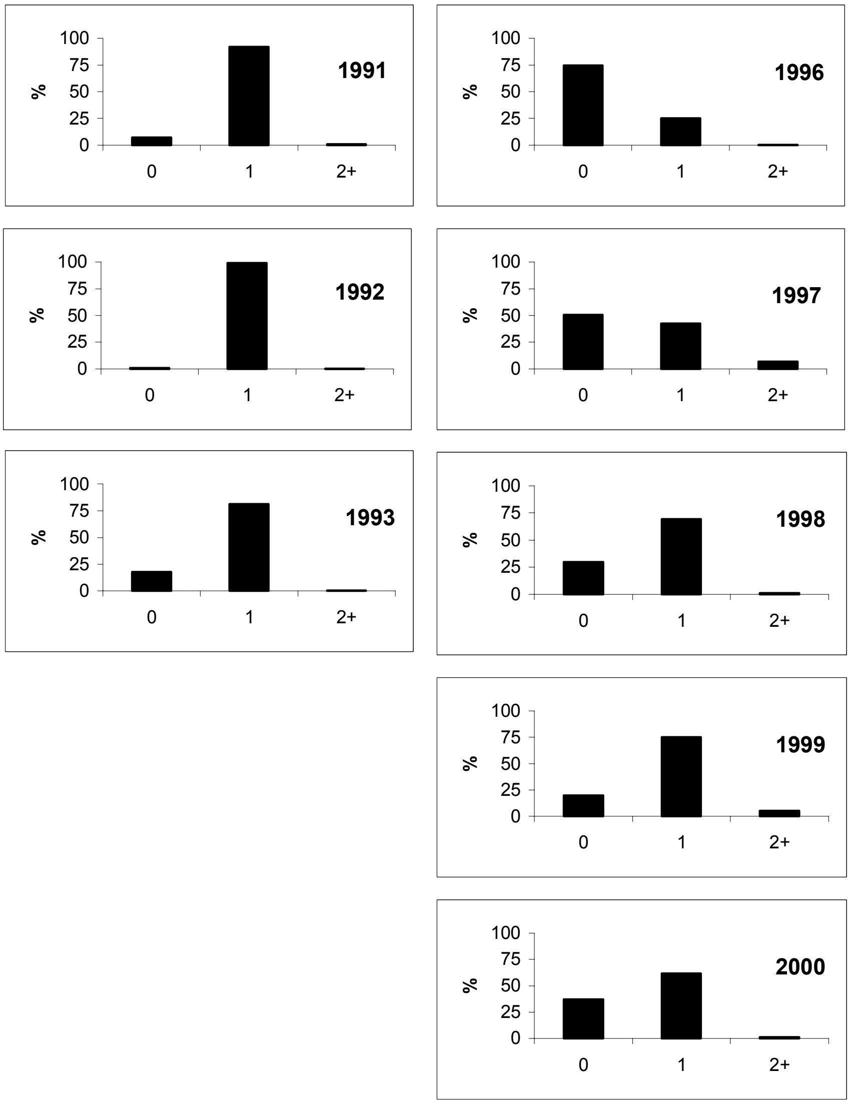


Figure 12.4.1.1. Age composition of Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South; 1991-2000). Data for 1994 and 1995 not available.

SUB-DIVISION IXa SOUTH

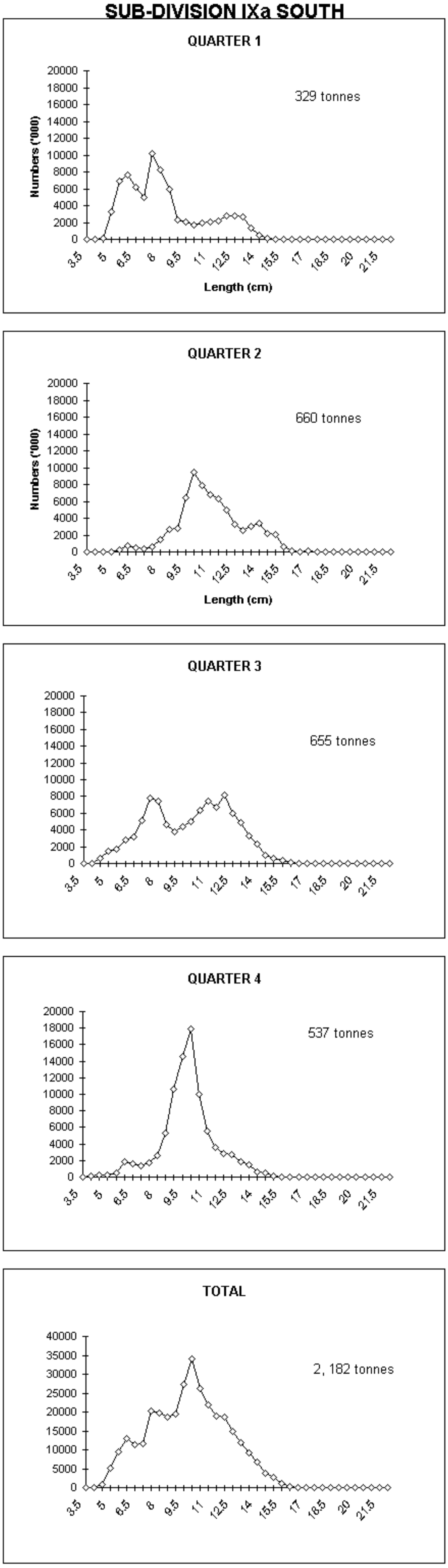
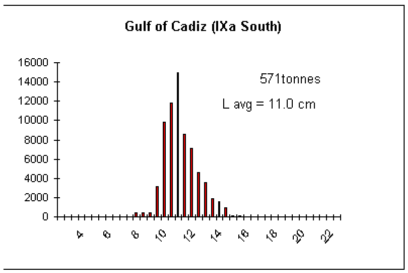
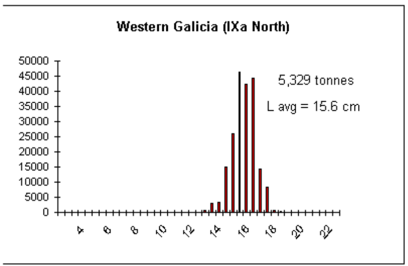


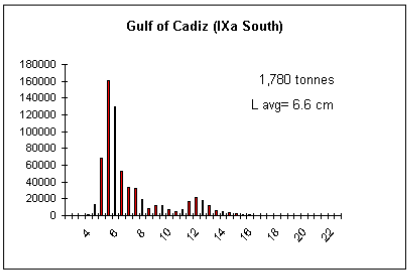
Figure 12.4.2.1. Length distribution ('000) of anchovy landings in Sub-division IXa South (Gulf of Cadiz) by quarter in 2000. Without data for Sub-division IXa North (Western Galicia).

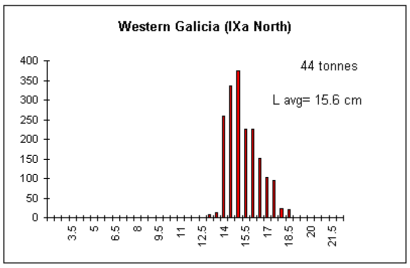
1995



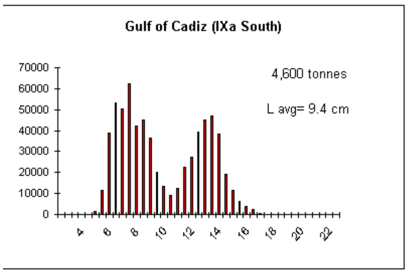


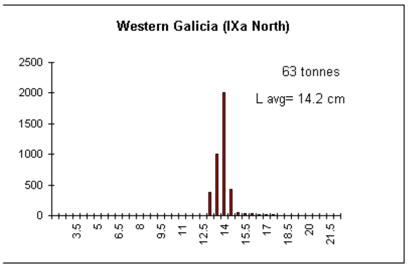
1996



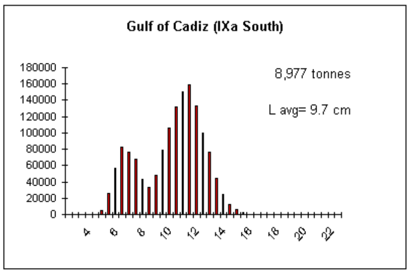


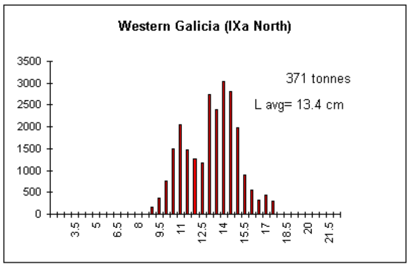
1997



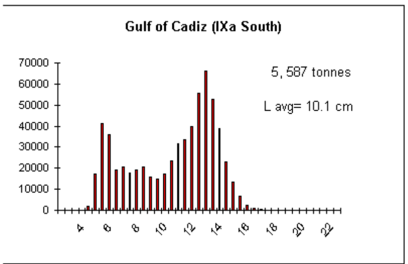


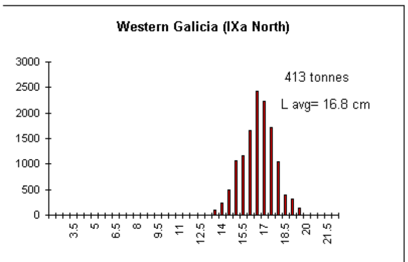
1998





1999





2000

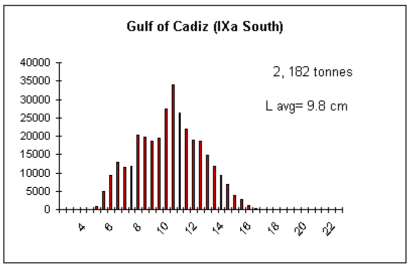


Figure 12.4.2.2. Length distribution ('000) of anchovy in Sub-divisions IXa South and IXa North (1995-2000).

