Advisory Committee on Fisheries Management **ICES CM 2001/ACFM:06**

REPORT OF THE

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

ICES, Headquarters
14–23 September 2000

PART 1 OF 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Terms of Reference

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy met at ICES headquarters from 14–23 September 2000 to address the following terms of reference, as decided at the 87th Statutory Meeting:

a) assess the status of and provide catch options for 2001 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 2001 for the sardine stock in Divisions VIIIc and IXa and separately for Divisions VIIIc and IXa;

c) assess the status of and provide catch options for 2001 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 climatic effects;

f) identify major deficiencies in the assessments.

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 appears to be adequate for mackerel (approximately 86% coverage of catch), sardine and anchovy. Although total numbers aged have decreased for horsemackerel, there has been an increase in numbers aged for the Western stock component which has been poorly sampled in the past. A short summary of the data, similar to that presented in recent Working Group is shown for each stock species. The overall sampling intensity is similar in recent years. Intensive sampling programmes continue to be carried out by Spain and Portugal. Sampling programmes in Spain, Portugal, Ireland, England, France continue to be supported by EU funded programmes.

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

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

In 1999 86% of the total catch was covered by the sampling programmes. The overall sampling level appears to be very consistent in recent years and at a satisfactory level. Spain and Portugal continue to carry out extremely intensive programme on their catches and Germany have restarted a sampling programme 1999 which had not been carried out for the previous 2 years. Ireland Spain and Norway reduced their programmes slightly while Scotland increased the numbers of fish measured and aged. Denmark only carries out sampling on their catches from IVa in the second and third quarters. Less than half of the UK total catch is sampled and there are no samples from the UK catches in VIIh and VIIj. In addition there are still a number of mackerel catching countries which did not carry out any sampling programmes, e.g. France, Faroes, Estonia and Sweden (these countries account for over 36,000t of unsampled catches).

The are fewer areas than in previous years which do not appear to be adequately sampled:

- Division IIIa in which 5,422 t are taken but where no sampling is carried out;
- Division IVc where 3,992 t are taken but inadequately sampled;
- Division VIIIa where 2,554 t are taken but inadequately sampled.

See Figure 1.3.6.1 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	Catch covered by samplingprogramme	Samples	Measured	Aged
Spain	45,914*	45,914	321	21,506	2,393
Belgium	177	0	0	0	0
Iceland	357	0	0	0	0
Portugal	2,002	2,002	344	33,204	1,574
Estonia	3,595	0	0	0	0
Sweden	5,233	0	0	0	0
Faroe Islands	11,620	0	0	0	0
France	16,367	0	0	0	0
UK (rest)	19,401	8,697	33	4,031	1,218
Germany	19,948	11,315	43	17,987	1,104
The Netherlands	28,070	40,798	96	7,924	2,222
Denmark	30,011	21,899	4	245	243
Russia	51,348	51,348	5	5,683	500
Ireland	59,575	53,467	40	6,992	2,570
Scotland	139,933	133,400	91	10,168	3,965
Norway	160,738	157,815	132	14,421	1,643
Total	548,375	526,656	1,109	116,978	17,432

∗ Unofficial catch

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	2,526	181,769	5,454

The overall sampling levels on horsemackerel appears to have remained at about the same intensity in recent years. However, although the overall number of fish aged in 1999 was less then that of 1998 and 1997 the number of horsemackerel aged in the northern fisheries has increased and there has been a decrease in the numbers aged in the southern fisheries. The large numbers of samples and measured fish are mainly due to intensive length measurement programs in the southern areas. In 1999, 74% of the numbered measured were from Division IXa.

Countries that carried out comprehensive sampling programmes in 1999 were Netherlands, Portugal, Spain, while England and Wales, Ireland, Germany, and Norway all increased their sampling intensity. France, Denmark and Scotland 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 1999.**

Horse mackerel sampling

Country	Catches	Catch covered by sampling programme (tons)	Catch covered by sampling programme (%)	Samples	Measured	Aged
Netherlands	83,450	83,450	100	108	13,914	2,675
Ireland	57,983	31,736	55	31	5,927	833
Spain∗	39,833	39,773	100	671	4,7861	864
Germany	23,549	6,615	28	75	24,390	754
Denmark	26,040	0	0	0	15	22
France	25,141	0	0	0	0	0
Portugal	14,422	14,422	6	1,247	113,207	876
U.K.(Scotland)	11,197	0	0	0	0	0
Norway	46,648	43,421	93	16	2,120	195
U.K.(England)	9,268	2,977	32	10	1,043	0
Others∗∗, unallocted	25,502	0	0	0	0	0
Total	363,033	222,394	61	2,158	208,477	6,219

∗Unofficial catches

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

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

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	62	8,495	1,525
Spain	100	57	2,568	0
Norway	93	16	2,120	195
Ireland	55	31	5,927	833
Denmark	0	0	15	5
UK (Scotland)	0	0	0	0
UK (England & Wales)	32	10	1,043	0
Faroe Islands	0	0	0	0
Germany	30	45	17260	602
Others	0	0	0	0
Total 273,888	52	221	37,428	3,160

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

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	46	5,419	1,150
Germany	21	30	7,130	152
Denmark	0	0	0	0
Others	0	0	0	0
Total 37,224	77	76	12,549	1,302

The sampling intensity for the Southern fishery was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Spain	100	614	45,293	864
Portugal	100	1,247	113,207	2,628
Total 51,921 t	100	1,861	158,500	3,492

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

There were less fish aged and measured by Spain and Portugal this year but the proportion of the catch covered by the sampling programme increased slightly.

The summarised details of individual sampling programmes in 1999 are shown below:

Country	Catch (t)	Catch covered by sampling programme	Samples	Measured	Aged
Spain∗	22,271	22,281	425	49,511	1,942
Portugal	71,820	71,820	410	45,956	6,309
France	17,730	0	0	0	0
U.K. (E&W)	3,568	0	0	0	0
Ireland	3,500	0	0	0	0
Germany	143	29	19	593	198
Total	119,032	94,130	894	96,060	8,449

∗ Unofficial catches

Anchovy

The sampling programmes carried out on anchovy in 1999 are summarised below. The programmes are shown separately for Sub area VIII and for Division IXa. Sampling throughout Divisions VIIb+d and VIIIc appears to be satisfactory. A full sampling programme was again carried out by France on catches in Division VIIIa.

The overall sampling levels for recent years are shown below:

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1992	40,800	37,700	289	17,112	3,805
1993	39,700	39,700	323	21,113	6,563
1994	34,600	34,400	281	17,111	2,923
1995	42,104	35,048	?	?	?
1996	38,773	36,053	214	17,800	4,029
1997	27,440	20,966	258	18,850	5,194
1998	31,617	31,617	268	15,520	5,181
1999	40,156	40,156	397	33,778	10,227

The sampling programmes for France and Spain are summarised below:

Country	Div	Catch	Catch covered	Samples	Measured	Aged
France	VIIIa,b,d	12,196	12,196	51	1,937	1,827
Spain∗	VIIIb,d	4,895	4,895	75	4,503	1,094
Spain∗	VIII c(east)	8,249	8,249	184	11,444	3,245
Total		25,340	25,340	310	17,884	6,166

∗ Unofficial catches

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

Country	Div	Catch	Catch covered	Samples	Measured	Aged
Spain∗	Div.IXa	6,000	6,000	39	6,737	1,776
Portugal	Div.IXa	1,408	1,408	9	1,210	250
Total	Div.IXa	7,408	7,408	39	7,947	2,035

∗Unofficial catches

Sampling has improved considerably since last year with all catches being sampled for length and age.

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 horsemackerel 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 1999 there was still large scale area misreporting of catches particularly from Division IVa into VIa and IIa and in Area VII (also possibly some species misreporting). The misreporting of catches from IVa into VIa in the first quarter should be considerably less significant from January 2000 as the area is now open until 15th February and because the continuing trend of earlier migration out of this area (see Section 2.8.4) 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.

Unlike previous years, information on mackerel discard levels was not explicitly reported for any fleet. The total mackerel catch reported by this Working Group for 1999 must therefore be considered an underestimate. Mackerel discarding levels are likely to be highest in Sub-Areas VI and VII from the directed fisheries on horsemackerel. (See Section 1.3.3. below)

1.3.3 Discards

Mackerel

In 1999 no countries supplied discard data in age disaggregated format. This is an unwelcome development. However an unknown proportion of discarded catches are included in the unallocated catch category.

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

In some fisheries e.g. those in Subareas 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.

Discard information form Norwegian and Scottish purse seine fisheries from an EU study completed in 1999 is not used (see Section 3.2.2). Further studies on discards, funded under the PESCA programme and the CFP Study programme, are now being funded and a small amount of information was made available from Scotland. This information was however not extensive enough to be included in the catch estimates.

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.

Horse Mackerel

Discarding of horsemackerel is not considered to be a problem.

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

Sardine

Discarding in the sardine fishery in Division VIIIc and IXa is not considered to be a problem.

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.

Mackerel

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

Horse Mackerel

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

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

Sardine

An otolith exchange involving France, Spain and Portugal is on course within the EU Project PELASSES. This exchange aims to assess the precision of sardine age readings and investigate differences in otolith structure between areas (identified in the last otolith Workshop, Anon., 1997).

Anchovy

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

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

In the Gulf of Cadiz the problems of interpretation of otolith readings continues. However, this year catch at age readings were available to the Working Group (Milan and Ramos 2000 Working Document).

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. The latest Egg survey WG in 2000 reported that it would be inappropriate to use mackerel samples from the egg survey to produce a new ogive for the stock as the 2001 egg survey would only cover distribution area of the spawning stock . Last year a revised maturity ogive for southern mackerel was accepted by the Working Group (Perez *et al.*, 1999 WD.). There is no new information on mackerel maturity in the southern area.

Horse Mackerel

There is no new information on horse mackerel maturity. The uncertainty about the level of natural mortality (ICES 1998/ Assess:6) still persists.

Sardine

A different definition of mature fish for the Daily Egg Production Method and the calculation of maturity ogives for analytical assessment, was identified (Anon., 2000). Due to 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 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.

Anchovy

Results of a Portuguese acoustic survey in the Gulf of Cadiz which produced a new maturity ogive were presented to the Working Group (Morais 2000 Working Document).

1.3.6 Quality Control and Data Archiving

In previous years the Working Group has reviewed its procedures for collection and maintenance of national catch, catch sampling and age-structured information. This year the Working Group addressed the issue quality control to reflect current requests from ICES in its review of this issue. The issues addressed this year were:

- Quality of the input data
- Transparency of data handling by the Working Group
- Current methods of compiling disaggregated fisheries assessment data
- Archiving past data and requirements of a future database
- ICES handbook for stock specific data & procedures

Quality of the Input data. Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Data co-ordinators have the responsibility for combining, collating, and interpolating information where necessary. A number of validation checks are incorporated in the data submission spreadsheet and these are checked by the co-ordinators who in the first instance report anomalies to the laboratory which provided the data. Although it was suggested in last years Working Group that it would be helpful to provide an indication of what data could be used as representative of these unsampled catches neither this nor information on stratification were provided with the data this year.

The Working Group decided that further development work on data input spreadsheets would not be carried out. The reason for this is that it would represent a duplication of effort in light of the intention of ICES to develop a standard platform for the collection storage of disaggregated fisheries assessment data. In the interim period the existing sheets will be used in tandem with the sallocl programme (where appropriate) and all species coordinators will be issued with the latest version of and explanatory documentation for the sallocl programme. **The Working Group recommends that a directory be allocated on the ICES server to store relevant documentation and the most recent version of exchange sheets and programmes used to aggregate the data, and that these items be available over the ICES web server.**

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 there is a problem with the reporting of French catches for horsemackerel. This table should 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 Section 1.4). As data is aggregated by area, this year maps have been provided of total catch and numbers of aged and measured fish by area. This gives a picture of the quality of the overall sampling programme in relation to where the fisheries are taking place (see Figure 1.3.6.1). It was decided that these should replace the quality plots which were produced in last years Working Group Report.

Transparency of data handling by the Working Group. The current practice of data handling by the working group is that the 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. It is the intention of the Working group that in the interim period until the standard database is developed 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.

Information on official, area misreported, unallocated, discarded and sampled catches are recorded on the WG-data exchange sheet (MS Excel; for definitions see text table below). However only sampled, official, WG and discards are available in the file *Sam.out*. Changes to sallocl , suggested by last years Working Group to enable the construction of catch tables by area according to the WG report Tables 2.2.2.1 to 2.2.2.6 were not made, and in the case of NEA mackerel an access database is being used as an interim measure to aggregate the data for these tables.

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
Discarded Catch	Catch which is discarded
WG Catch	The sum of the 4 categories above
Sampled Catch	The catch corresponding to the age distribution

Current methods of compiling fisheries assessment data. As mentioned above each species co-ordinator is responsible for compiling the national data to produce the input data for the IFAP system. In addition to checking the major task involved is to allocate samples of catch numbers ,mean length and mean weight at age to unsampled catches. There are at present no defined criteria on how this should be done, but the following general process is implemented by the species co-ordinators. Searches are made for appropriate samples by gear (fleet) area 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 should be stored each year in the data archives. 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.

Archiving past data and requirements from a future database. In last years WG, members were asked to provide any kind of national data reported to previous working groups (official catches, working group catches, catch-at-age and biological sampling data), and the species co-ordinators provided their summary tables. However, there was little response from the national institutes. Prior to 1997, most of the data was handled in multiple spreadsheet systems in different formats. These are now stored in the original format, separately for each stock and catch year. Table 1.3.6.2 gives an overview on data collected by Sept. 2000. The data are saved on the ICES system and should be backed up on Compact Disk. The WG recommends an increase of national efforts to gain historic data. It should at least be possible to provide an overview which data are stored where, in which format and for what time frame within the next year. This overview should then build the basis to raise funds (possibly in the framework of a EU-study) for completing the collection of historic data, for verification and transfer into digital format.

The WG addressed the requirements which it would need from a database and standard platform used to submit and store the disaggregated fisheries assessment data and produce outputs for the report. These details are given in a working document produced by the sub-group (Zimmerman*n et* al 2000 WD). The compilation of this type information from each working group should expedite the building of the new ICES database.

ICES handbook for stock specific data. The Working Group felt that most of the requirements for the handbook on stock specific data could be met by the completion of the diagnostic tables. In addition calculations conducted outside IFAP (such as the inputs for the NEA mackerel predictions) would be documented.

1.4 Checklists for quality of assessments

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

1.5 Working Group on Mackerel and Horse Mackerel Egg Surveys [WGMEGS]

The WG met in Santander, Spain on the 18-21 January, 2000 under the chairmanship of Dr. C. Hammer, Germany.

The Working Group was given nine terms of reference and the responses are given below.

T.o.R. a) Co-ordinate the timing and planning of the 2001 Mackerel/Horse Mackerel Egg Surveys in the ICES Subareas VI to IX for estimating the spawning stock size;

The survey in 2001 will involve vessels from 7 nations: Portugal, Spain (IEO & AZTI), Germany, UK (FRS & CEFAS), Netherlands, Norway & Ireland. There will be seven survey periods from 1st Jan to 21st July. The instructions for the surveys follow those of previous years with the following additions or emphases:

- To use 20cm dia. opening on GULF III samplers, and 40 or 60 cm dia. opening on Bongo nets.
- Egg Production Estimates will be produced for both species and western and southern areas plus NEA Mackerel.
- A new standard area was defined extending the western limits based on observations in 1998.
- All surveys should emphasise area coverage and use alternate transects for the initial part of the survey, and fill in on the return track.
- ALL eggs should be sorted from the catch and retained. Mackerel and horse mackerel should be sorted to species.

T.o.R. b) Co-ordinate the planning of sampling for maturity of both mackerel and horse mackerel for analysis histologically;

Due to the surveys only covering part of the total stock area, i.e. the spawning area, it was not considered appropriate to use these surveys for maturity studies.

T.o.R. c) Co-ordinate the planning of sampling for fecundity and atresia taking into account the recommendations of the WGMHSA regarding the level of sampling;

The sample collection programme for estimation of adult parameters was expanded based on the recommendations as follows;

Mackerel Potential Fecundity – Samples will be collected in March 2001 by CEFAS in the area 47^o – 52^oN, and by Germany in the area 52^o – 60^oN. 400 females will be collected at 20 stations along the 200m isobath, in four weight categories. Samples will be analysed by FRS, CEFAS & IMR

Horse Mackerel Potential Fecundity - Samples will collected from December 2000 to April 2001 by Ireland, Germany & Netherlands in the western area, and IPIMAR, IEO & Germany in the southern area. In the west 80 fish will be collected at 4 stations. In the south 260 fish will be collected at 5 stations along 200m isobath, in 4 weight categories. Samples will be analysed by MI, RIVO, IEO & IPIMAR.

Mackerel Atresia - 600 fish will be collected in the west and 300 in the south in four weight categories, at a maximum of 20 fish per station.

Horse mackerel atresia –Due to the very low level of atresia seen in 1998, no additional effort will be applied.

T.o.R. d) Review all the mackerel fecundity and atresia data collected in the western area as part of the 1998 survey and report back to the WGMHSA on whether or not any changes should be made to the 1998 data set;

This was reviewed, and no changes recommended.

T.o.R. e) Review all information on maturity, fecundity and atresia for both mackerel and horse mackerel, analysed since the last meeting of WGMEGS. (All relevant working documents presented to the 1999 WGMHSA should be made available to this WG);

Mackerel Western – no new information.

Mackerel southern - no new information on fecundity or atresia.

A new maturity ogive was developed based on microscopic examination, which showed a slower maturation than the macroscopic ogive or the ogive used by the WG. The new ogive has bee adopted.

Horse mackerel western - Atresia was very low in 1998

- maturity – new estimates were made but there were problems with the pattern of sampling in the adult and juvenile areas. This has not been clarified as yet and the original ogive retained.

Horse Mackerel Southern – a lower fecundity weight relationship was found using stereometric techniques as against earlier histometric techniques.

As in the western area there was very low atresia prevalence.

The microscopically determined ogive was sharper than for the macroscopic, but was quite similar to the current WG ogive.

Further discussion of horse mackerel adult parameters is presented in Section 4.7.

T.o.R. f) Examine the reasons for the high variance on the estimate of mackerel egg production in the southern area in 1998 and decide on whether the sampling strategy needs to be revised in this area;

The variance was caused by a few single stations, high values. No replication of these was done because of bad weather. The current sampling strategy allows for extra stations to be placed on such occasions. However, weather remains a problem.

No changes were appropriate in mackerel fecundity or atresia. An extensive review of all data resulted in corrections at one station for volume filtered. This resulted in a 6% reduction in southern area estimate, reducing the southern contribution to the NEAM from 25 to 24%. SSB went from 850 kt to 800 kt.

T.o.R. g) Present horse mackerel fecundity and atresia estimates for the southern area from sampling in 1998. Review the egg production estimate and calculate a revised estimate of SSB for the southern horse mackerel in 1998;

The two rectangles with remarkably high values were given "mean" values – This gave a "new" egg estimate of 17.85 $*10^{13}$ eggs from 100.3 $* 10^{13}$ eggs using these stations or 18.6 $* 10^{13}$ reported previously using mean values. No SSB was calculated due to lack of valid fecundity data.

T.o.R. h) Review the results of the 1999 North Sea Egg Survey;

The survey was carried out by Norway and the Netherlands. The whole area and spawning period were not fully covered. No potential or realised fecundity measures were taken. The survey biomass estimate using a conservative estimated fecundity was 95,000 tonnes.

T.o.R. i) Consider producing a manual detailing all methods used in the current egg surveys from sample collection through to the final estimate of SSB's.

No action taken.

Problems and recommendations

The WG highlighted ongoing areas for continued research to improve the quality of the survey and associated estimates. These were for adult parameters uncertainty in the calculation of :

- fecundity – this was mainly in terms of the amount of material collected and it's spati0-temporal spread rather than the estimation methodologies.
- determinate v indeterminate spawning. This is only seen as a problem for horse mackerel (see Section 4.6)
- atresia – again sample collection is the main problem, atresia in horse mackerel is minimal.
- Maturity – conflicts between micro- and macroscopic determination need to be resolved, although it is felt that the microscopic approach is better. It was also felt that this was not a task that WGMEGS could take on.

For the survey data collection itself areas for study included:

- egg identification and staging, this being addressed by the egg exchange programme, results will be reported to the next WGMEGS in 2002. A workshop is to be held in Lowestoft in December 2000 to improve the quality of these measures
- measurement of volume of water filtered by samplers – recommendations have been made by the Plankton Sampler Study Group and these will be addressed
- spawning area coverage – changes in distribution of spawning over time will always tend to result in some weaknesses in coverage. The survey design is intended to minimise the impact of this.

WGMEGS Recommendations

1. The WG strongly recommends a mackerel egg survey on a triennial basis in the North Sea. Due to lack of ship time, the temporal and area coverage is insufficient

2. The WG was of the opinion that a specific recommendation for a sampling scheme is needed from the WGMHSA with regard to mackerel and horse mackerel adult parameters.

3. The WG recommends that the next meeting of the group should take place in Dublin from 16 to 20 April 2002.

4. The WG recommends that an exchange of histological atresia slides should take place between relevant institutes.

5. The WG recommends the conduct of a joint training course/workshop for identification of atresia and fecundity from prepared slides AND egg identification and staging workshop in Lowestoft in December 2000.

6. Sampling depth: The WG recommends to carry exploratory analysis of the data related to the net deployment, specially with the maximum sampling depth, in order to detect possible problems.

7. The WG recommends to extend the sampling area as much as necessary in order to delimitate the spawning area whenever possible, even when this results in reduced total number of stations.

Other reports

The WG also received reports from the following relevant EU programmes: INDICES, EU GAM project & EU sampler concerted action.

1.6 Additional comments from WGMHSA

WGMHSA fully endorses the recommendations made by WGMEGS. In response to Recommendation 2 of WGMEGS, WGMHSA makes the following recommendation.

1.7 Recommendation

WGMHSA strongly recommends that the collection programme outlined by WGMEGS in response to T.o.R. c) (see above) be carried out in full. Furthermore the WG recommends that the collection of data on primary adult parameters – fecundity and atresia – be carried out on an annual basis. To this end all institutes which are in a position to collect adult fish in the western spawning area in the first quarter are encouraged to do, following preservation protocols designated by CEFAS.

1.8 Sardine DEPM Workshop

An ICES Workshop on the Estimation of the Spawning Stock Biomass of Sardine was held in June 2000 (Vigo ,Spain) to present and evaluate estimates of egg production, adult parameters and spawning stock biomass from 1999 surveys, to standardise sampling and estimation methodologies, to identify future areas of research and to plan surveys for 2002 (Anon., 2000). Furthermore, the 1997 SSB estimate for the Portuguese survey was recalculated using estimates of all adult parameters for this survey. The estimate previously available was based on adult parameters from the 1988 survey. The revised estimate for the total area (147.9 thousand tonnes) is about 40 thousand tonnes lower than the previous one.

The main results for the 1999 surveys and their comparison with previous estimates are presented and commented in Section 9.3.1.

Regarding methodological issues, the workshop identified the need to standardise criteria between the two countries for post-ovullatory follicle (POF) ageing and cohort delimitation and for the classification of destroyed eggs. On the other hand, common criteria have been used for egg staging and both countries agreed to adopt the egg ageing method of Bernal *et al.* (1999). Methodological problems regarding sampling and estimation were identified: survey timing, spatial autocorrelation in egg sampling, the influence of survey design and use of post-stratification in adult parameter estimates, the adequacy of the mortality model currently used for estimation of egg production and the influence of POF cohorts used in spawning fraction estimates. These areas were considered as a priority for future research.

Studies on the influence of spatial autocorrelation in egg samples and of adult survey design and estimation have already started. Preliminary results showed the existence of spatial structures up to 50 km and larger spatial variation in the inshore-offshore than in the alongshore direction (Stratoudakis *et al.* (2000)). The use of line transects instead of stations as the basic sampling unit did not improve the precision of egg production estimates as expected (Bernal *et al.*, 2000) and the workshop identified the need of further analysis of the spatial structure of the data.

It was also recognised that small changes in adult parameters have a large impact in the SSB estimated by the DEPM model. Estimation of spawning biomass is entirely based on the selected survey design, using design-based estimators. Judgement sampling and survey post-stratification have been recommended as ways of achieving sampling proportional to local fish densities and reliable estimation of spawning biomass when there are spatial differences in the DEPM adult parameters. Post-stratification has been used in DEPM Spanish surveys when considerable area differences in adult parameters were detected and sampling effort allowed meaningful comparisons. In the case of Portuguese surveys adult parameters have been estimated for the entire survey area using a simple random sample estimator. A higher sampling effort in 1999 allowed detecting large area differences in spawning fraction estimated in the Portuguese survey and stressed the need of further research in this area.

The workshop agreed that future DEPM surveys should be carried out every 3 years and that the next survey should be carried out in 2002. In the period up to the next survey it was agreed to use the opportunities offered by acoustic/egg surveys planned within the EU project PELASSES surveys to carry out research in order to:

1) obtain more reliable information on egg ageing and diurnal synchronicity of spawning
2) validate the ageing criteria for post-ovulatory follicles
3) compare macroscopic and microscopic maturity
4) identify the best timing of future surveys
5) understand the spatial structure of egg patches

The Working Group recognised the need to continue research within these areas merging the experience of different people already working in DEPM. A new ICES Study Group would be an appropriate forum to achieve these goals.

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	[redacted]	-	-	-
Denmark	YES	YES	YES	NO
England	YES	YES	YES	NO
Estonia	[redacted]	-	-	-
Faroes	YES	YES	YES	NO
France	[redacted]	-	-	-
Germany	YES	YES	YES	NO
Iceland	[redacted]	-	-	-
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Norway	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Russia	YES	YES	YES	NO
Scotland	YES	YES	YES	NO
Spain	YES	YES	YES	NO
Sweden	YES	YES	NO	[redacted]

B. Horse Mackerel

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

C. Sardine

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

C. Anchovy

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

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

Stock	Catchyear	Format			Comments
		X	W	D	
Horse Mackerel: Western and North Sea					
HOM_NS+W	1991	X			Files from Svein Iversen, April 1999
	1992	X			Files from Svein Iversen, April 1999
	1993	X			Files from Svein Iversen, April 1999
	1994	X			Files from Svein Iversen, April 1999
	1995	X			Files from Svein Iversen, April 1999
	1996	X			Files from Svein Iversen, April 1999
	1997	X	W	D	Files from Svein Iversen, April 1999
	1998		W	D	Files provided by Pablo Abaunza Sept 1999
	1999		W	D	Files provided by Svein Iversen Sept 2000
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
North East Atlantic Mackerel					
NEAM	1991	X			North Sea +Western WG Files on ICES system [Database.91], March 1999
	1992	X			North Sea +Western WG Files on ICES system [Database.92], March 1999
	1993	X			North Sea +Western WG Files on ICES system [Database.93], March 1999
	1997		W	D	Files from Ciaran Kelly, April 1999
	1998		W	D	Files from Ciaran Kelly, Sept 1999
	1999		W	D	Files from Ciaran Kelly, Sept 2000
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 from Ciaran Kelly, Sept 2000; (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.92], March 2000
	1995	X			WG Files on ICES system [Database.93], March 2000
	1996	X			WG Files on ICES system [Database.92], March 2001
	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; (W) contained in NEAM
Sardine					
	1992	X			WG Files on ICES system [Database.92], March 1999
	1993	X			WG Files on ICES system [Database.93], March 1999
	1997		W	D	W for Portugal only, files provided by Pablo Carrera and Kenneth Patterson
	1998		W		files provided by Pablo Carrera Sept 1999
	1999		W		files provided by Pablo Carrera Sept 2000
Anchovy					
Anchovy in VIII	1987-95	X			revised data, all in on e spreadsheet, provided by Andres Uriarte Sept 1999
	1996	X			file provided by Andres Uriarte Sept 1999
	1997	X	W	D	files provided by Andres Uriarte Sept 1999
	1998	X	W		files provided by Andres Uriarte Sept 1999
	1999	X	W		files provided by Andres Uriarte Sept 2000
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

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)* in the whole distribution area. Stock components are separated on the basis of catch distribution, which is more reflecting management considerations and different historical information available than biological evidence: Western component: spawning in Sub-areas and Div. VI, VII, VIIIabde, distributed also in IIa, Vb, XII, XIV; North Sea component: spawning in IV and IIIa (but as the North Sea component is almost non-existent, most of the catches in IVa and IIIa actually belong 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 one country in the last years, although it appears to be a major problem in the fishery. Failure of other nations to supply own discard estimates resulted in a halt of discard reporting in this year. 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 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 survey north and west of Scotland in winter, survey north and west of the Iberian peninsula in March, both currently not used in the assessment.
	Egg surveys	The triannual egg and larvae survey for mackerel and horse mackerel currently provides the only fishery independent SSB estimate (and a number of other parameters) used in the assessment. The survey is conducted since 1977. In its present form the survey aims at covering the whole spawning time (January - July) and area (Southern Bay of Biscay to West of Scotland) for both species since 1992.
	Larvae surveys	See above
	Other surveys	Yearly Russian aerial survey conducted over international and part of the Norwegian and Faroese waters (Div. IIa) in summer, gives distribution and biomass estimate, currently 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	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 (2000): 1,109; total number of fish aged: 17,432; total number of fish measured: 116,978. Weight at age in the stock: For Western component, derived from the Dutch and Irish national sampling program (catches in March-May from Div. VIIj). Only presented as point estimates without variances. For both other components: constant value since 1984 (start of data series). Weight at age in the catch: derived from the total international catch at age data, weighted by the relative proportion of the egg production estimates of SSB for the respective component. 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 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. Many 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 8 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: 8 parameters. Recruitment for survivors year: Total number of parameters: 38 Total number of observations: 99 Number of observations per parameter: 2.6
	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 oberservation in the separable period contributes a weight of 1 except 0-group, which is downweighted to 0.01.
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		• 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 (39 to 5) • weighting for survey indices 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 datapoints 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 ($F_{4\text{-}8}$). This exploitation pattern is subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the last 3 years.
4.4	Recruitment	Geometric mean over whole period except last 3 years.
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: Implemented in a spreadsheet, which is most convenient given that we need flexible additional constraints, but error prone. Two optimisations need to be run. This should be changed, either to one optimisation or to 'buttons' to deal with the minimization.

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	The management regime simulated is applied to year 1 of the projections, which is in fact 1 year too early. Uncertainty likely to be underestimated as only uncertainty in population numbers and recruitment is taken into account.

Table 1.4.2. Checklist Western Horse Mackerel assessments

1. General

step	*Item*	*Considerations*
1.1	Stock definition	Assessments are performed for horse mackerel *(Trachurus trachurus)* in the combined areas II, V, VI, VIIabcefghik, VIIIab. In divisions IVa and IIIa, only fish distributed in the northern part (in the Norwegian EEZ) is believed to belong to this stock. There remains some uncertainty if Western, Southern and North Sea horse mackerel are separate stocks or components of one stock. For some fleets, problems may occur with mixing of the 3 different *Trachurus* species in the area.
1.2	Stock structure	There are indications that the Western horse mackerel stock is spatially age structured, as oldest animals are believed to migrate longest distances from the spawning grounds on the continental shelf edge west and south-west of the British isles.
1.3	Single/multi-species	Single species assessments, but horse mackerel was also included in the multi-species model. Techniques for stock or stock component differentiation are currently under review; results are expected for 2003.

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 only available for one country, but nevertheless used in the assessment. Misreporting is corrected by re-allocating catches from official reported areas to areas where catches were taken, based on additional information. Separation of Western and North Sea horse mackerel on the basis of the spatial and temporal distribution of catches (see above).
2.2	Indices of abundance	
	Catch per unit effort	CPUE information not available and not used for this assessment.
	Gear surveys (trawl, longline)	No gear surveys used for the assessment
	Acoustic surveys	No acoustic surveys used for the assessment
	Egg surveys	The triennial egg and larvae survey for mackerel and horse mackerel currently provides the only fishery independent SSB estimate (and a number of other parameters) used in the assessment. The survey is conducted since 1977, biomass estimates for the horse mackerel assessment derived since 1983. In its present form the survey aims at covering the whole spawning time (January - July) and area (Southern Bay of Biscay to West of Scotland) for both species since 1992.
	Larvae surveys	See above
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive in-formation	<u>Catch at age</u>: 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 (2000): 988; total number of fish aged: 3'384; total number of fish measured: 36084. <u>Weight at age in the stock</u>: derived from the Dutch national sampling program (freezer trawlers' catches in the 1st and 2nd quarter). Only presented as point estimates without variances. <u>Weight at age in the catch</u>: derived from the total int'l catch at age data. In some countries, weight at age is derived from general length-weight relation-ships, others use direct measurements. Constant value used for 2 yr old. <u>Maturity at age</u>: should be derived from egg surveys; however, for the last two years proportions were used based on a rounded maturity ogive from the neighbouring Cantabrian Sea.
2.4	Tagging information	Not used recently.
2.5	Environmental data	Used so far only for Norwegian catch predictions in the following year (catches are believed to be proportional to North Atlantic water influx) for the short term predictions.
2.6	Fishery information	Several scientists involved in the assessment of this stock are familiar with the fishery. Many nations have placed observers aboard the fishing vessels. Anecdotal information on the fishery may be used in the judgement of the assessment.

Table 1.4.2 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Current assessment models age structured single sex: ADAPT, ISVPA, Combined Separable/ADAPT.
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. Selection at age: Separable for the years 1997 - 1999, selection at the oldest age 1.2 relative to age 7. 1982 - 1996, VPA with scaled average F(7-9) applied at the oldest age. 1982 year class calibrated independently.
	Recruitment	1997 - 1999 Separable VPA population estimates at age 1 transformed to age zero using m = 0.15. 1982 - 1996 VPA estimates. Depensation is not considered. Environmentally driven reductions or increases in recruitment are not considered.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of a weighted sum of squares. Apart from the 1986 survey (weight = 0.0), each survey is assumed to contribute a weight of 1. Catch at age data for 1997 - 1999 assumed to be measured with error. 1982 - 1996 exact.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	None
3.6	Retrospective evaluation	None
3.7		• selection at final age not well determined • duration of separable period not well determined • weighting for survey indices not related to variability in the data • correlation structure of parameters not properly assessed and presented • SSB estimate from egg surveys assumed absoulte • relationship between number of parameters, number of datapoints and total SSQ not addressed • results compared with alternative models

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model.
4.2	Spatially explicit or not	Not
4.3	Key model (input) parameters	Stock weights at age: from last year in assessment Mortality at age: same as for assessment Maturity at age: average of the two most recent years used Proportion of m and f before spawning: 0.45 for both. Fishing mortalities by age: Average 0f final three assessment years. Numbers at age: Final year in assessment; ages 0 to 11+
4.4	Recruitment	Geometric mean excluding 1983 - 1998.
4.5	Evaluation of uncertainty	Uncertainty in model parameters is NOT incorporated.
4.6	Evaluation of predictions	Predictions are not evaluated post-hoc
4.7	Major Deficiencies	New assessment model structure. Sensitivity not yet fully evaluated.

Table 1.4.2 (Cont'd)

5. Prediction model(s) – MEDIUM TERM

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	None
5.2	Spatially explicit or not	
5.3	Key model parameters	
5.4	Recruitment	
5.5	Evaluation of uncertainty	
5.6	Evaluation of predictions	
5.7	Major Deficiencies	

Table 1.4.3. 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 still are 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 73000 t proposed for *Trachurus spp*. until 1999. 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 and 1998.
2.2	Indices of abundance	The following series of age disaggregated indices are available: two series of bottom trawl surveys from 1985 onwards. Another series of bottom trawl surveys from 1989 onwards. The relationship between the indeces 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 assemment. 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 is no significative 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	Enviromental information is available from acoustic surveys and bottom trawl surveys. Satellite images can provide useful information on the dynamics of the aquatic systems based mainly in the estimation of the sea surface temperature.
2.6	Fishery information	Horse mackerel is mainly caught by purse seiners and bottom trawlers. The catches are relatively uniform over the year, although the second and third quarter show relatively higher catches.

Table 1.4.3 (Cont'd)

3. Assessment model

Step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	XSA. The model is tunned 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.
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, - bootstrapping - bayes posteriors	No evaluation of assessment uncertainty
3.6	Retrospective evaluation	Yes

4. Prediction model(s)

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age. Using IFAP short term forecast and Y/R routines.
4.2	Spatially explicit or not	No
4.3	Key model parameters	Fishing mortality
4.4	Recruitment	Geometric mean over the XSA model estimates at age 0 in the assessment period.
4.5	Evaluation of uncertainty	No
4.6	Evaluation of predictions	No

Table 1.4.4. Quality of assessment for Iberian sardine stock

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.

Table 1.4.4 (Cont'd)

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*
4.1	Age, size, sex or fleet-structured prediction model	Age.Using IFAP short term forecast and Y/R routines
4.2	Spatially explicit or not	Two scenarios, for the whole area and for each VIIIc and IXa Divisions.
4.3	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 2000, estimated as the projection of geometric mean of the last 6 recruitments at age 0
4.4	Recruitment	Geometric mean of the last six years as estimated by the ICA model
4.5	Evaluation of uncertainty	No
4.6	Evaluation of predictions	No

Table 1.4.5 Quality of assessments

Checklist TEMPLATE- 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 Channeland from the population(s) in the Ixa.
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	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.
	Catch per unit effort	There exists series of catch per unit effort for the two 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	Series since 1987-2000 with a gap in 1993
	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).
2.4	Tagging information	No tagging program
2.5	Environmental data	Many informations exists, particularly on the temperature, water stratification, upwelling index. Hydrodynamic model is currently used.
2.6	Fishery information	Two main fishery. A Spanih 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 at 1.2. It is considered as variable and probably higher some years. Catchability for the DEPM index which is assumed as abosolute indicator of Biomass and therefore set the general level of Biomass for the assessment *and hence Fishing mortality etc.)
	Recruitment	No stock recruitment relationship is assumed. However, below 18,000 tonnes a link between recruitment and spawner abundance is assumed.

Table 1.4.5 (Cont'd)

3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Accuracy of the data are not taken into account. Only, a weighted factor allows to translate the validity of the information used. Log normal errorsassumed
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Assimptotic estimates of variances. No explicit 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 ICES deterministic projections (IFAP).
4.2	Spatially explicit or not	No
4.3	Key model parameters	Fishing mortality and catchability assumpotion for DEPM
4.4	Recruitment	Geometric mean or use of an environmental index to qualify the level below or above the average. This is on state of refinement
4.5	Evaluation of uncertainty	Short term sensitivity analysis (Cook 1993)
4.6	Evaluation of predictions	See cuality pages of the previous assessment

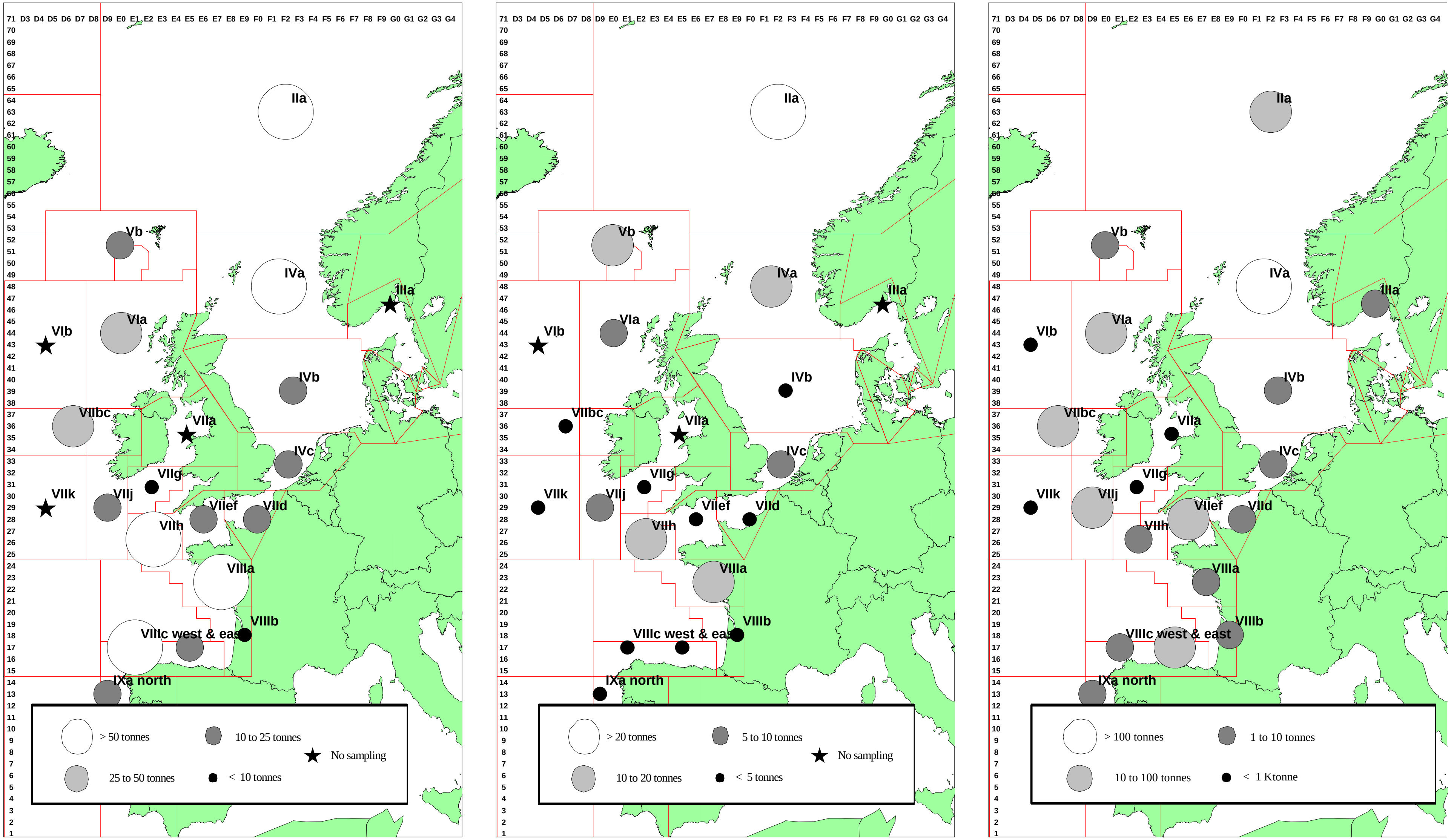

Figure 1.3.6.1. Sampling of mackerel for age and length in relation to tonnage landed by ICES division. A. Tonnage landed per fish aged (left). B. Tonnage landed per fish measured (centre) & C. Tonnage landed.

2 NORTHEAST ATLANTIC MACKEREL

2.1 ICES advice applicable to 1999 and 2000

The TACs agreed by the various management authorities and the advice given by ACFM for 1999 and 2000 are given in Table 2.1.1.

For 1998, ACFM recommended a fishing mortality between 0.15 and 0.20, the highest tabulated F consistent with the precautionary approach was given as $0.8F_{97.}$ For 1999 and 2000 a fishing mortality not exceeding Fpa = 0.17 was recommended.

In 1999 the Faroes allocated a quota of 17,250 t plus a by-catch quota of 18,600 t to Russia in Faroes EEZ (in total 35,850 t). In 2000 a quota of 30,000 t was allocated in the Faroes EEZ including a Russian quota of 10,000 t. It is again important to stress that while the TAC options are meant to apply to the total catch of all mackerel over the total distribution area the actual agreed TACs do not apply to the catches taken in international waters. The Russian catches in international waters in 1999 were about 30,000 tonnes.

In addition to the TACs and the national quota the following are some of the more important additional management measures which were in force in 1998 and 1999, and are again in force in 2000. 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.

2.2 The Fishery in 1999

2.2.1 Catch Estimates

The total estimated catch in 1999 was about 609,000 t which was nearly 57,000t lower than the catch taken in 1998. The TACs set for 1999 for all those areas for which TACs were agreed amounted to 555,465 t (See Section 2.1.). The corresponding TAC for 1998 was 549,335 t. The decrease in catches taken in 1999 appears mainly to have been as a result of the decrease in catches from IIa and Vb (61,000 t). The corresponding TACs as best ascertained by the Working Group (Section 2.1) agreed for 2000 amount to 610,745 t.

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.2.1. This table shows the development of the fisheries since 1969. Some slight changes made during 1998 were not appended to the caton file (540t). The highest catches (almost 300,000 t) were again taken from Sub-area IV and Division IIIa – over 285,000 t of these having been taken in Division IVa. The catches, taken from Divisions IIa and Div Vb (72,848t), where the international fisheries take place, were over 61,000 t lower than recorded in 1998 however this reduction was mainly in Norwegian waters (22,000 t reduction in the catch in international waters). The overall catch taken in the fisheries in Sub-areas VI and VII and in Divisions VIIa,b,d,e was 192,487 t compared to 218,600t in 1998.

The catch taken in Div.VIa decreased from 110,000 t in 1998 to 99,000 t in 1999. And the catch in VII and VIIIabde decreased from 108,000t in 1998 to 94,000t in 1999.

The catches taken in Divisions VIIIc and IXa have slowly increased in recent years but remained at about 44,000 t in 1999 which is the same as 1998.

The amounts of catch misreported during 1999 was about 100,000 t compared with 98,300 t in the previous year. These catches were mainly taken in Division IVa but were reported as having been taken in VIa and IIa.

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 1999 was similar to those of 1998.

Percentage distribution of the total catches from 1990 - 1999

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

The catches per quarter and per Sub-area and by Division are shown in Table 2.2.2.6. These catches are shown per statistical rectangle in Figures 2.8 1.1 to 2.8.1.4.and are discussed in more detail in Section 2.7. It should be noted that these figures are based on details submitted on the official log books supplied by fishermen and should not be taken to indicate the true location of the stock.

The quarterly distributions of the fisheries in 1999 which are shown in Table 2.2.2.6 were similar to that of recent yeras. 34% of the total catch was taken during the 1st quarter as the shoals migrate from Div.IVa through Sub-area VI to the main spawning areas in Sub-area VII. About 9% of the total catch was taken in Quarter 2, most of it from Sub-areas VI and VII. During Quarter 3 in which 30% of the total catch was taken the main catches were recorded from Division IIa and Division IVa from the shoals on the summer feeding areas. During Quarter 4, in which 27% of the total catch was taken, the main catches were recorded from Divisions IVa and Area VII. The main catches of southern mackerel are taken in VIIIc (78%) and these are mainly taken in the first quarter. Catches from IXa which comprise 22% of southern mackerel catches are mainly taken in the third quarter (59%).

National catches

The national catches recorded by the various countries for the different areas are shown in Tables 2.2.2.2 - 2.2.2.5. As has been stated in previous reports these figures should not be used to study trends in national figures. This is because of the high degree of misreporting, and because of the “unallocated” catches recorded in some years due to some countries exceeding their quota. The main mackerel catching countries in recent years continue to be Norway, United Kingdom, Ireland, Netherlands and Russia.

The total catch recorded from Divisions IIa and Vb (Table 2.2.2.2) in 1999 was about 71,000 t which was 61,000t less than the catches taken in 1998. Catches reported from this area are taken by Norway and Russia, however most of the Norwegian catch was misreported from IVa. This is a change from recent years and similar to the situation to 1994. The total catch taken from the “international” fishery was about 57,000t which is lower than last year and similar to 1997.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.2.3) in 1999 was 299,800 t compared with 269,700 t in 1998. The increase was probably due to the assumption by the working group of that 40,000t reported from Iia waer in fact misreported from IVa. About 60,000 t, believed to have been taken in Div. IVa, were reported as having been taken in Div.VIa. The main catches were recorded by Norway (106,917 t), while substantial catches were also recorded by Denmark, (29,353 t) and the United Kingdom (31,578 t). No explicit discard information was reported this year, although some discards were reported as unallocated catches. This is an unwelcome development and the working group recommends (as in previous years) that observers are placed on board commercial vessels where discarding is believed to be a problem.

The total catch estimated to have been taken from the Western areas (Table 2.2.2.4) was 192,000 t. About 60,000 t were reported as having been taken in this area but were believed to have been taken in Div.IVa. The main catches continue to be taken by United Kingdom (127,00 t) and Ireland. (48,000 t). The Netherlands, (25,000 t) Germany (19,500 t) and France (14,500 t) continue to have important fisheries in this area.

The total catch recorded from Divisions VIIIc and IXa (Table 2.2.2.5) in 1999 was 43,796 t. compared with 44,164 t in 1998. The catch in 1999 has remained at the same level as 1998 which was the highest recorded since the start of the time series in 1977. The TAC for 1999 was 39,200 t which is a 4,000t increase over the quota for 1998. The continued high catches are probably as a result of increased prices for mackerel and a consequent increase in effort by the Spanish handline fleet which target mackerel in Div. VIII c (east). The recent reduction in sardine catches in Division IXa(N) and VIIIc(W) continues to cause a redirection of effort towards the mackerel fishery. Most of the catch from this area is taken by Spain (>90%).

2.2.2 Discards

A discard monitoring programme was piloted for the Scottish and Norwegian fleets in 1998 with EU support. This was continued in 1999 and will be ongoing in 2000 and 2001. Preliminary analyses indicated that discarding was at a low scale. These data will be further investigated and the potential for raising from the vessels mnitored to the whole fishery examined. This will be reported to WGMHSA in 2001.

2.2.3 Species Mixing

Scomber sp.

As in previous years, there was both a Spanish and a Portuguese fishery for Spanish mackerel, *Scomber japonicus,* in the south of Division VIIIb, in Division VIIIc and Division IXa.

Table 2.2.3.1 shows the Spanish landings by sub-division in the period 1982-1999. The total Spanish landings in 1999 were 2033 t, a decrease in all areas compared to 1998. In 1999 the catch in Division VIIIb was 632 t, lower than in 1998. The catch in Sub-division VIIIc East reached 1414 t in 1999, a fall with respect to 1998. In Sub-division VIIIc West the catch was only 3 t, lower than in 1998 and having fallen greatly in comparison with 1997. In Sub-division IXa North the catch was 104 t in 1999, a fall with respect the previous years.

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

In Sub-division IXa South, the Gulf of Cadiz, there is a small Spanish fishery for mixed mackerel species which had a catch of 879 t of *Scomber japonicus* in 1999. In the bottom trawl surveys carried out in the Gulf of Cadiz in 1999, catches of *S. Scombrus* increased with respect to previous years, with *S. japonicus* making up 62% and *S. Scombrus* 38% 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), in 1998 the catch of *S. Scombrus* was 25%. Due to the uncertainties as to the proportion of *S. Scombrus* in landings, they have never been included in the mackerel catches reported to this Working Group by Spain.

In Portugal the landings of *S. Japonicus* from Division IXa (CN, CS and S) were 13877 t in 1999, the highest catches since 1982, more abundant in the southern areas than those of the north (Table 2.2.3.1). These highest catches are as a result of the combination of large abundance and high prices for this species which caused the shift of sardine to Spanish mackerel as target species. These species are landed by all fleets but the purse seiners accounted for 73% of total weight. Landing data are collected from the auction market system and sent to the General Directorate for Fisheries where they are compiled. This includes information on the landings per species by day and vessel. There is no error in the identification of mackerel species in the Portuguese fishery in Division IXa.

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

2.3 Stock Components

2.3.1 Biological evidence for stock components

No new biological evidence has been presented to assist in stock component definition for mackerel. A proposal is planned for submission to the EU FP5 programme to investigate the definition of the western and North Sea stock components. This will involve IMR (Bergen), MLA (Aberdeen), MI (Dublin), AZTI (Spain), and university partners. It will incorporate genetic, parasite, morphometric, otolith microchemistry and egg and recruit distribution studies.

This proposal has been constructed with reference to the recommendation made in 1999 by WGMHSA (ICES 2000/ACFM:5).

"The Working Group recommend that research should be carried out to determine the migration and distribution pattern of the North Sea mackerel and to what extent it is subject to the winter fishery in area IVa. This research should include tagging, genetic and otolith micro-chemistry studies and parasitology studies, as well as examination of the distribution patterns and migrations. The main aim of this work should be to determine to what extent the N. Sea component fish are caught in the fishery, and whether western fish at all life history stages can join the N. Sea component."

2.3.2 Allocation of catches to component

Since 1987 all catches taken in the North Sea and Division IIIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in the international waters. It has not been possible to calculate the total catch taken from the North Sea stock component separately but it has been assumed to be 10,000 t for a number of years. This is because of the very low stock size and because of the low catches taken from Divisions IVb,c. This figure was originally based on a comparison of the age compositions of the spawning stock calculated at the time of the North Sea egg surveys. This assumption has been continued for the catches taken in 1999. It should be pointed out that if the North Sea stock increases then this figure might need to be reviewed. An international egg survey carried out in the North Sea during June 1999 again provided a very low index of stock size in the area. (<100,00 t) (W.D Iversen and Eltink 1999). A further egg survey in the North Sea is planned for 2002 and should give additional information on the state of the stock.

Prior to 1995 catches from Divisions VIIIc and IXa were all considered belonging to the southern mackerel stock, although no separate assessment had been carried out on the stock. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern stock were combined with those from the western stock. The same procedure was carried out by the 1997 - 1999 Working Groups and again by the present Working Group, - the new population unit again being called the Northeast Atlantic mackerel unit.

The TAC for the Southern area applies to Divisions VIIIc and IXa. Since 1990, 3,000t of this TAC, which has been fixed at 35,000t, have been permitted to be taken from Div.VIIIb in Spanish waters. This area is included in the "Western "management area". These catches (3,000t) have always been included by the Working Group in the western component and are therefore included in the assessment for the Western area and the provision of catch options for that area.

2.4 Biological data

2.4.1 Catch in numbers at age

The 1999 catches in numbers at age by quarter for NE Atlantic mackerel (Areas II, III, IV, V, VI, VII, VIII and IX) are shown in Table 2.4.1.1. These catch in numbers relate to a tonnage of 608,928t. The correction for the Russian catches (540t in 1998) was not included in the caton file for the 2000 assessment. This revision will have a negligible effect on the SOP for the 1998 total catch (101%). The Percentage catch by numbers at age is given in Table 2.4.1.2.

The age structure of the catches of NE Atlantic mackerel is predominantly 2-7 year old fish. These age groups constitute 78% of the total catches. There was an even spread of ages 3 to 6 in catches which target mackerel in the northern areas. The 1996 year class did not appear as abundant in the catches as had been expected. In the southern North Sea, English Channel, and southern Celtic Sea (IVc VIId VIIef VIIh) 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, Russia, 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 31,528t) and the UK (England & Wales) and Germany who provide aged data for about 50% of their catches. In addition there were no aged samples to cover the entire catch from IIIa, (total catch 5,420t) and some minor catches in VIIa VIb and VIIk. As in 1998 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 1999 catches by some of the fleets were provided by England Ireland Netherlands Norway Portugal Scotland Spain Russia. The length distributions were available from most of the fishing fleets and account for almost 88% 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 1999 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 1999 for the NE Atlantic is shown in Table 2.4.3.1. These data continue the long time series and may be useful in investigating changes in relation to stock size.

Mean weights

The mean weights at age in the catch per quarter and ICES Division for NE Atlantic mackerel in 1999 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 2.10.2.4. The stock weights of NE Atlantic are based on a relative weighting of the North Sea, Western and Southern mackerel components (0.02, 0.73, 0.25 respectively). In the case of North Sea and Southern components constant values for the stock weights have been used since the start of the data series in 1984. For the Western component the stock weights were based on Dutch mean weights at age from commercial catch data from Division VIIj over the period March to May. From the 1997 WG onwards the stock weights for the Western component are based on mean weights at age in the catch from Irish and Dutch commercial catch data (from Division VIIb & VIIj over the spawning period March to May) which is weighted by the number of observations from each country.

2.4.4 Maturity Ogive

The maturity ogive was revised by last years Working Group, taking into account new histological analysis from the Southern area. No new information was available this year, and the maturity ogive arrived at last year was used also for 1999.

2.4.5 Natural Mortality Proportion of F and M

The value for natural mortality used by the WG for all components of the NE Atlantic mackerel stock is 0.15. This estimate agrees with the value obtained from Norwegian tagging studies carried out in the North Sea (Hamre, 1978). The proportion of F and M before spawning for NE Atlantic mackerel is taken as 0.4 this is the same as for western mackerel.

2.5 Extension of data set for the period 1972-1983

Since 1995, ICES has acknowledged the necessity of carrying out a single assessment of mackerel for a population unit called Northeast Atlantic mackerel, putting together all European Atlantic mackerel (ICES CM 1996). Up to now the assessment goes back to 1984 and ACFM raised the issue of producing a complete historical perspective of the whole

NEAM back to 1972, parallel to the one that has been produced for the western mackerel over the same time period. 1972 is the first year for which catch at age are available in the western area.

One of the reasons that prevented that assessment over the period 1972-1999 was the lack of the catches at age from the southern area before 1984 and the uncertain catches in tonnes before 1977.

A working document was submitted to the WG (Uriarte *et al*. WD2000) that reviews the catches produced by the southern fishing fleets between 1972-1983. The paper provides:

a) a recovery of statistical data since 1972 of the catches in tonnes produced by the southern fleets and landed in Spain and Portugal which have not previously been reported to the ICES WG.

b) An estimate of the catches at age of mackerel landed in Portugal and Spain covering the period 1972-1983, which is based on the fitting of separable models for the Divisions VIIIbc and IXa and

c) A comparison of the separable catch estimates with other simpler methods of estimating the corresponding catches at age for the southern area, by checking its performance for fitting the most recent catches at age reported by the southern fleets since 1984.

The procedure to estimate the catches by separable models for the period 1972-83 is made in and relies on a parallel assessment of the NEAM for the same period 1972-98. That assessment was solely based on the addition of the western and southern catches. The assessment started with a preliminary estimate (based for instance on percentages at age constant for the catches of the southern area). Then the assessment is made and Population at age estimates for NEAM are attained. Next the separable model is fitted for the recent period of the fishery and applied to obtain the composition by age of the catches in tonnes of the remote period. This procedure provides new improved estimates of the catches at age for the remote period which allows start a new assessment of NEAM over the whole period. Therefore the final estimate of the southern fleet catches for the remote was achieved in an iterative procedure that uses progressively improved estimates of the southern catches at age in that period to make the assessment of NEAM, until convergence of these catches were achieved.

The major conclusions were that the separable fitting procedure of the mackerel catches at age of the southern fleets performed better than the two other simple methods considered in the WD and can be adopted as the best ad hoc estimates of the age composition of those catches. These estimates are consistent with the fishing pattern in the southern fleets in the recent years and with the age structure of the North East Atlantic mackerel population in the remote period as inferred from the parallel assessment of NEAM implicit in the method (mainly guided by the catches of mackerel in the western area and the triennial egg surveys).

The major draw back of this procedure is that it relies on the estimates of the population in the remote period 72-83, which is achieved in an iterative procedure that uses progressively improved estimates of the southern catches at age in that period. If the period covered for the fitting procedure of the fishing pattern (1988-98) can be considered sufficient, then the current exercise would not have to be repeated every year.

The results of this work put the WG in the position for trying a complete historical perspective of the whole NEAM starting back in 1972, similar to the one produced for the western mackerel.

The catches at age, mean weights at age in the catch and stock and the proportion mature for the North East Atlantic mackerel should be calculated from data of the southern, western and North Sea components. However, due to inconsistencies in the catch of the western area data this exercise was postponed till next years WG meeting. **The WG recommends that the assessment data be prepared before next years WG meeting in order to be able to do an assessment for the North East Atlantic mackerel over the period 1972-2000 at it next meeting.**

2.6 Fishery Independent Information

2.6.1 Egg survey estimates of spawning biomass

The last egg surveys in the western and southern areas were carried out in 1998, and in the North Sea in 1999 (see 3.1.4.1). The biomass estimate from the 1998 surveys was used in the last stock assessment in 1999. No new data have become available since that would alter the perception of these surveys.

2.6.2 Acoustic surveys

An acoustic survey was carried out by the Marine Laboratory Aberdeen in January 2000. This was intended as a pilot survey to determine if a useful acoustic abundance estimate could be developed for the western component of the NEA mackerel stock. Based on distribution patterns in previous years the survey was planned to cover the area between the Viking and Tampen Banks in the northern North Sea. Dramatic changes in the timing of the migration made this design impossible (see 2.8.4.). The survey, as carried out, covered the whole shelf break area from the NW of the Hebrides (approx 61°N 6°W) to Viking Bank (approx 60°N 3.5°E), although the bulk of the fish were seen at the western end of the survey area. It was not possible to calculate the tonnage from the acoustic integration as bad weather prevented any useful fishing being carried out. It is hoped to obtain data from monitored commercial catches, but this has not yet been made available.

An acoustic survey was also carried out by the Institute of Marine Research Bergen in October/November1999. The survey was primarily designed to test multi-frequency methodologies. This survey located substantial concentrations of mackerel in the shelf break area between the Viking and Tampen Banks (approx 60°N 3.5°E to 61°30N 2°E). A provisional estimate of approximately 1,000,000 t of mackerel were identified, although the whole distribution area was probably not surveyed.

Both the above surveys were reasonably successful. They showed that the stock was amenable to acoustic survey methodology, and that it was possible to observe the fish acoustically, without major mixing with plankton or other fish species. This is important as mackerel has no swim bladder and hence has a low target strength. It is recommended that these surveys be continued with the aim of producing a robust annual stock estimate. The parties should consider coordinating these surveys.

A two part acoustic survey was carried out by IEO in ICES Sub-divisions VIIe and VIIh and also in sub-divisions VIIIc and IXa, in March and April 2000. These surveys were primarily targeted on sardine (see 9.3.2), however, the most common species observed was mackerel. In division VII most of the fish seen were young (<29cm), and were concentrated on a single transect off Cornwall and off Cap Finisterre. Mackerel were ubiquitous throughout the Cantabrian Sea, and some were seen in the north of IXa. There were more adults in this area, particularly in the centre of the Cantabrian Sea. Abundance estimation was difficult due to a high plankton background, however a tentative biomass of 706,000 t was calculated. This should be compared to the estimate for the same area in 1999 of 574,000 t.

2.6.3 Trawl surveys for juvenile mackerel (Mackerel recruit indices)

As previously reported the traditional mackerel recruit index for mackerel has not been calculated this year. In part, this is due to previous doubts about the performance of the index which had shown an upward trend in recent years in relation to the recruitment calculated from the assessment (ICES 2000/ACFM:5). Secondly, following the decision by WGMHMSA not to use the recruit index, a number of surveys were discontinued. This makes any calculation of the traditional recruit index impossible. Investigations of the use of the existing recruit survey data to predict recruitment are planned, and progress will be reported at the next meeting of WGMHSA.

The recruit distributions are presented in section 2.8.2.

NEA Mackerel

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 1999 and from 1990 to 1999 respectively, for which mackerel is the target species from March to May. The Figure also show the effort of the Aviles and La Coruna trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 1999. 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 mainly for the Santoña fleet, whereas the effort of the trawl fleets is rather stable during all period. The purse-seine fleet effort fluctuated during available period.

Portuguese Mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988 - 1998 is also included and as in Spain mackerel is a by catch. The effort for this fleet increased in 1998 as compared with to previous years. In 1999, the effort is not available.

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 Aviles trawl fleet and the Spanish hand-line fleets show an increase since 1994, and for the A Coruña trawl fleet it is rather stable for the whole period. The CPUE of the Portuguese trawl fleet shows a decrease since 1992.

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.

2.8 Distribution of mackerel in 1999

2.8.1 Distribution of commercial catches in 1999

The distribution of the mackerel catches taken in 1999 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 and Ireland. In these data the Spanish catches are not based on official data.

First Quarter 1999

Catches reported by rectangle during this quarter totalled about 201,180 tonnes, down by approximately 10% from 1998. The perennial problem of mis-reporting between Divisions IVa and VIa, which gave large catches just west of 4^{o} W, seemed to be reduced from recent years. This may have been due to the expected relaxation of fishing regulations in IVa in the first quarter and possibly to the change in the timing of the migration (see Section 2.8.4.). There is still evidence of large reported catches just west of 4^{o}W but this is reduced from previous years. In general, the pattern of fishing in IVa appears to be a better reflection of what was actually happening in the fishery. Otherwise, the general distribution of catches was similar to 1995 to 1998 suggesting that the pattern and timing of the pre-spawning migration remains relatively constant. Slightly more catches were apparently taken in the English channel area in 1999 than 1998. The catch distribution is shown in Figure 2.8.1.1.

Second Quarter 1999

Catches during this quarter totalled about 51,540 tonnes, down slightly from 1998.The general distribution of catches was slightly different to 1998. The catches taken in international waters east and north of the Faroe Islands was reduced. Similar fishing patterns to 1998 were apparent west of the British Isles and around the Iberian peninsula. Catches in the North Sea were spread over much more of the area than in 1998. The catch distribution is shown in Figure 2.8.1.2.

Third Quarter 1999

Catches during this quarter totalled about 168,300 tonnes, up by around 20,000 tonnes from 1998. The general distribution of catches was slightly different to 1998.The main catch areas were in the area west of Norway and in Faroese and international waters in the Norwegian Sea, the distribution here was very similar to 1998. The increased catches taken around Scotland were substantially reduced, as were catches along the Portuguese coast. As in the second quarter, the North Sea catches were more widely spread. There were signs of an increase in catch along the Dutch coast. The catch distribution is shown in Figure 2.8.1.3.

Fourth Quarter 1999

Catches during this quarter totalled about 163,000 tonnes, down by 10,000 tonnes from 1998. 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 suggestion of reduced catches NW of Scotland and NW of Ireland. Increased catches could be seen in the English Channel, from the Western Approaches through to the Dutch coast. The catch distribution is shown in Figure 2.8.1.4.

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

2.8.2 Distribution of juvenile mackerel

Surveys in winter 1998/1999 & 1999/2000

The juvenile distribution data made available to WGMHSA in 1999 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 1998 and 1999

No data were available for the North Sea, data for the Western Approaches and Biscay have been added. For age 0 fish in 1998 there were high catch rates off NW Ireland and area off the north Portuguese coast (Fig. 2.8.2.1 left). Low catches were recorded in the Hebrides and Celtic Sea areas. Reasonable catches were taken in the central part of Biscay. In 1999, (Fig. 2.8.2.1 right) catch rates remained high off NW Ireland, but were reduced off Portugal. There were suggestions of larger catches in both the Celtic Sea and Biscay in 1999.

Low abundances were recorded for 1 year old fish throughout most of the area surveyed in 1998 (Fig. 2.8.2.2 left). The area off the north Portuguese coast, showed reasonable catches, although this was slightly down from 1997. Reasonable catches were also taken in Biscay, although this cannot be compared to 1997 as no survey data were available for this area. The situation had changed considerably by 1999 (Fig. 2.8.2.2 right). Much better catch rates were recorded in NW Ireland and in Biscay. One good catch was taken in the north of Scotland. Catch rates off Portugal were well down on 1998.

First quarter 1999 & 2000

The catch rates in this quarter in 1999 were better than those in 1998 (Fig. 2.8.2.3 left). Good catches of 1 year old fish were taken in Shetland and NW Irish waters, however catch rates in the Celtic Sea area were similar to 1998. The situation improved again in 2000 (Fig. 2.8.2.3 right). Good catches were seen in NW Ireland and off the Hebrides. Large catches were recorded in the extreme north of the North Sea. Previous observations would suggest that these were likely to be western fish and not from the North Sea. Very good catches were also seen in the Celtic Sea and the Western Approaches. Good catches of 1 year old fish were taken in the central N. Sea in 1998, but data for this area were unavailable for this report.

There were very good catches of 2 year old fish throughout the area in particular around Shetland, the Hebrides, south west of Ireland and off Cornwall (Fig 2.8.2.4 left). Very few young fish were seen in the main part of the North Sea. The catch rates remained high in 2000 (Fig 2.8.2.4 right), particularly off the Hebrides and Cornwall, but good catches were also taken in the Celtic Sea and the Western Approaches. Fewer fish were caught near the Shetlands.

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 (see Section 3.3.2.2.).

Trends in survey results

It is possible to describe a few key changes over the last few years.

In quarter 4 the “hot spot” near the Spanish Portuguese border has reduced significantly from 1997. High catches continued to be recorded of NW Ireland for all ages and in both quarters. Catch rates west of Ireland and the Hebrides were much improved from 1997 and previous years. Catch rates in Biscay improved particularly for age 1 fish in 1999. In quarter 1 better catch rates of 1 year old fish were recorded in Shetland waters in 1999, and particularly 2000. Large numbers of age 2 fish were caught from the Celtic Sea to Shetland in 1999 & 2000, continuing the pattern seen in 1998. Based on recent trends (ICES 1998/Assess:6, ICES 1999/ACFM:6 & ICES 2000/ACFM:5), it might suggest that 1999 should be another reasonable year for recruitment. The only major downward trend was in the area off Portugal.

It should be noted that the problems of inadequate coverage, at least in the 4th quarter, have mostly been solved in 1999 & 2000, due to co-ordination of the western IBTS surveys. It is expected that valid bottom trawl surveys will continue to be carried out over the bulk of the western area, and the results made available to this working group.

2.8.3 Distribution and migration of adult mackerel

Acoustic surveys

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

- An acoustic survey by the Marine Laboratory Aberdeen, January 2000. The survey covered the shelf break area from the NW of the Hebrides (approx 61°N 6°W) to Viking Bank (approx 60°N 3.5°E),
- An acoustic survey by the Institute of Marine Research Bergen in October/November1999. This covered the shelf break area between the Viking and Tampen Banks (approx 60°N 3.5°E to 61°30N 2°E).
- A two part acoustic survey was carried out by IEO in ICES Sub-divisions VIIe and VIIh and also in sub-divisions VIIIc and IXa, in March and April 2000.

The MLA survey showed that the bulk of the fish were seen at the western end of the survey area. A secondary concentration was seen NW of the Shetlands. No fish remained in the over-wintering area near the Viking Bank (Figure 2.8.3.1). The survey showed unequivocally that the migration of the mackerel out of the North Sea was much earlier in 2000 than has been seen in recent years. These results should be compared with the confidential information from commercial vessels presented below.

The IMR survey showed that in the latter part of 1999, there were substantial concentrations of mackerel along the shelf break area between the Viking and Tampen Banks (approx 59°N 3.5°E to 61°30N 2°E). A provisional estimate of approximately 1,000,000 t of mackerel was made. The fish were slightly further north than in recent years but no evidence of major migration movements was seen.

Together these two surveys suggest that the mackerel migration has switched from mid February in recent years to some time between the end of November and the end of December.

The IEO surveys were primarily targeted on sardine, however, the most common species observed was mackerel. In division VII substantial numbers of young fish were seen off Cornwall and Cap Finisterre (Figure 2.8.3.2.). Mackerel were ubiquitous throughout the Cantabrian Sea, and some were seen in the north of IXa (Figure 2.8.3.3.). There were more adults in this area, particularly in the centre of the Cantabrian Sea. These are assumed to be adults which migrated in from the north. Large numbers of juveniles were also seen in this area. This is in contrast to the findings of the trawl surveys. However, these are carried out early in the fourth quarter, and probably more importantly, use a different gear to most other bottom trawl surveys. This *Baka* gear is towed slowly, and has a very low headline height. Comparative studies indicate that it is very poor at catching mackerel. This acoustic survey underlines this problem, and suggests that large numbers of juvenile mackerel are to be found in the Cantabrian Sea which are not seen in other surveys (see Sections 2.8.2. and 3.3.2.3).

Aerial Surveys

Four aerial surveys for mackerel in the Norwegian Sea have been carried out during the summer 1997 –2000 by the Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO – Murmansk, Russia). These surveys were 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 bioproductivity and the availability and distribution of other marine organisms (sea mammals and birds). Distribution maps from the surveys are presented in Figure 2.8.3.4.).

The surveys use visual and video techniques to quantify the mackerel aggregations which occur very close to the surface in this area and at this time. The survey in 2000 produced the following major conclusions;

The feeding migration to the southern Norwegian Sea began 7-12 days later than in previous years, and was mainly to the east of the area surveyed. Movements of mackerel aggregations from the Norwegian EEZ to international waters were local, short-term, unstable and partial in character.

The number of surface feeding mackerel schools was considerably reduced in 2000, while the number of schools in the depth band 5-20 m increased. This had some impact on the accuracy of the mackerel biomass estimation. However, initial estimates suggest that the total mackerel biomass entering the Norwegian Sea was similar to 1999.

Summarised results for the four surveys are presented in the text table below.

Year	Study Period (duration)	Total study area (miles x 10^2)	Area where mackerel schools were observed (miles x 10^2)	Total area of locations of the maximum mackerel aggregations (miles x 10^2)	Estimation of mackerel biomass ($x10^6$)
1997	22.07-30.07 (9 days)	55.000	22.500	11.700	Not determined but the possibility to do it was supported
1998	06.07-15.08 (25 days)	115.000	47.000	12.500	2,5
1999	06.07-10.08 (35 days)	215.000	56.000	13.000	2,5
2000	13.07-18.08 (37 days)	255.000	60.000	13.200	2,43 (preliminary data)

The working group agreed that these surveys represented an important innovation, and that they were particularly appropriate in this area and at this time, due to the very shallow distribution of many of the mackerel schools. It was felt that a wider geographical coverage involving aircraft and vessels from other countries would be highly desirable to clarify the migrations of the mackerel at this time of the year.

Inferences from commercial data

Commercial catch locations and tonnages were obtained from fishing vessels from a number of EU countries. The data was obtained from the skippers direct, usually by interview or being given access to private diaries. The data are considered as confidential and are not held with vessel identifications. Data were available for four winter fishing seasons: 96/97, 97/98, 98/99 & 99/2000. Most of the fishing activity took place in the first quarter and the analysis was based on this period. The data were divided into half month periods to follow the progress of the migration as tracked by the commercial fleet (Reid WD 2000).

The plot in Figure 2.8.3 5 represents a synthesis of these data using the mean latitude and longitude of all hauls for each half month period (January to March) by year. The main observations are that in 1997 and 1998, the fishery started in the northern North Sea, and moved westwards after the second half of February. In 1999 the pattern changed. In the first half of January, the fishing location was similar to the previous years. In the second half of January, the fishery was found much farther west (around 6°W). In the first half of February, the fishery moved back east, and was very similar to 1997 and 98. The sudden shift in the second half of January is believed to be a result of a large group of mackerel moving rapidly out of the North Sea at this time. There was some evidence in the late February fishery that the remainder of the stock also moved west earlier than in previous years.

In 2000 the pattern of the fishery changed dramatically. The fishery in the first half of January was found at about 6°W, approximately 200 miles further west than previously. The fishery continued for the next six weeks in the area of the Hebrides and then moved to the normal March areas west of Ireland.

These data are summarised in Figure 2.8.3.6. The percentages of catches and tonnes east and west of the 4°W longitude are plotted against year. Both plots show an obvious progression over the four years, with the effort and catch shifting steadily from ICES Division IVa to VIa.

These observations confirm the findings of the Scottish acoustic survey that the spawning migration in 2000 occurred much earlier than in previous years, and that this may well have been a progressive change over the last four years. It was agreed that where other members of the WG have access to similar data they should be encouraged to forward them (in confidential form) to MLA for inclusion in the analysis.

2.9 Recruitment forecasting

No further work was carried out on recruitment forecasting prior to or at the meeting.

2.10 State of the stock

2.10.1 Data exploration and Preliminary Modelling

The sensitivity of the ICA model to different weightings to the SSB's from egg surveys was tested by applying weightings of 1 and 10 compared to a weighting 5 as was used at last years WG. All other input parameters were kept the same as at last years WG except the period of separable constraint was extended with one more year to include the whole period of SSB's from egg surveys (Table 2.10.1.1). The result of this exercise was that the assessment of this year showed to be very stable. The SSB's in the last year differed only less than 0.3% with weightings of 1 and 10 compared to a weighting of 5. This could be caused by the fact that there are catch at age data now available one year after the biomass estimate from the last egg survey.

As last year some exploratory runs were done with the recently developed AMCI model (Skagen, WD 2000). This model has a population model with a fishing mortality model that basically is separable, as has ICA, but it has a wider range of options with respect to modelling the relation between population and model and a wider range of objective functions. It can relax the assumption that the fishing mortalities are separable by allowing for recursive updating of the fishing mortalities, by which the selection pattern can change slowly, and it allows for using tag return data as a source of information about mortalities, in addition to survey indices and indices of spawning biomass. It gives more feedom to choose which parameters to estimate, including estimation of mortalities and abundances in separate steps using different objective functions. Some of these options were applied with the mackerel data, to get an impression of the range of uncertainty due to model specification. The data used were those used for the final assessment.

The following options were examined:

1. A key run, using the catches at age, SSB estimates and tag return data, with a log sum of squares as objective function for the catches and SSB's, and a modified Poisson likelihood function for the tag return data, SSB-measurements were considered as relative. A slowly changing selection pattern was assumed.
2. An 'ICA like' run run, using a fixed selection pattern for the last 8 years, taken from the current ICA assessment, and without using the tag return data.
3. As 1, but without using SSB data.
4. As 1, but with a high weight given to SSB data.
5. As 1, but without using the tag return data.
6. As 1, but with a stepwise estimation of parameters. First, fishing mortalities were estimated keeping the recruitments fixed, by comparing modelled and observed log(C(a,y)/C(a+1,y+1)) as well as tag returns, using a modified Poisson likelihood function for both. Next, recruitments were estimated keeping the mortalities fixed, with log sum of squares as objective functions for catches and SSB measurements. The process was repeated until convergence.

The results are shown in Figure 2.10.1.1 together with the outcome of the final ICA run. The results may give some impression of the robustness of the results to the choice of model assumptions. It seems less certain that SSB has increased in recent years as rapidly as the final ICA assessment indicates. Moreover, estimating the mortalities separately from the stock numbers suggest that the mortality may have been lower, and the SSB correspondingly higher in the past than indicated by the VPA part of ICA. Figure 2.10.1.2 shows the results of a non-parametric bootstrap of the catch and SSB residuals in Run 1, indicating the range of the results caused by the likely noise in the data. Figure 2.10.1.3 shows the selection pattern by year, normalised to the average F4-8, in Run 1, indicating a shift towards heavier exploitation of the older fish after 1992.

For the first time other exploratory runs were carried out by means of ISVPA. Implementation of egg survey based estimates of SSB for Northeast Atlantic mackerel in stock assessment is a traditional point of consideration for the WG. In previous years the SSB estimates based on catch-at-age analysis were generally lower than estimates based on egg surveys for recent years. It was stated (ICES, 1999) that this may be because the egg surveys overestimate the stock, the converged catch-based assessment underestimates the stock or both. In order to reveal tendencies in stock size determined by catch-at-age data only a separable model named ISVPA (Vasilyev, 1998; 1998a; 2000; Vasilyev *et al*., 2000) was also implemented. This model may be advantageous in the deficit of auxiliary information since its parameter estimation procedure incorporates some principles of robust statistics (it is based on minimization of median of distribution of squared residuals in logarithmic catches. It always guarantees zero sums of residuals within ages and years, what helps to diminish e influence of errors (noise) in catch-at-age data on the results if the assessment. Besides that for ISVPA it is not necessary to use any preliminary assumptions about the age of unit selectivity and value of selectivity for this and oldest ages (the only assumption used is that selectivity for oldest age is equal to that of previous age). The results of ISVPA are totally based on catch-at-age data and free from survey estimates, which may still determine the results in ICA-like methods even when supplied with very low weights if catch-at-age data per se reveals no minimum.

In the ISVPA runs the input data were taken just the same as for the ICA run but, as was mentioned above, no survey data were used. Another difference between ICA and ISVPA runs is that for ISVPA the whole time interval (1984-1999) was considered as separable and was ascribed by single selectivity pattern. For comparison the ISVPA-derived estimates of selectivity pattern were also produced separately for two periods: 1984-1991 and 1992-1999. The ISVPA-derived estimates of selection pattern are compared to ICA results in Figure 2.10.1.4.

ISVPA parameter estimation revealed distinct minimum of loss function with respect to terminal effort factor (Figure 2.10.1.2). The results of stock assessment by means of ISVPA are given in Tables 2.10.1.1-4 and compared to results of ICA run on Figures 2.10.1.6-9. The results obtained by ICA and ISVPA in general are rather similar and regardless of implementation of egg survey SSB estimates in assessment support the perception that Northeast Atlantic mackerel stock is in a good state in recent years.

The assessment method is robust to the analysis method used. Therefore the WG decided to continue to use ICA for the standard assessment.

2.10.2 Stock Assessment

Tables 2.10.2.1 to 2.10.2.5 show the catches in number, the SSB index values used in the assessment, the mean weights at age in the catch the mean weights at age in the stock, and the proportion of fish spawning. Natural mortality was again assumed to be 0.15 for all age groups.

ICA fits to the catch at age data and the egg production estimates were used to examine the relationship between the indices and the catch at age data as estimated by a separable VPA. 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 8 years to include the SSB index time series over the period 1992-1998. 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:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=1999}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S_a.\overline{N}_{a,y}))^2 +$$
$$\sum_{y=1992}^{y=1999}\sum(\ln(EPB_y) - \ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S_a - PM.M))^2$$

subject to the constraints

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

where

N - mean exploited population abundance over the year.

N - population abundance on 1 January.

O - percentage maturity.

M - natural mortality.

F - fishing mortality at age 5.

S - selection at age over the time period 1992–1999, 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 - the ratio between egg estimates of biomass and the assessment model of biomass

Tables 2.10.2.6, 2.10.2.7 present the estimated fishing mortalities, population numbers-at-age. Table 2.10.2.8a,b,c,d,e and Figures 2.10.2.1–2.10.2.4 present the ICA diagnostic output. The stock summary is presented in Table 2.10.2.9.

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. This is still the case.

The problem of assessing the stock with very little supplementary data, which also has been pointed out previously, is still serious. Two years ago, the problem was to obtain a stable stock estimate when the last independent information was far back in time, the last two 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, can only be explained by recent strong year classes coming into the spawning stock, while there is no clear evidence yet that this is the case. This year different weighting factors of 1 and 10 appeared to have no significant effect on the predicted SSB in the last year, which indicates that the catch in number at age data contain information on strong year classes coming into the fishery in recent years.

Estimates provided by the AMCI model also uses the large data set of Norwegian tags 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 first time from the ISVPA. These results also provide a perception of the stock which is in line with that from ICA.

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 13 - 18%, which is slightly better than in the last assessment done in 1999. The 1998 and 1999 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 - 1999), are shown in Figure 2.10.3.1. 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.

Estimates of uncertainty in future stock and catches by a non-parametric bootstrap method are given in Section 2.12.1. This approach takes the point estimates of stock numbers and fishing mortalities from ICA, with the option that recruitment estimates for the youngest ages may be substituted with other values. The CVs of the numbers at age, which are derived from the optimisation process in ICA, are used in a parametric bootstrap to provide stochastic starting values for projections. Thus, the distribution of SSBin the first prediction year is indicative of the uncertainty of the parameter estimation by the ICA assessment. This uncertainty assumes a lognormal distribution, and does not necessarily reflect the uncertainty in model specification. It should also be noted that these distributions will be biased, i.e. the mean of the lognormal distribution will not coincide with the point estimate, since the log-transform is non-linear. Correction for this bias is not straightforward and has not been attempted.

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 2000 (age 0) and year class 1999 (age 1), the ICA-estimated abundances in 2000 (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 2000:

Age 0 No recruitment indices are available for the 2000 year class. The geometric mean was used for the 2000 recruitment. The value of 4252 million fish is calculated from the geometric mean (1972-1996) of recruitment to the Western mackerel, raised by the ratio (1.156) of the estimated Western and North East Atlantic mackerel recruitments for the period 1984-1996.

Age 1 The recruitment at age 1 is taken to be the geometric mean recruitment (4252 million fish) brought forward 1 year by the total mortality at age 0 in that year.

Recruitment at age 0 in 2001 and 2002 was also assumed to be 4252 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 the unregulated catches taken in international waters, Division IIa; “Northern” area reflects all areas except Div. 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 the ratio *status quo* F (1997-1999) 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 1997–1999. Weight at age in the catch was taken as an average of the values for the period 1997–1999 for each area. Weight at age in the stock was calculated from an average (1997–1999) of weights at age for the NEA mackerel stock.

The catch for 2000 is assumed to be 652,000 t, which corresponds to the TAC in 2000 (see Section 2.1) plus an expected additional catch of 40,000 t in international waters.

Predictions were made in an Excel spreadsheet and it was checked that the predictions from the spreadsheet resulted in exactly the same numbers as the ICES prediction program.

Eight single option summary tables are presented and summarised in the text tables below. In addition Table 2.11.3 refers to 4 options with a catch constraint of 652 kt in 2000 and to 4 options with *status quo* fishing mortality (Fsq = 0.185) in 2000. Each of these two options for 2000 are then followed by:

F2001 = F2002 = 0.15 corresponding to earlier EU-Norway agreements;
F2001 = F2002 = 0.17 corresponding to F_{pa} and the EU-Norway agreements for 2001;
F2001 = F2002 = 0.185 = Fsq corresponding to the mean fishing mortality for the period 1997–1999;
F2001 = F2002 = 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 2000 = 652 kt F=0.15 2001,2002			Catch 2000 = 652 kt F= F_{pa} = 0.17 2001,2002			Catch 2000 = 652 kt F= F_{sq} =0.185 2001,2002			Catch 2000 = 652 kt F= 0.20 2001,2002		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2000	0.174	652	3952	0.174	652	3952	0.174	652	3952	0.174	652	3952
2001	0.15	599	4008	0.17	673	3981	0.185	728	3961	0.20	782	3940
2002	0.15	612	4020	0.17	677	3934	0.185	723	3871	0.20	767	3809

UNITS: ‘000 t

	Status quo (F97-99=0.185) F=0.15 2001,2002			*Status quo* (F97-99=0.185) F= F_{pa} = 0.17 2001,2002			*Status quo* (F97-99=0.185) F= F_{sq} =0.185 2001,2002			*Status quo* (F97-99=0.185) F= 0.20 2001,2002		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2000	0.185	705	3933	0.185	705	3933	0.185	705	3933	0.185	705	3933
2001	0.15	592	3966	0.17	665	3939	0.185	719	3919	0.20	773	3899
2002	0.15	606	3986	0.17	670	3900	0.185	716	3838	0.20	760	3776

For options F = 0.15 the forecasts for 2001 and 2002 predict that SSB will increase compared to 2000.
For options F = 0.17 the forecasts predict that SSB will remain stable in 2001 and 2002 compared to 2000.
For options F = $F_{status\ quo}$ = 0.185 the forecasts predict that SSB will be stable in 2001, but decrease in 2002 compared to 2000.
For options F = 0.20 the forecasts predict that SSB will decrease in 2001 and 2002 compared to 2000.

A detailed multifleet prediction table is presented in Table 2.11.4 for the $F_{status\ quo}$ =0.185 in 2000-2002.

Two multifleet management option tables are presented. Table 2.11.5 presents the option for *status quo* F in 2000 and Table 2.11.6 presents the option of a catch constraint of 652 kt in 2000; each is followed by a range of F_{2000} values for both areas.

The forecasts of SSB in 2000 and 2001 for the two scenarios are only slightly higher compared to the predicted SSB values last year, because the SSB obtained from the 1998 egg surveys was high and strong year classes seem to recruit to the adult population. However, a main revision is expected to take place when the SSB biomass from the 2001 egg survey will become available in 2002.

2.12 Medium term

2.12.1 Stochastic predictions

Medium-term 10-years forward projections of the stock, were performed using a medium term projection program which mimics the WGTERM projection software currently used at ICES. Estimates of uncertainty in future stock and catches, based on a non-parametric bootstrap method, were used to examine the implications of using a constant exploitation pattern with Fsq (ages 4 – 8 = 0.185) from 1999 to 2008. A thousand stochastic projections were done under the following assumptions:

- The population state and fishery selectivities were initialised in 1999 according to the parameter estimates from the final ICA assessment. An F scaling factor was added to ensure that the stochastic estimates of SSB and catches for 2000 are consistent with the results from the deterministic predictions (section 2.12.1).

- The stock-recruitment relationship used which assumes constant recruitment above a SSB threshold and recruitment declining linearly below the threshold (Occam form) is shown in Figure 2.12.1.1. The threshold was defined equal to 2.348 million tons, the lowest estimated SSB in the Western mackerel SSB time series (1972 - 96) scaled by the ratio of the mean of the NE Atlantic SSB to the that of the Western component (1984 - 96). The horizontal component of the SRR was defined by the geometric mean of the Western mackerel recruitment time series (1972 - 96) scaled by the ratio of the geometric mean of the NE Atlantic to the Western recruitment (1984 - 96). Independent recruitments were drawn using a non-parametric bootstrap of the log residuals from this relationship (1972 - 96).

- Recruitment in years 1999 and 2000 were drawn from the SRR because ICA estimates are not reliable for these years.

- 2000 fishing mortality was taken to be Fsq = geometric mean (1997- 99) = 0.185.

- The maturity ogive, stock weights at age, and catch weights at age were held constant at the 1997-99 mean.

Results are summarised in Figure 2.12.1.1. The SSB trajectory under Fsq suggests that the stock would initially increase as a result of the current age structure of the population, and will then stabilise at a slightly lower level. The decrease is the result of the numbers at age in the population being gradually replaced by the bootstrapped recruitment values. However, even under the more pessimistic scenario considered, the projected biomass would be above SSB_{pa} (2.3 million tons) in 2008 under the constant F = Fsq policy applied. The expected catches would peak towards the year 2001 with values lying between 657 and close to 800 thousand tons, based on the 5% and 95% percentiles. On the same basis, catches are predicted to fall between 550 and 800 thousand tons by the end of the projection period. Spawning biomass trajectories for a range of F multipliers between 0.5 and 1.5 for the years 2003 and 2008 are shown in Figure 2.12.1.2. Those results suggest that if fishing mortality is kept at the level of Fsq there is a probability of of the spawning biomass falling bellow Bpa that is <5% in the medium term. It should also be noted that the uncertainty in these projections is conditional on the structural accuracy of the ICA model and the subset of uncertainty included in the projection program input. The uncertainty in a number of parameter estimates, i. e. fishing mortality pattern, and data such as weight at age in the catch and in the stock, were not taken into account in the projections. Therefore, the stochastic scenarios presented need to be interpreted cautiously, as uncertainty is likely to have been under-estimated.

2.12.2 Deterministic predictions

The question of multi-annual TACs for the NE Atlantic mackerel was raised by ACFM. To address that request five-year medium term deterministic predictions were conducted to test the sensitivity of the predicted SSB and the catches to variations in recruitment level. The predictions were conducted under conditions of constant recruitment (in numbers) equal to: a) 5000 million, b) geometric mean recruitment = 4252 million and c) constant recruitment = 3000 million, where values in a) and b) are arbitrary. Four constant harvesting policies F = 0.15, F = 0.17, Fsq (ages 4 - 8 = 0.185) and F = 0.2 were compared in Figures 2.12.2.1 to 2.12.2.4. Fishing mortality in the year 2000 is equal to Fsq in all scenarios considered. The results suggest that under those conditions it is unlikely that the predicted biomass would fall below Bpa (2.3 million tons) in the coming 5 years.

2.13 Long-term yield

Table 2.13.1 and Figure 2.13.1 present the yield per recruit forecasts for the combined North East Atlantic Mackerel stock. 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 0.186.

The time series of stock and recruitment estimates for North East Atlantic management unit is short (1983-1996). Thus the estimates of F_{med}, F_{high} and F_{low} for short time series will be unreliable. Therefore, these estimates were obtained from the longer time series of the Western Mackerel, i.e. from 1972 and onwards, raised to the North East Atlantic Mackerel.

The SSB was defined as the SSB of the Western mackerel SSB time series (1972 - 96) scaled by the ratio of the mean of the NE Atlantic SSB to that of the Western component (1984 - 96). The recruitment was defined as the recruitment of the Western mackerel recruitment time series (1972 - 96) scaled by the ratio of the geometric mean of the NE Atlantic to the Western recruitment (1984 - 96).

A stock-recruitment plot is presented in Figure 2.13.1.

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). The values of the reference points calculated in 1999 were similar to the values used previously by the Working Group (text table below).

ACFM 1999 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:

$\mathbf{F}_{lim}$: $\mathbf{F}_{loss}$: 0.26	$\mathbf{B}_{pa}$: $\mathbf{B}_{loss}$: 2.3 million t.
	$\mathbf{F}_{pa}$ = $\mathbf{F}_{lim}$ x 0.65. $F_{0.1}$ = 0.17

$F_{0.1}$ was estimated to be 0.186 in the present assessment compared to 0.189 in 1999.

The Working Group will await until the full catch at age time series of the North East Atlantic Mackerel stock back to 1972 is available (probably to the 2001 Working Group Meeting), before new reference points are evaluated.

2.15 Management Measures and Considerations

Last years and this years assessments indicate that the stock is larger than predicted in the previous years and is the largest in the time series. According to this estimate, the stock is now well above Bpa and is harvested just below Fpa. 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. In particular, the abundance of the youngest year classes is poorly substantiated, and the predictions are heavily dependent on these.

The agreement between EU and Norway in1999 is to maintain in 2000 a fishing mortality of 0.17, unless advised otherwise. 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 Working Group once again has to emphasise that the fishing mortalities derived from studies of predictions and simulations apply to the total exploitation of the stock, including areas where no quota regulations apply.

The forecasts of SSB in 2000 and 2001 for the two scenarios of F status quo and a catch constraint of 652,000t are only slightly higher compared to the predicted SSB values last year. This is because the SSB obtained from the 1998 egg surveys was high and strong year classes seem to recruit to the adult population. However, a major revision of SSB might take place when the SSB biomass from the 2001 egg survey will become available in 2002 and will be used to predict the catches in 2003. The catch predictions for 2002, which would be made at next years working group, are expected to be similar to this years prediction for 2002, since both use the same last SSB from the 1998 egg survey. Therefore a multi-annual TAC might be considered for the period 2001 and 2002. The effect of incoming recruitment to catches, F’s and SSB’s in 2002 is demonstrated by including two additional arbitrary values of recruitment (3000 and 5000 million recruits at age 0) in the prediction over the period 2000-2005 (Figures 2.11.1-4). The predictions for 2002 do not appear to be very sensitive to the strength of the incoming year classes 1999-2001.

These catch forecasts are based on the assumption that the exploitation patterns in each area, which are very different, as well as the partial fishing mortality levels, will be maintained. 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 1997–1999. This split by area should only be regarded as an example, because the split could also be based on other criteria**.** If necessary, advise 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

In 1999 (ICES 2000/ACFM:5) presented a sensitivity analysis for *status quo* forecasts made using data from the North East Atlantic Mackerel stock. The results revealed that the forecasts were sensitive to the accuracy of the estimated fishing mortality in 2000. Since this years assessment is just an extension of last years assessment updated with catches in the 1999, the Working Group felt that a sensitivity analysis was not needed this year.

Table 2.1.1 The TACs agreed by the various management authorities and the advice given by ACFM for 1999 and 2000.

Area	Agreed TACs in 1999	Agreed TACs in 2000	Stock components	ACFM advice 1999	ACFM advice 2000	Areas used for allocations	Catch in 1999
IV, IIIa	62,455	69,725	North Sea	Lowest possible level	Lowest possible level	IIa, IIIa, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV	565,100
Iia	111,350	124,710	Western	Significant reduction in F	Reduce F below $F_{pa} = 0.17$		
Vb, VI, VII, VIIIa,b,d,e, XII, XIV	310,810	348,110					
Vb, IIa, IVa - Faroese EEZ	35,850	30,000					
VIIIc, IXa	35,000	39,200	Southern	Significant reduction in F	Reduce F below $F_{pa} = 0.17$	VIIIc, Ixa	43,800
Total	555,465	611,745					608,900

Table 2.2.2.1 Catches of MACKEREL by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions			Sub-area IV and Division IIIa			Divs	Divs. VIIIc	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

*Preliminary.

[1]For 1976–1985 only Division IIa.
[2]Discards estimated only for one fleet in recent years.
§ 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 2.2.2.2 Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb). (Data submitted by Working Group members.)

Country	1984	1985	1986	1987	1988	1989
Denmark	11,787	7,610	1,653	3,133	4,265	6,433
Faroe Islands	137				22	1,247
France		16				11
Germany, Fed. Rep.			99		380	
German Dem. Rep.			16	292		2,409
Norway	82,005	61,065	85,400	25,000	86,400	68,300
Poland						
United Kingdom			2,131	157	1,413	
USSR	4,293	9,405	11,813	18,604	27,924	12,088
Discards						
Total	98,222	78,096	101,112	47,186	120,404	90,488

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[1]
Denmark	6,800	1,098	251			4,746	3,198	37	2,090	106
Estonia			216		3,302	1,925	3,741	4,422	7,356	3,595
Faroe Islands	3,100	5,793	3,347	1,167	6,258	9,032	2,965	7,628	2,716	3,011
France		23	6	6	5	5	0	270		
Germany							1			
Iceland							92	925	357	
Ireland										100
Latvia			100	4,700	1,508	389	233			
Netherlands							561			661
Norway	77,200	76,760	91,900	110,500	141,114	93,315	47,992	41,000	54,477	53,821
Russia			42,440	49,600	28,041	44,537	44,545	50,207	67,201	51,003
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	105,449	134,219	72,848

[1]Preliminary for 1999
[2]Russia.

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

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

Country	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	102	191	351	106	62	114	125	177
Denmark	41,719	42,502	47,852	30,891	24,057	21,934	25,326	29,353
Estonia	400					-	-	
Faroe Islands		11,408	11,027	17,883	13,886	1,367	4,832	4,370
France	956	1,480	1,570	1,599	1,316	1,532	1,908	2,056
Germany, Fed. Rep.	4,610	4,940	1,479	712	542	213	423	473
Iceland								357
Ireland	13,136	13,206	9,032	5,607	5,280	280	145	11,293
Latvia	211					-	-	
Netherlands	6,547	7,770	3,637	1,275	1,996	951	1,373	2,819
Norway	115,700	112,700	114,428	108,890	88,444	96,300	103,700	106,917
Sweden	5,100	5,934	7,099	6,285	5,307	4,714	5,146	5,233
United Kingdom	35,137	41,010	27,479	21,609	18,545	19,204	19,755	31,578
Russia						3,525	635	345
Romania			2,903			-	-	
Misreported (IIa)			109,625	18,647	-	-	-	40,000
Misreported (VIa)	127,000	146,697	134,765	106,987	51,781	73,523	98,432	59,882
Unallocated	13,566	-	-	983	236	1,102	3,147	4,946
Discards	2,980	2,720	1,150	730	1,387	2,807	4,753	
Total	367,164	390,558	472,397	322,204	212,839	227,566	269,700	299,799

[1]Preliminary for 1998

Table 2.2.2.4 Catch (t) of MACKEREL in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e). (Data submitted by Working Group members).

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

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999
Denmark	1,573	194		2,239	1,443	1,271	-	-	552
Estonia					361		-	-	
Faroe Islands	4,095		2,350	4,283	4,248	-	2,158	3,681	4,239
France	10,364	9,109	8,296	9,998	10,178	14,347	19,114	15,927	14,311
Germany	17,138	21,952	23,776	25,011	23,703	15,685	15,161	20,989	19,476
Ireland	64,827	76,313	81,773	79,996	72,927	49,033	52,849	66,505	48,282
Netherlands	29,156	32,365	44,600	40,698	34,514	34,203	22,749	28,790	25,141
Norway			600	2,552			-	-	
Spain	4,020	2,764	3,162	4,126	4,509	2,271	7,842	3,340	4,120
United Kingdom	162,588	196,890	215,265	208,656	190,344	127,612	128,836	165,994	127,094
Unallocated	-3,802	1,472	0	4,632	28,245	10,603	4,577	8,351	9,254
Misreported (IVa)	-130,000	-127,000	-146,697	-134,765	-106,987	-51,781	-73,523	-98,255	-59,982
Discards	23,550	22,020	15,660	4,220	6,991	10,028	16,057	3,277	
Grand Total	183,509	236,079	248,785	251,646	270,476	213,272	195,820	218,599	192,486

[1]Preliminary

Table 2.2.2.5 Landings (tonnes) of mackerel in Divisions VIIIc and IXa, 1977–1999. 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
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
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
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
Poland[2]	-	-	-	-	-	-	-	-	-	-	-	
USSR[2]	-	-	-	-	-	-	-	-	-	-	-	
Total[2]	7,928	4,875	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693	7,990	6,165
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

[1]Division VIIIc.

[2]Division IXa.

Table 2.2.2.6 Catches of mackerel by Division and Sub-area in 1999.
(Data submitted by Working Group members.)

Area \ Quarter	1	2	3	4	Total
IIa & Vb	2,714	4,417	63,613	2,104	72,848
IIIa	376	287	2,903	1,856	5,422
IVa	67,553	644	101,026	116,071	285,295
IVbc	1,356	563	4,124	3,038	9,082
VI	74,291	10,825	249	13,300	98,666
VII	38,863	19,388	4,712	24,183	87,147
VIIIabde	3,105	2,018	100	1,452	6,674
Sub total	188,259	38,142	176,727	162,005	565,133
VIIIc	17,254	18,112	907	1,358	37,631
IXa	1,000	569	3,298	1,298	6,165
Grand Total	206,512	56,824	180,932	164,661	608,929

Table 2.2.3.1 Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-1999.

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Spain	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427	247	778	362	1218	632
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416	1753	414
	VIIIc west															47	610	12	3
	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026	1765	418
	IXa North												2557	7560	4705	5066	1727	412	104
	IXa South											895	800	1013	364	370	613	969	879
	Total	0	0	0	0	0	0	0	0	0	0	895	3357	8573	5068	5437	2340	1381	983
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903	7872	8894	7729	4364	2033
Portugal	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481	296
	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414	10407
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779	1578	1427	1749	2778	2796	3173
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759	5408	6690	13877

Table 2.4.5.1 Catch in numbers at age (000's) for NE Atlantic mackerel

Quarters 1 to 4

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	IXa	Total
0	0	0	0	0	0	5,874	63,968	0	10	17	7,314	0	0	0	20	0	0	0	0	7	0	0	77,208
1	1	19	48	2,585	8,511	5,352	3,088	2,535	204	1,585	3,277	2	343	13,556	14,585	39	15,167	114	0	2,733	0	5	73,630
2	100	20,304	11,249	2,892	4,246	1,770	1,964	4,911	888	3,392	1,579	20	12,906	9,044	17,575	420	11,194	1,208	0	28,282	1	109	131,319
3	1,040	35,106	82,803	1,068	1,458	624	1,011	1,264	1,465	8,414	1,869	44	20,465	2,448	8,472	343	582	10,804	4	49,507	1	1,074	232,863
4	1,577	44,458	89,159	1,732	987	182	686	748	1,371	18,526	2,258	30	13,598	1,233	5,660	72	1,341	20,148	9	43,440	1	1,374	249,364
5	2,373	34,619	104,742	2,330	586	35	83	520	2,041	16,751	1,489	2	11,906	1,090	3,549	81	481	24,892	15	48,070	1	863	267,013
6	2,044	14,246	114,957	2,012	101	69	69	414	2,382	19,984	1,847	2	6,542	909	1,750	38	1,140	17,629	8	42,046	1	567	228,683
7	1,588	9,215	95,791	816	1	22	23	319	1,275	10,249	1,025	1	4,049	258	348	23	343	7,226	3	25,245	1	285	165,127
8	609	3,964	61,123	703	2	0	0	78	636	4,972	475	3	2,060	147	110	9	224	2,870	0	13,360	0	135	81,484
9	340	1,788	29,499	314	0	6	2	120	412	2,636	308	0	601	115	153	92	17	1,346	0	9,037	0	94	47,004
10	230	1,179	17,712	147	0	7	2	34	186	2,040	281	0	386	100	70	2	4	544	0	5,520	0	45	28,504
11	183	775	8,891	0	0	1	1	35	232	1,098	220	0	204	98	17	2	4	204	0	3,298	0	3	15,782
12	146	1,636	10,089	49	0	4	1	3	76	862	125	0	76	13	7	0	0	104	0	1,622	0	49	14,776
13	99	289	4,304	29	0	1	0	57	62	516	88	0	154	23	7	5	9	43	0	1,541	0	6	7,822
14	37	117	1,529	0	0	0	0	3	22	161	22	0	134	16	3	0	0	62	0	300	0	0	2,479
15	26	142	3,604	49	0	0	0	0	0	130	42	0	264	4	9	0	0	677	0	608	0	92	5,562
SOP	5,420	70,983	586,272	5,099	3,887	2,209	4,356	2,547	4,142	30,851	4,776	31	23,264	7,538	12,137	287	5,384	37,175	95	89,252	2	1,893	928,363
Catch	5,423	70,859	586,296	5,099	3,882	2,202	4,364	2,564	4,130	30,908	4,775	31	23,308	7,600	12,132	288	5,390	37,370	91	89,864	2	1,892	928,373
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	IXa	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	4	0	0	3,262	2,308	549	66	14	38	38	0	338	0	1,046	0	0	0	0	128	0	5	7,712
2	6	93	1,379	0	1,571	1,922	666	151	324	1,116	556	0	9,664	24	1,546	1	161	410	0	6,745	0	104	24,680
3	77	705	14,782	0	343	312	449	50	836	4,967	761	1	8,475	0	3,093	4	358	7,648	4	26,957	0	1,015	81,047
4	138	1,076	20,328	0	236	67	275	90	1,363	8,768	1,047	1	7,014	129	1,718	1	736	15,788	0	20,553	0	1,306	80,466
5	173	553	29,026	0	224	26	26	49	1,543	7,490	379	1	4,498	215	879	0	408	22,716	15	29,128	0	666	107,483
6	179	369	32,410	0	1	30	16	37	1,630	8,272	856	1	2,989	86	656	0	545	11,807	8	34,530	0	402	96,022
7	134	157	26,136	0	1	16	3	50	902	4,742	622	0	2,287	64	272	0	300	4,379	3	20,888	0	187	60,023
8	67	32	12,654	0	1	3	2	24	394	1,880	271	0	867	0	72	0	215	529	0	11,761	0	36	28,937
9	41	41	8,372	0	0	3	0	15	289	1,313	182	0	388	0	47	0	0	300	0	7,073	0	46	17,964
10	22	33	4,577	0	0	2	0	7	147	873	168	0	146	0	67	0	0	246	0	4,683	0	23	11,202
11	8	0	1,804	0	0	0	0	8	170	666	129	0	170	0	15	0	0	61	0	2,977	0	5	6,121
12	7	33	1,178	0	0	2	0	3	98	391	74	0	98	0	7	0	0	14	0	1,395	0	37	3,595
13	4	0	837	0	0	0	0	2	48	224	33	0	120	0	0	0	0	0	0	1,322	0	0	2,591
14	0	0	71	0	0	0	0	1	17	94	14	0	120	0	3	0	0	62	0	302	0	0	675
15	5	0	1,208	0	0	0	0	0	0	421	17	0	28	0	3	0	0	0	0	576	0	0	1,842
SOP	375	1,260	67,565	0	1,362	630	368	210	2,900	15,372	1,876	1	10,719	222	2,028	2	1,005	24,757	15	73,846	1	1,434	205,963
Catch	376	1,260	67,553	0	1,365	630	370	209	2,887	15,377	1,877	1	10,670	250	2,026	2	1,004	24,596	15	74,290	1	1,434	206,513
SOP%	100%	100%	100%	0%	100%	100%	101%	99%	99%	100%	100%	100%	100%	117%	100%	100%	100%	101%	98%	101%	102%	100%	100%

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	IXa	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	14	2	237	409	530	510	24	14	439	14	0	5	0	49	1	4	5	0	134	0	0	2,502
2	21	316	47	240	221	264	801	976	224	1,391	307	0	44	0	168	66	162	72	0	14,662	1	5	19,756
3	253	3,100	456	164	139	126	403	1,089	486	4,020	527	0	1,656	34	88	62	182	2,303	0	7,489	0	37	22,471
4	241	1,980	542	119	96	152	278	366	1,006	8,067	736	1	2,080	54	104	21	61	4,189	0	7,802	0	82	30,576
5	133	2,090	288	149	26	36	36	415	486	8,221	686	1	7,071	155	32	29	66	11,840	0	4,289	0	36	38,964
6	80	1,230	181	115	17	23	23	293	542	10,547	767	1	3,553	215	32	97	49	6,048	0	3,274	0	11	37,014
7	34	617	78	27	0	10	6	244	312	5,492	419	0	1,793	180	11	14	49	2,824	0	1,592	0	4	13,800
8	7	108	16	26	0	3	3	49	146	2,282	166	0	1,238	140	7	3	8	2,212	0	841	0	1	7,285
9	9	142	21	9	0	4	1	87	113	1,420	135	0	472	109	9	5	38	960	0	700	0	1	4,226
10	7	102	15	9	0	5	1	24	62	1,186	106	0	240	98	6	1	4	386	0	315	0	1	2,401
11	0	0	0	0	0	1	1	24	62	880	90	0	114	54	0	1	4	143	0	0	0	0	1,376
12	7	113	17	0	0	2	0	0	201	491	48	0	42	11	0	0	0	50	0	0	0	1	793
13	0	0	0	0	0	1	0	49	14	392	34	0	34	23	0	9	9	43	0	176	0	0	877
14	0	0	0	0	0	0	0	0	5	97	6	0	15	15	0	0	0	21	0	0	0	0	161
15	0	0	0	0	0	0	0	0	0	67	29	0	244	4	0	0	0	677	0	0	0	0	1,017
SOP	267	4,379	644	316	246	199	373	976	1,094	16,751	1,369	1	6,894	476	120	82	162	11,798	0	10,866	1	36	58,585
Catch	267	4,379	644	315	247	199	371	923	1,095	16,754	1,368	1	6,820	477	120	82	163	11,764	0	10,825	1	36	58,323
SOP%	100%	100%	100%	100%	100%	100%	100%	106%	100%	100%	100%	100%	101%	100%	100%	101%	101%	100%	101%	100%	99%	100%	100%

Table 2.4.1.1 (continued)

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	1,629	44,767	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	45,405
1	0	0	30	2,326	1,929	1,422	1,636	3	0	2	2,608	0	0	13	499	1	58	0	0	325	0	0	10,895
2	57	19,830	3,387	2,362	1,027	324	260	122	1	133	625	15	2,296	8	1,307	36	51	58	0	55	0	2	31,915
3	482	30,719	21,102	1,747	596	70	113	115	2	140	564	36	5,922	6	701	40	12	150	0	37	0	24	62,579
4	798	39,240	25,667	1,065	409	27	71	38	2	101	464	17	2,728	15	374	13	6	69	0	65	0	29	71,179
5	969	31,330	32,404	1,419	132	23	23	44	1	14	86	0	0	18	292	15	4	0	0	61	0	16	66,940
6	975	12,047	34,310	1,106	69	12	34	31	1	10	77	0	0	23	106	11	5	0	0	71	0	10	48,690
7	1,283	8,021	34,195	265	0	1	11	26	0	3	31	0	0	13	27	9	3	0	0	111	0	4	43,803
8	456	3,106	17,567	268	0	0	3	5	0	1	17	3	486	7	16	2	1	12	0	61	0	1	22,279
9	250	1,412	10,353	66	0	1	1	10	0	1	8	0	0	7	11	4	1	0	0	61	0	1	12,185
10	201	921	7,363	86	0	0	1	3	0	0	6	0	0	3	1	1	0	0	0	40	0	1	8,628
11	94	217	3,364	0	0	0	0	3	0	0	6	0	0	2	1	1	0	0	0	5	0	0	4,368
12	110	1,301	4,935	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	1	6,351
13	94	395	2,467	0	0	0	0	6	0	0	1	0	0	0	6	2	1	0	0	10	0	0	2,981
14	17	103	761	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	882
15	21	124	930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,074
SOP	2,902	63,575	101,020	3,015	1,110	579	2,716	98	3	107	803	22	3,253	47	635	34	38	93		248		34	180,909
Catch	2,903	63,578	101,025	3,008	1,115	579	2,719	97	3	107	801	23	3,250	47	635	34	36	93		249		34	180,932
SOP%	100%	100%	100%	100%	100%	100%	100%	101%	100%	99%	100%	100%	100%	100%	100%	101%	105%	100%		100%		100%	100%

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIe	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	4,044	9,201	0	10	17	7,305	0	0	0	20	0	0	0	0	1	0	0	20,599
1	0	0	16	0	2,921	983	307	2,412	176	1,104	936	1	0	13,543	12,567	37	15,105	108	0	2,155	0	0	52,490
2	23	63	6,438	0	1,426	91	49	3,662	323	881	49	8	1,902	6,815	14,165	326	10,790	796	0	8,991	0	0	54,849
3	279	382	26,452	37	378	17	47	0	81	287	17	7	3,487	2,406	5,603	237	0	698	0	8,024	0	7	46,455
4	849	469	42,627	606	264	6	41	264	19	170	12	2	1,269	1,036	3,464	36	630	203	0	6,940	0	107	67,913
5	1,104	986	43,923	762	201	7	8	0	1	92	4	0	317	1,486	2,345	51	0	36	0	4,822	0	146	66,626
6	910	612	47,149	791	13	4	7	0	1	34	4	0	0	365	966	0	538	21	0	5,071	0	161	56,757
7	296	530	27,395	634	0	0	1	0	0	12	2	0	0	0	30	0	0	12	0	2,654	0	109	31,274
8	159	318	20,505	403	1	0	1	0	0	6	1	0	0	0	14	4	0	18	0	1,296	0	96	22,973
9	82	182	10,754	220	0	0	0	0	0	2	0	0	0	0	66	23	0	0	0	1,266	0	45	12,639
10	0	134	5,867	63	0	0	0	0	0	1	0	0	0	0	1	0	0	3	0	305	0	11	6,384
11	0	61	3,726	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	317	0	0	4,102
12	22	68	3,630	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237	0	10	4,036
13	0	35	1,600	29	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	33	0	6	1,703
14	0	14	697	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	711
15	0	18	1,674	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73	0	10	1,824
SOP	1,855	1,744	116,060	1,769	1,269	593	704	1,325	126	621	739	6	2,158	6,890	9,161	200	5,198	565		13,299		360	164,636
Catch	1,855	1,745	116,071	1,765	1,274	593	704	1,325	126	619	739	6	2,158	6,881	9,160	200	5,203	565		13,300		358	164,660
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		100%		100%	100%

Table 2.4.1.2 Percentage catch numbers at age for NE atlantic mackerel

Quarters 1 to 4

Ages	IXa central	IXa north	VIIIc east	VIIIc west	IIa	IIIa	IVa	IVb	Vb	VIa	VIb	VIIa	VIIbc	VIIg	VIIj	VIIk	VIIIb	IVc	VIIe	VIIh	VIId	VIIef	Total
0	42%	49%	0%	33%						0%							0%					0%	4%
1	38%	5%	2%	15%	0%	0%	0%	17%	0%	1%	7%	2%	0%	4%	0%		2%	54%	23%	60%	49%	20%	5%
2	13%	3%	4%	7%	12%	1%	2%	17%	2%	10%	18%	24%	17%	35%	1%	0%	6%	27%	44%	37%	26%	32%	8%
3	4%	2%	10%	8%	21%	10%	11%	13%	23%	18%	13%	46%	27%	32%	11%	10%	13%	9%	11%	2%	9%	18%	13%
4	1%	1%	21%	10%	27%	18%	15%	11%	30%	16%	15%	21%	18%	7%	21%	21%	17%	6%	7%	4%	4%	11%	16%
5	1%	0%	17%	7%	21%	22%	18%	15%	18%	18%	14%	2%	16%	9%	35%	30%	16%	4%	6%	2%	7%	7%	17%
6	1%	0%	22%	8%	9%	19%	18%	13%	13%	15%	14%	2%	9%	3%	18%	21%	19%	1%	4%	4%	3%	3%	14%
7	0%	0%	11%	5%	6%	14%	16%	6%	6%	9%	11%	1%	6%	2%	7%	6%	11%	0%	3%	1%	1%	1%	9%
8	0%	0%	5%	2%	2%	6%	9%	5%	3%	6%	4%	3%	3%	1%	3%	0%	5%	0%	1%	1%	1%	0%	6%
9	0%	0%	3%	2%	1%	3%	5%	2%	2%	3%	2%	0%	1%	3%	1%	0%	4%	0%	1%	0%	0%	0%	3%
10	0%	0%	2%	1%	1%	2%	3%	1%	1%	2%	2%	0%	1%	0%	1%	0%	2%	0%	0%	0%	0%	0%	2%
11	0%	0%	2%	1%	0%	1%	2%			1%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	1%
12	0%	0%	1%	1%	1%	1%	2%	0%	1%	1%	0%	0%	0%		0%		1%	0%	0%		0%	0%	1%
13	0%	0%	1%	0%	0%	1%	1%	0%	0%	1%	0%	0%	0%	0%	0%		1%	0%	1%	0%	0%	0%	0%
14		0%	0%	0%	0%	0%	0%			0%		0%	0%		0%	0%	0%	0%	0%		0%	0%	0%
15			0%	0%	0%	0%	1%	0%	0%	0%			0%		1%	0%		0%			0%	0%	0%

Table 2.4.2.1	MACKEREL length distributions in 1999 catches by country and by various fleets.													
Length	Portugal			Spain			Netherlands	Ireland	Norway	Scotland		England		Russia
(cm)	artisanal	purse seine	trawl	artisanal	purse seine	trawl	pel. trawl	pel. trawl	purse seine	Purse Seine	Pel. Trawl	hand lines	Pel. Trawl	all gears
13														
14					1%									
15					2%									
16		0%			3%									
17		0%			7%									
18	0%	2%			9%									
19	1%	7%	0%		11%	0%						0%		
20	5%	15%	0%		10%	1%						0%	0%	
21	5%	23%	3%		6%	6%						1%		
22	3%	13%	9%		3%	10%	0%			1%		0%	0%	
23	1%	10%	10%		2%	8%				0%	0%	0%	0%	0%
24	1%	9%	8%		3%	5%	0%					0%	0%	
25	2%	11%	9%	0%	3%	2%	0%	0%			0%	0%	1%	
26	2%	5%	8%	0%	1%	2%	1%	2%			0%	1%	2%	
27	3%	1%	5%	0%	0%	1%	3%	2%		1%	0%	3%	5%	
28	6%	1%	5%	0%	0%	3%	5%	1%		3%	1%	5%	5%	0%
29	11%	2%	10%	0%	1%	6%	9%	2%	0%	4%	1%	7%	8%	1%
30	11%	1%	12%	1%	2%	6%	8%	2%	0%	10%	3%	9%	12%	3%
31	9%	0%	8%	1%	2%	7%	5%	5%	1%	14%	6%	15%	11%	3%
32	7%	0%	5%	3%	2%	6%	7%	9%	2%	15%	7%	19%	10%	14%
33	9%	0%	3%	6%	2%	5%	8%	11%	6%	12%	7%	14%	8%	16%
34	9%	0%	2%	7%	3%	3%	6%	10%	10%	12%	15%	13%	6%	15%
35	5%	0%	1%	10%	3%	5%	7%	11%	13%	8%	12%	6%	7%	17%
36	3%	0%	1%	15%	4%	5%	9%	11%	14%	6%	11%	4%	5%	12%
37	2%		0%	18%	5%	6%	10%	11%	14%	4%	10%	2%	4%	7%
38	1%		0%	17%	6%	5%	8%	9%	14%	3%	7%	1%	6%	4%
39	1%		0%	10%	4%	4%	6%	6%	10%	3%	10%	0%	3%	2%
40	1%		0%	5%	2%	3%	3%	4%	7%	2%	5%	0%	3%	1%
41	0%		0%	3%	1%	2%	3%	2%	4%	1%	3%	0%	2%	0%
42	0%		0%	1%	1%	1%	1%	1%	2%	0%	1%	0%	1%	0%
43	0%		0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
44	0%		0%	0%	0%	0%	0%	0%	0%		0%	0%	0%	
45	0%			0%	0%	0%	0%	0%	0%	0%	0%			
46									0%					
47						0%			0%					
48			0%											
49					0%									
50														

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

Mean Length at Age by Area (cm)

Quarters: 1 to 4

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	IXa	Vb	XII	Total
0.00						23.7	19.6		25.6	26.7	22.7			23.5	22.1					23.5			20.2
1	23.0	23.0	27.3	28.8	28.5	26.1	26.0	28.5	29.5	28.8	24.8	29.1	27.4	29.8	28.1	28.4	27.9	29.8	27.5	25.7	27.1	23.0	26.0
2	31.8	31.2	32.1	31.4	32.0	31.3	29.7	30.1	30.9	30.7	30.0	31.3	30.1	32.4	30.7	31.7	30.0	31.7	29.8	29.6	29.2	30.3	30.7
3	33.7	33.6	33.5	32.1	33.1	33.7	32.0	31.1	33.3	33.8	32.6	32.9	32.9	33.9	32.4	32.4	31.7	33.6	34.6	31.9	32.0	32.9	33.0
4	35.6	34.0	35.1	33.9	35.2	35.0	33.1	33.8	34.9	35.3	34.6	33.8	34.6	34.4	33.3	34.5	34.1	35.0	35.4	34.2	34.8	34.5	34.6
5	36.7	35.6	36.2	35.2	35.7	36.3	35.4	34.8	37.5	37.5	37.4	36.2	36.2	34.6	33.9	34.4	36.7	36.8	37.2	35.4	36.1	35.9	36.1
6	37.7	37.3	37.2	36.1	36.5	37.5	36.5	35.0	38.0	37.9	38.0	37.6	37.7	37.9	34.9	34.2	34.9	38.4	39.0	36.8	37.7	37.0	37.3
7	38.5	37.6	38.3	37.1	37.0	38.4	37.8	38.0	38.6	38.6	38.8	38.3	38.7	39.1	36.6	37.9	38.8	39.7	40.1	38.2	39.1	37.7	38.3
8	39.4	38.3	39.0	38.2	36.4	39.4	37.5	40.2	39.4	39.2	39.6	41.1	39.6	40.1	37.8	38.6	39.7	39.7	39.7	38.9	40.3	38.6	39.0
9	39.4	39.2	39.7	39.6	40.6	40.7	39.7	39.4	40.4	40.6	40.8	39.7	40.1	40.5	35.6	35.1	39.3	40.4	40.0	39.9	41.7	39.8	39.8
10	40.2	39.4	40.2	37.5	41.5	40.7	40.1	41.2	40.3	41.1	41.3	41.2	39.7	41.5	37.2	41.4	41.5	40.4	42.2	40.3	40.8	37.2	40.2
11	40.8	40.3	40.7	40.4	42.4	42.8	41.1	37.6	41.0	41.9	41.8	38.8	37.8	42.4	38.9	38.5	38.5	39.4	41.8	40.8	40.5		40.8
12	41.8	41.6	41.7	41.3	43.2	42.6	41.0	41.6	41.5	41.8	41.8	42.7	41.0	43.1	39.5			41.0	40.9	41.5	41.5	41.5	41.7
13	42.9	41.8	42.1	44.5	44.2	45.9	40.6	42.6	41.9	42.3	42.3	42.0	43.5	44.2	41.6	42.5	42.5	43.4	42.2	41.9	47.2	44.5	42.1
14	43.5	43.6	42.8	43.0	41.8		41.5	43.1	43.0	42.0	42.2	42.6	42.5	41.8	41.1			42.3	42.5	41.7			42.6
15	43.3	43.8	42.9	43.1	47.5				43.3	43.2	44.2	42.5	43.4	47.0	41.1			44.2	43.7	42.5		43.1	43.0

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	IXa	Vb	XII	Total
0																							
1		23.0			28.6	24.1	24.7	28.8	28.7	28.8	28.2		27.4		21.8					25.4		23.0	26.0
2	30.0	30.3	30.1	29.6	31.7	31.2	29.6	30.6	30.8	31.0	30.0	29.8	29.6	33.5	28.5	29.2	30.1	30.2	29.8	29.5		30.3	29.8
3	32.6	32.9	32.6	32.7	33.5	33.5	31.7	33.3	33.5	33.8	32.8	33.1	32.6		31.1	31.3	32.1	33.7	34.7	31.8	33.3	32.9	32.4
4	34.9	34.5	34.9	34.7	34.5	35.0	32.7	35.0	35.1	35.2	34.8	34.8	34.7	35.8	33.0	34.0	35.3	34.9	35.4	34.2	36.4	34.5	34.7
5	36.3	35.9	36.3	36.2	36.5	36.3	34.6	37.5	37.5	37.4	37.5	36.4	36.1	37.8	34.8	36.1	37.1	37.0	37.2	35.4	36.9	35.9	36.2
6	37.7	36.8	37.5	37.4	37.4	37.6	35.6	38.0	38.0	37.9	38.1	37.8	37.6	38.0	34.3	35.8	38.3	38.6	39.0	36.9	38.2	36.8	37.5
7	38.7	37.2	38.6	38.4	36.5	38.2	37.2	38.6	38.6	38.5	38.8	38.4	38.5	40.2	36.6	37.0	38.9	39.8	40.1	38.2	39.4	37.2	38.5
8	39.6	37.5	39.4	39.5	36.0	39.0	36.7	39.5	39.4	39.2	39.8	39.2	38.8		38.2	41.5	39.6	39.3	39.7	38.8	40.3	37.5	39.1
9	41.4	39.3	41.2	41.2		41.1	39.8	40.4	40.4	40.6	40.8	39.3	39.4		37.3			40.0	39.9	40.0	41.5	39.3	40.6
10	40.9	36.0	41.0	41.0		40.7	39.7	40.3	40.3	41.1	41.3	41.2	38.0		37.0	39.5		40.0	42.3	40.3	40.8	36.0	40.6
11	41.4		41.4	40.4		42.6	40.5	41.0	41.0	41.9	41.6	40.5	37.3		39.0			41.2	42.1	40.7	40.5		41.0
12	43.9	41.5	43.8	43.5		42.5	40.3	41.6	41.6	41.8	41.7		39.9		39.5			40.3		41.5	41.5	41.5	42.5
13	41.8		42.3	42.1		45.8	40.2	42.0	42.0	42.3	41.8		43.6					39.6	39.6	41.0			41.7
14	42.9		46.3	43.0			41.5	43.1	43.1	43.0	42.1	42.5	42.5		41.1			42.5	42.5	41.7			42.6
15	41.3		41.5	41.3						43.3	42.6		39.9		41.1					42.7			41.9

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	IXa	Vb	XII	Total
0																							
1	23.0	23.0	23.0	28.8	28.3	23.3	26.0	26.5	28.5	25.9	28.6	25.3	27.5		25.3	26.5	26.5	27.5	27.5	28.3	28.3	23.0	26.2
2	30.3	30.3	30.3	31.4	32.5	30.9	29.0	28.6	30.7	30.1	30.5	29.0	28.8		29.0	28.6	28.6	29.2	29.2	28.8	29.2	30.3	29.1
3	32.9	32.9	32.9	32.1	32.8	34.0	32.0	31.0	33.2	33.9	32.9	32.1	33.0	32.8	31.5	31.0	31.0	33.4	33.8	31.4	31.4	32.9	32.5
4	34.5	34.5	34.5	33.7	35.6	35.1	32.9	33.7	34.5	35.4	34.7	34.6	35.2	34.9	33.7	33.7	33.7	35.4	35.4	33.8	33.6	34.5	34.7
5	35.9	35.9	35.9	34.8	33.8	36.3	34.9	34.3	37.5	37.6	37.6	36.4	36.3	36.2	36.0	34.3	34.3	36.3	36.3	35.7	34.7	35.9	36.5
6	36.8	36.8	36.8	35.2	36.5	37.6	36.1	34.2	38.1	38.0	38.1	37.6	37.9	37.7	35.8	34.2	34.2	38.0	38.0	36.9	36.4	36.8	37.7
7	37.2	37.2	37.2	34.6	38.8	38.4	37.6	37.9	38.8	38.6	38.7	38.3	39.0	38.8	37.4	37.9	37.9	39.4	39.6	38.7	37.8	37.2	38.7
8	37.5	37.5	37.5	36.9	40.0	39.6	37.8	40.5	39.5	39.3	39.5	38.8	39.5	40.2	37.9	40.5	40.5	39.8	39.8	41.0	41.2	37.5	39.7
9	39.3	39.3	39.3	34.7	40.6	40.4	40.7	39.3	40.6	40.6	40.9	39.9	40.7	40.6	37.3	39.2	39.3	40.6	40.6	41.3	42.3	39.3	40.6
10	36.0	36.0	36.0	35.5	41.5	40.7	40.9	41.6	40.3	41.1	41.2	41.1	40.8	41.5		41.5	41.5	40.7	40.3	41.2	41.2	36.0	40.8
11					42.4	43.0	41.5	36.5	40.9	41.8	42.1	38.2	38.5	42.4		36.5	36.5	38.6	39.0				41.1
12	41.6	41.6	41.6	41.5	43.2	42.7	41.6		41.4	41.9	42.0	42.7	41.9	43.2				41.8	40.8			41.6	41.8
13				44.5	44.2	45.9	41.6	42.5	41.6	42.3	42.9	42.5	43.3	44.2		42.5	42.5	43.4	44.3	48.5	48.5		44.1
14					41.8		41.5		42.7	42.7	42.4	43.5	42.3	41.8				41.7	41.2				42.5
15				43.1	47.5					43.1	45.2	42.5	43.6	47.5				44.2	43.7				44.0

Table 2.4.3.1 (continued)

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0						23.3	19.2				18.5			23.5									19.4
1			27.5	28.6	28.3	29.6	26.3	28.5	28.0	29.2	24.3	27.6		29.7	27.6	26.5	27.5			27.1	27.1	23.0	27.2
2	32.9	31.2	32.2	31.4	32.4	31.7	31.5	28.6	30.4	30.5	29.8	30.5	30.5	32.2	30.2	28.6	29.5	30.5		29.3	29.3	30.3	31.2
3	34.0	32.6	33.7	32.1	32.9	33.8	33.1	31.0	32.8	32.0	32.1	32.7	32.7	33.2	32.1	31.0	31.0	32.7		30.6	30.1	32.9	33.5
4	35.8	34.0	35.1	33.7	35.6	35.0	34.1	33.7	34.1	33.0	33.4	33.5	33.5	34.0	33.7	33.7	32.9	33.5		33.6	31.9	34.5	34.4
5	36.6	35.6	36.1	34.8	34.1	36.4	37.0	34.3	36.7	35.3	35.8	32.4		36.7	32.6	34.3	34.3			34.3	34.3	35.9	35.8
6	37.6	37.4	37.1	35.1	35.5	37.3	37.7	34.2	37.4	36.6	36.9	32.8		36.8	33.0	34.2	32.4			35.6	35.6	36.8	37.2
7	38.4	37.6	38.1	34.6	36.5	39.5	38.4	37.0	38.3	38.1	38.5	38.6		37.7	38.2	37.9	37.9			37.1	37.1	37.2	38.0
8	39.2	38.3	38.9	36.6	36.0	42.3	39.1	40.5	39.6	38.3	38.7	41.5	41.5	39.2	38.7	40.5	40.5	41.5		38.3	38.3	37.5	38.9
9	39.2	39.2	39.2	34.5		40.6	38.7	39.3	40.8	40.2	40.6	37.5		39.1	39.4	39.3	39.3			41.0	41.0	39.5	39.2
10	40.3	39.8	39.9	35.6		41.6	39.6	41.5	40.7	40.4	40.9			40.9	41.6	41.5	41.6			40.5	40.5	36.0	39.8
11	40.7	40.3	40.6			42.3	39.5	36.5	41.4	41.2	41.2			41.0	36.6	36.6	36.6						40.6
12	41.8	41.7	41.8				39.6		42.1	41.3	41.1			41.8								41.5	41.6
13	43.0	41.9	42.2				39.6	42.6	42.4	41.6	41.1	40.8		43.9	41.4	42.6	42.6			39.6	39.6		42.2
14	41.5	40.6	43.5						43.6	42.5	41.9			41.8									43.5
15	43.7	42.9	43.7							43.0	43.2			41.5									43.7

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0						23.9	20.9		25.6	26.7	12.7				22.1					23.5			22.1
1			27.5		26.5	27.2	27.0	28.8	28.7	30.0	26.4	29.8		29.6	28.7	28.5	27.9	28.9		25.3			28.8
2	31.0	30.7	30.6		31.8	31.6	32.0	30.5	31.1	31.2	31.6	32.7	32.0	32.4	31.0	32.6	30.0	32.7		32.1			31.4
3	34.0	33.7	34.0	32.2	33.3	33.6	33.4		32.3	32.9	33.2	33.6	33.7	33.9	33.1	33.0		33.6		33.3		32.2	33.7
4	36.0	34.9	35.1	34.4	34.8	35.1	34.7	33.5	32.9	34.1	34.4	35.2	34.3	34.0	33.4	35.3	32.5	36.2		34.4		34.4	34.9
5	37.0	36.0	36.3	36.1	36.2	36.4	35.6		35.5	36.3	36.6	37.3	36.4	34.0	33.7	34.5		37.3		35.6		36.1	36.1
6	38.0	37.0	37.0	37.6	36.6	37.1	35.9		36.3	37.0	37.3	37.8		38.0	35.4		31.5	37.8		36.3		37.6	36.9
7	39.3	38.0	38.2	38.5	36.5	38.5	36.1		37.3	37.7	38.2	38.0			36.6			38.0		37.5		38.5	38.1
8	40.0	38.9	38.8	39.0	36.0	41.5	38.9		37.7	37.9	38.4	37.8			37.1	38.5		37.8		39.0		39.0	38.8
9	39.0	39.2	39.1	40.3		40.3			40.9	40.0	40.1				33.7	33.5				38.7		40.3	39.1
10	39.8	39.8	40.0	41.0		41.8			41.2	40.0	40.6	41.5			40.1			41.5		40.3		41.0	40.0
11	40.5	40.5	40.5			41.5			41.9	40.7	41.3				40.5					41.5			40.6
12	42.0	41.7	41.0	41.3					41.8	40.9	41.1									41.5		41.3	41.1
13	42.1	41.8	41.9	44.5					42.1	40.9	41.4				42.9					43.3		44.5	42.0
14	41.6	43.3	41.6						43.0	42.3	42.4												41.6
15	43.4	43.7	43.2	43.1					43.3	43.0	42.9									40.5		43.1	43.1

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

Mean weight

Quarters 1 - 4

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	IXa	Total
0	0.000	0.000	0.000	0.000	0.000	0.030	0.095	0.000	0.116	0.145	0.085	0.000	0.000	0.101	0.085	0.000	0.000	0.000	0.000	0.101	0.000	0.000	0.062
1	0.091	0.091	0.174	0.196	0.139	0.143	0.129	0.173	0.160	0.163	0.114	0.194	0.151	0.221	0.177	0.164	0.168	0.203	0.139	0.106	0.146	0.091	0.176
2	0.258	0.291	0.288	0.288	0.288	0.233	0.178	0.219	0.207	0.205	0.193	0.266	0.198	0.287	0.223	0.244	0.222	0.248	0.184	0.246	0.175	0.258	0.236
3	0.336	0.362	0.342	0.298	0.329	0.309	0.225	0.289	0.262	0.266	0.245	0.308	0.279	0.338	0.252	0.260	0.230	0.286	0.301	0.262	0.248	0.336	0.307
4	0.433	0.400	0.398	0.342	0.409	0.327	0.260	0.391	0.338	0.306	0.297	0.357	0.318	0.360	0.272	0.329	0.293	0.331	0.347	0.317	0.322	0.379	0.361
5	0.498	0.455	0.441	0.365	0.377	0.377	0.309	0.358	0.387	0.372	0.360	0.357	0.346	0.346	0.290	0.315	0.363	0.371	0.387	0.389	0.370	0.415	0.408
6	0.552	0.522	0.494	0.394	0.437	0.478	0.362	0.388	0.403	0.395	0.376	0.402	0.391	0.444	0.315	0.284	0.393	0.441	0.465	0.414	0.428	0.475	0.454
7	0.556	0.524	0.528	0.468	0.442	0.435	0.417	0.418	0.422	0.408	0.399	0.423	0.441	0.470	0.366	0.416	0.463	0.464	0.477	0.461	0.475	0.477	0.501
8	0.613	0.560	0.588	0.506	0.464	0.466	0.398	0.469	0.453	0.439	0.432	0.536	0.473	0.460	0.418	0.459	0.474	0.470	0.464	0.499	0.521	0.536	0.537
9	0.596	0.584	0.594	0.525	0.507	0.514	0.470	0.476	0.490	0.482	0.475	0.463	0.469	0.508	0.336	0.546	0.474	0.520	0.513	0.536	0.574	0.583	0.569
10	0.631	0.612	0.631	0.605	0.494	0.502	0.472	0.502	0.495	0.505	0.489	0.548	0.480	0.495	0.379	0.581	0.589	0.603	0.609	0.588	0.526	0.610	0.597
11	0.661	0.624	0.648	0.599	0.579	0.588	0.480	0.498	0.513	0.524	0.505	0.425	0.474	0.573	0.398	0.373	0.372	0.487	0.644	0.573	0.534	0.000	0.609
12	0.704	0.730	0.702	0.663	0.597	0.679	0.497	0.537	0.534	0.532	0.537	0.651	0.530	0.576	0.427	0.000	0.000	0.538	0.473	0.679	0.575	0.587	0.682
13	0.723	0.711	0.719	0.691	0.580	0.714	0.464	0.709	0.593	0.551	0.536	0.536	0.643	0.630	0.611	0.706	0.736	0.653	0.622	0.638	0.663	0.698	0.691
14	0.816	0.820	0.786	0.750	0.559	0.000	0.490	0.696	0.595	0.578	0.511	0.622	0.595	0.593	0.467	0.000	0.000	0.607	0.627	0.627	0.000	0.000	0.737
15	0.754	0.799	0.739	0.781	0.736	0.000	0.000	0.000	0.629	0.590	0.662	0.635	0.579	0.734	0.467	0.000	0.000	0.606	0.683	0.666	0.000	0.751	0.752

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	IXa	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.091	0.000	0.000	0.149	0.105	0.096	0.173	0.153	0.153	0.144	0.000	0.151	0.000	0.067	0.000	0.000	0.000	0.000	0.139	0.000	0.091	0.139
2	0.215	0.258	0.216	0.217	0.260	0.226	0.169	0.225	0.205	0.200	0.176	0.184	0.169	0.287	0.162	0.186	0.193	0.207	0.184	0.191	0.000	0.258	0.191
3	0.276	0.306	0.281	0.287	0.329	0.278	0.209	0.288	0.270	0.264	0.264	0.288	0.248	0.000	0.211	0.232	0.242	0.287	0.301	0.263	0.269	0.306	0.281
4	0.349	0.379	0.354	0.352	0.358	0.319	0.221	0.314	0.314	0.303	0.303	0.315	0.304	0.364	0.250	0.307	0.333	0.336	0.347	0.337	0.391	0.379	0.339
5	0.400	0.410	0.397	0.408	0.397	0.364	0.277	0.388	0.386	0.371	0.366	0.371	0.357	0.436	0.294	0.300	0.400	0.387	0.397	0.388	0.406	0.410	0.376
6	0.464	0.466	0.480	0.468	0.486	0.393	0.304	0.406	0.402	0.385	0.374	0.423	0.409	0.436	0.306	0.372	0.437	0.477	0.467	0.416	0.464	0.466	0.436
7	0.480	0.438	0.457	0.490	0.440	0.443	0.348	0.427	0.421	0.408	0.398	0.446	0.452	0.532	0.358	0.445	0.468	0.476	0.476	0.463	0.493	0.438	0.468
8	0.535	0.455	0.526	0.544	0.461	0.441	0.336	0.465	0.452	0.432	0.431	0.475	0.475	0.000	0.421	0.649	0.473	0.510	0.469	0.482	0.537	0.455	0.497
9	0.614	0.543	0.607	0.522	0.000	0.509	0.421	0.495	0.490	0.486	0.466	0.493	0.477	0.000	0.346	0.000	0.000	0.539	0.514	0.539	0.578	0.543	0.562
10	0.592	0.463	0.592	0.600	0.000	0.501	0.426	0.486	0.486	0.506	0.484	0.505	0.429	0.000	0.366	0.505	0.000	0.527	0.549	0.436	0.549	0.463	0.553
11	0.616	0.000	0.616	0.596	0.000	0.577	0.452	0.513	0.513	0.539	0.496	0.532	0.403	0.000	0.391	0.000	0.000	0.537	0.661	0.561	0.534	0.000	0.569
12	0.746	0.532	0.746	0.746	0.000	0.571	0.446	0.537	0.537	0.533	0.504	0.000	0.546	0.000	0.467	0.000	0.000	0.563	0.000	0.616	0.575	0.532	0.652
13	0.633	0.000	0.643	0.659	0.000	0.714	0.445	0.558	0.558	0.554	0.509	0.000	0.540	0.000	0.000	0.000	0.000	0.433	0.433	0.679	0.000	0.000	0.593
14	0.660	0.000	0.664	0.755	0.000	0.000	0.490	0.000	0.000	0.586	0.516	0.636	0.575	0.000	0.467	0.000	0.000	0.536	0.636	0.633	0.000	0.000	0.636
15	0.639	0.000	0.633	0.682	0.000	0.000	0.000	0.000	0.000	0.591	0.535	0.000	0.542	0.000	0.467	0.000	0.000	0.000	0.000	0.676	0.000	0.000	0.635

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	VIa central	VIa north	VIIa	VIIb	VIIc east	VIIc west	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	IXa	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.091	0.091	0.091	0.196	0.157	0.100	0.112	0.133	0.160	0.111	0.150	0.135	0.139	0.000	0.136	0.133	0.133	0.136	0.139	0.091	0.168	0.091	0.134
2	0.258	0.259	0.258	0.268	0.304	0.210	0.159	0.154	0.204	0.181	0.186	0.199	0.174	0.000	0.196	0.154	0.154	0.166	0.190	0.169	0.173	0.258	0.176
3	0.336	0.336	0.336	0.290	0.379	0.291	0.215	0.203	0.261	0.268	0.225	0.225	0.261	0.266	0.244	0.207	0.207	0.274	0.269	0.259	0.215	0.336	0.259
4	0.379	0.379	0.379	0.331	0.428	0.319	0.237	0.261	0.286	0.310	0.262	0.287	0.306	0.318	0.288	0.261	0.261	0.311	0.312	0.271	0.263	0.379	0.308
5	0.410	0.410	0.410	0.330	0.528	0.365	0.266	0.266	0.387	0.374	0.364	0.334	0.336	0.369	0.365	0.266	0.266	0.342	0.342	0.331	0.310	0.410	0.341
6	0.486	0.486	0.486	0.329	0.430	0.394	0.317	0.362	0.406	0.387	0.374	0.300	0.372	0.411	0.322	0.362	0.362	0.379	0.379	0.362	0.220	0.486	0.383
7	0.436	0.430	0.432	0.334	0.447	0.413	0.361	0.416	0.434	0.408	0.394	0.433	0.425	0.447	0.435	0.416	0.416	0.450	0.450	0.412	0.386	0.430	0.425
8	0.492	0.496	0.465	0.432	0.430	0.462	0.362	0.504	0.466	0.434	0.433	0.411	0.438	0.490	0.434	0.504	0.504	0.393	0.456	0.492	0.534	0.492	0.452
9	0.563	0.543	0.543	0.389	0.607	0.493	0.464	0.474	0.491	0.493	0.475	0.656	0.667	0.607	0.436	0.474	0.474	0.512	0.606	0.524	0.567	0.543	0.496
10	0.463	0.463	0.453	0.398	0.494	0.501	0.471	0.583	0.496	0.504	0.482	0.496	0.460	0.494	0.000	0.583	0.583	0.462	0.490	0.492	0.492	0.453	0.490
11	0.000	0.000	0.000	0.000	0.570	0.591	0.490	0.372	0.529	0.591	0.595	0.390	0.430	0.570	0.000	0.372	0.372	0.440	0.479	0.000	0.000	0.000	0.539
12	0.432	0.432	0.432	0.632	0.567	0.680	0.490	0.000	0.536	0.624	0.513	0.651	0.516	0.567	0.000	0.000	0.000	0.512	0.473	0.000	0.000	0.432	0.437
13	0.000	0.000	0.000	0.868	0.639	0.719	0.466	0.706	0.607	0.550	0.542	0.536	0.552	0.000	0.000	0.706	0.736	0.575	0.571	0.738	0.536	0.000	0.685
14	0.000	0.000	0.000	0.000	0.569	0.000	0.490	0.000	0.592	0.571	0.506	0.575	0.559	0.569	0.000	0.000	0.000	0.546	0.507	0.000	0.000	0.000	0.563
15	0.000	0.000	0.000	0.781	0.736	0.000	0.000	0.000	0.000	0.595	0.647	0.595	0.582	0.736	0.000	0.000	0.000	0.606	0.683	0.000	0.000	0.000	0.600

Table 2.4.3.2 Continued

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.000	0.000	0.000	0.000	0.000	0.094	0.052	0.000	0.000	0.000	0.044	0.000	0.000	0.121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.054
1	0.000	0.000	0.178	0.196	0.188	0.206	0.140	0.133	0.154	0.194	0.107	0.172	0.000	0.220	0.172	0.133	0.156	0.000	0.000	0.146	0.146	0.091	0.163
2	0.317	0.291	0.287	0.268	0.301	0.260	0.249	0.154	0.197	0.224	0.210	0.246	0.247	0.262	0.223	0.154	0.201	0.247	0.000	0.195	0.195	0.258	0.281
3	0.372	0.329	0.360	0.288	0.320	0.327	0.292	0.207	0.253	0.262	0.266	0.311	0.311	0.302	0.253	0.207	0.207	0.311	0.000	0.218	0.234	0.336	0.364
4	0.433	0.403	0.418	0.328	0.408	0.372	0.324	0.281	0.298	0.298	0.303	0.361	0.362	0.348	0.312	0.281	0.254	0.362	0.000	0.307	0.261	0.379	0.404
5	0.480	0.458	0.460	0.328	0.335	0.426	0.425	0.268	0.361	0.349	0.394	0.284	0.000	0.422	0.265	0.386	0.268	0.000	0.000	0.230	0.282	0.410	0.455
6	0.525	0.530	0.509	0.305	0.436	0.465	0.450	0.282	0.393	0.387	0.420	0.387	0.000	0.449	0.294	0.282	0.237	0.000	0.000	0.355	0.355	0.465	0.509
7	0.580	0.540	0.553	0.330	0.440	0.670	0.473	0.416	0.412	0.436	0.480	0.458	0.000	0.475	0.437	0.416	0.416	0.000	0.000	0.378	0.378	0.438	0.549
8	0.606	0.565	0.596	0.402	0.451	0.724	0.465	0.504	0.458	0.448	0.491	0.551	0.551	0.532	0.398	0.504	0.504	0.551	0.000	0.392	0.392	0.455	0.588
9	0.602	0.601	0.602	0.280	0.000	0.623	0.487	0.474	0.503	0.517	0.566	0.422	0.000	0.531	0.449	0.474	0.474	0.000	0.000	0.504	0.504	0.543	0.596
10	0.641	0.651	0.632	0.388	0.000	0.679	0.482	0.583	0.603	0.514	0.584	0.000	0.000	0.548	0.583	0.583	0.581	0.000	0.000	0.464	0.464	0.493	0.629
11	0.666	0.682	0.664	0.000	0.000	0.724	0.519	0.372	0.632	0.570	0.595	0.000	0.000	0.642	0.372	0.372	0.372	0.000	0.000	0.000	0.000	0.000	0.658
12	0.704	0.754	0.734	0.000	0.000	0.000	0.519	0.000	0.658	0.585	0.594	0.000	0.000	0.653	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.532	0.714
13	0.800	0.719	0.746	0.000	0.000	0.000	0.519	0.706	0.671	0.683	0.596	0.431	0.000	0.666	0.610	0.706	0.706	0.000	0.000	0.404	0.404	0.000	0.743
14	0.819	0.824	0.819	0.000	0.000	0.000	0.000	0.000	0.620	0.690	0.624	0.000	0.000	0.569	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.831
15	0.757	0.790	0.797	0.000	0.000	0.000	0.000	0.000	0.000	0.679	0.696	0.000	0.000	0.652	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.798

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	IXa central	IXa north	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0.000	0.000	0.000	0.000	0.000	0.059	0.068	0.000	0.116	0.145	0.086	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.101	0.000	0.000	0.080
1	0.000	0.000	0.178	0.000	0.190	0.159	0.152	0.173	0.182	0.213	0.143	0.206	0.000	0.221	0.162	0.166	0.158	0.206	0.000	0.152	0.000	0.000	0.186
2	0.275	0.310	0.289	0.000	0.285	0.259	0.263	0.226	0.211	0.241	0.236	0.275	0.268	0.257	0.224	0.264	0.224	0.275	0.000	0.263	0.000	0.000	0.252
3	0.368	0.364	0.362	0.289	0.326	0.318	0.301	0.000	0.238	0.279	0.286	0.303	0.317	0.327	0.274	0.283	0.000	0.302	0.000	0.296	0.000	0.209	0.338
4	0.407	0.413	0.406	0.372	0.296	0.374	0.341	0.298	0.263	0.303	0.334	0.366	0.324	0.368	0.279	0.267	0.240	0.366	0.000	0.342	0.000	0.372	0.389
5	0.514	0.495	0.455	0.441	0.390	0.425	0.371	0.000	0.323	0.365	0.408	0.436	0.375	0.331	0.288	0.331	0.000	0.435	0.000	0.369	0.000	0.411	0.441
6	0.564	0.507	0.468	0.499	0.440	0.457	0.380	0.000	0.348	0.376	0.432	0.456	0.000	0.457	0.336	0.000	0.214	0.456	0.000	0.436	0.000	0.499	0.460
7	0.583	0.550	0.539	0.541	0.443	0.571	0.386	0.000	0.368	0.413	0.469	0.464	0.000	0.000	0.358	0.000	0.000	0.464	0.000	0.480	0.000	0.541	0.536
8	0.676	0.562	0.566	0.587	0.451	0.679	0.380	0.000	0.393	0.407	0.477	0.458	0.000	0.000	0.423	0.403	0.000	0.498	0.000	0.550	0.000	0.587	0.568
9	0.672	0.680	0.676	0.627	0.000	0.642	0.000	0.000	0.509	0.481	0.548	0.000	0.000	0.000	0.302	0.295	0.000	0.000	0.000	0.538	0.000	0.627	0.572
10	0.628	0.630	0.628	0.684	0.000	0.679	0.000	0.000	0.623	0.495	0.570	0.631	0.000	0.000	0.528	0.000	0.000	0.631	0.000	0.606	0.000	0.684	0.628
11	0.662	0.663	0.650	0.000	0.000	0.678	0.000	0.000	0.596	0.515	0.604	0.000	0.000	0.000	0.521	0.000	0.000	0.000	0.000	0.683	0.000	0.000	0.663
12	0.749	0.710	0.682	0.683	0.000	0.000	0.000	0.000	0.646	0.540	0.594	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.657	0.000	0.683	0.682
13	0.734	0.715	0.718	0.868	0.000	0.000	0.000	0.000	0.598	0.531	0.611	0.000	0.000	0.000	0.621	0.000	0.000	0.000	0.000	0.750	0.000	0.868	0.721
14	0.756	0.814	0.740	0.000	0.000	0.000	0.000	0.000	0.597	0.647	0.653	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.741
15	0.778	0.787	0.774	0.781	0.000	0.000	0.000	0.000	0.609	0.674	0.682	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.637	0.000	0.781	0.789

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	-	-

- Not available

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	-	26.0
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	-	-

- Not available

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

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

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

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

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

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

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

Table 2.7.3 (Cont'd)

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

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

(-) Not available

IXa trawl fleet (Portugal) (Catch thousands)

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

Table 2.10.1.1 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1997-2000.

Assessment year	**2000**	**1999**	**1998 ###**	**1997**	**1996**	**1995**
First data year	1972	1984	1984	1984	1984	1984
Final data year	1999	1998	1997	1996	1995	1994
No of years for separable constraint ?	8	7	12	11	10	10
Constant selection pattern model (Y/N)	S1(92-99)	S1(92-98)	S1(86-88); S2(89-97)	S1(86-88); S2(89-96)	S1(86-88); S2(89-95)	S1(85-89); S2(90-94)
S to be fixed on last age	1.2	1.2	1.2 / 1.2	1.2 / 1.2	1.0 / 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

Table 2.10.1.2 Results of ISVPA run.

Year	R(0), Th.	B	SSB	F(4-8)
1984	6023.29	3192.62	2762.41	0.240
1985	3587.98	3506.99	2924.77	0.193
1986	2732.90	3544.24	2979.12	0.182
1987	2846.45	3447.90	3031.72	0.179
1988	3258.72	3477.34	3109.87	0.236
1989	3744.00	3248.15	2845.57	0.222
1990	3801.80	2951.61	2544.68	0.218
1991	4635.51	3266.64	2818.44	0.204
1992	5817.07	3531.17	2963.45	0.254
1993	6550.02	3648.82	2983.51	0.277
1994	5766.28	3760.46	3010.98	0.278
1995	4853.17	4149.90	3420.25	0.248
1996	4368.58	4167.42	3546.05	0.206
1997	3780.07	4358.80	3738.70	0.200
1998	3975.42	4329.15	3778.19	0.221
1999	9681.88	4263.26	3735.29	0.178

Table 2.10.1.3 Results from ISVPA. Population abundance

Year\age	0	1	2	3	4	5	6	7	8	9	10	11	12
1984	6023.3	2280.9	2476.5	2870.3	1966.7	753.9	430.9	247.4	460.7	275.7	209.6	123.1	282.8
1985	3588.0	5133.7	1903.1	1985.2	2176.4	1415.2	518.2	290.1	162.7	298.7	173.3	132.6	480.4
1986	2732.9	3063.4	4307.6	1545.7	1541.5	1620.8	1016.3	366.2	201.3	111.7	200.2	116.7	412.4
1987	2846.4	2334.4	2574.0	3509.7	1207.1	1157.5	1176.4	726.6	257.3	140.0	76.0	136.8	335.5
1988	3258.7	2431.6	1962.0	2098.7	2744.6	908.2	842.1	843.2	512.1	179.6	95.6	52.1	227.3
1989	3744.0	2777.8	2029.9	1574.6	1594.5	1980.7	626.5	569.4	557.1	333.8	113.5	60.8	156.7
1990	3801.8	3193.2	2322.9	1635.5	1205.1	1163.0	1385.1	430.0	382.5	369.5	215.2	73.6	123.9
1991	4635.5	3242.9	2671.3	1873.4	1254.0	881.2	815.9	954.0	290.0	254.8	239.4	140.2	249.9
1992	5817.1	3956.2	2717.5	2163.0	1446.7	926.4	626.5	570.2	653.9	196.5	168.2	158.9	264.6
1993	6550.0	4955.5	3295.9	2170.6	1629.1	1030.9	628.8	416.0	369.3	417.2	121.3	104.6	245.4
1994	5766.3	5575.4	4117.6	2616.4	1616.4	1141.9	684.9	407.8	262.5	229.2	249.5	73.1	206.1
1995	4853.2	4908.0	4632.0	3267.6	1947.1	1131.9	757.7	443.6	256.9	162.6	136.8	150.1	157.2
1996	4368.6	4135.2	4091.4	3705.1	2467.7	1392.9	772.1	505.9	289.1	165.0	101.1	85.7	143.1
1997	3780.1	3728.1	3464.3	3310.7	2857.8	1820.1	988.2	538.3	345.9	195.3	108.6	66.9	119.8
1998	3975.4	3226.6	3125.5	2808.0	2561.5	2117.3	1298.6	693.3	370.6	235.4	129.6	72.5	100.4
1999	9681.9	3390.6	2698.2	2518.5	2149.3	1868.5	1480.9	891.4	465.9	245.8	151.8	84.1	163.0

Table 2.10.1.4 Results from ISVPA. Residuals in lnC

Year\Age	0	1	2	3	4	5	6	7	8	9	10	11	12	AgeSUM
1984	1.6657	-0.7034	-0.6015	0.7706	0.2627	0.5830	0.1230	-0.8927	-0.5294	-0.3599	-0.3132	0.0000	0.0000	0.0048
1985	1.1128	0.8027	-1.5684	-1.1349	0.4856	0.1414	0.6456	0.1713	-0.4541	-0.2626	0.0653	0.0000	0.0000	0.0048
1986	0.9247	-0.1807	0.6584	-1.2710	-0.8983	0.4052	0.2346	0.6755	0.1429	-0.5028	-0.1838	0.0000	0.0000	0.0046
1987	-0.9809	-0.2350	0.2210	0.8032	-0.9096	-0.6224	0.2948	0.2117	0.6436	0.2594	0.3187	0.0000	0.0000	0.0044
1988	0.6402	0.7648	0.0673	-0.2265	0.2245	-0.8749	-0.6965	0.0560	0.0151	0.1894	-0.1551	0.0000	0.0000	0.0042
1989	0.7292	-0.1320	0.9556	0.2493	-0.2980	0.0506	-0.8832	-0.6907	-0.0639	-0.1296	0.2170	0.0000	0.0000	0.0044
1990	-0.2640	0.5254	0.4361	0.9076	0.2131	-0.2410	-0.0105	-0.7074	-0.4793	0.0078	-0.3835	0.0000	0.0000	0.0043
1991	-1.2865	-0.3066	0.3695	0.1442	0.8237	0.2822	-0.0972	0.0932	-0.1145	-0.2370	0.3332	0.0000	0.0000	0.0041
1992	-0.2405	-0.3429	-0.1499	0.3512	0.1434	0.5215	0.1615	-0.1394	-0.1253	-0.0069	-0.1690	0.0000	0.0000	0.0038
1993	-1.2438	-0.2165	-0.1217	-0.0175	0.3503	0.1132	0.5748	0.3750	0.0221	0.0274	0.1404	0.0000	0.0000	0.0036
1994	-0.8499	-0.1993	-0.2969	-0.0680	-0.0445	0.2165	0.1618	0.6266	0.4413	0.2057	-0.1899	0.0000	0.0000	0.0033
1995	-1.1200	-0.5643	0.1157	-0.0883	-0.1034	-0.1535	0.2276	0.3537	0.6285	0.5024	0.2046	0.0000	0.0000	0.0030
1996	0.0956	0.1581	-0.2969	-0.0686	-0.1597	-0.2457	-0.3457	0.2157	-0.0329	0.5076	0.1750	0.0000	0.0000	0.0025
1997	0.2149	0.4754	-0.0040	-0.2638	0.0263	-0.1572	-0.2268	-0.1697	-0.0097	-0.0497	0.1661	0.0000	0.0000	0.0018
1998	0.6025	0.1547	0.2165	-0.0863	-0.1145	-0.0167	-0.1612	-0.1753	-0.0800	-0.1451	-0.1937	0.0000	0.0000	0.0009
1999	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
YearSum:	-0.0001	0.0003	0.0007	0.0011	0.0015	0.0020	0.0026	0.0035	0.0046	0.0061	0.0320	0.0000	0.0000	

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

Catch in Number

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	67.00
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	73.52
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	131.32
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	212.65
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	249.96
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	267.01
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	228.68
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	149.11
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	81.45
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	47.00
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	28.50
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	15.79
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	30.59

x 10 ^ 6

Table 2.10.2.2 North East Atlantic mackerel. Biomass estimates from egg surveys.

INDICES OF SPAWNING BIOMASS

INDEX1

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

	1999
1	*******

x 10 ^ 3

Table 2.10.2.3 North East Atlantic mackerel. Catch weights at age.

Weights at age in the catches (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	0.06200
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	0.17600
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	0.23600
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	0.30700
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	0.36100
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	0.40600
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	0.45400
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	0.50100
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	0.53700
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	0.56900
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	0.58700
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	0.60900
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	0.68800

Table 2.10.2.4 North East Atlantic mackerel. Stock weights at age.

Weights at age in the stock (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	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	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	0.20900
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	0.25600
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	0.31500
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	0.36100
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	0.40900
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	0.43700
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	0.45900
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	0.49700
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	0.51400
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	0.47800
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	0.60100

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	1999
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.0600	0.0600
2	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.5800	0.5800
3	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.8500	0.8500
4	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800	0.9800
5	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800	0.9800
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.10.2.6 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	1999
0	0.04229	0.02545	0.01466	0.00152	0.01597	0.01532	0.00766	0.00268	0.00605	0.00743	0.00733	0.00701	0.00514	0.00467	0.00484	0.00414
1	0.02448	0.04759	0.02103	0.01432	0.03541	0.02204	0.03928	0.02177	0.02682	0.03298	0.03250	0.03110	0.02278	0.02070	0.02146	0.01838
2	0.06271	0.01883	0.09139	0.07110	0.05638	0.09395	0.08827	0.07296	0.06377	0.07839	0.07726	0.07393	0.05415	0.04920	0.05102	0.04370
3	0.20913	0.05174	0.04047	0.19732	0.10454	0.11235	0.16273	0.11142	0.11936	0.14674	0.14462	0.13838	0.10136	0.09210	0.09549	0.08179
4	0.21389	0.19173	0.08240	0.07591	0.21846	0.12537	0.14895	0.20772	0.18403	0.22623	0.22298	0.21336	0.15627	0.14199	0.14723	0.12611
5	0.26239	0.19648	0.21840	0.12749	0.11927	0.22279	0.15675	0.18516	0.22801	0.28030	0.27627	0.26435	0.19361	0.17593	0.18242	0.15624
6	0.24175	0.25685	0.22730	0.21890	0.16002	0.10849	0.22713	0.17723	0.23921	0.29407	0.28984	0.27733	0.20313	0.18457	0.19138	0.16392
7	0.11951	0.22303	0.29291	0.25036	0.25223	0.15122	0.12364	0.26227	0.28559	0.35109	0.34604	0.33111	0.24251	0.22036	0.22849	0.19571
8	0.19724	0.13833	0.21535	0.32519	0.29632	0.21444	0.17691	0.20258	0.29254	0.35964	0.35446	0.33916	0.24841	0.22572	0.23405	0.20047
9	0.21525	0.21411	0.12397	0.26837	0.32502	0.26598	0.23998	0.21855	0.32808	0.40332	0.39752	0.38037	0.27859	0.25314	0.26248	0.22482
10	0.21864	0.24398	0.20698	0.26072	0.22723	0.31336	0.18823	0.30252	0.28333	0.34831	0.34330	0.32848	0.24059	0.21861	0.22668	0.19415
11	0.25972	0.22567	0.21292	0.24393	0.25030	0.23332	0.24876	0.24394	0.27361	0.33636	0.33152	0.31722	0.23234	0.21111	0.21890	0.18749
12	0.25972	0.22567	0.21292	0.24393	0.25030	0.23332	0.24876	0.24394	0.27361	0.33636	0.33152	0.31722	0.23234	0.21111	0.21890	0.18749

Table 2.10.2.7 North East Atlantic mackerel. Population at age

Population Abundance (1 January)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	7496	3480	3590	5254	3746	4633	3421	4030	5052	6670	4861	5687	6765	5206	5124
1	1425	6185	2920	3045	4516	3173	3927	2922	3459	4322	5698	4153	4861	5793	4460
2	1529	1197	5076	2461	2583	3751	2672	3250	2461	2899	3600	4748	3465	4089	4884
3	3899	1236	1011	3987	1973	2102	2939	2105	2600	1988	2307	2868	3795	2825	3351
4	2170	2723	1011	836	2817	1529	1617	2150	1621	1986	1477	1718	2149	2952	2218
5	1174	1508	1935	801	667	1949	1161	1199	1503	1161	1363	1017	1195	1582	2204
6	492	777	1066	1339	607	509	1342	854	857	1030	755	890	672	847	1142
7	212	333	518	731	926	445	393	921	616	581	661	486	581	472	606
8	372	162	229	332	490	619	329	299	610	398	352	402	301	392	326
9	267	263	121	159	207	314	430	237	210	392	239	213	247	202	269
10	206	185	183	92	105	129	207	291	164	130	225	138	125	161	135
11	142	142	125	128	61	72	81	148	185	107	79	138	86	85	111
12	326	515	441	314	267	185	136	263	306	256	219	157	159	141	125

x 10 ^ 6

Population Abundance (1 January)

AGE	1999	2000
0	17447	(6005)
1	4389	14955
2	3757	3709
3	3994	3095
4	2621	3168
5	1648	1989
6	1581	1213
7	812	1155
8	415	575
9	222	292
10	178	153
11	93	126
12	192	203

x 10 ^ 6

Table 2.10.2.8a North East Atlantic mackerel. Diagnostic output.

Predicted catch in Number

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	28.29	45.88	32.96	36.90	32.18	22.50	22.96	67.00
1	85.05	130.26	169.29	118.14	101.68	110.22	87.95	74.24
2	141.30	203.14	248.79	314.48	169.72	182.43	225.71	149.25
3	272.07	252.35	288.95	344.77	340.14	231.10	283.73	291.62
4	253.61	374.49	274.93	307.35	289.33	363.49	282.48	288.86
5	285.45	264.41	306.68	220.17	195.74	237.57	342.10	221.74
6	169.92	244.63	177.01	200.91	115.04	132.91	185.20	222.41
7	142.61	160.45	180.27	127.80	116.47	86.96	115.34	134.34
8	144.11	112.27	97.99	107.93	61.58	73.79	63.37	70.22
9	54.84	121.31	73.27	62.75	55.90	42.04	57.93	41.64
10	37.77	35.76	61.03	36.14	24.91	29.39	25.47	29.29
11	41.30	28.37	20.84	34.85	16.57	15.00	20.35	14.72

x 10 ^ 6

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	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
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
6	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
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.10.2.8b North East Atlantic mackerel. Diagnostic output.

Predicted SSB Index Values

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	3183.0	*******	*******	3131.8	*******	*******	3648.4

x 10 ^ 3

Fitted Selection Pattern

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.1612	0.1295	0.0671	0.0119	0.1339	0.0687	0.0489	0.0145	0.0265	0.0265	0.0265	0.0265	0.0265	0.0265	0.0265
1	0.0933	0.2422	0.0963	0.1123	0.2969	0.0989	0.2506	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176
2	0.2390	0.0959	0.4184	0.5577	0.4727	0.4217	0.5631	0.3940	0.2797	0.2797	0.2797	0.2797	0.2797	0.2797	0.2797
3	0.7970	0.2633	0.1853	1.5476	0.8765	0.5043	1.0382	0.6017	0.5235	0.5235	0.5235	0.5235	0.5235	0.5235	0.5235
4	0.8152	0.9758	0.3773	0.5954	1.8316	0.5627	0.9503	1.1218	0.8071	0.8071	0.8071	0.8071	0.8071	0.8071	0.8071
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	0.9213	1.3072	1.0407	1.7170	1.3416	0.4869	1.4490	0.9571	1.0491	1.0491	1.0491	1.0491	1.0491	1.0491	1.0491
7	0.4555	1.1351	1.3412	1.9637	2.1148	0.6788	0.7888	1.4164	1.2526	1.2526	1.2526	1.2526	1.2526	1.2526	1.2526
8	0.7517	0.7040	0.9860	2.5506	2.4844	0.9625	1.1286	1.0941	1.2830	1.2830	1.2830	1.2830	1.2830	1.2830	1.2830
9	0.8203	1.0897	0.5676	2.1050	2.7250	1.1939	1.5310	1.1803	1.4389	1.4389	1.4389	1.4389	1.4389	1.4389	1.4389
10	0.8333	1.2417	0.9477	2.0450	1.9052	1.4065	1.2009	1.6338	1.2426	1.2426	1.2426	1.2426	1.2426	1.2426	1.2426
11	0.9898	1.1485	0.9749	1.9133	2.0986	1.0473	1.5870	1.3174	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
12	0.9898	1.1485	0.9749	1.9133	2.0986	1.0473	1.5870	1.3174	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Fitted Selection Pattern

AGE	1999
0	0.0265
1	0.1176
2	0.2797
3	0.5235
4	0.8071
5	1.0000
6	1.0491
7	1.2526
8	1.2830
9	1.4389
10	1.2426
11	1.2000
12	1.2000

Table 2.10.2.8c North East Atlantic mackerel. Diagnostic output.

```
 -----------------------------------------------------------------
 No of years for separable analysis : 8
 Age range in the analysis : 0  . . . 12
 Year range in the analysis : 1984  . . . 1999
 Number of indices of SSB : 1
 Number of age-structured indices : 0

 Parameters to estimate : 38
 Number of observations : 99

 Conventional single selection vector model to be fitted.

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

PARAMETER ESTIMATES

 |Parm.|       |Maximum |    |         |         |         |         | Mean of |
 | No. |       |Likelh. | CV |  Lower  | Upper   |  -s.e.  |   +s.e. | Param.  |
 |     |       |Estimate| (%)| 95% CL  | 95% CL  |         |         | Distrib.|

Separable model : F by year
    1   1992     0.2280   7    0.1968    0.2641    0.2115    0.2458    0.2286
    2   1993     0.2803   7    0.2414    0.3255    0.2597    0.3025    0.2811
    3   1994     0.2763   8    0.2351    0.3247    0.2544    0.3000    0.2772
    4   1995     0.2643   9    0.2205    0.3169    0.2410    0.2900    0.2655
    5   1996     0.1936  10    0.1578    0.2376    0.1744    0.2149    0.1947
    6   1997     0.1759  11    0.1400    0.2211    0.1566    0.1977    0.1771
    7   1998     0.1824  13    0.1403    0.2372    0.1596    0.2086    0.1841
    8   1999     0.1562  15    0.1154    0.2116    0.1338    0.1824    0.1581

Separable Model: Selection (S) by age
    9      0     0.0265  53    0.0093    0.0755    0.0156    0.0452    0.0306
   10      1     0.1176   8    0.0995    0.1391    0.1080    0.1282    0.1181
   11      2     0.2797   7    0.2399    0.3260    0.2586    0.3024    0.2805
   12      3     0.5235   7    0.4525    0.6056    0.4860    0.5639    0.5249
   13      4     0.8071   7    0.7010    0.9293    0.7511    0.8673    0.8092
           5     1.0000      Fixed : Reference Age
   14      6     1.0491   6    0.9187    1.1981    0.9804    1.1227    1.0515
   15      7     1.2526   6    1.1027    1.4228    1.1737    1.3367    1.2552
   16      8     1.2830   6    1.1360    1.4490    1.2058    1.3652    1.2855
   17      9     1.4389   6    1.2791    1.6186    1.3550    1.5279    1.4415
   18     10     1.2426   6    1.0989    1.4051    1.1671    1.3230    1.2451
          11     1.2000      Fixed : Last true age

Separable model: Populations in year 1999
   19      0   17447308 150     907962 335265589   3861887  78823782  54394426
   20      1    4388674  22    2808738   6857335   3494979   5510895   4503932
   21      2    3757001  18    2625166   5376824   3129035   4510993   3820367
   22      3    3994479  15    2969287   5373636   3433538   4647063   4040476
   23      4    2621330  13    2005999   3425413   2286865   3004713   2645865
   24      5    1647553  13    1270327   2136796   1442863   1881280   1662114
   25      6    1580903  13    1222945   2043636   1386815   1802155   1594524
   26      7     811906  13     626825   1051635    711508    926471    819010
   27      8     415261  13     317532    543070    362131    476187    419171
   28      9     222078  14     167383    294645    192245    256540    224400
   29     10     178290  15     131519    241695    152654    208231    180451
   30     11      92510  16      67556    126680     78801    108603     93707

Separable model: Populations at age
   31   1992     185163  15     136610    250972    158552    216241    187405
   32   1993     106513  12      83530    135821     94091    120576    107336
   33   1994      79208  11      63056     99497     70508     88982     79746
   34   1995     137512  11     109077    173359    122183    154764    138476
   35   1996      85793  12      67173    109574     75725     97200     86464
   36   1997      84629  13      65439    109447     74223     96494     85361
   37   1998     111162  14      83812    147437     96245    128390    112322

 SSB Index catchabilities
   INDEX1

 Linear model fitted. Slopes at age :
   38    1  Q  1.073       7 .9951     1.356     1.073     1.257     1.165
```

Table 2.10.2.8d North East Atlantic mackerel. Diagnostic output.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.4291	-0.8631	-0.2617	-0.9163	0.1651	0.4701	0.9790	0.0000
1	-0.0174	-0.0164	-0.1391	-0.3709	0.1645	0.2700	0.1219	-0.0098
2	0.1008	0.0347	-0.1162	0.0806	-0.0050	0.0220	0.0178	-0.1280
3	0.2695	0.0552	0.0605	-0.0133	-0.0201	0.0312	-0.0699	-0.3158
4	0.0499	0.0615	-0.0277	-0.1111	-0.0357	0.0415	0.1346	-0.1446
5	0.0700	-0.0791	-0.0175	-0.1641	-0.0969	0.0380	0.0564	0.1858
6	-0.0850	0.0434	0.0437	-0.0153	-0.1778	0.0161	0.1143	0.0278
7	-0.2248	-0.0678	0.0518	0.1078	0.0285	-0.0302	0.0261	0.1043
8	-0.0400	-0.1385	0.0795	0.0496	-0.0983	-0.1039	0.1380	0.1484
9	-0.0685	0.0007	0.0885	0.0977	0.0675	-0.0635	-0.2015	0.1212
10	-0.0312	0.0814	-0.0574	0.1607	0.0352	-0.0945	-0.0433	-0.0271
11	-0.0083	0.0242	-0.0210	0.0855	0.1025	-0.0723	-0.2066	0.0699

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	*******	*******	*******	*******	*******	*******	0.05708	*******	*******	-.09780	*******	*******	0.04071

INDEX1

	1999
1	*******

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 1999

Variance	0.0190
Skewness test stat.	-2.0749
Kurtosis test statistic	2.3923
Partial chi-square	0.0967
Significance in fit	0.0000
Degrees of freedom	59

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Linear catchability relationship assumed

Variance	0.0362
Skewness test stat.	-0.4793
Kurtosis test statistic	-0.5303
Partial chi-square	0.0048
Significance in fit	0.0024
Number of observations	3
Degrees of freedom	2
Weight in the analysis	5.0000

Table 2.10.2.8e North East Atlantic mackerel. Diagnostic output.

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.1512	99	38	61	0.0681
Catches at age	4.1367	96	37	59	0.0701
SSB Indices					
INDEX1	0.0145	3	1	2	0.0072

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	1.4852	99	38	61	0.0243
Catches at age	1.1232	96	37	59	0.0190
SSB Indices					
INDEX1	0.3620	3	1	2	0.1810

Table 2.10.2.9 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	7495900	3388372	2644534	648084	0.2451	0.2070	100
1985	3479540	3593332	2616217	614275	0.2348	0.2013	100
1986	3589750	3585648	2635568	602128	0.2285	0.2073	103
1987	5254430	3467593	2617207	654805	0.2502	0.1996	99
1988	3746350	3637086	2696528	676288	0.2508	0.2093	103
1989	4632700	3655928	2734950	585921	0.2142	0.1645	100
1990	3421480	3458773	2593869	625611	0.2412	0.1667	99
1991	4029770	3823536	2923550	667883	0.2284	0.2070	98
1992	5052480	3948608	2965390	760351	0.2564	0.2459	99
1993	6670070	3883367	2802804	825036	0.2944	0.3023	100
1994	4860760	3828455	2658922	823477	0.3097	0.2979	100
1995	5686910	4053434	2917652	756291	0.2592	0.2851	100
1996	6765000	4056179	3014205	563585	0.1870	0.2088	100
1997	5205660	4474264	3261925	569543	0.1746	0.1897	99
1998	5123640	4732194	3398942	667218	0.1963	0.1967	100
1999	(4252000)	5194572	3830775	608928	0.1590	0.1685	100

Table 2.10.3.1 Assessment quality control diagram for the North East Atlantic mackerel combined (average F(4-8,u))

Assessment Quality Control Diagram 1

Average F(4-8,u)													
Date of assessment	Year												
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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

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
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)]	

[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

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	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			

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

Year class	AGE	Stock in numbers at 1st January 2000	
2000	0	4252	<--- geometric mean over period 1972-1996 of Western recruitment, raised by the average ratio of the estimated Western and NEA area recruitments for the period 1984-1996.
1999	1	3645	<--- corrected 1-year olds
1998	2	3709	<-- from ICA
1997	3	3095	<-- from ICA
1996	4	3168	<-- from ICA
1995	5	1989	<-- from ICA
1994	6	1213	<-- from ICA
1993	7	1155	<-- from ICA
1992	8	575	<-- from ICA
1991	9	292	<-- from ICA
1990	10	153	<-- from ICA
1989	11	126	<-- from ICA
	12+	203	<-- from ICA

CALCULATION OF RECRUITMENT AT AGE 1	
Numbers at age **1**	14955
At age **0** one year earlier	17447
CORRECTED **1**-YEAR OLDS	3645

(N_age_1_in_2000 / N_age_0_in 1999) x GM recruitment

Calculation of status quo F and fishery pattern by fleet

	MAC-south catch at age			SOUTHERN
AGE	**1997**	**1998**	**1999**	**TOTAL (n)**
0	28269	53123	66972	**148365**
1	27597	31394	13109	**72099**
2	22949	22826	8634	**54409**
3	7954	21466	12828	**42247**
4	26407	10624	22031	**59062**
5	17135	19696	17387	**54218**
6	6300	15450	21849	**43599**
7	6807	6584	11407	**24797**
8	5918	4298	4667	**14883**
9	4890	4135	2882	**11908**
10	2780	2702	2330	**7812**
11	1609	1990	1788	**5387**
12	1314	1929	991	**7649**
13	347	578	585	
14	184	420	203	
15+	251	675	172	

	MAC-northern catch at age			NORTHERN
AGE	**1997**	**1998**	**1999**	**TOTAL (n)**
0	8200	8003	31	**16234**
1	120600	67958	60411	**248969**
2	161300	206941	122685	**490926**
3	232700	243100	199824	**675624**
4	353100	312562	227933	**893595**
5	229500	342249	249626	**821375**
6	128400	192169	206833	**527402**
7	77700	111804	137701	**327205**
8	60800	68448	76786	**206034**
9	34700	43218	44122	**122040**
10	24000	21684	26175	**71859**
11	12400	14561	13998	**40959**
12+	22900	19331	28634	**70865**

F(4-8)97 =	0.1897
F(4-8)98 =	0.1967
F(4-8)99 =	0.1685
	0.1850 = Fsq (4-8) 97-99

		Rescaling factor		Rescaled fishery pattern for the prediction	
Mean F(4-8)	**0.1685**	**1.0978**			
AGE	**F-values from ICA**		**Rescaled F-values**	**SOUTH**	**NORTH**
0	0.00414		0.00454	**0.0041**	**0.0004**
1	0.01838		0.02018	**0.0045**	**0.0156**
2	0.04370		0.04797	**0.0048**	**0.0432**
3	0.08179		0.08979	**0.0053**	**0.0845**
4	0.12611		0.13844	**0.0086**	**0.1299**
5	0.15624		0.17152	**0.0106**	**0.1609**
6	0.16392		0.17995	**0.0137**	**0.1662**
7	0.19571		0.21485	**0.0151**	**0.1997**
8	0.20047		0.22007	**0.0148**	**0.2052**
9	0.22482		0.24681	**0.0219**	**0.2249**
10	0.19415		0.21314	**0.0209**	**0.1922**
11	0.18749		0.20582	**0.0239**	**0.1819**
12+	0.18749		0.20582	**0.0201**	**0.1858**
	F of WG2000				

TOTAL (n) 1997-1999			
SOUTHERN TOTAL (n)	**NORTHERN TOTAL (n)**	**SOUTHERN fraction**	**NORTHERN fraction**
148365	16234	0.90137	0.09863
72099	248969	0.22456	0.77544
54409	490926	0.09977	0.90023
42247	675624	0.05885	0.94115
59062	893595	0.06200	0.93800
54218	821375	0.06192	0.93808
43599	527402	0.07636	0.92364
24797	327205	0.07045	0.92955
14883	206034	0.06737	0.93263
11908	122040	0.08890	0.91110
7812	71859	0.09805	0.90195
5387	40959	0.11624	0.88376
7649	70865	0.09742	0.90258

Proportion of F and M before spawing

F	M
0.4	0.4

Table 2.11.1 (Cont'd)

AGE	Proportion MATURE		1997	1998	1999
0	0.00		0.00	0.00	0.00
1	0.09	NEA	0.14	0.06	0.06
2	0.60		0.65	0.58	0.58
3	0.87		0.91	0.85	0.85
4	0.98		0.97	0.98	0.98
5	0.98		0.97	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		1997	1998	1999
0	0.000		0.000	0.000	0.000
1	0.091	NEA	0.084	0.094	0.094
2	0.191		0.197	0.168	0.209
3	0.243		0.232	0.241	0.256
4	0.302		0.301	0.289	0.315
5	0.359		0.363	0.353	0.361
6	0.409		0.404	0.413	0.409
7	0.441		0.447	0.439	0.437
8	0.473		0.482	0.478	0.459
9	0.510		0.519	0.514	0.497
10	0.538		0.54	0.561	0.514
11	0.517		0.533	0.539	0.478
12+	0.609		0.601	0.624	0.601

AGE	NORTHERN Mean weight at age in the CATCH		1997	1998	1999
0	0.076		0.076	0.060	0.092
1	0.166	NORTHERN	0.150	0.165	0.184
2	0.234		0.235	0.231	0.237
3	0.307		0.295	0.317	0.310
4	0.361		0.361	0.356	0.367
5	0.412		0.418	0.411	0.408
6	0.458		0.455	0.458	0.461
7	0.486		0.484	0.465	0.509
8	0.532		0.529	0.522	0.544
9	0.564		0.559	0.558	0.575
10	0.587		0.583	0.583	0.595
11	0.607		0.598	0.605	0.619
12+	0.661		0.640	0.645	0.698

AGE	SOUTHERN Mean weight at age in the CATCH		1997	1998	1999
0	0.068		0.076	0.065	0.062
1	0.129	SOUTHERN	0.111	0.138	0.137
2	0.190		0.176	0.192	0.202
3	0.257		0.274	0.237	0.261
4	0.312		0.319	0.313	0.302
5	0.362		0.366	0.350	0.371
6	0.392		0.416	0.375	0.385
7	0.421		0.449	0.407	0.407
8	0.451		0.472	0.449	0.433
9	0.484		0.509	0.461	0.481
10	0.508		0.529	0.494	0.503
11	0.523		0.544	0.493	0.531
12+	0.566	weighted mean weight!	0.583	0.513	0.528
			0.596	0.566	0.549
			0.644	0.616	0.572
			0.664	0.643	0.594

AGE	NEA Mean weight at age in the CATCH		1997	1998	1999
0	0.068		0.076	0.065	0.062
1	0.159	NEA	0.143	0.157	0.176
2	0.231		0.230	0.227	0.236
3	0.304		0.295	0.310	0.307
4	0.358		0.359	0.354	0.361
5	0.410		0.415	0.408	0.406
6	0.453		0.453	0.452	0.454
7	0.481		0.481	0.462	0.501
8	0.526		0.524	0.518	0.537
9	0.557		0.553	0.550	0.569
10	0.579		0.577	0.573	0.587
11	0.597		0.591	0.591	0.609
12+	0.652		0.636	0.631	0.688

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

Rundate: 19 Sep 2000 19:14

2000

	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	0.0004	0.076	0.0041	0.068	**4252**	0.15	0.00	0.4	0.4	0.000
1	0.0156	0.166	0.0045	0.129	**3645**	0.15	0.09	0.4	0.4	0.091
2	0.0432	0.234	0.0048	0.190	3709	0.15	0.60	0.4	0.4	0.191
3	0.0845	0.307	0.0053	0.257	3095	0.15	0.87	0.4	0.4	0.243
4	0.1299	0.361	0.0086	0.312	3168	0.15	0.98	0.4	0.4	0.302
5	0.1609	0.412	0.0106	0.362	1989	0.15	0.98	0.4	0.4	0.359
6	0.1662	0.458	0.0137	0.392	1213	0.15	0.99	0.4	0.4	0.409
7	0.1997	0.486	0.0151	0.421	1155	0.15	1.00	0.4	0.4	0.441
8	0.2052	0.532	0.0148	0.451	575	0.15	1.00	0.4	0.4	0.473
9	0.2249	0.564	0.0219	0.484	292	0.15	1.00	0.4	0.4	0.510
10	0.1922	0.587	0.0209	0.508	153	0.15	1.00	0.4	0.4	0.538
11	0.1819	0.607	0.0239	0.523	126	0.15	1.00	0.4	0.4	0.517
12+	0.1858	0.661	0.0201	0.566	203	0.15	1.00	0.4	0.4	0.609
UNIT:		(kg)		(kg)	(millions)					(kg)

2001

	NORTHERN		SOUTHERN							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0004	0.076	0.0041	0.068	4252	0.15	0.00	0.4	0.4	0.000
1	0.0156	0.166	0.0045	0.129	-	0.15	0.09	0.4	0.4	0.091
2	0.0432	0.234	0.0048	0.190	-	0.15	0.60	0.4	0.4	0.191
3	0.0845	0.307	0.0053	0.257	-	0.15	0.87	0.4	0.4	0.243
4	0.1299	0.361	0.0086	0.312	-	0.15	0.98	0.4	0.4	0.302
5	0.1609	0.412	0.0106	0.362	-	0.15	0.98	0.4	0.4	0.359
6	0.1662	0.458	0.0137	0.392	-	0.15	0.99	0.4	0.4	0.409
7	0.1997	0.486	0.0151	0.421	-	0.15	1.00	0.4	0.4	0.441
8	0.2052	0.532	0.0148	0.451	-	0.15	1.00	0.4	0.4	0.473
9	0.2249	0.564	0.0219	0.484	-	0.15	1.00	0.4	0.4	0.510
10	0.1922	0.587	0.0209	0.508	-	0.15	1.00	0.4	0.4	0.538
11	0.1819	0.607	0.0239	0.523	-	0.15	1.00	0.4	0.4	0.517
12+	0.1858	0.661	0.0201	0.566	-	0.15	1.00	0.4	0.4	0.609
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	0.0004	0.076	0.0041	0.068	4252	0.15	0.00	0.4	0.4	0.000
1	0.0156	0.166	0.0045	0.129	-	0.15	0.09	0.4	0.4	0.091
2	0.0432	0.234	0.0048	0.190	-	0.15	0.60	0.4	0.4	0.191
3	0.0845	0.307	0.0053	0.257	-	0.15	0.87	0.4	0.4	0.243
4	0.1299	0.361	0.0086	0.312	-	0.15	0.98	0.4	0.4	0.302
5	0.1609	0.412	0.0106	0.362	-	0.15	0.98	0.4	0.4	0.359
6	0.1662	0.458	0.0137	0.392	-	0.15	0.99	0.4	0.4	0.409
7	0.1997	0.486	0.0151	0.421	-	0.15	1.00	0.4	0.4	0.441
8	0.2052	0.532	0.0148	0.451	-	0.15	1.00	0.4	0.4	0.473
9	0.2249	0.564	0.0219	0.484	-	0.15	1.00	0.4	0.4	0.510
10	0.1922	0.587	0.0209	0.508	-	0.15	1.00	0.4	0.4	0.538
11	0.1819	0.607	0.0239	0.523	-	0.15	1.00	0.4	0.4	0.517
12+	0.1858	0.661	0.0201	0.566	-	0.15	1.00	0.4	0.4	0.609
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 2.11.3 NORTH EAST ATLANTIC MACKEREL. Two area prediction summary table.