12.5 Effort and Catch per Unit Effort

Data on fishing effort (number of effective fishing trips) and CPUE indices of anchovy in Division IXa correspond to the Spanish purse-seine fleets both in the Gulf of Cadiz (since 1988) and in Sub-division IXa North (since 1995), (Tables 12.5.1 and 12.5.2; Figures 12.5.1- 12.5.3). A recent increased coverage of the monitoring of the Gulf of Cadiz fishery promotes the gathering of new information about fleets whose behaviour was unknown before (*e.g*., the Punta Umbría fleet). No data are available for the Portuguese fleets.

Since 1998 the dynamics of the Gulf of Cadiz fleets has experienced some changes which deserve being mentioned. Firstly, the fishing activity of multi-purpose fleets has experienced a drastic reduction which contrasts with the increase of the fishing effort exerted by the single-purpose ones. It seems very probable that this change was initially driven by the high anchovy yields recorded in 1998, which stimulated part of the multi-purpose vessels to be exclusively dedicated to the purse-seine fishery. However, the most important factor affecting the recent purse-seine fishery in this area has been the lack of renewal of the UE-Morocco Fishery Agreement since 2000 onwards. The Barbate single-purpose fleet has traditionally alternated the anchovy fishing both in the Gulf of Cadiz fishing grounds (where this fleet is the main responsible for anchovy exploitation) and the Moroccan ones under successive Fishery Agreements. The lack of Agreement renewal led to the acceptance by almost the whole of this fleet (*i.e*., the one showing the higher relative fishing power) of subsidized stoppages throughout 2000 and 2001 (a similar situation occurred during the second half of 1995; ICES CM 1997/Assess:3). Such stoppages have therefore caused drastic reductions in fishing effort, with the consequent decrease in catches. The void left by this powerful fleet in the Gulf of Cadiz seems to have been partially filled by the remaining single-purpose fleets, as evidenced by their increased levels of fishing effort in 2000 in relation to 1999 (see Table 12.5.1).

In Sub-division IXa North, very high effort and CPUE levels were recorded in 1995 when there was a high abundance of anchovy in this area. A sharp decline in effort and CPUE was observed in 1996, suggesting low anchovy abundance. A slight recovery in effort levels and CPUE has been observed since 1997, but it is unknown if this trend still occurs in 2000 because of the absence of data for this year (Figure 12.5.3).

Table 12.5.1 ANCHOVY in Division IXa. Effort data : Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) number of fishing trips. (SP: single purpose; MP: multi purpose).

Year	SUB-DIVISION IXa SOUTH								SUB-DIVISION IXa NORTH	
	PURSE SEINE								PURSE SEINE	
	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	VIGO	RIVEIRA
	No. fishing trips								No. fishing trip	
1988	3958	17	-	210	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1989	4415	39	-	234	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1990	4622	92	-	660	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1991	3981	40	-	919	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1992	3450	116	-	583	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1993	2152	5	-	225	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1994	1625	69	-	899	*n.a.*	*n.a.*	196	28	*n.a.*	*n.a.*
1995	528	17	-	377	*n.a.*	*n.a.*	22	17	1537	252
1996	1595	89	-	1659	*n.a.*	*n.a.*	76	55	32	3
1997	2207	115	-	1738	*n.a.*	*n.a.*	75	13	31	23
1998	2153	-	2234	-	*n.a.*	*n.a.*	177	30	134	269
1999	1762	9	2167	-	660	595	330	257	51	85
2000	785	2	2196	-	1776	169	572	-	*n.a.*	*n.a.*

Table 12.5.2 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) CPUE series in commercial fisheries. (SP: single purpose; MP: multi purpose).

Year	SUB-DIVISION IXa SOUTH								SUB-DIVISION IXa NORTH	
	PURSE SEINE								PURSE SEINE	
	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	VIGO	RIVEIRA
	Kg/fishing trip								Kg/fishing trip	
1988	1047	461	-	420	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1989	1139	534	-	943	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1990	1128	287	-	643	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1991	1312	339	-	456	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1992	819	173	-	300	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1993	641	268	-	225	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
1994	1326	262	-	398	*n.a.*	*n.a.*	204	174	*n.a.*	*n.a.*
1995	377	134	-	166	*n.a.*	*n.a.*	52	25	2509	2286
1996	497	315	-	246	*n.a.*	*n.a.*	137	157	847	4
1997	1580	306	-	288	*n.a.*	*n.a.*	105	126	1068	639
1998	3144	-	221	-	*n.a.*	*n.a.*	242	197	1489	512
1999	2162	219	241	-	142	143	134	150	1088	1585
2000	1365	77	208	-	169	142	391	-	*n.a.*	*n.a.*

Fishing effort (no of effective fishing trips)

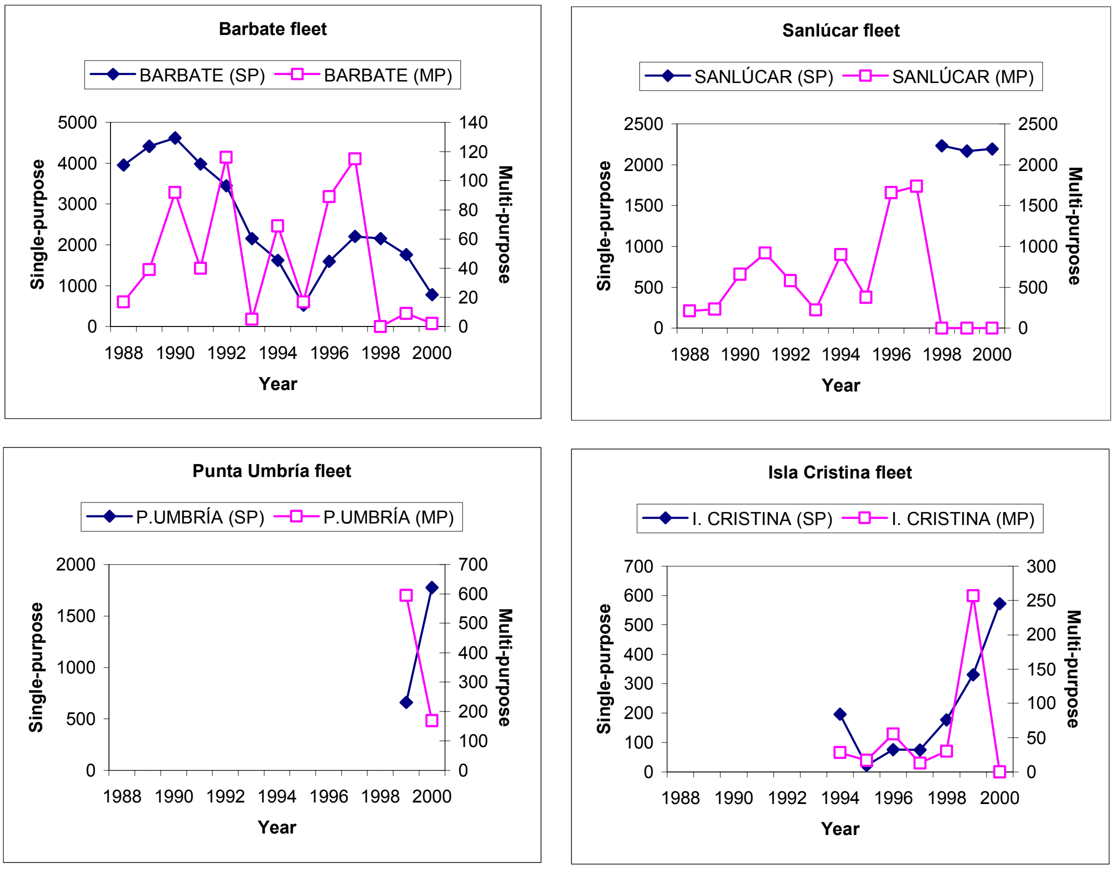


Figure 12.5.1. ANCHOVY in Division IXa. Spanish Effort series in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.

CPUE (Kg/fishing trip)

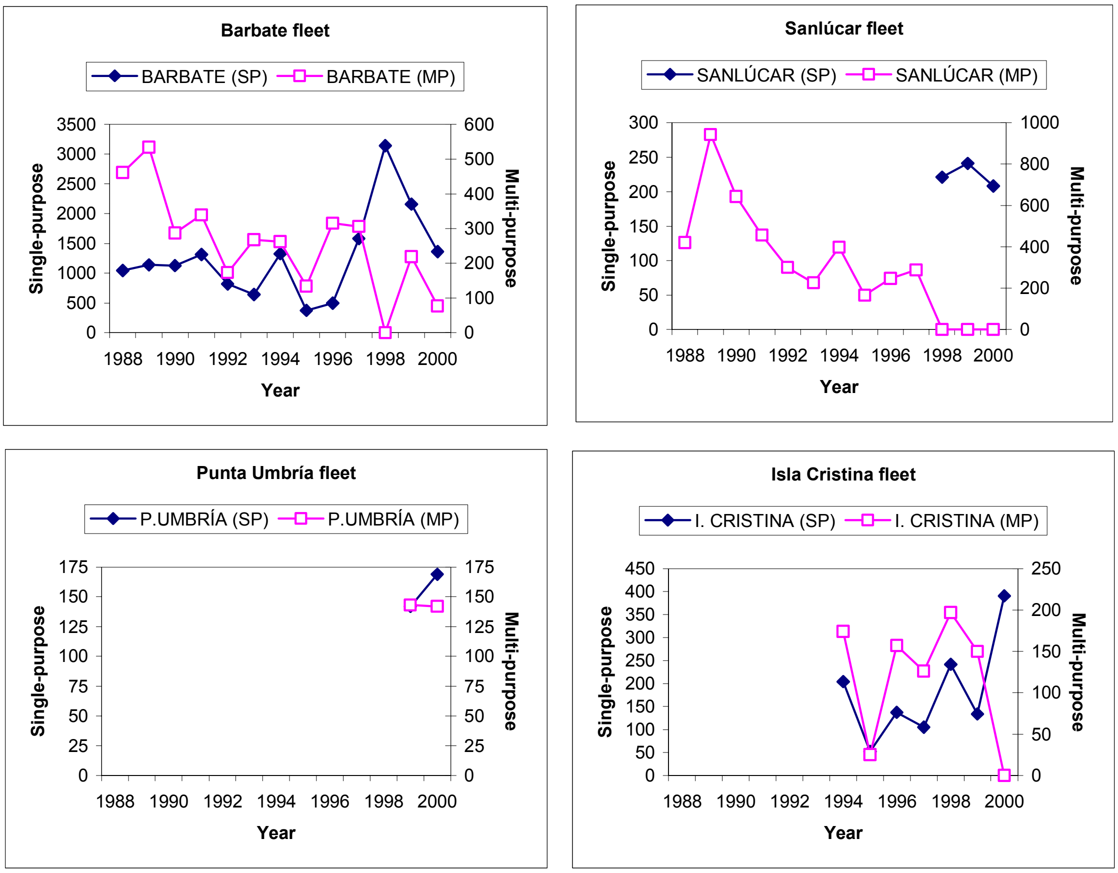
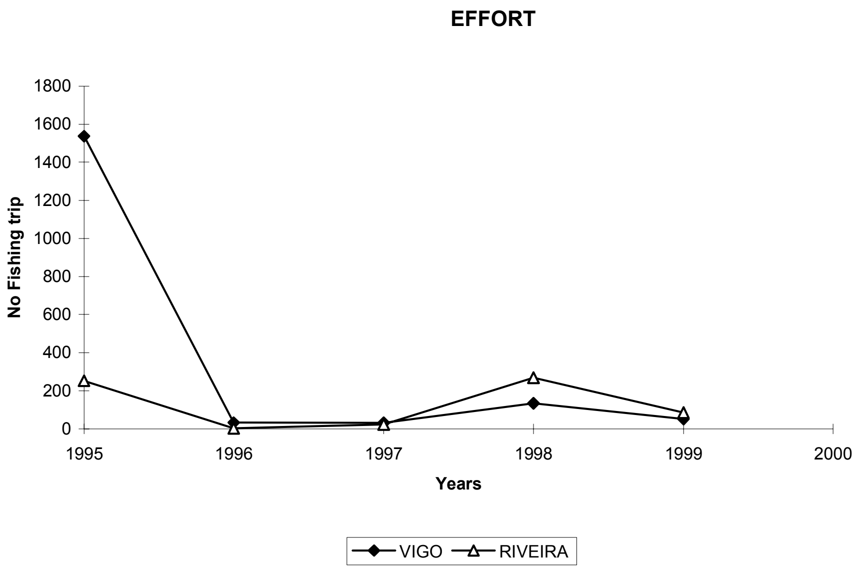


Figure 12.5.2. ANCHOVY in Division IXa. Spanish CPUE series in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.



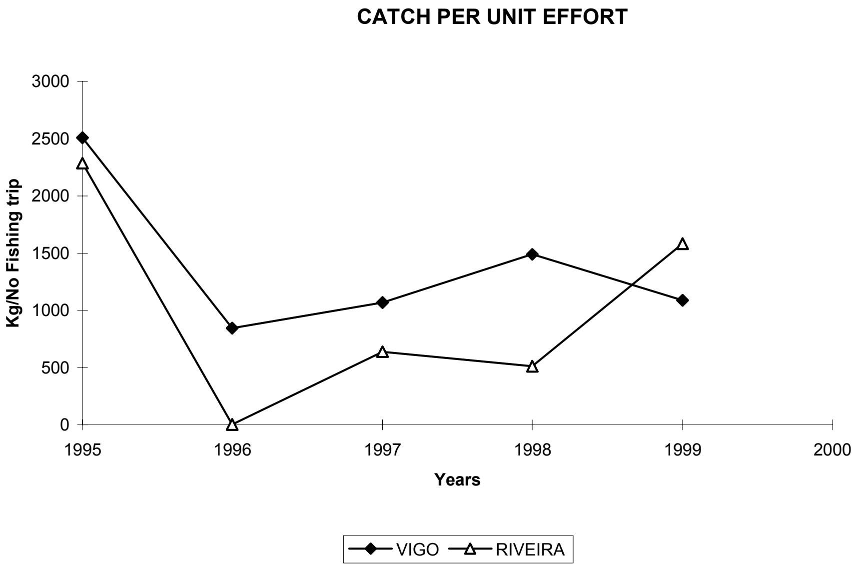


Figure 12.5.3. ANCHOVY in Division IXa. Spanish Effort and CPUE series in commercial fisheries in Western Galicia (Sub-division IXa North).

12.6 Recruitment Forecasting

Recruitment forecasts of anchovy in Division IXa are not available. By analogy with the anchovy stock in Sub-area VIII, recruitment may be driven by environmental factors and may be highly variable as a result.

12.7 State of the Stock

12.7.1 Data exploration

A preliminary analytical assessment for anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) was presented by Ramos *et al*. (WD 2001). However, results presented herein correspond to further trials performed by the Working Group including both updated information from the 2000 acoustic survey and some modifications to the separable model.

The anchovy population in the Sub-division IXa South appears to be stable and relatively independent from other anchovy populations in the Division based on the following fishery and biological evidences:

- Recent fishery statistics and acoustic surveys data indicate that the anchovy resource along the Division is almost exclusively located in the Sub-division IXa South, particularly in the Spanish Gulf of Cadiz (more than 80% of the total landings; about 90% of the total biomass).

- Correlation analyses of annual landings per Sub-division indicate that Algarve and Gulf of Cadiz share similar recent catch trajectories, which are very different from those exhibited by the remaining northernmost Sub-divisions (Table 12.7.1.1; see also Ramos *et al*., WD 2001). Furthermore, fluctuations in catches between Sub-divisions as a result of a possible northward migration from the Gulf of Cadiz anchovy were not found (Table 12.7.1.2).

- Although scarce, the available biological information on anchovy in Division IXa suggests the existence of differences in size composition and maturity (seasonal proportion of mature individuals, maturity-length ogives) between southern and northern populations, the southern ones exhibiting smaller size at age and size at maturity (ICES CM 2001/ACFM:06).

- Other anchovy populations in the Division seem to develop only when suitable environmental conditions take place, as occurred in 1995.

For lack of more consistent biological data (*e.g.* morphometrics/genetics-based studies), the points mentioned above were considered sufficient to justify a separate data exploration of anchovy in Sub-division IXa South.

For the purpose of the data exploration exercise the seasonal and annual catch-at-age data for the Algarvian anchovy were compiled by applying ALKs from the Gulf of Cadiz. This was justified by the similarities found in size composition between both the Algarvian and the Gulf of Cadiz anchovy in acoustic surveys data. The period of the analysis is 1995 to 2000, and, as with the exception of the catch at age data in the second half of 1995, the remaining data required was available. Weights at age in the catches were estimated as usual, whereas weights-at-age in the stock were calculated as the average of the weighed mean weights in the catches of the second and third quarter in each year. The maturity ogive was based on biological samples collected in the Gulf of Cadiz during the spawning season (*i.e.*, the second and third quarters).

A separable model based on the approach presented by Ramos *et al.* (WG 2001) and run on a spread-sheet was fit to catch-at-age data for the period 1995 to 2000 and to two biomass indices: an aggregated CPUE from the Barbate single-purpose purse-seine fleet, available from 1995 to date, and acoustic estimates of biomass for the years 1998 to 2000. Data were analysed by half-year-periods (Table 12.7.1.3). The catches at age were assumed to be linked by the usual catch equations; the relationship between the index series and the stock sizes was assumed linear. A constant selection pattern was assumed for the whole period. Parameters estimated were selectivity-at-age for both half-year-periods in relation to the reference age (age 1), recruitment, survey catchability (k1) and CPUE catchability (k2) and F values per half-year-period from 1996 to 2000. Parameters were estimated by minimising the sum of squares of the log-residuals from the catch-at-age, the CPUE and the acoustics biomass data. F values for 1995 were computed as an average of the Fs in subsequent years.

Catches in the year 2000 were low as only a small fraction of the Barbate purse-seine fleet operated in that year (Fig. 12.7.1.1.a). As a result, the CPUE in year 2000 as an index of resource abundance may contain additional uncertainty, therefore fitting the model to both the CPUE and the acoustic survey time-series seemed sensible. The model fits the catch at age and the CPUE data reasonably well (Fig. 12.7.1.2). The acoustic estimates of biomass, the average biomass and the biomass at the time of the acoustic survey as estimated by the model were plotted in Figure 12.7.1.3, showing that the fit to the acoustic data was poor. This is likely to be related to the facts that the two biomass indices show conflicting trends but the CPUE time-series has more information than the acoustic one so the former will be more powerful in any regression. Residuals from the model fit to the catch at age data were plotted in Figure 12.7.1.4 suggesting that they broadly conform to assumptions of normality. The likelihood profile shown in Figure 12.7.1.5 suggests that the confidence intervals around the estimate of k1 are probably wide, nevertheless as the point estimate (k1= 4.24) seemed high the Working Group discussed that particular result. Main points made were: the Portuguese surveys aim at estimating sardine biomass therefore the coverage and sampling strategies may not be suitable for anchovy. Particular reference was made to uncertainty in target strength and to the possibility that the older ages migrated outside the survey area. Nonetheless, the WG highlighted that the acoustic estimate of biomass was much higher than the one estimated by the assessment model.