Catch constraint of 652 kt in 2000 and F=0.15 in 2001-2005

		NORTHERN			SOUTHERN			TOTAL			1st of January		1st of January		Spawning time	
			Catch in	Catch in		Catch in	Catch in		Catch in	Catch in	Stock	Stock	SP. ST.	SP. ST.	SP. ST.	SP. ST.
Year	**F Factor**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**size**	**biomass**	**size**	**biomass**	**size**	**biomass**
2000	0.919503	0.159	1531.827	609.570	0.012	141.799	42.430	0.170	1673.626	652.000	23575.000	5160.436	14004.830	4439.078	12556.038	3952.253
2001	0.810800	0.140	1370.325	560.025	0.010	126.691	39.119	0.150	1497.016	599.144	22994.584	5151.559	13685.269	4479.924	12319.289	4008.038
2002	0.810800	0.140	1368.891	571.222	0.010	129.232	40.958	0.150	1498.123	612.179	22658.228	5154.071	13417.444	4500.114	12063.931	4020.360
2003	0.810800	0.140	1351.896	571.846	0.010	128.661	41.362	0.150	1480.557	613.207	22367.757	5113.034	13137.736	4462.854	11807.097	3984.120
2004	0.810800	0.140	1328.118	567.154	0.010	128.031	41.578	0.150	1456.148	608.732	22134.030	5058.402	12910.026	4410.408	11602.534	3936.309
2005	0.810800	0.140	1308.907	561.488	0.010	127.306	41.624	0.150	1436.214	603.112	21955.454	5011.625	12733.692	4364.554	11444.704	3894.773
	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 652 kt in 2000 and F=0.17 in 2001-2005

		NORTHERN			SOUTHERN			TOTAL			1st of January		1st of January		Spawning time	
			Catch in	Catch in		Catch in	Catch in		Catch in	Catch in	Stock	Stock	SP. ST.	SP. ST.	SP. ST.	SP. ST.
Year	**F Factor**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**size**	**biomass**	**size**	**biomass**	**size**	**biomass**
2000	0.919503	0.159	1531.827	609.570	0.012	141.799	42.430	0.170	1673.626	652.000	23575.000	5160.436	14004.830	4439.078	12556.038	3952.253
2001	0.919000	0.158	1540.844	629.250	0.012	142.638	43.967	0.170	1683.482	673.217	22994.584	5151.559	13685.269	4479.924	12245.630	3980.788
2002	0.919000	0.158	1517.013	631.370	0.012	143.704	45.291	0.170	1660.717	676.661	22485.984	5086.341	13252.579	4433.940	11844.559	3934.128
2003	0.919000	0.158	1480.036	623.049	0.012	141.563	45.075	0.170	1621.599	668.124	22069.356	4989.909	12848.660	4341.798	11479.771	3849.762
2004	0.919000	0.158	1440.102	610.557	0.012	139.647	44.742	0.170	1579.749	655.299	21746.980	4892.614	12532.688	4246.811	11199.514	3765.097
2005	0.919000	0.158	1409.137	598.721	0.012	137.899	44.318	0.170	1547.036	643.039	21508.229	4813.838	12296.227	4168.972	10990.544	3696.004
	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 652 kt in 2000 and F=0.185 in 2001-2005

		NORTHERN			SOUTHERN			TOTAL			1st of January		1st of January		Spawning time	
			Catch in	Catch in		Catch in	Catch in		Catch in	Catch in	Stock	Stock	SP. ST.	SP. ST.	SP. ST.	SP. ST.
Year	**F Factor**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**size**	**biomass**	**size**	**biomass**	**size**	**biomass**
2000	0.919503	0.159	1531.827	609.570	0.012	141.799	42.430	0.170	1673.626	652.000	23575.000	5160.436	14004.830	4439.078	12556.038	3952.253
2001	1.000000	0.172	1666.702	680.275	0.013	154.437	47.543	0.185	1821.140	727.818	22994.584	5151.559	13685.269	4479.924	12190.831	3960.525
2002	1.000000	0.172	1623.263	674.257	0.013	154.168	48.385	0.185	1777.431	722.641	22358.875	5036.432	13130.970	4385.188	11683.733	3871.020
2003	1.000000	0.172	1569.554	658.343	0.013	150.703	47.639	0.185	1720.257	705.983	21852.218	4900.558	12638.454	4253.981	11243.142	3752.927
2004	1.000000	0.172	1516.632	639.516	0.013	147.742	46.854	0.185	1664.374	686.370	21469.048	4774.046	12261.964	4129.864	10911.929	3643.464
2005	1.000000	0.172	1476.549	622.860	0.013	145.192	46.060	0.185	1621.741	668.920	21190.938	4674.296	11986.177	4031.059	10670.229	3556.659
	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 652 kt in 2000 and F=0.20 in 2001-2005

		NORTHERN			SOUTHERN			TOTAL			1st of January		1st of January		Spawning time	
			Catch in	Catch in		Catch in	Catch in		Catch in	Catch in	Stock	Stock	SP. ST.	SP. ST.	SP. ST.	SP. ST.
Year	**F Factor**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**F**	**numbers**	**weight**	**size**	**biomass**	**size**	**biomass**	**size**	**biomass**
2000	0.919503	0.159	1531.827	609.570	0.012	141.799	42.430	0.170	1673.626	652.000	23575.000	5160.436	14004.830	4439.078	12556.038	3952.253
2001	1.081500	0.186	1791.810	730.936	0.014	166.191	51.094	0.200	1958.001	782.030	22994.584	5151.559	13685.269	4479.924	12135.986	3940.254
2002	1.081500	0.186	1726.307	715.629	0.014	164.387	51.373	0.200	1890.695	767.002	22232.541	4986.888	13010.153	4336.804	11524.788	3808.744
2003	1.081500	0.186	1654.409	691.394	0.014	159.478	50.044	0.200	1813.887	741.438	21638.972	4813.017	12432.140	4167.970	11012.051	3658.607
2004	1.081500	0.186	1587.826	665.860	0.014	155.409	48.777	0.200	1743.236	714.637	21199.141	4659.309	11999.259	4016.740	10634.137	3526.426
2005	1.081500	0.186	1538.442	644.267	0.014	152.038	47.602	0.200	1690.479	691.869	20885.906	4540.797	11688.375	3899.182	10363.817	3424.063
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.4 NORTH EAST ATLANTIC MACKEREL. Two area prediction detailed table. Rundate: 20 Sep 2000 16:34

Fsq = 0.185 constraint for each fleet in 2000-2005

YEAR 2000 F-factor ***1.00000***

		NORTHERN			SOUTHERN			TOTAL			1st of January		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	SP. ST. size	SP. ST. biomass
2000	**0**	0.0004	1.576	0.120	0.0041	16.153	1.098	0.0045	17.729	1.218	4252.00	0.00	0.00	0.00	0.00	0.00
1999	**1**	0.0156	52.289	8.680	0.0045	15.083	1.946	0.0201	67.372	10.626	3645.00	331.70	328.05	29.85	306.47	27.89
1998	**2**	0.0432	145.363	34.015	0.0048	16.151	3.069	0.0480	161.515	37.084	3709.00	708.42	2225.40	425.05	2055.95	392.69
1997	**3**	0.0845	232.533	71.388	0.0053	14.585	3.748	0.0898	247.118	75.136	3095.00	752.09	2692.65	654.31	2446.37	594.47
1996	**4**	0.1299	357.481	129.050	0.0086	23.667	7.384	0.1385	381.147	136.435	3168.00	956.74	3104.64	937.60	2766.26	835.41
1995	**5**	0.1609	273.682	112.757	0.0106	18.030	6.527	0.1715	291.712	119.284	1989.00	714.05	1949.22	699.77	1714.00	615.33
1994	**6**	0.1662	171.721	78.648	0.0137	14.155	5.549	0.1799	185.876	84.197	1213.00	496.12	1200.87	491.16	1052.41	430.44
1993	**7**	0.1997	193.264	93.926	0.0151	14.613	6.152	0.2148	207.877	100.078	1155.00	509.36	1155.00	509.36	998.18	440.20
1992	**8**	0.2052	98.622	52.467	0.0148	7.113	3.208	0.2200	105.735	55.675	575.00	271.98	575.00	271.98	495.90	234.56
1991	**9**	0.2249	54.207	30.573	0.0219	5.278	2.555	0.2468	59.485	33.127	292.00	148.92	292.00	148.92	249.14	127.06
1990	**10**	0.1922	24.659	14.475	0.0209	2.681	1.362	0.2131	27.341	15.837	153.00	82.31	153.00	82.31	132.32	71.19
1989	**11**	0.1819	19.285	11.706	0.0239	2.534	1.325	0.2058	21.819	13.032	126.00	65.14	126.00	65.14	109.29	56.50
1988	**12+**	0.1858	31.736	20.977	0.0201	3.433	1.943	0.2059	35.169	22.921	203.00	123.63	203.00	123.63	176.06	107.22
		0.1724	1656.418	658.783	0.0126	153.479	45.867	**0.185**	1809.897	**704.649**	23575.00	5160.44	14004.83	4439.08	12502.36	**3932.95**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2001 F-factor: ***1.0000***

		NORTHERN			SOUTHERN			TOTAL			1st of January		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	SP. ST. size	SP. ST. biomass
2001	**0**	0.0004	1.576	0.120	0.0041	16.153	1.098	0.0045	17.729	1.218	4252.00	0.00	0.00	0.00	0.00	0.00
2000	**1**	0.0156	52.264	8.676	0.0045	15.076	1.945	0.0201	67.341	10.621	3643.30	331.54	327.90	29.84	306.33	27.88
1999	**2**	0.0432	120.510	28.199	0.0048	13.390	2.544	0.0480	133.900	30.743	3074.85	587.30	1844.91	352.38	1704.43	325.55
1998	**3**	0.0845	228.608	70.183	0.0053	14.339	3.685	0.0898	242.947	73.868	3042.75	739.39	2647.19	643.27	2405.07	584.43
1997	**4**	0.1299	274.779	99.195	0.0086	18.192	5.676	0.1385	292.971	104.871	2435.10	735.40	2386.40	720.69	2126.30	642.14
1996	**5**	0.1609	326.665	134.586	0.0106	21.521	7.790	0.1715	348.186	142.377	2374.06	852.29	2326.58	835.24	2045.82	734.45
1995	**6**	0.1662	204.160	93.505	0.0137	16.829	6.597	0.1799	220.989	100.102	1442.15	589.84	1427.72	583.94	1251.22	511.75
1994	**7**	0.1997	145.934	70.924	0.0151	11.035	4.646	0.2148	156.968	75.569	872.14	384.61	872.14	384.61	753.73	332.39
1993	**8**	0.2052	137.549	73.176	0.0148	9.921	4.474	0.2200	147.470	77.651	801.96	379.33	801.96	379.33	691.63	327.14
1992	**9**	0.2249	73.731	41.584	0.0219	7.180	3.475	0.2468	80.911	45.059	397.17	202.56	397.17	202.56	338.88	172.83
1991	**10**	0.1922	31.648	18.577	0.0209	3.441	1.748	0.2131	35.089	20.326	196.36	105.64	196.36	105.64	169.82	91.36
1990	**11**	0.1819	16.288	9.887	0.0239	2.140	1.119	0.2058	18.428	11.006	106.41	55.02	106.41	55.02	92.30	47.72
1989	**12+**	0.1858	36.033	23.818	0.0201	3.898	2.206	0.2059	39.931	26.024	230.49	140.37	230.49	140.37	199.90	121.74
		0.1724	1649.745	672.430	0.0126	153.114	47.004	**0.185**	1802.859	**719.435**	22868.74	5103.27	13565.23	4432.88	12085.44	**3919.38**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2002 F-factor: **1.0000**

		NORTHERN			SOUTHERN			TOTAL			1st of January		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	SP. ST. size	SP. ST. biomass
2002	**0**	0.0004	1.576	0.120	0.0041	16.153	1.098	0.0045	17.729	1.218	4252.00	0.00	0.00	0.00	0.00	0.00
2001	**1**	0.0156	52.264	8.676	0.0045	15.076	1.945	0.0201	67.341	10.621	3643.30	331.54	327.90	29.84	306.33	27.88
2000	**2**	0.0432	120.453	28.186	0.0048	13.384	2.543	0.0480	133.837	30.729	3073.42	587.02	1844.05	352.21	1703.63	325.39
1999	**3**	0.0845	189.522	58.183	0.0053	11.887	3.055	0.0898	201.409	61.238	2522.51	612.97	2194.59	533.28	1993.86	484.51
1998	**4**	0.1299	270.141	97.521	0.0086	17.885	5.580	0.1385	288.025	103.101	2393.99	722.99	2346.11	708.53	2090.41	631.30
1997	**5**	0.1609	251.093	103.450	0.0106	16.542	5.988	0.1715	267.635	109.439	1824.83	655.11	1788.34	642.01	1572.53	564.54
1996	**6**	0.1662	243.684	111.607	0.0137	20.087	7.874	0.1799	263.771	119.481	1721.34	704.03	1704.12	696.99	1493.45	610.82
1995	**7**	0.1997	173.502	84.322	0.0151	13.119	5.523	0.2148	186.621	89.845	1036.90	457.27	1036.90	457.27	896.11	395.19
1994	**8**	0.2052	103.864	55.255	0.0148	7.491	3.379	0.2200	111.355	58.634	605.56	286.43	605.56	286.43	522.25	247.03
1993	**9**	0.2249	102.833	57.998	0.0219	10.014	4.847	0.2468	112.847	62.844	553.94	282.51	553.94	282.51	472.64	241.05
1992	**10**	0.1922	43.047	25.268	0.0209	4.681	2.378	0.2131	47.728	27.646	267.09	143.69	267.09	143.69	230.98	124.27
1991	**11**	0.1819	20.904	12.689	0.0239	2.747	1.436	0.2058	23.650	14.125	136.57	70.61	136.57	70.61	118.46	61.24
1990	**12+**	0.1858	36.898	24.390	0.0201	3.992	2.259	0.2059	40.890	26.649	236.02	143.74	236.02	143.74	204.70	124.66
		0.1724	1609.780	667.665	0.0126	153.057	47.905	**0.185**	1762.837	**715.571**	22267.46	4997.91	13041.18	4347.11	11605.36	**3837.87**
	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 management option table. Assuming *status quo* fishing mortality of 0.185 for each fleet in 2000.

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11:25 Wednesday, September 20, 2000
   Mackerel (combined Southern, Western & N.Sea spawn.comp.)

                              Multi fleet prediction with mangement option table
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Year: 2000								
Northern			Southern			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1724	658783	1.0000	0.0126	45867	704649	5160436	3932949
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2001									Year: 2002	
Northern			Southern			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	5103273	4174729	5656547	4700422
0.0500	0.0086	36329	0.0500	0.0006	2533	38863	.	4161527	5620921	4652161
0.1000	0.0172	72358	0.1000	0.0013	5046	77404	.	4148371	5585595	4604484
0.1500	0.0259	108089	0.1500	0.0019	7539	115628	.	4135263	5550566	4557383
0.2000	0.0345	143524	0.2000	0.0025	10012	153535	.	4122200	5515830	4510850
0.2500	0.0431	178666	0.2500	0.0031	12465	191131	.	4109184	5481386	4464878
0.3000	0.0517	213518	0.3000	0.0038	14898	228416	.	4096214	5447230	4419460
0.3500	0.0603	248083	0.3500	0.0044	17312	265395	.	4083290	5413360	4374588
0.4000	0.0690	282363	0.4000	0.0050	19707	302070	.	4070412	5379774	4330256
0.4500	0.0776	316361	0.4500	0.0057	22082	338443	.	4057580	5346468	4286455
0.5000	0.0862	350079	0.5000	0.0063	24439	374518	.	4044793	5313440	4243181
0.5500	0.0948	383520	0.5500	0.0069	26777	410297	.	4032051	5280688	4200424
0.6000	0.1034	416686	0.6000	0.0075	29096	445783	.	4019354	5248209	4158180
0.6500	0.1120	449581	0.6500	0.0082	31398	480979	.	4006702	5216000	4116441
0.7000	0.1207	482206	0.7000	0.0088	33680	515886	.	3994095	5184060	4075200
0.7500	0.1293	514564	0.7500	0.0094	35945	550509	.	3981533	5152384	4034452
0.8000	0.1379	546657	0.8000	0.0100	38192	584849	.	3969015	5120972	3994189
0.8500	0.1465	578488	0.8500	0.0107	40421	618909	.	3956541	5089821	3954406
0.9000	0.1551	610059	0.9000	0.0113	42633	652692	.	3944111	5058928	3915097
0.9500	0.1638	641372	0.9500	0.0119	44827	686199	.	3931726	5028291	3876254
1.0000	0.1724	672430	1.0000	0.0126	47004	719435	.	3919384	4997907	3837873
1.0500	0.1810	703236	1.0500	0.0132	49164	752400	.	3907085	4967775	3799948
1.1000	0.1896	733790	1.1000	0.0138	51307	785098	.	3894830	4937891	3762471
1.1500	0.1982	764097	1.1500	0.0144	53434	817530	.	3882619	4908254	3725438
1.2000	0.2069	794157	1.2000	0.0151	55543	849700	.	3870450	4878862	3688844
1.2500	0.2155	823973	1.2500	0.0157	57636	881610	.	3858325	4849712	3652681
1.3000	0.2241	853548	1.3000	0.0163	59713	913262	.	3846242	4820802	3616945
1.3500	0.2327	882883	1.3500	0.0170	61774	944658	.	3834201	4792129	3581631
1.4000	0.2413	911981	1.4000	0.0176	63819	975800	.	3822204	4763692	3546732
1.4500	0.2500	940844	1.4500	0.0182	65848	1006692	.	3810248	4735489	3512244
1.5000	0.2586	969474	1.5000	0.0188	67861	1037335	.	3798335	4707517	3478160
1.5500	0.2672	997873	1.5500	0.0195	69859	1067731	.	3786463	4679774	3444477
1.6000	0.2758	1026043	1.6000	0.0201	71841	1097884	.	3774634	4652258	3411189
1.6500	0.2844	1053986	1.6500	0.0207	73808	1127794	.	3762846	4624968	3378291
1.7000	0.2930	1081704	1.7000	0.0214	75760	1157464	.	3751100	4597900	3345778
1.7500	0.3017	1109200	1.7500	0.0220	77697	1186896	.	3739395	4571053	3313644
1.8000	0.3103	1136475	1.8000	0.0226	79619	1216093	.	3727731	4544426	3281886
1.8500	0.3189	1163531	1.8500	0.0232	81526	1245056	.	3716108	4518015	3250498
1.9000	0.3275	1190370	1.9000	0.0239	83418	1273788	.	3704526	4491819	3219475
1.9500	0.3361	1216994	1.9500	0.0245	85297	1302291	.	3692985	4465837	3188814
2.0000	0.3448	1243406	2.0000	0.0251	87160	1330566	.	3681484	4440065	3158508
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

```
Notes: Run name            : MANELT01
       Date and time       : 20SEP00:12:46
       Computation of ref. F: Northern: Simple mean, age 4 - 8
                              Southern: Simple mean, age 4 - 8
       Basis for 2000      : F factors
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Table 2.11.6 North East Atlantic Mackerel: Two area management option table. Assuming a total catch constraint of 665,000 t in 2000.

11:25 Wednesday, September 20, 2000
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet prediction with mangement option table

Year: 2000								
Northern			Southern			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.9393	0.1619	621732	0.9393	0.0118	43279	665011	5160436	3947496
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2001									Year: 2002	
Northern			Southern			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	5139625	4208083	5691255	4732763
0.0500	0.0086	36652	0.0500	0.0006	2555	39207	.	4194757	5655318	4684084
0.1000	0.0172	72999	0.1000	0.0013	5090	78090	.	4181479	5619682	4635994
0.1500	0.0259	109046	0.1500	0.0019	7605	116651	.	4168248	5584347	4588485
0.2000	0.0345	144794	0.2000	0.0025	10099	154893	.	4155063	5549309	4541550
0.2500	0.0431	180247	0.2500	0.0031	12573	192820	.	4141926	5514564	4495181
0.3000	0.0517	215407	0.3000	0.0038	15028	230434	.	4128835	5480111	4449372
0.3500	0.0603	250276	0.3500	0.0044	17463	267739	.	4115790	5445947	4404114
0.4000	0.0690	284858	0.4000	0.0050	19878	304736	.	4102792	5412069	4359400
0.4500	0.0776	319154	0.4500	0.0057	22274	341429	.	4089839	5378475	4315224
0.5000	0.0862	353169	0.5000	0.0063	24651	377820	.	4076933	5345161	4271579
0.5500	0.0948	386903	0.5500	0.0069	27009	413913	.	4064072	5312125	4228457
0.6000	0.1034	420361	0.6000	0.0075	29349	449710	.	4051257	5279366	4185852
0.6500	0.1120	453543	0.6500	0.0082	31670	485213	.	4038488	5246879	4143757
0.7000	0.1207	486454	0.7000	0.0088	33972	520426	.	4025763	5214663	4102165
0.7500	0.1293	519094	0.7500	0.0094	36256	555350	.	4013084	5182715	4061070
0.8000	0.1379	551467	0.8000	0.0100	38522	589990	.	4000450	5151033	4020466
0.8500	0.1465	583576	0.8500	0.0107	40771	624346	.	3987860	5119614	3980346
0.9000	0.1551	615422	0.9000	0.0113	43001	658423	.	3975314	5088456	3940704
0.9500	0.1638	647007	0.9500	0.0119	45214	692222	.	3962814	5057556	3901534
1.0000	0.1724	678336	1.0000	0.0126	47410	725745	.	3950357	5026912	3862829
1.0500	0.1810	709408	1.0500	0.0132	49588	758996	.	3937944	4996522	3824584
1.1000	0.1896	740228	1.1000	0.0138	51749	791977	.	3925576	4966384	3786793
1.1500	0.1982	770797	1.1500	0.0144	53893	824690	.	3913250	4936494	3749450
1.2000	0.2069	801117	1.2000	0.0151	56021	857138	.	3900969	4906852	3712548
1.2500	0.2155	831191	1.2500	0.0157	58132	889323	.	3888731	4877453	3676083
1.3000	0.2241	861021	1.3000	0.0163	60226	921247	.	3876536	4848298	3640049
1.3500	0.2327	890609	1.3500	0.0170	62304	952914	.	3864384	4819382	3604440
1.4000	0.2413	919958	1.4000	0.0176	64366	984324	.	3852275	4790704	3569251
1.4500	0.2500	949069	1.4500	0.0182	66412	1015481	.	3840209	4762262	3534476
1.5000	0.2586	977945	1.5000	0.0188	68442	1046387	.	3828185	4734053	3500110
1.5500	0.2672	1006587	1.5500	0.0195	70457	1077044	.	3816204	4706076	3466148
1.6000	0.2758	1034999	1.6000	0.0201	72455	1107454	.	3804265	4678329	3432585
1.6500	0.2844	1063181	1.6500	0.0207	74439	1137620	.	3792368	4650808	3399415
1.7000	0.2930	1091137	1.7000	0.0214	76407	1167543	.	3780513	4623513	3366633
1.7500	0.3017	1118867	1.7500	0.0220	78360	1197227	.	3768700	4596441	3334236
1.8000	0.3103	1146375	1.8000	0.0226	80297	1226672	.	3756928	4569589	3302216
1.8500	0.3189	1173662	1.8500	0.0232	82220	1255882	.	3745198	4542957	3270571
1.9000	0.3275	1200730	1.9000	0.0239	84129	1284858	.	3733509	4516542	3239295
1.9500	0.3361	1227581	1.9500	0.0245	86022	1313603	.	3721861	4490343	3208383
2.0000	0.3448	1254216	2.0000	0.0251	87901	1342118	.	3710254	4464356	3177830
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

```
Notes: Run name               : MANELT01
       Date and time          : 20SEP00:12:46
       Computation of ref. F: Northern: Simple mean, age 4 - 8
                              Southern: Simple mean, age 4 - 8
       Basis for 2000         : F factors
```

Table 2.13.1 Two area yield per recruit table for the Mackerel in the North East Atlantic.

11:57 Tuesday, September 19, 2000
Mackerel (combined Southern, Western & N.Sea spawn.comp.)

Multi fleet yield per recruit: Summary table

Northern			Southern			Total			1 January		Spawning time	
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.0000	0.0000	0.000	0.000	7.179	2247.411	4.992	2091.025	4.701	1969.253
0.2000	0.0345	56.430	0.2000	0.0025	4.461	60.891	6.321	1777.019	4.139	1621.719	3.849	1505.459
0.4000	0.0690	89.123	0.4000	0.0050	6.876	95.999	5.762	1482.023	3.584	1327.775	3.294	1216.139
0.6000	0.1034	109.586	0.6000	0.0075	8.287	117.873	5.365	1281.043	3.192	1127.815	2.902	1020.117
0.8000	0.1379	123.107	0.8000	0.0100	9.162	132.269	5.067	1135.797	2.898	983.560	2.609	879.264
1.0000	0.1724	132.402	1.0000	0.0126	9.737	142.139	4.834	1026.051	2.669	874.775	2.381	773.458
1.2000	0.2069	138.989	1.2000	0.0151	10.135	149.124	4.645	940.178	2.484	789.837	2.196	691.161
1.4000	0.2413	143.762	1.4000	0.0176	10.427	154.190	4.487	871.066	2.331	721.636	2.043	625.326
1.6000	0.2758	147.280	1.6000	0.0201	10.654	157.934	4.353	814.143	2.201	665.599	1.914	571.431
1.8000	0.3103	149.903	1.8000	0.0226	10.839	160.742	4.238	766.349	2.089	618.668	1.804	526.455
2.0000	0.3448	151.870	2.0000	0.0251	10.998	162.868	4.136	725.563	1.992	578.725	1.707	488.311
2.2000	0.3792	153.348	2.2000	0.0276	11.140	164.488	4.047	690.277	1.906	544.261	1.622	455.512
2.4000	0.4137	154.454	2.4000	0.0301	11.270	165.724	3.966	659.387	1.829	514.174	1.546	426.977
2.6000	0.4482	155.272	2.6000	0.0327	11.392	166.664	3.893	632.069	1.760	487.642	1.478	401.897
2.8000	0.4827	155.864	2.8000	0.0352	11.509	167.373	3.827	607.697	1.697	464.038	1.417	379.659
3.0000	0.5171	156.276	3.0000	0.0377	11.622	167.898	3.767	585.784	1.640	442.877	1.361	359.788
3.2000	0.5516	156.544	3.2000	0.0402	11.732	168.276	3.711	565.948	1.588	423.778	1.309	341.910
3.4000	0.5861	156.695	3.4000	0.0427	11.841	168.535	3.659	547.884	1.540	406.436	1.262	325.729
3.6000	0.6206	156.750	3.6000	0.0452	11.947	168.697	3.611	531.345	1.495	390.605	1.218	311.005
3.8000	0.6550	156.726	3.8000	0.0477	12.053	168.779	3.566	516.131	1.453	376.085	1.178	297.541
4.0000	0.6895	156.637	4.0000	0.0502	12.157	168.794	3.524	502.073	1.415	362.709	1.140	285.178
-	-	Grams	-	-	Grams	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJAJ02
Date and time : 19SEP00:12:33
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Recruitment : Single recruit

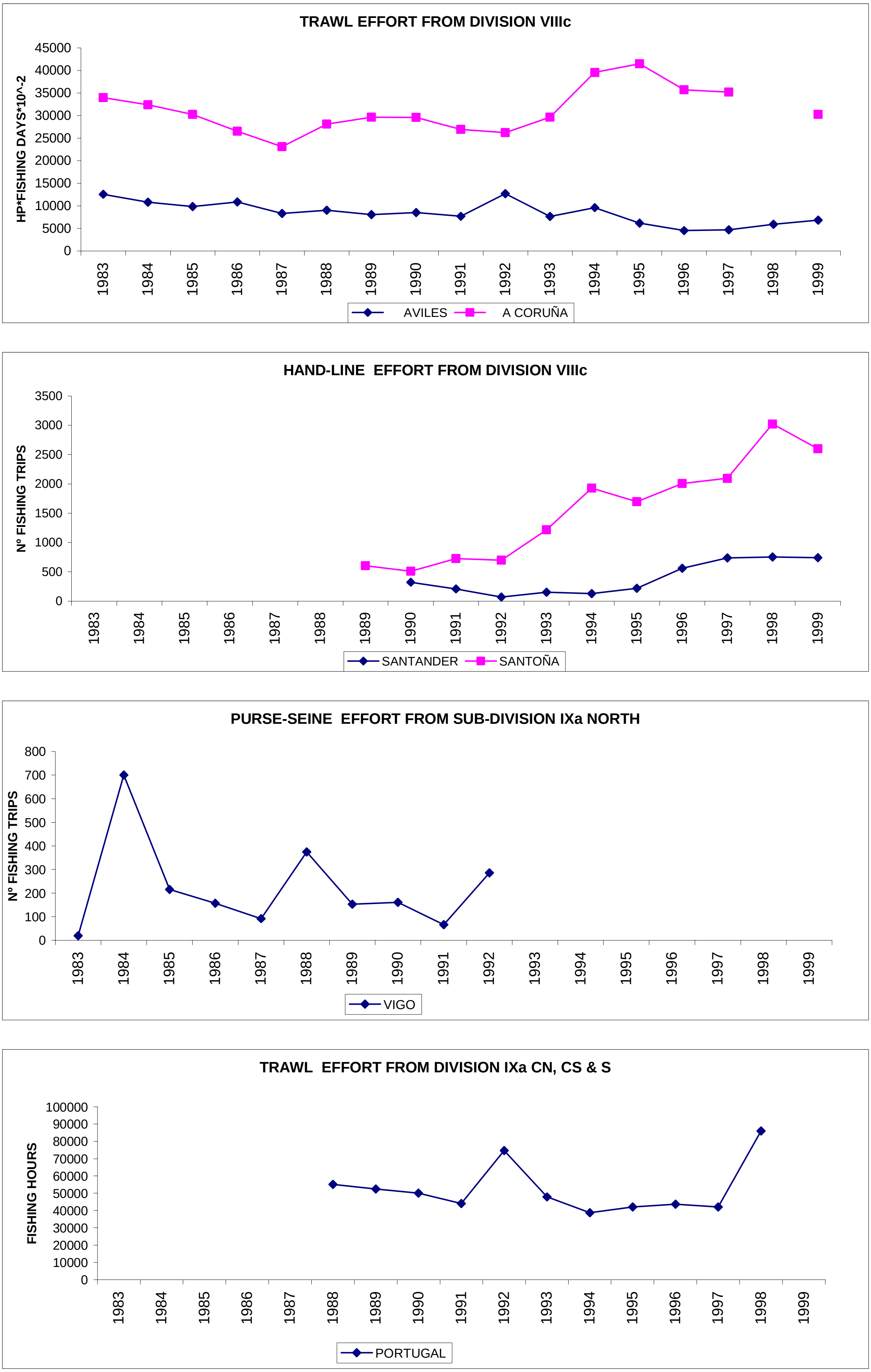
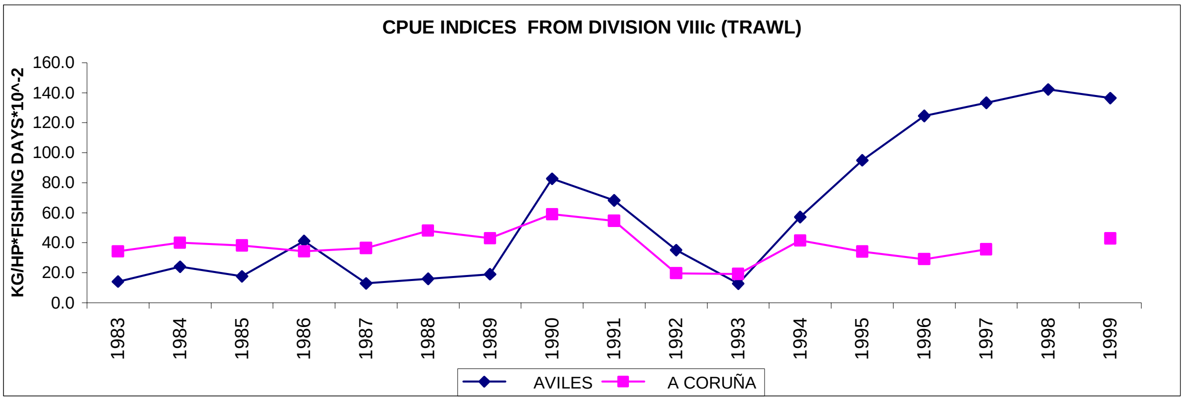
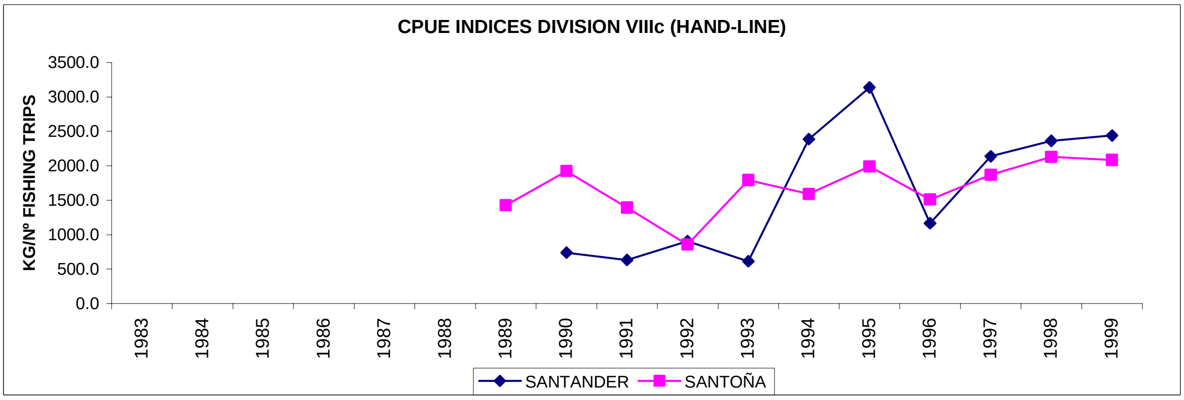
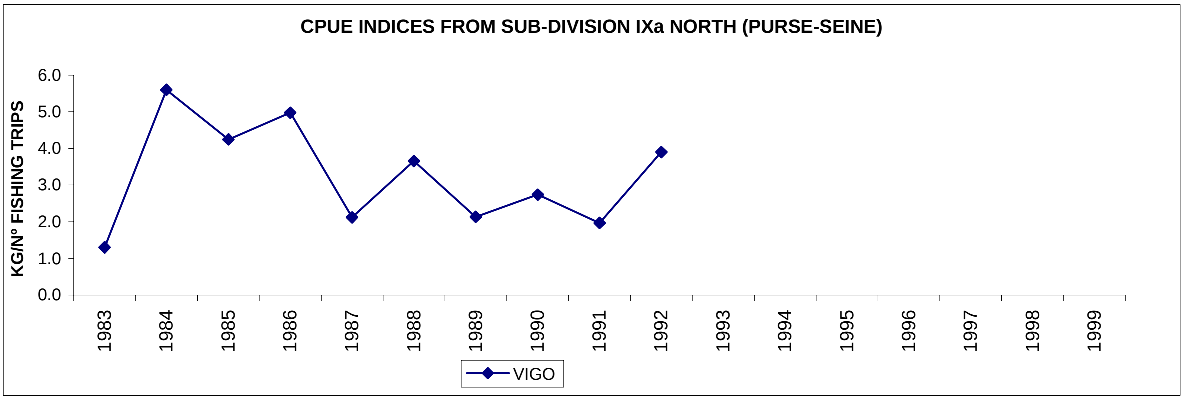


Figure 2.7.1 : SOUTHERN MACKEREL Effort data by fleets and area







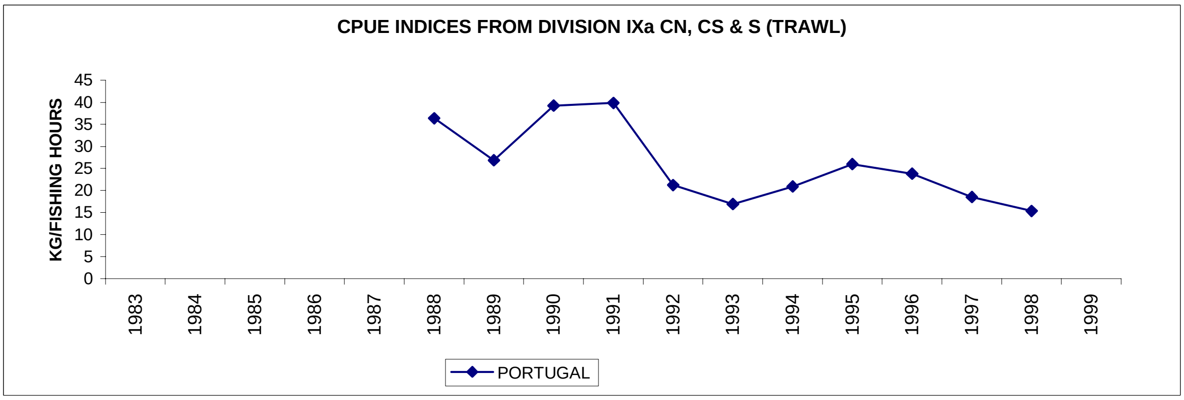


Figure 2.7.2 : SOUTHERN MACKEREL CPUE indices by fleets and area

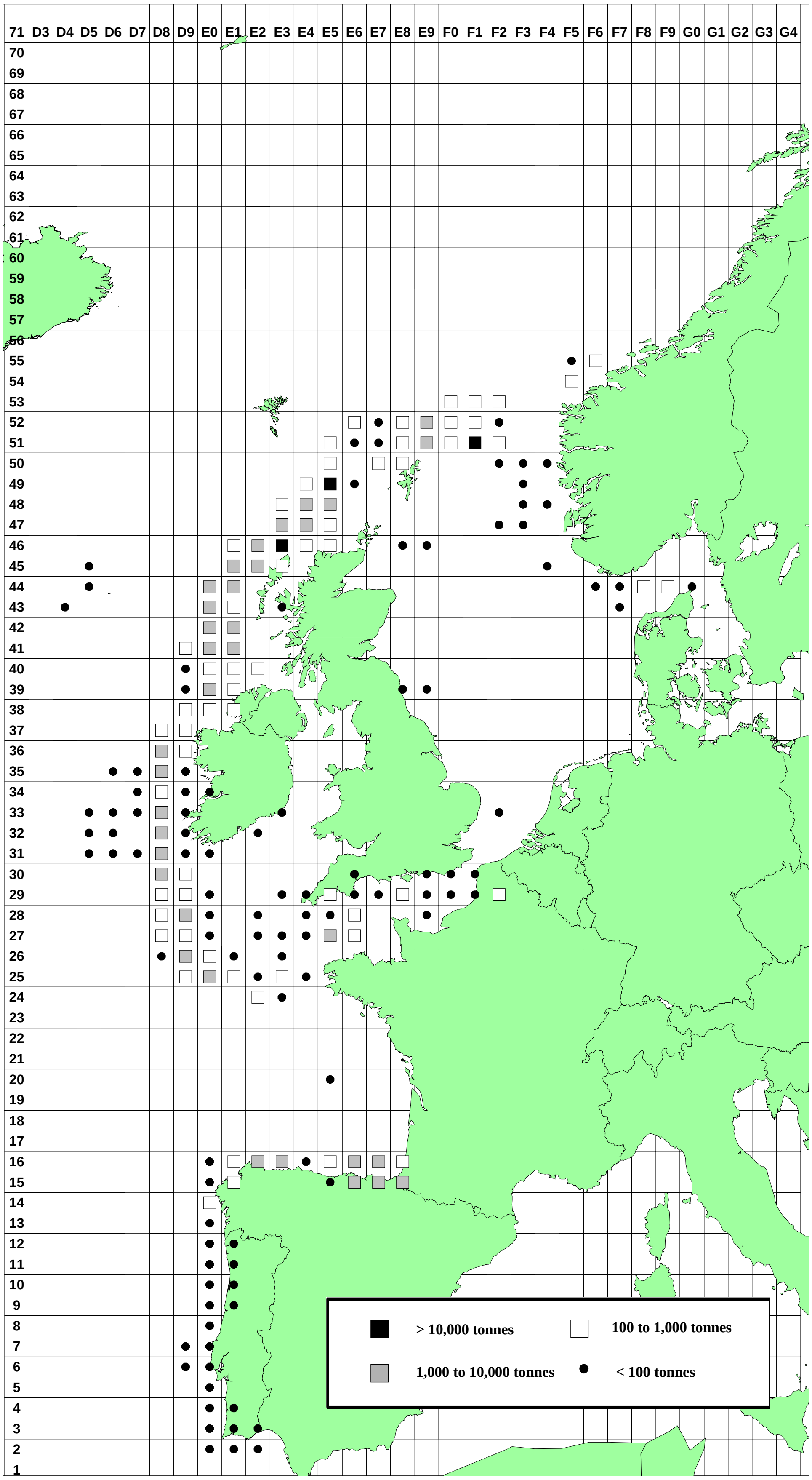


Figure 2.8.1.1. Mackerel commercial catches in Quarter 1 1999

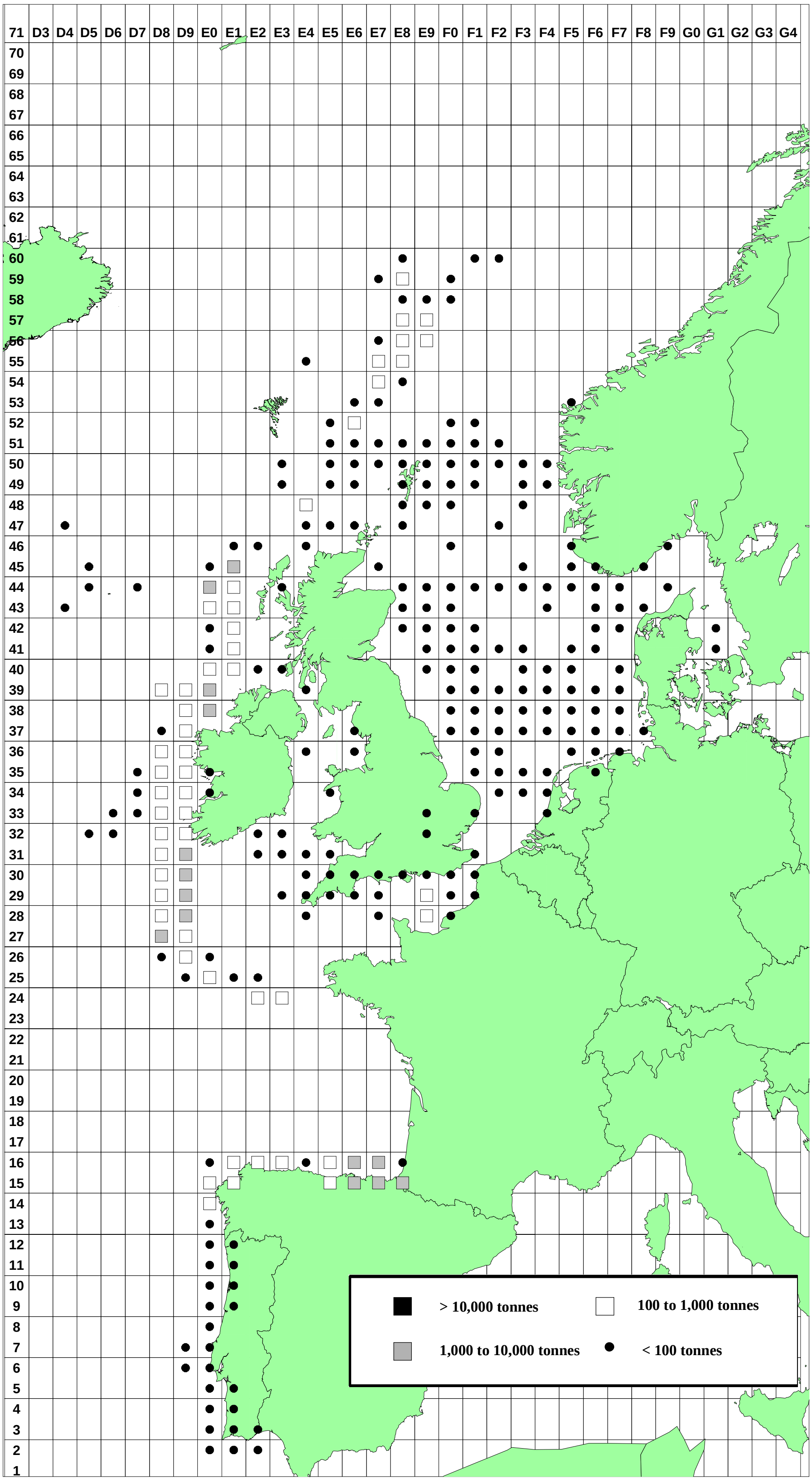


Figure 2.8.1.2. Mackerel commercial catches in Quarter 2 1999

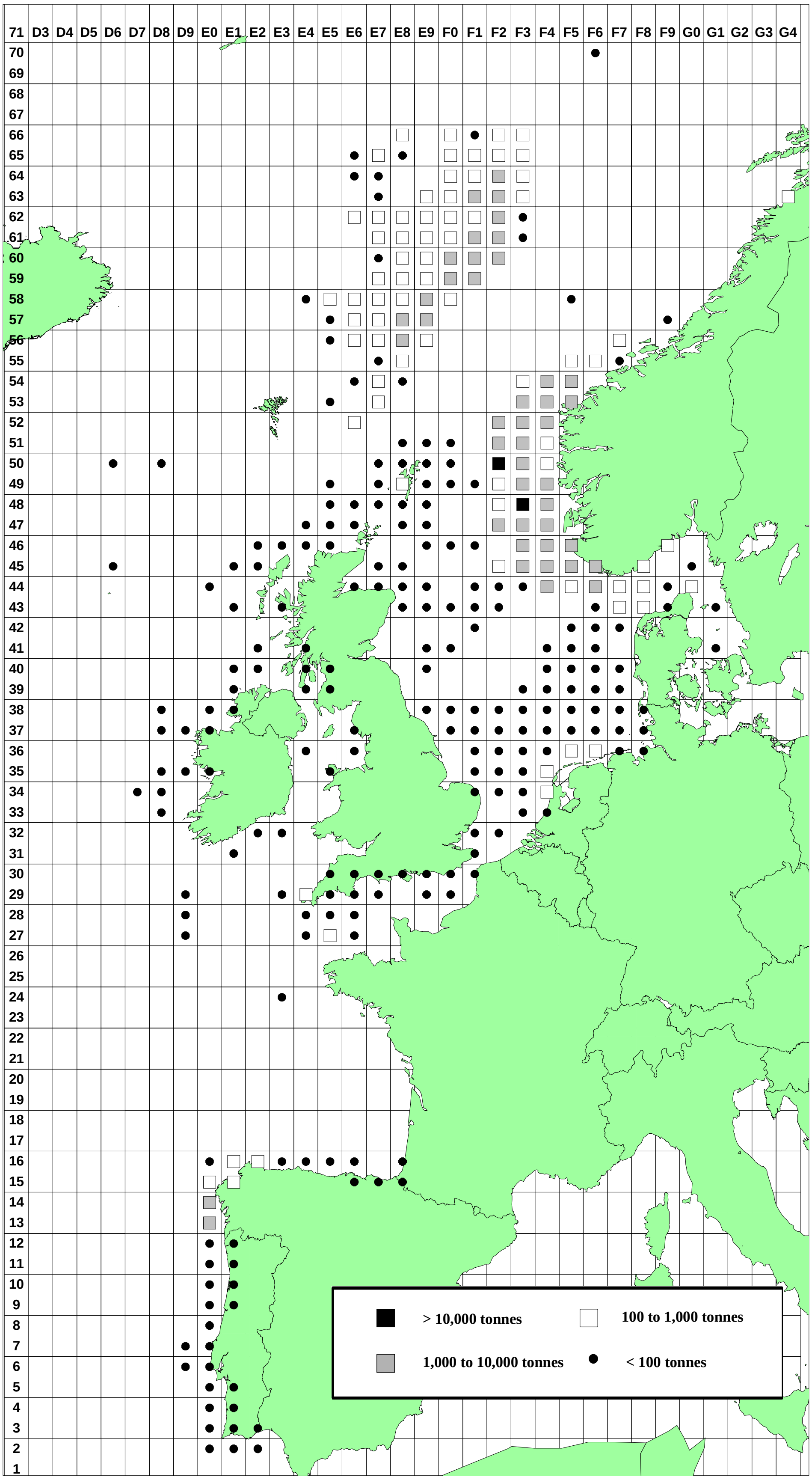


Figure 2.8.1.3 Mackerel commercial catches in Quarter 3 1999

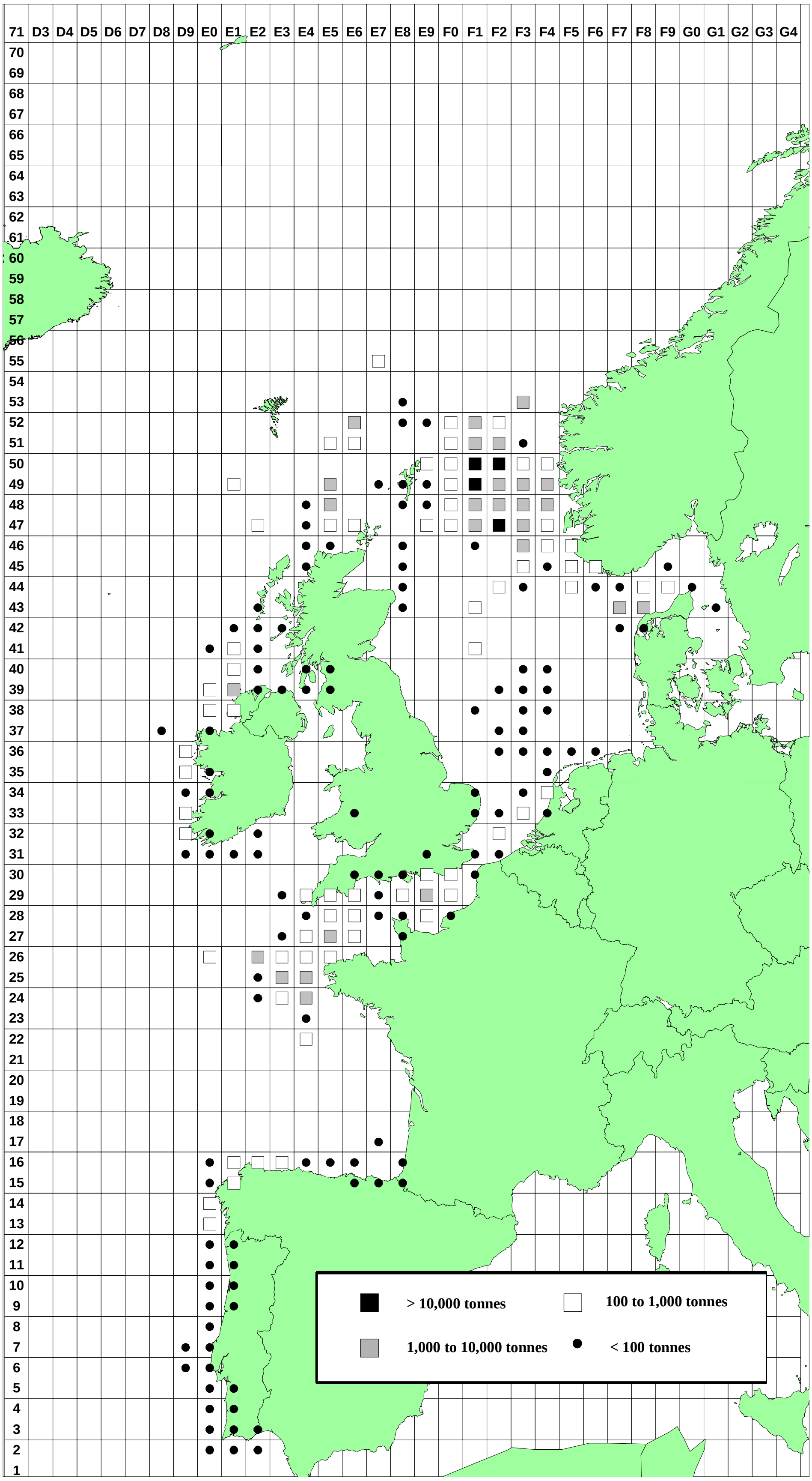


Figure 2.8.1.4. Mackerel commercial catches in Quarter 4 1999

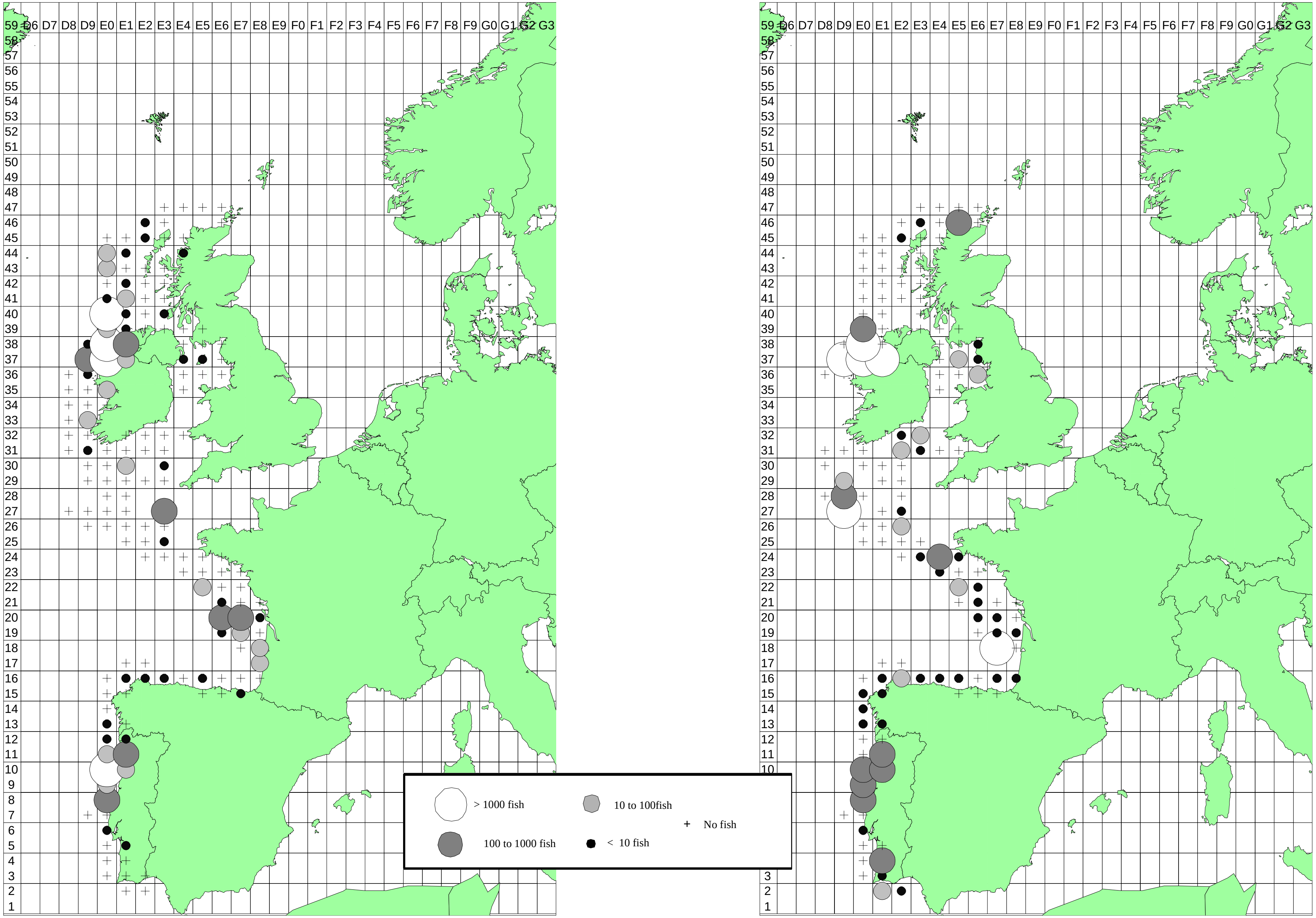


Figure 2.8.2.1. Distribution of mackerel recruits. Quarter 4 – Age 0- 1998 (left) and 1999 (right). Catch rates per hour

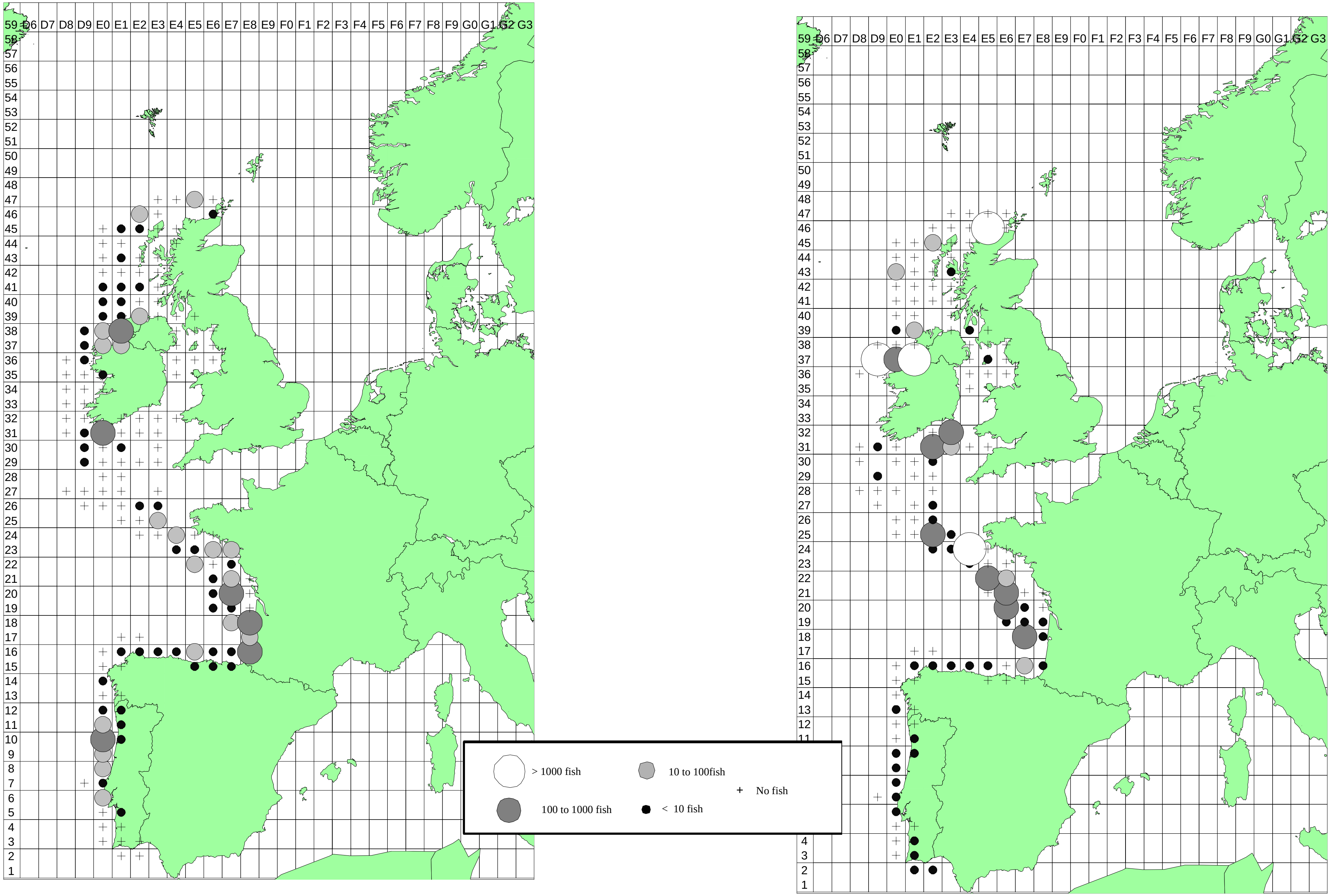


Figure 2.8.2.2. Distribution of mackerel recruits. Quarter 4 – Age 1- 1998 (left) and 1999 (right). Catch rates per hour

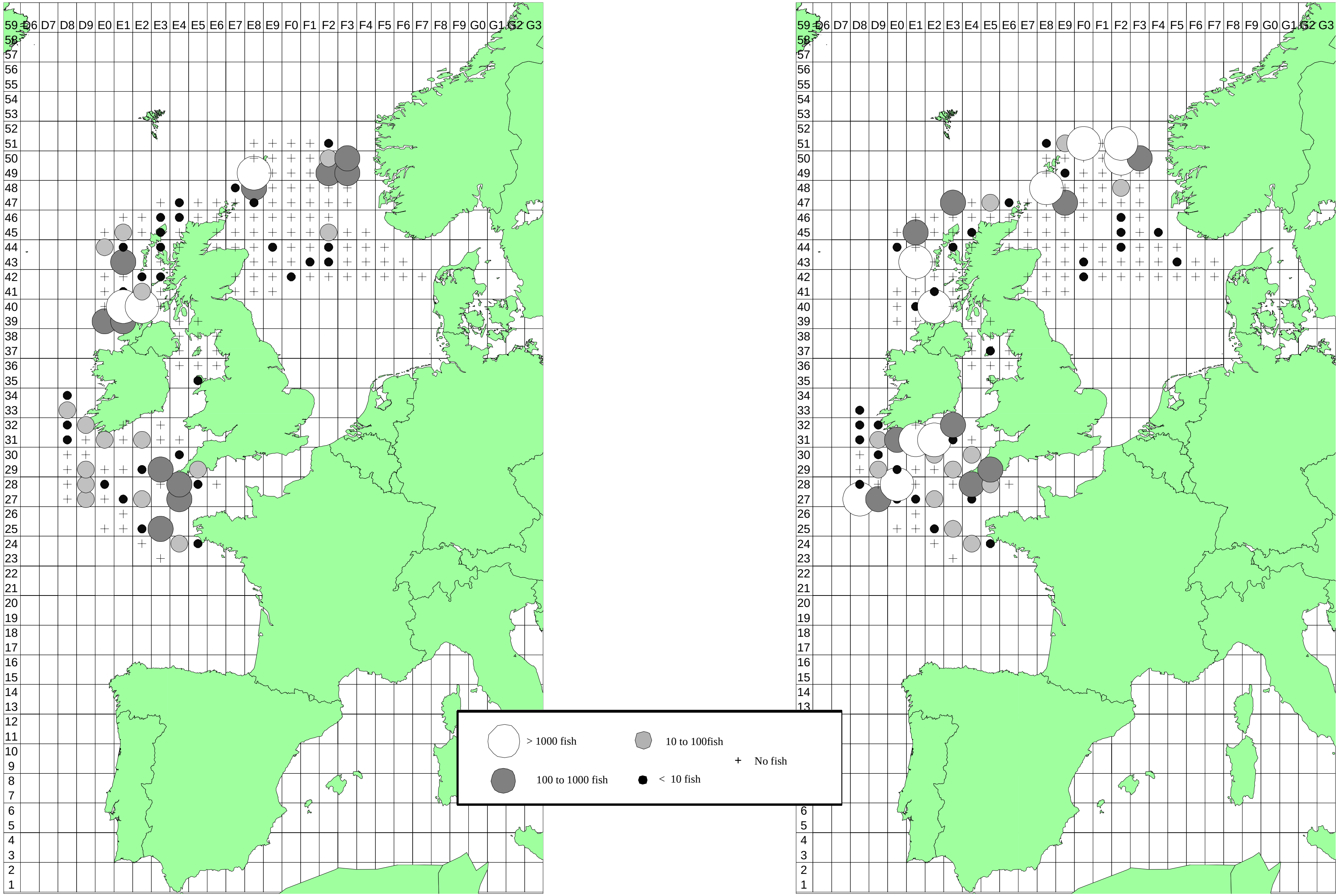


Figure 2.8.2.3. Distribution of mackerel recruits. Quarter 1 – Age 1- 1999 (left) and 2000 (right). Catch rates per hour

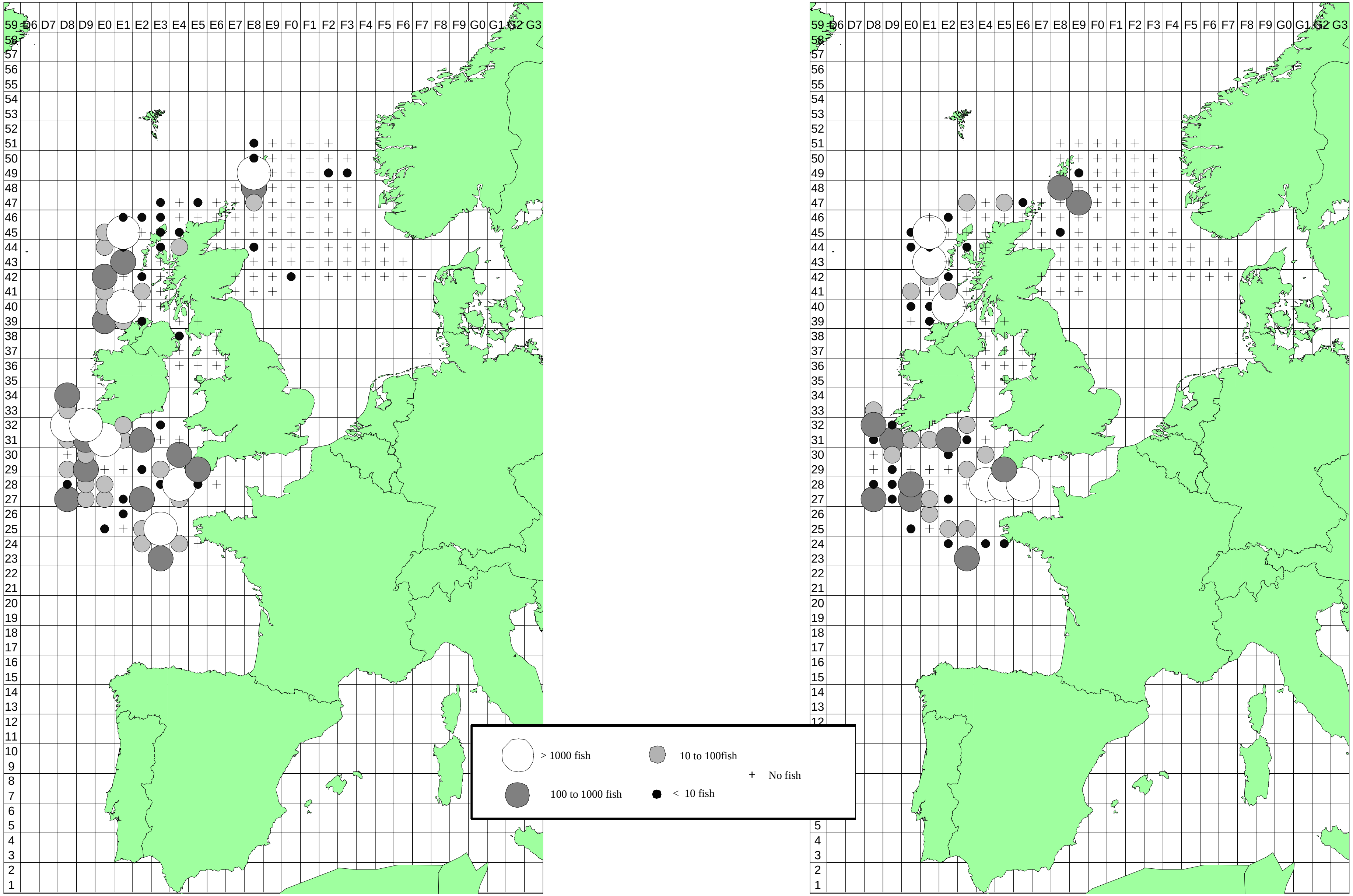


Figure 2.8.2.4. Distribution of mackerel recruits. Quarter 1 – Age 2- 1999 (left) and 2000 (right). Catch rates per hour

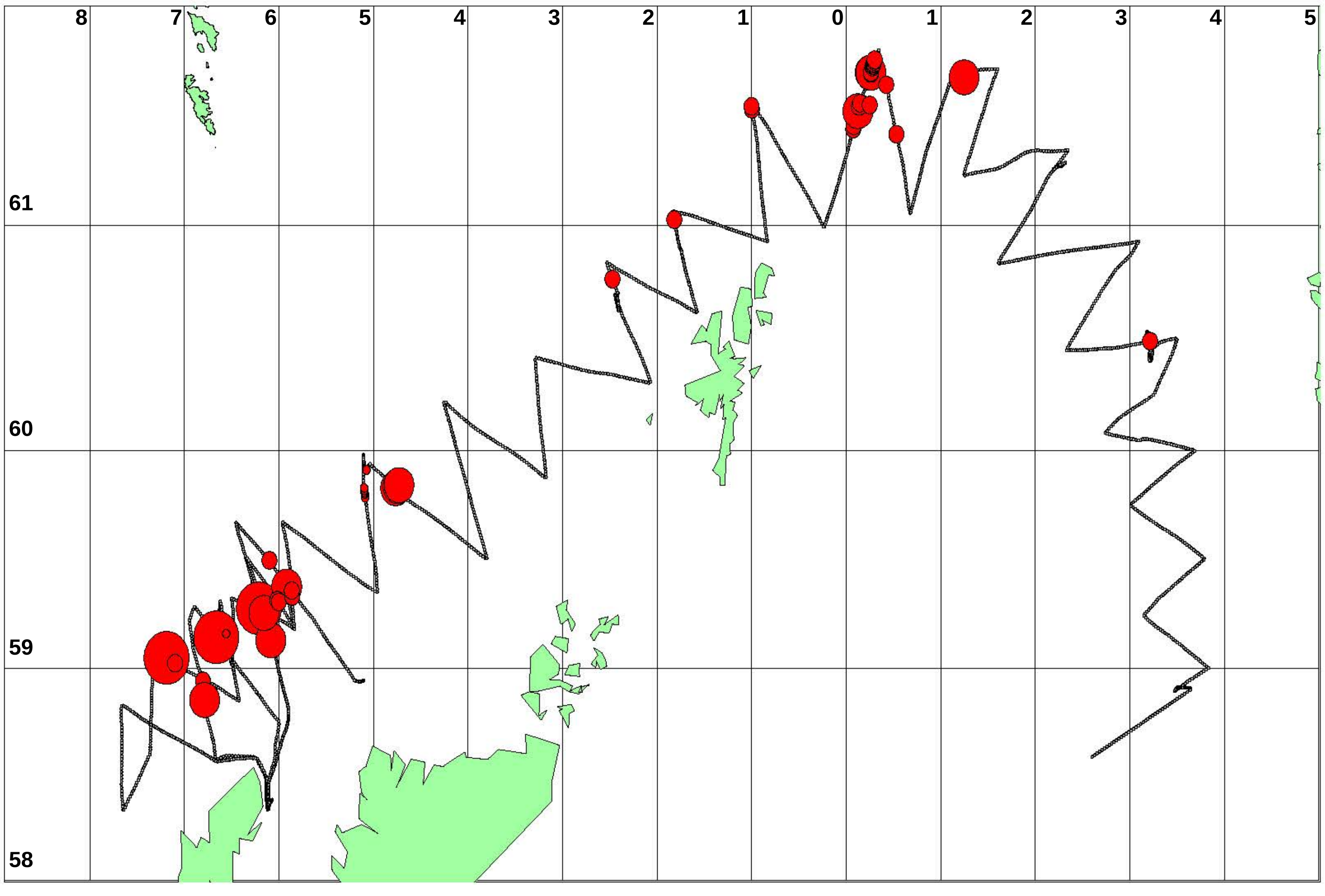
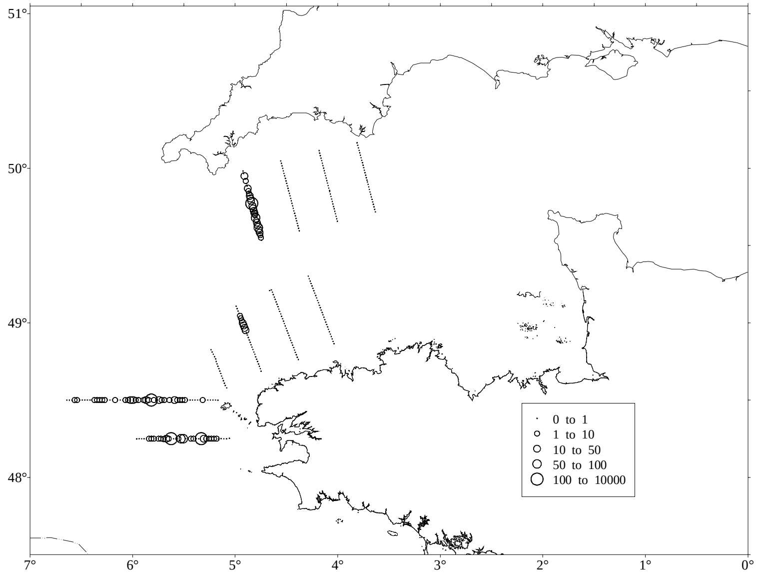


Figure 2.8.3.1. Cruise track and observed mackerel acoustic traces for the Scotia survey in January 2000. Circles are log scaled to maximum**.**



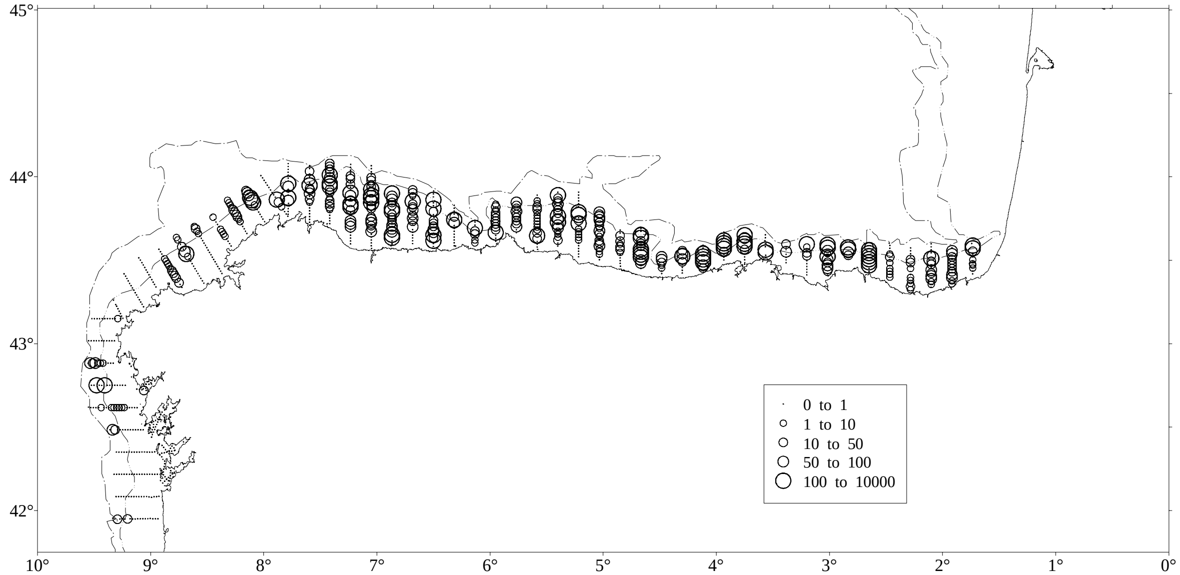


Figure 2.8.3.2. Acoustic back-scattering energy allocated to mackerel. for the IEO survey in the English Channel in March/April 2000. Circles are scaled to maximum.

Figure 2.8.3.3. Acoustic back-scattering energy allocated to mackerel. for the IEO survey in the Cantabrian Sea in March/April 2000. Circles are scaled to maximum.

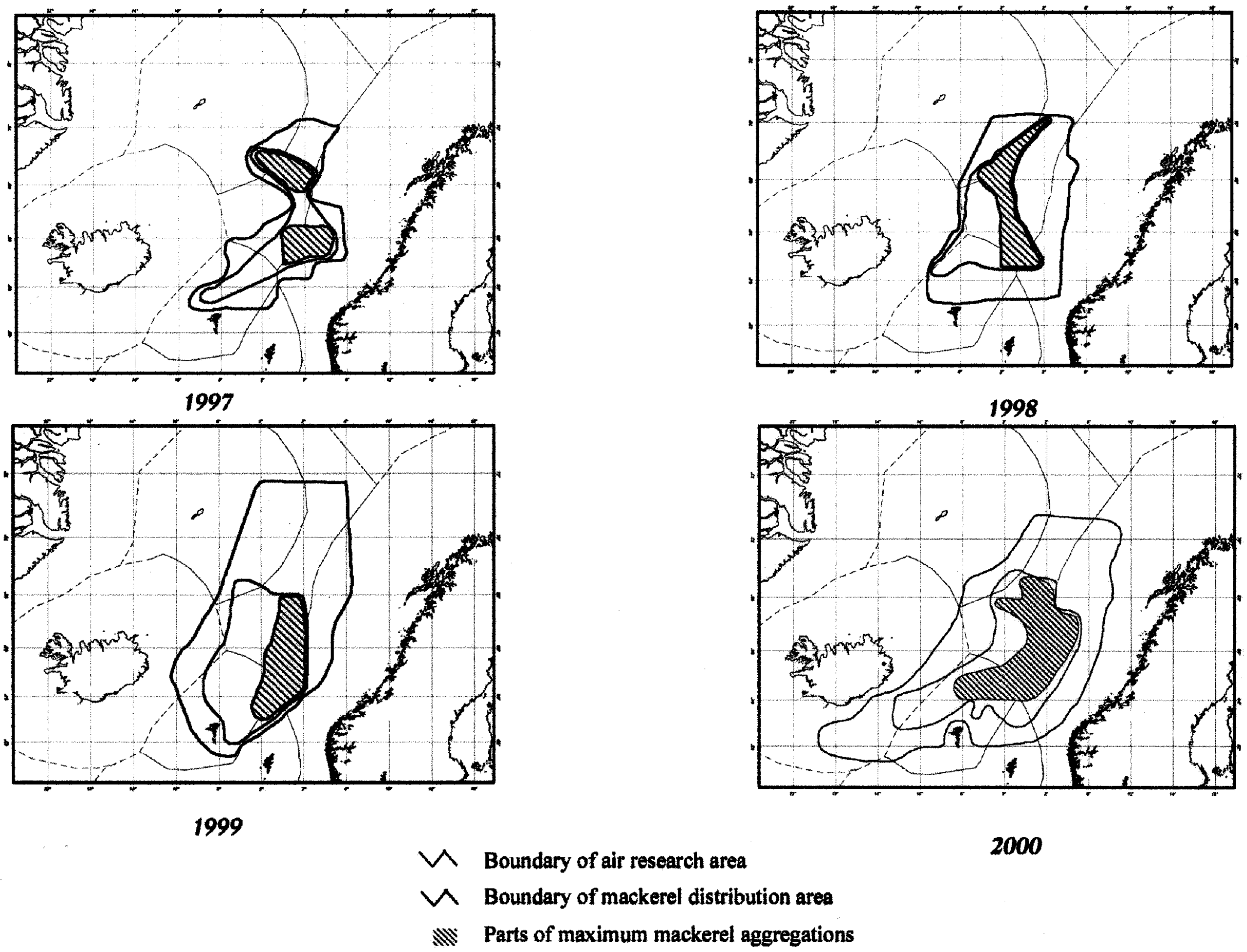


Figure 2.8.3.4

Figure 3.8.3.4. Area distributions from Russian aerial surveys 1997 – 2000. The survey area is bounded by the outer black line and the area of mackerel distribution by the inner black line. The main area of mackerel concentration is represented by the shaded area

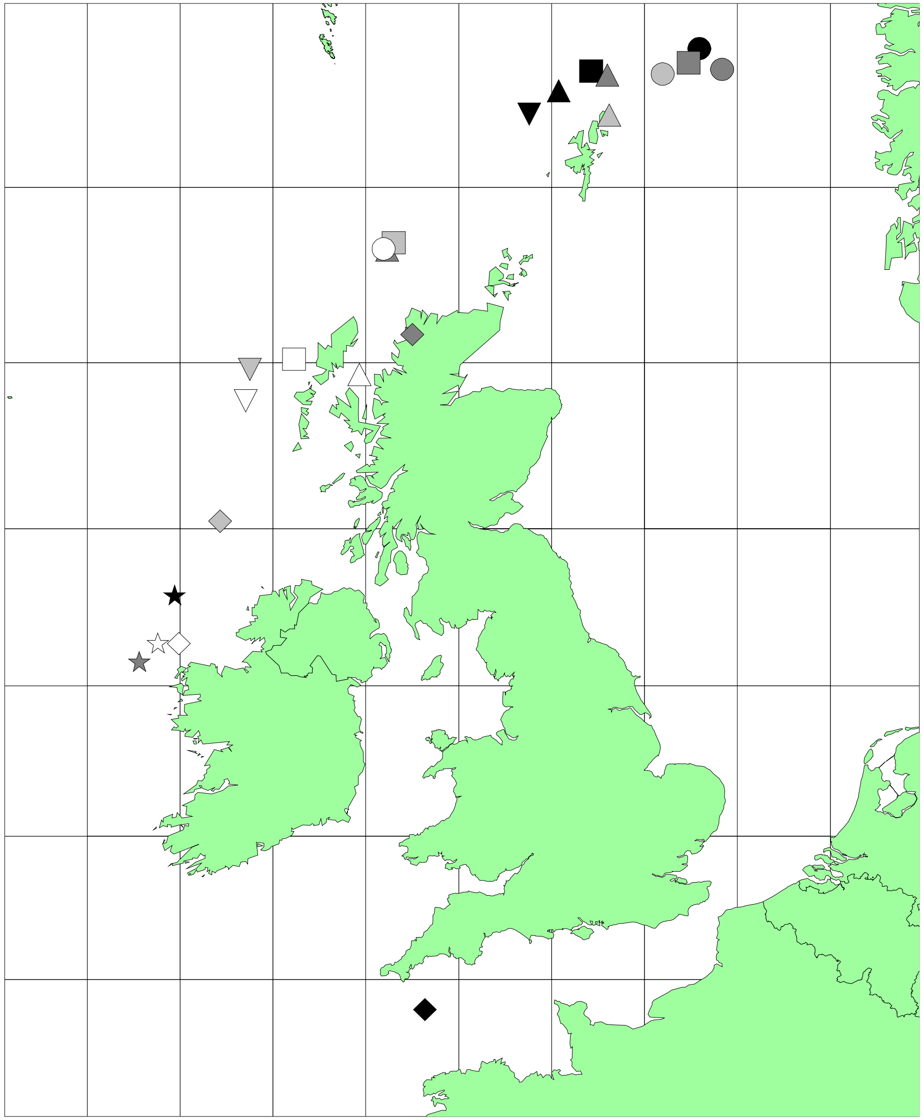
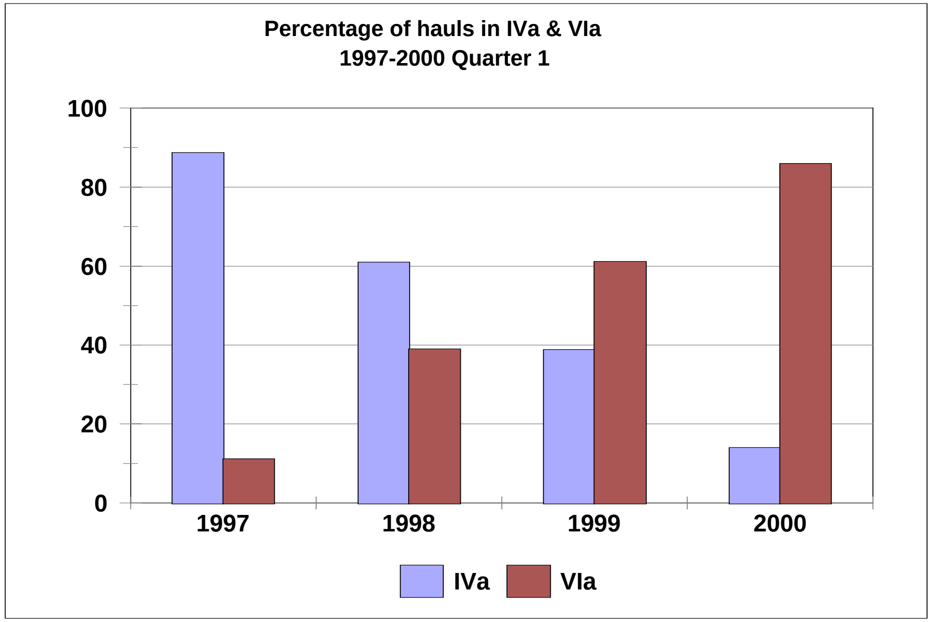


Figure 2.8.3.5. Mean catch locations by half month for quarter 1 1997-2000 –

Black symbols for 1997, dark gray for 1998, light gray for 1999 & white for 2000.

1st half of January
1st half of February
1st half of March
2nd half of January
2nd half of February
1st half of March



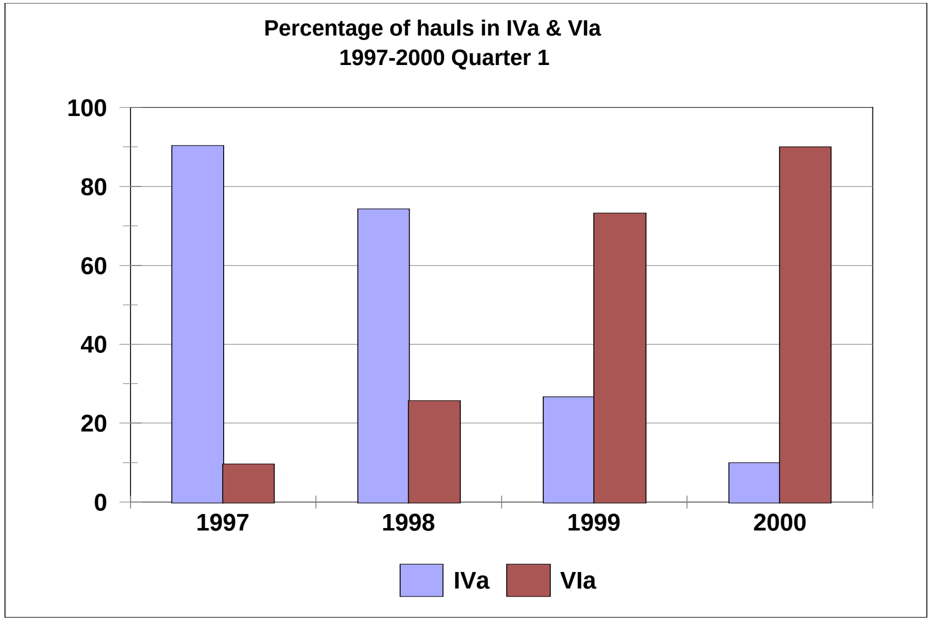
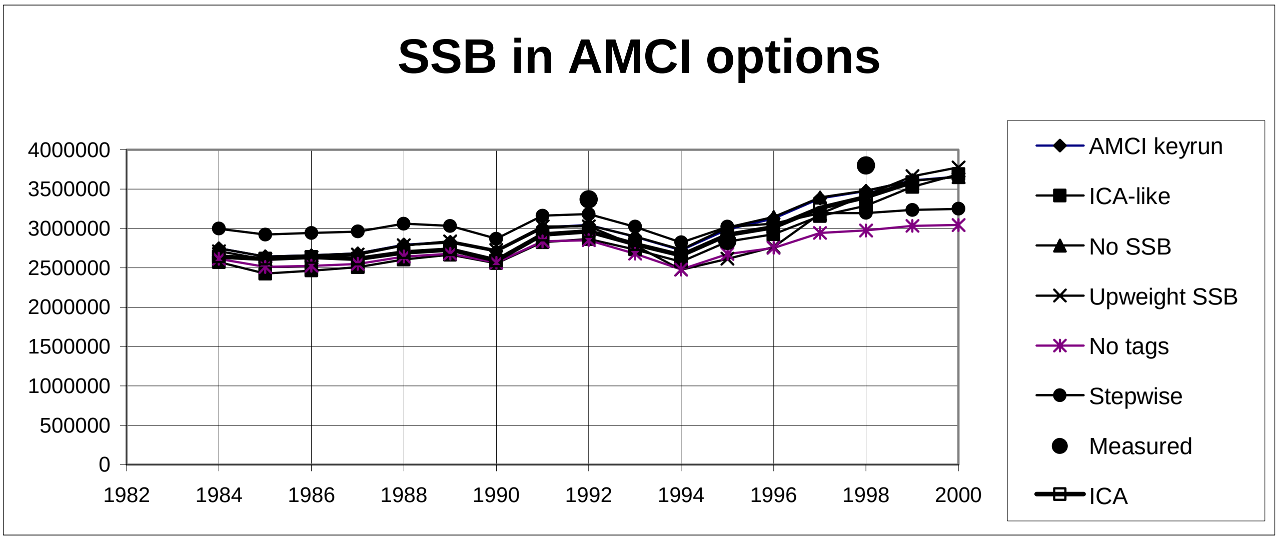
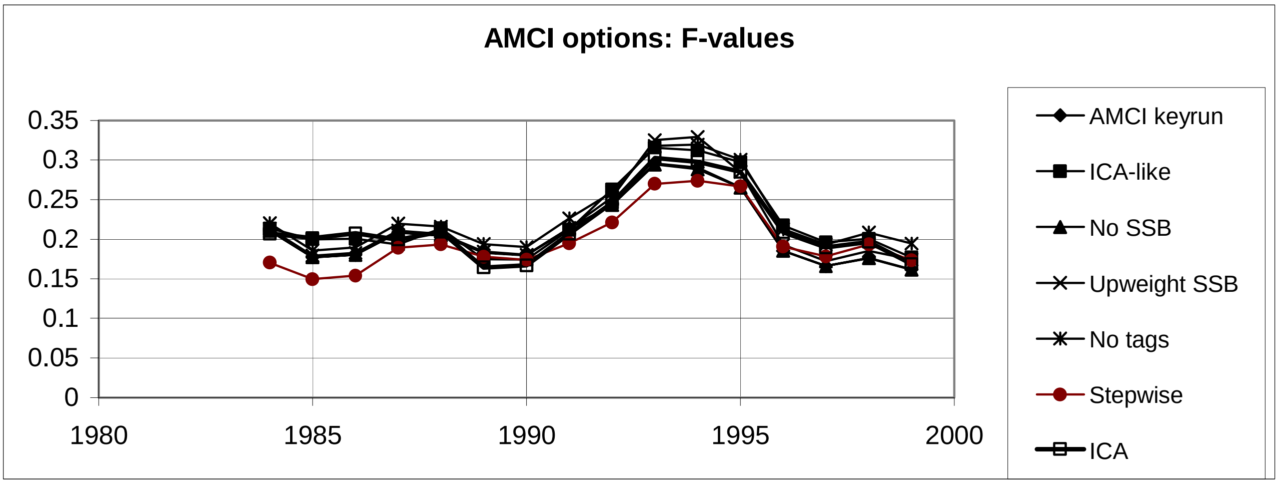


Figure 2.8.3.6. Number of hauls (left) and tonnages caught (right) east and west of 4^{o}W as percentages of totals, for 1997-2000





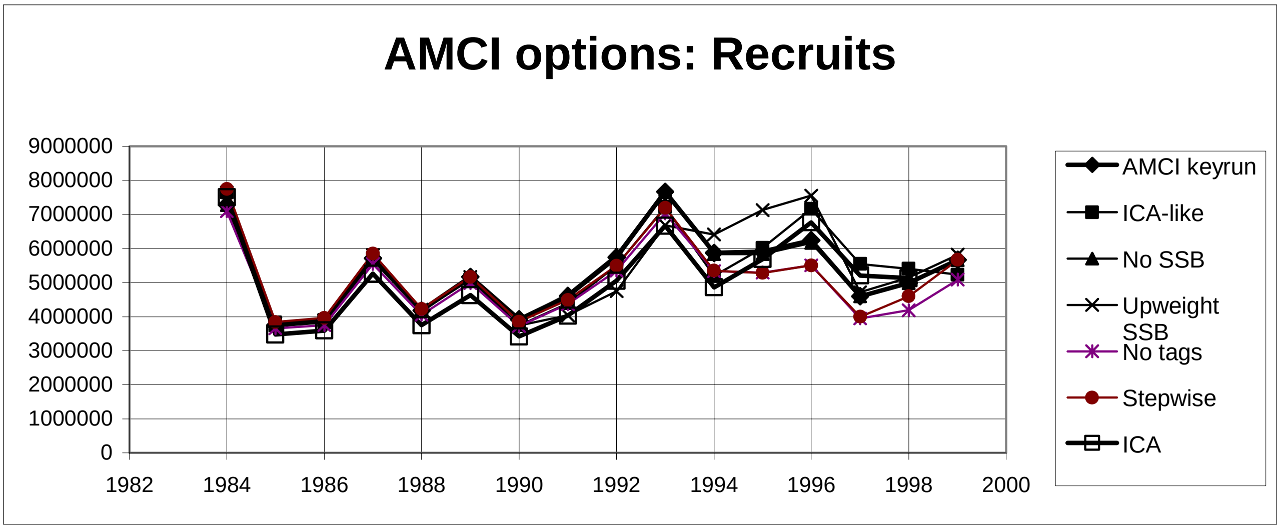
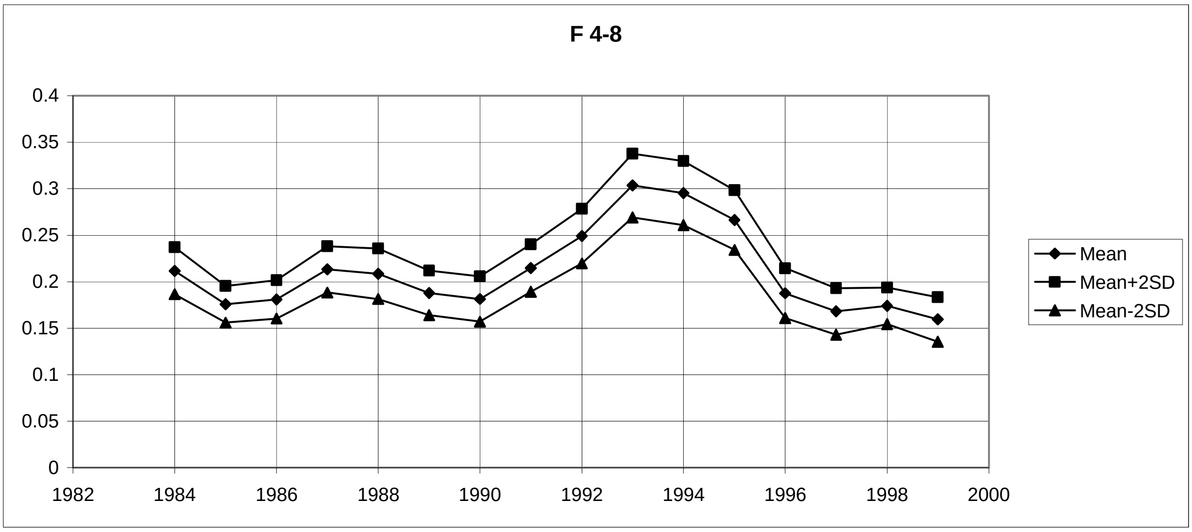
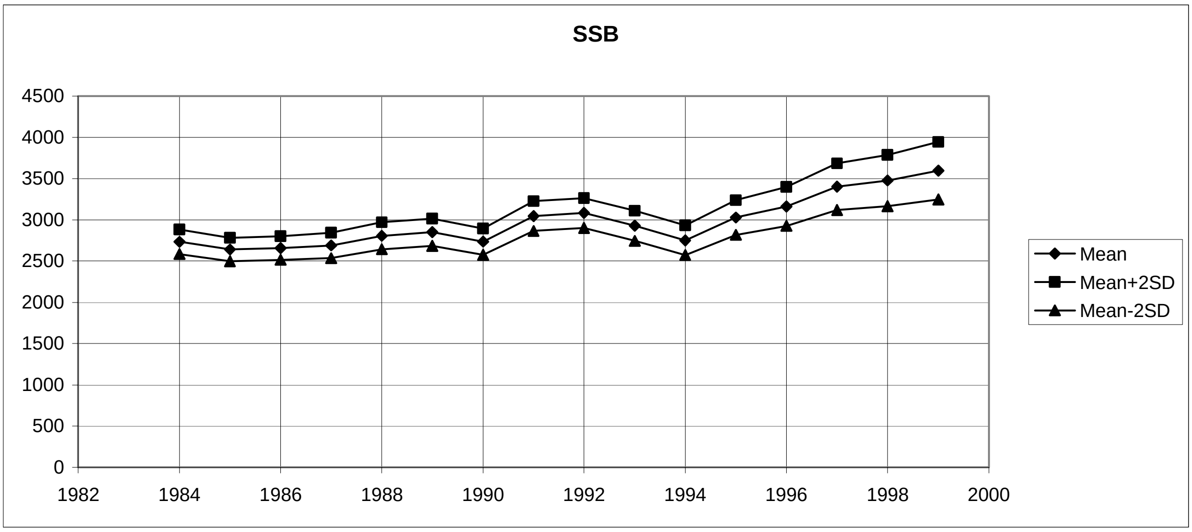


Figure 2.10.1.1 **Results from the AMCI exploratory runs**





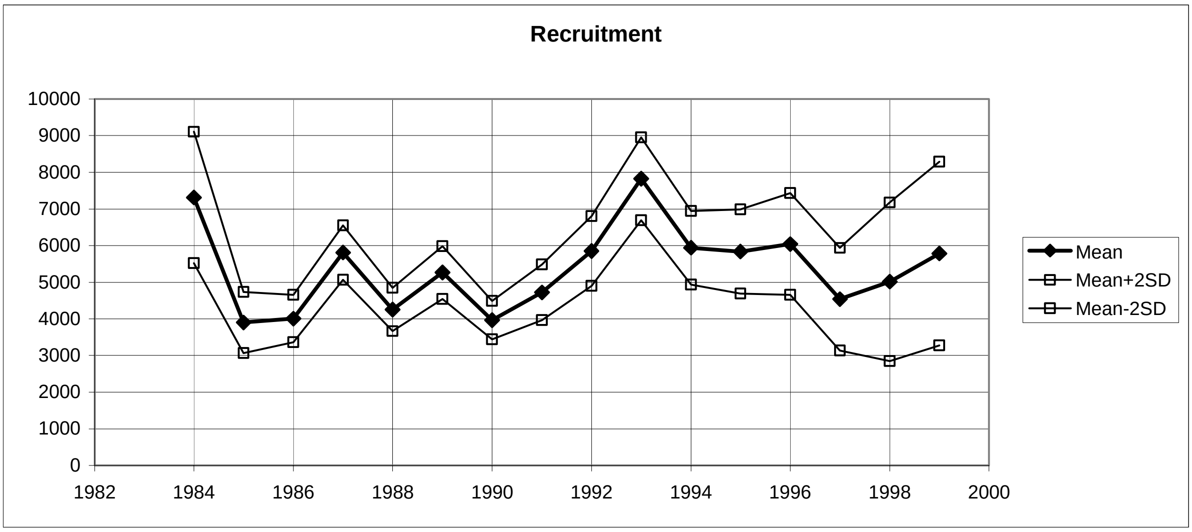


Figure 2.10.1.2 **Results from AMCI run 1: Non-parametric bootstrap**

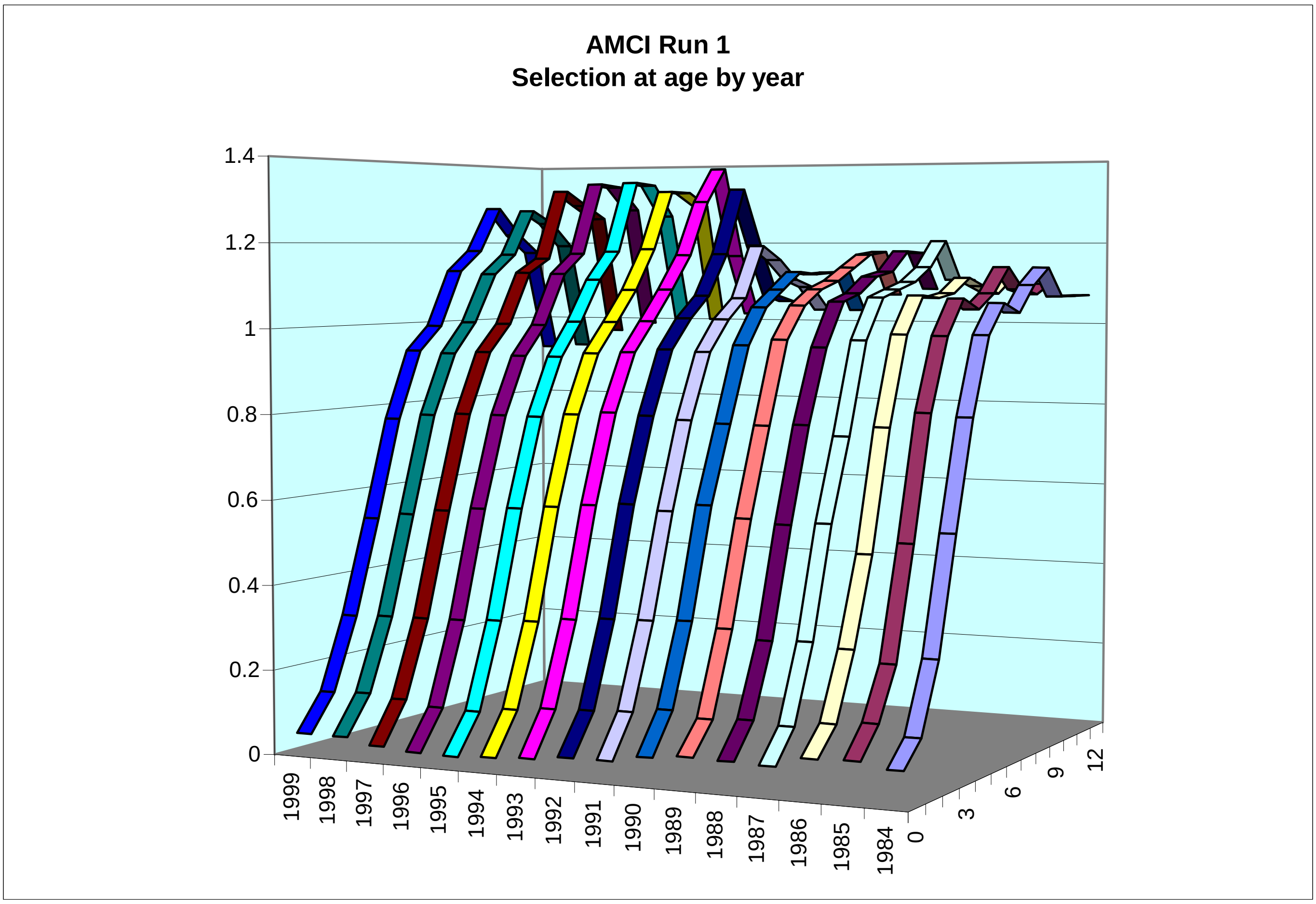


Figure 2.10.1.3 Selection pattern by year, normalised to the average F(4-8) from AMCI run 1.

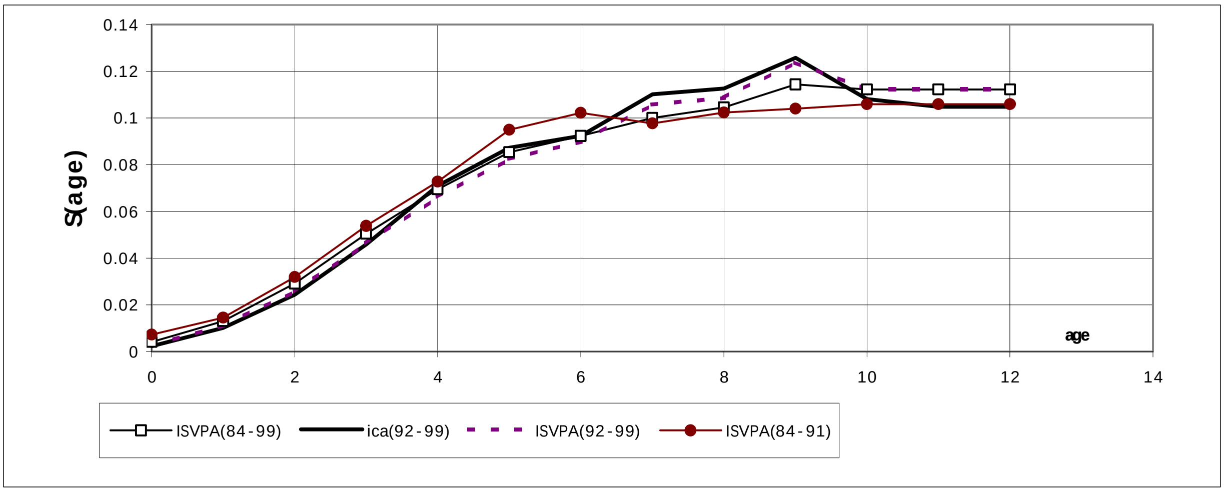


Figure 2.10.1.4 Estimates of selection pattern for Northeast Atlantic mackerel.
(For ICA selection factors are renormalized to SUM=1 for comparison)

Figure 2.10.1.5 Profile of ISVPA loss function as function of terminal effort factor for Northeast Atlantic mackerel.

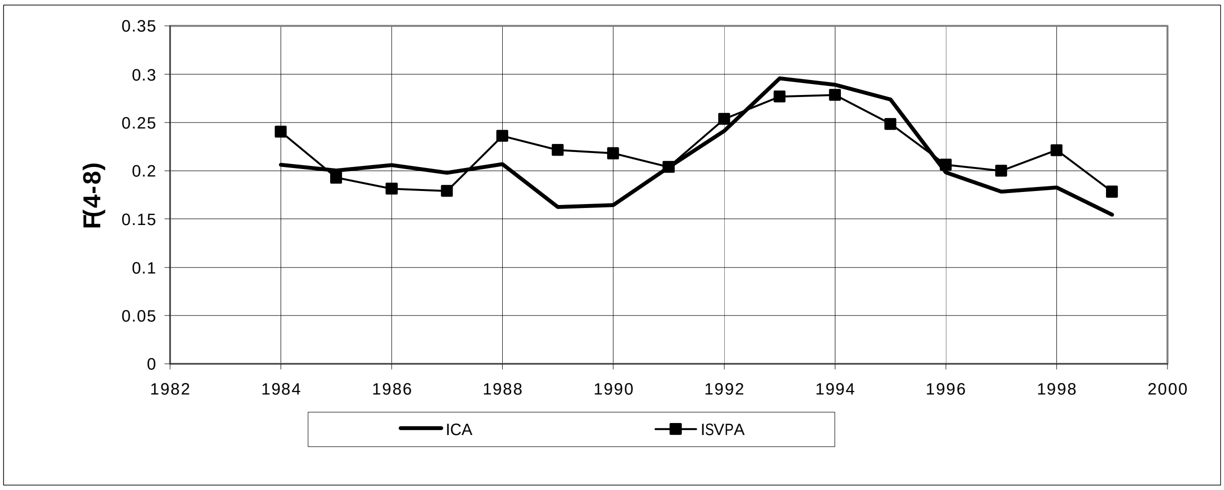


Figure 2.10.1.6 Estimates of mean F for ages 4-8 (for ISVPA - egg survey estimates of SSB are not used), M=0.15.

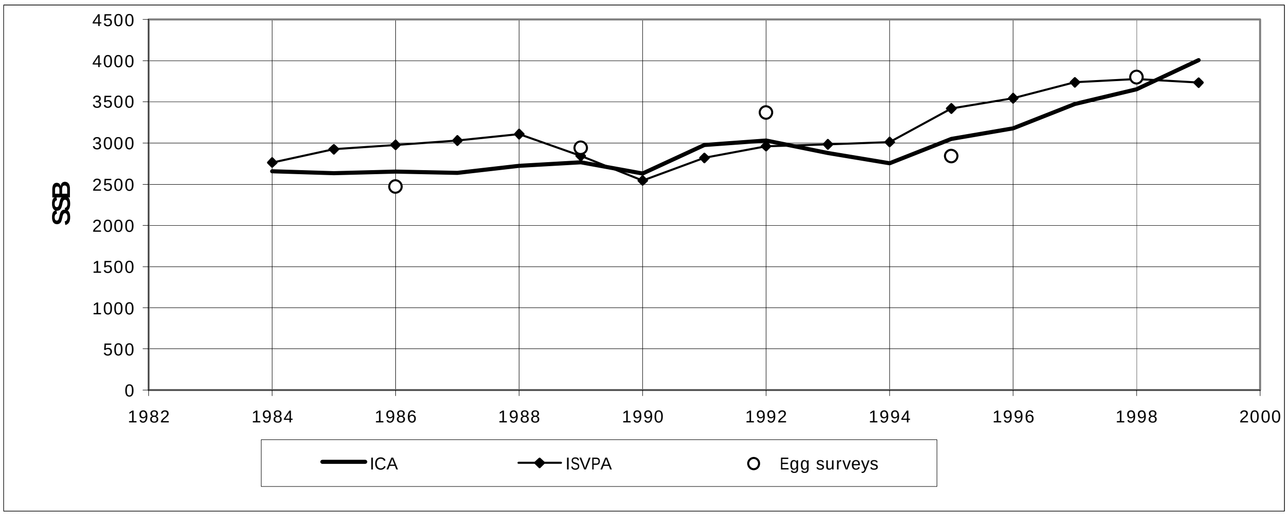


Figure 2.10.1.7 Northeast Atlantic mackerel: estimates of SSB.

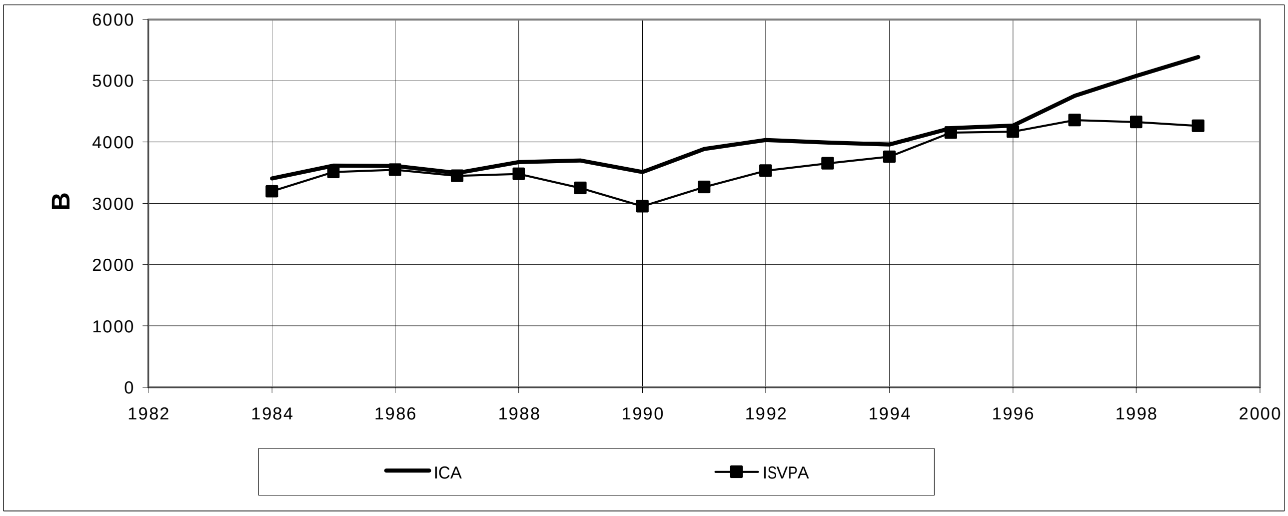


Figure 2.10.1.8 Northeast Atlantic mackerel: estimates of total stock biomass.

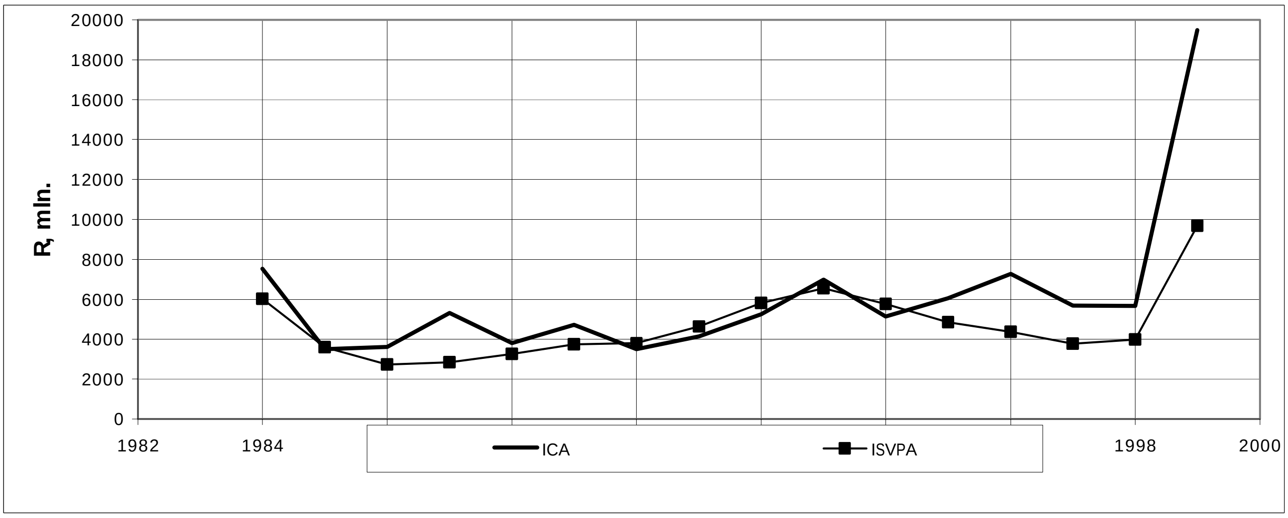


Figure 2.10.1.9 Northeast Atlantic mackerel: estimates of recruitment.

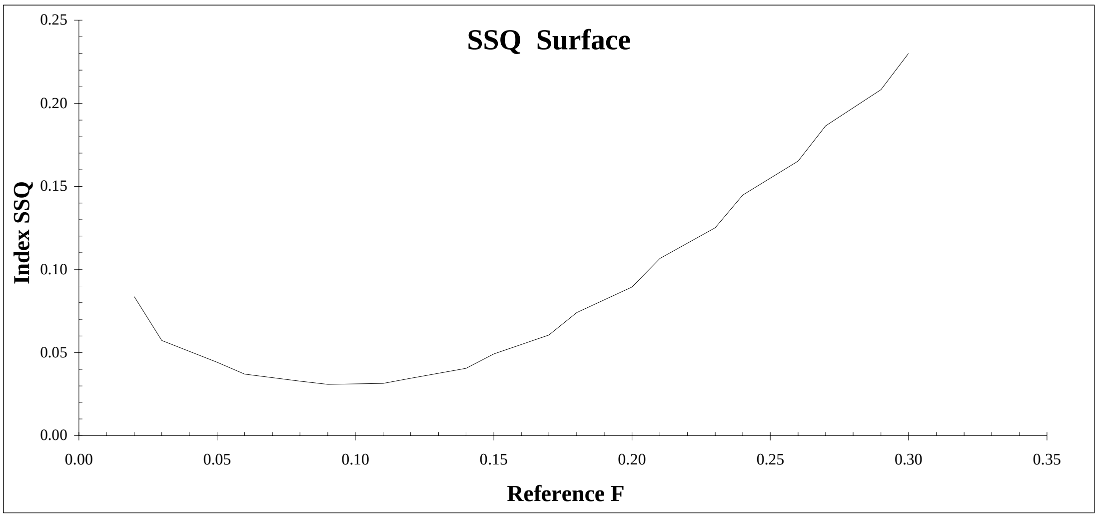


Figure 2.10.2.1 **The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (1992-1998).**

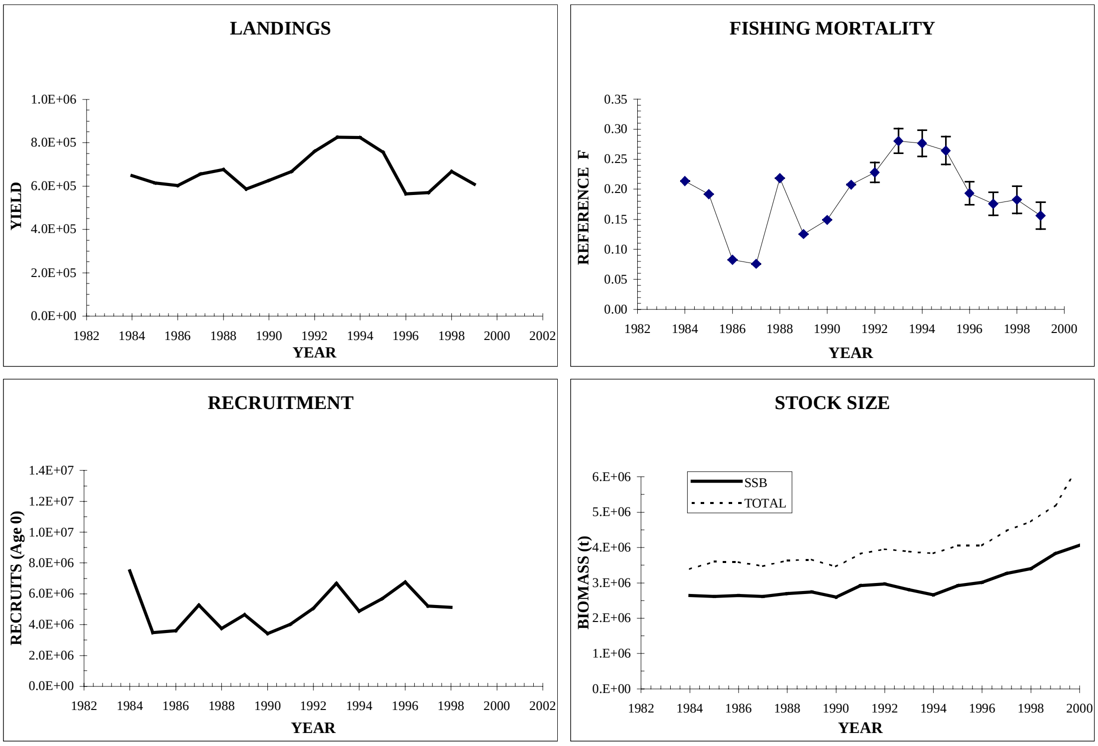


Figure 2.10.2.2 **The long term trends in stock parameters for North East Atlantic mackerel.**
Only SSB estimates from egg surveys covering the range 1992-1998 are used in the biomass index.

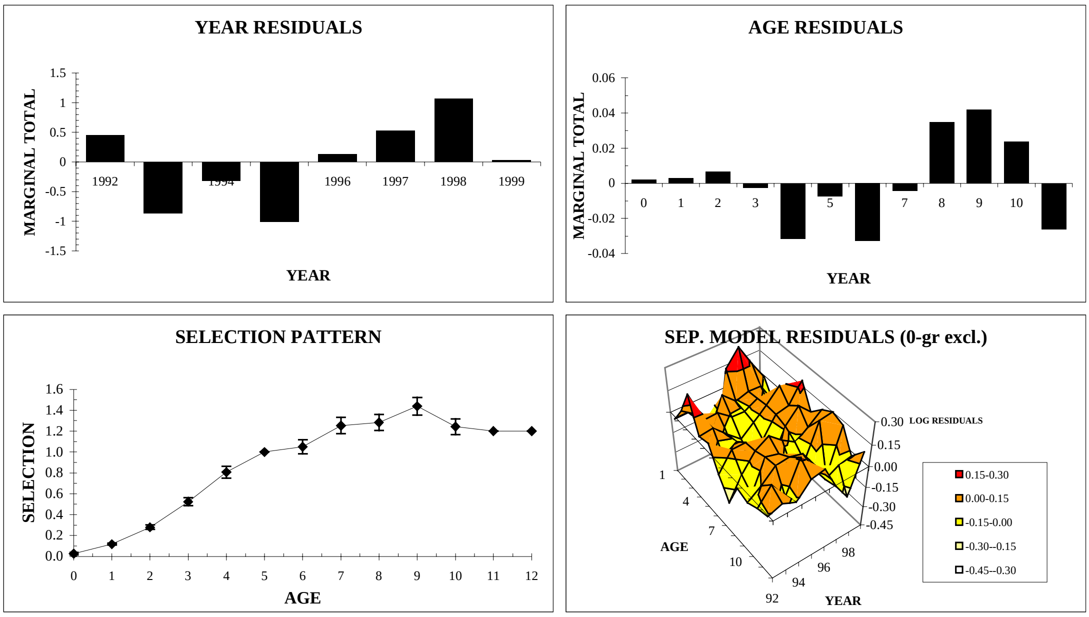


Figure 2.10.2.3 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data. Only SSB estimates from egg surveys covering the range 1992-1998 are used in the biomass index and there is only one period of separable constraint (1992-1999).

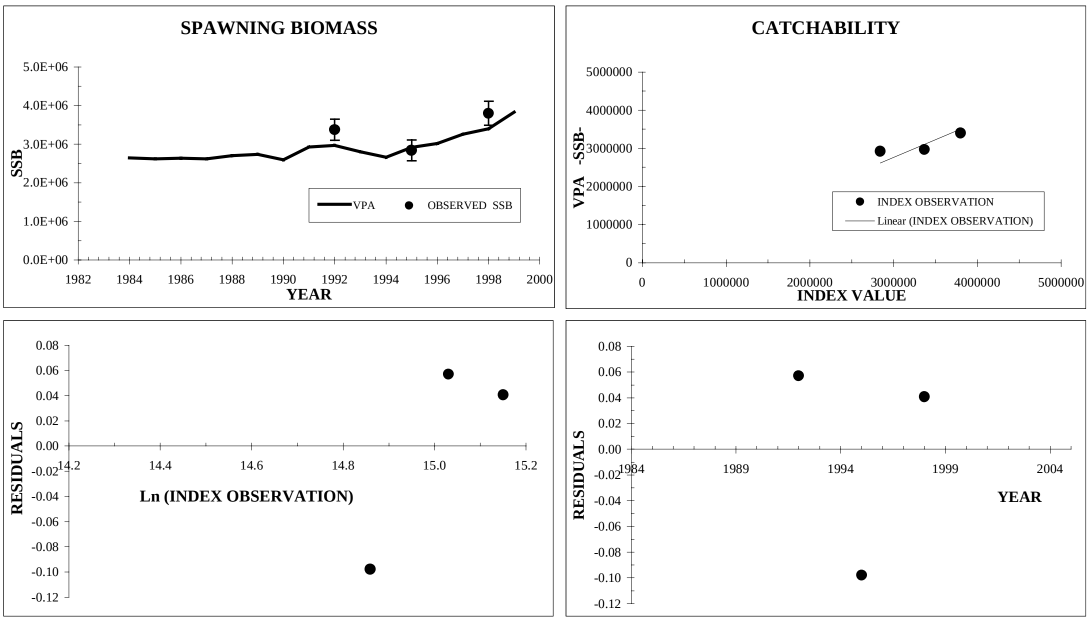


Figure 2.10.2.4 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel. Only SSB estimates from egg surveys covering the range 1992-1998 in the biomass index and there is only on period of separable constraint (1992-1999).

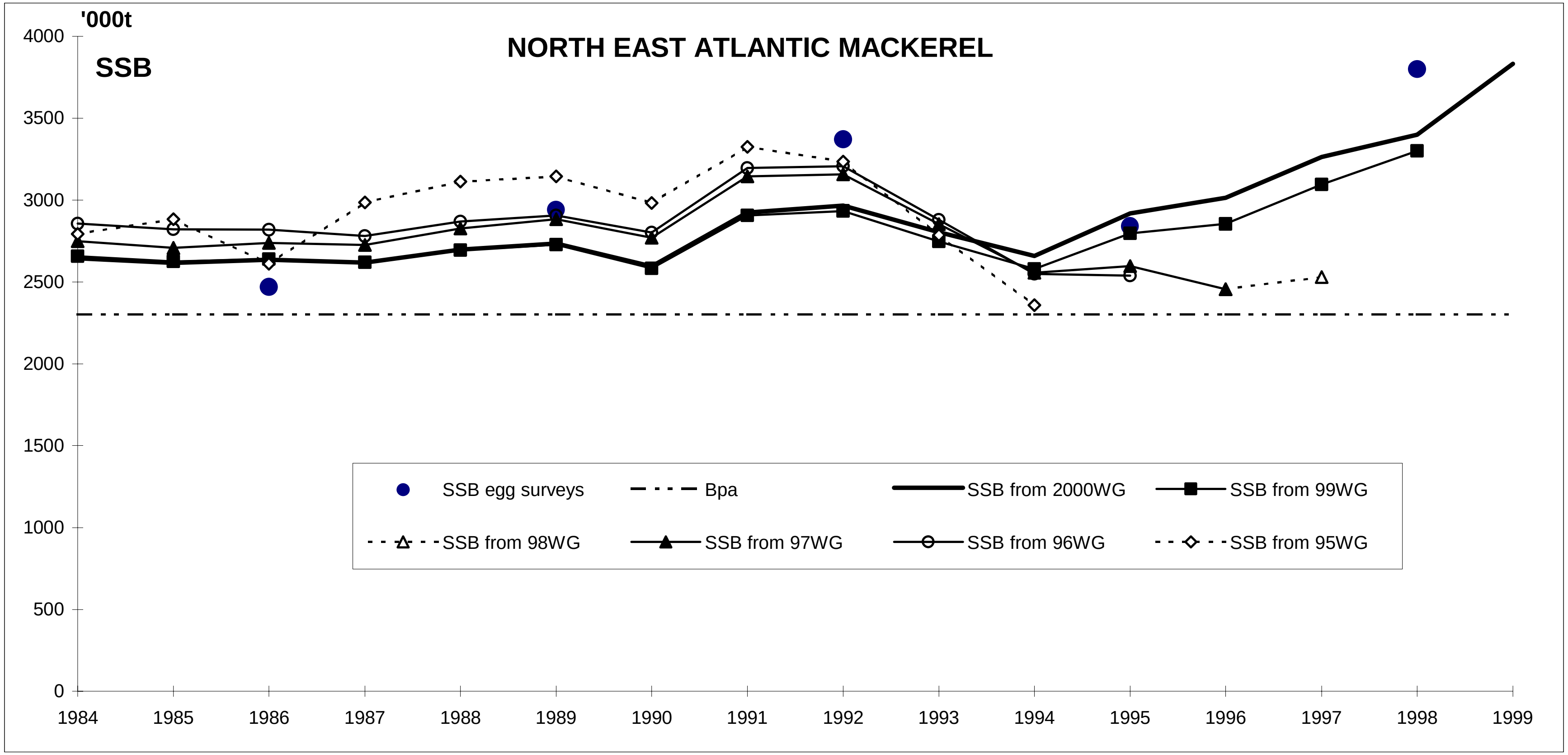
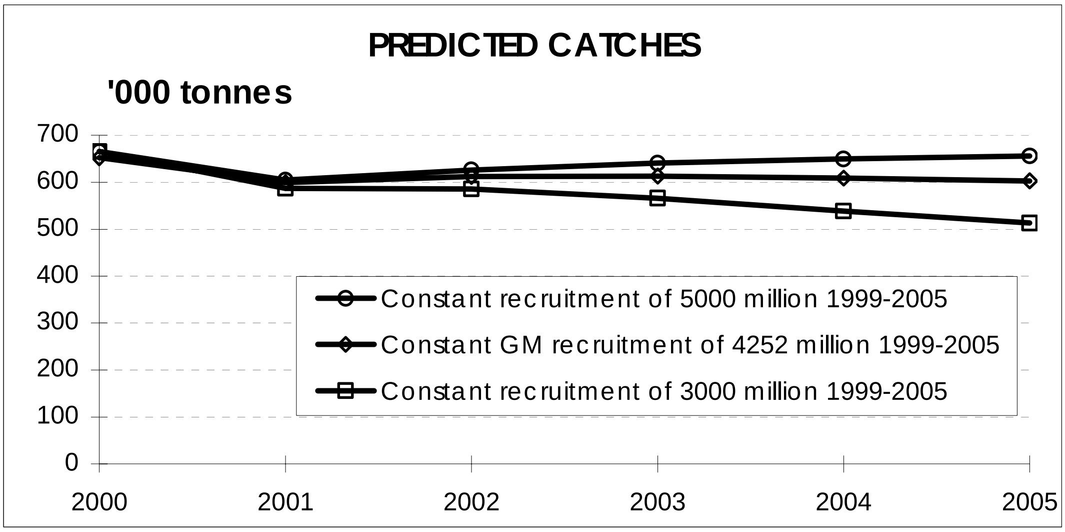
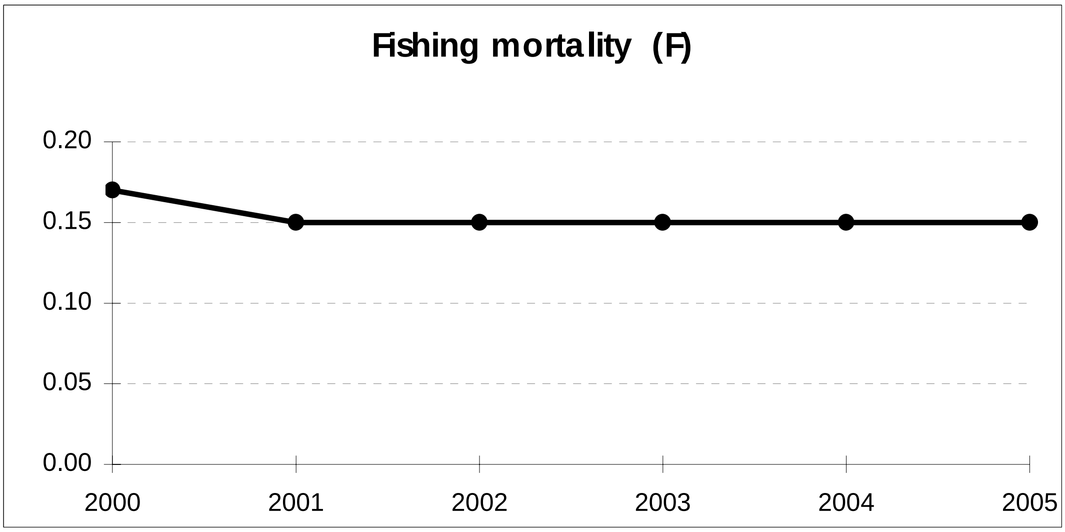


Figure 2.10.3.1 **Comparison of spawning stock biomass estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1986, 1989, 1992, 1995 and 1998 are also shown. At the 1999 and 2000 working group only the last three biomass estimates (1992, 1995 and 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.**

Catch constraint of 652 kt in 2000 and F=0.15 in 2001-2005





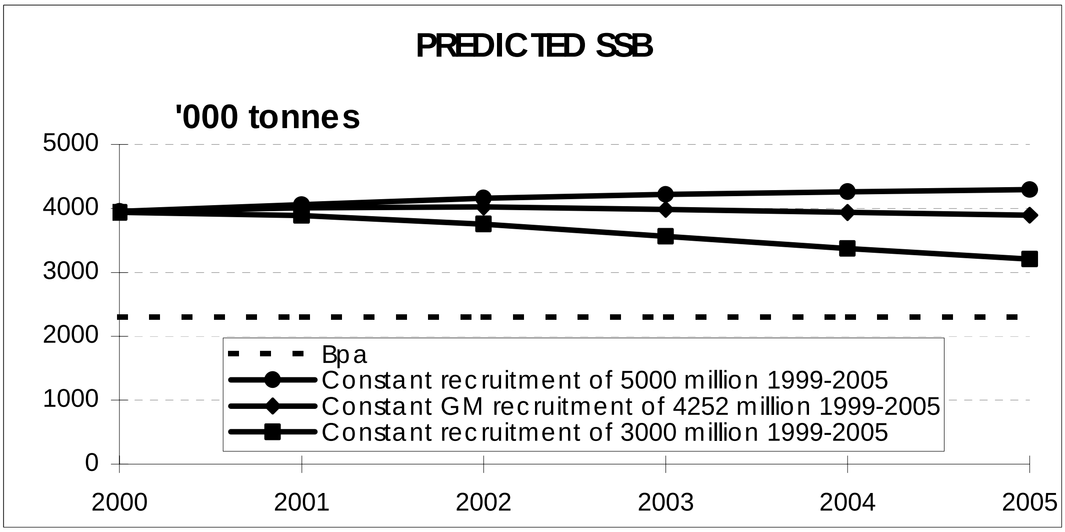


Figure 2.11.1 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

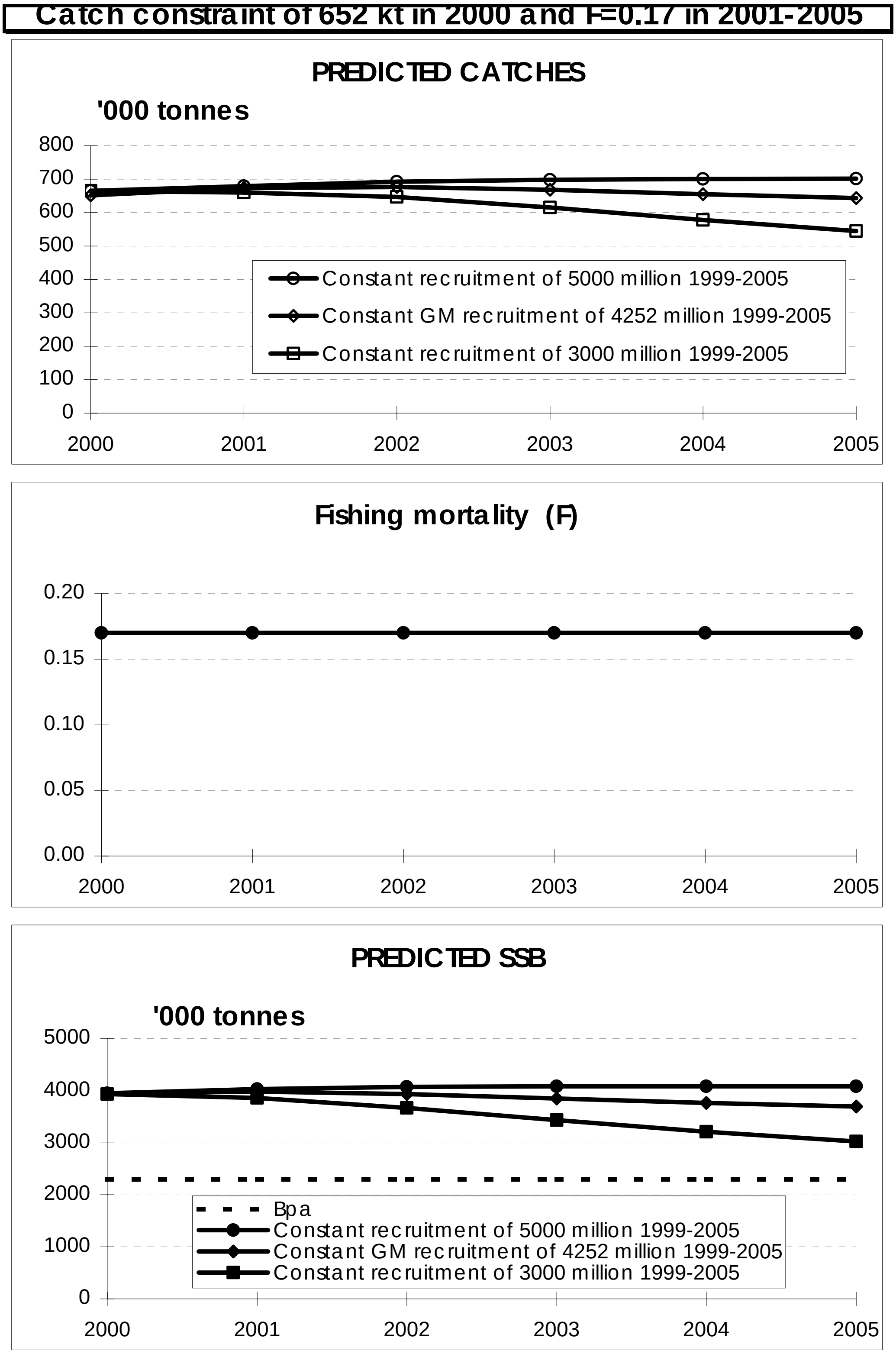


Figure 2.11.2 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

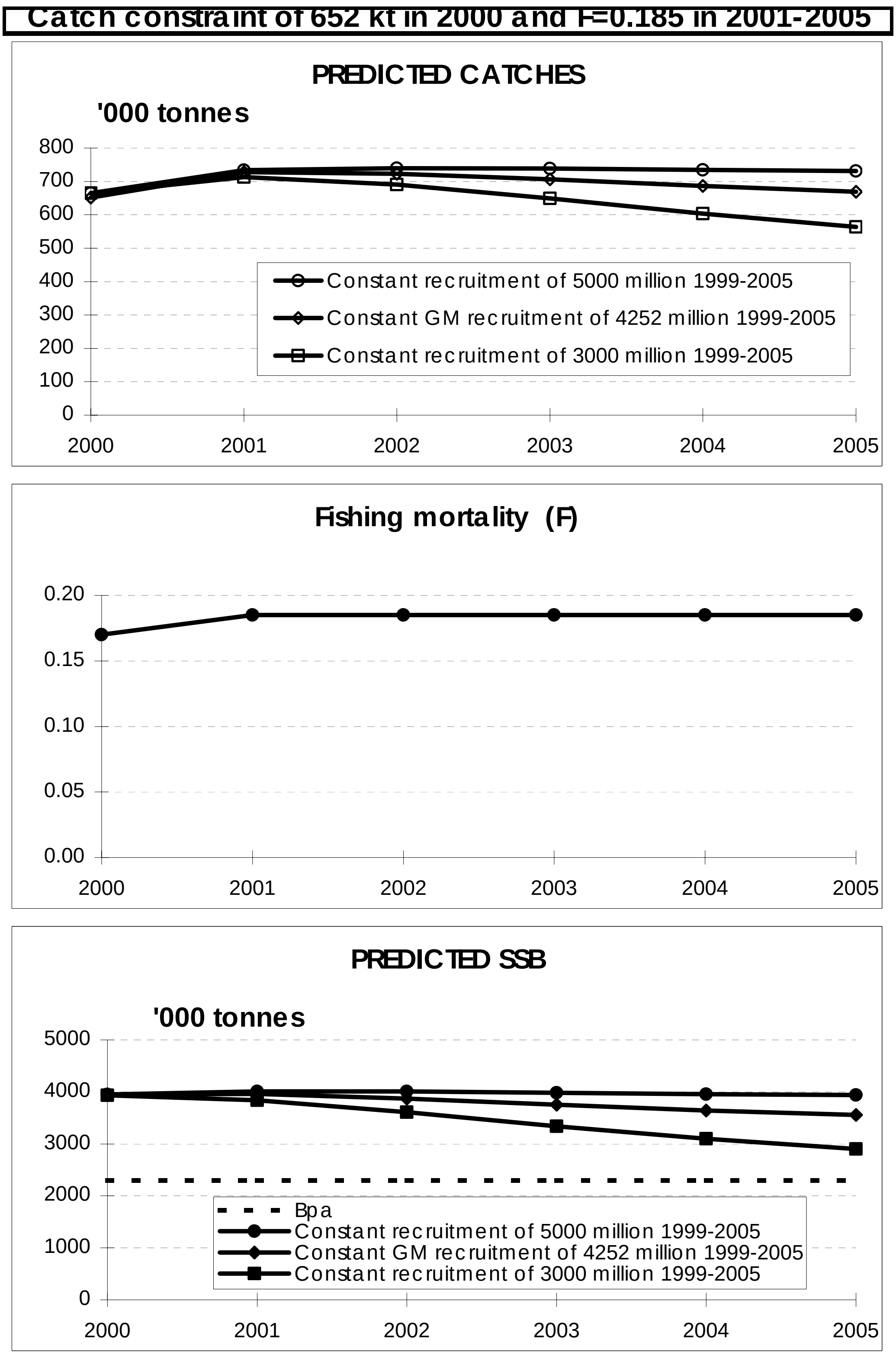


Figure 2.11.3 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

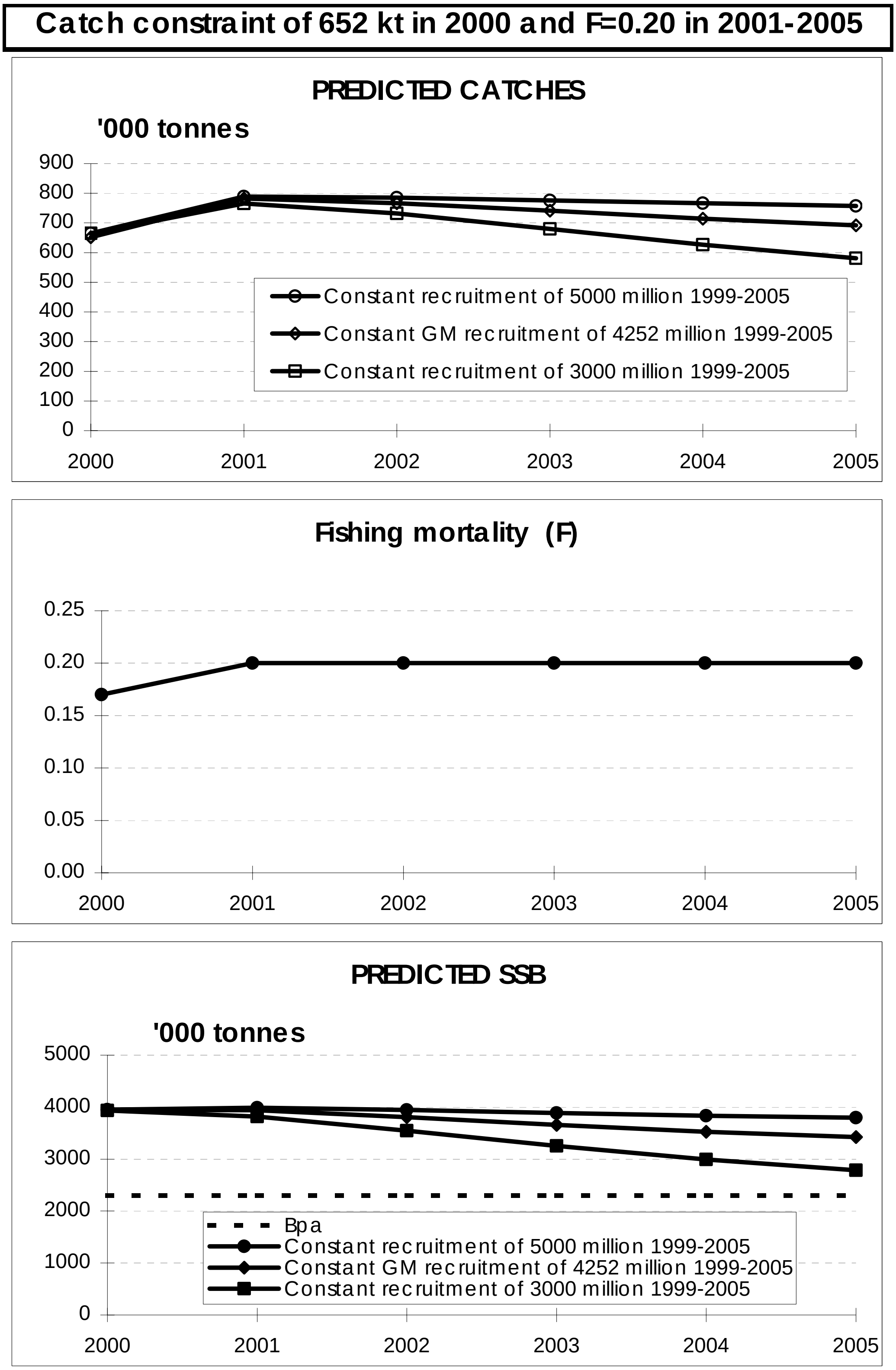
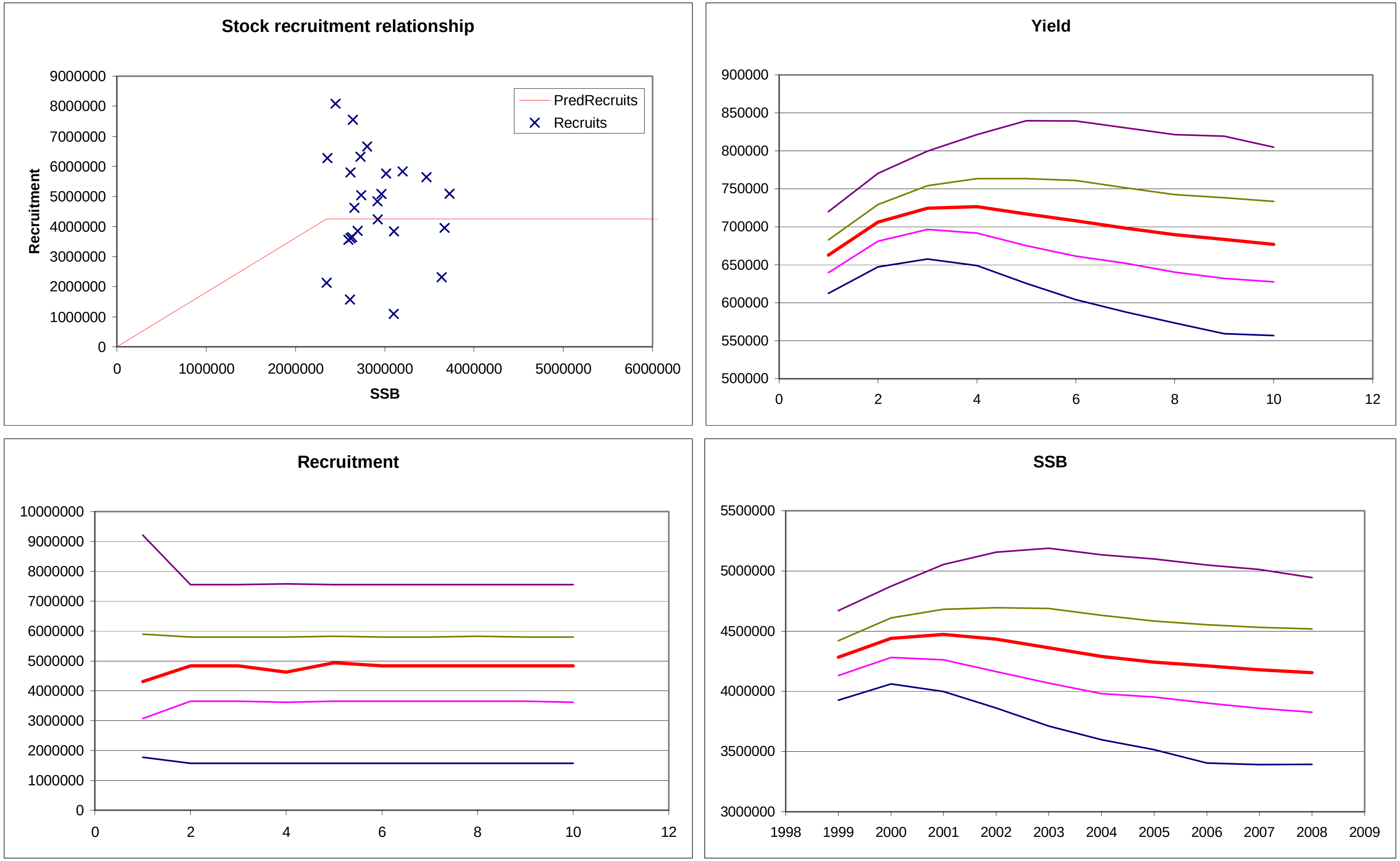
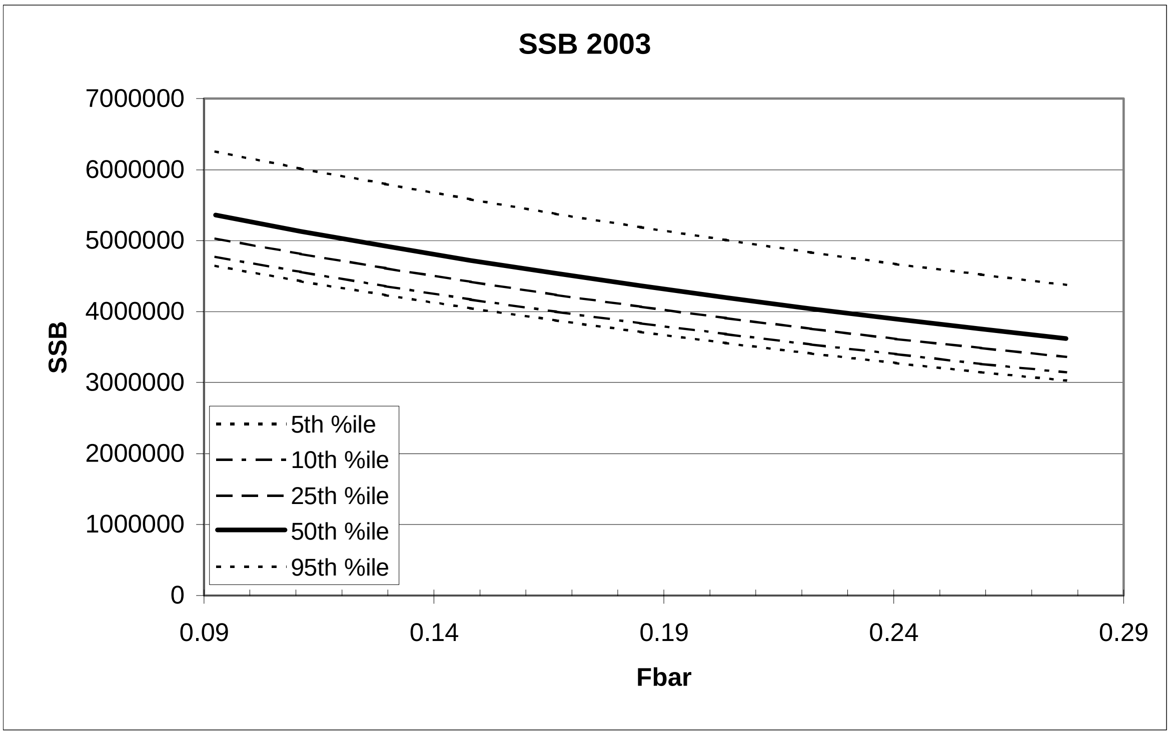


Figure 2.11.4 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

Figure 2.12.1.1 Atlantic mackerel medium term projections. Recruitment randomly distributed around the geometic mean (4,252 million) computed over the years 1972-1996





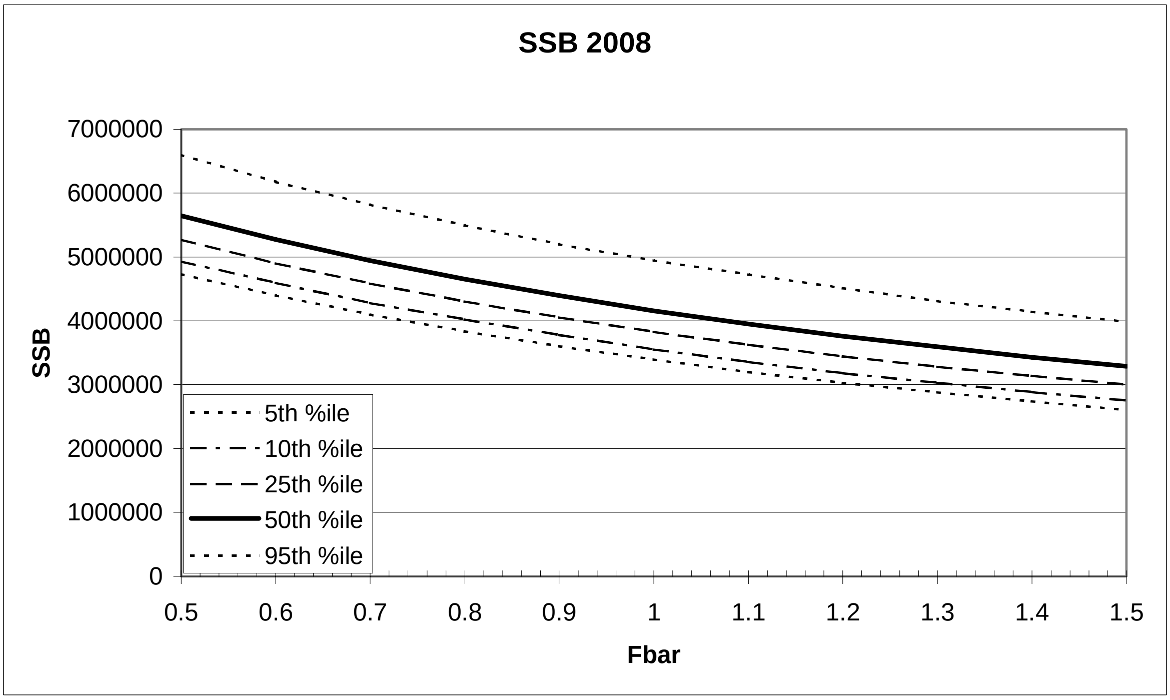


Figure 2.12.1.2 Atlantic mackerel medium term SSB probability profiles. Recruitment randomly distributed around the geometric mean (4252 million) and computed over 1972 – 1996. Fbar over 4-8 y.o. and years 1997-1999.

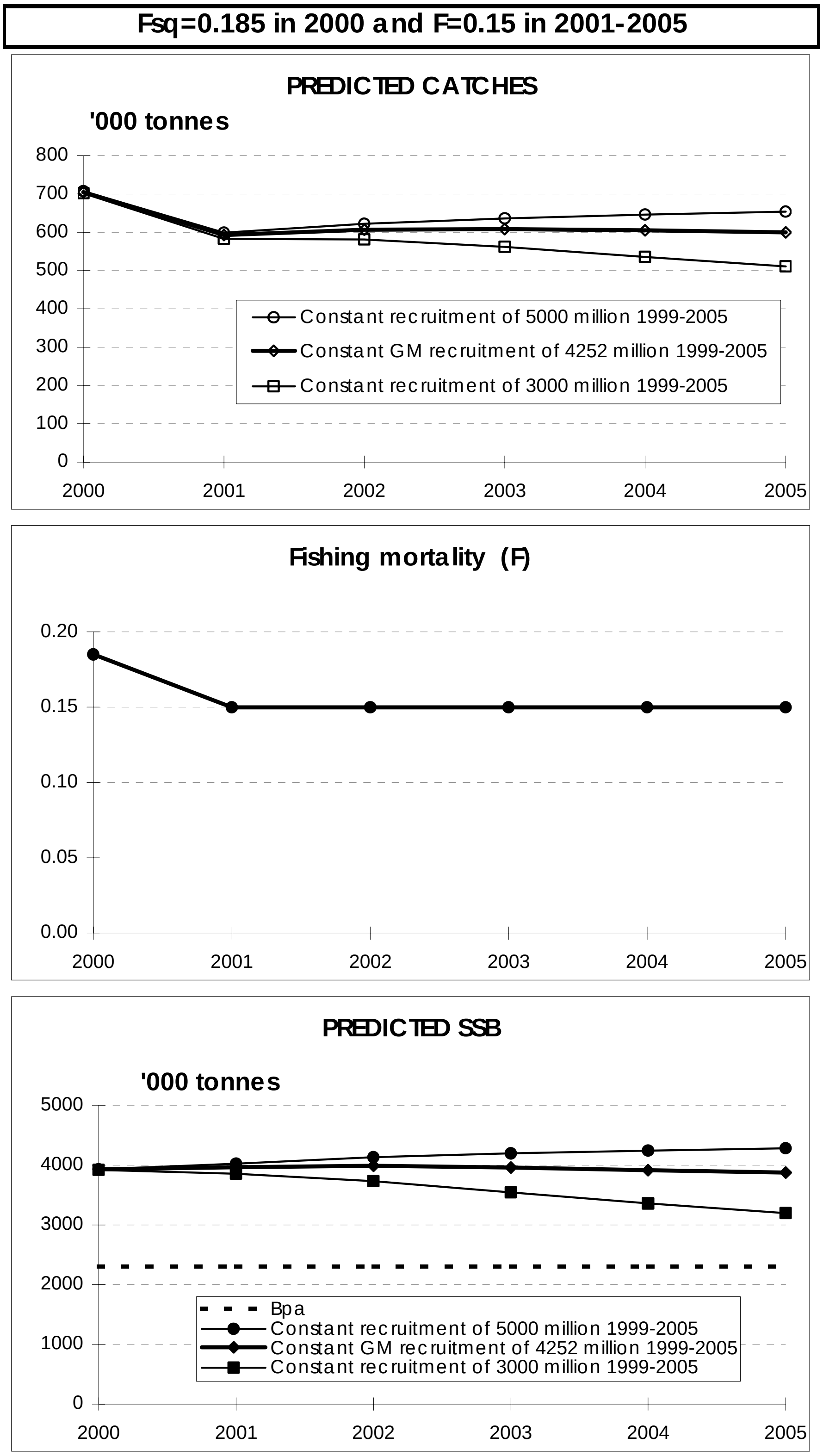


Figure 2.12.2.1 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

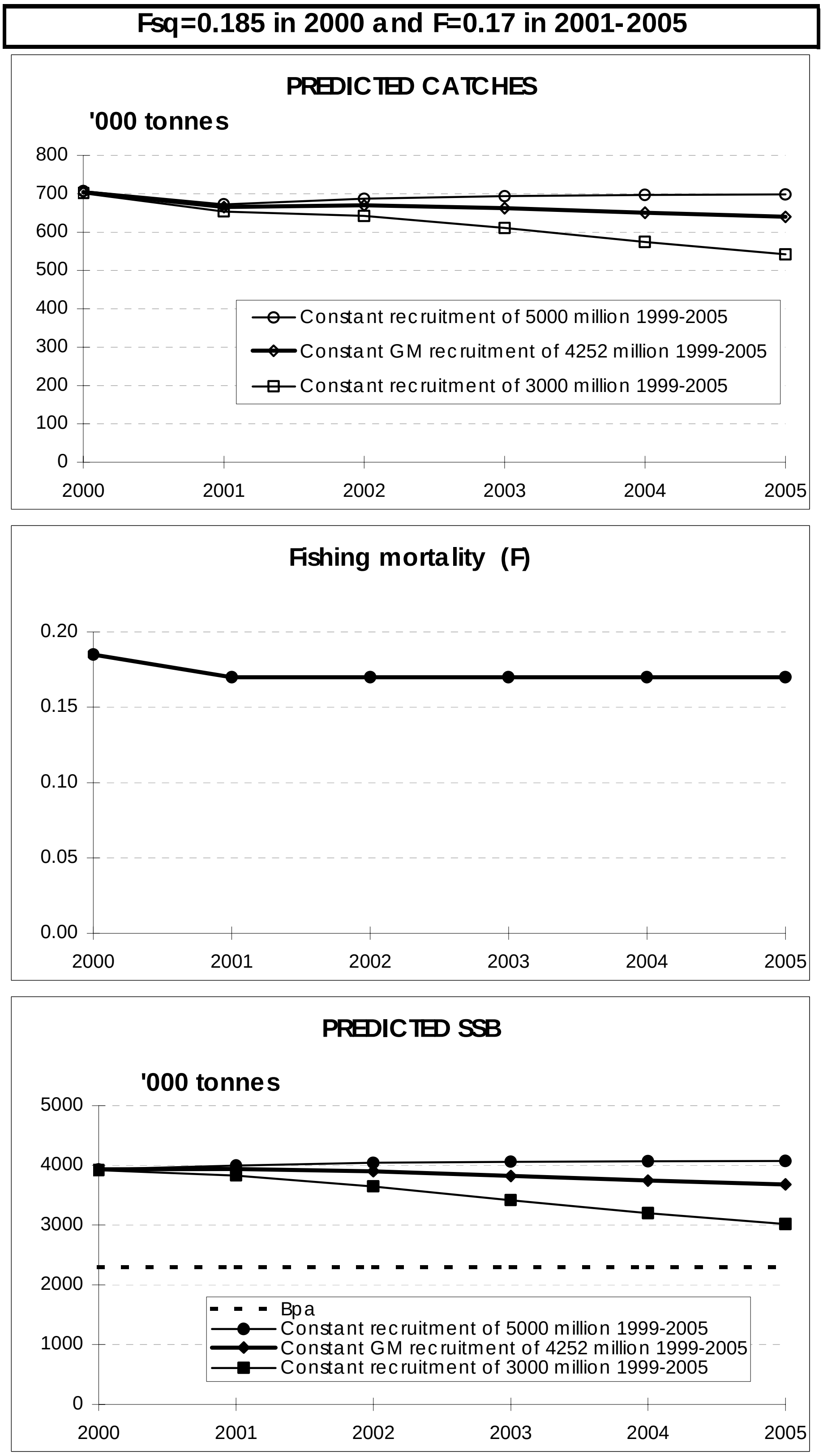


Figure 2.12.2.2 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

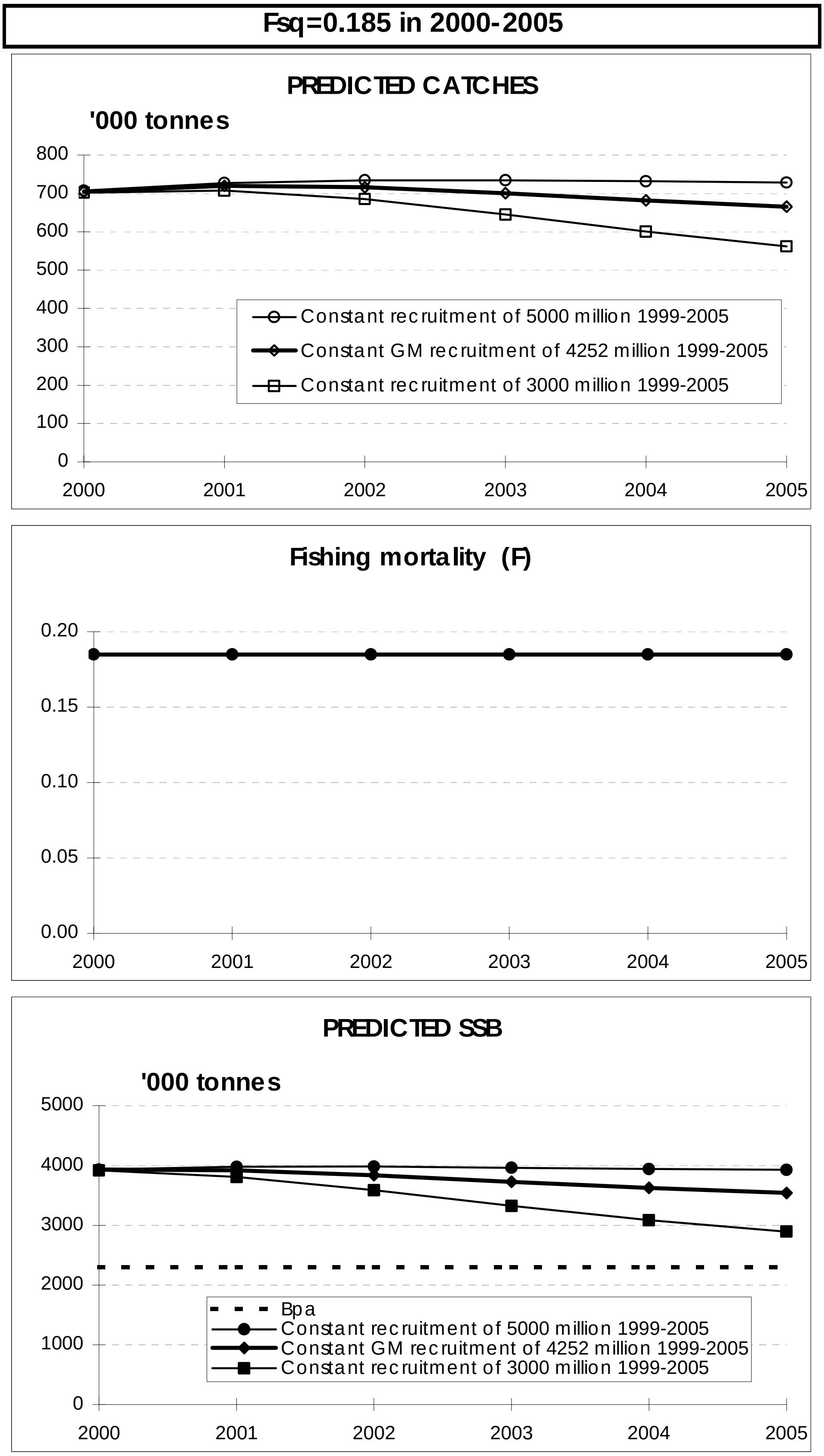


Figure 2.12.2.3 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

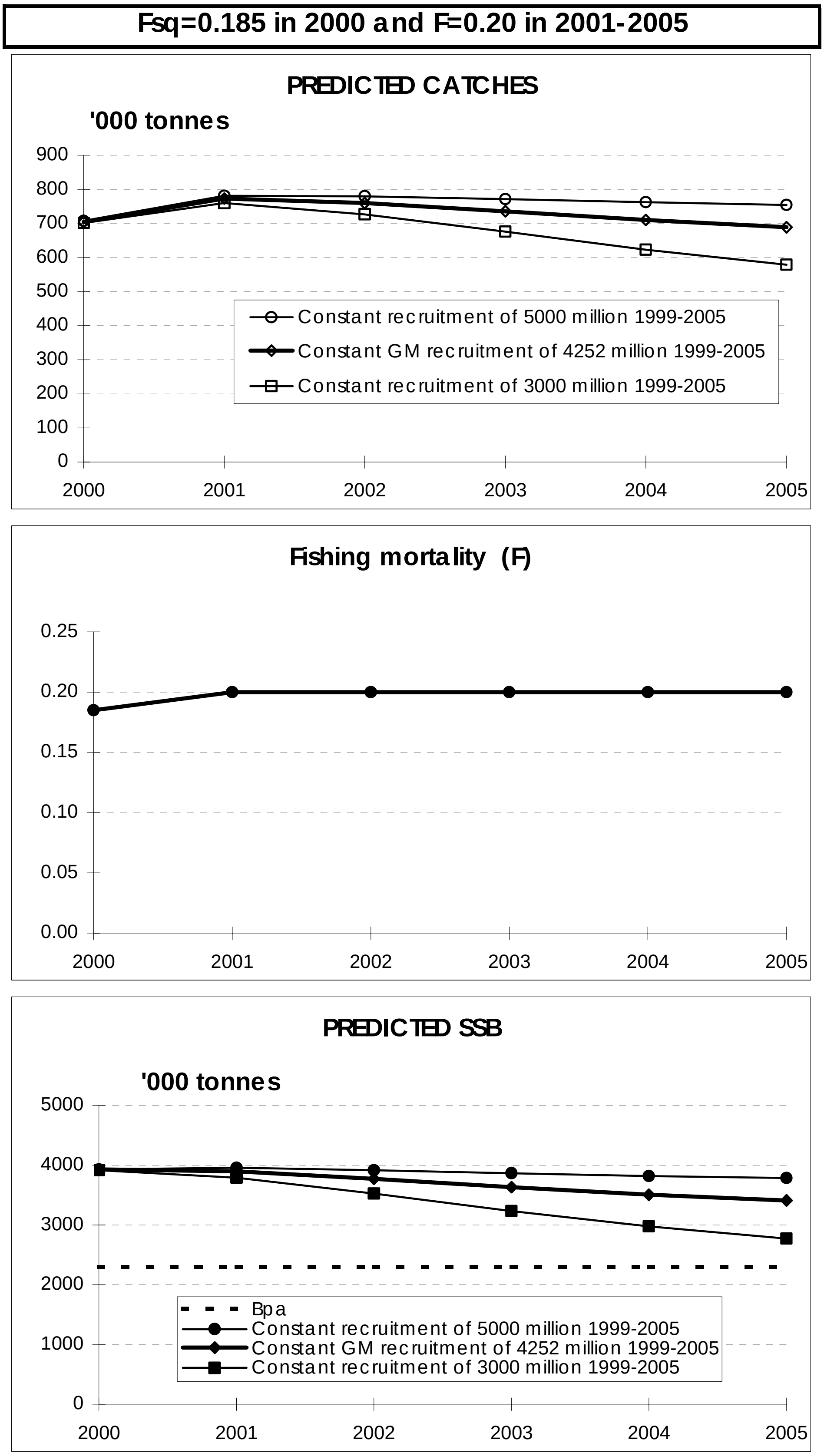


Figure 2.12.2.4 Deterministic medium term prediction up to 2005. Constant recruitment levels assumed for the period 1999-2005. Arbitrary recruitment levels of 3000 and 5000 are presented to indicate the sensitivity to incoming recruitment.

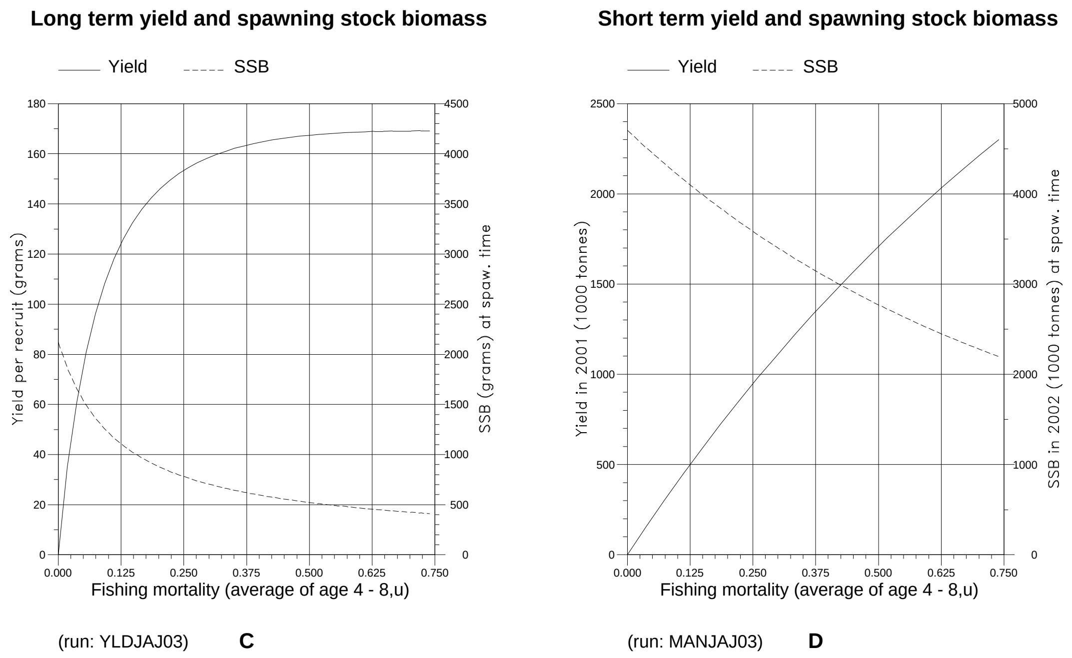


Figure 2.13.1 North East Atlantic Mackerel: Yield per recruit and short term yield and SSB.

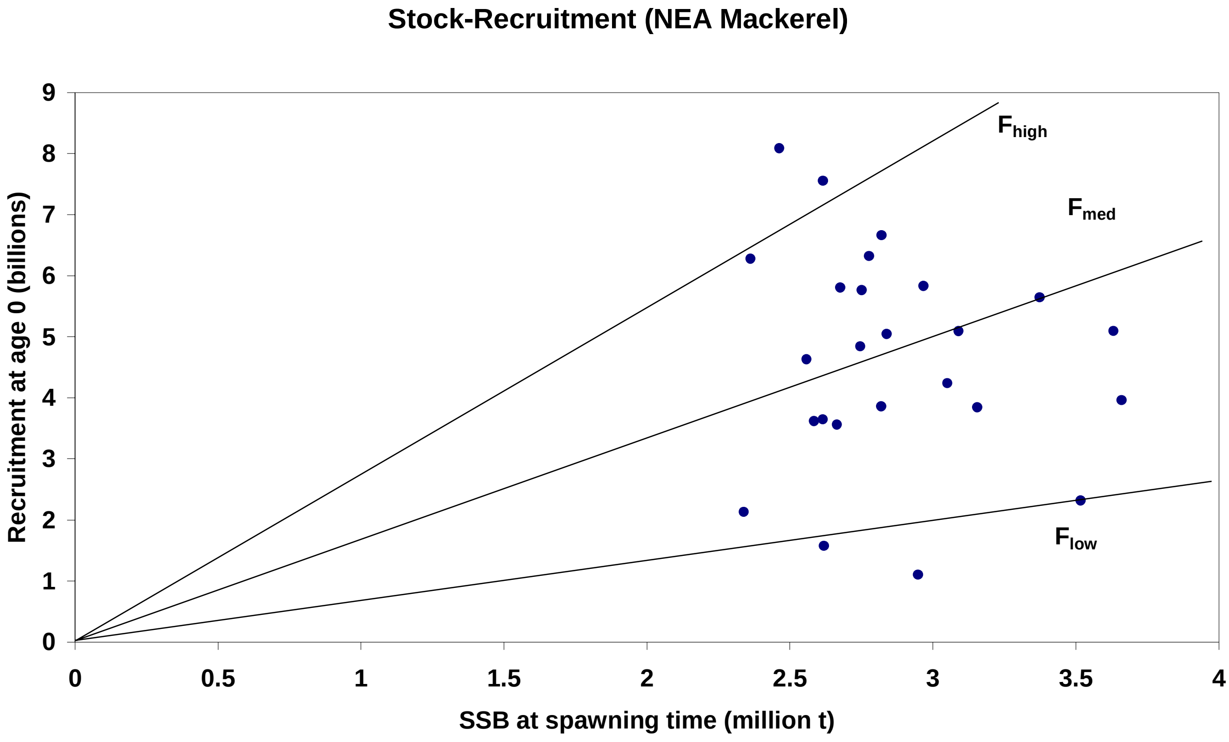


Figure 2.13.2 Stock-recruitment plot for North East Atlantic Mackerel with lines indicating F_{low}, F_{med} and F_{high}.

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

3.1 North Sea Mackerel Component

3.1.1 ACFM Advice applicable to 1999 and 2000

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

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

- There should be no fishing for mackerel in Division IVa during the period 1 January–31 July. Due to a later return from the North Sea the later years ACFM changed this advice for 2000: 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 last one about the 30 cm landing size was not repeated by ACFM in the advice for 1999 and 2000, but no reason for this was given by ACFM.

3.1.2 The Fishery in 1999

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 which takes place in its distribution area which is assumed to be similar to what observed when the stock component was much more abundant (Section 3.1.6), 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 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

A new egg survey in the North Sea is planned to take place in 2002.

3.1.4.2 Trawl Surveys

As mentioned elsewhere, it is not presently possible to positively identify juvenile mackerel caught in the North Sea IBTS as belonging to the North Sea or western components.

In the 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.

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 feeding in these areas during the second half of the year. How this might have influenced the present migration pattern and thereby the distribution of the North Sea component is unknown.

3.1.7 Recruitment Forecasting

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

3.1.8 State of the Stock 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 the first quarter of 2000 (Reid, WD 2000) demonstrated that the stock probably left the North Sea in December. However, the Working group will not change the advice, but keep a close look at the development of the mackerel migration durin November 2000- March 2001:

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

- There should be no fishing for mackerel in Divisions IIIa and IVb,c at any time of the year;
- There should be no fishing for mackerel in Division IVa during the period 1 February–31 July;
- The 30 cm minimum landing size at present in force in Sub-area IV should be maintained.

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

3.2 Western Mackerel Component

3.2.1 Biological Data

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

3.2.1.1 Catch in numbers at age

The 1999 catches in numbers at age by quarter for Western mackerel (Areas II, III, IV, V, VI, VII and Divisions VIIIa and VIIIb) are shown in Table 3.2.1.1 and correspond to a total catch of 565,133t. The correction for the Russian catches (540t in 1998) was not included in the caton file for the 2000 assessment. This revision will have a negligible effect on the SOP for the 1998 total catch (101%).

The age structure of the catches of Western mackerel is predominantly 2-7 year old fish. These age groups constitute 82% of the total catches. There was an even spread of ages 3 to 6 in catches which target mackerel. In the southern North Sea, English Channel, and southern Celtic Sea (IVc VIId VIIef VIIh) 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, Portugal, Russia, 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 31,528t) and the UK (England & Wales) and Germany who provide aged data for about 50% of their catches. In addition there were no aged samples to cover the entire catch from IIIa, (total catch 5,420t) and some minor catches in VIIa VIb and VIIk. As in 1998 catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleets. This is obviously undesirable where the only aged samples available are from a different type of gear.

Sampling data is further discussed in Section 1.4.1.

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

3.2.1.2 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter for 1999 for Western mackerel is shown in Table 3.2.1.2.1. These data continue the long time series and are useful in investigating changes in relation to stock size.

Mean weights

The mean weights at age in the catches per quarter for Western mackerel is shown in Table 3.2.1.2.2. The mean weights at age in the stock at spawning time for Western mackerel are given in Table 2.4.3.3. These data are based on samples from the Dutch and Irish fleets (VIIj), fishing on the spawning grounds during the period March to May 1999.

3.2.1.3 Maturity Ogive

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

3.2.2 Fishery independent information

3.2.2.1 Egg surveys

The last mackerel egg survey in the western area was carried out in 1998 and the results were fully reported in the 1999 report of WGMHSA (ICES 2000/ACFM:5) No new information which would lead to a reassessment of the results have been identified (see 1.7. and ICES 2000/G:01). Information on the historic time series of egg surveys which cover the area of the Western stock were also given in that report. Based on the 1998 egg survey the relative contribution of the Western area to the NE Atlantic egg survey estimates would be 0.75.

3.2.2.2 Trawl surveys

Bottom trawl surveys which provide information on Western stock juvenile mackerel include;

- Scottish surveys to the north and west of the British Isles in quarters 1 and 4.
- An English survey in the western approaches and Celtic Sea in quarter 1.
- An Irish survey on the west & south coasts of Ireland in quarter 4.
- A French survey in the Celtic Sea and Biscay in Quarter 4.

This combination has resulted in a nearly complete coverage of the western area in the fourth quarter.

Recruit distributions from these surveys are given in section 2.8.2. The index of recruitment derived from these surveys was not used in the assessment; reasons for this are given in section 2.6.3. A Generalised additive model (GAM) was used in 1999 to try and improve the performance of the recruitment index; details of this were given in ICES 2000/ACFM:5. Data from these surveys continue to be the only source of information on the distribution of juvenile

State of the Stock Component

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

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

ICA fits to the catch at age data and the estimates of SSB were used to examine the relationship between the indices and the catch at age data as estimated by a separable VPA. 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 1989–1999, Figure 3.2.3.3). The short time span for the first period was selected in order to exclude the 1985 catch data, which includes a zero catch of 0-group. A terminal selection of 1.2 was used for both periods, as there is no evidence for a difference between the values estimated for the oldest ages. A list of input parameters used in assessments made since the 1997 Working Group is given in Table 3.2.3.9. Both selection patterns were calculated relative to the reference fishing mortality at age 5.

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

$$\sum_{a=0}^{a=11}\sum_{y=1986}^{y=1988}\lambda_a(\ln(C_{a,y})-\ln(F_y.S1_a.\overline{N}_{a,y}))^2+$$
$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=1999}\lambda_a(\ln(C_{a,y})-\ln(F_y.S2_a.\overline{N}_{a,y}))^2+$$
$$\sum_{y=1977}^{y=1986}\Sigma(\ln(EPB_y)-\ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S1_a-PM.M))^2+$$
$$\sum_{y=1989}^{y=1999}\Sigma(\ln(EPB_y)-\ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a-PM.M))^2$$

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

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

Comments on the assessment of NEA mackerel, of which the western component is a subset, are given in section 2.9.1.

3.3 Southern Mackerel Component

3.3.1 Biological Data

3.3.1.1 Catch in numbers at age

The 1999 catches in numbers at age for Divisions VIIIc and IXa are discussed in Section 2.4. (Table 2.4.1.1 NEA mackerel).

3.3.1.2 Mean lengths at age and mean weigths at age

The mean lengths at age and mean weigths at age for Divisions VIIIc and IXa are discussed in Section 2.4. (Tables 2.4.3.1 and 2.4.3.2 - NEA mackerel).

The mean weights at age in the stock for the Southern mackerel are 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.

3.3.1.3 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, due to an overestimation of maturity of the ogive used in the ICES WG for ages 1 to 3 with respect to the maturity obtained microscopically (Perez, Villamor and Abaunza, WD 1999). The 1999 WG set the proportion mature for ages 4-6 to 1.00, because spent fish with only atretic oocytes have been assigned to inmature fish in this analysis (see Section 2.4.4, NEA Mackerel).

3.3.1.4 Natural Mortality

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

3.3.2 Fishery- independent information

3.3.2.1 Egg Surveys

The egg survey carried out in 1998 was the second in the series in the southern area where the annual egg production method was applied. A limited survey was carried out in 1992 with poor temporal and spatial coverage, and in 1995 the first survey with a reasonably good coverage was performed.

The temporal and spatial coverage in 1998 was improved compared to the previous survey in 1995. The estimate of total annual production of stage I eggs was more than double the estimate obtained in 1995. The coefficient of variation of the total annual stage I egg production, 40.34%, was very high, mainly due to the high standard error values during sampling periods 3 and 4 on the Cantabrian coast. In both periods 3 and 4, a couple of the sampled rectangles showed a high density of mackerel stage I eggs, and due to bad weather conditions, only one sample per ICES rectangle was obtained. Those high density values were thus extrapolated to the whole rectangle area, and they had a large impact in the total egg production estimate for that year, rising it to more than double the one in 1995.

The 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 data corresponding to the fecundity and atresia from the southern area was revised by the Working Group on mackerel and horse mackerel egg surveys (ICES, 2000/G:01). There are no changes from those presented at this WG in 1999 (ICES, 2000/ACFM:5). The total potential fecundity of 1276 oocytes per gram female was similar to that obtained in the western spawning area (1176 CEFAS and 1255 MLA). Analysis of all the atresia samples has not yet been completed. The samples analysed to date give an atresia value of 105 oocytes per gram female resulting in a realised fecundity of 1,171 oocytes per gram female for the southern area.

The revised estimate of total spawning stock biomass for the southern area, is reduced from 850,000 t to 800,000 t 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%.

3.3.2.2 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.

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

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

3.3.2.3 Acoustic surveys

The mackerel biomass was estimated to be 320,000 t in 1999, and 706,000 tonnes in 2000 (Carrera, WD 2000) 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 an overestimated due to high plankton abundance in the area. 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). Acoustic surveys in Divisions VIIIc and IXa suggest an increase in the abundance of this stock component (Carrera et al., WD 1999). Further information is given in Section 2.6.2.- NEA Mackerel.

3.3.3 Effort and Catch per Unit Effort

This information is now given in Section 2.7.

Table 3.2.1.1 Catch in numbers at age (000's) for Western Atlantic mackerel

All Quarters

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	0	10	0	0	0	20	0	0	0	0	1	0	0	31
1	1	18	48	2,565	8,511	2,525	204	2	343	13,556	14,581	39	15,167	114	0	2,733	0	5	60,411
2	106	20,304	11,249	2,592	4,246	4,911	886	23	12,906	6,844	17,175	420	11,184	1,336	0	28,392	1	109	122,685
3	1,040	35,108	62,803	1,968	1,456	1,264	1,455	44	20,483	2,446	9,472	343	552	10,804	4	49,507	1	1,074	199,824
4	1,977	44,468	89,159	1,729	987	748	1,971	20	13,598	1,233	5,660	72	1,341	20,148	8	43,440	1	1,374	227,933
5	2,379	34,519	104,742	2,330	585	543	2,041	2	11,886	1,850	3,548	91	481	34,692	15	49,070	1	853	249,626
6	2,044	14,246	114,057	2,012	101	414	2,182	2	6,542	909	1,750	28	1,140	17,870	8	42,945	1	583	206,833
7	1,556	9,219	86,791	816	1	319	1,215	1	4,049	258	348	23	343	7,226	3	25,245	1	286	137,701
8	689	3,564	51,123	763	2	78	539	3	2,560	147	110	9	224	2,870	0	13,968	0	135	76,786
9	342	1,788	29,499	314	0	122	412	0	871	115	133	32	17	1,345	0	9,037	0	94	44,122
10	230	1,179	17,712	147	0	34	199	0	386	100	70	2	4	544	0	5,520	0	46	26,175
11	103	775	8,991	0	0	35	232	0	284	56	17	2	4	204	0	3,295	0	0	13,998
12	146	1,535	10,099	49	0	3	78	0	78	13	7	0	0	104	0	1,622	0	49	13,785
13	99	299	4,904	29	0	57	62	0	154	23	7	5	9	43	0	1,541	0	6	7,236
14	17	117	1,529	0	0	1	22	0	134	15	3	0	0	82	0	303	0	0	2,225
15	26	142	3,604	49	0	0	0	0	264	4	3	0	0	677	0	609	0	10	5,388
SOP	5,420	70,983	285,272	5,099	3,977	2,547	4,143	31	23,364	7,636	12,131	287	6,384	37,175	16	98,252	2	1,866	564,578
Catch	5,422	70,983	285,295	5,089	3,992	2,554	4,120	31	23,308	7,666	12,132	288	6,390	37,318	15	98,664	2	1,865	565,133
SOP%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%

Quarter 1

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	4	0	0	3,252	86	14	0	338	0	1,045	0	0	0	0	120	0	5	4,864
2	6	93	1,378	0	1,571	151	339	0	8,664	21	1,516	1	181	410	0	6,745	0	104	21,180
3	77	906	14,792	0	343	50	886	1	9,418	0	3,099	4	358	7,648	4	35,957	0	1,015	74,559
4	128	1,076	20,328	0	228	90	1,353	1	7,014	129	1,718	1	735	15,709	8	29,553	0	1,206	79,279
5	173	593	28,026	0	224	83	1,543	1	4,498	215	879	0	408	22,716	15	39,128	0	665	99,168
6	179	359	32,418	0	1	91	1,638	1	2,989	86	655	0	546	11,801	8	34,530	0	402	85,705
7	134	151	25,135	0	1	50	902	0	2,287	64	272	0	300	4,379	3	20,888	0	169	54,736
8	67	32	12,654	0	1	24	394	0	867	0	72	0	215	628	0	11,781	0	35	26,772
9	41	41	8,372	0	0	15	299	0	399	0	47	0	0	383	0	7,012	0	46	16,656
10	22	30	4,577	0	0	7	147	0	146	0	67	0	0	246	0	4,860	0	33	10,137
11	9	0	1,901	0	0	8	170	0	170	0	15	0	0	61	0	2,977	0	0	5,313
12	7	33	1,518	0	0	3	58	0	36	0	7	0	0	54	0	1,385	0	37	3,139
13	4	0	837	0	0	2	48	0	120	0	0	0	0	0	0	1,322	0	0	2,333
14	0	0	71	0	0	1	17	0	120	0	3	0	0	62	0	303	0	0	578
15	5	0	1,000	0	0	0	0	0	20	0	3	0	0	0	0	536	0	0	1,564
SOP	375	1,280	67,555	0	1,352	210	2,920	1	10,719	222	2,026	2	1,005	24,757	15	73,845	1	1,434	187,719
Catch	376	1,280	67,553	0	1,356	208	2,897	1	10,670	250	2,026	2	1,004	24,896	15	74,290	1	1,434	188,259
SOP%	100%	100%	100%	0%	100%	99%	99%	100%	100%	112%	100%	100%	100%	101%	98%	101%	102%	100%	100%

Quarter 2

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	14	2	237	409	24	14	0	5	0	49	1	4	6	0	134	0	0	901
2	21	318	47	240	221	976	224	0	44	0	169	55	162	72	0	14,602	1	3	17,153
3	203	3,100	456	184	139	1,098	486	0	1,656	34	69	62	182	2,308	0	7,488	0	27	17,495
4	241	3,683	542	118	95	366	598	1	2,588	54	104	21	61	4,169	0	7,882	0	32	20,554
5	133	2,030	299	149	28	415	495	1	7,071	132	32	23	69	11,940	0	5,259	0	18	28,095
6	80	1,228	181	115	17	293	542	1	3,553	215	32	17	49	6,048	0	3,274	0	11	15,655
7	34	517	76	27	0	244	312	0	1,763	180	11	14	40	2,834	0	1,592	0	4	7,649
8	7	108	16	26	0	49	145	0	1,228	140	7	3	8	2,212	0	841	0	1	4,791
9	9	142	21	9	0	97	113	0	472	109	9	5	16	962	0	700	0	1	2,665
10	7	102	15	9	0	24	52	0	240	98	0	1	4	295	0	315	0	1	1,162
11	0	0	0	0	0	24	62	0	114	54	0	1	4	143	0	0	0	0	402
12	7	113	17	0	0	0	20	0	42	11	0	0	0	50	0	0	0	1	262
13	0	0	0	0	0	49	14	0	34	23	0	3	8	42	0	176	0	0	350
14	0	0	0	0	0	0	5	0	15	15	0	0	0	21	0	0	0	0	55
15	0	0	0	0	0	0	0	0	244	4	0	0	0	677	0	0	0	0	925
SOP	287	4,379	644	316	246	916	1,094	1	6,834	476	120	52	152	11,760	0	10,855	1	38	38,173
Catch	287	4,379	644	315	247	923	1,095	1	6,820	477	120	52	153	11,764	0	10,825	1	38	38,142
SOP%	100%	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	101%	101%	100%	101%	100%	99%	100%	100%

Table 3.2.1.1 (continued)

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	30	2,328	1,929	3	0	0	0	13	499	1	58	0	0	325	0	0	5,186
2	57	19,830	3,387	2,352	1,027	102	1	15	2,296	8	1,307	36	51	58	0	55	0	2	30,583
3	482	30,719	21,103	1,747	596	115	2	36	5,922	6	701	40	12	150	0	37	0	24	61,693
4	758	39,240	25,667	1,085	409	38	2	17	2,728	15	374	13	6	69	0	65	0	29	70,517
5	969	31,330	32,494	1,419	132	44	1	0	0	18	292	15	4	0	0	61	0	16	66,794
6	975	12,047	34,310	1,106	69	31	1	0	0	23	108	11	5	0	0	71	0	10	48,766
7	1,093	8,021	34,195	255	0	26	0	0	0	13	27	9	3	0	0	111	0	4	43,757
8	456	3,106	17,867	256	0	5	0	3	466	7	16	2	1	12	0	61	0	1	22,257
9	230	1,412	10,353	85	0	10	0	0	0	7	11	4	1	0	0	61	0	1	12,174
10	201	923	7,263	85	0	3	0	0	0	3	1	1	0	0	0	40	0	1	8,521
11	94	717	3,364	0	0	3	0	0	0	2	1	1	0	0	0	0	0	0	4,182
12	110	1,301	4,935	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	6,348
13	94	265	2,467	0	0	5	0	0	0	0	6	2	1	0	0	10	0	0	2,850
14	17	103	761	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	881
15	21	124	930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,074
SOP	2,902	63,575	101,020	3,015	1,110	96	3	22	3,653	47	826	34	28	93		248	0	34	176,706
Catch	2,903	63,579	101,026	3,009	1,115	97	3	23	3,660	47	826	34	30	93		249	0	34	176,727
SOP%	100%	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	101%	105%	100%		100%	102%	100%	100%

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0	0	0	0	0	0	0	10	0	0	0	20	0	0	0	0	1	0	0	31
1	0	0	16	0	2,921	2,412	176	1	0	13,543	12,987	37	15,105	108	0	2,155	0	0	49,460
2	22	63	6,438	0	1,428	3,682	323	8	1,902	6,815	14,183	328	10,790	796	0	6,991	0	0	53,769
3	278	382	26,452	37	378	0	81	7	3,487	2,406	5,603	237	0	698	0	6,024	0	7	46,077
4	849	469	42,622	526	254	254	18	2	1,268	1,035	3,464	36	539	200	0	5,940	0	107	57,583
5	1,104	565	43,923	762	201	0	1	0	317	1,485	2,345	51	0	36	0	4,622	0	155	55,569
6	810	612	47,149	791	13	0	1	0	0	585	955	0	539	22	0	5,071	0	161	56,707
7	296	530	27,385	534	0	0	0	0	0	0	38	0	0	12	0	2,654	0	109	31,559
8	159	319	20,586	481	1	0	0	0	0	0	14	4	0	19	0	1,285	0	98	22,967
9	62	192	10,754	220	0	0	0	0	0	0	66	23	0	0	0	1,265	0	45	12,627
10	0	124	5,857	53	0	0	0	0	0	0	1	0	0	3	0	305	0	11	6,354
11	0	57	3,726	0	0	0	0	0	0	0	1	0	0	0	0	317	0	0	4,101
12	22	88	3,630	49	0	0	0	0	0	0	0	0	0	0	0	237	0	10	4,036
13	0	35	1,600	29	0	0	0	0	0	0	1	0	0	0	0	33	0	6	1,702
14	0	14	697	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	711
15	0	18	1,674	49	0	0	0	0	0	0	0	0	0	0	0	73	0	10	1,824
SOP	1,855	1,744	116,060	1,768	1,269	1,325	126	6	2,158	6,890	9,161	200	5,199	565	0	13,298	0	360	161,985
Catch	1,856	1,745	116,071	1,765	1,274	1,325	126	6	2,158	6,891	9,160	200	5,203	565		13,300		359	162,005
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		100%		100%	100%

Table 3.2.1.2.1 Mean weight (kg) at age for Western mackerel

Mean weight

All Quarters

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0							0.116			0.101	0.080					0.101			0.092
1	0.091	0.091	0.174	0.196	0.189	0.173	0.180	0.194	0.161	0.221	0.173	0.164	0.168	0.203	0.138	0.135	0.146	0.091	0.184
2	0.290	0.291	0.288	0.268	0.289	0.210	0.207	0.256	0.198	0.287	0.223	0.244	0.222	0.248	0.184	0.195	0.175	0.258	0.237
3	0.356	0.382	0.342	0.288	0.323	0.209	0.265	0.308	0.278	0.336	0.253	0.260	0.230	0.285	0.301	0.252	0.248	0.335	0.310
4	0.433	0.400	0.398	0.342	0.409	0.291	0.308	0.357	0.318	0.360	0.272	0.320	0.293	0.331	0.347	0.317	0.322	0.378	0.367
5	0.486	0.455	0.441	0.365	0.377	0.303	0.387	0.357	0.346	0.345	0.290	0.313	0.383	0.371	0.387	0.359	0.373	0.415	0.408
6	0.532	0.522	0.484	0.394	0.437	0.309	0.403	0.402	0.391	0.444	0.315	0.284	0.319	0.441	0.486	0.414	0.428	0.475	0.461
7	0.556	0.534	0.529	0.468	0.442	0.418	0.422	0.423	0.441	0.470	0.366	0.416	0.463	0.464	0.477	0.461	0.475	0.477	0.509
8	0.613	0.563	0.566	0.506	0.464	0.489	0.453	0.536	0.472	0.492	0.418	0.458	0.474	0.470	0.484	0.489	0.521	0.536	0.544
9	0.596	0.594	0.594	0.523	0.507	0.476	0.490	0.463	0.488	0.508	0.336	0.346	0.474	0.520	0.513	0.536	0.574	0.583	0.575
10	0.631	0.612	0.621	0.486	0.494	0.562	0.485	0.548	0.460	0.495	0.374	0.581	0.583	0.503	0.639	0.538	0.535	0.510	0.595
11	0.661	0.634	0.648	0.598	0.570	0.406	0.512	0.425	0.414	0.573	0.395	0.372	0.372	0.487	0.644	0.573	0.534		0.619
12	0.704	0.730	0.702	0.683	0.567	0.537	0.534	0.551	0.530	0.575	0.407			0.538	0.473	0.618	0.575	0.563	0.691
13	0.793	0.713	0.719	0.868	0.630	0.700	0.552	0.535	0.543	0.631	0.611	0.706	0.706	0.553	0.522	0.618	0.863	0.868	0.692
14	0.816	0.823	0.785	0.750	0.559	0.598	0.595	0.622	0.568	0.559	0.457			0.607	0.627	0.623			0.741
15	0.754	0.790	0.735	0.781	0.736		0.609	0.535	0.579	0.729	0.457			0.606	0.583	0.666		0.781	0.705

Quarter 1

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0																			
1		0.091			0.190	0.173	0.163		0.161		0.067					0.123		0.091	0.159
2	0.213	0.258	0.216	0.217	0.282	0.223	0.205	0.184	0.169	0.287	0.162	0.186	0.192	0.207	0.184	0.191		0.258	0.190
3	0.276	0.336	0.281	0.287	0.329	0.266	0.270	0.266	0.246		0.211	0.232	0.242	0.287	0.301	0.252	0.299	0.336	0.262
4	0.349	0.378	0.354	0.352	0.384	0.314	0.314	0.315	0.304	0.394	0.250	0.307	0.333	0.336	0.347	0.323	0.391	0.378	0.332
5	0.400	0.410	0.397	0.408	0.397	0.388	0.386	0.371	0.357	0.436	0.294	0.390	0.400	0.387	0.387	0.358	0.406	0.410	0.377
6	0.454	0.465	0.450	0.458	0.486	0.405	0.402	0.423	0.409	0.435	0.286	0.372	0.427	0.472	0.487	0.416	0.454	0.465	0.436
7	0.493	0.438	0.487	0.490	0.440	0.427	0.421	0.445	0.452	0.532	0.358	0.445	0.469	0.476	0.478	0.463	0.493	0.438	0.474
8	0.535	0.455	0.525	0.544	0.461	0.455	0.452	0.475	0.475		0.421	0.640	0.473	0.510	0.493	0.482	0.527	0.455	0.502
9	0.614	0.543	0.607	0.622		0.490	0.490	0.483	0.477		0.345			0.539	0.514	0.538	0.576	0.543	0.570
10	0.592	0.463	0.592	0.600		0.485	0.485	0.565	0.423		0.368	0.508		0.527	0.649	0.538	0.549	0.463	0.558
11	0.616		0.615	0.598		0.513	0.513	0.532	0.403		0.391			0.597	0.661	0.561	0.534		0.574
12	0.746	0.532	0.745	0.745		0.537	0.537		0.546		0.407			0.563		0.610	0.575	0.532	0.670
13	0.633		0.643	0.659		0.556	0.556		0.540					0.433	0.433	0.575			0.597
14	0.680		0.854	0.750		0.598	0.598	0.628	0.570		0.457			0.628	0.628	0.623			0.639
15	0.609		0.622	0.609					0.542		0.457					0.670			0.637

Quarter 2

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0																			
1	0.091	0.091	0.091	0.196	0.187	0.133	0.160	0.126	0.138		0.126	0.133	0.133	0.138	0.138	0.168	0.168	0.091	0.179
2	0.258	0.258	0.258	0.268	0.304	0.154	0.204	0.189	0.174		0.190	0.154	0.154	0.188	0.190	0.163	0.173	0.258	0.169
3	0.336	0.336	0.336	0.290	0.319	0.207	0.261	0.235	0.261	0.260	0.244	0.207	0.207	0.274	0.289	0.219	0.218	0.336	0.257
4	0.378	0.378	0.378	0.331	0.428	0.281	0.296	0.297	0.305	0.318	0.298	0.281	0.281	0.311	0.312	0.271	0.263	0.378	0.309
5	0.410	0.410	0.410	0.330	0.326	0.288	0.387	0.334	0.338	0.349	0.365	0.288	0.288	0.342	0.342	0.331	0.310	0.410	0.345
6	0.465	0.465	0.465	0.328	0.436	0.282	0.405	0.369	0.376	0.411	0.355	0.282	0.282	0.379	0.379	0.362	0.350	0.465	0.382
7	0.438	0.438	0.438	0.334	0.447	0.416	0.424	0.393	0.425	0.447	0.408	0.416	0.416	0.446	0.450	0.412	0.386	0.438	0.431
8	0.455	0.455	0.455	0.402	0.488	0.504	0.455	0.411	0.439	0.490	0.424	0.504	0.504	0.459	0.455	0.495	0.534	0.455	0.461
9	0.543	0.543	0.543	0.289	0.507	0.474	0.491	0.456	0.497	0.507	0.404	0.474	0.474	0.512	0.505	0.521	0.597	0.543	0.510
10	0.463	0.463	0.463	0.388	0.494	0.583	0.485	0.485	0.483	0.494		0.583	0.583	0.482	0.480	0.482	0.482	0.463	0.483
11					0.570	0.372	0.509	0.390	0.430	0.570		0.372	0.372	0.440	0.478				0.460
12	0.532	0.532	0.532	0.533	0.567		0.528	0.551	0.516	0.567				0.512	0.473			0.532	0.527
13				0.868	0.630	0.706	0.537	0.536	0.552	0.630		0.706	0.706	0.555	0.571	0.928	0.928		0.772
14					0.559		0.582	0.575	0.556	0.559				0.546	0.537				0.555
15				0.781	0.736			0.535	0.582	0.736				0.606	0.583				0.600

Table 3.2.1.2.1 Continued

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0										0.101									0.101
1			0.178	0.196	0.188	0.133	0.154	0.172		0.220	0.172	0.133	0.156			0.146	0.146	0.091	0.187
2	0.317	0.291	0.297	0.268	0.301	0.154	0.197	0.246	0.247	0.282	0.223	0.154	0.201	0.247		0.195	0.195	0.258	0.283
3	0.372	0.389	0.360	0.288	0.320	0.207	0.253	0.311	0.311	0.302	0.269	0.207	0.207	0.311		0.218	0.234	0.336	0.366
4	0.433	0.403	0.418	0.328	0.426	0.281	0.286	0.361	0.362	0.348	0.312	0.281	0.254	0.362		0.307	0.261	0.378	0.405
5	0.480	0.458	0.460	0.328	0.335	0.288	0.361	0.284		0.402	0.285	0.288	0.288			0.292	0.292	0.410	0.455
6	0.525	0.530	0.509	0.325	0.436	0.282	0.383	0.297		0.448	0.294	0.282	0.237			0.355	0.355	0.465	0.509
7	0.560	0.540	0.553	0.330	0.440	0.416	0.412	0.458		0.475	0.437	0.416	0.416			0.378	0.378	0.438	0.549
8	0.605	0.565	0.596	0.402	0.461	0.504	0.458	0.551	0.551	0.532	0.396	0.504	0.504	0.551		0.392	0.392	0.455	0.588
9	0.602	0.601	0.602	0.280		0.474	0.503	0.422		0.531	0.449	0.474	0.474			0.504	0.504	0.543	0.599
10	0.641	0.631	0.632	0.386		0.583	0.503			0.548	0.583	0.583	0.583			0.464	0.464	0.463	0.629
11	0.665	0.632	0.664			0.372	0.532			0.642	0.372	0.372	0.372						0.658
12	0.704	0.754	0.704				0.556			0.663								0.532	0.714
13	0.800	0.713	0.746			0.706	0.571	0.531		0.666	0.610	0.706	0.706			0.484	0.484		0.743
14	0.819	0.824	0.819				0.620			0.559									0.820
15	0.787	0.790	0.787							0.652									0.788

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0							0.116				0.080					0.101			0.092
1			0.178		0.190	0.173	0.182	0.206		0.221	0.182	0.166	0.168	0.206		0.132			0.186
2	0.275	0.310	0.299		0.285	0.226	0.211	0.275	0.268	0.287	0.229	0.269	0.224	0.275		0.263			0.252
3	0.366	0.364	0.362	0.299	0.326		0.238	0.302	0.317	0.337	0.274	0.283		0.302		0.296		0.299	0.336
4	0.461	0.413	0.408	0.372	0.396	0.298	0.253	0.355	0.334	0.358	0.279	0.357	0.240	0.355		0.344		0.372	0.389
5	0.514	0.455	0.456	0.441	0.390		0.323	0.435	0.375	0.331	0.288	0.331		0.435		0.399		0.441	0.441
6	0.564	0.507	0.488	0.499	0.440		0.346	0.456		0.457	0.336		0.214	0.456		0.436		0.499	0.480
7	0.583	0.550	0.539	0.541	0.440		0.380	0.464			0.358			0.464		0.480		0.541	0.535
8	0.676	0.592	0.566	0.567	0.461		0.393	0.458			0.423	0.403		0.458		0.550		0.567	0.566
9	0.572	0.598	0.576	0.627			0.509				0.302	0.296				0.538		0.627	0.572
10	0.625	0.630	0.629	0.664			0.523	0.631			0.525			0.631		0.606		0.664	0.628
11	0.662	0.663	0.650				0.550				0.521					0.683			0.653
12	0.749	0.710	0.682	0.683			0.545									0.667		0.683	0.682
13	0.734	0.715	0.718	0.868			0.558				0.621					0.750		0.868	0.721
14	0.755	0.814	0.740				0.597												0.741
15	0.778	0.787	0.774	0.781			0.609									0.637		0.781	0.769

Table 3.2.1.2.2 Mean length (cm) at age for Western mackerel
Mean Length at Age by Area (cm)

uarters 1 to4

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0							25.61			23.50	22.12					23.50			23.27
1	23.00	23.00	27.31	28.57	28.50	28.53	29.53	29.13	27.43	29.79	28.11	28.38	27.93	29.78	27.50	25.68	27.12	23.00	28.42
2	31.77	31.21	32.13	31.44	31.96	30.11	30.88	31.26	30.06	32.37	30.74	31.72	29.98	31.65	29.79	29.80	29.17	30.30	30.72
3	33.66	33.56	33.52	32.08	33.12	31.10	33.32	32.87	32.87	33.91	32.39	32.39	31.69	33.63	34.65	31.89	32.04	32.92	32.97
4	35.58	34.03	35.06	33.89	35.15	33.78	34.89	33.76	34.55	34.36	33.27	34.52	34.09	35.02	35.37	34.16	34.84	34.49	34.58
5	36.73	35.59	36.22	35.23	35.74	34.76	37.53	36.24	36.20	34.63	33.89	34.41	36.70	36.78	37.21	35.42	36.14	35.94	36.01
6	37.72	37.32	37.19	36.10	36.53	35.02	38.02	37.49	37.75	37.89	34.86	34.20	34.88	38.40	39.01	36.83	37.74	37.01	37.21
7	38.50	37.55	38.27	37.12	37.03	38.01	38.58	38.28	38.73	39.11	36.61	37.89	38.79	39.66	40.11	38.19	39.09	37.67	38.29
8	39.39	38.31	38.97	38.20	36.43	40.19	39.45	41.08	39.60	40.13	37.85	38.64	39.66	39.71	39.68	38.94	40.35	38.58	38.99
9	39.44	39.21	39.73	38.57	40.61	39.39	40.44	39.66	40.09	40.53	35.58	35.12	39.25	40.39	39.98	39.93	41.66	39.79	39.76
10	40.22	39.38	40.20	37.48	41.49	41.24	40.28	41.24	39.73	41.48	37.18	41.45	41.50	40.37	42.16	40.31	40.82	37.18	40.16
11	40.77	40.30	40.73	40.42	42.41	37.57	40.96	38.76	37.78	42.39	38.87	36.50	36.50	39.41	41.83	40.80	40.50		40.64
12	41.77	41.64	41.73	41.30	43.17	41.60	41.55	42.70	40.96	43.06	39.50			41.01	40.83	41.50	41.50	41.46	41.68
13	42.91	41.80	42.14	44.50	44.17	42.48	41.94	42.04	43.45	44.17	41.57	42.50	42.50	43.38	42.19	41.86	47.18	44.50	42.13
14	43.48	43.56	42.76	42.96	41.75	43.06	42.98	42.62	42.48	41.75	41.10			42.31	42.49	41.70			42.62
15	43.25	43.79	42.85	43.10	47.50		43.28	42.50	43.35	46.99	41.10			44.23	43.67	42.45		43.10	43.03

Quarter 1

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0																			
1		23.00			28.57	28.55	28.71		27.43		21.60					25.40		23.00	26.91
2	30.01	30.30	30.08	29.64	31.72	30.55	30.78	29.80	29.52	33.50	28.54	29.20	30.10	30.21	29.80	29.50		30.30	29.70
3	32.61	32.92	32.55	32.70	33.48	33.33	33.51	33.10	32.62		31.13	31.34	32.06	33.72	34.65	31.77	33.30	32.92	32.27
4	34.86	34.49	34.93	34.67	34.52	34.96	35.10	34.80	34.75	36.83	32.96	34.00	35.29	34.92	35.37	34.21	36.40	34.49	34.60
5	36.33	35.90	36.29	36.20	36.50	37.48	37.53	36.40	36.08	37.80	34.79	36.12	37.14	37.05	37.23	35.36	36.90	35.90	36.10
6	37.69	36.78	37.54	37.44	37.37	38.04	38.00	37.80	37.60	38.00	34.35	35.75	38.30	38.62	39.03	36.90	38.20	36.78	37.42
7	38.72	37.17	38.58	38.41	36.50	38.60	38.55	38.40	38.51	40.17	36.58	37.00	38.92	39.83	40.12	38.25	39.40	37.17	38.54
8	39.64	37.48	39.41	39.54	36.00	39.46	39.43	39.20	38.78		38.25	41.50	39.63	39.31	39.65	38.79	40.30	37.48	39.11
9	41.44	39.32	41.18	41.24		40.43	40.43	39.30	39.39		37.30			40.00	39.87	40.01	41.50	39.32	40.58
10	40.92	36.00	41.02	40.99		40.28	40.28	41.20	38.04		37.05	39.50		39.97	42.26	40.25	40.80	36.00	40.51
11	41.41		41.42	40.42		40.98	40.98	40.50	37.27		39.00			41.23	42.14	40.73	40.50		40.87
12	43.86	41.50	43.82	43.49		41.60	41.60		39.92		39.50			40.29		41.50	41.50	41.50	42.58
13	41.83		42.29	42.10		42.04	42.04		43.50					38.50	38.50	40.96			41.59
14	42.86		46.34	42.96		43.06	43.06	42.50	42.50		41.10			42.50	42.50	41.70			42.56
15	41.30		41.47	41.30					39.85		41.10					42.72			41.88

Quarter 2

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0																			
1	23.00	23.00	23.00	28.57	28.30	26.50	28.53	25.33	27.50		25.30	26.47	26.50	27.50	27.50	28.30	28.30	23.00	28.04
2	30.30	30.30	30.30	31.44	32.51	28.60	30.69	28.99	28.84		29.00	28.60	28.60	29.18	29.23	28.81	29.16	30.30	28.94
3	32.92	32.92	32.92	32.11	32.83	31.01	33.17	32.05	33.05	32.83	31.50	31.01	31.01	33.38	33.78	31.39	31.36	32.92	32.18
4	34.49	34.49	34.49	33.72	35.65	33.70	34.46	34.56	35.24	34.86	33.70	33.70	33.70	35.38	35.41	33.78	33.56	34.49	34.47
5	35.90	35.90	35.90	34.83	33.81	34.26	37.54	36.38	36.31	36.23	36.00	34.26	34.26	36.25	36.25	35.71	34.71	35.90	36.11
6	36.78	36.78	36.78	35.16	36.53	34.17	38.09	37.49	37.87	37.66	35.80	34.17	34.17	37.98	37.98	36.89	36.41	36.78	37.50
7	37.17	37.17	37.17	34.60	38.78	37.90	38.65	38.33	39.02	38.83	37.40	37.90	37.90	39.40	39.48	38.69	37.59	37.17	38.86
8	37.48	37.48	37.48	36.85	39.97	40.50	39.50	38.82	39.46	40.18	37.90	40.50	40.50	39.82	39.76	40.97	41.24	37.48	39.86
9	39.32	39.32	39.32	34.66	40.61	39.25	40.47	39.93	40.69	40.61	37.30	39.25	39.25	40.54	40.61	41.27	42.34	39.32	40.59
10	36.00	36.00	36.00	35.51	41.49	41.50	40.29	41.10	40.76	41.49		41.50	41.50	40.69	40.34	41.20	41.20	36.00	40.37
11					42.41	36.50	40.89	38.20	38.55	42.41		36.50	36.50	38.63	38.96				39.31
12	41.50	41.50	41.50	41.50	43.17		41.39	42.70	41.87	43.17				41.77	40.83			41.50	41.68
13				44.50	44.17	42.50	41.61	42.50	43.29	44.17		42.50	42.50	43.43	44.25	48.50	48.50		45.78
14					41.75		42.70	43.50	42.30	41.75				41.74	41.17				41.97
15				43.10	47.50			42.50	43.64	47.50				44.23	43.67				44.08

Table 3.2.1.2.2 (continued)

Quarter 3

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0										23.50									23.50
1			27.50	28.57	28.33	26.50	28.04	27.62		29.71	27.62	26.50	27.45			27.10	27.10	23.00	28.28
2	32.80	31.23	32.18	31.44	32.41	28.60	30.41	30.49	30.50	32.20	30.23	28.60	29.53	30.50		29.30	29.30	30.30	31.28
3	33.96	33.64	33.66	32.08	32.86	31.01	32.83	32.72	32.73	33.17	32.07	31.01	31.01	32.73		30.60	30.08	32.92	33.48
4	35.59	33.96	35.08	33.66	35.60	33.70	34.13	33.50	33.50	34.05	33.67	33.70	32.90	33.50		33.63	31.87	34.49	34.37
5	36.60	35.55	36.09	34.80	34.14	34.26	36.72	32.45		35.68	32.59	34.26	34.26			34.33	34.33	35.90	35.79
6	37.56	37.41	37.15	35.12	36.50	34.17	37.42	32.82		36.79	33.02	34.17	32.39			35.64	35.64	36.78	37.16
7	38.39	37.56	38.12	34.50	36.50	37.90	38.25	38.53		37.75	38.22	37.90	37.90			37.14	37.14	37.17	38.00
8	39.17	38.31	38.89	36.84	36.00	40.50	39.56	41.48	41.50	39.24	36.67	40.50	40.50	41.50		38.33	38.33	37.48	38.84
9	39.20	39.20	39.20	34.50		39.25	40.77	37.50		39.12	38.40	39.25	39.25			41.00	41.00	39.32	39.18
10	40.28	39.80	39.86	35.50		41.50	40.68			40.92	41.50	41.50	41.50			40.50	40.50	36.00	39.82
11	40.70	40.28	40.63			36.50	41.44			41.83	36.50	36.50	36.50						40.57
12	41.60	41.65	41.60				42.05			41.83								41.50	41.61
13	42.95	41.80	42.24			42.50	42.38	40.50		43.91	41.40	42.50	42.50			39.50	39.50		42.21
14	43.50	43.60	43.50				43.53			41.75									43.51
15	43.70	43.80	43.70							41.53									43.71

Quarter 4

Ages	IIIa	IIa	IVa	IVb	IVc	VIIIa	VIIIb	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIa	VIb	Vb	Total
0							25.61				22.12					23.50			23.27
1			27.50		28.54	28.55	29.67	29.90		29.79	28.66	28.50	27.93	29.90		25.32			28.60
2	31.03	32.67	32.56		31.81	30.53	31.11	32.70	32.00	32.37	31.04	32.60	30.00	32.70		32.15			31.38
3	34.00	33.74	33.97	32.20	33.31		32.28	33.60	33.70	33.93	33.14	33.00		33.60		33.26		32.20	33.73
4	36.00	34.92	35.12	34.40	34.83	33.50	32.86	35.20	34.30	34.03	33.38	35.30	32.50	35.20		34.39		34.40	34.87
5	37.00	36.00	36.29	36.10	36.22		35.52	37.30	35.50	34.01	33.68	34.50		37.30		35.60		36.10	36.06
6	38.00	37.00	36.98	37.60	36.57		36.27	37.80		38.00	35.40		31.50	37.80		36.32		37.60	36.87
7	39.00	38.01	38.17	38.50	36.50		37.34	38.00			35.52			38.00		37.49		38.50	38.12
8	39.99	38.78	38.77	39.00	36.00		37.67	37.80			37.09	36.50		37.80		39.00		39.00	38.80
9	39.00	39.19	39.11	40.30			40.89				33.69	33.50				38.70		40.30	39.06
10	39.80	39.80	40.01	41.00			41.24	41.50			40.14			41.50		40.30		41.00	40.03
11	40.50	40.50	40.47				41.90				40.50					41.50			40.55
12	42.00	41.67	41.03	41.30			41.80									41.50		41.30	41.08
13	42.10	41.83	41.90	44.50			42.07				42.90					43.30		44.50	41.98
14	41.60	43.31	41.58				43.01												41.61
15	43.40	43.71	43.20	43.10			43.28									40.50		43.10	43.10

Table 3.2.3.1 Western mackerel. Catch in numbers at age.

Catch in Number

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

x 10 ^ 6

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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
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
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
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
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
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
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
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
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

x 10 ^ 6

Table 3.2.3.2 Western mackerel. Biomass estimates from egg surveys.

INDICES OF SPAWNING BIOMASS

INDEX1

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

x 10 ^ 3

INDEX1

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

x 10 ^ 3

Table 3.2.3.3 Western mackerel. Catch weights at age.

Weights at age in the catches (Kg)

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

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 3.2.3.4 Western mackerel. Stock weights at age.

Weights at age in the stock (Kg)

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

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 3.2.3.5 Western mackerel. Fishing mortality at age.

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.00086	0.00000	0.00041	0.00022	0.00733	0.00226	0.00334	0.01578	0.00388	0.00591	0.00117	0.00000	0.00008	0.00000	0.00057
1	0.00255	0.02134	0.02501	0.01937	0.07424	0.03910	0.04199	0.14205	0.11929	0.06351	0.03720	0.03007	0.01410	0.04587	0.01122
2	0.00687	0.01191	0.01818	0.03580	0.08335	0.09733	0.18614	0.10311	0.26965	0.16696	0.13317	0.16764	0.06684	0.01747	0.06258
3	0.01362	0.04330	0.03540	0.08644	0.14047	0.08786	0.19134	0.29260	0.16715	0.18980	0.22498	0.18476	0.21914	0.05088	0.08051
4	0.07632	0.06457	0.09113	0.10951	0.20959	0.09464	0.18469	0.23646	0.28760	0.09342	0.22130	0.27079	0.22134	0.19945	0.09655
5	0.00000	0.11164	0.13763	0.21822	0.13552	0.08459	0.19749	0.23561	0.27314	0.19563	0.09282	0.22793	0.24827	0.20634	0.14075
6	0.00000	0.13866	0.14337	0.13757	0.19224	0.08533	0.15602	0.25975	0.23114	0.22968	0.21832	0.09697	0.23550	0.24556	0.17481
7	0.00000	0.17846	0.22000	0.49746	0.40374	0.14364	0.11905	0.26984	0.26677	0.23196	0.23009	0.21008	0.09543	0.22009	0.22499
8	0.00000	0.17833	0.21984	0.34858	0.30693	0.20478	0.17192	0.16139	0.24503	0.30295	0.29758	0.21849	0.16629	0.12922	0.22482
9	0.00000	0.13536	0.16687	0.26460	0.16432	0.16373	0.28168	0.31540	0.20349	0.24504	0.36601	0.25434	0.17107	0.18811	0.17066
10	0.00000	0.14499	0.17874	0.28342	0.17600	0.10986	0.32069	0.41308	0.30986	0.30136	0.25227	0.34068	0.19794	0.20100	0.18280
11	0.00000	0.13397	0.16515	0.26187	0.16262	0.10151	0.23699	0.49953	0.48004	0.33476	0.30924	0.30220	0.23138	0.23123	0.16890
12	0.00000	0.13397	0.16515	0.26187	0.16262	0.10151	0.23699	0.49953	0.48004	0.33476	0.30924	0.30220	0.23138	0.23123	0.16890

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.00070	0.00077	0.00106	0.00111	0.00122	0.00144	0.00184	0.00181	0.00167	0.00123	0.00113	0.00120	0.00110
1	0.01387	0.01514	0.02043	0.02136	0.02342	0.02781	0.03555	0.03496	0.03224	0.02374	0.02186	0.02309	0.02118
2	0.07735	0.08441	0.05959	0.06228	0.06831	0.08110	0.10367	0.10195	0.09403	0.06924	0.06375	0.06734	0.06178
3	0.09952	0.10859	0.10464	0.10937	0.11995	0.14241	0.18204	0.17901	0.16510	0.12158	0.11195	0.11824	0.10848
4	0.11935	0.13024	0.14988	0.15665	0.17181	0.20398	0.26075	0.25641	0.23649	0.17414	0.16034	0.16936	0.15539
5	0.17399	0.18985	0.18580	0.19419	0.21299	0.25287	0.32324	0.31786	0.29316	0.21588	0.19877	0.20995	0.19263
6	0.21609	0.23579	0.18318	0.19145	0.20998	0.24929	0.31867	0.31337	0.28902	0.21282	0.19596	0.20699	0.18990
7	0.27812	0.30348	0.21112	0.22066	0.24202	0.28733	0.36729	0.36118	0.33311	0.24529	0.22586	0.23856	0.21888
8	0.27791	0.30325	0.22320	0.23328	0.25586	0.30376	0.38830	0.38184	0.35217	0.25933	0.23878	0.25221	0.23140
9	0.21096	0.23019	0.25866	0.27034	0.29651	0.35202	0.44999	0.44249	0.40811	0.30052	0.27671	0.29228	0.26816
10	0.22596	0.24657	0.23368	0.24423	0.26787	0.31802	0.40653	0.39976	0.36870	0.27150	0.24999	0.26405	0.24226
11	0.20878	0.22782	0.22296	0.23303	0.25559	0.30344	0.38789	0.38143	0.35180	0.25905	0.23853	0.25195	0.23115
12	0.20878	0.22782	0.22296	0.23303	0.25559	0.30344	0.38789	0.38143	0.35180	0.25905	0.23853	0.25195	0.23115

Table 3.2.3.6 The Western mackerel population numbers at age.

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	2004.5	4406.3	3424.4	4882.4	5043.0	954.1	3322.5	5468.1	5427.1	6993.3	1842.8	1361.5	6534.7	3129.3	3154.7
1	5235.0	1723.8	3792.6	2946.2	4201.4	4308.9	819.3	2850.2	4632.7	4653.1	5983.7	1584.3	1171.8	5624.0	2693.4
2	1901.8	4494.3	1452.4	3183.7	2487.2	3357.4	3566.5	676.2	2128.3	3539.0	3758.5	4962.2	1323.2	994.5	4623.6
3	2340.7	1625.7	3822.5	1227.5	2643.9	1969.5	2621.8	2548.3	525.0	1398.9	2577.7	2831.6	3611.8	1065.3	841.1
4	7433.5	1987.4	1339.9	3175.6	969.1	1977.4	1552.6	1863.6	1637.0	382.3	995.9	1771.7	2026.1	2496.9	871.4
5	0.0	5927.9	1603.6	1052.8	2449.8	676.4	1548.3	1111.0	1266.2	1056.8	299.7	687.0	1163.1	1397.6	1760.5
6	0.0	0.0	4563.3	1202.8	728.5	1841.3	534.9	1093.8	755.5	829.4	748.0	235.1	470.8	781.0	978.6
7	0.0	0.0	0.0	3403.0	902.2	517.4	1455.2	393.9	726.1	516.1	567.4	517.5	183.6	320.2	525.9
8	0.0	0.0	0.0	0.0	1781.1	518.6	385.7	1111.9	258.9	478.6	352.2	388.0	361.0	143.7	221.1
9	0.0	0.0	0.0	0.0	0.0	1127.8	363.7	279.6	814.4	174.4	304.3	225.1	268.4	263.1	108.7
10	0.0	0.0	0.0	0.0	0.0	0.0	824.1	236.2	175.5	571.9	117.5	181.6	150.3	194.7	187.6
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	514.7	134.5	110.8	364.2	78.6	111.2	106.1	137.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	324.0	663.8	595.3	519.1	230.0	417.7	415.6

x 10 ^ 6

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	5018.9	3337.2	4364.0	3078.4	3666.5	4400.8	5762.9	4001.5	4186.5	4983.0	3388.6	3634.0	30.4	2694.2
1	2713.7	4316.8	2870.2	3752.1	2646.7	3152.0	3782.3	4951.0	3437.9	3597.4	4283.6	2913.3	3124.1	26.1
2	2292.4	2303.5	3659.7	2420.4	3161.3	2225.3	2638.5	3141.8	4115.0	2865.2	3023.6	3607.2	2450.3	2632.6
3	3738.2	1826.2	1822.2	2967.7	1957.5	2541.3	1766.1	2047.4	2442.1	3223.9	2301.1	2441.7	2902.6	1982.6
4	668.0	2912.7	1410.1	1412.5	2289.7	1494.4	1897.0	1267.1	1473.3	1782.0	2457.2	1770.8	1867.3	2241.4
5	681.0	510.3	2200.9	1044.7	1039.5	1659.6	1048.9	1258.0	843.9	1001.0	1288.7	1801.6	1286.7	1375.9
6	1316.3	492.5	363.2	1573.1	740.5	723.1	1109.3	653.4	787.9	541.8	694.3	909.2	1257.0	913.4
7	707.2	912.8	334.9	260.3	1118.1	516.6	485.0	694.2	411.1	507.9	376.9	491.3	636.3	894.8
8	361.4	460.9	580.0	233.4	179.7	755.5	333.6	289.1	416.4	253.6	342.1	258.8	333.1	440.0
9	152.0	235.6	292.9	399.4	159.1	119.7	479.9	194.7	169.9	252.0	168.4	231.9	173.1	227.5
10	78.9	106.0	161.1	194.7	262.3	101.8	72.5	263.4	107.7	97.2	160.6	109.9	149.0	114.0
11	134.5	54.1	71.3	109.8	131.2	172.7	63.7	41.5	152.0	64.1	63.8	107.7	72.7	100.7
12	346.4	276.3	187.0	139.3	249.3	276.7	218.6	190.5	132.3	136.2	115.7	93.2	149.0	151.4

x 10 ^ 6

Table 3.2.3.7a Western mackerel. Diagnostic output.

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-----------------------------------------------------------------
No of years for separable analysis : 14
Age range in the analysis : 0  . . . 12
Year range in the analysis : 1972  . . . 1999
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 60
Number of observations : 176

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

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

PARAMETER ESTIMATES

|Parm.|      | Maximum |    |        |         |         |         ³ Mean of |
| No. |      | Likelh. | CV |  Lower | Upper   |  -s.e.  |   +s.e. ³ Param.  |
|     |      | Estimate| (%)| 95% CL | 95% CL  |         |         ³ Distrib.|
Separable model : F by year
   1   1986     0.1407  15    0.1031    0.1922    0.1201    0.1650    0.1425
   2   1987     0.1740  15    0.1294    0.2340    0.1496    0.2024    0.1760
   3   1988     0.1898  14    0.1432    0.2517    0.1644    0.2192    0.1918
   4   1989     0.1858  11    0.1488    0.2320    0.1659    0.2081    0.1870
   5   1990     0.1942  11    0.1558    0.2420    0.1736    0.2173    0.1954
   6   1991     0.2130  11    0.1715    0.2645    0.1907    0.2379    0.2143
   7   1992     0.2529  10    0.2040    0.3134    0.2266    0.2821    0.2544
   8   1993     0.3232  10    0.2606    0.4009    0.2896    0.3608    0.3252
   9   1994     0.3179  11    0.2541    0.3976    0.2835    0.3563    0.3199
  10   1995     0.2932  12    0.2303    0.3732    0.2592    0.3316    0.2954
  11   1996     0.2159  13    0.1664    0.2801    0.1890    0.2466    0.2178
  12   1997     0.1988  14    0.1505    0.2626    0.1724    0.2291    0.2008
  13   1998     0.2100  15    0.1536    0.2869    0.1790    0.2462    0.2126
  14   1999     0.1926  18    0.1343    0.2764    0.1602    0.2316    0.1959

Separable Model: Selection (S1) by age 1986 1988
  15      0     0.0041 145    0.0002    0.0708    0.0009    0.0174    0.0118
  16      1     0.0797  20    0.0535    0.1189    0.0650    0.0977    0.0814
  17      2     0.4446  20    0.2999    0.6590    0.3637    0.5435    0.4537
  18      3     0.5720  20    0.3859    0.8477    0.4680    0.6991    0.5836
  19      4     0.6860  20    0.4629    1.0167    0.5612    0.8385    0.7000
          5     1.0000     Fixed : Reference Age
  20      6     1.2420  19    0.8410    1.8342    1.0180    1.5153    1.2668
  21      7     1.5985  19    1.0860    2.3528    1.3124    1.9470    1.6299
  22      8     1.5973  19    1.0837    2.3545    1.3105    1.9470    1.6289
  23      9     1.2125  19    0.8242    1.7837    0.9958    1.4764    1.2362
  24     10     1.2987  19    0.8868    1.9020    1.0690    1.5778    1.3236
         11     1.2000     Fixed : Last true age
```