According to the model, fishing mortality seemed to have been increasing until 1999 and then gone down in 2000 (Figure 12.7.1.1.b). The model is reflecting a stock with high levels of mortality, but given the catch data and the pattern of natural mortality adopted the estimated selectivity for age 2 ($S_{2,1st\ S} = 0.47$ and $S_{2,2nd\ S} = 0.25$) is substantially lower than the one for age 1 ($S_1 = 1$) . Few fish older than 2 years old appear in the catches and in the surveys, from what is known of the sizes sampled in the surveys. However it cannot be established whether that is the result of natural mortality, migration of older fish outside the sampling area or higher fishing mortality than estimated by the model.

Although the assessment presented here is considered preliminary and for the purpose of data exploration, the results suggest that the capacity in the fishery prior to 2000 may result in relatively high fishing mortality when the stock is at low levels. By analogy with the anchovy stock in Sub-area VIII, this stock may fluctuate widely due to variations in recruitment largely driven by environmental factors. Given current uncertainty in stock status, the Working Group considered it unwise to allow further increases in fishing capacity if sustainable utilisation is to be ensured.

Table 12.7.1.1 **Results of the correlation analysis of annual anchovy catches per Sub-division (see Table 12.2.1.1). (α=0.05).**

a) Correl. Coef.	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	1	0.9267	0.8928	-0.1074	-0.3996
IXa C-N		1	0.5991	-0.1342	-0.4453
IXa C-S			1	0.0528	-0.0668
IXa S (Algarve)				1	0.6318
IXa S (GCadiz)					1

b) # observat.	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	12	12	12	12	12
IXa C-N		28	28	28	13
IXa C-S			28	28	13
IXa S (Algarve)				28	13
IXa S (GCadiz)					13

c) Significance	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	1	0.0000	0.0001	0.7397	0.1981
IXa C-N		1	0.0008	0.4960	0.1273
IXa C-S			1	0.7897	0.8282
IXa S (Algarve)				1	0.0205
IXa S (GCadiz)					1

Table 12.7.1.2 **Results of the correlation analysis of annual anchovy catches per Sub-division under the assumption of a 1-year time lag between catches from one sub-division (in the year y) and those from the northernmost subdivision (in the year y+1) within each pair of values. (α=0.05).**

a) Correl. Coef.	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	1	-0.1784	-0.2406	-0.1292	-0.1177
IXa C-N		1	0.0811	-0.0788	-0.2895
IXa C-S			1	0.0705	0.1250
IXa S (Algarve)				1	0.4355
IXa S (GCadiz)					1

b) # observat.	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	1	11	11	11	12
IXa C-N		1	27	27	12
IXa C-S			1	27	12
IXa S (Algarve)				1	12
IXa S (GCadiz)					1

c) Significance	IXa N	IXa C-N	IXa C-S	IXa S (Algarve)	IXa S (GCadiz)
IXa N	1	0.5997	0.4760	0.7050	0.7157
IXa C-N		1	0.6875	0.6960	0.3615
IXa C-S			1	0.7267	0.6987
IXa S (Algarve)				1	0.1570
IXa S (GCadiz)					1

Table 12.7.1.3. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Input values for the seasonal separable assessment model.

Anchovy IXa-South (Algarve+Golfo de Cádiz)
Years: 1995-2000
Fleets: All

Half-year Catch in number (in millions) at age (1995-2000)

	1995		1996		1997		1998		1999		2000	
AGE	1sem	2sem	1sem	2sem	1sem	2sem	1sem	2sem	1sem	2sem	1sem	2sem
0	0	*n.a.*	0	495.13	0	335.67	0	465.60	0	126.26	0	129.46
1	26.51	*n.a.*	143.75	19.89	191.06	89.10	722.99	341.82	422.57	109.26	161.65	58.89
2	0.19	*n.a.*	0.90	1.21	32.46	12.41	12.03	1.51	32.29	2.65	3.51	0.55

Mean weight at age in the stock (in g), maturity ogive (average estimate) and natural mortality (semestral) estimates

AGE	Mean weight	Maturity	Natural mortality
0	3	0	0.6
1	10	0.79	0.6
2	21	1	0.6

Acoustic Biomass estimates (in tons) in Sub-division IXa South (Algarve+Gulf of Cadiz)

Nov. 1998	Mar. 1999	Nov. 2000
30695	24763	33909

Annual anchovy CPUE (kg/fishing trip) of the Barbate single-purpose purse-seine fleet

1995	1996	1997	1998	1999	2000
377	497	1580	3144	2162	1365

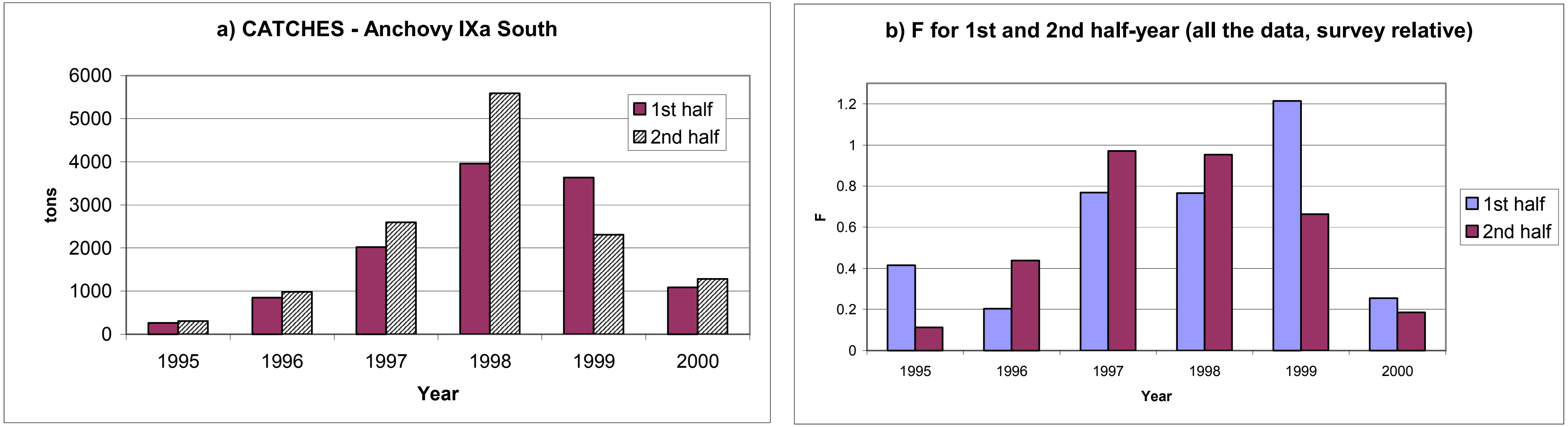


Figure 12.7.1.1. Anchovy in Sub-division IXa South :(a) catches on a half-year basis from 1995 to 2000 and estimated fishing mortality (F) by the model (b).

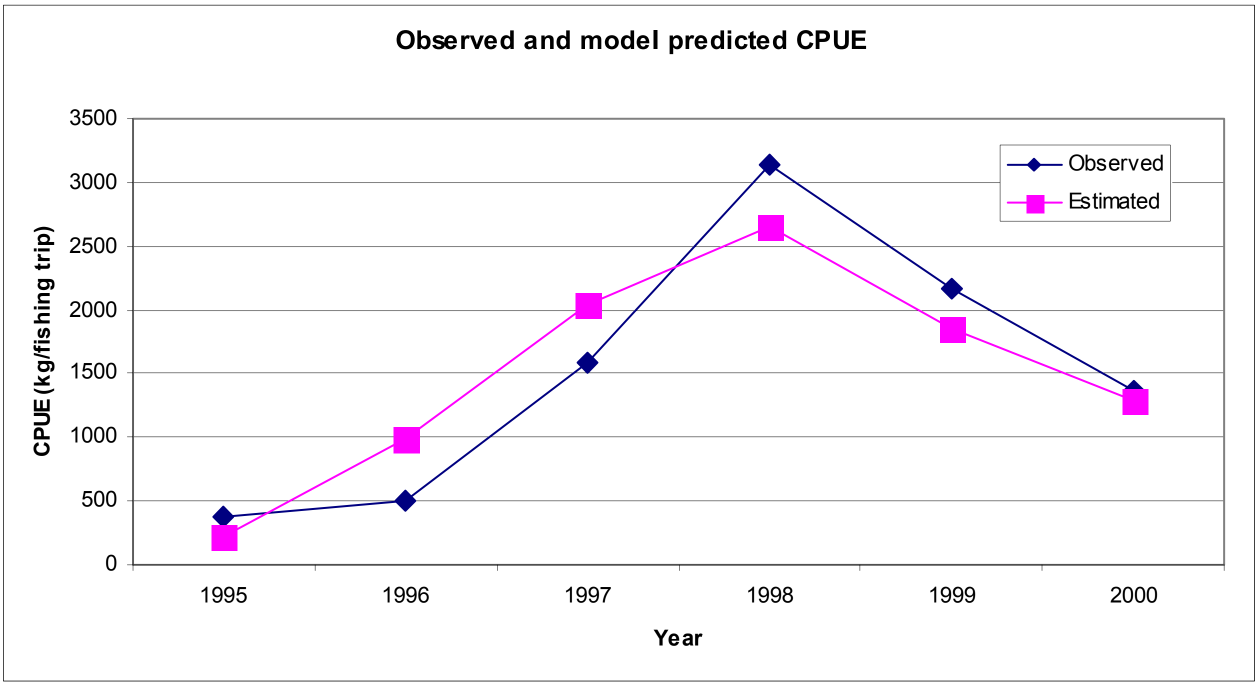


Figure 12.7.1.2. Anchovy in Sub-division IXa. Observed and model predicted CPUE for the Barbate single-purpose purse-seine fleet.