Table 3.2.3.7b Western mackerel. Diagnostic output.

Separable Model: Selection (S2) by age from 1989 to 1999

25	0	0.0057	80	0.0012	0.0275	0.0026	0.0127	0.0079
26	1	0.1100	12	0.0864	0.1400	0.0972	0.1244	0.1108
27	2	0.3207	11	0.2554	0.4027	0.2856	0.3602	0.3229
28	3	0.5632	11	0.4525	0.7010	0.5037	0.6297	0.5667
29	4	0.8067	10	0.6524	0.9974	0.7239	0.8989	0.8114
	5	1.0000		Fixed : Reference Age				
30	6	0.9859	10	0.8073	1.2040	0.8903	1.0917	0.9910
31	7	1.1363	9	0.9369	1.3781	1.0298	1.2538	1.1418
32	8	1.2013	9	0.9982	1.4457	1.0929	1.3203	1.2066
33	9	1.3921	9	1.1643	1.6644	1.2708	1.5250	1.3979
34	10	1.2577	9	1.0454	1.5130	1.1445	1.3820	1.2633
	11	1.2000		Fixed : Last true age				

Separable model: Populations in year 1999

35	0	30383	264	169	5455036	2150	429255	1012605
36	1	3124087	32	1639532	5952869	2248352	4340921	3297762
37	2	2450251	24	1505081	3988975	1910845	3141924	2527176
38	3	2902581	19	1962029	4294013	2376892	3544536	2961103
39	4	1867251	17	1323863	2633676	1566747	2225392	1896218
40	5	1286691	16	929704	1780753	1090108	1518724	1304498
41	6	1257003	15	924825	1708492	1074825	1470058	1272505
42	7	636252	15	468393	864267	544205	743868	644068
43	8	333084	16	242939	456678	283548	391274	337430
44	9	173123	16	124901	239963	146560	204502	175542
45	10	149010	17	105524	210415	124955	177695	151337
46	11	72649	18	50466	104584	60325	87491	73915

Separable model: Populations at age

47	1986	137049	28	77698	241738	102595	183073	142916
48	1987	134527	23	85453	211782	106723	169574	138181
49	1988	54147	20	36314	80738	44163	66389	55284
50	1989	71268	18	49479	102652	59162	85852	72514
51	1990	109756	16	79311	151887	92991	129543	111274
52	1991	131248	15	96673	178188	112291	153405	132854
53	1992	172713	14	129756	229892	149265	199845	174561
54	1993	63740	14	48232	84233	55289	73482	64388
55	1994	41545	14	31254	55223	35930	48038	41985
56	1995	151989	15	112429	205470	130319	177263	153798
57	1996	64102	16	46808	87787	54601	75257	64933
58	1997	63780	16	46312	87838	54171	75094	64636
59	1998	107656	16	77360	149818	90952	127428	109197

SSB Index catchabilities
INDEX1
Linear model fitted. Slopes at age :

60	1	Q	1.092	5	1.040	1.269	1.092	1.209	1.151

Table 3.2.3.7c Western mackerel. Diagnostic output.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	2.383	-0.277	-2.106	1.739	0.525	0.167	-1.230	0.286	-2.664	-0.555	0.220	0.831	0.683	0.000
1	-0.083	-0.415	0.497	-0.230	0.388	-0.189	-0.069	-0.068	-0.090	-0.313	0.147	0.338	0.096	-0.007
2	0.423	-0.066	-0.309	0.444	0.399	0.044	-0.066	-0.175	-0.275	-0.024	-0.118	-0.073	-0.054	-0.106
3	-0.704	0.686	0.004	0.189	0.356	-0.054	0.102	-0.035	-0.037	-0.044	-0.060	0.026	-0.041	-0.328
4	-0.159	-0.297	0.423	-0.111	0.074	0.076	0.017	-0.046	-0.023	-0.074	-0.004	0.042	0.197	-0.093
5	0.434	-0.244	-0.211	0.026	-0.121	-0.021	-0.147	-0.119	-0.097	-0.095	-0.055	0.059	0.075	0.174
6	0.283	-0.003	-0.213	-0.209	-0.031	-0.044	0.027	-0.132	0.073	0.034	-0.058	0.110	0.194	0.022
7	0.192	-0.073	-0.217	-0.094	-0.167	-0.152	-0.072	0.046	-0.066	0.221	0.068	0.091	0.141	0.168
8	-0.079	0.026	-0.008	-0.022	-0.005	0.275	-0.308	-0.046	0.190	-0.080	-0.084	-0.108	0.242	0.181
9	-0.357	0.203	0.135	0.069	-0.097	0.099	0.418	-0.310	0.175	0.208	-0.128	-0.088	-0.237	0.151
10	-0.020	0.190	-0.113	0.005	-0.221	0.168	0.319	0.503	-0.361	0.251	0.065	-0.322	-0.092	-0.132
11	0.019	0.045	0.181	0.023	-0.291	0.058	-0.058	0.387	0.467	-0.163	0.171	-0.020	-0.428	0.002

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.1402	*******	*******	0.0711	*******	*******	0.0004	*******	*******	-0.1532	*******	*******	-0.0606	*******	*******

INDEX1

	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.0101	*******	*******	-0.0632	*******	*******	0.0756	*******

Table 3.2.3.7d Western mackerel. Diagnostic output.

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1986 to 1999	
Variance	0.0646
Skewness test stat.	2.0284
Kurtosis test statistic	2.6343
Partial chi-square	0.6368
Significance in fit	0.0000
Degrees of freedom	**

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Linear catchability relationship assumed

Variance	0.0440
Skewness test stat.	-0.1113
Kurtosis test statistic	-0.4877
Partial chi-square	0.0209
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	30.5855	176	60	116	0.2637
Catches at age	30.5239	168	59	109	0.2800
SSB Indices					
INDEX1	0.0617	8	1	7	0.0088

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.5789	176	60	116	0.0740
Catches at age	7.0374	168	59	109	0.0646
SSB Indices					
INDEX1	1.5416	8	1	7	0.2202

Table 3.2.3.8 Western mackerel. Stock summary.

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1972	2004490	4135899	3084362	170775	0.0554	0.0153	76
1973	4406320	4039602	3185217	219445	0.0689	0.1343	68
1974	3424400	4154657	3210690	298054	0.0928	0.1624	72
1975	4882390	4051261	2958742	491380	0.1661	0.2623	56
1976	5043040	3667739	2602981	507178	0.1948	0.2496	74
1977	954060	3565920	2586187	325974	0.1260	0.1226	85
1978	3322510	3548524	2767595	503913	0.1821	0.1658	80
1979	5468070	3252449	2435808	605744	0.2487	0.2326	78
1980	5427110	3024820	2071983	604761	0.2919	0.2607	75
1981	6993320	3110125	2160194	661762	0.3063	0.2107	94
1982	1842820	3006628	2051327	623819	0.3041	0.2120	89
1983	1361490	3160769	2296930	614287	0.2674	0.2049	90
1984	6534740	2939002	2294666	550929	0.2401	0.1934	97
1985	3129260	3082622	2267176	561292	0.2476	0.2001	100
1986	3154660	3100521	2294141	537615	0.2343	0.1724	100
1987	5018910	3073510	2347269	615380	0.2622	0.2131	97
1988	3337240	3315909	2473429	628000	0.2539	0.2325	100
1989	4363990	3343189	2490181	567400	0.2279	0.1906	99
1990	3078380	3113030	2337382	605937	0.2592	0.1992	100
1991	3666520	3504577	2675854	646169	0.2415	0.2185	98
1992	4400790	3639643	2709764	742305	0.2739	0.2594	99
1993	5762860	3471194	2473949	805039	0.3254	0.3317	100
1994	4001520	3272975	2243554	795723	0.3547	0.3261	99
1995	4186540	3380779	2408822	728742	0.3025	0.3008	100
1996	4982990	3236141	2413456	529464	0.2194	0.2215	100
1997	3388590	3418578	2492676	528835	0.2122	0.2039	99
1998	3634020	3336278	2504015	623411	0.2490	0.2154	100
1999	30380	3602567	2739284	565132	0.2063	0.1976	100

Table 3.2.3.9 Input parameters of the final ICA assessments of Western Mackerel for the years 1997-2000.

Assessment year	**2000**	**1999**	**1998 ###**	**1997**
First data year	1972	1972	1972	1972
Final data year	1999	1998	1997	1996
No of years for separable constraint ?	14	13	-	11
Constant selection pattern model (Y/N)	S1(86-88); S2(89-99)	S1(86-88); S2(89-98)	-	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
Reference age for separable constraint	5	5	-	5
First age for calculation of reference F	4	4	-	4
Last age for calculation of reference F	8	8	-	8
Shrink the final populations	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
	Abundance index	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
Survey indices weighting	Egg surveys	5.0	5.0	-	1.0
Stock recruitment relationship fitted?		No	No	-	No
Parameters to be estimated		60	58	-	53
Number of observations		176	164	-	139

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

Table 3.3. 2.1 SOUTHERN MACKEREL. CPUE at age from surveys. The units for the Spanish surveys are numbers at age per half an hour and for the Portuguese surveys are numbers at age per hour.

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

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

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

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

* DIFFERENT SHIP

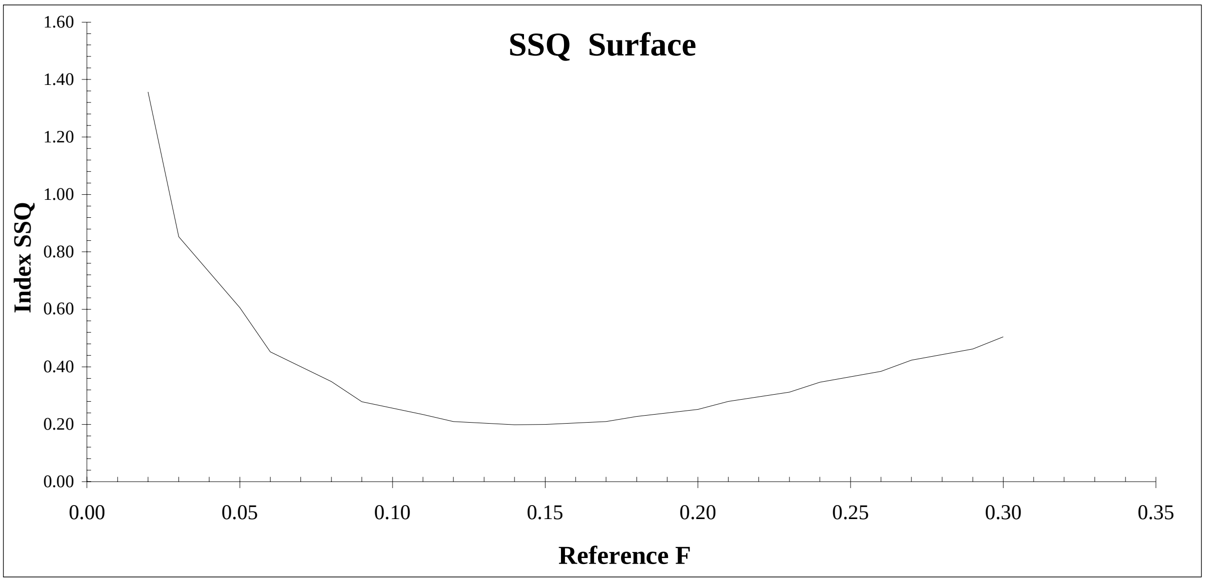


Figure 3.2.3.1 **The sum of squares surface for the ICA separable VPA fit to the Western mackerel egg survey biomass estimates (1977-1998).**

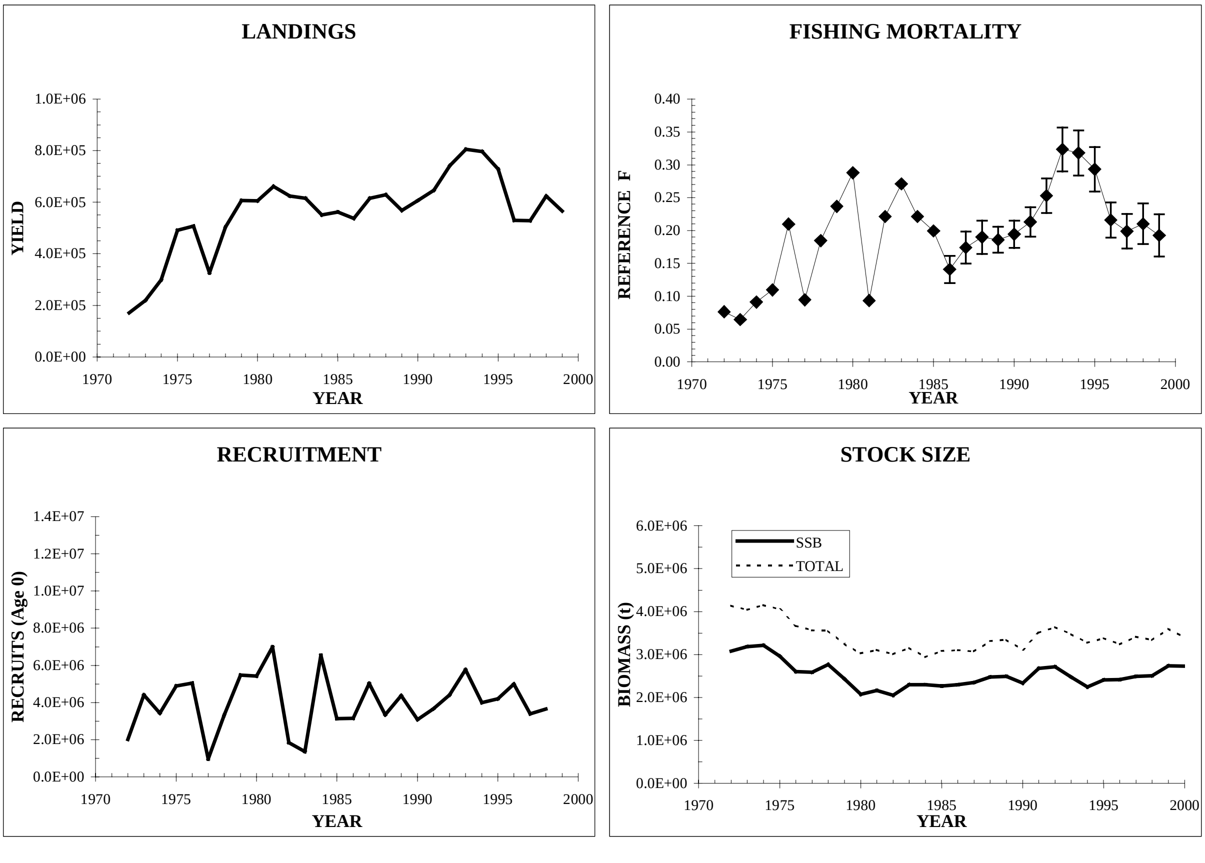


Figure 3.2.3.2 **The long term trends in stock parameters for Western mackerel.**
SSB estimates from egg surveys covering the range 1977-1998 are used in the biomass index.

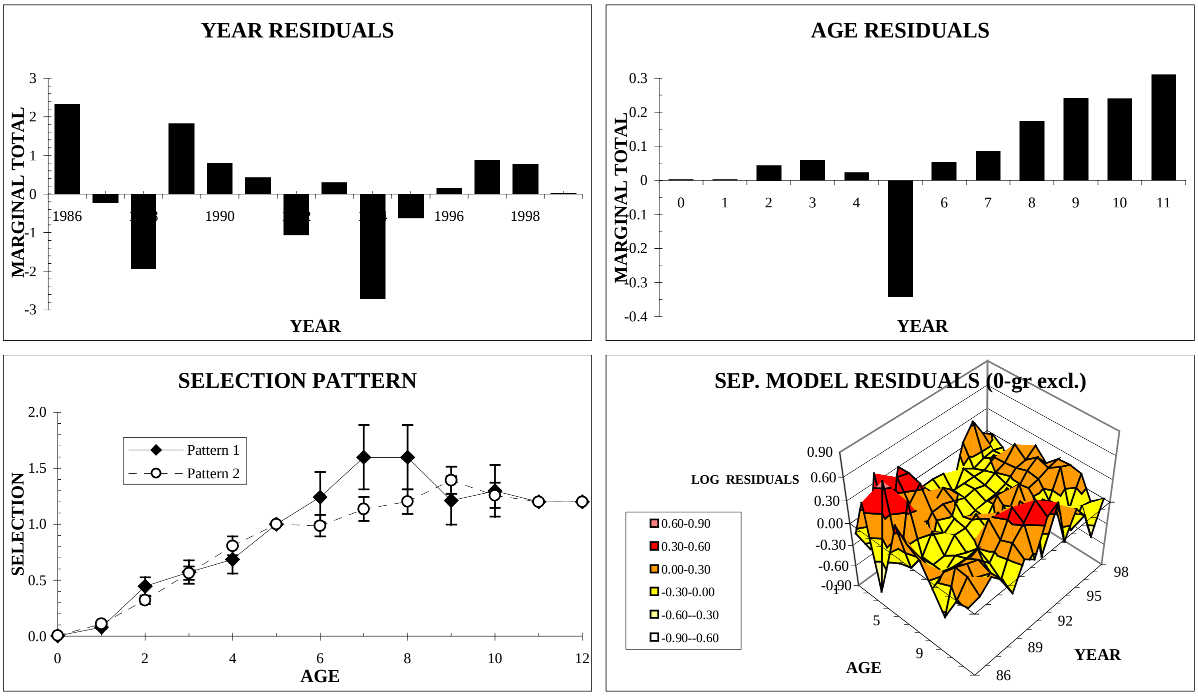


Figure 3.2.3.3 **The catch at age residuals and ages fitted by ICA to the Western mackerel data. SSB estimates from egg surveys covering the range 1977-1998 are used in the biomass index and there is two periods of separable constraint (1986-1988;1989-1999).**

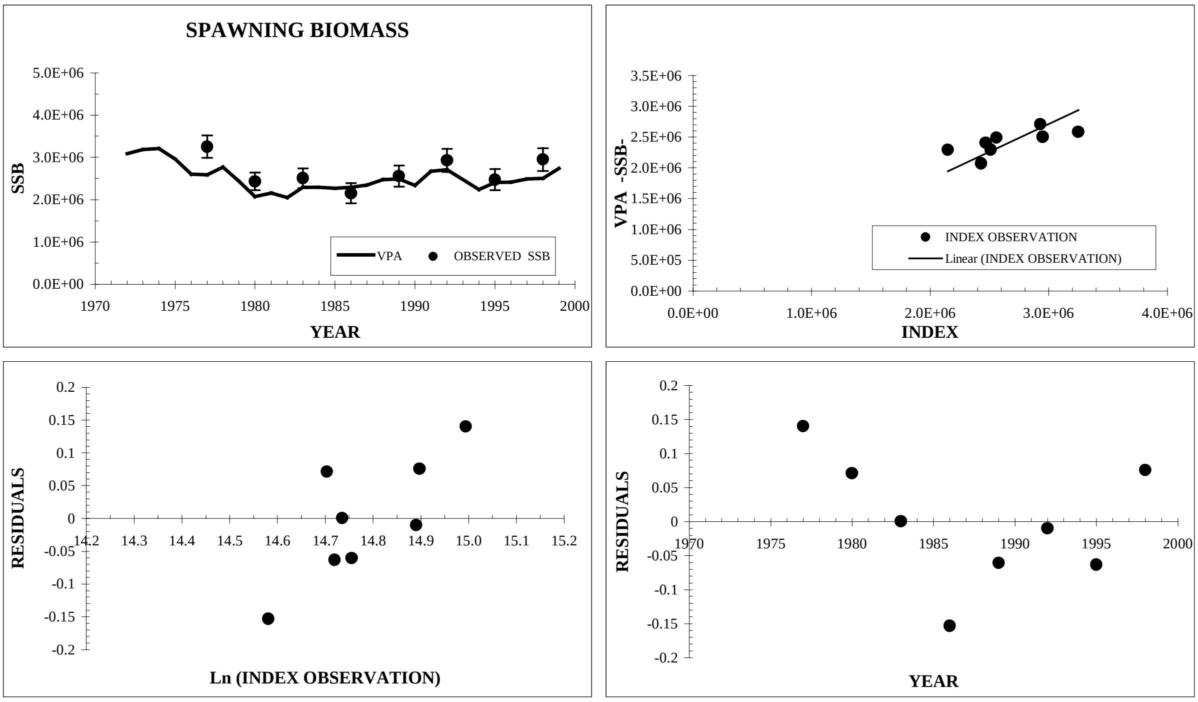


Figure 3.2.3.4 **The diagnostics for the egg production index as fitted by ICA to the Western mackerel. Only SSB estimates from egg surveys covering the range 1977-1998 in the biomass index and there is two periods of separable**

4 HORSE MACKEREL

4.1 Fisheries in 1999

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 1999 was 363,000 t which is 35,500 t less than in 1998. Ireland, Denmark and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have a directed trawl and purse seine fishery.

The quarterly catches of horse mackerel by Division and Sub-division in 1999 are given in Table 4.1.2. The distribution of the fisheries in 1999 are given in Figure 4.1.1.a–d. The figures are based on data provided by Denmark, England and Wales, Scotland, Ireland, Northern Ireland, Faroese Isles, Germany, Denmark, Netherlands, Norway, Portugal and Spain covering 92 % of the total catches.

First quarter: 106,900 t. This is approximately the same as in 1998. The catches this quarter (Figure 4.1.1.a) are mainly distributed in the western and southern areas as in previous years.

Second quarter: 46,800 t. This is 23,000 t less than in 1998. 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). For the first time catches have been reported east and north east of the Faroe Islands.

Third quarter: 43,800 t. This is 24,000 t less than in 1998, and the catches were distributed as in previous years (Figure 4.1.1.c). The fishery has never been reported as far north as in 1999. The fishery in this area was carried out by the Faroese fleet in the second and third quarter. This is the first year they are reporting catches by statistical rectangles to the working group. However, they have fished horse mackerel in these areas for some of the later years.

Fourth quarter: 165,700 t. This is the quarter when relatively large catches have been taken in Division IVa since 1987. The catches increased by 7,000 t since 1998 and the distribution of the catches were as in previous years (Figure 4.1.1.d).

4.2 Stock Units

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

4.3 Allocation of Catches to Stocks

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

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. It seems strange that only catches from western part of Division IIIa are allocated to this stock. The reason for this is that the catches in the western part of this Division taken in the fourth quarter usually are taken in neighbouring area of catches of western fish in Division IVa. In 1999 there were no information about where and when the Swedish catches were taken in Division IIIa (1957 t). The Working group therefore decided as in most years to allocate the total catches of Division IIIa to the western stock.

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

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId. All catches in Division IIIa in 1999 (2,095 t) were allocated to the western stock.

Southern stock: Divisions VIIIc and Ixa. All catches from thse aeas 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 have provided data about discard and the amount of discards given in Table 4.3.1 are therefore not representative for the total fishery.

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 2000/ACFM: 5), 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 Subdivision VIIIc East , the total catch of *T. mediterraneus* was 2692 t in 1999, 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 1986-1999 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 eleven 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), 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 the 1999 annual length composition by fleet. These length distributions cover 89 % of the total landings and are shown in Table 4.6.1.

4.7 Fecundity of horse mackerel

Horse mackerel is a batch spawner, which implies that horse mackerel spawn their eggs in several batches during the spawning season. There are two types of batch spawners: determinate and indeterminate spawners. For determinate spawners the fecundity is determined prior to spawning, which implies that in an individual fish the development of vitellogenic oocytes stops prior to spawning. In such case after starting a continuous increase in fecundity there might be a short period of a constant fecundity prior to the onset of spawning. This would be the right period for fecundity estimation and furthermore it would provide an indication that this species is a determinate spawner. For indeterminate spawners the fecundity is not determined prior to spawning, because in an individual fish the development of vitellogenic oocytes even continues after the onset of spawning in which case the potential fecundity can not be estimated. Fecundity estimations both prior to spawning and during spawning would underestimate the fecundity. If fecundity is estimated prior to spawning the fecundity will be underestimated because the eggs from *de novo* vitellogenesis are not taken into account. If fecundity is estimated at a time that no more vitellogenic oocytes develop then fecundity will be underestimated because of the loss of eggs by spawning.

Up to now horse mackerel has been assumed to be a determinate spawner.

In 1998 the horse mackerel fecundity was estimated much lower compared to earlier years (ICES, 1999/G:5). This was expected be due to exceptional early spawning in 1998 and it was assumed that spawning fish had been used for the fecundity estimation. An important fact is that horse mackerel spawning can not easily be recognised in histological slides of the ovaries as having spawned in the current season. This is caused by the long time interval between two batches of spawning. It is that long that the post-ovulatory-follicles (POF's) can have disappeared before other stages of spawning activity (migrating nucleus stage, hyaline oocyte stage) appear. Therefore, fecundity sampling should be carried out before any spawning takes place, because as soon as spawning starts individual fish can not be identified any more as not having spawned yet. If fish have spawned, fecundity will be underestimated, which then will cause spawning stock biomass to be overestimated.

In 2000 a small scale test sampling for fecundity was carried out as a test case for the sampling in 2001, which is the year in which the extensive international egg surveys will be carried out. The aim was to sample 25 horse mackerel for fecundity every two weeks from January to April 2000 to allow an investigation of the changes in fecundity over time until the start of spawning season and to determine the appropriate time for fecundity sampling.

The sampling for fecundity over the period January to April 2000 shows that the fecundity increases continuously over the whole period of sampling, but also after spawning started in March (Figure 4.7.1). Ovaries, which showed signs of spawning, had still a low fecundity. This is an indication that horse mackerel might be an indeterminate spawner.

The aim of this small-scale fecundity sampling in 2000 was to estimate the most appropriate time for the estimation of the maximum level fecundity before the onset of spawning, but this appears to be impossible with this early spawning of horse mackerel.

The oocyte development rate was estimated to be approximately 10 vitellogenic oocytes/g female/day. The historic estimate of the potential fecundity is 1557 eggs/gramme female, which has been used for the biomass calculation from all egg surveys up to 1998 (ICES, 2000/ACFM:5). If a development rate of 10 vitellogenic oocytes per gramme female per day is applied to this fecundity, it would require just over 5 months of development (5.2 * 30 * 10 = 1560). This would imply that the development of vitellogenic oocytes would stop around the middle of May assuming that the onset of vitelllogenic oocytes development starts in the middle of December. It should be taken into account that the production rate of vitellogenic oocytes might increase with increasing temperatures. Based on this development rate the historic estimate of 1557 eggs per gramme female does not seem to be a serious underestimate of the potential fecundity. However, in 2001 a lot more effort has to be put in to validate this historic fecundity estimate.

For the egg survey in 2001 fecundity information should be collected in such way that an extrapolated potential fecundity possibly can be calculated. This might be obtained from information on the production rate of vitellogenic oocytes and the duration of the period of vitellogenic oocytes development (oocyte diameter frequency distributions might help in determining at what time there is evidence that vitellogenesis stops). Recommendations concerning the fecundity sampling in 2001 are given in Eltink (WD 2000). A last possibility to discuss the fecundity problems and sampling in 2001 will be in December 2000 at a meeting on egg stageing and fecundity / atresia at CEFAS, Lowestoft, UK.

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[1]					
II + Vb	2,538	2,557					
IV + IIIa	31,295	58,746					
VI	35,073	40,381					
VII	250,656	186,604					
VIII	38,562	47,012					
IX	41,574	27,733					
Total	399,698	363,033					

[1]Preliminary.

Table 4.1.2 Quarterly catches of HORSE MACKEREL by Division and Sub-division in 1999.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	0	188	2,369	2,557
IIIa	0	0	498	1,597	2,095
IVa	627	99	2,029	44,561	47,316
IVbc	100	285	2,704	6,246	9,335
VIId	1	333	599	26,956	27,889
VIa,b	13,243	2,597	13,880	10,661	40,381
VIIa–c,e–k	72,177	29,157	7,677	49,704	158,715
VIIIa,b,d,e	9,512	721	137	12,453	22,824
VIIIc	6,126	6,869	6,225	4,968	24,188
IXa	5,068	6,711	9,825	6,129	27,733
Sum	106,854	46,772	43,761	165,646	363,033

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

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

[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 (1,426 t) included in Western horse mackerel.
[6]Includes 1937 t from Vb
[7]Includes 132 t from Vb

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 1986-1999.

	Divisions	ub-Divisior	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	VIIIab		-	-	-	23	298	2122	1123	649	1573	2271	1175	557	740	1100
		VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592
	VIIIc	VIIIc west	-	-	-	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
		IXa North	-	-	-	0	0	0	0	0	0	0	0	0	0	0
	IXa	IXa C, N &	-	-	-	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0	0	0
	TOTAL		**-**	**-**	**-**	**3926**	**3241**	**7142**	**5927**	**6225**	**4917**	**6856**	**4618**	**3821**	**4495**	**2692**
	IXa		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526.4901	320
	X		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920.048	1472.965	690
T. picturatu	**zorean Area**															
	34.1.1		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344
	Madeira's area															
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**

(-) Not available

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

	England & Wa	gland & Wa	Netherlands	Germany	Norway	Ireland	Spain				Portugal		
cm	Pair trawl	Lines	Pel.trawl	Pel. Trawl	P.seine	Pel. trawl	P.seine	Dem.trawl	Gill net	Hook	Artisan	Trawl	P.seine
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.10
11	0.00	0.00	0.00	0.00	0.00	0.00	2.30	0.01	0.00	0.00	0.00	0.00	2.10
12	0.00	0.00	0.00	0.00	0.00	0.00	9.15	0.01	0.00	0.00	0.00	0.00	4.88
13	0.00	0.00	0.00	0.01	0.00	0.01	12.70	0.19	0.00	0.00	0.00	0.00	2.02
14	0.00	0.00	0.00	0.00	0.00	0.00	10.66	0.81	0.00	0.00	0.00	0.00	0.20
15	0.00	0.00	0.00	0.04	0.00	0.04	7.80	2.75	0.00	0.00	0.00	0.00	0.12
16	0.00	0.00	0.00	0.67	0.00	0.74	4.92	3.06	0.00	0.00	0.00	0.09	0.97
17	0.63	0.00	0.61	2.21	0.00	2.44	5.54	3.01	0.05	0.00	0.00	0.73	1.51
18	3.13	0.00	0.81	2.15	0.00	2.37	4.18	4.30	0.11	0.00	0.00	0.87	1.92
19	6.26	0.00	1.12	3.05	0.00	3.38	2.39	3.02	0.25	0.00	0.00	1.21	7.75
20	6.89	0.00	1.58	3.16	0.00	3.49	1.54	1.63	0.11	0.00	0.00	1.55	11.54
21	3.13	0.00	2.17	2.26	0.00	2.50	1.21	0.95	0.22	0.33	0.00	1.86	11.40
22	20.74	0.00	3.77	3.97	0.00	4.40	1.41	0.82	1.61	4.97	0.00	3.24	17.77
23	22.00	0.00	6.76	5.60	0.00	6.19	2.67	2.91	3.80	11.44	0.00	5.63	16.16
24	17.22	0.00	12.36	7.42	0.00	8.05	7.29	3.21	4.01	12.98	0.00	9.94	8.35
25	1.21	1.61	14.71	9.71	0.00	10.46	8.70	4.21	9.28	5.59	0.00	12.04	4.91
26	1.83	0.00	13.98	9.47	0.00	9.85	5.58	4.85	9.37	4.82	0.00	11.49	3.46
27	0.45	10.75	12.74	10.69	0.00	10.80	3.62	5.81	7.79	7.12	0.00	10.81	2.10
28	1.04	15.05	9.30	10.20	0.08	10.16	2.10	7.05	7.83	7.78	0.08	8.28	0.81
29	1.37	22.04	6.98	7.30	0.31	7.13	1.55	9.10	7.95	9.56	0.31	6.18	0.57
30	1.80	10.75	5.52	6.08	2.19	5.62	1.20	9.50	7.59	13.26	2.19	5.16	0.74
31	1.65	13.98	3.58	4.95	7.99	4.23	1.19	7.47	7.81	10.53	7.99	4.35	0.34
32	2.28	8.06	1.41	3.14	15.11	2.51	0.83	6.78	7.20	4.39	15.11	3.50	0.15
33	2.10	6.99	1.07	2.60	23.10	1.91	0.55	4.00	6.23	3.17	23.10	4.27	0.04
34	2.31	2.69	0.86	1.98	20.67	1.34	0.26	3.04	5.72	1.71	20.67	3.70	0.00
35	1.32	5.38	0.30	1.73	16.52	1.17	0.11	1.81	4.21	0.77	16.52	2.69	0.00
36	1.34	2.69	0.19	0.95	8.93	0.68	0.10	1.48	2.46	1.00	8.93	1.48	0.01
37	0.64	0.00	0.16	0.45	3.21	0.35	0.05	1.88	2.04	0.00	3.21	0.61	0.00
38	0.25	0.00	0.00	0.14	1.33	0.10	0.04	1.45	1.90	0.57	1.33	0.20	0.00
39	0.04	0.00	0.02	0.05	0.55	0.04	0.04	1.90	1.23	0.00	0.55	0.09	0.00
40	0.21	0.00	0.00	0.02	0.00	0.02	0.03	1.29	0.56	0.00	0.00	0.00	0.01
41	0.17	0.00	0.00	0.00	0.00	0.00	0.04	1.05	0.43	0.00	0.00	0.00	0.00
42+	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.64	0.26	0.00	0.00	0.00	0.04
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

0.00=<0.005%

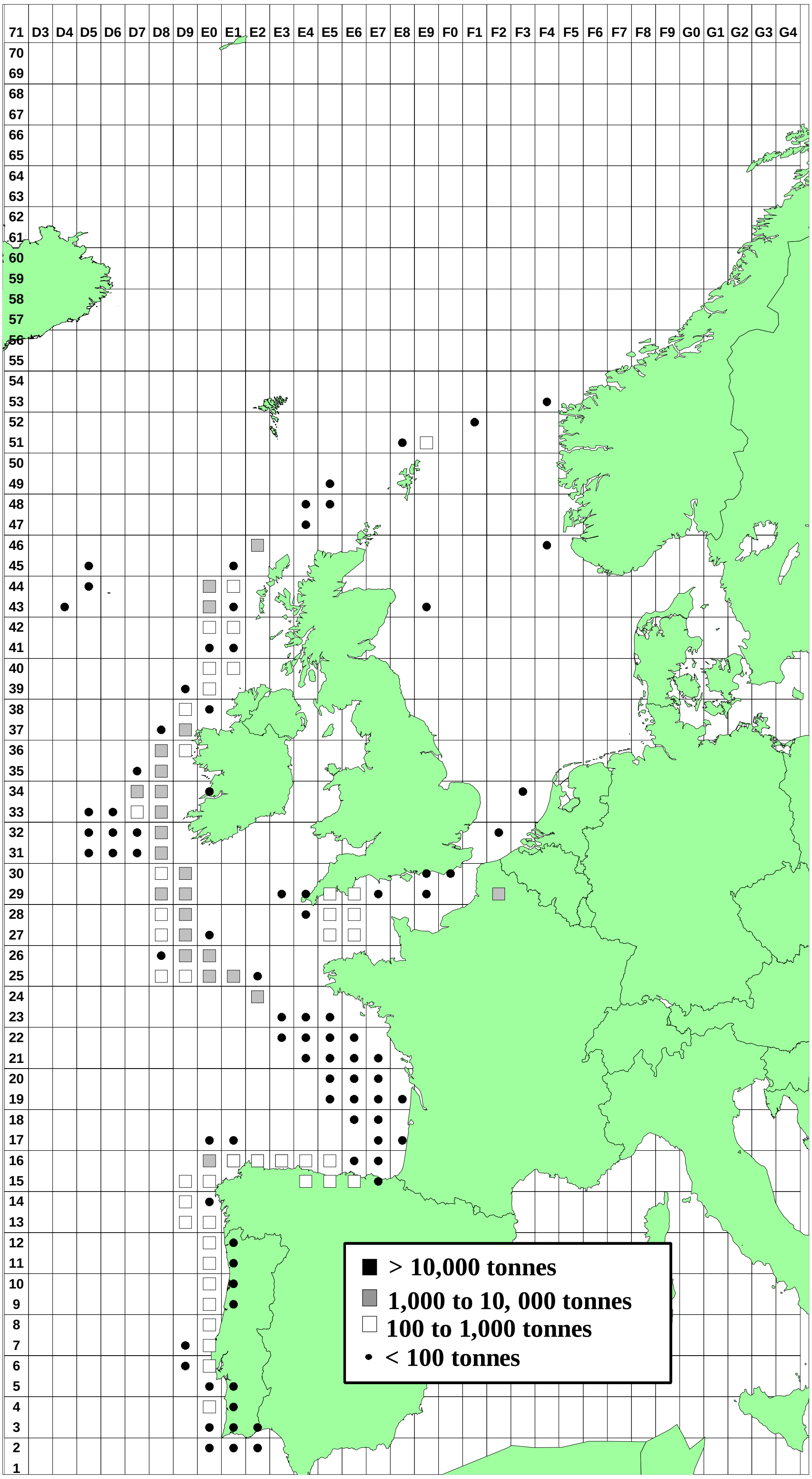


Figure 4.1.1a. Horse Mackerel commercial catches in quarter 1 – 1999

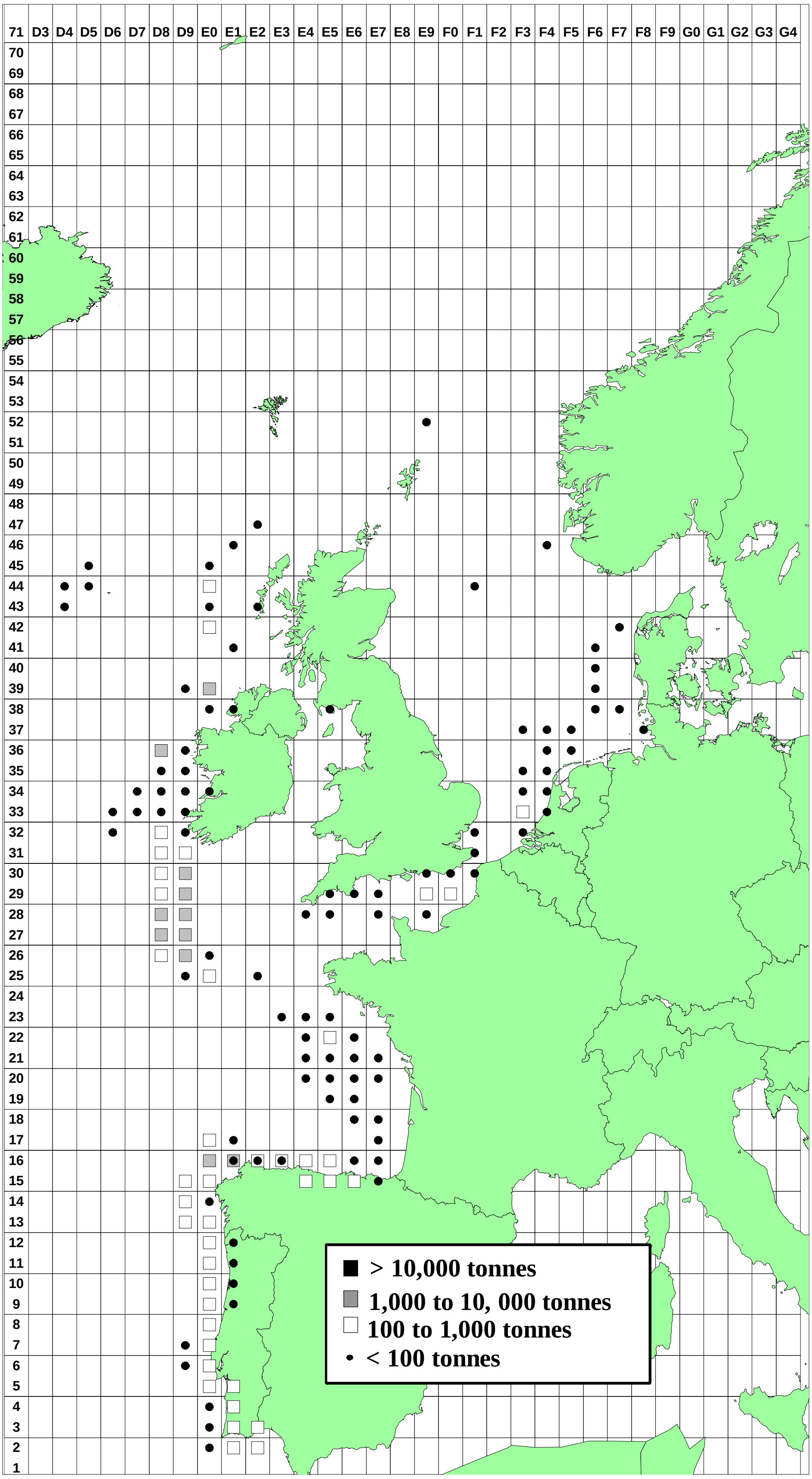


Figure 4.1.1b. Horse Mackerel commercial catches in quarter 2 – 1999

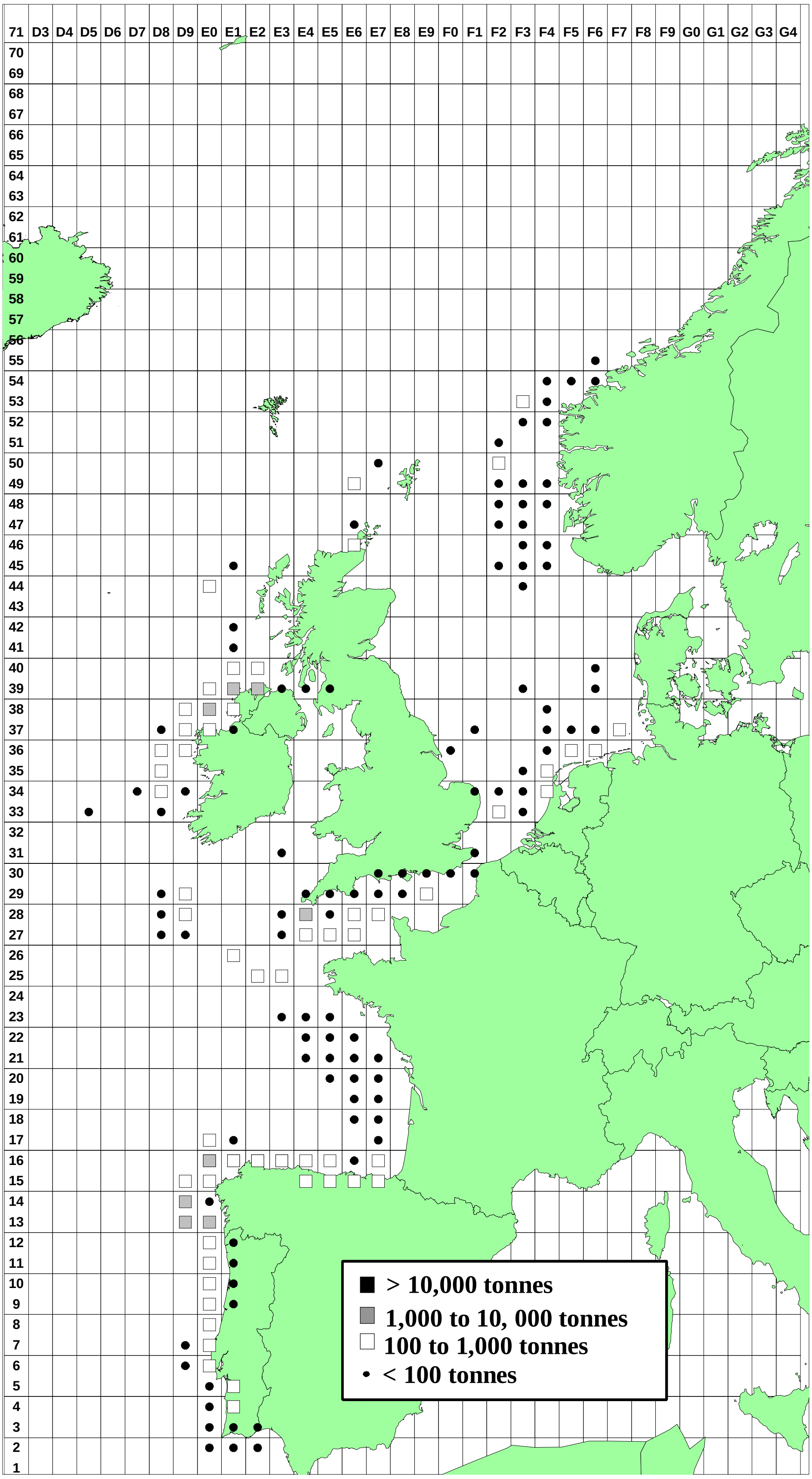


Figure 4.1.1c. Horse Mackerel commercial catches in quarter 3 – 1999

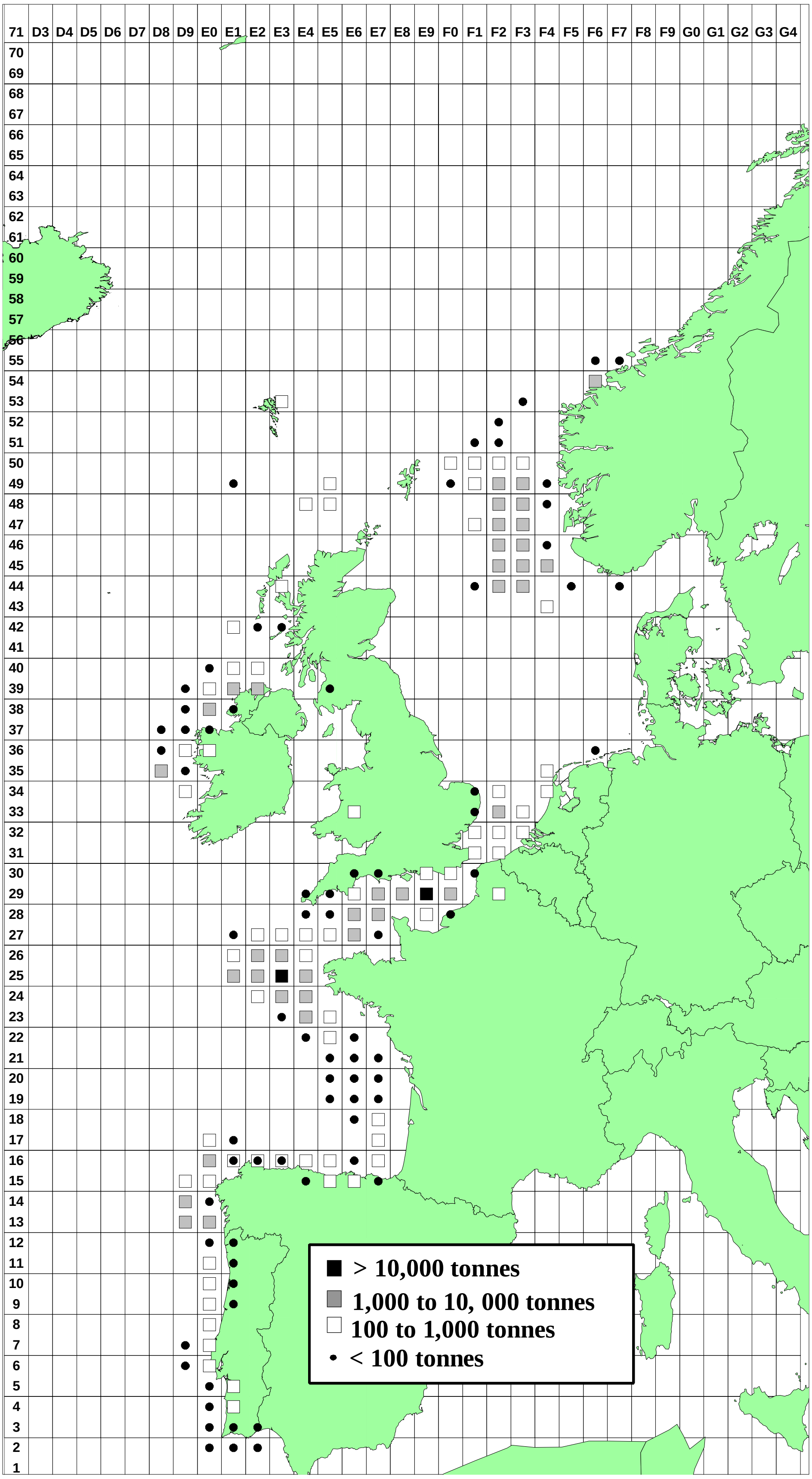


Figure 4.1.1d. Horse Mackerel commercial catches in quarter 4 - 1999

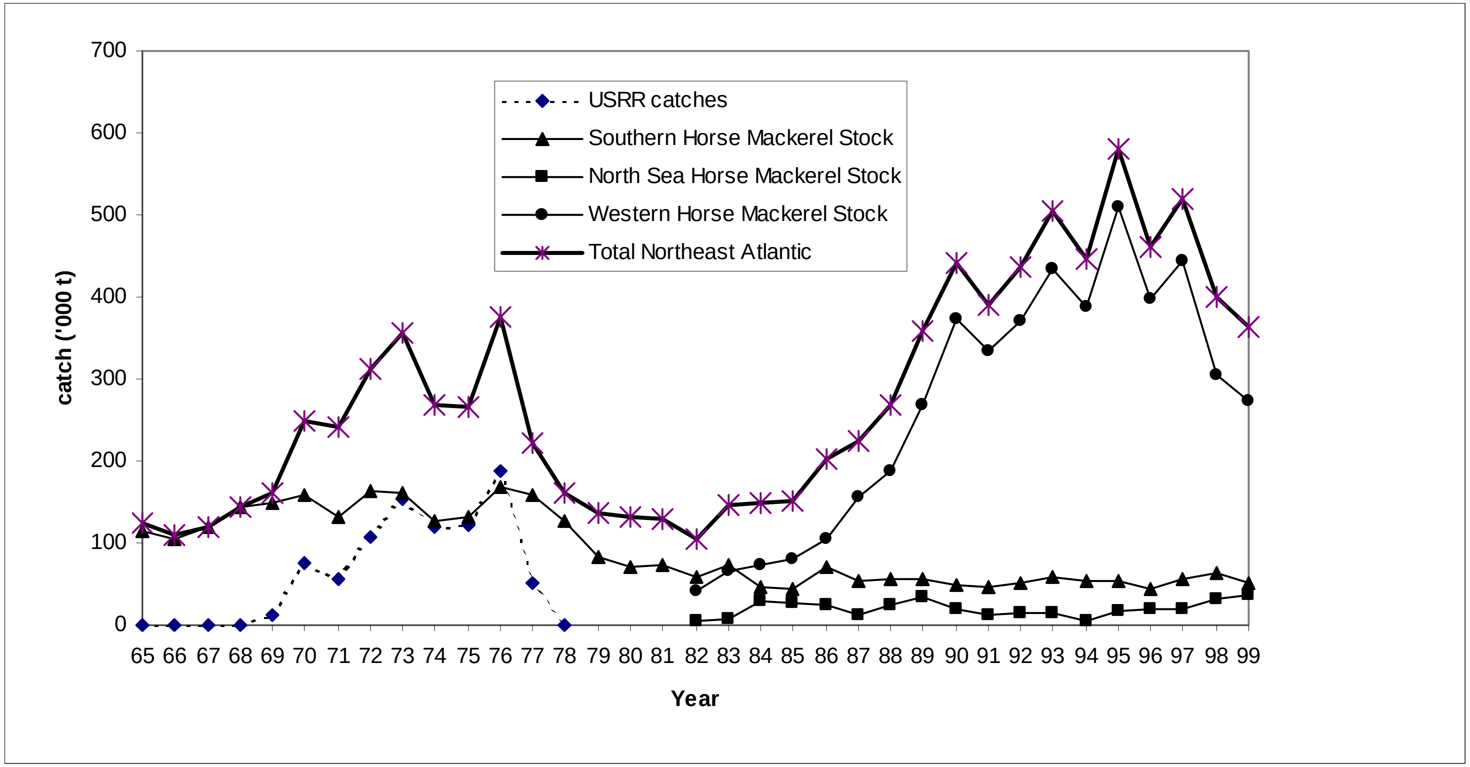
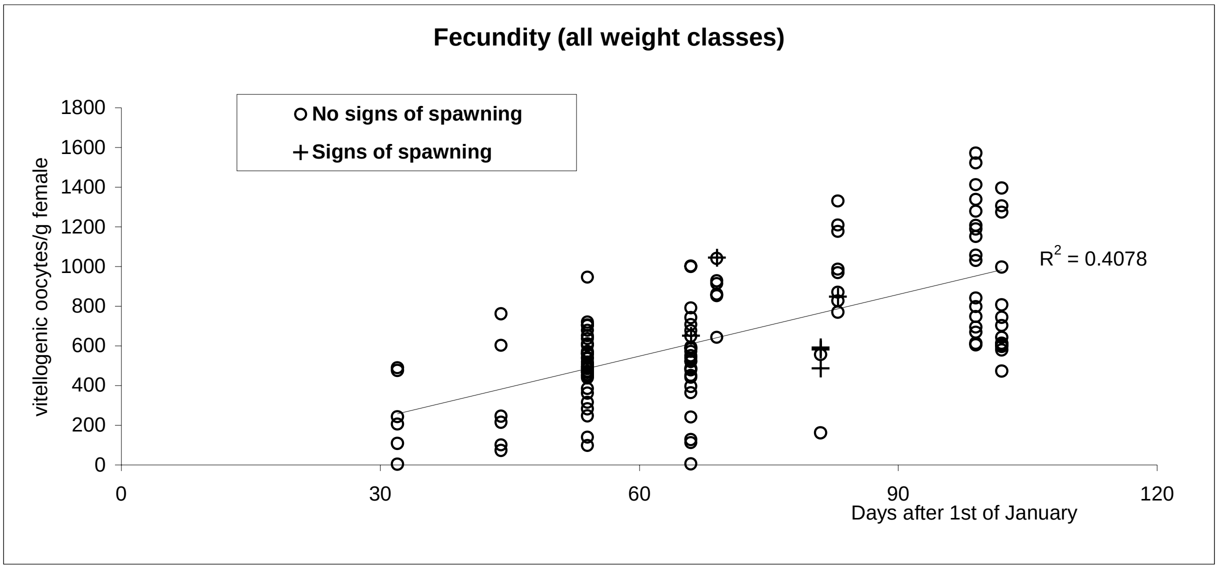


Figure 4.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965-1999. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic.



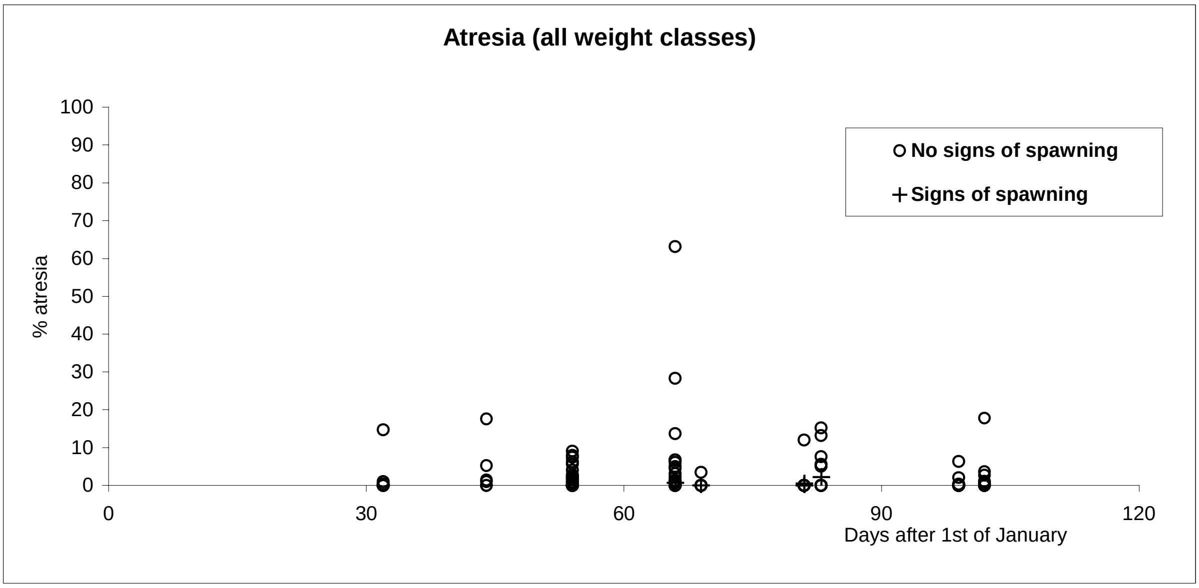


Figure 4.7.1 Upper panel: The development of vitellogenic oocytes per gramme female fish over time in ovaries of horse mackerel in (all weight classes combined). Already in March fish showed signs of spawning. Lower panel: The percentage of atresia is low (average 2.8%).

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

5.1 ACFM advice Applicable to 1998 and 1999

As usual no TAC advice was given by the ACFM. 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 1999 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 since 1993 been fixed at 60,000 t.

5.2 The Fishery in 1999 on the North Sea stock.

Catches taken in - IVb, c and VIId are regarded as belonging to the North Sea horse mackerel and in most years also catches from division IIIa - except western part of Skagerrak (see Sections 4.2 and 4.3). Table 4.3.1 shows the catches of this stock from 1982–1999. Sweden reported a catch of 1957 t from IIIa, which were assumed to be taken from the western stock. The total catch taken from this stock in 1999 is 37,224 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 from Egg Surveys

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

5.4 Biological Data

5.4.1 Catch in Numbers at Age

Catch in numbers at age (Tables 5.4.1.1 and 2) were calculated according to a few Dutch and German samples collected in Divisions IVb and IVc the third and fourth quarter, and in VIId the first, third and fourth quarter. At present the sampling intensity is rather low and the quality the catch at age data may be questionable. If an analytical assessment is to be done in the future the sampling need to be improved. The allocations of samples to calculate catch in numbers by age for the different Divisions are available in the Working Group archive. For the earlier years age compositions were presented based on samples taken from smaller Dutch commercial catches and research vessel catches. These are available for the period 1987–1995. These Dutch samples covered only a small proportion of the total catch, but give a rough indication of the age composition of the stock (Figure 5.4.1.1).

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.

5.4.2 Mean weight at age and mean length at age

Mean weight at age and mean length at age in the catches of 1999 are given in Tables 5.4.2.1 and 2.

5.4.3 Maturity at age

No data have been made available for this Working Group.

5.4.4 Natural mortality

There is no information available about natural mortality.

5.5 State of the Stock

It was not possible to do any analytical assessment. Estimates of total age composition are available since 1995 mainly based on Dutch samples. Estimates of age composition prior 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. The egg surveys in later years for mackerel in the North Sea do not cover the spawning area of horse mackerel. In 1999 the catch level increased by 92% compared to the average long-term catch level, and the 1999-catch of 37224 tons is the highest on record. 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 are no information of the SSB since 1991 it is not known if this stock is still exploited moderately. The Working Group therefore recommends that a new egg survey should be carried out and collection of age distribution data is improved.

5.6 Reference Points for Management Purposes

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

5.7 Harvest Control Rules

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

5.8 Management Measures and Considerations

EU has since 1987 set a TAC for EU waters in Division IIa and Sub-area IV. This TAC has been 60,000 t since 1993. However, this TAC is set for a wider area than the North Sea horse mackerel is distributed in. This TAC area also covers parts of the distribution area of western horse mackerel in EU waters of Divisions IVa and IIa.

No forecast for the North Sea stock has been made for 2001.

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

The Working Group recommends that if a TAC is set for this stock, it should apply to those areas where the North Sea horse mackerel are fished, i.e. Divisions IVb,c, VIId and eastern part of Division IIIa.

Table 5.4.1.1. Catch number North Sea horse mackerel stock by quarter and area

Catch number at age: Quarter 1

Ages	IVb	Ivbc	IVc	VIId	**Total**
0	0.0	0.0	0.0	0.0	**0.0**
1	0.0	0.0	0.0	0.0	**0.0**
2	0.0	0.0	0.1	0.0	**0.1**
3	0.0	0.0	40.9	0.4	**41.4**
4	0.0	0.0	50.5	0.5	**51.0**
5	0.0	0.0	40.7	0.4	**41.1**
6	0.0	0.0	50.0	0.5	**50.5**
7	0.0	0.0	99.5	1.1	**100.5**
8	0.0	0.0	79.0	0.8	**79.8**
9	0.0	0.0	88.7	1.0	**89.6**
10	0.0	0.0	10.0	0.1	**10.2**
11	0.0	0.0	19.6	0.2	**19.8**
12	0.0	0.0	0.1	0.0	**0.1**
13	0.0	0.0	0.1	0.0	**0.1**
14	0.0	0.0	9.9	0.1	**10.0**
15	0.0	0.0	10.0	0.1	**10.2**

Catch number at age: Quarter 2

Ages	IVb	Ivbc	IVc	VIId	**Total**
0	0.0	0.0	0.0	0.0	**0.0**
1	0.0	0.0	0.0	0.0	**0.0**
2	0.0	0.0	0.6	0.4	**1.0**
3	9.3	0.0	107.3	136.4	**253.0**
4	11.5	0.0	132.1	168.3	**311.9**
5	9.3	0.0	106.6	135.6	**251.5**
6	11.4	0.0	130.9	166.6	**308.9**
7	22.7	0.0	260.3	331.6	**614.6**
8	18.0	0.0	206.8	263.4	**488.2**
9	20.3	0.0	232.0	295.6	**547.9**
10	2.3	0.0	26.3	33.5	**62.1**
11	4.5	0.0	51.3	65.3	**121.1**
12	0.0	0.0	0.3	0.4	**0.8**
13	0.0	0.0	0.3	0.4	**0.8**
14	2.3	0.0	26.0	33.1	**61.3**
15	2.3	0.0	26.3	33.5	**62.1**

Table 5.4.1.1. (Continued) Catch number North Sea horse mackerel stock by quarter and area

Catch number at age: Quarter 3

Ages	IVb	Ivbc	IVc	VIId	**Total**
0	0.0	0.0	0.0	0.0	**0.0**
1	233.4	2.3	166.9	390.4	**793.0**
2	2353.2	14.7	1502.5	726.7	**4597.2**
3	1867.3	16.8	1502.5	283.7	**3670.3**
4	1321.6	13.3	667.7	374.2	**2376.8**
5	1339.4	13.6	1168.6	649.0	**3170.6**
6	569.5	9.2	1168.6	254.8	**2002.1**
7	666.5	7.3	1001.7	156.3	**1831.7**
8	148.9	4.6	667.7	92.3	**913.5**
9	122.8	1.5	166.9	56.8	**348.0**
10	47.4	1.4	333.9	37.3	**420.0**
11	0.0	0.0	0.0	20.0	**20.0**
12	25.9	0.1	0.0	16.4	**42.4**
13	0.0	0.3	0.0	25.7	**26.0**
14	25.9	0.1	0.0	3.7	**29.7**
15	73.3	0.2	0.0	63.8	**137.3**

Catch number at age: Quarter 4

Ages	IVb	IVbc	IVc	VIId	**Total**
0	0.0	0.0	0.0	0.0	**0.0**
1	706.7	6.3	2133.7	8775.4	**11622.0**
2	2608.8	23.3	7877.1	16342.8	**26852.0**
3	781.7	7.0	2360.0	16015.8	**19164.4**
4	912.3	8.1	2754.5	11170.4	**14845.4**
5	542.6	4.8	1638.3	17474.5	**19660.2**
6	765.6	6.8	2309.4	20746.1	**23827.9**
7	514.9	4.1	1374.7	16195.3	**18088.9**
8	674.6	5.7	1912.7	17678.5	**20271.4**
9	466.1	4.1	1398.4	10059.0	**11927.6**
10	232.0	2.0	673.9	6814.3	**7722.2**
11	121.6	0.9	317.0	1543.8	**1983.5**
12	112.8	0.0	0.0	269.1	**381.9**
13	51.5	0.0	0.0	1322.5	**1374.0**
14	197.5	1.6	527.6	2947.3	**3673.9**
15	989.1	3.1	1054.8	1773.1	**3820.1**

Table 5.4.1.2. Catch in numbers, 1995-199, for the North Sea horse mackerel stock

Age	CATCH IN NUMBERS (MILLIONS) 1995	1996	1997	1998	1999	Mean weight (kg) in catch 1999	Mean Length (cm) in catch 1999
0	0	0	0	0	0.000	0.000	0.0
1	0	0	0	2.295	12.415	0.063	19.2
2	1.760	4.578	5.753	22.125	31.450	0.102	22.0
3	3.117	13.778	16.235	36.693	23.129	0.126	23.5
4	7.190	11.043	8.140	38.818	17.585	0.142	24.8
5	10.321	11.867	11.979	20.787	23.123	0.160	25.5
6	12.082	9.637	11.044	12.100	26.189	0.175	26.4
7	13.161	12.492	10.151	13.988	20.636	0.199	27.2
8	11.426	7.958	8.282	10.794	21.753	0.231	29.2
9	12.644	6.599	7.205	8.256	12.913	0.250	29.5
10	7.247	1.481	2.386	4.005	8.214	0.259	29.5
11	5.872	5.314	0.748	2.723	2.144	0.300	30.6
12	0.010	0.290	0.000	0.707	0.425	0.329	32.1
13	8.843	1.281	0.187	1.808	1.401	0.367	33.3
14	0.202	8.924	0.000	0.306	3.775	0.299	31.1
15+	4.369	8.005	0.935	5.105	4.030	0.360	32.5

Table 5.4.2.1. Length at age North Sea horse mackerel stock by quarter and area

Mean Length at age: Quarter 1

Ages	IVb	IVbc	IVc	VIId	**Mean Lgt**
0	0.00	0.00	0.00	0.00	**0.00**
1	0.00	0.00	0.00	0.00	**0.00**
2	0.00	0.00	22.50	22.50	**22.50**
3	0.00	0.00	24.24	24.24	**24.24**
4	0.00	0.00	25.29	25.29	**25.29**
5	0.00	0.00	26.48	26.48	**26.48**
6	0.00	0.00	26.50	26.50	**26.50**
7	0.00	0.00	28.79	28.79	**28.79**
8	0.00	0.00	29.37	29.37	**29.37**
9	0.00	0.00	29.94	29.94	**29.94**
10	0.00	0.00	32.48	32.48	**32.48**
11	0.00	0.00	31.50	31.50	**31.50**
12	0.00	0.00	30.50	30.50	**30.50**
13	0.00	0.00	29.50	29.50	**29.50**
14	0.00	0.00	34.51	34.51	**34.51**
15	0.00	0.00	33.46	33.46	**33.46**

Mean Length at age: Quarter 2

Ages	IVb	IVbc	IVc	VIId	**Mean Lgt**
0	0.00	0.00	0.00	0.00	**0.00**
1	0.00	0.00	19.50	0.00	**19.50**
2	22.50	0.00	22.00	22.50	**22.22**
3	24.24	0.00	24.23	24.24	**24.24**
4	25.29	0.00	25.29	25.29	**25.29**
5	26.48	0.00	26.48	26.48	**26.48**
6	26.50	0.00	26.51	26.50	**26.51**
7	28.79	0.00	28.79	28.79	**28.79**
8	29.37	0.00	29.37	29.37	**29.37**
9	29.94	0.00	29.94	29.94	**29.94**
10	32.48	0.00	32.47	32.48	**32.47**
11	31.50	0.00	31.50	31.50	**31.50**
12	30.50	0.00	30.50	30.50	**30.50**
13	29.50	0.00	29.50	29.50	**29.50**
14	34.51	0.00	34.51	34.51	**34.51**
15	33.46	0.00	33.46	33.46	**33.46**

Table 5.4.2.1. (Continued) Length at age North Sea horse mackerel stock by quarter and area.

Mean Length at age: Quarter 3

Ages	IVb	IVbc	IVc	VIId	**Mean Lgt**
0	0.00	0.00	0.00	0.00	**0.00**
1	19.50	19.03	19.50	19.83	**19.66**
2	22.51	21.90	21.39	22.23	**22.10**
3	24.13	23.44	22.83	22.82	**23.49**
4	25.44	25.00	25.00	24.66	**25.19**
5	26.19	26.16	26.36	26.16	**26.25**
6	27.08	27.16	27.64	27.81	**27.50**
7	28.13	27.76	27.67	29.27	**27.97**
8	29.18	28.89	28.50	30.46	**28.81**
9	30.92	29.78	27.50	27.64	**28.74**
10	31.50	30.25	30.00	33.17	**30.45**
11	0.00	0.00	0.00	30.39	**30.39**
12	32.50	32.50	0.00	31.93	**32.28**
13	0.00	31.50	0.00	31.96	**31.95**
14	31.50	31.50	0.00	35.46	**31.99**
15	31.15	31.15	0.00	32.89	**31.96**

Mean Length at age: Quarter 4

Ages	IVb	IVbc	IVc	VIId	**Mean Lgt**
0	0.0	0.0	0.0	0.0	**0.0**
1	20.3	20.3	20.3	18.9	**19.2**
2	21.6	21.6	21.6	22.2	**22.0**
3	21.5	21.5	21.5	23.9	**23.5**
4	23.8	23.8	23.8	25.0	**24.7**
5	19.0	19.0	19.0	26.1	**25.3**
6	22.1	22.1	22.1	26.9	**26.3**
7	20.3	18.8	18.8	28.0	**27.1**
8	25.4	25.0	25.0	29.8	**29.2**
9	25.9	25.9	25.9	30.1	**29.5**
10	19.9	19.3	19.3	30.7	**29.4**
11	24.8	23.6	23.6	32.4	**30.5**
12	33.5	0.0	0.0	31.6	**32.1**
13	33.4	0.0	0.0	33.3	**33.3**
14	28.4	27.9	27.9	31.7	**31.0**
15	32.9	30.6	30.6	33.5	**32.5**

Table 5.4.2.2. Weight at age North Sea horse mackerel stock by quarter and area

Mean weight at age: Quarter 1

Ages	IVb	IVbc	IVc	VIId	**Mean Wgt**
0	0.000	0.000	0.000	0.000	**0.000**
1	0.000	0.000	0.000	0.000	**0.000**
2	0.000	0.000	0.095	0.095	**0.095**
3	0.000	0.000	0.121	0.121	**0.121**
4	0.000	0.000	0.132	0.132	**0.132**
5	0.000	0.000	0.154	0.154	**0.154**
6	0.000	0.000	0.154	0.154	**0.154**
7	0.000	0.000	0.209	0.209	**0.209**
8	0.000	0.000	0.221	0.221	**0.221**
9	0.000	0.000	0.240	0.240	**0.240**
10	0.000	0.000	0.288	0.288	**0.288**
11	0.000	0.000	0.252	0.252	**0.252**
12	0.000	0.000	0.284	0.284	**0.284**
13	0.000	0.000	0.189	0.189	**0.189**
14	0.000	0.000	0.379	0.379	**0.379**
15	0.000	0.000	0.316	0.316	**0.316**

Mean weight at age: Quarter 2

Ages	IVb	IVbc	IVc	VIId	**Mean Wgt**
0	0.000	0.000	0.000	0.000	**0.000**
1	0.000	0.000	0.076	0.000	**0.076**
2	0.095	0.000	0.102	0.095	**0.099**
3	0.121	0.000	0.121	0.121	**0.121**
4	0.132	0.000	0.132	0.132	**0.132**
5	0.154	0.000	0.154	0.154	**0.154**
6	0.154	0.000	0.154	0.154	**0.154**
7	0.209	0.000	0.209	0.209	**0.209**
8	0.221	0.000	0.221	0.221	**0.221**
9	0.240	0.000	0.240	0.240	**0.240**
10	0.288	0.000	0.288	0.288	**0.288**
11	0.252	0.000	0.252	0.252	**0.252**
12	0.284	0.000	0.284	0.284	**0.284**
13	0.189	0.000	0.189	0.189	**0.189**
14	0.379	0.000	0.379	0.379	**0.379**
15	0.316	0.000	0.316	0.316	**0.316**

Table 5.4.2.2. (Continued) Weight at age North Sea horse mackerel stock by quarter and area

Mean weight at age: Quarter 3

Ages	IVb	IVbc	IVc	VIId	**Mean Wgt**
0	0.0000	0.0000	0.0000	0.0000	**0.0000**
1	0.0790	0.0646	0.0760	0.0730	**0.0754**
2	0.1130	0.1066	0.1110	0.1071	**0.1114**
3	0.1352	0.1248	0.1330	0.1158	**0.1328**
4	0.1506	0.1395	0.1550	0.1471	**0.1512**
5	0.1664	0.1654	0.1820	0.1800	**0.1749**
6	0.1785	0.1814	0.1960	0.2190	**0.1939**
7	0.2077	0.2001	0.2000	0.2613	**0.2080**
8	0.2323	0.2215	0.2190	0.2920	**0.2286**
9	0.2843	0.2702	0.2070	0.2167	**0.2361**
10	0.2810	0.2459	0.2250	0.3843	**0.2455**
11	0.0000	0.0000	0.0000	0.2920	**0.2920**
12	0.3270	0.3270	0.0000	0.3410	**0.3324**
13	0.0000	0.3070	0.0000	0.3420	**0.3416**
14	0.2720	0.2720	0.0000	0.4920	**0.2994**
15	0.3088	0.3088	0.0000	0.3820	**0.3428**

Mean weight at age: Quarter 4

Ages	IVb	IVbc	IVc	VIId	**Mean Wgt**
0	0.000	0.000	0.000	0.000	**0.000**
1	0.084	0.084	0.084	0.055	**0.062**
2	0.102	0.102	0.102	0.100	**0.101**
3	0.119	0.119	0.119	0.126	**0.125**
4	0.147	0.147	0.147	0.139	**0.141**
5	0.128	0.128	0.128	0.161	**0.157**
6	0.155	0.155	0.155	0.176	**0.173**
7	0.157	0.133	0.133	0.205	**0.198**
8	0.209	0.202	0.202	0.236	**0.232**
9	0.252	0.252	0.252	0.250	**0.251**
10	0.147	0.139	0.139	0.275	**0.259**
11	0.249	0.230	0.230	0.323	**0.303**
12	0.383	0.000	0.000	0.306	**0.329**
13	0.382	0.000	0.000	0.367	**0.367**
14	0.298	0.294	0.294	0.299	**0.298**
15	0.380	0.335	0.335	0.367	**0.362**

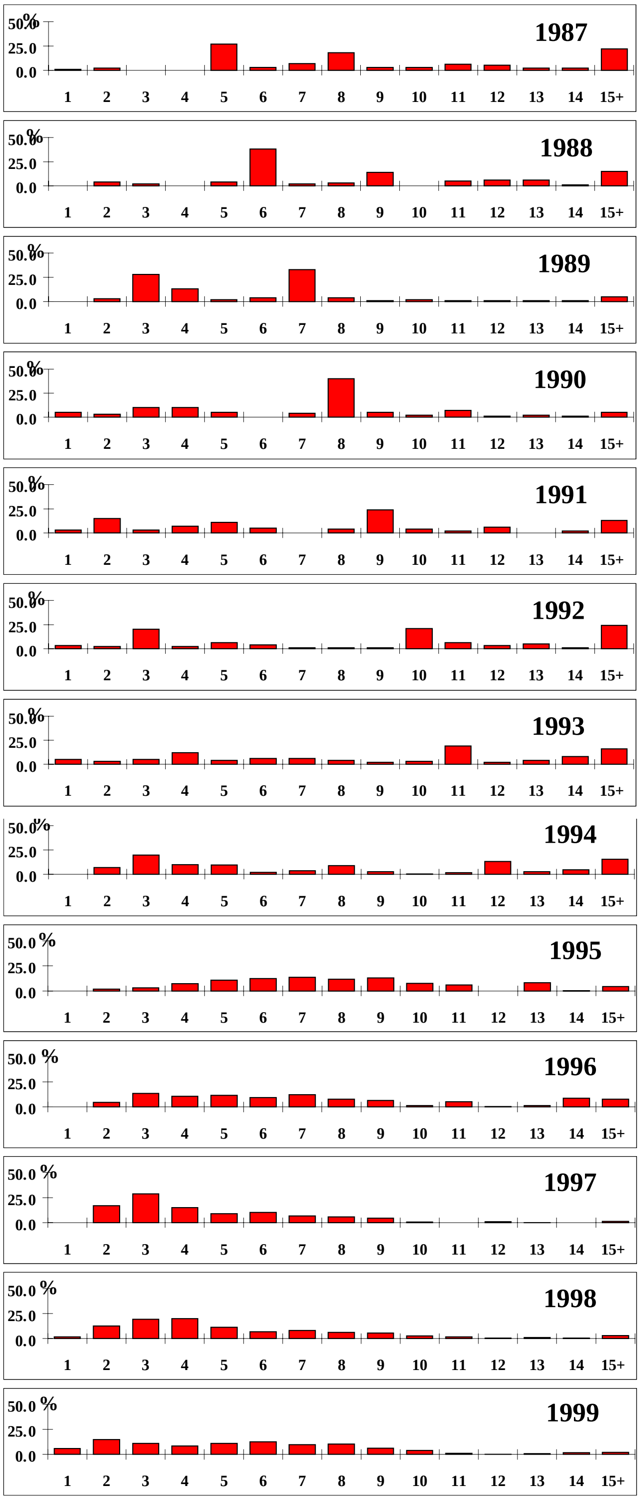


Figure 5.4.1.1. Age composition North Sea horse mackerel stock from commercial and research vessel samples, 1987-1999.

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 1999 and 2000

For 1999 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. This advice was repeated for 2000. In addition ICES 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. EU has set TACs for horse mackerel since 1989 in Division Vb (EU waters only), Sub areas VI and VII, Divisions VIIIa,b,d,e. These areas do not correspond to the total distribution area of western horse mackerel. The TAC should apply to all areas where western horse mackerel are fished. During the period 1994-1997 the TAC set by EU was 300,000 t, 320,000 t in 1998 and 265,000 t in 1999 and 240,000 t in 2000.

In 1998 and 1999 the catches of western horse mackerel were respectively 100% and 37% above the recommended TACs by ACFM.

6.2 The Fishery in 1999 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 1999 was 273,900 t (Table 4.3.1) which is about 30,000 t less than in 1998.

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 1996. Since then the catches have been about 2,500 t.

Sub-area IV and Division IIIa

All the catches from Divisions IVa and IIIa in 1999 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 due to the availability of western horse mackerel for the Norwegian fleet in October –November (section 6.3.2).

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. 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 horsemackerel increased from below 100,000 t prior 1989 to 320,000 t in 1995 (Table 4.3.1). Since than the catches dropped to 158,000 t in 1999.

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 VIIc are allocated to the western stock. The catches of western horse mackerel in these areas were less tha 10,000 t in the period 1982-1988. Since then the catches have usually fluctated between 10,000-30,000 t (Table 4.3.1).

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

6.3 Fishery Independent Information from Egg Surveys

6.3.1 Egg surveys

In 1998 the level of atresia observed in the western spawning area was very low (ICES, 1999/G:5) (section 1.7). However, the fecundity estimate in 1998 was very low, possibly because of very early spawning. To clarify this the Netherlands sampled ovaries in January-April 2000. However, the problem is still not solved and there are indications that horse mackerel might be an indeterminate spawner (Eltink, WD 2000) (see section 4.7). According Eltink (WD 2000) the historic fecundity of 1557 eggs/g female does not appear to be a serious underestimate of the potential fecundity. A revised fecundity (1481 eggs/g) and atresia (15eggs/g) estimate by Portugal for southern horse mackerel collected in 1998 (Costa, WD 2000) suggests also that the historic fecundity of 1557 eggs/g female might be valid. Furthermore, the new assessment on western horse mackerel shows that the biomass estimates from egg survey match quite well with the spawning stock biomass estimates (see section 6.5). Therefore the WG decided to continue to use the historic fecundity estimate of 1557 eggs/g female and therefore also to use the biomass estimates from egg surveys for tuning the assessment. The working group considers the SSB estimate based on the 1998 egg surveys of 1.4 mill t (ICES 1999/G:5) still to be valid.

6.3.2 Environmental effects

The Norwegian fishery for horse mackerel is unregulated and is carried out by purse seiners mainly in the Norwegian economical zone in the North Sea in October. This fishery is therefore reflecting the availability of horse mackerel in these areas. There is good correlation between modelled inflow of Atlantic water the first quarter of a year and the Norwegian horse mackerel catches later that year (Iversen *et al.* 1998). This relation has been used to predict the catches in 1997, 1998 and 1999 The predicted and actual catches are given below.

Year	1997	1998	1999
Predicted Norwegian catches	70,000 t	30,000 t	42,000 t
Actual Norwegian catches	46,000 t	13,400 t	46,600 t

The predicted catches during 1997-1999 have reflected the trend in the actual catches very well. The modelled inflow of Atlantic water the first quarter of 2000 was 2.4 Sverdrup (Iversen et.al., WD 2000) corresponding to a predicted catch of 60,000 t in 2000.

6.4 Biological Data

6.4.1 Catch in numbers

In 1998 and 1999 there were a significant increase in age readings compared with previous years. This has improved the quality of the catch at age matrix of the western horse mackerel. In1 1998 and 1999, the Netherlands (Division VIa, Subareas IV, VII and VIII) and Norway (Divisions IIa and IVa), Ireland (Division VIa and Divisions VIIbc, VIIj) and Germany (Divisions VIIef) and Spain (Division VIIIab, except 1999) provided catch in numbers at age. The catch sampled for age reading in 1999 provided 51% of the total catch.

Catches from other countries were converted to numbers at age using adequate data provided by the countries quoted above. The procedure has been carried out using the specific software for calculating international catch at age (Patterson, WD 1999).

The total annual and quarterly catches in numbers for western horse mackerel in 1999 are shown in Table 6.4.1.1. The sampling intensity is discussed in Section 1.4. The catch at age matrix shows the predominance and the dominance of the 1982 yearclass (see Figure 6.4.1.1). Currently this cohort has been included in the plus group since 1996.

6.4.2 Mean length at age and mean weight at age

Mean length at age and mean length 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 (Germany, Ireland, the Netherlands, Norway and Spain) improving the quality of the data. These data were applied to the catches from other countries using the specific software for calculating international catch at age, mean weight and mean length at age in the catches (Patterson, WD 1999). The mean weight and mean length at age in the catches by year and quarters of 1999 are shown in Tables 6.4.2.2 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 6.5.1.1d).

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 rounded maturity ogive for assessment purposes (ADAPT assessment) of the western horse mackerel (ICES, 2000/ACFM:5). This ogive was based on the estimated maturity ogive from the Cantabrian Sea (southern area), which is close to the western area. The difference between the maturity ogive as used for the years 1987-1997 and the new maturity ogive applied for 1998 and 1999 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
1998-1999	0.00	0.00	0.05	0.25	0.70	0.95	1.00

6.4.4 Natural mortality

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

6.5 State of the Stock

As during last year's WG, data exploration, preliminary modelling and preliminary catch predictions were conducted by the 'ADAPT'-type method (Gavaris, 1988) in which an arbitrary choice of selection pattern is made. This method was used at earlier Working Group meetings (1994 - 1998) to estimate the size of this stock and associated mortality rates. Since 1998, it has been used for comparability with a Baysian VPA - based assessment. The Bayseian model structure has shown extreme sensitivity of the results to inherent structural deficiencies; therefore, this year, the Working Group decided to examine the use of alternative models for the assessment of this stock. Two models were constructed which were based on an assumption of the separability of fishing mortality. The Instantaneous Separable VPA model (Kizner and Vasilyev 1997) was applied to the catch at age matrix and used to estimate time series of population abundance and fishing mortality. In addition a new model was constructed using a combination of the Pope and Shepherd(1982) separable VPA algorithm for the most recent three years of the time series and an ADAPT type structure for the earlier years.

6.5.1 Data Exploration and Preliminary Modelling using ADAPT

The use of the ADAPT method allows the estimation of some of the uncertainty in the assessment, and of the sensitivity of the assessment to the assumed selection pattern. As fishing mortality has historically been rather low in this stock, VPA 'convergence' does not help stabilise the analysis rapidly and hence the population model is likely to be strongly dependent on starting assumptions.

The model is a conventional VPA, which is fitted by a non-linear minimisation of the sum of squares with respect to population abundance at age 14 in 1999 subject to the constraints detailed below. Given population abundance N, fishing mortality F, natural mortality M, weights at age W, and maturity at age 0, egg survey estimates of SSB U, and the proportion of fishing and natural mortality exerted before spawning PF and PM respectively, the VPA is fitted by minimising:

$$\sum_y \left(\ln\left(U_y\right) - \ln\left(\sum_{a,y} N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_{a,y} - PM.M_{a,y})\right)\right)^2$$

where subscripts a and y denote age and year, respectively.

Given the lack of age-structured surveys it is necessary to impose some constraints about the exploitation pattern on the model. Although some of these constraints are not very realistic there are insufficient observations available to make objective parameter estimations. These constraints are somewhat arbitrary:

a) Selection pattern in 1999 and later years is equal to 1 on ages 4 and older (based on exploratory runs);
b) Selection on ages 0 to 4 in 1999 set to the mean of the previous 3 years (in last years assessment a mean over 3 – 5 years was used).
c) Natural mortality, weights at age in the stock and in the catch are assumed to be known precisely;
d) Maturity ogive is assumed to be known precisely.
e) Fishing mortality on the oldest age taken as an arithmetic mean from age 6 to the penultimate true age (14) in the catch at age matrix.

The choices made about constraints listed above were made after a number of exploratory model fits, which are documented in ICES (1996/Assess:7). The model is fitted to the traditional egg production estimates of biomass (Table 6.5.1.2 d). As before, egg survey information prior to 1992 was excluded on account of uncertainty introduced by the unknown maturity of the 1982 cohort.

Input data for the assessment and projections are given in Table 6.5.1.1. No changes were made to the proportion of fish mature at age: As new data on the Western Horse Mackerel maturity at age was lacking, updated information from the southern stock was used for 1998 and onwards (see Sec. 6.4.3). The influence of changes to historic maturity up to 4 years previously was explored during last year's assessment and gave negligible differences. Fishing mortality, fitted populations, stock sizes and other parameters calculated by the ADAPT procedure are presented in Table 6.5.1.2. In Figure 6.5.1.1 some of these parameters are compared graphically. From Figure 6.5.1.1.b it is striking that the VPA fit of SSB (expected) to the SSB estimates from egg surveys (observed) shows a discrepancy. This may be caused by invalid assumptions made on the following parameters:

- the model structure might have been inappropriate
- natural mortality might be overestimated (an exploratory run with M reduced to M=0.05 improved the fit considerably),
- the selection pattern was presumed to be constant, but is now believed to have changed over the last years (see the increase in F(2-4) since 1994; Fig. 6.5.1.1d),
- maturity ogive,
- treatment of the SSB estimates as absolute measures of stock abundance,
- age composition estimates could be biased due to poor sampling coverage.

Due to these uncertainties, it was as in last year decided not to use the ADAPT short and medium term predictions. For comparability, these can be found in a working document (WD Zimmermann 2000).

6.5.2 The Bayesian Horse mackerel assessment (***R.I.P*** ✞)

Since 1998 a Bayesian VPA based assessment has been attempted for the Western Horse mackerel stock. It was constructed in an effort to make a more comprehensive assessment of uncertainty in some quantities used for management. The approach is similar to that used for the assessment of Norwegian Spring-Spawning Herring (Patterson, 1997).

The assessment results established that the posterior distributions of the uncertain parameters (maturity and natural mortality) showed that there was little, if any, information about the most likely values in the model structure and data. The results also highlighted deficiencies in the underlying structural assumptions used for the Bayesian analysis. In the years in which the prior distributions were sampled for maturity at age, estimated SSB was biased downwards towards the egg survey values. This did not occur in the adjacent years where the priors for maturity were not applied. In addition, the highest probability of agreement between the estimated SSB and the egg surveys was achieved at the lowest bound of the natural mortality distribution. This could be taken as an inference for too high a value of natural mortality (a negative lower bound would have resulted in negative mortality). However, it is more likely that the final natural mortality distribution was artificially induced by mis-specification of the model structure, specifically - selection at age, maturity at age and/or the use of an absolute scaling for the egg survey estimates.

Given the sensitivity of the model results to the inherent structural deficiencies, the Working Group decided to examine the use of alternative models for the assessment of this stock.

6.5.3 An Instantaneous Separable VPA assessment of the Western Horse mackerel

Western horse mackerel stock is traditionally a rather difficult stock for assessment because of an extremely abundant cohort and the only fishery independent information available, a relatively short time series of estimates of SSB from egg surveys in early years. In an attempt to outline the tendencies in the stock dynamics from catch-at age data alone, a separable model ISVPA (Kizner and Vasilyev 1997) was implemented. The main formulas of the model are the following:

$$N(a, y) = N(a+1, y+1)exp(M)/[1 - f(y)s(a)]$$

$$C(a, y) = \varphi(a,y)N(a,y)exp(-M/2)$$

$$\varphi(a,y) = f(y)s(a)$$

($a=1,..., m-1; y=1,...,n-1$), where a - age index, m - total number of age groups, y - year index, n - total number of years, $N(a,y)$ - abundance of the age group a in year y, $C(a,y)$ - catch from age group a in year y, M - natural mortality coefficient, $\varphi(a,y)$ - fraction of the abundance of age group a, taken as a catch in the middle of the year y (plays the role similar to that of $F(a,y)$ in traditional VPA), $f(y)$ - year factor (or effort factor), $s(a)$ - age factor (or selectivity factor).

The selectivity factors are normalized:

$$\sum_{a=1}^{m} s(a) = 1$$

Estimated values of $\varphi(a,y)$ are transformed into instantaneous fishing mortality coefficients $F(a,y)$ by the formula

$$F(a,y) = - \ln[1- \varphi(a,y)],$$

which is given by rewriting the first equation above as

$$\ln[N(a,y)/N(a+1,y+1)] = M - \ln[1-\varphi(a,y)]$$

and compares with traditional population equation:

$$\ln[N(a,y)/N(a+1,y+1)] = M + F(a,y).$$

In addition to the version of ISVPA used for Northeast Atlantic mackerel stock assessment (Section 2.10.1), named here "version 1", two additional versions were also tested. These versions differed in the statistical restrictions imposed on the solution: version 1 implies "unbiased" estimates of logarithms of parameters (that is zero sums of residuals in logarithmic catches within ages and years); version 2 guarantees "unbiased separabilization" (zero sums of residuals in separable representation of fishing mortality (in terms of fractions)); Version 3 guarantees "unbiased" estimates of effort factors. In all versions of ISVPA the only restriction imposed on the selectivity pattern is that selectivity at the oldest true age group must be equal to that of previous one.

The results of stock assessment performed using the 3 versions of ISVPA are given in Tables 6.5.3.1. Although the profiles of the ISVPA loss function (the median of distribution of squared residuals in logarithmic catches) have minima for each version of the model, the minimum for Version 2 is more pronounced and the loss function for this version is free from local minima (Figure 6.5.3.1).

Figure 6.5.3.2 illustrates the ISVPA-estimates of selectivity at age. For all of the ISVPA models the selectivity patterns are characterised by a strong increase at oldest ages. Figures 6.5.3.3-6 represent the estimates of F(2-4), F(5-15), total stock and spawning stock biomass. The residuals of logarithmic catches, of the separable representation of fishing mortality (in terms of fractions) and of the estimates of effort the factor for version of ISVPA are given in Tables 6.5.3.2-5. Tables 6.5.3.5 - 6 present the ISVPA estimates of fishing mortality and population numbers at age.

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

Any assessment model constructed for the Western Horse mackerel should take into account the special 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 using age independent fleet catchability, an assumption of constant selection at age is required, for years to which the Separable model is fitted. 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 assessment, 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 6.5.4.1 presents an illustration of the preliminary model structure and the parameters estimated within the non-linear minimisation. The age structure of the assessment has been reduced from 15+ to 11+. This aggregates the 1982 year class within the plus group for the years 1993 - 1999, removing its influence on the selection pattern estimated for the cohorts currently dominating the catches.

The separable model is currently fitted to the catch data for the years 1997 - 1999. This is the shortest time period to which the model can be fitted and was selected as 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 1997 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 1996 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 fitted 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 allow for the directed fishing of the dominant 1982 year class, fishing mortality on this year class at age 10 in 1992 was estimated as a parameter within the model.

The objective function for the model is calculated as

$$\sum_y \left(\ln(U_y) - \ln\left(\sum_{a,y} N_{a,y}.\,O_{a,y}.\,W_{a,y}.\exp(-PF.\,F_{a,y} - PM.\,M_{a,y})\right)\right)^2$$

Where : N represents the population abundance estimated by a separable VPA for the years 1997 - 1999 and an ADAPT type VPA for the years 1982 - 1996; F - fishing mortality; M - natural mortality; W - weights at age; O - maturity at age; U - the egg survey 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 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 scaling of the fishing mortality for age 10 and the plus group relative to the average of ages 7 - 9.
3) 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, are assumed to be known precisely (0.45). The egg survey SSB estimates are considered to be absolute measures of stock abundance.

The model was initially fitted with constraints that mimic, as closely as possible, the ADAPT assessment (F at the oldest age estimated as 1.0 x the arithmetic average of ages 4 - 9). The fitted time series of spawning stock biomass estimates exhibits a comparable trend to that estimated within ADAPT (Figure 6.5.4.2). The divergence in the estimates of SSB at the beginning of the assessment is generated by very low estimates for the 1983 fishing mortalities at the oldest age and plus group estimated by the SAD model structure. Higher Fs and lower SSB are estimated at the oldest ages (10- 15+) in the ADAPT model; these ages are included in the plus group within SAD.

In a second model structure (SAD2) the effect of increasing fishing mortality on the oldest age and the plus group was examined by raising the average fishing mortality, used at the oldest age and for the plus group, by a factor of 2.0. The resulting SSB trends are compared with the ADAPT model and the egg survey estimates of SSB in Figure 6.5.4.3. It can be seen that raising the fishing mortality at the oldest ages in the assessment has a significant effect on the fit of the estimated time series of SSB to the egg production estimates. The estimates of SSB for the first years of the time series and the years 1993 - 1996 are more consistent with the egg survey derived values. Raising fishing mortality on the oldest ages to give a higher selection at those ages is consistent with the known exploitation history of this stock for which the fishery is directed at juveniles and oldest individuals by the prosecuting fleets. Figure 6.4.1.1 illustrates the age composition of the time series of catch at age data, the selection for older in the early years is very apparent. The over-estimation of spawning stock size by the model in the years 1986 - 1990, is also consistent with the known growth pattern of the 1982 year class. There were density dependent reductions in growth and maturity within this year class and imposed by it on contemporary year classes. The uncertainty in maturity for this year class has been comprehensively discussed in ICES (1998/Assess:6).

A further development of the model is the estimation, within the non-linear minimisation, of the fishing mortality of the 1982 year class at the oldest assessment age (and the plus group associated with it in that year). This introduces the ADAPT type specification to the historic VPA for this anomalous year class. The results of the minimised model are also plotted as a time series in Figure 6.5.4.3 (SAD3). The improved fit to the historic SSB estimates is immediately apparent, although over estimation of the 1986 SSB is still present.

In order to investigate the sensitivity of model estimates to the presence or absence of the survey observations, a weighting factor was used to down-weight residuals within the objective function. Figure 6.5.4.4 presents the results of a series of model fits excluding combinations of survey values. 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. As discussed above it is known that both growth and maturity of the stock were suppressed by the abundant 1982 year class. Given the doubts about the maturity during the early years of its presence in the fishery the decision was taken to exclude the 1986 survey from the data set to which the model was fitted.

There is insufficient information in the catch at age data to estimate the value of selection at the oldest age in the separable part of the model. Therefore, in order to investigate the sensitivity of model estimates to the assumed selection at the oldest age, models were fitted with range of values. The results are shown in Figure 6.5.4.5a - d. For each terminal selection value, the figures show the estimated time series of SSB, average fishing mortality, recruitment and the selection at age. Higher values of selection at the oldest age reduce the estimate of stock biomass in the 1997, the first year of the separable range. This results from lower fishing mortalities at the oldest ages in the final year and increases at the youngest ages (Figure 6.5.4.5b). There is a simultaneous revision of the strength of the recruitment estimated for the 1992 - 1995 year classes. The assessment is pivoting around the 1998 survey data point. As the oldest age selection is increased, the selection at the youngest ages is reduced in order to maintain the fit to the 1998 egg survey estimate. This sensitivity analysis demonstrates that the abundance of the 1992 - 1995 year classes is poorly determined by the current model structure. There is evidence in the catch at age data (Figure 6.4.1.1) that the 1993, 1994 and 1995 year classes are stronger than the low values observed during the late 1980's. A terminal selection of 1.2 was chosen based on the results of the independent ISVPA fit to the catch at age data.

Figure 6.5.4.6 presents a comparison of the results from fitting the SAD assessment model to the survey data series, ADAPT, ISVPA version 2 and egg survey estimates.

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 could be run at the meeting. Although the SAD model is 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. Therefore, the Working Group recommended that the current of the State of the Stock be based on the estimates derived from the SAD assessment.

6.5.5 Stock assessment

The accepted SAD assessment model is fitted to the catch data for the years 1982 - 1999. The years 1997 - 1999 are modelled within the Separable VPA with a reference age for unit selection of 7 and a terminal selection of 1.2. The ADAPT VPA is applied to the years 1982 - 1996. Apart from 1992, fishing mortality at the oldest age is estimated as a scaling of the fishing mortality at ages 7 - 9 in the same year. The scaling factor is estimated as a parameter within the minimisation. After scaling, the fishing mortality at the oldest age is 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), is estimated as a parameter. At the current stage of development no estimates of the uncertainty in the point estimates is calculated.

The assessment results for fishing mortality, population abundance at age and the stock summary time series are presented in Tables 6.5.5.1. - 6.5.5.3. The stock summary plots are presented in Figures 6.5.5.1 a - f.

SSB is estimated by the model to have increased to a peak value of 2,850,000t in 1988 following the recruitment of the 1982 year class. With the lack of recruitments of equivalent magnitude, SSB declined has declined steadily until 1999 (Figure 6.5.5.1f). The 1999 estimate of SSB, at 1,424,000t, estimated to be above the historic low that gave rise to the 1982 year class.

F is estimated by the model to have remained relatively stable within the range 0.1 - 0.25 throughout the history of the fishery.

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.

6.5.6 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 estimation of the selectivity at the oldest age and 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 to the period of separability, especially back to the 1995 egg survey estimate. Estimates of uncertainty of the point estimates are not calculated, therefore the reliability of the assessment cannot be determined statistically. However, the minimisation is extremely stable, re-starts over a wide range of values converge to one solution in relatively few iteration. This gives confidence that there are no local minima and that the solution surface has a well defined global minimum.

6.6 Catch Prediction

A calculation of the consequences of different short-term catch options was made from the results of the SAD assessment. Input data for the catch predictions are given in Table 6.6.1; the following assumptions were made in the calculations:

1. Recruitments in 1999 and later were taken as the geometric mean of the years 1983 - 1998, excluding the 1982 year class.

2. Exploitation in 2000 and later was assumed to follow the unscaled selection pattern estimated for the period 1997 - 1999.

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 1997 to 1999.

The results of the deterministic catch prediction are presented in Table 6.6.2 and Figure 6.6.1b. **The values are conditional on the assumptions of a model that is still under development and should be used accordingly.**

If the fishing mortality in 2000 is the same as in 1999 the catch will be 280,000 t, it is predicted that continued fishing at that level will result in a catch of 260,000t in 2001. SSB will continue to decline at these catch levels from the 2000 estimate of 1322,000t to 1098,000 in 2001 and 900,000t in 2002.

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 and estimates have not been quantified therefore short and medium term risks have not been evaluated.

6.8 Long-Term Yield

Table 6.8.1 and Figure 6.6.1a 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.

F_{max} is poorly defined at a combined reference F of about 0.64. 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.

The time series of stock and recruitment estimates for this management unit are short. The estimates of F_{med}, F_{high} and F_{low} for short time series will be unreliable.

Fbar(4-10) at 0.17 is currently estimated to be higher than F0.1 (0.15). With a constant recruitment at the geometric mean of the time series (2663000 without the 1982 year class), the equilibrium yield at F0.1 is 133,000t and the equilibrium spawning stock biomass 680,000t.

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 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 was 530,000 t, the ISVPA version 2 model estimate of the SSB in 1982 is 930,000t and the SAD assessment estimate is 500,000.

In Section 6.5.6 it is noted that the assessment of uncertainty in the population model estimates is incomplete, and therefore it is proposed to retain the use of the egg survey biomass estimate as the reference value for B_{pa}. Conventionally this has been rounded to 500,000 t. The Study Group on the Precautionary Approach to Fisheries Management has accepted this Working Groups recommendation that these values should be used as B_{pa}.

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 F0.1 (0.15) and F35%SPR (0.15).

6.10 Harvest control Laws

The stock is at present in a transition from harvesting the large 1982 year class to the fishing of younger ages. Given the 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 were no significant recruitments. Recently however fisheries in Divisions VIId and VIIe,f have taken large catches of mainly juvenile horse mackerel from both the North Sea and western stocks. For example in 1998 about 13,400 t and in 1999 about 27,500 t were taken in the third and fourth quarter from Division VIId. In 1998 about 22% and in 1999 about 36% of the catches in numbers were between 1-4 years old. Similarly in Divisions VIIe-f over 42,600 t of horse mackerel were taken in the third and fourth quarter in 1998 and about 32,000 in 1999 of which 86% and 53% of the catches in numbers in the respective years 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 which allows regulation of the conflicting exploitation patterns be devised and evaluated.

If the fishing mortality in 2000 is the same as in 1999 the catch will be 280,000 t, it is predicted that continued fishing at that level will result in a catch of 260,000t in 2001. SSB will continue to decline at these catch levels from the 2000 estimate of 1322,000t to 1098,000 in 2001 and 900,000t in 2002.

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 6.2.1 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[1]
Faroe Islands	1,598	799[3]	188[3]	132[3]
Denmark	-	-	1,755[3]	
France	-	-	-	
Germany	-	-	-	
Norway	887	1,170	234	2304
Russia	881	648	345	121
UK (England + Wales)	-	-	-	
Estonia	-	-	22	
Total	3,366	2,617	2,544	2557

[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[4]	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[1]
Belgium	19	21
Denmark	2,048	8,006
Estonia	22	-
Faroe Islands	28	908
France	379	60
Germany	4,620	4,071
Ireland	-	404
Netherlands	3,811	3,610
Norway	13,129	44,344
Poland	-	-
Russia	-	-
Sweden	3,411	1,957
UK (Engl. + Wales)	2	11
UK (N. Ireland)	-	-
UK (Scotland)	3,041	1,658
Unallocated + discards	737	-325
Total	31,247	64,725

[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[1]
Denmark	973	615	-	42	-	294	106	114	780
Faroe Islands	3,059	628	255	-	820	80	-	-	-
France	2	17	4	3	+	-	-	-	52
Germany, Fed. Rep.	1,162	2,474	2,500	6,281	10,023	1,430	1,368	943	229
Ireland	19,493	15,911	24,766	32,994	44,802	65,564	120,124	87,872	22,474
Netherlands	1,907	660	3,369	2,150	590	341	2,326	572	498
Norway	-	-	-	-	-	-	-	-	-
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[1]
Denmark	-	-
Faroe Islands	-	-
France	221	25,007
Germany	414	1,031
Ireland	21,608	31,736
Netherlands	885	1,139
Norway	-	-
Russia	-	-
Spain	-	-
UK (Engl. + Wales)	10	344
UK (N.Ireland)	1,132	-
UK (Scotland)	10,447	4,544
Unallocated +disc.	98	1,507
Total	34,815	65,308

[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[1]
Faroe Islands	-	-
Belgium	18	-
Denmark	25,492	19,223
France	24,223	-
Germany	25,414	15,247
Ireland	51,720	25,843
Netherlands	91,946	56,223
Norway	-	-
Russia	-	-
Spain	-	-
UK (Engl. + Wales)	12,832	8,885
UK (N.Ireland)	-	-
UK (Scotland)	5,095	4,994
Unallocated + discards	12,706	31,239
Total	249,446	161,654

[1]Provisional.
[2]Includes Sub-area VI.
[3]Includes a negative unallocated catch of -4,000 t.
[4]Includes 5 t from Jersey.

Table 6.2.5 Landings (t) of HORSE MACKEREL in Sub-area VIII by country.
(Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	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[1]
Denmark	1,728	4,818
France	1,844	74
Germany	3,268	3,197
Netherlands	6,604	22,479
Russia	-	-
Spain	23,599	24,190
UK (Engl. + Wales)	9	29
Unallocated + discards	1,884	-8658
Total	38,936	46,129

[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 1999

1. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	Total
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
2	0	0	0	0	0	303	0	0	0	2700	820	1	924	17	0	4764
3	0	0	0	0	158	3667	0	173	0	32477	9983	7	11118	202	0	57785
4	0	0	0	0	1393	6343	37	0	0	46299	21003	16	15850	287	0	91228
5	0	0	0	0	2581	6875	2142	173	0	44968	22720	16	15394	279	0	95149
6	1	0	8	0	7380	4721	1544	346	0	31549	17248	11	10801	196	0	73804
7	4	0	39	0	4454	5075	3055	1039	0	18292	24257	15	6262	114	0	62605
8	5	0	46	0	1013	4756	2449	1039	0	12731	21543	16	4358	79	0	48035
9	7	0	67	0	2263	4147	1574	1385	0	8985	19651	15	3076	56	0	41224
10	6	0	51	0	2440	1375	565	1385	0	6528	5406	4	2235	41	0	20034
11	10	0	94	0	3478	1061	329	346	0	563	6443	5	193	4	0	12524
12	8	0	87	0	3598	471	152	0	0	3345	2488	1	1145	21	0	11316
13	6	0	55	0	1526	661	1355	519	0	3103	1846	1	1062	19	0	10153
14	22	0	203	0	18538	1771	736	346	0	1449	9781	7	496	9	0	33358
15+	24	0	282	0	3858	1923	2073	1903	0	3586	10443	6	1228	22	0	25349

2. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	Total
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
2	0	0	0	0	0	631	370	6	0	172	9601	2	150	152	0	11084
3	0	0	0	0	0	1067	2221	50	0	1031	15799	3	902	915	0	21988
4	0	0	0	0	0	1422	1481	24	0	688	21475	4	601	610	0	26304
5	0	0	0	0	0	1468	3710	74	0	1723	21563	4	1507	1528	0	31577
6	0	0	0	0	72	1440	1111	48	0	516	21855	4	451	457	0	25953
7	0	0	16	0	13	1225	0	90	0	0	18858	3	0	0	0	20205
8	0	0	11	0	217	642	370	96	0	172	9778	2	150	152	0	11590
9	0	0	1	0	358	499	0	120	0	0	7683	1	0	0	0	8662
10	0	0	2	0	151	227	0	120	0	0	3492	1	0	0	0	3993
11	0	0	5	0	368	227	0	30	0	0	3492	1	0	0	0	4122
12	0	0	30	0	561	227	0	0	0	0	3492	1	0	0	0	4311
13	0	0	14	0	1083	272	0	45	0	0	4191	1	0	0	0	5605
14	0	0	7	0	2143	182	0	30	0	0	2794	0	0	0	0	5155
15+	0	0	169	0	3681	45	0	165	0	0	699	0	0	0	0	4759

3. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	Total
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
2	0	0	0	0	0	217	35	152	0	25	162	0	34	9	0	636
3	0	0	0	0	0	4639	876	3050	1	509	3247	0	681	183	0	13186
4	0	0	0	0	306	7927	1774	4728	2	790	5033	0	1055	284	6	21904
5	0	0	0	0	7069	8630	2433	4270	2	759	4546	0	953	256	24	28941
6	0	0	4	0	17782	4040	1323	1678	1	415	1786	0	374	101	30	27533
7	28	9	323	0	26442	951	276	457	0	315	487	0	102	27	24	29443
8	20	6	223	0	14223	735	241	305	0	77	325	0	68	18	42	16282
9	1	0	16	0	2287	584	156	305	0	65	325	0	68	18	12	3838
10	4	1	48	0	1071	301	170	0	0	26	0	0	0	0	6	1627
11	8	3	90	0	657	301	170	0	0	21	0	0	0	0	0	1250
12	54	17	611	0	705	584	156	305	0	104	325	0	68	18	0	2948
13	24	8	279	0	129	150	85	0	0	34	0	0	0	0	6	716
14	11	3	123	0	0	150	85	0	0	29	0	0	0	0	0	402
15+	304	98	3469	0	2548	0	0	0	0	151	0	0	0	0	0	6569

4. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	15	0	0	2653	15	2008	0	6860	1	0	0	0	0	11551
2	0	0	140	0	0	7959	45	6024	0	20579	3	0	0	0	0	34749
3	0	0	122	0	0	16978	95	12851	0	43901	5	0	0	0	0	73953
4	0	0	73	0	0	18310	103	13859	0	47345	6	0	2489	34	8	82227
5	0	0	91	0	650	15409	86	11663	0	39842	5	0	9956	138	34	77873
6	4	4	152	0	13635	10374	58	7852	0	26823	3	0	12445	172	42	71565
7	355	326	7217	21	19523	5859	33	4434	0	15148	2	0	9956	138	34	63045
8	245	225	4971	15	13256	5610	31	4246	0	14505	2	0	17423	241	59	60828
9	18	16	371	1	5852	1603	9	1213	0	4145	1	0	4978	69	17	18292
10	52	48	1072	3	212	801	4	607	0	2072	0	0	2489	34	8	7405
11	99	91	2000	6	1496	0	0	0	0	0	0	0	0	0	0	3692
12	671	616	13548	40	0	0	0	0	0	0	0	0	0	0	0	14875
13	307	281	6189	18	267	801	4	607	0	2072	0	0	2489	34	8	13079
14	135	124	2732	8	0	0	0	0	0	0	0	0	0	0	0	3000
15+	3809	3495	76865	226	35	0	0	0	0	0	0	0	0	0	0	84431

total year 1999

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	15	0	0	2653	15	2008	0	6860	1	0	0	0	0	11551
2	0	0	140	0	0	9109	450	6182	0	23476	10586	2	1109	178	0	51232
3	0	0	122	0	158	26351	3192	16125	1	77918	29034	10	12701	1299	0	166912
4	0	0	73	0	1699	34003	3394	18611	2	95121	47517	20	19995	1215	14	221663
5	0	0	91	0	10300	32381	8371	16180	2	87292	48834	20	27810	2201	58	233540
6	6	4	164	0	38869	20574	4035	9923	1	59304	40891	15	24071	926	72	198856
7	387	335	7596	21	50431	13110	3363	6020	0	33756	43603	19	16320	279	58	175297
8	269	231	5250	15	28708	11743	3092	5686	0	27485	31647	18	22000	491	101	136735
9	27	17	455	1	10760	6834	1738	3023	0	13194	27659	16	8122	143	29	72017
10	62	50	1173	3	3874	2704	739	2111	0	8626	8899	4	4724	75	14	33058
11	117	94	2189	6	5999	1588	499	376	0	584	9935	5	193	4	0	21588
12	733	633	14276	40	4864	1282	308	305	0	3449	6305	2	1213	39	0	33449
13	337	289	6537	18	3004	1885	1445	1170	0	5209	6037	2	3551	54	14	29553
14	168	128	3065	8	20681	2103	821	376	0	1478	12574	7	496	9	0	41915
15+	4137	3593	80785	226	10122	1968	2073	2068	0	3737	11141	6	1228	22	0	121108

Table 6.4.2.1. Western horse mackerel mean weight (Kg) at age in catch by quarter and area in 1999

1. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2	0.000	0.000	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.085	0.100	0.100	0.085	0.085	0.000	**0.088**
3	0.000	0.000	0.000	0.000	0.138	0.102	0.000	0.138	0.000	0.102	0.101	0.101	0.102	0.102	0.000	**0.102**
4	0.000	0.000	0.000	0.000	0.142	0.111	0.134	0.000	0.000	0.106	0.110	0.110	0.106	0.106	0.000	**0.108**
5	0.000	0.000	0.000	0.000	0.162	0.120	0.131	0.145	0.000	0.120	0.120	0.119	0.120	0.120	0.000	**0.121**
6	0.152	0.000	0.153	0.000	0.194	0.144	0.144	0.184	0.000	0.131	0.150	0.149	0.131	0.131	0.000	**0.143**
7	0.212	0.000	0.232	0.000	0.211	0.158	0.171	0.197	0.000	0.145	0.163	0.160	0.145	0.145	0.000	**0.160**
8	0.235	0.000	0.243	0.000	0.229	0.182	0.187	0.243	0.000	0.181	0.180	0.180	0.181	0.181	0.000	**0.183**
9	0.257	0.000	0.257	0.000	0.238	0.178	0.176	0.281	0.000	0.165	0.183	0.182	0.165	0.165	0.000	**0.183**
10	0.259	0.000	0.261	0.000	0.246	0.204	0.229	0.278	0.000	0.177	0.209	0.209	0.177	0.177	0.000	**0.204**
11	0.273	0.000	0.275	0.000	0.247	0.204	0.224	0.270	0.000	0.209	0.191	0.191	0.209	0.209	0.000	**0.213**
12	0.292	0.000	0.304	0.000	0.268	0.207	0.206	0.000	0.000	0.148	0.234	0.231	0.148	0.148	0.000	**0.209**
13	0.325	0.000	0.330	0.000	0.299	0.192	0.181	0.343	0.000	0.165	0.214	0.204	0.165	0.165	0.000	**0.208**
14	0.312	0.000	0.312	0.000	0.289	0.218	0.256	0.365	0.000	0.223	0.210	0.209	0.223	0.223	0.000	**0.259**
15+	0.314	0.000	0.335	0.000	0.317	0.208	0.295	0.334	0.000	0.155	0.221	0.215	0.155	0.155	0.000	**0.238**

2. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2	0.000	0.000	0.000	0.000	0.000	0.092	0.099	0.099	0.000	0.099	0.092	0.092	0.099	0.099	0.000	**0.093**
3	0.000	0.000	0.000	0.000	0.000	0.100	0.105	0.115	0.000	0.105	0.100	0.100	0.105	0.105	0.000	**0.101**
4	0.000	0.000	0.000	0.000	0.000	0.123	0.113	0.113	0.000	0.113	0.123	0.123	0.113	0.113	0.000	**0.122**
5	0.000	0.000	0.000	0.000	0.000	0.145	0.122	0.127	0.000	0.122	0.145	0.145	0.122	0.122	0.000	**0.139**
6	0.000	0.000	0.235	0.000	0.136	0.171	0.132	0.165	0.000	0.132	0.171	0.171	0.132	0.132	0.000	**0.167**
7	0.000	0.000	0.343	0.000	0.212	0.185	0.000	0.197	0.000	0.000	0.185	0.185	0.000	0.000	0.000	**0.185**
8	0.000	0.000	0.321	0.000	0.250	0.187	0.160	0.238	0.000	0.160	0.187	0.187	0.160	0.160	0.000	**0.187**
9	0.000	0.000	0.317	0.000	0.239	0.205	0.000	0.281	0.000	0.000	0.205	0.205	0.000	0.000	0.000	**0.207**
10	0.000	0.000	0.339	0.000	0.216	0.234	0.000	0.278	0.000	0.000	0.234	0.234	0.000	0.000	0.000	**0.235**
11	0.000	0.000	0.362	0.000	0.269	0.224	0.000	0.270	0.000	0.000	0.224	0.224	0.000	0.000	0.000	**0.228**
12	0.000	0.000	0.382	0.000	0.302	0.204	0.000	0.000	0.000	0.000	0.204	0.204	0.000	0.000	0.000	**0.218**
13	0.000	0.000	0.379	0.000	0.297	0.216	0.000	0.343	0.000	0.000	0.216	0.216	0.000	0.000	0.000	**0.233**
14	0.000	0.000	0.327	0.000	0.297	0.220	0.000	0.365	0.000	0.000	0.220	0.220	0.000	0.000	0.000	**0.253**
15+	**0.000**	**0.000**	**0.404**	**0.000**	**0.314**	**0.196**	**0.000**	**0.334**	**0.000**	**0.000**	**0.196**	**0.196**	**0.000**	**0.000**	**0.000**	**0.299**

3. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2	0.000	0.000	0.000	0.000	0.000	0.123	0.123	0.123	0.123	0.123	0.123	0.000	0.123	0.123	0.000	**0.123**
3	0.000	0.000	0.000	0.000	0.000	0.130	0.130	0.129	0.129	0.129	0.129	0.000	0.129	0.129	0.000	**0.129**
4	0.000	0.000	0.000	0.000	0.154	0.141	0.141	0.142	0.142	0.142	0.142	0.000	0.142	0.142	0.143	**0.142**
5	0.000	0.000	0.000	0.000	0.170	0.152	0.153	0.151	0.151	0.150	0.151	0.000	0.151	0.151	0.166	**0.156**
6	0.248	0.248	0.248	0.000	0.177	0.162	0.168	0.159	0.159	0.158	0.159	0.000	0.159	0.159	0.183	**0.172**
7	0.343	0.343	0.343	0.000	0.190	0.188	0.196	0.182	0.182	0.176	0.182	0.000	0.182	0.182	0.189	**0.191**
8	0.321	0.321	0.321	0.000	0.200	0.202	0.202	0.202	0.202	0.193	0.202	0.000	0.202	0.202	0.217	**0.202**
9	0.330	0.330	0.330	0.000	0.197	0.232	0.232	0.232	0.232	0.239	0.232	0.000	0.232	0.232	0.302	**0.212**
10	0.342	0.342	0.342	0.000	0.221	0.211	0.211	0.000	0.000	0.205	0.000	0.000	0.000	0.000	0.220	**0.222**
11	0.365	0.365	0.365	0.000	0.215	0.195	0.195	0.000	0.000	0.203	0.000	0.000	0.000	0.000	0.000	**0.219**
12	0.383	0.383	0.383	0.000	0.218	0.195	0.206	0.184	0.184	0.212	0.184	0.000	0.184	0.184	0.000	**0.242**
13	0.382	0.382	0.382	0.000	0.213	0.231	0.231	0.000	0.000	0.237	0.000	0.000	0.000	0.000	0.307	**0.294**
14	0.331	0.331	0.331	0.000	0.000	0.254	0.254	0.000	0.000	0.231	0.000	0.000	0.000	0.000	0.000	**0.279**
15+	0.405	0.405	0.405	0.000	0.236	0.000	0.000	0.000	0.000	0.240	0.000	0.000	0.000	0.000	0.000	**0.335**

4. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.000	0.000	0.078	0.000	0.000	0.050	0.050	0.050	0.000	0.050	0.050	0.000	0.000	0.000	0.000	**0.050**
2	0.000	0.000	0.112	0.000	0.000	0.087	0.087	0.087	0.000	0.087	0.087	0.000	0.000	0.000	0.000	**0.087**
3	0.000	0.000	0.134	0.000	0.000	0.111	0.111	0.111	0.000	0.111	0.111	0.000	0.000	0.000	0.000	**0.111**
4	0.000	0.000	0.153	0.000	0.154	0.129	0.129	0.129	0.000	0.129	0.129	0.000	0.143	0.143	0.143	**0.129**
5	0.000	0.000	0.174	0.000	0.162	0.155	0.155	0.155	0.000	0.155	0.155	0.000	0.166	0.166	0.166	**0.156**
6	0.248	0.248	0.223	0.248	0.175	0.174	0.174	0.174	0.000	0.174	0.174	0.000	0.183	0.183	0.183	**0.176**
7	0.343	0.343	0.341	0.343	0.194	0.192	0.192	0.192	0.000	0.192	0.192	0.000	0.189	0.189	0.189	**0.211**
8	0.321	0.321	0.321	0.321	0.195	0.217	0.217	0.217	0.000	0.217	0.217	0.000	0.217	0.217	0.217	**0.222**
9	0.330	0.330	0.328	0.330	0.203	0.302	0.302	0.302	0.000	0.302	0.302	0.000	0.302	0.302	0.302	**0.271**
10	0.342	0.342	0.341	0.342	0.248	0.220	0.220	0.220	0.000	0.220	0.220	0.000	0.220	0.220	0.220	**0.240**
11	0.365	0.365	0.365	0.365	0.211	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.303**
12	0.383	0.383	0.383	0.383	0.218	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.383**
13	0.382	0.382	0.382	0.382	0.268	0.307	0.307	0.307	0.000	0.307	0.307	0.000	0.307	0.307	0.307	**0.345**
14	0.331	0.331	0.331	0.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.331**
15+	0.405	0.405	0.405	0.405	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.404**

total year 1999

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.000	0.000	0.078	0.000	0.000	0.050	0.050	0.050	0.000	0.050	0.050	0.000	0.000	0.000	0.000	**0.050**
2	0.000	0.000	0.112	0.000	0.000	0.089	0.100	0.088	0.123	0.087	0.093	0.094	0.088	0.099	0.000	**0.089**
3	0.000	0.000	0.134	0.000	0.138	0.113	0.112	0.115	0.129	0.107	0.104	0.101	0.104	0.108	0.000	**0.108**
4	0.000	0.000	0.153	0.000	0.144	0.128	0.128	0.132	0.142	0.118	0.119	0.112	0.113	0.119	0.143	**0.121**
5	0.000	0.000	0.174	0.000	0.168	0.146	0.134	0.154	0.151	0.136	0.134	0.124	0.138	0.128	0.166	**0.140**
6	0.232	0.248	0.220	0.248	0.179	0.165	0.149	0.172	0.159	0.151	0.162	0.155	0.158	0.144	0.183	**0.162**
7	0.341	0.343	0.341	0.343	0.193	0.178	0.174	0.192	0.182	0.166	0.173	0.165	0.172	0.170	0.189	**0.186**
8	0.320	0.321	0.320	0.321	0.199	0.200	0.185	0.221	0.202	0.200	0.182	0.181	0.210	0.193	0.217	**0.203**
9	0.310	0.330	0.317	0.330	0.210	0.214	0.181	0.285	0.232	0.209	0.189	0.184	0.250	0.240	0.302	**0.210**
10	0.334	0.342	0.337	0.342	0.238	0.212	0.225	0.261	0.000	0.187	0.219	0.213	0.200	0.197	0.220	**0.217**
11	0.357	0.365	0.361	0.365	0.236	0.205	0.214	0.270	0.000	0.209	0.203	0.195	0.209	0.209	0.000	**0.231**
12	0.382	0.383	0.382	0.383	0.265	0.201	0.206	0.184	0.184	0.149	0.215	0.222	0.150	0.165	0.000	**0.290**
13	0.381	0.382	0.382	0.382	0.292	0.248	0.184	0.324	0.000	0.222	0.215	0.209	0.265	0.256	0.307	**0.276**
14	0.328	0.331	0.329	0.331	0.290	0.221	0.256	0.365	0.000	0.223	0.213	0.210	0.223	0.223	0.000	**0.263**
15+	0.404	0.405	0.404	0.405	0.295	0.208	0.295	0.334	0.000	0.158	0.220	0.215	0.155	0.155	0.000	**0.362**

Table 6.4.2.2. Western horse mackerel mean length (cm) at age in the catches by quarter and area in 1999

1. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2	0.0	0.0	0.0	0.0	0.0	23.2	0.0	0.0	0.0	22.5	23.5	23.5	22.5	22.5	0.0	**22.7**
3	0.0	0.0	0.0	0.0	26.3	24.2	0.0	24.5	0.0	24.3	24.2	24.2	24.3	24.3	0.0	**24.3**
4	0.0	0.0	0.0	0.0	26.4	24.8	25.5	0.0	0.0	24.8	24.8	24.8	24.8	24.8	0.0	**24.8**
5	0.0	0.0	0.0	0.0	27.5	25.8	26.0	26.5	0.0	25.8	25.8	25.8	25.8	25.8	0.0	**25.8**
6	27.5	0.0	27.5	0.0	29.2	27.0	26.9	27.0	0.0	26.7	27.0	27.1	26.7	26.7	0.0	**27.0**
7	30.3	0.0	30.5	0.0	30.1	27.9	28.6	28.5	0.0	27.7	27.7	27.8	27.7	27.7	0.0	**28.0**
8	31.7	0.0	31.7	0.0	31.0	29.1	29.4	30.0	0.0	29.2	28.9	28.9	29.2	29.2	0.0	**29.1**
9	32.4	0.0	32.4	0.0	31.4	29.2	28.9	31.3	0.0	28.9	29.3	29.3	28.9	28.9	0.0	**29.4**
10	32.5	0.0	32.5	0.0	31.6	30.3	31.0	31.5	0.0	29.1	30.4	30.6	29.1	29.1	0.0	**30.1**
11	32.9	0.0	32.9	0.0	31.6	30.2	30.2	31.0	0.0	30.5	29.5	29.6	30.5	30.5	0.0	**30.3**
12	33.9	0.0	33.9	0.0	32.6	30.7	29.2	0.0	0.0	28.9	31.1	31.5	28.9	28.9	0.0	**30.6**
13	34.8	0.0	34.7	0.0	33.7	29.8	29.5	33.8	0.0	29.4	30.0	30.0	29.4	29.4	0.0	**30.5**
14	34.2	0.0	34.2	0.0	33.2	31.4	32.9	34.0	0.0	31.3	31.1	31.1	31.3	31.3	0.0	**32.4**
15+	34.5	0.0	34.4	0.0	34.3	30.8	33.7	33.9	0.0	28.9	30.8	31.0	28.9	28.9	0.0	**31.5**

2. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2	0.0	0.0	0.0	0.0	0.0	23.2	23.5	23.5	0.0	23.5	23.2	23.2	23.5	23.5	0.0	**23.2**
3	0.0	0.0	0.0	0.0	0.0	23.9	24.5	24.5	0.0	24.5	23.9	23.9	24.5	24.5	0.0	**24.0**
4	0.0	0.0	0.0	0.0	0.0	24.7	25.3	25.3	0.0	25.3	24.7	24.7	25.3	25.3	0.0	**24.7**
5	0.0	0.0	0.0	0.0	0.0	26.0	26.0	26.1	0.0	26.0	26.0	26.0	26.0	26.0	0.0	**26.0**
6	0.0	0.0	27.9	0.0	27.5	27.3	26.5	26.8	0.0	26.5	27.3	27.3	26.5	26.5	0.0	**27.2**
7	0.0	0.0	31.9	0.0	30.3	28.1	0.0	28.5	0.0	0.0	28.1	28.1	0.0	0.0	0.0	**28.1**
8	0.0	0.0	31.7	0.0	33.1	28.4	28.5	29.9	0.0	28.5	28.4	28.4	28.5	28.5	0.0	**28.5**
9	0.0	0.0	30.3	0.0	32.1	29.3	0.0	31.3	0.0	0.0	29.3	29.3	0.0	0.0	0.0	**29.5**
10	0.0	0.0	32.6	0.0	31.2	30.9	0.0	31.5	0.0	0.0	30.9	30.9	0.0	0.0	0.0	**30.9**
11	0.0	0.0	32.7	0.0	33.3	29.9	0.0	31.0	0.0	0.0	29.9	29.9	0.0	0.0	0.0	**30.2**
12	0.0	0.0	33.5	0.0	34.8	29.9	0.0	0.0	0.0	0.0	29.9	29.9	0.0	0.0	0.0	**30.6**
13	0.0	0.0	33.4	0.0	34.6	30.2	0.0	33.8	0.0	0.0	30.2	30.2	0.0	0.0	0.0	**31.1**
14	0.0	0.0	33.0	0.0	34.6	30.5	0.0	34.0	0.0	0.0	30.5	30.5	0.0	0.0	0.0	**32.2**
15+	0.0	0.0	34.1	0.0	35.2	30.5	0.0	33.9	0.0	0.0	30.5	30.5	0.0	0.0	0.0	**34.4**

3. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2	0.0	0.0	0.0	0.0	0.0	23.5	23.5	23.5	23.5	23.5	23.5	0.0	23.5	23.5	0.0	**23.5**
3	0.0	0.0	0.0	0.0	0.0	24.7	24.7	24.7	24.7	24.7	24.7	0.0	24.7	24.7	0.0	**24.7**
4	0.0	0.0	0.0	0.0	25.7	25.4	25.4	25.4	25.4	25.4	25.4	0.0	25.4	25.4	24.5	**25.4**
5	0.0	0.0	0.0	0.0	26.8	28.9	32.2	26.0	26.0	25.9	26.0	0.0	26.0	26.0	26.0	**27.6**
6	28.0	28.0	28.0	0.0	27.2	26.6	27.0	26.4	26.4	26.3	26.4	0.0	26.4	26.4	27.3	**27.0**
7	31.9	31.9	31.9	0.0	28.1	28.0	28.2	27.8	27.8	27.4	27.8	0.0	27.8	27.8	27.3	**28.1**
8	31.7	31.7	31.7	0.0	28.7	29.1	29.4	29.0	29.0	28.4	29.0	0.0	29.0	29.0	28.9	**28.8**
9	30.0	30.0	30.0	0.0	28.6	30.6	30.2	31.0	31.0	31.1	31.0	0.0	31.0	31.0	30.5	**29.5**
10	32.6	32.6	32.6	0.0	29.9	29.0	29.0	0.0	0.0	28.8	0.0	0.0	0.0	0.0	28.5	**29.7**
11	32.7	32.7	32.7	0.0	29.6	29.0	29.0	0.0	0.0	28.7	0.0	0.0	0.0	0.0	0.0	**29.6**
12	33.5	33.5	33.5	0.0	29.8	29.3	30.1	28.5	28.5	29.4	28.5	0.0	28.5	28.5	0.0	**30.3**
13	33.4	33.4	33.4	0.0	29.5	31.5	31.5	0.0	0.0	30.1	0.0	0.0	0.0	0.0	31.5	**31.9**
14	32.8	32.8	32.8	0.0	0.0	31.5	31.5	0.0	0.0	29.9	0.0	0.0	0.0	0.0	0.0	**31.8**
15+	34.1	34.1	34.1	0.0	30.8	0.0	0.0	0.0	0.0	30.3	0.0	0.0	0.0	0.0	0.0	**32.7**

4. Quarter

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.0	0.0	19.5	0.0	0.0	18.5	18.5	18.5	0.0	18.5	18.5	0.0	0.0	0.0	0.0	**18.5**
2	0.0	0.0	22.0	0.0	0.0	21.7	21.7	21.7	0.0	21.7	21.7	0.0	0.0	0.0	0.0	**21.7**
3	0.0	0.0	23.5	0.0	0.0	23.4	23.4	23.4	0.0	23.4	23.4	0.0	0.0	0.0	0.0	**23.4**
4	0.0	0.0	25.2	0.0	25.7	24.8	24.8	24.8	0.0	24.8	24.8	0.0	24.5	24.5	24.5	**24.8**
5	0.0	0.0	26.3	0.0	26.5	26.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	26.0	**26.0**
6	28.0	28.0	27.7	28.0	27.3	26.9	26.9	26.9	0.0	26.9	26.9	0.0	27.3	27.3	27.3	**27.1**
7	31.9	31.9	31.9	31.9	28.5	27.5	27.5	27.5	0.0	27.5	27.5	0.0	27.3	27.3	27.3	**28.3**
8	31.7	31.7	31.7	31.7	28.6	28.9	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	28.9	**29.1**
9	30.0	30.0	30.0	30.0	29.0	30.5	30.5	30.5	0.0	30.5	30.5	0.0	30.5	30.5	30.5	**30.0**
10	32.6	32.6	32.6	32.6	31.5	28.5	28.5	28.5	0.0	28.5	28.5	0.0	28.5	28.5	28.5	**29.2**
11	32.7	32.7	32.7	32.7	29.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**31.4**
12	33.5	33.5	33.5	33.5	29.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**33.5**
13	33.4	33.4	33.4	33.4	32.5	31.5	31.5	31.5	0.0	31.5	31.5	0.0	31.5	31.5	31.5	**32.5**
14	32.8	32.8	32.8	32.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**32.8**
15+	34.1	34.1	34.1	34.1	30.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**34.1**

total year 1999

Ages	IIa	IIIa	IVa	Vb	VIa	VIIacek	VIIbc	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIII	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**
1	0.0	0.0	19.5	0.0	0.0	18.5	18.5	18.5	0.0	18.5	18.5	0.0	0.0	0.0	0.0	**18.5**
2	0.0	0.0	22.0	0.0	0.0	21.9	23.3	21.7	23.5	21.8	23.2	23.3	22.7	23.4	0.0	**22.1**
3	0.0	0.0	23.5	0.0	26.3	23.8	24.5	23.6	24.7	23.8	24.1	24.1	24.4	24.5	0.0	**23.9**
4	0.0	0.0	25.2	0.0	26.3	24.9	25.3	25.0	25.4	24.8	24.8	24.8	24.8	25.2	24.5	**24.9**
5	0.0	0.0	26.3	0.0	27.0	26.8	27.8	26.0	26.0	25.9	25.9	25.8	25.9	26.0	26.0	**26.1**
6	27.9	28.0	27.7	28.0	27.6	26.9	26.8	26.8	26.4	26.8	27.1	27.1	27.0	26.7	27.3	**27.1**
7	31.9	31.9	31.9	31.9	28.4	27.7	28.6	27.7	27.8	27.6	27.9	27.9	27.4	27.5	27.3	**28.1**
8	31.7	31.7	31.7	31.7	28.8	29.0	29.3	29.1	29.0	29.0	28.8	28.9	29.0	28.8	28.9	**29.0**
9	30.7	30.0	30.3	30.0	29.5	29.6	29.0	30.9	31.0	29.4	29.3	29.3	29.9	29.9	30.5	**29.5**
10	32.6	32.6	32.6	32.6	31.1	29.7	30.6	30.6	0.0	29.0	30.6	30.6	28.8	28.8	28.5	**30.0**
11	32.7	32.7	32.7	32.7	30.9	29.9	29.8	31.0	0.0	30.4	29.7	29.6	30.5	30.5	0.0	**30.4**
12	33.5	33.5	33.5	33.5	32.4	30.0	29.6	28.5	28.5	28.9	30.3	31.0	28.8	28.7	0.0	**31.9**
13	33.4	33.4	33.4	33.4	33.7	30.7	29.6	32.6	0.0	30.3	30.1	30.1	30.9	30.8	31.5	**31.5**
14	33.0	32.8	32.9	32.8	33.4	31.3	32.8	34.0	0.0	31.3	30.9	31.1	31.3	31.3	0.0	**32.4**
15+	34.1	34.1	34.1	34.1	33.7	30.8	33.7	33.9	0.0	29.0	30.8	31.0	28.9	28.9	0.0	**33.5**

Table 6.5.1.1: Western Horse Mackerel: Input to ADAPT

a. Catch in numbers (thousands)(canum)

thousands

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0	0	0	123	0
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843	4036	3726	71802	11551
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412	615759	417131	153811	51232
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838	841304	703245	464537	166912
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181	157053	390131	340241	221663
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812	67924	231570	206255	233540
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565	45939	112433	141961	198856
7	6013	37775	29105	9808	79428	34886	10613	1159554	19305	19000	42840	124050	205842	26425	48597	120131	111607	175297
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028	49091	122121	74827	136735
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838	44193	103944	64746	72017
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799	48439	95516	47935	33058
11	4473	2428	0	263	2255	16252	14301	12629	95505	13060	12000	1177060	21847	58051	89046	79553	60645	21588
12	12560	12204	486	659	746	7484	15158	21975	14040	51200	22750	6420	909325	62531	65209	148103	33499	33449
13	19489	17142	1337	2888	619	1173	4537	12471	32496	9710	69970	16110	9861	1044929	54915	80255	67648	29553
14	13205	27505	3866	970	211	168	4285	8162	16935	9000	12110	52610	14411	38647	343831	38548	60735	41915
15+	5579	33335	38732	27005	37295	27613	28378	16468	53023	49400	32200	33490	37138	149957	165073	239225	155807	121108

Other input parameters

Minimum acceptable stock size
500000 t
CV of the egg survey: 0.2
Ref. age for calculation of F
at last age: 6
Lowest/Highest age for ref. F:
5/14
First fully recruited age: 4
Forthcoming recruitment at age
3146500000
Years to recalculate the selectic
3
1000 iterations

b. Proportion of fish mature at start of year (matprop)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001-2005
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.05	0.05
3	0.8	0.7	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.25	0.25	0.25	0.25
4	1	1	0.85	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
5	1	1	1	0.95	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.95	0.95	0.95	0.95
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 6.5.1.1 (cont'd): Western Horse Mackerel: Input to ADAPT

c. Mean weight at age in the catch (kg) (weca)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001-2005
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	0.010	0.010
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	0.050	0.043	0.043
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	0.089	0.084	0.084
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	0.108	0.101	0.101
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	0.121	0.114	0.114
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	0.140	0.141	0.141
6	0.273	0.247	0.216	0.199	0.196	0.174	0.157	0.220	0.129	0.141	0.157	0.154	0.153	0.130	0.155	0.179	0.162	0.162	0.168	0.168
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	0.186	0.182	0.182
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	0.203	0.195	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	0.210	0.204	0.204
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	0.217	0.221	0.221
11	0.348	0.300	0.255	0.241	0.319	0.336	0.434	0.381	0.328	0.303	0.288	0.238	0.275	0.222	0.224	0.240	0.227	0.231	0.233	0.233
12	0.348	0.310	0.344	0.251	0.287	0.244	0.404	0.400	0.355	0.323	0.306	0.308	0.240	0.215	0.233	0.246	0.242	0.290	0.259	0.259
13	0.348	0.315	0.232	0.314	0.345	0.328	0.331	0.421	0.399	0.354	0.359	0.327	0.326	0.246	0.229	0.272	0.231	0.276	0.260	0.260
14	0.356	0.311	0.306	0.346	0.260	0.245	0.392	0.448	0.388	0.365	0.393	0.376	0.342	0.237	0.280	0.309	0.239	0.263	0.270	0.270
15+	0.366	0.332	0.308	0.321	0.360	0.373	0.424	0.516	0.379	0.330	0.401	0.421	0.383	0.298	0.332	0.288	0.272	0.362	0.307	0.307

d. Mean weight at age in the stock (kg) (west)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001-2005
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
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	0.106	0.092	0.092
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	0.118	0.113	0.113
5	0.232	0.227	0.155	0.140	0.134	0.126	0.126	0.103	0.127	0.137	0.133	0.153	0.147	0.096	0.129	0.124	0.129	0.132	0.128	0.128
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	0.156	0.153	0.153
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	0.169	0.163	0.163
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	0.177	0.174	0.174
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	0.191	0.184	0.184
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	0.209	0.203	0.203
11	0.344	0.305	0.300	0.300	0.300	0.291	0.337	0.263	0.272	0.266	0.292	0.211	0.197	0.187	0.206	0.197	0.202	0.209	0.203	0.203
12	0.348	0.309	0.300	0.300	0.300	0.297	0.352	0.302	0.404	0.295	0.211	0.258	0.231	0.229	0.217	0.226	0.217	0.212	0.218	0.218
13	0.348	0.311	0.300	0.325	0.300	0.303	0.361	0.411	0.404	0.349	0.245	0.288	0.270	0.218	0.221	0.236	0.207	0.205	0.216	0.216
14	0.361	0.312	0.305	0.325	0.300	0.303	0.352	0.383	0.404	0.361	0.361	0.338	0.270	0.272	0.237	0.260	0.212	0.224	0.232	0.232
15+	0.364	0.310	0.285	0.303	0.346	0.339	0.390	0.358	0.404	0.381	0.403	0.405	0.338	0.348	0.273	0.256	0.225	0.232	0.238	0.238

Table 6.5.1.2: Western Horse Mackerel: Historical assessment (output from ADAPT)

a. Fishing mortality

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0	0	0	0	0.000	0	0	0.001	0.002	0	0.001	0	0	0.000	0.001	0.000
1	0.001	0.000	0	0.000	0	0	0.006	0	0.011	0.010	0.028	0.021	0.003	0.012	0.002	0.004	0.228	0.076
2	0.007	0.001	0.004	0.002	0	0.000	0.002	0	0.032	0.032	0.015	0.020	0.233	0.110	0.187	0.194	0.227	0.239
3	0.018	0.014	0.002	0.012	0.001	0	0.001	0.008	0.041	0.013	0.054	0.005	0.049	0.159	0.323	0.317	0.323	0.386
4	0.007	0.009	0.019	0.003	0.014	0.002	0.002	0.007	0.030	0.073	0.055	0.053	0.042	0.118	0.086	0.230	0.236	0.238
5	0.008	0.011	0.031	0.027	0.006	0.026	0.015	0.003	0.015	0.082	0.122	0.116	0.049	0.054	0.051	0.166	0.173	0.238
6	0.008	0.033	0.020	0.025	0.047	0.002	0.034	0.014	0.006	0.038	0.091	0.211	0.047	0.132	0.058	0.107	0.138	0.238
7	0.010	0.044	0.036	0.014	0.030	0.042	0.013	0.058	0.024	0.014	0.029	0.132	0.202	0.056	0.098	0.199	0.139	0.238
8	0.003	0.026	0.037	0.018	0.030	0.035	0.051	0.015	0.081	0.031	0.012	0.053	0.123	0.342	0.133	0.355	0.174	0.238
9	0.013	0.008	0.028	0.008	0.027	0.019	0.033	0.099	0.059	0.093	0.031	0.025	0.036	0.207	0.096	0.430	0.305	0.238
10	0.052	0.235	0.012	0.021	0.022	0.017	0.020	0.050	0.160	0.044	0.108	0.007	0.048	0.118	0.128	0.290	0.340	0.238
11	0.097	0.144	0	0.001	0.008	0.039	0.035	0.035	0.079	0.041	0.030	0.158	0.054	0.086	0.145	0.300	0.286	0.238
12	0.060	0.388	0.037	0.062	0.004	0.030	0.044	0.066	0.047	0.053	0.088	0.019	0.167	0.204	0.124	0.356	0.188	0.238
13	0.068	0.103	0.062	0.298	0.072	0.007	0.022	0.043	0.125	0.039	0.090	0.079	0.035	0.277	0.263	0.209	0.258	0.238
14	0.039	0.123	0.029	0.056	0.030	0.024	0.031	0.048	0.073	0.044	0.060	0.085	0.089	0.178	0.130	0.281	0.228	0.238
15+	0.039	0.123	0.029	0.056	0.030	0.024	0.031	0.048	0.073	0.044	0.060	0.085	0.089	0.178	0.130	0.281	0.228	0.238
mean $F_{5\text{-}14}$																		
unweighted	0.036	0.111	0.029	0.053	0.028	0.024	0.030	0.043	0.067	0.048	0.066	0.088	0.085	0.165	0.122	0.269	0.223	0.238
weighted	0.019	0.040	0.030	0.022	0.026	0.026	0.033	0.051	0.069	0.075	0.090	0.130	0.125	0.203	0.111	0.223	0.186	0.238
mean $F_{2\text{-}4}$ u	0.010	0.008	0.008	0.005	0.005	0.001	0.001	0.005	0.035	0.039	0.041	0.026	0.108	0.129	0.198	0.247	0.262	0.287

b. Population numbers (millions)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	69186	2633	4420	4975	3823	5442	1932	2229	2455	3841	5680	5743	5314	3439	1104	439	199	3656
1	2257	59549	2266	3804	4282	3290	4684	1662	1919	2113	3303	4878	4943	4571	2960	950	378	171
2	2161	1940	51249	1951	3273	3685	2832	4009	1431	1634	1801	2765	4111	4240	3888	2544	814	259
3	5654	1847	1668	43940	1675	2817	3172	2432	3451	1193	1362	1528	2334	2802	3269	2777	1804	559
4	1282	4782	1568	1433	37386	1441	2425	2728	2076	2849	1013	1111	1308	1912	2058	2037	1741	1124
5	1253	1096	4080	1324	1230	31725	1238	2084	2333	1734	2279	826	908	1080	1462	1626	1393	1184
6	1103	1070	933	3406	1109	1053	26612	1050	1789	1979	1375	1736	633	744	880	1196	1185	1008
7	624	942	891	788	2860	911	905	22141	892	1531	1640	1081	1210	520	561	715	925	889
8	380	532	776	740	669	2388	752	769	17983	750	1300	1372	816	851	423	438	505	693
9	24	326	446	644	625	558	1984	615	652	14277	626	1106	1120	621	520	319	264	365
10	24	20	279	373	550	524	471	1653	479	529	11201	522	928	930	435	407	179	168
11	52	19	14	237	315	463	444	398	1353	351	435	8656	446	761	711	329	262	109
12	232	41	14	12	204	269	383	369	331	1076	290	364	6362	364	602	530	210	170
13	319	188	24	12	10	175	224	316	297	272	879	229	307	4635	255	457	319	150
14	373	256	146	19	8	8	149	189	260	225	225	691	182	255	3024	169	320	212
15+	157	311	1465	535	1359	1261	988	381	815	1238	598	440	469	990	1452	1049	820	614

Table 6.5.1.2 (cont'd): Western Horse Mackerel: Historical assessment (output from ADAPT)

c. Spawning stock biomass (tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
median	255899	2046020	2213761	3088562	4115711	4827796	5470107	4845176	4452055	4366521	3496927	3223692	2659041	2236284	2100680	1296284	1054006	903935

d. Observed and expected spawning stock biomass (from egg survey estimates)(tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed											2210000			1710000			140000	
expected	1817483	2043778	2211289	3085203	4111238	4822424	5463794	4839311	4446101	4360257	3491484	3218110	2653656	2230789	2094459	1291431	1049038	898617

e. Landings (tonnes)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
41588	64862	73625	80521	105665	156247	188100	268867	373463	333600	368200	432000	347842	512995	396448	442571	303543	275283

f. Recruitment at age 1 (millions)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2257	59549	2266	3804	4282	3290	4684	1662	1919	2113	3303	4878	4943	4571	2960	950	378	171
											Geometric mean over yearclasses 1981 and 1983-1996						**3146**

Table 6.5.3.1 The ISVPA stock summary time series

(a) ISVPA estimates of selectivities for WHM

age	Version 1	Version 2	Version 3
1	0.00	0.01	0.01
2	0.01	0.02	0.04
3	0.02	0.03	0.05
4	0.04	0.03	0.04
5	0.05	0.03	0.04
6	0.06	0.04	0.04
7	0.07	0.04	0.05
8	0.08	0.06	0.06
9	0.07	0.06	0.06
10	0.08	0.07	0.08
11	0.06	0.08	0.07
12	0.10	0.11	0.09
13	0.12	0.14	0.12
14	0.12	0.14	0.12
15	0.12	0.14	0.12

(b) ISVPA estimates of F(2-4) for WHM

Year	Version 1	Version 2	Version 3
1982	0.01	0.04	0.04
1983	0.01	0.12	0.11
1984	0.00	0.03	0.04
1985	0.01	0.07	0.05
1986	0.00	0.03	0.03
1987	0.00	0.02	0.03
1988	0.01	0.03	0.03
1989	0.00	0.04	0.04
1990	0.03	0.06	0.07
1991	0.02	0.04	0.06
1992	0.03	0.05	0.08
1993	0.03	0.06	0.09
1994	0.04	0.06	0.10
1995	0.08	0.10	0.15
1996	0.06	0.08	0.14
1997	0.12	0.15	0.26
1998	0.16	0.14	0.38
1999	0.19	0.14	0.47

c) ISVPA estimates of F(5-15) for WHM

Year	Version 1	Version 2	Version 3
1982	0.04	0.13	0.08
1983	0.06	0.43	0.22
1984	0.02	0.11	0.07
1985	0.03	0.21	0.10
1986	0.01	0.09	0.06
1987	0.01	0.07	0.05
1988	0.04	0.08	0.06
1989	0.01	0.11	0.08
1990	0.12	0.19	0.14
1991	0.11	0.12	0.11
1992	0.13	0.17	0.16
1993	0.12	0.19	0.19
1994	0.17	0.19	0.21
1995	0.38	0.35	0.32
1996	0.31	0.28	0.30
1997	0.73	0.57	0.63
1998	1.17	0.50	1.17
1999	1.51	0.53	1.35

(d) ISVPA estimates of B(th.t) for WHM

Year	Version 1	Version 2	Version 3
1982	1501	1022	1005
1983	1571	1220	1167
1984	2595	2498	2324
1985	2764	3147	2879
1986	4141	3510	3199
1987	4681	3926	4237
1988	4529	4055	4624
1989	4536	3753	4454
1990	4139	3448	4234
1991	3833	3150	3911
1992	3274	2704	3326
1993	3129	2573	3082
1994	2794	2352	2658
1995	2310	2077	2205
1996	1807	1944	1828
1997	1332	1672	1382
1998	839	1365	880
1999	606	1214	530

(e) ISVPA estimates of SSB(th.t) for WHM

Year	Version 1	Version 2	Version 3
1982	1428	930	927
1983	1513	1121	1070
1984	1618	1048	1045
1985	1794	1748	1646
1986	3195	2206	2095
1987	3293	2805	2651
1988	3492	3417	3484
1989	3742	3289	3589
1990	3629	3167	3724
1991	3610	2973	3718
1992	3051	2512	3148
1993	2868	2315	2874
1994	2525	2001	2400
1995	2065	1689	1938
1996	1569	1465	1518
1997	1143	1231	1119
1998	663	1037	717
1999	430	1018	460

Table 6.5.3.2 **ISVPA, Version2: residulas in Ln C**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AgeSum
1982	-2.15	-1.07	-0.53	-1.22	-1.07	-1.27	-1.28	-2.77	-1.05	0.30	1.18	-0.09	0.26	0.00	0.00	-10.79
1983	-5.03	-4.76	-1.67	-2.03	-1.83	-0.77	-0.62	-1.58	-2.79	0.63	0.31	1.12	-0.67	0.00	0.00	-19.68
1984	-9.85	-1.52	-2.88	0.14	0.38	-0.08	0.54	0.26	-0.11	-1.10	-5.98	0.09	0.61	0.00	0.00	-19.51
1985	-4.52	-3.41	-1.32	-3.12	-0.29	-0.61	-1.17	-1.01	-1.83	-1.17	-3.98	-0.20	1.31	0.00	0.00	-21.33
1986	-10.81	-12.05	-3.94	-0.10	-1.67	0.92	0.32	0.22	0.25	-0.14	-1.24	-2.15	0.72	0.00	0.00	-29.67
1987	-4.88	-5.69	-11.90	-2.52	0.64	-2.68	0.97	0.46	0.06	-0.12	0.72	0.13	-1.38	0.00	0.00	-26.19
1988	0.81	-2.08	-4.51	-3.48	-0.77	0.55	-0.98	0.69	0.22	-0.28	0.46	0.35	-0.54	0.00	0.00	-9.54
1989	-9.10	-10.79	-1.28	-2.30	-3.56	-1.34	0.62	-1.39	0.98	0.11	-0.04	0.44	-0.16	0.00	0.00	-27.79
1990	0.20	-0.12	0.37	-0.30	-2.12	-3.33	-1.37	0.16	-0.51	0.70	0.07	-0.51	0.40	0.00	0.00	-6.35
1991	-0.03	0.32	-0.93	1.51	0.94	-0.91	-2.17	-0.93	0.72	-0.55	-0.24	-0.18	-0.31	0.00	0.00	-2.77
1992	0.85	-1.28	0.27	0.43	1.54	0.54	-1.56	-2.81	-1.15	0.37	-1.16	-0.04	-0.06	0.00	0.00	-4.06
1993	0.61	-0.96	-2.62	0.31	0.89	1.70	0.66	-1.30	-2.09	-2.91	0.63	-1.93	-0.35	0.00	0.00	-7.36
1994	-1.20	1.54	-0.33	-0.41	0.08	-0.23	1.39	0.24	-1.63	-1.58	-0.75	0.33	-1.35	0.00	0.00	-3.91
1995	-0.60	0.41	0.21	0.19	-0.78	0.37	-0.64	0.95	0.21	-1.11	-1.43	-0.21	0.14	0.00	0.00	-2.31
1996	-2.79	0.91	1.24	-0.08	-0.60	-0.66	0.16	0.18	-0.16	-0.24	-0.60	-1.02	0.23	0.00	0.00	-3.43
1997	-2.65	0.14	0.44	0.35	-0.13	-0.56	-0.07	0.54	0.73	0.21	0.08	-0.56	-1.04	0.00	0.00	-2.50
1998	1.53	-0.02	0.30	0.27	-0.06	-0.40	-0.25	-0.37	0.46	0.31	0.40	-0.43	-0.59	0.00	0.00	1.16
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YearSum	-49.61	-40.45	-29.08	-12.38	-8.40	-8.74	-5.46	-8.45	-7.70	-6.56	-11.55	-4.87	-2.79	0.00	0.00	