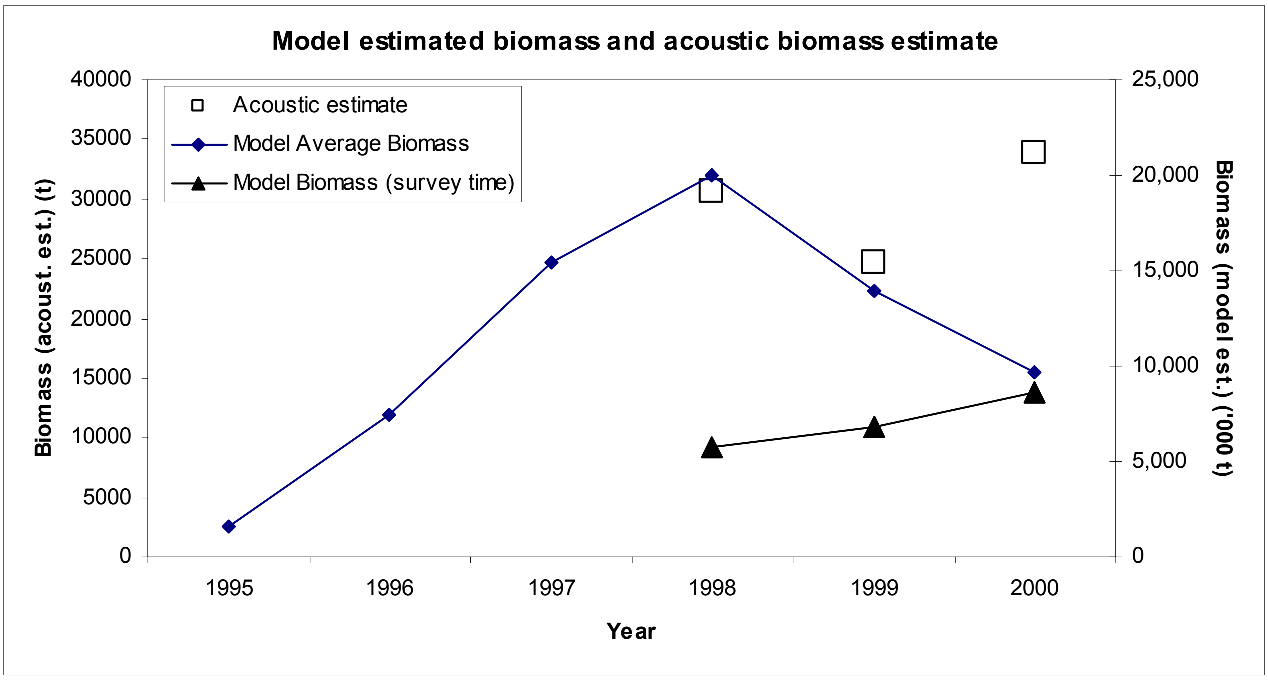


Figure 12.7.1.3. Anchovy in Sub-division IXa South. Model estimated biomass and acoustic biomass estimates.

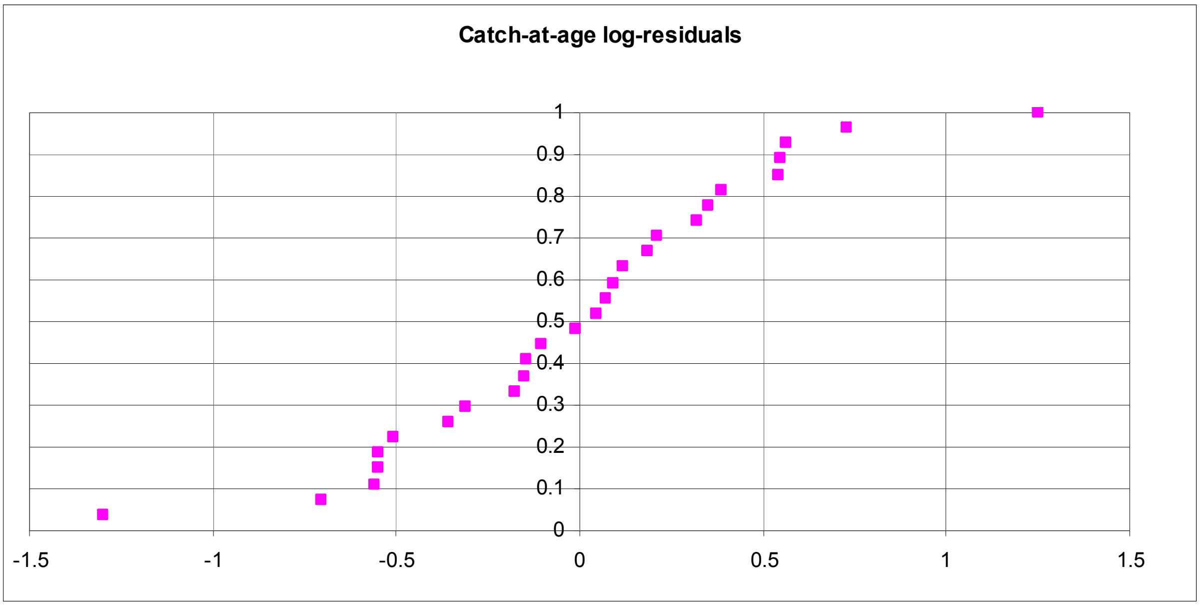


Figure 12.7.1.4. Anchovy in Sub-division IXa South. Sorted log-residuals from fit to catch-at-age data.

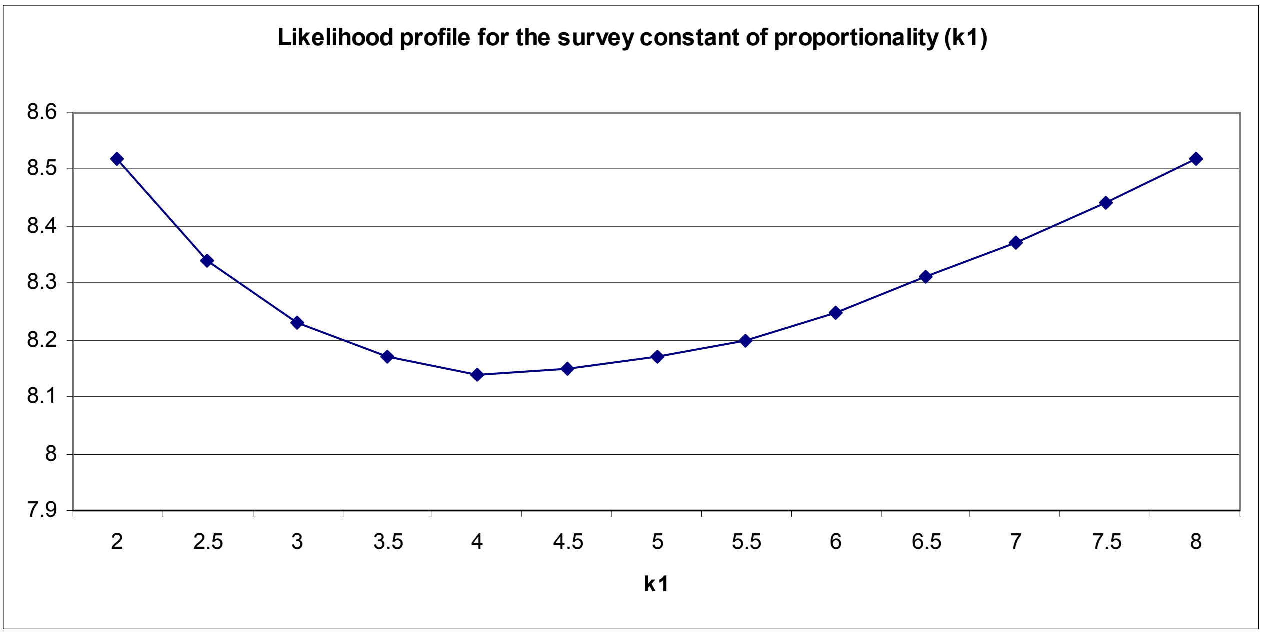


Figure 12.7.1.5. Anchovy in Sub-division IXa South. Likelihood profile for the survey constant of proportionality (k1).

12.8 Catch Predictions

No catch predictions have been estimated for this stock.

12.9 Medium-Term Predictions

No medium-term predictions have been estimated for this stock.

12.10 Long-Term Yield

No long-term yield predictions have been estimated for this stock.

12.11 Reference Points for Management Purposes

It is not possible to determine limit and precautionary reference points based on the available information.

12.12 Harvest Control Rules

Harvest control rules cannot be provided, as reference points are not determined.

12.13 Management Considerations

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

- Minimum landing size: 10 cm total length.
- Minimum vessel tonnage of 20 GRT with temporary exemption.
- Maximum engine power: 450 h.p.
- Purse-seine maximum length: 450 m.
- Purse-seine maximum depth: 80 m.
- Fishing time limited to 5 days per week, from Monday to Friday.
- Cessation of fishing activities from Saturday 00:00 h to Sunday 12:00 h.
- Fishing prohibition inside bays and estuaries.