Table 6.5.3.3 **ISVPA, Version 2: residuals in f*s**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AgeSUM
1982	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.08	-0.06	0.04	0.26	-0.01	0.06	0.00	0.00	0.00
1983	-0.03	-0.10	-0.11	-0.10	-0.11	-0.08	-0.08	-0.19	-0.23	0.26	0.11	0.91	-0.27	0.00	0.00	0.00
1984	-0.01	-0.02	-0.04	0.00	0.02	0.00	0.04	0.02	-0.01	-0.06	-0.09	0.01	0.14	0.00	0.00	0.00
1985	-0.01	-0.05	-0.05	-0.06	-0.02	-0.04	-0.07	-0.08	-0.11	-0.12	-0.17	-0.04	0.83	0.00	0.00	0.00
1986	-0.01	-0.02	-0.03	0.00	-0.03	0.06	0.02	0.01	0.02	-0.01	-0.06	-0.10	0.15	0.00	0.00	0.00
1987	0.00	-0.02	-0.03	-0.02	0.02	-0.03	0.06	0.03	0.00	-0.01	0.06	0.01	-0.08	0.00	0.00	0.00
1988	0.01	-0.02	-0.03	-0.02	-0.02	0.03	-0.03	0.05	0.01	-0.02	0.04	0.04	-0.05	0.00	0.00	0.00
1989	-0.01	-0.03	-0.03	-0.03	-0.04	-0.04	0.05	-0.06	0.13	0.01	0.00	0.08	-0.03	0.00	0.00	0.00
1990	0.00	-0.01	0.03	-0.02	-0.06	-0.08	-0.07	0.02	-0.05	0.16	0.01	-0.09	0.14	0.00	0.00	0.00
1991	0.00	0.01	-0.03	0.14	0.07	-0.03	-0.05	-0.05	0.09	-0.04	-0.02	-0.02	-0.05	0.00	0.00	0.00
1992	0.02	-0.03	0.02	0.03	0.22	0.05	-0.06	-0.10	-0.08	0.06	-0.10	-0.01	-0.01	0.00	0.00	0.00
1993	0.01	-0.03	-0.06	0.02	0.09	0.35	0.08	-0.09	-0.11	-0.14	0.14	-0.19	-0.08	0.00	0.00	0.00
1994	-0.01	0.18	-0.02	-0.02	0.01	-0.02	0.27	0.03	-0.10	-0.12	-0.08	0.09	-0.21	0.00	0.00	0.00
1995	-0.01	0.04	0.03	0.02	-0.06	0.06	-0.07	0.32	0.05	-0.17	-0.20	-0.07	0.07	0.00	0.00	0.00
1996	-0.02	0.10	0.23	-0.01	-0.04	-0.05	0.02	0.03	-0.03	-0.05	-0.10	-0.20	0.10	0.00	0.00	0.00
1997	-0.03	0.02	0.09	0.06	-0.02	-0.08	-0.01	0.21	0.31	0.08	0.03	-0.22	-0.43	0.00	0.00	0.00
1998	0.10	0.00	0.05	0.04	-0.01	-0.06	-0.04	-0.08	0.16	0.12	0.17	-0.17	-0.28	0.00	0.00	0.00
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YearSum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 6.5.3.4 **ISVPA, Version 2: residuals in f**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AgeSUM
1982	-1.32	-0.99	-0.62	-1.06	-0.99	-1.08	-1.08	-1.40	-0.98	0.52	3.36	-0.13	0.44	0.00	0.00	-5.33
1983	-3.99	-3.98	-3.26	-3.49	-3.37	-2.16	-1.85	-3.19	-3.77	3.52	1.48	8.31	-1.96	0.00	0.00	-17.69
1984	-1.21	-0.94	-1.14	0.17	0.56	-0.09	0.86	0.36	-0.13	-0.80	-1.20	0.11	1.01	0.00	0.00	-2.46
1985	-2.21	-2.16	-1.64	-2.14	-0.56	-1.02	-1.55	-1.42	-1.88	-1.54	-2.20	-0.41	6.04	0.00	0.00	-12.69
1986	-1.02	-1.02	-1.00	-0.10	-0.82	1.54	0.38	0.25	0.29	-0.13	-0.72	-0.90	1.07	0.00	0.00	-2.17
1987	-0.76	-0.76	-0.77	-0.70	0.68	-0.71	1.25	0.45	0.05	-0.08	0.82	0.11	-0.57	0.00	0.00	-1.01
1988	1.14	-0.80	-0.90	-0.88	-0.49	0.67	-0.57	0.91	0.22	-0.22	0.53	0.38	-0.38	0.00	0.00	-0.38
1989	-1.27	-1.27	-0.92	-1.14	-1.23	-0.94	1.10	-0.95	2.11	0.15	-0.04	0.70	-0.19	0.00	0.00	-3.90
1990	0.47	-0.24	0.94	-0.54	-1.83	-2.00	-1.55	0.36	-0.83	2.12	0.15	-0.83	1.03	0.00	0.00	-2.76
1991	-0.04	0.53	-0.85	4.93	2.17	-0.84	-1.24	-0.85	1.47	-0.59	-0.30	-0.23	-0.38	0.00	0.00	3.79
1992	2.48	-1.33	0.56	0.98	6.75	1.33	-1.45	-1.73	-1.26	0.82	-1.26	-0.07	-0.10	0.00	0.00	5.71
1993	1.70	-1.26	-1.89	0.74	2.92	9.11	1.90	-1.48	-1.78	-1.93	1.78	-1.74	-0.60	0.00	0.00	7.48
1994	-1.46	7.60	-0.59	-0.70	0.18	-0.43	6.25	0.57	-1.67	-1.65	-1.09	0.80	-1.54	0.00	0.00	6.25
1995	-1.54	1.72	0.78	0.70	-1.86	1.53	-1.62	5.45	0.81	-2.31	-2.61	-0.66	0.51	0.00	0.00	0.90
1996	-2.69	4.23	7.03	-0.21	-1.29	-1.37	0.48	0.58	-0.42	-0.62	-1.28	-1.83	0.73	0.00	0.00	3.34
1997	-4.49	0.74	2.66	2.06	-0.57	-2.06	-0.33	3.49	5.18	1.14	0.43	-2.06	-3.13	0.00	0.00	3.05
1998	16.21	-0.07	1.59	1.39	-0.25	-1.47	-0.98	-1.38	2.59	1.61	2.17	-1.56	-2.00	0.00	0.00	17.85
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YearSum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 6.5.3.5 ISVPA, Version 2: F = -ln(1-f(y)*s(a))

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	F(2-4)	F(5-15)
1982	0.01	0.04	0.05	0.04	0.05	0.06	0.07	0.09	0.09	0.12	0.12	0.18	0.23	0.23	0.23	0.04	0.13
1983	0.03	0.10	0.14	0.12	0.14	0.17	0.19	0.27	0.28	0.36	0.37	0.58	0.81	0.81	0.81	0.12	0.43
1984	0.01	0.03	0.04	0.03	0.04	0.05	0.05	0.07	0.08	0.09	0.10	0.14	0.18	0.18	0.18	0.03	0.11
1985	0.01	0.06	0.08	0.06	0.08	0.09	0.10	0.14	0.14	0.18	0.19	0.28	0.37	0.37	0.37	0.07	0.21
1986	0.01	0.02	0.03	0.03	0.03	0.04	0.05	0.06	0.06	0.08	0.08	0.12	0.15	0.15	0.15	0.03	0.09
1987	0.00	0.02	0.03	0.02	0.03	0.03	0.03	0.05	0.05	0.06	0.06	0.09	0.11	0.11	0.11	0.02	0.07
1988	0.01	0.02	0.03	0.03	0.03	0.04	0.04	0.06	0.06	0.07	0.07	0.10	0.13	0.13	0.13	0.03	0.08
1989	0.01	0.03	0.04	0.04	0.04	0.05	0.06	0.08	0.08	0.10	0.10	0.15	0.19	0.19	0.19	0.04	0.11
1990	0.01	0.05	0.07	0.06	0.07	0.08	0.10	0.13	0.13	0.17	0.17	0.26	0.34	0.34	0.34	0.06	0.19
1991	0.01	0.03	0.05	0.04	0.05	0.06	0.06	0.09	0.09	0.11	0.11	0.17	0.21	0.21	0.21	0.04	0.12
1992	0.01	0.05	0.06	0.05	0.06	0.07	0.08	0.11	0.12	0.15	0.15	0.22	0.29	0.29	0.29	0.05	0.17
1993	0.01	0.05	0.07	0.06	0.07	0.08	0.09	0.13	0.13	0.16	0.17	0.25	0.33	0.33	0.33	0.06	0.19
1994	0.01	0.05	0.07	0.06	0.07	0.08	0.10	0.13	0.13	0.17	0.18	0.26	0.34	0.34	0.34	0.06	0.19
1995	0.02	0.09	0.12	0.10	0.12	0.14	0.16	0.23	0.23	0.30	0.31	0.47	0.64	0.64	0.64	0.10	0.35
1996	0.02	0.07	0.10	0.08	0.10	0.12	0.13	0.18	0.19	0.24	0.25	0.37	0.50	0.50	0.50	0.08	0.28
1997	0.03	0.12	0.17	0.14	0.17	0.21	0.24	0.34	0.34	0.45	0.47	0.75	1.09	1.09	1.09	0.15	0.57
1998	0.03	0.11	0.16	0.13	0.16	0.19	0.22	0.31	0.31	0.40	0.42	0.67	0.95	0.95	0.95	0.14	0.50
1999	0.03	0.12	0.16	0.14	0.16	0.20	0.23	0.32	0.32	0.42	0.44	0.70	1.00	1.00	1.00	0.14	0.53

Table 6.5.3.6 ISVPA, Version 2: Population estimates

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1982	2476	1243	3430	685	581	526	353	219	10	8	13	91	78	69	29
1983	36718	2111	1031	2807	565	476	427	284	172	8	6	10	65	54	65
1984	2681	30802	1640	770	2145	423	345	302	186	112	5	4	5	25	251
1985	8859	2290	25736	1356	641	1774	347	281	242	149	88	4	3	3	94
1986	8334	7517	1864	20529	1094	512	1394	269	210	180	107	62	2	2	287
1987	2437	7127	6311	1551	17168	911	423	1146	218	170	143	85	48	2	282
1988	1992	2087	6021	5296	1307	14409	760	352	942	179	138	116	67	37	244
1989	1200	1705	1757	5028	4442	1091	11962	628	286	766	143	110	90	50	101
1990	1284	1024	1422	1449	4174	3666	893	9720	500	228	597	111	82	64	200
1991	2450	1090	837	1141	1175	3350	2900	698	7341	377	166	431	74	50	276
1992	3314	2090	907	688	944	966	2726	2342	551	5787	290	127	315	52	137
1993	4307	2820	1719	733	561	764	771	2157	1797	422	4298	214	87	202	129
1994	4180	3660	2307	1381	595	451	605	604	1633	1358	308	3117	144	54	140
1995	4587	3550	2991	1850	1119	478	357	473	456	1230	987	223	2073	88	342
1996	3940	3863	2802	2285	1440	856	356	261	325	312	788	624	120	941	452
1997	1868	3330	3094	2186	1810	1124	655	268	187	232	211	528	370	62	388
1998	593	1559	2531	2243	1627	1314	786	444	165	114	128	114	215	107	273
1999	429	496	1197	1860	1690	1198	934	544	281	104	66	72	50	71	206

Table 6.5.5.1 The fishing mortality at age estimated by the SAD assessment model for the Western Horse mackerel

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	0.006	0.000	0.000	0.001	0.000	0.000	0.005	0.000	0.010
2	0.013	0.004	0.005	0.015	0.000	0.000	0.002	0.000	0.027
3	0.050	0.025	0.010	0.016	0.005	0.000	0.001	0.009	0.038
4	0.034	0.025	0.035	0.012	0.020	0.014	0.007	0.014	0.034
5	0.042	0.057	0.093	0.049	0.026	0.037	0.113	0.010	0.031
6	0.051	0.197	0.112	0.080	0.089	0.008	0.049	0.116	0.024
7	0.067	0.343	0.262	0.083	0.104	0.084	0.063	0.086	0.236
8	0.085	0.187	0.394	0.163	0.212	0.131	0.107	0.080	0.125
9	0.023	0.243	0.235	0.110	0.289	0.157	0.136	0.226	0.369
10	0.106	0.472	0.544	0.217	0.369	0.227	0.186	0.240	0.446
+gp	0.106	0.472	0.544	0.217	0.369	0.227	0.186	0.240	0.446

F	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.011	0.029	0.018	0.002	0.008	0.001	0.016	0.016	0.014
2	0.029	0.015	0.020	0.192	0.076	0.115	0.113	0.117	0.098
3	0.010	0.049	0.006	0.052	0.126	0.206	0.179	0.185	0.155
4	0.066	0.045	0.048	0.044	0.124	0.066	0.125	0.129	0.108
5	0.092	0.109	0.093	0.045	0.058	0.054	0.106	0.109	0.091
6	0.084	0.103	0.185	0.037	0.120	0.062	0.113	0.117	0.098
7	0.055	0.066	0.152	0.172	0.044	0.088	0.180	0.186	0.156
8	0.413	0.051	0.129	0.145	0.280	0.102	0.242	0.250	0.209
9	0.150	0.703	0.113	0.095	0.252	0.075	0.279	0.288	0.241
10	0.377	0.187	0.241	0.251	0.351	0.161	0.216	0.223	0.187
+gp	0.377	0.187	0.241	0.251	0.351	0.161	0.216	0.223	0.187

Table 6.5.5.2 The population numbers at age estimated by the SAD assessment model for the Western Horse mackerel

N	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	49098198	367726	1136534	2364133	3446068	5993413	2345520	2413967	2317687
1	495795	42259211	316505	978224	2034828	2966059	5158578	2018097	2077720
2	1224227	424394	36367581	272418	840790	1751393	2552833	4417787	1736992
3	2017065	1040417	363770	31131457	230945	723675	1507054	2192277	3802425
4	255149	1651154	873605	309966	26361150	197737	622873	1295427	1869413
5	233167	212349	1385560	726293	263578	22235217	167897	532534	1099580
6	171607	192369	172561	1086799	595030	221004	18443701	129095	453884
7	100649	140301	135940	132744	863181	468405	188615	15109308	98896
8	14906	81051	85713	90002	105155	669258	370794	152496	11928933
9	13354	11789	57836	49754	65827	73243	505319	286709	121105
10	11967	11233	7957	39361	38362	42437	53899	379776	196759
+gp	589892	263509	113254	174857	142751	278981	421153	360706	631456

N	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	3699409	6773711	8243981	8292611	5517784	1112136	2126884	1070982		
1	1994852	3181114	5818664	7095660	7135369	4749201	957225	1830626	921689	
2	1770575	1698829	2660238	4920731	6093075	6094300	4083931	811037	1550260	782600
3	1455900	1480121	1439893	2243746	3496266	4862673	4674146	3138721	621036	1209957
4	3152029	1240135	1212554	1232184	1834139	2654089	3404827	3363186	2245294	457879
5	1555617	2539108	1020812	994605	1014661	1394797	2138691	2585597	2543604	1734358
6	917476	1221748	1959321	800904	818523	824331	1137497	1656132	1995336	1998215
7	381492	726286	948942	1401242	664332	625127	666889	874371	1268366	1557553
8	67210	310726	585376	701675	1015092	547280	492966	479308	624760	934239
9	9063701	38282	254269	442802	522512	660291	425504	333090	321325	436273
10	72069	6712085	16315	195426	346755	349684	527318	277154	215004	217384
+gp	451265	940213	6454314	4795097	4901362	5183823	3233401	2029632	1560498	1772669

Table 6.5.5.3 The population summary time series age estimated by the SAD assessment model for the Western Horse mackerel

YEAR	RECRUITS Age 0	Biomass (tonnes)	SSB (tonnes)	TOTAL INT. ANDINGS(tonnes	Fbar (4 - 10)
1982	49098198	624550	503546	41588	0.06
1983	367726	634114	524289	64862	0.22
1984	1136534	2303882	571819	73625	0.24
1985	2364133	3023223	1362169	80521	0.10
1986	3446068	3236134	1902855	105665	0.16
1987	5993413	3346059	2434398	156247	0.09
1988	2345520	3351629	2850352	188100	0.09
1989	2413967	3302982	2627912	268867	0.11
1990	2317687	2931666	2247193	373463	0.18
1991	3699409	2809082	2158276	333600	0.18
1992	6773711	2511542	1957652	368200	0.18
1993	8243981	2603831	1994255	432000	0.14
1994	8292611	2469632	1771589	347842	0.11
1995	5517784	2574986	1703830	512995	0.18
1996	1112136	3018069	2029368	396448	0.09
1997	2126884	2571254	1686534	442571	0.18
1998	1070982	2012525	1417418	303543	0.19
1999		1845116	1424275	275283	0.16

Table 6.6.1 The input data for the Western Horse mackerel short term deterministic prediction

	N	F	Swt	Cwt	Mat	M	PF	PM
0	2691105	0.000	0.000	0.015	0.000	0.15	0.45	0.45
1	974742	0.015	0.000	0.046	0.000	0.15	0.45	0.45
2	1628418	0.109	0.050	0.080	0.067	0.15	0.45	0.45
3	650788	0.173	0.093	0.102	0.300	0.15	0.45	0.45
4	2352844	0.121	0.113	0.116	0.667	0.15	0.45	0.45
5	2658765	0.102	0.128	0.141	0.900	0.15	0.45	0.45
6	2078511	0.109	0.155	0.165	1.000	0.15	0.45	0.45
7	1316573	0.174	0.163	0.183	1.000	0.15	0.45	0.45
8	647418	0.234	0.175	0.186	1.000	0.15	0.45	0.45
9	332976	0.269	0.184	0.206	1.000	0.15	0.45	0.45
10	223077	0.209	0.203	0.218	1.000	0.15	0.45	0.45
11+	1618905	0.209	0.225	0.278	1.000	0.15	0.45	0.45

Table 6.6.2 The management option table for the Western Horse mackerel short term deterministic prediction

MFDP version 1a
Run: whm2000
Western Horse Mackerel 2000 W.G.
Time and date: 09:09 22/09/00
Fbar age range: 4-10

2000				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
1675709	1322094	1.0000	0.1740	278947

2001					2002	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
1443208	1193289	0.0000	0.0000	0	1492834	1177331
.	1183347	0.1000	0.0174	27834	1468492	1145842
.	1173495	0.2000	0.0348	55150	1444609	1115250
.	1163730	0.3000	0.0522	81959	1421175	1085527
.	1154053	0.4000	0.0696	108272	1398181	1056648
.	1144463	0.5000	0.0870	134098	1375619	1028588
.	1134958	0.6000	0.1044	159446	1353479	1001321
.	1125538	0.7000	0.1218	184328	1331753	974825
.	1116203	0.8000	0.1392	208751	1310432	949077
.	1106950	0.9000	0.1566	232725	1289510	924055
.	1097780	1.0000	0.1740	256259	1268976	899736
.	1088692	1.1000	0.1914	279362	1248825	876101
.	1079685	1.2000	0.2088	302043	1229047	853129
.	1070758	1.3000	0.2262	324309	1209636	830801
.	1061911	1.4000	0.2436	346169	1190584	809098
.	1053142	1.5000	0.2610	367632	1171884	788001
.	1044452	1.6000	0.2784	388704	1153529	767492
.	1035838	1.7000	0.2958	409394	1135512	747554
.	1027302	1.8000	0.3132	429710	1117827	728171
.	1018841	1.9000	0.3306	449658	1100466	709326
.	1010455	2.0000	0.3480	469246	1083423	691004

Input units are thousands and kg - output in tonnes

Table 6.8.1 The yield per recruit table for the Western Horse mackerel short term deterministic prediction

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	7.1792	0.7950	3.9482	0.6935	3.6905	0.6482
0.1000	0.0174	0.0738	0.0134	6.6885	0.6951	3.4703	0.5949	3.2184	0.5515
0.2000	0.0348	0.1323	0.0232	6.2994	0.6175	3.0938	0.5185	2.8474	0.4768
0.3000	0.0522	0.1800	0.0304	5.9821	0.5555	2.7887	0.4578	2.5478	0.4177
0.4000	0.0696	0.2199	0.0360	5.7175	0.5049	2.5361	0.4084	2.3005	0.3698
0.5000	0.0870	0.2537	0.0402	5.4927	0.4628	2.3232	0.3674	2.0927	0.3303
0.6000	0.1044	0.2829	0.0435	5.2988	0.4272	2.1409	0.3330	1.9155	0.2972
0.7000	0.1218	0.3085	0.0462	5.1295	0.3968	1.9829	0.3037	1.7624	0.2691
0.8000	0.1392	0.3310	0.0483	4.9799	0.3704	1.8444	0.2784	1.6288	0.2450
0.9000	0.1566	0.3512	0.0500	4.8466	0.3474	1.7220	0.2564	1.5111	0.2242
1.0000	0.1740	0.3693	0.0514	4.7268	0.3270	1.6129	0.2371	1.4065	0.2059
1.1000	0.1914	0.3856	0.0526	4.6183	0.3089	1.5150	0.2200	1.3130	0.1899
1.2000	0.2088	0.4006	0.0535	4.5196	0.2927	1.4265	0.2048	1.2289	0.1757
1.3000	0.2262	0.4143	0.0543	4.4292	0.2781	1.3462	0.1912	1.1528	0.1630
1.4000	0.2436	0.4269	0.0549	4.3460	0.2649	1.2730	0.1790	1.0836	0.1516
1.5000	0.2610	0.4385	0.0555	4.2691	0.2529	1.2059	0.1679	1.0205	0.1414
1.6000	0.2784	0.4493	0.0560	4.1978	0.2419	1.1441	0.1578	0.9627	0.1321
1.7000	0.2958	0.4594	0.0563	4.1315	0.2318	1.0872	0.1486	0.9095	0.1237
1.8000	0.3132	0.4688	0.0567	4.0695	0.2225	1.0344	0.1402	0.8605	0.1160
1.9000	0.3306	0.4776	0.0570	4.0115	0.2139	0.9855	0.1325	0.8151	0.1090
2.0000	0.3480	0.4859	0.0572	3.9571	0.2059	0.9400	0.1254	0.7730	0.1026

Reference point	F multiplie	Absolute F
Fbar(4-10)	1.0000	0.174
FMax	3.6783	0.6399
F0.1	0.8861	0.1542
F35%SPR	0.8862	0.1542

MFYPR version 2a
Run: whm2000
Time and date: 09:16 22/09/00
Yield per results

Weights in kilogram

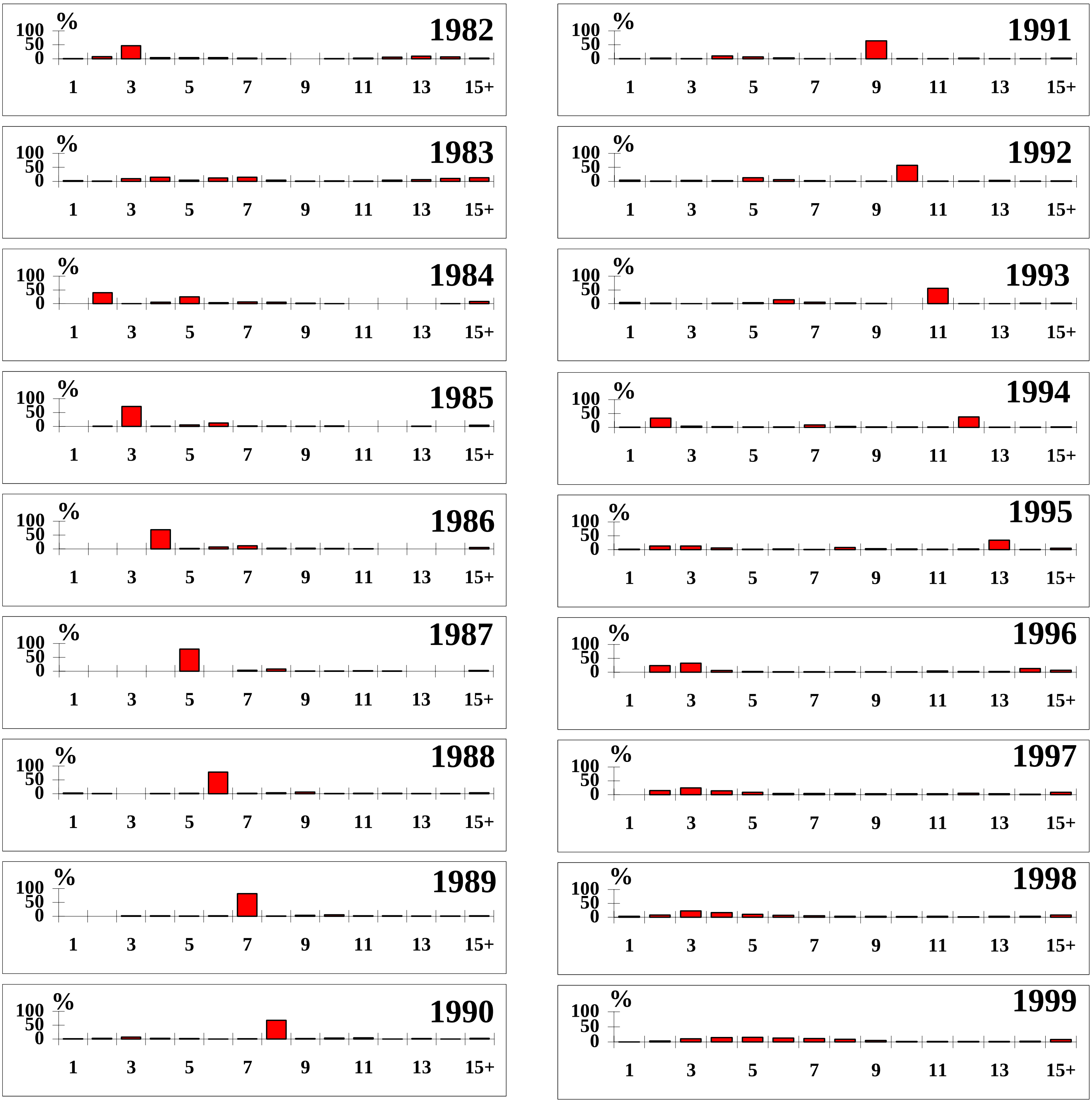


Figure 6.4.1.1 The age composition of the WESTERN HORSE MACKEREL in the international catches during 1983-1999

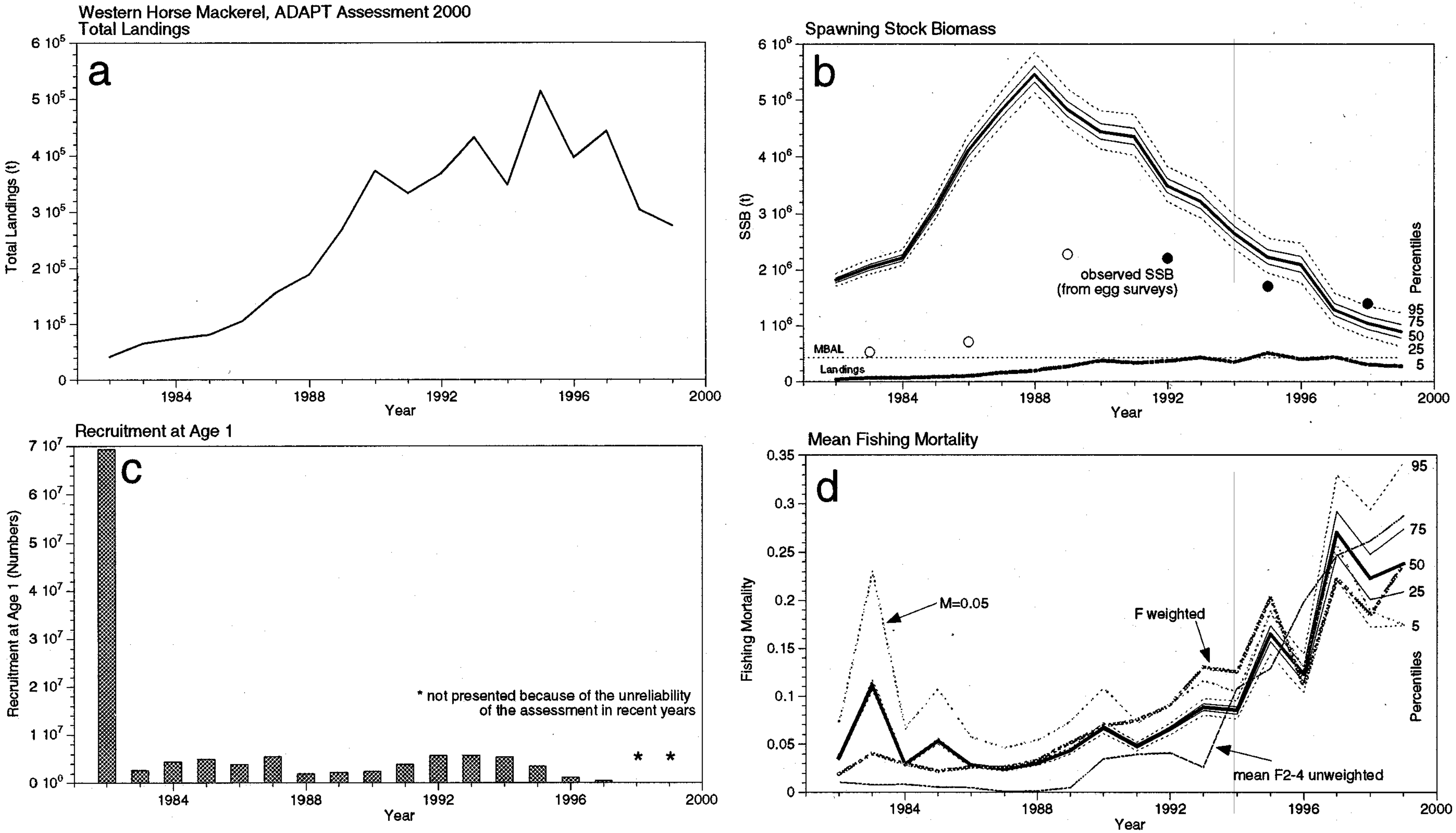


Figure 6.5.1.1. Western Horse Mackerel: Results of the ADAPT-assessment. a.: Total landings; b.: Spawning stock biomass (median, 5th, 25th, 75th and 95th percentiles of the expected SSB fitted to SSB estimates from egg surveys) compared to SSB values estimated from egg surveys (as circles) and the Minimum Biological Acceptable Level (MBAL); c.: Recruitment at age 1; d.: Mean fishing mortality (median, 5th, 25th, 75th and 95th percentiles), means for age groups 5-14 (unweighted and weighted by stock numbers), mean F on ages 2-4 and mean F resulting from the exploratory run with reduced Natural Mortality (M=0.05 instead of 0.15).

WESTERN HORSE MACKEREL: ISVPA RUNS

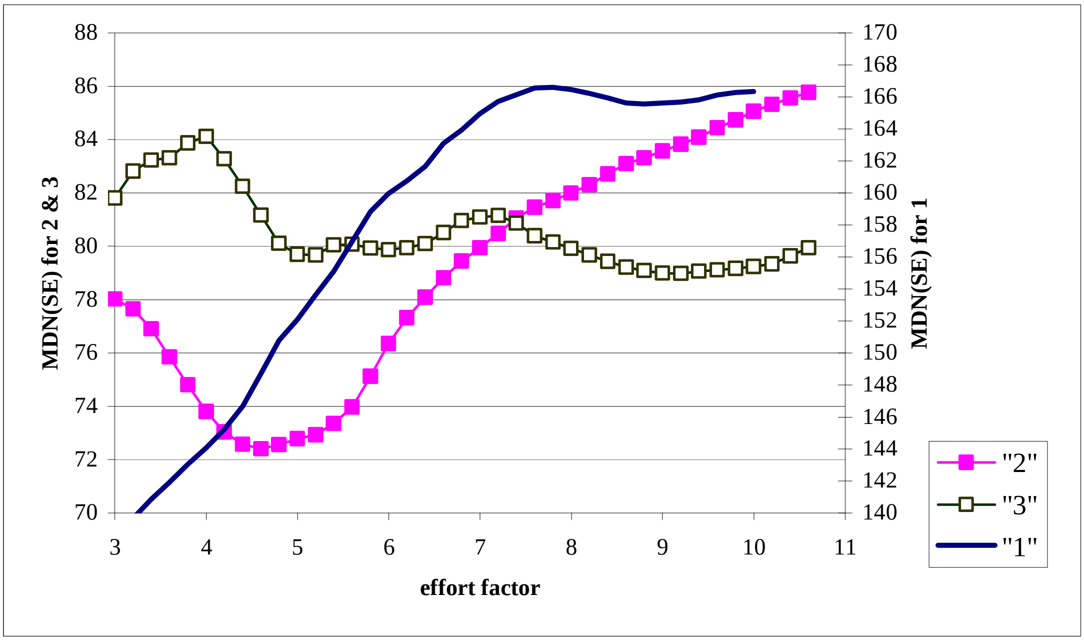


Figure 6.5.3.1 **Profiles of ISVPA loss function as function of terminal effort factor**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)

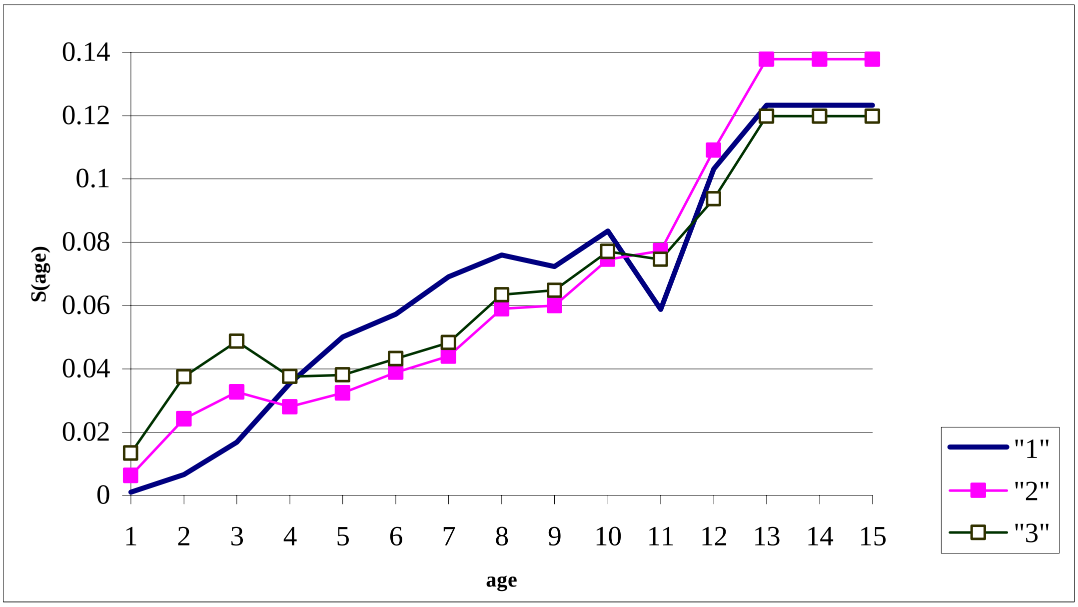


Figure 6.5.3.2 **ISVPA- estimates of selectivity**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)

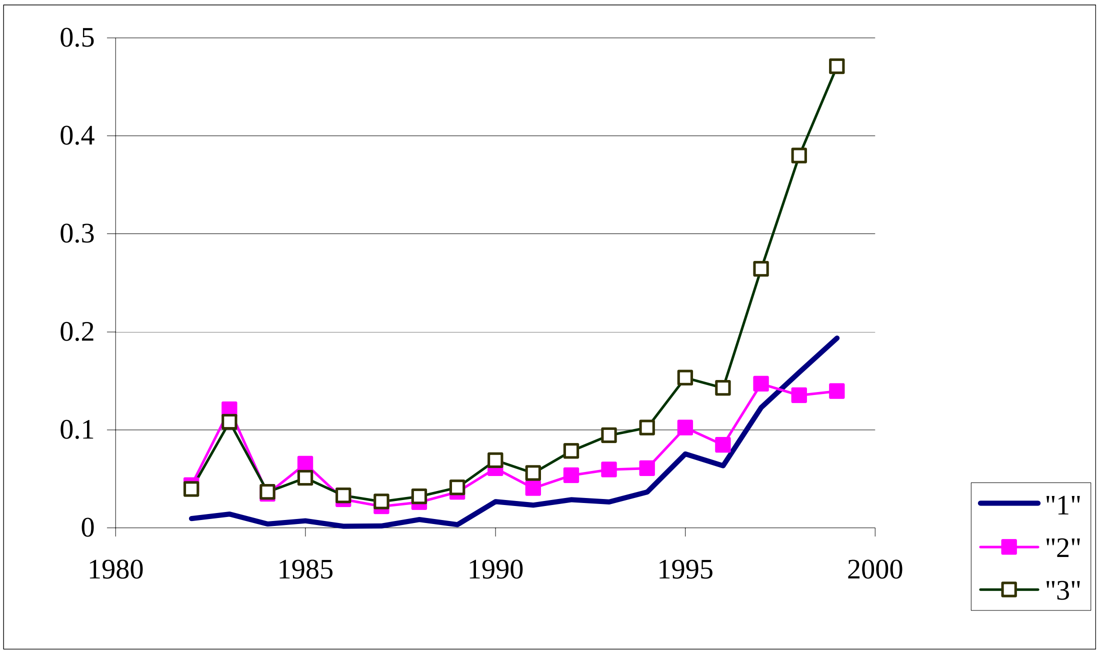


Figure 6.5.3.3 **ISVPA-estimates of F(2-4)**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)

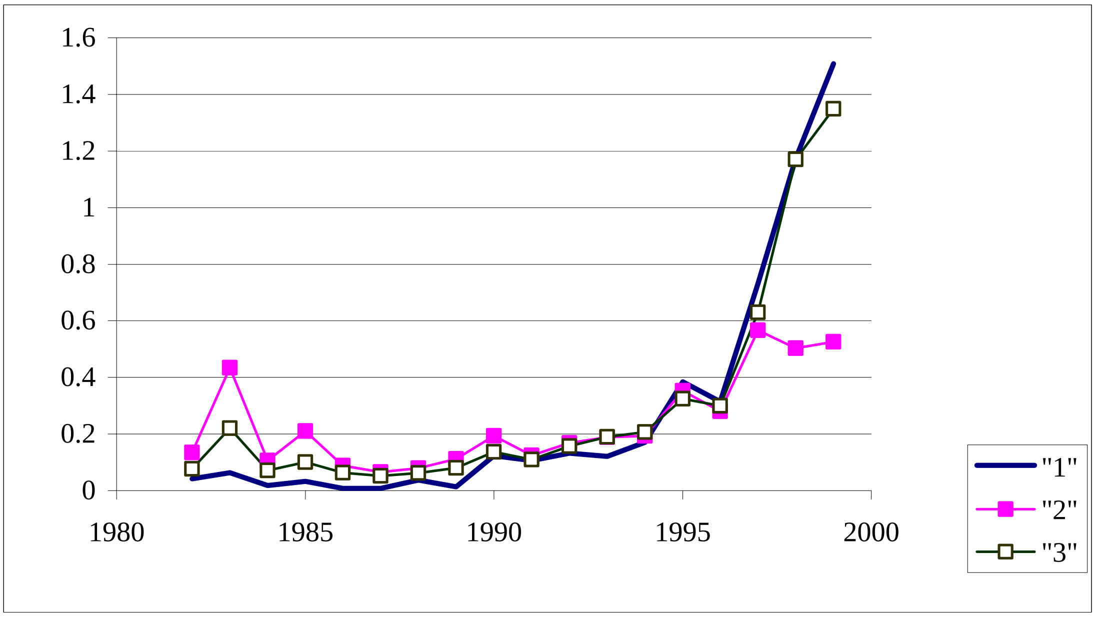


Figure 6.5.3.4 **ISVPA-estimates of F(5-15)**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)

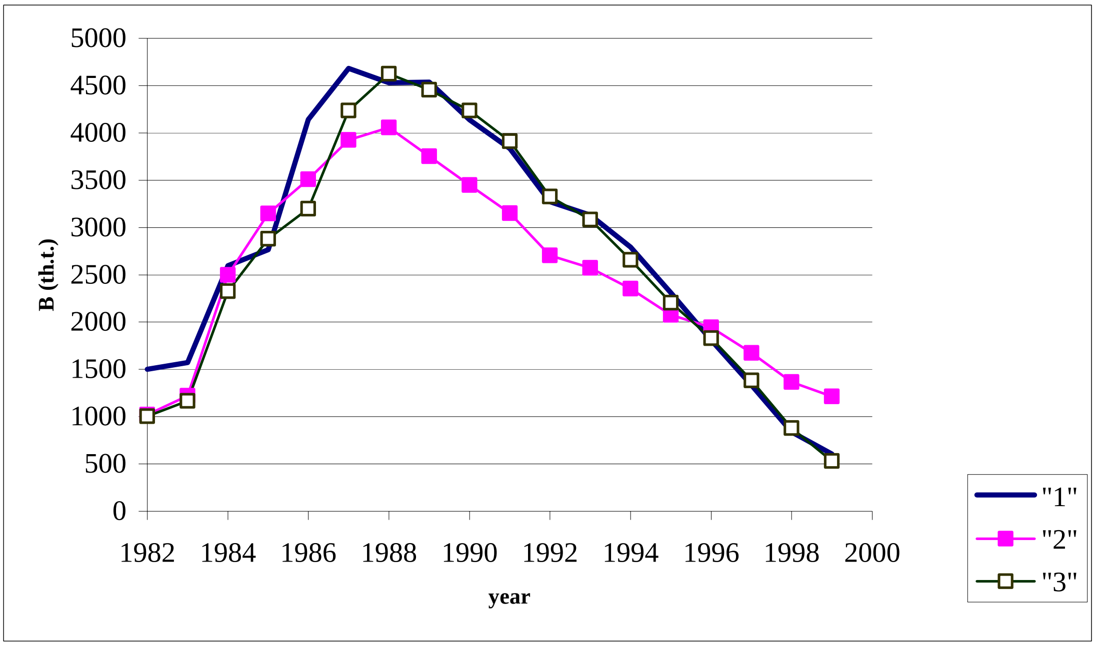


Figure 6.5.3.5 **ISVPA-estimates of stock biomass**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)

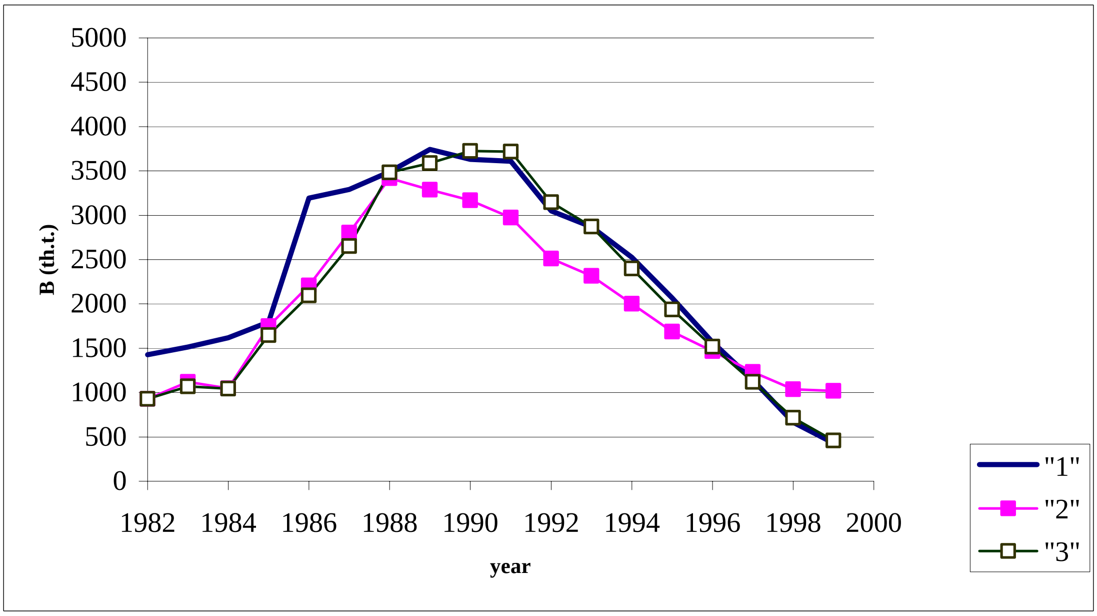
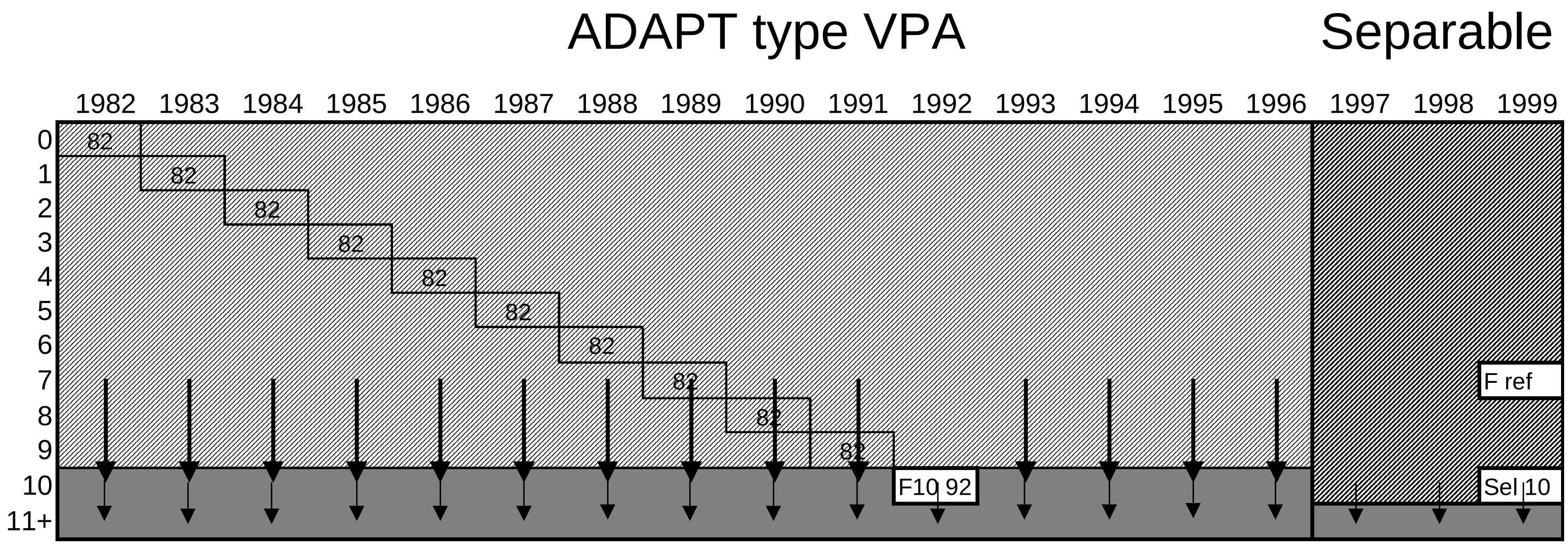


Figure 6.5.3.6 **ISVPA-estimates of SSB**
1- ISVPA, version1 ("unbiased" estimates of logarithms of parameters)
2- ISVPA, version 2 ("unbiased" separabilization)
3- ISVPA, version 3 ("unbiased" estimates of effort factor)



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 6.5.4.1 An illustration of the SAD model structure used for the assessment of the Western horse mackerel stock.

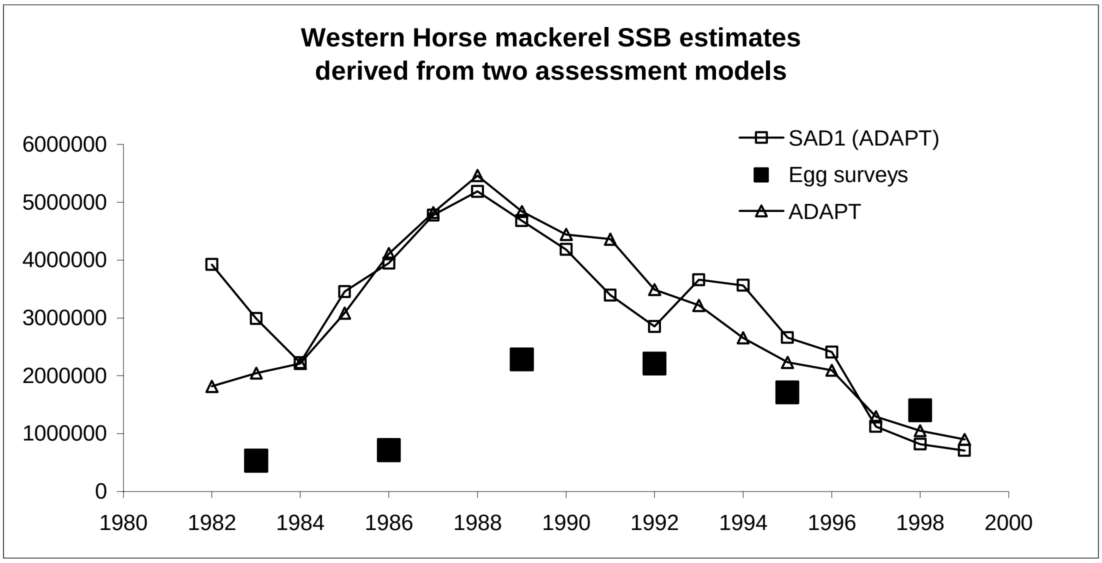


Figure 6.5.4.2 A comparison of the Western horse mackerel ADAPT model estimates of SSB with those derived from the SAD model specified with an "ADAPT structure" and the those of the triennial egg survey.

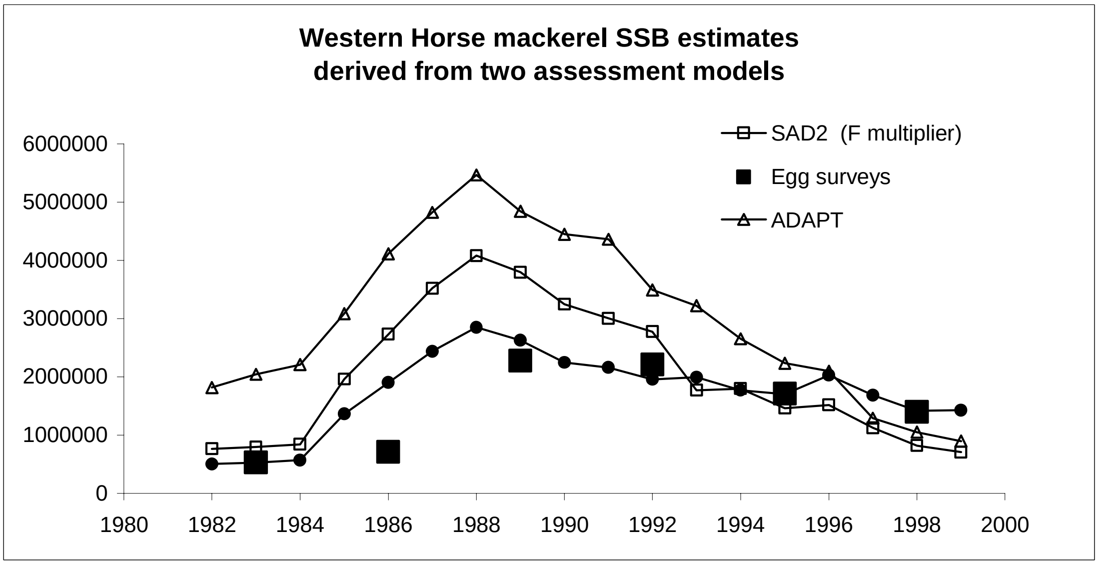


Figure 6.5.4.3 A comparison of the Western horse mackerel ADAPT model estimates of SSB with those derived from the SAD2 and SAD3 models specified with a fishing mortality on the oldest age and on the plus group of 2 x the average F at ages 7 - 9 in the years 1982 - 1996 (SAD2) and also estimation of the fishing mortality at age 10 in 1992 of the 1982 year class (SAD3).

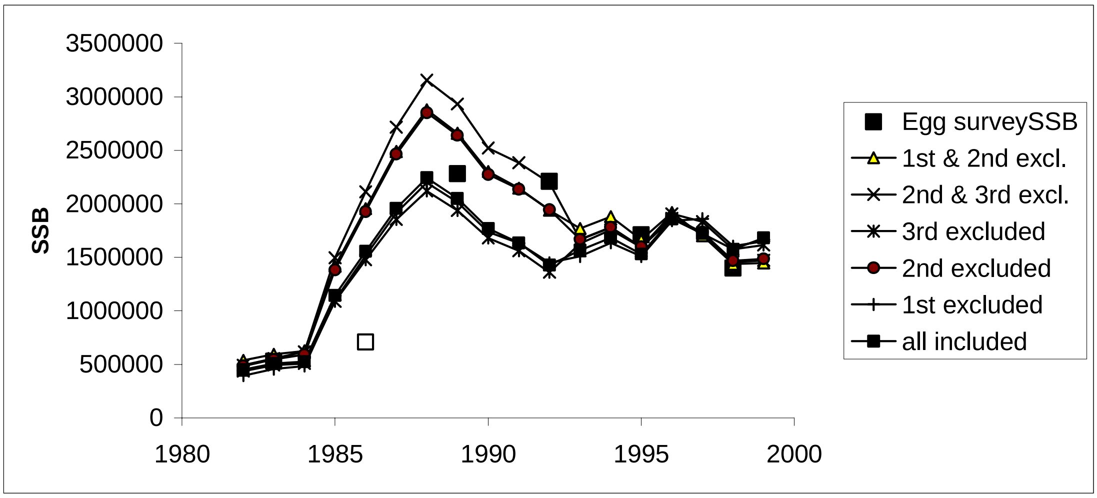


Figure 6.5.4.4 A sensitivity analysis of the change in the time series of Western horse mackerel SSB estimates estimated by the SAD model. The lines represent estimates derived from models fitted to six combinations of the triennial egg survey data points.

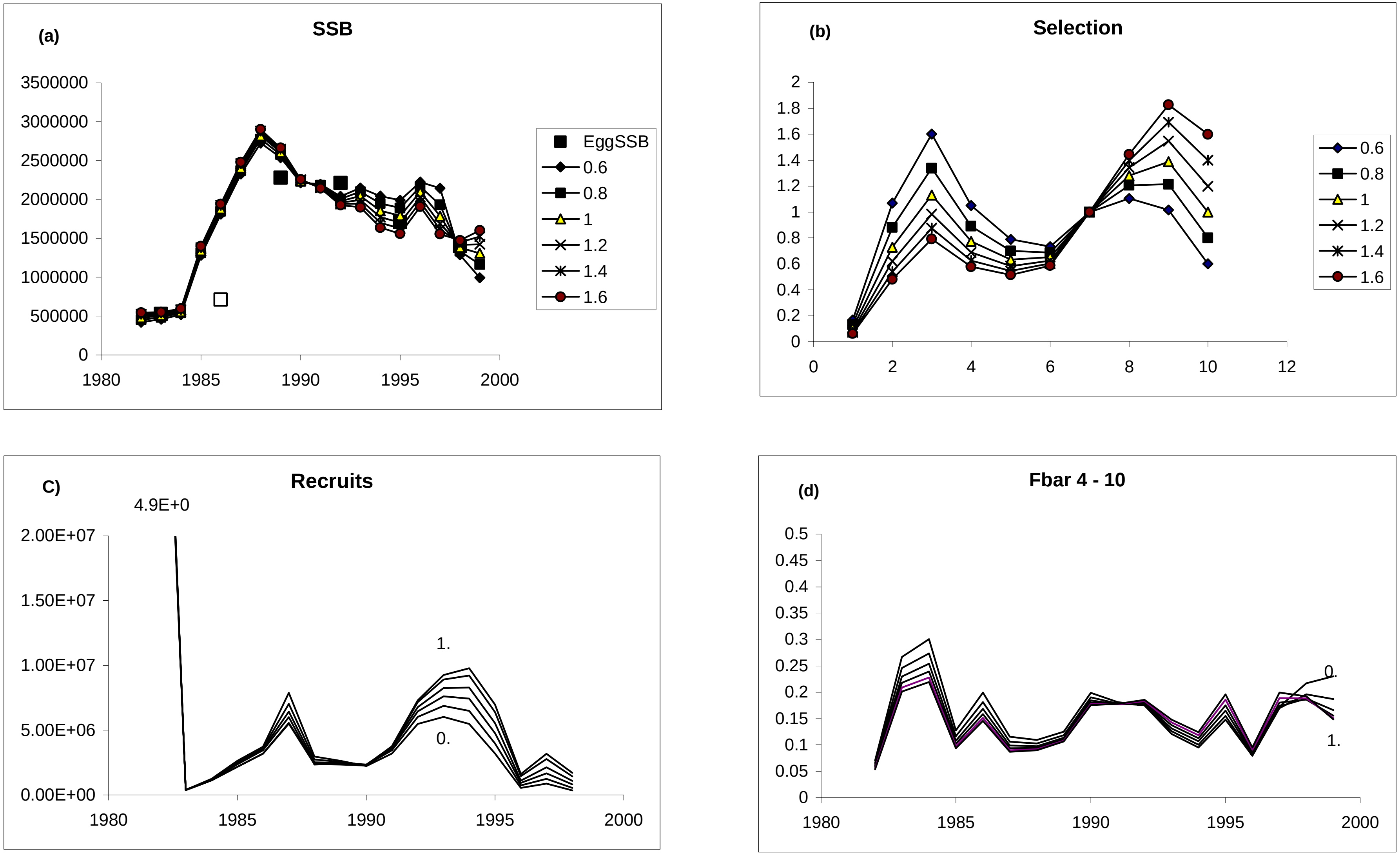


Figure 6.5.4.5a,b,c,d. A sensitivity analysis of the change in the selection at the oldest age in the separable model within the SAD assessment structure.
(a) the influence on the time series of Western horse mackerel SSB estimates (b) the response of selection at age,
(c) the effect on recruitment, (d) the effect on aveage fishign mortality at ages 4 - 10.

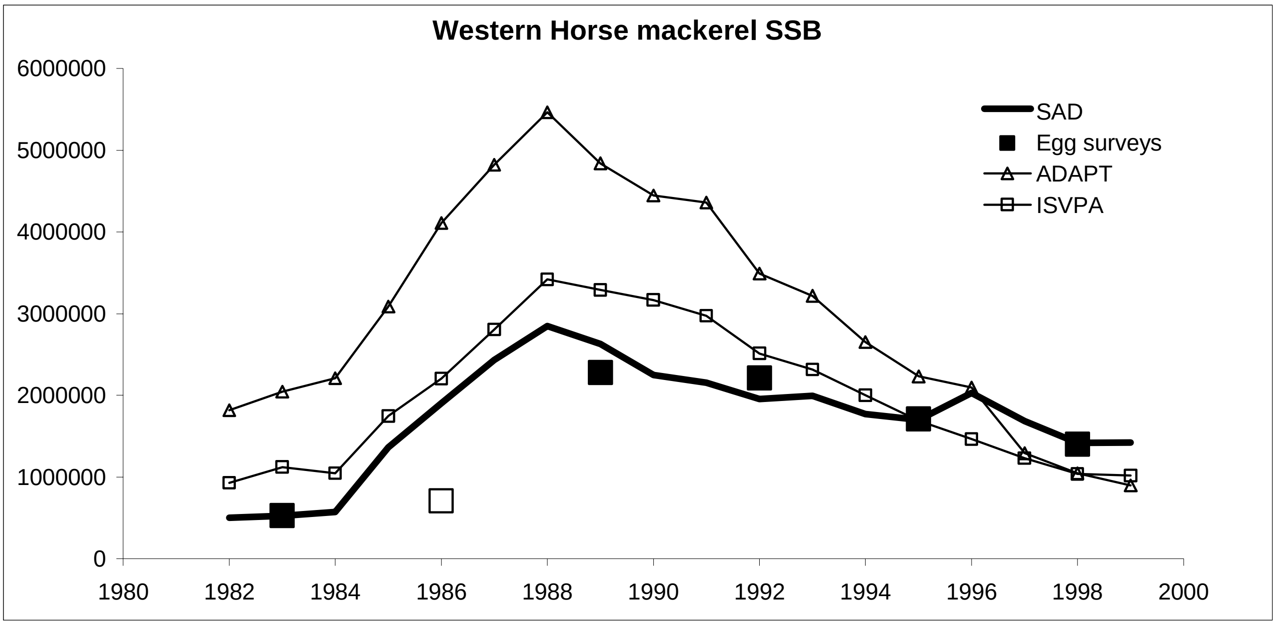


Figure 6.5.4.6 A comparison of the Western horse mackerel SAD model estimates of SSB with those derived from the ADAPT VPA and the separable ISVPA and the those of the triennial egg survey.

Western horse mackerel

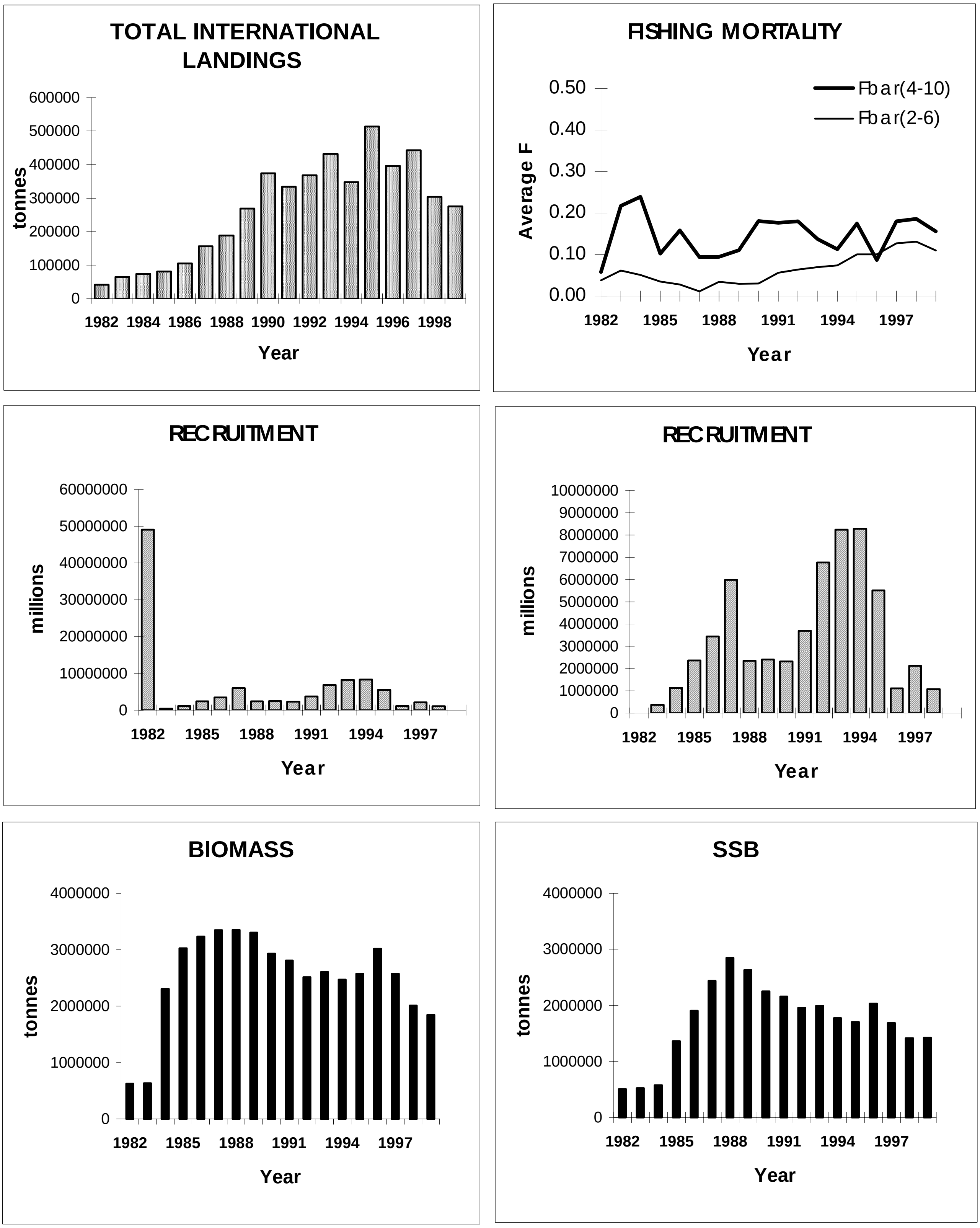
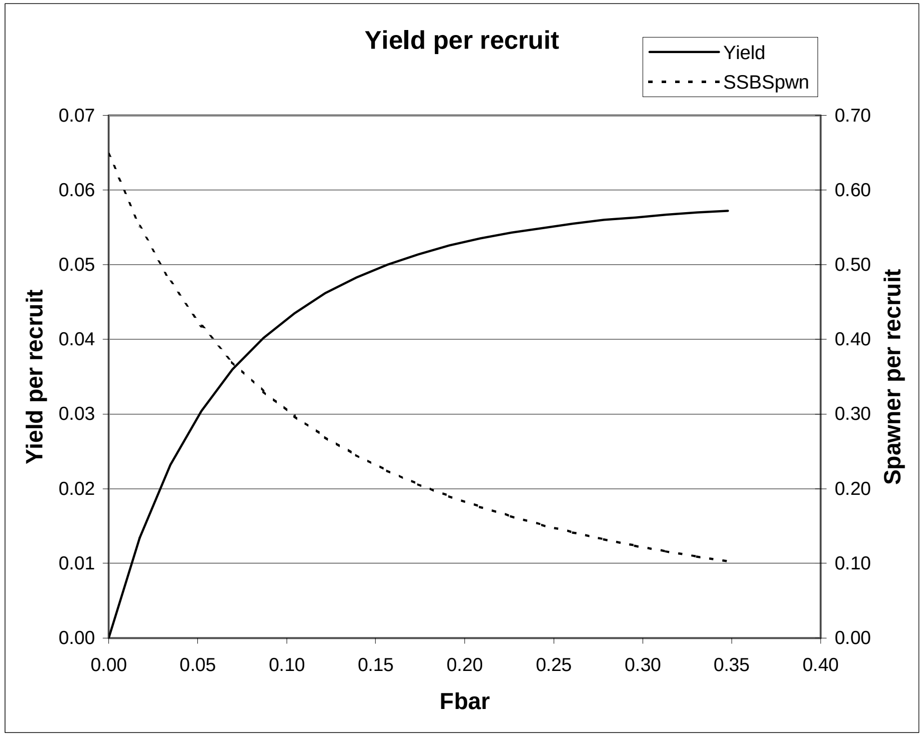
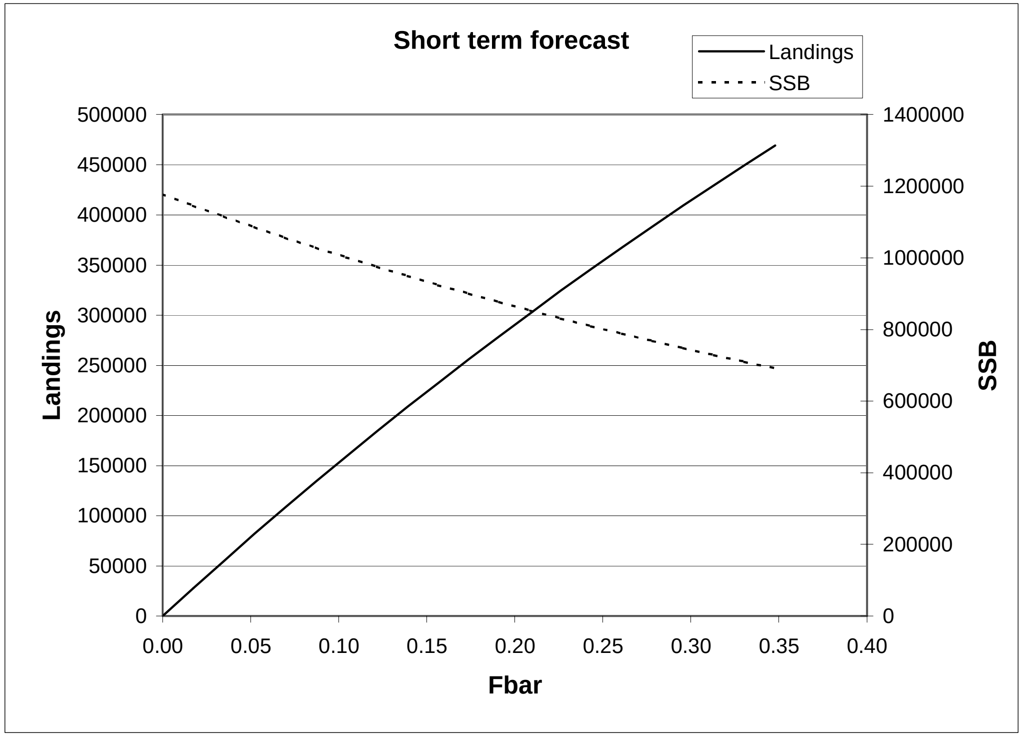


Figure 6.5.5.1 The stock summary plots for the Western Horse mackerel.
a) Landings b) Average fishing mortality (4 - 10)
c) Recruitment 1982 - 1999 d) Recruitment 1983 - 1999
e) Stock biomass f) Spawning stock biomass





MFYPR version 2a
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Time and date: 09:16 22/09/00

Reference point	F multiplier	Absolute F
Fbar(4-10)	1.0000	0.1740
FMax	3.6783	0.6399
F0.1	0.8861	0.1542
F35%SPR	0.8862	0.1542

Weights in kilograms

MFDP version 1a
Run: whm2000
Western Horse Mackerel 2000 W.G.
Time and date: 09:09 22/09/00
Fbar age range: 4-10

Input units are thousands and kg - output in tonnes

Figure 6.6.1a,b The results of the deterministic catch prediction and yield per recruit for the Western Horse mackerel stock.

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIC AND IXA)

7.1 ICES advice Applicable to 1999 and 2000

ICES in 1999 stated that there are no explicit management objectives for this stock. However, for any management objectives to meet precautionary criteria, their aim should be to reduce or maintain F below Fpa and to increase or maintain spawning stock biomass above Bpa. The stock is considered to be harvested outside safe biological limits although the spawning stock is estimated above the proposed Bpa. ICES stated that fishing mortality should be reduced to below Fpa, corresponding to landings less than 59,000 t in 2000. ICES proposes that Bpa be set at 205,000 t and Fpa be established at 0.17, which is considered to provide approximately 95% probability of avoiding Flim. A total catch of 61,000 t in 2000 corresponding to $F_{status\ quo}$ (F = 0.18), was considered inconsistent with the precautionary approach. ICES recommended that the TAC for this stock should only apply to *Trachurus trachurus* and that other species of horse mackerel be excluded. The TAC up to 1997 (73,000 t) included catches of other species of horse mackerel.

7.2 The Fishery

7.2.1 The Fishery in 1999

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 51,922 t in 1999 which represents a decrease of 19.5% compared to the 1998 catches. This level of catch is similar to the mean level of catches obtained during the period 1990-1997: 51,229 t (± 4,671). The catch by country and gear is shown in Table 7.2.1.1. The Portuguese catches show a significative decrease of 32%, which represents one of the lowest level of catches reached since 1986. This decrease is principally due to the decrease in the catches from bottom trawlers (-48%), that can partly be explained by a strike of Portuguese bottom trawlers during the first quarter of 1999. In the Spanish catches the decrease is lesser, 13% compared to 1998 catches, which still represents a high catch figure in the last fourteen years. The high level of Spanish catches reached on this stock during 1997, 1998 and 1999 is due to the higher catches obtained by the purse seiners. The falls in abundance of other target species, like sardine in the Spanish area, has forced the purse seine fisheries to target other species like horse mackerel (ICES CM 1999/ACFM: 6). The 1999 proportion of the catches by gear presents a similar pattern than in 1997 and 1998, being the purse seiners catches the most important ones in the Spanish area (73% of the catches) whereas in the Portuguese waters, the trawler's catches are the majority, although in 1999 this proportion (48%) is close to that of purse seiner's. The bottom trawl catches from Spain in 1999 also present an important decrease of 24% compared with the high value obtained in 1998.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.*, 1995; Villamor *et al.*, 1997), although the second and third quarter show relatively higher catches (see Table 7.2.1.2).

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, it was obtained a CPUE indices from 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 to 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.

7.3 Biological Data

7.3.1 Catch in numbers at age

The catch in numbers at age from all gears for 1999 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. The 1986 and 1987 year classes are strong but do not reach the extreme high level of the 1982 year class. The 1991 and 1992 year classes are shown as strong in the catches specially in previous years. In 1999 the catches on intermediate ages (4 to 6) are also noticeable as they were in 1998. 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 3,492 fish aged distributed by quarters. Catch in numbers at age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Sub-division. The sampling intensity is discussed in Section 1.4. 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 1999 mean weights and mean lengths at age in the catch by quarter and Sub-division for the Spanish and Portuguese data. Table 7.3.2.3 presents the weight at age in the stock and in the catch. The matrix of mean weights at age in the stock was calculated in the following way: for each age, the mean weight in the catch in the fourth quarter of each year, was averaged with the mean weight in the catch in the first quarter of the following year. Then an overall average over the years was calculated for the final mean weight estimate for each age.

The data before 1985 have not yet been revised according to the approved ageing methodology and should therefore be considered only correct for ages 0 and 1, ages in which both methods were in agreement.

7.3.3 Maturity at age

The proportions of fish mature at each age have been considered to be constant over the assessment period. The maturity ogive used before to the 1992 assessment (ICES 1993/Assess:7) presented low estimates at the age range 5 to 8 due to lower availability of this range of fish on the catches (ICES 1993/Assess:7; ICES 1998/Assess:6). As ACFM requested in 1992 the maturity ogive was smoothed as follows. 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 2000 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.

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.

Portuguese surveys show similar catch rates and variability in the data, showing the following mean and standard deviation in the time series: 24.3 (±19.7) and 21.6 (±17) for July and October surveys respectively. Both surveys present similar trends for the 1995-1998 period. The Spanish October survey biomass index shows a decrease of 24% compared with the index obtained in 1998 but this is still a high value compared with the rest of the series. This series has less variability than the observed in the Portuguese series, giving a mean yield of 21 (±11.5). 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 Spanish and Portuguese bottom trawl fleets in 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 area, in 1999, the index at age 0 from the October survey shows a slight increase compared with the 1998 index, but it is still continuing the low levels obtained since 1995. In the Portuguese October survey the recruitment (age 0) observed in 1998 was one of the lowest value in the series contrasting with the extremely high value reached in 1997. It seems that there exists no good agreement in trends between these surveys in the abundance index for the 0 group. In the Spanish October survey in 1999 the yields in the range of ages from 4 to 9 years old were noticeable, as they were in 1998, changing the pattern observed in 1997 (Table 7.4.1.2). In the Portuguese July survey there is a strong fall in the observed 1995 abundance indices, except for ages 0 and 1, that it is continuing in 1997 and 1998.

7.4.2 Egg surveys

Some problems have been detected in the research work related with egg surveys which are 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 MHMEGG WG (ICES 2000/G:01 Ref:D) provided a revised estimate of the 1998 egg production using mean values instead 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 have been presented to the Working Group (WD, Costa, 2000). Then the Working Group recommends to combine these data with those already presented previously for the Division VIIIc to obtain, as soon as possible, an estimation of the SSB from 1998 egg survey.

7.5 Effort and Catch per Unit Effort

Figure 7.5.1 shows the evolution of the commercial standardized 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 1999. A Coruña bottom trawl fleet in 1999 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 increased by 35.7%, comparing with the 1998 observed effort, anyway, it is maintained below the mean effort level from the total 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 1999. In 1999 both fleets show minor changes in catch rates comparing with previous years. The Avilés trawl fleet show a slight decrease in 1999, reaching a catch rate similar to the relatively low levels obtained in 1997 and 1998. For A Coruña trawl fleet a slight increase, comparing with the 1997 catch rate, is observed, but it still is at a lower level than the CPUE mean of the series (147 ± 25). 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 1999 (Table 7.5.2).

As it has been observed in 1997, the catch rates of juveniles (up to age 3) from the Galician trawl fleet has been mantained in 1999. Also in 1999, there was an increase of the intermediate ages (4 – 9) for the same fleet. A similar pattern is obtained with the Aviles trawl fleet during the period 1997- 99: poor representation of the younger ages and a noticeable catch rate on intermediate ages (4 – 9). There is no estimation of effort in 1998 for A Coruña bottom trawl fleet.

7.6 Recruitment Forecasting

In 1999 the index of the 0 group from the Spanish survey carried out in the recruitment season (October) was 30.74 fish/1/2h. The Portuguese October survey was not used in this year's assessment because was carried out with a different vessel and fishing gear from the rest of the series, and to date there is no conversion factor between vessels and gears. Figure 7.6.1 shows the evolution of these indices from 1985 to 1999. 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. From 1989 to 1994 these surveys gave different estimates, but in 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate. In 1996 and 1997 the recruitment indices from the Portuguese survey were much higher than the ones from the Spanish one.

7.7 State of the Stock

7.7.1 Data exploration and preliminary modelling

All available data were used in the preliminary assessment of this stock. Given the high coherence of the time series and of the previous assessments carried out using Extended Survivors Analysis (XSA), no alternative methods were considered to be used with this stock. However, a production model was used, as a preliminary attempt to assess this stock with this alternative method (WD Abaunza et al, 2000). This model gave a similar perception of the stock as that from the VPA-based model: stability in the SSB estimates and the level of fishing mortality is slightly higher than the Fpa and F_{MSY} The use of such model is not intended as a replacement to age-structured models, but as a way to corroborate the coherence of the assessment.

As in last year's assessment, XSA parameters were set at catchability independent of age for ages equal or greater than 9 years old, and the plus group at 12. The strength of shrinkage has a significant decreasing effect on the standard errors of the log catchability (Anon. 1995/Assess:2). In order to compare the independent information provided by the different fleets, XSA was firstly run with each fleet in separate, without shrinkage.

The external information used in the tuning was:

Fleet 1: Catch per unit of effort of the trawl fleet from A Coruña (VIIIc West - North Galicia)

Fleet 2: Catch per unit of effort of the trawl fleet from Avilé s (VIIIc East - Cantabrian Sea)

Fleet 3: Portuguese October Trawl Survey during the recruitment season (Division IXa)

Fleet 4: Portuguese July Trawl Survey end of spawning season in Division IXa

Fleet 5: Spanish October trawl Survey during the recruitment season (Sub-division IXa North and Division VIIIc)

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 October Portuguese survey has been a very influential index in previous assessments, therefore a comparison was done between this year's assessment with and without the 1999 estimates of this survey. The result suggests that the inclusion or not of the last year of the October Portuguese survey may slightly change the perception of the state of the stock, not in terms of trends but of the biomass estimates over time.

The slopes of the linear regressions between log-catchability and log-population were analysed for the ages with catchability dependent on year class strength: fleets 1 and 4 presented a negative slope at age 0 with a low coefficient of determination, as did fleet 3 at ages 0 and 1 with a zero R-square. Therefore those ages were not included in the tuning, because they were not providing any information.

Figure 7.7.1.1 compares the SSB estimated for 1997, 1998 and 1999 by tuning fleet without shrinkage. The lowest SSB values were estimated from fleet 1 - A Coruña (VIIIc west) and the highest ones correspond to the estimates provided by fleet 3 (October Portuguese bottom-trawl survey). The 1997 and 1998 SSB estimates from the 1999 assessment agree closely with those given by fleets 1, 4 and 5. Fleets 2 and 3 provided higher values of SSB. In 1998 there was no estimate of fishing effort for fleet 1, hence that year was removed from the CPUE series. The options for the final assessment were taken in accordance with this exploratory analysis, and keeping consistency with last year's assessment.

7.7.2 Stock assessment

The final stock assessment was performed following the conclusions of the preliminary modelling (Section 7.7.1). Figure 7.7.1.1 compares this assessment SSB estimates with those from the last assessment and from the preliminary assessments with each fleet at a time. Results show coherence among assessments, except those made only with fleets 2 and 3.

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 1.00. 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. Figure 7.7.2.2 represents the retrospective SSB estimates performed by the final VPA, and the 1995 egg survey estimate, indicating a very good agreement among them. The tuning diagnostics and final results are given in Tables 7.7.2.1-7.7.2.4. Figure 7.7.2.3 shows the fish stock summary trends over the period 1985-1998 according to the final assessment.

7.7.3 Reliability of the assessment and uncertainty estimation

This assessment is relatively consistent with the assessments performed in previous years. The spawning stock biomass estimated from the 1995 egg surveys is in close agreement with the 1995 SSB level estimated using the two October surveys, the July survey information and the two commercial fleets. Thus this assessment seems to be reliable, with a relatively low level of uncertainty.

7.8 Catch Predictions

The terminal population in 1999 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 1985-1997. 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 97-99) the predicted catch in weight for 2000 is 52,500 t. In 2001, assuming the same recruitment level, the catch at Fstatus quo is predicted to be 55,100 t. The spawning stock biomass is predicted to decrease from 241,200 t at the beginning of 2000 to 228,800 t in 2001 (Table 7.8.2.a) at Fstatus quo. Assuming F status quo in 2001, the spawning stock biomass is predicted to decrease in 2002 to 216,300 t.

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 Fmax to be 0.18 (in fact 0.1755), at the reference age (1-11).

7.10 Reference Points for Management Purpose

As can be seen from Figure 7.10.1, the range of SSBs is quite narrow, and no stock-dependent trend in the recruitment can be inferred from these observations. The very strong 1982 year class has contributed substantially to the SSB during the whole period 1985-1999. The lowest biomass attained during the period was 132,000 t in 1985, which originated a medium recruitment.

In 1998 ACFM defined Blim as Bloss, and Bpa was defined as Bloss x 1.5 that corresponded to 205000 t. In the past this Working Group proposed Fmax as Fpa. This was further supported by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10). ACFM established Fpa as Flim * 0.63 = 0.17, which is close to the current Fmax (0.1755). Flim was considered equal to Floss. This working group considers that there are not reasons to change these reference points.

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 last year recommendation from this working group. In 1999, F attained the same value as Fpa (F99 = 0.17). Table 7.12.1 summarises 2 management options: F status-quo and Fpa.

Table 7.2.1.1. Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984–1999 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1962	7,231	46,345	3,400	56,976	-	-	-	-	53,202	110,778
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,733	28,776	19,330	376[1]	-	48,482	72,235
1982	12,676	9,906	8,304	30,886	-[2]	-[2]	-[2]	-	28,450	59,336
1983	16,768	6,442	7,741	30,951	8,511	34,054	797	-	43,362	74,313
1984	8,603	3,732	4,972	17,307	12,772	15,334	884	-	28,990	46,297
1985	3,579	2,143	3,698	9,420	16,612	16,555	949	-	34,109	43,529
1986	-[2]	-[2]	-[2]	28,526	9,464	32,878	481	143	42,967	71,493
1987	11,457	6,744	3,244	21,445	-[2]	-[2]	-[2]	-[2]	33,193	54,648
1988	11,621	9,067	4,941	25,629	-[2]	-[2]	-[2]	-[2]	30,763	56,392
1989	12,517	8,203	4,511	25,231	-[2]	-[2]	-[2]	-[2]	31,170	56,401
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205
1991	9,437	5,003	3,056	17,497	9,681	18,019	187	127	28,014	45,511
1992	12,189	7,027	3,438	22,654	11,146	16,972	81	103	28,302	50,956
1993	14,706	4,679	6,363	25,747	14,506	16,897	124	154	31,681	57,428
1994	10,494	5,366	3,201	19,061	10,864	22,382	145	136	33,527	52,588
1995	12,620	2,945	2,133	17,698	11,589	23,125	162	107	34,983	52,681
1996	7,583	2,085	4,385	14,053	10,360	19,917	214	146	30,637	44,690
1997	9,446	5,332	1,958	16,736	8,140	31,582	169	143	40,034	56,770
1998	13,221	5,906	2,217	21,334	13,150	29,805	63	118	43,136	64,480
1999	6,866	5,705	1,849	14,420	10,015	27,332	29	126	37,502	51,922

[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 8c-E, 8c-W, 9a-N		Unit:tonnes		Total
Quarter/Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34116
1986	-	-	-	-	42967
1987	5179	8678	11067	8269	33193
1988	6445	7936	7918	8464	30763
1989	7824	7480	8011	7855	31170
1990	6827	7871	7766	6783	29247
1991	5369	7220	8741	6686	28016
1992	4065	8750	10042	5445	28302
1993	5546	9227	9823	7085	31681
1994	6486	8966	9732	8343	33527
1995	6050	10328	10969	7636	34983
1996	7188	8045	8211	7193	30637
1997	6638	11132	13854	8410	40034
1998	8244	10696	13089	11107	43135
1999	7715	9589	12027	8170	37502

Country/ Sub-division	Portugal 9a-CN, 9a-CS, 9a-S		Unit:tonnes		Total
Quarter/ Year	1	2	3	4	
1984	4669	6506	3577	2358	17110
1985	1226	3055	2946	2192	9419
1986	4627	8093	7542	8264	28526
1987	3902	5474	6654	3524	19554
1988	3069	7402	7554	7100	25125
1989	4074	9096	8543	3513	25226
1990	3341	5753	5873	4992	19959
1991	3101	5630	5094	3672	17497
1992	2516	5661	7196	7281	22654
1993	5455	6401	8384	5507	25747
1994	4418	5051	6386	3206	19061
1995	3240	4618	6038	3802	17698
1996	2649	3830	4068	3506	14053
1997	4449	5370	4218	2699	16736
1998	5498	5846	6005	3995	21344
1999	3479	3991	4023	2927	14420

Table 7.3.1.1a.- Southern horse mackerel catch in numbers at age (in thousands) by quarter and area in 1999

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	1087.614	1392.630	5459.599	2043.948	152.048	457.163	9505.389
2	907.826	1027.597	3860.885	626.363	481.478	7557.155	13553.478
3	2841.520	5606.755	16359.595	769.171	45.137	2381.036	25161.696
4	840.574	2519.082	1869.224	987.348	144.550	3065.136	8585.341
5	95.846	321.352	305.395	992.924	301.900	3534.657	5456.227
6	85.614	337.284	635.104	1376.614	820.470	2787.196	5956.668
7	18.655	79.525	314.959	1912.969	1830.000	2750.993	6888.445
8	18.140	51.901	191.158	1633.244	1990.569	2663.266	6530.138
9	16.476	34.456	190.948	707.502	1123.639	1187.961	3244.506
10	26.257	30.164	296.851	327.281	533.902	413.841	1602.040
11	23.224	22.383	215.458	175.790	480.127	236.912	1130.669
12	18.568	23.873	255.911	137.820	393.774	205.278	1016.656
13	9.828	7.492	86.515	10.582	176.699	5.710	286.998
14	0.000	0.000	16.040	13.408	90.753	8.192	128.393
15+	0.000	0.000	48.681	30.361	1424.953	17.776	1521.771
Total	5990.141	11454.494	30106.323	11745.325	9990.001	27272.273	90568.416

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	39.048	184.705	17.787	1471.091	1002.065	47730.402	50406.050
2	674.871	3084.647	1368.773	3908.936	1647.583	12333.588	22343.528
3	2866.273	9110.721	4624.462	794.752	616.674	820.394	15967.002
4	3057.689	8872.786	1590.077	2759.981	4739.044	1815.926	19777.814
5	619.061	1744.336	490.978	3278.092	6859.787	2529.754	14902.946
6	337.060	986.295	830.817	1403.612	4470.503	2031.184	9722.411
7	61.879	187.145	414.600	1499.991	3118.594	1981.531	7201.861
8	14.455	49.945	505.630	1228.623	2726.917	1300.933	5812.049
9	3.836	17.372	192.162	696.575	1444.981	593.042	2944.132
10	0.000	3.403	120.063	345.405	447.884	252.819	1169.574
11	0.000	1.701	71.508	282.689	244.209	99.879	699.986
12	0.000	0.425	44.531	319.375	173.638	95.420	633.390
13	0.000	0.851	83.484	125.645	16.279	4.032	230.291
14	0.000	0.000	25.977	44.004	16.116	2.606	88.703
15+	0.000	0.000	32.740	821.532	53.497	13.243	921.012
Total	7674.173	24244.332	10413.590	18980.304	27577.770	71604.754	152820.750

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	377.885	224.546	297.380	3744.749	0.000	13747.455	18014.129
1	762.186	689.254	681.801	11178.584	30.889	32338.484	44919.013
2	912.211	2055.926	2432.459	4999.860	1024.821	5700.616	16213.681
3	1746.472	10051.624	5360.141	1460.167	2899.047	403.214	20174.193
4	492.722	2925.304	2647.076	4961.953	18696.770	2283.253	31514.355
5	101.757	663.355	1093.474	2990.557	2209.243	732.692	7689.321
6	43.700	331.153	821.420	1568.547	775.845	376.154	3873.118
7	18.117	183.111	784.297	1792.705	609.243	274.103	3643.460
8	4.644	82.293	466.321	1955.864	531.132	229.909	3265.520
9	2.677	79.232	524.437	1637.723	389.356	151.280	2782.029
10	0.567	18.194	223.092	1828.265	320.406	70.303	2460.259
11	0.223	6.715	143.494	839.960	129.291	13.065	1132.525
12	0.000	6.819	203.444	463.243	87.230	15.767	776.504
13	0.000	3.104	112.654	252.314	26.060	1.181	395.313
14	0.000	0.624	46.156	422.796	2.149	0.378	472.102
15+	0.000	0.000	34.928	665.021	3.043	0.538	703.530
Total	4463.161	17321.254	15872.575	40762.310	27734.525	56338.390	158029.053

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	1181.514	4239.902	18747.708	8304.470	708.012	366.486	32366.578
1	900.712	669.194	2449.807	4996.997	1822.574	2476.306	12414.878
2	891.590	2143.075	2870.447	1329.406	3164.068	572.758	10079.754
3	1275.997	5384.849	1669.088	924.732	2573.484	268.321	10820.473
4	493.926	2144.267	443.942	4607.260	11782.388	1629.879	20607.736
5	256.827	1213.336	328.767	2238.495	2971.107	1836.907	8588.613
6	136.099	726.821	306.802	1194.627	1101.184	1006.757	4336.191
7	31.346	160.623	108.712	1329.848	516.920	871.928	2988.031
8	7.091	34.882	41.907	1307.639	466.551	683.859	2534.837
9	13.986	46.485	88.938	908.664	309.718	473.641	1827.446
10	12.421	37.132	81.694	874.638	340.254	197.650	1531.369
11	2.097	6.104	33.339	411.220	187.869	27.964	666.496
12	2.097	6.554	45.579	243.542	82.737	53.043	431.455
13	0.148	0.450	26.437	67.915	28.331	0.376	123.509
14	0.148	0.000	14.859	19.023	5.062	0.105	39.049
15+	0.000	0.000	2.685	25.363	7.321	0.130	35.499
Total	5206.001	16813.675	27260.710	28783.839	26067.580	10466.110	109391.914

Table 7.3.1.1.b.- Total catch in numbers at age (in thousands) in 1999.

AGES	AREA IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	1559.399	4464.448	19045.088	12049.218	708.012	14113.941	51940.106
1	2789.560	2935.784	8608.994	19690.621	3007.577	83002.355	120034.891
2	3386.498	8311.244	10532.565	10864.564	6317.951	26164.117	65576.940
3	8730.262	30153.950	28013.287	3948.822	6134.341	3872.964	80853.626
4	4884.911	16461.440	6550.319	13316.542	35362.752	8794.194	85370.157
5	1073.491	3942.379	2218.613	9500.069	12342.037	8634.011	37710.599
6	602.472	2381.553	2594.142	5543.400	7168.002	6201.290	24490.861
7	129.998	610.404	1622.568	6535.513	6074.758	5878.555	20851.795
8	44.330	219.021	1205.016	6125.371	5715.168	4877.967	18186.873
9	36.975	177.545	996.485	3950.465	3267.693	2405.925	10835.088
10	39.245	88.892	721.700	3375.589	1642.447	934.613	6802.487
11	25.544	36.903	463.799	1709.660	1041.495	377.819	3655.221
12	20.665	37.672	549.466	1163.981	737.379	369.508	2878.670
13	9.976	11.896	309.090	456.457	247.370	11.299	1046.088
14	0.148	0.624	103.032	499.231	114.080	11.281	728.395
15+	0.000	0.000	119.034	1542.278	1488.814	31.687	3181.813
Total	23333.476	69833.755	83653.198	100271.779	91369.876	165681.526	534143.609

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

Table 7.3.2.1a.- Southern horse mackerel mean weight at age (in kg) by quarter and area in 1999

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	0.035	0.037	0.032	0.018	0.026	0.052	0.034
2	0.043	0.044	0.043	0.062	0.041	0.059	0.056
3	0.066	0.069	0.068	0.085	0.071	0.078	0.077
4	0.104	0.105	0.102	0.099	0.122	0.110	0.116
5	0.129	0.129	0.129	0.126	0.155	0.124	0.129
6	0.153	0.152	0.156	0.169	0.201	0.163	0.170
7	0.180	0.180	0.180	0.186	0.241	0.188	0.201
8	0.206	0.202	0.203	0.202	0.232	0.204	0.213
9	0.227	0.222	0.250	0.208	0.255	0.199	0.225
10	0.238	0.255	0.268	0.212	0.287	0.201	0.249
11	0.247	0.251	0.268	0.238	0.291	0.225	0.269
12	0.249	0.290	0.295	0.219	0.329	0.216	0.286
13	0.265	0.268	0.273	0.350	0.410	0.347	0.371
14	0.000	0.000	0.475	0.345	0.349	0.344	0.364
15+	0.000	0.000	0.654	0.352	0.508	0.352	0.507
Total	0.068	0.078	0.073	0.135	0.270	0.124	0.123

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	0.038	0.040	0.023	0.028	0.026	0.021	0.021
2	0.046	0.048	0.044	0.040	0.037	0.041	0.043
3	0.073	0.085	0.071	0.091	0.108	0.075	0.095
4	0.099	0.099	0.095	0.114	0.121	0.116	0.123
5	0.126	0.129	0.134	0.121	0.127	0.126	0.131
6	0.148	0.154	0.164	0.157	0.154	0.155	0.161
7	0.171	0.174	0.184	0.215	0.179	0.169	0.185
8	0.215	0.213	0.223	0.228	0.203	0.192	0.208
9	0.239	0.240	0.251	0.239	0.195	0.181	0.207
10	0.000	0.290	0.290	0.294	0.207	0.184	0.236
11	0.000	0.316	0.316	0.295	0.231	0.207	0.262
12	0.000	0.344	0.344	0.349	0.223	0.208	0.293
13	0.000	0.389	0.398	0.415	0.360	0.368	0.404
14	0.000	0.000	0.485	0.352	0.347	0.352	0.390
15+	0.000	0.000	0.612	0.464	0.383	0.417	0.464
Total	0.090	0.092	0.107	0.143	0.141	0.044	0.091

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.022	0.020	0.023	0.019	0.000	0.022	0.022
1	0.044	0.047	0.048	0.050	0.062	0.039	0.043
2	0.066	0.072	0.067	0.066	0.123	0.045	0.067
3	0.091	0.093	0.093	0.120	0.129	0.124	0.109
4	0.121	0.121	0.123	0.139	0.128	0.131	0.131
5	0.146	0.148	0.149	0.175	0.162	0.174	0.167
6	0.163	0.167	0.172	0.197	0.179	0.182	0.186
7	0.190	0.194	0.198	0.236	0.224	0.213	0.223
8	0.207	0.219	0.226	0.258	0.244	0.219	0.248
9	0.243	0.246	0.248	0.304	0.247	0.228	0.280
10	0.275	0.278	0.285	0.319	0.279	0.259	0.309
11	0.289	0.297	0.296	0.361	0.349	0.322	0.351
12	0.000	0.328	0.336	0.303	0.290	0.267	0.310
13	0.000	0.399	0.400	0.451	0.421	0.413	0.434
14	0.000	0.430	0.470	0.523	0.526	0.533	0.518
15+	0.000	0.000	0.550	0.534	0.533	0.542	0.535
Total	0.078	0.099	0.125	0.142	0.142	0.045	0.103

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.029	0.018	0.023	0.020	0.018	0.022	0.022
1	0.046	0.062	0.046	0.035	0.069	0.048	0.049
2	0.070	0.078	0.065	0.074	0.091	0.054	0.083
3	0.098	0.098	0.095	0.125	0.125	0.143	0.119
4	0.125	0.126	0.126	0.136	0.132	0.153	0.137
5	0.139	0.142	0.145	0.177	0.161	0.178	0.170
6	0.156	0.157	0.161	0.196	0.175	0.184	0.184
7	0.175	0.174	0.178	0.231	0.221	0.214	0.221
8	0.191	0.191	0.194	0.249	0.248	0.220	0.240
9	0.219	0.212	0.219	0.259	0.266	0.230	0.251
10	0.228	0.226	0.233	0.290	0.293	0.262	0.284
11	0.277	0.272	0.279	0.349	0.349	0.306	0.344
12	0.277	0.275	0.288	0.294	0.298	0.257	0.291
13	0.341	0.320	0.338	0.408	0.403	0.421	0.392
14	0.341	0.000	0.362	0.501	0.504	0.511	0.450
15+	0.000	0.000	0.605	0.501	0.510	0.509	0.510
Total	0.076	0.085	0.042	0.111	0.134	0.141	0.102

Table 7.3.2.1b.- Total mean weight at age (in kg) in 1999.

AGES	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
	AREA						
0	0.027	0.018	0.023	0.020	0.018	0.022	0.021
1	0.041	0.045	0.037	0.041	0.052	0.029	0.033
2	0.057	0.061	0.055	0.057	0.078	0.047	0.055
3	0.078	0.087	0.075	0.109	0.125	0.087	0.086
4	0.105	0.107	0.110	0.130	0.129	0.125	0.122
5	0.131	0.136	0.142	0.152	0.142	0.141	0.143
6	0.151	0.156	0.164	0.180	0.165	0.165	0.167
7	0.176	0.181	0.190	0.215	0.206	0.186	0.201
8	0.206	0.209	0.220	0.235	0.221	0.204	0.221
9	0.227	0.232	0.247	0.265	0.229	0.203	0.238
10	0.236	0.249	0.273	0.299	0.265	0.214	0.275
11	0.249	0.266	0.285	0.335	0.295	0.229	0.305
12	0.252	0.295	0.314	0.304	0.296	0.222	0.293
13	0.266	0.313	0.359	0.432	0.407	0.364	0.401
14	0.341	0.430	0.459	0.502	0.359	0.353	0.471
15+	0.000	0.000	0.611	0.493	0.503	0.383	0.501
Total	0.079	0.090	0.077	0.133	0.153	0.064	0.098

Table 7.3.2.2a.- Southern horse mackerel mean length at age (in cm) by quarter and area in 1999

QUARTER 1

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
	AREA						
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	15.8	16.1	15.3	12.5	14.2	18.2	16.7
2	17.1	17.2	17.1	19.5	16.8	19.1	19.5
3	19.7	20.0	20.0	21.7	20.1	21.0	22.4
4	23.2	23.3	23.0	22.9	24.7	23.8	25.6
5	25.0	25.0	25.0	24.8	26.5	24.8	25.4
6	26.5	26.4	26.6	27.6	29.2	27.2	27.9
7	28.0	28.0	28.0	28.5	31.2	28.6	29.3
8	29.3	29.1	29.2	29.4	30.8	29.5	30.0
9	30.3	30.1	31.2	29.6	31.8	29.2	30.5
10	30.8	31.5	32.0	29.7	33.1	29.3	31.7
11	31.2	31.4	32.0	31.1	33.4	30.5	32.7
12	31.3	32.8	33.1	30.2	34.7	30.1	33.3
13	32.0	32.1	32.3	35.7	37.6	35.6	36.9
14	0.0	0.0	39.1	35.5	35.7	35.5	36.1
15+	0.0	0.0	43.1	35.8	40.6	35.8	40.5
Total	19.5	20.6	19.8	24.2	31.6	24.1	24.4

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	16.0	16.5	13.6	14.7	14.4	13.2	13.3
2	17.5	17.8	17.1	16.6	16.1	16.7	17.4
3	20.5	21.6	20.2	22.1	23.6	20.5	24.9
4	22.7	22.8	22.4	24.1	24.6	24.2	27.0
5	24.7	25.0	25.3	24.6	25.0	24.9	25.9
6	26.2	26.5	27.1	26.8	26.7	26.8	27.7
7	27.5	27.6	28.2	29.9	28.1	27.6	28.6
8	29.8	29.7	30.1	30.6	29.5	28.9	29.7
9	30.8	30.9	31.4	31.0	29.0	28.2	29.5
10	0.0	33.0	33.0	33.3	29.5	28.4	30.8
11	0.0	34.0	34.0	33.5	30.7	29.6	32.0
12	0.0	35.0	35.0	35.4	30.3	29.6	33.1
13	0.0	36.5	36.8	37.8	36.1	36.4	37.3
14	0.0	0.0	39.3	35.8	35.6	35.8	36.8
15+	0.0	0.0	42.5	39.4	36.8	37.8	39.3
Total	21.8	22.0	22.5	24.4	25.5	15.9	21.2

Table 7.3.2.2a (Cont'd)

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	12.9	12.4	13.1	12.8	0.0	13.5	13.6
1	16.6	17.0	17.2	18.0	19.5	16.4	17.1
2	19.4	20.1	19.5	19.6	24.7	17.3	20.2
3	21.7	21.9	21.9	24.4	25.2	24.8	24.5
4	24.1	24.1	24.2	25.8	25.1	25.3	25.4
5	25.8	25.9	26.0	27.9	27.2	27.9	27.6
6	26.9	27.1	27.3	29.1	28.1	28.4	28.6
7	28.4	28.6	28.8	31.0	30.5	30.0	30.4
8	29.2	29.8	30.2	32.0	31.4	30.2	31.5
9	31.0	31.1	31.2	33.7	31.5	30.7	32.7
10	32.4	32.5	32.8	34.4	32.9	32.1	34.0
11	33.0	33.3	33.3	36.0	35.6	34.6	35.6
12	0.0	34.5	34.8	33.8	33.3	32.4	34.0
13	0.0	37.0	37.0	39.0	38.1	37.8	38.4
14	0.0	38.0	39.2	41.1	41.2	41.4	40.9
15+	0.0	0.0	41.4	41.4	41.4	41.6	41.4
Total	20.1	22.2	23.6	23.9	25.9	16.6	22.0

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	14.4	12.1	13.1	13.1	12.6	13.5	13.5
1	16.9	18.9	16.9	15.8	20.2	17.7	18.4
2	19.7	20.5	19.2	20.3	22.2	18.3	22.3
3	22.3	22.4	22.1	24.8	24.8	26.0	25.8
4	24.4	24.5	24.5	25.6	25.4	26.7	26.0
5	25.3	25.5	25.8	28.1	27.2	28.2	28.1
6	26.4	26.5	26.7	29.0	27.9	28.5	28.9
7	27.6	27.5	27.7	30.8	30.3	30.0	30.5
8	28.4	28.4	28.6	31.6	31.5	30.3	31.2
9	29.9	29.5	29.9	32.0	32.3	30.8	31.8
10	30.3	30.1	30.5	33.4	33.5	32.2	33.3
11	32.5	32.3	32.6	35.6	35.6	34.0	35.5
12	32.5	32.4	32.9	33.5	33.7	32.0	33.4
13	35.0	34.2	34.9	37.7	37.5	38.1	37.1
14	35.0	0.0	35.7	40.5	40.6	40.8	38.8
15+	0.0	0.0	42.5	40.5	40.8	40.7	40.7
Total	19.7	20.2	15.4	21.6	25.1	24.9	21.9

Table 7.3.2.2b.- Total southern horse mackerel mean length (cm) at age in 1999.

	AREA						
AGES	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	14.0	12.1	13.1	13.0	12.6	13.5	**13.1**
1	16.4	17.0	15.9	16.6	17.9	14.6	**15.2**
2	18.5	19.0	18.2	18.6	20.6	17.6	**18.4**
3	20.7	21.6	20.5	23.5	24.8	21.6	**21.5**
4	23.1	23.3	23.4	25.2	25.1	24.8	**24.5**
5	25.0	25.3	25.7	26.5	26.0	25.8	**26.0**
6	26.3	26.6	27.0	28.1	27.3	27.4	**27.4**
7	27.7	27.9	28.4	30.0	29.5	28.5	**29.2**
8	29.3	29.4	29.9	31.0	30.3	29.5	**30.3**
9	30.2	30.5	31.1	32.1	30.6	29.4	**30.9**
10	30.7	31.2	32.3	33.6	32.2	29.9	**32.5**
11	31.3	32.0	32.7	35.0	33.4	30.6	**33.8**
12	31.4	33.1	33.8	33.8	33.4	30.4	**33.2**
13	32.0	33.8	35.4	38.4	37.6	36.2	**37.2**
14	35.0	38.0	38.7	40.5	36.0	35.8	**39.5**
15+	0.0	0.0	42.4	40.2	40.4	36.8	**40.4**
Total	**20.4**	**21.4**	**19.4**	**23.4**	**26.1**	**18.1**	**21.2**

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

Table 7.4.1.1 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

	Portugal IXa (20-500 m depth)			Spain (20-500m depth)
	Bottom trawl (20-mm codend)			
Year	Kg/h March	kg/h Jun-Jul	kg/h Oct	kg/30 minutes Sept-Oct
1979		12.2	5.5	-
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

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

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

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

***** In 1999 the surveys was carried out with a different research vessel and different gear. There is no estimation of the calibration factor.

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

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.	n.a.
1999	20154	0	0	2	5	35	46	65	99	118	65	37	23	17	5	3	14

Table 7.7.2.1

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Lowestoft VPA Version 3.1

   4/08/2007   5:49

 Extended Survivors Analysis

 Horse mackerel south

 CPUE data from file input\hom9atu7.dat

 Catch data for  15 years. 1985 to 1999. Ages  0 to  12.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 8cWest            ,   1985, 1999,   0,    11,   .000,  1.000
 8cEast            ,   1985, 1999,   0,    11,   .000,  1.000
 OctPtSur          ,   1985, 1999,   0,    11,   .800,   .900
 OctSpSur          ,   1985, 1999,   0,    11,   .780,   .880
 JulPtSur          ,   1989, 1999,   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   80 iterations


 Total absolute residual between iterations
 79 and  80 =     .00120

 Final year F values
 Age         ,      0,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 79,  .0479,  .2056,  .3195,  .2690,  .2567,  .1161,  .0812,  .0894,  .1103,  .1866
 Iteration 80,  .0479,  .2054,  .3188,  .2691,  .2568,  .1162,  .0812,  .0895,  .1103,  .1866


 Age         ,     10,     11
 Iteration 79,  .1501,  .1390
 Iteration 80,  .1501,  .1389



 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
 Fishing mortalities
    Age,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999

      0,  .058,  .019,  .029,  .008,  .008,  .003,  .032,  .014,  .020,  .048
      1,  .262,  .105,  .222,  .079,  .110,  .175,  .039,  .465,  .635,  .205
      2,  .262,  .164,  .222,  .310,  .289,  .161,  .082,  .229,  .320,  .319
      3,  .118,  .087,  .164,  .295,  .162,  .148,  .069,  .107,  .184,  .269
      4,  .075,  .085,  .099,  .153,  .104,  .110,  .111,  .073,  .108,  .257
      5,  .097,  .075,  .074,  .140,  .063,  .090,  .083,  .059,  .079,  .116
      6,  .107,  .122,  .083,  .089,  .151,  .078,  .083,  .042,  .108,  .081
      7,  .207,  .176,  .167,  .152,  .117,  .149,  .100,  .107,  .126,  .089
      8,  .194,  .285,  .192,  .194,  .156,  .136,  .122,  .202,  .190,  .110
      9,  .280,  .235,  .511,  .395,  .189,  .132,  .176,  .181,  .143,  .187
     10,  .245,  .421,  .286,  .447,  .213,  .290,  .151,  .262,  .201,  .150
     11,  .447,  .327,  .432,  .309,  .338,  .362,  .340,  .195,  .146,  .139
```

cont.

Table 7.7.2.1 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1990	9.26E+05	7.67E+05	4.71E+05	5.82E+05	5.33E+05	1.67E+05	1.26E+05	7.43E+04	4.69E+05	4.17E+04
1991	1.83E+06	7.53E+05	5.08E+05	3.12E+05	4.45E+05	4.26E+05	1.31E+05	9.73E+04	5.20E+04	3.32E+05
1992	1.71E+06	1.54E+06	5.83E+05	3.71E+05	2.46E+05	3.52E+05	3.40E+05	9.95E+04	7.02E+04	3.37E+04
1993	1.37E+06	1.43E+06	1.06E+06	4.02E+05	2.71E+05	1.92E+05	2.81E+05	2.69E+05	7.25E+04	4.98E+04
1994	1.27E+06	1.17E+06	1.14E+06	6.71E+05	2.58E+05	2.00E+05	1.43E+05	2.21E+05	1.99E+05	5.14E+04
1995	1.17E+06	1.08E+06	9.05E+05	7.33E+05	4.91E+05	2.00E+05	1.62E+05	1.06E+05	1.69E+05	1.47E+05
1996	1.31E+06	1.00E+06	7.82E+05	6.63E+05	5.44E+05	3.78E+05	1.57E+05	1.29E+05	7.88E+04	1.27E+05
1997	6.69E+05	1.09E+06	8.29E+05	6.20E+05	5.33E+05	4.19E+05	3.00E+05	1.25E+05	1.00E+05	6.00E+04
1998	8.26E+05	5.68E+05	5.91E+05	5.67E+05	4.79E+05	4.26E+05	3.40E+05	2.47E+05	9.64E+04	7.05E+04
1999	1.20E+06	6.97E+05	2.59E+05	3.69E+05	4.06E+05	3.70E+05	3.39E+05	2.63E+05	1.88E+05	6.86E+04

Estimated population abundance at 1st Jan 2000

	0.00E+00	9.83E+05	4.89E+05	1.62E+05	2.43E+05	2.70E+05	2.84E+05	2.69E+05	2.07E+05	1.45E+05

Taper weighted geometric mean of the VPA populations:

	1.21E+06	9.84E+05	6.61E+05	5.07E+05	3.79E+05	2.84E+05	2.11E+05	1.50E+05	1.01E+05	6.59E+04

Standard error of the weighted Log(VPA populations) :

	.3267	.3258	.4199	.3802	.4358	.4909	.5461	.5976	.6505	.6761

YEAR	AGE 10	11
1990	3.25E+04	1.04E+04
1991	2.71E+04	2.19E+04
1992	2.26E+05	1.53E+04
1993	1.74E+04	1.46E+05
1994	2.89E+04	9.57E+03
1995	3.66E+04	2.01E+04
1996	1.11E+05	2.36E+04
1997	9.19E+04	8.19E+04
1998	4.31E+04	6.08E+04
1999	5.26E+04	3.04E+04

Estimated population abundance at 1st Jan 2000

	4.90E+04	3.90E+04

Taper weighted geometric mean of the VPA populations:

	4.24E+04	2.50E+04

Standard error of the weighted Log(VPA populations) :

	.7626	.8698

Log catchability residuals.

Fleet : 8cWest

Age	1985	1986	1987	1988	1989
0	99.99	99.99	99.99	99.99	99.99
1	.11	.48	-.21	.57	1.02
2	1.21	.45	1.19	1.16	-.34
3	1.67	2.35	2.13	1.49	1.31
4	-.18	1.29	2.25	1.04	.97
5	.32	.40	1.54	.71	.65
6	.17	-.07	1.00	.62	.24
7	-.23	-.55	.33	-.13	-.13
8	-.11	-.42	-.82	-.57	-.05
9	-.12	-.62	.10	-.54	.65
10	-.31	.39	.14	-.25	1.33
11	-.58	-.01	-.05	-.25	-.19

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	.79	-.41	.34	-.11	.35	-.24	-.67	-.46	99.99	-.54
2	1.19	.00	.29	1.68	1.15	.48	-.69	-3.11	99.99	-2.00
3	.38	-1.85	-.35	.88	-.78	1.03	-.54	-2.49	99.99	-.66
4	.33	-.67	-.85	.71	-1.03	-.18	.44	-2.01	99.99	.35
5	-.55	-.59	-.05	1.05	-.50	-.31	.48	-1.58	99.99	.03
6	-.29	-.25	.10	.06	.90	-.23	.31	-1.64	99.99	-.05
7	-.02	.28	-.03	.34	.25	.13	.04	-.58	99.99	-.04
8	.19	.42	.03	.09	.24	.10	-.13	-.08	99.99	.22
9	-.71	.16	.60	.48	-.39	-.41	.11	-.06	99.99	.26
10	-.23	.43	.55	-.04	-.44	-.08	.09	.11	99.99	-.08
11	-.68	-.17	-.10	.34	-.78	-.46	.63	.12	99.99	.01

cont.

Table 7.7.2.1 (Continued)

```
 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,  -12.5682, -13.2875, -12.5174, -11.8932, -11.3983, -10.7278, -10.4719, -10.0503, -10.0503, -10.0503,
 S.E(Log q),    1.4857,   1.4291,   1.0780,    .8130,    .6805,    .2849,    .3046,    .4475,    .4533,    .4364,



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,     .27,    1.141,     13.99,     .22,     14,     .57,  -14.36,

 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,     .47,    1.048,     13.02,     .31,     14,     .69,  -12.57,
  3,    1.01,    -.009,     13.29,     .07,     14,    1.53,  -13.29,
  4,    1.57,    -.451,     12.34,     .07,     14,    1.76,  -12.52,
  5,    1.10,    -.157,     11.83,     .24,     14,     .94,  -11.89,
  6,    1.25,    -.480,     11.20,     .30,     14,     .89,  -11.40,
  7,     .93,     .477,     10.81,     .84,     14,     .28,  -10.73,
  8,     .84,    1.431,     10.64,     .90,     14,     .24,  -10.47,
  9,     .99,     .058,     10.06,     .72,     14,     .47,  -10.05,
 10,     .91,     .552,     10.01,     .81,     14,     .41,   -9.95,
 11,     .77,    2.420,     10.14,     .92,     14,     .26,  -10.18,
1

 Fleet : 8cEast

  Age  ,  1985,  1986,  1987,  1988,  1989
     0 , -2.59,  2.04, -2.32,  5.61,  4.18
     1 ,   .37,   .23,  -.16,   .23,   .75
     2 ,  1.95,   .96,  1.45, -1.19,  -.71
     3 ,   .81,  1.26,  1.40,  -.64,   .16
     4 , -1.16,   .72,   .46,  -.72,   .42
     5 ,  -.72,   .00,   .72,  -.46,   .32
     6 ,  -.47,  -.57,   .50,  -.15,  -.11
     7 ,  -.35,  -.72,  -.40,  -.64,  -.53
     8 ,  -.06,  -.57, -1.03,  -.58,  -.50
     9 ,  -.18,  -.85,  -.24,   .12,   .47
    10 ,  -.11,  -.73,  -.51,   .72,  1.34
    11 ,  -.62, -1.69,  -.66,   .50, -1.17


  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999
     0 , -1.92,  2.88, -2.13, 99.99, -2.45, -1.72, 99.99, 99.99, 99.99, 99.99
     1 ,   .93,   .86,  -.69,  -.01,  -.28,   .29,   .49,   .01,  -.60, -1.46
     2 ,  1.58,  2.42, -1.93,  1.11,  1.11,  1.37,  2.11, -2.10, -3.25, -2.09
     3 ,  1.21,   .08,  -.10,   .56, -2.10,   .71,   .99, -1.19,  -.25,  -.76
     4 ,  -.14,   .31,  -.51,   .18, -2.01,   .25,  1.65,  -.38,  -.26,   .77
     5 ,  -.53,  -.38,  -.53,  -.35,  -.96,   .14,  1.19,  -.13,   .24,   .90
     6 ,  -.20,  -.87,  -.51, -1.06,   .75,   .03,   .62,  -.04,   .82,   .42
     7 ,   .13,  -.75,  -.76,  -.52,   .46,   .55,   .16,   .80,   .86,   .15
     8 ,   .08,  -.64,  -.91, -1.41,   .44,   .63,   .29,  1.31,  1.07,   .27
     9 ,  -.69,  -.79,  -.13,  -.38,  -.15,   .26,   .36,   .64,   .28,   .36
    10 ,  -.20, -1.30,  -.35, -1.24,  -.15,   .90,   .06,  1.05,   .21,  -.50
    11 ,  -.43, -1.54, -1.23,  -.58,  -.52,   .58,   .53,   .54,  -.15,  -.95

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

    Age ,        2,        3,        4,        5,        6,        7,        8,        9,       10,       11
 Mean Log q,  -10.6605, -10.9387, -10.7955, -10.5736, -10.5106, -10.1344,  -9.8531,  -9.5740,  -9.5740,  -9.5740,
 S.E(Log q),    1.9692,   1.0212,    .9105,    .6454,    .6131,    .6041,    .8359,    .4652,    .8098,    .8791,


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,    1.46,    -.097,     14.79,     .01,     10,    3.49,  -14.58,
  1,     .27,    1.082,     13.24,     .18,     15,     .72,  -11.70,
```

cont.

Table 7.7.2.1 (Continued)

```
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,     .807,     12.14,     .19,     15,     .92,  -10.66,
  3,    1.07,    -.077,     10.78,     .11,     15,    1.15,  -10.94,
  4,     .52,    1.499,     11.77,     .51,     15,     .45,  -10.80,
  5,     .61,    1.700,     11.34,     .67,     15,     .36,  -10.57,
  6,     .99,     .039,     10.54,     .45,     15,     .63,  -10.51,
  7,     .87,     .455,     10.36,     .57,     15,     .55,  -10.13,
  8,     .63,    1.575,     10.47,     .66,     15,     .50,   -9.85,
  9,     .98,     .103,      9.61,     .69,     15,     .48,   -9.57,
 10,     .85,     .531,      9.76,     .56,     15,     .71,   -9.60,
 11,     .81,     .834,     10.01,     .67,     15,     .63,   -9.98,
1

 Fleet : OctPtSur

  Age  ,  1985,  1986,  1987,  1988,  1989
     0 , 99.99, 99.99, 99.99, 99.99, 99.99
     1 , 99.99, 99.99, 99.99, 99.99, 99.99
     2 , -2.41,   .83,  -.15,  -.33,  -.44
     3 , -4.15,  1.92,   .07,   .56,  -.27
     4 , -2.04, -1.22,   .41,   .62,  -.20
     5 , 99.99,  -.64, -1.36,   .60,   .07
     6 , 99.99, 99.99,  -.70,   .49,   .86
     7 , 99.99,  -.04,  -.39,  1.89, -1.52
     8 , 99.99, 99.99, 99.99,   .36,  -.08
     9 , 99.99, 99.99, 99.99,  -.35, 99.99
    10 , 99.99, 99.99, 99.99, 99.99, 99.99
    11 , 99.99, 99.99, 99.99, 99.99, 99.99


  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999
     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 ,  -.16,  -.97,  1.45,   .02,  -.05,   .74, -2.24,   .59,  1.50, 99.99
     3 ,  -.30,   .09,   .94,   .66,   .63,   .74,  -.48,  -.26, -1.61, 99.99
     4 ,  -.08,  -.08,   .65,  -.09,   .83,   .46,   .09,  1.02, -2.09, 99.99
     5 ,   .96,  -.35,  -.03, 99.99,   .06,   .55,  -.09,  1.91, -2.30, 99.99
     6 ,  -.08,   .59,   .01, 99.99,  -.17,   .05,  -.32,  1.25, -1.77, 99.99
     7 ,  -.03,   .37,  1.59, 99.99, -1.20,  -.44,  -.67,  2.01, -1.30, 99.99
     8 ,  -.77,   .82,  1.13, 99.99, -1.33, -1.18, 99.99,  1.19, 99.99, 99.99
     9 ,   .64, -1.88,  1.05, 99.99,  -.74, 99.99, 99.99,  1.04, 99.99, 99.99
    10 ,   .46,   .09,  -.75, 99.99, 99.99, 99.99, 99.99,  -.57, 99.99, 99.99
    11 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99



 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


   Age ,         2,         3,         4,         5,         6,         7,         8,         9,        10,        11
 Mean Log q,   -9.1885,   -9.9703,  -10.0823,  -10.4715,  -10.7518,  -10.8805,  -10.6126,   -9.8179,   -9.8179,     .0000,
 S.E(Log q),    1.1522,    1.0927,     .9502,    1.1524,     .8585,    1.2726,    1.0873,    1.2125,     .6343,     .0000,



 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,    1.03,    -.024,      9.05,     .06,     14,    1.26,   -9.19,
  3,   -1.58,   -2.069,     18.23,     .07,     14,    1.50,   -9.97,
  4,    2.18,    -.794,      6.83,     .05,     14,    2.11,  -10.08,
  5,    5.97,   -1.103,      -.02,     .01,     12,    6.79,  -10.47,
  6,    1.12,    -.187,     10.58,     .26,     11,    1.02,  -10.75,
  7,   -2.88,   -2.111,     14.56,     .04,     12,    3.08,  -10.88,
  8,  -21.03,   -2.160,     33.73,     .00,      8,   17.79,  -10.61,
  9,  -12.43,   -2.034,     26.34,     .01,      6,   11.27,   -9.82,
 10,    2.08,   -2.721,      8.87,     .81,      4,     .63,  -10.05,
 11,     .00,     .000,       .00,     .00,      0,     .00,     .00,
```

cont.

Table 7.7.2.1 (Continued)

Fleet : OctSpSur

Age	1985	1986	1987	1988	1989
0	.25	.01	.42	.64	.39
1	.90	.31	.05	-.68	-.74
2	3.97	.68	1.14	.00	-1.73
3	3.16	.77	.81	.91	.94
4	.33	.38	1.43	.02	.04
5	.52	.19	-.47	.79	1.48
6	.28	.13	.21	.71	1.55
7	.31	1.05	.38	.11	.65
8	.45	.67	.38	.05	.59
9	.11	.87	.92	.67	.72
10	.37	1.15	.84	1.42	2.76
11	-.24	.64	.87	.83	.47

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	-.21	-.61	-.25	.21	1.25	-.29	-.33	-.23	-.19	-.40
1	-.14	-.35	-.22	-.47	.25	1.05	.14	-.24	-.29	.64
2	-.72	-.37	-2.07	-1.50	.36	-.07	.82	-.47	.99	1.66
3	-.82	99.99	-1.43	-1.41	-2.03	-.18	.90	.20	1.42	.04
4	.29	-2.29	99.99	-1.05	-1.04	-.58	1.08	-.40	1.64	.89
5	.35	-1.70	-1.51	.07	-.55	-.24	.68	-.60	.94	.67
6	.61	-1.49	-1.10	.35	.05	.05	.23	-1.00	.48	-.08
7	.45	-1.64	-.28	.16	-.20	.56	.42	-.56	-.21	-.06
8	.73	-.60	.13	-.09	-.25	.04	-.74	.47	-.38	-.23
9	-.29	-.13	.63	-.08	-.98	-.28	.50	-.44	-.92	.24
10	.45	.95	.80	1.02	-.38	.14	-.52	.11	-1.48	-.34
11	.14	1.25	1.35	.48	.14	.11	-.76	-.05	-1.18	-1.18

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-10.8978	-11.1287	-10.5195	-10.3843	-10.0608	-9.5780	-9.2086	-8.8973	-8.8973	-8.8973
S.E(Log q)	1.3101	1.2487	1.1340	.9165	.7820	.6212	.4601	.6182	1.0744	.8425

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	.51	.978	11.78	.29	15	.54	-9.60
1	.70	.570	11.13	.28	15	.55	-10.01

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	-3.74	-1.384	22.76	.01	15	4.70	-10.90
3	.54	.761	12.06	.24	14	.69	-11.13
4	.72	.452	11.19	.23	14	.85	-10.52
5	2.21	-.953	7.76	.06	15	2.03	-10.38
6	1.19	-.356	9.63	.26	15	.97	-10.06
7	.92	.273	9.77	.53	15	.60	-9.58
8	.92	.363	9.38	.70	15	.44	-9.21
9	1.30	-.809	8.24	.43	15	.82	-8.90
10	1.81	-1.114	6.86	.16	15	1.82	-8.56
11	1.38	-.931	8.29	.38	15	1.16	-8.79

1

Fleet : JulPtSur

Age	1985	1986	1987	1988	1989
0	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	-.36
2	99.99	99.99	99.99	99.99	-.41
3	99.99	99.99	99.99	99.99	.64
4	99.99	99.99	99.99	99.99	1.18
5	99.99	99.99	99.99	99.99	.14
6	99.99	99.99	99.99	99.99	.11
7	99.99	99.99	99.99	99.99	-.77
8	99.99	99.99	99.99	99.99	.21
9	99.99	99.99	99.99	99.99	-.14
10	99.99	99.99	99.99	99.99	-.53
11	99.99	99.99	99.99	99.99	.49

cont.

Table 7.7.2.1 (Continued)

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	-.28	-.30	.63	-.21	.19	-.78	99.99	.26	.65	99.99
2	.56	-.86	-.22	1.12	.91	-1.62	99.99	.00	.44	99.99
3	-.02	-1.28	.25	2.21	1.32	-.35	99.99	-1.27	-1.27	99.99
4	-.52	-1.43	-.13	.76	1.65	.40	99.99	-.52	-1.27	99.99
5	.13	-1.22	-.81	1.92	1.70	.64	99.99	-.99	-1.51	99.99
6	.18	-.54	-1.11	2.47	2.33	.32	99.99	-1.42	-2.20	99.99
7	.82	.25	.22	1.55	1.34	-.26	99.99	-1.14	-1.81	99.99
8	-.87	.69	.33	2.05	-.32	-1.97	99.99	99.99	99.99	99.99
9	-.22	-1.34	.83	.88	-.19	99.99	99.99	99.99	99.99	99.99
10	-1.09	.58	-.70	-.34	.40	99.99	99.99	99.99	99.99	99.99
11	.17	.74	1.16	-2.55	1.29	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-9.1460	-9.8418	-10.0528	-10.2227	-10.3898	-10.4440	-9.9054	-9.0727	-9.0727	-9.0727
S.E(Log q)	.9025	1.2651	1.0717	1.2905	1.6548	1.1722	1.3337	.8458	.7147	1.5349

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	.46	.920	11.36	.32	9	.54	-8.45

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	.62	.556	10.82	.26	9	.59	-9.15
3	1.08	-.044	9.57	.05	9	1.48	-9.84
4	-.94	-2.355	15.43	.20	9	.78	-10.05
5	-.64	-3.682	13.95	.46	9	.49	-10.22
6	-2.10	-1.106	16.05	.02	9	3.41	-10.39
7	1.27	-.284	10.02	.15	9	1.60	-10.44
8	-11.55	-1.682	31.87	.00	7	13.17	-9.91
9	5.71	-2.511	-.24	.09	6	3.17	-9.07
10	1.30	-.622	8.96	.58	6	.93	-9.32
11	-5.10	-3.456	14.94	.10	6	4.01	-8.88

1

Terminal year survivor and F summaries :

Age 0 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
8cWest	1.	.000	.000	.00	0	.000	.000
8cEast	1.	.000	.000	.00	0	.000	.000
OctPtSur	1.	.000	.000	.00	0	.000	.000
OctSpSur	660006.	.572	.000	.00	1	.218	.000
JulPtSur	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	983915.	.33				.707	.048
F shrinkage mean	3088429.	1.00				.075	.015

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
982627.	.27	.38	3	1.401	.048

Age 1 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
8cWest	284824.	.659	.000	.00	1	.131	.330
8cEast	113931.	.914	.000	.00	1	.068	.682
OctPtSur	1.	.000	.000	.00	0	.000	.000
OctSpSur	614292.	.412	.414	1.00	2	.333	.167
JulPtSur	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	661139.	.42				.397	.156
F shrinkage mean	336413.	1.00				.070	.286

cont.

Table 7.7.2.1 (Continued)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
488605.,	.25,	.26,	6,	1.031,	.205

Age 2 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
8cWest	,	21843.,	1.554,	.000,	.00,	1,	.053,	1.331
8cEast	,	63049.,	.790,	.632,	.80,	2,	.132,	.675
OctPtSur	,	1.,	.000,	.000,	.00,	0,	.000,	.000
OctSpSur	,	169873.,	.425,	.498,	1.17,	3,	.430,	.306
JulPtSur	,	309929.,	.572,	.000,	.00,	1,	.208,	.179
F shrinkage mean	,	251252.,	1.00,,,,				.177,	.217

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
162343.,	.31,	.32,	8,	1.039,	.319

Age 3 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
8cWest	,	145476.,	.599,	.086,	.14,	2,	.150,	.416
8cEast	,	125900.,	.630,	.641,	1.02,	3,	.167,	.467
OctPtSur	,	1091304.,	1.205,	.000,	.00,	1,	.045,	.066
OctSpSur	,	220328.,	.390,	.228,	.58,	4,	.332,	.293
JulPtSur	,	336877.,	.512,	.084,	.16,	2,	.190,	.201
F shrinkage mean	,	522063.,	1.00,,,,				.117,	.134

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
242950.,	.25,	.21,	13,	.825,	.269

Age 4 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
8cWest	,	145452.,	.533,	.679,	1.28,	3,	.180,	.435
8cEast	,	349989.,	.510,	.356,	.70,	5,	.213,	.204
OctPtSur	,	135388.,	.835,	1.085,	1.30,	2,	.074,	.461
OctSpSur	,	317575.,	.362,	.279,	.77,	5,	.365,	.223
JulPtSur	,	165222.,	.785,	.619,	.79,	2,	.080,	.392
F shrinkage mean	,	741326.,	1.00,,,,				.088,	.102

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
270395.,	.23,	.21,	18,	.905,	.257

Age 5 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
8cWest	,	191198.,	.459,	.411,	.89,	4,	.185,	.168
8cEast	,	376318.,	.408,	.369,	.90,	6,	.257,	.089
OctPtSur	,	59093.,	.640,	.613,	.96,	3,	.101,	.465
OctSpSur	,	774617.,	.376,	.171,	.46,	6,	.265,	.044
JulPtSur	,	106404.,	.512,	.170,	.33,	3,	.136,	.284
F shrinkage mean	,	448824.,	1.00,,,,				.056,	.075

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
283669.,	.20,	.22,	23,	1.113,	.116

cont.

Table 7.7.2.1 (Continued)

```
Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
8cWest              ,    220060.,   .413,       .387,    .94,   5,  .181,     .098
8cEast              ,    343376.,   .346,       .190,    .55,   6,  .274,     .064
OctPtSur            ,    220234.,   .569,       .765,   1.35,   4,  .096,     .098
OctSpSur            ,    340990.,   .323,       .161,    .50,   7,  .275,     .065
JulPtSur            ,    156936.,   .446,       .454,   1.02,   4,  .134,     .135

  F shrinkage mean  ,    234749.,   1.00,,,,                        .041,     .092

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   268741.,       .18,      .14,   27,    .819,   .081


Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
8cWest              ,    184211.,   .252,       .218,    .86,   6,  .373,     .100
8cEast              ,    316873.,   .309,       .211,    .68,   8,  .228,     .059
OctPtSur            ,    181472.,   .490,       .665,   1.36,   5,  .083,     .101
OctSpSur            ,    198417.,   .302,       .169,    .56,   8,  .213,     .093
JulPtSur            ,    145062.,   .454,       .418,    .92,   5,  .074,     .125

  F shrinkage mean  ,    151650.,   1.00,,,,                        .028,     .120

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   206664.,       .15,      .12,   33,    .819,   .089


Age  8   Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
8cWest              ,    146815.,   .252,       .263,   1.04,   7,  .338,     .109
8cEast              ,    203161.,   .295,       .282,    .96,   9,  .218,     .080
OctPtSur            ,    204267.,   .465,       .370,    .79,   6,  .082,     .079
OctSpSur            ,    100270.,   .266,       .177,    .66,   9,  .270,     .156
JulPtSur            ,    150483.,   .469,       .526,   1.12,   6,  .066,     .106

  F shrinkage mean  ,     96343.,   1.00,,,,                        .026,     .161

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   144702.,       .14,      .12,   38,    .885,   .110


Age  9   Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
8cWest              ,     38518.,   .218,       .162,    .74,   8,  .355,     .232
8cEast              ,     72431.,   .259,       .218,    .84,  10,  .254,     .130
OctPtSur            ,     93154.,   .473,       .354,    .75,   6,  .059,     .102
OctSpSur            ,     37496.,   .253,       .142,    .56,  10,  .252,     .238
JulPtSur            ,     61352.,   .448,       .486,   1.09,   6,  .053,     .152

  F shrinkage mean  ,     56210.,   1.00,,,,                        .026,     .165

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    48986.,       .13,      .10,   41,    .803,   .187
```

cont.

Table 7.7.2.1 (Continued)

Age 10 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
8cWest	,	37840.,	.183,	.069,	.38,	9,	.435,	.154
8cEast	,	43541.,	.251,	.188,	.75,	11,	.231,	.135
OctPtSur	,	45783.,	.444,	.270,	.61,	7,	.058,	.129
OctSpSur	,	35455.,	.252,	.189,	.75,	11,	.215,	.164
JulPtSur	,	48951.,	.467,	.361,	.77,	6,	.038,	.121
F shrinkage mean	,	25129.,	1.00,,,,				.024,	.224

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
38978.,	.12,	.07,	45,	.619,	.150

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1988

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
8cWest	,	23962.,	.175,	.111,	.64,	10,	.476,	.132
8cEast	,	29266.,	.251,	.173,	.69,	12,	.221,	.110
OctPtSur	,	28114.,	.503,	.244,	.48,	6,	.041,	.114
OctSpSur	,	13833.,	.262,	.205,	.78,	10,	.202,	.219
JulPtSur	,	28843.,	.469,	.428,	.91,	7,	.035,	.111
F shrinkage mean	,	25727.,	1.00,,,,				.025,	.124

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
22748.,	.12,	.08,	46,	.712,	.139

Table 7.2.2.2

1 Run title : Horse mackerel south

At 4/08/2007 5:51

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989
AGE					
0	.2874	.2812	.0415	.1463	.2572
1	.4449	.5418	.4769	.2884	.2719
2	.2266	.2386	.4060	.1154	.1064
3	.0549	.2552	.2408	.1447	.1509
4	.1285	.1061	.1628	.1141	.1884
5	.1001	.1836	.0899	.1582	.1723
6	.0741	.1205	.2049	.1339	.2508
7	.1572	.3672	.1218	.2337	.0991
8	.1146	.3922	.1129	.1832	.2244
9	.1714	.2708	.1927	.3327	.3541
10	.2031	.3341	.1349	.6129	.6911
11	.2981	.4463	.1192	.3925	.4792
+gp	.2981	.4463	.1192	.3925	.4792
0 FBAR 0- 3	.2535	.3292	.2913	.1737	.1966
FBAR 7-11	.1889	.3621	.1363	.3510	.3696
FBAR 1-11	.1794	.2960	.2057	.2463	.2717

Table 8 Fishing mortality (F) at age

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	FBAR 97-99
AGE											
0	.0576	.0189	.0292	.0084	.0081	.0032	.0320	.0139	.0201	.0479	.0273
1	.2623	.1049	.2224	.0795	.1099	.1750	.0389	.4649	.6354	.2054	.4352
2	.2624	.1644	.2221	.3099	.2892	.1609	.0820	.2291	.3195	.3188	.2891
3	.1183	.0874	.1637	.2947	.1623	.1478	.0692	.1066	.1837	.2691	.1865
4	.0754	.0855	.0994	.1529	.1040	.1102	.1110	.0734	.1079	.2568	.1460
5	.0967	.0754	.0741	.1396	.0632	.0902	.0828	.0591	.0794	.1162	.0849
6	.1065	.1223	.0826	.0894	.1506	.0778	.0827	.0419	.1080	.0812	.0770
7	.2074	.1762	.1666	.1522	.1174	.1486	.1001	.1068	.1261	.0895	.1074
8	.1940	.2846	.1922	.1943	.1555	.1356	.1218	.2019	.1898	.1103	.1673
9	.2804	.2347	.5110	.3951	.1889	.1316	.1760	.1807	.1432	.1866	.1702
10	.2453	.4207	.2863	.4471	.2129	.2899	.1505	.2624	.2008	.1501	.2044
11	.4466	.3273	.4321	.3090	.3381	.3619	.3396	.1946	.1463	.1389	.1600
+gp	.4466	.3273	.4321	.3090	.3381	.3619	.3396	.1946	.1463	.1389	
0 FBAR 0- 3	.1752	.0939	.1594	.1731	.1424	.1217	.0556	.2036	.2897	.2103	
FBAR 7-11	.2747	.2887	.3176	.2995	.2026	.2135	.1776	.1893	.1612	.1351	
FBAR 1-11	.2087	.1894	.2230	.2331	.1720	.1663	.1232	.1747	.2036	.1748	

Table 7.7.2.3

Run title : Horse mackerel south

At 4/08/2007 5:51

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
AGE					
0	1698760	2705587	1412536	965883	1152694
1	892947	1096886	1757882	1166314	718204
2	451273	492576	549197	939148	752389
3	1610373	309661	333974	314967	720248
4	234144	1311981	206502	225942	234575
5	165919	177226	1015528	151029	173505
6	106843	129202	126949	798908	110967
7	54564	85397	98579	89018	601442
8	39627	40133	50915	75120	60650
9	42906	30414	23336	39145	53831
10	27059	31113	19967	16564	24157
11	13438	19010	19173	15018	7724
+gp	39948	41849	53123	45092	33057
0 TOTAL	5377802	6471034	5667660	4842148	4643441

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	GMST 85-97
AGE												
0	926191	1825287	1710108	1374894	1266974	1166781	1310791	669069	825890	1197469	0	1320855
1	767120	752556	1541549	1429572	1173438	1081741	1001000	1092634	567938	696705	982627	1074579
2	470981	507926	583212	1062234	1136439	904832	781565	828677	590783	258947	488605	693073
3	582239	311830	370887	402001	670614	732528	663078	619728	567201	369423	162343	520625
4	533096	445205	245923	271010	257701	490724	543889	532533	479474	406258	242950	363694
5	167238	425505	351803	191632	200189	199888	378296	418957	425937	370478	270395	259175
6	125704	130669	339630	281176	143454	161752	157204	299743	339914	338625	283669	183446
7	74321	97260	99524	269153	221311	106204	128798	124564	247412	262627	268741	124876
8	468813	51989	70188	72518	198952	169388	78786	100302	96354	187725	206664	85053
9	41711	332341	33663	49850	51394	146574	127302	60034	70546	68596	144702	58099
10	32517	27122	226208	17381	28903	36622	110605	91886	43131	52617	48986	37084
11	10418	21899	15327	146224	9567	20106	23588	81896	60837	30369	38978	20429
+gp	33968	39115	37804	22836	51467	76751	88277	86608	188554	64926	71381	
0 TOTAL	4234315	4968703	5625826	5590480	5410402	5293890	5393180	5006633	4503970	4304767	3210042	

Table 7.7.2.4

Run title : Horse mackerel south ,

At 4/08/2007 5:51

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 0- 3,	FBAR 7-11,	FBAR 1-11,
1985,	1698760,	290173,	124723,	43535,	.3491,	.2535,	.1889,	.1794,
1986,	2705587,	324981,	172494,	71258,	.4131,	.3292,	.3621,	.2960,
1987,	1412536,	345385,	192457,	52747,	.2741,	.2913,	.1363,	.2057,
1988,	965883,	344148,	196530,	55888,	.2844,	.1737,	.3510,	.2463,
1989,	1152694,	334370,	193994,	56396,	.2907,	.1966,	.3696,	.2717,
1990,	926191,	337629,	207834,	49207,	.2368,	.1752,	.2747,	.2087,
1991,	1825287,	331710,	212809,	45511,	.2139,	.0939,	.2887,	.1894,
1992,	1710108,	351313,	206912,	50956,	.2463,	.1594,	.3176,	.2230,
1993,	1374894,	362399,	197557,	57428,	.2907,	.1731,	.2995,	.2331,
1994,	1266974,	346205,	177158,	52588,	.2968,	.1424,	.2026,	.1720,
1995,	1166781,	373637,	205270,	52681,	.2566,	.1217,	.2135,	.1663,
1996,	1310791,	391878,	229305,	44690,	.1949,	.0556,	.1776,	.1232,
1997,	669069,	420525,	252027,	56770,	.2253,	.2036,	.1893,	.1747,
1998,	825890,	427970,	289119,	64480,	.2230,	.2897,	.1612,	.2036,
1999,	1197469,	354948,	246799,	51922,	.2104,	.2103,	.1351,	.1748,
Arith. Mean ,	1347261,	355818,	206999,	53737,	.2671,	.1913,	.0000,	.2045,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

1

Table 7.8.1.- Input data for predictions

10:09 Wednesday, September 20, 2000

Southern horse mackerel (Divisions VIIIc and IXa). Single option prediction: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1320.855	0.1500	0.0000	0.2500	0.2500	0.000	0.0273	0.019
1	982.627	0.1500	0.0000	0.2500	0.2500	0.032	0.4352	0.033
2	488.605	0.1500	0.0400	0.2500	0.2500	0.055	0.2891	0.057
3	162.343	0.1500	0.2700	0.2500	0.2500	0.075	0.1865	0.083
4	242.950	0.1500	0.6300	0.2500	0.2500	0.105	0.1460	0.114
5	270.395	0.1500	0.8100	0.2500	0.2500	0.127	0.0849	0.139
6	283.669	0.1500	0.9000	0.2500	0.2500	0.154	0.0770	0.165
7	268.741	0.1500	0.9500	0.2500	0.2500	0.176	0.1074	0.186
8	206.664	0.1500	0.9700	0.2500	0.2500	0.213	0.1673	0.209
9	144.702	0.1500	0.9800	0.2500	0.2500	0.240	0.1702	0.230
10	48.986	0.1500	0.9900	0.2500	0.2500	0.269	0.2044	0.257
11	38.978	0.1500	1.0000	0.2500	0.2500	0.304	0.1600	0.282
12+	71.381	0.1500	1.0000	0.2500	0.2500	0.349	0.1600	0.348
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Unit Millions - - - - Kilograms - Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1320.855	0.1500	0.0000	0.2500	0.2500	0.000	0.0273	0.019
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.4352	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2891	0.057
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1865	0.083
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1460	0.114
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0849	0.139
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0770	0.165
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1074	0.186
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1673	0.209
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1702	0.230
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2044	0.257
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.1600	0.282
12+	.	0.1500	1.0000	0.2500	0.2500	0.349	0.1600	0.348
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Table 7.8.2.a.- Prediction with management option table

Southern horse mackerel (Divisions VIIIc and IXa)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1844	350027	241251	52517	0.0000	0.0000	344298	237211	0	402902	261075
.	.	.	.	.	0.1000	0.0184	.	236353	6098	395556	256164
.	.	.	.	.	0.2000	0.0369	.	235499	12056	388397	251354
.	.	.	.	.	0.3000	0.0553	.	234648	17878	381418	246644
.	.	.	.	.	0.4000	0.0737	.	233800	23568	374614	242031
.	.	.	.	.	0.5000	0.0922	.	232956	29129	367979	237514
.	.	.	.	.	0.6000	0.1106	.	232115	34566	361509	233089
.	.	.	.	.	0.7000	0.1291	.	231277	39882	355197	228755
.	.	.	.	.	0.8000	0.1475	.	230442	45079	349040	224509
.	.	.	.	.	0.9000	0.1659	.	229611	50163	343031	220351
.	.	.	.	.	1.0000	0.1844	.	228783	55136	337168	216277
.	.	.	.	.	1.1000	0.2028	.	227958	60000	331445	212286
.	.	.	.	.	1.2000	0.2212	.	227137	64760	325858	208376
.	.	.	.	.	1.3000	0.2397	.	226318	69417	320403	204546
.	.	.	.	.	1.4000	0.2581	.	225503	73976	315077	200793
.	.	.	.	.	1.5000	0.2765	.	224691	78438	309874	197115
.	.	.	.	.	1.6000	0.2950	.	223883	82806	304792	193512
.	.	.	.	.	1.7000	0.3134	.	223077	87082	299827	189981
.	.	.	.	.	1.8000	0.3319	.	222275	91270	294976	186521
.	.	.	.	.	1.9000	0.3503	.	221475	95372	290235	183131
.	.	.	.	.	2.0000	0.3687	.	220679	99389	285601	179808
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

The SAS System 10:09 Wednesday, September 20, 2000

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Notes: Run name             : MANHOM06
       Date and time        : 20SEP00:14:34
       Computation of ref. F: Simple mean, age 1 - 11
       Basis for 2000       : F factors
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Table 7.8.2.b.- Southern horse mackerel. Prediction with management option table

Year: 2000 F-factor: 1.0000 Reference F: 0.1844

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size (1 January)	Sp.stock biomass (1 January)	Sp.stock size (Spawning time)	Sp.stock biomass (Spawning time)
0	0.2730	294034	5587	1320855	0	0	0	0	0
1	0.4352	323730	10683	982627	31444	0	0	0	0
2	0.2891	114325	6517	488605	26873	19544	1075	17512	963
3	0.1865	25709	2134	162343	12176	43833	3287	40296	3022
4	0.1460	30703	3500	242950	25510	153059	16071	142141	14925
5	0.0849	20460	2844	270395	34340	219020	27816	206528	26229
6	0.0770	19541	3224	283669	43685	255302	39317	241217	37147
7	0.1074	25447	4733	268741	47298	255304	44933	239393	42133
8	0.1673	29626	6192	206664	44019	200464	42699	185177	39443
9	0.1702	21074	4847	144702	34728	141808	34034	130899	31416
10	0.2044	8431	2167	48986	13177	48496	13045	44384	11939
11	0.1600	5362	1512	38978	11849	38978	11849	36071	10966
12+	0.1600	9820	3417	71381	24926	71381	24926	66058	23068
Total		928263	57357	4530896	350027	1447188	259053	1349676	241251
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001 F-factor: 1.0000 Reference F: 0.1844

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size (1 January)	Sp.stock biomass (1 January)	Sp.stock size (Spawning time)	Sp.stock biomass (Spawning time)
0	0.2730	294034	5587	1320855	0	0	0	0	0
1	0.4352	285064	9407	865264	27688	0	0	0	0
2	0.2891	128062	7300	547318	30102	21893	1204	19617	1079
3	0.1865	49879	4140	314963	23622	85040	6378	78179	5863
4	0.1460	14654	1671	115956	12175	73052	7670	67842	7123
5	0.0849	13673	1901	180703	22949	146370	18589	138022	17529
6	0.0770	14727	2430	213788	32923	192409	29631	181794	27996
7	0.1074	21406	3982	226062	39787	214759	37798	201374	35442
8	0.1673	29783	6225	207753	44251	201520	42924	186152	39650
9	0.1702	21915	5041	150475	36114	147465	35392	136121	32669
10	0.2044	18080	4647	105054	28260	104004	27977	95185	25605
11	0.1600	4728	1333	34368	10448	34368	10448	31805	9669
12+	0.1600	11136	3875	80942	28265	80942	28265	74906	26157
Total		907141	57536	4363500	336586	1301822	246276	1210996	228783
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2002 F-factor: 1.0000 Reference F: 0.1844

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size (1 January)	Sp.stock biomass (1 January)	Sp.stock size (Spawning time)	Sp.stock biomass (Spawning time)
0	0.2730	294034	5587	1320855	0	0	0	0	0
1	0.4352	285064	9407	865264	27688	0	0	0	0
2	0.2891	112767	6428	481947	26507	19278	1060	17274	950
3	0.1865	55872	4637	352810	26461	95259	7144	87573	6568
4	0.1460	28430	3241	224967	23622	141729	14882	131620	13820
5	0.0849	6526	907	86247	10953	69860	8872	65875	8366
6	0.0770	9842	1624	142873	22002	128586	19802	121492	18710
7	0.1074	16133	3001	170372	29985	161853	28486	151766	26711
8	0.1673	25053	5236	174759	37224	169516	36107	156589	33353
9	0.1702	22031	5067	151267	36304	148242	35578	136838	32841
10	0.2044	18802	4832	109245	29387	108153	29093	98983	26626
11	0.1600	10140	2860	73705	22406	73705	22406	68209	20736
12+	0.1600	11635	4049	84574	29533	84574	29533	78267	27331
Total		896328	56875	4238886	322074	1200755	232965	1114485	216012
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 7.9.1.- Yield per recruit summary table

Yield per recruit: Summary table

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0.000	0.000	7.179	1017.104	3.774	869.706	3.635	837.696
0.1000	0.0184	0.107	13.050	6.464	842.836	3.164	704.454	3.037	675.984
0.2000	0.0369	0.195	21.982	5.880	706.890	2.676	576.779	2.560	551.425
0.3000	0.0553	0.268	28.096	5.395	599.080	2.281	476.566	2.174	453.959
0.4000	0.0737	0.330	32.252	4.987	512.389	1.957	396.857	1.858	376.674
0.5000	0.0922	0.382	35.031	4.640	441.844	1.687	332.734	1.597	314.694
0.6000	0.1106	0.427	36.834	4.342	383.839	1.462	280.643	1.379	264.499
0.7000	0.1291	0.466	37.942	4.084	335.710	1.272	237.962	1.195	223.499
0.8000	0.1475	0.500	38.554	3.860	295.451	1.110	202.726	1.040	189.755
0.9000	0.1659	0.530	38.812	3.663	261.531	0.972	173.442	0.908	161.797
1.0000	0.1844	0.557	38.819	3.490	232.764	0.854	148.958	0.795	138.492
1.1000	0.2028	0.580	38.649	3.337	208.224	0.752	128.376	0.697	118.961
1.2000	0.2212	0.601	38.357	3.201	187.176	0.664	110.990	0.613	102.511
1.3000	0.2397	0.619	37.982	3.079	169.033	0.587	96.238	0.540	88.596
1.4000	0.2581	0.636	37.553	2.971	153.323	0.520	83.671	0.477	76.776
1.5000	0.2765	0.651	37.093	2.873	139.663	0.462	72.924	0.422	66.698
1.6000	0.2950	0.665	36.616	2.785	127.738	0.410	63.704	0.374	58.077
1.7000	0.3134	0.677	36.133	2.705	117.291	0.365	55.769	0.332	50.678
1.8000	0.3319	0.688	35.653	2.633	108.105	0.326	48.919	0.295	44.309
1.9000	0.3503	0.699	35.182	2.568	100.004	0.291	42.990	0.263	38.813
2.0000	0.3687	0.708	34.724	2.508	92.837	0.260	37.846	0.234	34.058
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDHOM03
Date and time : 20SEP00:17:56
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.5785
F-max factor : 0.9518
F-0.1 reference F : 0.1067
F-max reference F : 0.1755
Recruitment : Single recruit

Table 7.12.1a.- Single option prediction summary table (F *status quo*)

SOUTHERN HORSE MACKEREL

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
2000	1.0000	0.1844	928263	57357	4530896	350027	1447188	259053	1349676	241251
2001	1.0000	0.1844	907141	57536	4363500	336586	1301822	246276	1210996	228783
2002	1.0000	0.1844	896328	56875	4238886	322074	1200755	232965	1114485	216012
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM02
Date and time : 20SEP00:10:12
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.12.1b.- Single option prediction summary table (Fpa)

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
2000	0.9220	0.1700	865252	53322	4530896	350027	1447188	259053	1353071	241885
2001	0.9220	0.1700	857859	54317	4421452	341407	1316427	248935	1227859	231900
2002	0.9220	0.1700	853452	54329	4334050	331226	1231936	238470	1146664	221766
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRHOM02
Date and time : 20SEP00:10:12
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

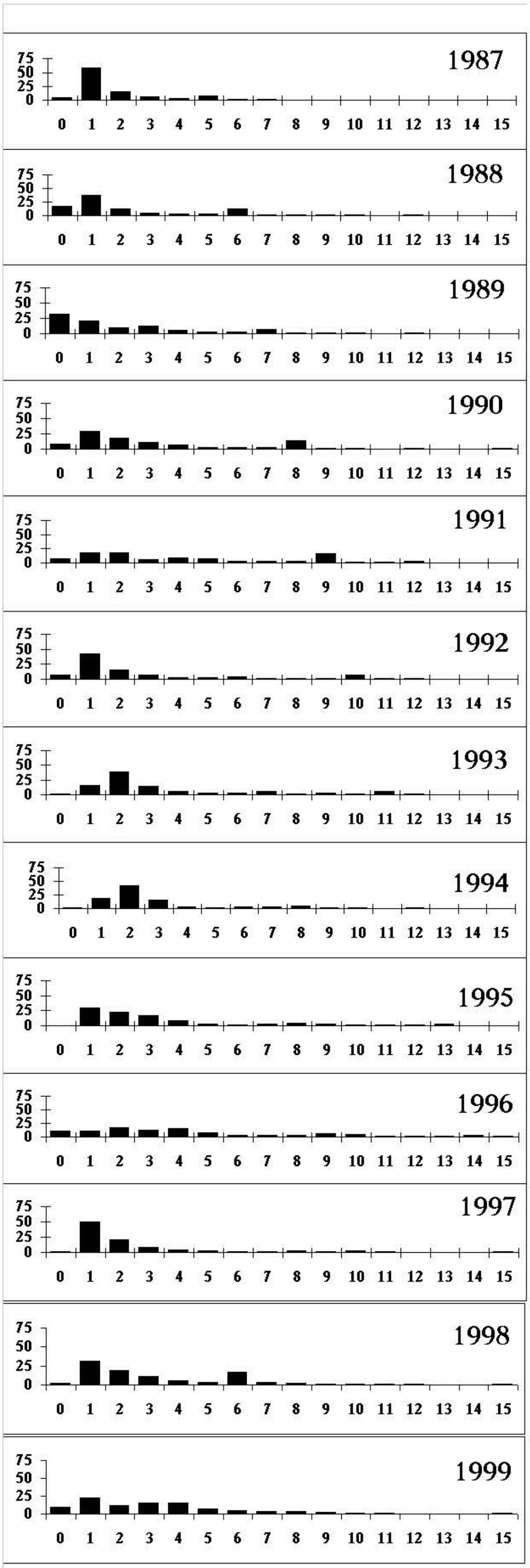
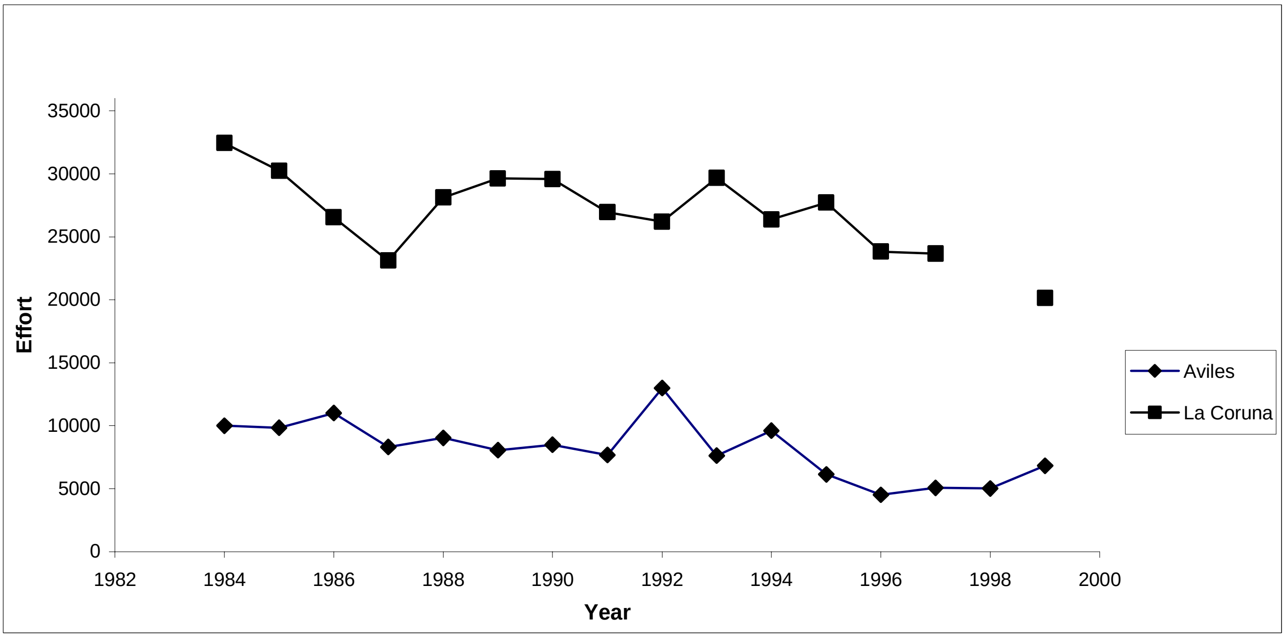


Figure 7.3.1.1 The age composition of southern horse mackerel in the international catches from 1987–1999. Age 15 is aplus group.

Figure 7.5.1



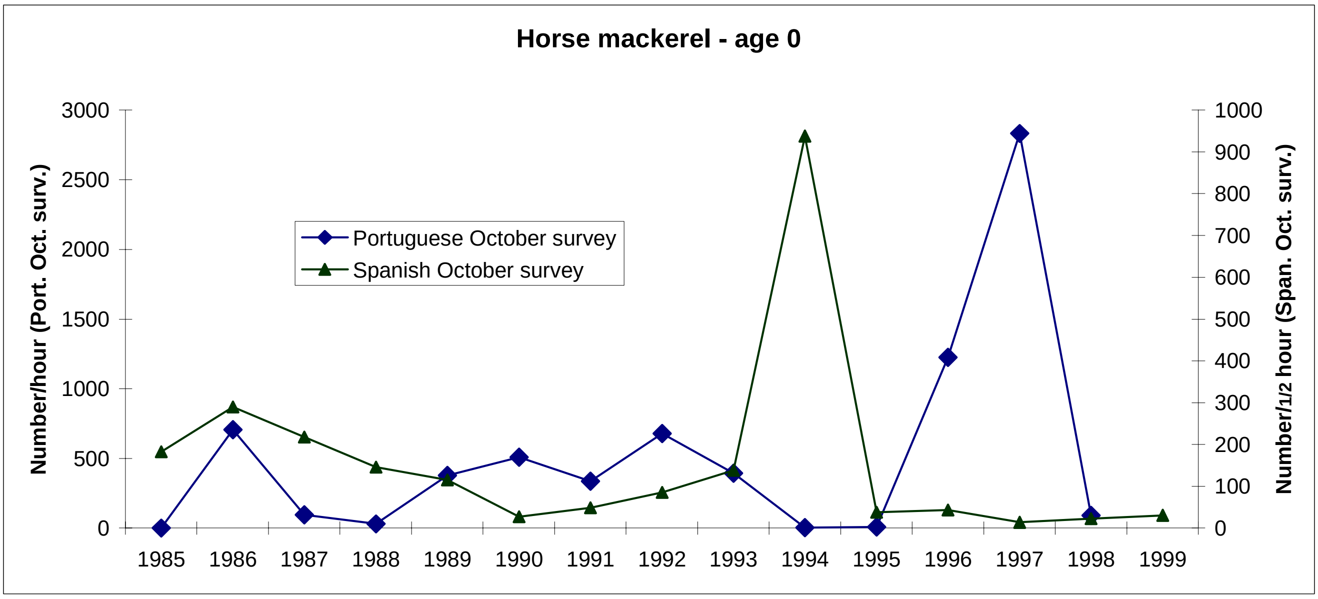


Figure 7.6.1 - Catches of age 0 horse mackerel in bottom trawl surveys used in the tuning of the VPA.

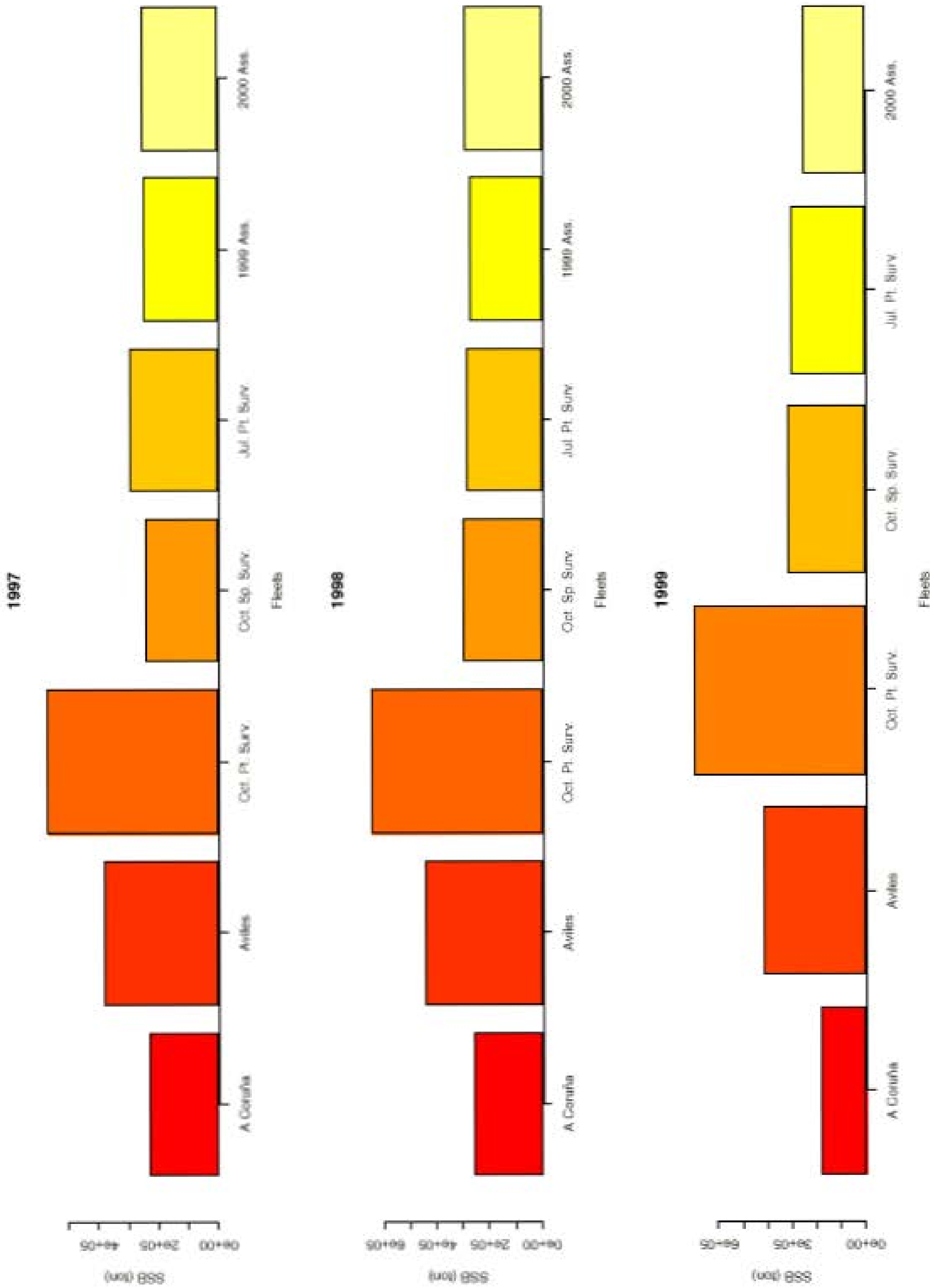


Figure 7.7.1.1.- SSB estimates in 1997, 1998 and 1999 by source of independent information.

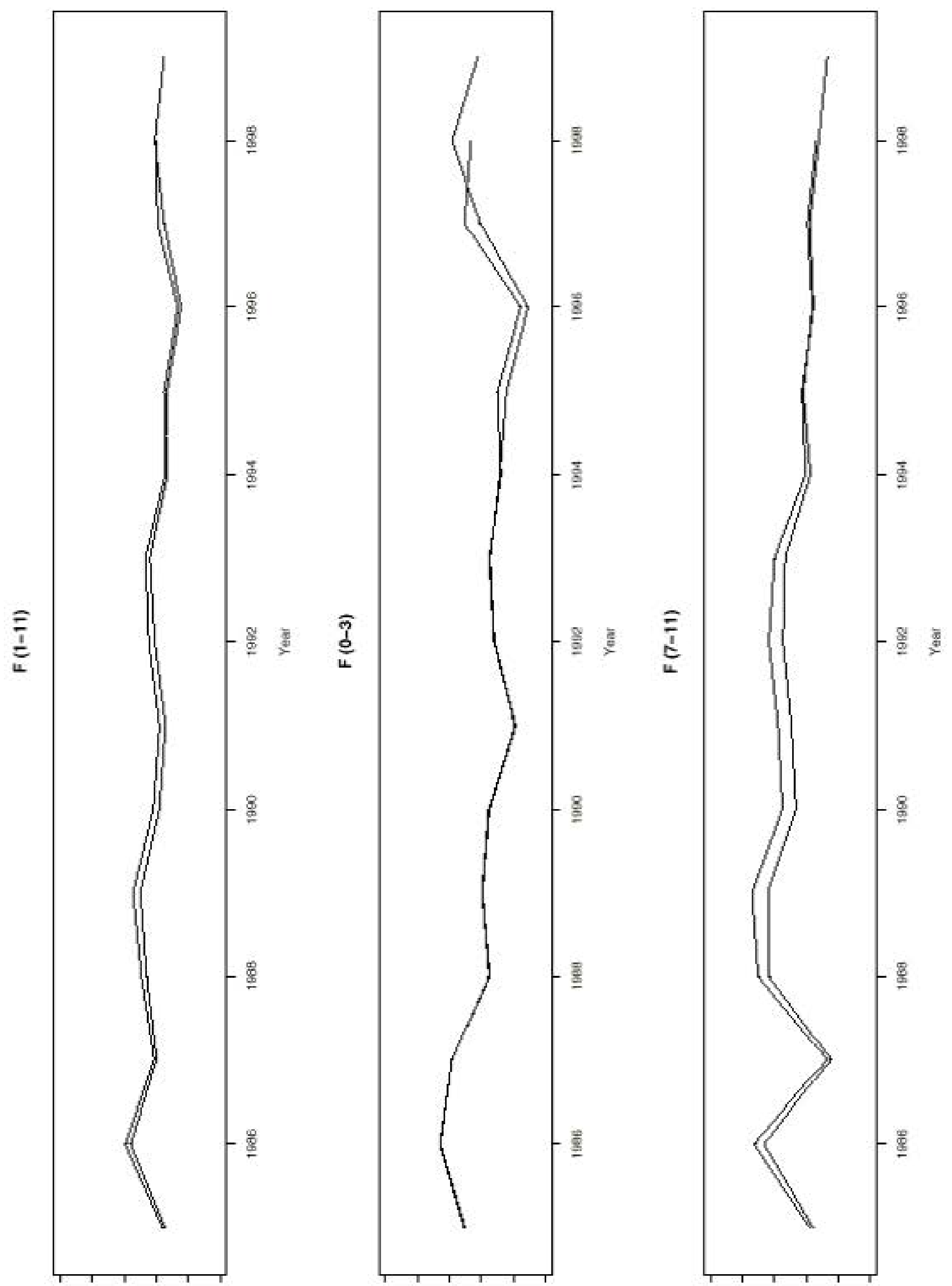


Figure 7.7.2.1.- Comparison of the 1998 and 1999 assessments for different F's bar from the final VPA Figure

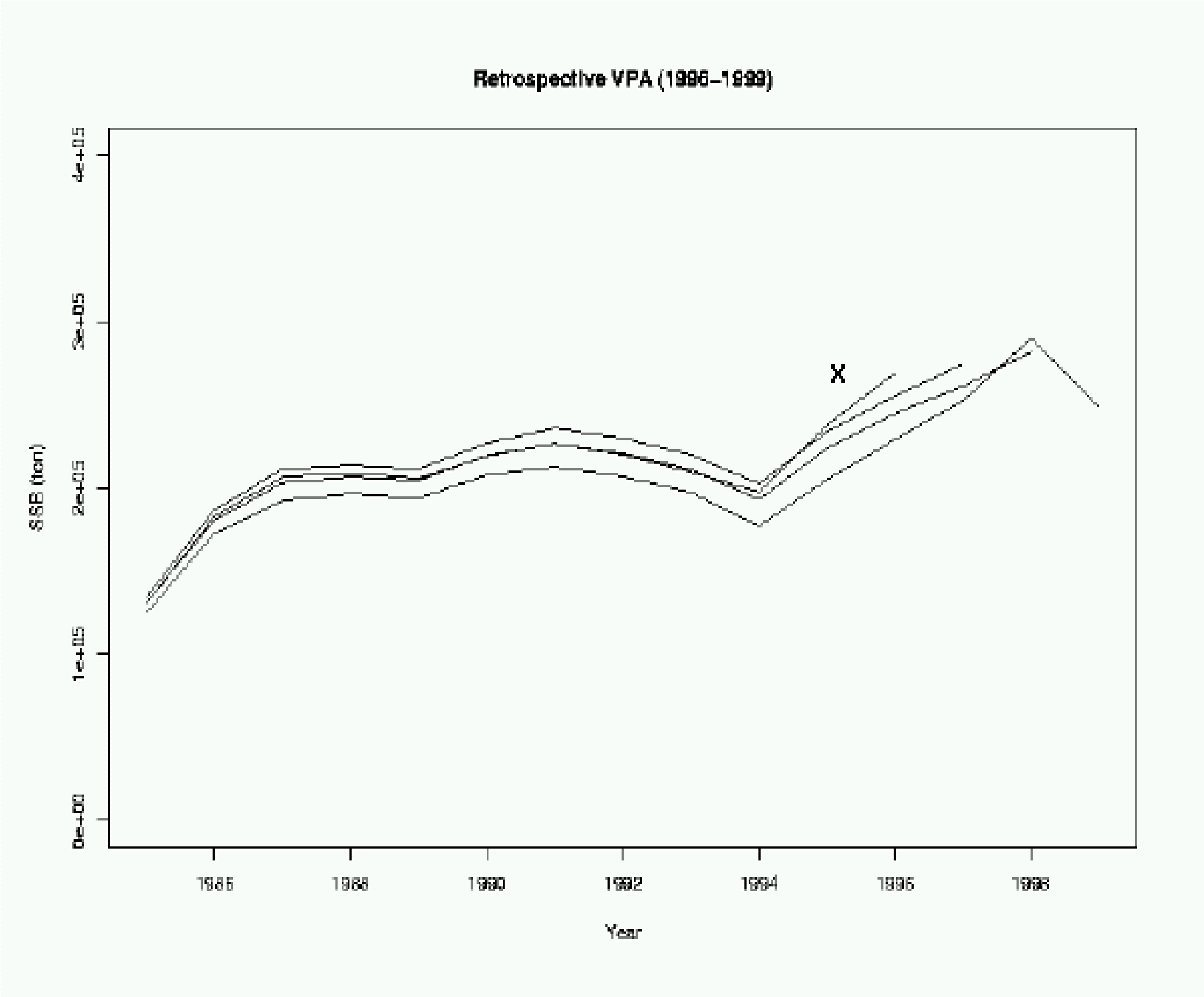


Figure 7.7.2.2.- Comparison of the retrospective SSB estimates from XSA and the 1995 egg survey estimate (cross).

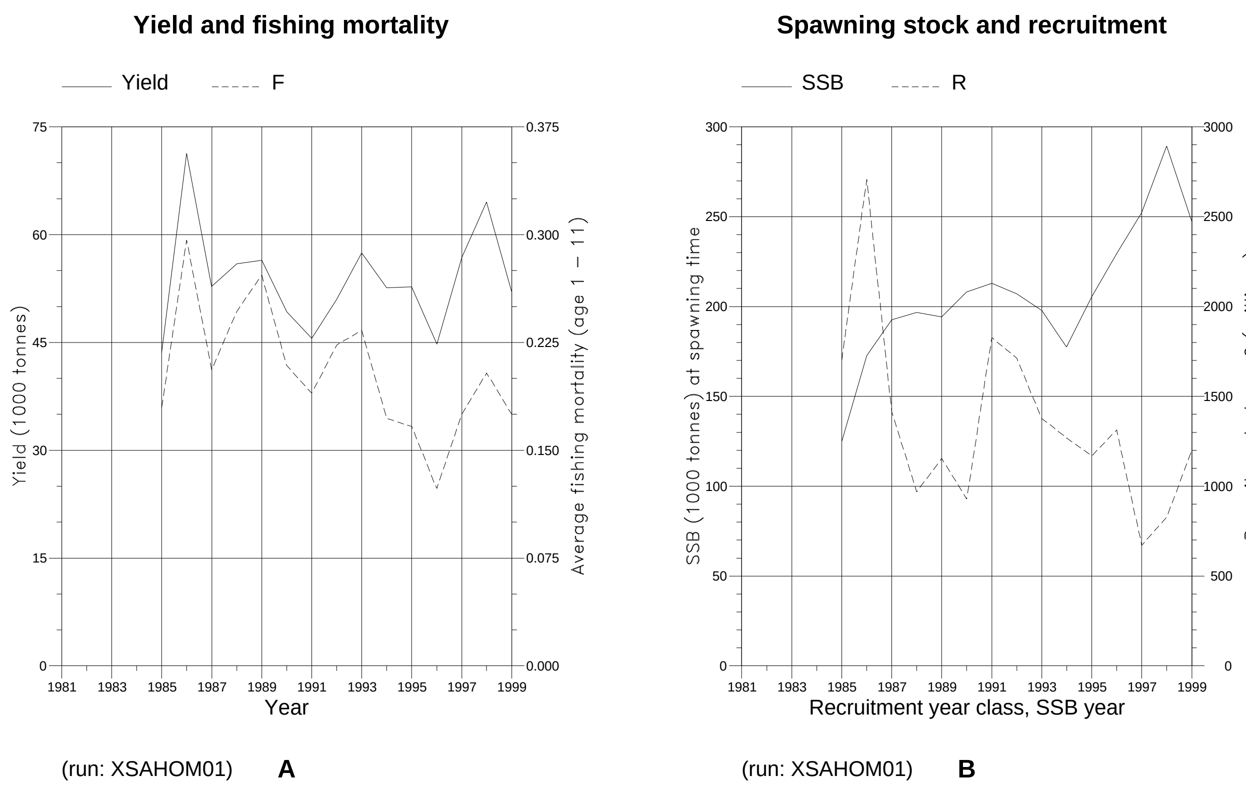


Figure 7.7.2.3

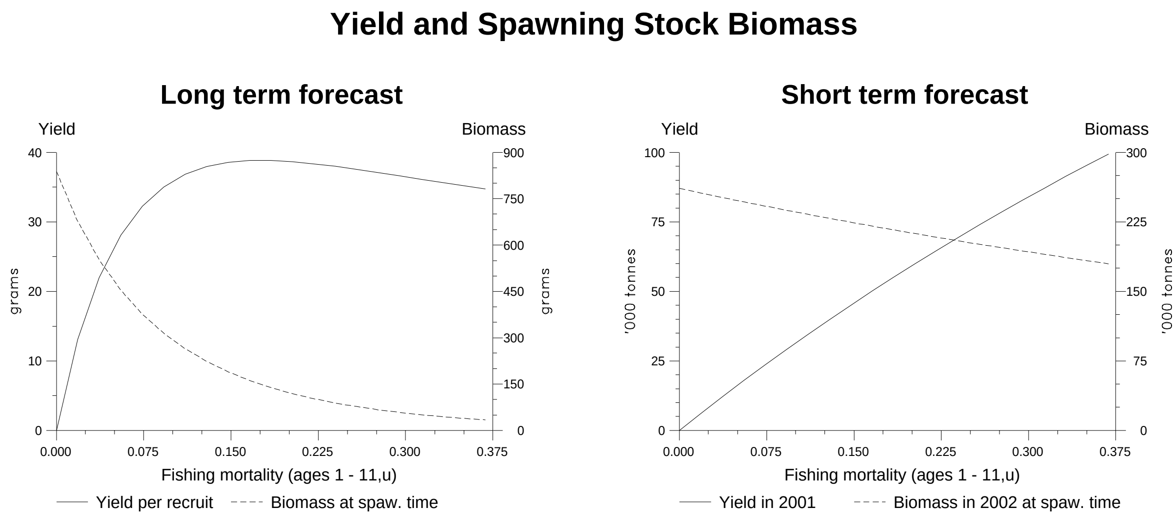
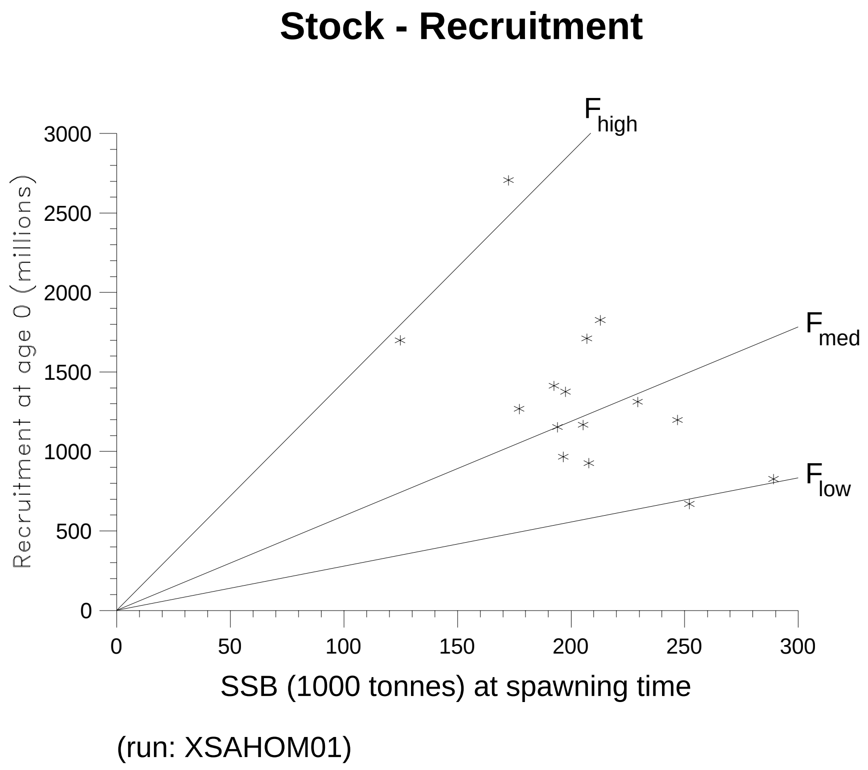


Figure 7.8.1



Stock - Recruitment
F high
F med
F low
Recruitment at age 0 (millions)
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
SSB (1000 tonnes) at spawning time
(run: XSAHOM01)

Figure 7.10.1

Advisory Committee on Fisheries Management ICES CM 2001/ACFM:06

REPORT OF THE

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

ICES, Headquarters
14–23 September 2000

PART 2 OF 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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PART 2

8 SARDINE GENERAL

Sardine (*Sardina pilchardus*, Walb) has a wide distribution around both North-East Atlantic waters and in the Mediterranean Sea. Its northernmost boundary distribution seems to be likely related with the sea surface temperature and reaches up to the North Sea. Nevertheless, as in other sardine stocks, distribution area and abundance may be related with "regimes" (Lluch-Belda *et al*, 1989) and, hence, changes in both abundance and distribution should be expected.

Most of the studies about distribution and abundance of this fish species were done off the Iberian Peninsula waters, in Moroccan waters and in the Mediterranean Sea (Abad *et al*, 1999, Kifani, 1998, ICES CM 2000/ACFM:5), where sardine is a target species. In northern areas, sardine is not a target species and, is spite catches are routinely reported from this area, they could not reflect the true abundance or distribution of this fish specie.

Under the frame of the EU project PELASSES, a wide area, from Gibraltar to the Celtic Sea was covered in spring 2000 (Marques, 2000 WD and Carrera 2000 WD). Main feature of these surveys was the combination of both acoustic records, provided by 38 and 120 kHz frequencies, and egg samples provided in a continuously way by the CUFES. This device consists on a pump located at 3-5 m depth which provides a water flow of about 600 l/min to a concentrator. From here a smaller water volume (20 l/min) is conducted to a collector.

Acoustic Surveys

In ICES Sub-Division VIIe and in a small part of the VIIh, an acoustic survey was conducted from 19th March to 23rd. The survey, carried out on board R/V Thalassa, mainly covered VIIe. Sardine around the French coast was scarce. Moreover, in this area the presence of any fish specie was scarce. Off the English waters, the occurrence of fish was higher, being sprat the most abundant fish specie. Sardine was found close to the Celtic Sea. Nevertheless, the distribution of the sardine eggs was wider. This could be explained by the currents regime in the English Channel. In VIIe a total of 247 tonnes were estimated, corresponding to 6 million fish, most of the younger (i.e.<18cm length). In the Celtic Sea only a few were steamed, close to the French coast. The bulk of the area was no covered and the outer limit of the distribution is located further than the outer limit of the tracks Total abundance was estimated to be 3283 tonnes corresponding to 56 million fish. Younger specimen were located close to the coast and the adults offshore (Figure 8.1).

From mid April to mid May, VIIIab Divisions were surveyed by the R/V Thalassa. Sardine around VIIIab showed a wide distribution, covering from the coastal waters where the younger were mainly located, to the continental shelf break. Close to the slope large number of spawning adults were detected.

The Fishery

In VII and VIIIab Division catch data area available from France, UK (England and Wales) and Germany (Table 8.1). Germany also provided catch-at-age data from VIIef ICES Division. In VIIIab Division catches were reported by France.

In Division VII reported catches were below 5 thousand tonnes from 1983 to 1991. From 1992 to 1996 catches reached its maximum level, with 23 thousand tonnes reported in 1994. Since 1997, catches are around 4 thousand tonnes. Reported catches in VII for 1999 were 3,711 tonnes, most of then located in VIIef. Total landings in VIIIab were 17730 tonnes, which are similar to that of the last year. Landings in VIIIab presents a stable period from 1983 to 1996 at around 7 thousand tonnes. Since that catches notably increased up to 18 thousand tonnes.

In Division VII, as shown in Table 8.2 most of the catches occurred during the first and the fourth quarter. Length distribution from VIIef are available for the first and fourth quarter (Table 8.3). Mean length were similar for both quarter (12.5 cm).

Acoustic surveys has been performed for anchovy since 1989 in Divisions VIIIab. Some results were also given for sardine. In addition, Spain has also conducted two surveys covering part of VIIIb from 1997 to 1999. From these time series, the sardine biomass estimated was always higher than 200,000 tonnes. The fishing effort in this area for sardine is therefore low and could no reflect the dynamics of sardine.

Although the first acoustic survey in the northern part of this stock was conducted this year, the knowledge about sardine population around VII Area is still scarce. The Working Groups recommends that the study of the sardine in this northern part should be increased and all the member countries should make available the information of sardine in their waters concerning surveys, catch compositions and eggs and larvae distribution.

Table 8.1: Annual catches of sardine by ICES Sub-Division

DIVISION	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
VIId	211	147	465	512	67	29	93	64
VIIe,f	590	661	1 624	2 058	682	438	91	808
VIIg	-	1	-					
VIIh	2	-			216	2 119	957	235
Total VII	**803**	**809**	**2 089**	**2 570**	**965**	**2 586**	**1 141**	**1 107**
VIIIa	6 013	4 472	8 090	10 186	7 631	7 770	8 885	8 381
VIIIb	454	19	79	77	77	38	85	104
Total VIIIab	**6 467**	**4 491**	**8 169**	**10 263**	**7 708**	**7 808**	**8 970**	**8 485**

DIVISION	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
VIId	170	153	127	2 086	1 621	179	71	103	247
VIIe,f	4 687	19 635	5 304	20 985	13 787	8 278	2 584	4 223	3 415
VIIg									
VIIh	110	4	71	-	1 439	1 350	1 058	101	11
Total VII	**4 968**	**19 793**	**5 502**	**23 071**	**16 846**	**9 807**	**3 713**	**4 427**	**3 711**
VIIIa	9 113	8 565	4 703	7 164		8 180	11 361	10 674	
VIIIb	482	141	548	119		526	160	7 749	
Total VIIIab	**9 595**	**8 706**	**5 251**	**7 283**		**8 706**	**11 521**	**18 423**	**17 730**

1983-90 only French data was available for Sub-Area VII

Table 8.2: Sardine landings in 1999 by country. Below, quarterly distribution of the German and UK catches.

Division	**Germany**	**UK**	**France**	**Year**
VIId	62	185		**247**
VIIef	58	3357		**3415**
VIIg				
VIIh	13	25		**38**
VIIj				
VIIIab	11		17730	**17741**
Total	**143**	**3567**	**17730**	**21440**

Country	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Year**
Germany			57	87	**143**
UK	2112	2	77	1377	**3568**
Total	**2112**	**2**	**134**	**1463**	**3711**

Table 8.3: Sardine length distribution by quarter in ICES Division VIIef
(1) Provided by UK (England and Wales)
(2) Provided by Germany

	1st Q	2nd Q	3rd Q	4th Q
8				
8.5				
9				
9.5				
10	200			
10.5	200			2
11	1327			17
11.5	1377			47
12	3130			63
12.5	5159			53
13	2805			35
13.5	927			17
14	125			5
14.5	50			1
15	25			
15.5	0			
16				
16.5	100			
17				
17.5				
18				
Total	15426			240
Mean length	12.6			12.5

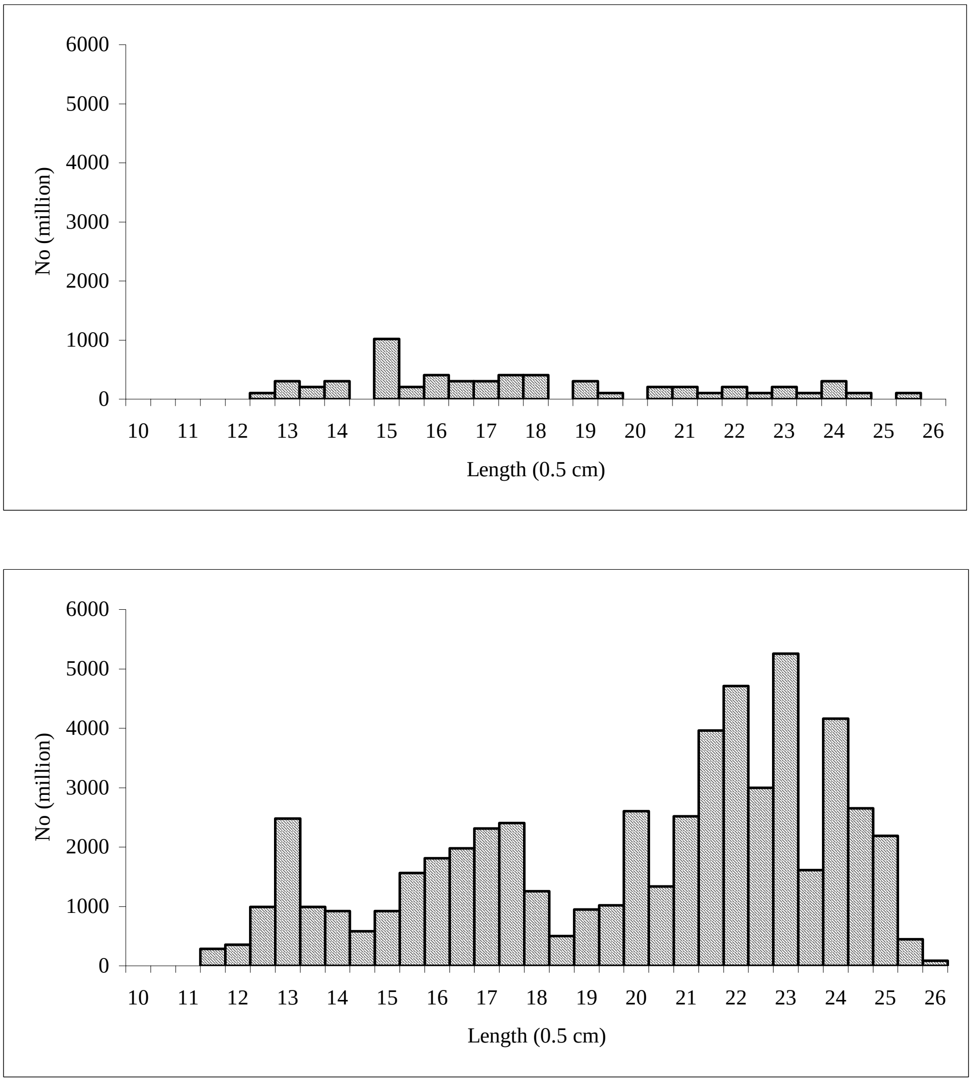


Figure 8.1: Estimated fish abundance by length class (0.5 cm) during PELACUS 0300 acoustic survey. Upper pannel, VIIef; lower pannel VIIh Division

9 SARDINE IN DIVISIONS VIIIC AND IXA

9.1 ACFM Advice Applicable to 1999 and 2000

In October 1998, ACFM recommended a reduction in fishing mortality to a value of F=0.20, corresponding to a predicted catch of 38000 t. If this reduction could not be implemented in 1999, ACFM advised a stepwise reduction in fishing mortality aiming at an increase of 20% in spawning stock biomass in 2000 and corresponding to a 40% decrease in F in 1999.

Based on new data provided by Anon. (1999), ACFM considered that there has been a severe decline in abundance in the northern part of the distribution of the stock whereas abundance in the southern areas has been approximately stable. Spatial changes in distribution and a shift in the exploitation pattern in southern areas towards older ages are perceived. It is unclear whether these changes are due to changes in migration driven by climatic effects, a contraction of the distribution or local depletion of independent units. ACFM considers that "perceptions the overall state of the stock depends on the extent to which reliance is placed on information from the northern and southern areas, and therefore the state of the stock is considered to be uncertain". For 2000, ACFM recommends that "fishing mortality be reduced below F=0.20, corresponding to a catch of less than 81000 t in order to prevent short-term decline in stock size and promote recovery of the stock".

9.2 The Fishery in 1999

As estimated by the Working Group, catches in divisions VIIIc and IXa were 94,091 t (22,271 t from Spain and 71,820 t from Portugal). The bulk of the landings (99%) was done by purse seiners. Table 9.2.1 summarises the quarterly landings by ICES Sub-Division.

In March, a ban was imposed to the purse seine fishery off Galician waters (IXa North, VIIIc West and the most western part of VIIIc East). An other management regulation implemented in 1999 was a minimum landing size of 11 cm (EU reg. 850/98). In Spain, a maximum allowable catch of 7,000 Kg per fishing day and a week limitation in the number of fishing days (4 in Galicia, 5 in the rest of Spain) were also implemented. In Portugal, new regulations have been gradually implemented since 1997 and the 1999 measures included: (1) an overall limitation in the number of fishing days (180 days per year, and 48 hours of ban during the weekend), (2) an overall catches reduction of about 10 % of the 1997 catches, (3) a closure of the purse-seine fishery in the northern part of the Portuguese area in February and March and finally, (4) an yearly and daily catches limits for all fishermen organisations. Daily catch limitations have been imposed for the first time in 1999.

In 1999, catches by both countries were lower than those realised in 1998. In Sub-division VIIIc-East, catches were 7,407 t which represented a reduction of 30 % compared to 1998. As 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 4,455 t (20 % of reduction) and most of them were made during the second and fourth quarter. In IXa-N, sardine catches were the lowest ever reported (2,563 t, a reduction of 21 %from 1998) due to the absence of fish in the area. Most of the landings from that area occurred during the second and third quarter. In IXa-CN, landings yielded to 31,574 t, which were more or less at the same level than the previous years. However, a large decrease in the catches was observed in the fourth quarter, for which there was no available explanation. Almost 50 % of the catches in this area was obtained during the third quarter. In IX-CS, catches also decreased (21,747 t or a reduction of 26%) and this reduction was equally distributed throughout the year. There is also some mentions that part of the purse-seine's fleet directed its effort to Spanish mackerel during the first and second quarter of the year. In IXa S, the reduction was 11 % lower (18,499 t), compared to an increase of 19% (7,846 t) in Cadiz.

In 1999, the bulk of the catches for this stock occurred in IXa Central North during the third quarter. The contribution of the catches off Galician waters, which reached up to 90,000 t in the earlier eighties, was almost negligible.

Annual catches from both Spain and Portugal are available since 1940 (Figure 9.2.1 and Table 9.2.2). Declining trends are observed in northern areas (from IXaCN to VIIIc) whereas in the most southern areas, catches have shown a slight increasing trend.

9.3 Fishery Independent Information

9.3.1 Egg surveys

DEPM surveys were carried out in 1999, both in Spain and Portugal (Anon., 2000). An overview of the methodology of these surveys has already been presented in Anon. (2000a) and a detailed description can be found in Anon. (2000b).

The Portuguese survey covered the Portuguese coast and the Gulf of Cádiz from 10th of January to 3rd of February and the Spanish survey was carried out off the North Atlantic Spanish coast from the 16th of March to the 11th of April. Adult parameters are estimated for the entire survey areas (unstratified). Survey timing of the Portuguese survey was changed from March to January, a change which is expected to increase the precision of SSB estimates and also result on a sightly larger estimate due to higher condition of fish in January. Parameters for the Spanish survey were based on samples collected in the Gulf of Biscay due to the small number of adult fish observed in the other areas. Due to inadequate sampling, it was not possible to estimate spawning fraction in the Spanish area and therefore the 1997 estimate was used in the calculation of SSB.

Parameter estimates for the two surveys are presented in Table 9.3.1.1. The total 1999 SSB estimate is 215.5 Ktonnes , with 95% of the biomass coming from the Portuguese survey (Portuguese coast+Gulf of Cadiz), a distribution pattern which is similar to the one observed in 1997. SSB estimates for both areas are well below the corresponding estimates from acoustic surveys. The Portuguese survey gave a much higher SSB than the two previous surveys, mainly due to the combination of a higher egg production and lower spawning fraction. However, the lower spawning fraction is due to very low estimates in the southern region (Algarve+Cadiz) and it is possible that the SSB estimates have been biased by problems related to adult survey design and post-stratification (Tables 9.3.1.1 and 9.3.1.2). An opposite situation was observed in the Spanish surveys. SSB estimates for 1999 where in this case, the lowest of all available estimates. Although the 1999 estimate has to be interpreted with caution, because it uses the 1997 spawning fraction, the SSB series shows a clear decreasing pattern in the Spanish area.

The issue of sampling design and adult parameter estimation has been is addressed by Stratoudakis and Fryer (WD, 2000). This WD demonstrates the impact of post-stratification on the 1999 DEPM estimation of sardine spawning biomass off Portugal, and propose sensible designs for future surveys. Poststratifying the Portuguese 1999 DEPM survey into two strata (western and southern) increases the SSB estimate by at least 100 Kt, nearly 50% more than the original (unstratified) estimate. A series of simulated populations was constructed consisting of the two strata, in which fish abundance and mean spawning fraction in each stratum were allowed to vary widely, and where egg production, sex ratio and batch fecundity were assumed known without error. Then each population was sampled using simple random sampling and various forms of stratified random sampling (allocation proportional to survey area, to fish abundance, and optimal allocation). Ignoring spatial structure in spawning fraction led to very biased and imprecise estimates of fish abundance. In the population scenario that most closely resembles the 1999 Portuguese DEPM survey, the bias was –25%, suggesting that unstratified estimation underestimates the true SSB. Stratified random sampling with allocation proportional to the abundance and optimal allocation outperformed allocation proportional to area and were robust to moderate levels of misallocation. Therefore, the authors believe that future adult surveys for DEPM would benefit by adopting an *a priori* stratified design, in which stratum effort is allocated according to the sardine abundance estimate from the most recent acoustic survey.

In spite of these recent findings, Stratoudakis and Fryer (WD, 2000) do not propose the use of the stratified SSB estimate in current years assessment, the first obvious reason being that new estimates have to be calculated for the previous surveys and the second because there are still doubts whether the large difference in spawning fraction between areas is a real biological phenomena or a temperature related artifact. The working group considers that research in this area should continue within the proposed Study Group on the Estimation of the Spawning Stock Biomass of Sardine and Anchovy by the Daily Egg Production Method and that the approach proposed in this WD should be used in the future.

9.3.2 Acoustic surveys

Acoustic activities undertaken in this area are co-ordinated in the frame of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII (ICES CM 1999/G:13).

Last year, a project called “Direct abundance estimation and distribution of pelagic fish species in north east Atlantic waters: Improving acoustic and daily egg production methods for sardine and anchovy (PELASSES)”, was approved by the EU under the frame of the “Common Fisheries Policy”. With the objective of improving the precision of the acoustic estimation, this project merges acoustic and ichthyoplankton activities. This combination of different sampling activities has been facilitated by the fact that the surveys currently performed in this area are conducted during the spawning time of two very important pelagic species, sardine and anchovy. Moreover, the recent development of the Continuous Underway Fish Egg Sampler (CUFES) is also an important factor that has contributed largely to the realisation of this objective. This CUFES device consists on a pump located at 3-5 m depth which provides a water flow of about 600 l/min to a concentrator. From there, a small volume of water (20 l/min) is directed to a collector in which plankton with a size greater than 500 µm is retained. CUFES provides continuous records of the plankton present at 3 m depth. An other objective of this project consists in the calibration of this equipment to allow the estimation of the eggs in the whole water column. If such a calibration is successful, both methods will be performed simultaneously on a single R/V.

To summarise, 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 the abundance of sardine and anchovy or other pelagic fish. This will be the first attempt to realise this objective which corresponds also to a recommendation of ICES to cover the entire sardine distribution. New common statistical techniques will be developed to improve the precision of the estimations.

2. The distribution of the main species of pelagic fish at the spawning time.

3. The egg distribution at 5 meters depth and, once CUFES is calibrated, the egg production of the main pelagic fish species.

4. The feasibility of using a single research vessel to get abundance and biomass estimates by echo-integration and egg production methods.

5. Biological samples collected from a wide area will be available to be used for many purposes (i.e. stock identification, otolith exchanges ...).

Portuguese November 1999 Acoustic Survey

This survey was performed in accordance to the standard survey design and strategies which consists in: (1) the calibration of the 38 kHz transducer prior the survey, (2) a distance of 8 nm between parallel transects and, (3) the application of the Nakken and Dommasnes method (1978). Moreover, several CalVET tows were also done during night hours throughout all the surveyed area. The survey was carried out on board R/V Noruega (Marques, WD 2000).

Sardine occurred in two main areas (Figure 9.3.2.1): (1) Off the northern coast, where juveniles are predominant and, (2) in the southern part (Algarve and Cadiz) where the bulk of the population is composed of adult fish (Figure 9.3.2.2, Table 9.3.2.1). Between Cape Roca and Cape San Vicente, sardine abundance was low. Compared with the previous year, there was an important decrease in both biomass and number (from 621,000 t or 21,168 million fish to 272,000 t or 7,866 million fish). This decrease was mainly concentrated in the northern part and Cadiz. In IXa-Central North, juveniles continued to be the dominant age groups (71% in numbers), so the observed decrease seems to be related with an overall decrease of the population. On the contrary in Cadiz, almost no recruits were observed. However, a significant decrease in the absolute number of recruits was also observed. Adults, as it was already mentioned, were mostly concentrated in Algarve and their number remained quite stable (from 95,000 t or 2,019 million fish to 92,000 t or 1,537 million fish, with 99 % belonging to the 1+ age groups in 1999 compared to only 58% in 1998). The egg distribution, as determined by the CalVET tows, matched quite well the acoustic adult distribution (Figure 9.3.2.3).

For this time series, long-term fluctuation in the estimated biomass by area is presented in Figure 9.3.2.11. From this Figure, it can be concluded that:

- An important decrease in the biomass was observed in the north part.

- Large biomass fluctuations in the central part, with the lowest value in 1999

- A stable situation in the south of Portugal where most of the adults are present.

- A poor 1999 year class compared with the previous year, which had more incidence in Cadiz, one of the traditional nursery areas.

Due to the shortness of the time series in Cadiz and giving the influence of the incoming recruitment in the total biomass, no conclusion on the dynamic of sardine in Cadiz could be suggested.

Portuguese March 2000 acoustic survey

This survey conducted in March 2000 has provided for the first time additional information on sardine eggs. Due to the bad weather conditions found in Cadiz, 33% of this area was not covered which however corresponds to the traditional area with less fish abundance.

In comparison to the November survey, sardine were more distributed in the southern parts. On the contrary in IXa-CN, sardine were restricted in a small area, around Porto. Accordingly, the sardine biomass estimated in IXa Central South was higher than that of the November survey (Figures 9.3.2.4 , 9.3.2.5 and Table 9.3.2.1). The number of juveniles increased in northern part and in addition, a large number of fish smaller than 8 cm (modal length of 6 cm) appeared in Cadiz. Taking into consideration the growth pattern of this species, most of these fish were probably hatched in late January 2000 but classified as fish of the age group 1 according to the ageing criteria. These fish notably increased the age group abundance (an increase of 16 % if their abundance is estimated to be about half the age 1 fish abundance in Cadiz). Furthermore, during the second half of the year, these fish will be re-allocated into age group 0. This situation has often happened and might lead to an over-estimation of age group 1 in the Portuguese March surveys.

Comparing with the last March acoustic survey , there was a decrease of 12% in the total biomass. Although this decrease was lower, important changes in the biomass was observed in the different areas. In the northern part, total biomass was estimated at 98,000 t or 3,685 million fish, a decrease of 38 % compared to 1998. Nevertheless in the Central part, which roughly corresponds to IXa Central South, the biomass increased to 150 % (from 35,000 t or 830 million fish in 1999 to 90,000 t or 2,715 millions fish this year). In Algarve (IXa South), the biomass increased by 50 % (from 39,000 t or 862 millions fish estimated last year to 59,000 t or 1,011 millions fish this year). In Cadiz, the biomass decreased by 36% (from 191,000 t or 5,495 millions fish to 122,000 t or 4,463 million fish).

This survey shows a stable situation for the adults, compared with the March and November surveys. On the other hand, the strength of the 1999 year-class could be over-estimated because part of the age 1 fish are presumed to belong the 2000 year-class. The duration of the spawning period for sardine is more than 7 months long, and it occurs from late September to early May. For this species, the recruitment is the result of the temporal and spatial integration of a long hatching process, and takes mainly place from April to October. Thus, this survey was characterised by:

- Stable population of adults mainly concentrated in the Algarve area as it was observed during the previous survey, but distributed northwards as well

- Large amount of sardines recently hatched, specially in Cadiz, which might over-estimate the strength of the 1999 year class.

Figure 9.3.2.10 shows the long-term changes in the estimated biomass from the acoustic survey conducted in March in the region of the Atlantic waters of the Iberian Peninsula (Spanish and Portuguese time series combined). Long-term trends suggest:

- A decrease of the biomass in the north part, after a period of three years of increasing trend (from 1996 with the lowest value in 1998), and a decreasing trend for the last two years.

- A small decreasing trend in the southern areas (from IXa Central South to IXa Cadiz). In IXa Central South, the biomass has been stable up to 1998. But in 1999, it decreased sharply and increased again in 2000. In IXa South, there was a decreasing trend in the biomass from 1995 to 1999 and an increase in 2000. In Cadiz, time series is short and no long-term trends could be observed.

On the other hand, CUFES performance was high and provided a good spatial distribution of the egg distribution. Moreover, the egg distribution provided by CUFES is similar to the adult distribution obtained from the acoustics (Figure 9.3.2.6).

Spanish April 2000 Acoustic Survey

As it was stated in the previous section, the Spanish survey also covered Sub-Division VIIeh during the last days of March 2000, whereas the Spanish area was covered in April. This survey was co-ordinated with those performed by

Portugal and France. (i.e. same methods, and also using CUFES). The survey was conducted on board R/V Thalassa (Carrera, WD 2000).

Figures 9.3.2.7 and 9.3.2.8 show respectively the sardine distribution along the surveyed area and the estimated number of fish at age by Sub-Division.

Off Galician waters, sardine were distributed in small patches without continuity. Only in the northern part of this area, sardine were found in thick and big schools close to the shore. As long as the inner part of the Bay of Biscay was reaching, the sardine distribution became wider. Total biomass notably increased from the previous surveys (from 43,000 t or 726 million fish in 1999 to 96,000 t or 13,121 million fish in 2000). Nevertheless the sardine biomass estimated in IXa-N was lower than that of the previous year (from 4,000 t to 2,000 t). In addition, the small number of fish belonging to age group 1 suggests that a low recruitment occurred in 1999. This situation agreed with the data obtained from the 1999 Portuguese November acoustic survey. In VIIIc-West, the biomass increased from 5,000 t to 31,000 t and in the same way, the biomass in VIIIc-East increased from 35,000 t to the 63,000 t.

To summarise, this survey provided three main conclusions:

- Poor representation of the 1999 year class
- Sardine abundance estimates from this survey time series is still decreasing in IXa-North, which can also be observed in landings from this area.
- The biomass in the Cantabrian sea, where all the fish are mature, notably increased everywhere in all VIIIc Division, the age group 3 being the most important.

Long-term trend in this time series is shown in Figure 9.3.2.10 and can be summarised as follows:

- In the inner part of the Bay of Biscay, the sardine biomass has slowly decreased over time. Nevertheless, short-term trend shows an increasing trend since 1998.
- In the rest of VIIIc Division, sardine shows an important declining trend, specially in the most western part. However, from 1999 to 2000, the biomass increased.
- In IXa North, the estimated biomass was always lower than 20,000 t and since 1993, it shows a declining trend. It should also be noted that this trend is similar to the sardine landings in this Sub-division

As in the case of the Portuguese, CUFES performance was good and the egg distribution obtained with this device, as presented in Figure 9.3.2.9, is similar to the adult distribution described from the acoustic data.

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 length weight relationship were calculated for each quarter. In Portugal both ALK and L/W relationship were compiled on a quarterly and Sub-Division basis. 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) and from IXa-CS and South gave higher mean length throughout the year.

The catch-at-age data for 1998 has been revised after that some misallocations in IXa-CN were found. Accordingly, mean weight at age was also changed. This updating caused a decrease in the catch-at-age for age group 1 (19%) and a slight increase in others age groups, except the plus group. The effect of this updating in the assessment model will be explained later.

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 Subdivision as well as their relative contribution to the catches.

Total catch was 1,777 millions which represents a decrease of 23 % from the previous year. The most important decrease was observed on age group 0, which represented 14 % of total catch in 1999 compared to 58 % in 1998. The bulk of the catches for this age group was taken in IXa-CN (64 %) as in the previous year. The Portuguese November acoustic survey estimated the 1999 recruitment as half the 1998 one. Therefore, lower catches for this age group were expected. Age groups 1 and 2 were the most represented in the catches (27 % and 20 % respectively), and they were mostly caught in IXa-CN (40 % of the total catches were from these age groups). Older fish (3+) were more represented in IXa CS and IXaS where catches were composed by more that 50% of these age groups.

Since 1978 the contribution of younger fish follows a decreasing trend, with the lowest contribution in 1995. In 1999 the contribution of the younger sardine to the overall catches was 20% higher than the one of the older fish (3+).

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) compared with the Northern Portuguese area. In the same way, mean weight at age were consistently higher in VIIIc.

SOP's were all below +/-5 % except for the second quarter in IXa Cadiz which gave a value of 7 % in the first quarter in IXa-N with 12 %. In this case, because only 68 t were landed, overall SOP for this quarter still remained bellow 5 %.

9.4.3 Maturity at age

The maturity ogive for 1999 was based on the biological samples collected during the spawning period (i.e. the fourth quarter of 1998 and the first one of 1999). Age classes from the samples obtained in 1998 were shifted by one year. Samples for each country were weighting 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	61.9	91.1	98.7	99.5	100	100

In comparison to the previous years, the proportion of fish mature at age 1 is lower whereas for the other age groups, the values are similar.

9.4.4 Natural mortality

According to Pestana (1989), the natural mortality was estimated at 0.33, and considered constant for all ages and years.

9.5 Effort and Catch per Unit Effort

Data on fishing effort and CPUE has been regularly provided in this section both for Portuguese purse-seine fleet and Spanish purse-seine fleets from Sada and Vigo-Riveira. However, it was recognised last year 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 1999.

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). The hypothesis of a negative impact of winter upwelling on sardine recruitment has been suggested by Santos *et al*. (1997). A possible mechanism coupling the two phenomena is that upweeling induces the offshore transport of larvae to areas with unfavorable feeding conditions.

The relation of winter upwelling and sardine recruitment off Portugal has been further explored by Borges *et al.* (2000). The authors also showed the relation between winter upwelling indices and the NAO (North Atlantic Oscillation) index. The paper uses a time series of sardine catches (as an index of recruitment 2 years before), indices of winter northern winds and of the NAO for the western Portuguese coast in the period 1945-1991. The results show a significant negative correlation between the mean northern wind index and sardine catches, where the period of high catches observed before 1970 coincides with lower values of the wind index and the period of lower catches after 1970 coincides with higher values of winter northern winds (Figure 9.6.1). Coastal upwelling is non-existent or very weak when the winter northern winds have low strength (left side of the triangle superimposed on Figure 9.6.1) and so do not play an important role in the survival rate of spawning in the area. It is noteworthy that when the winter upwelling overpasses a certain limit and gets stronger, it forces the recruitment or catch to be lower (right side of the triangle). In summary, strong winter north winds appear to have a negative impact on sardine recruitment but when low values are observed other factors become important in recruitment strength. The non-linear relationship implicit in the process needs to be further explored but these results may soon be useful in recruitment monitoring if the mean north wind index can be estimated in time. The working group considered that both the update of the current winter wind series and the availability of these data on time ,will enable its future incorporation in the assessment of sardine stock status.

9.7 State of Stock

9.7.1 Data exploration

Last year the assessment model was checked in order to know the sensitivity to different assumptions and input data (ICES CM 2000/ACFM:5). Several options, including different tuning fleets and input data were used. Finally the Working Group concluded to adopt as tuning data for the model three time series of acoustic surveys (Spanish Spring, Portuguese March and Portuguese November), with linear catchability model and the DEPM time series as an absolute estimator of the fish abundance.

As explained in previous sections catch-at-age and weights-at-age for 1998 were updated according to the new available information. Furthermore, weights in the stock at age for 1998 were reviewed since the last Working Group meeting. DEPM was also updated for 1997 according to the revision made at the Workshop on the Estimation of Spawning Stock Biomass of Sardine (ICES CM 2000/G:07).

In order to check how these changes affected the assessment model, a preliminary run was carried out with the same settings of the previous assessment with corrected historic input data. No major changes occurred in both estimated recruitment and fishing mortality. Nevertheless, SSB estimated for 1998 was 22% lower and that was mainly due to the revision of the weights-at-age in the stocks.

A new run was performed using last year assessment model with historical data revisions and input data updated to 1999 (RUN 1, Figure 9.7.2.2). The inclusion of a new year did no change the perception of the stock and only a small decrease in the recruitment and fishing mortality estimated for 1998 was observed.

In previous years, a difference in the signals given by the different tuning fleets which cover different parts of the stock area has been observed in the assessment. Therefore, it was decided to explore further the separate influence of each tunning fleet in the model fitness and results. Furthermore, it was observed that DEPM estimates, used as absolute indices in the first model, repeatedly gives a lower stock size estimate and that the linear catchability model considered for the Spanish acustic survey provides a poor fit for most ages. The first exploratory model included 14 years of Separable Period divided in two periods, from 1986 to 1990 and from 1991 to 1999, with abrupt change between both. A shift in the pattern of residuals from the separable model was observed from 1990 to 1991 which coincided with the period of change in the selection pattern.

Thus, aiming to explore deeper the assessment model, a series of preliminary analyses were carried out. This exercise consisted in two kinds of trials, i) the effect of the different tuning data in the assessment model and, ii) the effect of the separable period in the assessment model.

Six runs were performed using each of the different fleets as input data and testing different catchability models for DEPM and the Spanish acoustic survey. Table 9.7.1.1 summarises the input data and options for each run. Figures 9.7.1.1a-c show the results in terms of parameter estimates from all exploratory runs.

First model was fitted using only the Spanish March Acoustic survey (RUN-2). SSB estimated by this model give similar results for the most recent history (i.e. from 1989 to 1999). Nevertheless, SSB for years 1989 and backwards is higher than that estimated for the model including all fleets. Fishing mortality give similar trend of that of the test model, but, as in the case of the SSB, estimated $F_{(2-5)}$ for the beginning of the time series is lower and, on the contrary, is higher for the most recent years. Using DEPM alone as absolute estimator (RUN-3) gives a low perception of the stock size for the most recent history, with low SSB and high $F_{(2-5)}$. It should be noted that this series has a single point in the 80's (1988) and two points in the end of the 90's (97 and 99). The Portuguese November Acoustic Survey (RUN-4) gives a contradictory perception of that shown by the previous run, with high SSB for the nineties with low $F_{(2-5)}$ for the same period. The effect of the Portuguese March Acoustic Survey used as the single tunning fleet was not possible to test because the objective function did not converge. Its effect was nevertheless explored in RUN 7 (see below).

Next exploratory analysis investigated changes in the fitted catchability model for different fleets. The observation of the residuals given by the Spanish March Acoustic Survey index, suggested a power relationship rather than a linear one. Thus, RUN-5 shows the effect of such change in the perception of the stock. In spite the power model matched better than the linear, SSQ surface for this index did not reach any minimum and the index prediction gave higher CV than the linear one. Perception of the stock remains similar to the test model, and no major changes can be observed in the SSB estimated in the most recent years, with a small difference for the period 1988-1992. $F_{(2-5)}$ is similar to the test model for the period 1993-99. Nevertheless, this model present a marked peak in 1990 and from this year backwards, the estimated $F_{(2-5)}$ is higher than the test model. RUN-6 shows the perception of the stock when DEPM is treated as relative estimator with linear catchability. This model scales SSB upwards throughout the assessment period giving a more optimistic perception of the stock. $F_{(2-5)}$ is always lower than the test model and the estimated SSB higher. In recent years, SSB estimates are close to those provided by the model constructed with the Portuguese November acoustic survey alone. The exclusion of the Portuguese March Acoustic Survey (RUN-7) provides no change in the perception of the stock.

Overall, the sensitivity analysis indicates:

- The model is sensitive to which tuning fleets are included
- The exclusion of the Portuguese March Acoustic Survey does not give any change in the perception of the stock
- The model constructed with the Spanish Acoustic Survey alone as tuning fleet gives a perception close to that of the model made with all the fleets
- Compared with the test model the Portuguese November Acoustic Survey provides a more optimistic perception of the stock for the most recent years. Moreover, this perception is contradictory to that given by the model with DEPM alone as an absolute index.
- Similar perception of the stock is obtained for the models constructed with the Portuguese November AS or when DEPM is used as linear estimator in the general model.
- Although a power model could be suggested for the Spanish March Acoustic Survey, the CV of this model is lower than with the linear one.

Previous to check the sensitive to the selection pattern, catch-at-age data was analysed in order to know whether the selection pattern has changed. Figure 9.7.1.2 shows the relative differences between catches of the younger fish (age groups 0, 1 and 2) and the older (age groups 3+). The contribution of the younger fish to the overall catches shows a decreasing trend from 1978 to 1995 and an increasing trend since this year to 1998. This trend is affected by the strength of the incoming recruitment. Nevertheless, in spite the trend for the most recent years is positive, the contribution of the younger fish is the lowest of the time series, both relative and absolute terms. This plot suggests that since 1993 the fishing pattern has changed and the contribution of the younger fish to the catch became lower. The explanation for this change seems to be related with poor recruitment occurred from 1993 to 1995. The 1997 and 1998 year classes have been estimated to be above the mean recruitment of the last years but unexpectedly, they had little reflex on the catches.

Terminal numbers at age in the separable model are used to perform a VPA back in time. The chose of the appropriate selection pattern is important to increase the accuracy and precision of the parameters estimation.

Different options concerning the separable period were tested. The results of the parameters estimation are given in figure 9.7.1.3. First model (RUN-8) was performed with two separable periods similar to those used in last year assessment, from 1987 to 1991 and from 1992 to 1999, assuming abrupt change in the selection pattern. This model give similar results to that of the test model, but the estimated $F_{(2\text{-}5)}$ was lower for year 1991. Residuals from the separable period shown a shift at the period change, as in the test model. Same behaviour in the residuals was observed when the model was constructed with two periods, from 1987 to 1990 and 1991 to 1999.

Taking into account the analysis of the catch-at-age matrix, it seems that the major change occurred from 1993 to 1994. Therefore, a new model (RUN-9) was constructed with two separable periods, from 1987 to 1993 and from 1994 to 1999. This model yields lower SSB for the period 1993-1996. Also estimated $F_{(2\text{-}5)}$ for the same period was slightly lower than that of the test model. Another model was performed with a lower separable period, from 1991 to 1993 for the first period and from 1994 to 1999 for the second. This model gives a different perception of the stock, with lower SSB for the whole period (1978-1999) and higher $F_{(2\text{-}5)}$, specially for 1990.

The analysis of the influence of the choice the separable period gives:

- Less sensitivity in the parameter estimates than the choice of the tuning fleet.

- A shift in the pattern of residuals of the separable model in those models in which the two periods were not properly chosen.

- Less abrupt change in the trend of residuals when the change in the separable period is set in 1993.

A trial run was also made with the AMCI model (Assessment Model Combining Information from various sources AMCI, Skagen, 2000, see also Section 2). This model has a population model with a fishing mortality model that basically is separable, as has ICA, but it can relax the assumption that the fishing mortalities are separable by allowing for recursive updating of the fishing mortalities, by which the selection pattern can change slowly. In spite the model has not been deeply tested, and it was never used for this stock, a preliminary run was made mainly to analyse further the changes in selection pattern throughout the assessment period. Figure 9.7.1.4 shows the selection pattern by year, normalised to the average F2-5, estimated by the model. It is clear that a pattern where higher selection of younger fish prevailed in the eighties while an opposite pattern is observed in the 90´s, with 1989-1993 as a transition period. The change in the proportion of younger/older fish along the nineties does not allow to fit a single appropriate selection pattern for this period.

On the basis of the above exploration, the Working Group stresses that the dynamic of this stock, which might include changes in both distribution area, changes in the age pattern distribution along the Iberian Peninsula (Azevedo, WD 1999) and large recruitment variability, makes difficult to get an appropriate model for the whole time series. Therefore, uncertainties about the true dynamics and absolute values still remain. The exploratory analysis showed a large sensitivity of the assessment to the different tuning series. Although improvement of the assessment by changing options regarding tuning were considered, the Working Group considers that the uncertainty currently prevailing advises for caution before significant knowledge is added. Nevertheless a model constructed with 13 years of separable period divided from 1987 to 1993 and from 1994 to 1999 including all the available tuning fleets and DEPM spawning biomass as an absolute estimator, gives lower residuals without noticeable trends. The Working Group decided to adopt such model as the most appropriate to represent the dynamic of this stock.

9.7.2 Stock assessment

Based on the previous analysis, an Integrated Catch at Age analysis (Patterson and Melvin 1996) has again been used for the assessment of sardine. The model was fitted by a non-linear minimisation of the following objective function:

$$\sum_{0}^{6+}\sum_{1987}^{1993}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{1,a}\cdot\overline{N}_{ay}\right)\right]^2+\sum_{0}^{6+}\sum_{1994}^{1999}\lambda_a\left[\ln\left(C_{a,y}\right)-\ln\left(F_y\cdot S_{2,a}\cdot\overline{N}_{ay}\right)\right]^2+$$

$$+\sum_{1987}^{1993}\left[\ln\left(DEPM_y\right)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{1,a}-PM\cdot M)\right)\right]^2+$$

$$\sum_{1994}^{1999}\left[\ln\left(DEPM_y\right)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{2,a}-PM\cdot M)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{1999}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{1999}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

$$+\sum_{1987}^{1993}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{1,a}-M\right)\right)\right]^2+\sum_{1994}^{1999}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp\left(-F_y\cdot S_{2,a}-M\right)\right)\right]^2$$

with constrains 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 1994–1999 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. The inclusion of two selection patterns reflect the change found in the catch at age matrix. SSB indices from the DEPM are below the estimated SSB in the three years.

As in last years assessment, a negative trend in residuals with time is observed for age groups 4-6 in the Spanish March acoustic survey and an opposite trend in the November Portuguese acoustic survey. These patterns indicate that the Spanish survey overestimates the population given by the model in the 80's and the Portuguese November survey is overestimating it in the 90's. Furthermore, a high residual corresponding to 1983 year-class is evident in the Spanish survey. Separable model residuals are similar to those observed from last year's assessment with values higher than ±0.5 for age group 0 in 1991, 1993 and 1995 and on age group 5 in 1998 . However, the abrupt change in the residual pattern from 1990 to 1991 observed in last years assessment is now smoothed due the change in the limits of the two separable periods. CV's expressed in % of the parameter estimates are similar to previous assessments and are mainly in the range 15-30%.

Figure 9.7.2.2 shows the estimated recruitment, F2–5 and SSB for the whole time series provided by the models fitted this year and in the last years assessment. Estimated recruitments are similar to those in the last years assessment. This years assessment confirms that the 1998 year-class has been well above those in the previous six years. Recruitment estimated for 1999 represents a 16% decrease relatively to that in 1998. Strong year-classes are observed in 1983, 1991 and 1998 but with decreasing strength in that order. Fishing mortality shows a similar pattern as in last year except for the period 1991-1994 where lower values were estimated, coinciding with the transition between the two selection patterns. F(2-5) for 1999 shows a 25% decrease relatively to that in 1998, what seems to reflect in part a decrease in fishing effort due to fishery regulations. The SSB time series estimated this year is comparable to that observed in the last years assessment. Estimated SSB again shows two clear periods of higher abundance (1982–86 and 1993–95), the second one with slighlty relative importance. After a declining period up to 1997, SSB seems to be stable in the last two years. At present the stock is considered to be at a low level, similar to that observed in 1990.

9.7.3 Reliability of the assessment model

As it was stated last year from various working documents (Azevedo, 1999 WD; Bernal 1999 WD; Carrera *et al*, 1999 WD; Morais *et al*, 1999 WD; Stratoudakis, 1999;WD) important changes in both sardine distribution and abundance has been detected since earlier nineties. A change of the sardine distribution towards southern areas and a reduction of the overall sardine distribution area, leads to a different perception of the stock depending on the area considered. Both the catch distribution by areas and the age composition of the catches in each area have gradually changed. Population abundance and catches are dependent of the strength of the incoming recruitment which shows low to average values in recent years and a short-term impact on catches and population abundance. As a consequence of this dynamics, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if areal/temporal differences are not considered.

The assessment model presently available to the Working Group improved the precision in the parameters estimation. Nevertheless, uncertainties about accuracy still remain. Taking into account the similar trends observed from the different assessment models explored and the lack of a more appropriate model in which an area perception of the evolution of this stock can be observed, the Working Group concludes that the parameters estimated by the model should be regarded as relative.

9.8 Catch Predictions

9.8.1 Divisions VIIIc and IXa combined

Input values for short term catch predictions (until 2002) are presented in Table 9.8.1. Numbers at age for ages 2-6+ were based on the population numbers estimated by the assessment model at the beginning of 2000. There is indication that the 1999 recruitment is poorly estimated by this model (CV=0.41). The number of age 1 fish for projections was calculated by replacing the 1999 recruitment estimated by the model with the geometric mean recruitment for the last six years and projecting forward one year using the F at age 0 estimated by the model. Input value for recruitment in 2000 was fixed at 7831 million fish, which corresponds to the geometric mean of the period 1994-1999. Large variations in recruitment are observed in the time series. The lowest recruitments have been observed in the more recent period and the strongest recruitments in this period are still lower than most of the recruitments in the 80's. Therefore, the mean value used for projections is considered to be representative of the recent years.

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. Stock and catch weights at age were calculated as mean values for the last three years. The use of these mean values is expected to smooth the interannual variability in these parameters. Due to the decrease in the fishing mortality in the last year input values for the exploitation pattern were those estimated by the assessment model for 1999. The 1999 maturity ogive was used in projections.

Results of the predictions are shown in Table 9.8.2 and Table 9.8.2.1. At F *status* quo (F2-5 in 1999 equal to 0.30) these predictions indicate about 23% increase in the catches and a 27% increase in the SSB comparatively to 1999. Preliminary information on catches for the first semester of 2000 indicate a level of catches similar to that in 1999, both off the Portuguese coast and off the Northern Spanish coast. The effort for these fisheries in 2000 is not expected to increased due to fisheries regulations limiting both fishing effort and catches.

However, keeping F at Fstatus quo indicates a decrease in SSB in 2002. A reduction of 20% of current fishing mortality provides a increase in SSB until 2002 while maintaining the catch level. The predicted SSB value for 2002 is comparable to the SSB level observed in 94-95.

9.8.2 Catch predictions by area for Divisions VIIIc and IXa

Table 9.8.2 presents the input data. 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 estimated for the areas combined in 1999 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 1997–1999.

Catch forecasts for each Division are shown in Table 9.8.2.2. At F *status quo*, catches are expected to increase in both areas in 2000 and 2001 and SSB is expected to increase until 2001 and then decrease slightly. Considering a 20% reduction of fishing mortality SSB will maintain the increasing trend along the projection period and catches in each area will be similar to those in 1999.

Catch prediction by area were calculated on the basis of the estimated parameters in the assessment model for 1999 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 1997–1999. There is no any scientific evidence to forecast catches according to ICES Divisions. This split by area should only be regarded as an example, because the split could also be based on other criteria. If necessary, advise on other criteria on how to split the catches between “Northern” and “Southern” areas should become available from the management bodies outside ICES.

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

Input data for yield per recruit analysis is shown in Table 9.11.1. As for the short term catch predictions, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25. Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. Population numbers used in the projection are those used for short term predictions. Results are shown in Table 9.11.2 and Figure 9.11.1.

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.

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 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 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 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

The distribution and abundance of the Iberian sardine stock has changed. Since earlier nineties, the distribution pattern is changing with an overall decrease in the distribution area and a reduction in abundance in the north part and a stable situation in the south. Thus the perception of this stock is heavily dependent of the area. On the other hand, the proportion of younger fish (i.e. age groups 0, 1 and 2) in the catches show a decreasing trend since 1978, being lower than the contribution of the older fish (age groups 3+) from 1993 to 1995. As a consequence, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if stationarity has to be assumed along the time series.

Exploratory analysis performed this year, in which the sensitivity to different options for tuning fleets and for the separable period and selection pattern was studied, resulted in an improvement of the assessment model. Although the precision of the model increased, uncertainties about the true level of the parameters estimated by the model still remain. Nevertheless, the perception of this stock obtained from the different models gave similar trends in recruitment, stock size and fishing mortality.

At present the Spawning Stock Biomass of this stock is considered to be lower, similar to that observed in 1990. The estimated 1998 year class is above the geometric mean of the time series. Because of the high CV (41%) in the estimation of the 1999 year class and given the relative low catches of this age group during 1999 compared with those obtained in 1998, the strength of the 1999 recruitment is unknown. Fishing mortality increased from 1995 to 1998 when reached its highest value since 1980. Nevertheless, fishing mortality shows a sharp decrease last year. Management measures undertaken by both countries Spain and Portugal to reduce the fishing effort (i.e. closure periods, limitation of the fishing days) and the overall catches (daily and/or annual allowable catches per boat or per fisherman organisation) as well as the strength of the 1998 year class contributed to such diminution in the fishing mortality.

The differences in the evolution of the stock abundance in different areas remains a matter of concern. The biological relationship between the different areas 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.

9.16 Stock Identification, Composition, Distribution And Migration In Relation To Climatic Effects

Last year, a considerable amount of progress has been made regarding the knowledge of sardine dynamics within the current stock unit. An overall reduction of the distribution area and a shift in the distribution pattern to the southern areas were important changes observed between the 80's and the 90's. These changes were accompanied by weak year-classes in the recent years and introduced considerable changes in the fishery distribution and in the fishing pattern along the area. Possible explanations to these changes include changes in upwelling patterns affecting larval survival. Although different perceptions of the stock are apparent from the northern and southern areas, no basis for a change in the assessment unit currently defined was advanced. Furthermore, the need of a better knowledge of the dynamics of the population to the north and south of the current stock was identified. It was also evident that the assessment model currently used is not able to describe properly these temporal and spatial changes.

During 1999, research has continued in several areas to try to answer these questions but the need of an integrated approach was recognised. A proposal for a new Project has been prepared and will be submitted to the EU-Quality of Life Program in October 2000. 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 goes from the French coast to the Spanish Mediterranean and the Morrocan coast. 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 and development of appropriate assessment models.

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	2401	1199	1141	2666	**7407**
VIIIc-W	209	1885	986	1375	**4455**
IXa-N	68	1080	1249	167	**2563**
IXa-CN	932	6109	15464	9068	**31574**
IXa-CS	4806	3670	6262	7009	**21747**
IXa-S (A)	2890	5164	5980	4466	**18499**
IXa-S (C)	2458	1312	2158	1917	**7846**
Total	**13764**	**20419**	**33240**	**26668**	**94091**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2.55	1.27	1.21	2.83	**7.87**
VIIIc-W	0.22	2.00	1.05	1.46	**4.73**
IXa-N	0.07	1.15	1.33	0.18	**2.72**
IXa-CN	0.99	6.49	16.44	9.64	**33.56**
IXa-CS	5.11	3.90	6.66	7.45	**23.11**
IXa-S (A)	3.07	5.49	6.36	4.75	**19.66**
IXa-S (C)	2.61	1.39	2.29	2.04	**8.34**
Total	**14.63**	**21.70**	**35.33**	**28.34**	

Table 9.2.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-1998.

Year	Sub-area 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**

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

Table 9.3.1.1 Parameter estimates for the 1999 Portuguese and Spanish DEPM surveys.

	Portugal	Spain	Total
Parameters	January 1999	April 1999*	
Egg production (eggs10^{-12})	5.24 (35)	0.34 (44)	
Female weight (g)	44.42 (5)	66.03 (41)	
Sex ratio	0.61 (5)	0.55 (45)	
Batch fecundity	18416 (5)	21800 (12)	
Spawning fraction	0.101 (15)	-	
Spawning biomass (Kt)	**205.1** (39)	**10.4** (77)**	**215.5** (86)

* Adult parameters correspond to the values obtained in Gulf of Biscay region
** Estimated with spawning fraction obtained in 1997

Table 9.3.1.2 Comparison of SSB estimates (CV's within brackets) by survey and for the total area obtained with DEPM.

Year	Portugal	Spain	Total
1988	115.1 (34)	180.2 (50)	295.3 (33)
1997	127.2 (57)	20.7 (84)	147.9 (51)
1999	205.1 (39)	10.4 (77)	215.5 (39)

Table 9.3.2.1.a. Sardine assessment during the Portuguese 1999 Fall Acoustic survey. Number in thousand fish and Biomass in tonnes

AREA			1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	46726	24332	15157	2887	152		68		**89323**
	%	52.31	27.24	16.97	3.23	0.17		0.08		
	Mean Weight	19.5	37.7	49.2	60.7	66.9		72.1		
	No fish	2396691	646062	308149	47588	2279		944		**3401712**
	%	70.46	18.99	9.06	1.40	0.07		0.03		
	Mean Length	13.9	17.3	18.8	20.1	20.8		21.3		
Oc. Sul	**Biomass**	12787	1410	3905	5030	5461	2516	1251		32360
	%	39.51	4.36	12.07	15.54	16.88	7.78	3.87		
	Mean Weight	10.1	39.5	51.4	58.6	65.8	69.5	73.4		
	No fish	1265134	35656	75996	85837	83046	36213	17049		**1598932**
	%	79.12	2.23	4.75	5.37	5.19	2.26	1.07		
	Mean Length	11.1	17.5	19	19.9	20.6	20.9	21.3		
Algarve	**Biomass**	1204	5630	13648	14850	23272	23035	7633	2878	92151
	%	1.31	6.11	14.81	16.11	25.25	25.00	8.28	3.12	
	Mean Weight	34.5	48.5	52.1	57.6	62.2	66.5	70.2	76	
	No fish	34937	116064	261777	257656	373976	346213	108751	37863	1537236
	%	2.27	7.55	17.03	16.76	24.33	22.52	7.07	2.46	
	Mean Length	16.8	18.7	19.2	19.8	20.3	20.7	21.1	21.6	
Cadiz	**Biomass**	3953	20741	9648	10551	10046	1880	1418	232	58468
	%	6.76	35.47	16.50	18.05	17.18	3.22	2.43	0.40	
	Mean Weight	31.1	39.8	44.1	49.7	52.2	64.1	63.4	61.9	
	No fish	127204	521275	218721	212487	192545	29347	22377	3752	1327708
	%	9.58	39.26	16.47	16.00	14.50	2.21	1.69	0.28	
	Mean Length	16.2	17.6	18.1	18.8	19.1	20.4	20.4	20.3	
Portugal	**Biomass**	60747	31449	32811	22886	29018	25621	9098	2878	213834
	%	28.41	14.71	15.34	10.70	13.57	11.98	4.25	1.35	
	Mean Weight	21.4	41.9	50.9	59.0	65.0	45.3	71.9	76.0	
	No fish	3696787	797816.8	645959.8	391121	459342.4	382446.9	126786.6	37863	6537880
	%	56.54	12.20	9.88	5.98	7.03	5.85	1.94	0.58	
	Mean Length	13.9	17.8	19.0	19.9	20.6	13.9	21.2	21.6	
Whole Area	**Biomass**	64731	52230	42503	33487	39116	27565	10579	3172	272302
	%	23.77	19.18	15.61	12.30	14.36	10.12	3.88	1.16	
	Mean Weight	23.8	41.4	49.2	56.7	61.8	50.0	69.8	69.0	
	No fish	3824007	1319109	864699	603627	651907	411814	149184	41635	7865588
	%	48.62	16.77	10.99	7.67	8.29	5.24	1.90	0.53	
	Mean Length	14.7	17.9	18.8	19.5	20.1	19.4	21.0	21.0	

Table 9.3.2.1.b. Sardine assessment during the Portuguese 2000 Spring Acoustic Survey. Number in thousand fish and Biomass in tonnes.

AREA		1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	52427	12754	15442	9625	3510	2646	1299	**97704**
	%	53.66	13.05	15.80	9.85	3.59	2.71	1.33	
	Mean Weight	18.7	42.2	49.4	60.3	65	71	74.4	
	No fish	2802193	302069	312436	159507	54044	37249	17448	**3684945**
	%	76.04	8.20	8.48	4.33	1.47	1.01	0.47	
	Mean Length	13.9	18.1	19.1	20.3	20.8	21.4	21.7	
Oc. Sul	**Biomass**	34833	20844	15365	12362	4831	1452	641	**90328**
	%	38.56	23.08	17.01	13.69	5.35	1.61	0.71	
	Mean Weight	21.6	40.8	53.8	60.1	65.7	74.2	81.2	
	No fish	1611902	511258	285429	205721	73488	19565	7896	**2715259**
	%	59.36	18.83	10.51	7.58	2.71	0.72	0.29	
	Mean Length	14.4	17.9	19.6	20.3	20.9	21.7	22.3	
Algarve	**Biomass**	79	5489	7749	8322	10473	13677	13484	**59272**
	%	0.13	9.26	13.07	14.04	17.67	23.07	22.75	
	Mean Weight	32.8	42.3	49.3	54.1	61.8	63.7	73.2	
	No fish	2407	129778	157150	153772	169467	214544	184210	**1011328**
	%	0.24	12.83	15.54	15.20	16.76	21.21	18.21	
	Mean Length	16.8	18.1	19	19.6	20.5	20.7	21.6	
Cadiz	**Biomass**	17457	48713	22171	12309	13180	3523	5105	**122458**
	%	14.26	39.78	18.10	10.05	10.76	2.88	4.17	
	Mean Weight	8.1	39.7	47.5	51.8	56.1	63.8	66.3	
	No fish	2164952	1226822	466663	237681	234946	55264	77048	**4463375**
	%	48.50	27.49	10.46	5.33	5.26	1.24	1.73	
	Mean Length	9.1	17.8	18.8	19.4	19.9	20.7	20.9	
Portugal	**Biomass**	87339	39087	38556	30309	18814	17775	15424	**247304**
	%	35.32	15.81	15.59	12.26	7.61	7.19	6.24	
	Mean Weight	24.4	41.8	50.8	58.2	64.2	69.6	76.3	
	No fish	4416502	943105	755015	519000	296999	271358	209554	**7411532**
	%	59.59	12.72	10.19	7.00	4.01	3.66	2.83	
	Mean Length	15.0	18.0	19.2	20.1	20.7	21.3	21.9	
Whole	**Biomass**	104796	87800	60727	42618	31994	21298	20529	**369762**
Area	**%**	28.34	23.75	16.42	11.53	8.65	5.76	5.55	
	Mean Weight	20.3	41.3	50.0	56.6	62.2	68.2	73.8	
	No fish	6581454	2169927	1221678	756681	531945	326622	286602	**11874907**
	%	55.42	18.27	10.29	6.37	4.48	2.75	2.41	
	Mean Length	13.6	18.0	19.1	19.9	20.5	21.1	21.6	

Table 9.3.2.1.c. Sardine assessment during the Spanish 2000 Acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		1	2	3	4	5	6	7	8	9	Total
VIIIc-Ee	**Biomass**	2866	8786	7585	4085	2612	648	346	129		**27057**
(>3°30')	**%**	10.6	32.5	28.0	15.1	9.7	2.4	1.3	0.5		
	Mean Weight	45.0	59.3	70.8	79.1	85.1	92.9	101.2	98.9		
	No fish	63307	147507	106827	51469	30598	6956	3420	1305		**411390**
	%	15.4	35.9	26.0	12.5	7.4	1.7	0.8	0.3		
	Mean Length	17.7	19.6	20.9	21.8	22.4	23.1	23.8	23.6		
VIIIc-Ew	**Biomass**	294	6819	11783	7515	7457	1348	201	431	67	**35917**
(<3°30')	**%**	0.8	19.0	32.8	20.9	20.8	3.8	0.6	1.2	0.2	
	Mean Weight	53.6	66.0	74.0	80.4	83.5	91.8	100.6	89.3	100.6	
	No fish	5454	102998	158898	93236	89114	14646	2002	4807	667	**471823**
	%	1.2	21.8	33.7	19.8	18.9	3.1	0.4	1.0	0.1	
	Mean Length	18.9	20.4	21.3	21.9	22.2	23.0	23.8	22.7	23.8	
VIIIc-W	**Biomass**		1435	12726	8069	6089	2114	852	142		**31427**
	%		4.6	40.5	25.7	19.4	6.7	2.7	0.5		
	Mean Weight		78.3	76.7	83.2	88.0	88.0	96.1	106.6		
	No fish		18316	165628	96701	69061	23928	8853	1328		**383815**
	%		4.8	43.2	25.2	18.0	6.2	2.3	0.3		
	Mean Length		21.7	21.5	22.2	22.6	22.6	23.4	24.3		
IXa-N	**Biomass**	878	764	222	50	9	13	8			**1944**
	%	45.2	39.3	11.4	2.6	0.5	0.6	0.4			
	Mean Weight	38.1	44.5	53.7	59.4	84.0	89.3	106.6			
	No fish	22894	16987	4086	843	106	141	71			**45127**
	%	50.7	37.6	9.1	1.9	0.2	0.3	0.2			
	Mean Length	16.7	17.7	18.9	19.6	22.3	22.8	24.3			
Spain	**Biomass**	4038	17805	32316	19719	16167	4123	1407	702	67	**96345**
	%	4.2	18.5	33.5	20.5	16.8	4.3	1.5	0.7	0.1	
	Mean Weight	43.6	61.8	74.0	81.1	85.4	90.0	98.0	93.9	100.6	
	No fish	91656	285808	435440	242249	188879	45671	14346	7440	667	**1312155**
	%	7.0	21.8	33.2	18.5	14.4	3.5	1.1	0.6	0.1	
	Mean Length	17.6	19.9	21.3	22.0	22.4	22.8	23.5	23.2	23.8	

Table 9.4.1.1 Length composition (thousands) by quarter 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			0					0
10			1					1
10.5	11		3					14
11	11		11	18			389	429
11.5	33		25	66			991	1115
12	57	1	58	144	94		2530	2884
12.5	92	8	67	281	281		4342	5071
13	82	53	32	555	172		8599	9493
13.5	9	120	20	508	187		10425	11269
14	39	293	9	734	313		10216	11604
14.5	80	176	18	871	529	108	8798	10581
15	209	109	32	978	751	331	7067	9478
15.5	157	95	44	935	1366	709	3959	7265
16	320	84	88	1246	2313	1660	2799	8509
16.5	523	59	105	1335	3581	2317	2599	10520
17	539	46	103	708	3522	2801	4632	12351
17.5	722	31	78	1162	4948	3723	4442	15109
18	629	50	63	1888	11590	4526	3969	22714
18.5	741	73	56	2420	13619	6407	2788	26104
19	1045	146	45	2216	20239	8936	2429	35057
19.5	1223	220	59	1293	15116	9580	1870	29362
20	1517	359	51	777	7567	8622	1269	20163
20.5	2340	456	59	661	4921	4060	640	13138
21	4048	433	58	272	3121	1896	183	10011
21.5	3774	290	60	263	1215	1058		6659
22	4664	207	58	116	261	170		5477
22.5	2584	116	35	43	188	26		2993
23	2764	50	20	1				2834
23.5	1287	27		9		20		1341
24	636	15						651
24.5	297	2				2		302
25	123							123
25.5	137	1						138
26	38							38
Total	30733	3521	1260	19500	95895	56953	84938	292800
Mean l	21.2	19.1	17.7	17.5	18.9	19.1	15.4	18.1
sd	2.14	2.98	3.16	2.25	1.43	1.37	2.16	2.65
Catch	**2401**	**209**	**68**	**932**	**4806**	**2890**	**2458**	**13764**

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								
9.5								
10	1							1
10.5	1						25	26
11	1						50	51
11.5					224		50	274
12	9			26	559		99	694
12.5	5		54	163	1715		395	2332
13	24		31	419	2151		397	3023
13.5	35		72	892	2925		819	4743
14	156		76	1345	5470		668	7715
14.5	297	9	211	1274	5434		1149	8374
15	523	38	273	1205	6398		2747	11184
15.5	477	25	979	3301	3160		5900	13842
16	775	90	896	5276	2793	2	9632	19464
16.5	798	41	1731	8357	3296	12	8137	22371
17	890	84	1924	12913	3435	916	3781	23943
17.5	818	102	2430	18265	2301	4828	2318	31061
18	699	134	2486	18229	4347	8872	1326	36093
18.5	390	207	2104	13296	6927	10992	655	34570
19	171	307	2147	11525	8523	11180	655	34508
19.5	442	696	1837	8802	6733	11844	255	30609
20	896	978	1323	7016	6533	15244	73	32063
20.5	1857	2491	997	2528	4129	9225		21227
21	2395	2632	597	1484	3317	5089		15514
21.5	2322	3184	297	501	1130	2283		9718
22	2078	3596	131	157	562	565		7089
22.5	1050	3473	55	51	85	211		4926
23	541	1983	31		5	46		2605
23.5	201	964	43		7	97		1312
24	51	435	1		18			505
24.5	94	132						226
25		54			12			67
25.5	0							0
26								
Total	17997	21655	20725	117027	82191	81406	39130	380130
Mean l	20.0	21.8	18.4	18.1	17.5	19.6	16.4	18.4
sd	2.50	1.37	1.68	1.49	2.56	1.10	1.21	2.19
Catch	**1199**	**1885**	**1080**	**6109**	**3670**	**5164**	**1312**	**20419**

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		6						6
8		6						6
8.5		52						52
9		65						65
9.5		91						91
10		98						98
10.5		176		24			278	478
11		52	199	845			742	1837
11.5		39	247	2959			1761	5006
12		52	366	5206			2873	8497
12.5	61	98	412	5457			2430	8458
13	138	104	577	5664	34		1877	8395
13.5	247	91	278	9361	17		1912	11906
14	144	78	268	8229			2107	10825
14.5	3	98	198	6656	50		4322	11328
15	24	63	281	4795	211		6210	11585
15.5	59	38	296	4212	347		6868	11822
16	35	14	440	5237	407	39	7043	13214
16.5	45	24	555	7094	1222	45	7300	16285
17	186	91	915	10173	1331	238	4276	17211
17.5	315	141	867	16709	2383	1788	3498	25700
18	430	260	1464	25455	4234	6728	3058	41630
18.5	407	340	1890	31377	9508	13121	1252	57895
19	422	546	2296	27813	22595	17391	1561	72623
19.5	276	646	2691	33005	21550	19743	520	78431
20	228	955	2421	27273	17338	18845	173	67233
20.5	618	1563	1996	18171	8196	8277	87	38908
21	1269	1607	1126	8097	3401	3603		19103
21.5	2224	1541	500	2143	760	1135		8302
22	2928	1323	221	400	224	232		5328
22.5	1610	998	154	100	12	31		2905
23	854	519	19		34			1426
23.5	328	160			5			492
24	68	164			5			237
24.5	14	27						41
25	8	19						27
25.5		1						1
26								
Total	12940	12146	20676	266456	93863	91218	60149	557447
Mean l	21.1	20.3	18.5	18.1	19.5	19.6	15.7	18.4
sd	2.29	3.11	2.54	2.46	1.00	0.87	1.97	2.40
Catch	**1141**	**986**	**1249**	**15464**	**6262**	**5980**	**2158**	**33240**

Table 9.4.1.1: Cont'd

Length	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Total
				Fourth Quarter				
7								
7.5								
8								
8.5								
9								
9.5			17		66			83
10			86	13	49			148
10.5			233	30	214			476
11		57	774	848	49			1727
11.5		99	812	3412	721			5043
12		311	797	8760	868			10736
12.5		396	469	12381	779			14026
13	107	212	326	11121	1546		22	13335
13.5	124	127	201	9145	709		44	10350
14	215	49	161	10254	1267	47	110	12102
14.5	68	37	125	7984	646	26	619	9505
15	93	29	73	7786	616		993	9591
15.5	81	67	119	8096	702	55	1105	10225
16	260	164	135	7651	1239	204	2222	11876
16.5	265	573	198	7512	2454	253	3131	14386
17	386	693	217	9718	4541	113	5027	20695
17.5	1274	923	171	17342	4765	803	4994	30273
18	2253	846	132	18704	9325	2808	5498	39566
18.5	2319	688	78	21595	14677	6100	3720	49177
19	4385	688	80	13263	19216	11473	4668	53773
19.5	4594	832	113	10454	21207	13869	2758	53827
20	4950	708	125	8055	15404	14840	1544	45625
20.5	4079	1107	95	2741	8334	8868	580	25804
21	3942	1528	64	1678	4113	5762	536	17621
21.5	3422	2526	83	546	1786	2267		10629
22	2235	1827	95	200	833	479		5669
22.5	1081	1894	55	81	254	127		3493
23	710	832	34	12	116	107		1811
23.5	389	598	13	5				1005
24	233	245	1	1				480
24.5	37	70						107
25	42	25						67
25.5	5	6						11
26								
Total	37551	18157	5882	199386	116496	68201	37571	483243
Mean l	20.2	20.2	14.3	16.6	19.0	19.9	18.0	18.1
sd	1.70	2.87	3.37	2.60	1.90	0.98	1.40	2.63
Catch	**2666**	**1375**	**167**	**9068**	**7009**	**4466**	**1917**	**26668**

Table 9.4.1.2

Table 9.4.1 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	4255	1274	749	8374	8689	3262	61523	88125
2	3728	678	214	4514	23150	11776	12348	56409
3	6779	626	116	6885	39790	9189	3919	67303
4	7868	678	71	1563	15745	15531	4141	45598
5	3789	152	56	806	5788	9795	2078	22465
6	2048	75	27	668	4006	4767	793	12384
7	1756	30	18	121	618	1221	136	3900
8	127		9	19	98	121		374
9	163	4						167
10	219	4		15				
11								
Total	30733	3521	1260	22964	97883	55664	84938	296725
Catch	2401	209	68	932	4806	2890	2458	13764
	Second Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	5900	920	11055	55464	38011	3054	23990	138395
2	1731	2488	6311	35422	14268	9776	11296	81293
3	3880	5184	2007	31050	15829	14496	2829	75275
4	3872	7448	912	4282	6757	18415	594	42280
5	1372	2971	247	2074	3826	16891	222	27602
6	695	1568	96	1582	3447	14509	183	22080
7	466	858	85		508	4074	15	6006
8	18		14		126	196		355
9	36	109				196		341
10	26	109						
11								
Total	17997	21655	20725	129874	82773	81607	39130	393627
Catch	1199	1885	1080	6109	3670	5164	1312	20419
	Third Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1347	1802	5448	52662	782		44933	106973.837
1	2527	3730	8475	90361	12770	3998	6818	128679
2	2249	1938	4021	58793	27477	16249	3833	114560
3	2597	2079	1888	61625	35533	13320	2711	119752
4	2079	1345	655	11306	10892	22485	930	49693
5	1123	624	144	1732	4032	25359	737	33751
6	870	493		1419	2344	6592	172	11891
7	147	134	44		57	1099	8	1490
8						508	5	514
9								
10								
11								
Total	12940	12146	20676	277897	93887	89610	60149	567304
Catch	1141	986	1249	15464	6262	5980	2158	33240
	Fourth Quarter							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	3556	4667	4713	104449	11076	690	9891	139042.323
1	19029	4154	627	64371	18981	5114	7751	120027
2	5685	2338	279	47984	26898	15256	10806	109247
3	4491	2611	145	15566	35508	14221	4820	77361
4	2624	2339	73	1494	12233	18195	2643	39599
5	1022	1061	14	148	6380	12005	1070	21699
6	904	743		156	2958	5141	559	10462
7	240	243	33		800	608	32	1956
8					102	147		249
9								
10								
11								
Total	37551	18157	5882	234169	114935	71378	37571	519642
Catch	2666	1375	167	9068	7009	4466	1917	26668
	Whole Year							
	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	4903	6469	10162	157111	11857	690	54824	246016
1	31712	10078	20906	218570	78450	15428	100082	475225
2	13394	7442	10824	146713	91794	53058	38283	361509
3	17748	10500	4156	115125	126660	51225	14278	339691
4	16442	11810	1712	18646	45628	74626	8308	177170
5	7306	4809	461	4759	20026	64050	4107	105518
6	4519	2880	122	3824	12755	31010	1707	56817
7	2608	1266	179	121	1982	7002	192	13351
8	145		23	19	326	973	5	1492
9	199	113				196		508
10	245	113		15				
11								
Total	99220	55478	48544	664905	389478	298259	221786	1777297
Catch	7407	4455	2563	31574	21747	18499	7846	94091

Table 9.4.1.3: Relative distribution of sardine catches. Upper pannel, relative contribution of each age group within each Sul
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	4.94	11.66	20.93	23.63	3.04	0.23	24.72	13.84
1	**31.96**	18.17	**43.07**	**32.87**	20.14	5.17	**45.13**	**26.74**
2	13.50	13.42	22.30	22.07	23.57	17.79	17.26	20.34
3	17.89	18.93	8.56	17.31	**32.52**	17.17	6.44	19.11
4	16.57	**21.29**	3.53	2.80	11.72	**25.02**	3.75	9.97
5	7.36	8.67	0.95	0.72	5.14	21.47	1.85	5.94
6+	7.78	7.88	0.67	0.60	3.87	13.14	0.86	4.06

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca
0	1.99	2.63	4.13	**63.86**	4.82	0.28	22.28
1	6.67	2.12	4.40	**45.99**	16.51	3.25	21.06
2	3.70	2.06	2.99	**40.58**	25.39	14.68	10.59
3	5.22	3.09	1.22	33.89	**37.29**	15.08	4.20
4	9.28	6.67	0.97	10.52	25.75	**42.12**	4.69
5	6.92	4.56	0.44	4.51	18.98	**60.70**	3.89
6+	10.69	6.06	0.45	5.51	20.87	**54.29**	2.64

Table 9.4.2.1: Mean length at age by quarter and ICES Sub-Division

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
First Quarter								
0								
1	17.1	15.6	15.6	15.2	16.2	16.4	14.2	14.8
2	20.3	20.2	19.6	17.5	18.1	17.8	17.5	18.0
3	21.3	21.1	20.8	19.0	19.2	19.0	18.6	19.3
4	22.0	21.5	21.4	19.9	19.9	19.6	19.3	20.1
5	22.7	22.1	22.0	20.3	20.5	20.1	19.8	20.7
6	22.8	22.2	22.5	21.0	20.9	20.4	20.1	21.0
7	23.3	23.2	22.2	21.4	21.1	20.9	19.7	22.0
8	23.9		22.8	20.3	21.7	22.2		22.6
9	23.6	24.3						23.6
10	24.3	24.3		22.3				
11								
Total	21.2	19.1	17.7	17.5	18.9	19.1	15.4	18.1
Second Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	16.8	18.0	17.2	17.0	15.1	18.0	15.8	16.3
2	20.6	20.4	19.3	18.2	18.6	18.5	16.8	18.3
3	21.3	21.7	20.0	19.4	19.6	18.7	17.9	19.5
4	21.7	22.0	20.3	20.3	20.1	19.7	19.1	20.4
5	22.4	22.6	21.9	20.3	20.8	20.3	19.4	20.8
6	22.3	22.9	22.0	21.0	20.9	20.4	19.5	20.8
7	22.6	23.5	22.0		22.1	20.8	20.0	21.4
8	23.8		22.8		21.8	21.3		21.6
9	23.7	24.3				21.3		22.5
10	24.5	24.3						
11								
Total	20.0	21.8	18.4	18.1	17.5	19.6	16.4	18.4
Third Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	15.7	14.1	15.1	13.7	15.6		14.9	14.4
1	19.9	20.2	19.2	17.9	18.2	18.3	17.1	18.1
2	21.8	21.5	20.3	19.2	19.4	19.0	18.2	19.3
3	22.1	21.7	20.6	20.2	19.8	19.1	18.3	20.0
4	22.4	22.4	20.9	20.9	20.1	19.9	19.2	20.4
5	22.6	22.8	21.4	20.9	20.6	20.1	19.5	20.3
6	22.5	22.4		20.5	20.8	20.2	19.6	20.6
7	23.2	23.7	22.3		22.1	20.8	20.4	21.4
8						20.8	20.8	20.8
9								
10								
11								
Total	21.1	20.3	18.5	18.1	19.5	19.6	15.7	18.4
Fourth Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	17.1	16.2	12.9	14.0	14.4	16.9	16.4	14.4
1	19.7	20.1	18.8	18.0	18.2	18.6	17.8	18.4
2	21.1	21.7	20.8	18.9	19.1	19.3	18.5	19.1
3	21.5	21.9	21.4	20.1	19.8	19.9	18.9	20.0
4	22.1	22.6	21.6	21.0	20.3	20.2	19.9	20.5
5	22.7	22.9	21.6	21.5	20.4	20.6	20.2	20.8
6	22.4	22.6		21.5	21.0	20.8	20.3	21.1
7	23.9	23.8	22.9		21.0	21.1	20.3	21.8
8					20.8	21.8		21.4
9								
10								
11								
Total	20.2	20.2	14.3	16.6	19.0	19.9	18.0	18.0
Whole Year	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	16.7	15.6	14.1	13.9	14	17	15.2	14.4
1	18.8	19.4	18.0	17.6	16.5	18.0	15.1	17.0
2	20.9	21.1	19.7	18.8	18.8	18.7	17.7	18.8
3	21.5	21.7	20.3	19.9	19.6	19.2	18.5	19.7
4	22.0	22.2	20.7	20.7	20.1	19.9	19.4	20.3
5	22.6	22.7	21.7	20.6	20.6	20.3	19.8	20.6
6	22.6	22.7	22.1	20.8	20.9	20.4	20.0	20.8
7	23.3	23.6	22.3	21.4	21.3	20.8	19.9	21.7
8	23.9		22.8	20.3	21.4	21.2	20.8	21.5
9	23.6	24.3				21.3		22.8
10	24.3	24.3		22.3				
11								
Total	20.6	20.8	17.9	17.5	18.8	19.6	16.1	18.3

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	0.040	0.030	0.031	0.026	0.030	0.033	0.022	0.025
2	0.067	0.066	0.060	0.039	0.042	0.042	0.042	0.044
3	0.078	0.075	0.073	0.050	0.050	0.050	0.051	0.053
4	0.087	0.080	0.080	0.057	0.057	0.055	0.057	0.062
5	0.095	0.088	0.086	0.062	0.062	0.060	0.061	0.067
6	0.097	0.089	0.092	0.067	0.066	0.062	0.065	0.070
7	0.104	0.102	0.088	0.072	0.068	0.067	0.061	0.084
8	0.112		0.095	0.060	0.074	0.080		0.089
9	0.107	0.116						0.107
10	0.118	0.116		0.080				
11								
Total	0.079	0.059	0.048	0.041	0.049	0.052	0.030	0.047
	Second Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	0.039	0.049	0.042	0.039	0.027	0.049	0.033	0.035
2	0.073	0.071	0.059	0.047	0.050	0.053	0.039	0.049
3	0.080	0.085	0.067	0.057	0.059	0.055	0.047	0.060
4	0.085	0.089	0.070	0.066	0.064	0.063	0.058	0.070
5	0.093	0.097	0.087	0.066	0.070	0.070	0.060	0.074
6	0.093	0.100	0.089	0.074	0.072	0.070	0.061	0.073
7	0.097	0.109	0.089		0.085	0.074	0.066	0.082
8	0.112		0.098		0.081	0.079		0.082
9	0.112	0.119				0.079		0.095
10	0.122	0.119						
11								
Total	0.069	0.087	0.052	0.047	0.044	0.063	0.036	0.052
	Third Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.036	0.028	0.032	0.023	0.033		0.030	0.027
1	0.073	0.076	0.064	0.052	0.054	0.054	0.045	0.054
2	0.095	0.091	0.076	0.064	0.065	0.060	0.054	0.065
3	0.099	0.095	0.080	0.075	0.070	0.061	0.055	0.072
4	0.104	0.105	0.084	0.082	0.073	0.069	0.064	0.076
5	0.107	0.110	0.090	0.083	0.078	0.071	0.067	0.074
6	0.106	0.105		0.078	0.081	0.073	0.068	0.079
7	0.116	0.125	0.102		0.098	0.079	0.077	0.088
8						0.078	0.082	0.078
9								
10								
11								
Total	0.089	0.081	0.061	0.056	0.067	0.067	0.035	0.059
	Fourth Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.043	0.038	0.019	0.021	0.027	0.040	0.037	0.024
1	0.066	0.071	0.058	0.047	0.052	0.052	0.048	0.052
2	0.082	0.089	0.079	0.056	0.061	0.057	0.055	0.059
3	0.087	0.092	0.086	0.068	0.068	0.062	0.058	0.068
4	0.094	0.102	0.088	0.080	0.073	0.065	0.068	0.072
5	0.102	0.105	0.087	0.086	0.075	0.069	0.071	0.074
6	0.098	0.102		0.086	0.081	0.070	0.072	0.078
7	0.121	0.119	0.105		0.081	0.073	0.072	0.089
8					0.078	0.080		0.079
9								
10								
11								
Total	0.073	0.076	0.029	0.039	0.061	0.063	0.051	0.051
	Whole Year							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.041	0.035	0.026	0.022	0.028	0.040	0.031	0.025
1	0.058	0.065	0.051	0.046	0.038	0.048	0.028	0.042
2	0.079	0.081	0.066	0.057	0.055	0.054	0.046	0.056
3	0.084	0.088	0.073	0.067	0.062	0.058	0.053	0.065
4	0.090	0.093	0.077	0.076	0.066	0.064	0.061	0.070
5	0.098	0.100	0.088	0.072	0.071	0.069	0.065	0.073
6	0.098	0.101	0.090	0.075	0.074	0.069	0.067	0.075
7	0.105	0.112	0.095	0.072	0.079	0.074	0.064	0.084
8	0.112		0.097	0.060	0.078	0.079	0.082	0.082
9	0.108	0.119				0.079		0.099
10	0.118	0.119		0.080				
11								
Total	0.076	0.080	0.053	0.047	0.056	0.062	0.036	0.053

Table 9.7.1.1: Input values and main results on the stock perception for the different models explored

	Year range	Age Range	Sep constraint	Ref. Age	Sel. Pattern	SSB index	AS indices	Index weights	Age weights
Test Model **(RUN 1)**	1978-1999	0-6+	14 years 1986-1999	3	1986-90; 1991-99	DEPM, absolute	Sp. March (86-88;90-93;96-00) Pt March, incl. Cadiz (96-99) Pt Fall (84-87; 92; 97-99)	Equal weights	0.5 for Age 0 1 for 1+

		SSB index	AS indices	COMMENTS
TUNING EFFECT	**RUN-2**		Sp. March (86-88;90-93;96-00)	SSB higher in 80's, Fbar, higher in 90's,lower in 80's
	RUN-3	DEPM, absolute		SSB lower in 90's; Fbar higher, specially since 96
	RUN-4		Pt Fall (84-87; 92; 97-99)	SSB higher in 90's, lower in 80's; Fbar lower in 90's, higher in 80's
	RUN-5	DEPM, absolute	All, Sp. March with power model	SSB lower in 80's; Fbar higher in 80's, peak in 1990
	RUN-6	DEPM, linear model	All	SSB scaled upward, Fbar scale downward
	RUN-7	DEPM, absolute	Without Pt March	No noticeable effects

		SEP. CONSTRAINT	SELECTION PATTERN	COMMENTS
Sep. Const. and Sel. Pattern	**RUN-8**	1987-1999	1987-1991; 1992-1999	Small changes in SSB, Fbar diferent for 1991. Shift in residual
	RUN-9	1987-1999	1987-1993; 1994-1999	SSB lower mid 90's, Fbar lower mid 90's. No shift in residuals

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
0	120.8	30.5	277.1	208.6	449.1	246.0
1	60.2	189.1	101.3	548.6	366.2	475.2
2	542.2	280.7	347.7	453.3	501.6	361.5
3	1094.4	829.7	514.7	391.1	352.5	339.7
4	272.5	472.9	652.7	337.3	233.7	177.2
5	112.6	70.2	197.2	225.2	178.7	105.5
6	72.1	64.5	46.6	70.3	105.9	72.2

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

Table 9.7.2.1a (cont): Input values for the assessment model.

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

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998	1999
0	0.02000	0.02500	0.01900	0.02200	0.02400	0.02500
1	0.03600	0.04700	0.03800	0.03300	0.04000	0.04200
2	0.05800	0.05900	0.05100	0.05200	0.05500	0.05600
3	0.06200	0.06600	0.05800	0.06200	0.06100	0.06500
4	0.07000	0.07100	0.06100	0.06900	0.06400	0.07000
5	0.07600	0.08200	0.07100	0.07300	0.06700	0.07300
6	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

Table 9.7.2.1a (cont): Input values for the assessment model.

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998	1999
0	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
2	0.04000	0.05000	0.04700	0.05000	0.04100	0.03900
3	0.04900	0.06200	0.06100	0.05800	0.05300	0.05400
4	0.06000	0.07200	0.06900	0.06800	0.06100	0.06200
5	0.06700	0.07900	0.07500	0.07400	0.06700	0.06800
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Natural Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Natural Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999
0	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
2	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
4	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
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.30000

Table 9.7.2.1a (cont): Input values for the assessment model.

Proportion of fish spawning

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500
2	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.2300	0.6000	0.7400	0.7900	0.4700
2	0.9500	0.9500	0.9500	0.8300	0.8100	0.9100	0.9100	0.9300
3	1.0000	1.0000	1.0000	0.9100	0.8800	0.9600	0.9500	0.9400
4	1.0000	1.0000	1.0000	0.9200	0.8900	0.9700	0.9800	0.9700
5	1.0000	1.0000	1.0000	0.9400	0.9400	1.0000	1.0000	0.9900
6	1.0000	1.0000	1.0000	0.9770	0.9870	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998	1999
0	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
2	0.8900	0.9800	0.8900	0.9180	0.9240	0.9110
3	0.9600	0.9700	0.9200	0.9500	0.9560	0.9870
4	0.9600	0.9900	0.9600	0.9720	0.9870	0.9950
5	0.9700	1.0000	1.0000	0.9930	0.9950	1.0000
6	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

Table 9.7.2.1a (cont): Input values for the assessment model

INDEX1

	1998	1999
1	*******	215.50

x 10 ^ 3

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
1	*******	*******	10.6	56.5	509.8	214.5	91.7
2	*******	*******	54.2	263.1	103.1	160.4	285.8
3	*******	*******	90.5	125.7	80.4	134.6	435.4
4	*******	*******	350.8	123.3	33.8	124.3	242.2
5	*******	*******	213.8	65.7	20.6	28.4	188.9
6	*******	*******	24.8	61.0	25.4	64.0	68.1

x 10 ^ 3

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

AGE	1996	1997	1998	1999	2000
1	1625.0	6344.1	1636.2	5711.7	6581.5
2	2082.2	3238.1	4015.0	2552.6	2169.9
3	2414.5	1551.8	2190.9	1460.7	1221.7
4	2906.0	1260.2	1434.0	844.4	756.7
5	386.5	1360.1	1185.0	595.7	531.9
6	12.0	202.8	980.0	469.1	613.2

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	2956.6	2063.2	2493.1	3714.5	*******	*******	*******	*******
1	5733.2	2743.5	1611.9	2379.4	*******	*******	*******	*******
2	1152.2	4548.2	1669.6	1343.7	*******	*******	*******	*******
3	1036.8	1083.4	658.4	928.7	*******	*******	*******	*******
4	528.3	839.2	322.9	665.6	*******	*******	*******	*******
5	76.4	143.8	127.3	236.5	*******	*******	*******	*******
6	40.1	70.0	49.6	79.9	*******	*******	*******	*******

x 10 ^ 6

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	6349.1	*******	*******	*******	*******	2424.7	8680.4	3696.8
1	5480.5	*******	*******	*******	*******	1961.2	1809.4	798.0
2	1157.1	*******	*******	*******	*******	906.4	1214.6	646.0
3	1002.6	*******	*******	*******	*******	728.9	823.3	391.1
4	437.4	*******	*******	*******	*******	1040.6	396.2	459.3
5	108.2	*******	*******	*******	*******	771.8	367.1	382.4
6	18.8	*******	*******	*******	*******	322.4	220.4	164.6

x 10 ^ 6

Table 9.7.2.1.b: Ouput values from the assessment model.

Fishing Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07728	0.05314	0.06273	0.11495	0.00832	0.05312	0.01537	0.04080
1	0.45261	0.21893	0.25880	0.22625	0.14065	0.11413	0.26593	0.10838
2	0.45111	0.40334	0.42218	0.42774	0.41461	0.25584	0.15290	0.36037
3	0.46137	0.44848	0.32074	0.38266	0.36266	0.36735	0.27108	0.24940
4	0.37770	0.73055	0.33849	0.31640	0.41076	0.32593	0.26410	0.29238
5	0.64843	0.56748	0.47325	0.46525	0.42498	0.33244	0.35084	0.32886
6	0.64843	0.56748	0.47325	0.46525	0.42498	0.33244	0.35084	0.32886

Fishing Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.05358	0.06651	0.06630	0.06694	0.07282	0.05673	0.05053	0.04930
1	0.17744	0.14612	0.14566	0.14706	0.15997	0.12463	0.11101	0.10830
2	0.33983	0.25269	0.25190	0.25431	0.27665	0.21553	0.19198	0.18729
3	0.26723	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883
4	0.32732	0.37901	0.37781	0.38144	0.41494	0.32328	0.28795	0.28092
5	0.37716	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883
6	0.37716	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999
0	0.02170	0.02062	0.02960	0.03437	0.03555	0.02641
1	0.04545	0.04319	0.06201	0.07200	0.07446	0.05533
2	0.12983	0.12338	0.17714	0.20569	0.21273	0.15805
3	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379
4	0.33012	0.31373	0.45041	0.52300	0.54091	0.40188
5	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379
6	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379

Population Abundance (1 January)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	13696.	15279.	16513.	11058.	8782.	24249.	9079.	7861.
1	7316.	9114.	10416.	11149.	7087.	6261.	16532.	6428.
2	3024.	3345.	5264.	5781.	6393.	4426.	4016.	9110.
3	927.	1385.	1607.	2481.	2710.	3036.	2464.	2478.
4	505.	420.	636.	838.	1217.	1355.	1512.	1351.
5	101.	249.	145.	326.	439.	580.	703.	835.
6	40.	96.	92.	238.	432.	572.	460.	428.

x 10 ^ 6

Table 9.7.2.1b (cont): Ouput values from the assessment model.

Population Abundance (1 January)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	6831.	11604.	7171.	7201.	6741.	15880.	12052.	5323.
1	5425.	4655.	7806.	4825.	4842.	4506.	10787.	8238.
2	4146.	3266.	2892.	4851.	2994.	2966.	2860.	6940.
3	4568.	2122.	1824.	1616.	2704.	1632.	1719.	1697.
4	1388.	2514.	1062.	913.	806.	1307.	861.	938.
5	725.	719.	1237.	523.	448.	383.	680.	464.
6	618.	653.	724.	931.	879.	460.	390.	595.

x 10 ^ 6

Population Abundance (1 January)

AGE	1994	1995	1996	1997	1998	1999	2000
0	5492.	4233.	7170.	7289.	12383.	10421.	8714.
1	3642.	3863.	2981.	5004.	5063.	8591.	7296.
2	5314.	2502.	2660.	2014.	3348.	3379.	5844.
3	4137.	3355.	1590.	1602.	1179.	1946.	2074.
4	932.	2280.	1874.	795.	756.	548.	1012.
5	509.	482.	1198.	858.	339.	316.	264.
6	360.	337.	178.	237.	348.	300.	325.

x 10 ^ 6

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	13696210	314031	227020	145609	0.6414	0.4847	83
1979	15279370	386221	282170	157241	0.5573	0.5375	96
1980	16512580	496260	369887	194802	0.5267	0.3887	95
1981	11057950	610270	462565	216517	0.4681	0.3980	89
1982	8781680	635223	500969	206946	0.4131	0.4033	96
1983	24249390	596704	482201	183837	0.3812	0.3204	104
1984	9079300	713617	542075	206005	0.3800	0.2597	95
1985	7860890	751590	606911	208440	0.3434	0.3077	94
1986	6831300	666490	545965	187363	0.3432	0.3279	97
1987	11604270	574469	469240	177695	0.3787	0.3393	100
1988	7171390	541402	428614	161530	0.3769	0.3382	102
1989	7200580	524140	363683	140962	0.3876	0.3414	96
1990	6741300	491178	357095	149430	0.4185	0.3714	104
1991	15879750	448676	358115	132587	0.3702	0.2894	99
1992	12052280	619464	481746	130249	0.2704	0.2578	99
1993	5322550	743659	545570	142495	0.2612	0.2515	98
1994	5491650	654256	528695	136581	0.2583	0.2480	98
1995	4232910	681058	564793	125280	0.2218	0.2357	98
1996	7170140	566235	452914	116736	0.2577	0.3383	101
1997	7289440	460062	356030	115814	0.3253	0.3929	98
1998	12382800	419781	324417	108925	0.3358	0.4063	97
1999	10420760	494127	366815	94091	0.2565	0.3019	98

```
No of years for separable analysis : 13
Age range in the analysis : 0  . . . 6
Year range in the analysis : 1978  . . . 1999
Number of indices of SSB : 1
Number of age-structured indices : 3

Parameters to estimate : 58
Number of observations : 239

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): Ouput values from 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	0.3627	22	0.2355	0.5585	0.2910	0.4520	0.3716
2	1988	0.3615	22	0.2317	0.5642	0.2881	0.4537	0.3710
3	1989	0.3650	23	0.2310	0.5769	0.2890	0.4610	0.3751
4	1990	0.3971	22	0.2534	0.6222	0.3158	0.4993	0.4076
5	1991	0.3094	22	0.1974	0.4848	0.2460	0.3890	0.3176
6	1992	0.2756	22	0.1784	0.4257	0.2207	0.3440	0.2824
7	1993	0.2688	22	0.1736	0.4162	0.2151	0.3360	0.2756
8	1994	0.2660	24	0.1658	0.4266	0.2090	0.3385	0.2738
9	1995	0.2528	23	0.1602	0.3989	0.2003	0.3190	0.2597
10	1996	0.3629	22	0.2353	0.5597	0.2909	0.4527	0.3719
11	1997	0.4214	21	0.2774	0.6401	0.3404	0.5216	0.4311
12	1998	0.4358	21	0.2839	0.6690	0.3502	0.5423	0.4463
13	1999	0.3238	23	0.2057	0.5096	0.2569	0.4081	0.3326
Separable Model: Selection (S1) by age 1987 1993								
14	0	0.1834	23	0.1147	0.2932	0.1443	0.2330	0.1887
15	1	0.4029	19	0.2749	0.5904	0.3315	0.4896	0.4106
16	2	0.6967	18	0.4848	1.0012	0.5790	0.8383	0.7087
	3	1.0000		Fixed : Reference Age				
17	4	1.0450	16	0.7627	1.4317	0.8899	1.2271	1.0586
	5	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1994 to 1999								
18	0	0.0816	27	0.0472	0.1411	0.0617	0.1079	0.0848
19	1	0.1709	22	0.1104	0.2644	0.1368	0.2135	0.1752
20	2	0.4881	20	0.3255	0.7320	0.3970	0.6002	0.4987
	3	1.0000		Fixed : Reference Age				
21	4	1.2412	17	0.8837	1.7432	1.0437	1.4760	1.2600
	5	1.0000		Fixed : Last true age				
Separable model: Populations in year 1999								
22	0	10420764	41	4598139	23616580	6864599	15819180	11369352
23	1	8591389	27	5054494	14603236	6554199	11261782	8911899
24	2	3379036	21	2203172	5182476	2716597	4203010	3460449
25	3	1945652	19	1324796	2857469	1599204	2367154	1983421
26	4	548142	20	364601	824078	445193	674897	560132
27	5	316296	24	194746	513709	246963	405093	326128
Separable model: Populations at age								
28	1987	719348	34	363332	1424210	507685	1019256	764380
29	1988	1237060	28	709980	2155435	931876	1642190	1287709
30	1989	523047	28	301975	905963	395204	692246	543999
31	1990	448420	26	267220	752491	344337	583966	464336
32	1991	382876	25	230935	634785	295825	495545	395828
33	1992	680134	24	420403	1100331	532106	869342	700933
34	1993	464300	24	289700	744132	364992	590629	477942
35	1994	509278	23	318316	814800	400704	647270	524129
36	1995	481849	25	293937	789891	374449	620054	497416
37	1996	1197589	25	728727	1968117	929469	1543053	1236679
38	1997	858487	24	531454	1386764	672163	1096461	884572
39	1998	338895	24	209804	547415	265347	432829	349191

SSB Index catchabilities

INDEX1

Absolute estimator. No fitted catchability.

Age-structured index catchabilities

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Linear model fitted. Slopes at age :

40	1	Q	.2050E-01	26	.1592E-01	.4472E-01	.2050E-01	.3472E-01	.2762E-01
41	2	Q	.3947E-01	26	.3070E-01	.8565E-01	.3947E-01	.6662E-01	.5307E-01
42	3	Q	.8377E-01	26	.6494E-01	.1836	.8377E-01	.1423	.1131
43	4	Q	.1641	27	.1256	.3735	.1641	.2860	.2251
44	5	Q	.2716	29	.2040	.6563	.2716	.4930	.3825
45	6	Q	.5451	28	.4157	1.258	.5451	.9590	.7524

Table 9.7.2.1b (cont): Ouput values from the assessment model.

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Linear model fitted. Slopes at age :

46	1	Q	726.6	41	486.4	2504.	726.6	1676.	1204.
47	2	Q	937.7	40	634.1	3132.	937.7	2118.	1531.
48	3	Q	1204.	40	814.5	4018.	1204.	2718.	1965.
49	4	Q	1654.	41	1107.	5697.	1654.	3814.	2741.
50	5	Q	1700.	44	1112.	6306.	1700.	4122.	2920.
51	6	Q	997.7	42	662.1	3533.	997.7	2344.	1676.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear model fitted. Slopes at age :

52	0	Q	542.4	34	390.2	1496.	542.4	1077.	810.4
53	1	Q	515.0	33	372.0	1404.	515.0	1014.	765.4
54	2	Q	623.6	33	450.5	1699.	623.6	1228.	926.5
55	3	Q	712.9	34	513.2	1964.	712.9	1414.	1064.
56	4	Q	985.9	34	704.7	2777.	985.9	1985.	1487.
57	5	Q	669.7	35	474.0	1943.	669.7	1375.	1024.
58	6	Q	397.3	35	283.7	1122.	397.3	801.4	600.1

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994
0	0.8133	0.2831	-0.4726	-0.4486	0.7493	-0.0165	-0.9110	0.1845
1	0.0034	0.0900	0.0031	-0.0170	0.0562	0.0340	-0.2435	-0.8297
2	0.0642	-0.0317	-0.0274	-0.1834	-0.1221	0.0537	0.0639	-0.0199
3	0.0243	-0.0809	-0.0888	-0.0764	0.0866	-0.0431	0.4183	0.2778
4	-0.2434	0.0560	-0.1205	0.2234	-0.1548	0.0066	0.2656	0.1900
5	-0.2008	-0.1005	0.3739	0.1768	-0.1579	-0.2369	0.1927	0.0988

Separable Model Residuals

Age	1995	1996	1997	1998	1999
0	-0.8807	0.4409	-0.0067	0.1973	0.0607
1	0.3062	-0.4121	0.6146	0.1662	0.1863
2	0.1230	-0.0611	0.3459	-0.0914	-0.1561
3	0.2553	0.2123	-0.1934	-0.0182	-0.3085
4	-0.1091	0.1081	0.1868	-0.1551	0.1259
5	-0.2736	-0.4635	-0.1218	0.5494	0.3390

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	-0.3736	*******

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	-0.8785

Table 9.7.2.1b (cont): Ouput values from the assessment model.

INDEX1

	1998	1999
1	*******	-0.5319

AGE-STRUCTURED INDEX RESIDUALS

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-0.596	1.991	0.437	*******	-0.260	-1.195	-0.182	0.438
2	-1.934	0.810	-0.459	*******	-0.619	0.690	-0.267	0.553
3	1.126	-1.724	-0.585	*******	0.339	0.314	-0.361	0.081
4	0.082	1.906	-0.850	*******	-0.752	0.763	-1.389	-0.071
5	0.879	1.244	1.072	*******	-0.177	-0.377	-0.330	0.271
6	0.678	1.408	0.953	*******	0.348	0.962	-0.421	1.364

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Age	1994	1995	1996	1997	1998	1999	2000
1	*******	*******	-1.666	-0.512	1.677	0.278	-0.409
2	*******	*******	-0.554	1.309	-0.134	0.287	0.317
3	*******	*******	-0.240	0.092	-0.045	-0.054	1.056
4	*******	*******	0.296	0.123	-1.118	0.478	0.532
5	*******	*******	-0.274	-1.109	-1.336	-0.971	1.107
6	*******	*******	-1.220	-0.593	-1.849	-0.806	-0.825

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Age	1996	1997	1998	1999	2000
1	-0.205	0.641	-0.725	-0.008	0.297
2	-0.074	0.652	0.360	-0.114	-0.824
3	0.378	-0.060	0.595	-0.335	-0.578
4	0.100	0.137	0.321	0.083	-0.640
5	-1.516	0.087	0.882	0.239	0.308
6	-2.552	0.003	1.199	0.582	0.768

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.179	-0.370	-0.028	-0.147	*******	*******	*******	*******
1	0.177	0.233	-0.063	0.450	*******	*******	*******	*******
2	-0.313	0.440	0.206	0.143	*******	*******	*******	*******
3	0.050	0.068	-1.025	0.177	*******	*******	*******	*******
4	-0.467	0.136	-0.813	-0.634	*******	*******	*******	*******
5	-1.165	-0.725	-0.660	-0.047	*******	*******	*******	*******
6	-0.862	-0.255	-0.919	-0.514	*******	*******	*******	*******

Table 9.7.2.1b (cont): Ouput values from the assessment model.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.336	*******	*******	*******	*******	-0.139	0.608	-0.082
1	0.410	*******	*******	*******	*******	0.113	0.023	-1.343
2	0.069	*******	*******	*******	*******	0.188	-0.021	-0.714
3	0.381	*******	*******	*******	*******	0.272	0.715	-0.638
4	-0.070	*******	*******	*******	*******	1.102	0.205	0.540
5	-0.856	*******	*******	*******	*******	1.016	1.216	1.219
6	-1.529	*******	*******	*******	*******	1.951	1.202	0.923

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 1999	
Variance	0.1398
Skewness test stat.	-0.8008
Kurtosis test statistic	1.5674
Partial chi-square	0.4425
Significance in fit	0.0000
Degrees of freedom	43

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance
Last age is a plus-group

Variance	0.3981
Skewness test stat.	-0.8264
Kurtosis test statistic	-0.5437
Partial chi-square	0.0932
Significance in fit	0.0074
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+IX

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.1867	0.1222	0.0927	0.1410	0.1376	0.1973
Skewness test stat.	0.6822	-0.9477	-0.8766	0.4389	0.0778	-0.2149
Kurtosis test statisti	-0.2406	0.2251	0.5632	-0.1816	-0.9440	-0.9088
Partial chi-square	0.1814	0.1154	0.0844	0.1279	0.1292	0.1784
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12	12
Degrees of freedom	11	11	11	11	11	11
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Table 9.7.2.1b (cont): Ouput values from the assessment model.

DISTRIBUTION STATISTICS FOR FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.0445	0.0521	0.0394	0.0228	0.1349	0.3700
Skewness test stat.	-0.1861	-0.3469	0.0748	-1.1328	-0.9666	-1.0993
Kurtosis test statisti	-0.4576	-0.4103	-0.6819	-0.0098	-0.0832	-0.0681
Partial chi-square	0.0081	0.0095	0.0074	0.0043	0.0258	0.0778
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0001	0.0007
Number of observations	5	5	5	5	5	5
Degrees of freedom	4	4	4	4	4	4
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	0.0143	0.0465	0.0185	0.0454	0.0582	0.1439	0.2114
Skewness test stat.	1.1146	-2.1325	-1.1014	-0.8759	0.4152	0.3105	0.4710
Kurtosis test statisti	-0.1296	1.2320	0.0190	-0.2797	-0.4784	-0.9603	-0.6941
Partial chi-square	0.0045	0.0149	0.0061	0.0154	0.0203	0.0530	0.0821
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	108.6666	239	58	181	0.6004
Catches at age	7.2539	78	39	39	0.1860
SSB Indices					
INDEX1	1.1942	3	0	3	0.3981
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	57.9221	72	6	66	0.8776
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	15.9296	30	6	24	0.6637
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	26.3668	56	7	49	0.5381

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.2353	239	58	181	0.0510
Catches at age	5.4516	78	39	39	0.1398
SSB Indices					
INDEX1	1.1942	3	0	3	0.3981
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	1.6089	72	6	66	0.0244
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	0.4425	30	6	24	0.0184
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	0.5381	56	7	49	0.0110

Table 9.8.1 – Sardine: input data for short-term predictions.

10:23 Friday, September 22, 2000

Sardine in Divisions VIIIc and IXa

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	5483.000	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	5844.000	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	2074.000	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	1012.000	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	264.000	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	325.000	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANXAN04

Date and time: 22SEP00:12:59

Table 9.8.2 – Sardine:Results of short-term predictions.

10:23 Friday, September 22, 2000

Sardine in Divisions VIIIc and IXa

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
Reference F Factor	F	Stock biomass	Sp.stock biomass	Catch in weight	Reference F Factor	F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.3019	607	466	116	0.0000	0.0000	618	509	0	723	604
.	.	.	.	.	0.0500	0.0151	.	507	7	716	596
.	.	.	.	.	0.1000	0.0302	.	505	14	710	588
.	.	.	.	.	0.1500	0.0453	.	504	22	704	581
.	.	.	.	.	0.2000	0.0604	.	502	29	698	573
.	.	.	.	.	0.2500	0.0755	.	501	35	691	566
.	.	.	.	.	0.3000	0.0906	.	499	42	685	559
.	.	.	.	.	0.3500	0.1057	.	497	49	680	552
.	.	.	.	.	0.4000	0.1208	.	496	56	674	545
.	.	.	.	.	0.4500	0.1359	.	494	62	668	538
.	.	.	.	.	0.5000	0.1509	.	493	69	662	531
.	.	.	.	.	0.5500	0.1660	.	491	75	657	525
.	.	.	.	.	0.6000	0.1811	.	490	81	651	518
.	.	.	.	.	0.6500	0.1962	.	488	88	646	512
.	.	.	.	.	0.7000	0.2113	.	487	94	640	506
.	.	.	.	.	0.7500	0.2264	.	485	100	635	500
.	.	.	.	.	0.8000	0.2415	.	484	106	630	494
.	.	.	.	.	0.8500	0.2566	.	482	112	624	488
.	.	.	.	.	0.9000	0.2717	.	481	118	619	482
.	.	.	.	.	0.9500	0.2868	.	479	123	614	476
.	.	.	.	.	1.0000	0.3019	.	478	129	609	471
.	.	.	.	.	1.0500	0.3170	.	476	135	604	465
.	.	.	.	.	1.1000	0.3321	.	475	140	600	460
.	.	.	.	.	1.1500	0.3472	.	473	146	595	454
.	.	.	.	.	1.2000	0.3623	.	472	151	590	449
.	.	.	.	.	1.2500	0.3774	.	470	156	585	444
.	.	.	.	.	1.3000	0.3925	.	469	162	581	439
.	.	.	.	.	1.3500	0.4076	.	467	167	576	434
.	.	.	.	.	1.4000	0.4227	.	466	172	572	429
.	.	.	.	.	1.4500	0.4378	.	465	177	567	424
.	.	.	.	.	1.5000	0.4529	.	463	182	563	419
.	.	.	.	.	1.5500	0.4679	.	462	187	559	415
.	.	.	.	.	1.6000	0.4830	.	460	192	555	410
.	.	.	.	.	1.6500	0.4981	.	459	197	550	406
.	.	.	.	.	1.7000	0.5132	.	457	202	546	401
.	.	.	.	.	1.7500	0.5283	.	456	207	542	397
.	.	.	.	.	1.8000	0.5434	.	455	211	538	392
.	.	.	.	.	1.8500	0.5585	.	453	216	534	388
.	.	.	.	.	1.9000	0.5736	.	452	220	530	384
.	.	.	.	.	1.9500	0.5887	.	451	225	526	380
.	.	.	.	.	2.0000	0.6038	.	449	229	523	376
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANXAN04
Date and time : 22SEP00:12:59
Computation of ref. F: Simple mean, age 2 - 5
Basis for 2000 : F factors

Table 9.8.2.1 – Sardine: Input data for short-term predictions for Divisions VIIIc and IXa.

.10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table: Input data

2000	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	5483.000	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	5844.000	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	2074.000	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	1012.000	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	264.000	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	325.000	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2001	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	.	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	.	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	.	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	.	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	.	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2002	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	.	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	.	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	.	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	.	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	.	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

Notes: Run name : MANXAN05
Date and time: 22SEP00:18:05

Table 9.8.2.2 – Sardine: Results of short-term predictions for Divisions VIIIc and IXa.

10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table

Year: 2000								
Division IXa			Division VIIIc			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.2676	106	1.0000	0.0343	15	121	607	466
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2001									Year: 2002	
Division IXa			Division VIIIc			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	618	509	723	604
0.0500	0.0134	7	0.0500	0.0017	1	8	.	507	716	596
0.1000	0.0268	13	0.1000	0.0034	2	15	.	505	710	588
0.1500	0.0401	20	0.1500	0.0051	3	22	.	504	704	581
0.2000	0.0535	26	0.2000	0.0069	4	30	.	502	698	573
0.2500	0.0669	32	0.2500	0.0086	5	37	.	501	691	566
0.3000	0.0803	38	0.3000	0.0103	6	44	.	499	685	559
0.3500	0.0936	44	0.3500	0.0120	6	51	.	498	680	552
0.4000	0.1070	50	0.4000	0.0137	7	58	.	496	674	545
0.4500	0.1204	56	0.4500	0.0154	8	64	.	494	668	538
0.5000	0.1338	62	0.5000	0.0172	9	71	.	493	662	531
0.5500	0.1472	68	0.5500	0.0189	10	78	.	491	657	525
0.6000	0.1605	74	0.6000	0.0206	11	84	.	490	651	518
0.6500	0.1739	79	0.6500	0.0223	11	91	.	488	646	512
0.7000	0.1873	85	0.7000	0.0240	12	97	.	487	640	506
0.7500	0.2007	90	0.7500	0.0257	13	103	.	485	635	500
0.8000	0.2140	96	0.8000	0.0275	14	110	.	484	630	494
0.8500	0.2274	101	0.8500	0.0292	15	116	.	482	624	488
0.9000	0.2408	107	0.9000	0.0309	15	122	.	481	619	482
0.9500	0.2542	112	0.9500	0.0326	16	128	.	479	614	476
1.0000	0.2676	117	1.0000	0.0343	17	134	.	478	609	471
1.0500	0.2809	122	1.0500	0.0360	18	140	.	476	604	465
1.1000	0.2943	127	1.1000	0.0378	18	145	.	475	600	460
1.1500	0.3077	132	1.1500	0.0395	19	151	.	473	595	454
1.2000	0.3211	137	1.2000	0.0412	20	157	.	472	590	449
1.2500	0.3344	142	1.2500	0.0429	20	162	.	470	585	444
1.3000	0.3478	147	1.3000	0.0446	21	168	.	469	581	439
1.3500	0.3612	152	1.3500	0.0463	22	173	.	467	576	434
1.4000	0.3746	156	1.4000	0.0481	22	179	.	466	572	429
1.4500	0.3880	161	1.4500	0.0498	23	184	.	465	568	424
1.5000	0.4013	165	1.5000	0.0515	24	189	.	463	563	419
1.5500	0.4147	170	1.5500	0.0532	24	194	.	462	559	415
1.6000	0.4281	174	1.6000	0.0549	25	199	.	460	555	410
1.6500	0.4415	179	1.6500	0.0566	25	204	.	459	550	406
1.7000	0.4548	183	1.7000	0.0583	26	209	.	458	546	401
1.7500	0.4682	188	1.7500	0.0601	27	214	.	456	542	397
1.8000	0.4816	192	1.8000	0.0618	27	219	.	455	538	392
1.8500	0.4950	196	1.8500	0.0635	28	224	.	453	534	388
1.9000	0.5084	200	1.9000	0.0652	28	229	.	452	530	384
1.9500	0.5217	204	1.9500	0.0669	29	233	.	451	526	380
2.0000	0.5351	208	2.0000	0.0686	30	238	.	449	523	376
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

```
----------------------------------------------------------------------------------------------------------------
Notes: Run name             : MANXAN05
       Date and time        : 22SEP00:18:05
       Computation of ref. F: Division IXa:   Simple mean, age 2 - 5
                              Division VIIIc: Simple mean, age 2 - 5
       Basis for 2000       : F factors
```

Table 9.11.1 – Sardine: input data for long term predictions.

Sardine in Divisions VIIIc and IXa

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDXAN04
Date and time: 23SEP00:17:36

Table 9.11.2 – Sardine: results of yield per recruit analysis.

```
The SAS System                     17:35 Saturday, September 23, 2000
   Sardine in Divisions VIIIc and IXa

                                     Yield per recruit: Summary table
```