It must be pointed out that the Spanish purse-seine fleet in the Gulf of Cadiz does not observe the normal voluntary closure of three months (December to February) since 1997 (ICES CM 1992/Assess:17, ICES CM 1993/Assess:19, ICES CM 1995/Assess: 2, ICES CM 1996/Assess: 7, ICES CM 1997/Assess: 3 and ICES CM 1998/Assess: 6).

Given the limited knowledge of the biology and dynamics of this population and to avoid an increase in effort, a precautionary TAC at the level of recent average catches (since 1988, but excluding 1995, 1998 and 2000) is recommended. This recommended catch level corresponds to about 4,900 tonnes.

13 RECOMMENDATIONS

General

The Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. Existing observer programmes should be continued.

The Working Group therefore strongly recommends that ICES takes over the responsibility for the completion and further development of the EMAS input database in a reasonable time frame. Continuity of assessment input data storage on an ICES server has to be assured until the database is fully implemented.

The WG recommends that archives folder should be given access only to designated members of the MHSA Working Group. The WG recommends that national institutes increase national efforts to gain historic data, aiming to provide an overview which data are stored where, in which format and for what time frame.

Mackerel

The Working Group recommends to revise the mean weights at age in the stock for the Southern Mackerel and to compute these data by year to be presented in the 2002 Working Group meeting.

The Working Group recommends that the sub group of the WG on verifying catch at age and catch number data for mackerel for the early period (back to 1972) in the western area meet in Dublin for two days prior to the meeting of WGMEGS in April 2002.

Horse Mackerel

The Working Group encourages the further use of the promising otoliths processing method of stained slice sections. Age readers who start to apply this new processing method should first read a reference set of otoliths of known age processed according to this new method in order to estimate their precision and accuracy (bias) in the age reading before they read large quantities of otoliths of which the ageing are used for assessment purposes. In future when more age readers apply this technique otolith exchanges will be needed.

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 if a TAC is set for the North Sea Horse Mackerel 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.

The Working Group recommends that the IBTS collect age composition samples from Horse Mackerel in third quarter in the area of the North Sea (IVbc, VIId and IIIa), to improve the fishery independent abundance indices.

The Working Group recommends that the work should be completed to examine effort data in the years prior to 1985, in order to understand the large fluctuations in the catches in previous years.

The Working Group recommends that the weights-at-age in the stock should be revised to provide weights on an annual basis.

- The Working Group recommends that new information on maturity at age from Division IXa be analysed and presented at the next meeting.
- The Working Group recommends to obtain an estimation of the 1998 egg survey for southern horse mackerel as soon as possible.
- The WG recommends that a revision of the way survey indices are calculated should be done in time for the next WG meeting in 2002.

Sardine

Anchovy

The Working Group recommends to extend backwards the catch-at-age data series for the Gulf of Cadiz anchovy (Sub-division IXa South, Spain) as far as possible, and to recover all the information available on the anchovy fishery and biology (including information on age structure by Sub-division if available) off Portuguese waters.

The Working Group recommends to continue with the recovery and provision of all the information available (past and present) on anchovy from the Portuguese acoustic surveys carried out in Division IXa. Regarding these surveys, more details on the sampling strategy (including sampling coverage, identification of fishing stations, etc) should be available to this Working Group.

The Working Group recommends to the ICES PGPAS (Planning Group for Pelagic Acoustic Surveys in ICES Sub-Areas VIII and IX) to investigate and update available experiences on anchovy target strength (TS) measurements in order to obtain more accurate abundances estimates.

The WG recommends that the studies about the relationship between the oceanographic environment and the Bay of Biscay anchovy recruitment should be continued and enhanced in the next years in order to help to provide of scientific advice.

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15 ABSTRACTS OF WORKING DOCUMENTS

Carrera P.
Acoustic Abundance Estimates From The Multidisciplinary Survey Pelacus 0401
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The survey PELACUS 0401 was the main activity at the IEO within the frame of the PELASSES project. The main goal for this project is to try to combine different direct assessment methods, comprising acoustic, ichthyoplankton and sampling techniques, in a single research vessel in order to achieve an improvement of the abundance estimates, as well as a general knowledge of the ecosystem provided from extensive sampling techniques.

The surveys will give an improved estimation of the abundance of all pelagic fish present in north-east Atlantic waters in spring during the spawning period, but focussing on sardine and anchovy. Complementary to this main objective, the survey design and strategies will allow the environment be characterised by recording different variables in vertical and horizontal profiles along the surveyed area with no noticeable extra effort. These variables will help improve the acoustic estimations, whilst an extensive environment characterisation at the spawning time will be done.

In summary, this study will provide the following outcomes:

1. A synoptic coverage from the Gulf of Cadiz to the Celtic Sea to assess by the echo-integration method the abundance of sardine and anchovy and the other pelagic fish species.

2. Distribution of the main pelagic fish species at the spawning time and biological information.

3. Egg distribution at 5 meters depth and, once CUFES is calibrated, egg production of the main pelagic fish species.

4. The feasibility of using a single research vessel to obtain abundance and biomass estimates by acoustic echo-integration and daily egg production methods.

5. Maps of climatic hydrographic and planktonic parameters that potentially influence the spatial distribution of the pelagic fish species.

This WD provides the main results found around the Spanish area.

Chernook, V., Zabavnikov, V., Shevchenko, V., Shamray, E., Bjelland, B., Slotte, A., Godø, O. R. and Iversen, S. A.
Preliminary results of Russian-Norwegian investigations on mackerel in July 2001.
Document available from: Evgeny Shamray, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia.
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In July-August 2001 PINRO continued annual complex airborne research of feeding mackerel in the Norwegian Sea with purpose of study distribution and migration. During July 14-20 IMR hired the Norwegian fishing vessel for special joint research with aircraft-laboratory, with emphasis on calibration and validation of aircraft remote observations.

Based on the experience from this joint research, Norwegian and Russian scientist discussed how such cooperation can be used for future studies of mackerel distribution and migration, and how similar methodology can be used for improving our understanding of distribution and migration of other pelagic fishes.

As showed by preliminary results of joint PINRO aircraft-laboratory and research IMR vessel, there is a high agreement in the environmental data collected during the coverage of the same area.

Preliminary results of collaboration studies are presented in this paper.

Chernook, V., Zabavnikov, V., Shamray, E., Sveinbjörsson, S. and Thordarson, G.
Preliminary results joint Russian-Icelandic fisheries investigations, July 2001.
Document available from: Evgeny Shamray, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia.
E-mail: inter@pinro.murmansk.ru

In July-August 2001 PINRO continued annual complex airborne research of feeding mackerel in the Norwegian Sea with the aim of monitoring its distribution. During late July 2001 Icelandic research vessel Árni Friðriksson RE 200 carried out annual blue whiting survey in the southern and eastern parts of Icelandic EEZ. According to ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy these parties cooperated during the different surveys.

During flights, the aircraft-laboratory carried out research in some areas, which were investigated by research vessel. Comparison between data shows very high similarity. In the area where long time passed, new data show changes in the spatial structure of sea surface temperature. Assumptions about recent changes in fish behavior were confirmed later by the research vessel and by the displacement of blue whiting fisheries.

Preliminary results from this collaboration are presented in this paper.

Cunningham C., McAllister M. and Kirkwood G.
The Development of a Bayesian Model for the North East Atlantic Mackerel Population.
Document available from: Carryn Cunningham, Renewable Resources Assessment Group., Department of Environmental Science and Technology., Imperial College of Science, Technology and Medicine., Prince Consort Road, London, SW7 2BP, Great Britain.
E-mail: c.l.cunningham@ic.ac.uk

In this working document, we discuss a number of alternative Bayesian operating models for the North East Atlantic mackerel population, a highly migratory fish population consisting of more than one distinct stock, which explicitly include migration of the stocks between different areas in the North East Atlantic during the four quarters of the year. We present some preliminary deterministic results from the base case model. Results from these models will be used in Bayesian decision analysis to determine which, of a number of alternative management options, will be the most effective for this stock, given a pre-selected set of management goals.

Eltink A.
Improvements in the quality of the basic horse mackerel age data during the last 20 years
Document available from: Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands.
E-mail: guus@rivo.dlo.nl

This paper describes the improvements in the quality of the basic horse mackerel age data within the ICES area over the last 20 years and presents new results on a comparison of otolith-processing techniques of both the broken/burnt and the stained sliced otoliths of known age. The results from experienced age readers demonstrate that the processing technique of the stained sliced transverse sectioned otoliths can considerably reduce the bias in age reading and at the same time improve precision. However, some readers still need help to adapt to age reading otoliths from this new processing technique. Reading stained sliced otoliths is again a major step forward in the process of getting good quality basic horse mackerel age data. In future other staining techniques should be investigated to improve age reading results even more.

Fleck M. and Panten K.
By-catch of mackerel and horse mackerel in different German fisheries
Document available from: Kay Panten. Bundesforschungsanstalt für Fischerei, Institut für Seefischerei, Palmaille 9, D-22767 Hamburg, Germany.
E-mail: panten.ish@bfa-fisch.de

Eight German commercial fisheries were examined for mackerel and horse mackerel by-catch between April 1998 and September 2000. Groundfish fisheries in the North Sea and pelagic fisheries in the North Sea and waters west of the U.K. were examined. Within the time period 291 hauls containing mackerel and 156 hauls containing horse mackerel were sampled. By-catches of mackerel and horse mackerel in the groundfish fisheries were negligible and were usually discarded. In the herring fishery by-catch of horse mackerel was low and was discarded; for mackerel by-catch was high and usually discarded. In the mackerel fishery horse mackerel was regularly caught, catches were both retained and discarded. In the horse mackerel fishery mackerel was a regular by-catch, and like horse mackerel was both retained and discarded. Retention generally occurred if the mackerel was caught towards the end of a fishing trip. In the pelagic fisheries sampled the discard resulted from small amounts of non-target species per haul, which are too small to process in economic terms, but nonetheless sum to large discard values.