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0	0	27861	1087	17476	1020	16092	939
0.0500	0.0151	190	13	27291	1038	16911	970	15525	890
0.1000	0.0302	363	25	26771	993	16396	926	15008	846
0.1500	0.0453	522	35	26295	952	15925	885	14535	806
0.2000	0.0604	668	45	25857	915	15492	848	14100	770
0.2500	0.0755	803	53	25453	881	15093	815	13699	737
0.3000	0.0906	929	61	25079	850	14724	784	13327	707
0.3500	0.1057	1045	68	24731	822	14381	755	12982	679
0.4000	0.1208	1154	74	24407	796	14062	729	12661	654
0.4500	0.1359	1255	80	24104	771	13764	705	12361	630
0.5000	0.1509	1350	85	23820	749	13485	683	12081	608
0.5500	0.1660	1440	90	23554	728	13224	662	11817	588
0.6000	0.1811	1524	95	23303	708	12978	643	11569	569
0.6500	0.1962	1604	99	23066	690	12746	625	11336	552
0.7000	0.2113	1679	103	22843	673	12527	608	11115	535
0.7500	0.2264	1751	106	22631	657	12320	592	10906	520
0.8000	0.2415	1818	110	22430	642	12123	577	10708	505
0.8500	0.2566	1883	113	22239	628	11937	564	10520	492
0.9000	0.2717	1944	115	22057	615	11760	550	10342	479
0.9500	0.2868	2003	118	21883	603	11591	538	10171	467
1.0000	0.3019	2059	121	21717	591	11430	526	10009	456
1.0500	0.3170	2113	123	21559	580	11276	515	9854	445
1.1000	0.3321	2164	125	21407	569	11129	505	9705	435
1.1500	0.3472	2214	127	21262	559	10988	495	9563	425
1.2000	0.3623	2261	129	21122	549	10852	486	9427	416
1.2500	0.3774	2307	131	20988	540	10723	477	9296	407
1.3000	0.3925	2351	133	20858	531	10598	468	9170	399
1.3500	0.4076	2393	135	20734	523	10478	460	9049	391
1.4000	0.4227	2434	136	20614	515	10362	452	8932	384
1.4500	0.4378	2474	138	20498	508	10251	445	8820	376
1.5000	0.4529	2512	139	20386	500	10143	438	8711	369
1.5500	0.4679	2549	141	20277	493	10039	431	8606	363
1.6000	0.4830	2585	142	20172	487	9939	424	8505	357
1.6500	0.4981	2619	143	20071	480	9842	418	8407	350
1.7000	0.5132	2653	144	19972	474	9748	412	8312	345
1.7500	0.5283	2686	146	19877	468	9656	406	8220	339
1.8000	0.5434	2718	147	19784	462	9568	400	8131	334
1.8500	0.5585	2749	148	19693	457	9482	395	8044	328
1.9000	0.5736	2779	149	19606	452	9399	390	7960	323
1.9500	0.5887	2808	150	19520	446	9318	385	7879	319
2.0000	0.6038	2836	151	19437	441	9239	380	7799	314
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name             : YLDXAN04
       Date and time        : 23SEP00:17:36
       Computation of ref. F: Simple mean, age 2 - 5
       F-0.1 factor         : 1.5072
       F-max factor         : Not found
       F-0.1 reference F    : 0.4550
       F-max reference F    : Not found
       Recruitment          : 7831 (Thousands)
```

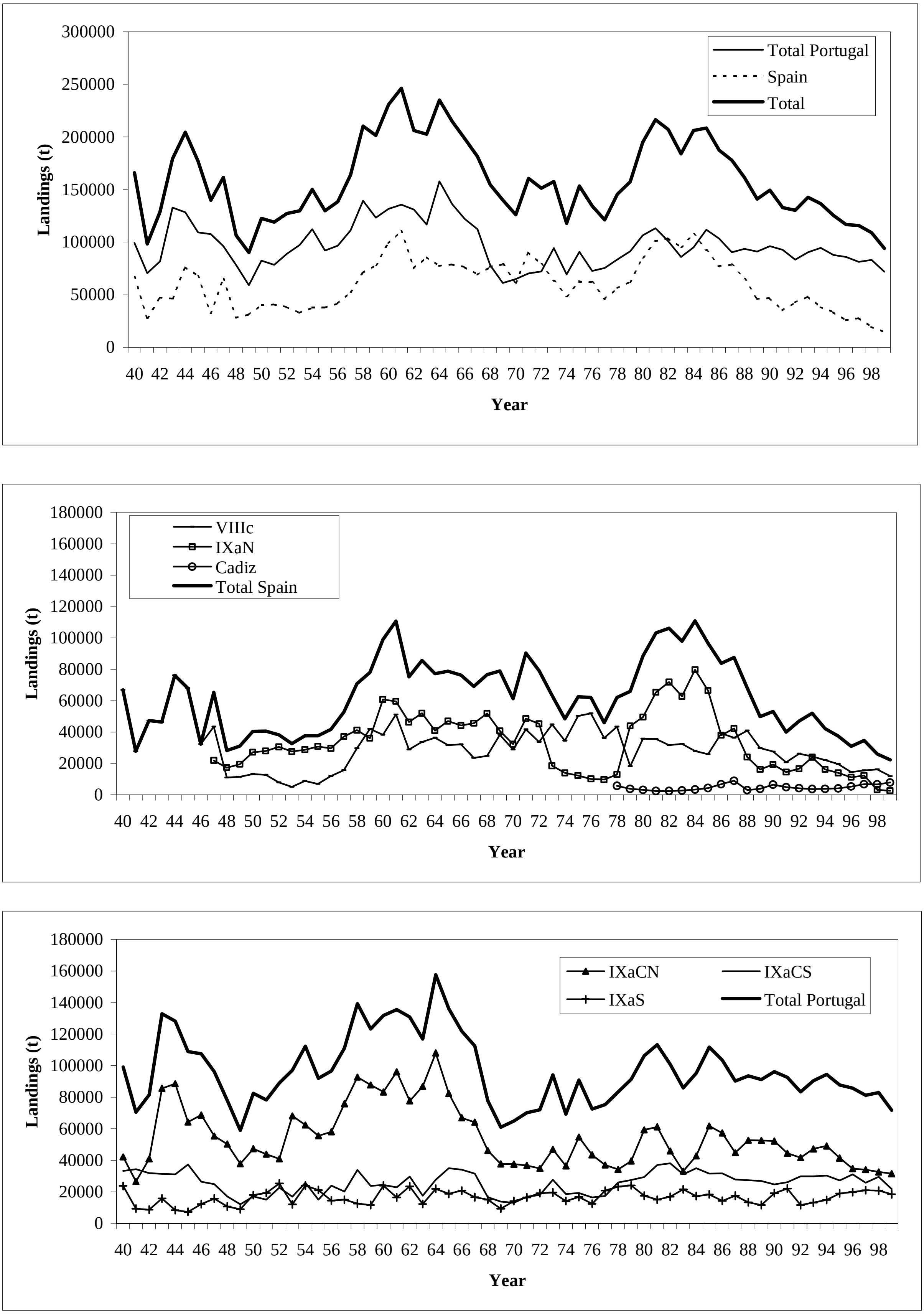


Figure 9.2.1: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

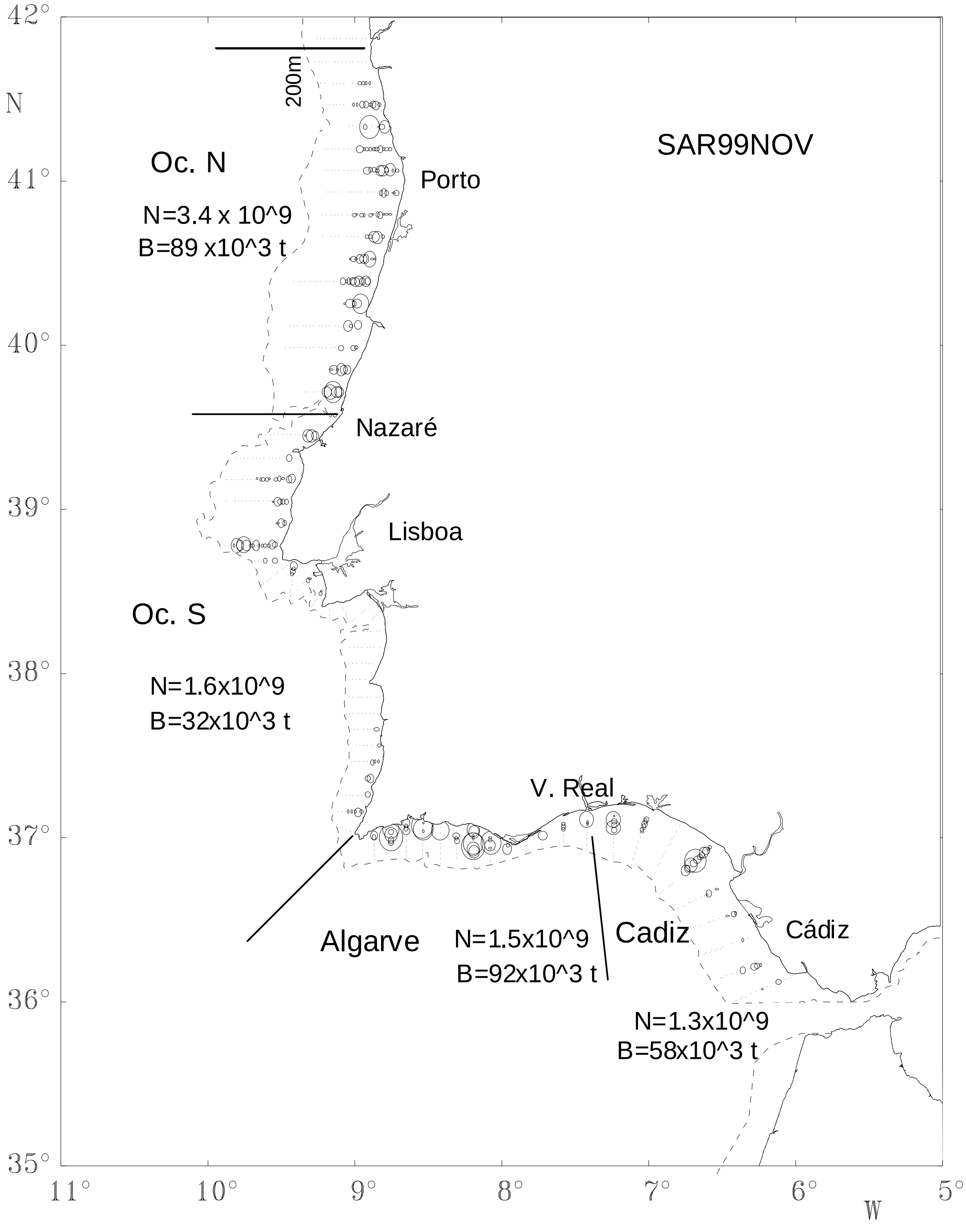


Figure 9.3.2.1 – SAR99NOV: acoustic energy distribution per nautical mile and abundance in number and biomass for sardine in each zone. Circle diameter is proportional to the square root of the acoustic energy (SA).

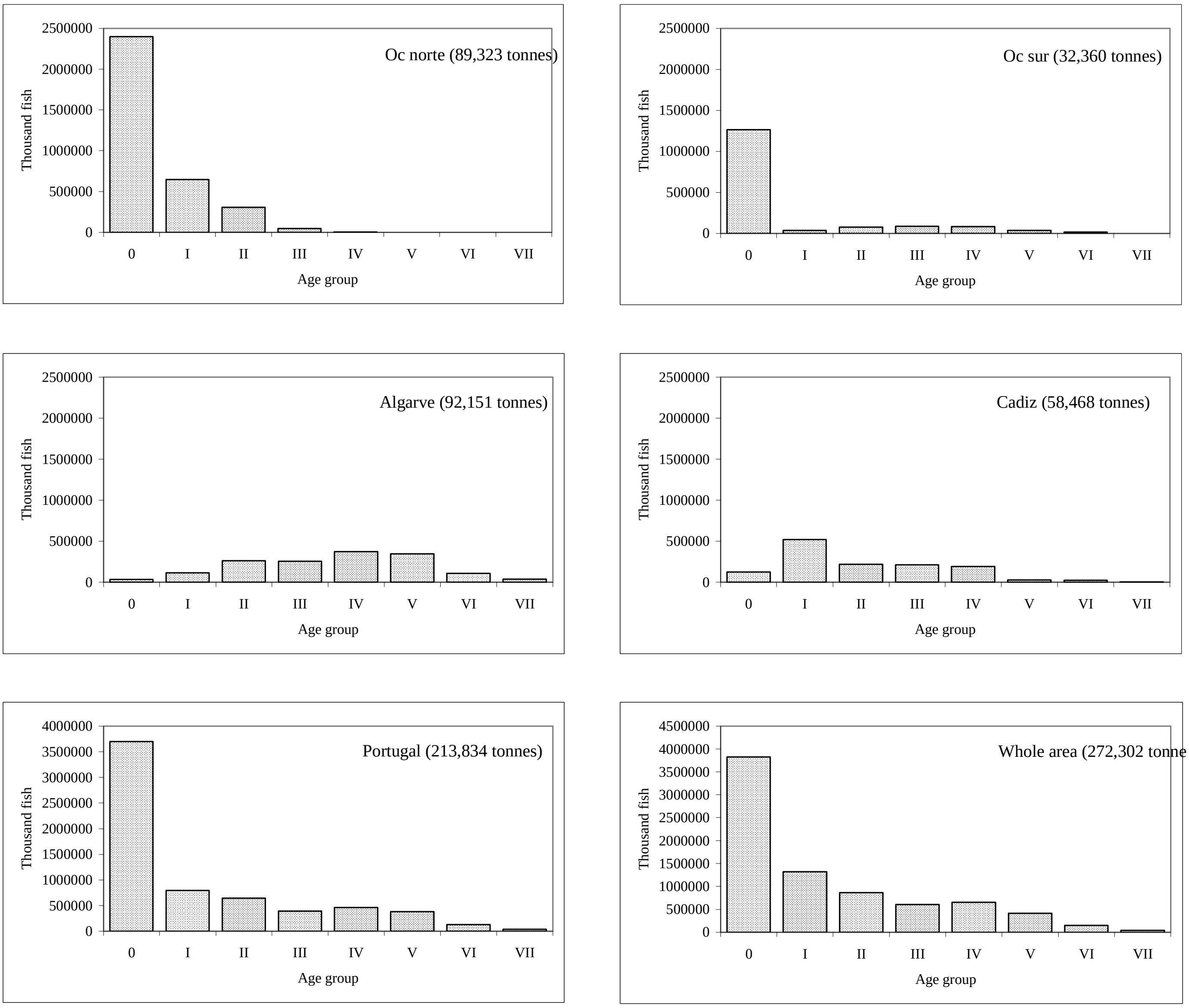


Figure 9.3.2.2: Estimated fish number of sardine (thousands) by area for the Portuguese Fall Acoustic survey 1999.

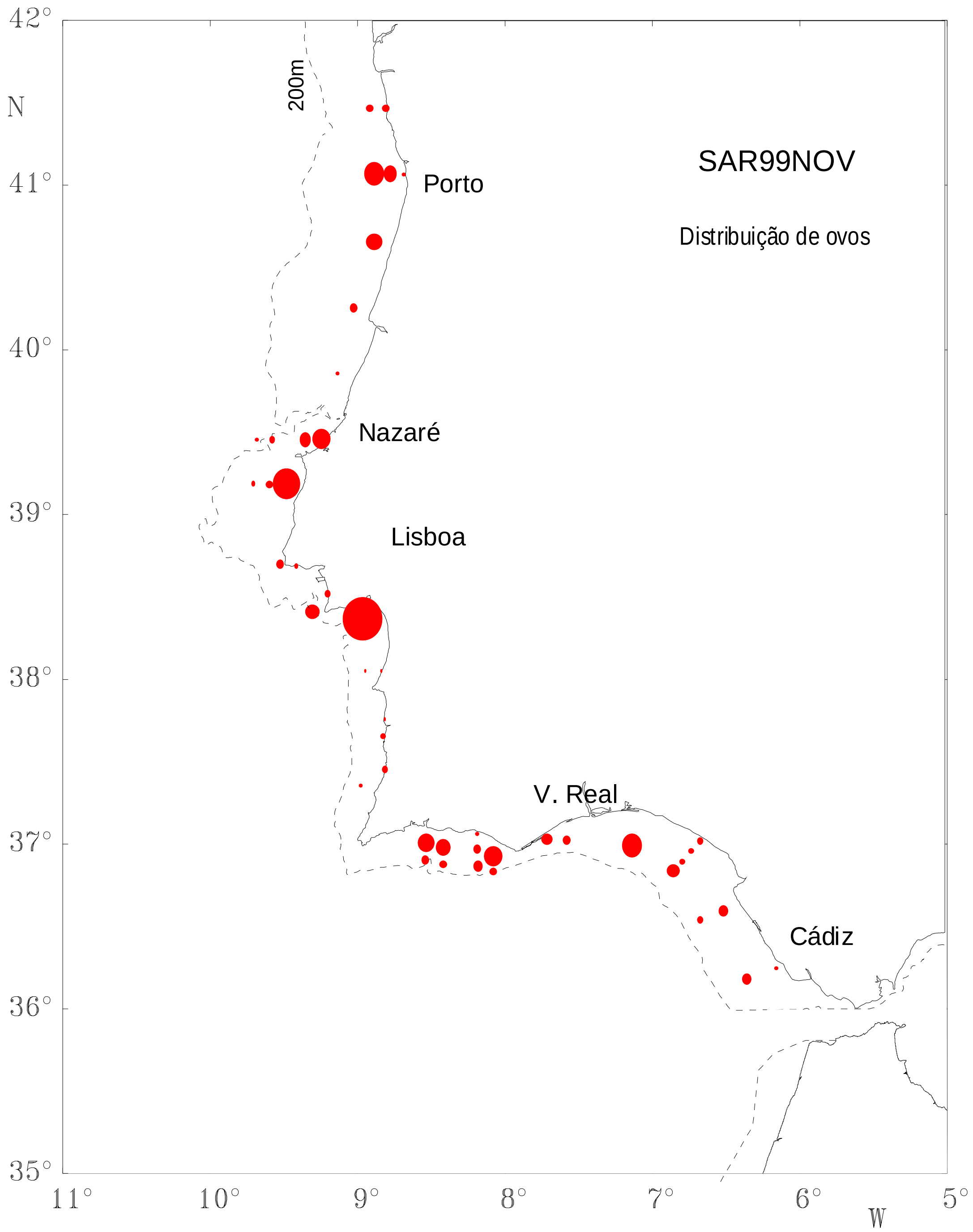


Figure 9.3.2.3: Egg numbers from CalVET tows during the Portuguese Fall Acoustic survey 1999.

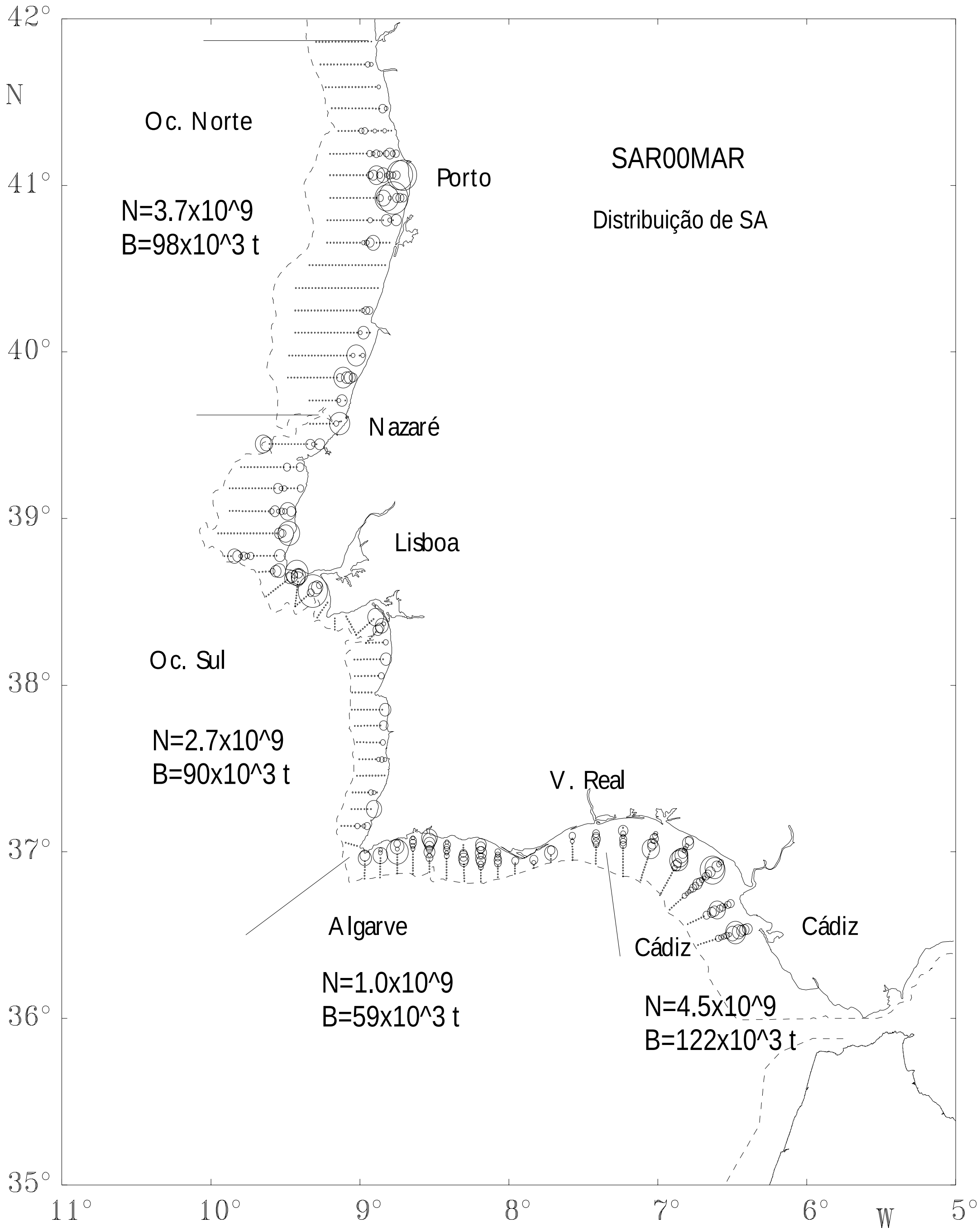


Figure 9.3.2.4 – SAR00MAR: acoustic energy distribution per nautical mile and abundance in number and biomass for sardine, in each zone. Circle diameter is proportional to the square root of the acoustic energy (SA). Note that 35% of the Cadiz area was not covered.

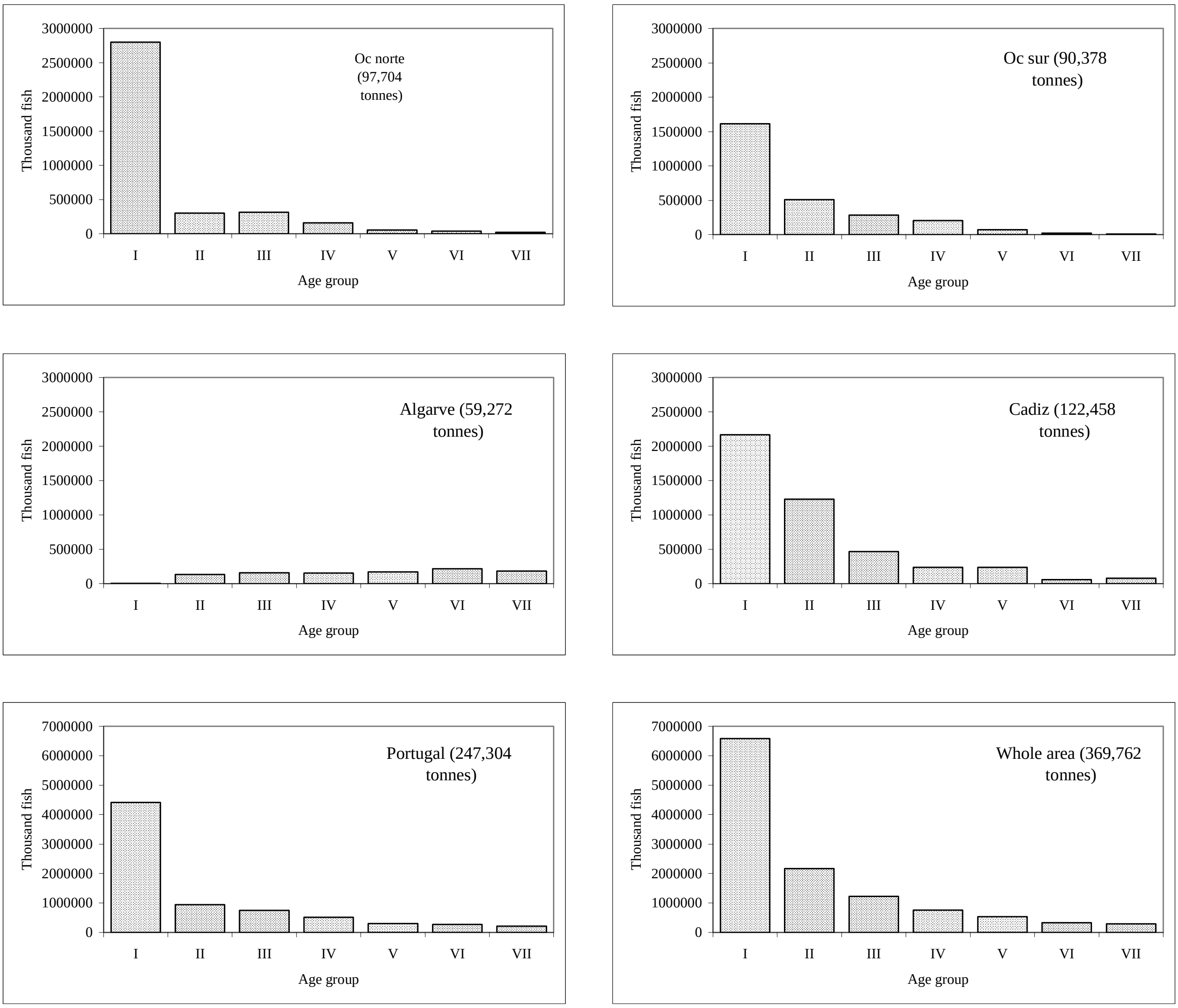


Figure 9.3.2.5: Estimated fish number of sardine (thousands) by area for the Portuguese Spring Acoustic survey 2000.

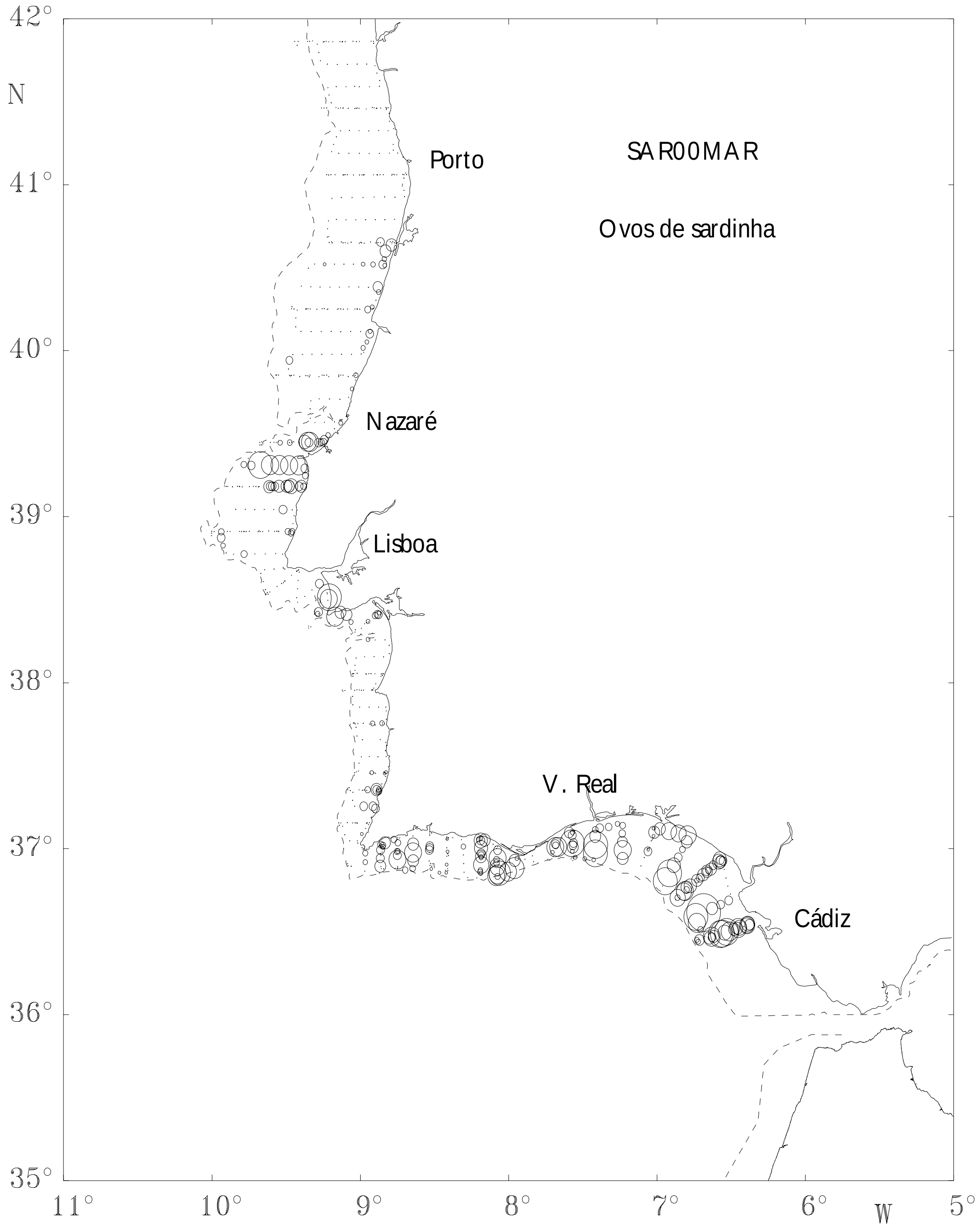


Figure 9.3.2.6 – Egg numbers from CUFES during the Portuguese Spring Acoustic Survey 2000.

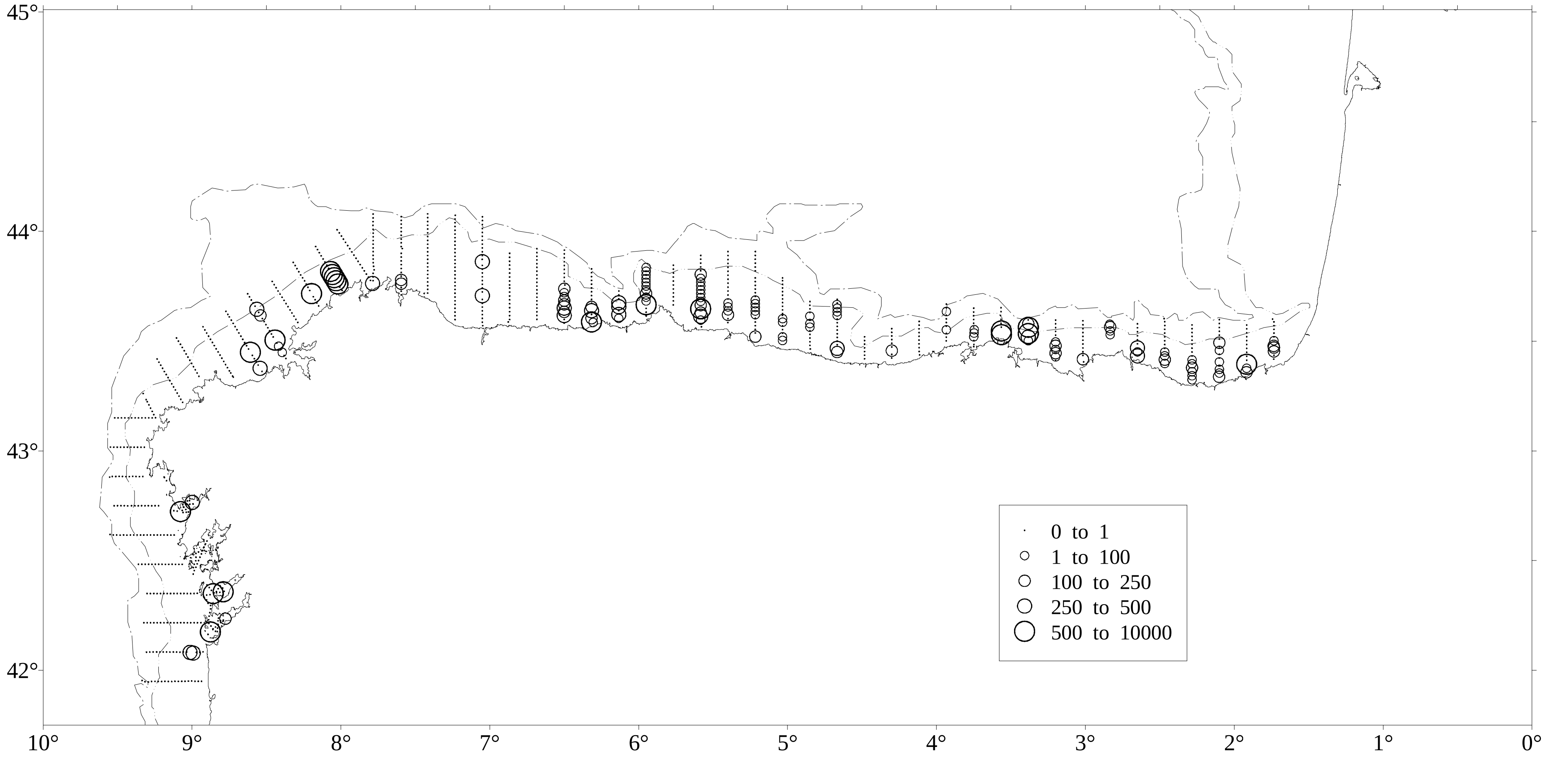


Figure 9.3.2.7 – Classed acoustic energy distribution per nautical mile for sardine during the Spanish Spring Acoustic Survey 2000.

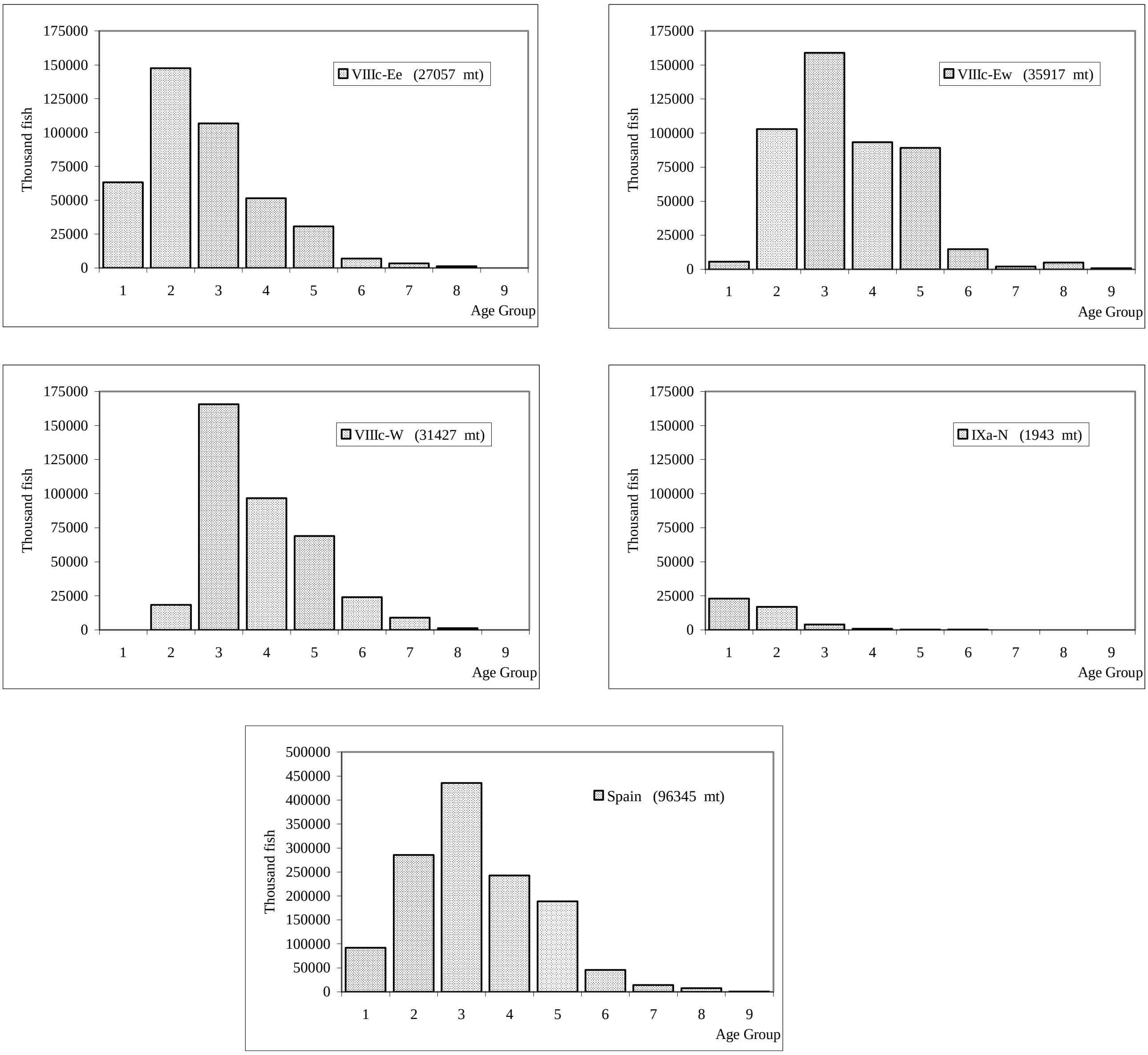


Figure 9.3.2.8: Estimated fish number of sardine (thousands) by area for the Spanish Spring Acoustic survey 2000.

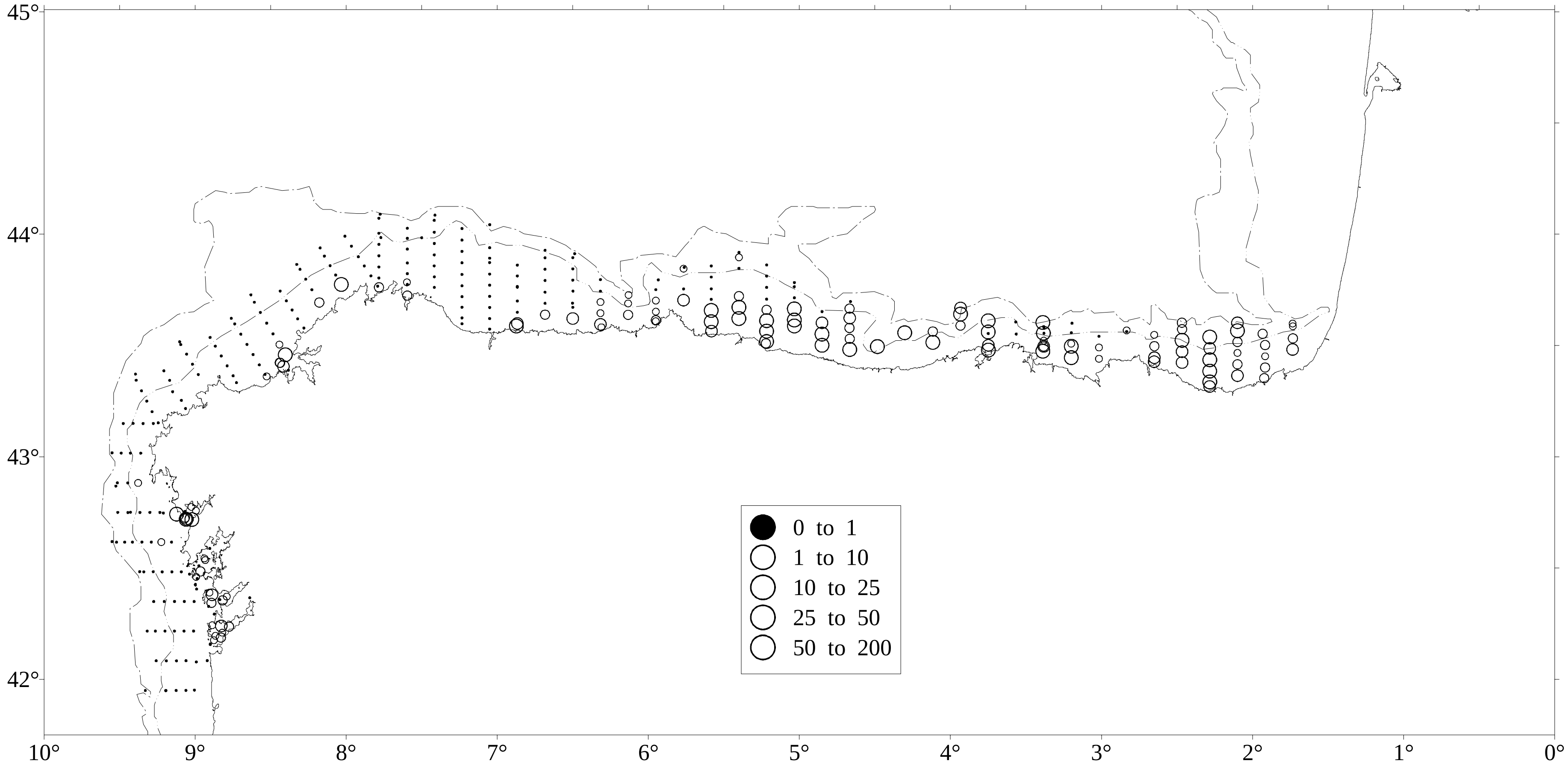


Figure 9.3.2.9 Egg numbers from CUFES during the Spanish Spring Acoustic Survey 2000.

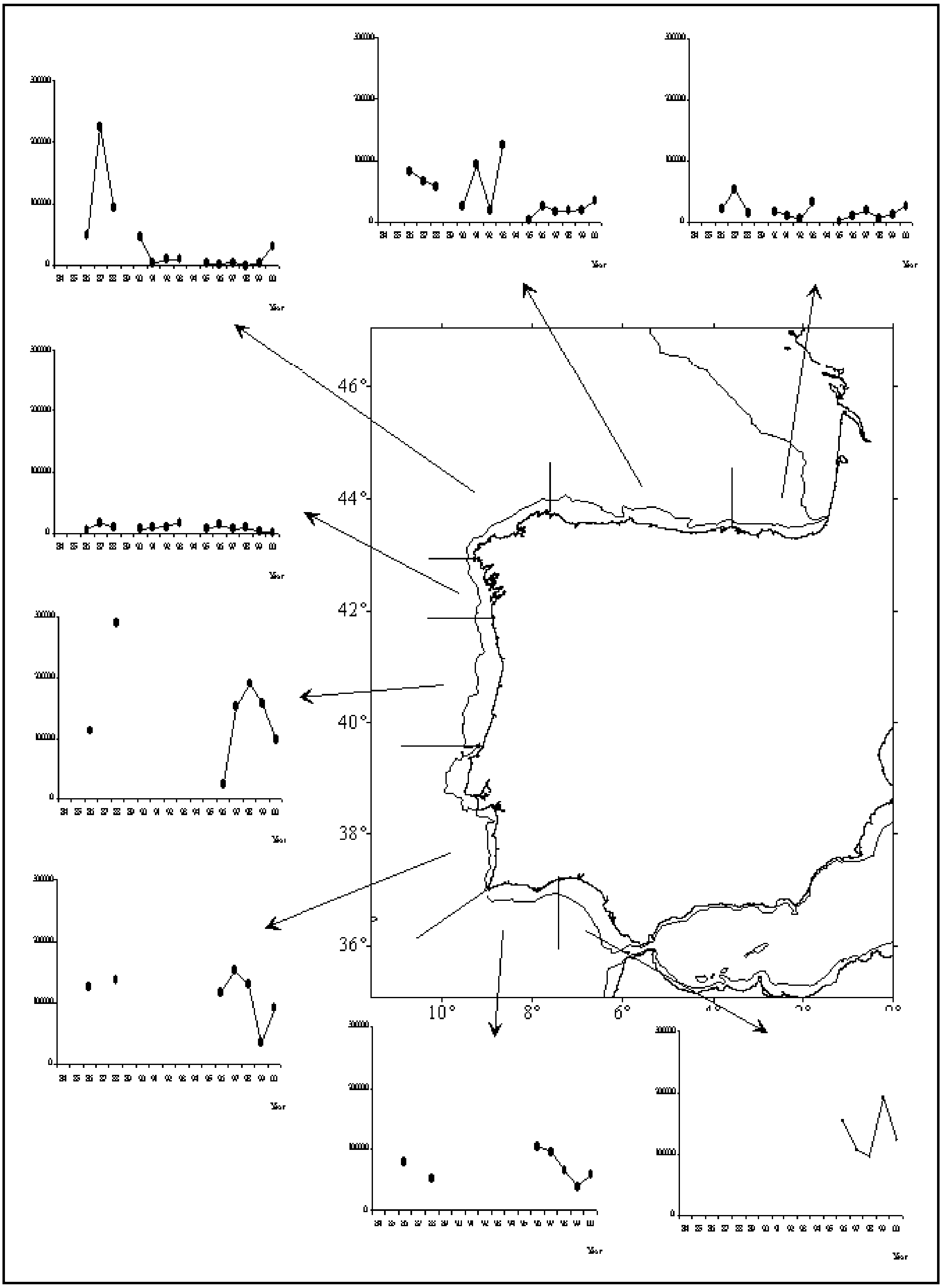


Figure 9.3.2.10: Estimated total biomass by area for sardine during the March acoustic surveys time series along the Iberian Peninsula (Spanish and Portuguese time series combined). Series starts in 1984. Maximum biomass value set at 300,000 tonnes.

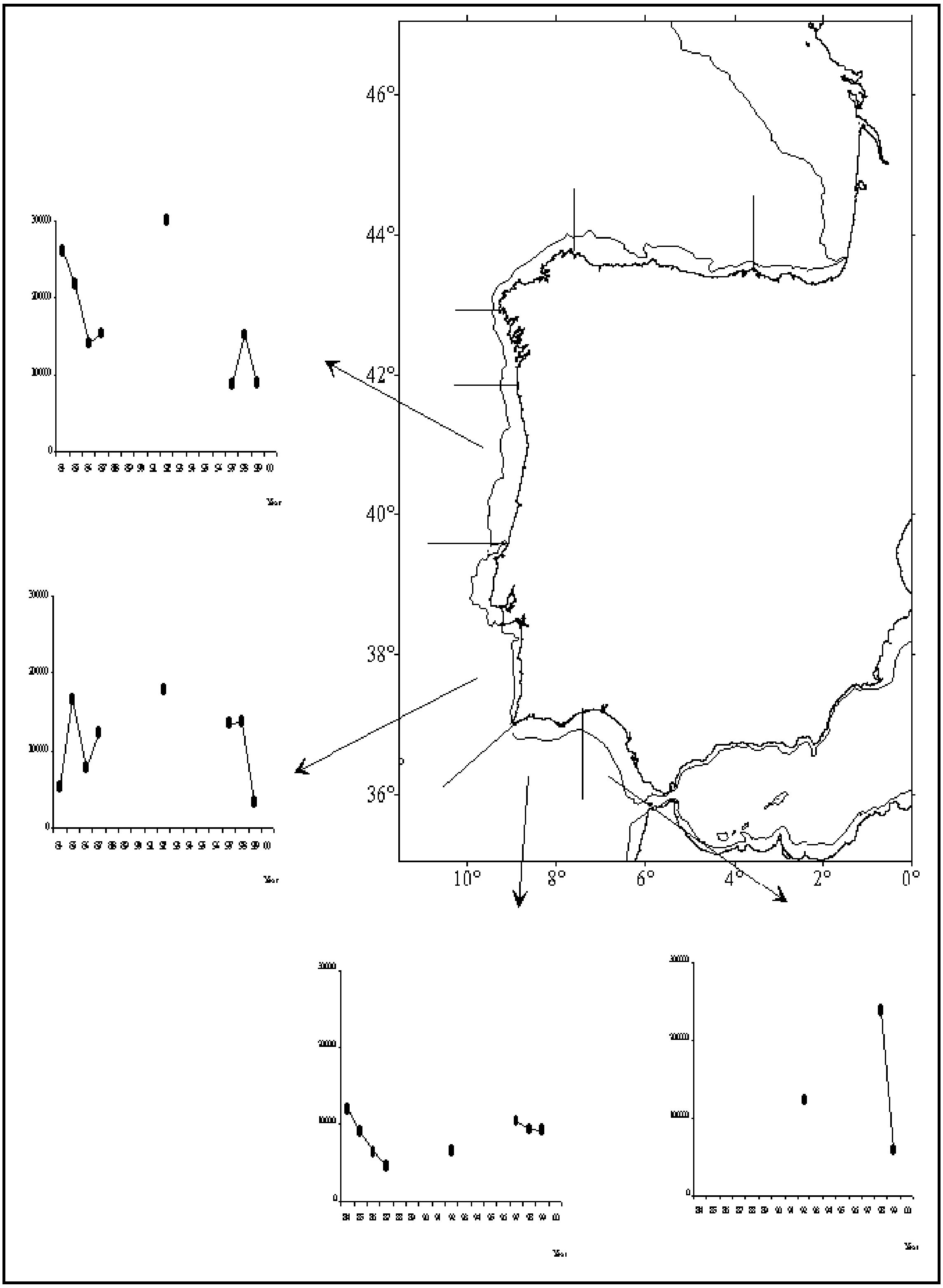


Figure 9.3.2.11: Estimated total biomass by area for sardine from the Portuguese November acoustic surveys time series. Series starts in 1984. Maximum biomass value set at 300,000 tonnes.

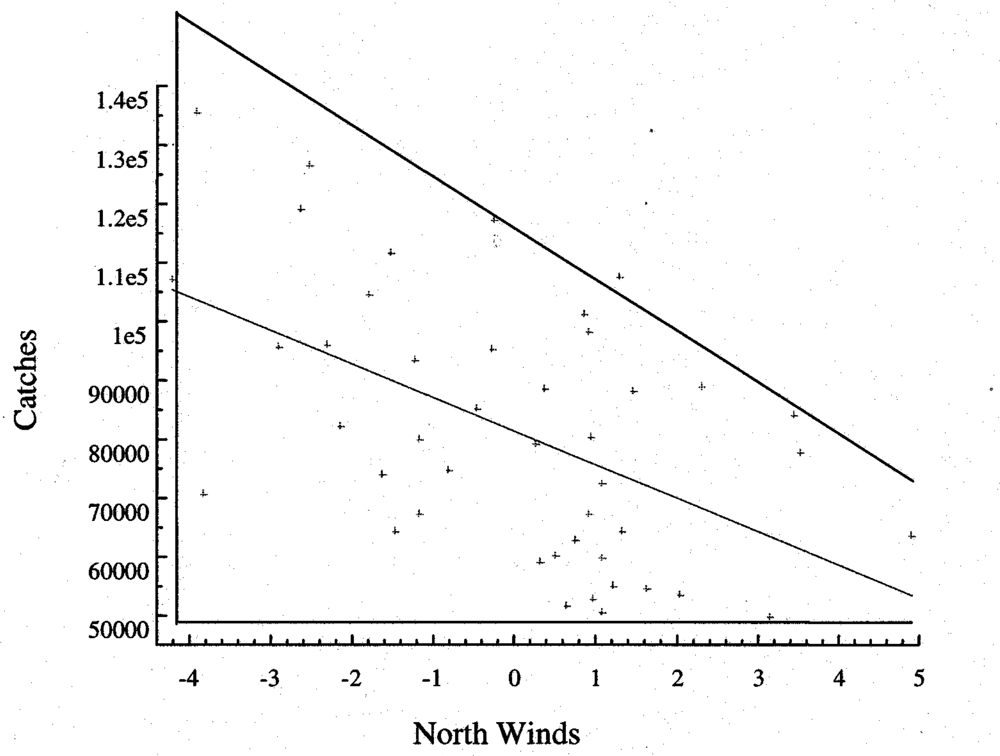
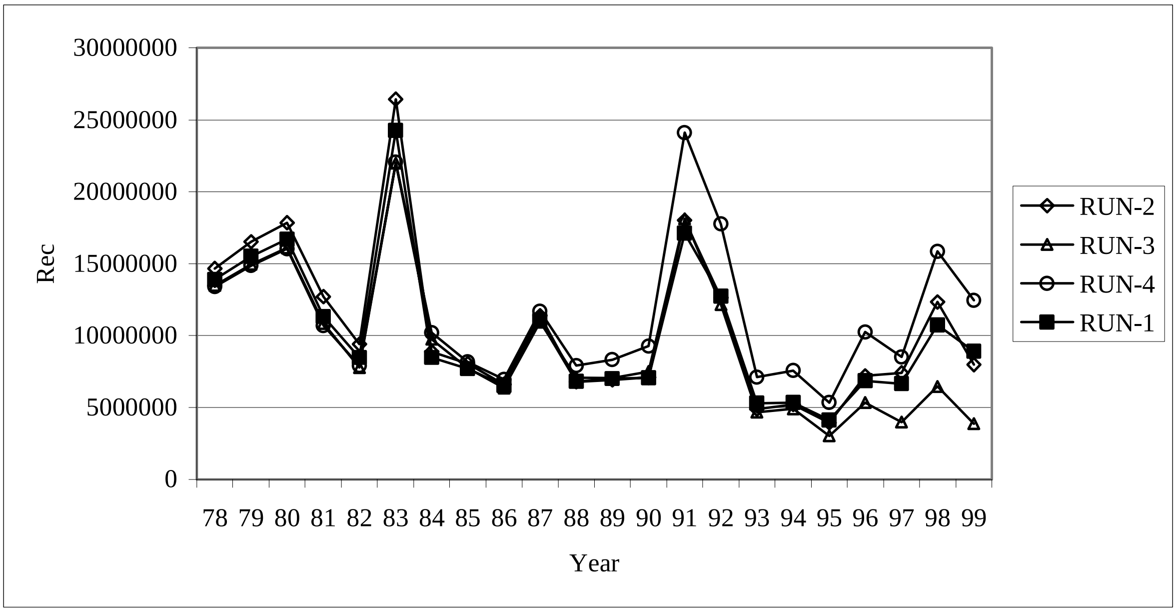
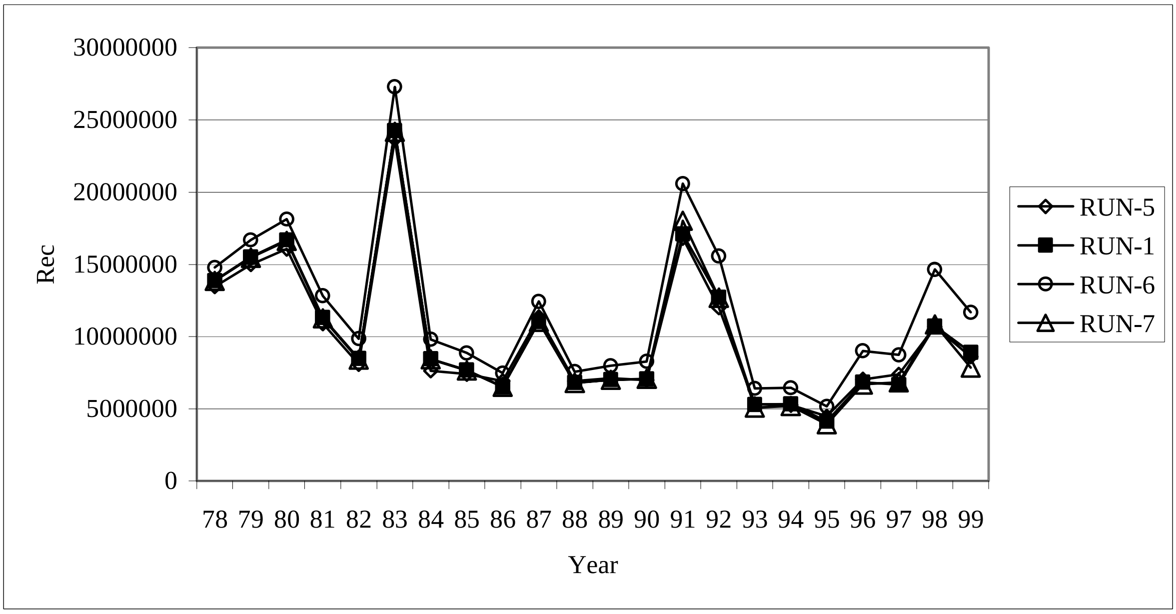


Figure 9.6.1 Correlation between sardine catches and the mean north wind index in the western Iberian coast (1947-1991). The superimposed triangle is intended to emphasise the decrease in the varaibility of catches with increasing northern winds.



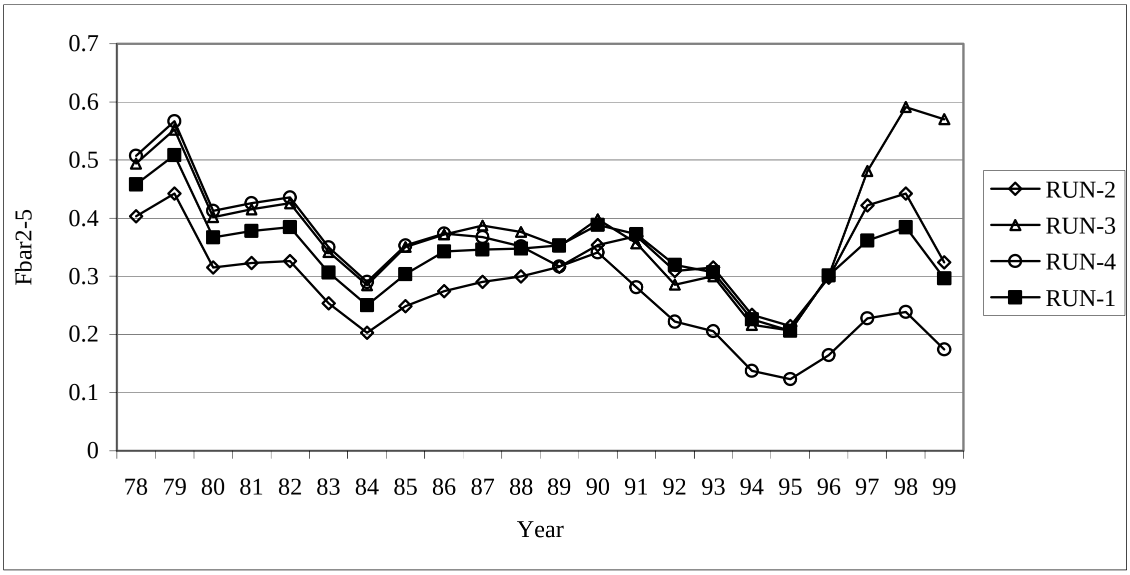


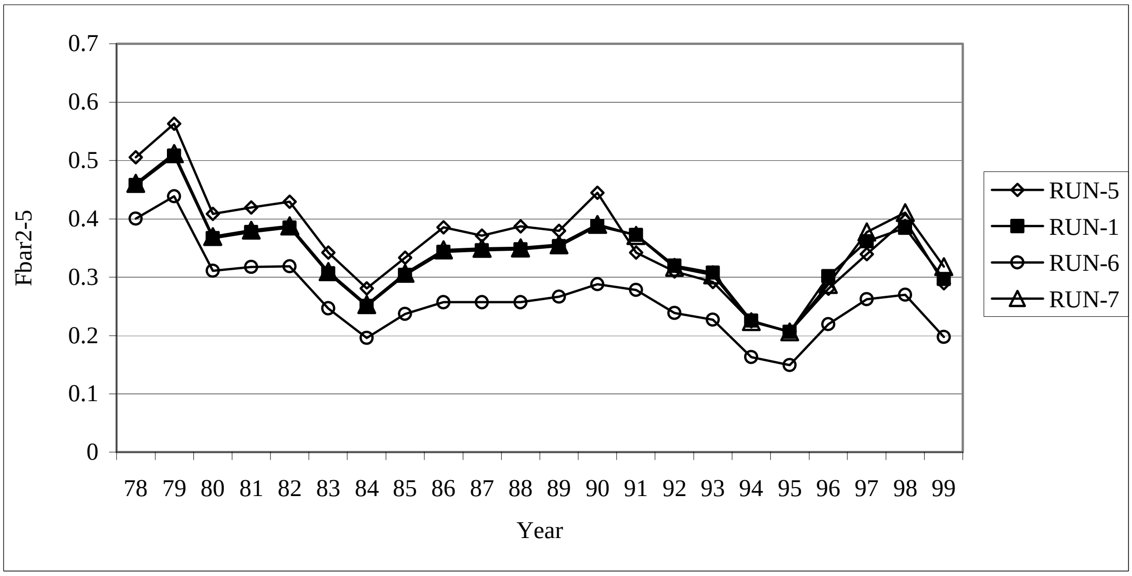
RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1a: Estimated Iberian sardine recruitment from various assessment model options (ICA)

RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1b: Estimated Iberian sardine SSB from various assessment models





RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference Run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1c Estimated Iberian sardine F(2-5) from various assessment models

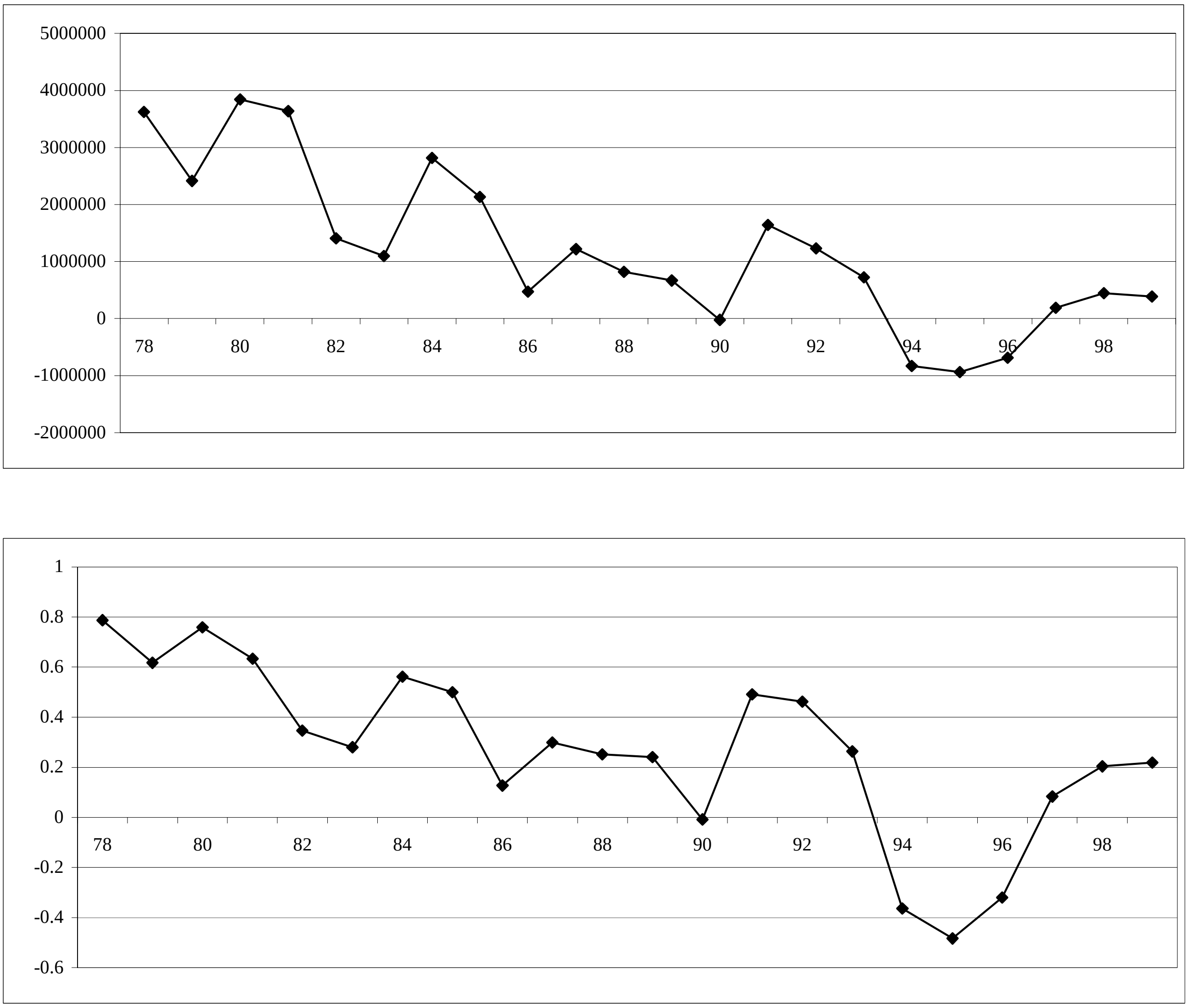
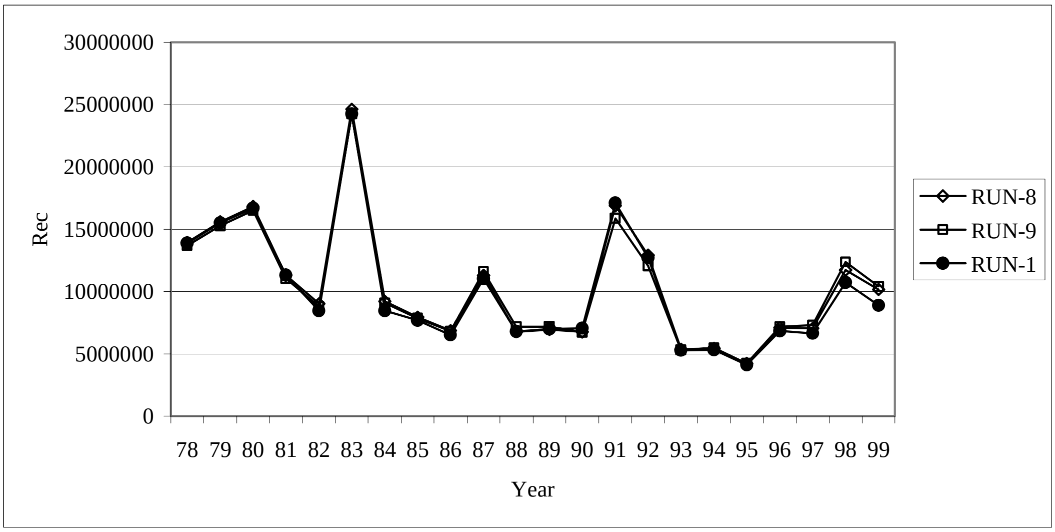
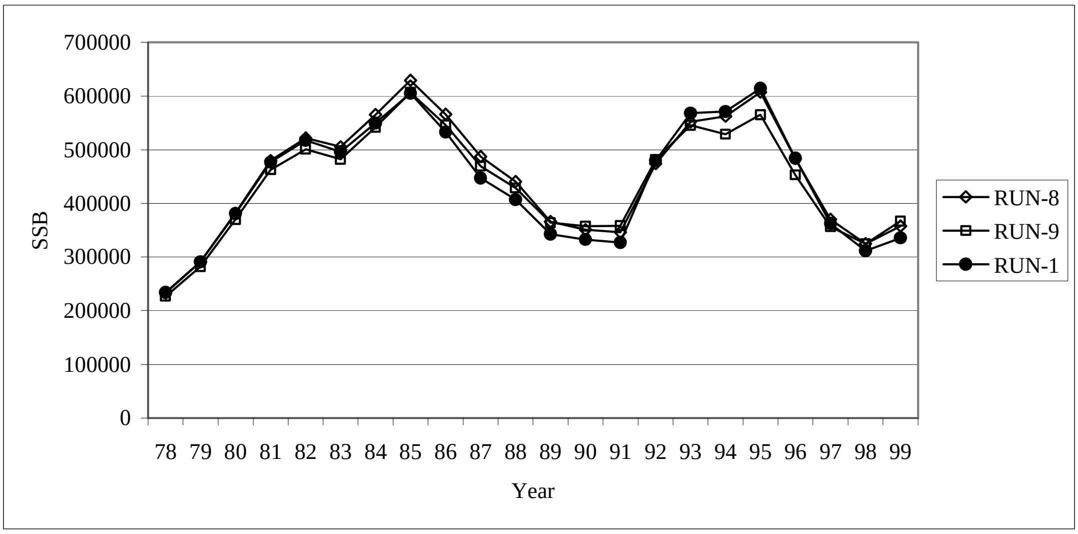
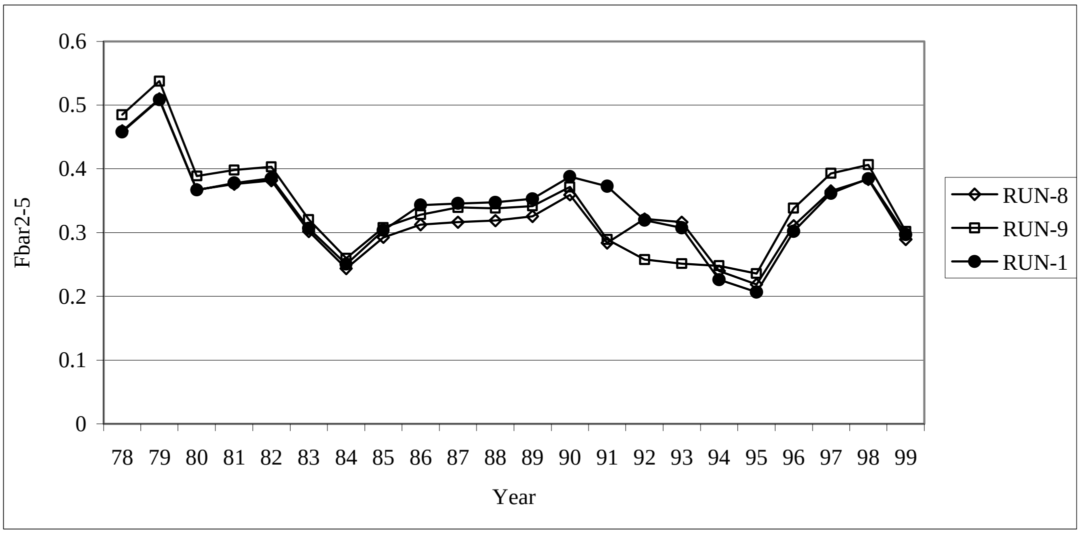


Figure 9.7.1.2: Differences in catches between younger fish (ages groups 0, 1 and 2) and older fish (3+). Upper pannel absolute numbers, lower pannel relative numbers.







RUN-8	Fitted model with Separable periods 1987-91 and 1992-99. Abrupt change assumed
RUN-9	Fitted model with Separable periods 1987-93 and 1994-99. Abrupt change assumed
RUN-1	**Fitted model with all the fleets (Reference Run)**

Figure 9.7.1.3: Estimated Iberian sardine recruitment, SSB, F(2-5) for different models with different separable periods.

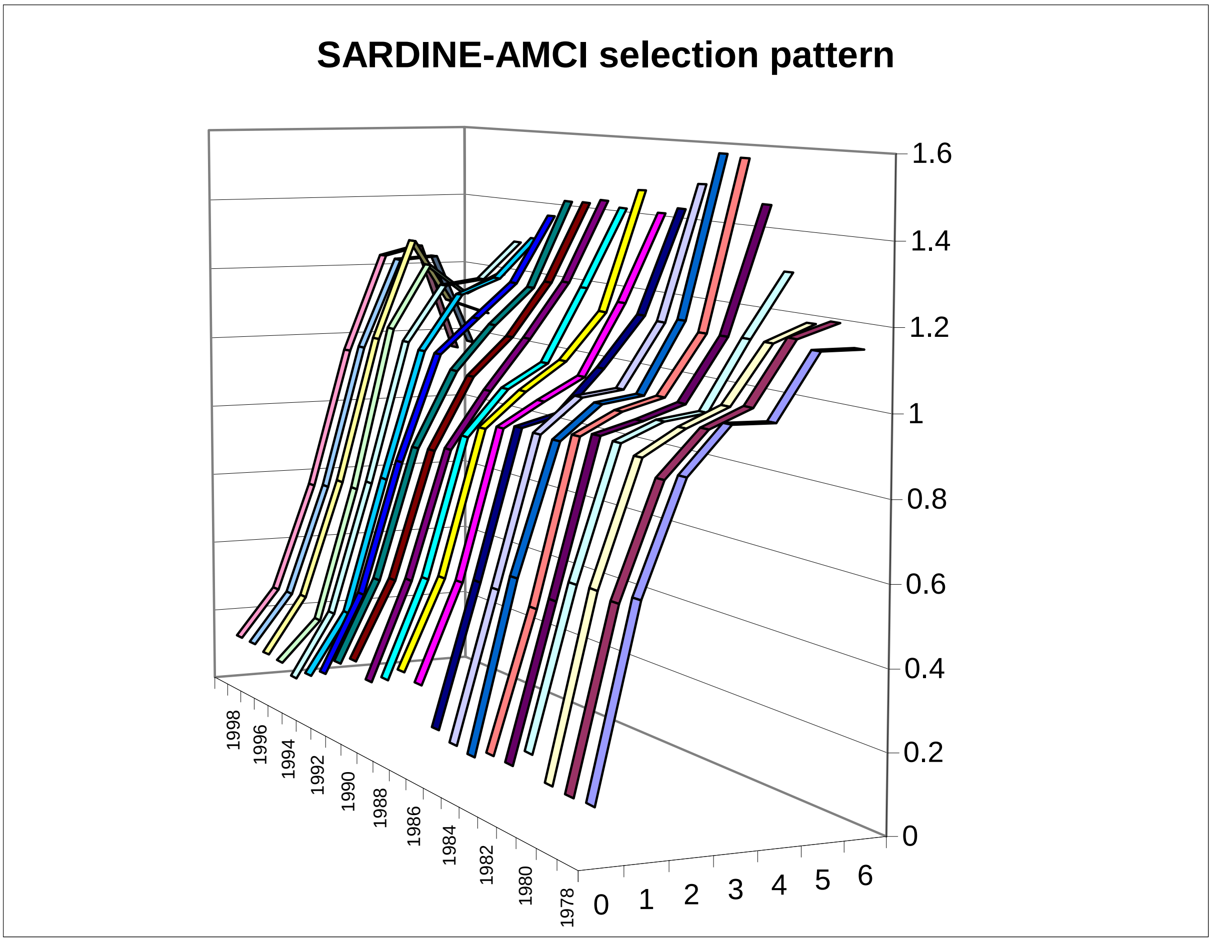


Figure 9.7.1.4: Fitted selection pattern for each year along the time series from AMCI model

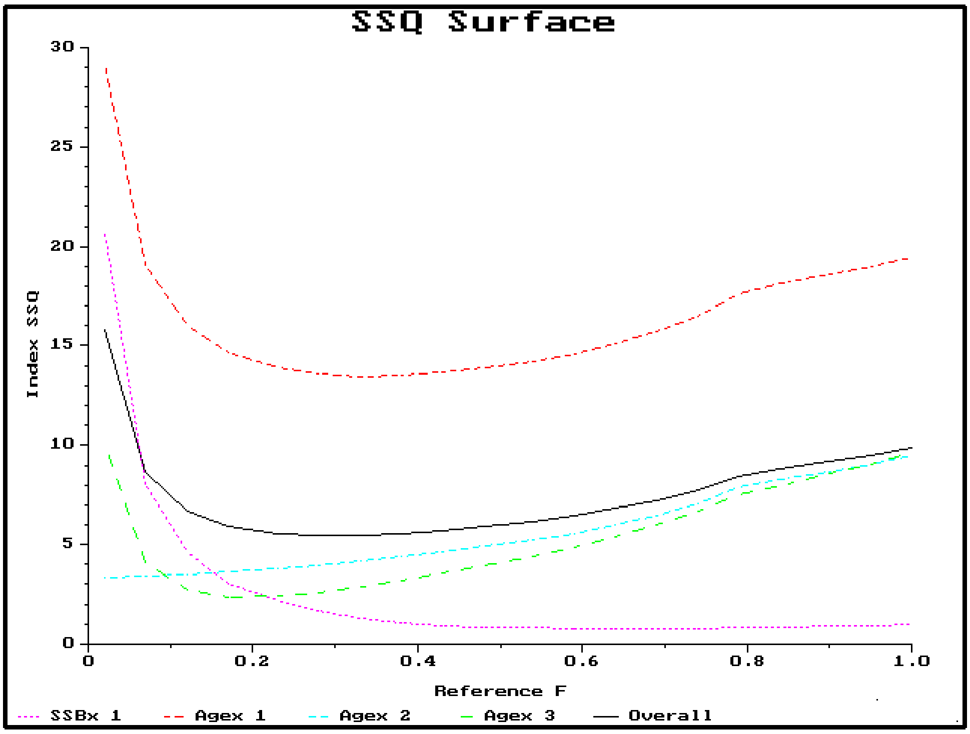
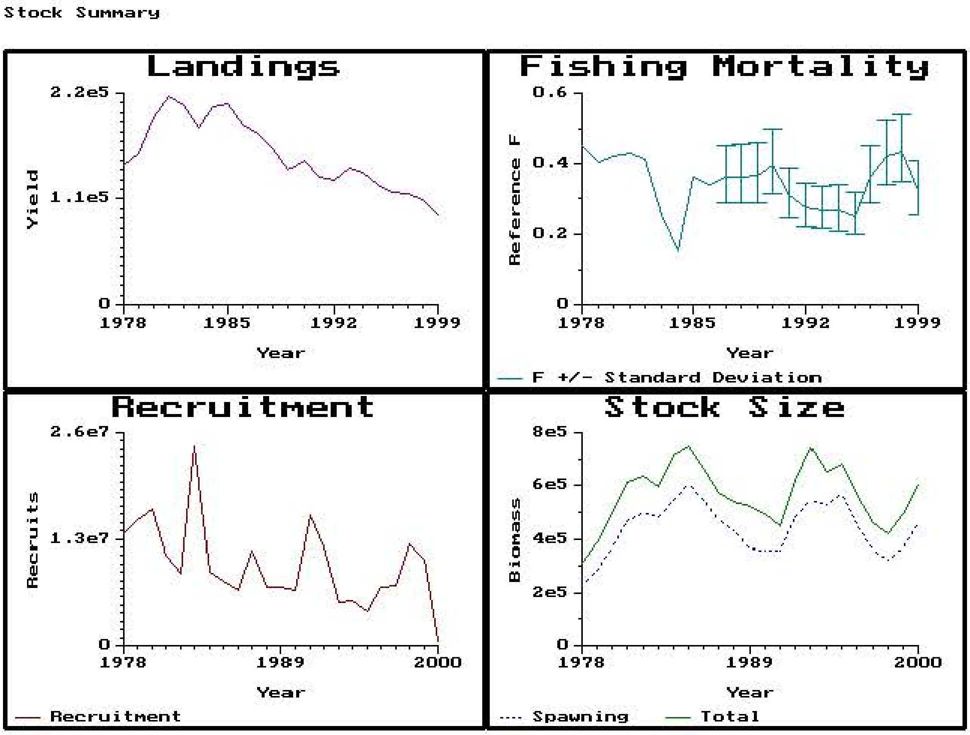


Figure 9.7.2.1 Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model. (SSBx1 is DEPM –absolute estimator-; Agex 1 is the Spanish Spring Acoustic survey time series –linear estimator-; Agex 2 is the Portuguese Spring Acoustic survey time series –linear estimator-; Agex 3 is the Portuguese Fall Acoustic survey time series –linear estimator-)



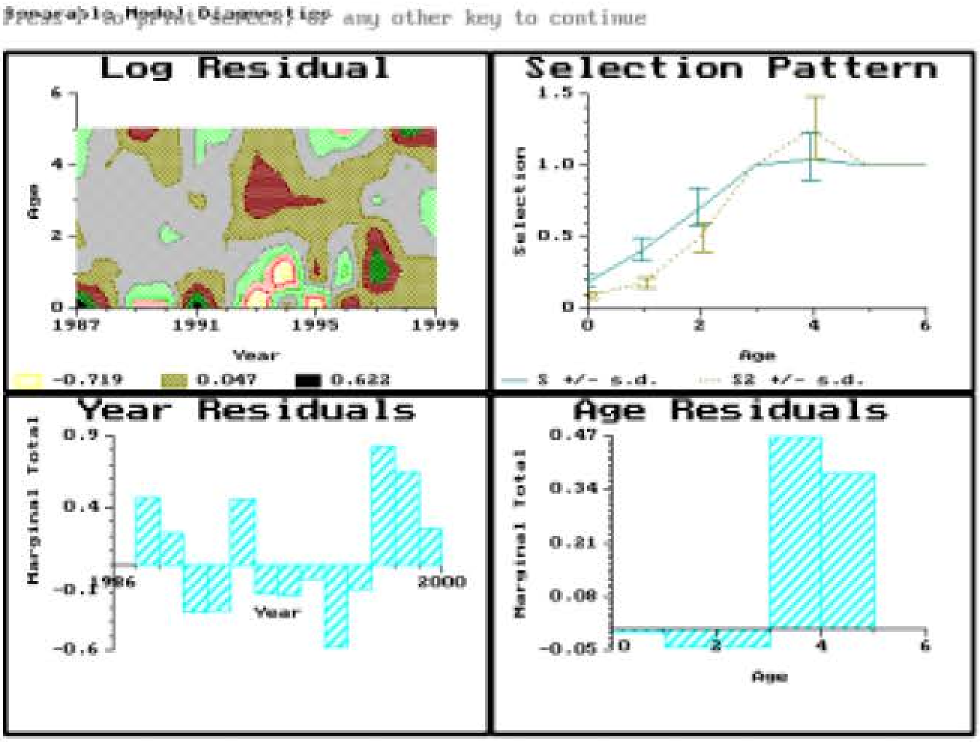
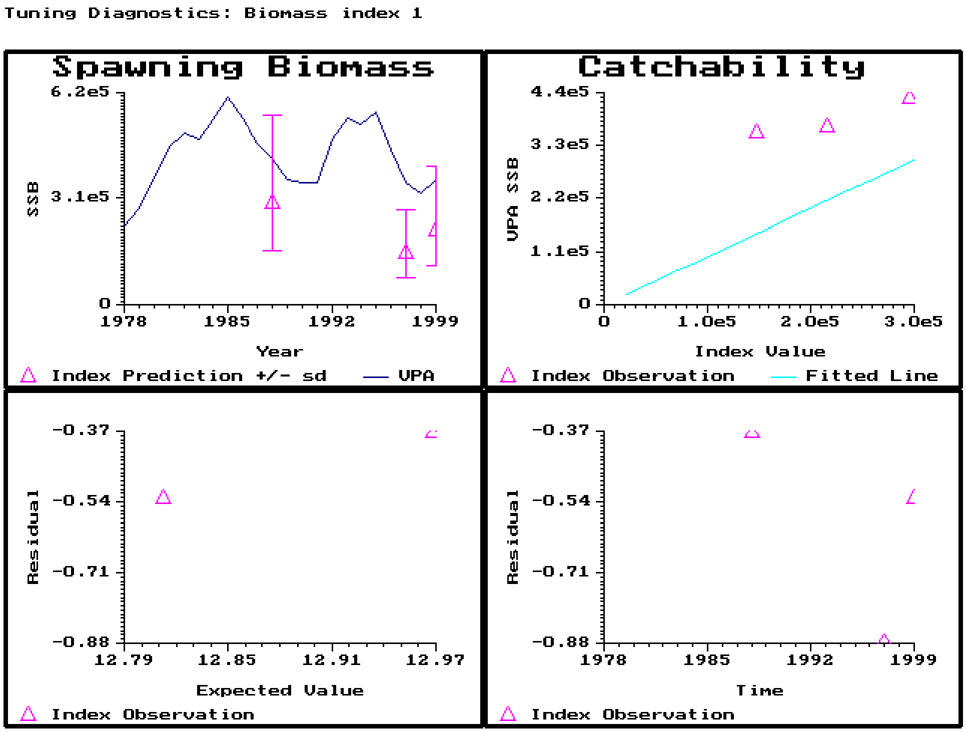


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



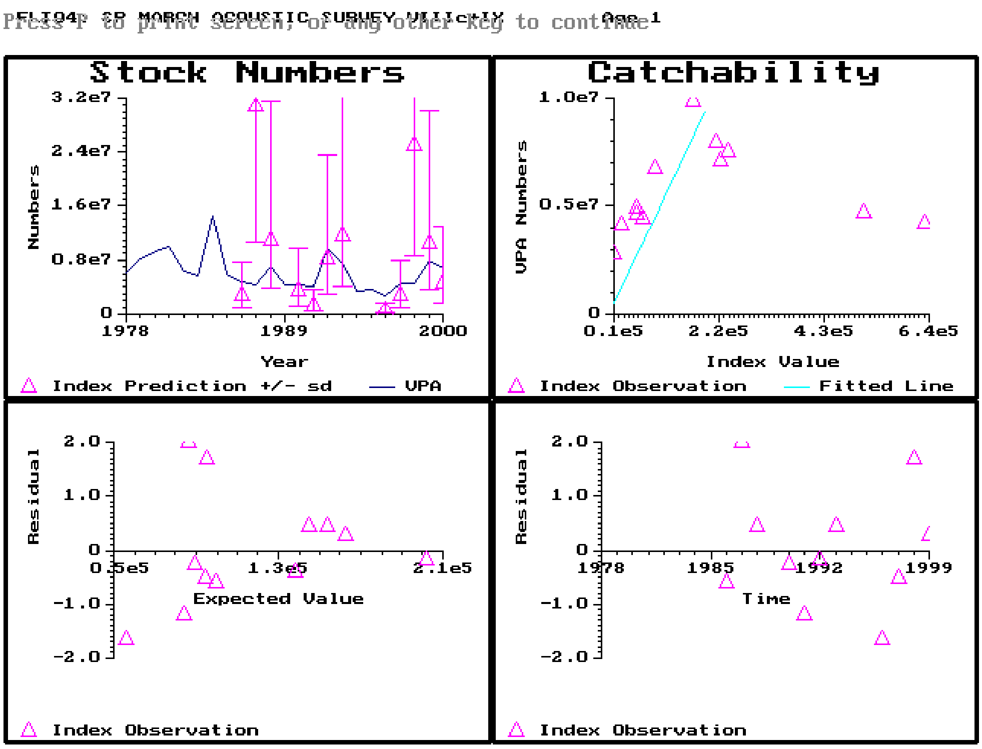
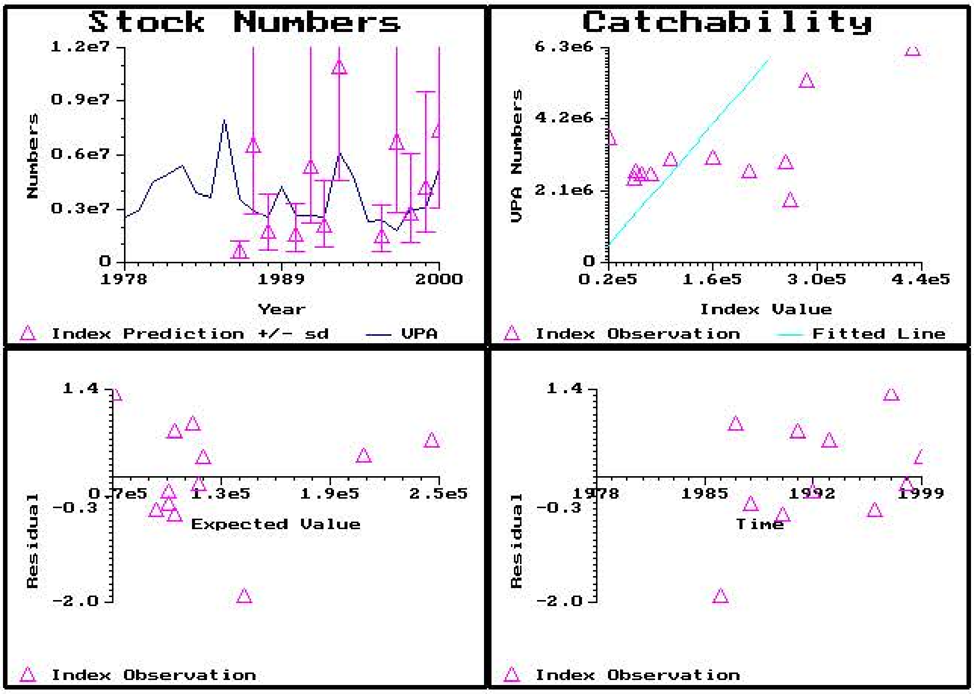


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX Age 2



FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX Age 3

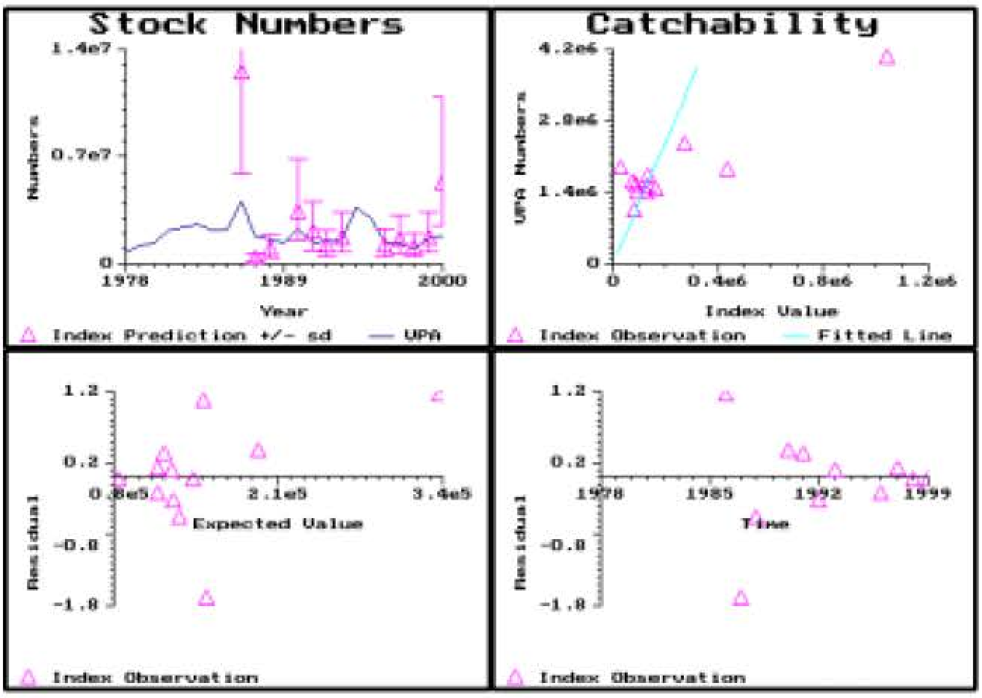
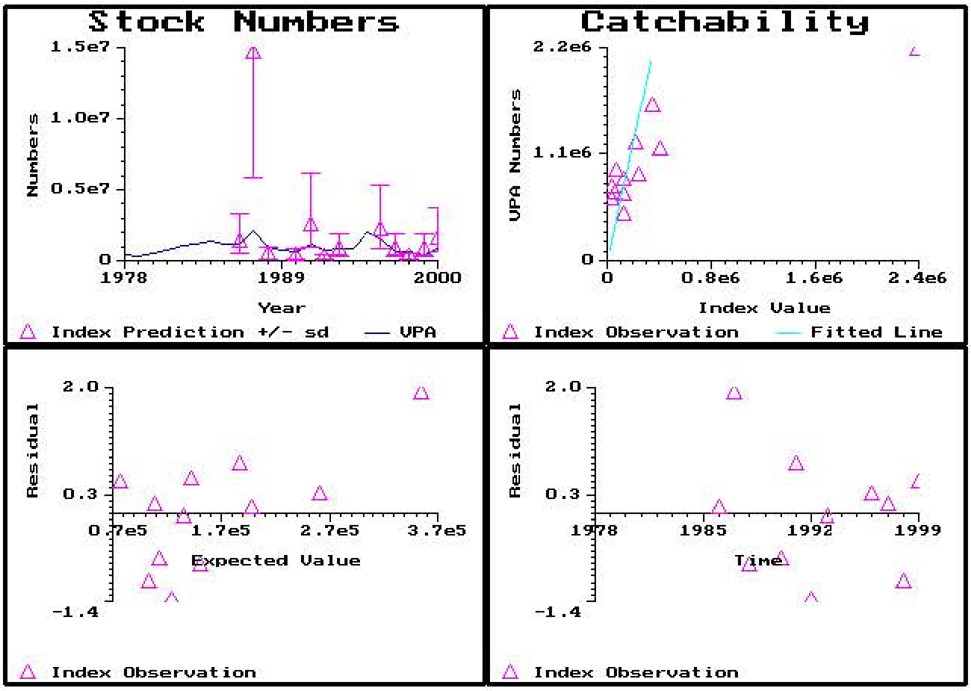


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX Age 4



PFLT04P SP MARCH ACOUSTIC SURVEY VIIIc+IX to contAge 5

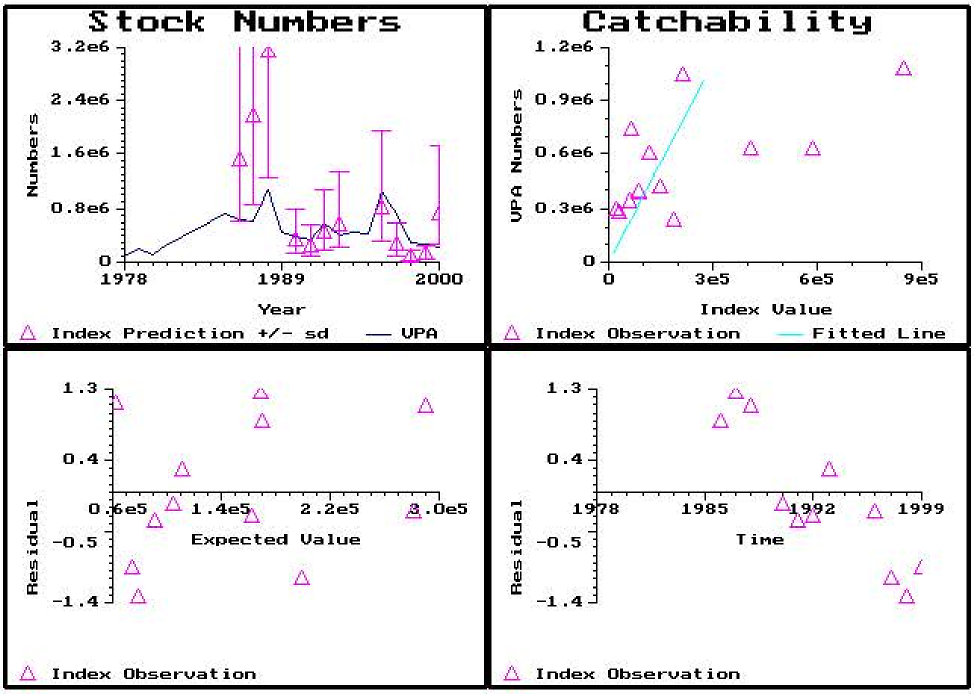
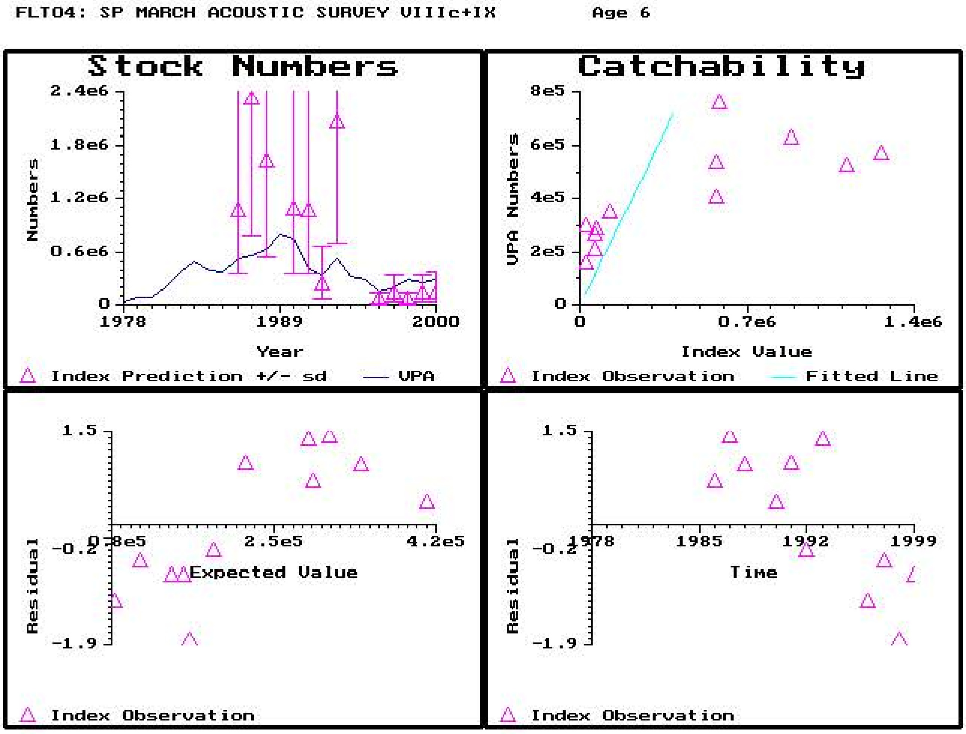


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



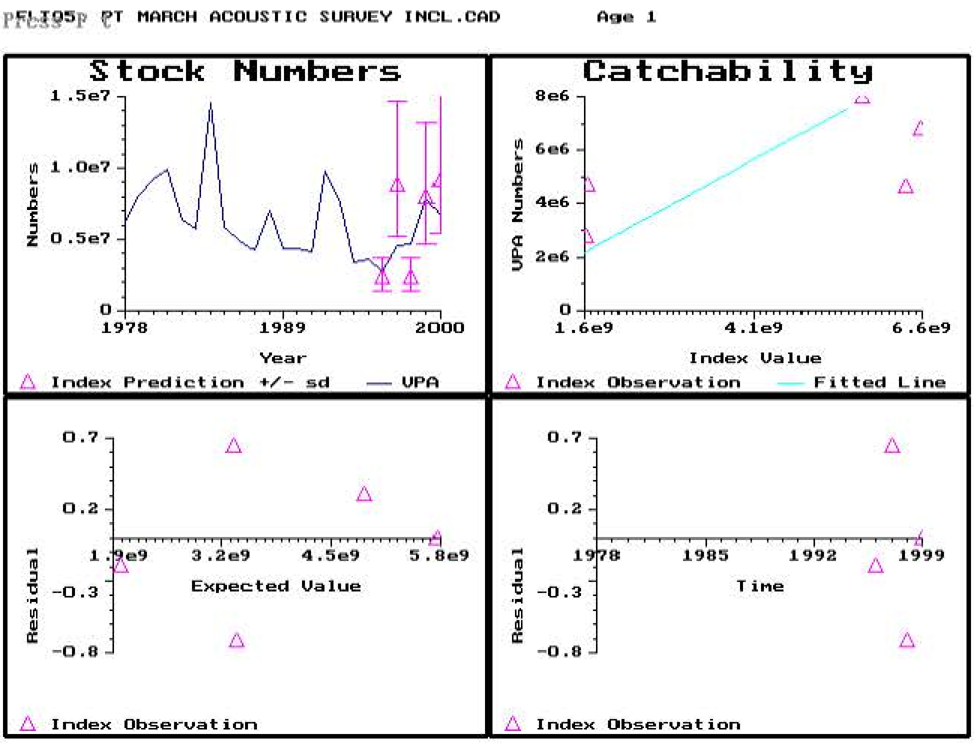
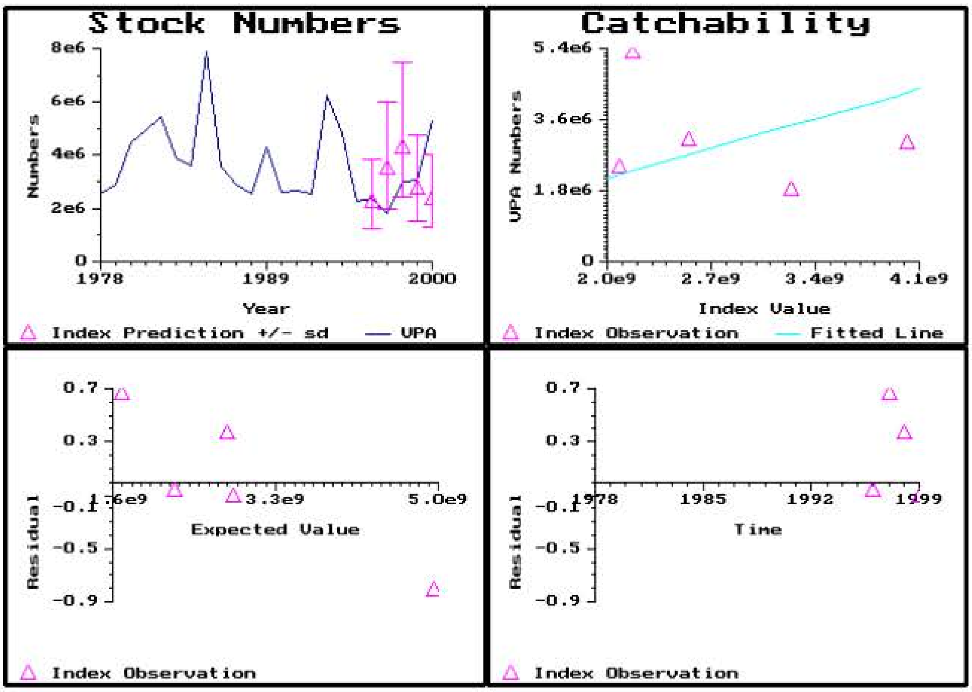


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD Age 2



FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD Age 3

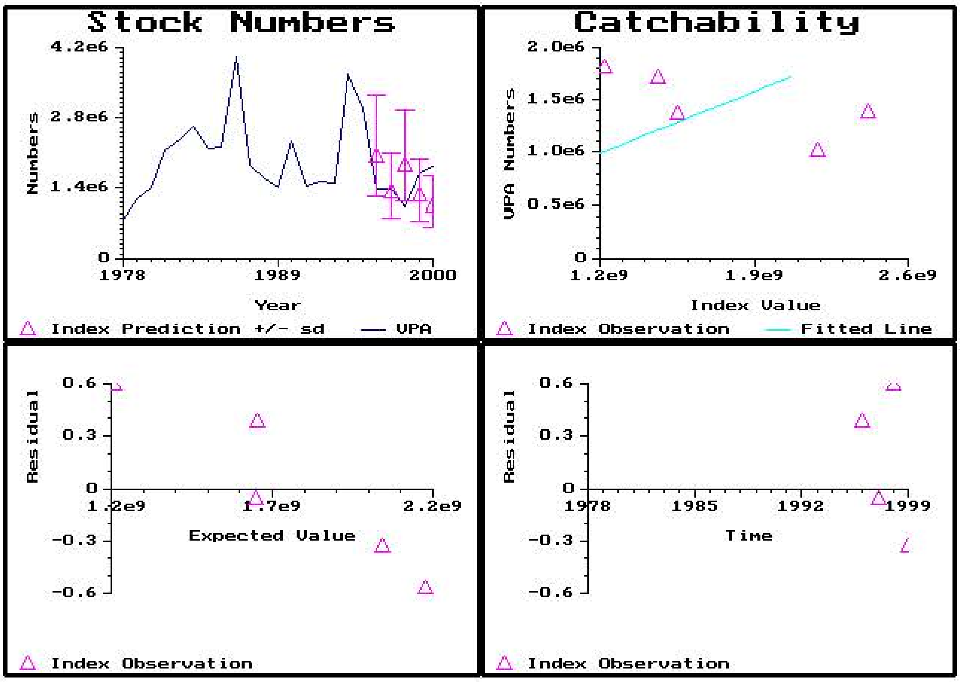
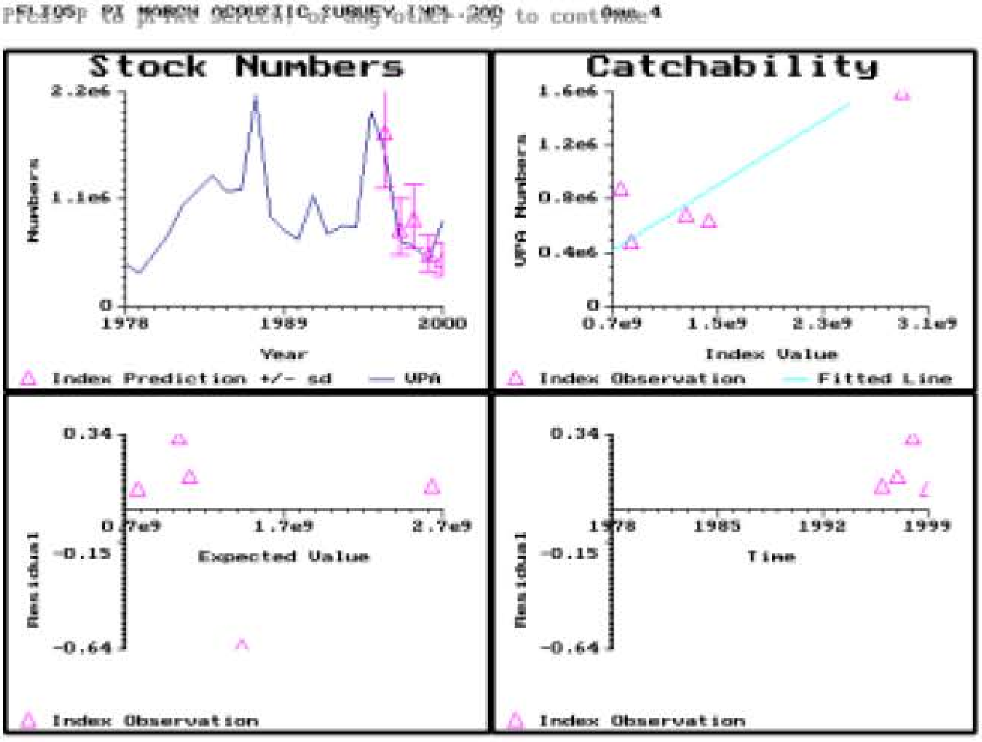


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



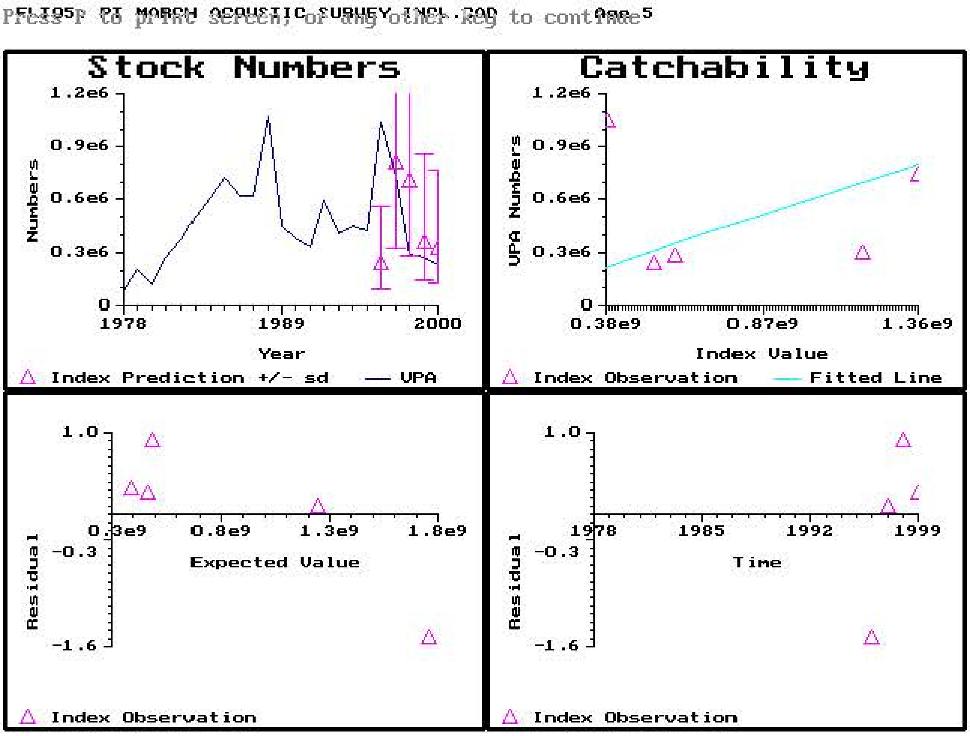
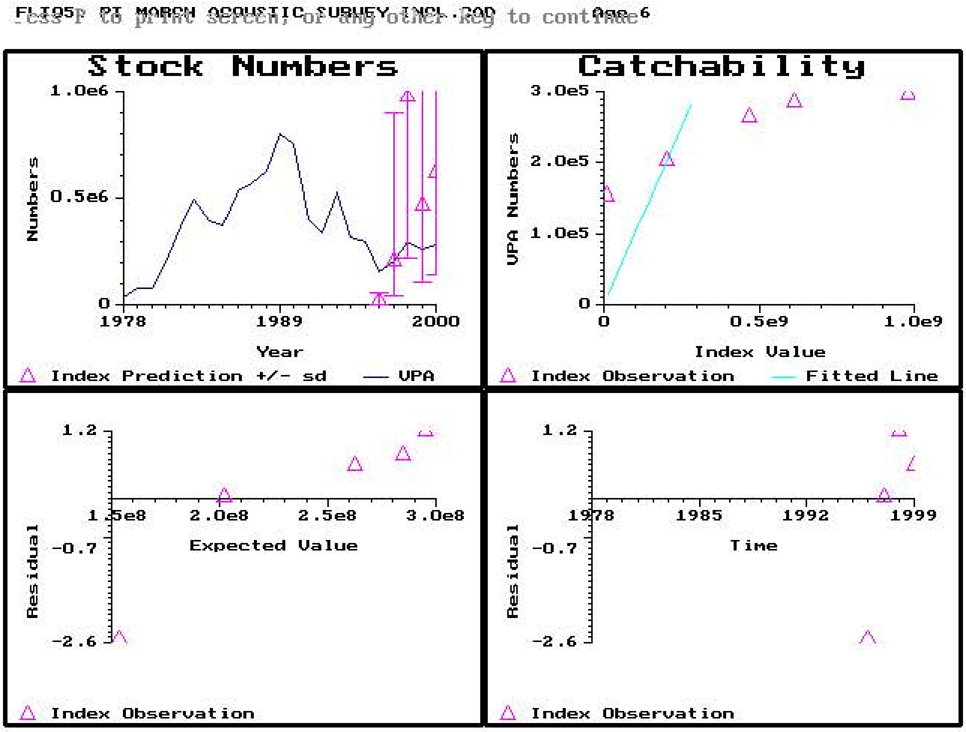


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



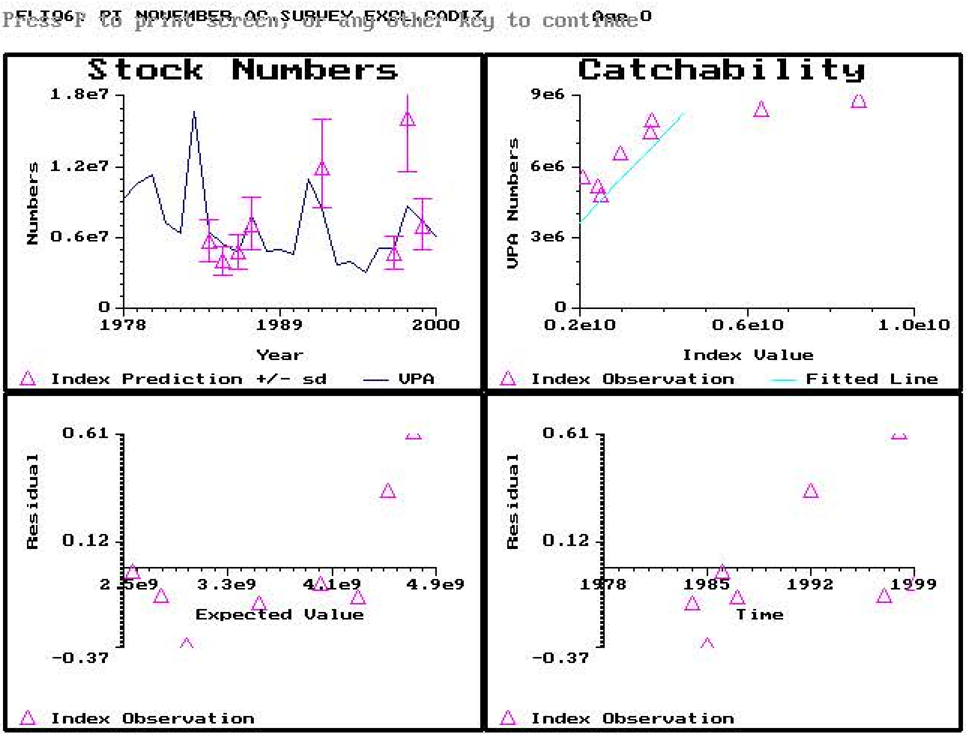
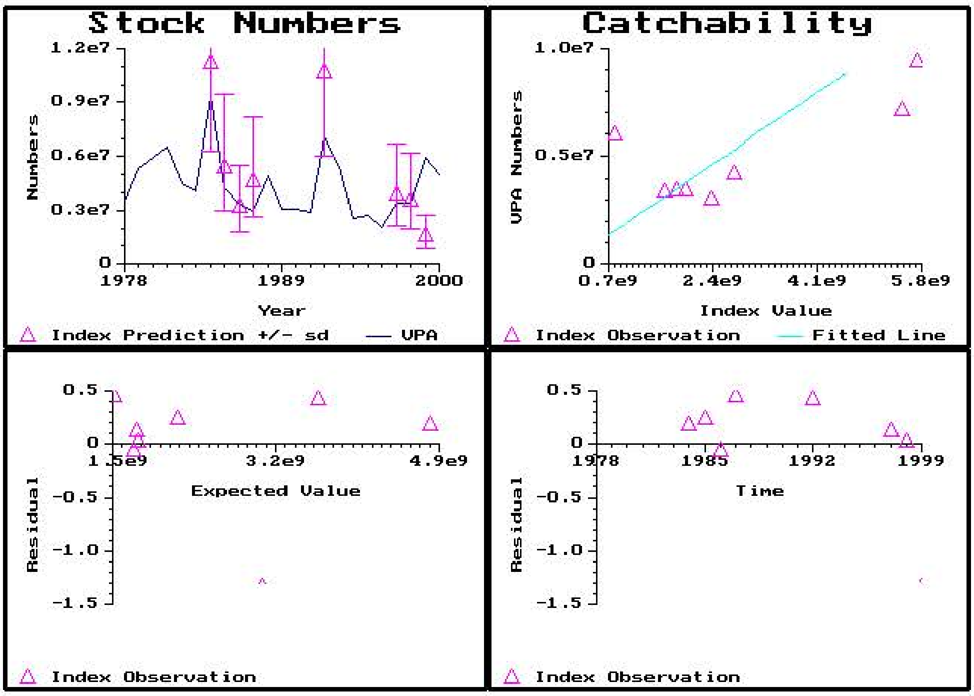


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 1



FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ Age 2

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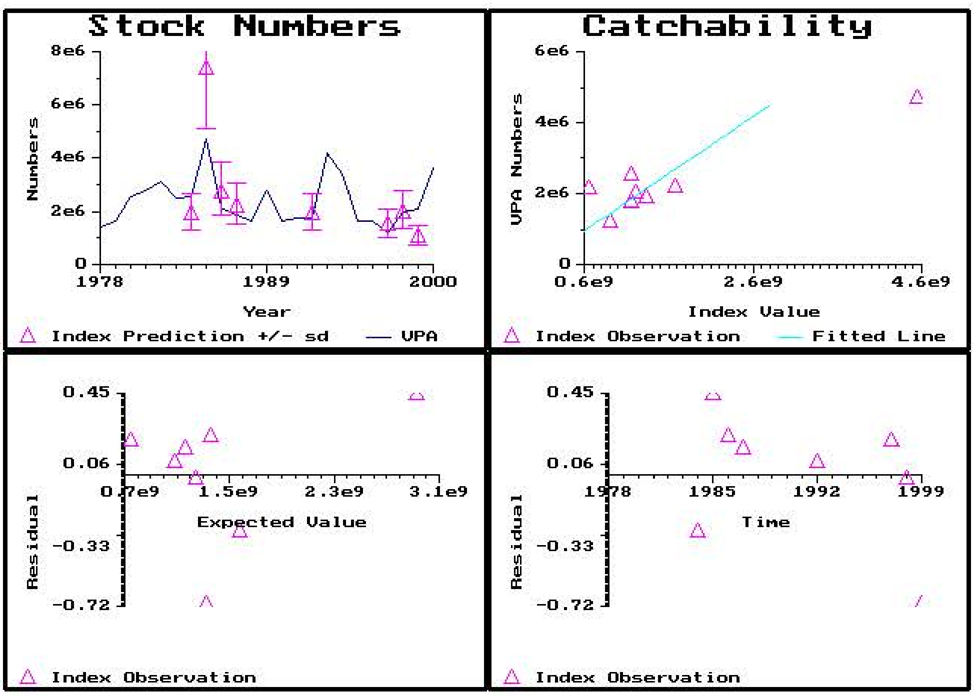
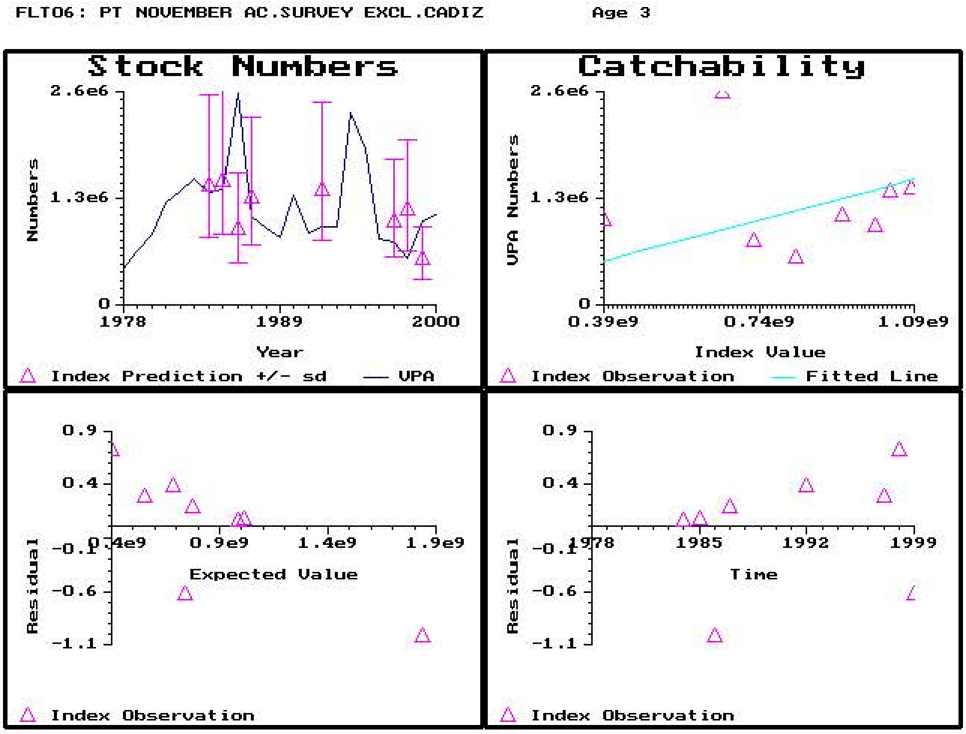


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



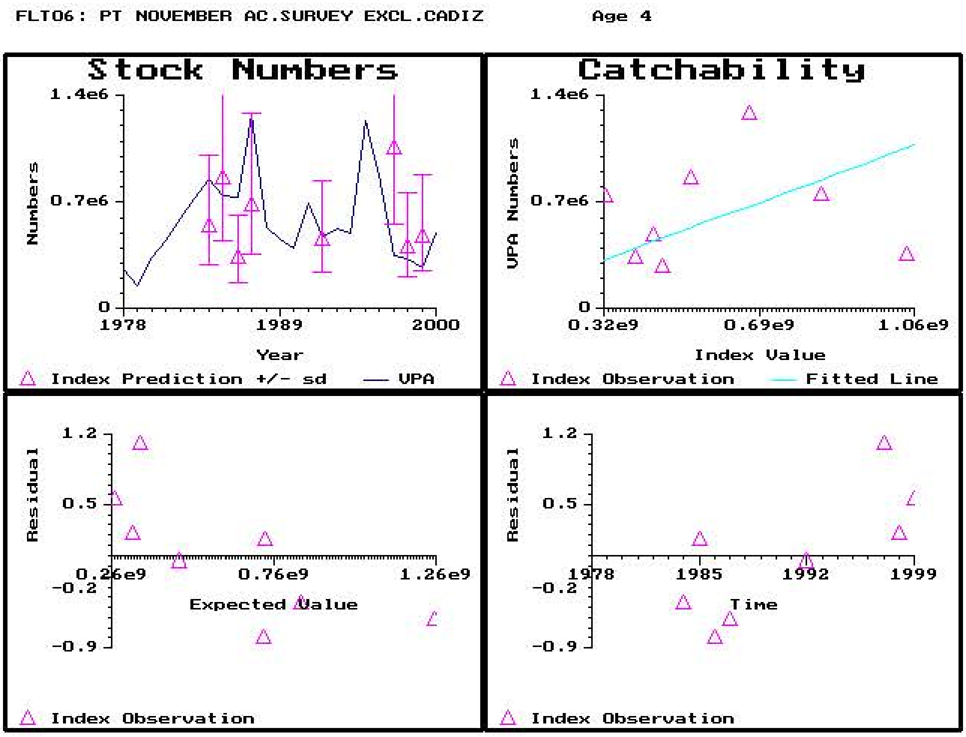
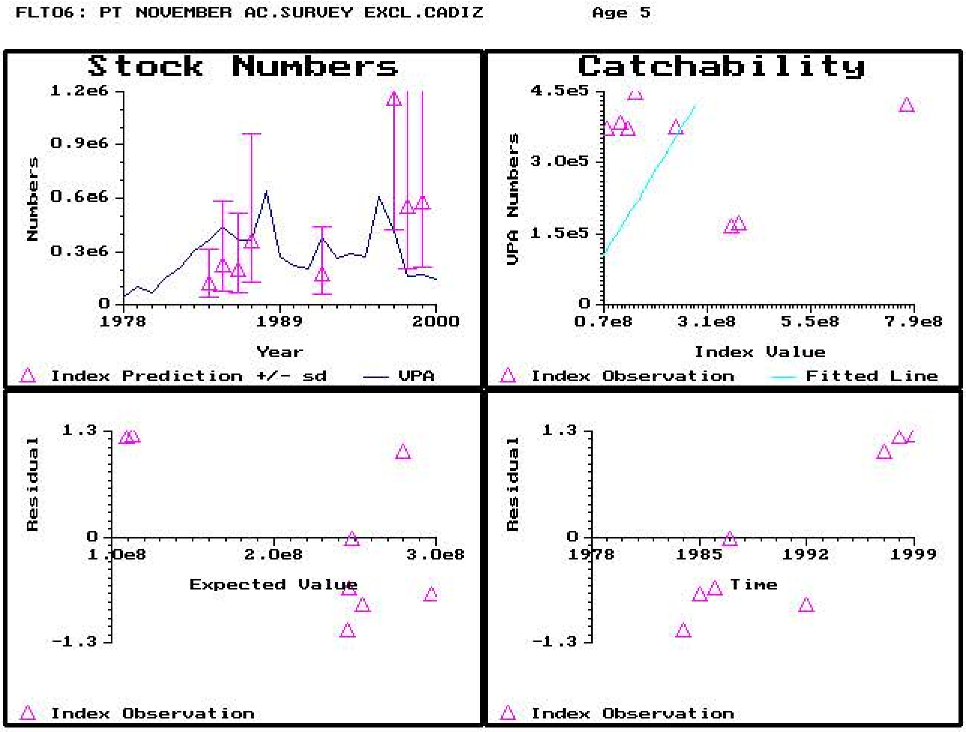


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



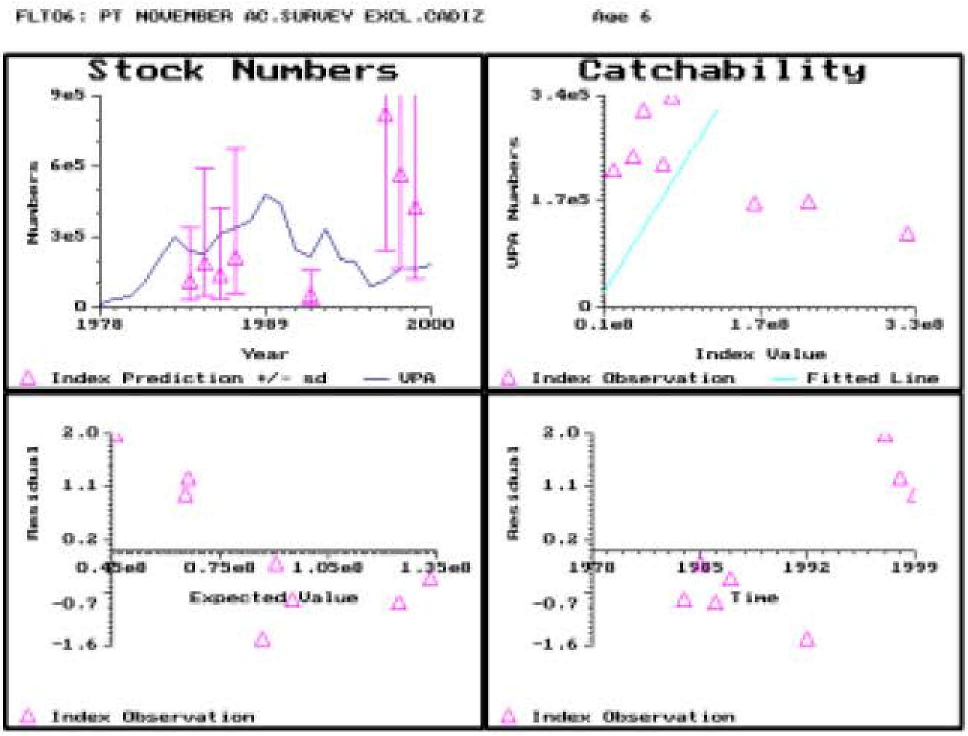


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

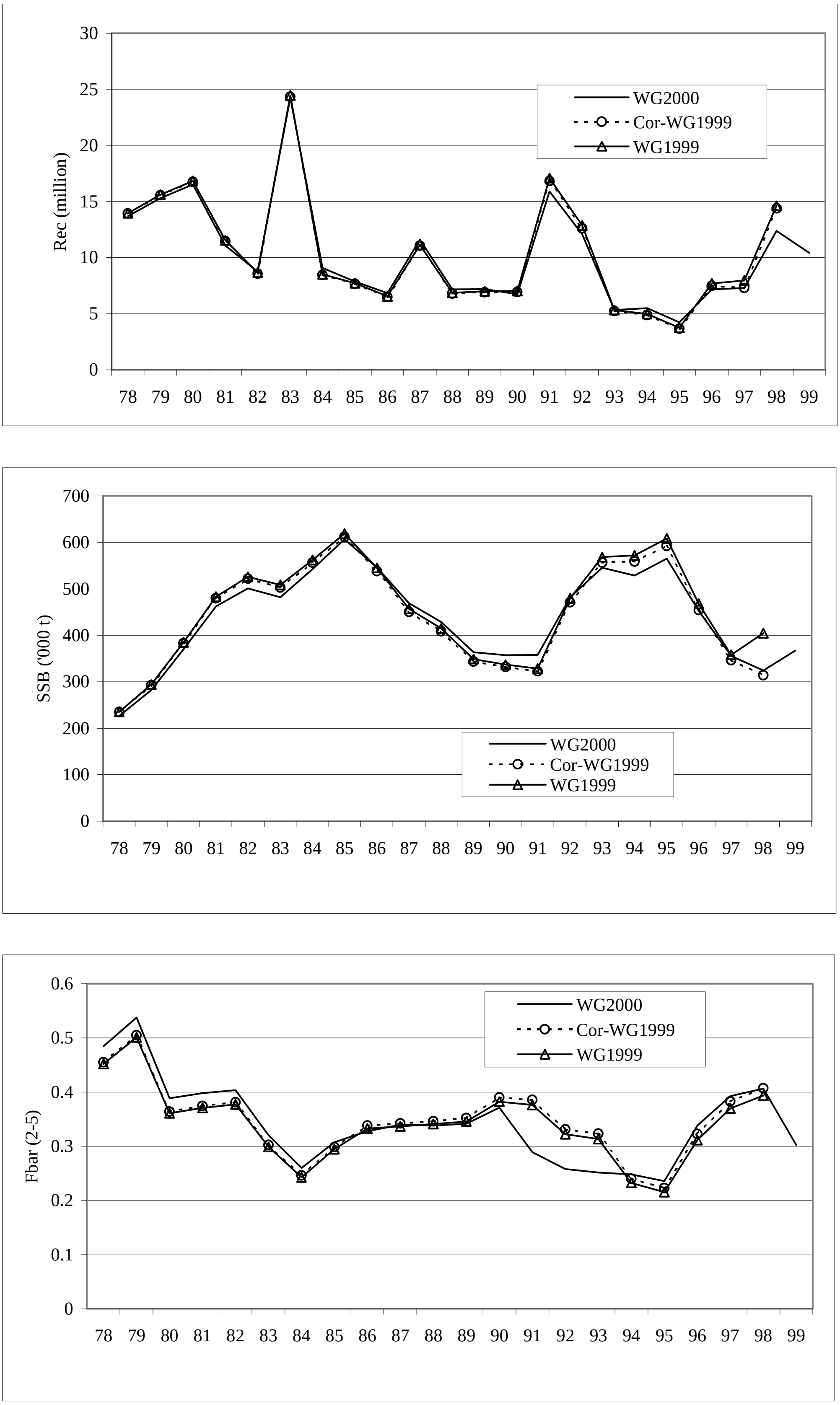
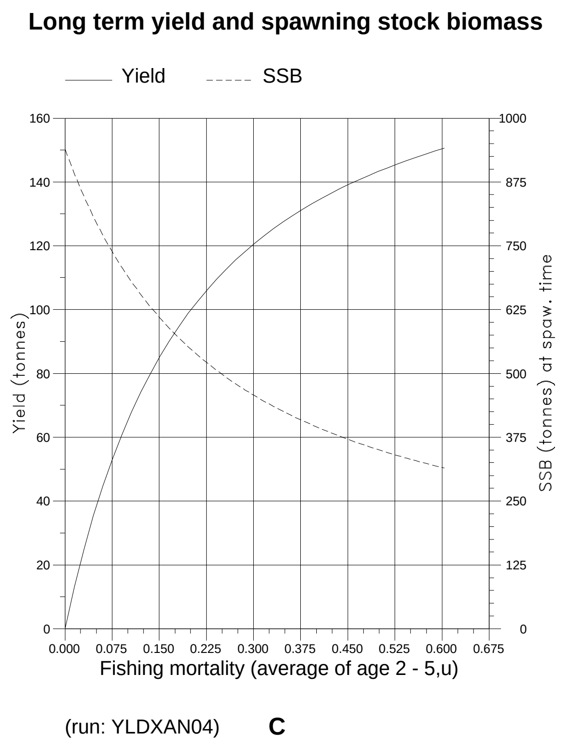


Figure 9.7.2.2: Comparative analysis of the assessment model. Dashed line corresponds to the estimation of the assessment model (with updated values for 1998 catch-at-age, 1998 weight-at-age in both stock catch). Line with triangle corresponds to the estimation of the last assessment.



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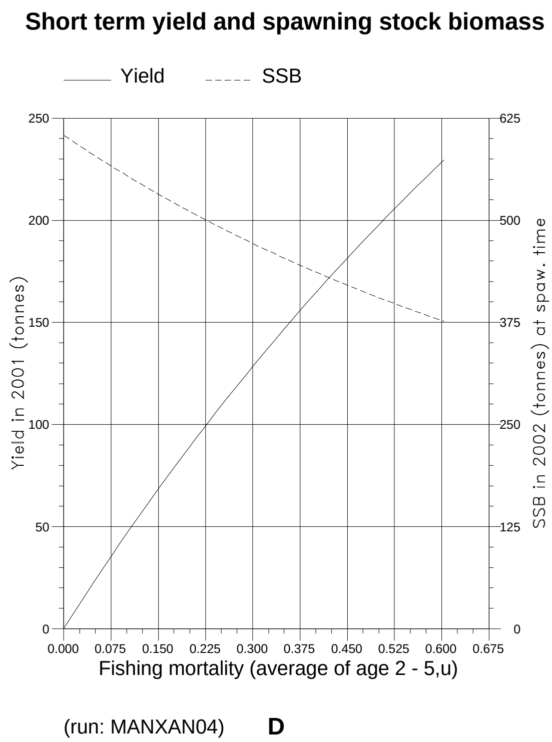

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Figure 9.11.1

10 ANCHOVY – GENERAL

10.1 Stock Units

The Working Group reviewed the basis for the discrimination of the stocks in Sub-area VIII and Division IXa. No detailed study has been made to discriminate sub-populations along the whole European Atlantic distribution of the anchovy. Morphological studies have shown large variability among samples of anchovies coming from different areas, from the central part of the Bay of Biscay to the West of Galicia (Prouzet and Metuzals, 1994, and Junquera, 1993). These authors explain that the variability is reflecting the different environments in the recruitment zones where the development of larvae and juveniles took place. They suggest that the population may be structured into sub-populations or groups with a certain degree of reproductive isolation. In the light of information like the well defined spawning areas of the anchovy at the South-east corner of the Bay of Biscay (Motos *et al*., 1996) and the complementary seasonality of the fisheries along the coasts of the Bay of Biscay (showing a general migration pattern; Prouzet *et al.*, 1991 and 1994), the Working Group 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). However, these informations are presently too scarce to change our opinion on the possibility to find a different stock unit in the North of the Bay of Biscay. This small stock 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 Working Group 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 dynamic on the anchovy in IXa and its possible connection with anchovies from other areas.

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 1991-1999. In Sub-area VIII during the first quarter, the main fishery (predominantly by the French fleet) was located around the Gironde estuary from 44°N up to 47°N. During the second quarter, the main landings (predominantly Spanish) were caught in the Southern part of the Bay of Biscay (south of 45°N.), mainly in Sub-areas VIIIb and VIIIc. During the third quarter, the fishery was spread in the Bay of Biscay: the Spanish one in the Center and in the South and for the first time in the North (VIIIa,b and c) and the French one in the Center and the North (VIIIa mainly). During the fourth quarter, the main fishery is located in the North of the Bay of Biscay 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 1999 were low and most of the fish was caught as usually during the first and fourth quarter in Sub-division Central North. The Portuguese catches peaked 1995 (7056 tonnes) and since then they remained low. The Spanish fishery in 1999 was mainly located in the Bay of Cadiz. During 1999, in that area, the landings decreased reaching a lower level than the historical maximum for this area (8977 t) observed in 1998 and are relatively stable throughout the year without undergoing any significant rise in spring-summer as it was usual. The decrease of Spanish catches in IXa North since the maximum level in 1995 (5,329 t) is continuing in 1999.

The distribution of fisheries in the Sub-area VIII is rather constant during this period: the main fishing areas appeared in VIIIc and VIIIb in Spring (mainly landings from the Spanish fishery) and in the VIIIb and VIIIa during the rest of the year (mainly French fishery). Since the bilateral agreement between France and Spain in 1992 (see chapter 10.2), there is an increase of the catches in the VIIIa, particularly during the second half of the year.

Since 1998, the distribution of fisheries in Division IXa was situated in the Gulf of Cadiz (Sub-Division IXa South, except in 1995, when it was mainly found in the northern part of Division Ixa (Sub-Division Ixa North and Central North).

Historically, catches to the West of the Iberian Peninsula (from Subdivisions IXa Central and North) have shown episodic increases (Junquera, 1986 and Pestana WD 1996), probably due to environmental favourable conditions (Uriarte *et al*., 1996).

Table 10.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters and total in the period 1991-1999.

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

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

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	
1999	1617	0	139	318		949		351	5750	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	
1999	692	30	723	12		98		0	4266	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	
1999	5942	96	957	413		8249		8529	10016	0

Not available

11 ANCHOVY - SUB-AREA VIII

11.1 ACFM Advice Applicable to 1999 and 2000

ICES advice from ACFM in November 1999 states: "ICES recommends that there be no fishing of anchovy until there is evidence of recruitment which would bring SSB above B_{pa}. The 1998 year class is known to be weak while the 1999 year class is predicted to be weak based on environmental conditions. SSB is expected to decrease to unacceptable levels due to poor recruitment. A survey in April 2000 will provide additional information on the strength of the 1999 year class and this information will be reviewed by ICES when available."

As relevant factors to be considered in management, ICES further pointed out: "A strong reduction of the spawning biomass in 2000, linked to adverse environmental conditions, is expected to bring the stock below B_{pa}, even under conditions of no catches. For this reason, ICES advises that there should be no fishery. It is recognized that the state of the resource can change quickly, and therefore in-year monitoring and management could be appropriate."

The values of reference points proposed by ICES are B_{pa} = 36,000 t and B_{lim} = 18,000 t.

This approach to management is intended by ICES to be "consistent with the precautionary approach" in that it seeks to achieve a low probability of falling below the B_{lim} reference point, in accordance with international agreements on the precautionary approach to fisheries.

STECF endorsed the ICES advice. However, STECF also pointed out that at least two management options were possible for 2000:

Option A: Closure of the fishery and opening, if there is evidence that SSB is estimated to be above B_{pa} in 2000.

A closure of the fishery will give the maximum protection to the spawning stock biomass. The fishery can be opened if after the April survey there is sufficient evidence that the then fully mature 1999 year class will result in bringing the spawning stock biomass above B_{pa} in 2000. However, the fishery season will be quite advanced by then and a very fast decision should therefore be taken. In order to guarantee this, STECF recommends that a decision process is set allowing the possible reopening of the fishery on the 1st of May based on the preliminary spawning stock biomass estimate available at the end of April. If the preliminary spawning stock biomass estimate is above $B_{pa,}$ then a TAC for 2000 can be adopted for the remainder of the year.

Option B: No closure of the fishery in 2000 until survey data confirm that spawning stock biomass is expected to fall below $B_{pa.}$

Maintaining the fishery at a low level until the verification of the level of spawning biomass would be an option to consider. This would imply the setting of a low TAC for 2000. Then, if the spawning stock biomass at the end of April is confirmed to be above B_{pa}, the TAC could be revised upwards. Otherwise, the fishery would be closed. The level of the TAC should be set at a lower value than the expected catches at status quo fishing mortality corresponding to a period up to 30 April. In view of the observed seasonal pattern of fishing, about 24% of the catch is taken by that date. A TAC of 3000 t would guarantee that there is a decrease in fishing mortality of 80% while it is also close to the expected catches by 30 April (about 24% of the status quo catch forecast).

Considering these advices and the necessity to protect as much as possible the future of the stock and the fishery economy of the Bay of Biscay, the fishery council adopted a provisional TAC fixed at 16,000 tonnes, the half of the usual precautionary TAC, for 2000.

The Commission also acknowledged the need to enhance scientific and technical knowledge in order to define precautionary reference points for the management of the stock of anchovy in the Bay of Biscay. So, a scientific meeting conducted by STECF was held at Brussels to analyze from a managerial point of view the risk analysis.

The principal conclusions of workshop (STECF-SGRST report, 2000) are based on the comparison of revenue and biological risk in both a high-risk scenario (B1 = 36 000t, intermediate harvest model) and a low-risk scenario (B1 = 9000t, recent historic harvest model), both being considered plausible.

The comparison indicated:

Under conditions of high underlying biological risk, imposing closures is effective at avoiding stock collapses and in maintaining revenue. The calculation is fairly robust to the choice of value at which to close the fishery, in the range 18000 to 36000 t. Average revenue in the longer term, is roughly doubled by adopting a policy of closing the fishery at low stock sizes.

Under conditions of low underlying biological risk, imposing closures at low stock sizes does not, in the longer term, have a large impact on revenue (max. about 10% reduction) compared with the unregulated case.

However, data do not permit a view as to whether the 'high risk' or 'low risk' situation is closer to reality and the range of high-risk scenarios has not been explored fully.

In order to secure and updated decision of the anchovy TAC for 2000, the Commission convened at Brussels a meeting (29-31 May) under the auspices of STECF in order to analyze:

- The results of the acoustic and egg surveys conducted in April and May;
- The commercial catch rates observed during the first months of 2000;
- As far as possible, any physical and oceanographic features, such as upwelling index, allowing a forecast of the strength of the 2000 year class.

The re-assessment of the state of the stock by STECF in May 2000 with the new information gathered (DEPM and Acoustic surveys and catch data) resulted in a substantial increase in the perceived stock size: about 50,000 t at spawning time in May compared with previous ICES estimates of 25,000 t.

Finally, the managers decided to revise the provisional TAC and to bring the level to the usual precautionary level: 33,000 tonnes.

11.2 The Fishery in 1999

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 (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 1999

In 1999 a total of 27,259 tonnes were caught in Subarea VIII (Table 11.2.1.1 and Figure 11.2.1.1). It is a 15.6% decrease compared to the level of 1998 catches. This decrease is due to the French fishery that had a 60 % decrease of these landings. At the contrary, the Spanish catches had a 55% increase. As usual, the main Spanish fishery took place in Spring (79%) and the main French fishery in the second half of the year (63 %) (Table 11.2.1.2 and Figure 11.2.1.2).

In 1999, as in other years, Spanish and French fisheries were well separated temporally and spatially. About 79% of the Spanish landings were caught in divisions VIIIc and VIIIb in Spring, while the French landings were caught in divisions

VIIIb in Winter (29.2 %) or in Summer and autumn in division VIIIa (63%) (Table 11.2.1.3). However, as mentioned previously, for the first time a significant number of Spanish purse seiners went in the North of the Bay of Biscay to catch anchovy during the summer and the beginning of autumn.

During the first half of 2000, total international catches reached 24,061 t (preliminary data) which is a higher level than the one reached for the same period in 1999. This increase is especially due to a good fishing season for the Spanish purse seiners. There has also been some increase in the level of French catches for the first semester. (see Tables 11.2.1.1 & 2).

11.2.2 Discard

It is believed than there is no discarding in the Spanish fishery and the discards have not been recorded in the French fishery.

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 2 age group largely predominates in the catches during the first semester. For the international catches, 2 year-old anchovies make up 51.2 % of the landings (61.5% for the first semester), followed by age 1 with 43.5%. As usually, the 0 and 3 age groups represented respectively a low proportion of the catches in 1999, respectively 3.6 and 1.8% for each category. Approximately 17% of the catches of anchovy (in numbers) consisted of immature fish prior to their first spawning in May.

The catches of anchovy corresponding to the Spanish live bait fishery for tuna fishing for the period 1987-1999 are given in Table 11.3.1.2. In 1999, catches at age 0 were higher than those of the previous year. Live bait catches of anchovy are rather variable depending on the availability of the different small pelagic species which are used as live bait by this tuna fishing.

Table 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, appeared during the second half of the year. The estimates of the catches at age on annual basis since 1987 is presented along with the inputs to the assessment in Table 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 bimodal distribution. For the French landings, the smaller group corresponds mainly to the production of small purse-seine and pelagic trawlers fishing close to the shore. (Figure 11.3.2.2).

For the third quarter, the French and Spanish landings had some different length distributions. This is probably due to the fact that the major part of the Spanish catches was made in the South of the Bay of Biscay whereas the French catches were made in the North. We can notice for the French catches a bimodal distribution, the inferior fraction corresponds to the anchovy caught off the coast by the smaller boats. (Figure 11.3.2.3)

For the fourth quarter, the size distribution of the French and Spanish landings were similar. That corresponds to productions caught off the North of the Bay of Biscay by the two fisheries. (Figure 11.3.2.4).

The series of mean weight at age in the fishery by half year, from 1987 to 1999, 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 and 1996, when no estimate of mean weight at age for the stock existed, the average of the rest of the years has been taken.

11.3.3 Maturity at Age

As reported in previous years' reports, anchovies are fully mature as soon as they are 1 year old, at the following Spring after they spawn. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Motos, 1994).

11.3.4 Natural Mortality

The natural mortality for this stock is high and probably variable. In previous Working Group report, estimates of natural mortality were obtained from consecutive estimates of the population in numbers at age supplied by the DEPM method and the catches taken between surveys (ICES 1992, Asses:17). For the purpose of the assessment applied in the Working Group, a natural mortality of 1.2, fixed value around the historical average, is adopted.

In the framework of an international project between France and Spain (Project 95/018), a statistical approach to get better estimates of natural mortality has been carried out. This approach used DEPM information and trends in CPUE of some French pelagic trawler fleet chosen as reference. In that study, we use as inputs the estimates given by the DEPM for the level of abundance of SSB. Given that level, we use as a decreasing trends the Z estimates calculated from the CPUE values of the French reference fleets. Finally, we try to appreciate the degree of convergence among the level of abundance in June of the next year calculated as indicated above and the level of SSB given by the DEPM for the next year. The main results are shown in the following table (after Prouzet *et al*, 1999).

Cohort	Z est.	Confidence interval of Z (90%)		F est.	Confidence interval of F (90%)		M est.	Confidence interval of M (90%)	
1986	1.16	0.75	1.57	0.59	0.34	0.97	0.57	0.13	0.98
1987	4.56	3.41	5.70	0.98	0.58	1.67	3.59	2.69	4.61
1988	1.93	1.70	2.17	0.63	0.50	0.78	1.30	1.05	1.54
1989	3.76	2.90	4.62	0.71	0.43	1.14	3.01	2.15	3.73
1990	1.94	1.68	2.21	1.2	0.87	1.67	0.74	0.36	1.05
1991	1.92	1.58	2.25	0.43	0.27	0.74	1.48	1.12	1.82
1993	2.67	2.18	3.16	1.01	0.68	1.54	1.65	1.07	2.14

From the results obtained, M (natural mortality) can vary widely among years and it seems that the assumption of a constant M use for the current management procedure is a strong simplification of the actual population dynamic.

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 2000, with a gap in 1993 (Table 11.4.1.1). A review of the most recent surveys since 1995 was presented in Uriarte *et al*. (WD1999) (for the years 1995, 1997, 1998 and 1999. This year a new WD (Uriarte *et al*., 2000) provides the final estimate of the Spawning Biomass in year 2000 according to the positive spawning area and the total egg production.

Besides, this document revises as well the results of the 1994 DEPM survey for Bay of Biscay anchovy assessment (Motos et al., 1995), according to the revision of the Spawning frequency AZTI is making of the whole set of DEPM surveys and the revision of the ageing procedures of the eggs and egg production estimates (Uriarte et al. 2000WD). The biomass estimate for that year turned out to be 60,062 t, which is as expected smaller (by about 10,000 t) than the one originally estimated by Motos et al.(op. cit.). This is mainly due to the drop in the egg production estimate.

The spawning area, and total egg production estimated from the survey in 2000 is presented in Table 11.4.1.1. The map of egg abundance and the positive spawning area is shown in Figure 11.4.1.1.

With the new estimate of biomass for 1994, the set of the DEPM biomass (SSB), spawning area (A) and egg production per surface unit (P0) was revisited to establish the best multiple relationship of the two latter to predict the SSB. This relationship was used to update the estimates for the 1996 and 1999 and produce the figure for the current year 2000. In all these years only the total Egg production is available, due to the lack of adult sampling. The model is similar to the one defined by Uriarte et al., 1999 (WD 1999) and similar to the one used in the previous year working group (ICES CM1999/ACFM:6). The model is such as:

$LN(SSB) = \alpha LN(P0) + \beta LN(A) + cste + \xi$,

With P0: daily egg production per 0.05 m^2 and A: positive spawning area. The constant term give us a mean estimate of the inverse of the daily fecundity. The parameters were fitted to the complete set of surveys (excluding the repeated June estimates of 1989 and 1990, for which there are other estimates produced by surveys in May) (Uriarte *et al*. WD2000):

Dependent variable: Ln BIOMASS

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-2,8227	1,01948	-2,76878	0,0277
Ln po	0,707834	0,159838	4,42845	0,0030
Ln sa	1,19684	0,102478	11,679	0,0000

R-squared = 97 %   R-squared (adjusted for d.f.) = 96 %, Standard Error of Est. = 0,137639
Mean absolute error = 0,0860291

The spawning area and the egg production estimates arising from the DEPM surveys are in Table 11.4.1.1.

That allows defining the following biomasses:

BIOMASS(tons)	1996	CV(%)	1999	CV(%)	1999+	CV(%)	2000	CV(%)
F(Po,SA)May	39,545	16.0	63,115	14.8	69,074	15.1	44,973	14.5

Summary of the Predictions for the SSB according to the different analysis. The log predictions were transformed to original scale including a biass correction factor as $SSB = \exp(\hat{y} + \frac{1}{2}\sigma^2)$. The estimate selected for 1999 is 1999+, which includes the addition for an extra area corresponding to a radial to the north of the surveying area because it was presumed that the northern edge of the spawning was not fully covered by the survey (Uriarte et al., WD2000).

These estimates turn out to be almost identical to the ones already provided to previous working groups and, in the case of 2000, almost identical to the one provided in May to the European Commission (ad hoc STECF meeting).

The 2000 estimate confirms a decreasing trend in the Biomass since 1998, similar to the one recorded during 1992-1996 (Figure 11.4.1.2). The drop of biomass is however not so sharp as the one predicted by ICES (2000/ACFM:5), and this is certainly due to a lesser decrease of recruitments (specially for 1999) than foreseen last year. The spatial distribution of the eggs production is not fully concordant with the biomass distribution obtained in the acoustic survey, while the egg survey suggest a stronger biomass in the south (young and old anchovies), the acoustic suggest a stronger biomass to the north mainly of one year old anchovies.

Since the beginning of the use of the DEPM survey to assess the status of the Bay of Biscay anchovy, the estimates provided for 1989 have been considered downward biased as suggested by their authors (Motos and Santiago, 1989). For these reasons, there have always been raised by 1 standard deviation of that estimate for the purposes of the assessment.

11.4.2 Acoustic surveys

The French acoustic surveys estimates that are available up to now (since 1983) are 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, a new acoustic survey was performed for anchovy in the French waters, mainly to study the behaviour of the species in the central part of the Bay (close to the Gironde estuary) and to investigate the relationships between ecology of anchovy and its environment.

According to the discussion which took place in 1993 (Anon. 1993/ Assess:7) the acoustic values are considered to be relative indices of abundance and the values of 1983 and 1984 seems to be underestimated.

In 2000, within the frame of the EU Study Project PELASSES, a series of co-ordinated acoustic surveys have been planned covering the continental shelf of 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 coast.

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 first survey (PELACUS 0300) was organised by the Spain (IEO). The survey track is shown in Figure 9.3.2 (see chapter 9.3 on the Sardine).

The survey was divided in two phases. First part from 17th March to 25th covering the most northern area (ICES Division VII) and from 28th March to 13th April covering the Spanish area. Data analysis is described in Porteiro *et al*. (1996). Basically echo-integrated energy (back-scattered energy expressed in m^2/nmi^2) is allocated into fish species by scrutinising of the echo-traces and/or according to the fish proportion found at the fishing stations weighted by a TS/length relationship.

Anchovy was found in the northern part of the Bay of Biscay (off the Brittany coasts). In addition a scarce distribution was also located in the English area. In the Spanish area anchovy was found in a low density in the inner part of the Bay of Biscay. On the contrary, few isolated echo-traces with high density were found close to Cape Peñas (5°30’W) as shown in Figure 11.4.2.1.

Anchovy eggs from CUFES were only found in the inner part of the Bay of Biscay (Figure 11.4.2.1). Both the acoustic and the egg distributions were similar.

For assessment purposes, two different weight/length relationships were calculated.

A total of 4 949 tonnes corresponding to 262 millions fish were estimated in the French area. Figure 11.4.2.2 shows the length distributions from three different areas. In the inner part of the Bay of Biscay, only 574 tonnes, corresponding to 29 million fish were estimated.

Concerning those fish of the western part, in spite the smaller distribution area, the high density led an estimation of 5,853 t.

A second survey (PEL2000) was conducted from 18th April to 14th May 2000 and, following the previous one, covered from the Spanish/French border to Brest. The methodology was similar to that used in the previous survey.

Acoustic energy allocated to anchovy is shown in Figure 11.4.2.3. According to that, main output for the acoustic assessment is shown in the text table below:

Zone	Area (milles²)	Biomass (t)	Coef. Var.
Gironde	1460	22600	9.8 %
Offshore of Gironde	2300	16100	32.8 %
Centre	750	400	32.8 %
South	2180	8600	33.7 %
Total	**6690**	**47700**	

The Biomass is estimated to 47700 t but probably underestimated (Jacques Massé, pers.comm.).

Most of the fish belonged to age group 1. Figure 11.4.2.4. shows the length distributions of anchovies sampled during the scientific survey. As usually, the smallest fish have been caught close to the Gironde estuary.

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 French mid-water trawlers involved in the anchovy fishery has increased continuously up to 1994. Afterwards this fleet has been slightly decreasing. Therefore, it seems that after the rapid increase of the French fishing effort since 1984, we observe a certain reduction of the fishing effort for the last years, according to the decrease in the number of vessels involved in the fishery. That is confirmed in 1999. The main French fishing effort is concentrated in the central and northern part of the Bay of Biscay in the second half of the year, whereas for the Spanish fishery, the main fishing season takes place during the first half of the year in the south-eastern part of the Bay.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different. The current effort may be at the level that existed in this fishery at the beginning of the 1970's (Anon. 1996/Assess:2).

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). As an example, the indices for the first half of 1997 and 1998 showed strong decreases of CPUE for the total catch, suggesting a decrease of the population in these two recent years. The DEPM estimates of biomass showed, however, that this was not the case. For 1999, we noticed an increase of the global CPUE (in tons per boat per day) and particularly a large increase of the catch per unit of effort for the 2 years old, which is one of the highest, recorded on the 1987-1999 period. These levels are in agreement with the DEPM estimates made in 1998 and confirm the presence of a relevant population of 2 years old in the Bay of Biscay during the first part of the year 1999. On the other hand, the CPUE at age 1 is at a low level.

In 2000 the preliminary CPUE of Spanish purse seines reveal a strong increase in the catch per boat of anchovies at age 1, and a rather relevant presence of the two years old. In general for this spring fishery the catchability seems to have increased in this year due to the general good weather that prevail over late April, May and June. This made that only a single day of fishing were lost due to bad weather along the fishing season.

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 methodology to validate and to treat the data is given in Prouzet and Lissardy (2000). Table 11.5.3. gives the catch per trip in number of 1 year old anchovy for three different harbours, located in the South (Bayonne), in the Center (Saint-Gilles Croix de Vie) and in the Central-North (La Turballe) of the Bay of Biscay. Two fleets were chosen as reference: Saint-Gilles-Croix-de-Vie (LS), La Turballe (SN) fishing harbours because their fishing behaviour correspond to that observed during the first quarter 2000.

A deviance analysis made on the following model: $DEPMbiomass \approx a * \log(meancpue) + b + \varepsilon$ in using as dependant variable the series of DEPM biomass of age 1 (see Table 10.4.1.1) and as independent variables the series of mean cpue of age 1 for the first quarter from La Turballe and Saint-Gilles Croix de Vie fishing harbours weighted by their number of observations (Table 11.5.3) showed that 81% of the deviance of the DEPM biomass is explained by the variation of mean catch per trip. The results are shown in Table 11.5.4.

In 2000, from information gathered on the location of anchovy catches[1], we estimated the main fishing areas for anchovy during the first quarter. As generally observed, the fishing zone was centred on the Gironde estuary between 46°15 North down to the latitude of the Bassin d'Arcachon: 44°45 North. Figure 11.5.1., shows the fluctuation of the catches according to the day of fishing. This fluctuation can be strong some days. Figure 11.5.2 shows the trends of the mean catch per trip for these 2 fleets. We can notice a decrease of catches per trip through January with the lowest levels in February then followed by a significant increase in March. The trend of the catch fluctuations is the same for the two fishing fleets: Saint-Gilles Croix de Vie (LS) and La Turballe (SN).

Table 11.5.5. gives the statistic summary of the data collected on these CPUE. The catch per trip were very high even when we applied a correction factor of 71% for the percentage of 1 year old anchovy in the catches. This is difficult presently to know if the high level of catch per trip is due to a strong abundance of anchovy in winter or mainly to a change in the behaviour of the fishing fleet in 2000 (change of behaviour due to a possible closure of the fishery at the end of June 2000).

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 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 indexes are available to this Working Group:

One is the Upwelling index of Borja *et al*. (1996; 1998), which was mainly based on last years prediction. 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 Working Group confirmed that relationship. The estimates of this Upwelling since 1986 are reported in Table 11.6.1, updated with the 2000 estimate). That Upwelling index was used for the first time in 1999 to predict the Recruitment of the Bay of Biscay anchovy in 2000, given the indications of a very weak recruitment entering the fishery with the potential reduction of the Biomass below 36,000 t. From the assessment performed in 1999, the variation of the index explained about 57.5 % (Adjusted R2 for d.f) of the variance of the Recruitment estimated from 1986 to 1997 (by a multiplicative model). The direct linear comparison between the upwelling Index and the anchovy population at age 1 estimates of DEPM surveys show that Upwelling explained about 54 % of recruitment variation (R = 0.734). The prediction made in 1999 turned to be far below the recruitment now is being estimated to have entered the fishery in 2000, but figure is not outside the confidence limits of the predictions made by the model as fitted last year (Figure 11.6.1). Assuming that the current estimate of recruitment at age 0 occurring in 1999 is close to reality (as provided in the assessment adopted below -section 12.8-), we have updated the above relationships with the new estimates for recruitment at ages 0 and 1 in 1998 and 1999. The coefficient of determination R^2 (adjusted for d.f.=12) of the multiplicative model for age 0 drops to 43.1%, being still significant. But now the best model turned out to be a linear model, not on the log scale but on the linear scale, for which the coefficient of determination (adjusted) reaches the value of 51.7%. Table 11.6.2. shows the fitted model to the recruitment at age 0. In practice the fitting to the multiplicative or linear models do not have major implications in the result of any forecast.

The second index relating environment with the recruitment of anchovy is provided by Petitgas et al. (WD2000). 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. Many variables were constructed to describe the variations of Gironde river plume, coastal upwelling and stratification / turbulence processes. A hierarchical procedure was implemented to test for the best regression model (Allain et al. 1999). Linear regressions with each set of 1, 2…7 variables are adjusted to the recruitment index. Among the "best" regressions according to the R^2 criterion (highest R^2 for a fixed number of parameters), they selected the models which variables are all significant according to a Student's t test. The fit was made on the series of abundance 1986-1998.

The variables and corresponding physical processes selected by this procedure for the period 1986-1998 are, in order of their explanatory power:

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[1] Professional fishermen indicated the precise locations of their catches for each fishing trip. So it was possible to define the main fishing zones for anchovy during the first quarter.

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). These upwelling events are caused by moderate and intermittent easterly to north-easterly winds. Their influence appears always positive and especially crucial in March-May (before the peak spawning), according to the examples of the 2 best recruitment years 1992 and 1998. This variable is therefore rather similar to the one produced by Borja et al. (1996, 1998) on the sole basis of wind data.

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 sereral and could have caused important larvae mortality (after the peak spawning) responsible for the bad recruitments in 1987, 1988 and 1990.

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 the week.

The environmental indexes were regressed by these authors on the ICES estimates at age 1 of anchovy on January 1 of year y, as reported in the ICES report. Petitgas et al. considered the period 1986-1998, given in the 1998 ICES report. Values are in numbers of fish (the unit being 10^6). The series of values was regressed on environmental indices constructed for spring of year y-1. The relationship built upon the two retained variables explained above turned out to be highly significant for the period 1986-1998 (R^2 =75.2%). However the inclusion of the two most recent recruitment estimates up to age 1 in 2000 dropped down the R^2 to 65.5% (and to 59.5 when adjusted for d.f.).

Because the model has 2 covariates, UPW with a positive effect and SBD with a negative one, low R is mainly due to SDB and not so much to UPW. Since 1998, summers have shown low UPW and no SBD and therefore, Petitgas' model tend to predict average recruitment values.

The Working Group examined this new index and pointed out the risks of using a binary variable which was selected from the available data of the short series of years 1986-98. It was considered that it might be too soon to make a direct use of this new index as had been done with the other. In any case, the ecological explanation given by this model to the occurrence of strong failure in the recruitment, when de-stratification takes place in early summer, fits well with the most recent recruitment that entered in the fishery and gives an explanation to the strong deviance of the forecast recruitment in 1999 by Borja's model and the actual recruitment estimated.

Table 11.6.1 gives the environmental indexes supplied by Petitgas et al. since 1986 and presents the coefficient of determination of their upwelling and predictions on this Working Group assessment estimates. It is interesting to note that the upwelling index arising from the hydrodynamic model of IFREMER gives a rather different perception of this phenomena during summer 2000 than the one describing Borja`s index. Figure 11.6.2 presents the general fitting of the environmental versus the population at age 0 estimates produced by the assessment performed this year. Table 11.6.2 gives the parameters fitted for linear simple or multiple models on age 0 from the assessment and their associated forecasts.

In last year working groups it was agreed that, since the environmental indexes do not estimate recruitment abundance directly (as surveys indexes do) but are just descriptors of the environment, they should not used as tuning data for the assessment and might only be considered to improve the projections of the fishery in next future. Their reliability as predictors should thus be re-evaluated every year from its fitting to the recruitment estimates provided by the assessment.

11.7 State of the Stock

11.7.1 Data exploration and Models of assessment

In this stock, natural mortality is believed to be high (but variable) and close to or higher than fishing mortality. For that reason, in a VPA the strength of the year classes will be conditional on the assumed natural mortality. The assessment of the anchovy fishery performed up to now has been based on fitting a separable selection model for fishing mortality with the auxiliary information provided by the direct estimates of biomass and population in numbers at age. The acoustic and egg surveys performed by France and Spain have allowed such analysis. Although the CPUE of the Spanish purse seiners is available, it has never been included in the assessment because of the likely changes in the catchability of these types of fleets, possibly inversely to the size of the stock (Csirke 1989).

The first step to assess the anchovy population in Subarea VIII was the comparison between the last year assessment and the one produced in a similar way (same tuning indexes and weighting factors) after adding the most recent fishery and survey indexes. This is shown in Figure 11.7.1.1, both assessments are very consistent. This assessment is an Integrated Catch at Age analysis, with a separable model of fishing mortality from 1987 to 1997 (with the ICA package, Patterson and Melvin 1996). This assessment, as those made in the previous years, reveals several puzzling results that deserve some analysis and considerations: there are large standard deviations between the catches at age and the separable model estimates (0.452) and between the auxiliary information to the population at age estimates (see table 11.7.1.1). This result in a poor Coefficient of determination of catches (in tonnes), which only attains 67%, and moderate fitting to the DEPM absolute estimates of spawning biomass (Coeff R2=67%).

In addition the data, as pointed out by ACFM, might be partly in contradiction: On one hand, the residuals to the DEPM are often positive specially for age 2 (indicating an estimate of the population at age 2 higher than the one modelled. On the other, the residuals from the catches at age 2 to the separable model are often negative (being caught less than expected by the separable model). These two sources of information (DEPM and Catches at age) might be partly in contradiction. The major problem of this summarised in Table 11.7.1.1.

In order to solve the problems that the current assessment implies, the Working Group explored the following approaches:

Analysis of individual residuals to search for potential outliers in the catches at age: The analysis consist on checking the statistical significance of the reduction in WSSQ that the elimination (strong down weighting) of a single catch at age produces in the total fitting of the separable model. This is made with an F test for the ratio between the reduction achieved in the WSSQ versus the residual variance remaining after the new fitting under the assumption of normal residuals (implicit in ICA). This is similar to the F tests in stepwise regressions (Wonnacott & Wonnacott 1981, Drapper & Smith 1981).

Sensitivity analysis of the weighting factors for the catches at age: In Table 11.7.1.2 three sets of catch at age weighting factors are presented. The first one is the weighting so far applied in the previous years, medium down weighting of age 0 and strong down weighting of ages 4 and 5 due to their scarce abundance in the catches. The first alternative try a stronger down weighting of age 0, because of the scarce separability of the catches of that age group. Catches at age 0 are made in different periods, areas and by different fleets and purposes than the rest of the anchovy catches. Half of those catches are made as live bait for the Spanish tuna boats and they catch only the amount required for tuna fishing, which depend as well upon the availability of other small pelagics, therefore this catch may be misleading sensu separable.

The second alternative weighting reduces the weight at age 3 to 0.1, this because of the fact that this age group supposes, on average for the last 13 years, less than 5% of the total international catch (both in numbers and tonnes, Table 11.7.1.2) and is mainly caught only during the first half of the year. The idea is increasing the precision of the separable model on ages 1 and 2 at the expenses of age 3.

Setting the selectivity of age 4 (the last true age in the catches) equal to the one calculated for age 3: This should reduce strongly the residuals at age 4, although due to the weighting factors the residuals in this age do not affect significantly the assessment.

Searching for residuals in the matrix of catches at age

Table 11.7.1.3 show the reduction in WSSQ of the assessment of reference achieved by the alternate omission of the catches at age 1 to 3 in the whole set of cage analysis of the assessment of reference (by a strong down weighting to 0.0001). Several residuals produce significant reduction in the total WSSQ and the most important comes from the catches at age 3 in 1991. This catches at age 3 as the rest of the 1998 cohort were revised upward in the revision of the catches at age made in 1997 (Uriarte et al. WD1997). By then they were already put in doubt because they were in strong contradiction with the DEPM population estimates. The current analysis also shows that they are as well in contradiction with the separable fishing pattern model. The benefits of omitting the catch at age 3 in 1991 can be seen in Table 11.7.1.4 (Column B): The log standard residual of the catches at age to the separable model are significantly reduced and the coefficient of determination of catches at age improves greatly. Figure 11.7.1.1 compared the results of this assessment with the two former ones.

Changing the weighting factors at age 0 and 3 and the selectivity at age 4

The two most trivial next changes are setting weighting factor at age 0 equal to 0.01 and letting S4 be equal to the convergence value of S3. Those two changes appear in columns C and D of Table 11.7.1.4. The reduction in the weighting factor produces a significant reduction of the WSSQ. This factor has changed from 0.1 (in the previous assessments) to 0.01. On the other hand, setting the selectivity at age 4 (the last true age group) equal to the selectivity to age 3 is not significant, which might be already expected since the weighting factor of this age group is already very low 0.01. The selectivity selected for age 4 such that it equal the one at age 3 was established by direct minimization in an excel workbook. The reduction so far achieved is only due to the down-weighting of the age 0 residuals and the reduction of the residuals to age 4, but the fitting of the other ages do not improve (see Table 11.7.1.5), neither to the DEPM.

Next step was down weighting the age 3 in the analysis. This is shown in Table 11.7.1.4 (columns E and F). Although the reduction in WSSQ necessarily significant (due to the smaller weighting): There is some improvement in the residuals for the separable model. The improvement is shown in Table 11.7.1.5 in the sense that catches at age 1 and 2 improve their fitting to the separable model at the expenses mainly of age 3. There is also some improvements in the fitting to the DEPM population estimates at age 3 and 2 (including a small reduction of the biass) and in the fitting to the acoustic (Table 11.7.1.4).

In this way this exploratory analysis show that the fitting to the separable model can be improved at the expenses of the ages 0 and 3, which can be considered marginal ages (in %) of the catch. Therefore the Working Group adopted the assessment based on considering age 3 in 1991 as an outlier and down weighting ages 0 and 3 to 0.01 and 0.1.

On the use of the auxiliary variables

Tuning the assessment using the DEPM and acoustic indexes both as aggregated indices of biomass and as aged structured indices was already discussed in previous years (ICES CM1999). Although the age structured index turn out to contain the most valuable information, the Working Group decided to let the information provided by the surveys tune the assessment in both ways as Biomass (in tons) and as age disaggregated indexes (in number) of the Spawning Population.

This year the Working Group decided to revisit this use of the auxiliary information. Figures 11.7.1.3 and 4 show the sensitivity of the assessment to the isolated use of acoustic or DEPM auxiliary information for the assessment. The use of the relative acoustic indexes as the sole source for the assessment drops down the SSB estimates and increases the fishing mortality. The use of the DEPM surveys alone (as absolute estimators) produce biomass and recruitments rather similar to the assessment of reference mentioned above (as last year but with down weighting factors for ages 0 and 1). This result simply evidence that the assessment is being driven by the use of the DEPM surveys as absolute estimates of Biomass and Population at age. In last year Working Group it was shown that when the DEPM series are taken entirely as relative then recruitment and biomasses decrease and fishing mortality increases substantially, as happens with the acoustic index. It suffices to consider a few years of the DEPM surveys as absolute to scale the whole assessment. Given the fact that the most recent years of the DEPM surveys are fully updated and revised for this Working Group)(since the 1994 estimate), those years taken as absolute estimations suffice to “anchor” the assessment on its current result. The other conclusion arising from Figure 11.7.1.4 is that the population at age estimates and SSB values from the DEPM surveys do not contain exactly the same information concerning the fishing mortality. Therefore its double use (as numbers and SSB) is justified.

Much of the above results and analysis are based on the idea that the DEPM surveys are usually unbiased and absolute estimators of biomass and its value and robustness should prevail over the assumption of separable fishing model. In fact we attribute the bad fitting of ages 1 and 2 to the non separability of fishing mortality for ages 0 and 3 and not to errors in the DEPM. All the assessment must be admitted rely on the confidence given to each source of data. Since the short living species has no covergence property via VPA to their true values, this means that only the auxiliary information supports the assessment. Therefore in no case we can escape to the subjective judgement of the robustness of the surveys, and so it will be in future. Therefore the Working Group concluded, as in previous years, to make use of all the auxiliary information available.

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 from 1987 to 1999 (with the ICA package, Patterson and Melvin 1996).

Inputs for the final assessment are summarised in Table 11.7.2.1. The assessment uses as tuning data the DEPM (1987-2000) and the Acoustic (1989-2000) figures as biomass and as population numbers at age estimates. The Acoustic and DEPM estimates are considered as relative and absolute estimates respectively and are down-weighted to 0.5 (because of the double use made of the indexes). For 1996 and 1999, the DEPM SSB biomasses included in the assessment are the ones obtained from the combined log-linear model of spawning area and Daily egg production per unit area explained in section 11.4.1.

The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier at this working group (Anon., 1995/Assess:2). The assessment starts in 1987 when the DEPM began to be applied. The separable model of fishing mortality is applied over the whole set of years (1987-99) (13 years). However the catch data of 1987 and 1988 are down-weighted in the analysis because for those years, the French catch at age data are considered to be more unreliable than for the rest of the years. In addition, the DEPM population as numbers at age estimates for those years, were not as reliable as for the following ones.

Ages 0, 4 and 5+ are heavily down-weighted (to 0.01) due to the small fraction of the catch they represent and to the large imprecision of the estimates. Age 3 is also down weighted to 0.1 again due to is low percentage in the catch and the improvement get through this in the fitting of the separable model to ages 1 and 2 (see previous section). The strong down weighting of ages 0, 4 and 5+ should assure that they do not interfere with the assessment of the other true ages.

The model was fitted to all these inputs by a non-linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=87}^{y=99}\lambda_{a,y}\left(Ln\left(C_{a,y}\right)-Ln\left(F_y\cdot S_a.\overline{N}_{a,y}\right)\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1987}^{y=2000}\left[Ln\left(SSB_{DEPM}\right)-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2$$

$$+\sum_{y=87}^{98}\ \sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right)-Ln\left(N_{a,y}\cdot\exp\left(-P_F\cdot F_y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989,91,92,97}^{98,2000}\left[Ln\left(SSB_{acoustic}\right)-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2+$$

$$+\sum_{y=89,91,92}^{97,2000}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right)-Ln\left(Q_{a,y}\cdot N_{a,y}\cdot\exp\left(-P_F\cdot F_Y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

with constraints on : $S_2 = S_4 = 0.7923$ and $F_{2000} = F_{1999}$

and $\overline{N}$: average exploited abundance over the year
N : population abundance on the first of January
N_0 : number of 0 group anchovy
O : maturity ogive, percentage of maturity
M : Natural Mortality
F_Y : Annual fishing mortality for the separable model
S_a : selection at age for the separable model
P_F and P_M : respectively proportion of *F* and *M* occurring until mid spawning time
$C_{a,Y}$: catches at age *a* the year *Y*
Q_a and $Q_{a,Y}$: catchability coefficients for the acoustic survey
SSB_{DEPM} and SSB_{acoust} : Spawning Biomass estimates from DEPM and Acoustic methods
SP_{DEPM} and SP_{acoust} : Spawning populations at age from DEPM and acoustic methods
$\lambda_{a,Y}$: 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 factor for the indices and/or ages (all equal a priori to 0.5)(see last portion of table 10.8.2.1)

Results of the assessment are presented in Table 11.7.2.2 and Figure 11.7.2.1.

The assessment thus defined is rather similar to the one implemented in 1999 for the period 1987-1998, with the exception of the severe down weighting of ages 0 and 3.

Comparison of results with the assessment and projections made last year.

Table 11.7.2.3 shows that anchovy assessments for the Bay of Biscay have been closely consistent in recent years. However small changes have happened between the previous and the current year assessment (Table 11.7.2.4 and

Figure 11.7.2.2). ICES forecasted a continuous decrease of biomass from 1998 to 2000. The current assessment confirms the decrease of biomass from 1998 to 1999, but results in a comparable figure for 2000. The estimate of biomass for 1998 decreases in comparison with the last years assessment (by about 26%), whereas the current perception of the biomass in 2000 (46750) greatly exceeds (by 86%) the forecasted biomass for this year (of 25000t). This is due to a different perception of the strength of the most recent year classes. The 1997 year class, although still very strong, is reduced by about 25%, whereas the predicted very weak 1998 and 1999 year classes are now perceived as low and at medium recruitment levels respectively. These estimates have increased 64% for the 1998 year class and 186% for the 1999 year class. This led to an underestimate of the expected biomass for 2000 from the last year assessment. According to the ICES forecast the spawning stock biomass was expected to be between 11 000 and 45 000 t with 95% probability. The new estimate is just in excess of the upper range of this expected range. The change in the perception of the stock size is marginally outside of the estimated range of precision of the survey and assessment methods currently used to provide advice on this stock, as calculated by ICES, therefore significantly different.

The ICA estimate of biomass in year 2000 is 46750 t, that is mainly due to the tuning biomass indexes used as inputs for this year in the assessment. This estimate of biomass for 2000 is based on a projection of the fishery during the current year with a fishing mortality equal to the one estimated for 1999 so that the indexes of biomasses from the surveys are fitted.

11.7.3 Reliability of the assessment and uncertainty of the estimation

The assessment is primarily driven by the Spawning Biomass estimates produced by the DEPM, this is the longest and most consistent independent estimate of the population in absolute terms. As shown in the exploratory analysis the adoption of the DEPM estimates as absolute figures allows scaling the whole analysis in the definition of recruitment, biomass and fishing mortality. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (1999). The log-variance of the populations estimates from the model versus the tuning indices seems reasonable, but the strong variations in abundance from year to year suggested by the direct DEPM estimates are not followed in parallel by the model (see Figure 11.7.2.1). The model tends to smooth annual variability in biomass. The separable model presents rather high level of absolute residuals both across years and ages, performing the best for age 1 and 2 (the most important age group in catches). These two ages have improved their fitting in comparison to the last year assessment.

There are changes in the fishing mortality in 1991 and 1992 mainly due to the down weighting of age 3 in 1991 what has lead to an improvement of the separable model.

The Working Group considers that this assessment shows reasonably well the recent trends in population abundance and fishing mortality according to the information available. From the output stock summary the only reference about the stock size has to be the spawning biomass and not the total stock size because the latter includes the biomass of the age 0 group at the beginning of every year (when it does not exist). The stock summary of this assessment is presented in Figure 11.7.3.1.

Table 11.7.2.3 shows that anchovy assessments for the Bay of Biscay have been closely consistent in recent years. However the reliability of recruitment estimates based on catches at age 0 for the last year are not reliable.

11.8 Catch Prediction

Predictions for catch and population for anchovy can be very problematic. This is due to three major factors:

- The predicted population is heavily dependent on new recruitment
- There is no discernible stock recruit relationship
- The fishery is principally on age 1 fish

These factors should be borne in mind in considering the two projections (2000 and 2001) detailed below.

Projection for 2000 made in 1999

The forecast for 2000 (made at the 1999 Working Group) was based on predictions for ages 0 and 1 in 1999. The prediction for age 1 was based on averaging the estimates provided for this age group by the assessment model and the estimate predicted using the upwelling index (Borja et al 1996 & 1998). Predictions for age 1 fish in 1999 from ICA were based on the catches of the 1998 year class at age 0. These were extremely low compared to historical values, leading to the perception that this year class (1998) was very weak. The inclusion of the upwelling index in the calculation indicated that this was an underestimate, but did not bring the estimate up to the level calculated in 2000. The current assessment gave a 64% greater abundance of that year class, and showed a strong negative residual for age 0 in 1998.

The underestimate may be due to the nature of the fishery for age 0 fish. The market demand for this size of fish is generally very low. Additionally, this age group is implicated in catches taken for live bait for the tuna fishery. These live bait catches are not specifically targeted on anchovy but cover all small pelagics. While this does not explain the unusually low catch level of 0 group anchovy in this year, it does indicate why such low levels may not necessarily indicate a low level of recruitment. Therefore, it was decided not to use these catch data in the context of the separable model to forecast year class strengths in the current assessment.

The prediction of the 1999 year class at age 0 was entirely based on the upwelling index. The new estimate of this year class made in 2000 was approximately 186 % higher than this prediction. This discrepancy was, however, within the 95% probability range of the prediction (see Figure 11.6.2). The combined effect of the two consecutive underestimates of consecutive recruitments resulted in the poor prediction in comparison to the current estimate of the SSB in 2000.

It is clear from the above that the upwelling index has limited value in the prediction of absolute recruitment levels. This is, at least in part, due to the relatively short time series of SSB estimates available to parameterise the index model. The standard error around the index will be greater following the inclusion of the data point for this year, however, the relationship remains statistically significant. One solution may be to use the index as a qualitative rather than an absolute measure.

Projection for 2001 made in 2000

Given all the above information it is possible to define the problems and requirements for stock prediction in anchovy:

- The fishery and the population are largely dependent on the number of age 1 fish in the population.

- But the fishery for age 0 in the previous year provides very little information about the abundance of age 1 in the present year. This means that prediction of stock abundance is dependent on the prediction of the level of recruitment.

- As there is no valid stock recruit relationship it is impossible to predict recruitment from the current SSB. So some other indicator for predicted recruitment is required.

- One possible indicator would be one using environmental information. Two possible candidates would be the upwelling index described by Borja (Borja et al. 1996, 1998, WD2000) or the slightly more complex stratification/upwelling index proposed by Petitgas et al (Allain 1999, WD 2000). Neither of these indices are currently fully reliable indicators of recruitment. The Borja index worked well for recruitment in 1998 but was much less accurate in 1999. Conversely, the Petitgas index worked well in 1999 but was less accurate in 1998.

- There are protocols for combining more than one, imperfect recruitment indices. For instance, Shepherd (1997) proposed combination using inverse variance weighting. However, such a combined index is untested on this stock, and the two indices are also measures of the same environmental phenomena, and there may be correlation problems. For these reasons it was not felt that such a combined index could be proposed at present.

- This leads to the conclusion that it would be incautious to rely on these environmental indices for the time being. However, the Working Group recognises that in the case of the stock scenario presented by anchovy, 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.

Given the inability to predict recruitment from catches, stock or environmental indices the Working Group felt that any prediction of future abundance would have to be based on some calculation from historical recruitment. The Working Group also agreed that in the face of this uncertainty, management should be conducted in a two-stage process. In the first stage a prediction would be made based on the most recent estimate of stock biomass and on a mean calculated from the recruitment time series 1986 – 1999. This could then be used by managers to set TACs for the first half of the coming year. A second assessment would be carried out following the completion of the acoustic and DEPM surveys in that year and a modified TAC set for the second half of that year.

The Working Group considered a variety of ways of calculating the mean recruitment to be used in the first stage of this process. The Working Group felt that, for the time being until more information becomes available, this calculated mean should be conservative, as the managers would have the ability to update TACs at the second stage. It was agreed that the most appropriate value, for the time being, would be a mean of the recruitments lower than arithmetic mean over the time series (8,653 million). This effectively means that the calculated value will tend to be an underestimate in 75% of cases. The chances of getting a lower recruitment than this value would therefore be 25%. The inputs and outputs of this project are in Tables 11.8.1 and 2. For prediction purposes, the recruitment at age 0 in the subsequent years would be set equal to the geometric mean 1986 to 1999 (12,175 million) and the status quo fishing mortality is set equal to the latest 5 years (1995-1999) instead of only the latest 3 years, due to the pronounced interannual fluctuations of the fishing mortality of this fishery.

An additional prediction is also presented, in which the conventional assumption of a recruitment at the geometric mean is applied. The short life span of the anchovy, implies that the development of the stock and its tolerance to exploitation is heavily dependent on the recruitment. The recruitment is poorly known and can vary over a large range. For the time being the working group does not consider the use of the geometric mean recruitment in the short term prediction to be compatible with the precautionary approach. The Working Group recommends further examination of plausible harvest control rules and that this should be made available to this Working Group in 2001. The inputs and outputs for this second projection are in Tables 11.8.3 and 4.

Weights at age in the catches would be set at the average values recorded since 1987 and weights in the stock are the average value input to the assessment since 1990 (the first year of accurate assessment of this parameter. A total catch constraint of 35,000 t for 2000 is assumed, consistent with the development of the fishery in 1999 (Table 11.2.1.3).

11.9 (Short-term risk analysis)

11.10 Medium term predictions

The analysis of the last year was not repeated. The fishing mortality is still considered to be within safe biological limits.

11.11 (Long-Term Yield)

11.12 Uncertainty in assessment

See 11.7.3

11.13 Reference points for management purposes

Reference points (B_{pa} & B_{lim}) have been defined in previous Working Group reports (ICES CM 1998/ Assess 6:). In view of the Working Group proposal for two stage management it is felt that these may not be entirely appropriate in this context. The following text describes the reference points as they are presently defined. It should be recognised that these may require modification in the future.

In the last year report (ICES CM 1998/ Assess 6:), the Working Group estimated the value of B_{lim} equal to 18,000 tonnes of anchovy which correspond to the minimum biomass below which no observations and no considerations on the dynamic of that stock have been made. The Working Group defined another precautionary level that was the B_{pre}: precautionary biomass. This level was defined as the double of B_{lim} and set at 36,000 tonnes.

B_{lim}: which is the level of biomass below which the stock has a high probability of collapse. Preliminary, it could be defined as the lowest estimated spawning stock biomass (from the assessment) over the past ten years (18,000 tonnes in 1989 according to Table 10.1.6 in Working Group report CM1998/Assess: 6).

That definition was consistent with the definition of MBAL previously accepted for this stock (set between 15,000 and 20,000 tonnes corresponding to the lowest DEPM estimates of the historical series observed in 1989 and 1991 during the period 1987-1998).

Bpa: Management of this stock has been guided by the need to withstand two successive years of poor recruitment, implying that catches may have to be reduced if the SSB reaches 36000 t. This value was adopted by ACFM as Bpa. However, in last years advise, ACFM interpreted this values as a limit point triggering closure of the fishery, rather than as a Bpa. The Working Group considers that SSB below 36000 t and above Blim should trigger a reduction in the fishery if there is indications of another poor year class, rather than its closure.

For the future, a harvest control rule as outlined in Section 11.14 should complement the precautionary framework.

11.14 Harvest Control Rules

One of the major problem for the fishery management of the Bay of Biscay anchovy is the long and short term fluctuation in biomass linked to variability in recruitment mainly driven by environmental factors.

The Working Group considered the possibility of making a concrete proposal of harvest control rules for the management of the fishery, but it was judged to be premature for several reasons. The basics for Harvest control rules on the Bay of Biscay anchovy were agreed by the Working Group, but the election of some concrete formulation was believed to be out of the scope of the Working Group. Instead a broad frame HCR could be proposed to managers for them to select those which can best reconcile the interests of fishermen subject to the management with the sustainability of the population from a biological point of view.

The Bay of Biscay anchovy is a small population, exploited by seasonal fisheries from two countries. The strong dependency of these fishermen on that resource means that whichever of the many harvest control rules envisaged, they will have a great impact on the different fisheries and communities. Because of this, the Working Group considers that its role must be to build up a general frame for the simulation of Harvest Control rules. This will then allow the different parties; fishermen and managers involved in the fishery, to make informed decisions for future management.

In these conditions, the Working Group considers that a real and effective management of that stock can be attained by using the scientific surveys to monitor the level of biomass and the recruitment indices to predict low recruitment level.

So, in order to avoid relying too much on the recruitment prediction based on an environmental index, the Working Group proposes that the annual TAC will be set in two steps. The idea of reviewing the management advice for short-lived species on the basis of information obtained during the fishing season is not new (as for south African anchovy COCHRANE 1998, or Capelin ICES CM ACFM:18). In South Africa a two stages TAC recommendation has been used to manage the local anchovy resource since the early 1990s (Cochrane *et al.* 1998). The approach taken is to provide an initial TAC based on a biomass estimate obtained by means of acoustics and to review this TAC when an estimate of recruitment becomes available in the middle of the season. Both the TAC initial and the TAC revised are computed by applying simple formulae to the survey estimates of biomass and recruitment. However, those apparently simple formulae are the result of a long process, which involved scientists and managers. The formulae are part of a management procedure (Butterworth et al. 1993) tested by means of computer simulations and finalised in consultation with industry and public representatives.

In the case of the Bay of Biscay anchovy the general proposed two stages are the following:

- a preliminary TAC for the year operative for the first part of the year (n+1) from January to June (until its update, see revised TAC). This TAC should be based on the biomass estimates of the year (n) called $B1_{(n)}$ and the qualitative level of recruitment in September the year (n) called Rsept(n). So the preliminary TAC call TACprelim is defined as Tacprelim= f(B1(n),Rsept(n)). The qualitative level of Rsept is based either on the value of the environmental index after Borja et al (WD 2000) (Called upindex(1)),or the best of the two available environmental indexes (upwelling iupindex(1) and upindex(2), the latter corresponding to the environmental index after Petitgas et al (WD 2000).

- a revised final TAC operative over the second part of the year from June to December and based on the biomass assessed the year (n+1) called $B2_{(n+1)}$. So this final TAC called revised TAC is defined as $TAC_{revised} = TAC2 = f[B2_{(n+1)}]$.

A working document (Prouzet, <u>WD</u> 2000) giving an example of a detailed harvest rules and retrospective analysis on recent history of the fishery, is presented and the Working Group thinks that it is a useful approach.

11.15 Management Measures and Considerations

The general framework of the anchovy management in the Bay of Biscay has been defined in the last working group report and this general framework remains presently valid. (See ICES CM1999\Assess: 6, for more details). As mentioned then, the assessment suggests that the current level of fishing mortality could be sustained in the long term provided that a step towards a more conservative approach is taken when the stock is at a low level. This seems presently to be the case according to the current assessment (mean $F_{(97-99)} = 0.49$, largely inferior to F_{pa}). However, the large variability of abundance due to the fluctuation of environmental factors makes the stock difficult to manage as the prediction of this recruitment is still uncertain. This implies the monitoring of the stock each year from direct estimation methods to validate our prediction on the recruitment and to correct if, necessary, our perception on the trend of the population. This suggests that it is necessary for the short-term management to be more active and to define the outlines of the fishery regulation as we proposed in section 11.14. These outlines have to be discussed inside an ad hoc study group in the framework of the ICES and EU community and consider not only the biological problems, but also the economical ones. That means some discussions not only among scientists but also with the fishery managers.

The history of the exploitation of this stock in relation to the proposed precautionary reference points is shown at Figure 11.15.1. The Bay of Biscay anchovy is a short-living species that is totally mature at 1 year old. Although the Bay of Biscay anchovy constitute a small stock, catches from this resource are economically very valuable. The Figure 11.15.1 shows two rapid variations of the abundance at constant F during two periods: 1991 to 1995 and 1997 up to now. Presently the mean F is lower than the mean F observed during the 1990-1996 period and the abundance estimated in 2000 is higher than B_{pa}.

For 2001, the estimates from the upwelling index give a large possibility of biomass. It seems difficult to give an accurate figure for the moment. It is the reason why a two step management plan seems the only solution for a positive management of that very valuable resource in the Bay of Biscay.

Table 11.2.1.1: Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII) As estimated by the Working Group members.

COUNTRY YEAR	FRANCE VIIIab	SPAIN VIIIbc, Landings	SPAIN Live Bait Catches	INTERNATIONAL 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	7,000	17,061		24,061 (*)
AVERAGE (1960-99)	5,638	28,145	318	33,886

(*) Preliminary data up to july for the French fishery and to June for the Spanish fishery

Table 11.2.1.2. Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII) (without live bait catches)

COUNTRY: **FRANCE** 1000 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
Average 87-99	1172	1010	567	466	714	867	757	1637	2485	1735	1011	55	12472
in percentage	9.4%	8.1%	4.5%	3.7%	5.7%	7.0%	6.1%	13.1%	19.9%	13.9%	8.1%	0.4%	100%
Average 92-99	1652	1366	840	200	320	1238	1121	2146	3086	2450	1542	25	15982
in percentage	10.3%	8.5%	5.3%	1.3%	2.0%	7.7%	7.0%	13.4%	19.3%	15.3%	9.6%	0.2%	100%

COUNTRY: **SPAIN**

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4133	3677	514	81	54	28	457	202	265	9864
1988	6	0	28	786	2931	3204	292	98	421	118	136	246	8266
1989	2	2	25	258	4295	795	90	510	116	198	1610	273	8173
1990	79	6	2085	1328	9947	2957	1202	3227	2278	123	16	10	23258
1991	100	40	23	1228	5291	1663	91	60	34	265	184	596	9573
1992	360	384	340	3458	13068	3437	384	286	505	63	94	89	22468
1993	102	59	1825	3169	7564	4488	795	340	198	65	546	23	19173
1994	0	9	149	5569	3991	5501	1133	181	106	643	198	74	17554
1995	0	0	35	5707	11485	1094	50	9	6	152	48	365	18951
1996	48	17	138	1628	9613	5329	1206	298	266	152	225	17	18937
1997	43	1	81	2746	2672	877	316	585	1898	331	203	185	9939
1998	35	235	493	371	4602	1083	1518	44	47	3	22	1	8455
1999	8	26	52	4626	4214	1396	1037	26	911	207	615	27	13144
Average 87-99	60	60	441	2693	6412	2488	630	440	524	214	315	167	14443
in percentage	0.4%	0.4%	3.1%	18.6%	44.4%	17.2%	4.4%	3.0%	3.6%	1.5%	2.2%	1.2%	100%
Average 92-99	75	92	389	3409	7151	2901	805	221	492	202	244	98	16078
in percentage	0.5%	0.6%	2.4%	21.2%	44.5%	18.0%	5.0%	1.4%	3.1%	1.3%	1.5%	0.6%	100%

Table 11.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 1999 (with live bait catches)

COUNTRIES	DIVISIONS	QUARTERS				CATCH (t)	
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	674	751	1425	10.8%
	VIIIb	21	3098	351	0	3471	26.4%
	VIIIc	65	7138	949	98	8249	62.8%
	TOTAL	87	10236	1974	849	13145	100
	%	0.7%	77.9%	15.0%	6.5%	100.0%	
FRANCE	VIIIa	0	0	5076	3515	8591	62.9%
	VIIIb	3987	1071	0	0	5058	37.1%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	3987	1071	5076	3515	13649	100.0%
	%	29.2%	7.8%	37.2%	25.8%	100.0%	
INTERNATIONAL	VIIIa	0	0	5750	4266	10016	37.4%
	VIIIb	4008	4169	351	0	8529	31.8%
	VIIIc	65	7138	949	98	8249	30.8%
	TOTAL	4074	11307	7050	4364	26794	100.0%
	%	15.2%	42.2%	26.3%	16.3%	100.0%	

Table 11.3.1.1: ANCHOVY catch at age in thousands for 1999 by country, division and quarter (without the catches from the live bait tuna fishing boats).

units: thousands

SPAIN	QUARTERS		1	2	3	4	Annual total
	AGE		VIIIbc	VIIIbc	VIIIabc	VIIIabc	VIIIbc
		0	0	0	7,596	4,230	11,826
		1	6,556	127,855	51,208	15,199	200,818
		2	843	230,541	26,782	10,052	268,217
		3	18	10,034	525	0	10,577
		4	0	108	0	0	108
	TOTAL(n)		7,416	368,538	86,111	29,481	491,546
	W MED.		11.91	28.37	23.53	28.92	27.31
	CATCH. (t)		86.5	10236.2	1973.6	848.2	13,144.5
	SOP		88.4	10456.1	2026.3	852.6	13,423.4
	VAR. %		102.13%	102.15%	102.67%	100.52%	102.12%

FRANCE	AGE		VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
		0	0	0	3,108	22,192	25,300
		1	51,345	34,311	85,355	70,761	241,771
		2	127,443	21,185	80,391	24,869	253,888
		3	7,710	0	0	0	7,710
		4	0	0	0	0	0
	TOTAL(n)		186,498	55,496	168,854	117,822	528,669
	W MED.		21.60	20.05	29.67	32.89	26.53
	CATCH. (t)		3,987.2	1,070.7	5,075.8	3,515.5	13,649.2
	SOP		4,028.8	1,112.7	5,009.4	3,875.2	14,026.0
	VAR. %		101.04%	103.92%	98.69%	110.23%	102.76%

	QUARTERS		1	2	3	4	Annual total
TOTAL	AGE		VIIIbc	VIIIbc	VIIIbc	VIIIbc	VIIIbc
Sub-area VIII		0	0	0	10,704	26,422	37,127
		1	57,900	162,167	136,562	85,960	442,589
		2	128,286	251,726	107,173	34,921	522,105
		3	7,727	10,034	525	0	18,286
		4	0	108	0	0	108
	TOTAL(n)		193,914	424,034	254,965	147,303	1,020,215
	W MED.		21.23	27.28	27.60	32.10	26.91
	CATCH. (t)		4,074	11,307	7,049	4,364	26,794
	SOP		4,117	11,569	7,036	4,728	27,449
	VAR. %		101.07%	102.32%	99.81%	108.34%	102.45%

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
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
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
2	1,461	203	1,496	139	0	0		477	209	522	58	0	810
3	912	3	0	0	0	0		0	0	0	0	0	0
Total	37,068	115,140	13,930	33,677	26,452	16,435	23,717	14,102	21,248	14,724	41,375	16,169	38,825
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5	465.126
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

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 [illegible]
[illegible]

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999	
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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Internat Catches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Catch Spain	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Catch France	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

Table 11.3.2.1. Length distribution ('000) of anchovy in Divisions VIIIa,b,c by country, by year, quarters and Sub-divisions in 1999.

	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
4				0		0		0
4.5				0		0		0
5				0		0		0
5.5				0		0		0
6				0		0		0
6.5				0		0		0
7			0	0	0	0	0	0
7.5			0	0	0	0	0	0
8		115	0	0	0	0	0	0
8.5		287	0	0	0	0	0	0
9		747	0	0	0	0	0	0
9.5	0	460	60	0	0	47	0	0
10	0	750	302	0	130	173	0	0
10.5	867	474	1368	1	529	337	0	0
11	2601	120	2506	314	2711	313	0	24
11.5	7803	482	3582	1128	4303	785	0	28
12	7802	456	6062	6356	4600	1109	0	219
12.5	8777	648	2824	11887	2912	1921	82	209
13	15818	714	3903	20201	1750	6995	1043	987
13.5	16906	600	4313	25484	3464	9447	1952	1577
14	22215	506	3943	32107	7725	12155	1894	2139
14.5	15088	313	4271	26520	7463	10201	6088	2898
15	17181	245	7442	27316	18157	9557	8875	2953
15.5	26033	172	5137	27302	16198	9585	14928	2904
16	21412	141	3476	36240	17030	8887	22986	3491
16.5	11271	131	2219	36990	21575	4882	22407	2971
17	7255	32	2251	44327	15597	4770	16542	3879
17.5	4329	10	901	30947	11437	2624	12032	1997
18	1317	9	468	22841	10147	1471	5641	1928
18.5	261	1	213	12065	8346	545	2488	653
19	104	4	128	4805	4536	263	573	622
19.5	0	0	85	1298	3460	39	0	172
20	0	0	43	293	3140	0	0	0
20.5	0	0	0	114	3140	0	0	0
21	0	0	0	0	756	0	0	0
21.5	0		0		0		0	
22	0		0		0		0	
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number ('000)	187041	7416	55496	368538	169108	86108	117531	29653
Catch (t)	87	3987	1071	10236	5076	1074	3515	849
Mean Length (cm)	14.51	11.88	13.98	15.63	16.05	14.82	16.23	15.82
Mean Weight (g)	21.6	11.91	20.05	28.37	29.67	23.53	32.89	28.92

Table 11.3.2.2. Mean weight at age in the national and international catches of anchovy in Sub-Area VIII on half year basis

Units: grams

INTERNATIONAL

YEAR	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
Sources	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
mean weight 1+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
mean weight 1+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

FRANCE

					Old values		Old values		Old values		Old values		Old values		Old values		Old values		Old values							
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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 11.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(from MOTOS & URIARTE WD1993, MOTOS et al. 1995 ; URIARTE et al. WD 1999; URIARTE et al WD 2000)

YEAR		1987	1988	1989(*)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 (prelimina
Period of year		2 - 7 June	21 - 28 Ma	10 - 21 Ma	4 - 15 May	6May-07Ju	6May-13Ju	No survey	May-3Jun	11 - 25 Ma	18 - 30 May	9 - 21 May	18 May - 8	22 May - 5 June	
Positive area (km2)		23850	45384	17546	59757	24264	67796		48735	31189	28448	50133	73131	51019	37883
Surveyed area (km2)		34934	59840	37930	79759	84032	92782		60330	51698	34294	59587	83156	61533	63192
Po (Egg per 0.05 m^2)(A+)		4.6	5.52	2.08	3.78	2.55	4.27		3.93	4.975	4.87	2.69	3.825	3.65	3.45
Total Daily egg production		2.20	5.01	0.73	5.02	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	97239	19276	90720	--	60062	54700	39545	51176	101976	69074	44973
	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 11.4.2.1. Evaluation of Anchovy abundance index from French acoustic surveys in the Bay of Biscay.

	1983	1984	1989 (2)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4	13/4-30/4		15/5-27/5			6/5-22/5	20/5-7/6		18/04 - 14/
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	*na*	2300(3)	*na*	*na*	1726(3)	9400 5600 (3)	*na*	6690(*)
Density (t/nm(**2))	15.4	10.3	3,0	4.5-32.2 (4	23.6	32.8	*na*	14.5	*na*	*na*	36.5	10.2	*na*	
Biomass (t)	50,000	38,500	15,500	)-110,000 (	64,000	89,000	*na*	35,000	*na*	*na*	63000	57000	*na*	47700(**)
Number (10**(-6))	2,600	2,000	805	300-7,500 (	3,173	9,342	*na*	*na*	*na*	*na*	3351	*na*	*na*	
Number of 1-group (10**(-6	1,800 (1)	600	400	100-7,500 (	1,873	9,072	*na*	*na*	*na*	*na*	2481	*na*	*na*	
Number of age 2-group (1(	800	1,400	405	0 -200 (4)	1,300	270	*na*	*na*	*na*	*na*	870	*na*	*na*	
Anchovy mean weight	19.2	19.3	19.3	*na*	20.2	9.5	*na*	*na*	*na*	*na*	18.8	*na*	*na*	

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems
(*) area where anchovy shools have been detected
(**) underestimation
last version July 2000 by Jacques Masse

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

* provisional
(1) Only St. Jean de Luz and Hendaya.
(2) Maximun number of potential boats; the number of pelagic trawling gears is rough of this number due to the fishing in pairs of mid-water trawlers.
n/a = Not available.

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)							
													(Provisional)	
YEAR	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
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
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
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
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
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
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
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
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
# in thousands														
* CPUE values for the years 1988-89 are updapted acording to the revised catches at age of Spring from Uriarte et al. WD 1997														

Table 11.5.3.: Statistics summary for the catch per trip during the first quarter for Saint-Gilles Croix de Vie, La Turballe and Bayonne fishing harbours from 1988 to 1998.(From Prouzet and Lissardy,2000)

Bayonne fishing harbour (BA)

Toutes zones	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nb observation	3	1	4	101	307	224	176	5	3	2	7
Nb marées	3	1	4	101	315	224	212	18	9	15	13
Minimum	5040	13090	141079	26478	20343	6477	11351	8496	13297	9185	15725
1° Quartile	11138		145225	108697	170212	40463	52656	21706	18111		46161
Moyenne	52072		185322	265726	329483	65424	117989	39505	32772	10249	110352
Médiane	17237		179388	225872	280067	60382	97755	44575	22924		80654
3° Quartile	75587		219485	401054	456634	82008	173160	45839	42509		184209
Maximum	133938	13090	241435	876198	1369256	172592	428951	76912	62094	11312	215347
SE moyenne	41084		24708	18664	12724	2464	6213	11712	14922	1063	31502
LCL moyenne				228698	304444	60569	105727				
UCL moyenne				302754	354521	70279	130251				

Saint-Gilles Croix de Vie fishing harbour (LS)

Toutes zones	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nb Observation	2	21	3	21	18	14	17	16	11	10	23
Nb marées	12	29	9	172	107	170	135	103	81	83	257
Minimum	2743	7549	11051	1031	1696	2233	2454	14046	4613	2262	27716
1° Quartile		38448	12608	15368	19510	11224	101296	50020	15526	12344	135986
Moyenne	7042	109189	15209	37251	221004	17849	119441	69305	75749	57879	192023
Médiane		93076	14165	23931	153455	18731	124098	71246	41279	32776	179322
3° Quartile		162644	17287	63069	318251	24032	148050	77707	106957	108244	237372
Maximum	11340	333806	20410	102458	950032	38023	243986	160709	252730	159851	468924
SE moyenne	4298	20195	2752	7143	60653	2820	13980	9223	24594	18052	22230
LCL moyenne		67063.96	3369.291	22351.449	93038.191	11755.509	89804.97	49646.98	20951.53	17043.73	145921.12
UCL moyenne		151314.51	27047.959	52150.815	348970.135	23941.788	149076.33	88962.93	130547.18	98714.61	238124.77

La Turballe fishing harbour (SN)

Toutes Zones	1991	1992	1993	1994	1995	1996	1997	1998
Nb Observation	91	78	196	315	206	254	214	220
Nb marées	149	117	227	347	241	256	241	230
Minimum	523	4100	1580	6362	128	1385	3337	21341
1° Quartile	33347	38233	6631	21063	2645	11902	41815	120807
Moyenne	40733	161715	17503	35491	39854	38423	94139	195335
Médiane	44570	76166	11273	33575	26575	22046	78844	202944
3° Quartile	50310	255727	25006	42559	58401	56213	136274	270592
Maximum	70950	777248	109547	123849	202164	314029	414559	389314
SE moyenne	1511	20303	1155	1118	2999	2454	4685	5799
LCL moyenne	37731	121286	15225	33292	33941	33589	84905	183906
UCL moyenne	43735	202144	19781	37690	45768	43257	103373	206764

Table 11.5.4. Percentage of DEPMbiomass deviance explained by the variation of the mean catch per trip of the French pelagic fleet in using a semi-logarithmic model. (From Prouzet and Lissardy, 2000).

Equation coefficients

	Values	Standard Error
Origin (b)	-22964.1	3426.1
log(Moy) (a)	2310.4	305.5

model equation : $biom = 2310.4 \times log(Moy) - 22964.1 + \varepsilon$

Results from deviance analysis.

	ddl	Residual Deviance	Residuals ddl	Deviance	Pseudo F	Proba ($F<F_{crit}$)	R^2
NULL			14	3624459722			0.81
log(Moy)	1	2953100247	13	671359475	57.18	4.1×10^{-6}	

Table 11.5.5: Statistics summary of the landings per trip for the two French main pelagic trawler fleets (LS and SN) operating during the first quarter 2000 for anchovy in the Bay of Biscay (after Prouzet and Lissardy, 2000).

	Saint-Gilles Croix de Vie (LS)	La Turballe (SN)	Whole fleet
Mean Weight (kg)	6436.9	5314.7	5791.3
SE mean (95% C.I.)	303.8 (5836.3 – 7037.4)	189.6 (4940.8 – 5688.6)	171.4 (5454.3 – 6128.4)
Mean number	332880	256976	282706
SE mean (95% C.I.)	17930(297302 – 368458)	8994 (239236 - 274714)	8739 (265506 – 299905)
Median weight (kg)	6165	5000	5410
1st Quartile	3567.5	3300	3350
3rd Quartile	9862.5	8400	8400
Median number	365000	242105	282380
1st Quartile	187732	157519	162202
3rd Quartile	485357	400000	400000

Tabla 11.6.1: Series of Upwelling indexes from Borja et al. (1996,98 6 WD2000) and Allain et al. (1999) & Petitgas et al (WD2000) including the Destratification variable

	WD2000 Borja's et al. (1996,9	**WD2000** Petitgas et al. (WD2000)		**Results from previous WG Reports** Age 0 in the assessment				**WG2000**	**Assessm** in year Y+ **WG2000**	**WD2000** Prediction of P.Petitgas Fitted for the period 86-97		**DEPM estimates** in year Y+1 **WG2000**
Year	Upwelling	Upwelling	SBD	1,996	1,997	1,998	1,999	2,000	Age_1 Serie	Adjusted		Age 1 Series
1986	617.5	20.49	0	5,901	6,164	6,483	6,461	5845.1	1756.1	3268.7		656.0
1987	508.4	47.25	1	8,276	8,267	7,424	7,447	8702.5	2597.6	2065.9		2349.0
1988	473.2	35.88	1	3,310	3,641	4,294	4,387	3473.2	1038.0	1363.2		346.9
1989	970.9	45.45	0	21,395	21,990	19,052	19,082	19651.7	5889.1	4811.4		5613.0
1990	905.9	50	1	7,272	7,506	7,206	7,319	7586.5	2266.8	2235.9		670.5
1991	1,076.3	110.74	0	27,393	28,271	27,767	28,402	27632.0	8223.5	8845.9		5571.0
1992	1,128.8	47.16	0	27,677	28,003	25,764	25,305	24102.8	7182.3	4917.2		
1993	570.9	53.03	0	15,551	14,455	13,877	13,334	12789.1	3827.0	5279.9		2030.1
1994	905.0	29.2	0	14,273	12,335	10,454	10,275	10405.3	3111.4	3807.5		2257.0
1995	1,204.0	74.99	0	14,963	14,650	14,051	13,397	14513.7	4336.7	6636.6		
1996	973.0	50.17	0		17,065	21,443	20,231	18197.0	5432.6	5102.9		3242.6
1997	1,230.5	100.04	0			30,950	34,648	25830.1	7742.4	8184.7		5466.7
1998	461.0	58.49	0				2,977	7841.4	2357.6	*5617.3*	Predicition	
1999	402.0	32.68	0					12582.4	3822.3	*4022.5*	Prediction	
2000	391.0	51.21	0							*5167.4*	Prediction	
								Age 0	Age 1			Age 1
							Geometric Mean:	12174	3645		Geometric Mean:	
							Arithmetic mean:	14225	4256		Arithmetic mean:	
							CV	54.4%	54.2%		CV	

Retrospective analysis of the Upwelling index performances

Coeff.Determination for age 0:	1986-96	1986-97	1986-98	1986-99	1986-00
with Borja's Upwelling index	51.5%	51.5%	58.6%	62.6%	55.4%
Petiga`'s Upwelling index	34.0%	36.0%	53.0%	47.7%	49.7%

Coeff.Determination for age 1:

Borja's Inc	Petitga's Multiple Index	
60.3%	75.2%	1986-1997
61.9%	65.5%	1986-1998
55.1%	65.5%	1986-1999

FORECA$	Linear models on assessment estimates			
(Actual fitting)	Borja's Inc	Petitga's Multiple Index		
Age 0	Upwelling	Upwelling	Multiple index	
1986-1999	55.4%	49.7%	65.0%	1986-1999
Adjusted for d.f.	51.7%	45.5%	59.5%	Adjusted for d.f.
ction for age 0 2000	*6034*	*13634*	*15298*	Prediction
CV for prediction	98.7%	43.4%	33.7%	CV for prediction

Linear models on assessment estimates			**FORECASTS**
Borja's Inc	Petitga's Multiple Index		(Actual fitting)
Upwelling	Multiple index		**Age 1**
55.3%	65.8%	1986-1999	1986-1999
51.6%	59.5%	Adjusted for d.f.	Adjusted for d.f.
1809	*4577*	Prediction	Prediction for age 1 2001
98.6%	33.6%	CV for prediction	CV for prediction

Table 11.6.2: Linear models fitted to age 0 between the environmental indexes and the assessment adopted by this Working Group in Sept.2000. (14 pairs of data)

a) Boja's et al. Upwelling Index (1986,1998)

```
Regression Analysis - Linear model: Y = a + b*X
-----------------------------------------------------------------------------
Dependent variable: Age_0
Independent variable: UpwellingAZTI  (Borja's et al Index
-----------------------------------------------------------------------------
                               Standard          T
Parameter       Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
Intercept       -1497.37         4317.4      -0.346823         0.7347
Slope            19.2621        4.98788        3.86179         0.0023
-----------------------------------------------------------------------------
Correlation Coefficient = 0.744396    R-squared = 55.4125 percent
R-squared (adjusted for d.f.) = 51.6969 percent  Standard Error of Est. = 5375.88

Forecast        Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Year             Value    for Forecast    for Forecast    for Forecast
  200          6034.12          5955.1        -6940.96         19009.2
----------------------------------------------------------------------
```

b) Petitgas et al Upwelling Index (WD2000)

```
Multiple Regression Analysis
-----------------------------------------------------------------------------
Dependent variable: Age_0
-----------------------------------------------------------------------------
                                       Standard          T
Parameter               Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
CONSTANT                 2732.51        3672.62       0.744023         0.4712
UpwelIfremer             212.949        61.8924        3.44063         0.0049
-----------------------------------------------------------------------------
R-squared = 49.66 percent      R-squared (adjusted for d.f.) = 45.465 percent
Standard Error of Est. = 5712.15   Mean absolute error = 4400.9

Forecast:       Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Row              Value    for Forecast    for Forecast    for Forecast
------------------------------------------------------------------------
    15         13637.6          5915.1         749.691         26525.5
------------------------------------------------------------------------
```

c) Petitgas et al Upwelling and destratification Multiple model (WD2000)

```
Multiple Regression Analysis
-----------------------------------------------------------------------------
Dependent variable: Age_1
-----------------------------------------------------------------------------
                                       Standard          T
Parameter               Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
CONSTANT                 1699.38        1022.49          1.662         0.1247
UpwelIfremer             56.1941        16.2808        3.45157         0.0054
Destratif               -2222.16        978.687       -2.27055         0.0443
-----------------------------------------------------------------------------
R-squared = 65.757 percent      R-squared (adjusted for d.f.) = 59.531 percent
Standard Error of Est. = 1471.26      Mean absolute error = 980.34

Forecast        Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Row              Value    for Forecast    for Forecast    for Forecast
------------------------------------------------------------------------
    15         4577.09         1539.17         1189.38         7964.79
------------------------------------------------------------------------
```

Table 11.7.1.1: Log Residuals to the Separable Model and DEPM from the Assessment of Reference (see text)

As made in the last year WG.

A) Catch at age

ln(x)-ln(y)

Year\ ages	0	1	2	3	4	5	Total
1987	0.495	0.050	-0.025	-0.068	-0.928	0.000	-0.5
1988	2.516	0.383	-0.261	-0.340	-1.940	0.000	0.4
1989	1.054	-0.235	-0.315	0.282	-1.641	0.000	-0.9
1990	-0.409	0.256	0.259	-0.245	-1.500	0.000	-1.6
1991	-0.805	-0.484	-0.759	0.691	-1.950	0.000	-3.3
1992	-1.122	-0.315	0.417	-0.153	-0.554	0.000	-1.7
1993	0.429	0.096	-0.014	-0.256	-1.202	0.000	-0.9
1994	0.428	0.086	-0.169	0.125	-0.807	0.000	-0.3
1995	-0.280	-0.041	-0.186	0.253	-1.391	0.000	-1.6
1996	-0.051	-0.160	-0.109	0.076	-1.919	0.000	-2.2
1997	0.387	0.085	-0.156	-0.104	-0.956	0.000	-0.7
1998	-1.402	0.127	0.011	-0.263	-0.207	0.000	-1.7
1999	0.278	0.322	-0.030	-0.526	-1.536	0.000	-1.5
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.5	0.2	-1.3	-0.5	-16.5	0.0	-16.7
Observaciones	13	13	13	13	13		65
Unweighted Squared log residuals of ...				Wy*(ln(x)-ln(y))^2			
Total USQR	12.40	0.77	1.08	1.27	24.71	0.00	40.24
Weighted Squared log residuals of ...				Wa*Wy*Wty*(ln(x)-ln(y))^2			
Total WSQR	0.91	0.70	1.05	1.21	0.22	0.00	4.09390

B) Log residuals for the fitting to the DEPM surveys.

Year\ ages	1	2	3 +	Total	SSB
1987	-0.390	0.477	0.103	0.1894	-0.2658
1988	0.723	0.376	0.351	1.4493	0.5132
1989	-0.606	0.375	-0.350	-0.5813	-0.3545
1990	0.704	0.585	0.100	1.3882	0.5276
1991	-0.292	-0.036	-1.197	-1.5243	-0.4242
1992	0.392	0.687	-0.511	0.5680	0.2179
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.100	0.404	-0.637	-0.1332	0.0288
1995	0.502	0.273	-0.406	0.3691	0.2257
1996	0.000	0.000	0.000	0.0000	0.0321
1997	0.332	0.766	-0.216	0.8817	0.2488
1998	0.245	0.496	0.289	1.0298	0.1300
1999	0.000	0.000	0.000	0.0000	0.1880
2000	0.000	0.000	0.000	0.0000	-0.0986
Total	1.7088	4.4020	-2.4741	3.6368	0.9691
TOTAL USSQ	2.20716	2.39512	2.66103	7.26331	1.14219
Total WSSQ	0.7357	0.7984	0.8870	2.4211	0.5711
Observaciones	10	10	10	30	13
Parámetros	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0736	0.0798	0.0887	0.0807	0.0439
Poderac.media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2207	0.2395	0.2661	0.2421	0.0879
Coefficient R2	86.8%	88.6%	74.8%		77.8%

Table 11.7.1.2: Weighting factors for the catches at age percentages of those ages in the Catch

Catch in weight	age 0	age 1	age 2	age 3	age 4	age 5
Average 87-99	4.4%	60.0%	31.1%	3.6%	0.5%	0.3%
Weighting factors	Wf0	Wf1	Wf2	Wf3	Wf4	Wf5
Previous	0.1	1	1	1	0.01	0.01
Alternative 1	0.01	1	1	1	0.01	0.01
Alternative 2	0.01	1	1	0.1	0.01	0.01

Table 11.7.1.3: Reduction in WSSQ by eliminating Year/Age Cage Observation and F ratio test

Initial WSSQ: 8.8218

Sensitivity Analysis of the catch at age matrix

a) Reduction in WSSQ by eliminating Year/Age Cage Observation

	Edad 1	Edad 2	Edad 3
1987	0.0006	0.0003	0.0257
1988	0.1160	0.0570	0.1199
1989	0.1433	0.1800	0.2351
1990	0.1041	0.1351	0.1172
1991	0.4177	1.0130	1.1720
1992	0.0394	0.4053	0.0144
1993	0.0276	0.0007	0.2737
1994	0.0010	0.0567	0.0052
1995	0.0008	0.0403	0.1469
1996	0.0562	0.0094	0.0174
1997	0.0052	0.0351	0.0275
1998	0.0264	0.0058	0.1623
1999	0.7183	0.0139	0.6718

b) Probability of the reductions in WSSQ (F.ratio test)

	Edad 1	Edad 2	Edad 3
1987	0.939	0.956	0.615
1988	0.284	0.454	0.276
1989	0.234	0.182	0.126
1990	0.311	0.248	0.282
1991	0.040	0.001	0.000
1992	0.535	0.044	0.706
1993	0.602	0.934	0.099
1994	0.921	0.455	0.821
1995	0.927	0.529	0.228
1996	0.457	0.761	0.679
1997	0.821	0.557	0.603
1998	0.610	0.811	0.205
1999	0.007	0.712	0.009

Table 11.7.1.4: Summary results of assessments of anchovy, changing the weighting factors at age 0 and 3 and the selectivity at age 4.
A- Assessment of reference similar to the one produced in last year, updating data, B- Down-weighting age 3 in 1991 to 0.0001
C- as B down-weighting age 0 to 0.01, D- as C but selectivity at 4 equal to age 3, E and F as D down weighting age 3 to 0.2 and to 0.1 respectively

RUN	**A**	**B**	**C**	**D**	**E**	**F**
Natural Mortality	1.20	1.20	1.20	1.20	1.20	1.20
NMM2+ (factor)	1.00	1.00	1.00	1.00	1.00	1.00
Slectivity at age 4	1.00	1.00	1.00	=Sel_3	=Sel_3	=Sel_3
Fitting summary						
Total Weighted squared residuals	8.8220	7.6497	6.7485	6.6921	5.5543	5.3491
Catches (Cages)	4.095	2.984	2.051	1.886	1.358	1.392
DEPM SSB (t)	0.571	0.581	0.581	0.588	0.645	0.600
DEPM SPages (1-3+)	2.421	2.557	2.551	2.655	2.231	2.054
Acoustic SSB (t)	0.751	0.688	0.673	0.671	0.571	0.562
Acoust. SPages (1-2+)	0.984	0.839	0.891	0.892	0.749	0.742
SSQ Total	*8.822*	*7.650*	*6.748*	*6.692*	*5.554*	*5.349*
SSQ Catches	*4.095*	*2.984*	*2.051*	*1.886*	*1.358*	*1.392*
SSQ tunning indices	*4.727*	*4.665*	*4.698*	*4.806*	*4.196*	*3.957*
Residual Variance	*0.0991*	*0.0860*	*0.0758*	*0.0752*	*0.0631*	*0.0601*
Observaciones	*125*	*125*	*125*	*125*	*125*	*125*
Parámetros	*36*	*36*	*36*	*36*	*37*	*36*
Degrees of freedom (d.f.)	*89*	*89*	*89*	*89*	*89*	*89*
Reducction in d.f.		*0*	*0*	*0*	*0*	*0*
Reducction in SSQ		*1.17*	*0.90*	*0.06*	*1.14*	*0.21*
F ratio for Red_SSQ		*13.64*	*11.89*	*0.75*	*18.03*	*3.41*
Probability of F		*0.0004*	*0.0009*	*0.3888*	*0.0001*	*0.0680*
Another fitting statics						
Coeficiente R2 Catch in tonnes	70.2%	89.3%	89.0%	89.2%	93.0%	91.8%
Coeficiente R2 Biomas DEPM	77.7%	72.5%	71.9%	71.6%	74.6%	75.4%
Coeficiente R2 Biomas Acustic	20.2%	24.3%	25.4%	25.5%	29.7%	29.6%
Log error estandard Cages	*0.4721*	*0.4030*	*0.3390*	*0.3251*	*0.3218*	*0.3333*
Log error estandard DEPM SSB	*0.2964*	*0.2991*	*0.2991*	*0.3007*	*0.3150*	*0.3039*
Log error estandard DEPM Pop. Age 1	*0.4698*	*0.4607*	*0.4643*	*0.4672*	*0.4287*	*0.4472*
Log error estandard DEPM Pop. Age 2	*0.4893*	*0.5417*	*0.5427*	*0.5488*	*0.5395*	*0.4960*
Log error estandard DEPM Pop. Age 3+	*0.5160*	*0.5111*	*0.5053*	*0.5263*	*0.4614*	*0.4126*
Log error estandard Acustic SSB	*0.5004*	*0.4790*	*0.4738*	*0.4731*	*0.4364*	*0.4326*
Log error estandard Acústica Pop. Age 1	*0.5190*	*0.4301*	*0.4138*	*0.4134*	*0.4425*	*0.4563*
Log error estandard Acústica Pop. Age 2+	*0.6218*	*0.6119*	*0.6504*	*0.6512*	*0.5508*	*0.5350*
Total Marginal residuals of age 2 in DEPM	4.4017	4.65	4.61	4.67	4.64	4.13
Weighting factos age 0	0.1000	0.1000	0.0100	0.0100	0.0100	0.0100
Weighting factos age 1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Weighting factos age 2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Weighting factos age 3	1.0000	1.0000	1.0000	1.0000	0.2000	0.1000
Weighting factos age 4	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Weighting age3 in 1991	1.0000	0.0001	0.0001	0.0001	0.0001	0.0001
Weighting factor DEPM	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
Weighting factor DEPM age 1	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor DEPM age 2	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor DEPM age 3+	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor Acoustic	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
Weighting factor Acoustic age 1	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor Acoustic age 2+	0.5	0.5	0.5	0.5	0.5	0.5

Table 11.7.1.5: Residuals to the Separable Model and to the DEPM of the assessments cases where catches at age 0 and 3 and increasingly down weighted.

Case B: Update of last year working group, down weighting age 3(1991) to 0.0001

W3=W2=W1=1

Catch at age log Residuals

Year\ ages	0	1	2	3	4	5	Total
1987	0.487	-0.023	-0.087	-0.061	-0.683	0.000	-0.4
1988	2.701	0.328	-0.307	-0.222	-2.162	0.000	0.3
1989	0.926	-0.145	-0.404	0.336	-1.805	0.000	-1.1
1990	-0.771	0.077	0.281	-0.272	-1.766	0.000	-2.5
1991	-2.546	-0.246	-0.412	1.742	-1.542	0.000	-1.0
1992	-1.092	-0.260	0.330	-0.174	-0.178	0.000	-1.4
1993	0.405	0.097	-0.009	-0.236	-1.530	0.000	-1.2
1994	0.415	0.655	-0.318	0.264	-1.097	0.000	-0.6
1995	-0.262	-0.045	-0.185	0.372	-1.651	0.000	-1.7
1996	-0.028	-0.166	-0.123	0.168	-2.104	0.000	-2.3
1997	0.432	0.088	-0.195	-0.027	-1.226	0.000	-0.9
1998	-1.377	0.111	-0.027	-0.162	-0.413	0.000	-1.9
1999	0.212	0.292	-0.059	-0.424	-1.686	0.000	-1.7
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.5	0.0	-1.4	1.2	-17.7	0.0	-16.4
Observations	13	13	13	13	13		65
Unweighted Squared log residuals of ...				Wy*(ln(y)-ln(y))^2			
Total USQR	13.04	0.42	0.76	3.78	28.70	0.00	46.70
Weighted Squared log residuals of ...				Wa*Wy*Wy*(ln(y)-ln(y))^2			
Total WSQR	0.93	0.37	0.71	0.72	0.26	0.00	2.98425

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.412	0.456	0.103	0.1466	-0.2653
1988	0.737	0.377	0.281	1.3945	0.0115
1989	-0.352	0.446	-0.340	-0.2452	-0.1780
1990	0.806	1.075	0.306	2.1862	0.6382
1991	-0.328	-0.834	-0.803	-1.9650	-0.4281
1992	0.367	0.532	-0.775	0.1244	0.1822
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.077	0.380	-0.759	-0.3412	-0.0162
1995	0.477	0.232	-0.541	0.1678	0.1887
1996	0.000	0.000	0.000	0.0000	-0.0036
1997	0.316	0.726	-0.370	0.6748	0.2279
1998	0.373	0.460	0.222	0.9646	0.1400
1999	0.000	0.000	0.000	0.0000	0.2396
2000	0.000	0.000	0.000	0.0000	-0.0636
Total	1.9596	4.6636	-2.6653	3.9491	1.1919
TOTAL USSQ	2.12290	2.35444	3.01274	7.48998	1.36277
Total WSSQ	0.7076	0.8791	0.8709	2.3567	0.5814
Observations	10	10	10	30	13
Parameters	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0708	0.0879	0.0871	0.0852	0.0447
Padanax media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2123	0.2638	0.2613	0.2557	0.0894
Log standard deviations	0.460796	0.541705	0.51115	0.505634	0.299065

Case D: as B but down weighting Cage 0 to 0.01 and SwB=SwD=0.4769

W3=W2=W1=1

Catch at age

Year\ ages	0	1	2	3	4	5	Total
1987	0.580	0.084	-0.037	-0.031	-0.380	0.000	0.2
1988	2.626	0.436	-0.352	-0.190	-1.662	0.000	1.3
1989	0.944	-0.105	-0.405	0.264	-1.318	0.000	-0.6
1990	-0.626	-0.089	0.288	-0.287	-1.343	0.000	-2.3
1991	-0.542	-0.256	-0.379	1.645	-0.997	0.000	-0.3
1992	-1.148	-0.324	0.376	-0.169	0.416	0.000	-0.9
1993	0.496	0.090	-0.004	-0.212	-0.886	0.000	-0.5
1994	0.438	0.080	-0.247	0.307	-0.529	0.000	-0.1
1995	-0.249	-0.028	-0.183	0.340	-1.036	0.000	-1.2
1996	-0.023	-0.162	-0.130	0.163	-1.688	0.000	-1.8
1997	0.459	0.080	-0.181	-0.004	-0.639	0.000	-0.3
1998	-1.540	0.095	-0.090	-0.237	0.385	0.000	-1.6
1999	0.299	0.157	-0.072	-0.274	-1.075	0.000	-0.9
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.7	0.1	-1.3	1.4	-10.3	0.0	-8.4
Observations	13	13	13	13	13		65
Unweighted Squared log residuals of ...				Wy*(ln(y)-ln(y))^2			
Total USQR	14.67	0.48	0.68	4.05	13.63	0.00	33.52
Weighted Squared log residuals of ...				Wa*Wy*Wy*(ln(y)-ln(y))^2			
Total WSQR	0.11	0.38	0.66	0.63	0.12	0.00	1.88810

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.403	0.437	0.058	0.0940	-0.2640
1988	0.744	0.350	0.153	1.2488	0.6149
1989	-0.317	0.456	-0.437	-0.2979	-0.1622
1990	0.638	1.137	0.370	2.2264	0.6603
1991	-0.357	-0.006	-0.838	-1.2004	-0.4274
1992	0.390	0.579	-0.747	0.1217	0.1753
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.065	0.317	-0.786	-0.3838	-0.0170
1995	0.423	0.239	-0.619	0.1034	0.1870
1996	0.000	0.000	0.000	0.0000	-0.0346
1997	0.312	0.725	-0.406	0.6308	0.2236
1998	0.366	0.406	0.318	1.0084	0.1089
1999	0.000	0.000	0.000	0.0000	0.1336
2000	0.000	0.000	0.000	0.0000	-0.0580
Total	2.0923	4.6702	-3.1238	3.5785	1.1679
TOTAL USSQ	2.16231	3.01145	2.70851	7.88380	1.17651
Total WSSQ	0.7274	1.0058	0.9233	2.6565	0.5878
Observations	10	10	10	30	13
Parameters	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0727	0.1004	0.0923	0.0885	0.0452
Padanax media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2182	0.3011	0.2770	0.2655	0.0904
Log standard deviations	0.46715	0.54877	0.52629	0.51522	0.30071

Case F: as D but down weighting W3=0.1

W3=0.1

Catch at age

Year\ ages	0	1	2	3	4	5	Total
1987	0.442	0.205	-0.138	-0.439	-0.469	0.000	-0.4
1988	2.640	0.138	-0.308	-0.996	-1.758	0.000	-0.2
1989	1.206	0.114	-0.255	0.379	-1.387	0.000	0.1
1990	-0.667	-0.170	0.172	-1.079	-1.341	0.000	-3.3
1991	-0.376	-0.204	-0.292	1.367	-1.081	0.000	-0.6
1992	-1.067	-0.323	0.196	-0.823	0.275	0.000	-1.7
1993	0.311	-0.016	-0.088	-0.942	-1.199	0.000	-1.9
1994	0.358	0.034	-0.078	-0.074	-0.610	0.000	-0.4
1995	-0.269	-0.027	-0.084	0.172	-0.737	0.000	-0.9
1996	-0.033	-0.147	-0.061	-0.129	-1.292	0.000	-1.7
1997	0.651	0.105	-0.126	-0.593	-0.356	0.000	-0.3
1998	-1.389	0.149	-0.193	-0.901	-0.198	0.000	-2.4
1999	-0.064	0.088	-0.154	-1.255	-1.706	0.000	-3.1
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.6	0.0	-1.2	-5.3	-11.8	0.0	-16.8
Observations	13	13	13	13	13		65
Unweighted Squared log residuals of ...					Wy*(ln(y)-ln(y))^2		
Total USQR	13.27	0.32	0.36	6.67	15.12	0.00	37.67
Weighted Squared log residuals of ...					Wa*Wy*Wy*(ln(y)-ln(y))^2		
Total WSQR	0.10	0.26	0.33	0.61	0.13	0.00	1.4501

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.268	0.395	0.112	0.1296	-0.2540
1988	0.623	0.522	0.282	1.4261	0.4491
1989	-0.388	0.231	-0.292	-0.3456	-0.2542
1990	0.802	1.011	0.250	2.0626	0.6267
1991	-0.412	-0.110	-0.731	-1.2527	-0.4901
1992	0.415	0.433	-0.719	0.1290	0.2179
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.143	0.522	-0.364	0.3104	0.1068
1995	0.476	0.283	-0.135	0.6271	0.2536
1996	0.000	0.000	0.000	0.0000	-0.0547
1997	0.194	0.565	-0.402	0.3569	0.1036
1998	0.326	0.392	0.082	0.7866	0.1541
1999	0.000	0.000	0.000	0.0000	0.3113
2000	0.000	0.000	0.000	0.0000	-0.0168
Total	1.9116	4.0949	-1.8251	4.1716	1.1521
TOTAL USSQ	1.99891	2.42122	1.07799	5.50812	1.20110
Total WSSQ	0.6625	0.8071	0.5343	1.9937	0.5505
Observations	10	10	10	30	13
Parameters	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0662	0.0807	0.0524	0.0666	0.0452
Padanax media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.1987	0.2421	0.1573	0.1994	0.0904
Log standard deviations	0.44575	0.49206	0.39661	0.44651	0.30066

Table 11.7.2.1.: Inputs for the anchovy assessment (subarea VIII)

Output Generated by ICA Version 1.4 **Assesssment downweighting W0=0.01 and W3=0.1**

Anchovy in subarea VIII - Bay of Biscay

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	35.5
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	433.9
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	531.6
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	19.1
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	1.0
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

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	24.5	10.7	54.0	41.4	126.4	111.9	46.6	42.0	65.2	113.1	69.7	15.7	37.8
1	276.0	443.0	160.3	1617.7	539.6	1992.1	1419.6	821.8	731.2	1319.5	820.9	897.5	392.4
2	192.7	130.2	173.6	114.1	432.9	184.6	569.5	592.8	324.3	304.2	202.1	292.9	618.4
3	51.3	27.8	15.2	38.8	7.3	38.7	13.6	67.9	64.5	36.0	10.1	22.1	66.7
4	23.9	8.2	3.6	3.8	2.9	0.8	3.3	1.8	8.5	8.4	1.4	1.2	5.5

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.018500
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.021900
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030500
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900
5	.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
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000	.012000
1	.021700	.022600	.021000	.016200	.016800	.015400	.016000	.017100	.019000	.016400	.011900	.014600	.016400
2	.033000	.029800	.029000	.029500	.028000	.031700	.027000	.025800	.031100	.028700	.026600	.029900	.028700
3	.038000	.034100	.033000	.034600	.034000	.031700	.033000	.032300	.034100	.033600	.037400	.036900	.033500
4	.041000	.042500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.040000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	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
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
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
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

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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
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

Table 11.7.2.1 (Cont'd)

INDICES OF SPAWNING BIOMASS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97

x 10 ^ 3

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	999990.	999990.	15500.	999990.	64000.	89000.	999990.	35000.	999990.	999990.	63000.	57000.	999990.	47700.

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

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0	*******	*******	2517.0
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0	*******	*******	331.0

x 10 ^ 3

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0049	0.0053	0.0047	0.0094	0.0079	0.0080	0.0063	0.0069	0.0077	0.0107	0.0046	0.0035	0.0052
1	0.3046	0.3319	0.2971	0.5901	0.4949	0.5022	0.3943	0.4362	0.4862	0.6733	0.2913	0.2168	0.3250
2	0.7014	0.7642	0.6840	1.3586	1.1395	1.1563	0.9079	1.0044	1.1194	1.5501	0.6708	0.4991	0.7483
3	0.6166	0.6719	0.6013	1.1944	1.0018	1.0166	0.7982	0.8830	0.9841	1.3628	0.5897	0.4388	0.6578
4	0.5557	0.6055	0.5419	1.0764	0.9028	0.9161	0.7193	0.7958	0.8869	1.2282	0.5315	0.3954	0.5929
5	0.5557	0.6055	0.5419	1.0764	0.9028	0.9161	0.7193	0.7958	0.8869	1.2282	0.5315	0.3954	0.5929

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	8703.	3473.	19652.	7587.	27632.	24103.	12789.	10405.	14514.	18197.	25830.	7841.	12582.	11469.
1	1752.	2608.	1041.	5891.	2264.	8257.	7202.	3828.	3112.	4338.	5422.	7744.	2354.	3770.
2	614.	389.	564.	233.	983.	416.	1505.	1462.	745.	576.	666.	1220.	1878.	512.
3	180.	92.	55.	86.	18.	95.	39.	183.	161.	73.	37.	103.	223.	268.
4	91.	29.	14.	9.	8.	2.	10.	5.	23.	18.	6.	6.	20.	35.
5	34.	4.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	4.	4.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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

Table 11.7.2.1 (Cont'd)

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	37280.	40585.	21582.	51967.	31477.	72976.	999990.	53953.	43317.	41559.	46158.	87437.	51230.	46750.

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	999990.	999990.	21730.	999990.	31692.	73475.	999990.	54322.	999990.	999990.	46474.	88034.	999990.	47070.

Predicted Age-Structured Index Values

DEPM SURVEYS (Ages 1 to 3+) Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	857.4	1260.0	511.0	2517.2	1012.0	3678.6	*******	1759.6	1397.2	*******	2670.2	3950.9
2	248.8	153.1	230.4	69.1	323.7	135.7	*******	513.2	247.7	*******	274.0	544.5
3	130.6	51.6	31.1	31.3	10.2	34.8	*******	71.2	66.6	*******	20.0	52.4

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	681.8	*******	1400.5	5097.9	*******	*******	*******	*******	3558.8	*******	*******	2450.4
2	492.7	*******	685.4	349.5	*******	*******	*******	*******	553.3	*******	*******	626.9

x 10 ^ 3

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069
1	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343
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
3	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791
4	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923
5	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923

Table 11.7.2.2. Results for the anchovy assessment (Sub area VIII)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	8702500	183447	37279	15308	0.4106	0.5409	99
1988	3473190	120223	40585	15581	0.3839	0.5893	100
1989	19651690	296209	21582	10614	0.4918	0.5274	100
1990	7586510	181598	51966	34272	0.6595	1.0477	99
1991	27631950	481087	31476	19634	0.6238	0.8787	101
1992	24102750	432766	72975	37885	0.5191	0.8917	100
1993	12789070	311185	81638	40293	0.4936	0.7001	99
1994	10405300	265507	53953	34631	0.6419	0.7745	99
1995	14513690	263014	43316	30115	0.6952	0.8632	99
1996	18196970	309336	41558	34373	0.8271	1.1954	100
1997	25830090	393986	46158	22337	0.4839	0.5173	99
1998	7841350	247896	87436	31617	0.3616	0.3849	102
1999	12582420	251910	51230	26794	0.5230	0.5770	98

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 1999
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 36
Number of observations : 125
Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1987	0.7014	24	0.4347	1.1319	0.5495	0.8954	0.7226
2	1988	0.7642	23	0.4868	1.1998	0.6072	0.9620	0.7848
3	1989	0.6840	18	0.4717	0.9917	0.5659	0.8267	0.6964
4	1990	1.3586	17	0.9663	1.9103	1.1418	1.6166	1.3793
5	1991	1.1395	16	0.8172	1.5889	0.9617	1.3501	1.1560
6	1992	1.1563	18	0.7969	1.6779	0.9563	1.3982	1.1774
7	1993	0.9079	18	0.6271	1.3145	0.7517	1.0966	0.9242
8	1994	1.0044	17	0.7081	1.4248	0.8403	1.2005	1.0205
9	1995	1.1194	19	0.7713	1.6247	0.9256	1.3537	1.1398
10	1996	1.5501	16	1.1315	2.1236	1.3201	1.8202	1.5703
11	1997	0.6708	19	0.4593	0.9795	0.5529	0.8137	0.6834
12	1998	0.4991	21	0.3282	0.7590	0.4030	0.6181	0.5107
13	1999	0.7483	24	0.4642	1.2062	0.5865	0.9547	0.7708
Separable Model: Selection (S) by age								
14	0	0.0069	71	0.0017	0.0279	0.0034	0.0141	0.0089
15	1	0.4343	10	0.3559	0.5300	0.3924	0.4807	0.4366
	2	1.0000		Fixed : Reference Age				
16	3	0.8791	25	0.5338	1.4478	0.6816	1.1339	0.9081
	4	0.7923		Fixed : Last true age				
Separable model: Populations in year 1999								
17	0	12582421	28	7156914	22120891	9435059	16779685	13114713
18	1	2353631	26	1407091	3936900	1810300	3060033	2436112
19	2	1877847	17	1339633	2632297	1580616	2230973	1905933
20	3	223149	20	147916	336646	180918	275237	228114
21	4	19930	24	12220	32503	15528	25579	20560
Separable model: Populations at age								
22	1987	91401	188	2290	3646870	13935	599477	535907
23	1988	29329	85	5520	155836	12509	68768	42168
24	1989	14105	33	7276	27341	10062	19771	14932
25	1990	9010	28	5185	15655	6797	11943	9375
26	1991	7815	32	4113	14849	5632	10843	8245
27	1992	1992	32	1046	3795	1434	2768	2103
28	1993	10328	33	5306	20105	7353	14509	10942
29	1994	5339	34	2692	10589	3765	7572	5675
30	1995	22775	31	12316	42115	16644	31165	23923
31	1996	18160	34	9240	35687	12865	25633	19271
32	1997	5649	44	2367	13481	3624	8804	6233
33	1998	6152	32	3234	11703	4432	8541	6493

SSB Index catchabilities
DEPM

Table 11.7.2.2 (Cont'd)

Absolute estimator. No fitted catchability.
Acoustic
Linear model fitted. Slopes at age :

34	2	Q	1.007	14	.8761	1.546	1.007	1.345	1.176

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 :

35	1	Q	1.011	19	.8359	1.821	1.011	1.505	1.258
36	2	Q	1.333	20	1.096	2.435	1.333	2.002	1.668

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.440	2.645	1.204	-0.889	-0.378	-1.069	0.308	0.356	-0.270	-0.035	0.649	-1.351	-0.063
1	0.205	0.137	0.114	-0.170	-0.204	-0.323	-0.010	0.034	-0.027	-0.147	0.104	0.149	0.101
2	-0.118	-0.205	-0.255	0.172	-0.292	0.196	-0.069	-0.078	-0.064	-0.061	-0.126	-0.150	-0.151
3	-0.441	-0.966	0.279	-1.079	1.387	-0.823	-0.942	-0.074	0.172	-0.130	-0.560	-0.901	-1.252
4	-0.474	-1.770	-1.286	-1.341	-1.080	0.275	-1.195	-0.610	-0.727	-1.292	-0.356	-0.196	-1.704

SPAWNING BIOMASS INDEX RESIDUALS
DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.2386	0.4476	-0.2550	0.6266	-0.4904	0.2176	*******	0.1073	0.2333	-0.0497	0.1032	0.1538	0.2988	-0.0388

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	*****	******	-0.3378	*****	0.7028	0.1917	*****	-0.4396	****	*****	0.3043	-0.4347	*****	0.0133

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	0.623	-0.388	0.802	-0.412	0.415	*******	0.143	0.480	*******	0.194	0.325
2	0.285	0.522	0.232	1.012	-0.109	0.433	*******	0.533	0.284	*******	0.565	0.333
3	0.084	0.275	-0.202	0.244	-0.753	-0.733	*******	-0.367	-0.138	*******	-0.422	0.072

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.5333	*******	0.2907	0.5764	*******	*******	*******	*******	-0.3608	*******	*******	0.0268
2	-0.1961	*******	0.6401	-0.2581	*******	*******	*******	*******	0.4526	*******	*******	-0.6386

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
Separable model fitted from 1987 to 1999

Variance	0.0455
Skewness test stat.	-4.2352
Kurtosis test statistic	-0.0847
Partial chi-square	0.1317
Significance in fit	0.0000
Degrees of freedom	32

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	0.0460
Skewness test stat.	0.9859
Kurtosis test statistic	-0.3791
Partial chi-square	0.0561
Significance in fit	0.0000
Number of observations	13
Degrees of freedom	13

Table 11.7.2.2 (Cont'd)

```
Weight in the analysis                0.5000
   DISTRIBUTION STATISTICS FOR   Acoustic
 Linear catchability relationship assumed
 Last age is a plus-group
 Variance                             0.0933
Skewness test stat.                   0.4263
Kurtosis test statistic              -0.5951
Partial chi-square                    0.0527
Significance in fit                   0.0000
Number of observations                     7
Degrees of freedom                         6
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               0.0663    0.0808    0.0542
Skewness test stat.     1.2182    1.8214   -1.8134
Kurtosis test statisti -0.7673   -0.4346   -0.2947
Partial chi-square      0.0462    0.0681    0.0541
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


  DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)
 Linear catchability relationship assumed
 Age                         1         2
 Variance               0.0780    0.1057
Skewness test stat.     0.0469    0.1190
Kurtosis test statisti -0.6594   -0.6834
Partial chi-square      0.0215    0.0318
Significance in fit     0.0001    0.0001
Number of observations       5         5
Degrees of freedom           4         4
Weight in the analysis  0.3750    0.3750