Holst J. C., Bjelland O. and Slotte A.
Distribution of mackerel in the Norwegian Sea 2001. A brief assessment of distribution based on trawl catches by Norwegian research vessels, summer 2001.
Document available from: Jens Christian Holst, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway.
E-mail: jens.holst@imr.no

Four pelagic trawl surveys were carried out between mid-June and mid-August 2001. Abundant catches were taken during each survey. In early June the northern limit to the mackerel distribution was observed around 67°N. This distribution is to be expected as mackerel migrate to the Norwegian Sea in June after spawning further south. By late July the centre of distribution had moved further to the north and east, and by August mackerel were caught slightly north of 71°N, and distributed between 20°W and 5°E. Catch rates were higher in the Norwegian zone, where it appears higher concentrations of mackerel are present, than in the International Zone, where a summer fishery for mackerel is prosecuted.

Iversen S. A., Skogen M. and Svendsen E.
A prediction of the Norwegian catch level of horse mackerel in 2001
Document available from: Svein A. Iversen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway.
E-mail: svein.iversen@imr.no

The Norwegian fishery for horse mackerel in the Norwegian Zone is considered to reflect the abundance and availability of that species during the autumn. It is shown that there is good correlation between the modelled winter influx of Atlantic water to the North Sea and the catch levels of horse mackerel in the Norwegian purse seine fishery the following autumn. The modelled flow of Atlantic water in early 2001 is 1.77 Sverdrup, the lowest inflow since 1955. Catches in 2001 are thus predicted to be rather low, due to the low inflow and the lower than predicted catches in 2000.

Kell, L., Roel B. A., Abaunza, P. And Murta, A.
Evaluation of Harvest Control Rules for Southern Horse Mackerel (*Trachurus trachurus*)
Document available from: Beatriz Roel, CEFAS, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, U.K.
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The performance of MSY harvest rules is investigated using a computer simulation framework. The framework includes the monitoring, assessment, prediction and implementation of a management control rule. The Southern horse mackerel stock is used as an example and some preliminary results are presented to illustrate the utility of the approach.

Marques, V and Morais, A.
Abundance Estimation and Distribution of Sardine (*Sardina pilchardus*) and Anchovy (*Engraulis encrasicholus)* in Portuguese Continental Waters and the Gulf of Cadiz
Document available from: Vítor Marques, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal.
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This paper presents the main results of the Portuguese acoustic surveys carried out during November 2000 and March 2001 with R. V. “Noruega”. These surveys covered the Portuguese continental shelf and the Gulf of Cadiz. The working document provides abundance estimates of sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicholus*) by length classes and its distribution in the surveyed area. The total abundance estimated for sardine was 710 thousand tonnes (36 x 10^9 individuals) for the November 2000 survey and 496 thousand tonnes (20.7 x 10^9 individuals) for the March 2001 survey. The sardine abundance estimated in the November 2000 survey was the highest of all the survey series, due mainly to an increase of the juveniles in the Occidental North area. Anchovy total estimated abundance was 34 thousand tonnes (5.0 x 10^6 individuals) in November 2000 and 25 thousand tonnes (2.7 x 10^6 individuals) in March 2001. The Portuguese anchovy landings are also presented.

Massé, J.

Report of the acoustic survey PEL2001.

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An acoustic survey PEL2001 was carried out from the 27th of April to the 6th of June 2001 on the French research vessel 'Thalassa'. The aim of this survey was to study the ecology and abundance of small pelagic species, particularly sardine and anchovy populations. A total of 4000 nautical miles were prospected mainly in the Bay of Biscay and fish sampling used pelagic and bottom trawls.

Anchovy: This population was more widely distributed than usual from the Spanish Coast (Basque country) up to 47°30'N. As is usual during the spawning season, the main biomass was found in the southern coastal area, and total biomass was estimated at 132,800 tonnes. This is the highest biomass of the historical acoustic estimation series. The length distribution indicates that the anchovy population is mainly composed of 1 year old fish.

A revision of the PEL2000 estimate was also made after checking the data and the software used in that survey. The new estimate of 98,484 tonnes is twice that of the estimate given to the Working Group in 2000 of 47,700 tonnes.

Sardine: Sardine present on the whole platform in 2000 was mainly concentrated in shallow water over the whole area and was found offshore only in the northern area of the Bay of Biscay. The exceptional hydrological conditions encountered in 2001 may explain these observations as unusual desalinated water was observed up to more than 50 nautical miles offshore. The biomass in 2001 is estimated at a level of 205,000 tonnes.

Moreno-Ventas X., Lavín A., Abaunza P. and Cabanas J. M.

The influence of environmental conditions on horse mackerel recruitment in the Atlantic Iberian Waters and a proposed regression model for recruitment estimates.

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Time series (1967-1997) of some environmental variables, such as air and sea surface temperature, precipitation, wind, Ekman transport and mean sea level, as well as time series (1985-1997) of recruitment of horse mackerel, were studied in Atlantic Iberian waters. Results indicate a statistically significant relationship between NAO and air temperature in Santander (Cantabrian Sea) and in Vigo (Galician waters, NW Spain). Environmental variables in Vigo, such as air temperature, SST and turbulence are significantly correlated with the annual Gulf Stream position. Principal Component Analysis of the abiotic parameters shows the first component to be positively related to temperature and negatively to intensity of spring/summer upwelling and explains 36.8% of variability observed. The second component is related to the oceanic index and turbulence, explaining 18%, and the third is related to Ekman transport explaining 9%. Horse mackerel recruitment is negatively correlated with air temperature in the Cantabrian Sea and SST and air temperature in Western Iberia. Recruitment is also negatively correlated with the yearly Ekman transport.

A multivariate regression model of 4 variables (air temperature in Vigo and Santander, Ekman transport during the upwelling period and offshore Ekman transport in autumn) has been applied explaining 91% of the variance observed in the recruitment time series.

Petitgas P., Allain G. and Lazure P.

A recruitment index for anchovy in 2002 in Biscay

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The IFREMER recruitment index is based on a multi-linear regression of the anchovy abundance on environmental indices. The anchovy abundance considered is the abundance at age 1 on January 1 of year y, as estimated by the ICES WG with the procedure ICA. The environmental indices are extracted from the hydrodynamic model of IFREMER for the French part of the continental shelf of Biscay. The period considered for constructing the environmental indices is March 1 to July 31 of year y-1. The regression model was adjusted using the values given in the 1998 and 2001 reports of the ICES WG. For predicting anchovy abundance at age 1 for 2001 and 2002, environmental indices have been extracted from the hydrodynamic model and the regression model used in extrapolation mode.

Porteiro, C., Carrera, P., Cabanas, J.M. and Bernal, M.
The effect of environmental changes in the Galician sardine fishery (1990-1999).
Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain.
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The highest catches of the Iberian sardine stock are taken from the southern part of Galician waters (NW corner of the Iberian Peninsula) and northern Portugal. Landings are mainly composed of younger fish, which reflects the proximity of the main recruitment area of this fish species to the fishery grounds. On the other hand, although landings in this area show a high variability, recent catches from southern Galicia have shown the lowest values reported over the last decades. Given the dependence of the fishery in this area on the strength of the recruitment, and the influence of abiotic events in the variability in this recruitment process, this paper analyses the relationship between recruitment (and hence the fishery) and large- and meso-scale oceanographic events. Three large-scale events (NAO-Spring, NAO-winter and Gulf Stream Current) and two meso-scale events relevant to the studied area (upwelling index during spring and a poleward current), together with the effect of the estimated Spawning Stock Biomass were studied. Younger sardine (termed *xoub*a) landings from southern Galicia represent a significant part of the total and their fluctuations are highly correlated with the estimated recruitment. In addition, recruitment processes seem to be driven, among other factors, by both meso-scale or local oceanographic events and large-scale events. This dependence on both phenomena explains the relative coincidence in stock size fluctuations or recruitment processes found in similar fish species around the world, which also show local anomalies from these general trends. The model was constructed using NAO-winter and spring indices, the upwelling index and the SSB and explains 54% of the total variability. It should also be mentioned that this stock has shown important changes in its area of distribution. Therefore, predictions based on this model should be noted with caution. Until further studies, in order to know the influence of these changes in stock distribution on the success of the recruitment, can be done the predictive model should be regarded as qualitative rather than quantitative. Given the values obtained for 2000 in the input variables of the model, the estimated recruitment suggests there is a high probability of a good recruitment (higher than the mean) for 2000.

Ramos F., Uriarte A., Millán M. and Villamor B.
Trial analytical assessment for anchovy (*Engraulis encrasicolus*, L.) in ICES Subdivision IXa-South.
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Assessment of the anchovy stock in Division IXa has not been possible to date since the only data available are the 1991-2000 series of catches at age of the Gulf of Cadiz anchovy (Sub-division IXa South, with gaps in 1994 and second half in 1996), and three punctuated biomass estimates from acoustic surveys in 1993, 1998 and 1999. Furthermore, the scarce biological data seem to suggest that populations inhabiting Division IXa South may have different biological characteristics and dynamics. Given the data availability, from biological and fishery-based studies (e.g., the recent distribution pattern of catches and biomass), an exploratory data analysis of anchovy in Sub-division IXa South was attempted (years 1995-2000). A first trial ICA analysis with annual data (1996-2000) was attempted but it proved unfeasible because of the catch-at-age data structure (only the 0,1 and 2 age classes are present in the fishery) and the shortness of the tuning index series. As an alternative, an analysis using half-year catches at age (years 1995-2000) was performed although under some assumptions on catch-at-age data and tuning indices. From this first exploratory analysis a preliminary figure on the recent fishing pattern of anchovy in this area may be obtained.

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Preliminary Results of the 2001 Mackerel and Horse Mackerel Egg Survey
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The following represents a preliminary investigation into the results of the 2001 egg survey. It is intended as a guide for the WGMHSA and does not represent a complete or definitive analysis of the survey.

Shamray E., Chernook V. and Zabavnikov V.
Preliminary Results From Russian Investigations On Mackerel In The Norwegian Sea In July 2001
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The annual complex aerial survey was carried out by PINRO flying-laboratory AN-26 “Arctica “ in the Norwegian Sea in July 2001. To obtain additional information the research PINRO vessels also participated. The basic aim of the investigation was to study distribution and migrations and to assess the biomass of mackerel in the Norwegian Sea.

Data on the thermal and hydrodynamic states of the sea surface were simultaneously collected and sites of high primary biological productivity defined. Marine mammals and sea birds were also assessed. This survey covered the Norwegian Sea from 62° to 72° N and between 10° W and 15° E.

This year, the Lidar system was additional onboard the flying-laboratory.

The surface temperature registered over the major area investigated was lower than the long-term mean, except in the extreme western and southwestern sites where the sea surface temperature anomalies had positive values and were of advective origin.

Compared to the previous years, the oceanographic and meteorological conditions observed during the year conditioned a shifting of major feeding migrations of mackerel to the east, their extension in time and a deeper depth distribution.

The circumstances mentioned above did not allow us to obtain an accurate estimate for the biomass of mackerel in the Norwegian Sea at the present time. Nevertheless, in the northern part of the investigations the biomass of mackerel for this area was calculated already.

Silva A., Magoulas A., Cinus S., Zampicinini G., Garção M. and Morais D.
Preliminary results on sardine morphometric and genetic variability in the Northeast Atlantic and Southwestern Mediterranean
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Samples of sardine for morphometric and genetic studies were collected during the 1999/2000 spawning season covering the area from the Celtic Sea to the Gulf of Cadiz, the Spanish Mediterranean, the coast of Morocco and the Azores (S.Miguel island). Some preliminary results from the analysis of four samples collected in distant locations: Gulf of Biscay, North Portugal, Alboran Sea (southwestern Mediterranean) and Azores are presented.

A discriminant analysis using morphometric variables shows that samples from the Mediterranean and the Portuguese north coast appear close together, clearly separated from the Azores sample. The sample from France shows considerable overlap with the previous groups on the first discriminant axis (which accounts for 68% of between group variance) but separates along the direction of the second discriminant axis (which explains 26% of the separation).

The analysis of three microsatellite DNA loci showed a high degree of polymorphism and most of the genotype frequencies in agreement with expectations under Hardy-Weinberg equilibrium (the most significant deviation was found in the sample from the Mediterranean Sea for one of the loci). A high degree of heterogeneity between samples was observed, with only a single pair of samples showing no significant differences, those from Azores and the Mediterranean Sea. Strong genetic differentiation among sardine is a new finding and shows stronger evidence for separation of stocks than the morphometric analyses. However, the development of morphometric characters is strongly influenced by the environment, whereas genetic markers, such as microsatellite DNA, are not. We suggest that this preliminary study suggests a greater degree of genetic separation than previously assumed for sardine and that these results should be substantiated by increasing the sample size and/or using more loci.

Silva A. and Soares E.
Sardine otolith exchange
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This document presents the results of an exchange of sardine otoliths, carried out within the framework of EU Project PELASSES to evaluate age reading agreement between project participants on samples collected during the March 2000 surveys. We observe an improvement on the agreement among readers since the 1997 otolith exchange (mainly for the most divergent readers); but there are still differences in age determinations in 28-46% of the otoliths (mainly one year old differences). Bias is not a serious problem for age groups 1 to 4, however some readers tend to underestimate the older ages while other readers show the opposite trend. Otoliths from the southern area (Division IXaS) present more problems of readability and precision than otoliths from Division VIIIc and otoliths from area VII (new for most readers) didn't raise special problems. Between reader differences are generally low for the Spanish survey otoliths, however the systematic differences between Portuguese and Spanish readers for the Portuguese survey otoliths suggest that otoliths from the southern area would be given lower ages if read by Spanish readers.

Skagen D. W. and Iversen S. A.
Acoustic registrations of mackerel in the North Sea in October – November 2000
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An acoustic survey for mackerel, using EK500 echosounders, was carried out in the northern North Sea from 15 October-5 November 2000. Echosounders operated simultaneously at 18, 38, 120 and 200 kHz, allowing a 'frequency response profile' to be displayed for any aggregation. Schools assumed to be mackerel showed a characteristic pattern, and were seen at 40 – 60 m depth, in dense schools just above the thermocline. Validation of these marks, by trawling, was only partially successful. An apparently low biomass estimate of 600,000 t is presented for the surveyed area, to which a high degree of uncertainty is attached. A similar survey is planned for 2001, in cooperation with a purse-seine vessel to allow for validation of samples and to get more target strength information.

Stratoudakis Y., Morais A., Silva A., Marques V. and Afonso-Dias C.
Sardine distribution, abundance and population structure off Portugal: acoustic surveys in 1984-2000
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We use data from 26 acoustic surveys to explore changes in sardine distribution area, abundance and population structure off Portugal during the past two decades. Graphical analysis is used to identify temporal trends and decadal and seasonal differences in acoustic estimates, while biological data from fish samples collected in the same surveys are simultaneously analysed for the first time. Sardine distribution area off Portugal is ~25% smaller in the 90s, when seasonal differences become less perceptible and a declining trend with time becomes evident. The reduction is almost exclusively due to a large reduction in the northern region (-41%) and these results are corroborated by similar trends in the mean depth of fishing hauls with sardine over time. Sardine abundance (in numbers) shows no clear trends over time, but is marked by the exceptional recruitment of 2000 in northern Portugal and by the dominance of younger fish in recent years (mean abundance of fish > 16 cm in northern Portugal is reduced by 50% in the 90s). During the 90s, there are also indications of changes in the maturation cycle of sardine (earlier maturation in the north) and of changes in the distribution and abundance of bogue and chub mackerel (increases in the south).

Uriarte A., Alvarez P., Iversen S. A., Molloy J., Villamor B., Martíns M.M. and Myklevoll S.
Spatial Pattern Of Migration And Recruitment Of North East Atlantic Mackerel
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An International tagging program on both adult and young mackerel was implemented in 1997 (and partly in 1998) from Portugal to the Shetland isles within the frame of European Study Project 96-035, with 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 (i.e., from the Northwest of Ireland and West of the Iberian Peninsula). Both external and internal tags were used in all the surveys in different proportions. 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.

We report here for the recaptures obtained up to March 2001: Adult recoveries show that almost all adult mackerel (regardless of the discrete areas of tagging, southern or western areas) 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 Faeroes, 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 (mainly division IVa). At the end of the year and during wintertime those mackerel migrate southward towards the spawning grounds through the west of the British islands. These observations on migration behaviour of adults are consistent with the results obtained from previous tagging experiments. A strong presence of southern adult mackerel during spring in the western spawning grounds has been observed which cast doubts on the reliability of the assumption of separate spawning components in these areas.

Recaptures of tagged juveniles (both from the west of the Iberian Peninsula and from the north-west of Ireland) suggest that in general, juveniles remain closer to the areas where they were tagged. Once they become adults, tag recoveries show the recruitment to the general migration pattern of adults.

Uriarte A. and Divina L.

Biomasses of Precaution for the Bay of Biscay anchovy population under the fishing pressure of the nineties.

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The question about the definition of the precautionary biomass of (Bpa) for anchovy has been discussed for several years in the MHSA ICES WG, particularly since the 1999 warning advice given by ICES to managers.

This document makes an exploratory analysis in search of a threshold limit of biomass in year Y to trigger a two phase management plan for the next year Y+1 (starting with a provisional TAC for the first half of the year) under certain conditions. In order to ascertain that problem, this WD calculates the risk of falling below Blim in year Y+1 for a set of population and forecasting scenarios in year Y under the current policy of setting annual TACs of about 33000 t. This approach differs from the previous setting of Bpa in its probabilistic approach. It also differs from and has similarities with other STECF works (STECF 2000) in several issues that are discussed in the manuscript.

Uriarte A., Santos M., Motos L. and Petitgas P.

Preliminary estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2001.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain.
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The assessment and scientific advice on the Bay of Biscay anchovy, entirely depends upon the availability of population direct estimates. Combined acoustic and egg surveys for sampling egg abundance and adult fecundity parameters were carried out in 2001 by the Instituto Tecnológico Pesquero y Alimentario (AZTI Fundation, Pasajes) and the Institute Français de Recherche pour l'Exploration de la Mer (IFREMER, Nantes) to assess the anchovy population biomass. The surveys were part of a European project (European Commission contract nº 00/13) entitled "POPULATION ESTIMATES OF THE BAY OF BISCAY ANCHOVY BY THE DAILY EGG PRODUCTION METHOD in 2001"

Within this international project the current survey contributes to its main objective, which is to provide biomass and population estimates of the anchovy in the Bay of Biscay on a yearly basis for its submission to the ICES working group on the assessment of this species.

This document describes the preliminary estimate of the SSB (Spawning Stock Biomass) based on its relationship with the spawning area (SA) and Daily egg production per surface unit (Po) (according to the results of the EU project 96/034, ANNEX 5).