 ANALYSIS OF VARIANCE
 Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        47.9750     125          36   89   0.5390
Catches at age                         37.6610      65          33   32   1.1769
  SSB Indices
  DEPM                                  1.1964      13           0   13   0.0920
  Acoustic                              1.1198       7           1    6   0.1866
   Aged Indices
DEPM SUVEYS (Ages 1 to 3+)              6.0384      30           0   30   0.2013
ACOUSTIC SURVEYS (ages 1 to 2+)         1.9595      10           2    8   0.2449
 Weighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         2.9804     125          36   89   0.0335
Catches at age                          1.4549      65          33   32   0.0455
  SSB Indices
  DEPM                                  0.2991      13           0   13   0.0230
  Acoustic                              0.2799       7           1    6   0.0467
   Aged Indices
DEPM SUVEYS (Ages 1 to 3+)              0.6709      30           0   30   0.0224
ACOUSTIC SURVEYS (ages 1 to 2+)         0.2756      10           2    8   0.0344
```

Table 11.7.2.3a. -Stock: Anchovy Sub-area VIII

Assessment Quality Control Diagram 1

Average F(1-3,u)													
Date of assessment	Year												
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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

Remarks: Assessments of 1996-2000 performed using ICA.

Table 11.7.2.3b. - 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
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

Remarks: Assessments of 1996-2000 performed using ICA.

Table 11.7.2.3c. - 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
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	(53503)				
1998	27519	19112	55649	28391	69737	88690	60978	45126	40617	54783	(88135)			
1999	37070	23389	55844	28794	71236	87618	58755	43727	37098	49641	118593	(59477)		
2000	40585	21582	51966	31476	72975	81638	53953	43316	41558	46158	87436	51230	(46750)	

Remarks: Assessments of 1996-2000 performed using ICA. In brackets the SSB estimate for the year of the assessment is presented.

Table 11.7.2.4: Comparisons between the assessment made in 1999 and in 2000 by this WG

Type of Assesmet	Assessment from ICES (2000)			Updated assessment Similar to 1999 assessment with a new year of data and down weighting ages 0 to 0.01 and age 3 to 0.1		
Assessment Year	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**
1987	7,447	0.5496	37,813	8,703	0.541	37,279
1988	4,387	0.5007	37,070	3,473	0.589	40,585
1989	19,082	0.5807	23,389	19,652	0.527	21,582
1990	7,319	0.6146	55,844	7,587	1.048	51,966
1991	28,402	1.2581	28,794	27,632	0.879	31,476
1992	25,305	0.8625	71,236	24,103	0.892	72,975
1993	13,334	0.5659	87,618	12,789	0.700	81,638
1994	10,275	0.6792	58,755	10,405	0.775	53,953
1995	13,397	0.8612	43,727	14,514	0.863	43,316
1996	20,231	1.2382	37,098	18,197	1.195	41,558
1997	34,648	0.4856	49641	25,830	0.517	46,158
1998	4,774	0.2511	118593	7,841	0.385	87,436
1999	4,394	0.251	59484	12,582	0.579	51,230
2000			25178		0.579	46,750
Geomet. mean(10y)	12,843	0.704	48,849	12,906	0.743	47,512

Table 11.8.1 Inputs for the Catch option Predictions for the Anchovy in Sub Area VIII. Fishing Mortality pattern as the average of the last five years (1995-1999). Case of average recruitment below the arithmetic mean of the total series (1986-1999, as shown in table 11.6.1) (resulting in 8653 millions at age 0).

The SAS System 12:27 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	8653.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	3770.000	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	512.000	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	268.000	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	35.000	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	4.000	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001 & 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND04

Date and time: 23SEP00:12:30

Table 11.8.2 Catch option Predictions for the Anchovy in Sub Area VIII. Case of average recruitment below the arithmetic mean of the total series (1986-1999, as shown in table 11.6.1) (resulting in 8653 millions at age 0).

The SAS System 12:27 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.5253	1.0798	193150	39573	35000	0.0000	0.0000	212754	39058	0	239306	56023
.	.	.	.	.	0.1000	0.0708	.	38188	2312	237778	53834
.	.	.	.	.	0.2000	0.1416	.	37341	4513	236337	51794
.	.	.	.	.	0.3000	0.2124	.	36516	6611	234978	49889
.	.	.	.	.	0.4000	0.2832	.	35712	8612	233696	48108
.	.	.	.	.	0.5000	0.3540	.	34929	10522	232484	46440
.	.	.	.	.	0.6000	0.4248	.	34166	12346	231339	44876
.	.	.	.	.	0.7000	0.4956	.	33423	14089	230256	43407
.	.	.	.	.	0.8000	0.5663	.	32698	15757	229231	42024
.	.	.	.	.	0.9000	0.6371	.	31993	17353	228260	40722
.	.	.	.	.	1.0000	0.7079	.	31305	18883	227340	39494
.	.	.	.	.	1.1000	0.7787	.	30634	20349	226468	38333
.	.	.	.	.	1.2000	0.8495	.	29980	21755	225640	37234
.	.	.	.	.	1.3000	0.9203	.	29343	23104	224853	36193
.	.	.	.	.	1.4000	0.9911	.	28721	24401	224106	35205
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND04
Date and time : 23SEP00:12:30
Computation of ref. F: Simple mean, age 1 - 3
Basis for 2000 : TAC constraints

Table 11.8.3 Inputs for the Catch option Predictions for the Anchovy in Sub Area VIII.

Case of Geometric mean Recruitment (1986-1999) at 12174 millions.

The SAS System 11:10 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	3770.000	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	512.000	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	268.000	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	35.000	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	4.000	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001 & 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND02

Date and time: 23SEP00:11:11

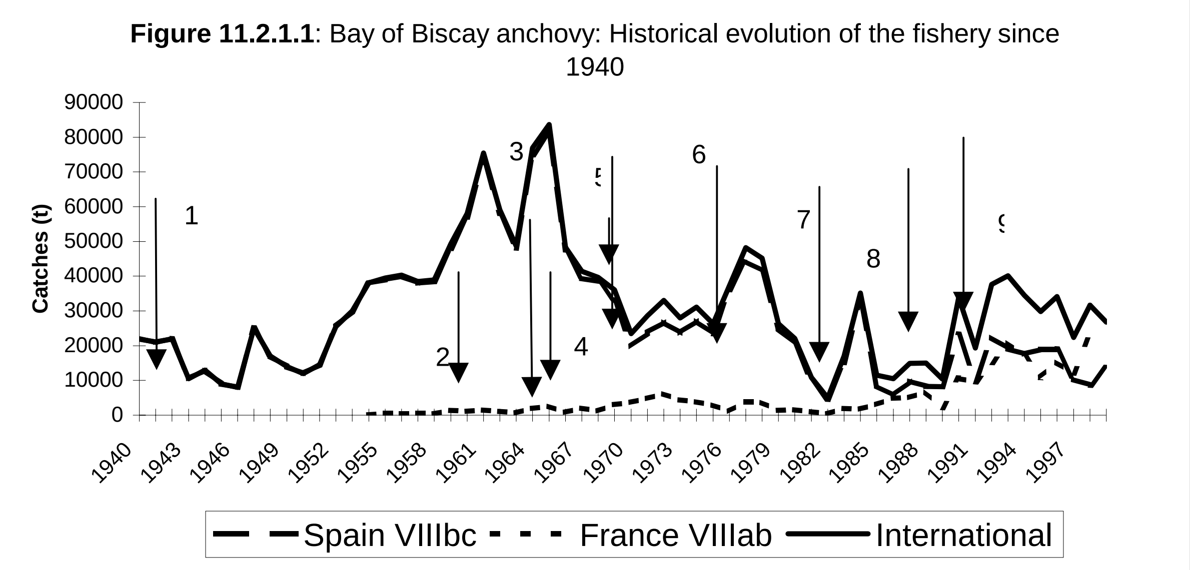
Table 11.8.4 Catch option Predictions for the Anchovy in Sub Area VIII. Case of Geometric mean Recruitment (1986-1999) at 12174 millions.

The SAS System 11:10 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay) Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.5110	1.0697	236967	39689	35000	0.0000	0.0000	229615	49809	0	248435	61844
.	.	.	.	.	0.1000	0.0708	.	48767	2818	246548	59225
.	.	.	.	.	0.2000	0.1416	.	47751	5509	244763	56786
.	.	.	.	.	0.3000	0.2124	.	46760	8081	243073	54512
.	.	.	.	.	0.4000	0.2832	.	45793	10541	241472	52389
.	.	.	.	.	0.5000	0.3540	.	44849	12896	239955	50405
.	.	.	.	.	0.6000	0.4248	.	43928	15151	238517	48548
.	.	.	.	.	0.7000	0.4956	.	43029	17311	237152	46807
.	.	.	.	.	0.8000	0.5663	.	42151	19383	235856	45174
.	.	.	.	.	0.9000	0.6371	.	41294	21372	234625	43639
.	.	.	.	.	1.0000	0.7079	.	40458	23281	233455	42195
.	.	.	.	.	1.1000	0.7787	.	39641	25115	232343	40834
.	.	.	.	.	1.2000	0.8495	.	38844	26877	231284	39551
.	.	.	.	.	1.3000	0.9203	.	38065	28573	230277	38339
.	.	.	.	.	1.4000	0.9911	.	37305	30205	229317	37192
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND02
Date and time : 23SEP00:11:11
Computation of ref. F: Simple mean, age 1 - 3
Basis for 2000 : TAC constraints



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

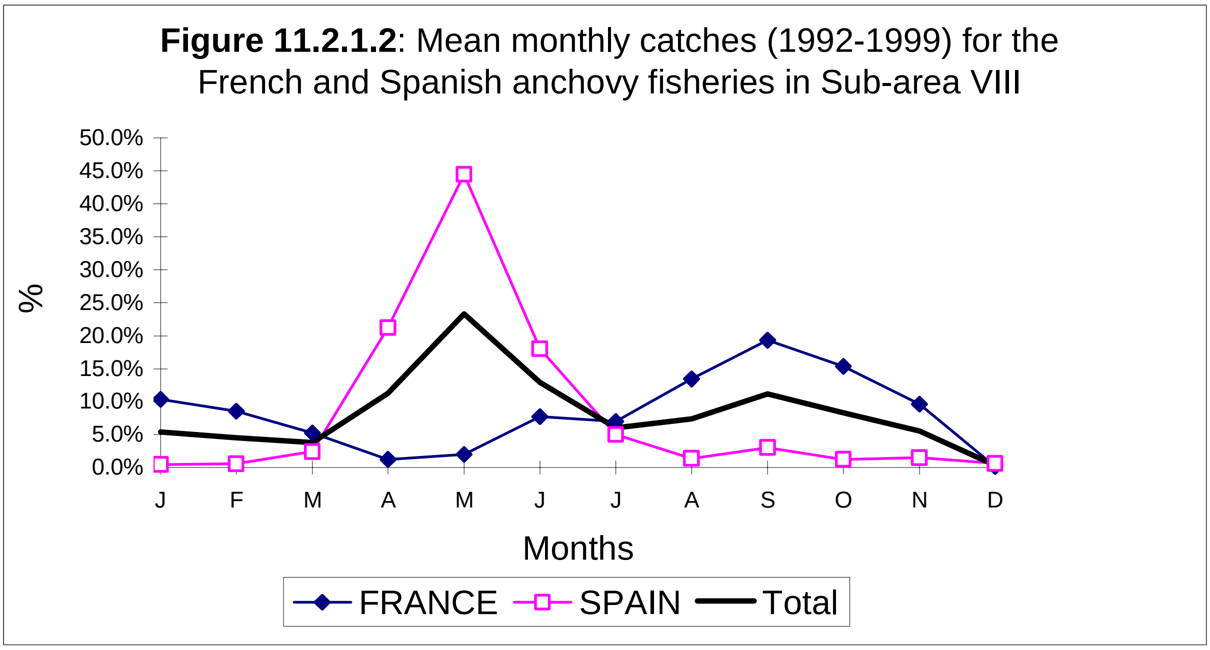


Figure 11.3.2.1 -First Quarter-

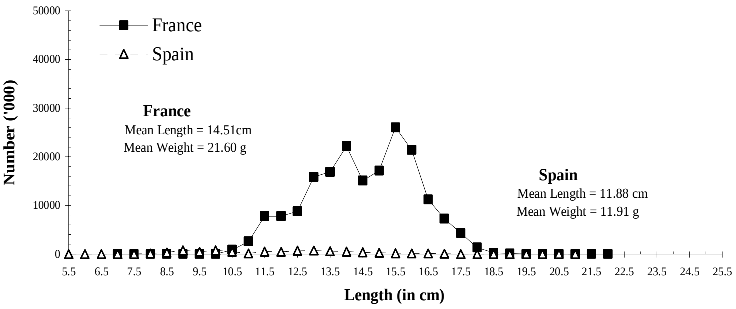


Figure 11.3.2.3 -Third Quarter-

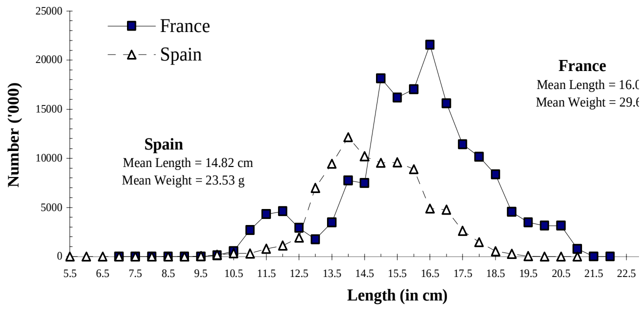


Figure 11.3.2.2 - Second Quarter

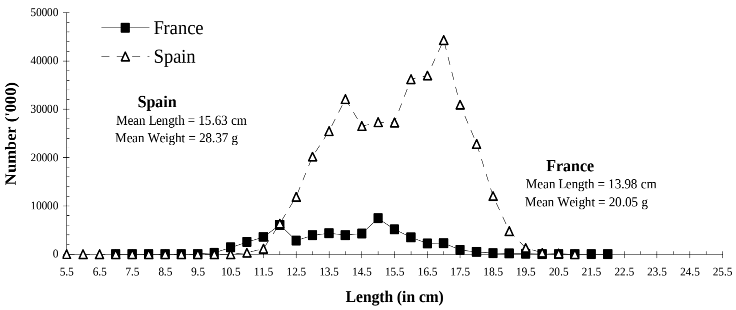
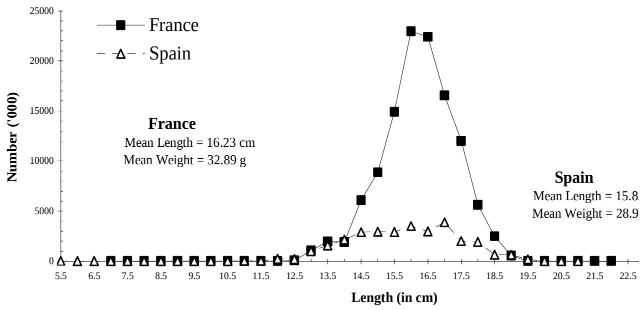


Figure 11.3.2.4 -Fourth Quarter-



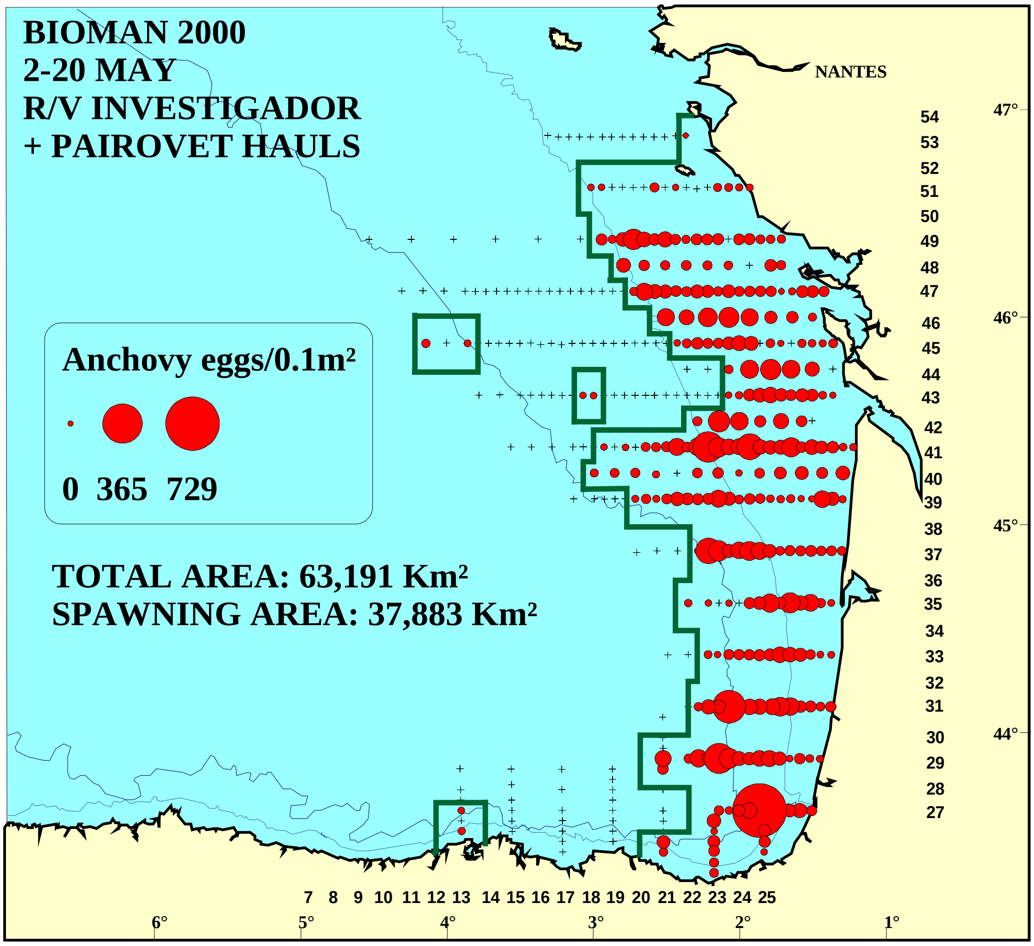


Figure 11.4.1.1: Anchovy Egg/0.1m² distribution found during BIOMAN 2000.
Solid line encloses the positive spawning area

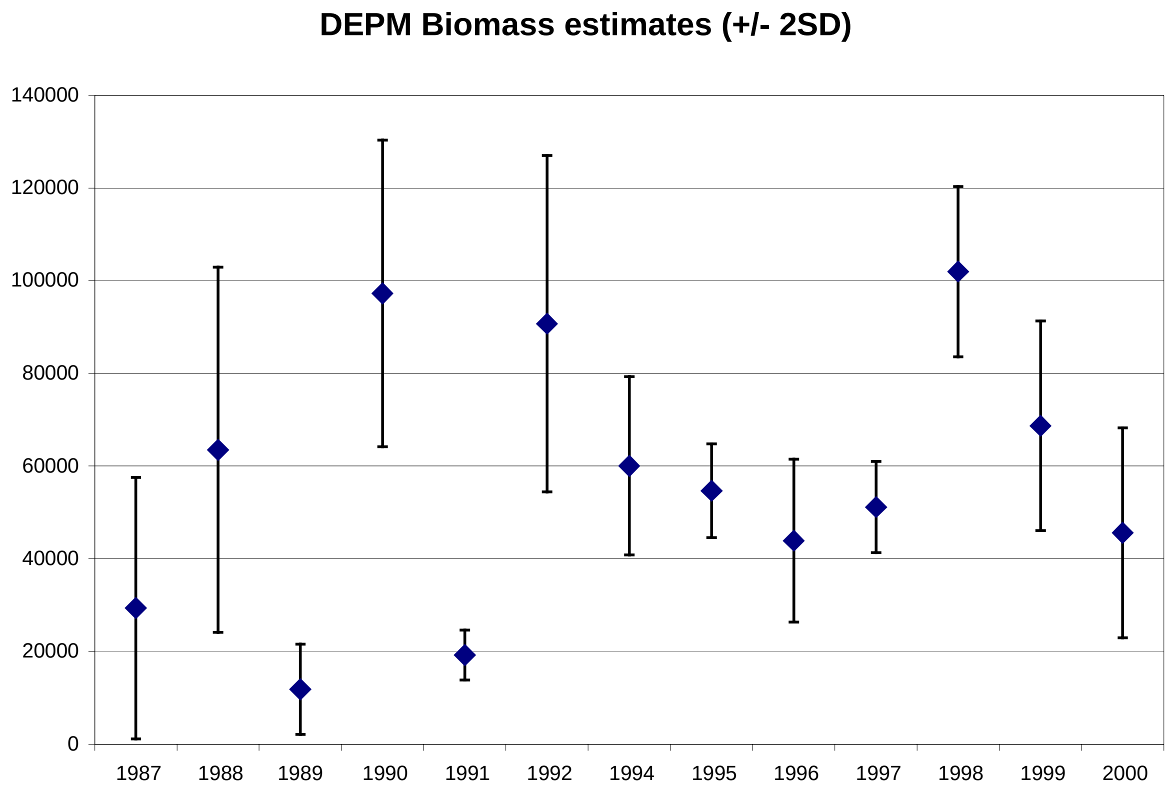


Figure 11.4.1.2: Series of Biomass estimates obtained from the Egg surveys since 1987 Uriarte et al WD2000. Most of them are full DEPM estimates, except in 1996, 1999 and 2000 which were deduced indirectly from the relationship of biomass with the spawning area and daily egg production per surface unit (P0).

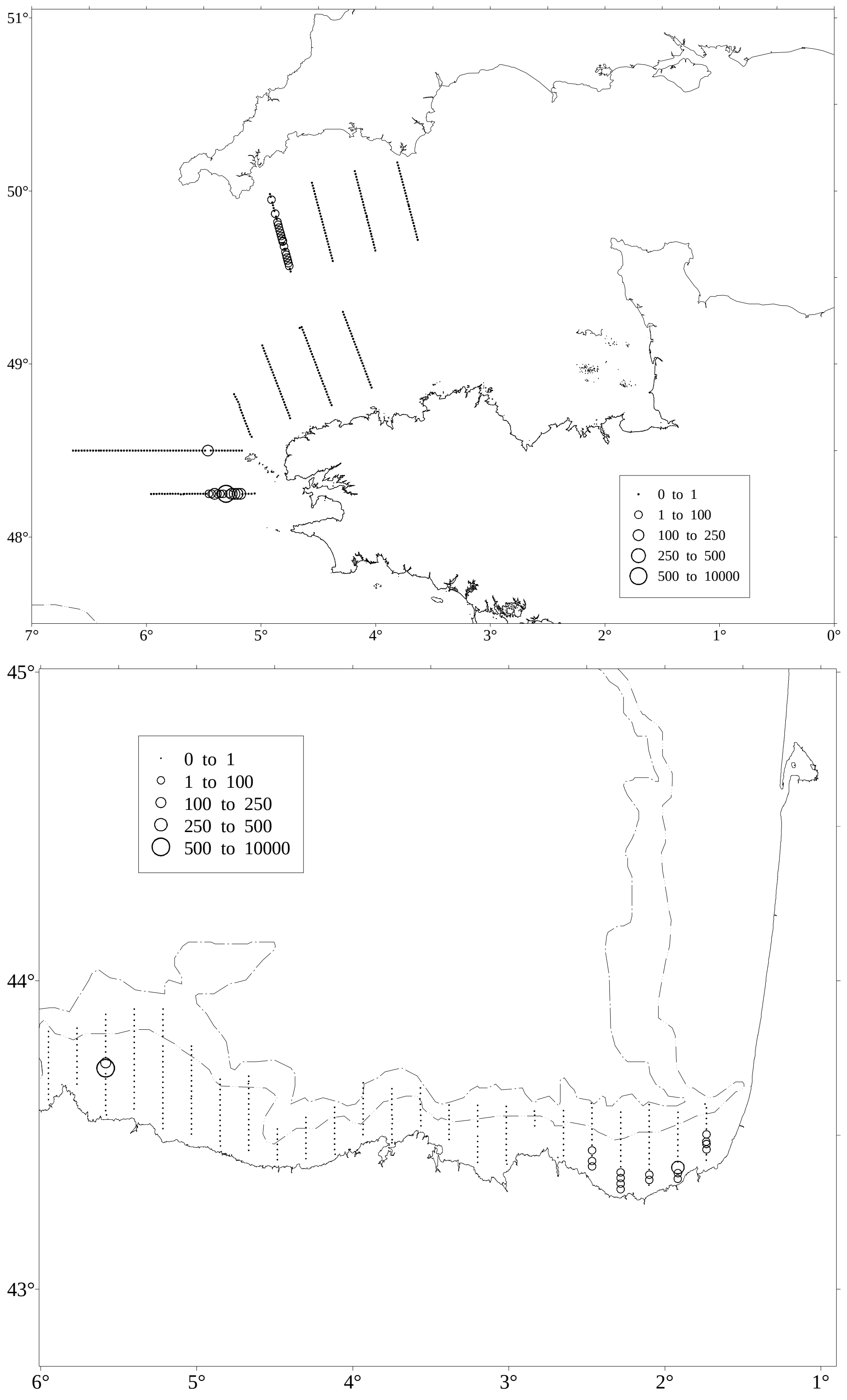
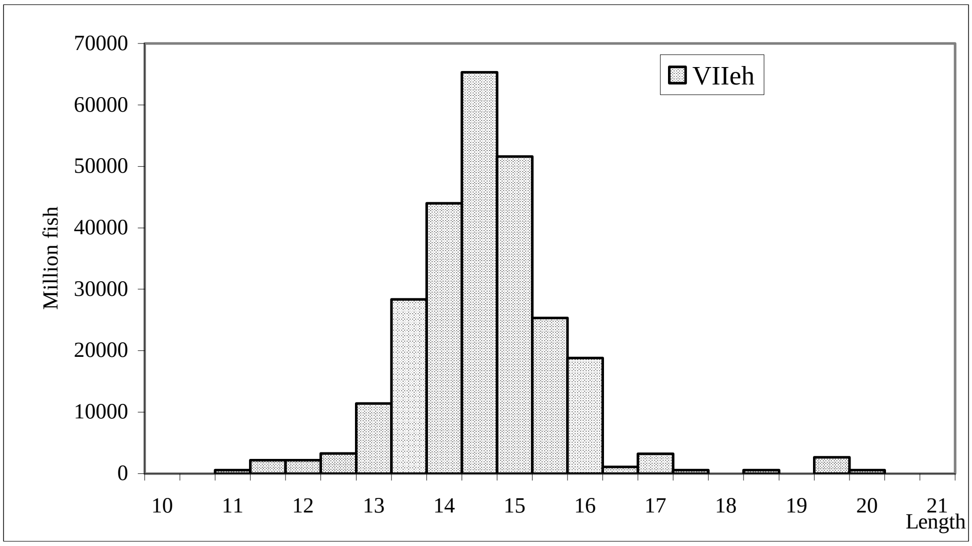
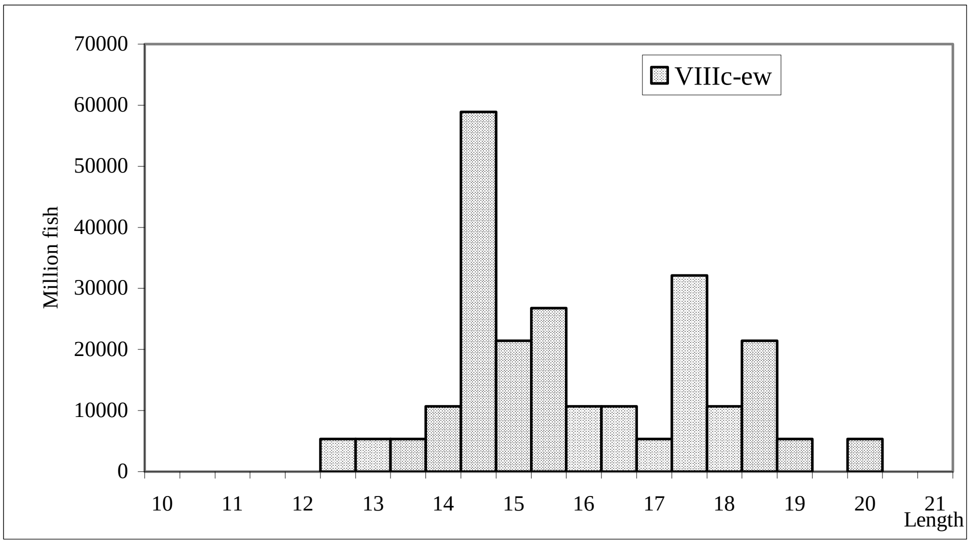


Figure 11.4.2.1: Acoustic energy allocated to anchovy during the acoustic survey PELACUS 0300





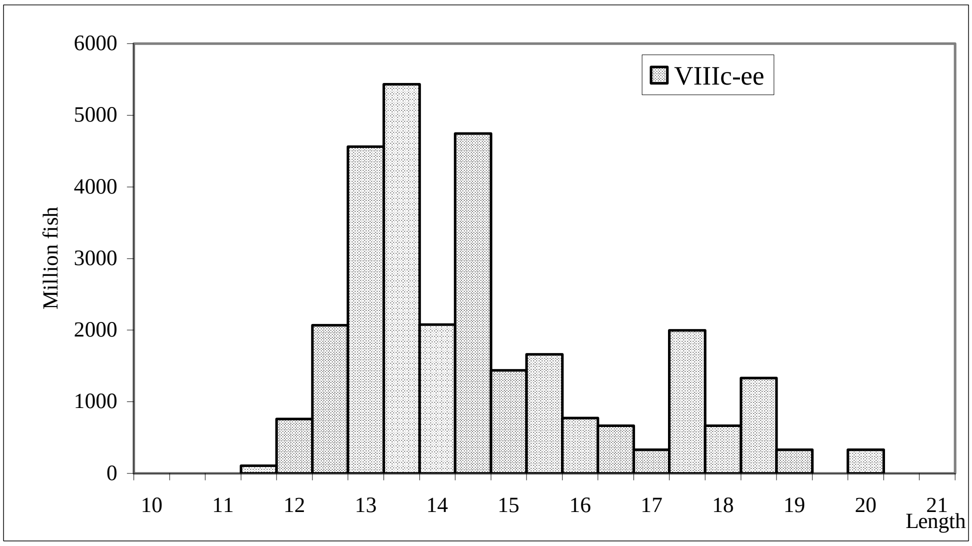


Figure 11.4.2.2: Estimated fish number at length class by ICES Sub-Division during the survey Pelacus 0300

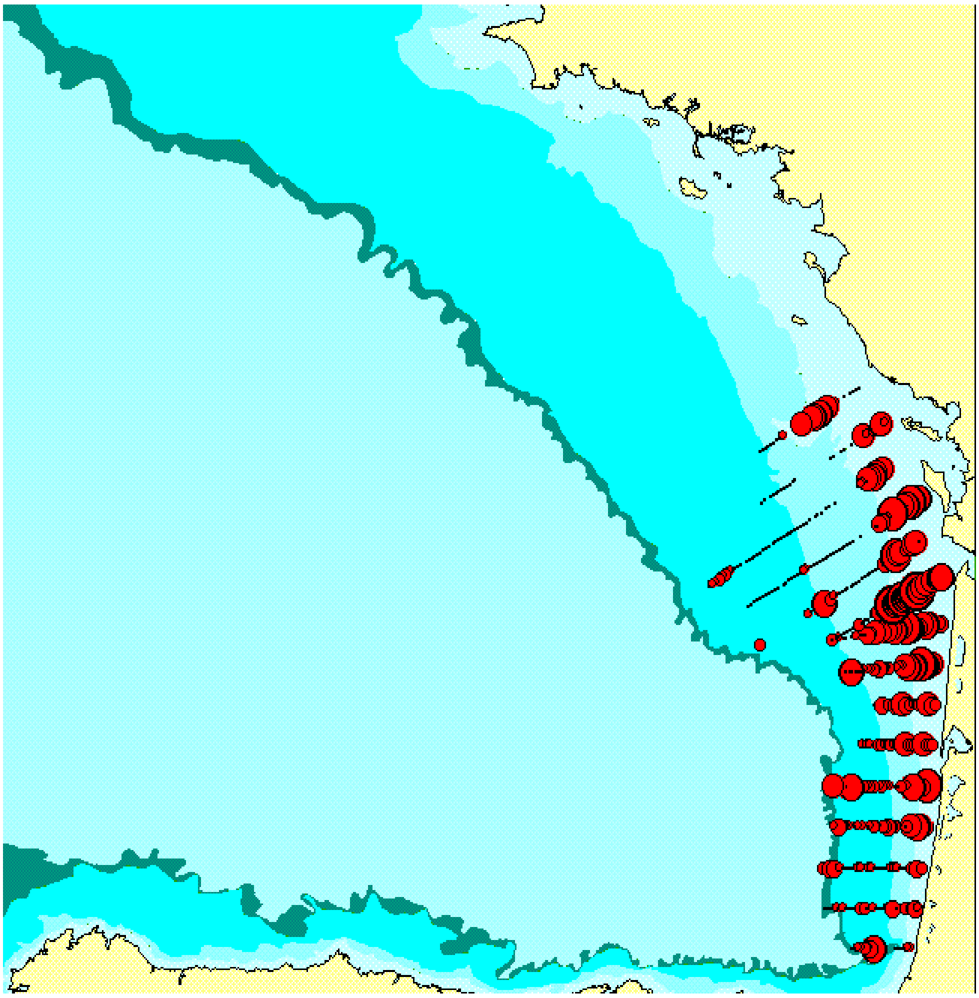
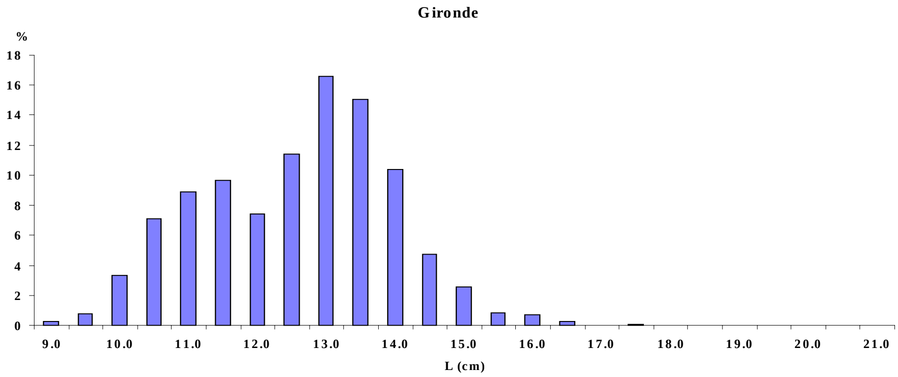
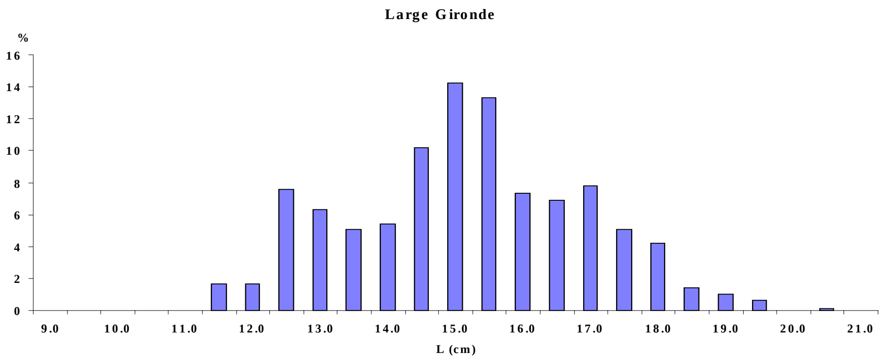


Figure 11.4.2.3. : Anchovy energies distribution during the survey PELASSES 2000 (after Massé, 2000).





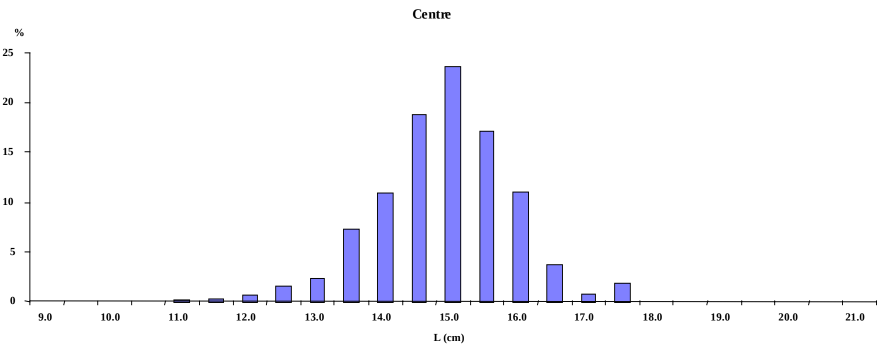


Figure 11.4.2.4. : Length distributions of anchovy sampled during the survey PELASSES 2000 in the Bay of Biscay (after Masse, WD 2000).

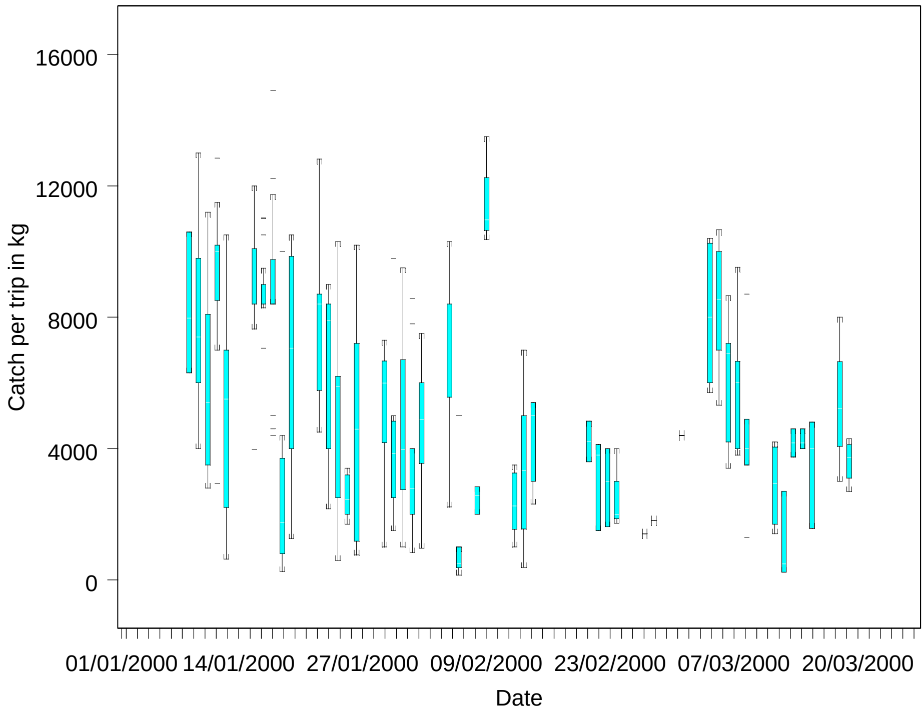


Figure 11.5.1: boxplots showing the daily variation of anchovy catch per trip (in kg) of the French pelagic fleet during the first quarter in 2000

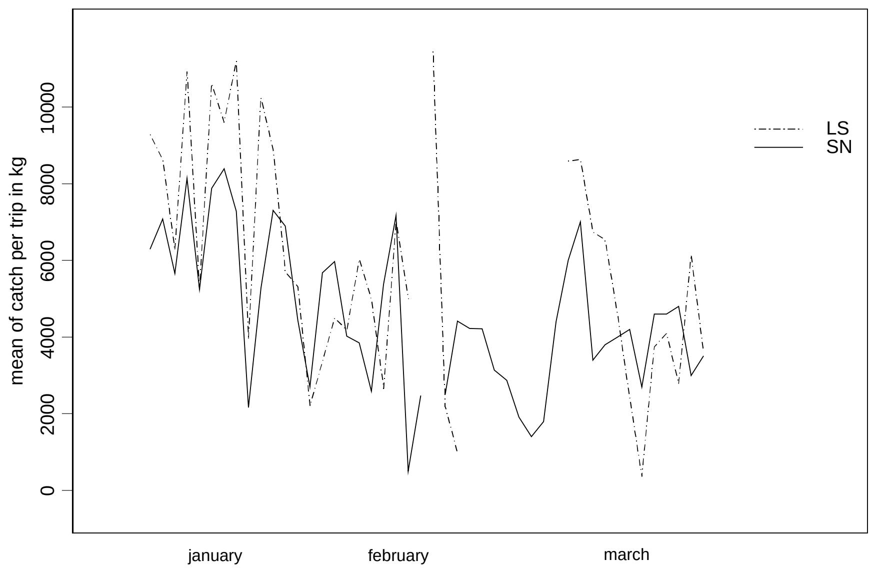
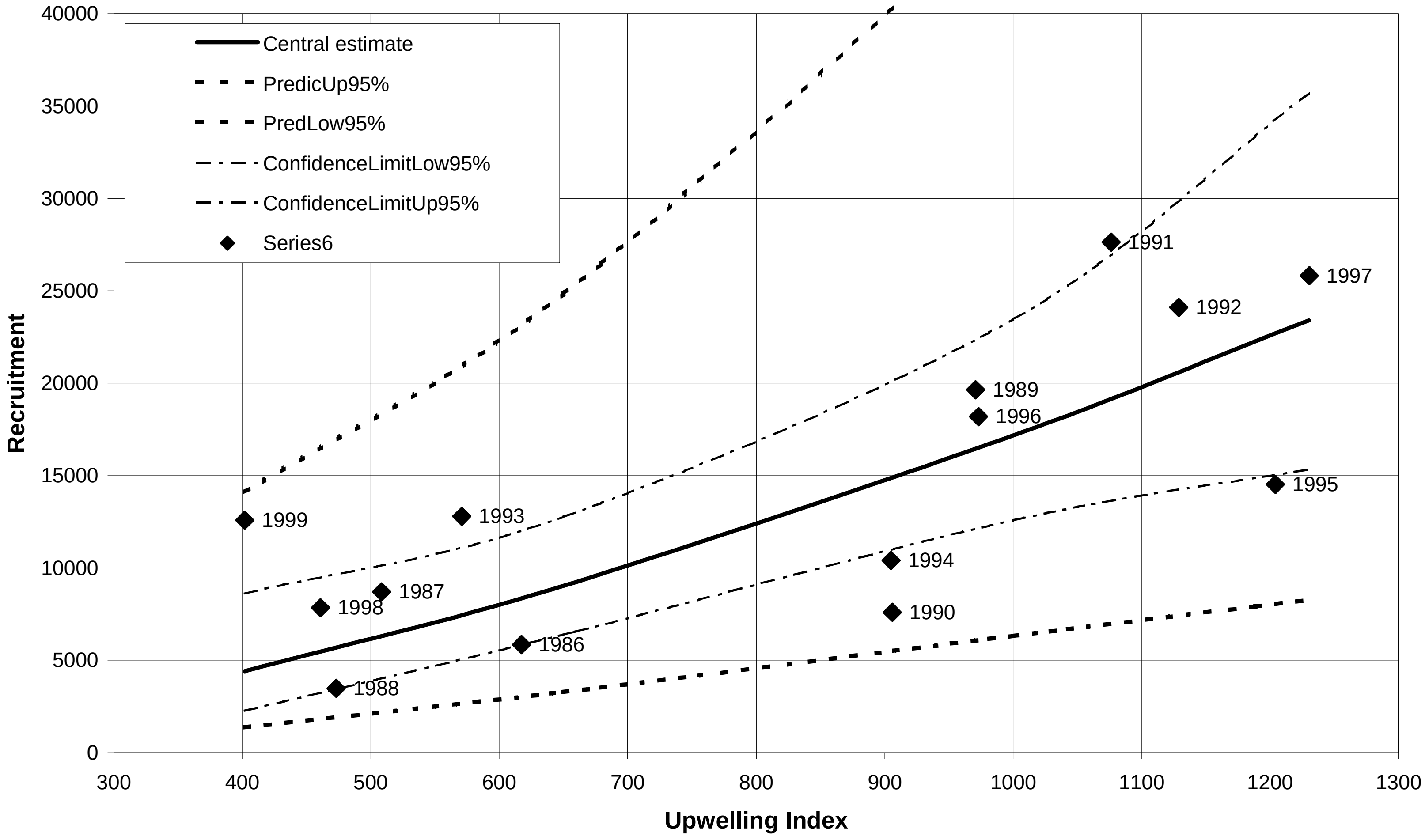
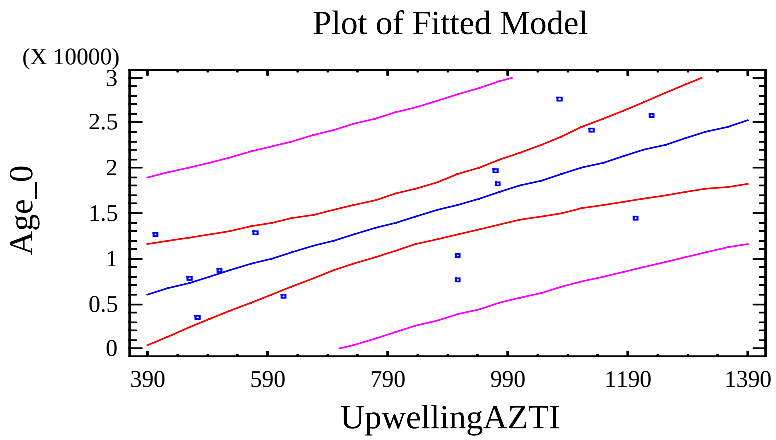


Figure 11.5.2: mean daily variation of the anchovy catch per trip for the French pelagic fleet during the winter fishing season in 2000 LS (Saint-Gilles Croix de Vie) and SN (La Turballe)

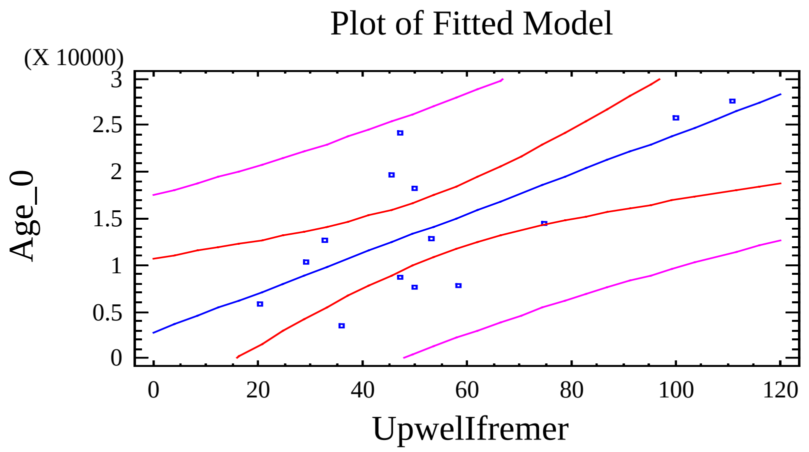
Figure 11.6.1: Predictive model in 1999 in comparison with the actual assessment



a) Borja's *et al*. Upwelling Index (1986,1998)



b) Use of Upwelling Index defined in Petitgas et al (WD2000)



c) Petitgas et al Upwelling and destratification Multiple model (WD2000)

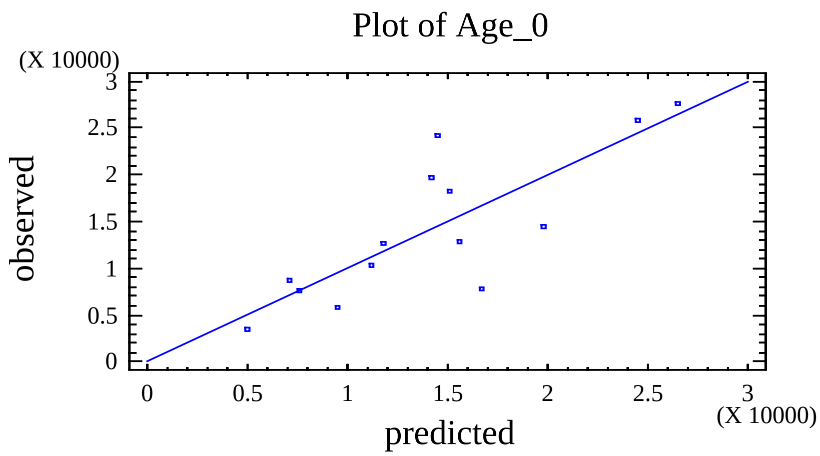
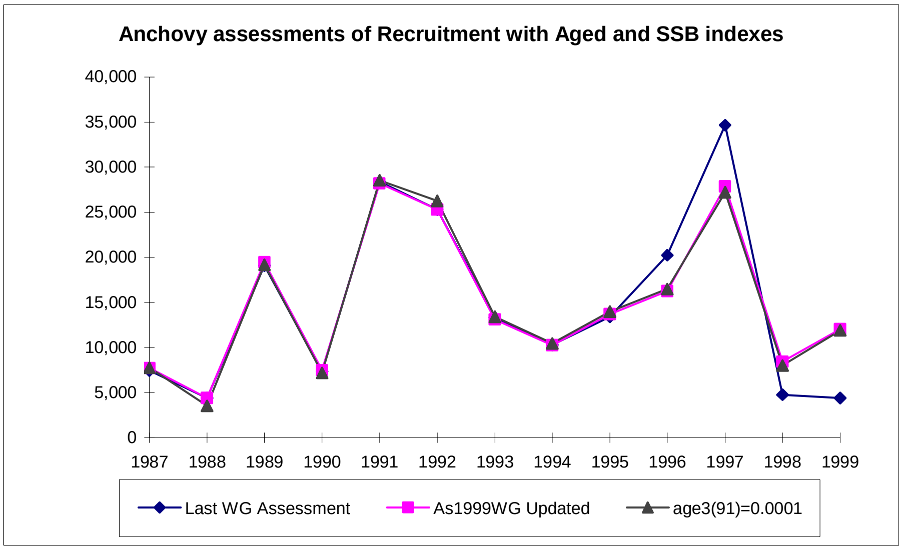
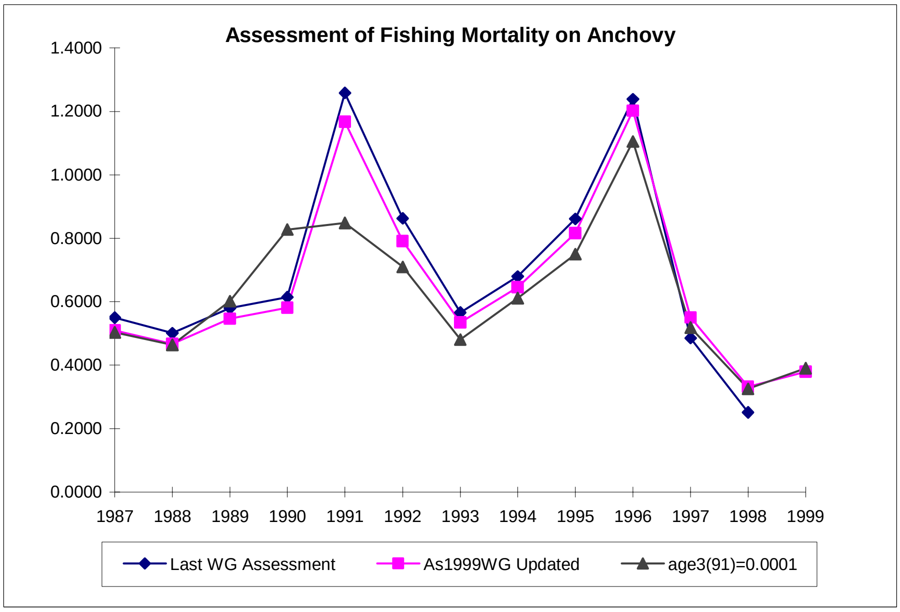


Figure 11.6.2: Linear models fitted to age 0 between the environmental indexes and the assessment adopted by this Working Group in Sept.2000. (14 pairs of data).





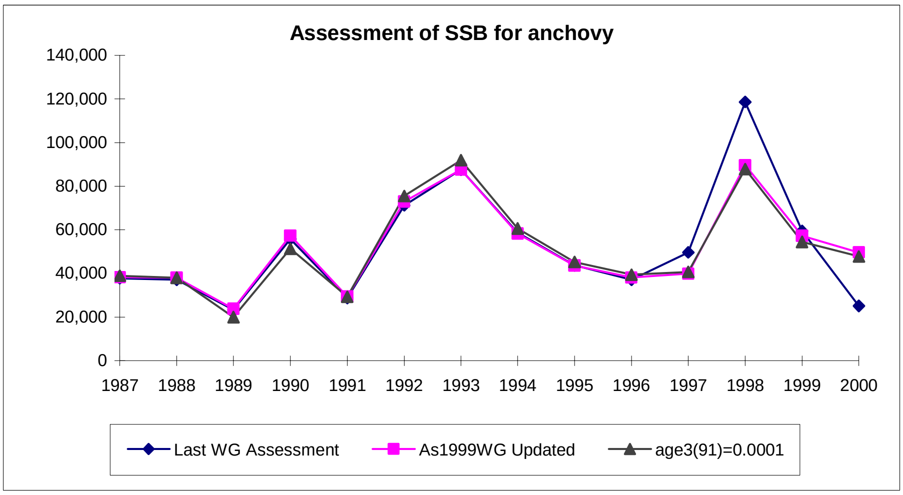


Figure 11.7.1.1: Comparison of Last year assessment versus the new updated data for the anchovy Concerning New the new information available and down weighting age 3 in 1991.

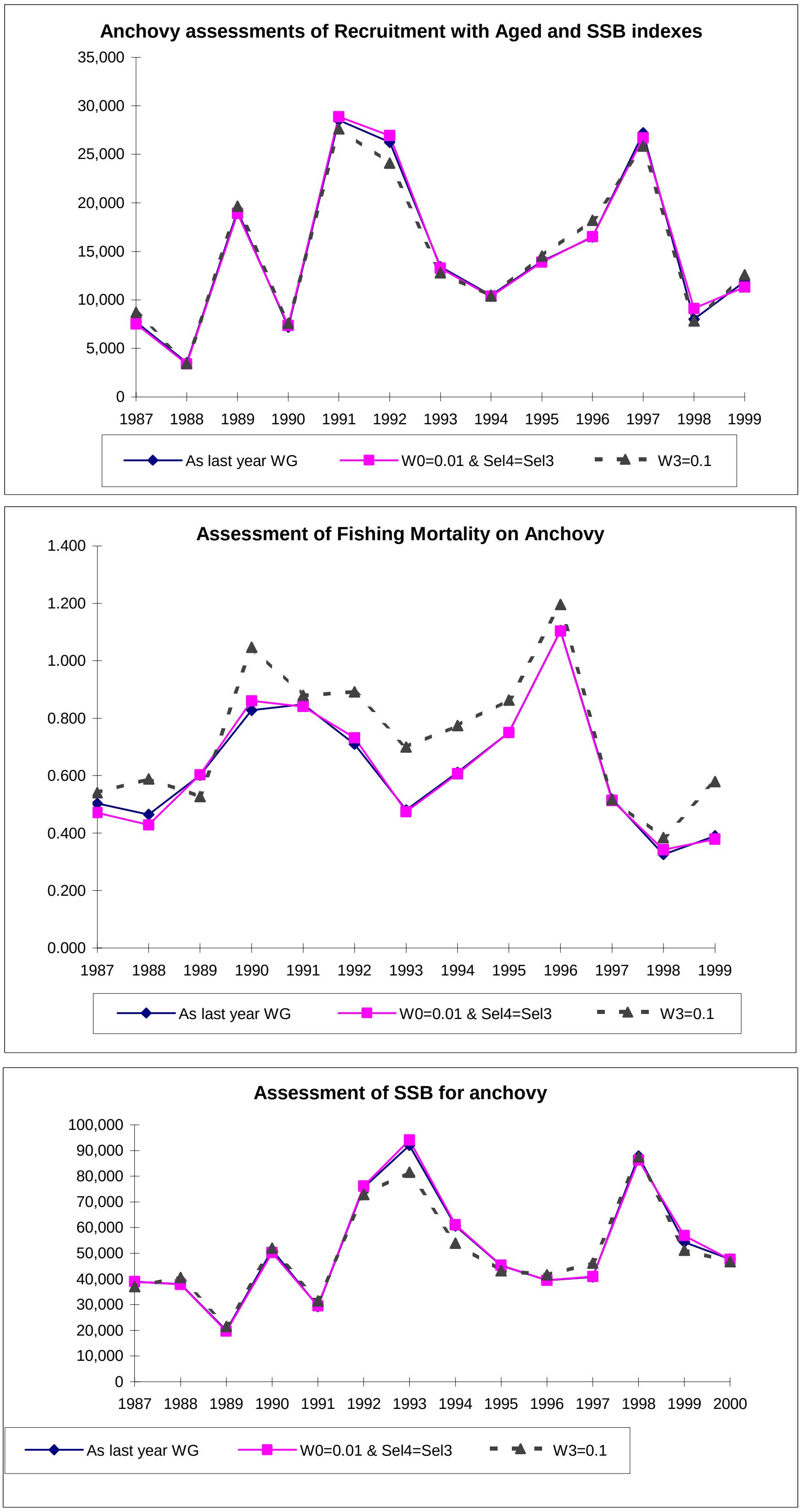
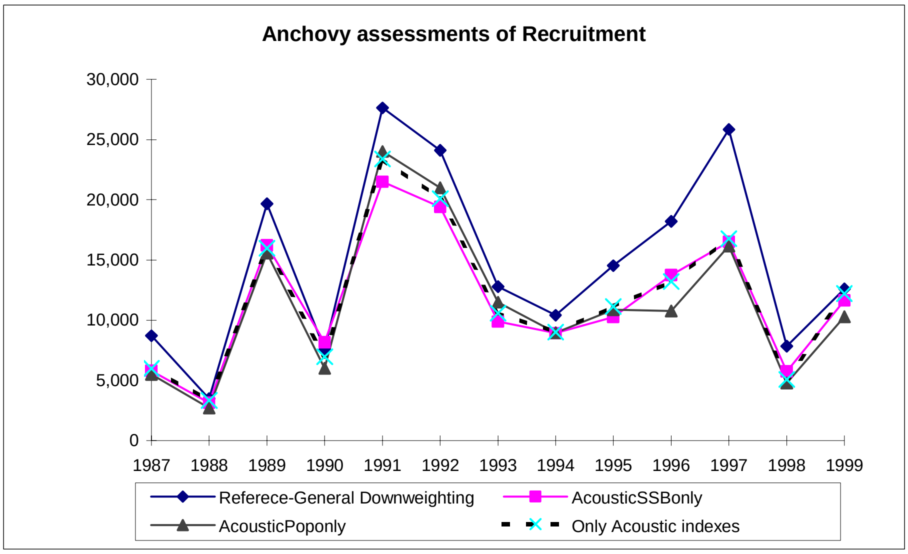
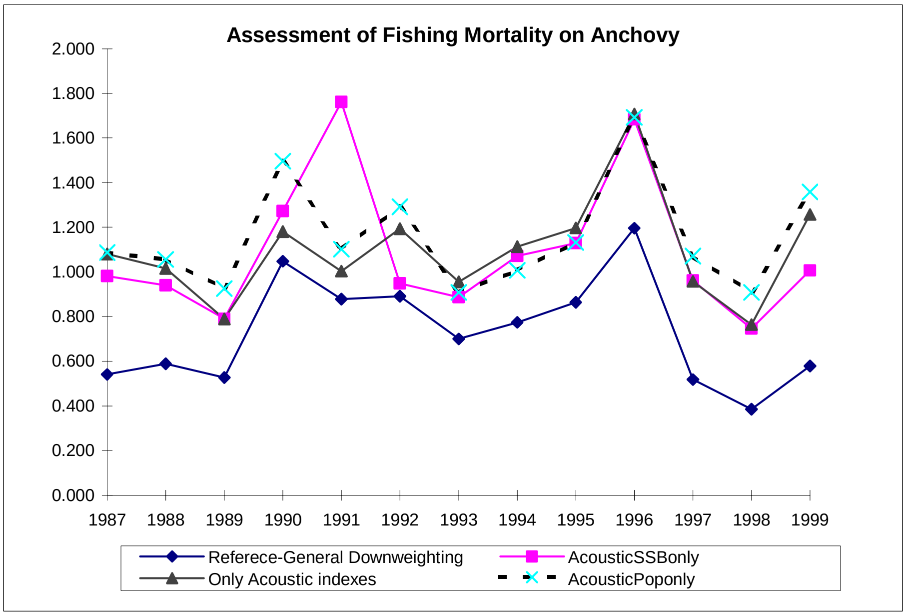


Figure 11.7.1.2: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning different weighting factors





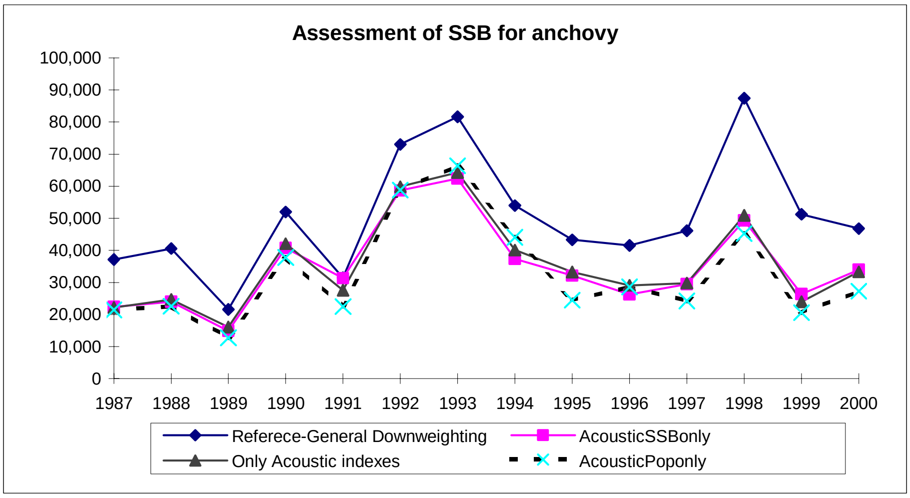
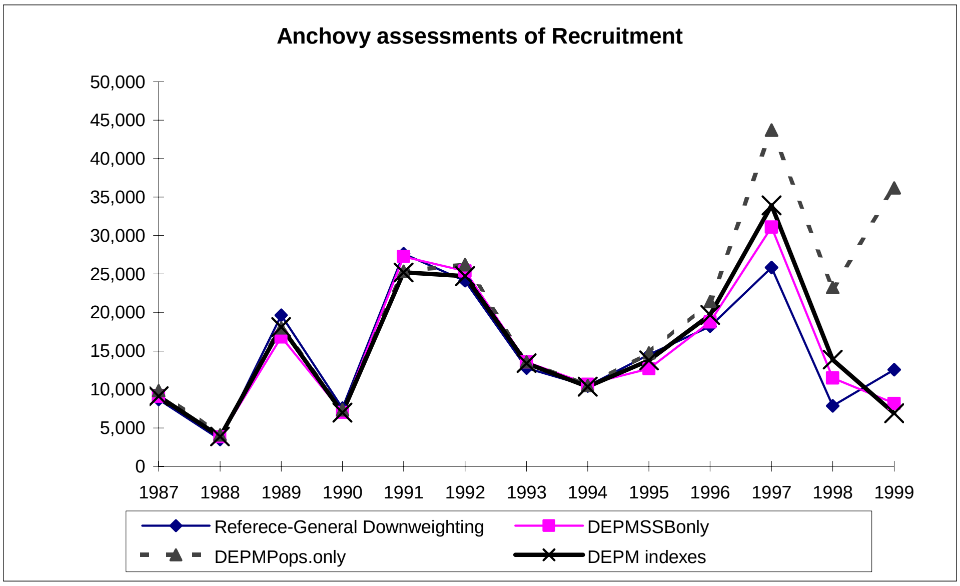
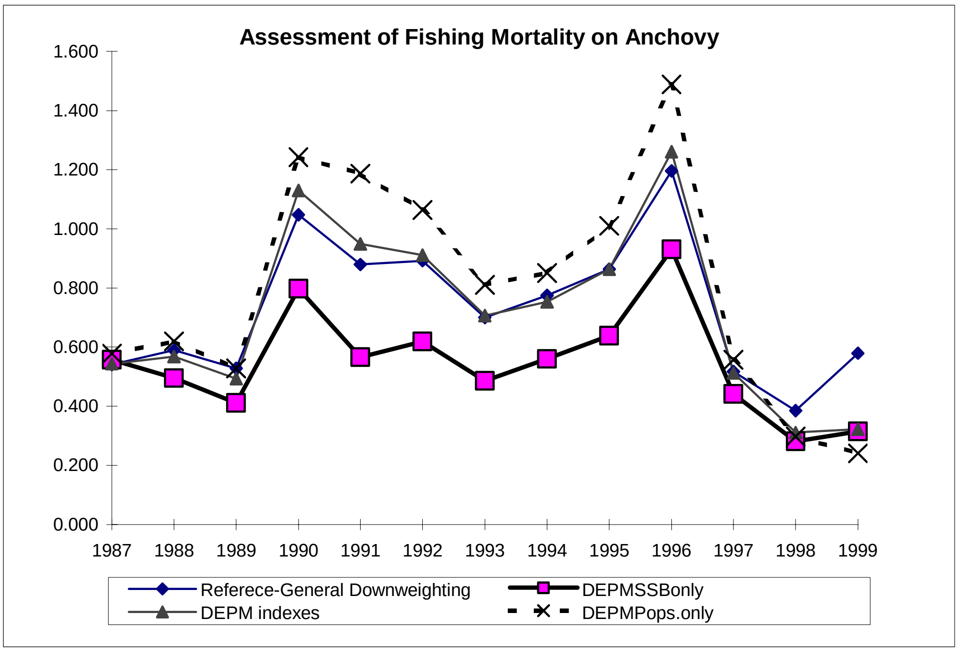


Figure 11.7.1.3: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning The sole use of Acoustic index in comparison with the standard assesment of reference





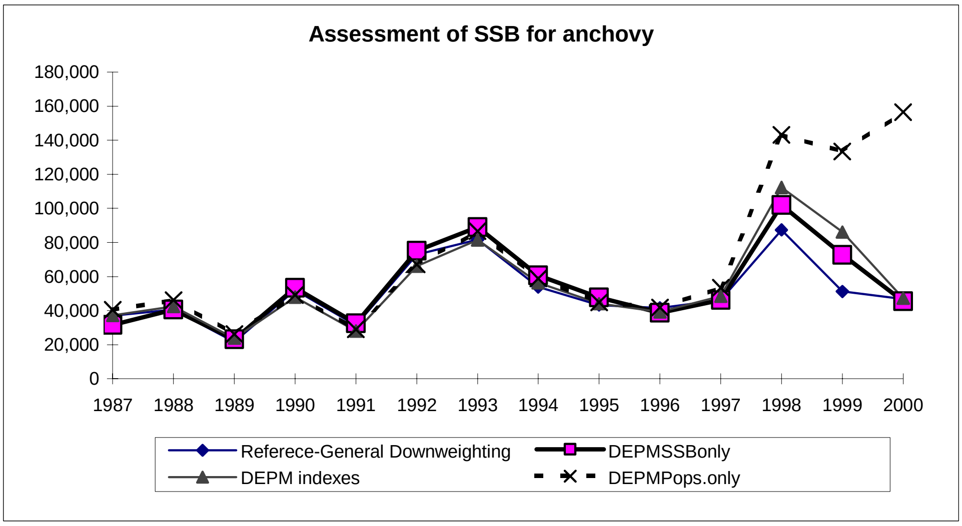
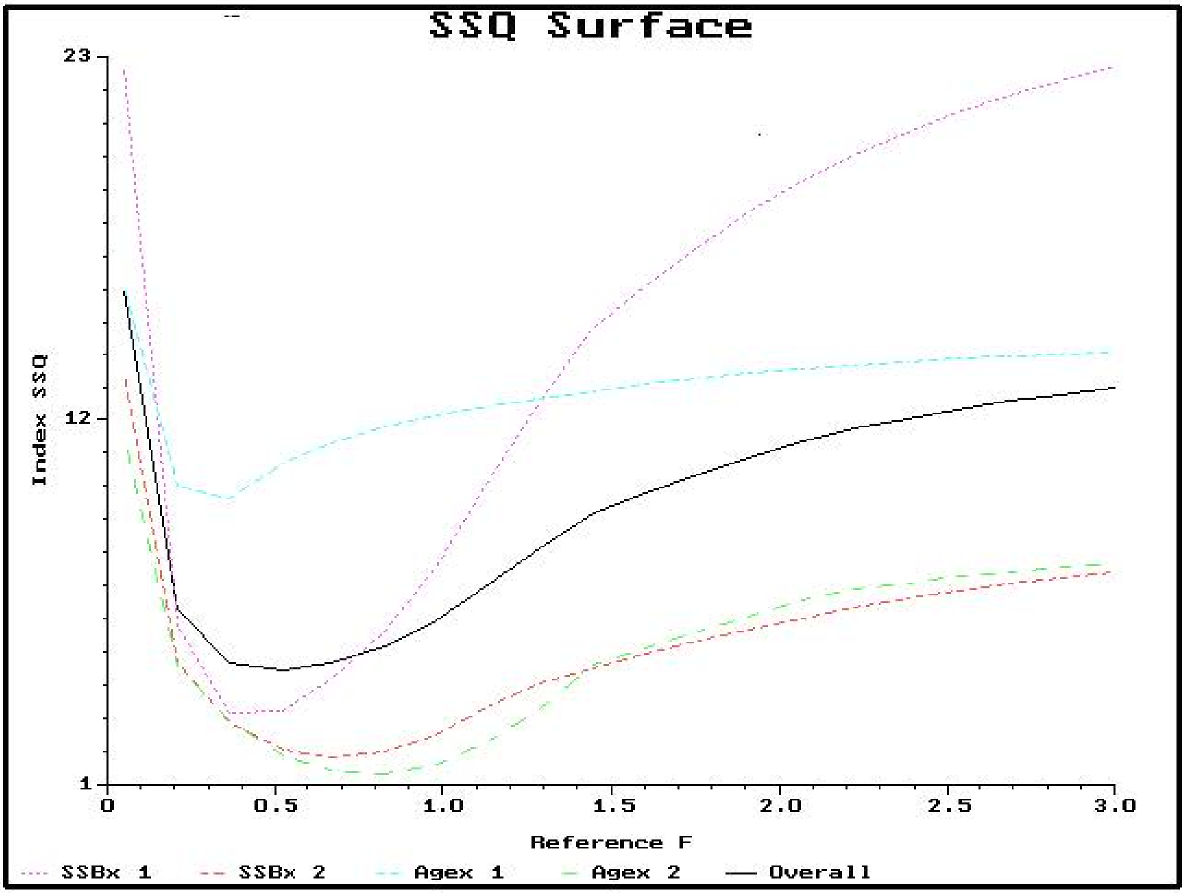
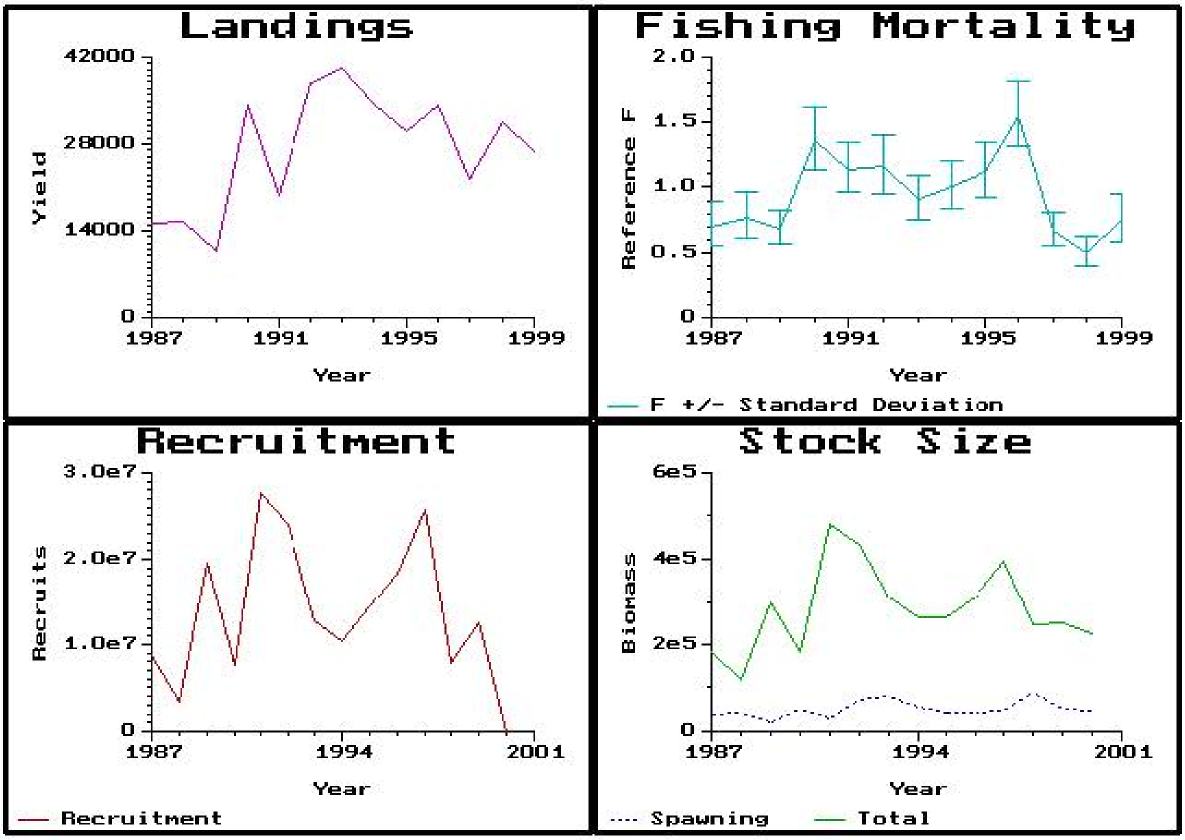


Figure 11.7.1.4: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning The sole use of DEPM index in comparison with the standard assesment of reference

Figure 11.7.2.1 Output figures from the assessment of the Anchovy in Subarea VIII



Stock Summary
Press P to print screen, or any other key to continue



Figures 11.7.2.1 (Cont….)

Separable Model Diagnostics
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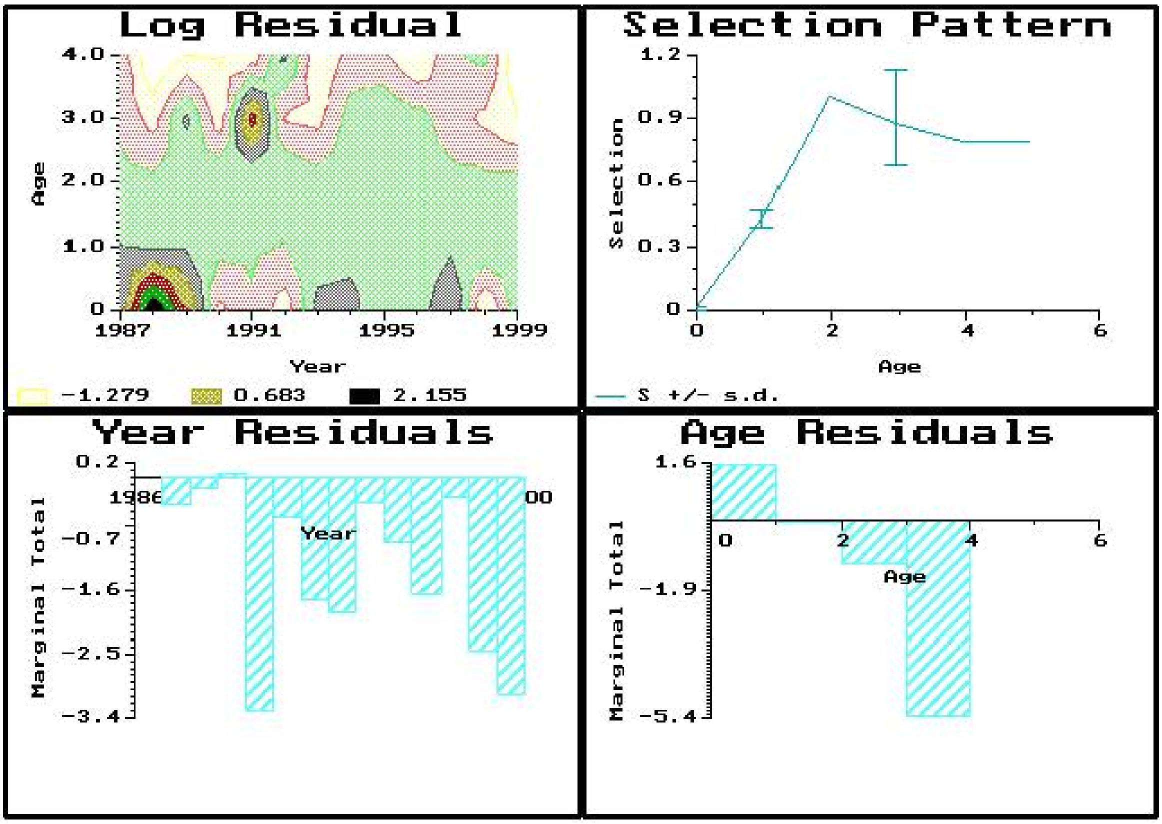
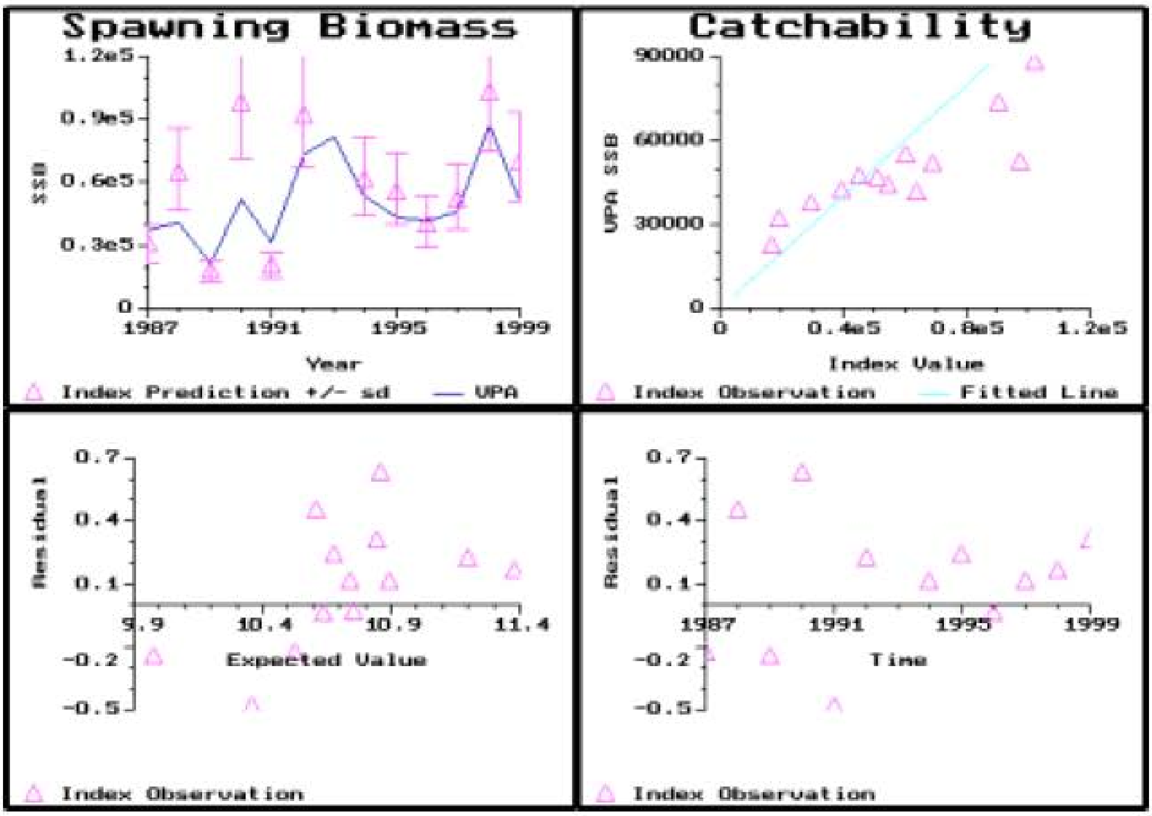
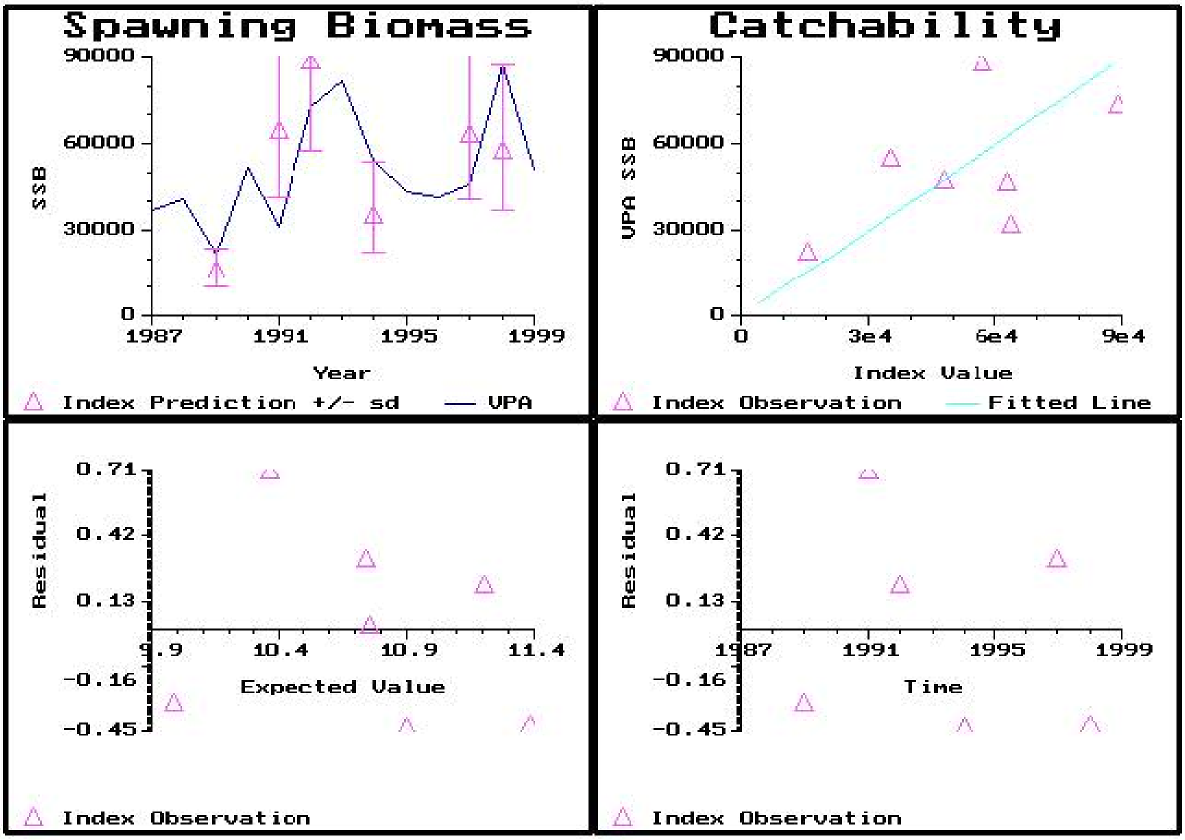


Tuning Diagnostics: Biomass index 1
Press P to print sc

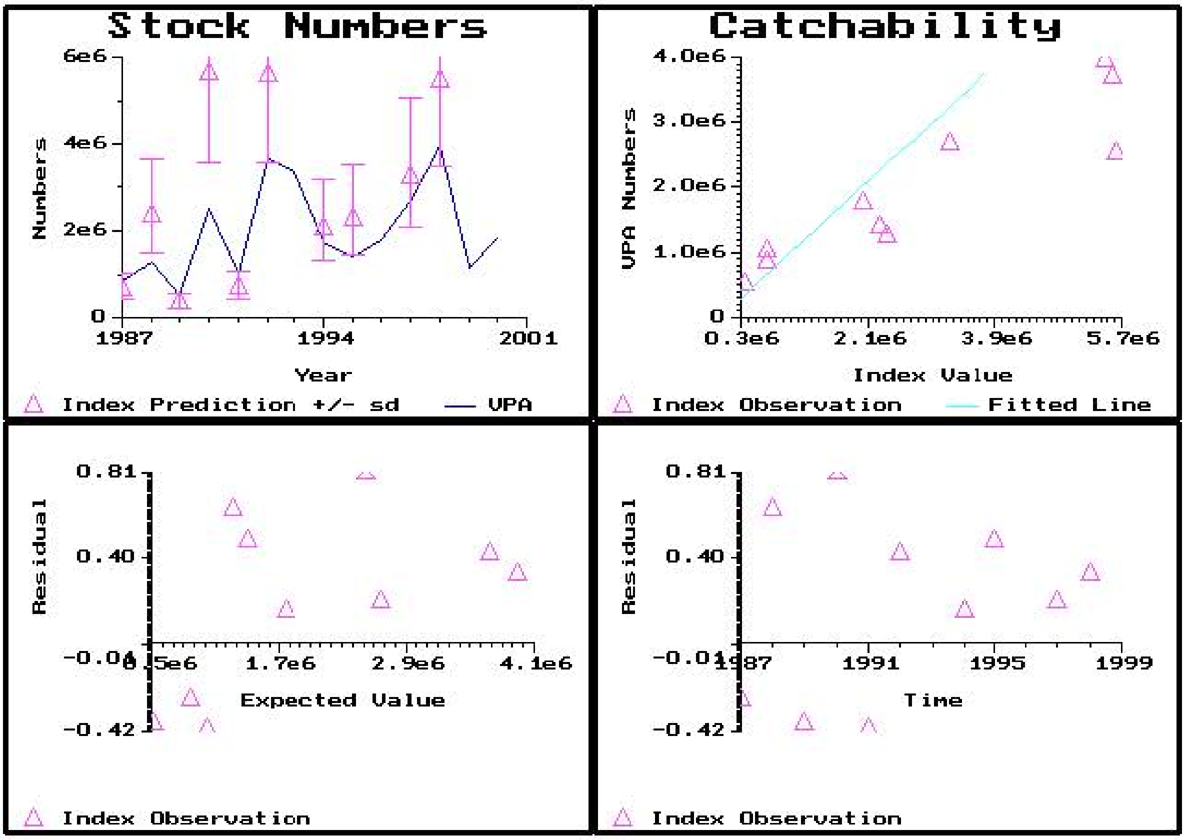


Figures 11.7.2.1 (Cont….)

Tuning Diagnostics: Biomass index 2

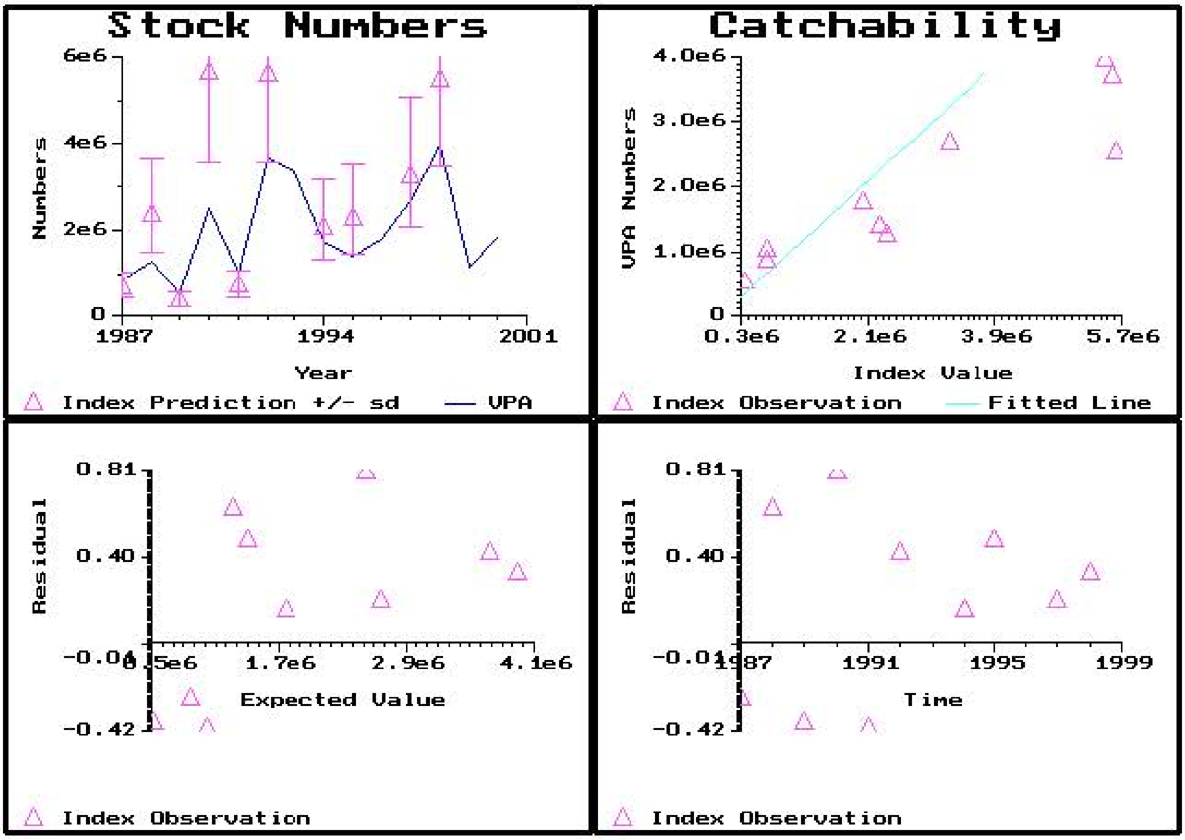


DEPM SUVEYS (Ages 1 to 3+) Age 1

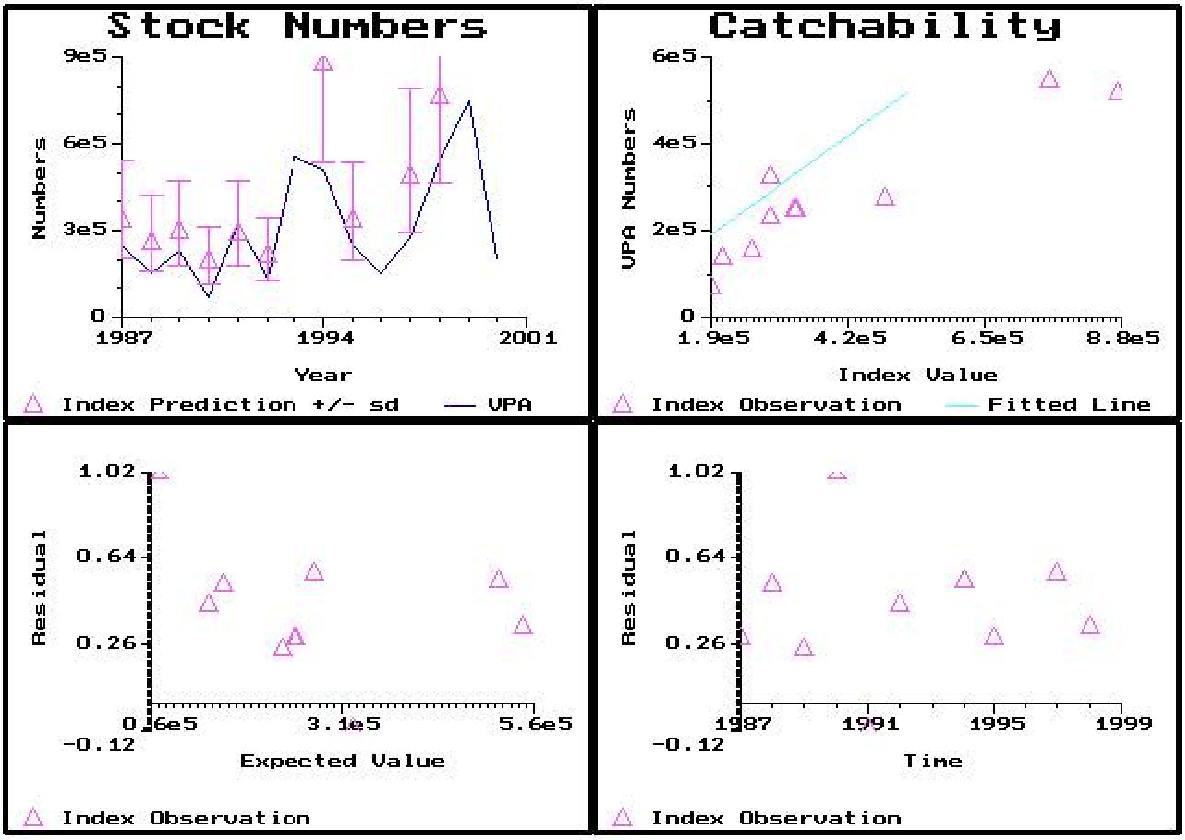


Figures 11.7.2.1 (Cont….)

DEPM SUVEYS (Ages 1 to 3+) Age 1

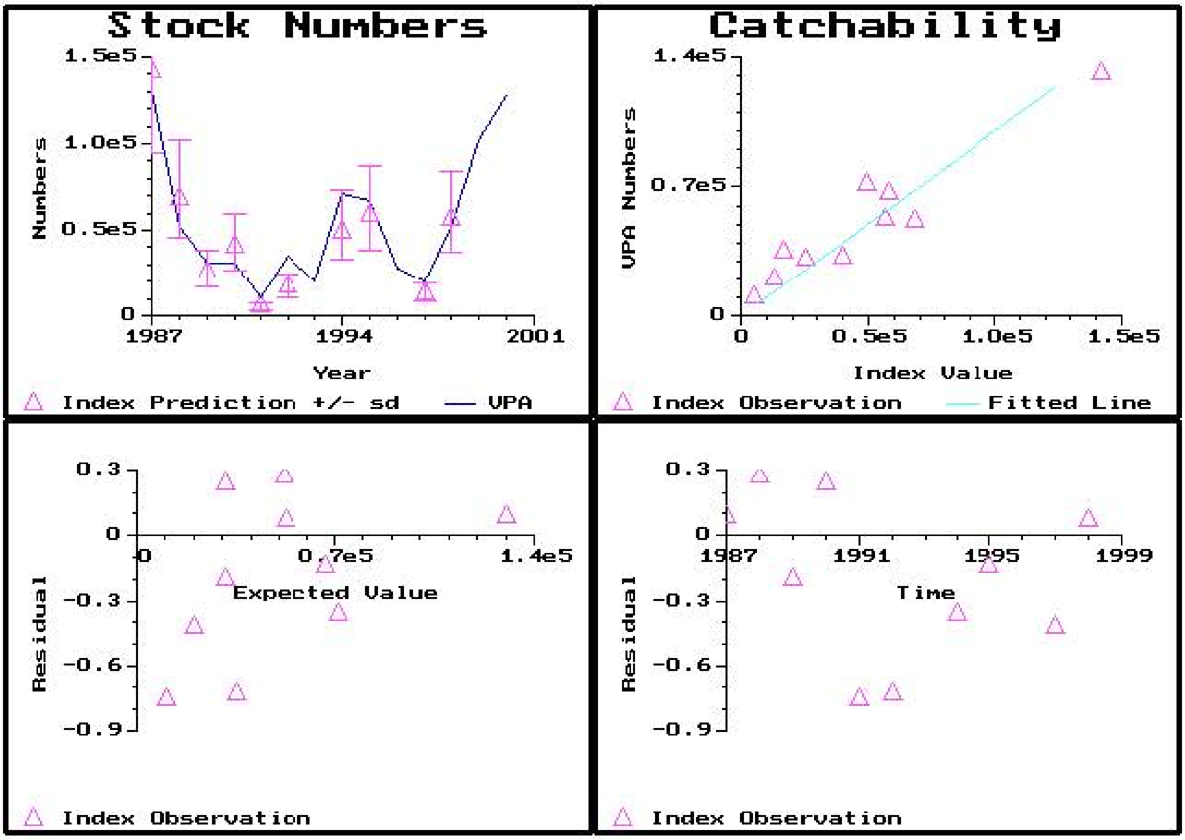


DEPM SUVEYS (Ages 1 to 3+) Age 2

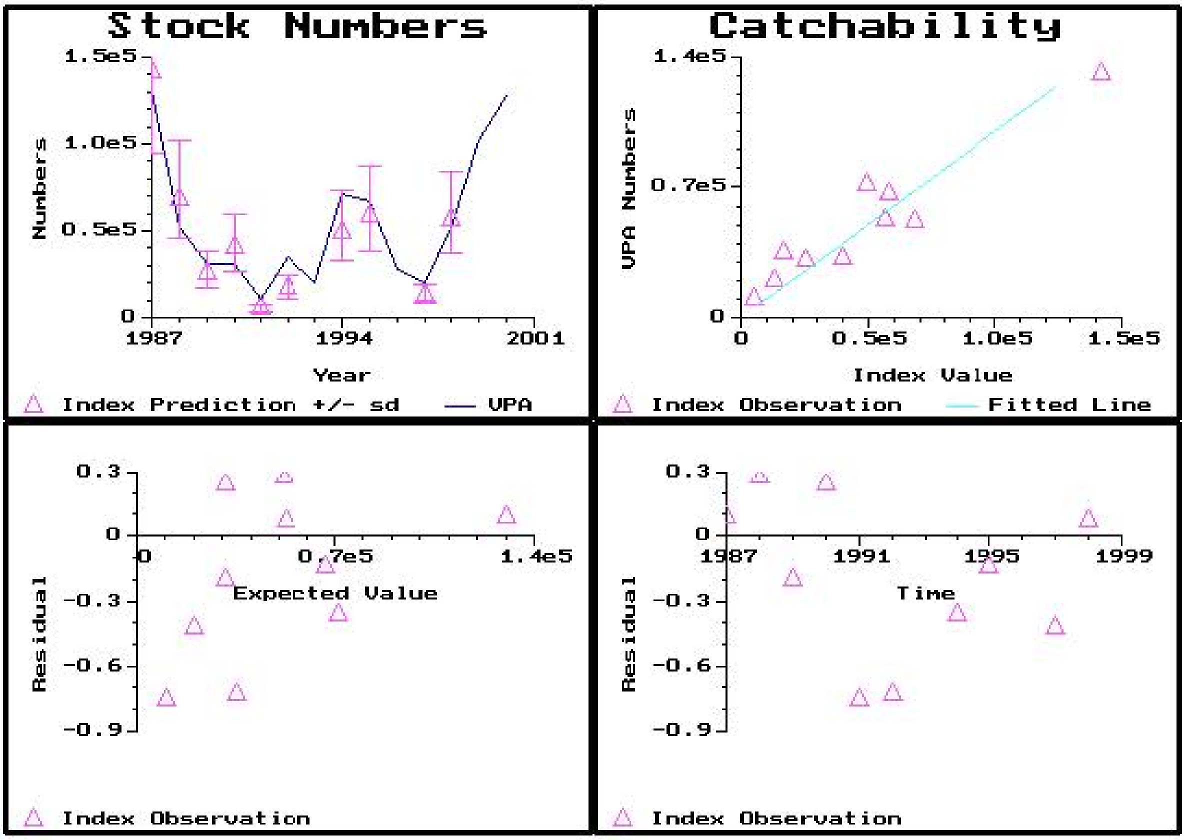


Figures 11.7.2.1 (Cont….)

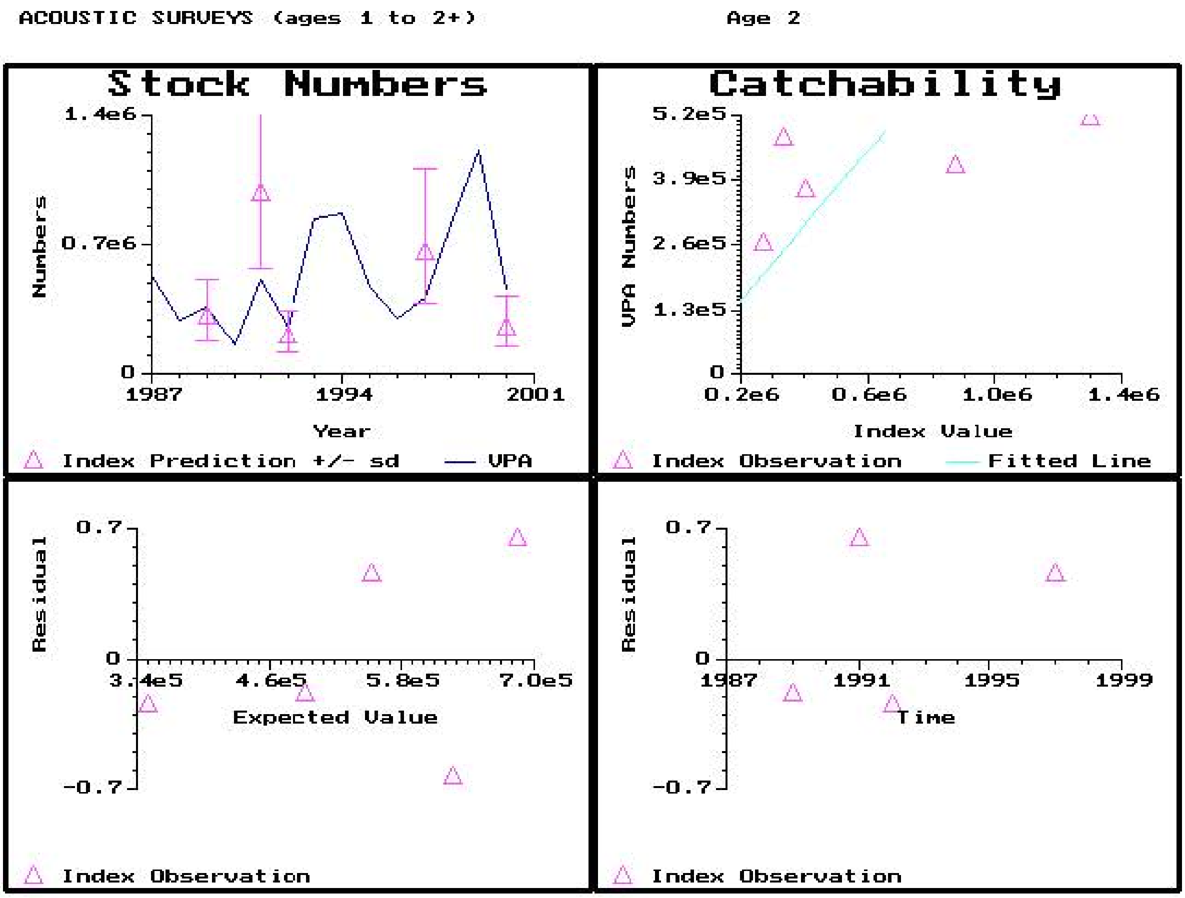
DEPM SUVEYS (Ages 1 to 3+) Age 3

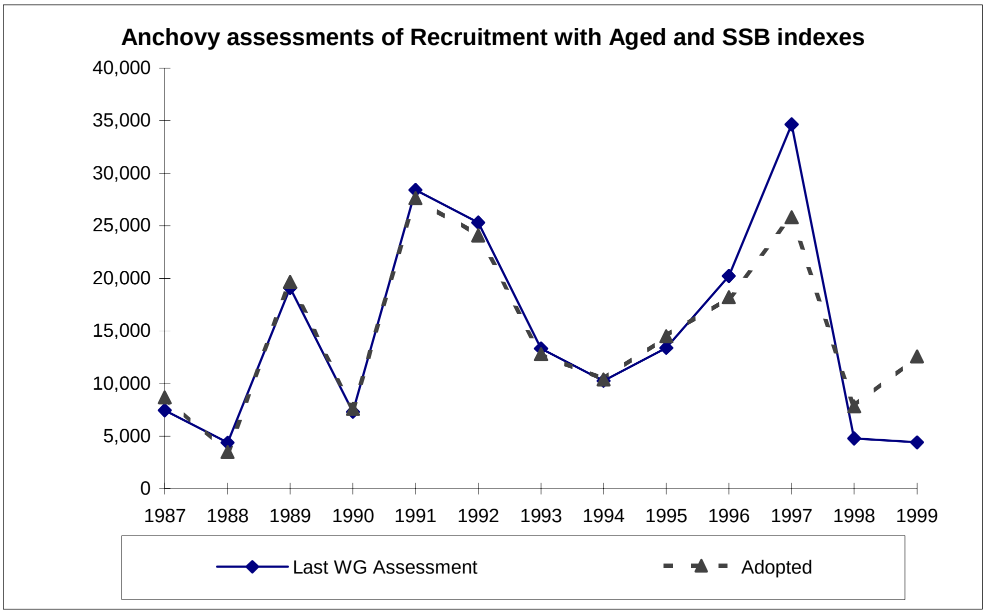


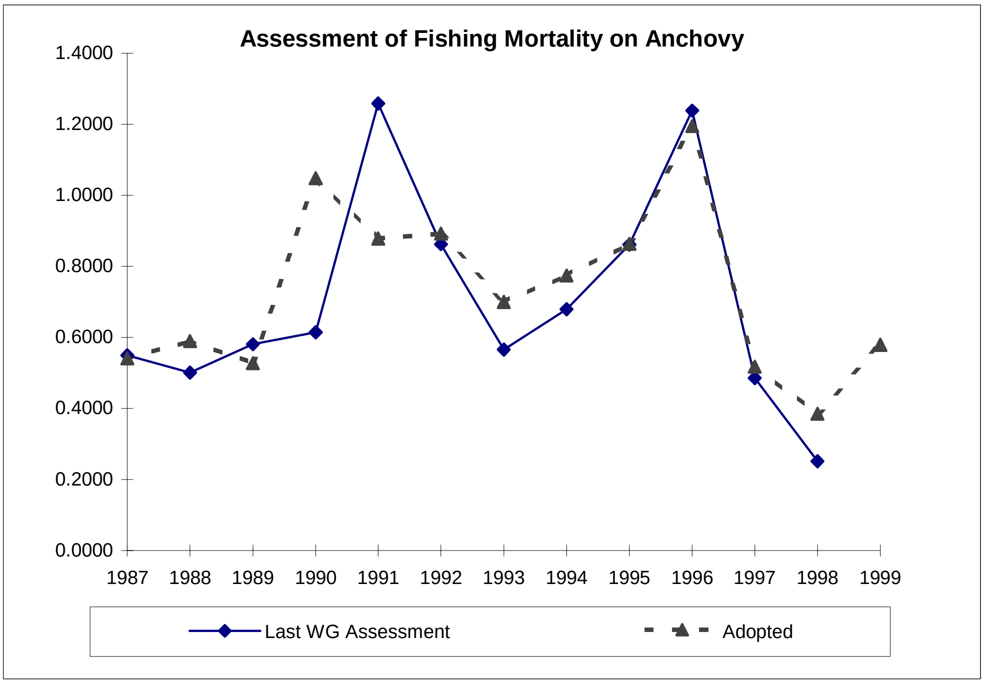
DEPM SUVEYS (Ages 1 to 3+) Age 3



Figures 11.7.2.1 (Cont….)







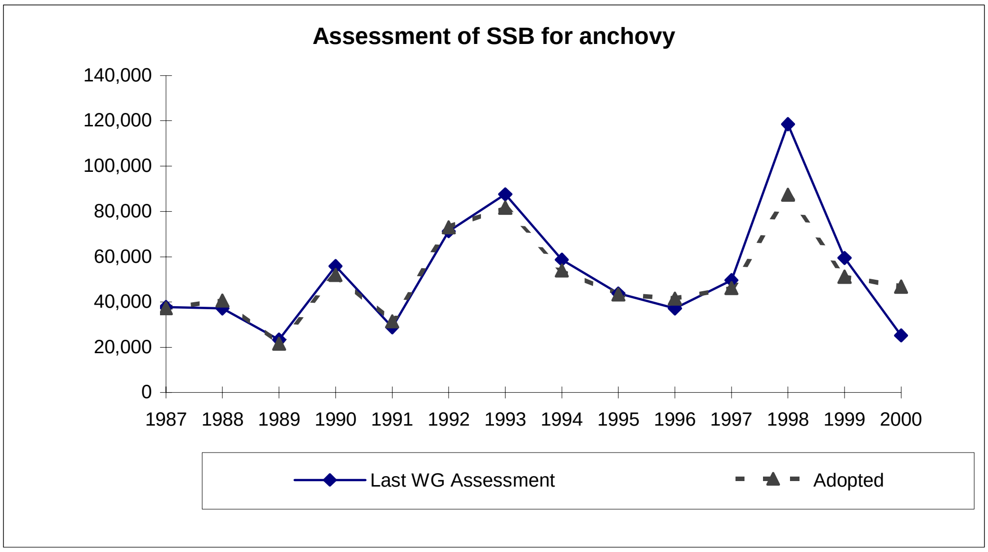


Figure 11.7.2.2: Comparison of last year assessment with the adopted one this year Concerning Anchovy in Subarea VIIII

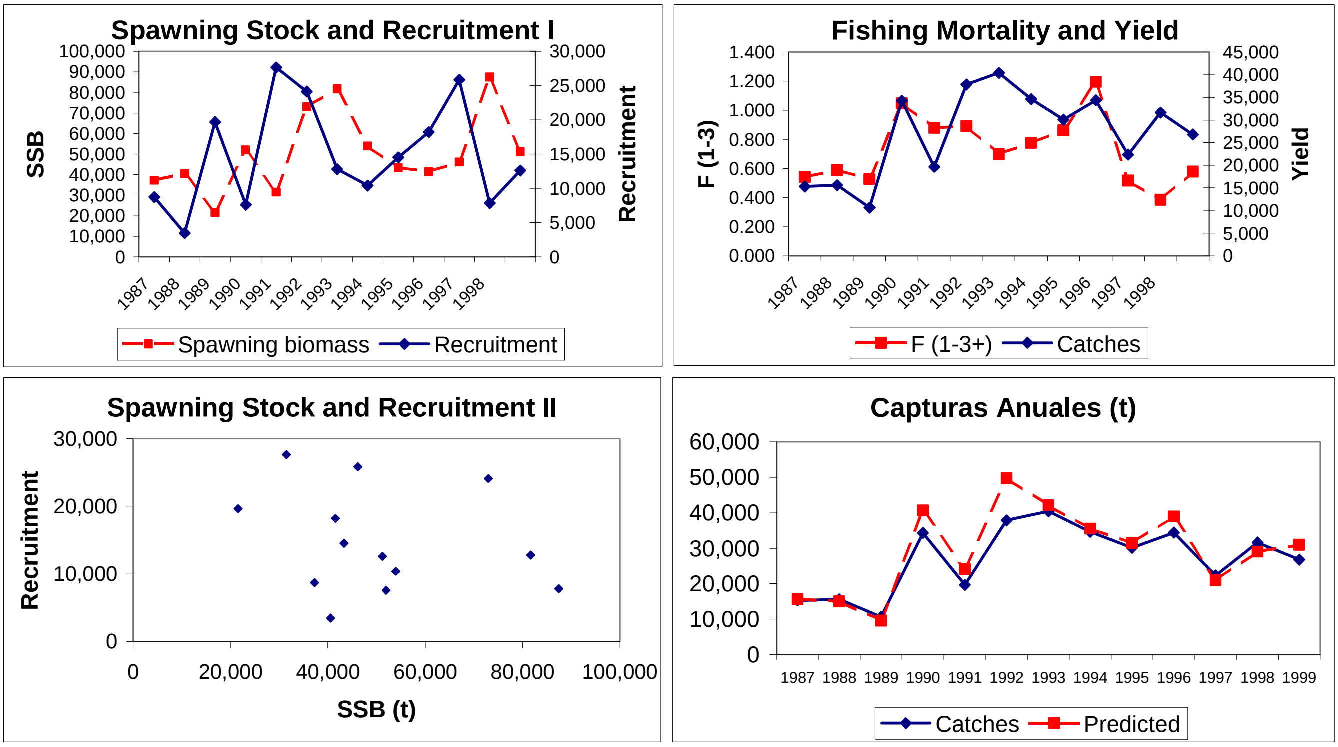


Figure 11. 7.3.1. Fish stock Summary - Anchovy in Sub-area VIII (Bay of Biscay).

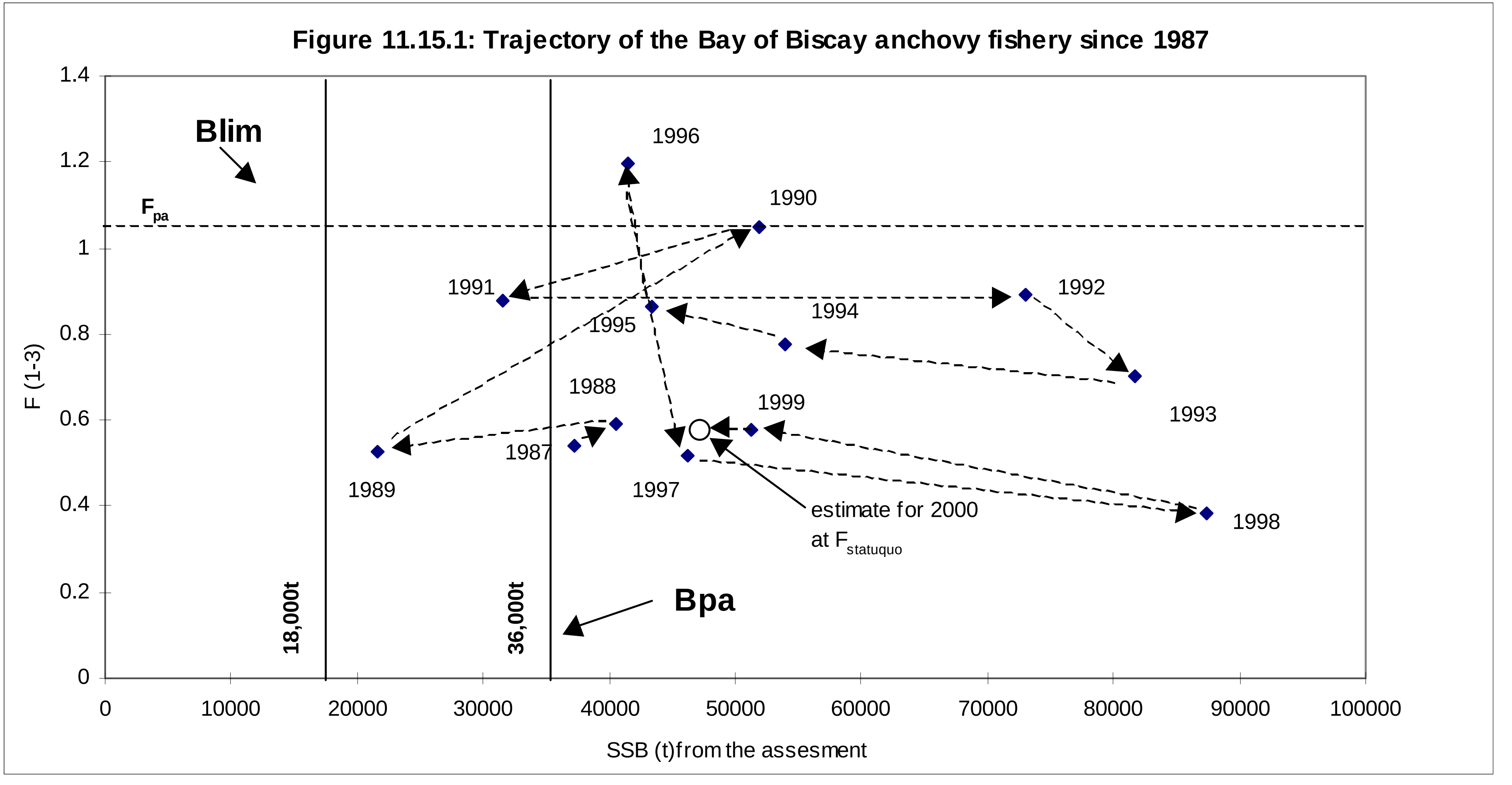


Figure 11.15.1: Trajectory of the Bay of Biscay anchovy fishery since 1987
Blim
Bpa
F_{pa}
18,000t
36,000t
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
estimate for 2000
at $F_{statuquo}$
F (1-3)
SSB (t) from the assesment
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000

12 ANCHOVY IN DIVISION IXA

12.1 ACFM Advice Applicable to 1999 and 2000

The advice given by ACFM was the following: If a traditional TAC is required it should be set at the average landings since 1988, excluding 1995, that is, 4,600 t in 1999 and 2000. For 2000, ACFM 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 in Division IXa was 13,000 tonnes for 1999 and 10,000 tonnes for 2000.

No management objectives have been articulated for this stock. The current TAC is almost three times higher than the average of catches of recent years (excluding 1995 and 1998), which is 4,600 t. In 1998, the catch of 11,000 t was over twice this level. It is recognised that the state of the resource can change quickly, and therefore an in-year monitoring and management would be appropiate. Lack of biological information for this stock hampers the provision of advice on more appropriate management measures. Monitoring of the stock would require regular sampling together with information from a series of acoustic and egg surveys.

12.2 The Fishery in 1999

In 1999 the anchovy fishery in Division IXa was once more situated in the Gulf of Cadiz (Sub-division IXa South) as is usual in this area, except in 1995, when it was mainly found in the northern part of Division IXa (Figure 12.2.1.1). Anchovy is the target species of the Spanish purse-seine fleet in the Gulf of Cadiz. The Spanish and Portuguese purse-seine fleets in the northern part of Division IXa target anchovy when abundance is high, due to high market prices, as occurred in 1995 (ICES 1997/ Assess:3). In 1999, the anchovy fishery in the northern part of Division IXa was low, as is usual in this area.

The increase in anchovy abundance in the northern part of Division IXa in 1995 may have been due to a variation in thermohaline conditions in the coastal waters northwest of the Iberian Peninsula, less saline and warmer than in preceding years (Diaz del Río et al., 1996 and ICES 1997/C:3), thus creating more favourable conditions for reproduction and larval survival. Before 1995 and since 1996 a change in the previously described trend occurred, with lower temperatures and increased salinity being registered (ICES 1997/C:3, ICES 1998/C:8 and ICES 1999/C:8).

The Spanish fleet in the Gulf of Cadiz is mainly made up of purse-seiners, though there is currently another kind of fleet present in the form of trawlers, whose usual target species is the deep-sea rose shrimp (*Parapenaeus longirostris*). Some of these trawlers switch to targeting anchovy in years when the yield of shrimps is low. The Spanish fleet in the west of Galicia is composed of purse-seiners. The Portuguese fleet is mainly made up of purse-seiners, with some trawlers and artisanal ships fishing a very small quantity of anchovies (Table 12.2.1.2).

12.2.1 Landings in Division IXa

The total catch in 1999 was 7,408 t (Table 12.2.1.1 and Figure 12.2.1.1), which represents a 32.4% decrease compared to the level of 1998 catches (10,962 t). Nevertheless, the catch in 1999 is still higher than the average catch levels registered in this area since 1988 (excluding 1995 and 1998). The decreased catches in 1999 are explained by the decrease experienced by the Spanish catches in the Gulf of Cadiz (Sub-division IXa South), where the anchovy fishery mainly takes place.

The Spanish catches also decreased in 1999 (6,000 t) with respect to 1998 (9,349 t) due to the aforementioned decrease in catches in the Gulf of Cadiz (Sub-division IXa South). Thus, Gulf of Cadiz catches decreased to 5,587 t in 1999, breaking the increasing trend which started since 1996 and culminated in the historical maximum for this area in 1998 (8,977 t). The average catch in the Gulf of Cadiz between 1988 and 1998 is about 4,200 t. The Spanish catches in Sub-division IXa North (413 t) have showed a slight increase with respect to those recorded in 1998 (371 t). However, these catches are still lower than those in 1995 (5,329 t), remaining at the low levels usually found in the area. The Portuguese catch in 1999 (1,408 t) slightly decreased with respect to 1998 (1,613 t) and fell respect to 1995 (7,056 t), (Table 12.2.1.1 and Figure 12.2.1.1).

Table 12.2.1.2 shows the catch by fishing gear and by country. In both countries the main part of the catch was taken using purse-seine, this gear accounting for 84% in the Spanish fishery and 96% in the Portuguese one. Spanish trawl catches of anchovy from the Gulf of Cadiz decreased from 1,148 t in 1998 to 993 t in 1999, although their relative importance in the whole anchovy fishery in this area has increased up to 18% in 1999 (13% in 1998).

From 1943 to 1987, catch data were only provided by Portugal, which varied between 88 t and 12,610 t (Table 12.2.1.1). The Portuguese annual landings alternate between periods of high catches (1936-1940, 1942-1948, 1955-1957, 1962-1966 and 1995) and periods of very low catch levels (1927-1936, 1966-1976, 1979-1984 and 1987-1994) (Pestana, 1996). For this same period, the Spanish catch data from the Gulf of Cadiz (Sub-division IXa South) cannot be provided since they have been combined with anchovy catches in the area of Morocco, whereas catches in Galician waters (Sub-division IXa North) are not available. The historical series of Spanish catches started in 1988 for the Gulf of Cadiz, and in 1989 for the Galician waters. Total Spanish catches from Division IXa ranged between 1,824 t (1996) and 9,349 t (1998).

12.2.2 Landings by Sub-division

Since 1988, the anchovy fishery in Division IXa was situated in the Gulf of Cadiz (Sub-division IXa South), except in 1995, when it was mainly found in the northern part of Division IXa (Sub-division IXa North and Central-North).

The distribution of Spanish catches in 1999 was similar to that of the years 1988-1994 and 1996-1998 (ICES 1992/Assess:17, ICES 1993/Assess: 19, ICES 1995/Assess: 2, ICES 1996/Assess: 7, ICES 1998/Assess: 6, ICES 1999/ACFM:6 and ICES 2000/ACFM:5) and completely different to that of 1995 (ICES 1997/Assess: 3). In 1999, the greatest catches (93%) were found in Sub-division IXa South (Gulf of Cadiz), and the rest (7%) in Sub-division IXa North (West of Galicia). Catches in the Gulf of Cadiz take place throughout the year, usually increasing in spring and summer. In 1998, however, catches were relatively stable throughout the year without undergoing any significant rise in spring-summer. This seasonal pattern was also evidenced in 1999, although autumn catches showed a lesser relative importance than in the precedent year. The small catches in Sub-division IXa North occurred mainly in the first and third quarters.(Table 12.2.2.1).

The greatest contribution to Portuguese annual landings came from IXa South during the period 1943-1967 (mean value 4,526 t).Thereafter, landings decreased to 386 t (mean value) from 1968 to 1983, and to 32 t (mean value) from 1984 to 1991. From 1992 to 1995, landings were less than 1 tonne, in 1996-1997 they were 32 t (mean value). In 1998, Portuguese landings from IXa South increased to 566 t, then decreasing to 355 t in 1999. In Sub-division IXa Central-North there were alternate periods of relatively high and low landings. After 1984, landings of Sub-division IXa Central-North made the greatest contribution to total annual landings (mean value 1,116 t). The mean percentage of landings by Sub-division (1970-1995) is 70% of the total in IXa Central-North, 5% in IXa Central-South and 20% in IXa South. The same landing pattern occurs in Sub-divisons IXa Central-North and Central-South during the period from 1970-1994 and in 1995 (Pestana, WD 1996). In 1996-1999, catches in Sub-division IXa Central-North and Central-South fell, but maintained the same pattern of catches as in the period 1970-1995.

Most of the Portuguese landings were made between May and October (mean 1927-1994). The 1995 landings show a different evolution with two very important periods, from April to June and from August to December. (Pestana, 1996). In 1996-1999, catches are taken mainly in the first and fourth quarters (Table 12.2.2.1).

12.3 Fishery-Independent Information

12.3.1 Acoustic surveys

In 1993, a Spanish acoustic survey to estimate anchovy abundance was carried out off 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 acoustic surveys have been conducted in this area by Spain. In Sub-division IXa North, Spain has been conducting acoustic surveys aimed at sardine since 1983, but no anchovy schools were detected (Carrera et al., WD 1999; Carrera, WD 2000).

In previous years, information on anchovy from the Portuguese sardine egg- and acoustic surveys in Division IXa was not available as there is no research project for anchovy in Portugal. Nevertheless, the updated information provided by IPIMAR from the November 1998 and March 1999 acoustic surveys for sardine has provided data about anchovy distribution and abundance (Morais, WD 2000). 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 32,959 t in November 1998, and 25,359 t in March 1999 (Table 12.3.1.1, Figure 12.3.1.3 and 12.3.1.4). The biggest concentrations of anchovy occurred in the Gulf of Cadiz (Spanish waters of the Sub-division IXa South), which accounted for 90% of total estimated biomass in both surveys (30,092 t and 24,763 t, respectively). As deduced from the integration values, large portions of such concentrations were composed by very dense schools located near the bottom and in depths between 50 and 90 m. Nevertheless, other surveys should be analysed to confirm whether this behavior is exceptional or not.

Off the Portuguese shelf, large concentrations of anchovy were found only in the area in front of Lisbon (Sub-division IXa Central-South), rendering biomass estimates of 1,951 t (November 1998) and 406 t (March 1999). Only low anchovy concentrations were found in small areas in the rest of the shelf(Table 12.3.1.1, Figure 12.3.1.3 and 12.3.1.4).

The anchovy size composition in the Sub-division IXa Central-North was clearly dominated by smaller anchovies (≤12.5 cm TL) than the ones found in Sub-division IXa Central-South, where anchovies larger than 13 cm TL were predominant. These differences were more noticeable during the November 1998 survey (Figure 12.3.1.5).

In the Sub-division IXa South, 71% (November 1998) and 59% (March 1999) of the Gulf of Cadiz anchovies were between 12 and 14 cm TL, although juveniles (5.5-8.0 cm TL) were also present (5% of total numbers) in the November 1998 survey. The size composition of the Algarvian anchovy was only available from the November 1998 survey, where 91% of the anchovies were between 11-14 cm TL (Figure 12.3.1.5).

12.4 Biological Data

12.4.1 Catch numbers at age

Catches at age of anchovy for the whole Division IXa are not available. The only available estimates were provided by Spain for anchovy catches in the Gulf of Cadiz (Sub-division IXa South) for the period 1996-1999. These data have been presented for the first time in this Working Group (Millán and Ramos, WD 2000).

Portugal has not provided estimates of length or age composition of anchovy landings in Sub-divisions IXa Central (north and south) and South (Algarve). Catches at age were only provided for the Spanish fishery in Sub-division IXa North in 1995, and these catches consisted of age 1 anchovies (ICES 1997/Assess:3). Catches at age of anchovy from this Sub-division are not normally available since commercial landings used to be insignificant, making very difficult the biological sampling of commercial catches. A few otolith samples were also collected in 1999, following the same procedure as in 1998. However, catches at age estimates are not presented owing to the small number of sampled otoliths and their failure to cover the whole length range. They were not considered representative of the population. Further, samples did not cover all quarters in the year. In the 1999 sample, 58.8% of anchovies were found to be age 1, 40.0% age 2 and 1.2% age 3 (B. Villamor, pers. comm.).

Difficulties experienced in recent years in age determination of the Gulf of Cadiz anchovy using otolith examination has also prevented from providing catch at age estimates of the Spanish landings in this area. In 1997 and 1998, an otolith exchange for the Gulf of Cadiz anchovy was carried out within the International Project co-funded by the European Commission entitled European Fish Ageing Network (EFAN), which aims at solving the difficulties involved in age reading. The conclusions reported from this exercise confirmed the existence of problems in the interpretation of both the otolith edge and the annual rings, which led to state the need for establishing more standarised ageing criteria for the species in this area (García Santamaría, 1998). Bearing in mind these problems, Millán and Ramos (WD 2000) have presented estimates of the age composition of Gulf of Cadiz anchovy landings from 1996 to 1999. The authors have corroborated the above problems in anchovy ageing and, therefore, such estimates must be considered as preliminary.

The age composition of the Gulf of Cadiz anchovy landings from 1996 to 1999 is presented in Table 12.4.1.1 and Figures 12.4.1.1 and 12.4.1.2. The Gulf of Cadiz anchovy fishery is supported by the 0, 1 and 2 age-groups. These results differ from those obtained from the EFAN exercise, in which older anchovies of 3 and 4 years old were also identified. By applying length frequency analysis methods to the 1989-1993 data series, Bellido *et al*. (2000) also conclude that the fishery is mainly supported by the 0, 1 and 2 age-groups, 2 year-old fish making up for only 3% of the fishery (pooled data for the whole series).

Following the estimates given in the WD, the contribution of the 0 and 1 age groups in 1996 and 1997 was different to that observed in 1998 and 1999 (Figure 12.4.1.1). In the first two years, the percentage composition of both age groups in landings was similar, with percentages around 50% each, whereas in the two following years 1 year-old anchovies largely dominated the landings, representing 69% and 73%, respectively.

Recruits showed a decreasing trend in relative numbers and weights during the period analysed, the lowest percentage (22%) being recorded in 1999. However, the highest catches in number and weight at age 0 in absolute terms were landed in 1998 and the lowest ones in 1999.

The success of the Gulf of Cadiz anchovy fishery is mainly related to the high abundance of the 1 year-old anchovies (Figure 12.4.1.2). This fact became apparent in 1998 and 1999, when 1 year-old anchovies (1997 and 1998 year classes) made up for 78% and 81% of the landings.

The 2 year-old anchovies were poorly represented in the landings, ranging between 1% (1996 and 1998) and 8% (1997). In 1999, this age group made up for about 5% of the total catch in numbers.

Landings of the 0 age-group anchovies were restricted to the second half in the year, whereas those of 1 and 2 year-old anchovies were present throughout the year, although they were 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 1999 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 1999 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 from 1988 to 1999. Figure 12.4.2.2 compares length distributions in Sub-divisions IXa South and IXa North from 1995 to 1999.

In 1999, as in previous years, a large number of juveniles were captured (individuals less than 10 cm long) in Sub-division IXa South 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 catch in Sub-division IXa South are smaller than those recorded from Sub-division IXa North (Table 12.4.2.2 and Figures 12.4.2.1 and 12.4.2.2).

Mean Length- and Mean Weight at Age in Landings

Mean length- and mean weight at age data for the whole Division IXa are not available for 1999 for the same reasons as explained previously (see Section 12.4.1).

Mean length and mean weight at age for 1 year-old fish in the catch of Sub-division IXa North in 1995 were 15.6 cm and 26.0 g respectively (ICES 1997/Assess:3). From the small samples of otoliths obtained in Sub-division IXa North in 1999, mean lengths were 15.5 cm, 17.6 cm and 17.9 cm for ages 1, 2 and 3 respectively (B. Villamor, pers. comm.). These mean lengths at age were almost identical to those estimated from the 1998 otolith sample (ICES 2000/ACFM: 5)

Mean lengths were estimated at 9.3 cm for age 0, 12.4 cm for age 1, 13.7 cm for age 2, 15.0 cm for age 3 and 15.5 for age 4 from the sample of otoliths of the Gulf of Cadiz anchovies (Sub-division IXa South) used in the EFAN otolith exchange (García Santamaría, 1999). As previously cited, Millán and Ramos (WD 2000) only recorded anchovies not older than 2 years. The annual and quarterly estimates of mean length- and mean weight at age in the 1996-1999 Spanish landings are showed in Tables 12.4.2.3 and 12.4.2.4. The smallest annual mean length- and mean weight at ages 0 and 1 were recorded in 1996 (6.3 cm and 6.9 cm; 2 g and 3 g).

An increase in the mean length (from 7.6 cm to 8.3 cm) was observed in the 0 age group between 1997 and 1998. A decrease to 7.4 cm was noted in 1999. The mean weight of this age group after 1996 varied between 3g (1997, 1999) and 4 g (1998).

Since 1997 onwards, the mean length at age 1 was mantained at around 10 cm, its mean weight ranging between 7 g (1998) and 9 g (1999). The mean length of the two year-old anchovies ranged between 13.6 cm and 14.3 cm, showing a stable inter-annual trend throughout the four-year period. Conversely, annual mean weights at age 2 showed a decreasing trend, from 19 g in 1996 to 16 g in 1998, but then increasing up to 18 g in 1999.

Seasonally, 0 age-group anchovies are larger and heavier in the fourth quarter. The 1 and 2 year-old anchovies showed 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 study undertaken over a four-year period (1989-1992) in the Spanish waters of the Gulf of Cadiz (Sub-division IXa South) show that the anchovy 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 reached 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).

Recent data from the Portuguese acoustic surveys in November 1998 and March 1999 (Morais, pers. comm.) indicated that 45% of anchovies in November 1998 and 78% in March 1999 were mature in the Algarve-Gulf of Cádiz area. 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 (see section 12.3.1 and Morais, WD 2000). 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.

12.5 Effort and Catch per Unit Effort

Data provided on fishing effort (number of effective fishing trips) and CPUE indices of anchovy in Division IXa correspond to the Spanish purse-seine fleet in the Gulf of Cadiz from 1988 to 1999, and to the Spanish purse-seine fleet in Sub-division IXa North from 1995 to 1999 (Table 12.5.1 and 12.5.2). No Portuguese data are available.

The effort and CPUE series of the Barbate single-purpose fleet in the Gulf of Cadiz experienced a strong declining trend from 1991 to 1995, this last year registering the lowest values for both variables. The decrease in fishing effort was not evident in the remaining Spanish fleets which showed fluctuating effort levels. However, their CPUE series also exhibited decreasing trends. Since 1996 onwards, an increase in effort is observed in the Barbate single-purpose and Sanlucar fleets, with a considerable increase in CPUE in the Barbate single-purpose fleet (Figure 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 (Figure 12.5.2).

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

Despite new biological information presented this year, no assessment of this stock can be made for the following reasons:

Catch-at-age data are only available for one part of the stock (Spanish Gulf of Cadiz), and this data series is still short (1996-1999).

The series of biomass estimates from acoustic surveys is also very short.

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 (see Sections 12.3 and 12.4), support the view that the populations inhabiting these areas may have different biological characteristics and dynamics.

Anchovy biomass in Division IXa was estimated at 32,959 t in November 1998 and at 25,359 t in March 1999 from acoustic surveys, 90% of these estimated biomass corresponded to the Gulf of Cadiz in both surveys (30,092 t and 24,763 t respectively). Anchovy biomass in the Gulf of Cadiz was estimated as 6,569 t in an acoustic survey in 1993.

Because of the lack of a more complete biological information, the state of the stock is unknown. By analogy with the anchovy stock in Sub-area VIII, it seems that this stock will fluctuate widely due to variations in recruitment largely driven by environmental factors.

12.8 Catch Preditions

No catch preditions 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 were the same as for the previous year and are summarised by Millan and Villamor (WD 1992). It must be pointed out that the purse-seine fleet in the Gulf of Cadiz did not observe the normal voluntary closure of three months in 1997, 1998 and 1999 (ICES 1992/Assess:17, ICES 1993/Assess:19, ICES 1995/Assess: 2, ICES 1996/Assess: 7, ICES 1997/Assess: 3 and ICES 1998/Assess: 6). The fleet probably continued fishing because of higher anchovy abundance.

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 catches (excluding 1995 and 1998) is recommended. The mean catches from the period 1988-1999 (excluding 1995 and 1998) are about 4,900 t.

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

(-) Not available
(0) Less than 1 tonne

Table 12.2. 1.2 ANCHOVY IXa. Catches (t) by gear and by country in 1988-1999.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594
Trawl IX a South	0.0	0.0	0.0	0.0	0.0	330	152	75	224	190	1148	993
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408
Trawl					4	9	1		56	46	37	43
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346
Artisanal					1	1	3		94	7	35	20
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409

* Portugal data without separate the catch by gear

Table 12.2.2.1 Anchovy catches (t) in Division IXa by country and Subdivisions in 1999.

COUNTRY	SUBDIVISIONS	QUARTER 1 C(t)	QUARTER 1 %	QUARTER 2 C(t)	QUARTER 2 %	QUARTER 3 C(t)	QUARTER 3 %	QUARTER 4 C(t)	QUARTER 4 %	ANUAL C (t)	ANUAL %
SPAIN	IXa North	76	18.4	7	1.8	318	76.9	12	2.9	413	6.9
	IXa South	1335	23.9	1982	35.5	1582	28.3	687	12.3	5587	93.1
	TOTAL	1411	23.5	1990	33.2	1900	31.7	699	11.6	6000	
PORTUGAL	IXa Central North	91	9.5	4	0.4	139	14.5	723	75.5	957	68.0
	IXa Central South	65	68.2	0	0.2	0	0.2	30	31.3	96	6.8
	IXa South	303	85.3	13	3.5	35	9.8	5	1.3	355	25.2
	TOTAL	460	32.6	17	1.2	174	12.4	758	53.8	1408	
TOTAL	IXa North	76	18.4	7	1.8	318	76.9	12	2.9	413	5.6
	IXa Central North	91	9.5	4	0.4	139	14.5	723	75.5	957	12.9
	IXa Central South	65	68.2	0	0.2	0	0.2	30	31.3	96	1.3
	IXa South	1638	27.6	1995	33.6	1617	27.2	692	11.6	5942	80.2
	TOTAL	1871	25.3	2006	27.1	2074	28.0	1457	19.7	7408	

Table 12.3.1.1. Estimated abundance in number (millions) and biomass (tonnes) from the 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 (t)	313	1951	603	2867	30092	32959
March 1999	Number	22	15	*	37	2079	2116
	Biomass (t)	190	406	*	596	24763	25359

* 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.

Table 12.4.1.1. Spanish catches in numbers at age (in thousands) of Gulf of Cadiz anchovy for 1996-1999, by year and quarter.

YEAR		QUARTERS				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	413465	71074	317216
	1	12772	130880	11550	7281	327614
	2	13	882	826	333	4249
	Total (n)	12785	131761	425842	78688	649078
	Catch (t)	41	807	585	348	1780
	SOP	36	742	619	299	1680
	VAR.%	88.11	92.06	105.87	85.97	94.36
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	237283	96475	273842
	1	67055	123878	69278	19430	330348
	2	22601	9828	11649	745	53737
	Total (n)	89656	133706	318211	116650	657927
	Catch (t)	906	1110	2006	578	4600
	SOP	844	1273	1923	596	4590
	VAR.%	93.07	114.71	95.88	103.07	99.78
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	75708	360599	432554
	1	325407	384529	220869	84729	1017658
	2	11066	879	1316	0	14889
	Total (n)	336473	385408	297893	445329	1465102
	Catch (t)	1773	2113	2514	2579	8977
	SOP	1923	2128	2599	2655	9299
	VAR.%	108.46	100.72	103.41	102.95	103.59
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	40549	84234	140055
	1	249922	115218	86931	20276	458099
	2	10982	18701	2450	146	30085
	Total (n)	260904	133919	129931	104656	628239
	Catch (t)	1335	1983	1582	687	5587
	SOP	1330	1756	1391	673	5111
	VAR.%	99.61	88.60	87.90	98.02	91.48

Table 12.4.2.1: Length distribution ('000) of ANCHOVY in Division IXa by country and Sub-divisions in 1999.

Length (cm)	QUARTER 1 SPAIN IXa North	QUARTER 1 PORTUGAL IXa C,CN,S	QUARTER 1 SPAIN IXa South	QUARTER 2 SPAIN IXa North	QUARTER 2 PORTUGAL IXa C,CN,S	QUARTER 2 SPAIN IXa South	QUARTER 3 SPAIN IXa North	QUARTER 3 PORTUGAL IXa C,CN,S	QUARTER 3 SPAIN IXa South	QUARTER 4 SPAIN IXa North	QUARTER 4 PORTUGAL IXa C,CN,S	QUARTER 4 SPAIN IXa South	TOTAL SPAIN IXa North	TOTAL PORTUGAL IXa C,CN,S	TOTAL SPAIN IXa South
3.5	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
4	0	-	1831	0	-	0	0	-	0	0	-	0	0	-	1831
4.5	0	-	15819	0	-	0	0	-	1236	0	-	0	0	-	17055
5	0	-	38804	0	-	0	0	-	2296	0	-	0	0	-	41100
5.5	0	-	34062	0	-	0	0	-	2119	0	-	0	0	-	36181
6	0	-	17339	0	-	0	0	-	1854	0	-	173	0	-	19366
6.5	0	-	16299	0	-	0	0	-	2914	0	-	1208	0	-	20421
7	0	-	11705	0	-	0	0	-	3974	0	-	2070	0	-	17749
7.5	0	-	5577	0	-	0	0	-	7647	0	-	5865	0	-	19089
8	0	-	1862	0	-	134	0	-	7363	0	-	11475	0	-	20835
8.5	0	-	1603	0	-	554	0	-	4464	0	-	9103	0	-	15724
9	0	-	2350	0	-	1072	0	-	2501	0	-	9015	0	-	14937
9.5	0	-	3593	0	-	2005	0	-	1498	0	-	10390	0	-	17487
10	0	-	5977	0	-	4585	0	-	2176	0	-	10792	0	-	23530
10.5	0	-	8935	0	-	5913	0	-	3478	0	-	13156	0	-	31482
11	0	-	9936	0	-	8294	0	-	7644	0	-	7719	0	-	33593
11.5	0	-	15791	0	-	11202	0	-	8584	0	-	4427	0	-	40004
12	0	-	21447	0	-	20221	0	-	8678	0	-	5267	0	-	55614
12.5	0	-	22351	0	-	25349	0	-	11085	0	-	7599	0	-	66384
13	0	-	14835	0	-	17713	0	-	16058	0	-	4020	0	-	52625
13.5	76	-	6386	0	-	16773	16	-	14220	1	-	1340	92	-	38719
14	218	-	2432	0	-	10084	27	-	9776	1	-	670	246	-	22962
14.5	360	-	1453	0	-	5626	133	-	5985	5	-	184	497	-	13247
15	839	-	400	20	-	2830	208	-	3397	8	-	184	1075	-	6811
15.5	339	-	118	71	-	1564	721	-	741	28	-		1160	-	2422
16	196	-		92	-	659	1320	-	229	51	-		1658	-	889
16.5	90	-		71	-	227	2185	-	18	84	-		2430	-	246
17	45	-		10	-		2086	-		80	-		2221	-	0
17.5	178	-		0	-		1482	-		57	-		1717	-	0
18	134	-		0	-		878	-		34	-		1045	-	0
18.5	59	-		0	-		325	-		12	-		397	-	0
19	164	-		0	-		147	-		6	-		317	-	0
19.5	89	-		0	-		46	-		2	-		138	-	0
20	0	-		0	-		0	-		0	-		0	-	0
20.5	0	-		0	-		0	-		0	-		0	-	0
21	0	-		0	-		0	-		0	-		0	-	0
21.5	0	-		0	-		0	-		0	-		0	-	0
22	0	-		0	-		0	-		0	-		0	-	0
Total N	2787	-	260904	265	-	134805	9574	-	129938	367	-	104656	12993	-	630304
Catch (T)	76	460	1335	7	17	1983	318	174	1582	12	758	687	413	1408	5587
L avg (cm)	16.0	-	8.7	16.2	-	12.7	17.1	-	11.4	17.1	-	10.2	16.8	-	10.4
W avg (g)	27.3	-	5.1	27.3	-	14.7	33.2	-	12.2	33.2	-	6.6	31.8	-	8.9

Table 12.4.2.2: Annual Length distribution ('000) of ANCHOVY in Division IXa from 1988 to 1999.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999	
Length (cm)	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa South**	**SPAIN IXa North**	**SPAIN IXa South**	**SPAIN IXa North**	**SPAIN IXa South**	**SPAIN IXa North**	**SPAIN IXa South**	**SPAIN IXa North**	**SPAIN IXa South**	**SPAIN IXa North**	**SPAIN IXa South**
3.5											1349						
4			4011	258	1						12677						1831
4.5		127	16601	3306	26	22					67819		1333		4656		17055
5	128	452	29122	43814	80	22					160894		11492		25825		41100
5.5	170	813	43716	77144	345	66					129791		38722		57086		36181
6		994	39979	43378	921	180					52812		53185		82442		19366
6.5		1207	37909	24724	2337	611	5488				33640		50275		76694		20421
7	255	2391	29592	15470	3567	1862	12009				32469		62492		68074		17749
7.5	351	5764	27140	16574	5993	3561	18391		439		19088		42120		43197		19089
8	3163	24708	24315	16633	12777	4083	23533		439		8949		45120		32964		20835
8.5	8073	62795	33427	15724	18240	2626	22031		447		11776		36200		47796		15724
9	12602	52082	46239	19735	14461	3843	20272		3108		12007		20009	156	78561		14937
9.5	21594	42387	74823	30742	20684	6848	14835		9805		6844		13611	367	106350		17487
10	34293	67553	95844	39474	31524	7100	23726		11823		4887		8951	754	132106		23530
10.5	49922	69793	96132	71062	31870	9496	27521		14966		7156		12231	1486	150718		31482
11	63848	68387	72419	83835	31776	9401	28394		8575		17343		22647	2047	158806		33604
11.5	55186	55528	63427	81931	31150	11636	33602		7105		21738		27353	1477	133585		40004
12	60928	41099	44273	77372	34504	24713	26439	74	4565		17855		39131	1267	99586		55614
12.5	37457	34212	28509	51932	29185	32918	30192	711	3606		11544		45267	1178	76285		66384
13	22608	17989	15263	43309	17040	26293	15732	3049	1855	8	6450	374	46852	2737	44979		52625
13.5	8149	11505	10619	25316	5725	12681	8517	3381	1544	12	4468	997	38183	2403	25038	92	38719
14	4270	7747	4689	17842	3378	5318	5719	14998	935	258	3880	2004	19127	3038	11847	246	22962
14.5	474	3190	1206	5211	2180	2535	4763	25944	135	335	1990	422	11268	2813	5712	497	13247
15	3896	2245	605	1987	315	943	3612	46371	138	375	790	48	6370	1976	2080	1075	6811
15.5	2436	1671	318	944	922	510	874	42244	6	226	703	40	3764	890	579	1160	2422
16	2126	4676	340	1533	355	56	813	44171		227	159	33	2224	560	138	1658	889
16.5	1690	7271	565	2087	271		368	14369		151		10	296	330		2430	246
17	1096	4349	373	1655	95		182	8378		104		10		438		2221	
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
Catch (T)	4263	5336	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587
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
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

Table 12.4.2.3. Mean length (±SD) at age (TL, in cm) in the Spanish catches of Gulf of Cadiz anchovy on a yearly and quarterly basis (1996-1999).

YEAR		**QUARTERS**				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			5.6 (0,8)	7.3 (1,9)	6.3 (1,9)
	1	7.4 (1,9)	8.5 (3,5)	12.9 (1,0)	13.7 (0,6)	6.9 (2,8)
	2	14.0 (0,4)	13.9 (0,4)	15.2 (0,5)	15.6 (0,2)	14.3 (0,7)
	Total	7.4 (1,9)	8.5 (3,5)	5.8 (1,5)	7.9 (2,7)	6.6 (2,5)
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.1 (1,4)	8.1 (1,8)	7.6 (1,6)
	1	10.0 (2,5)	10.5 (2,5)	13.1 (1,0)	13.0 (0,9)	10.2 (3,0)
	2	13.4 (0,6)	14.0 (0,6)	15.0 (0,8)	15.1 (0,4)	13.8 (0,9)
	Total	10.9 (2,6)	10.8 (2,6)	8.7 (3,0)	8.9 (2,5)	9.4 (3,0)
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.1 (1,9)	8.8 (2,1)	8.3 (2,2)
	1	9.5 (1,8)	9.2 (2,2)	11.9 (1,1)	12.2 (0,9)	10.2 (2,1)
	2	13.23 (0,6)	14.0 (0,4)	15.0 (0,5)		13.6 (0,8)
	Total	9.6 (1,9)	9.2 (2,2)	10.7 (2,5)	9.5 (2,3)	9.7 (2,3)
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.7 (1,6)	9.3 (1,3)	7.4 (2,2)
	1	8.2 (3,1)	12.2 (1,2)	12.7 (1,3)	12.5 (0,7)	10.7 (2,8)
	2	13.4 (0,7)	14.1 (0,7)	15.2 (0,4)	14.9 (0,2)	14.0 (0,9)
	Total	8.4 (3,3)	12.5 (1,3)	11.2 (2,8)	10.0 (1,7)	10.1 (3,1)

Table 12.4.2.4. Mean weight (±SD) at age (in g) in the Spanish catches of Gulf of Cadiz anchovy on a yearly and quarterly basis (1996-1999).

YEAR		QUARTERS				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			1.1 (0,6)	2.6 (2,0)	1.9 (2,4)
	1	2.8 (2,0)	5.6 (4,7)	14.2 (3,4)	15.3 (2,2)	3.1 (4,3)
	2	17.6 (1,5)	17.0 (1,5)	23.1 (2,2)	22.8 (0,9)	18.9 (3,2)
	Total	2.8 (2,1)	5.6 (4,8)	1.5 (2,5)	3.9 (4,4)	2.6 (3,8)
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			2.6 (1,6)	3.4 (2,7)	3.1 (2,3)
	1	7.3 (4,5)	8.8 (5,2)	15.1 (3,5)	13.1 (3,0)	8.5 (5,8)
	2	15.6 (2,5)	18.6 (2,7)	22.8 (3,6)	21.3 (1,9)	17.5 (3,7)
	Total	9.4 (5,4)	9.5 (5,6)	6.0 (6,5)	5.1 (4,7)	7.0 (6,1)
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			2.6 (2,3)	4.7 (2,9)	4.1 (2,9)
	1	5.44 (2,8)	5.5 (3,6)	10.7 (3,0)	11.2 (2,7)	7.2 (3,9)
	2	13.78 (1,9)	18.7 (1,8)	21.6 (2,2)		16.1 (3,1)
	Total	5.7 (3,2)	5.5 (3,7)	8.7 (4,6)	6.0 (3,9)	6.3 (4,0)
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			3.2 (2,2)	5.1 (2,0)	3.1 (2,8)
	1	4.7 (4,7)	12.1 (3,7)	13.9 (4,0)	11.7 (2,1)	9.0 (5,3)
	2	14.6 (2,7)	19.5 (3,5)	23.5 (1,9)	19.9 (0,8)	17.8 (3,6)
	Total	5.1 (5,0)	13.1 (4,5)	10.7 (6,3)	6.4 (3,3)	8.1 (2,8)

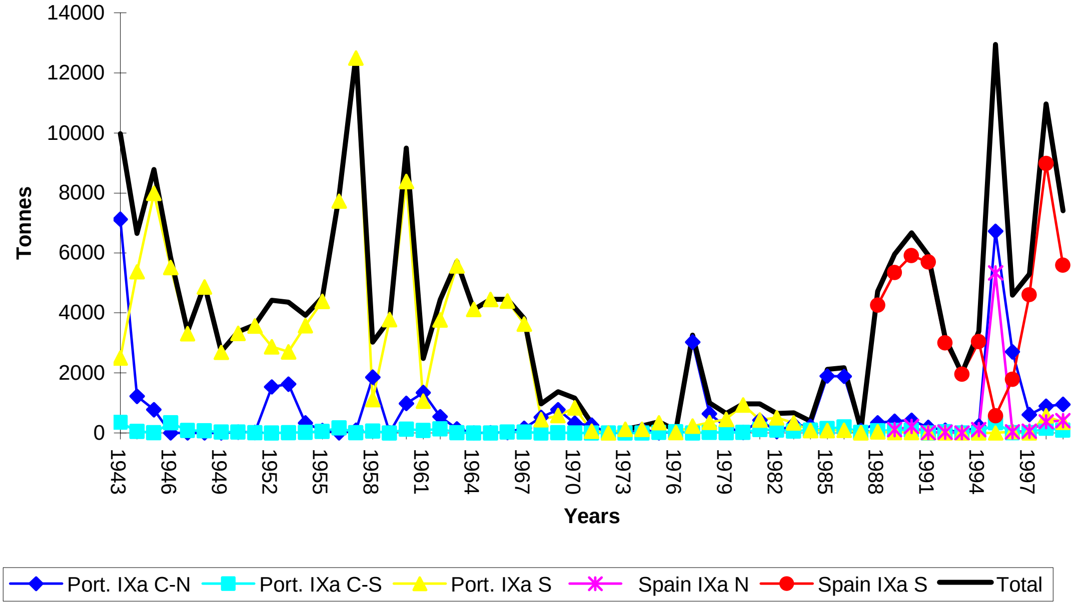
Table 12.5.1 ANCHOVY in Division IXa. Effort data : Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) number of fishing trips.

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE	BARBATE	SAN LUCAR	I. CRISTINA	I.CRISTINA	VIGO	RIVEIRA
Year	Single purpose	Multi purpose	Multi purpose	Single purpose	Multi purpose		
	No. fishing trip					No. fishing trip	
1988	3958	17	210	-	-	-	-
1989	4415	39	234	-	-	-	-
1990	4622	92	660	-	-	-	-
1991	3981	40	919	-	-	-	-
1992	3450	116	583	-	-	-	-
1993	2152	5	225	-	-	-	-
1994	1625	69	899	196	28	-	-
1995	528	17	377	22	17	1537	252
1996	1595	89	1659	76	55	32	3
1997	2207	115	1738	75	13	31	23
1998	2153	-	2234	177	30	134	269
1999	1762	9	2167	330	257	51	85

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

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE	BARBATE	SAN LUCAR	I. CRISTINA	I.CRISTINA	VIGO	RIVEIRA
Year	Single purpose	Multi purpose	Multi purpose	Single purpose	Multi purpose		
	kg/No. fishing trip					kg/No. fishing trip	
1988	1047	461	420	-	-	-	-
1989	1139	534	943	-	-	-	-
1990	1128	287	643	-	-	-	-
1991	1312	339	456	-	-	-	-
1992	819	173	300	-	-	-	-
1993	641	268	225	-	-	-	-
1994	1326	262	398	204	174	-	-
1995	377	134	166	52	25	2509	2286
1996	497	315	246	137	157	847	4
1997	1580	306	288	134	163	1068	639
1998	3144	-	221	242	197	1489	512
1999	2162	219	241	134	150	1088	1585

Figure 12.2.1.1: Portuguese and Spanish annual landings of Anchovy in Division IXa since 1943



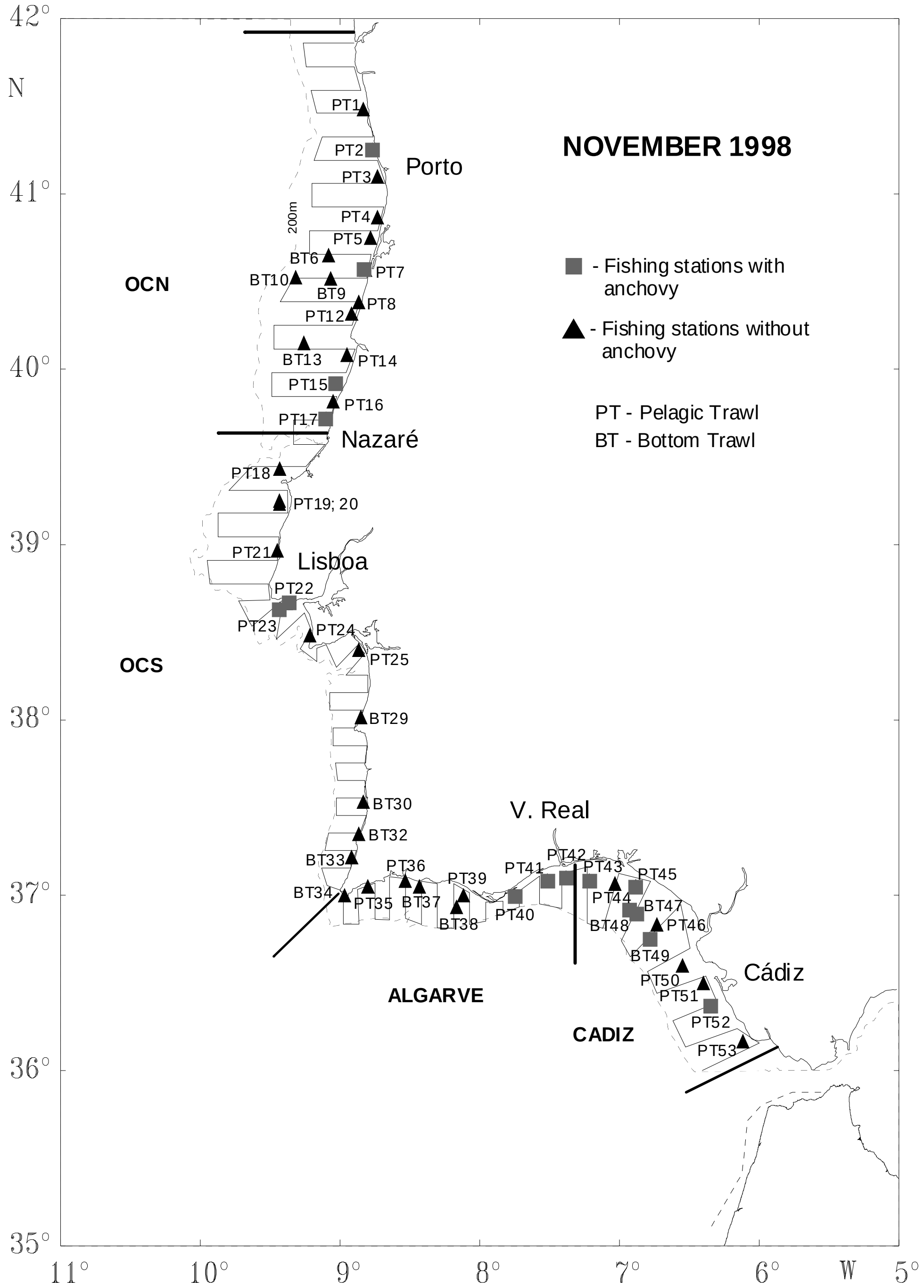


Figure 12.3.1.1. Survey track design and location of trawl stations (with and without anchovy) in November 1998 acoustic survey.

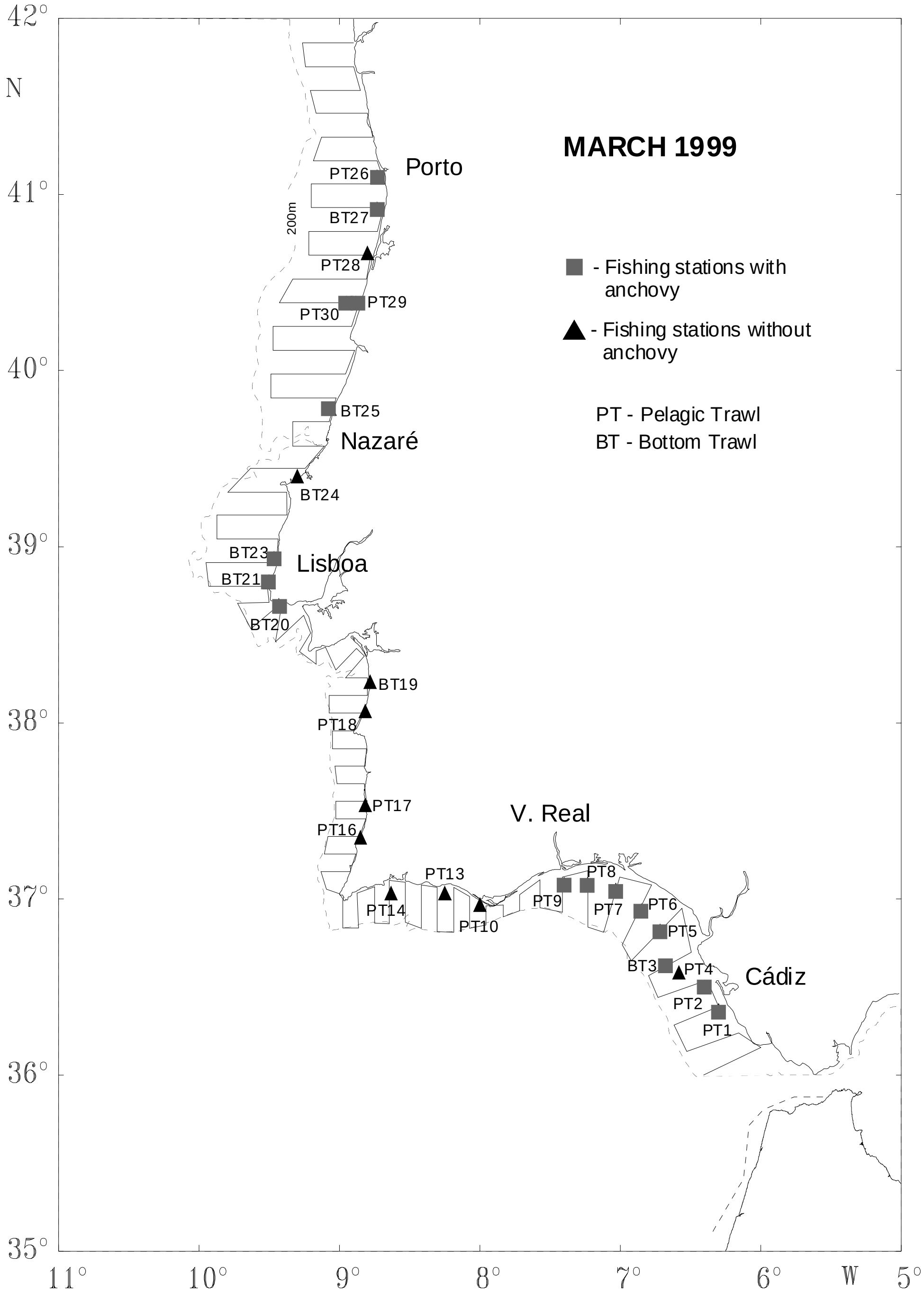


Figure 12.3.1.2 - Survey track design and location of trawl stations (with and without anchovy) in March 1999 acoustic survey.

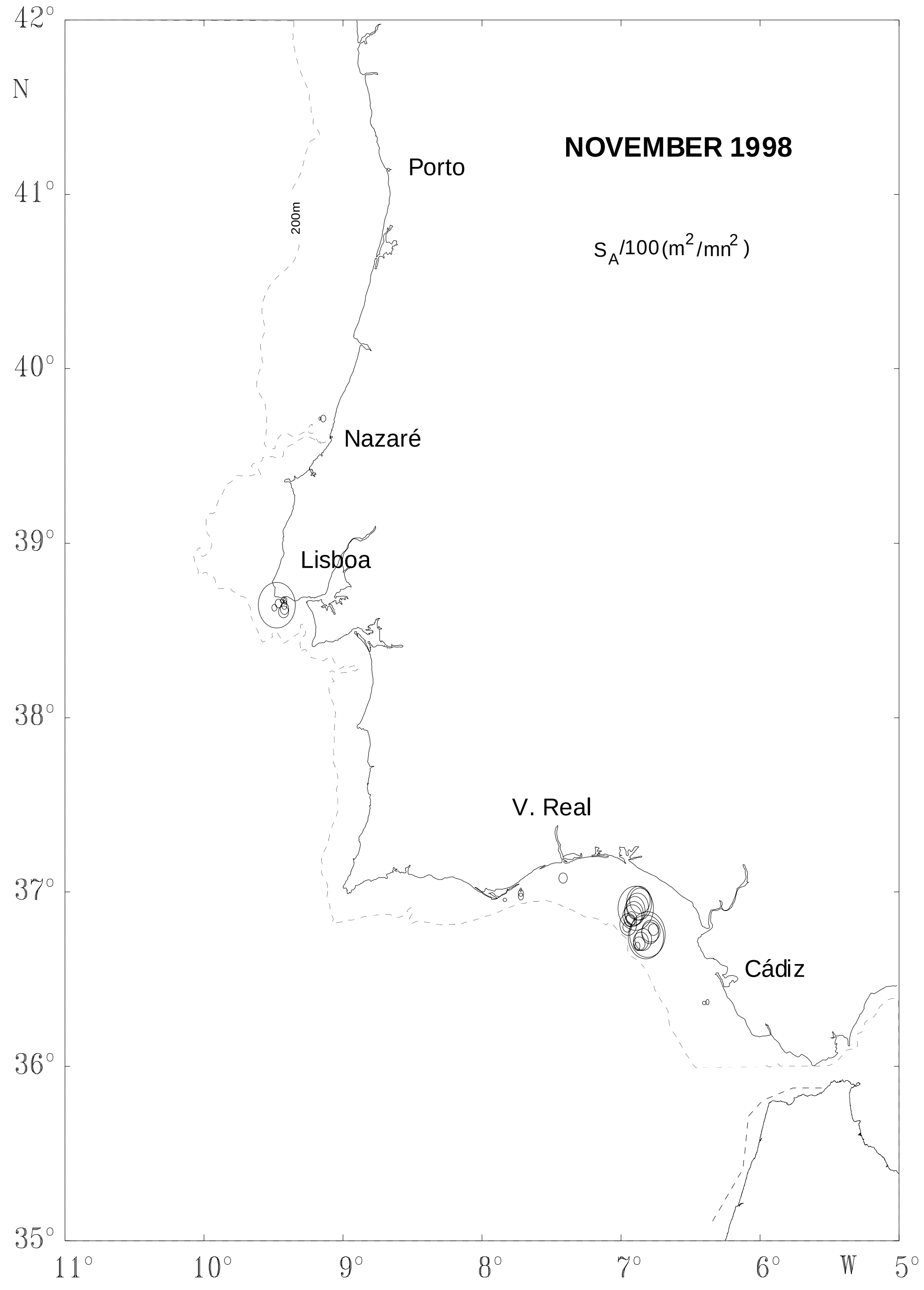


Figure 12.3.1.3 – Acoustic energy distribution per nautical mile during the November 1998 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

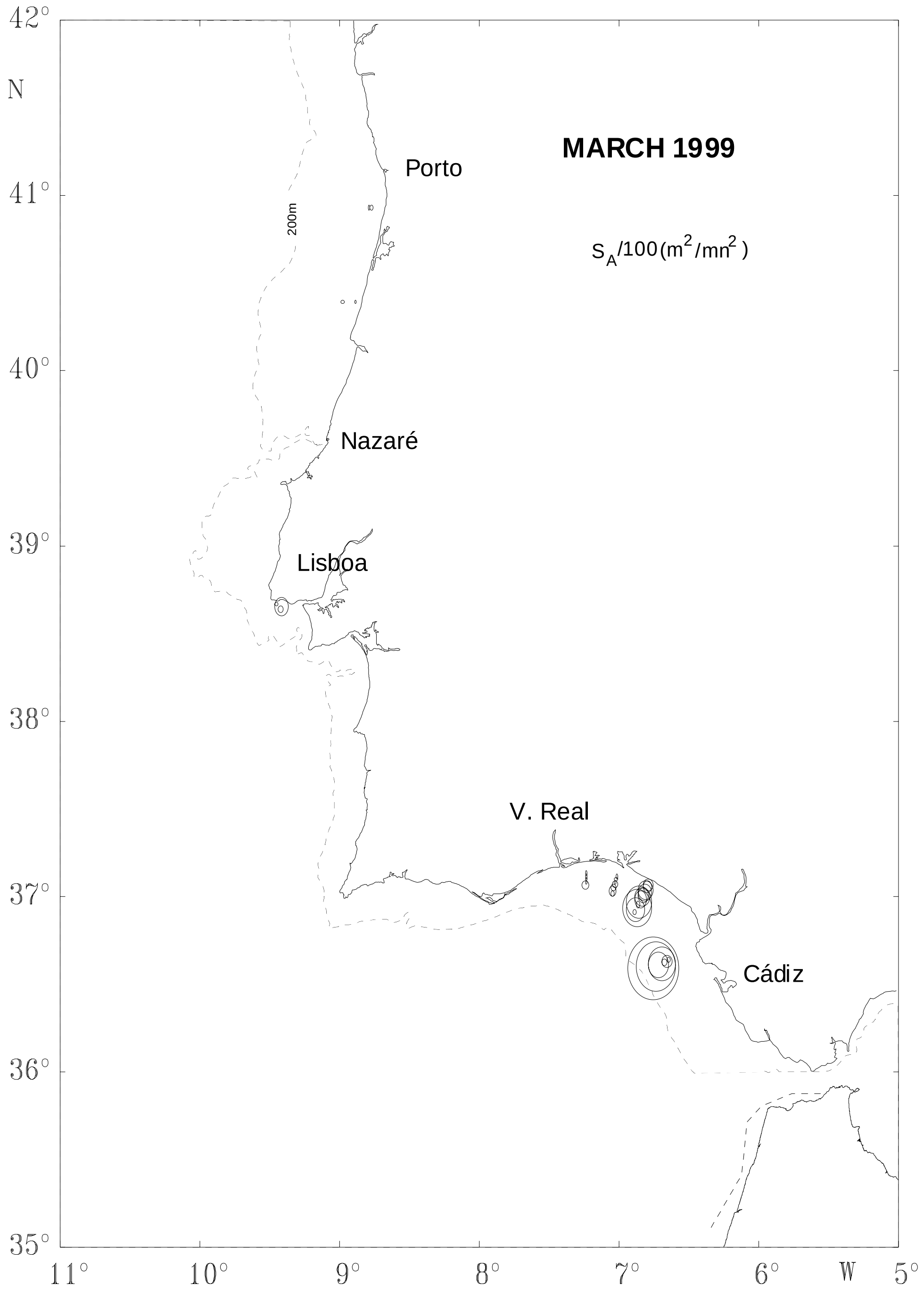


Figure 12.3.1.4 – Acoustic energy distribution per nautical mile during the March 1999 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

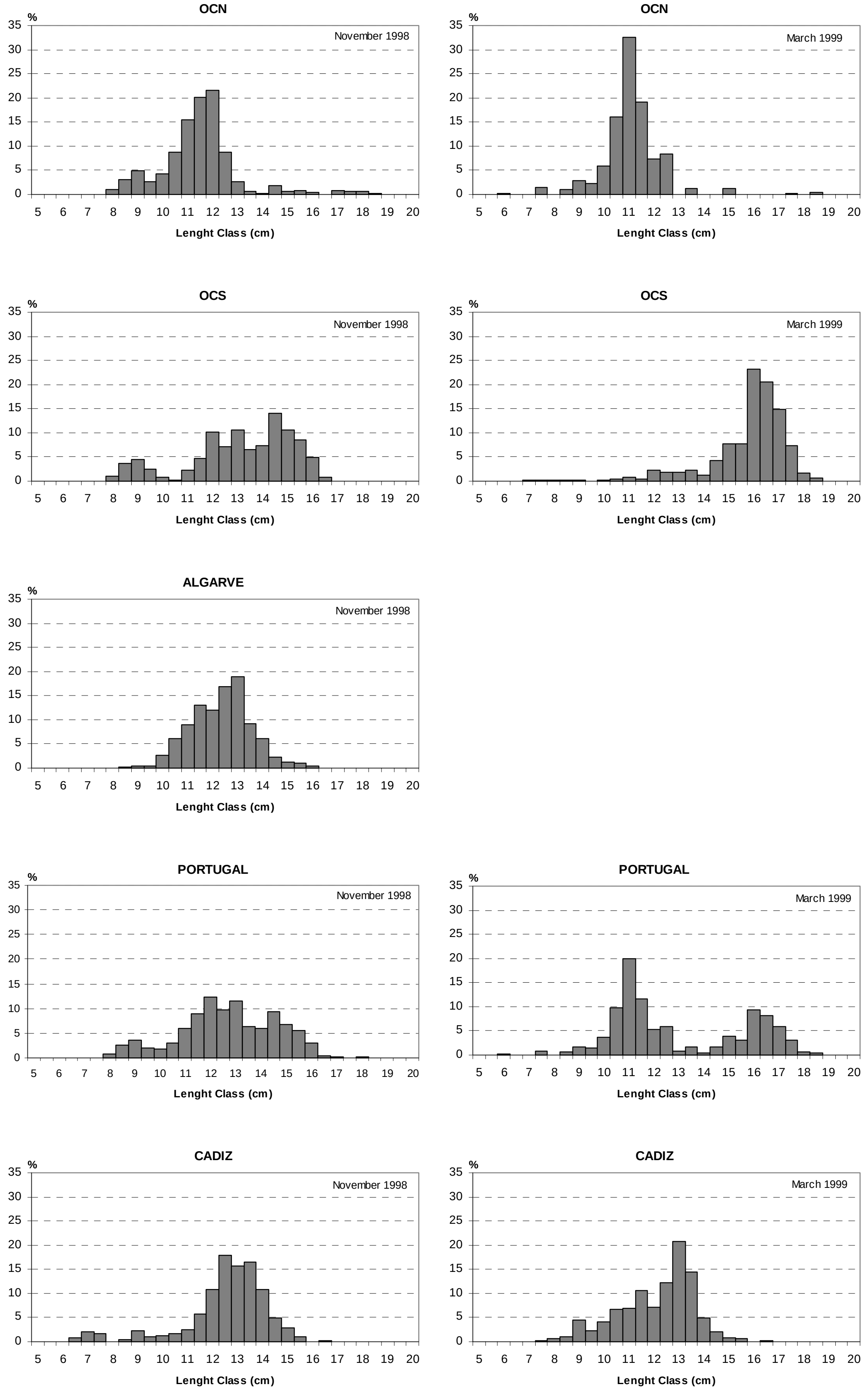


Figure 12.3.1.5 – Distribution of length class frequency (%) by region during the November 1998 and March 1999 acoustic surveys.

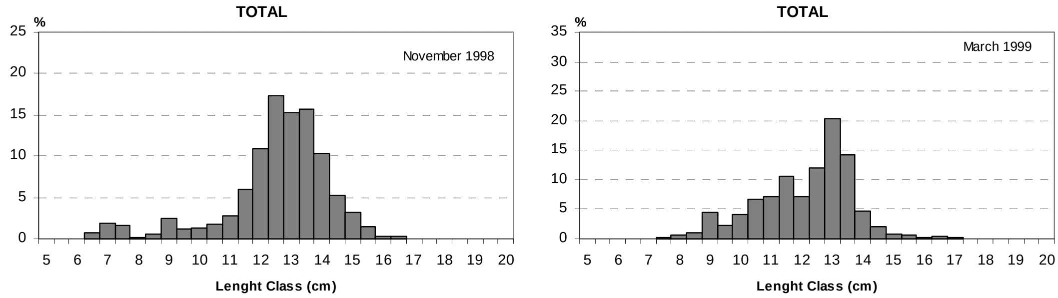


Figure 12.3.1.5 (cont.) – Distribution of length class frequency (%) for the total area during the November 1998 and March 1999 surveys.

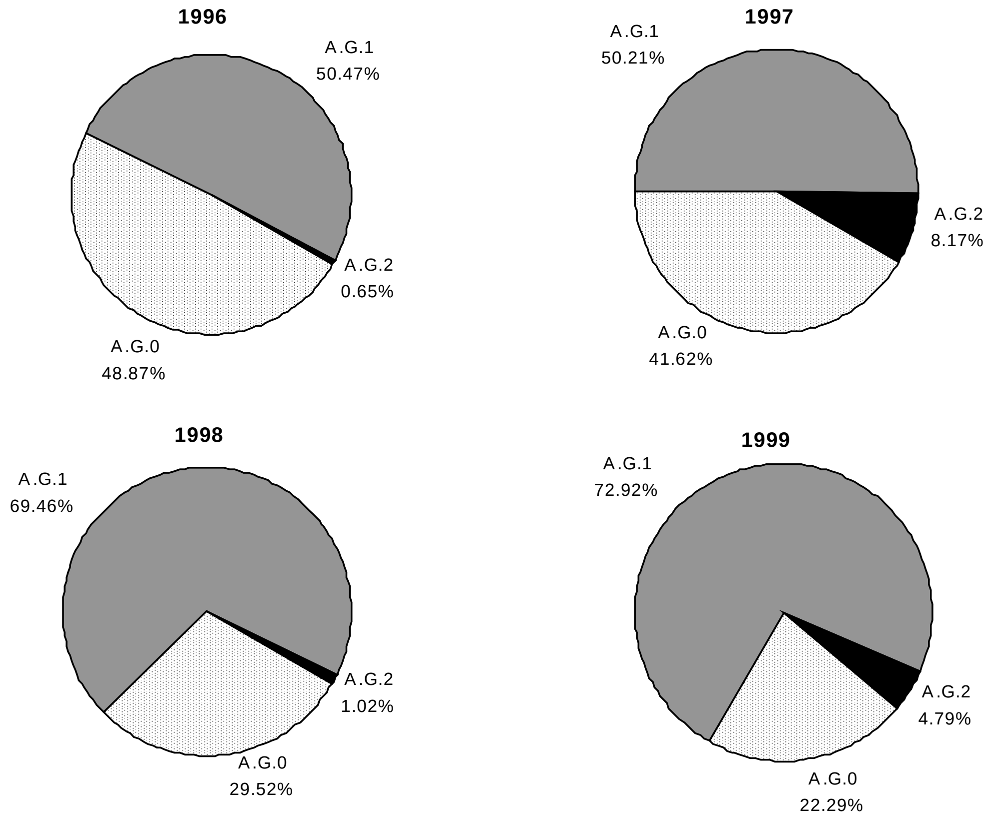


Figure 12.4.1.1. Annual relative numbers at age in the catches of Gulf of Cadiz anchovy (1996-1999).

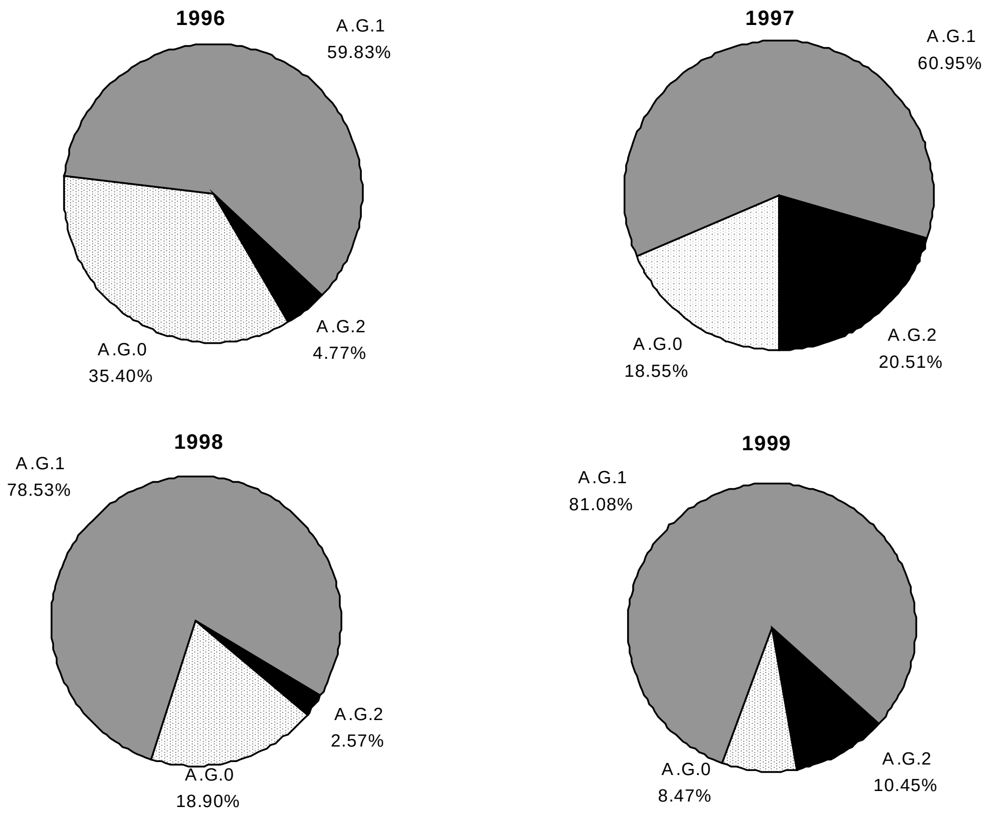


Figure 12.4.1.2. Annual relative weights at age in the Spanish catches of Gulf of Cadiz anchovy (1996-1999).

Figure 12.4.2.1: Length distribution ('000) of landings of ANCHOVY in Sub-divisions IXa South(Gulf of Cadiz) and IXa North (Western Galicia) by quarter in 1999

SUB-DIVISION IXa SOUTH **SUB-DIVISION IXa NORTH**

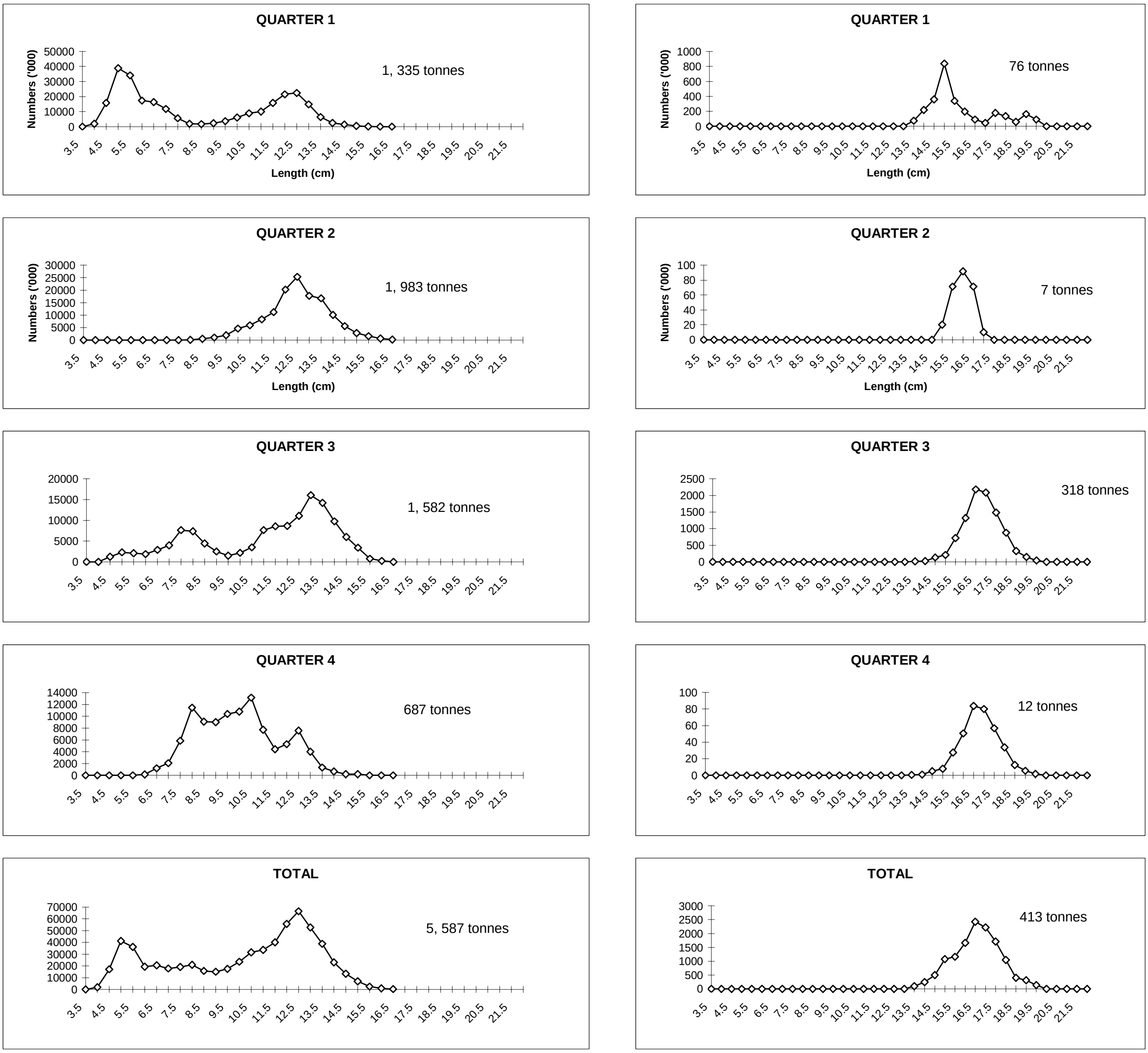
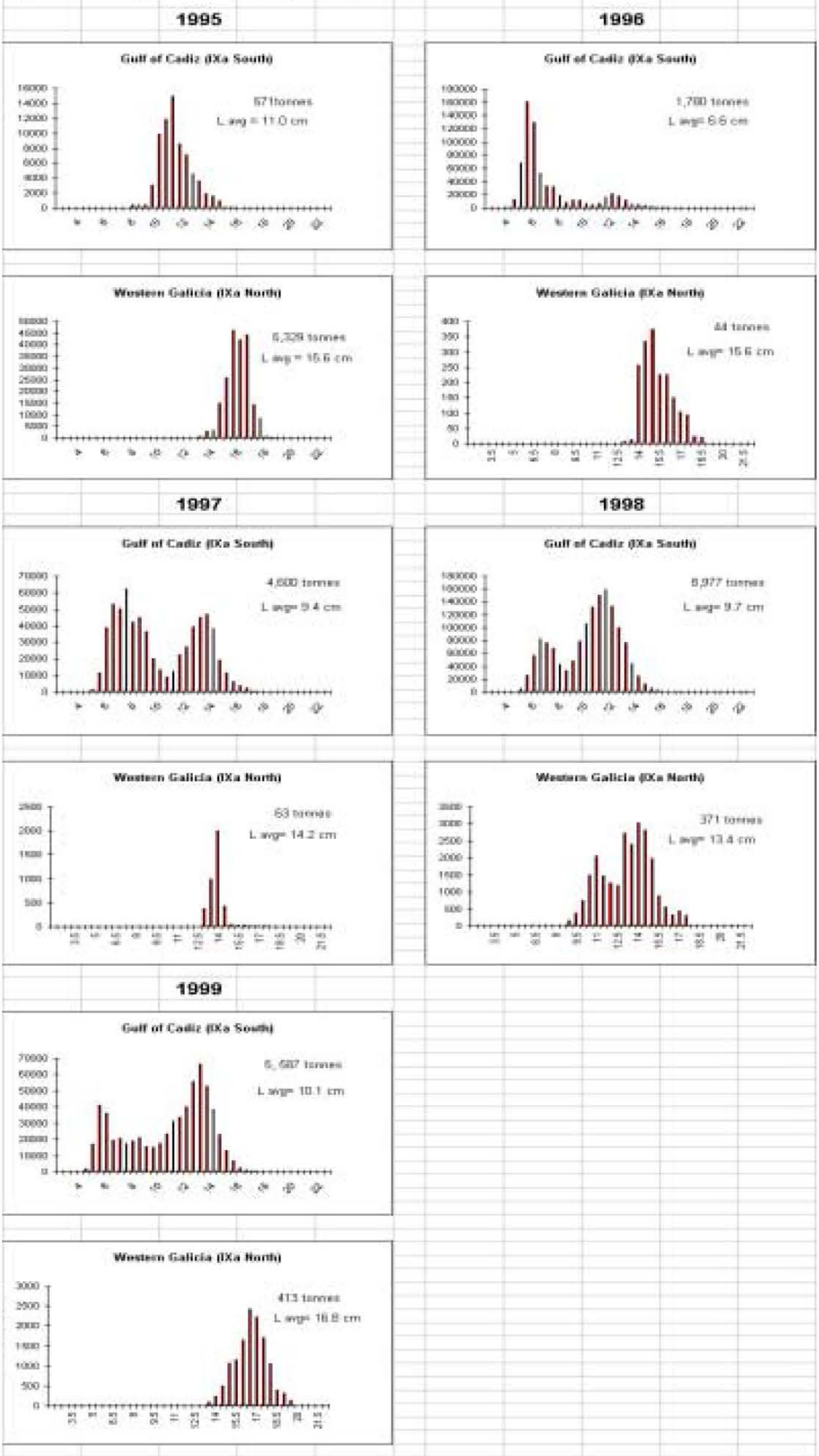
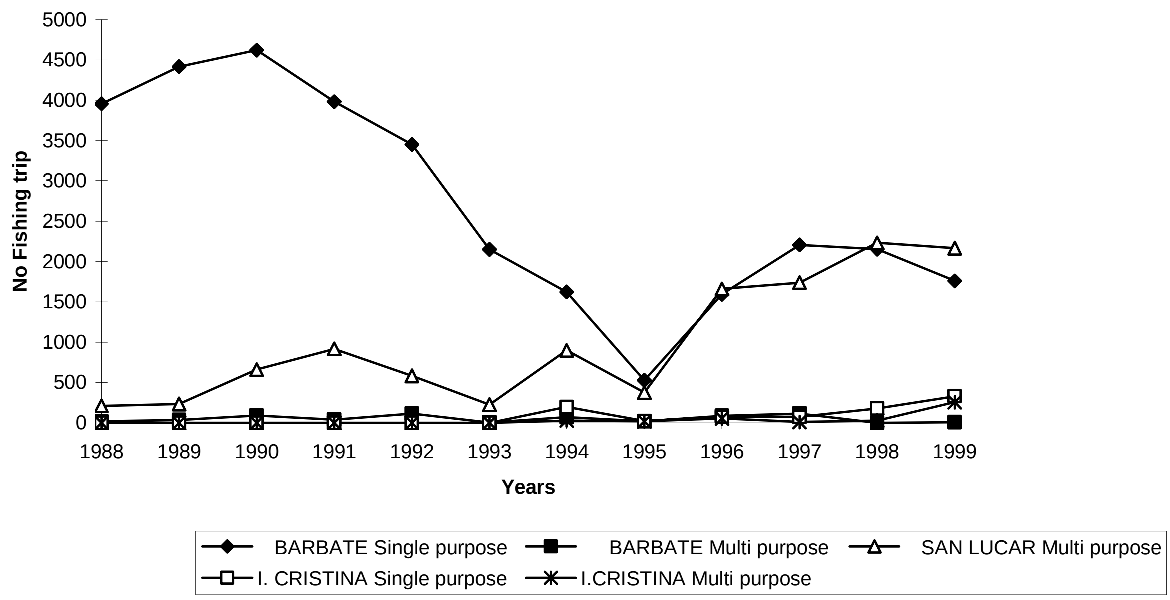


Figure 12.4.2.2 Length distribution ('000) of Anchovy in Sub-division IXa South and IXa North 1995-1999



EFFORT



CATCH PER UNIT EFFORT

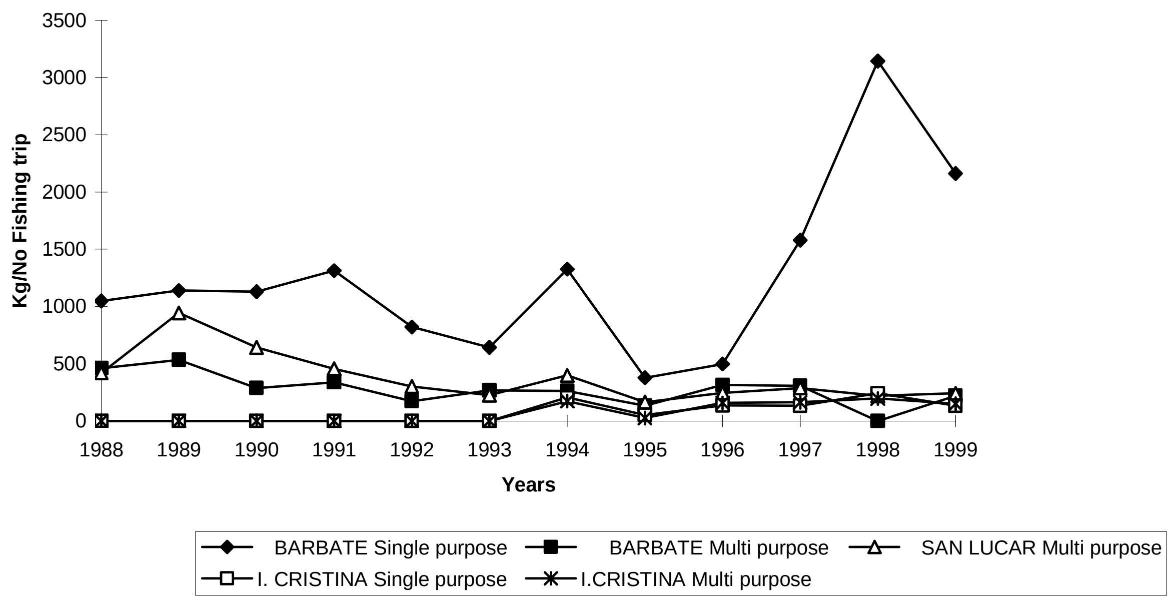
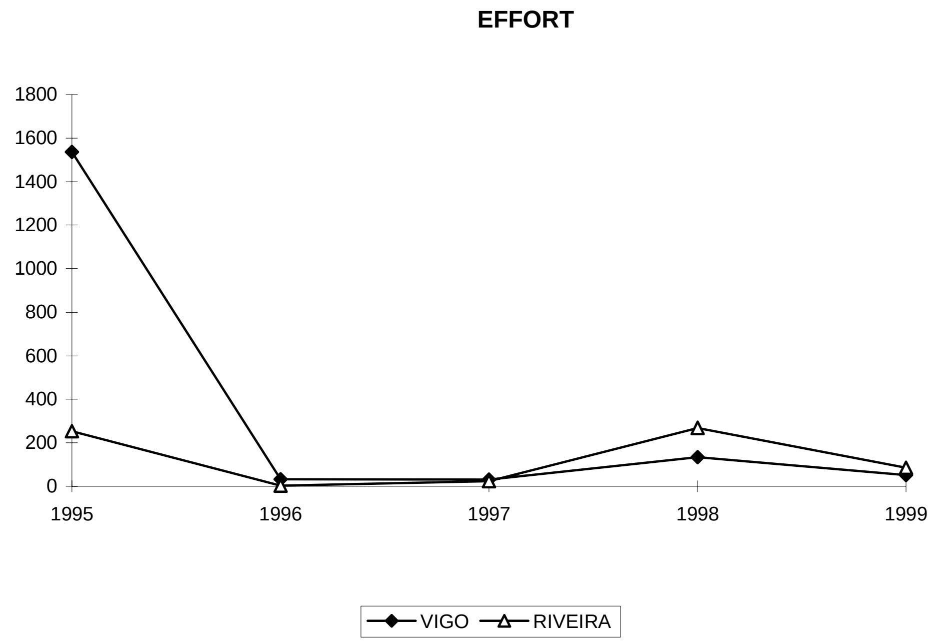


Figure12.5.1 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) Effort and CPUE series in comercial fisheries.



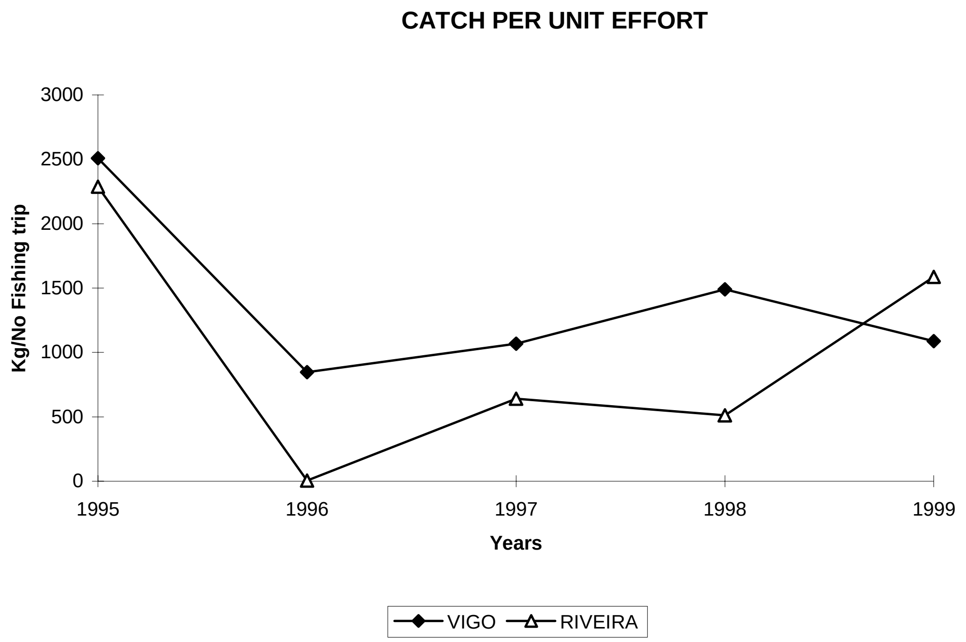


Figure12.5.2 ANCHOVY in Division IXa. Spain IXa North (Galician West) Effort and CPUE series in commercial fisheries.

13 RECOMMENDATIONS

General

The Working Group recommended that Dankert Skagen, who was only appointed for a term of one year, be appointed as chairman of the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group for a new term of 3 years.

The Working Group strongly recommends that the collection programme outlined by Working Group on Mackerel and Horse Mackerel Egg Surveys in response to T.o.R. c) (see above) be carried out in full. Furthermore the Working Group recommends that the collection of data on primary adult parametrs – fecundity and atresia – be carried out on an annual basis. To this end all institutes which are in a position to collect adult fish in the western spawning area in the first quater are encouraged to do, following preservation protocols designated by CEFAS.

The Working Group recommends that a directory be allocated on the ICES server to store relevant documentation and the most recent version of exchange sheets and programmes used to aggregate the data, and that these items be available over the ICES web server.

Mackerel & Horse Mackerel

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 to combine the horse mackerel fecundity estimates from Division IXa with those already presented for Division VIIIc, to obtain, as soon as possible, an estimation of the southern horse mackerel SSB from 1998 egg survey.

The Working Group recommends that the assessment data be prepared before next years Working Group meeting in order to be able to do an assessment fot the North East Atlantic Mackerel over the period 1972-2000 at it next meeting.

Sardine

The Working Group recommends that observers should be placed on vessels in order estimate discards in fisheries where mackerel discarding is perceived to be a problem.

The Working Group strongly recommends the creation of a Study Group on the Estimation of Sardine and Anchovy Spawning Stock Biomass by the Daily Egg Production Method, in order to carry on the studies already started in this area in a context profiting of the different experiences in the two species.

The Working Group recommends that studies for sardine stock identification should be continued in order to clarify the population structure within the current stock limits and the relationships with adjacent areas.

Considering current uncertainty in stock assessment and the inadequacy of the current model to explain all variability in the stock dynamics, the Working Group recommends the exploration of alternative assessment methods.

The Working Group recommends to carry on the application of the Daily Egg Production Method (DEPM) in Divisions VIIIc and IXa according to the sardine peak of spawning season in each of these areas.

The Working Group recommends that Portugal continues to perform the November acoustic survey which coincides with the spawning aggregation of sardine in the Portuguese area of Division IXa.

The Working Group also recommends to the continuation of joint acoustic surveys covering the in Divisions VIIIc and IXa each year in March-April. In order to understand the population distribution of sardine these surveys also must investigate the adjacent areas, mainly the French coast.

The Working Group recommends that all the member countries should make available the information of sardine in their waters concerning surveys, catch compositions and eggs and larvae distribution.

The Working Group recommends the implementation of studies on daily increments on age rings of sardine otoliths due to the occurrence of changes in the structure of younger sardine otoliths. This raised problems in allocation in the appropriate age groups.

The Working Group recommends the revision of the maturity at age and the adoption of a common definition of mature fish for DEPM estimation and for the calculation of stock maturity ogives.

The Working Group recommends the revision of the weights at age in the stock.

The Working Group recommends that an Workshop on Sardine Biological Sampling procedures for maturity at-age and weight-at age be held.

The Working Group recommends that an exchange of sardine otoliths be carried out routinely each year.

Anchovy

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.

Bay of Biscay anchovy should be monitoring with the DEPM and acoustic surveys.

The Working Group recommends further examination of plausible harvest control rules and that this should be made available to this Working Group in 2001.

The management of the Bay of Biscay anchovy requires an ad hoc process between scientists and managers to define and simulate a range of harvest control rules, so as that managers and interested bodies can make a proper discussion about the implications of those harvest control rules which lead ultimately to the adoption of an agreed management for future.

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 off Portuguese waters.

The Working Group recommends to undertake studies on the past history of the fishery on the Bay of Biscay anchovy, in order to build up a linger time series of anchovy catch at age and effort data to permit a fuller understanding of the stock dynamics and under varying environmental and fishery conditions.

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.

Since anchovy seems to exhibit biological differences along the Division IXa, the Working Group also recommends, if possible, to make available the results from the genetic studies which are currently in progress. Biological samples from this area have been provided by the 2000 acoustic surveys carried out under the PELASSES Project.

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15 ABSTRACTS OF WORKING DOCUMENTS

Abaunza, P., Fariña, A. C., Murta, A.

Applying Biomass Dynamic Models to the southern horse mackerel stock (Atlantic waters of Iberian Peninsula). A comparison with VPA-based methods. WD 2000.

Document available from: Pablo Abaunza, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain. Email: pablo.abaunza@st.ieo.es

The horse mackerel, an important target species in the fisheries of the Northeast Atlantic, is currently subject to assessment and management programmes in the ICES area. The current method used in the stock assessment of the Southern horse mackerel is based on VPA, using time series of catch-at-age data and CPUE from 1985 to present. The application of biomass-dynamic models to the assessment and catch prediction of this stock was never attempted before. In this paper, a production model was applied to the Southern horse mackerel stock. To quantify uncertainty in parameter estimates bootstrap confidence intervals were computed, which showed that estimates could be looked as reliable. The bootstrap standard deviations of Ft, r, q, MSY and F_{MSY} were not very high, despite the lack of trends in the effort series available. The current level of fishing mortality for 1998 was estimated inadequate for the sustainability of the resource, being well above F_{MSY} according to the biomass-dynamic models, and above F_{pa} according to the age-structured model. Both models showed a good agreement in the evolution of fishing mortality and in the perception of the state of the stock. Differences existed in the evolution of biomass estimates especially through the last years, in which the age-structured model showed an increasing trend. The estimates of MSY and F_{MSY} were in accordance with the precautionary approach philosophy. The biomass-dynamic model used here proved useful to be applied to the Southern horse mackerel stock, giving complementary information to the age-structured model, both in the perception of the state of the stock and in the definition of management targets.

Abaunza, P., Murta, A., Teia, A., Molloy, J., Nascetti, G., Mattiucci, S., Cimmaruta, R., Magoulas, A., Sanjuan, A., MacKenzie, K., Iversen, S., Dahle, G., Gordo, L., Zimmermann, C., Stransky, C., Santamaria, M.T., Ramos, P., Quinta, R.

HOMSIR: An international project on horse mackerel stock identification research in the ICES area and in the Mediterranean Sea. WD 2000.

Document available from: Pablo Abaunza, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain. Email: pablo.abaunza@st.ieo.es

The aim of this project is to assess the stock structure of the horse mackerel, which is an important target species in many north-east Atlantic and Mediterranean fisheries. The project will provide information currently lacking for an effective definition of horse mackerel stock boundaries, and will evaluate the status of the horse mackerel populations. The overall objective will be achieved integrating the results from several techniques such as genetic markers, other biological tags like morphometric studies and the use of parasites, physical tagging and life history traits (growth, reproduction and distribution). The genetic stock assessment will be performed by means of five different genetic approaches comprising the analysis of allozymes, the mitochondiral DNA and the microsatellite DNA. The proposed research will therefore set-up and improved multi-disciplinary tool for fish stock identification, and an exhaustive knowledge of horse mackerel stock structure, in order to allow an enhanced management of horse mackerel resource in European Union waters in short, medium and long term.

Borges, M.F., Santos, A. M. P., Crato, N., Mendes, H. and Mota, B.

Sardine catches and climatic changes off Portugal in the last decades. WD 2000.

Document available from: Maria F. Borges, Instituto de Investigação das Pescas e do Mar (IPIMAR), Av. Brasília, 1449-006 Lisboa, Portugal. Email: mfborges@ipimar.pt

Decades changes have been observed in the annual catch of sardine. Long-term changes have also been observed in alongshore winds off Portugal in the last decades. During sardine spawning season, north winds that favour upwelling lead to unfavourable conditions for egg and larval survival.

By using time series analysis, we investigated the effect of NAO conditions on the recruitment strength of sardine population in the period from 1946-1991. We also investigated the time lag between recruitment strength and its turnout in catches.

Our time series retrospective analysis lead to the possibility of forecasting sardine recruitment by using key environmental variables – the winter wind conditions during winter. We conclude that when winter north wind overpasses a certain limit, then resulting recruitment is forced to a lower bound.

Borja, A.

Report on anchovy recruitment in the Bay of Biscay. WD 2000.

Document available from: Angel Borja, AZTI, Avda. Satrustegui nº8, 20008 San Sebastián, Basque Country, Spain. Email: aborja@azti.es

Recruitment of anchovy in the Bay of Biscay is related primarily with the March-July upwelling in the southern corner of the area and potentially with turbulence.

In this document are presents results used these assuming to derive an upwelling index and turbulence data, giving a consistent result for long time-series data from 1967 to 2000, when compared with recruitment series based on CPUE.

For the series between 1967 and 1995 the correlation between recruitment and upwelling explains about 59-63% of the variance. However when including the last three years, the explained variance falls to 50-56%.

Has tried to incorporate new data about turbulence from other areas and has found that the turbulence in 44ºN 4ºW has significant values in a multiple regression, increasing the explained variance in 11% for the long time series 1967-2000.

The new upwelling data obtained for year 2000 is 391, after two years of very low upwelling. This makes possible that the recruitment at age 0 for this year 2000 will be low.

Borja, A., Uriarte, A. and Egaña, J.

Environmental factors affecting recruitment of the mackerel, *Scomber scombrus L. 1758*, along the North-eastern Atlantic coasts of Europe. WD 2000.

Document available from: Angel Borja, AZTI, Avda. Satrustegui nº8, 20008 San Sebastián, Basque Country, Spain. Email: aborja@azti.es

Research group has studied successfully the relationships between some environmental processes (turbulence, upwelling, the North Atlantic Oscillation): and the recruitment of some Atlantic species, such as the anchovy, the bluefin or the albacore.

Results show that the southern pre-spawning migration pattern of the Atlantic mackerel is directed towards areas with low turbulence mixing at spawning time, providing a “stable environment”, for egg and larvae survival. In the southern areas, where the spawning starts, the turbulence conditions of pre-spawning and spawning periods has the largest influence on the success of recruitment; this is probably related to the more ‘stable’ weather in the subsequent months and for the remainder of the year. In contrast, in the northern areas, the role of turbulence over the whole of the year becomes increasingly more relevant; this is probably related to the high levels of turbulence during autumn and winter, which may become limiting to the survival of juveniles.

At least 48% of the variability in the Atlantic mackerel recruitment may be explained by means of environmental variables, such as turbulence and NAO. Other variables, such as upwelling, are not statistically significant; however, they are potential future areas of research.

Good recruitments are related with environmental conditions (mainly low turbulence) in the spawning areas and periods; similarly, with conditions during the subsequent months, up to the start of the following year.

Carrera P.

Acoustic survey PELACUS 0300 within the frame of pelasses: sardine abundance estimates. WD 2000.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

This survey was the main activity of the PELASSES project. Part of the information got from this survey is still under treatment. Next steps will be the set up of the CUFES system and their calibration against the PairoVet tows; if this calibration was successful, DEPM would use CUFES as egg sampler, allowing a better coverage of the egg distribution area. As well as this calibration, new attempts for assessment aiming to improve the precision will be done by incorporating auxiliary variables such us Primary Production, egg distribution, etc.

First analysis of the available information revealed that:

a) The performance of the CUFES as anchovy and sardine egg sampler was good.
b) Sardine biomass increased but only in VIIIc.
c) No indication of a good 1999 year class was achieved
d) Sardine in VII was scarce, but the egg distribution was wider than that of the adults
e) In spring, anchovy is also present in VII Division
f) When mackerel is found with zooplankton masses, its biomass estimation could be over estimated.
g) 1999 mackerel year class seems to be good

In 2000, CUFES provided sardine and egg information from Gibraltar to the English Channel. Nevertheless, the spawning period of anchovy is narrower compared to that of sardine and it stars in mid May. Thus the number of anchovy eggs collected during this survey was low.

In VII, the most important fish species was sprat which was caught in almost of the fishing station. In this area sardine was scarce, in spite the wider but low density distribution of the eggs.

Mackerel use to be find associated with plankton layers. It seems to be possible distinguish the thick plankton layers from the mackerel, the problem arises when both are mixing in a single layer. It seems that the mackerel abundance was higher.

Chernook, V.I., Zabavnikov, V.B., Troyanovsky F.M. and Shamray E.A.

Preliminary Results of Complex Airborne Research Conducted by PINRO on Distribution and Biomass Estimation of Mackerel in 2000. WD 2000.

Document available from: Vladimir I. Chernook, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia. Email: inter@pinro.murmansk.ru

This working document presents the preliminary results of the Russian annual aierborne research carried out during summer 2000. These surveys covered the southern part of Norwegian Sea from 62° up to 72° N and between 18° W and 10° E.

Thermal, hydrodynamic and bioproductive processes in the Norwegian Sea were characterised by the late beginning of spring and summer processes.

Feeding migration of mackerel to the southern Norwegian Sea began by 7-12 days later compared to the usual pattern and was mainly of eastern.

Number of feeding “surface mackerel” reduced in the total abundance of the registered schools and the number of “deeper schools” in 5-20 m increased.

Costa, A. M.

Working Document. WD 2000.

Document available from: Ana Maria Costa, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1400, Lisboa, Portugal. Email: eamcosta@ipimar.pt

FILE NOT AVAILABLE

In this working document the final results of total fecundity and atresia of horse mackerel of the portuguese coast in 1998, determined with the histometric method are presents. Only tables and pictures are available.

Eltink, A., de Boois, I. and Wiegerinck, H.

Preliminary estimates of horse mackerel fecundity in 2000 and the planning of the fecundity sampling in 2001. WD 2000.

Document available from: Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands. Email: guus@rivo.dlo.nl

Up to now horse mackerel has been assumed to be a determinate spawner.

In 1998 the horse mackerel fecundity was estimated much lower compared to earlier years. This was expected be due to exceptional early spawning in 1998 and it was assumed that spawning fish had been used for the fecundity estimation. An important fact is that horse mackerel can not easily be recognised in histological slides of the ovaries as having spawned in the current season. This is caused by the long time interval between two batches of spawning. It is that long that the post-ovulatory-follicles (POF’s) can have disappeared before other stages of spawning activity (migrating nucleus stage, hyaline oocyte stage) appear. Therefore, fecundity sampling should be carried out before any spawning takes place, because as soon as spawning starts individual fish can not be identified any more as not having spawned yet.

In 2000 a small scale test sampling for fecundity was carried out as a test case for the sampling in 2001, which is the year in which the extensive international egg surveys will be carried out. The aim was to follow the changes in fecundity over time until the beginning of spawning season in order to estimate the most appropriate time for fecundity sampling. Results showed that fecundity was still low in March when spawning started, indicating that horse mackerel might an indeterminate spawner.

A sampling scheme for fecundity estimation has been proposed for the 2001 egg surveys based on the results of this test sampling in 2000.

Iversen S. A., Skogen M. and Svendsen E.

A prediction of the Norwegian catch level of horse mackerel in 2000. WD 2000.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: sveini@imr.no

Norway has since 1987 been the main fishing nation for horse mackerel in the northern part of the North Sea and Norwegian Sea. This fishery is carried out in the Norwegian economical zone in the second half of the year. This fishery is considered to exploit the western stock. It is shown that there is good correlation between the modelled winter influx of Atlantic water to the North Sea and the catch levels of horse mackerel in The Norwegian purse seine fishery the following autumn. The modelled inflow in 1999 was calculated at 2.22 Sverdrup corresponding to a predicted catch of 42,000 t. The actual Norwegian catch in 1999 was 46,600 t. The modelled inflow of Atlantic water the first quarter of 2000 was 2.4 Sverdrup corresponding to a predicted catch of 60,000 t.

Marques V.

Sintesis of the Portuguese Acoustic Surveys in the ICES Sub-Area IXa, carried out in November 1999 and March 2000. WD 2000.

Document available from: Vítor Marques, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: vmarques@ipimar.pt

This paper presents the main results of the Portuguese acoustic surveys carried out during November 1999 and March 2000. These surveys covered the Portuguese continental shelf and the Gulf of Cadiz waters.

About 35 % of the Gulf of Cadiz area were not covered, in March 2000 survey, due to bad weather.

Sardines juveniles were predominant between Caminha and Nazaré (OCNorte zone). Between Nazaré and Cabo da Roca adults were predominant. In front of Lisbon, between Cabo da Roca and Cabo Espichel, mainly juveniles were fished. From South of Cabo Espichel and V. Real de Santo António, only sardine adults were captured. In Gulf of Cadiz the fishing samples are bimodal with a class of little juveniles and another adults class.

Millan, M. and Ramos, F.

Preliminary estimates of catch in numbers, mean weight- and mean length at age in the 1996-1999 Spanish landings of Gulf of Gadiz anchovy (Sub-division IXa South). WD 2000.

Document available from: Milagros Millán, Instituto Español de Oceanografía. Unidad de Cádiz. Puerto pesquero, Muelle de Levante s/n, P.O. Box 2609, 11006 Cádiz, Spain. Email: milagros.millan@cd.ieo.es

This working document reports preliminary estimates of the age composition and mean length- and mean weight at age of the Spanish total landings of Gulf of Cadiz anchovy for 1996-1999. Age readings were carried out on 4 754 otoliths, which were monthly collected throughout the 4-year period, and assuming 1 January as birthday. As previously stated (EFAN otolith exchange exercise), the identification of true annual rings showed specially difficult due to the presence of many false marks, which are laid down with some degree of periodicity (spring and/or summer hyaline rings). During the analysed period, the Gulf of Cadiz anchovy fishery was based on the fishing of 0, 1 and 2 age-group anchovies, the 1-year-old ones being the better represented and the 2 year-old fish the less. The success of the Gulf of Cadiz anchovy fishery largely depends on the strength of the year class. Thus, the data support that the historical maximum of landings reached in 1998 is explained by a probable exceptional strength of the 1997 year class and the good recruitment to the fishery in that year. Intra- and inter-annual variations of both the mean length- and weight at age are also documented.

Morais A.

Abundance Estimation, Biological Aspects and Distribution of Anchovy (Engraulis encrasicholus) in Portuguese Continental Waters and the Bay of. WD 2000.

Document available from: Alexandre Morais, Instituto de Investigação das Pescas e do Mar (IPIMAR), Av. Brasília, 1449-006, Lisboa, Portugal, Email: amorais@ipimar.pt

This work presents results from two acoustic surveys in the Portuguese area and Bay of Cadiz carried out in November 1998 and March 1999 with R. V. "Noruega". This working document provides abundance estimates of anchovy (Engraulis encrasicholus) by length classes and its distribution in the survey area. It also describes some aspects of anchovy biology (Length-weight relationships and maturity-length ogives) in that area. Anchovy total estimated abundance was 33 thousand tonnes (2.5 x 106 individuals) in November 1998 and 25.5 thousand tonnes (2.1 x 106 individuals) in March 1999. In both surveys, more than 90% of the total biomass estimated was present in Cadiz. The maturity data obtained during the November 1998 survey shows significant differences between the Portuguese Occidental shelf and the area of Algarve and Bay of Cadiz. Finally, in both surveys rare demersal formations of dense anchovy concentrations were observed at moderate depths (50-90 m) in the Bay of Cadiz.

Murta, A. and Abaunza, P.

Has horse mackerel been more abundant than it is now in Iberian waters? WD 2000.

Document available from: Alberto Murta, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: amurta@ipimar.pt

According to the assessments carried out by this working group, the horse mackerel biomass in the Atlantic waters of Portugal and Spain attained a maximum in 1998. From 1985 to 1998 the estimated biomass presents an increasing trend. Nevertheless, historical catches around 2.5 times the current catch level were recorded between 1962 and 1978. This took us to suspect that in a broader time scale the biomass variation estimated from the assessment may have little meaning. Also, given the current catches, which are very low as compared with those from 1962 to 1978 there is the possibility of the stock to be severely depleted.

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. The catches from 1962-1978 appear exceptionally high when looking to the whole time series.

Petitgas, P., Allain, G., Lazure, P.

A recruitment index for anchovy in 2001 in Biscay. WD 2000.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France, Email: Pierre.Petitgas@ifremer.fr

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 Working Group 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 report of the ICES Working Group. For predicting anchovy abundance at age1 for 1999, 2000 and 2001, environmental indices have been extracted from the hydrodynamic model and the regression model used in extrapolation mode. The prediction for 2001 is an average recruitment.

Prouzet, P.

An example of determination of harvest rules for the management of anchovy in the Bay of Biscay. WD 2000.

Document available from: Patrick Prouzet, Institute Français de Recherche pour l'Exploration de la Mer B.P. 3, 64310 St-Pée-sur-Nivelle, France. Email: prouzet@st-pee.inra.fr

A preliminary annual TAC (TAC1) applied on the first part of the year (n+1) from January to June and set to zero when the revised one is defined. This TAC should be based on the biomass estimates of the year (n) called B1(n) and the qualitative level of recruitment in September the year (n) called Rsept(n). So the preliminary TAC, call TACprelim is defined as Tacprelim= f(B1(n),Rsept(n)). The qualitative level of Rsept is based either on the value of the environmental index after Borja et al (WD 2000) (called upindex(1)),or the best of the two available environmental indexes {upindex(1) and upindex(2), the latter corresponding to the environmental index after Petitgas et al (WD 2000)}.

A revised final TAC operative over the second part of the year from June to December and based on the biomass assessed the year (n+1) called B2(n+1). So this TAC called revised TAC is defined as TACrevised = TAC2 = f[B2(n+1)].

Reid D.

Documenting changes in western mackerel migtration timing 1997-2000. WD 1999.

Document available from: David G. Reid, Marine Laboratory, P.O.Box 101, Victoria Road, Aberdeen AB11 9DB, Scotland, United Kingdom. Email: reiddg@marlab.ac.uk

The western mackerel undertakes a pre-spawning migration from the eastern North Sea, in the vicinity of the Viking Bank, to their spawning areas west of the British Isles and in the Bay of Biscay. In the 1970s and 1980s this migration occurred initially in the months of August and September. During this period the migration has been later and more off-shore. But 1997 the migration could be shown to start as late as the middle to the end of February. This WD presents evidence from an acoustic survey in January 2000 and assembled commercial data from 1997-2000 from a number of EU countries that the timing of migration is again changing. The main conclusion is that in 2000 the migration started much earlier than in previous years and that this may be part of a general ternd to earlier migrations.

It seems likely that there has been a major change in some aspect of the ocean climate to stimulate this change, although to date no obvious candidate has been implicated. This will be investigated.

Skagen D. W.

Trial assessment for NEA mackerel using ICA and AMCI. WD 2000.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: dankert@imr.no

Assessment of the NEA mackerel has at times been problematic, since the only data available apart from catches at age are SSB measurements every third years. In last years Working Group a new programme AMCI was presented, which can make use of tag return data in addition to catches and SSB measurements. The program has been exxtended since then, and now offers a range of options for combining different kinds of information from different sources, into an assessment of a fish stock. The program includes a self contained parametric model for the population, functions for describing the relations between the population and the observations, and a selection of measures of the deviations of modelled data from the observations. The document gives a short description of the program and the options that are possible. Some trial runs are presented, showing that in general, the assessment is quite robust to model formulations.

Stratoudakis, Y. And Fryer, R.

Adult survey design and implications for sardine (Sardina pilchardus) DEPM estimation off Portugal. WD 2000.

Document available from: Yorgos Stratoudakis, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: yorgos@ipimar.pt

In the absence of adequate model-based estimators, estimation of spawning biomass from the Daily Egg Production Method (DEPM) is entirely based on the selected survey design, using design-based estimators. Judgement sampling and survey post-stratification have been recommended as ways of achieving sampling proportional to local fish densities and reliable estimation of spawning biomass when there are spatial differences in the DEPM adult parameters. Here, we discuss these concepts, demonstrate the impact of post-stratification on the DEPM estimation of sardine (Sardina pilchardus) spawning biomass off Portugal, and propose sensible designs for future surveys. Post-stratifying the Portuguese 1999 DEPM survey into two strata (western and southern) increases the SSB estimate by at least 100 Kt, nearly 50% more than the original (unstratified) estimate. This large difference led us to explore the impact of adult survey design and estimation in a simulation exercise. We constructed a series of populations consisting of two strata, in which fish abundance and mean spawning fraction in each stratum were allowed to vary widely, and where egg production, sex ratio and batch fecundity were assumed known without error. We then sampled each population using simple random sampling and various forms of stratified random sampling (allocation proportional to survey area, to fish abundance, and optimal allocation). Ignoring spatial structure in spawning fraction led to very biased and imprecise estimates of fish abundance. In the population scenario that most closely resembles the 1999 Portuguese DEPM survey, the bias was –25%, suggesting that unstratified estimation underestimates the true SSB. Stratified random sampling with allocation proportional and optimal allocation outperformed allocation proportional to area and were robust to moderate levels of misallocation. We believe that future adult surveys for DEPM would benefit by adopting an a priori stratified design, in which stratum effort is allocated according to the sardine abundance estimate from the most recent acoustic survey.

Uriarte A., Motos L., Santos M., Ibaibarriaga, L. and Prouzet P.

Estimates of spawning biomass of the Bay of Biscay Anchovy (Engraulis encrasicolus, L.) in 2000 and review of the assessment of biomass in 1994 and estimates in 1996 and 1999. WD 2000.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

This document includes the estimates arising from the 2000 May survey. Biomass estimate for this year was derived in May from the spawning area/biomass relationship using the extension of the spawning area found in survey and it was reported to STECF. Now the estimate of the SSB is based on its relationship with the spawning area (SA) and Daily egg production per surface unit (Po) which is the best model to estimate SSB. (EU project 96/034, ANNEX 5) and it is presented in this document.

Biomass estimates for 1996 and 1999 were derived from the spawning area/biomass relationship using the extension of the spawning area found during the 1996 and 1999 DEPM anchovy surveys, respectively. Additioally, SSN as a function of Po and Sa is presented. Changes on the results for 1994 involves modification for 1996 and 1999.

Uriarte, A., Villamor, B. and Martins, M.

Estimates of Catches at age of mackerel for the southern fleets between 1972 and 1983 and comparison of alternative procedures. WD 2000.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

Since 1995, ICES has acknowledged the necessity of carrying out a single assessment of mackerel for a population unit called Northeast Atlantic mackerel, putting together all European Atlantic mackerel (ICES CM 1996). The catches at age of mackerel caught in the western area are known since 1972, however the catches at age from the southern area are only known since 1984 and for this area total landings in tonnes are only known since 1977. Partly due to these reasons, so far the assessment of NEAM starts in 1984, whereas the assessment of the so called “western” mackerel goes back to 1972. ICES seeks for a complete historical perspective of the whole NEAM similar to the one produced for the western mackerel.

The current paper presents:

a) a recovery of statistical data since 1972 of the catches in tonnes produced by the southern fleets and landed in Spain and Portugal which have not previously been reported to the ICES Working Group.
b) An estimate of the catches at age of mackerel landed in the southern area covering the period 1972-1984, which is based on the fitting of separable models for the Divisions VIIIBC and IXa and
c) A comparison of the separable catch estimates with other simpler methods of estimating the corresponding catches at age for the southern area.

The aim of this effort is allowing for a complete historical perspective of the whole NEAM starting back in 1972, similar to the one produced for the western mackerel.

The idea of obtaining the unknown catches at age of mackerel from the southern fleets by a separable model comes from the procedures used by Cook and Reeves in 1993 to estimate unknown catches at age for certain years of the industrial fishery catches of Norway pout.

Vasilyev, D., Belikov, S. and Shamray E.

Tuning of natural mortality for Northeast Atlantic Mackerel. WD 2000.

Document available from: Dimitri Vasilyev, Federal Research Institute of Fisheries and Oceanography (VNIRO), 17 Verhne Krasnoselskaya, 107140, Moscow, Russia.

FAX: +7 095 264 9187

Spawning stock size estimates based on catch-at-age analysis for Northeast Atlantic Mackerel in recent years were generally lower than estimates based on egg surveys. The purpose of the this paper was to test the hypothesis that the above mentioned discrepancy may be caused by underestimated value of natural mortality (0.15), traditionally used in the assessment. Since it is always difficult to estimate the value of natural mortality together with other parameters of separable model it was decided to split the available information into two parts and to use catch-at-age data only for estimating of parameters of separable model (on this stage different values of M are taken as “known”). The estimates of SSB, based on egg survey, are used afterwards to choose the “best” value of M. A separable model named ISVPA was chosen for analysis of catch-at-age data because its minimization procedure, based on some principles of robust statistics, in some cases helps to produce unique solution using the catch-at-age data of real quality (high level of noise) without auxiliary information. The ISVPA-derived estimates of total biomass, SSB and recruitment are rather similar to results of ICA. The best fit with respect to egg survey SSB estimates was achieved for M=0.19.

Villamor, B. and Lucio, P.

A short note on the historical allocation by stocks of mackerel catches from divisions VIIIc and IXa. WD 2000.

Document available from: Begoña Villamor, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain. Email: begona.villamor@st.ieo.es

This paper describes the cases of misreporting of the official Spanish catches from Division VIIIc in the early years of the western mackerel assessment. This note is an extract of the reports of the Mackerel Working Groups (1974-1995), Sardine Working Group and Pelagics in Division VIIIc and IXa and Horse Mackerel Working Group (1985-1988).

Zimmermann C.

Western Horse Mackerel: Short and Medium-Term Predictions by ADAPT 2000-2005. WD 2000.

<u>Document available from:</u> Christopher Zimmermann, Inst. Seefischerei, Palmaille 9, 22767 Hamburg, Germany. <u>Email:</u> zimmermann.ish@bfa-fisch.de

The aim of this working document is to document the short and medium term projections for this stock using the ADAPT-method, as these data are not included in the Working Group report. The same was done in the last two years (WD Sparre & Zimmermann, Working Group MHSA 1998, WD Zimmermann, Working Group MHSA 1999). The agreed predictions for the Western Horse Mackerel were calculated using diferent approaches and are given in Sec. 6.5 of the Working Group report.

Zimmermann, C., Kelly, C., Abaunza, P., Carrera, P., Eltink, A., Iversen, S., Murta, A., Reid, D., Silva, A., Uriarte, A., Villamor, B.

Whitelist on the functionality and properties of an input application for the submission and processing of commercial catch and sampling data within the ICES enviroment. WD 2000.

<u>Document available from:</u> Christopher Zimmermann, Inst. Seefischerei, Palmaille 9, 22767 Hamburg, Germany. <u>Email:</u> zimmermann.ish@bfa-fisch.de

Historic data on catches and sampling of commercial catches at a disaggregated level and the subjective decisions to fill in missing information by the species co-ordinators have not been well documented by the different ICES Working Groups in the past. There was also no consistent storage of the disaggregated data at ICES. The need for changing this was stated by several ICES groups and defined in the ICES Code of Practice for Data Handling.

HAWorking Group and MHSA strongly recommended to ICES since 1998 that a standard application should be developed, preferably as a database-standalone, to ease data input, evaluation and documentation. This should be possibly used by all Working Groups, starting with the pelagics as soon as possible.

In late 2000, ICES stated that it intends to implement a standard system for data submission and storage, and asked the MHSA do produce a detailed list of the needed functionality of such an input application. The list presented here is the first attempt to support ICES in its effort to start with the development.

Advisory Committee on Fisheries Management ICES CM 2001/ACFM:06

REPORT OF THE

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

ICES, Headquarters
14–23 September 2000

PART 2 OF 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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8 SARDINE GENERAL

Sardine (*Sardina pilchardus*, Walb) has a wide distribution around both North-East Atlantic waters and in the Mediterranean Sea. Its northernmost boundary distribution seems to be likely related with the sea surface temperature and reaches up to the North Sea. Nevertheless, as in other sardine stocks, distribution area and abundance may be related with "regimes" (Lluch-Belda *et al*, 1989) and, hence, changes in both abundance and distribution should be expected.

Most of the studies about distribution and abundance of this fish species were done off the Iberian Peninsula waters, in Moroccan waters and in the Mediterranean Sea (Abad *et al*, 1999, Kifani, 1998, ICES CM 2000/ACFM:5), where sardine is a target species. In northern areas, sardine is not a target species and, is spite catches are routinely reported from this area, they could not reflect the true abundance or distribution of this fish specie.

Under the frame of the EU project PELASSES, a wide area, from Gibraltar to the Celtic Sea was covered in spring 2000 (Marques, 2000 WD and Carrera 2000 WD). Main feature of these surveys was the combination of both acoustic records, provided by 38 and 120 kHz frequencies, and egg samples provided in a continuously way by the CUFES. This device consists on a pump located at 3-5 m depth which provides a water flow of about 600 l/min to a concentrator. From here a smaller water volume (20 l/min) is conducted to a collector.

Acoustic Surveys

In ICES Sub-Division VIIe and in a small part of the VIIh, an acoustic survey was conducted from 19th March to 23rd. The survey, carried out on board R/V Thalassa, mainly covered VIIe. Sardine around the French coast was scarce. Moreover, in this area the presence of any fish specie was scarce. Off the English waters, the occurrence of fish was higher, being sprat the most abundant fish specie. Sardine was found close to the Celtic Sea. Nevertheless, the distribution of the sardine eggs was wider. This could be explained by the currents regime in the English Channel. In VIIe a total of 247 tonnes were estimated, corresponding to 6 million fish, most of the younger (i.e.<18cm length). In the Celtic Sea only a few were steamed, close to the French coast. The bulk of the area was no covered and the outer limit of the distribution is located further than the outer limit of the tracks Total abundance was estimated to be 3283 tonnes corresponding to 56 million fish. Younger specimen were located close to the coast and the adults offshore (Figure 8.1).

From mid April to mid May, VIIIab Divisions were surveyed by the R/V Thalassa. Sardine around VIIIab showed a wide distribution, covering from the coastal waters where the younger were mainly located, to the continental shelf break. Close to the slope large number of spawning adults were detected.

The Fishery

In VII and VIIIab Division catch data area available from France, UK (England and Wales) and Germany (Table 8.1). Germany also provided catch-at-age data from VIIef ICES Division. In VIIIab Division catches were reported by France.

In Division VII reported catches were below 5 thousand tonnes from 1983 to 1991. From 1992 to 1996 catches reached its maximum level, with 23 thousand tonnes reported in 1994. Since 1997, catches are around 4 thousand tonnes. Reported catches in VII for 1999 were 3,711 tonnes, most of then located in VIIef. Total landings in VIIIab were 17730 tonnes, which are similar to that of the last year. Landings in VIIIab presents a stable period from 1983 to 1996 at around 7 thousand tonnes. Since that catches notably increased up to 18 thousand tonnes.

In Division VII, as shown in Table 8.2 most of the catches occurred during the first and the fourth quarter. Length distribution from VIIef are available for the first and fourth quarter (Table 8.3). Mean length were similar for both quarter (12.5 cm).

Acoustic surveys has been performed for anchovy since 1989 in Divisions VIIIab. Some results were also given for sardine. In addition, Spain has also conducted two surveys covering part of VIIIb from 1997 to 1999. From these time series, the sardine biomass estimated was always higher than 200,000 tonnes. The fishing effort in this area for sardine is therefore low and could no reflect the dynamics of sardine.

Table 8.1: Annual catches of sardine by ICES Sub-Division

DIVISION	1983	1984	1985	1986	1987	1988	1989	1990
VIId	211	147	465	512	67	29	93	64
VIIe,f	590	661	1 624	2 058	682	438	91	808
VIIg	-	1	-					
VIIh	2	-			216	2 119	957	235
Total VII	**803**	**809**	**2 089**	**2 570**	**965**	**2 586**	**1 141**	**1 107**
VIIIa	6 013	4 472	8 090	10 186	7 631	7 770	8 885	8 381
VIIIb	454	19	79	77	77	38	85	104
Total VIIIab	**6 467**	**4 491**	**8 169**	**10 263**	**7 708**	**7 808**	**8 970**	**8 485**

DIVISION	1991	1992	1993	1994	1995	1996	1997	1998	1999
VIId	170	153	127	2 086	1 621	179	71	103	247
VIIe,f	4 687	19 635	5 304	20 985	13 787	8 278	2 584	4 223	3 415
VIIg									
VIIh	110	4	71	-	1 439	1 350	1 058	101	11
Total VII	**4 968**	**19 793**	**5 502**	**23 071**	**16 846**	**9 807**	**3 713**	**4 427**	**3 711**
VIIIa	9 113	8 565	4 703	7 164		8 180	11 361	10 674	
VIIIb	482	141	548	119		526	160	7 749	
Total VIIIab	**9 595**	**8 706**	**5 251**	**7 283**		**8 706**	**11 521**	**18 423**	**17 730**

1983-90 only French data was available for Sub-Area VII

Table 8.2: Sardine landings in 1999 by country. Below, quarterly distribution of the German and UK catches.

Division	Germany	UK	France	Year
VIId	62	185		**247**
VIIef	58	3357		**3415**
VIIg				
VIIh	13	25		**38**
VIIj				
VIIIab	11		17730	**17741**
Total	**143**	**3567**	**17730**	**21440**

Country	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Germany			57	87	**143**
UK	2112	2	77	1377	**3568**
Total	**2112**	**2**	**134**	**1463**	**3711**

Table 8.3: Sardine length distribution by quarter in ICES Division VIIef
(1) Provided by UK (England and Wales)
(2) Provided by Germany

	1st Q	2nd Q	3rd Q	4th Q
8				
8.5				
9				
9.5				
10	200			
10.5	200			2
11	1327			17
11.5	1377			47
12	3130			63
12.5	5159			53
13	2805			35
13.5	927			17
14	125			5
14.5	50			1
15	25			
15.5	0			
16				
16.5	100			
17				
17.5				
18				
Total	15426			240
Mean length	12.6			12.5

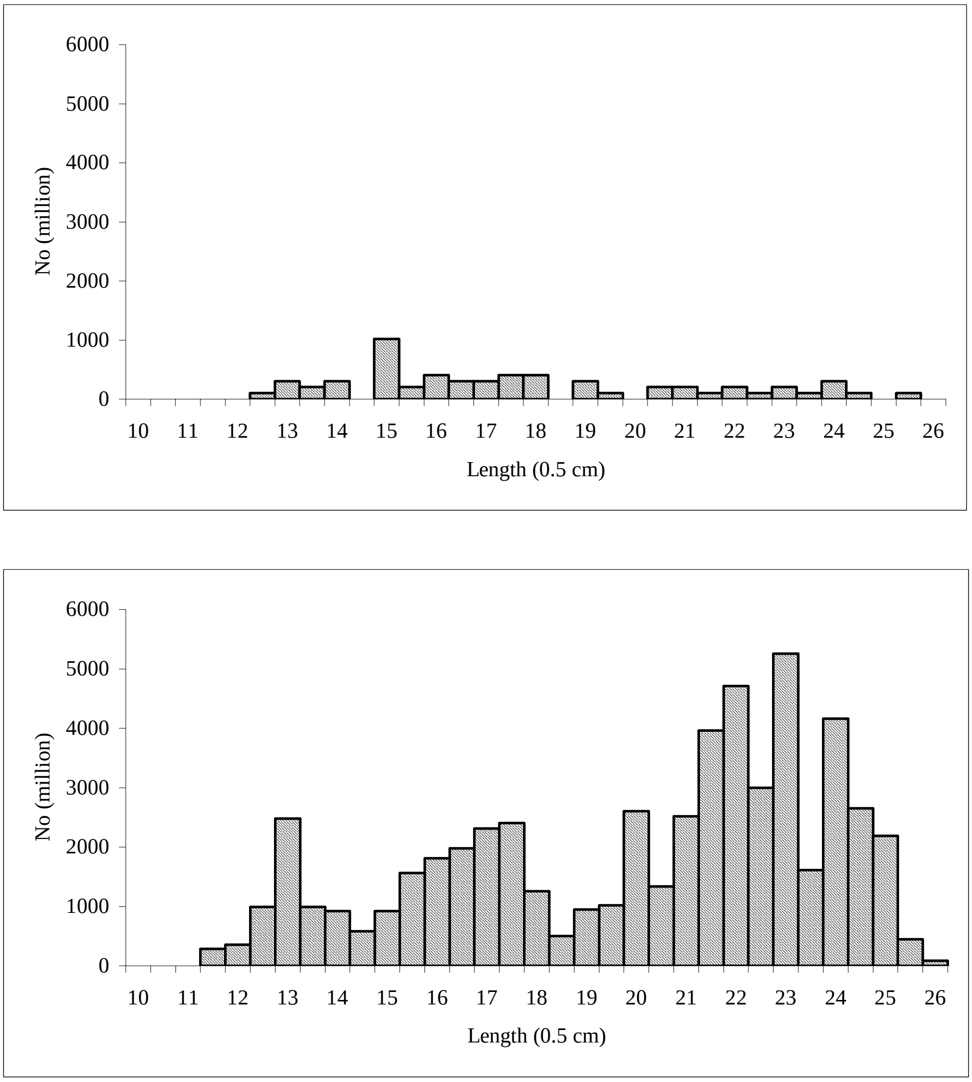


Figure 8.1: Estimated fish abundance by length class (0.5 cm) during PELACUS 0300 acoustic survey. Upper pannel, VIIef; lower pannel VIIh Division

9 SARDINE IN DIVISIONS VIIIC AND IXA

9.1 ACFM Advice Applicable to 1999 and 2000

In October 1998, ACFM recommended a reduction in fishing mortality to a value of F=0.20, corresponding to a predicted catch of 38000 t. If this reduction could not be implemented in 1999, ACFM advised a stepwise reduction in fishing mortality aiming at an increase of 20% in spawning stock biomass in 2000 and corresponding to a 40% decrease in F in 1999.

Based on new data provided by Anon. (1999), ACFM considered that there has been a severe decline in abundance in the northern part of the distribution of the stock whereas abundance in the southern areas has been approximately stable. Spatial changes in distribution and a shift in the exploitation pattern in southern areas towards older ages are perceived. It is unclear whether these changes are due to changes in migration driven by climatic effects, a contraction of the distribution or local depletion of independent units. ACFM considers that "perceptions the overall state of the stock depends on the extent to which reliance is placed on information from the northern and southern areas, and therefore the state of the stock is considered to be uncertain". For 2000, ACFM recommends that "fishing mortality be reduced below F=0.20, corresponding to a catch of less than 81000 t in order to prevent short-term decline in stock size and promote recovery of the stock".

9.2 The Fishery in 1999

As estimated by the Working Group, catches in divisions VIIIc and IXa were 94,091 t (22,271 t from Spain and 71,820 t from Portugal). The bulk of the landings (99%) was done by purse seiners. Table 9.2.1 summarises the quarterly landings by ICES Sub-Division.

In March, a ban was imposed to the purse seine fishery off Galician waters (IXa North, VIIIc West and the most western part of VIIIc East). An other management regulation implemented in 1999 was a minimum landing size of 11 cm (EU reg. 850/98). In Spain, a maximum allowable catch of 7,000 Kg per fishing day and a week limitation in the number of fishing days (4 in Galicia, 5 in the rest of Spain) were also implemented. In Portugal, new regulations have been gradually implemented since 1997 and the 1999 measures included: (1) an overall limitation in the number of fishing days (180 days per year, and 48 hours of ban during the weekend), (2) an overall catches reduction of about 10 % of the 1997 catches, (3) a closure of the purse-seine fishery in the northern part of the Portuguese area in February and March and finally, (4) an yearly and daily catches limits for all fishermen organisations. Daily catch limitations have been imposed for the first time in 1999.

In 1999, catches by both countries were lower than those realised in 1998. In Sub-division VIIIc-East, catches were 7,407 t which represented a reduction of 30 % compared to 1998. As 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 4,455 t (20 % of reduction) and most of them were made during the second and fourth quarter. In IXa-N, sardine catches were the lowest ever reported (2,563 t, a reduction of 21 %from 1998) due to the absence of fish in the area. Most of the landings from that area occurred during the second and third quarter. In IXa-CN, landings yielded to 31,574 t, which were more or less at the same level than the previous years. However, a large decrease in the catches was observed in the fourth quarter, for which there was no available explanation. Almost 50 % of the catches in this area was obtained during the third quarter. In IX-CS, catches also decreased (21,747 t or a reduction of 26%) and this reduction was equally distributed throughout the year. There is also some mentions that part of the purse-seine's fleet directed its effort to Spanish mackerel during the first and second quarter of the year. In IXa S, the reduction was 11 % lower (18,499 t), compared to an increase of 19% (7,846 t) in Cadiz.

In 1999, the bulk of the catches for this stock occurred in IXa Central North during the third quarter. The contribution of the catches off Galician waters, which reached up to 90,000 t in the earlier eighties, was almost negligible.

Annual catches from both Spain and Portugal are available since 1940 (Figure 9.2.1 and Table 9.2.2). Declining trends are observed in northern areas (from IXaCN to VIIIc) whereas in the most southern areas, catches have shown a slight increasing trend.

9.3 Fishery Independent Information

9.3.1 Egg surveys

DEPM surveys were carried out in 1999, both in Spain and Portugal (Anon., 2000). An overview of the methodology of these surveys has already been presented in Anon. (2000a) and a detailed description can be found in Anon. (2000b).

The Portuguese survey covered the Portuguese coast and the Gulf of Cádiz from 10th of January to 3rd of February and the Spanish survey was carried out off the North Atlantic Spanish coast from the 16th of March to the 11th of April. Adult parameters are estimated for the entire survey areas (unstratified). Survey timing of the Portuguese survey was changed from March to January, a change which is expected to increase the precision of SSB estimates and also result on a sightly larger estimate due to higher condition of fish in January. Parameters for the Spanish survey were based on samples collected in the Gulf of Biscay due to the small number of adult fish observed in the other areas. Due to inadequate sampling, it was not possible to estimate spawning fraction in the Spanish area and therefore the 1997 estimate was used in the calculation of SSB.

Parameter estimates for the two surveys are presented in Table 9.3.1.1. The total 1999 SSB estimate is 215.5 Ktonnes , with 95% of the biomass coming from the Portuguese survey (Portuguese coast+Gulf of Cadiz), a distribution pattern which is similar to the one observed in 1997. SSB estimates for both areas are well below the corresponding estimates from acoustic surveys. The Portuguese survey gave a much higher SSB than the two previous surveys, mainly due to the combination of a higher egg production and lower spawning fraction. However, the lower spawning fraction is due to very low estimates in the southern region (Algarve+Cadiz) and it is possible that the SSB estimates have been biased by problems related to adult survey design and post-stratification (Tables 9.3.1.1 and 9.3.1.2). An opposite situation was observed in the Spanish surveys. SSB estimates for 1999 where in this case, the lowest of all available estimates. Although the 1999 estimate has to be interpreted with caution, because it uses the 1997 spawning fraction, the SSB series shows a clear decreasing pattern in the Spanish area.

The issue of sampling design and adult parameter estimation has been is addressed by Stratoudakis and Fryer (WD, 2000). This WD demonstrates the impact of post-stratification on the 1999 DEPM estimation of sardine spawning biomass off Portugal, and propose sensible designs for future surveys. Poststratifying the Portuguese 1999 DEPM survey into two strata (western and southern) increases the SSB estimate by at least 100 Kt, nearly 50% more than the original (unstratified) estimate. A series of simulated populations was constructed consisting of the two strata, in which fish abundance and mean spawning fraction in each stratum were allowed to vary widely, and where egg production, sex ratio and batch fecundity were assumed known without error. Then each population was sampled using simple random sampling and various forms of stratified random sampling (allocation proportional to survey area, to fish abundance, and optimal allocation). Ignoring spatial structure in spawning fraction led to very biased and imprecise estimates of fish abundance. In the population scenario that most closely resembles the 1999 Portuguese DEPM survey, the bias was –25%, suggesting that unstratified estimation underestimates the true SSB. Stratified random sampling with allocation proportional to the abundance and optimal allocation outperformed allocation proportional to area and were robust to moderate levels of misallocation. Therefore, the authors believe that future adult surveys for DEPM would benefit by adopting an *a priori* stratified design, in which stratum effort is allocated according to the sardine abundance estimate from the most recent acoustic survey.

In spite of these recent findings, Stratoudakis and Fryer (WD, 2000) do not propose the use of the stratified SSB estimate in current years assessment, the first obvious reason being that new estimates have to be calculated for the previous surveys and the second because there are still doubts whether the large difference in spawning fraction between areas is a real biological phenomena or a temperature related artifact. The working group considers that research in this area should continue within the proposed Study Group on the Estimation of the Spawning Stock Biomass of Sardine and Anchovy by the Daily Egg Production Method and that the approach proposed in this WD should be used in the future.

9.3.2 Acoustic surveys

Acoustic activities undertaken in this area are co-ordinated in the frame of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII (ICES CM 1999/G:13).

Last year, a project called “Direct abundance estimation and distribution of pelagic fish species in north east Atlantic waters: Improving acoustic and daily egg production methods for sardine and anchovy (PELASSES)”, was approved by the EU under the frame of the “Common Fisheries Policy”. With the objective of improving the precision of the acoustic estimation, this project merges acoustic and ichthyoplankton activities. This combination of different sampling activities has been facilitated by the fact that the surveys currently performed in this area are conducted during the spawning time of two very important pelagic species, sardine and anchovy. Moreover, the recent development of the Continuous Underway Fish Egg Sampler (CUFES) is also an important factor that has contributed largely to the realisation of this objective. This CUFES device consists on a pump located at 3-5 m depth which provides a water flow of about 600 l/min to a concentrator. From there, a small volume of water (20 l/min) is directed to a collector in which plankton with a size greater than 500 µm is retained. CUFES provides continuous records of the plankton present at 3 m depth. An other objective of this project consists in the calibration of this equipment to allow the estimation of the eggs in the whole water column. If such a calibration is successful, both methods will be performed simultaneously on a single R/V.

To summarise, 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 the abundance of sardine and anchovy or other pelagic fish. This will be the first attempt to realise this objective which corresponds also to a recommendation of ICES to cover the entire sardine distribution. New common statistical techniques will be developed to improve the precision of the estimations.

2. The distribution of the main species of pelagic fish at the spawning time.

3. The egg distribution at 5 meters depth and, once CUFES is calibrated, the egg production of the main pelagic fish species.

4. The feasibility of using a single research vessel to get abundance and biomass estimates by echo-integration and egg production methods.

5. Biological samples collected from a wide area will be available to be used for many purposes (i.e. stock identification, otolith exchanges ...).

Portuguese November 1999 Acoustic Survey

This survey was performed in accordance to the standard survey design and strategies which consists in: (1) the calibration of the 38 kHz transducer prior the survey, (2) a distance of 8 nm between parallel transects and, (3) the application of the Nakken and Dommasnes method (1978). Moreover, several CalVET tows were also done during night hours throughout all the surveyed area. The survey was carried out on board R/V Noruega (Marques, WD 2000).

Sardine occurred in two main areas (Figure 9.3.2.1): (1) Off the northern coast, where juveniles are predominant and, (2) in the southern part (Algarve and Cadiz) where the bulk of the population is composed of adult fish (Figure 9.3.2.2, Table 9.3.2.1). Between Cape Roca and Cape San Vicente, sardine abundance was low. Compared with the previous year, there was an important decrease in both biomass and number (from 621,000 t or 21,168 million fish to 272,000 t or 7,866 million fish). This decrease was mainly concentrated in the northern part and Cadiz. In IXa-Central North, juveniles continued to be the dominant age groups (71% in numbers), so the observed decrease seems to be related with an overall decrease of the population. On the contrary in Cadiz, almost no recruits were observed. However, a significant decrease in the absolute number of recruits was also observed. Adults, as it was already mentioned, were mostly concentrated in Algarve and their number remained quite stable (from 95,000 t or 2,019 million fish to 92,000 t or 1,537 million fish, with 99 % belonging to the 1+ age groups in 1999 compared to only 58% in 1998). The egg distribution, as determined by the CalVET tows, matched quite well the acoustic adult distribution (Figure 9.3.2.3).

For this time series, long-term fluctuation in the estimated biomass by area is presented in Figure 9.3.2.11. From this Figure, it can be concluded that:

- An important decrease in the biomass was observed in the north part.

- Large biomass fluctuations in the central part, with the lowest value in 1999

- A stable situation in the south of Portugal where most of the adults are present.

- A poor 1999 year class compared with the previous year, which had more incidence in Cadiz, one of the traditional nursery areas.

Due to the shortness of the time series in Cadiz and giving the influence of the incoming recruitment in the total biomass, no conclusion on the dynamic of sardine in Cadiz could be suggested.

Portuguese March 2000 acoustic survey

This survey conducted in March 2000 has provided for the first time additional information on sardine eggs. Due to the bad weather conditions found in Cadiz, 33% of this area was not covered which however corresponds to the traditional area with less fish abundance.

In comparison to the November survey, sardine were more distributed in the southern parts. On the contrary in IXa-CN, sardine were restricted in a small area, around Porto. Accordingly, the sardine biomass estimated in IXa Central South was higher than that of the November survey (Figures 9.3.2.4 , 9.3.2.5 and Table 9.3.2.1). The number of juveniles increased in northern part and in addition, a large number of fish smaller than 8 cm (modal length of 6 cm) appeared in Cadiz. Taking into consideration the growth pattern of this species, most of these fish were probably hatched in late January 2000 but classified as fish of the age group 1 according to the ageing criteria. These fish notably increased the age group abundance (an increase of 16 % if their abundance is estimated to be about half the age 1 fish abundance in Cadiz). Furthermore, during the second half of the year, these fish will be re-allocated into age group 0. This situation has often happened and might lead to an over-estimation of age group 1 in the Portuguese March surveys.

Comparing with the last March acoustic survey , there was a decrease of 12% in the total biomass. Although this decrease was lower, important changes in the biomass was observed in the different areas. In the northern part, total biomass was estimated at 98,000 t or 3,685 million fish, a decrease of 38 % compared to 1998. Nevertheless in the Central part, which roughly corresponds to IXa Central South, the biomass increased to 150 % (from 35,000 t or 830 million fish in 1999 to 90,000 t or 2,715 millions fish this year). In Algarve (IXa South), the biomass increased by 50 % (from 39,000 t or 862 millions fish estimated last year to 59,000 t or 1,011 millions fish this year). In Cadiz, the biomass decreased by 36% (from 191,000 t or 5,495 millions fish to 122,000 t or 4,463 million fish).

This survey shows a stable situation for the adults, compared with the March and November surveys. On the other hand, the strength of the 1999 year-class could be over-estimated because part of the age 1 fish are presumed to belong the 2000 year-class. The duration of the spawning period for sardine is more than 7 months long, and it occurs from late September to early May. For this species, the recruitment is the result of the temporal and spatial integration of a long hatching process, and takes mainly place from April to October. Thus, this survey was characterised by:

- Stable population of adults mainly concentrated in the Algarve area as it was observed during the previous survey, but distributed northwards as well

- Large amount of sardines recently hatched, specially in Cadiz, which might over-estimate the strength of the 1999 year class.

Figure 9.3.2.10 shows the long-term changes in the estimated biomass from the acoustic survey conducted in March in the region of the Atlantic waters of the Iberian Peninsula (Spanish and Portuguese time series combined). Long-term trends suggest:

- A decrease of the biomass in the north part, after a period of three years of increasing trend (from 1996 with the lowest value in 1998), and a decreasing trend for the last two years.

- A small decreasing trend in the southern areas (from IXa Central South to IXa Cadiz). In IXa Central South, the biomass has been stable up to 1998. But in 1999, it decreased sharply and increased again in 2000. In IXa South, there was a decreasing trend in the biomass from 1995 to 1999 and an increase in 2000. In Cadiz, time series is short and no long-term trends could be observed.

On the other hand, CUFES performance was high and provided a good spatial distribution of the egg distribution. Moreover, the egg distribution provided by CUFES is similar to the adult distribution obtained from the acoustics (Figure 9.3.2.6).

Spanish April 2000 Acoustic Survey

As it was stated in the previous section, the Spanish survey also covered Sub-Division VIIeh during the last days of March 2000, whereas the Spanish area was covered in April. This survey was co-ordinated with those performed by

Portugal and France. (i.e. same methods, and also using CUFES). The survey was conducted on board R/V Thalassa (Carrera, WD 2000).

Figures 9.3.2.7 and 9.3.2.8 show respectively the sardine distribution along the surveyed area and the estimated number of fish at age by Sub-Division.

Off Galician waters, sardine were distributed in small patches without continuity. Only in the northern part of this area, sardine were found in thick and big schools close to the shore. As long as the inner part of the Bay of Biscay was reaching, the sardine distribution became wider. Total biomass notably increased from the previous surveys (from 43,000 t or 726 million fish in 1999 to 96,000 t or 13,121 million fish in 2000). Nevertheless the sardine biomass estimated in IXa-N was lower than that of the previous year (from 4,000 t to 2,000 t). In addition, the small number of fish belonging to age group 1 suggests that a low recruitment occurred in 1999. This situation agreed with the data obtained from the 1999 Portuguese November acoustic survey. In VIIIc-West, the biomass increased from 5,000 t to 31,000 t and in the same way, the biomass in VIIIc-East increased from 35,000 t to the 63,000 t.

To summarise, this survey provided three main conclusions:

- Poor representation of the 1999 year class
- Sardine abundance estimates from this survey time series is still decreasing in IXa-North, which can also be observed in landings from this area.
- The biomass in the Cantabrian sea, where all the fish are mature, notably increased everywhere in all VIIIc Division, the age group 3 being the most important.

Long-term trend in this time series is shown in Figure 9.3.2.10 and can be summarised as follows:

- In the inner part of the Bay of Biscay, the sardine biomass has slowly decreased over time. Nevertheless, short-term trend shows an increasing trend since 1998.
- In the rest of VIIIc Division, sardine shows an important declining trend, specially in the most western part. However, from 1999 to 2000, the biomass increased.
- In IXa North, the estimated biomass was always lower than 20,000 t and since 1993, it shows a declining trend. It should also be noted that this trend is similar to the sardine landings in this Sub-division

As in the case of the Portuguese, CUFES performance was good and the egg distribution obtained with this device, as presented in Figure 9.3.2.9, is similar to the adult distribution described from the acoustic data.

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 length weight relationship were calculated for each quarter. In Portugal both ALK and L/W relationship were compiled on a quarterly and Sub-Division basis. 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) and from IXa-CS and South gave higher mean length throughout the year.

The catch-at-age data for 1998 has been revised after that some misallocations in IXa-CN were found. Accordingly, mean weight at age was also changed. This updating caused a decrease in the catch-at-age for age group 1 (19%) and a slight increase in others age groups, except the plus group. The effect of this updating in the assessment model will be explained later.

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 Subdivision as well as their relative contribution to the catches.

Total catch was 1,777 millions which represents a decrease of 23 % from the previous year. The most important decrease was observed on age group 0, which represented 14 % of total catch in 1999 compared to 58 % in 1998. The bulk of the catches for this age group was taken in IXa-CN (64 %) as in the previous year. The Portuguese November acoustic survey estimated the 1999 recruitment as half the 1998 one. Therefore, lower catches for this age group were expected. Age groups 1 and 2 were the most represented in the catches (27 % and 20 % respectively), and they were mostly caught in IXa-CN (40 % of the total catches were from these age groups). Older fish (3+) were more represented in IXa CS and IXaS where catches were composed by more that 50% of these age groups.

Since 1978 the contribution of younger fish follows a decreasing trend, with the lowest contribution in 1995. In 1999 the contribution of the younger sardine to the overall catches was 20% higher than the one of the older fish (3+).

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) compared with the Northern Portuguese area. In the same way, mean weight at age were consistently higher in VIIIc.

SOP's were all below +/-5 % except for the second quarter in IXa Cadiz which gave a value of 7 % in the first quarter in IXa-N with 12 %. In this case, because only 68 t were landed, overall SOP for this quarter still remained bellow 5 %.

9.4.3 Maturity at age

The maturity ogive for 1999 was based on the biological samples collected during the spawning period (i.e. the fourth quarter of 1998 and the first one of 1999). Age classes from the samples obtained in 1998 were shifted by one year. Samples for each country were weighting 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	61.9	91.1	98.7	99.5	100	100

In comparison to the previous years, the proportion of fish mature at age 1 is lower whereas for the other age groups, the values are similar.

9.4.4 Natural mortality

According to Pestana (1989), the natural mortality was estimated at 0.33, and considered constant for all ages and years.

9.5 Effort and Catch per Unit Effort

Data on fishing effort and CPUE has been regularly provided in this section both for Portuguese purse-seine fleet and Spanish purse-seine fleets from Sada and Vigo-Riveira. However, it was recognised last year 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 1999.

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). The hypothesis of a negative impact of winter upwelling on sardine recruitment has been suggested by Santos *et al*. (1997). A possible mechanism coupling the two phenomena is that upweeling induces the offshore transport of larvae to areas with unfavorable feeding conditions.

The relation of winter upwelling and sardine recruitment off Portugal has been further explored by Borges *et al.* (2000). The authors also showed the relation between winter upwelling indices and the NAO (North Atlantic Oscillation) index. The paper uses a time series of sardine catches (as an index of recruitment 2 years before), indices of winter northern winds and of the NAO for the western Portuguese coast in the period 1945-1991. The results show a significant negative correlation between the mean northern wind index and sardine catches, where the period of high catches observed before 1970 coincides with lower values of the wind index and the period of lower catches after 1970 coincides with higher values of winter northern winds (Figure 9.6.1). Coastal upwelling is non-existent or very weak when the winter northern winds have low strength (left side of the triangle superimposed on Figure 9.6.1) and so do not play an important role in the survival rate of spawning in the area. It is noteworthy that when the winter upwelling overpasses a certain limit and gets stronger, it forces the recruitment or catch to be lower (right side of the triangle). In summary, strong winter north winds appear to have a negative impact on sardine recruitment but when low values are observed other factors become important in recruitment strength. The non-linear relationship implicit in the process needs to be further explored but these results may soon be useful in recruitment monitoring if the mean north wind index can be estimated in time. The working group considered that both the update of the current winter wind series and the availability of these data on time ,will enable its future incorporation in the assessment of sardine stock status.

9.7 State of Stock

9.7.1 Data exploration

Last year the assessment model was checked in order to know the sensitivity to different assumptions and input data (ICES CM 2000/ACFM:5). Several options, including different tuning fleets and input data were used. Finally the Working Group concluded to adopt as tuning data for the model three time series of acoustic surveys (Spanish Spring, Portuguese March and Portuguese November), with linear catchability model and the DEPM time series as an absolute estimator of the fish abundance.

As explained in previous sections catch-at-age and weights-at-age for 1998 were updated according to the new available information. Furthermore, weights in the stock at age for 1998 were reviewed since the last Working Group meeting. DEPM was also updated for 1997 according to the revision made at the Workshop on the Estimation of Spawning Stock Biomass of Sardine (ICES CM 2000/G:07).

In order to check how these changes affected the assessment model, a preliminary run was carried out with the same settings of the previous assessment with corrected historic input data. No major changes occurred in both estimated recruitment and fishing mortality. Nevertheless, SSB estimated for 1998 was 22% lower and that was mainly due to the revision of the weights-at-age in the stocks.

A new run was performed using last year assessment model with historical data revisions and input data updated to 1999 (RUN 1, Figure 9.7.2.2). The inclusion of a new year did no change the perception of the stock and only a small decrease in the recruitment and fishing mortality estimated for 1998 was observed.

In previous years, a difference in the signals given by the different tuning fleets which cover different parts of the stock area has been observed in the assessment. Therefore, it was decided to explore further the separate influence of each tunning fleet in the model fitness and results. Furthermore, it was observed that DEPM estimates, used as absolute indices in the first model, repeatedly gives a lower stock size estimate and that the linear catchability model considered for the Spanish acustic survey provides a poor fit for most ages. The first exploratory model included 14 years of Separable Period divided in two periods, from 1986 to 1990 and from 1991 to 1999, with abrupt change between both. A shift in the pattern of residuals from the separable model was observed from 1990 to 1991 which coincided with the period of change in the selection pattern.

Thus, aiming to explore deeper the assessment model, a series of preliminary analyses were carried out. This exercise consisted in two kinds of trials, i) the effect of the different tuning data in the assessment model and, ii) the effect of the separable period in the assessment model.

Six runs were performed using each of the different fleets as input data and testing different catchability models for DEPM and the Spanish acoustic survey. Table 9.7.1.1 summarises the input data and options for each run. Figures 9.7.1.1a-c show the results in terms of parameter estimates from all exploratory runs.

First model was fitted using only the Spanish March Acoustic survey (RUN-2). SSB estimated by this model give similar results for the most recent history (i.e. from 1989 to 1999). Nevertheless, SSB for years 1989 and backwards is higher than that estimated for the model including all fleets. Fishing mortality give similar trend of that of the test model, but, as in the case of the SSB, estimated $F_{(2\text{-}5)}$ for the beginning of the time series is lower and, on the contrary, is higher for the most recent years. Using DEPM alone as absolute estimator (RUN-3) gives a low perception of the stock size for the most recent history, with low SSB and high $F_{(2\text{-}5)}$. It should be noted that this series has a single point in the 80's (1988) and two points in the end of the 90's (97 and 99). The Portuguese November Acoustic Survey (RUN-4) gives a contradictory perception of that shown by the previous run, with high SSB for the nineties with low $F_{(2\text{-}5)}$ for the same period. The effect of the Portuguese March Acoustic Survey used as the single tunning fleet was not possible to test because the objective function did not converge. Its effect was nevertheless explored in RUN 7 (see below).

Next exploratory analysis investigated changes in the fitted catchability model for different fleets. The observation of the residuals given by the Spanish March Acoustic Survey index, suggested a power relationship rather than a linear one. Thus, RUN-5 shows the effect of such change in the perception of the stock. In spite the power model matched better than the linear, SSQ surface for this index did not reach any minimum and the index prediction gave higher CV than the linear one. Perception of the stock remains similar to the test model, and no major changes can be observed in the SSB estimated in the most recent years, with a small difference for the period 1988-1992. $F_{(2\text{-}5)}$ is similar to the test model for the period 1993-99. Nevertheless, this model present a marked peak in 1990 and from this year backwards, the estimated $F_{(2\text{-}5)}$ is higher than the test model. RUN-6 shows the perception of the stock when DEPM is treated as relative estimator with linear catchability. This model scales SSB upwards throughout the assessment period giving a more optimistic perception of the stock. $F_{(2\text{-}5)}$ is always lower than the test model and the estimated SSB higher. In recent years, SSB estimates are close to those provided by the model constructed with the Portuguese November acoustic survey alone. The exclusion of the Portuguese March Acoustic Survey (RUN-7) provides no change in the perception of the stock.

Overall, the sensitivity analysis indicates:

- The model is sensitive to which tuning fleets are included

- The exclusion of the Portuguese March Acoustic Survey does not give any change in the perception of the stock

- The model constructed with the Spanish Acoustic Survey alone as tuning fleet gives a perception close to that of the model made with all the fleets

- Compared with the test model the Portuguese November Acoustic Survey provides a more optimistic perception of the stock for the most recent years. Moreover, this perception is contradictory to that given by the model with DEPM alone as an absolute index.

- Similar perception of the stock is obtained for the models constructed with the Portuguese November AS or when DEPM is used as linear estimator in the general model.

- Although a power model could be suggested for the Spanish March Acoustic Survey, the CV of this model is lower than with the linear one.

Previous to check the sensitive to the selection pattern, catch-at-age data was analysed in order to know whether the selection pattern has changed. Figure 9.7.1.2 shows the relative differences between catches of the younger fish (age groups 0, 1 and 2) and the older (age groups 3+). The contribution of the younger fish to the overall catches shows a decreasing trend from 1978 to 1995 and an increasing trend since this year to 1998. This trend is affected by the strength of the incoming recruitment. Nevertheless, in spite the trend for the most recent years is positive, the contribution of the younger fish is the lowest of the time series, both relative and absolute terms. This plot suggests that since 1993 the fishing pattern has changed and the contribution of the younger fish to the catch became lower. The explanation for this change seems to be related with poor recruitment occurred from 1993 to 1995. The 1997 and 1998 year classes have been estimated to be above the mean recruitment of the last years but unexpectedly, they had little reflex on the catches.

Terminal numbers at age in the separable model are used to perform a VPA back in time. The chose of the appropriate selection pattern is important to increase the accuracy and precision of the parameters estimation.

Different options concerning the separable period were tested. The results of the parameters estimation are given in figure 9.7.1.3. First model (RUN-8) was performed with two separable periods similar to those used in last year assessment, from 1987 to 1991 and from 1992 to 1999, assuming abrupt change in the selection pattern. This model give similar results to that of the test model, but the estimated $F_{(2-5)}$ was lower for year 1991. Residuals from the separable period shown a shift at the period change, as in the test model. Same behaviour in the residuals was observed when the model was constructed with two periods, from 1987 to 1990 and 1991 to 1999.

Taking into account the analysis of the catch-at-age matrix, it seems that the major change occurred from 1993 to 1994. Therefore, a new model (RUN-9) was constructed with two separable periods, from 1987 to 1993 and from 1994 to 1999. This model yields lower SSB for the period 1993-1996. Also estimated $F_{(2-5)}$ for the same period was slightly lower than that of the test model. Another model was performed with a lower separable period, from 1991 to 1993 for the first period and from 1994 to 1999 for the second. This model gives a different perception of the stock, with lower SSB for the whole period (1978-1999) and higher $F_{(2-5)}$, specially for 1990.

The analysis of the influence of the choice the separable period gives:

- Less sensitivity in the parameter estimates than the choice of the tuning fleet.

- A shift in the pattern of residuals of the separable model in those models in which the two periods were not properly chosen.

- Less abrupt change in the trend of residuals when the change in the separable period is set in 1993.

A trial run was also made with the AMCI model (Assessment Model Combining Information from various sources AMCI, Skagen, 2000, see also Section 2). This model has a population model with a fishing mortality model that basically is separable, as has ICA, but it can relax the assumption that the fishing mortalities are separable by allowing for recursive updating of the fishing mortalities, by which the selection pattern can change slowly. In spite the model has not been deeply tested, and it was never used for this stock, a preliminary run was made mainly to analyse further the changes in selection pattern throughout the assessment period. Figure 9.7.1.4 shows the selection pattern by year, normalised to the average F2-5, estimated by the model. It is clear that a pattern where higher selection of younger fish prevailed in the eighties while an opposite pattern is observed in the 90´s, with 1989-1993 as a transition period. The change in the proportion of younger/older fish along the nineties does not allow to fit a single appropriate selection pattern for this period.

On the basis of the above exploration, the Working Group stresses that the dynamic of this stock, which might include changes in both distribution area, changes in the age pattern distribution along the Iberian Peninsula (Azevedo, WD 1999) and large recruitment variability, makes difficult to get an appropriate model for the whole time series. Therefore, uncertainties about the true dynamics and absolute values still remain. The exploratory analysis showed a large sensitivity of the assessment to the different tuning series. Although improvement of the assessment by changing options regarding tuning were considered, the Working Group considers that the uncertainty currently prevailing advises for caution before significant knowledge is added. Nevertheless a model constructed with 13 years of separable period divided from 1987 to 1993 and from 1994 to 1999 including all the available tuning fleets and DEPM spawning biomass as an absolute estimator, gives lower residuals without noticeable trends. The Working Group decided to adopt such model as the most appropriate to represent the dynamic of this stock.

9.7.2 Stock assessment

Based on the previous analysis, an Integrated Catch at Age analysis (Patterson and Melvin 1996) has again been used for the assessment of sardine. The model was fitted by a non-linear minimisation of the following objective function:

$$\sum_{0}^{6+}\sum_{1987}^{1993}\lambda_a\left[\ln(C_{a,y})-\ln(F_y\cdot S_{1,a}\cdot \overline{N}_{ay})\right]^2+\sum_{0}^{6+}\sum_{1994}^{1999}\lambda_a\left[\ln(C_{a,y})-\ln(F_y\cdot S_{2,a}\cdot \overline{N}_{ay})\right]^2+$$

$$+\sum_{1987}^{1993}\left[\ln(DEPM_y)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{1,a}-PM\cdot M)\right)\right]^2+$$

$$\sum_{1994}^{1999}\left[\ln(DEPM_y)-\ln\left(\sum_a Na,y\cdot Oa,y\cdot Way\cdot\exp(-PF\cdot F_y\cdot S_{2,a}-PM\cdot M)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}-M)\right)\right]^2+\sum_{1994}^{1999}\sum_{1}^{6}\left[\ln(ANP_{a,y})-\ln\left(Q_{ANPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}-M)\right)\right]^2+$$

$$+\sum_{1987}^{1993}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}-M)\right)\right]^2+\sum_{1994}^{1999}\sum_{1}^{6}\left[\ln(ASS_{a,y})-\ln\left(Q_{ASSa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}-M)\right)\right]^2$$

$$+\sum_{1987}^{1993}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{1,a}-M)\right)\right]^2+\sum_{1994}^{1999}\sum_{0}^{6}\left[\ln(ASP_{a,y})-\ln\left(Q_{ASPa}\cdot\overline{N}\cdot\exp(-F_y\cdot S_{2,a}-M)\right)\right]^2$$

with constrains 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 1994–1999 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. The inclusion of two selection patterns reflect the change found in the catch at age matrix. SSB indices from the DEPM are below the estimated SSB in the three years.

As in last years assessment, a negative trend in residuals with time is observed for age groups 4-6 in the Spanish March acoustic survey and an opposite trend in the November Portuguese acoustic survey. These patterns indicate that the Spanish survey overestimates the population given by the model in the 80’s and the Portuguese November survey is overestimating it in the 90’s. Furthermore, a high residual corresponding to 1983 year-class is evident in the Spanish survey. Separable model residuals are similar to those observed from last year’s assessment with values higher than ±0.5 for age group 0 in 1991, 1993 and 1995 and on age group 5 in 1998 . However, the abrupt change in the residual pattern from 1990 to 1991 observed in last years assessment is now smoothed due the change in the limits of the two separable periods. CV’s expressed in % of the parameter estimates are similar to previous assessments and are mainly in the range 15-30%.

Figure 9.7.2.2 shows the estimated recruitment, F2–5 and SSB for the whole time series provided by the models fitted this year and in the last years assessment. Estimated recruitments are similar to those in the last years assessment. This years assessment confirms that the 1998 year-class has been well above those in the previous six years. Recruitment estimated for 1999 represents a 16% decrease relatively to that in 1998. Strong year-classes are observed in 1983, 1991 and 1998 but with decreasing strength in that order. Fishing mortality shows a similar pattern as in last year except for the period 1991-1994 where lower values were estimated, coinciding with the transition between the two selection patterns. F(2-5) for 1999 shows a 25% decrease relatively to that in 1998, what seems to reflect in part a decrease in fishing effort due to fishery regulations. The SSB time series estimated this year is comparable to that observed in the last years assessment. Estimated SSB again shows two clear periods of higher abundance (1982–86 and 1993–95), the second one with slighlty relative importance. After a declining period up to 1997, SSB seems to be stable in the last two years. At present the stock is considered to be at a low level, similar to that observed in 1990.

9.7.3 Reliability of the assessment model

As it was stated last year from various working documents (Azevedo, 1999 WD; Bernal 1999 WD; Carrera *et al*, 1999 WD; Morais *et al*, 1999 WD; Stratoudakis, 1999;WD) important changes in both sardine distribution and abundance has been detected since earlier nineties. A change of the sardine distribution towards southern areas and a reduction of the overall sardine distribution area, leads to a different perception of the stock depending on the area considered. Both the catch distribution by areas and the age composition of the catches in each area have gradually changed. Population abundance and catches are dependent of the strength of the incoming recruitment which shows low to average values in recent years and a short-term impact on catches and population abundance. As a consequence of this dynamics, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if areal/temporal differences are not considered.

The assessment model presently available to the Working Group improved the precision in the parameters estimation. Nevertheless, uncertainties about accuracy still remain. Taking into account the similar trends observed from the different assessment models explored and the lack of a more appropriate model in which an area perception of the evolution of this stock can be observed, the Working Group concludes that the parameters estimated by the model should be regarded as relative.

9.8 Catch Predictions

9.8.1 Divisions VIIIc and IXa combined

Input values for short term catch predictions (until 2002) are presented in Table 9.8.1. Numbers at age for ages 2-6+ were based on the population numbers estimated by the assessment model at the beginning of 2000. There is indication that the 1999 recruitment is poorly estimated by this model (CV=0.41). The number of age 1 fish for projections was calculated by replacing the 1999 recruitment estimated by the model with the geometric mean recruitment for the last six years and projecting forward one year using the F at age 0 estimated by the model. Input value for recruitment in 2000 was fixed at 7831 million fish, which corresponds to the geometric mean of the period 1994-1999. Large variations in recruitment are observed in the time series. The lowest recruitments have been observed in the more recent period and the strongest recruitments in this period are still lower than most of the recruitments in the 80's. Therefore, the mean value used for projections is considered to be representative of the recent years.

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. Stock and catch weights at age were calculated as mean values for the last three years. The use of these mean values is expected to smooth the interannual variability in these parameters. Due to the decrease in the fishing mortality in the last year input values for the exploitation pattern were those estimated by the assessment model for 1999. The 1999 maturity ogive was used in projections.

Results of the predictions are shown in Table 9.8.2 and Table 9.8.2.1. At F *status* quo (F2-5 in 1999 equal to 0.30) these predictions indicate about 23% increase in the catches and a 27% increase in the SSB comparatively to 1999. Preliminary information on catches for the first semester of 2000 indicate a level of catches similar to that in 1999, both off the Portuguese coast and off the Northern Spanish coast. The effort for these fisheries in 2000 is not expected to increased due to fisheries regulations limiting both fishing effort and catches.

However, keeping F at Fstatus quo indicates a decrease in SSB in 2002. A reduction of 20% of current fishing mortality provides a increase in SSB until 2002 while maintaining the catch level. The predicted SSB value for 2002 is comparable to the SSB level observed in 94-95.

9.8.2 Catch predictions by area for Divisions VIIIc and IXa

Table 9.8.2 presents the input data. 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 estimated for the areas combined in 1999 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 1997–1999.

Catch forecasts for each Division are shown in Table 9.8.2.2. At F *status quo*, catches are expected to increase in both areas in 2000 and 2001 and SSB is expected to increase until 2001 and then decrease slightly. Considering a 20% reduction of fishing mortality SSB will maintain the increasing trend along the projection period and catches in each area will be similar to those in 1999.

Catch prediction by area were calculated on the basis of the estimated parameters in the assessment model for 1999 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 1997–1999. There is no any scientific evidence to forecast catches according to ICES Divisions. This split by area should only be regarded as an example, because the split could also be based on other criteria. If necessary, advise on other criteria on how to split the catches between "Northern" and "Southern" areas should become available from the management bodies outside ICES.

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

Input data for yield per recruit analysis is shown in Table 9.11.1. As for the short term catch predictions, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25. Maturity ogive, stock and catch weights at age were calculated as mean values for the last three years. Population numbers used in the projection are those used for short term predictions. Results are shown in Table 9.11.2 and Figure 9.11.1.

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.

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 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 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 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

The distribution and abundance of the Iberian sardine stock has changed. Since earlier nineties, the distribution pattern is changing with an overall decrease in the distribution area and a reduction in abundance in the north part and a stable situation in the south. Thus the perception of this stock is heavily dependent of the area. On the other hand, the proportion of younger fish (i.e. age groups 0, 1 and 2) in the catches show a decreasing trend since 1978, being lower than the contribution of the older fish (age groups 3+) from 1993 to 1995. As a consequence, neither the selection pattern nor the overall dynamic of the stock can be properly modelled if stationarity has to be assumed along the time series.

Exploratory analysis performed this year, in which the sensitivity to different options for tuning fleets and for the separable period and selection pattern was studied, resulted in an improvement of the assessment model. Although the precision of the model increased, uncertainties about the true level of the parameters estimated by the model still remain. Nevertheless, the perception of this stock obtained from the different models gave similar trends in recruitment, stock size and fishing mortality.

At present the Spawning Stock Biomass of this stock is considered to be lower, similar to that observed in 1990. The estimated 1998 year class is above the geometric mean of the time series. Because of the high CV (41%) in the estimation of the 1999 year class and given the relative low catches of this age group during 1999 compared with those obtained in 1998, the strength of the 1999 recruitment is unknown. Fishing mortality increased from 1995 to 1998 when reached its highest value since 1980. Nevertheless, fishing mortality shows a sharp decrease last year. Management measures undertaken by both countries Spain and Portugal to reduce the fishing effort (i.e. closure periods, limitation of the fishing days) and the overall catches (daily and/or annual allowable catches per boat or per fisherman organisation) as well as the strength of the 1998 year class contributed to such diminution in the fishing mortality.

The differences in the evolution of the stock abundance in different areas remains a matter of concern. The biological relationship between the different areas 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.

9.16 Stock Identification, Composition, Distribution And Migration In Relation To Climatic Effects

Last year, a considerable amount of progress has been made regarding the knowledge of sardine dynamics within the current stock unit. An overall reduction of the distribution area and a shift in the distribution pattern to the southern areas were important changes observed between the 80's and the 90's. These changes were accompanied by weak year-classes in the recent years and introduced considerable changes in the fishery distribution and in the fishing pattern along the area. Possible explanations to these changes include changes in upwelling patterns affecting larval survival. Although different perceptions of the stock are apparent from the northern and southern areas, no basis for a change in the assessment unit currently defined was advanced. Furthermore, the need of a better knowledge of the dynamics of the population to the north and south of the current stock was identified. It was also evident that the assessment model currently used is not able to describe properly these temporal and spatial changes.

During 1999, research has continued in several areas to try to answer these questions but the need of an integrated approach was recognised. A proposal for a new Project has been prepared and will be submitted to the EU-Quality of Life Program in October 2000. 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 goes from the French coast to the Spanish Mediterranean and the Morrocan coast. 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 and development of appropriate assessment models.

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	2401	1199	1141	2666	**7407**
VIIIc-W	209	1885	986	1375	**4455**
IXa-N	68	1080	1249	167	**2563**
IXa-CN	932	6109	15464	9068	**31574**
IXa-CS	4806	3670	6262	7009	**21747**
IXa-S (A)	2890	5164	5980	4466	**18499**
IXa-S (C)	2458	1312	2158	1917	**7846**
Total	**13764**	**20419**	**33240**	**26668**	**94091**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2.55	1.27	1.21	2.83	**7.87**
VIIIc-W	0.22	2.00	1.05	1.46	**4.73**
IXa-N	0.07	1.15	1.33	0.18	**2.72**
IXa-CN	0.99	6.49	16.44	9.64	**33.56**
IXa-CS	5.11	3.90	6.66	7.45	**23.11**
IXa-S (A)	3.07	5.49	6.36	4.75	**19.66**
IXa-S (C)	2.61	1.39	2.29	2.04	**8.34**
Total	**14.63**	**21.70**	**35.33**	**28.34**	

Table 9.2.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-1998.

			Sub-area								
Year	VIIIc	IXa North	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz	All sub-areas	Div. IXa	Portugal	Spain (excl.Cadiz)	Spain (incl.Cadiz)
1940	66816		42132	33275	23724		**165947**	**99131**	**99131**	**66816**	**66816**
1941	27801		26599	34423	9391		**98214**	**70413**	**70413**	**27801**	**27801**
1942	47208		40969	31957	8739		**128873**	**81665**	**81665**	**47208**	**47208**
1943	46348		85692	31362	15871		**179273**	**132925**	**132925**	**46348**	**46348**
1944	76147		88643	31135	8450		**204375**	**128228**	**128228**	**76147**	**76147**
1945	67998		64313	37289	7426		**177026**	**109028**	**109028**	**67998**	**67998**
1946	32280		68787	26430	12237		**139734**	**107454**	**107454**	**32280**	**32280**
1947	43459	21855	55407	25003	15667		**161391**	**117932**	**96077**	**65314**	**65314**
1948	10945	17320	50288	17060	10674		**106287**	**95342**	**78022**	**28265**	**28265**
1949	11519	19504	37868	12077	8952		**89920**	**78401**	**58897**	**31023**	**31023**
1950	13201	27121	47388	17025	17963		**122698**	**109497**	**82376**	**40322**	**40322**
1951	12713	27959	43906	15056	19269		**118903**	**106190**	**78231**	**40672**	**40672**
1952	7765	30485	40938	22687	25331		**127206**	**119441**	**88956**	**38250**	**38250**
1953	4969	27569	68145	16969	12051		**129703**	**124734**	**97165**	**32538**	**32538**
1954	8836	28816	62467	25736	24084		**149939**	**141103**	**112287**	**37652**	**37652**
1955	6851	30804	55618	15191	21150		**129614**	**122763**	**91959**	**37655**	**37655**
1956	12074	29614	58128	24069	14475		**138360**	**126286**	**96672**	**41688**	**41688**
1957	15624	37170	75896	20231	15010		**163931**	**148307**	**111137**	**52794**	**52794**
1958	29743	41143	92790	33937	12554		**210167**	**180424**	**139281**	**70886**	**70886**
1959	42005	36055	87845	23754	11680		**201339**	**159334**	**123279**	**78060**	**78060**
1960	38244	60713	83331	24384	24062		**230734**	**192490**	**131777**	**98957**	**98957**
1961	51212	59570	96105	22872	16528		**246287**	**195075**	**135505**	**110782**	**110782**
1962	28891	46381	77701	29643	23528		**206144**	**177253**	**130872**	**75272**	**75272**
1963	33796	51979	86859	17595	12397		**202626**	**168830**	**116851**	**85775**	**85775**
1964	36390	40897	108065	27636	22035		**235023**	**198633**	**157736**	**77287**	**77287**
1965	31732	47036	82354	35003	18797		**214922**	**183190**	**136154**	**78768**	**78768**
1966	32196	44154	66929	34153	20855		**198287**	**166091**	**121937**	**76350**	**76350**
1967	23480	45595	64210	31576	16635		**181496**	**158016**	**112421**	**69075**	**69075**
1968	24690	51828	46215	16671	14993		**154397**	**129707**	**77879**	**76518**	**76518**
1969	38254	40732	37782	13852	9350		**139970**	**101716**	**60984**	**78986**	**78986**
1970	28934	32306	37608	12989	14257		**126094**	**97160**	**64854**	**61240**	**61240**
1971	41691	48637	36728	16917	16534		**160507**	**118816**	**70179**	**90328**	**90328**
1972	33800	45275	34889	18007	19200		**151171**	**117371**	**72096**	**79075**	**79075**
1973	44768	18523	46984	27688	19570		**157533**	**112765**	**94242**	**63291**	**63291**
1974	34536	13894	36339	18717	14244		**117730**	**83194**	**69300**	**48430**	**48430**
1975	50260	12236	54819	19295	16714		**153324**	**103064**	**90828**	**62496**	**62496**
1976	51901	10140	43435	16548	12538		**134562**	**82661**	**72521**	**62041**	**62041**
1977	36149	9782	37064	17496	20745		**121236**	**85087**	**75305**	**45931**	**45931**
1978	43522	12915	34246	25974	23333	5619	**145609**	**102087**	**83553**	**56437**	**62056**
1979	18271	43876	39651	27532	24111	3800	**157241**	**138970**	**91294**	**62147**	**65947**
1980	35787	49593	59290	29433	17579	3120	**194802**	**159015**	**106302**	**85380**	**88500**
1981	35550	65330	61150	37054	15048	2384	**216517**	**180967**	**113253**	**100880**	**103264**
1982	31756	71889	45865	38082	16912	2442	**206946**	**175190**	**100859**	**103645**	**106087**
1983	32374	62843	33163	31163	21607	2688	**183837**	**151463**	**85932**	**95217**	**97905**
1984	27970	79606	42798	35032	17280	3319	**206005**	**178035**	**95110**	**107576**	**110895**
1985	25907	66491	61755	31535	18418	4333	**208439**	**182532**	**111709**	**92398**	**96731**
1986	39195	37960	57360	31737	14354	6757	**187363**	**148168**	**103451**	**77155**	**83912**
1987	36377	42234	44806	27795	17613	8870	**177696**	**141319**	**90214**	**78611**	**87481**
1988	40944	24005	52779	27420	13393	2990	**161531**	**120587**	**93591**	**64949**	**67939**
1989	29856	16179	52585	26783	11723	3835	**140961**	**111105**	**91091**	**46035**	**49870**
1990	27500	19253	52212	24723	19238	6503	**149429**	**121929**	**96173**	**46753**	**53256**
1991	20735	14383	44379	26150	22106	4834	**132587**	**111852**	**92635**	**35118**	**39952**
1992	26160	16579	41681	29968	11666	4196	**130250**	**104090**	**83315**	**42739**	**46935**
1993	24486	23905	47284	29995	13160	3664	**142495**	**118009**	**90440**	**48391**	**52055**
1994	22181	16151	49136	30390	14942	3782	**136582**	**114401**	**94468**	**38332**	**42114**
1995	19538	13928	41444	27270	19104	3996	**125280**	**105742**	**87818**	**33466**	**37462**
1996	14423	11251	34761	31117	19880	5304	**116736**	**102313**	**85758**	**25674**	**30978**
1997	15587	12291	34156	25863	21137	6780	**115814**	**100227**	**81156**	**27878**	**34658**
1998	16177	3263	32584	29564	20743	6594	**108924**	**92747**	**82890**	**19440**	**26034**
1999	11862	2563	31574	21747	18499	7846	**94091**	**82229**	**71820**	**14425**	**22271**

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

Table 9.3.1.1 Parameter estimates for the 1999 Portuguese and Spanish DEPM surveys.

	Portugal	Spain	Total
Parameters	January 1999	April 1999*	
Egg production (eggs10^{-12})	5.24 (35)	0.34 (44)	
Female weight (g)	44.42 (5)	66.03 (41)	
Sex ratio	0.61 (5)	0.55 (45)	
Batch fecundity	18416 (5)	21800 (12)	
Spawning fraction	0.101 (15)	-	
Spawning biomass (Kt)	**205.1** (39)	**10.4** (77)**	**215.5** (86)

* Adult parameters correspond to the values obtained in Gulf of Biscay region
** Estimated with spawning fraction obtained in 1997

Table 9.3.1.2 Comparison of SSB estimates (CV's within brackets) by survey and for the total area obtained with DEPM.

Year	Portugal	Spain	Total
1988	115.1 (34)	180.2 (50)	295.3 (33)
1997	127.2 (57)	20.7 (84)	147.9 (51)
1999	205.1 (39)	10.4 (77)	215.5 (39)

Table 9.3.2.1.a. Sardine assessment during the Portuguese 1999 Fall Acoustic survey. Number in thousand fish and Biomass in tonnes

AREA			1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	46726	24332	15157	2887	152		68		**89323**
	%	52.31	27.24	16.97	3.23	0.17		0.08		
	Mean Weight	19.5	37.7	49.2	60.7	66.9		72.1		
	No fish	2396691	646062	308149	47588	2279		944		**3401712**
	%	70.46	18.99	9.06	1.40	0.07		0.03		
	Mean Length	13.9	17.3	18.8	20.1	20.8		21.3		
Oc. Sul	**Biomass**	12787	1410	3905	5030	5461	2516	1251		32360
	%	39.51	4.36	12.07	15.54	16.88	7.78	3.87		
	Mean Weight	10.1	39.5	51.4	58.6	65.8	69.5	73.4		
	No fish	1265134	35656	75996	85837	83046	36213	17049		**1598932**
	%	79.12	2.23	4.75	5.37	5.19	2.26	1.07		
	Mean Length	11.1	17.5	19	19.9	20.6	20.9	21.3		
Algarve	**Biomass**	1204	5630	13648	14850	23272	23035	7633	2878	92151
	%	1.31	6.11	14.81	16.11	25.25	25.00	8.28	3.12	
	Mean Weight	34.5	48.5	52.1	57.6	62.2	66.5	70.2	76	
	No fish	34937	116064	261777	257656	373976	346213	108751	37863	1537236
	%	2.27	7.55	17.03	16.76	24.33	22.52	7.07	2.46	
	Mean Length	16.8	18.7	19.2	19.8	20.3	20.7	21.1	21.6	
Cadiz	**Biomass**	3953	20741	9648	10551	10046	1880	1418	232	58468
	%	6.76	35.47	16.50	18.05	17.18	3.22	2.43	0.40	
	Mean Weight	31.1	39.8	44.1	49.7	52.2	64.1	63.4	61.9	
	No fish	127204	521275	218721	212487	192545	29347	22377	3752	1327708
	%	9.58	39.26	16.47	16.00	14.50	2.21	1.69	0.28	
	Mean Length	16.2	17.6	18.1	18.8	19.1	20.4	20.4	20.3	
Portugal	**Biomass**	60747	31449	32811	22886	29018	25621	9098	2878	213834
	%	28.41	14.71	15.34	10.70	13.57	11.98	4.25	1.35	
	Mean Weight	21.4	41.9	50.9	59.0	65.0	45.3	71.9	76.0	
	No fish	3696787	797816.8	645959.8	391121	459342.4	382446.9	126786.6	37863	6537880
	%	56.54	12.20	9.88	5.98	7.03	5.85	1.94	0.58	
	Mean Length	13.9	17.8	19.0	19.9	20.6	13.9	21.2	21.6	
Whole Area	**Biomass**	64731	52230	42503	33487	39116	27565	10579	3172	272302
	%	23.77	19.18	15.61	12.30	14.36	10.12	3.88	1.16	
	Mean Weight	23.8	41.4	49.2	56.7	61.8	50.0	69.8	69.0	
	No fish	3824007	1319109	864699	603627	651907	411814	149184	41635	7865588
	%	48.62	16.77	10.99	7.67	8.29	5.24	1.90	0.53	
	Mean Length	14.7	17.9	18.8	19.5	20.1	19.4	21.0	21.0	

Table 9.3.2.1.b. Sardine assessment during the Portuguese 2000 Spring Acoustic Survey. Number in thousand fish and Biomass in tonnes.

AREA		1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	52427	12754	15442	9625	3510	2646	1299	**97704**
	%	53.66	13.05	15.80	9.85	3.59	2.71	1.33	
	Mean Weight	18.7	42.2	49.4	60.3	65	71	74.4	
	No fish	2802193	302069	312436	159507	54044	37249	17448	**3684945**
	%	76.04	8.20	8.48	4.33	1.47	1.01	0.47	
	Mean Length	13.9	18.1	19.1	20.3	20.8	21.4	21.7	
Oc. Sul	**Biomass**	34833	20844	15365	12362	4831	1452	641	**90328**
	%	38.56	23.08	17.01	13.69	5.35	1.61	0.71	
	Mean Weight	21.6	40.8	53.8	60.1	65.7	74.2	81.2	
	No fish	1611902	511258	285429	205721	73488	19565	7896	**2715259**
	%	59.36	18.83	10.51	7.58	2.71	0.72	0.29	
	Mean Length	14.4	17.9	19.6	20.3	20.9	21.7	22.3	
Algarve	**Biomass**	79	5489	7749	8322	10473	13677	13484	**59272**
	%	0.13	9.26	13.07	14.04	17.67	23.07	22.75	
	Mean Weight	32.8	42.3	49.3	54.1	61.8	63.7	73.2	
	No fish	2407	129778	157150	153772	169467	214544	184210	**1011328**
	%	0.24	12.83	15.54	15.20	16.76	21.21	18.21	
	Mean Length	16.8	18.1	19	19.6	20.5	20.7	21.6	
Cadiz	**Biomass**	17457	48713	22171	12309	13180	3523	5105	**122458**
	%	14.26	39.78	18.10	10.05	10.76	2.88	4.17	
	Mean Weight	8.1	39.7	47.5	51.8	56.1	63.8	66.3	
	No fish	2164952	1226822	466663	237681	234946	55264	77048	**4463375**
	%	48.50	27.49	10.46	5.33	5.26	1.24	1.73	
	Mean Length	9.1	17.8	18.8	19.4	19.9	20.7	20.9	
Portugal	**Biomass**	87339	39087	38556	30309	18814	17775	15424	**247304**
	%	35.32	15.81	15.59	12.26	7.61	7.19	6.24	
	Mean Weight	24.4	41.8	50.8	58.2	64.2	69.6	76.3	
	No fish	4416502	943105	755015	519000	296999	271358	209554	**7411532**
	%	59.59	12.72	10.19	7.00	4.01	3.66	2.83	
	Mean Length	15.0	18.0	19.2	20.1	20.7	21.3	21.9	
Whole	**Biomass**	104796	87800	60727	42618	31994	21298	20529	**369762**
Area	**%**	28.34	23.75	16.42	11.53	8.65	5.76	5.55	
	Mean Weight	20.3	41.3	50.0	56.6	62.2	68.2	73.8	
	No fish	6581454	2169927	1221678	756681	531945	326622	286602	**11874907**
	%	55.42	18.27	10.29	6.37	4.48	2.75	2.41	
	Mean Length	13.6	18.0	19.1	19.9	20.5	21.1	21.6	

Table 9.3.2.1.c. Sardine assessment during the Spanish 2000 Acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		1	2	3	4	5	6	7	8	9	Total
VIIIc-Ee	**Biomass**	2866	8786	7585	4085	2612	648	346	129		**27057**
(>3°30')	**%**	10.6	32.5	28.0	15.1	9.7	2.4	1.3	0.5		
	Mean Weight	45.0	59.3	70.8	79.1	85.1	92.9	101.2	98.9		
	No fish	63307	147507	106827	51469	30598	6956	3420	1305		**411390**
	%	15.4	35.9	26.0	12.5	7.4	1.7	0.8	0.3		
	Mean Length	17.7	19.6	20.9	21.8	22.4	23.1	23.8	23.6		
VIIIc-Ew	**Biomass**	294	6819	11783	7515	7457	1348	201	431	67	**35917**
(<3°30')	**%**	0.8	19.0	32.8	20.9	20.8	3.8	0.6	1.2	0.2	
	Mean Weight	53.6	66.0	74.0	80.4	83.5	91.8	100.6	89.3	100.6	
	No fish	5454	102998	158898	93236	89114	14646	2002	4807	667	**471823**
	%	1.2	21.8	33.7	19.8	18.9	3.1	0.4	1.0	0.1	
	Mean Length	18.9	20.4	21.3	21.9	22.2	23.0	23.8	22.7	23.8	
VIIIc-W	**Biomass**		1435	12726	8069	6089	2114	852	142		**31427**
	%		4.6	40.5	25.7	19.4	6.7	2.7	0.5		
	Mean Weight		78.3	76.7	83.2	88.0	88.0	96.1	106.6		
	No fish		18316	165628	96701	69061	23928	8853	1328		**383815**
	%		4.8	43.2	25.2	18.0	6.2	2.3	0.3		
	Mean Length		21.7	21.5	22.2	22.6	22.6	23.4	24.3		
IXa-N	**Biomass**	878	764	222	50	9	13	8			**1944**
	%	45.2	39.3	11.4	2.6	0.5	0.6	0.4			
	Mean Weight	38.1	44.5	53.7	59.4	84.0	89.3	106.6			
	No fish	22894	16987	4086	843	106	141	71			**45127**
	%	50.7	37.6	9.1	1.9	0.2	0.3	0.2			
	Mean Length	16.7	17.7	18.9	19.6	22.3	22.8	24.3			
Spain	**Biomass**	4038	17805	32316	19719	16167	4123	1407	702	67	**96345**
	%	4.2	18.5	33.5	20.5	16.8	4.3	1.5	0.7	0.1	
	Mean Weight	43.6	61.8	74.0	81.1	85.4	90.0	98.0	93.9	100.6	
	No fish	91656	285808	435440	242249	188879	45671	14346	7440	667	**1312155**
	%	7.0	21.8	33.2	18.5	14.4	3.5	1.1	0.6	0.1	
	Mean Length	17.6	19.9	21.3	22.0	22.4	22.8	23.5	23.2	23.8	

Table 9.4.1.1 Length composition (thousands) by quarter 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			0					0
10			1					1
10.5	11		3					14
11	11		11	18			389	429
11.5	33		25	66			991	1115
12	57	1	58	144	94		2530	2884
12.5	92	8	67	281	281		4342	5071
13	82	53	32	555	172		8599	9493
13.5	9	120	20	508	187		10425	11269
14	39	293	9	734	313		10216	11604
14.5	80	176	18	871	529	108	8798	10581
15	209	109	32	978	751	331	7067	9478
15.5	157	95	44	935	1366	709	3959	7265
16	320	84	88	1246	2313	1660	2799	8509
16.5	523	59	105	1335	3581	2317	2599	10520
17	539	46	103	708	3522	2801	4632	12351
17.5	722	31	78	1162	4948	3723	4442	15109
18	629	50	63	1888	11590	4526	3969	22714
18.5	741	73	56	2420	13619	6407	2788	26104
19	1045	146	45	2216	20239	8936	2429	35057
19.5	1223	220	59	1293	15116	9580	1870	29362
20	1517	359	51	777	7567	8622	1269	20163
20.5	2340	456	59	661	4921	4060	640	13138
21	4048	433	58	272	3121	1896	183	10011
21.5	3774	290	60	263	1215	1058		6659
22	4664	207	58	116	261	170		5477
22.5	2584	116	35	43	188	26		2993
23	2764	50	20	1				2834
23.5	1287	27		9		20		1341
24	636	15						651
24.5	297	2				2		302
25	123							123
25.5	137	1						138
26	38							38
Total	30733	3521	1260	19500	95895	56953	84938	292800
Mean l	21.2	19.1	17.7	17.5	18.9	19.1	15.4	18.1
sd	2.14	2.98	3.16	2.25	1.43	1.37	2.16	2.65
Catch	**2401**	**209**	**68**	**932**	**4806**	**2890**	**2458**	**13764**

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								
9.5								
10	1							1
10.5	1						25	26
11	1						50	51
11.5					224		50	274
12	9			26	559		99	694
12.5	5		54	163	1715		395	2332
13	24		31	419	2151		397	3023
13.5	35		72	892	2925		819	4743
14	156		76	1345	5470		668	7715
14.5	297	9	211	1274	5434		1149	8374
15	523	38	273	1205	6398		2747	11184
15.5	477	25	979	3301	3160		5900	13842
16	775	90	896	5276	2793	2	9632	19464
16.5	798	41	1731	8357	3296	12	8137	22371
17	890	84	1924	12913	3435	916	3781	23943
17.5	818	102	2430	18265	2301	4828	2318	31061
18	699	134	2486	18229	4347	8872	1326	36093
18.5	390	207	2104	13296	6927	10992	655	34570
19	171	307	2147	11525	8523	11180	655	34508
19.5	442	696	1837	8802	6733	11844	255	30609
20	896	978	1323	7016	6533	15244	73	32063
20.5	1857	2491	997	2528	4129	9225		21227
21	2395	2632	597	1484	3317	5089		15514
21.5	2322	3184	297	501	1130	2283		9718
22	2078	3596	131	157	562	565		7089
22.5	1050	3473	55	51	85	211		4926
23	541	1983	31		5	46		2605
23.5	201	964	43		7	97		1312
24	51	435	1		18			505
24.5	94	132						226
25		54			12			67
25.5	0							0
26								
Total	17997	21655	20725	117027	82191	81406	39130	380130
Mean l	20.0	21.8	18.4	18.1	17.5	19.6	16.4	18.4
sd	2.50	1.37	1.68	1.49	2.56	1.10	1.21	2.19
Catch	**1199**	**1885**	**1080**	**6109**	**3670**	**5164**	**1312**	**20419**

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		6						6
8		6						6
8.5		52						52
9		65						65
9.5		91						91
10		98						98
10.5		176		24			278	478
11		52	199	845			742	1837
11.5		39	247	2959			1761	5006
12		52	366	5206			2873	8497
12.5	61	98	412	5457			2430	8458
13	138	104	577	5664	34		1877	8395
13.5	247	91	278	9361	17		1912	11906
14	144	78	268	8229			2107	10825
14.5	3	98	198	6656	50		4322	11328
15	24	63	281	4795	211		6210	11585
15.5	59	38	296	4212	347		6868	11822
16	35	14	440	5237	407	39	7043	13214
16.5	45	24	555	7094	1222	45	7300	16285
17	186	91	915	10173	1331	238	4276	17211
17.5	315	141	867	16709	2383	1788	3498	25700
18	430	260	1464	25455	4234	6728	3058	41630
18.5	407	340	1890	31377	9508	13121	1252	57895
19	422	546	2296	27813	22595	17391	1561	72623
19.5	276	646	2691	33005	21550	19743	520	78431
20	228	955	2421	27273	17338	18845	173	67233
20.5	618	1563	1996	18171	8196	8277	87	38908
21	1269	1607	1126	8097	3401	3603		19103
21.5	2224	1541	500	2143	760	1135		8302
22	2928	1323	221	400	224	232		5328
22.5	1610	998	154	100	12	31		2905
23	854	519	19		34			1426
23.5	328	160			5			492
24	68	164			5			237
24.5	14	27						41
25	8	19						27
25.5		1						1
26								
Total	12940	12146	20676	266456	93863	91218	60149	557447
Mean l	21.1	20.3	18.5	18.1	19.5	19.6	15.7	18.4
sd	2.29	3.11	2.54	2.46	1.00	0.87	1.97	2.40
Catch	**1141**	**986**	**1249**	**15464**	**6262**	**5980**	**2158**	**33240**

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			17		66			83
10			86	13	49			148
10.5			233	30	214			476
11		57	774	848	49			1727
11.5		99	812	3412	721			5043
12		311	797	8760	868			10736
12.5		396	469	12381	779			14026
13	107	212	326	11121	1546		22	13335
13.5	124	127	201	9145	709		44	10350
14	215	49	161	10254	1267	47	110	12102
14.5	68	37	125	7984	646	26	619	9505
15	93	29	73	7786	616		993	9591
15.5	81	67	119	8096	702	55	1105	10225
16	260	164	135	7651	1239	204	2222	11876
16.5	265	573	198	7512	2454	253	3131	14386
17	386	693	217	9718	4541	113	5027	20695
17.5	1274	923	171	17342	4765	803	4994	30273
18	2253	846	132	18704	9325	2808	5498	39566
18.5	2319	688	78	21595	14677	6100	3720	49177
19	4385	688	80	13263	19216	11473	4668	53773
19.5	4594	832	113	10454	21207	13869	2758	53827
20	4950	708	125	8055	15404	14840	1544	45625
20.5	4079	1107	95	2741	8334	8868	580	25804
21	3942	1528	64	1678	4113	5762	536	17621
21.5	3422	2526	83	546	1786	2267		10629
22	2235	1827	95	200	833	479		5669
22.5	1081	1894	55	81	254	127		3493
23	710	832	34	12	116	107		1811
23.5	389	598	13	5				1005
24	233	245	1	1				480
24.5	37	70						107
25	42	25						67
25.5	5	6						11
26								
Total	37551	18157	5882	199386	116496	68201	37571	483243
Mean l	20.2	20.2	14.3	16.6	19.0	19.9	18.0	18.1
sd	1.70	2.87	3.37	2.60	1.90	0.98	1.40	2.63
Catch	**2666**	**1375**	**167**	**9068**	**7009**	**4466**	**1917**	**26668**

Table 9.4.1.2

Table 9.4.1 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	4255	1274	749	8374	8689	3262	61523	88125
2	3728	678	214	4514	23150	11776	12348	56409
3	6779	626	116	6885	39790	9189	3919	67303
4	7868	678	71	1563	15745	15531	4141	45598
5	3789	152	56	806	5788	9795	2078	22465
6	2048	75	27	668	4006	4767	793	12384
7	1756	30	18	121	618	1221	136	3900
8	127		9	19	98	121		374
9	163	4						167
10	219	4		15				
11								
Total	30733	3521	1260	22964	97883	55664	84938	296725
Catch	2401	209	68	932	4806	2890	2458	13764

Second Quarter

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	5900	920	11055	55464	38011	3054	23990	138395
2	1731	2488	6311	35422	14268	9776	11296	81293
3	3880	5184	2007	31050	15829	14496	2829	75275
4	3872	7448	912	4282	6757	18415	594	42280
5	1372	2971	247	2074	3826	16891	222	27602
6	695	1568	96	1582	3447	14509	183	22080
7	466	858	85		508	4074	15	6006
8	18		14		126	196		355
9	36	109				196		341
10	26	109						
11								
Total	17997	21655	20725	129874	82773	81607	39130	393627
Catch	1199	1885	1080	6109	3670	5164	1312	20419

Third Quarter

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	1347	1802	5448	52662	782		44933	106973.837
1	2527	3730	8475	90361	12770	3998	6818	128679
2	2249	1938	4021	58793	27477	16249	3833	114560
3	2597	2079	1888	61625	35533	13320	2711	119752
4	2079	1345	655	11306	10892	22485	930	49693
5	1123	624	144	1732	4032	25359	737	33751
6	870	493		1419	2344	6592	172	11891
7	147	134	44		57	1099	8	1490
8						508	5	514
9								
10								
11								
Total	12940	12146	20676	277897	93887	89610	60149	567304
Catch	1141	986	1249	15464	6262	5980	2158	33240

Fourth Quarter

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	3556	4667	4713	104449	11076	690	9891	139042.323
1	19029	4154	627	64371	18981	5114	7751	120027
2	5685	2338	279	47984	26898	15256	10806	109247
3	4491	2611	145	15566	35508	14221	4820	77361
4	2624	2339	73	1494	12233	18195	2643	39599
5	1022	1061	14	148	6380	12005	1070	21699
6	904	743		156	2958	5141	559	10462
7	240	243	33		800	608	32	1956
8					102	147		249
9								
10								
11								
Total	37551	18157	5882	234169	114935	71378	37571	519642
Catch	2666	1375	167	9068	7009	4466	1917	26668

Whole Year

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	4903	6469	10162	157111	11857	690	54824	246016
1	31712	10078	20906	218570	78450	15428	100082	475225
2	13394	7442	10824	146713	91794	53058	38283	361509
3	17748	10500	4156	115125	126660	51225	14278	339691
4	16442	11810	1712	18646	45628	74626	8308	177170
5	7306	4809	461	4759	20026	64050	4107	105518
6	4519	2880	122	3824	12755	31010	1707	56817
7	2608	1266	179	121	1982	7002	192	13351
8	145		23	19	326	973	5	1492
9	199	113				196		508
10	245	113		15				
11								
Total	99220	55478	48544	664905	389478	298259	221786	1777297
Catch	7407	4455	2563	31574	21747	18499	7846	94091

Table 9.4.1.3: Relative distribution of sardine catches. Upper pannel, relative contribution of each age group within each Sul
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	4.94	11.66	20.93	23.63	3.04	0.23	24.72	13.84
1	**31.96**	18.17	**43.07**	**32.87**	20.14	5.17	**45.13**	**26.74**
2	13.50	13.42	22.30	22.07	23.57	17.79	17.26	20.34
3	17.89	18.93	8.56	17.31	**32.52**	17.17	6.44	19.11
4	16.57	**21.29**	3.53	2.80	11.72	**25.02**	3.75	9.97
5	7.36	8.67	0.95	0.72	5.14	21.47	1.85	5.94
6+	7.78	7.88	0.67	0.60	3.87	13.14	0.86	4.06

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca
0	1.99	2.63	4.13	**63.86**	4.82	0.28	22.28
1	6.67	2.12	4.40	**45.99**	16.51	3.25	21.06
2	3.70	2.06	2.99	**40.58**	25.39	14.68	10.59
3	5.22	3.09	1.22	33.89	**37.29**	15.08	4.20
4	9.28	6.67	0.97	10.52	25.75	**42.12**	4.69
5	6.92	4.56	0.44	4.51	18.98	**60.70**	3.89
6+	10.69	6.06	0.45	5.51	20.87	**54.29**	2.64

Table 9.4.2.1: Mean length at age by quarter and ICES Sub-Division

	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
First Quarter								
0								
1	17.1	15.6	15.6	15.2	16.2	16.4	14.2	14.8
2	20.3	20.2	19.6	17.5	18.1	17.8	17.5	18.0
3	21.3	21.1	20.8	19.0	19.2	19.0	18.6	19.3
4	22.0	21.5	21.4	19.9	19.9	19.6	19.3	20.1
5	22.7	22.1	22.0	20.3	20.5	20.1	19.8	20.7
6	22.8	22.2	22.5	21.0	20.9	20.4	20.1	21.0
7	23.3	23.2	22.2	21.4	21.1	20.9	19.7	22.0
8	23.9		22.8	20.3	21.7	22.2		22.6
9	23.6	24.3						23.6
10	24.3	24.3		22.3				
11								
Total	21.2	19.1	17.7	17.5	18.9	19.1	15.4	18.1
Second Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0								
1	16.8	18.0	17.2	17.0	15.1	18.0	15.8	16.3
2	20.6	20.4	19.3	18.2	18.6	18.5	16.8	18.3
3	21.3	21.7	20.0	19.4	19.6	18.7	17.9	19.5
4	21.7	22.0	20.3	20.3	20.1	19.7	19.1	20.4
5	22.4	22.6	21.9	20.3	20.8	20.3	19.4	20.8
6	22.3	22.9	22.0	21.0	20.9	20.4	19.5	20.8
7	22.6	23.5	22.0		22.1	20.8	20.0	21.4
8	23.8		22.8		21.8	21.3		21.6
9	23.7	24.3				21.3		22.5
10	24.5	24.3						
11								
Total	20.0	21.8	18.4	18.1	17.5	19.6	16.4	18.4
Third Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	15.7	14.1	15.1	13.7	15.6		14.9	14.4
1	19.9	20.2	19.2	17.9	18.2	18.3	17.1	18.1
2	21.8	21.5	20.3	19.2	19.4	19.0	18.2	19.3
3	22.1	21.7	20.6	20.2	19.8	19.1	18.3	20.0
4	22.4	22.4	20.9	20.9	20.1	19.9	19.2	20.4
5	22.6	22.8	21.4	20.9	20.6	20.1	19.5	20.3
6	22.5	22.4		20.5	20.8	20.2	19.6	20.6
7	23.2	23.7	22.3		22.1	20.8	20.4	21.4
8						20.8	20.8	20.8
9								
10								
11								
Total	21.1	20.3	18.5	18.1	19.5	19.6	15.7	18.4
Fourth Quarter	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	17.1	16.2	12.9	14.0	14.4	16.9	16.4	14.4
1	19.7	20.1	18.8	18.0	18.2	18.6	17.8	18.4
2	21.1	21.7	20.8	18.9	19.1	19.3	18.5	19.1
3	21.5	21.9	21.4	20.1	19.8	19.9	18.9	20.0
4	22.1	22.6	21.6	21.0	20.3	20.2	19.9	20.5
5	22.7	22.9	21.6	21.5	20.4	20.6	20.2	20.8
6	22.4	22.6		21.5	21.0	20.8	20.3	21.1
7	23.9	23.8	22.9		21.0	21.1	20.3	21.8
8					20.8	21.8		21.4
9								
10								
11								
Total	20.2	20.2	14.3	16.6	19.0	19.9	18.0	18.0
Whole Year	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-Ca	Tot
0	16.7	15.6	14.1	13.9	14	17	15.2	14.4
1	18.8	19.4	18.0	17.6	16.5	18.0	15.1	17.0
2	20.9	21.1	19.7	18.8	18.8	18.7	17.7	18.8
3	21.5	21.7	20.3	19.9	19.6	19.2	18.5	19.7
4	22.0	22.2	20.7	20.7	20.1	19.9	19.4	20.3
5	22.6	22.7	21.7	20.6	20.6	20.3	19.8	20.6
6	22.6	22.7	22.1	20.8	20.9	20.4	20.0	20.8
7	23.3	23.6	22.3	21.4	21.3	20.8	19.9	21.7
8	23.9		22.8	20.3	21.4	21.2	20.8	21.5
9	23.6	24.3				21.3		22.8
10	24.3	24.3		22.3				
11								
Total	20.6	20.8	17.9	17.5	18.8	19.6	16.1	18.3

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	0.040	0.030	0.031	0.026	0.030	0.033	0.022	0.025
2	0.067	0.066	0.060	0.039	0.042	0.042	0.042	0.044
3	0.078	0.075	0.073	0.050	0.050	0.050	0.051	0.053
4	0.087	0.080	0.080	0.057	0.057	0.055	0.057	0.062
5	0.095	0.088	0.086	0.062	0.062	0.060	0.061	0.067
6	0.097	0.089	0.092	0.067	0.066	0.062	0.065	0.070
7	0.104	0.102	0.088	0.072	0.068	0.067	0.061	0.084
8	0.112		0.095	0.060	0.074	0.080		0.089
9	0.107	0.116						0.107
10	0.118	0.116		0.080				
11								
Total	0.079	0.059	0.048	0.041	0.049	0.052	0.030	0.047
	Second Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0								
1	0.039	0.049	0.042	0.039	0.027	0.049	0.033	0.035
2	0.073	0.071	0.059	0.047	0.050	0.053	0.039	0.049
3	0.080	0.085	0.067	0.057	0.059	0.055	0.047	0.060
4	0.085	0.089	0.070	0.066	0.064	0.063	0.058	0.070
5	0.093	0.097	0.087	0.066	0.070	0.070	0.060	0.074
6	0.093	0.100	0.089	0.074	0.072	0.070	0.061	0.073
7	0.097	0.109	0.089		0.085	0.074	0.066	0.082
8	0.112		0.098		0.081	0.079		0.082
9	0.112	0.119				0.079		0.095
10	0.122	0.119						
11								
Total	0.069	0.087	0.052	0.047	0.044	0.063	0.036	0.052
	Third Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.036	0.028	0.032	0.023	0.033		0.030	0.027
1	0.073	0.076	0.064	0.052	0.054	0.054	0.045	0.054
2	0.095	0.091	0.076	0.064	0.065	0.060	0.054	0.065
3	0.099	0.095	0.080	0.075	0.070	0.061	0.055	0.072
4	0.104	0.105	0.084	0.082	0.073	0.069	0.064	0.076
5	0.107	0.110	0.090	0.083	0.078	0.071	0.067	0.074
6	0.106	0.105		0.078	0.081	0.073	0.068	0.079
7	0.116	0.125	0.102		0.098	0.079	0.077	0.088
8						0.078	0.082	0.078
9								
10								
11								
Total	0.089	0.081	0.061	0.056	0.067	0.067	0.035	0.059
	Fourth Quarter							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.043	0.038	0.019	0.021	0.027	0.040	0.037	0.024
1	0.066	0.071	0.058	0.047	0.052	0.052	0.048	0.052
2	0.082	0.089	0.079	0.056	0.061	0.057	0.055	0.059
3	0.087	0.092	0.086	0.068	0.068	0.062	0.058	0.068
4	0.094	0.102	0.088	0.080	0.073	0.065	0.068	0.072
5	0.102	0.105	0.087	0.086	0.075	0.069	0.071	0.074
6	0.098	0.102		0.086	0.081	0.070	0.072	0.078
7	0.121	0.119	0.105		0.081	0.073	0.072	0.089
8					0.078	0.080		0.079
9								
10								
11								
Total	0.073	0.076	0.029	0.039	0.061	0.063	0.051	0.051
	Whole Year							
	VIIIc-E	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-Ca**	**Tot**
0	0.041	0.035	0.026	0.022	0.028	0.040	0.031	0.025
1	0.058	0.065	0.051	0.046	0.038	0.048	0.028	0.042
2	0.079	0.081	0.066	0.057	0.055	0.054	0.046	0.056
3	0.084	0.088	0.073	0.067	0.062	0.058	0.053	0.065
4	0.090	0.093	0.077	0.076	0.066	0.064	0.061	0.070
5	0.098	0.100	0.088	0.072	0.071	0.069	0.065	0.073
6	0.098	0.101	0.090	0.075	0.074	0.069	0.067	0.075
7	0.105	0.112	0.095	0.072	0.079	0.074	0.064	0.084
8	0.112		0.097	0.060	0.078	0.079	0.082	0.082
9	0.108	0.119				0.079		0.099
10	0.118	0.119		0.080				
11								
Total	0.076	0.080	0.053	0.047	0.056	0.062	0.036	0.053

Table 9.7.1.1: Input values and main results on the stock perception for the different models explored

	Year range	Age Range	Sep constraint	Ref. Age	Sel. Pattern	SSB index	AS indices	Index weights	Age weights
Test Model **(RUN 1)**	1978-1999	0-6+	14 years 1986-1999	3	1986-90; 1991-99	DEPM, absolute	Sp. March (86-88;90-93;96-00) Pt March, incl. Cadiz (96-99) Pt Fall (84-87; 92; 97-99)	Equal weights	0.5 for Age 0 1 for 1+

		SSB index	AS indices	COMMENTS
TUNING EFFECT	**RUN-2**		Sp. March (86-88;90-93;96-00)	SSB higher in 80's, Fbar, higher in 90's,lower in 80's
	RUN-3	DEPM, absolute		SSB lower in 90's; Fbar higher, specially since 96
	RUN-4		Pt Fall (84-87; 92; 97-99)	SSB higher in 90's, lower in 80's; Fbar lower in 90's, higher in 80's
	RUN-5	DEPM, absolute	All, Sp. March with power model	SSB lower in 80's; Fbar higher in 80's, peak in 1990
	RUN-6	DEPM, linear model	All	SSB scaled upward, Fbar scale downward
	RUN-7	DEPM, absolute	Without Pt March	No noticeable effects

		SEP. CONSTRAINT	SELECTION PATTERN	COMMENTS
Sep. Const. and Sel. Pattern	**RUN-8**	1987-1999	1987-1991; 1992-1999	Small changes in SSB, Fbar diferent for 1991. Shift in residual
	RUN-9	1987-1999	1987-1993; 1994-1999	SSB lower mid 90's, Fbar lower mid 90's. No shift in residuals

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
0	120.8	30.5	277.1	208.6	449.1	246.0
1	60.2	189.1	101.3	548.6	366.2	475.2
2	542.2	280.7	347.7	453.3	501.6	361.5
3	1094.4	829.7	514.7	391.1	352.5	339.7
4	272.5	472.9	652.7	337.3	233.7	177.2
5	112.6	70.2	197.2	225.2	178.7	105.5
6	72.1	64.5	46.6	70.3	105.9	72.2

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

Table 9.7.2.1a (cont): Input values for the assessment model.

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

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998	1999
0	0.02000	0.02500	0.01900	0.02200	0.02400	0.02500
1	0.03600	0.04700	0.03800	0.03300	0.04000	0.04200
2	0.05800	0.05900	0.05100	0.05200	0.05500	0.05600
3	0.06200	0.06600	0.05800	0.06200	0.06100	0.06500
4	0.07000	0.07100	0.06100	0.06900	0.06400	0.07000
5	0.07600	0.08200	0.07100	0.07300	0.06700	0.07300
6	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

Table 9.7.2.1a (cont): Input values for the assessment model.

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998	1999
0	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
2	0.04000	0.05000	0.04700	0.05000	0.04100	0.03900
3	0.04900	0.06200	0.06100	0.05800	0.05300	0.05400
4	0.06000	0.07200	0.06900	0.06800	0.06100	0.06200
5	0.06700	0.07900	0.07500	0.07400	0.06700	0.06800
6	0.10000	0.10000	0.10000	0.10000	0.10000	0.10000

Natural Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Natural Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
1	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
2	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
3	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
4	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
5	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000	0.33000

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999
0	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
2	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
4	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
6	0.33000	0.33000	0.33000	0.33000	0.33000	0.30000

Table 9.7.2.1a (cont): Input values for the assessment model.

Proportion of fish spawning

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500
2	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500	0.9500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.6500	0.6500	0.6500	0.2300	0.6000	0.7400	0.7900	0.4700
2	0.9500	0.9500	0.9500	0.8300	0.8100	0.9100	0.9100	0.9300
3	1.0000	1.0000	1.0000	0.9100	0.8800	0.9600	0.9500	0.9400
4	1.0000	1.0000	1.0000	0.9200	0.8900	0.9700	0.9800	0.9700
5	1.0000	1.0000	1.0000	0.9400	0.9400	1.0000	1.0000	0.9900
6	1.0000	1.0000	1.0000	0.9770	0.9870	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998	1999
0	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
2	0.8900	0.9800	0.8900	0.9180	0.9240	0.9110
3	0.9600	0.9700	0.9200	0.9500	0.9560	0.9870
4	0.9600	0.9900	0.9600	0.9720	0.9870	0.9950
5	0.9700	1.0000	1.0000	0.9930	0.9950	1.0000
6	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

Table 9.7.2.1a (cont): Input values for the assessment model

INDEX1

	1998	1999
1	*******	215.50

x 10 ^ 3

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
1	*******	*******	10.6	56.5	509.8	214.5	91.7
2	*******	*******	54.2	263.1	103.1	160.4	285.8
3	*******	*******	90.5	125.7	80.4	134.6	435.4
4	*******	*******	350.8	123.3	33.8	124.3	242.2
5	*******	*******	213.8	65.7	20.6	28.4	188.9
6	*******	*******	24.8	61.0	25.4	64.0	68.1

x 10 ^ 3

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

AGE	1996	1997	1998	1999	2000
1	1625.0	6344.1	1636.2	5711.7	6581.5
2	2082.2	3238.1	4015.0	2552.6	2169.9
3	2414.5	1551.8	2190.9	1460.7	1221.7
4	2906.0	1260.2	1434.0	844.4	756.7
5	386.5	1360.1	1185.0	595.7	531.9
6	12.0	202.8	980.0	469.1	613.2

x 10 ^ 6

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	2956.6	2063.2	2493.1	3714.5	*******	*******	*******	*******
1	5733.2	2743.5	1611.9	2379.4	*******	*******	*******	*******
2	1152.2	4548.2	1669.6	1343.7	*******	*******	*******	*******
3	1036.8	1083.4	658.4	928.7	*******	*******	*******	*******
4	528.3	839.2	322.9	665.6	*******	*******	*******	*******
5	76.4	143.8	127.3	236.5	*******	*******	*******	*******
6	40.1	70.0	49.6	79.9	*******	*******	*******	*******

x 10 ^ 6

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	6349.1	*******	*******	*******	*******	2424.7	8680.4	3696.8
1	5480.5	*******	*******	*******	*******	1961.2	1809.4	798.0
2	1157.1	*******	*******	*******	*******	906.4	1214.6	646.0
3	1002.6	*******	*******	*******	*******	728.9	823.3	391.1
4	437.4	*******	*******	*******	*******	1040.6	396.2	459.3
5	108.2	*******	*******	*******	*******	771.8	367.1	382.4
6	18.8	*******	*******	*******	*******	322.4	220.4	164.6

x 10 ^ 6

Table 9.7.2.1.b: Ouput values from the assessment model.

Fishing Mortality (per year)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07728	0.05314	0.06273	0.11495	0.00832	0.05312	0.01537	0.04080
1	0.45261	0.21893	0.25880	0.22625	0.14065	0.11413	0.26593	0.10838
2	0.45111	0.40334	0.42218	0.42774	0.41461	0.25584	0.15290	0.36037
3	0.46137	0.44848	0.32074	0.38266	0.36266	0.36735	0.27108	0.24940
4	0.37770	0.73055	0.33849	0.31640	0.41076	0.32593	0.26410	0.29238
5	0.64843	0.56748	0.47325	0.46525	0.42498	0.33244	0.35084	0.32886
6	0.64843	0.56748	0.47325	0.46525	0.42498	0.33244	0.35084	0.32886

Fishing Mortality (per year)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	0.05358	0.06651	0.06630	0.06694	0.07282	0.05673	0.05053	0.04930
1	0.17744	0.14612	0.14566	0.14706	0.15997	0.12463	0.11101	0.10830
2	0.33983	0.25269	0.25190	0.25431	0.27665	0.21553	0.19198	0.18729
3	0.26723	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883
4	0.32732	0.37901	0.37781	0.38144	0.41494	0.32328	0.28795	0.28092
5	0.37716	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883
6	0.37716	0.36269	0.36155	0.36502	0.39708	0.30936	0.27556	0.26883

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999
0	0.02170	0.02062	0.02960	0.03437	0.03555	0.02641
1	0.04545	0.04319	0.06201	0.07200	0.07446	0.05533
2	0.12983	0.12338	0.17714	0.20569	0.21273	0.15805
3	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379
4	0.33012	0.31373	0.45041	0.52300	0.54091	0.40188
5	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379
6	0.26597	0.25276	0.36289	0.42137	0.43580	0.32379

Population Abundance (1 January)

AGE	1978	1979	1980	1981	1982	1983	1984	1985
0	13696.	15279.	16513.	11058.	8782.	24249.	9079.	7861.
1	7316.	9114.	10416.	11149.	7087.	6261.	16532.	6428.
2	3024.	3345.	5264.	5781.	6393.	4426.	4016.	9110.
3	927.	1385.	1607.	2481.	2710.	3036.	2464.	2478.
4	505.	420.	636.	838.	1217.	1355.	1512.	1351.
5	101.	249.	145.	326.	439.	580.	703.	835.
6	40.	96.	92.	238.	432.	572.	460.	428.

x 10 ^ 6

Table 9.7.2.1b (cont): Ouput values from the assessment model.

Population Abundance (1 January)

AGE	1986	1987	1988	1989	1990	1991	1992	1993
0	6831.	11604.	7171.	7201.	6741.	15880.	12052.	5323.
1	5425.	4655.	7806.	4825.	4842.	4506.	10787.	8238.
2	4146.	3266.	2892.	4851.	2994.	2966.	2860.	6940.
3	4568.	2122.	1824.	1616.	2704.	1632.	1719.	1697.
4	1388.	2514.	1062.	913.	806.	1307.	861.	938.
5	725.	719.	1237.	523.	448.	383.	680.	464.
6	618.	653.	724.	931.	879.	460.	390.	595.

x 10 ^ 6

Population Abundance (1 January)

AGE	1994	1995	1996	1997	1998	1999	2000
0	5492.	4233.	7170.	7289.	12383.	10421.	8714.
1	3642.	3863.	2981.	5004.	5063.	8591.	7296.
2	5314.	2502.	2660.	2014.	3348.	3379.	5844.
3	4137.	3355.	1590.	1602.	1179.	1946.	2074.
4	932.	2280.	1874.	795.	756.	548.	1012.
5	509.	482.	1198.	858.	339.	316.	264.
6	360.	337.	178.	237.	348.	300.	325.

x 10 ^ 6

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	13696210	314031	227020	145609	0.6414	0.4847	83
1979	15279370	386221	282170	157241	0.5573	0.5375	96
1980	16512580	496260	369887	194802	0.5267	0.3887	95
1981	11057950	610270	462565	216517	0.4681	0.3980	89
1982	8781680	635223	500969	206946	0.4131	0.4033	96
1983	24249390	596704	482201	183837	0.3812	0.3204	104
1984	9079300	713617	542075	206005	0.3800	0.2597	95
1985	7860890	751590	606911	208440	0.3434	0.3077	94
1986	6831300	666490	545965	187363	0.3432	0.3279	97
1987	11604270	574469	469240	177695	0.3787	0.3393	100
1988	7171390	541402	428614	161530	0.3769	0.3382	102
1989	7200580	524140	363683	140962	0.3876	0.3414	96
1990	6741300	491178	357095	149430	0.4185	0.3714	104
1991	15879750	448676	358115	132587	0.3702	0.2894	99
1992	12052280	619464	481746	130249	0.2704	0.2578	99
1993	5322550	743659	545570	142495	0.2612	0.2515	98
1994	5491650	654256	528695	136581	0.2583	0.2480	98
1995	4232910	681058	564793	125280	0.2218	0.2357	98
1996	7170140	566235	452914	116736	0.2577	0.3383	101
1997	7289440	460062	356030	115814	0.3253	0.3929	98
1998	12382800	419781	324417	108925	0.3358	0.4063	97
1999	10420760	494127	366815	94091	0.2565	0.3019	98

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 6
Year range in the analysis : 1978 . . . 1999
Number of indices of SSB : 1
Number of age-structured indices : 3

Parameters to estimate : 58
Number of observations : 239

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): Ouput values from 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	0.3627	22	0.2355	0.5585	0.2910	0.4520	0.3716
2	1988	0.3615	22	0.2317	0.5642	0.2881	0.4537	0.3710
3	1989	0.3650	23	0.2310	0.5769	0.2890	0.4610	0.3751
4	1990	0.3971	22	0.2534	0.6222	0.3158	0.4993	0.4076
5	1991	0.3094	22	0.1974	0.4848	0.2460	0.3890	0.3176
6	1992	0.2756	22	0.1784	0.4257	0.2207	0.3440	0.2824
7	1993	0.2688	22	0.1736	0.4162	0.2151	0.3360	0.2756
8	1994	0.2660	24	0.1658	0.4266	0.2090	0.3385	0.2738
9	1995	0.2528	23	0.1602	0.3989	0.2003	0.3190	0.2597
10	1996	0.3629	22	0.2353	0.5597	0.2909	0.4527	0.3719
11	1997	0.4214	21	0.2774	0.6401	0.3404	0.5216	0.4311
12	1998	0.4358	21	0.2839	0.6690	0.3502	0.5423	0.4463
13	1999	0.3238	23	0.2057	0.5096	0.2569	0.4081	0.3326
Separable Model: Selection (S1) by age 1987 1993								
14	0	0.1834	23	0.1147	0.2932	0.1443	0.2330	0.1887
15	1	0.4029	19	0.2749	0.5904	0.3315	0.4896	0.4106
16	2	0.6967	18	0.4848	1.0012	0.5790	0.8383	0.7087
	3	1.0000		Fixed : Reference Age				
17	4	1.0450	16	0.7627	1.4317	0.8899	1.2271	1.0586
	5	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1994 to 1999								
18	0	0.0816	27	0.0472	0.1411	0.0617	0.1079	0.0848
19	1	0.1709	22	0.1104	0.2644	0.1368	0.2135	0.1752
20	2	0.4881	20	0.3255	0.7320	0.3970	0.6002	0.4987
	3	1.0000		Fixed : Reference Age				
21	4	1.2412	17	0.8837	1.7432	1.0437	1.4760	1.2600
	5	1.0000		Fixed : Last true age				
Separable model: Populations in year 1999								
22	0	10420764	41	4598139	23616580	6864599	15819180	11369352
23	1	8591389	27	5054494	14603236	6554199	11261782	8911899
24	2	3379036	21	2203172	5182476	2716597	4203010	3460449
25	3	1945652	19	1324796	2857469	1599204	2367154	1983421
26	4	548142	20	364601	824078	445193	674897	560132
27	5	316296	24	194746	513709	246963	405093	326128
Separable model: Populations at age								
28	1987	719348	34	363332	1424210	507685	1019256	764380
29	1988	1237060	28	709980	2155435	931876	1642190	1287709
30	1989	523047	28	301975	905963	395204	692246	543999
31	1990	448420	26	267220	752491	344337	583966	464336
32	1991	382876	25	230935	634785	295825	495545	395828
33	1992	680134	24	420403	1100331	532106	869342	700933
34	1993	464300	24	289700	744132	364992	590629	477942
35	1994	509278	23	318316	814800	400704	647270	524129
36	1995	481849	25	293937	789891	374449	620054	497416
37	1996	1197589	25	728727	1968117	929469	1543053	1236679
38	1997	858487	24	531454	1386764	672163	1096461	884572
39	1998	338895	24	209804	547415	265347	432829	349191

SSB Index catchabilities
INDEX1
Absolute estimator. No fitted catchability.

Age-structured index catchabilities
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Linear model fitted. Slopes at age :

40	1	Q	.2050E-01	26	.1592E-01	.4472E-01	.2050E-01	.3472E-01	.2762E-01
41	2	Q	.3947E-01	26	.3070E-01	.8565E-01	.3947E-01	.6662E-01	.5307E-01
42	3	Q	.8377E-01	26	.6494E-01	.1836	.8377E-01	.1423	.1131
43	4	Q	.1641	27	.1256	.3735	.1641	.2860	.2251
44	5	Q	.2716	29	.2040	.6563	.2716	.4930	.3825
45	6	Q	.5451	28	.4157	1.258	.5451	.9590	.7524

Table 9.7.2.1b (cont): Ouput values from the assessment model.

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Linear model fitted. Slopes at age :

46	1	Q	726.6	41	486.4	2504.	726.6	1676.	1204.
47	2	Q	937.7	40	634.1	3132.	937.7	2118.	1531.
48	3	Q	1204.	40	814.5	4018.	1204.	2718.	1965.
49	4	Q	1654.	41	1107.	5697.	1654.	3814.	2741.
50	5	Q	1700.	44	1112.	6306.	1700.	4122.	2920.
51	6	Q	997.7	42	662.1	3533.	997.7	2344.	1676.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Linear model fitted. Slopes at age :

52	0	Q	542.4	34	390.2	1496.	542.4	1077.	810.4
53	1	Q	515.0	33	372.0	1404.	515.0	1014.	765.4
54	2	Q	623.6	33	450.5	1699.	623.6	1228.	926.5
55	3	Q	712.9	34	513.2	1964.	712.9	1414.	1064.
56	4	Q	985.9	34	704.7	2777.	985.9	1985.	1487.
57	5	Q	669.7	35	474.0	1943.	669.7	1375.	1024.
58	6	Q	397.3	35	283.7	1122.	397.3	801.4	600.1

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994
0	0.8133	0.2831	-0.4726	-0.4486	0.7493	-0.0165	-0.9110	0.1845
1	0.0034	0.0900	0.0031	-0.0170	0.0562	0.0340	-0.2435	-0.8297
2	0.0642	-0.0317	-0.0274	-0.1834	-0.1221	0.0537	0.0639	-0.0199
3	0.0243	-0.0809	-0.0888	-0.0764	0.0866	-0.0431	0.4183	0.2778
4	-0.2434	0.0560	-0.1205	0.2234	-0.1548	0.0066	0.2656	0.1900
5	-0.2008	-0.1005	0.3739	0.1768	-0.1579	-0.2369	0.1927	0.0988

Separable Model Residuals

Age	1995	1996	1997	1998	1999
0	-0.8807	0.4409	-0.0067	0.1973	0.0607
1	0.3062	-0.4121	0.6146	0.1662	0.1863
2	0.1230	-0.0611	0.3459	-0.0914	-0.1561
3	0.2553	0.2123	-0.1934	-0.0182	-0.3085
4	-0.1091	0.1081	0.1868	-0.1551	0.1259
5	-0.2736	-0.4635	-0.1218	0.5494	0.3390

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1982	1983	1984	1985	1986	1987	1988	1989
1	*******	*******	*******	*******	*******	*******	-0.3736	*******

INDEX1

	1990	1991	1992	1993	1994	1995	1996	1997
1	*******	*******	*******	*******	*******	*******	*******	-0.8785

Table 9.7.2.1b (cont): Ouput values from the assessment model.

INDEX1

	1998	1999
1	*******	-0.5319

AGE-STRUCTURED INDEX RESIDUALS

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-0.596	1.991	0.437	*******	-0.260	-1.195	-0.182	0.438
2	-1.934	0.810	-0.459	*******	-0.619	0.690	-0.267	0.553
3	1.126	-1.724	-0.585	*******	0.339	0.314	-0.361	0.081
4	0.082	1.906	-0.850	*******	-0.752	0.763	-1.389	-0.071
5	0.879	1.244	1.072	*******	-0.177	-0.377	-0.330	0.271
6	0.678	1.408	0.953	*******	0.348	0.962	-0.421	1.364

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX

Age	1994	1995	1996	1997	1998	1999	2000
1	*******	*******	-1.666	-0.512	1.677	0.278	-0.409
2	*******	*******	-0.554	1.309	-0.134	0.287	0.317
3	*******	*******	-0.240	0.092	-0.045	-0.054	1.056
4	*******	*******	0.296	0.123	-1.118	0.478	0.532
5	*******	*******	-0.274	-1.109	-1.336	-0.971	1.107
6	*******	*******	-1.220	-0.593	-1.849	-0.806	-0.825

FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Age	1996	1997	1998	1999	2000
1	-0.205	0.641	-0.725	-0.008	0.297
2	-0.074	0.652	0.360	-0.114	-0.824
3	0.378	-0.060	0.595	-0.335	-0.578
4	0.100	0.137	0.321	0.083	-0.640
5	-1.516	0.087	0.882	0.239	0.308
6	-2.552	0.003	1.199	0.582	0.768

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.179	-0.370	-0.028	-0.147	*******	*******	*******	*******
1	0.177	0.233	-0.063	0.450	*******	*******	*******	*******
2	-0.313	0.440	0.206	0.143	*******	*******	*******	*******
3	0.050	0.068	-1.025	0.177	*******	*******	*******	*******
4	-0.467	0.136	-0.813	-0.634	*******	*******	*******	*******
5	-1.165	-0.725	-0.660	-0.047	*******	*******	*******	*******
6	-0.862	-0.255	-0.919	-0.514	*******	*******	*******	*******

Table 9.7.2.1b (cont): Ouput values from the assessment model.

FLT06: PT NOVEMBER AC.SURVEY EXCL.CADIZ

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.336	*******	*******	*******	*******	-0.139	0.608	-0.082
1	0.410	*******	*******	*******	*******	0.113	0.023	-1.343
2	0.069	*******	*******	*******	*******	0.188	-0.021	-0.714
3	0.381	*******	*******	*******	*******	0.272	0.715	-0.638
4	-0.070	*******	*******	*******	*******	1.102	0.205	0.540
5	-0.856	*******	*******	*******	*******	1.016	1.216	1.219
6	-1.529	*******	*******	*******	*******	1.951	1.202	0.923

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 1999

Variance	0.1398
Skewness test stat.	-0.8008
Kurtosis test statistic	1.5674
Partial chi-square	0.4425
Significance in fit	0.0000
Degrees of freedom	43

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance
Last age is a plus-group

Variance	0.3981
Skewness test stat.	-0.8264
Kurtosis test statistic	-0.5437
Partial chi-square	0.0932
Significance in fit	0.0074
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+IX

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.1867	0.1222	0.0927	0.1410	0.1376	0.1973
Skewness test stat.	0.6822	-0.9477	-0.8766	0.4389	0.0778	-0.2149
Kurtosis test statisti	-0.2406	0.2251	0.5632	-0.1816	-0.9440	-0.9088
Partial chi-square	0.1814	0.1154	0.0844	0.1279	0.1292	0.1784
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12	12
Degrees of freedom	11	11	11	11	11	11
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Table 9.7.2.1b (cont): Ouput values from the assessment model.

DISTRIBUTION STATISTICS FOR FLT05: PT MARCH ACOUSTIC SURVEY INCL.CAD

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.0445	0.0521	0.0394	0.0228	0.1349	0.3700
Skewness test stat.	-0.1861	-0.3469	0.0748	-1.1328	-0.9666	-1.0993
Kurtosis test statisti	-0.4576	-0.4103	-0.6819	-0.0098	-0.0832	-0.0681
Partial chi-square	0.0081	0.0095	0.0074	0.0043	0.0258	0.0778
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0001	0.0007
Number of observations	5	5	5	5	5	5
Degrees of freedom	4	4	4	4	4	4
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	0.0143	0.0465	0.0185	0.0454	0.0582	0.1439	0.2114
Skewness test stat.	1.1146	-2.1325	-1.1014	-0.8759	0.4152	0.3105	0.4710
Kurtosis test statisti	-0.1296	1.2320	0.0190	-0.2797	-0.4784	-0.9603	-0.6941
Partial chi-square	0.0045	0.0149	0.0061	0.0154	0.0203	0.0530	0.0821
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	108.6666	239	58	181	0.6004
Catches at age	7.2539	78	39	39	0.1860
SSB Indices					
INDEX1	1.1942	3	0	3	0.3981
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	57.9221	72	6	66	0.8776
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	15.9296	30	6	24	0.6637
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	26.3668	56	7	49	0.5381

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.2353	239	58	181	0.0510
Catches at age	5.4516	78	39	39	0.1398
SSB Indices					
INDEX1	1.1942	3	0	3	0.3981
Aged Indices					
FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+	1.6089	72	6	66	0.0244
FLT05: PT MARCH ACOUSTIC SURVEY INCL.C	0.4425	30	6	24	0.0184
FLT06: PT NOVEMBER AC.SURVEY EXCL.CADI	0.5381	56	7	49	0.0110

Table 9.8.1 – Sardine: input data for short-term predictions.

10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	5483.000	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	5844.000	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	2074.000	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	1012.000	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	264.000	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	325.000	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANXAN04
Date and time: 22SEP00:12:59

Table 9.8.2 – Sardine:Results of short-term predictions.

10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
Reference	Stock	Sp.stock	Catch in	F	Reference	Stock	Sp.stock	Catch in	Stock	Sp.stock	F
Factor	F	biomass	biomass	weight	Factor	F	biomass	biomass	weight	biomass	biomass
1.0000	0.3019	607	466	116	0.0000	0.0000	618	509	0	723	604
.	.	.	.	.	0.0500	0.0151	.	507	7	716	596
.	.	.	.	.	0.1000	0.0302	.	505	14	710	588
.	.	.	.	.	0.1500	0.0453	.	504	22	704	581
.	.	.	.	.	0.2000	0.0604	.	502	29	698	573
.	.	.	.	.	0.2500	0.0755	.	501	35	691	566
.	.	.	.	.	0.3000	0.0906	.	499	42	685	559
.	.	.	.	.	0.3500	0.1057	.	497	49	680	552
.	.	.	.	.	0.4000	0.1208	.	496	56	674	545
.	.	.	.	.	0.4500	0.1359	.	494	62	668	538
.	.	.	.	.	0.5000	0.1509	.	493	69	662	531
.	.	.	.	.	0.5500	0.1660	.	491	75	657	525
.	.	.	.	.	0.6000	0.1811	.	490	81	651	518
.	.	.	.	.	0.6500	0.1962	.	488	88	646	512
.	.	.	.	.	0.7000	0.2113	.	487	94	640	506
.	.	.	.	.	0.7500	0.2264	.	485	100	635	500
.	.	.	.	.	0.8000	0.2415	.	484	106	630	494
.	.	.	.	.	0.8500	0.2566	.	482	112	624	488
.	.	.	.	.	0.9000	0.2717	.	481	118	619	482
.	.	.	.	.	0.9500	0.2868	.	479	123	614	476
.	.	.	.	.	1.0000	0.3019	.	478	129	609	471
.	.	.	.	.	1.0500	0.3170	.	476	135	604	465
.	.	.	.	.	1.1000	0.3321	.	475	140	600	460
.	.	.	.	.	1.1500	0.3472	.	473	146	595	454
.	.	.	.	.	1.2000	0.3623	.	472	151	590	449
.	.	.	.	.	1.2500	0.3774	.	470	156	585	444
.	.	.	.	.	1.3000	0.3925	.	469	162	581	439
.	.	.	.	.	1.3500	0.4076	.	467	167	576	434
.	.	.	.	.	1.4000	0.4227	.	466	172	572	429
.	.	.	.	.	1.4500	0.4378	.	465	177	567	424
.	.	.	.	.	1.5000	0.4529	.	463	182	563	419
.	.	.	.	.	1.5500	0.4679	.	462	187	559	415
.	.	.	.	.	1.6000	0.4830	.	460	192	555	410
.	.	.	.	.	1.6500	0.4981	.	459	197	550	406
.	.	.	.	.	1.7000	0.5132	.	457	202	546	401
.	.	.	.	.	1.7500	0.5283	.	456	207	542	397
.	.	.	.	.	1.8000	0.5434	.	455	211	538	392
.	.	.	.	.	1.8500	0.5585	.	453	216	534	388
.	.	.	.	.	1.9000	0.5736	.	452	220	530	384
.	.	.	.	.	1.9500	0.5887	.	451	225	526	380
.	.	.	.	.	2.0000	0.6038	.	449	229	523	376
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANXAN04
Date and time : 22SEP00:12:59
Computation of ref. F: Simple mean, age 2 - 5
Basis for 2000 : F factors

Table 9.8.2.1 – Sardine: Input data for short-term predictions for Divisions VIIIc and IXa.

.10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table: Input data

2000	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	5483.000	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	5844.000	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	2074.000	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	1012.000	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	264.000	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	325.000	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2001	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	.	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	.	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	.	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	.	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	.	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

2002	Division IXa		Division VIIIc							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0252	0.024	0.0012	0.038	7831.000	0.3300	0.0000	0.2500	0.2500	0.000
1	0.0505	0.041	0.0049	0.060	.	0.3300	0.6190	0.2500	0.2500	0.023
2	0.1489	0.055	0.0091	0.080	.	0.3300	0.9110	0.2500	0.2500	0.043
3	0.2969	0.063	0.0269	0.085	.	0.3300	0.9870	0.2500	0.2500	0.055
4	0.3378	0.066	0.0641	0.091	.	0.3300	0.9950	0.2500	0.2500	0.064
5	0.2866	0.069	0.0372	0.099	.	0.3300	1.0000	0.2500	0.2500	0.070
6+	0.2698	0.100	0.0540	0.100	.	0.3300	1.0000	0.2500	0.2500	0.100
Unit	-	Kilograms	-	Kilograms	Thousands	-	-	-	-	Kilograms

Notes: Run name : MANXAN05
Date and time: 22SEP00:18:05

Table 9.8.2.2 – Sardine: Results of short-term predictions for Divisions VIIIc and IXa.

10:23 Friday, September 22, 2000
Sardine in Divisions VIIIc and IXa

Multi fleet prediction with mangement option table

Year: 2000								
Division IXa			Division VIIIc			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.2676	106	1.0000	0.0343	15	121	607	466
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 2001									Year: 2002	
Division IXa			Division VIIIc			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	618	509	723	604
0.0500	0.0134	7	0.0500	0.0017	1	8	.	507	716	596
0.1000	0.0268	13	0.1000	0.0034	2	15	.	505	710	588
0.1500	0.0401	20	0.1500	0.0051	3	22	.	504	704	581
0.2000	0.0535	26	0.2000	0.0069	4	30	.	502	698	573
0.2500	0.0669	32	0.2500	0.0086	5	37	.	501	691	566
0.3000	0.0803	38	0.3000	0.0103	6	44	.	499	685	559
0.3500	0.0936	44	0.3500	0.0120	6	51	.	498	680	552
0.4000	0.1070	50	0.4000	0.0137	7	58	.	496	674	545
0.4500	0.1204	56	0.4500	0.0154	8	64	.	494	668	538
0.5000	0.1338	62	0.5000	0.0172	9	71	.	493	662	531
0.5500	0.1472	68	0.5500	0.0189	10	78	.	491	657	525
0.6000	0.1605	74	0.6000	0.0206	11	84	.	490	651	518
0.6500	0.1739	79	0.6500	0.0223	11	91	.	488	646	512
0.7000	0.1873	85	0.7000	0.0240	12	97	.	487	640	506
0.7500	0.2007	90	0.7500	0.0257	13	103	.	485	635	500
0.8000	0.2140	96	0.8000	0.0275	14	110	.	484	630	494
0.8500	0.2274	101	0.8500	0.0292	15	116	.	482	624	488
0.9000	0.2408	107	0.9000	0.0309	15	122	.	481	619	482
0.9500	0.2542	112	0.9500	0.0326	16	128	.	479	614	476
1.0000	0.2676	117	1.0000	0.0343	17	134	.	478	609	471
1.0500	0.2809	122	1.0500	0.0360	18	140	.	476	604	465
1.1000	0.2943	127	1.1000	0.0378	18	145	.	475	600	460
1.1500	0.3077	132	1.1500	0.0395	19	151	.	473	595	454
1.2000	0.3211	137	1.2000	0.0412	20	157	.	472	590	449
1.2500	0.3344	142	1.2500	0.0429	20	162	.	470	585	444
1.3000	0.3478	147	1.3000	0.0446	21	168	.	469	581	439
1.3500	0.3612	152	1.3500	0.0463	22	173	.	467	576	434
1.4000	0.3746	156	1.4000	0.0481	22	179	.	466	572	429
1.4500	0.3880	161	1.4500	0.0498	23	184	.	465	568	424
1.5000	0.4013	165	1.5000	0.0515	24	189	.	463	563	419
1.5500	0.4147	170	1.5500	0.0532	24	194	.	462	559	415
1.6000	0.4281	174	1.6000	0.0549	25	199	.	460	555	410
1.6500	0.4415	179	1.6500	0.0566	25	204	.	459	550	406
1.7000	0.4548	183	1.7000	0.0583	26	209	.	458	546	401
1.7500	0.4682	188	1.7500	0.0601	27	214	.	456	542	397
1.8000	0.4816	192	1.8000	0.0618	27	219	.	455	538	392
1.8500	0.4950	196	1.8500	0.0635	28	224	.	453	534	388
1.9000	0.5084	200	1.9000	0.0652	28	229	.	452	530	384
1.9500	0.5217	204	1.9500	0.0669	29	233	.	451	526	380
2.0000	0.5351	208	2.0000	0.0686	30	238	.	449	523	376
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

```
-----------------------------------------------------------------------------------------------------------------------
Notes: Run name             : MANXAN05
       Date and time        : 22SEP00:18:05
       Computation of ref. F: Division IXa:   Simple mean, age 2 - 5
                              Division VIIIc: Simple mean, age 2 - 5
       Basis for 2000       : F factors
```

Table 9.11.1 – Sardine: input data for long term predictions.

Sardine in Divisions VIIIc and IXa

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	7831.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0264	0.024
1	.	0.3300	0.6190	0.2500	0.2500	0.023	0.0553	0.038
2	.	0.3300	0.9110	0.2500	0.2500	0.043	0.1581	0.054
3	.	0.3300	0.9870	0.2500	0.2500	0.055	0.3238	0.063
4	.	0.3300	0.9950	0.2500	0.2500	0.064	0.4019	0.068
5	.	0.3300	1.0000	0.2500	0.2500	0.070	0.3238	0.071
6+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.3238	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDXAN04
Date and time: 23SEP00:17:36

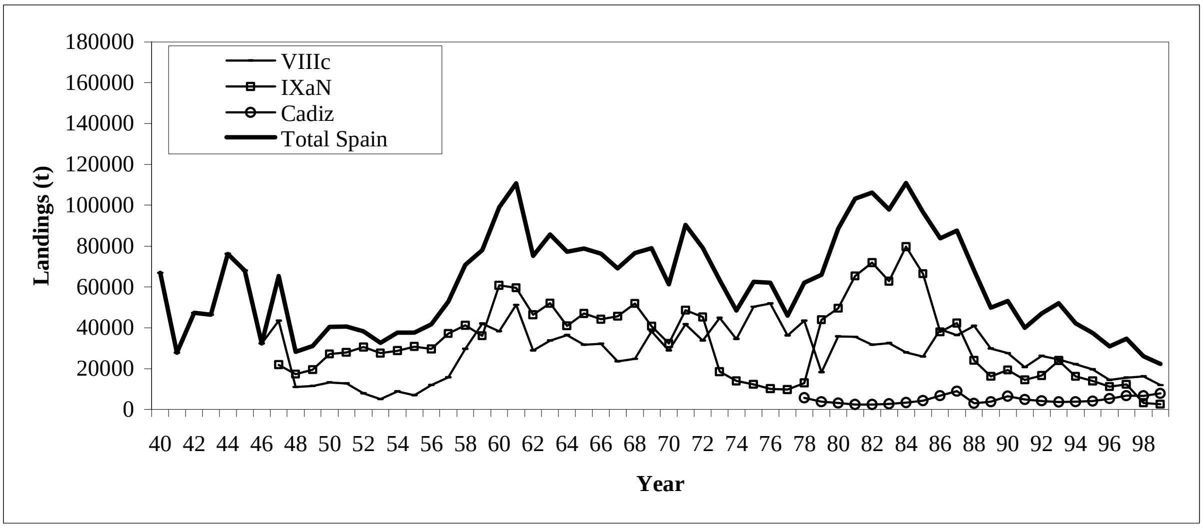
Table 9.11.2 – Sardine: results of yield per recruit analysis.

The SAS System 17:35 Saturday, September 23, 2000
Sardine in Divisions VIIIc and IXa

Yield per recruit: Summary table

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0	0	27861	1087	17476	1020	16092	939
0.0500	0.0151	190	13	27291	1038	16911	970	15525	890
0.1000	0.0302	363	25	26771	993	16396	926	15008	846
0.1500	0.0453	522	35	26295	952	15925	885	14535	806
0.2000	0.0604	668	45	25857	915	15492	848	14100	770
0.2500	0.0755	803	53	25453	881	15093	815	13699	737
0.3000	0.0906	929	61	25079	850	14724	784	13327	707
0.3500	0.1057	1045	68	24731	822	14381	755	12982	679
0.4000	0.1208	1154	74	24407	796	14062	729	12661	654
0.4500	0.1359	1255	80	24104	771	13764	705	12361	630
0.5000	0.1509	1350	85	23820	749	13485	683	12081	608
0.5500	0.1660	1440	90	23554	728	13224	662	11817	588
0.6000	0.1811	1524	95	23303	708	12978	643	11569	569
0.6500	0.1962	1604	99	23066	690	12746	625	11336	552
0.7000	0.2113	1679	103	22843	673	12527	608	11115	535
0.7500	0.2264	1751	106	22631	657	12320	592	10906	520
0.8000	0.2415	1818	110	22430	642	12123	577	10708	505
0.8500	0.2566	1883	113	22239	628	11937	564	10520	492
0.9000	0.2717	1944	115	22057	615	11760	550	10342	479
0.9500	0.2868	2003	118	21883	603	11591	538	10171	467
1.0000	0.3019	2059	121	21717	591	11430	526	10009	456
1.0500	0.3170	2113	123	21559	580	11276	515	9854	445
1.1000	0.3321	2164	125	21407	569	11129	505	9705	435
1.1500	0.3472	2214	127	21262	559	10988	495	9563	425
1.2000	0.3623	2261	129	21122	549	10852	486	9427	416
1.2500	0.3774	2307	131	20988	540	10723	477	9296	407
1.3000	0.3925	2351	133	20858	531	10598	468	9170	399
1.3500	0.4076	2393	135	20734	523	10478	460	9049	391
1.4000	0.4227	2434	136	20614	515	10362	452	8932	384
1.4500	0.4378	2474	138	20498	508	10251	445	8820	376
1.5000	0.4529	2512	139	20386	500	10143	438	8711	369
1.5500	0.4679	2549	141	20277	493	10039	431	8606	363
1.6000	0.4830	2585	142	20172	487	9939	424	8505	357
1.6500	0.4981	2619	143	20071	480	9842	418	8407	350
1.7000	0.5132	2653	144	19972	474	9748	412	8312	345
1.7500	0.5283	2686	146	19877	468	9656	406	8220	339
1.8000	0.5434	2718	147	19784	462	9568	400	8131	334
1.8500	0.5585	2749	148	19693	457	9482	395	8044	328
1.9000	0.5736	2779	149	19606	452	9399	390	7960	323
1.9500	0.5887	2808	150	19520	446	9318	385	7879	319
2.0000	0.6038	2836	151	19437	441	9239	380	7799	314
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YLDXAN04
Date and time : 23SEP00:17:36
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.5072
F-max factor : Not found
F-0.1 reference F : 0.4550
F-max reference F : Not found
Recruitment : 7831 (Thousands)



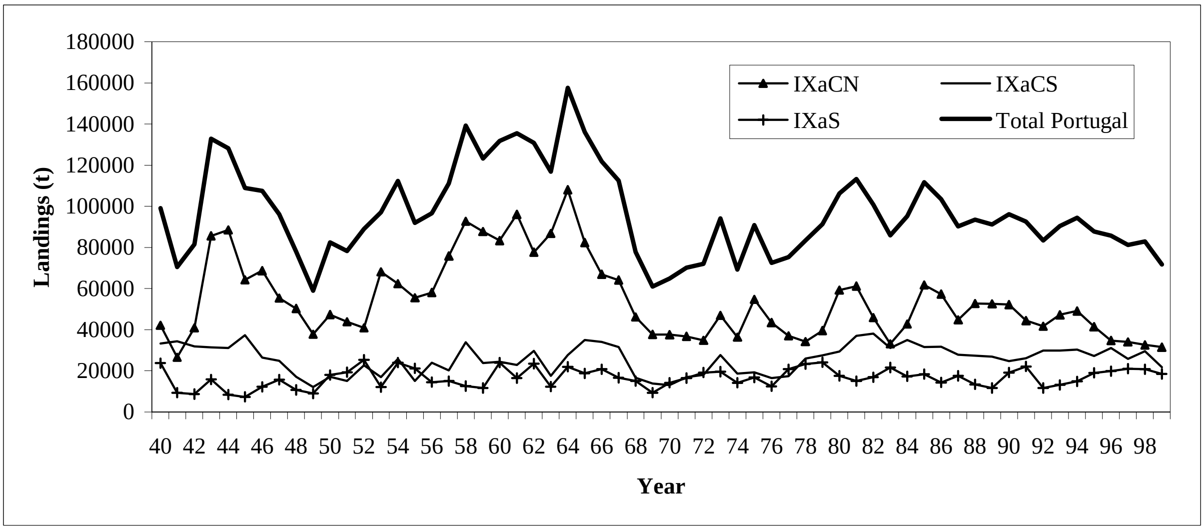


Figure 9.2.1: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

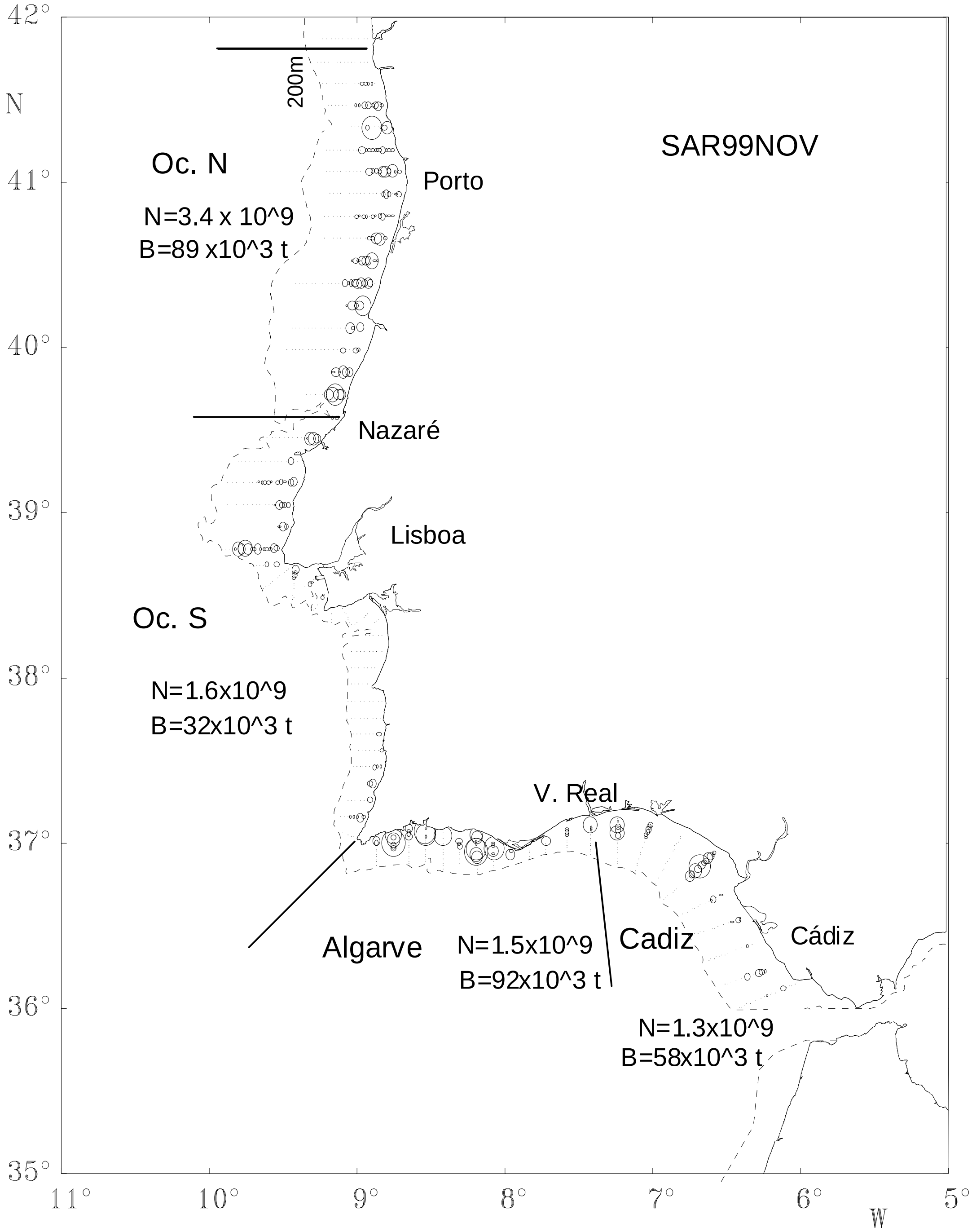


Figure 9.3.2.1 – SAR99NOV: acoustic energy distribution per nautical mile and abundance in number and biomass for sardine in each zone. Circle diameter is proportional to the square root of the acoustic energy (SA).

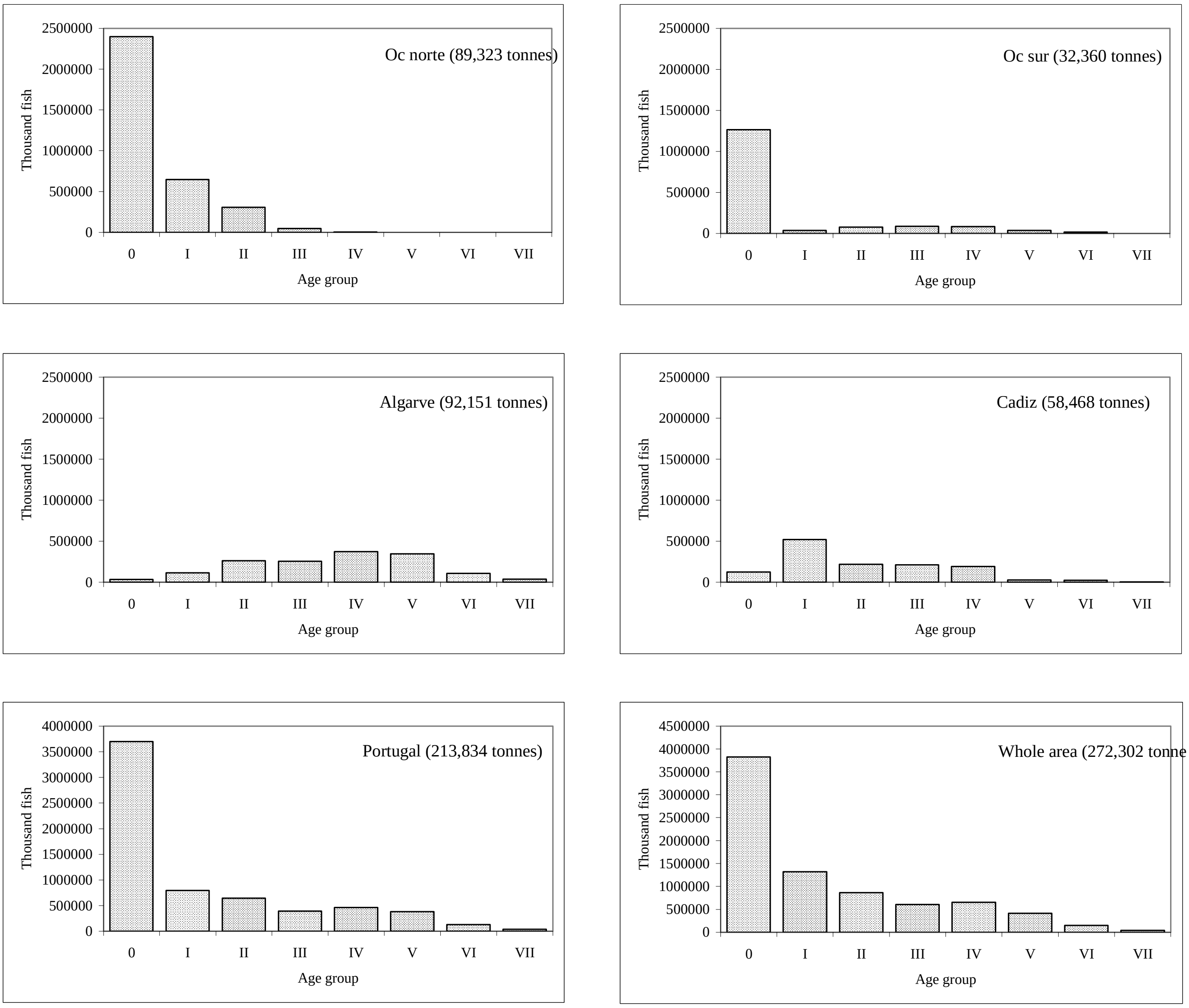


Figure 9.3.2.2: Estimated fish number of sardine (thousands) by area for the Portuguese Fall Acoustic survey 1999.

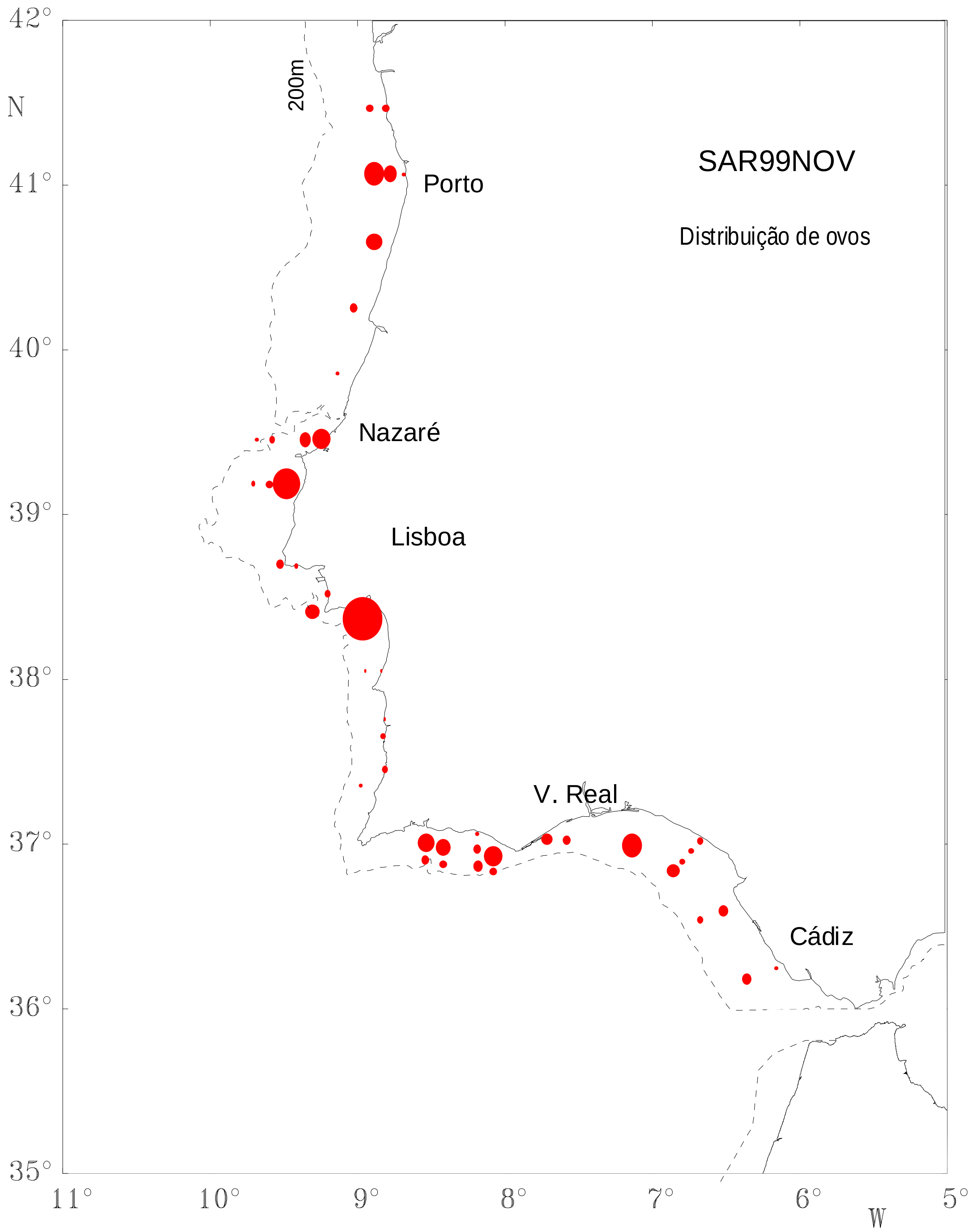


Figure 9.3.2.3: Egg numbers from CalVET tows during the Portuguese Fall Acoustic survey 1999.

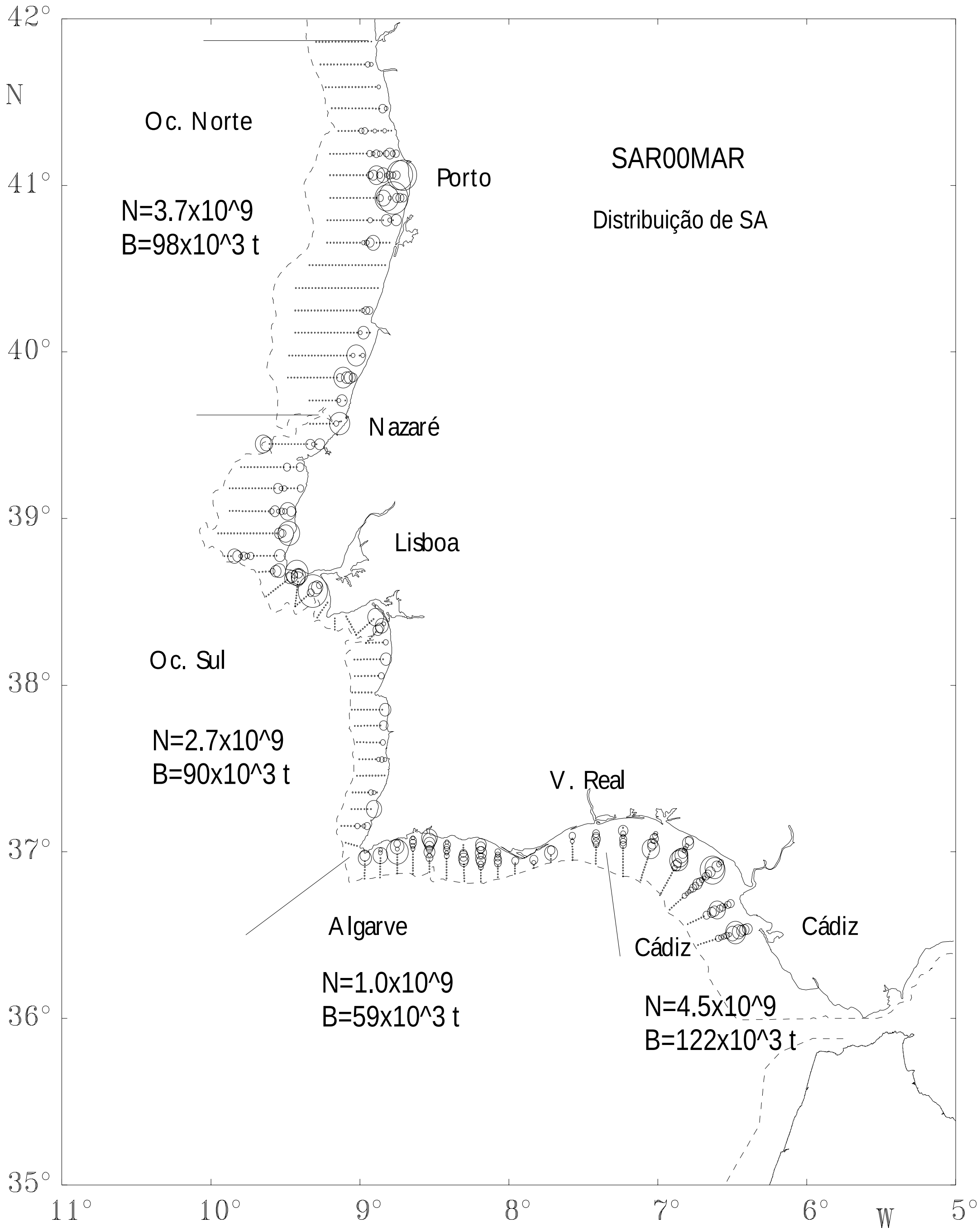


Figure 9.3.2.4 – SAR00MAR: acoustic energy distribution per nautical mile and abundance in number and biomass for sardine, in each zone. Circle diameter is proportional to the square root of the acoustic energy (SA). Note that 35% of the Cadiz area was not covered.

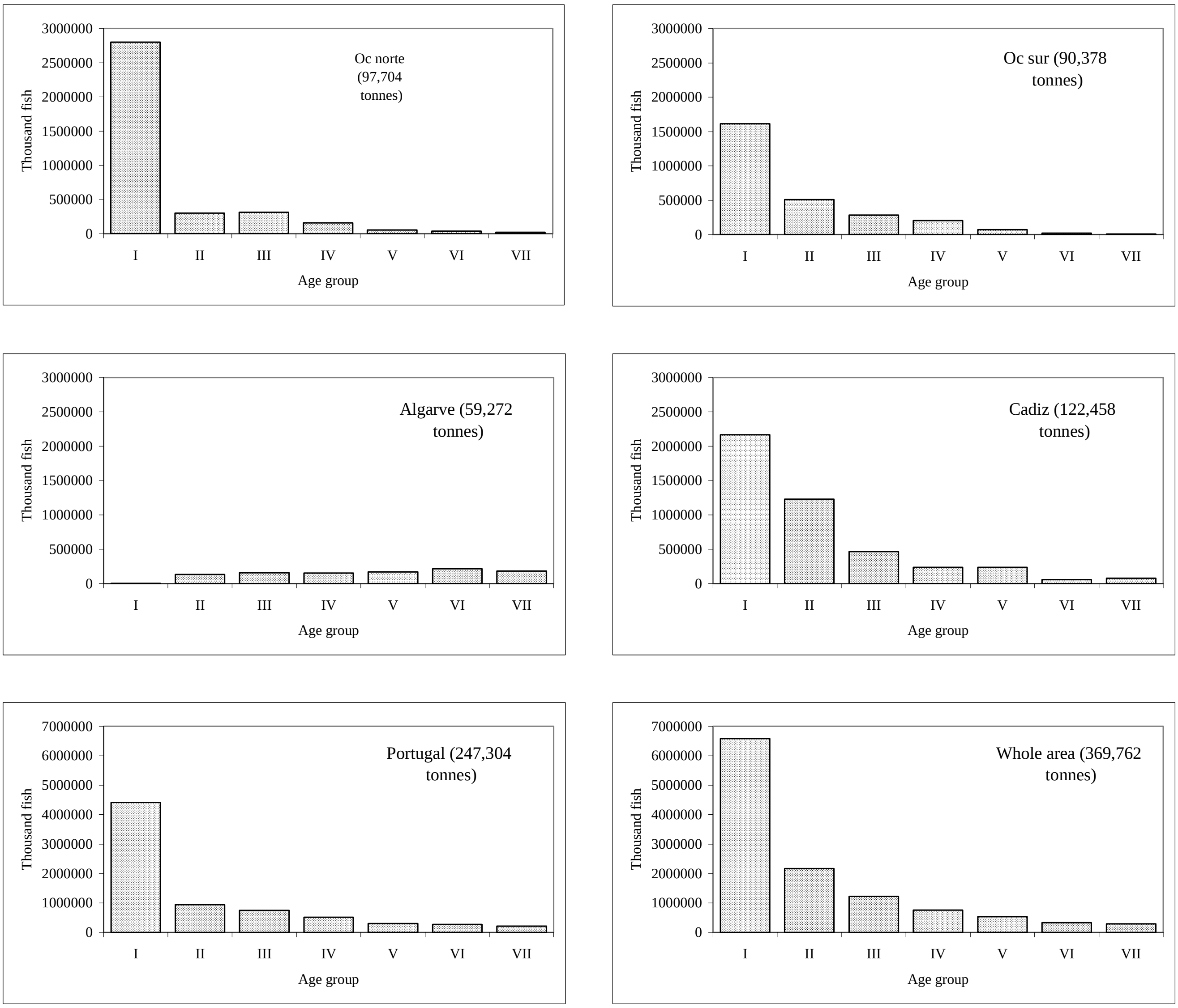


Figure 9.3.2.5: Estimated fish number of sardine (thousands) by area for the Portuguese Spring Acoustic survey 2000.

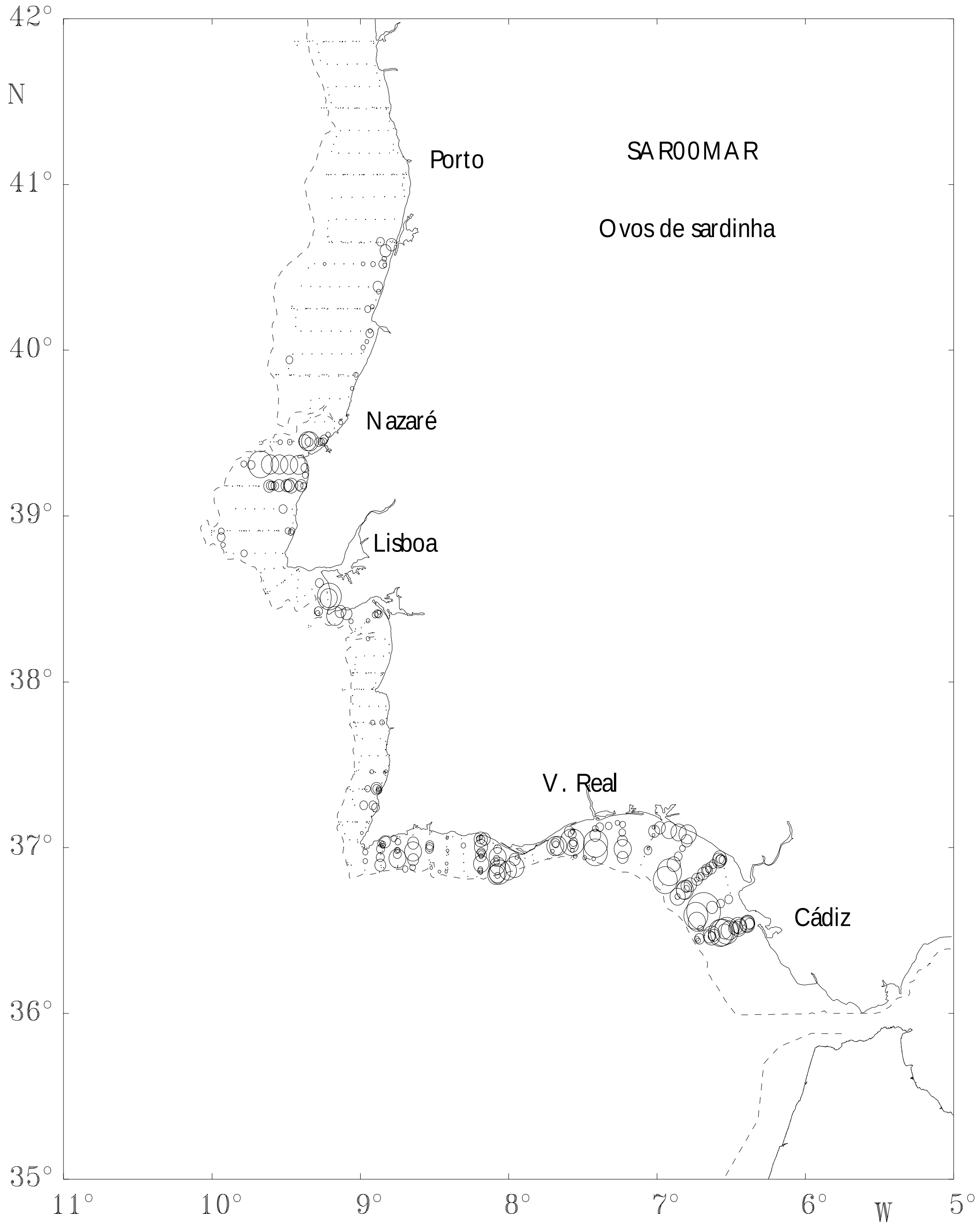


Figure 9.3.2.6 – Egg numbers from CUFES during the Portuguese Spring Acoustic Survey 2000.

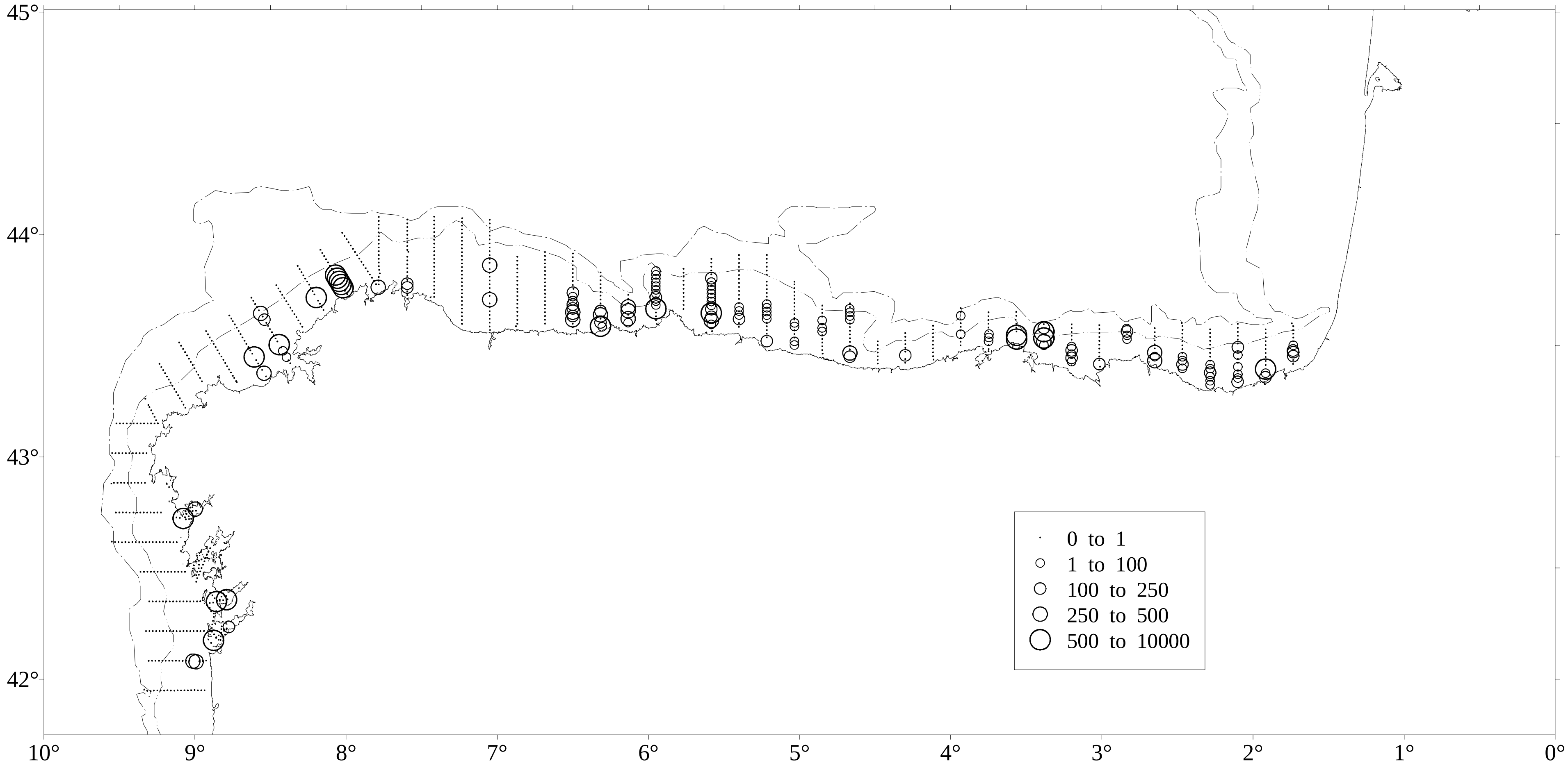


Figure 9.3.2.7 – Classed acoustic energy distribution per nautical mile for sardine during the Spanish Spring Acoustic Survey 2000.

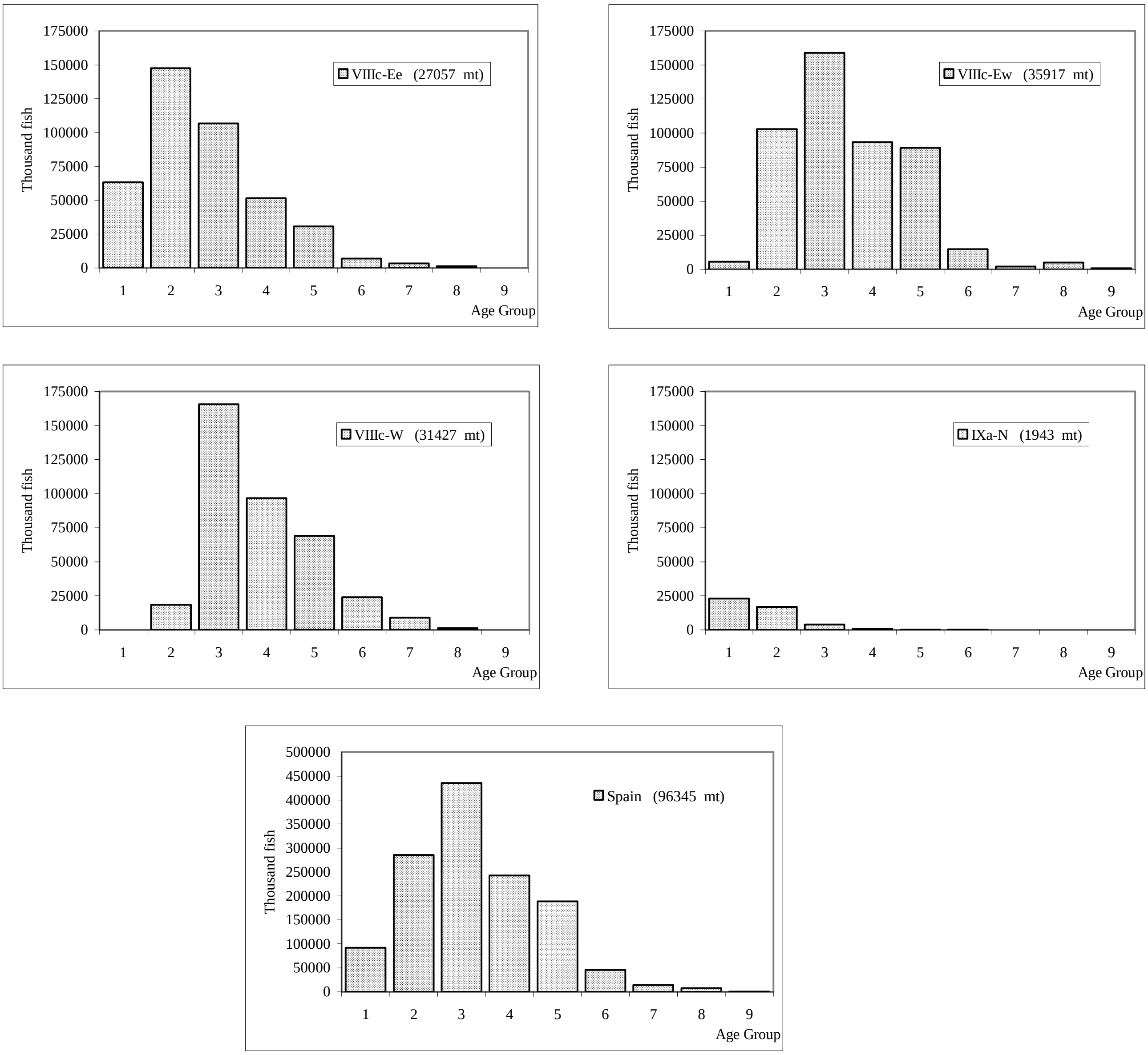


Figure 9.3.2.8: Estimated fish number of sardine (thousands) by area for the Spanish Spring Acoustic survey 2000.

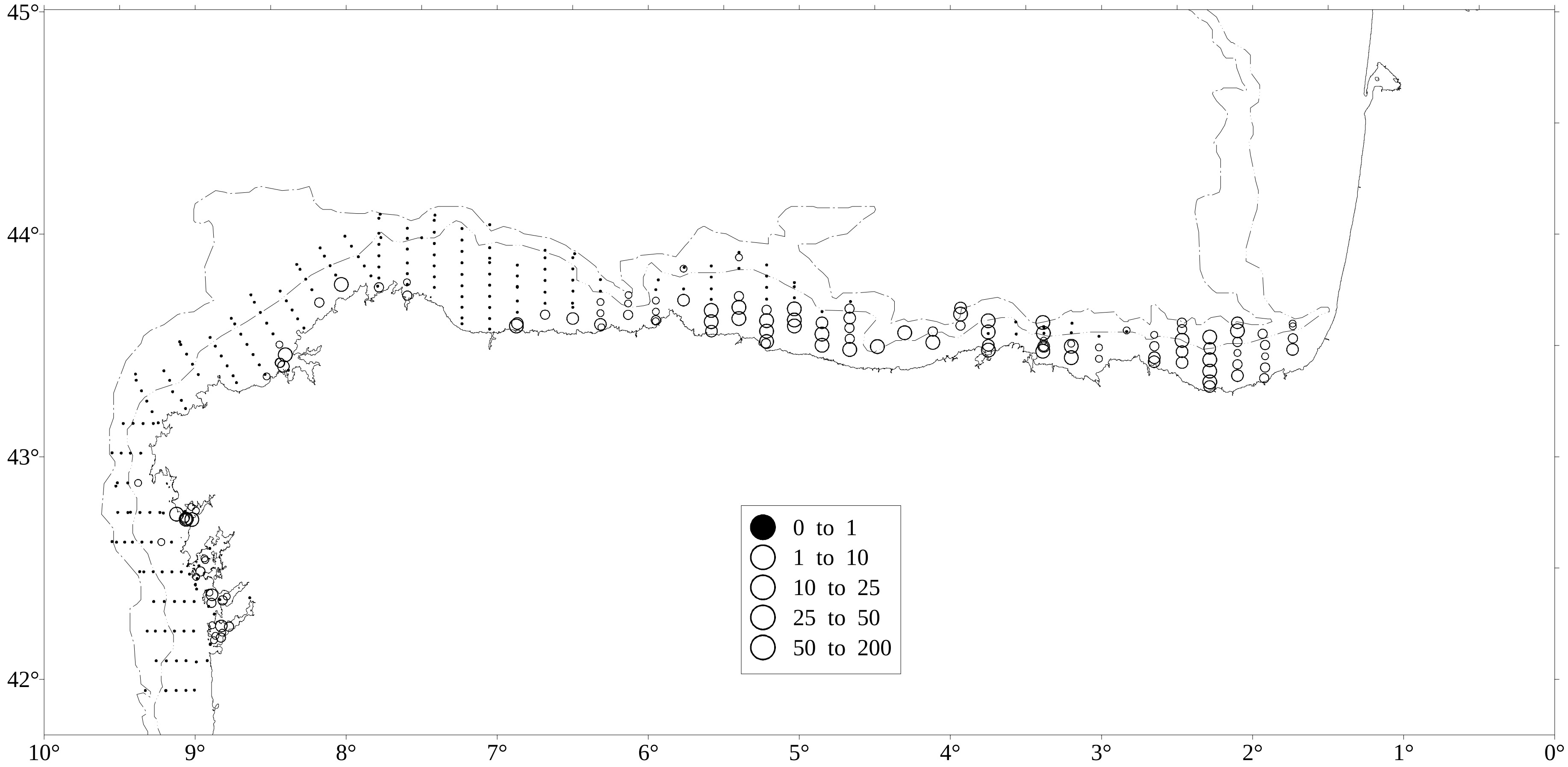


Figure 9.3.2.9 Egg numbers from CUFES during the Spanish Spring Acoustic Survey 2000.

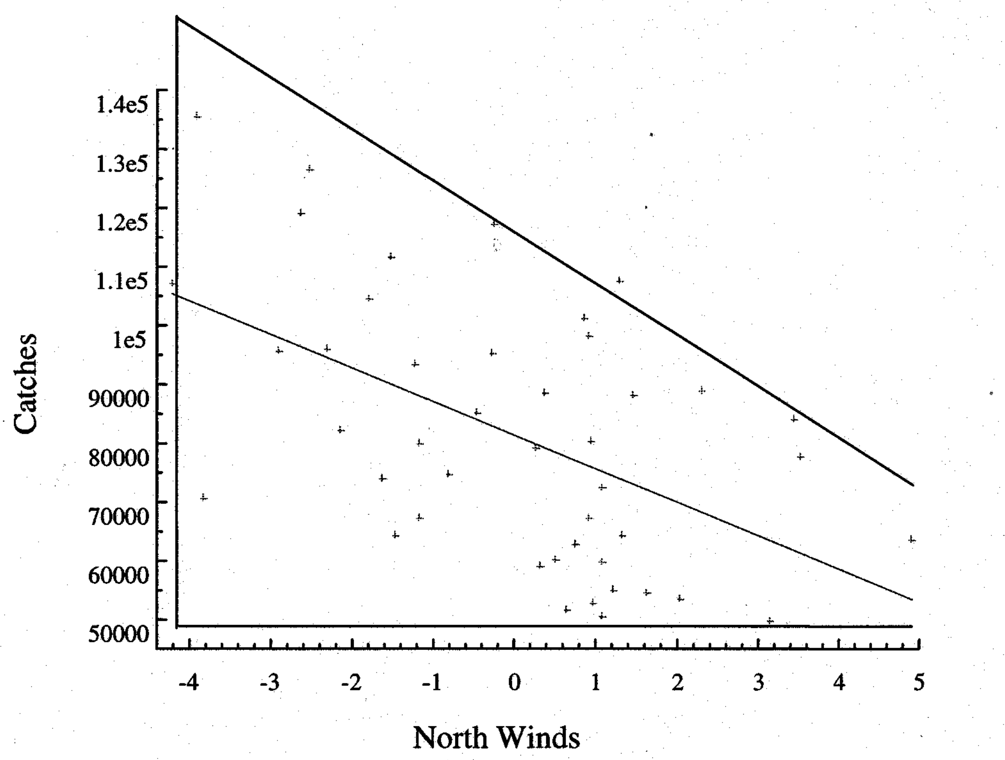
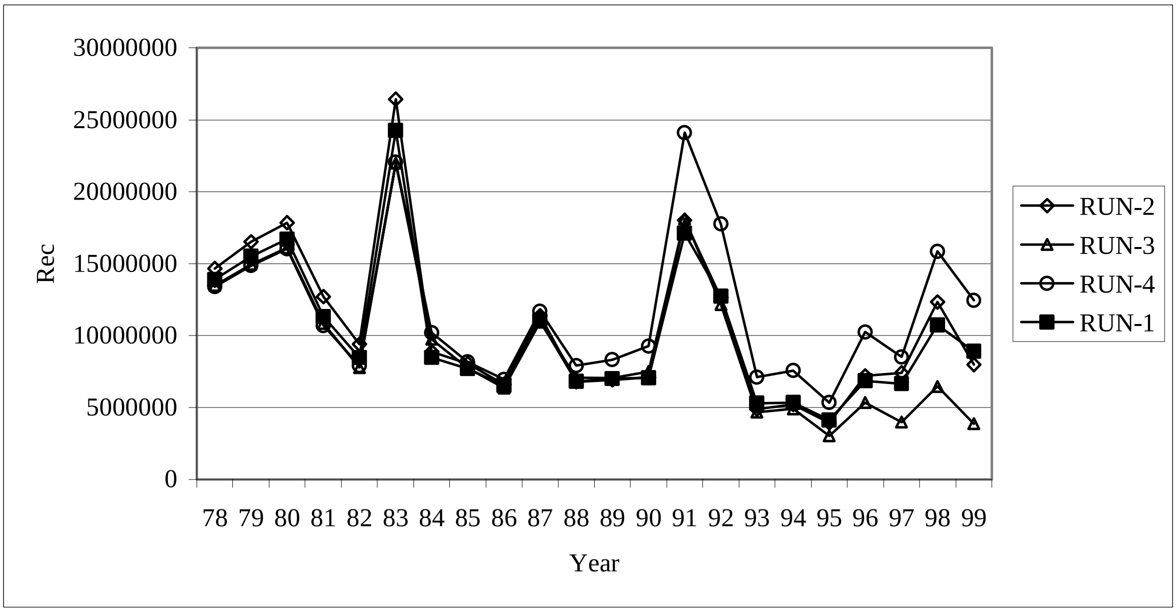
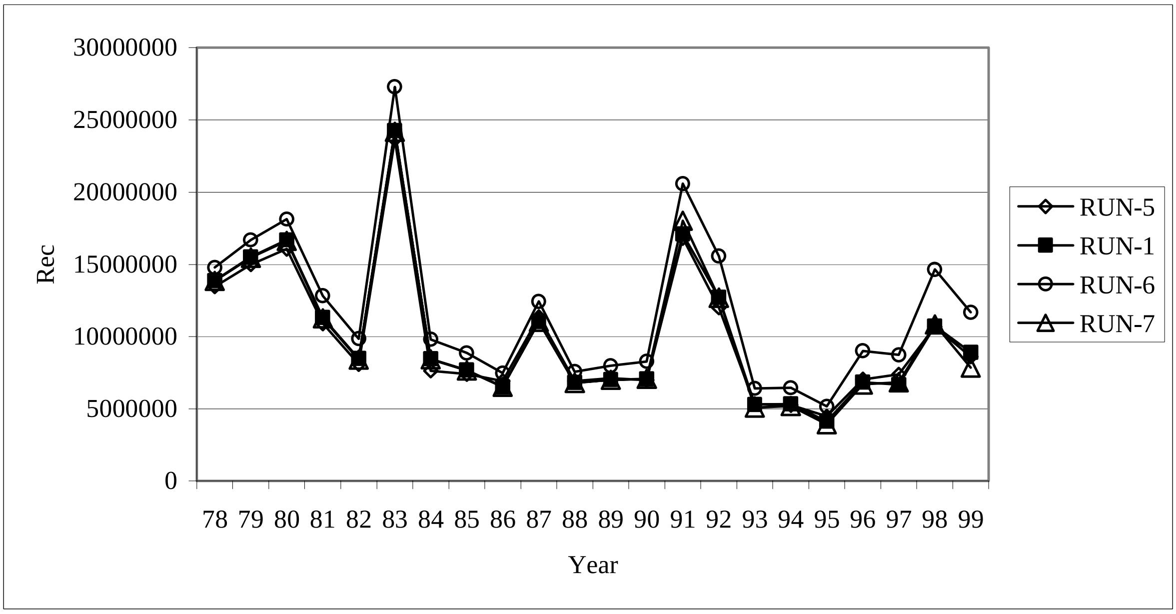


Figure 9.6.1 Correlation between sardine catches and the mean north wind index in the western Iberian coast (1947-1991). The superimposed triangle is intended to emphasise the decrease in the varaibility of catches with increasing northern winds.



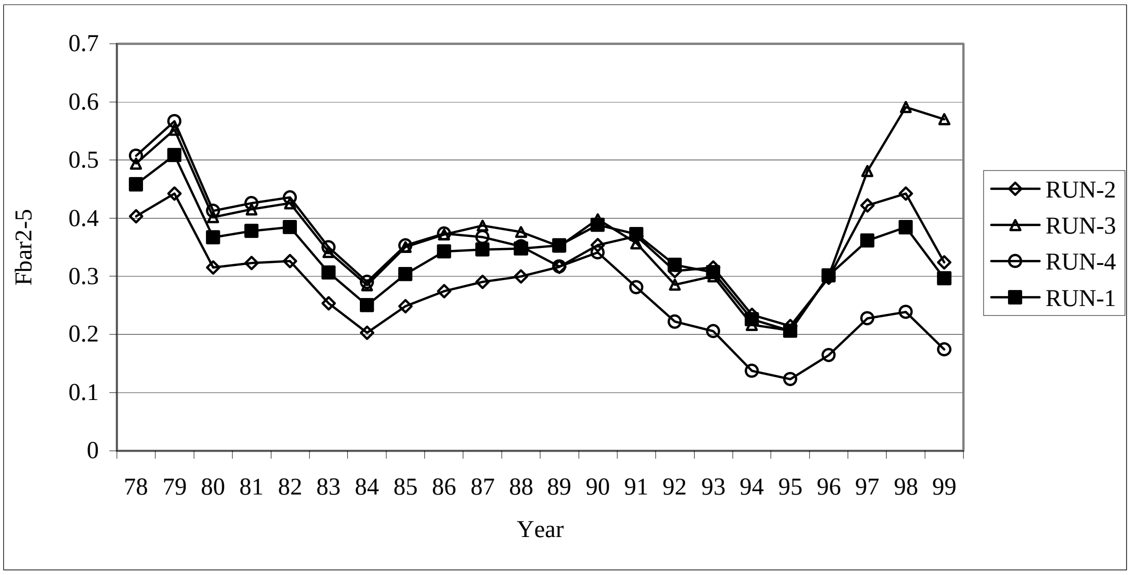


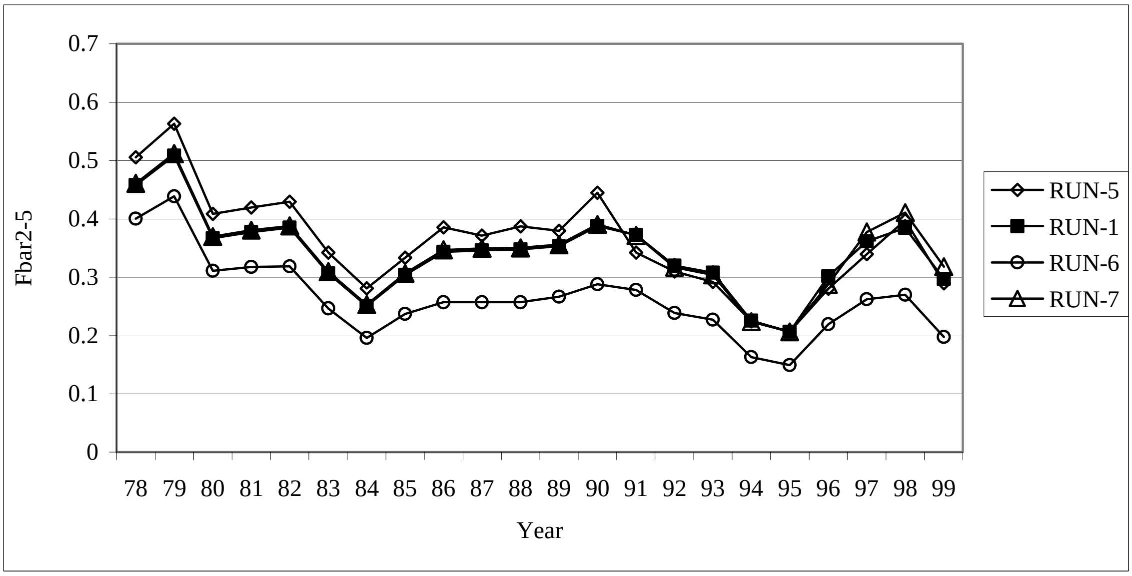
RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1a: Estimated Iberian sardine recruitment from various assessment model options (ICA)

RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1b: Estimated Iberian sardine SSB from various assessment models





RUN-2	Fitted model with only Spanish Spring Acoustic Survey
RUN-3	Fitted model with only DEPM time series as absolute estimator
RUN-4	Fitted model with only Portuguese Fall Acoustic Survey
RUN-1	**Fitted model with all the fleets (Reference Run)**
RUN-5	Fitted model with all the fleets as in WG98,but Spanish AS as power
RUN-6	Fitted model with all the fleets as in WG98 but DEPM as Linear
RUN-7	Fitted model with all the fleets as in WG98 without Portuguese Spring AS

Figure 9.7.1.1c Estimated Iberian sardine F(2-5) from various assessment models

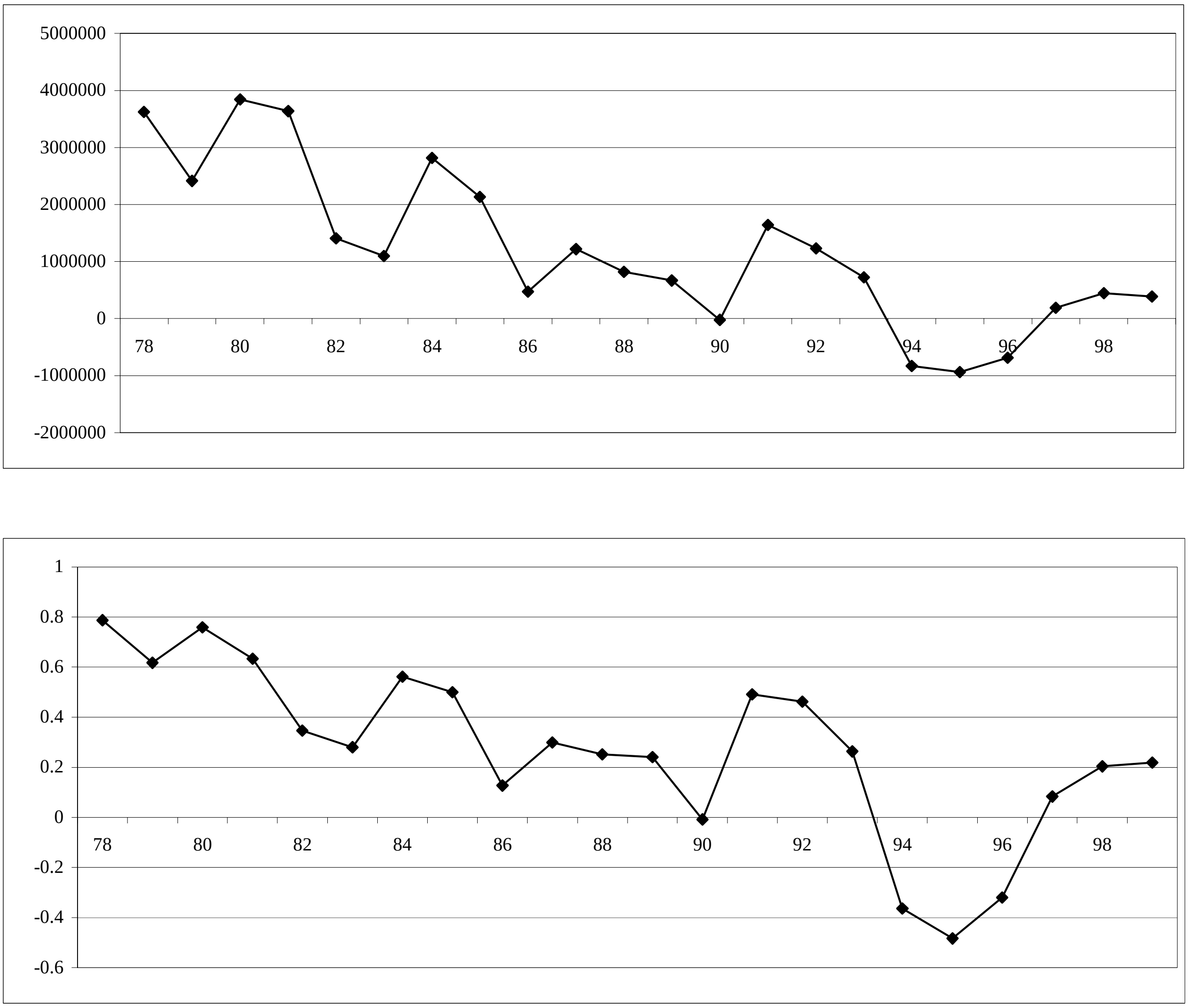
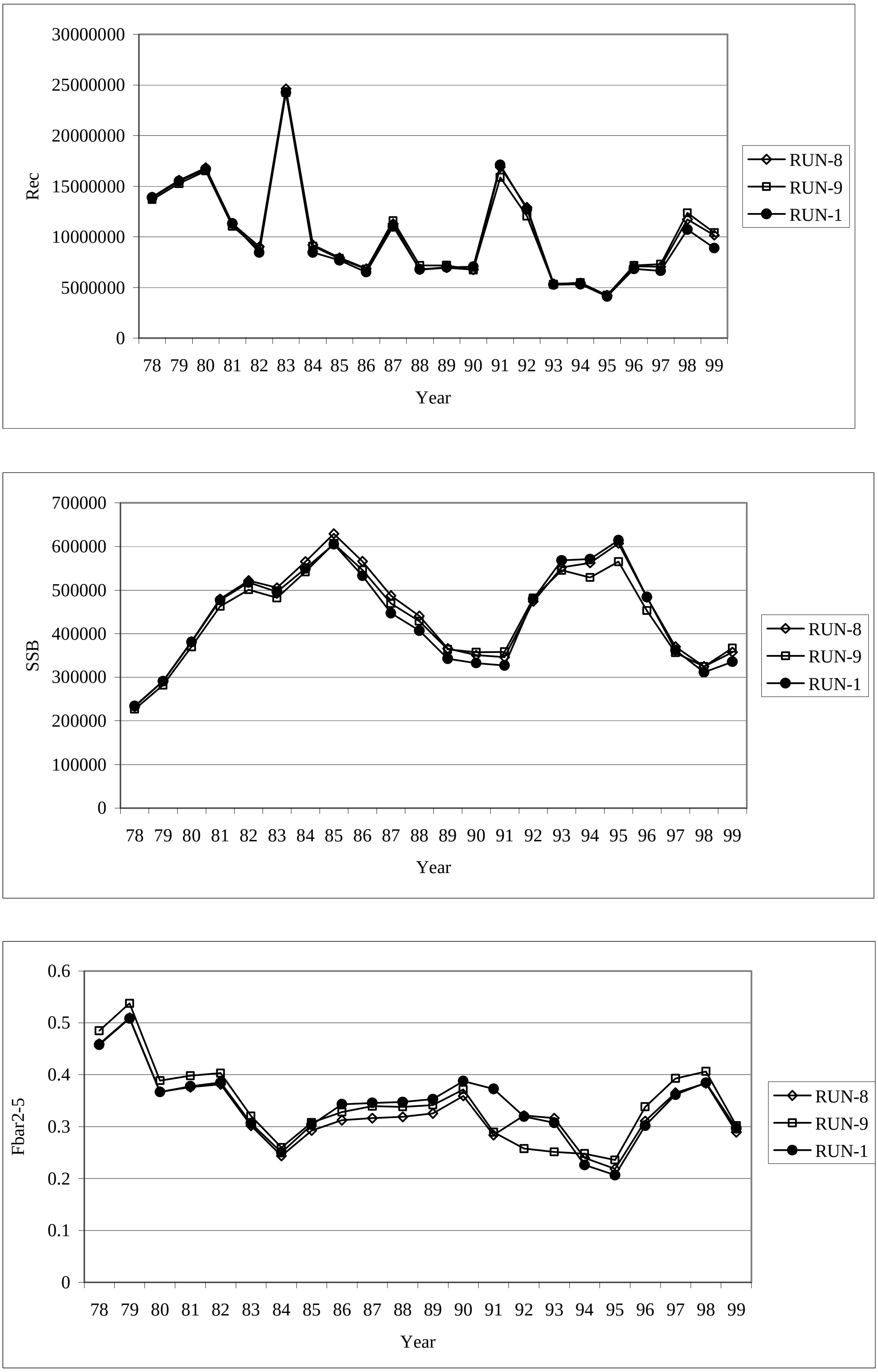


Figure 9.7.1.2: Differences in catches between younger fish (ages groups 0, 1 and 2) and older fish (3+). Upper pannel absolute numbers, lower pannel relative numbers.



RUN-8	Fitted model with Separable periods 1987-91 and 1992-99. Abrupt change assumed
RUN-9	Fitted model with Separable periods 1987-93 and 1994-99. Abrupt change assumed
RUN-1	**Fitted model with all the fleets (Reference Run)**

Figure 9.7.1.3: Estimated Iberian sardine recruitment, SSB, F(2-5) for different models with different separable periods.

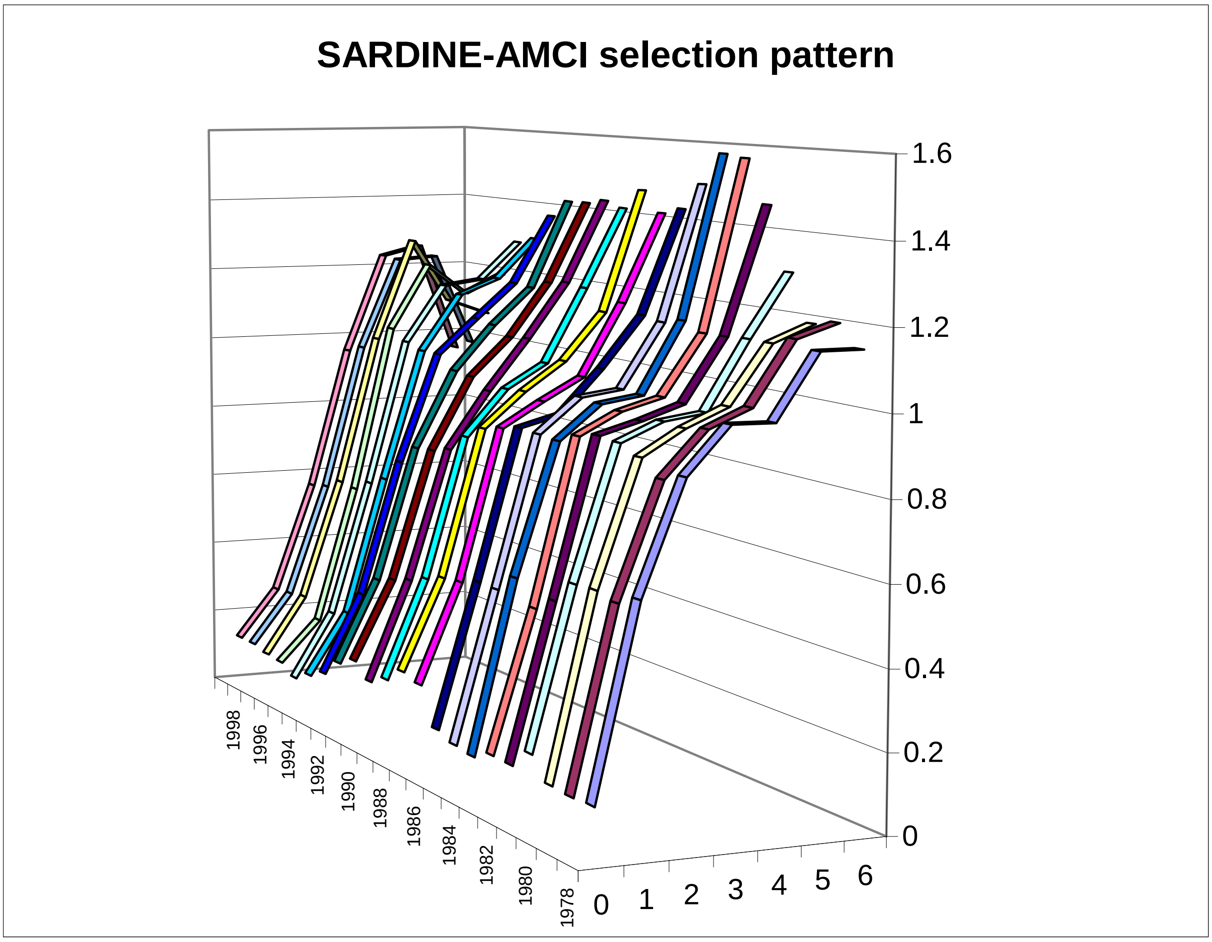


Figure 9.7.1.4: Fitted selection pattern for each year along the time series from AMCI model

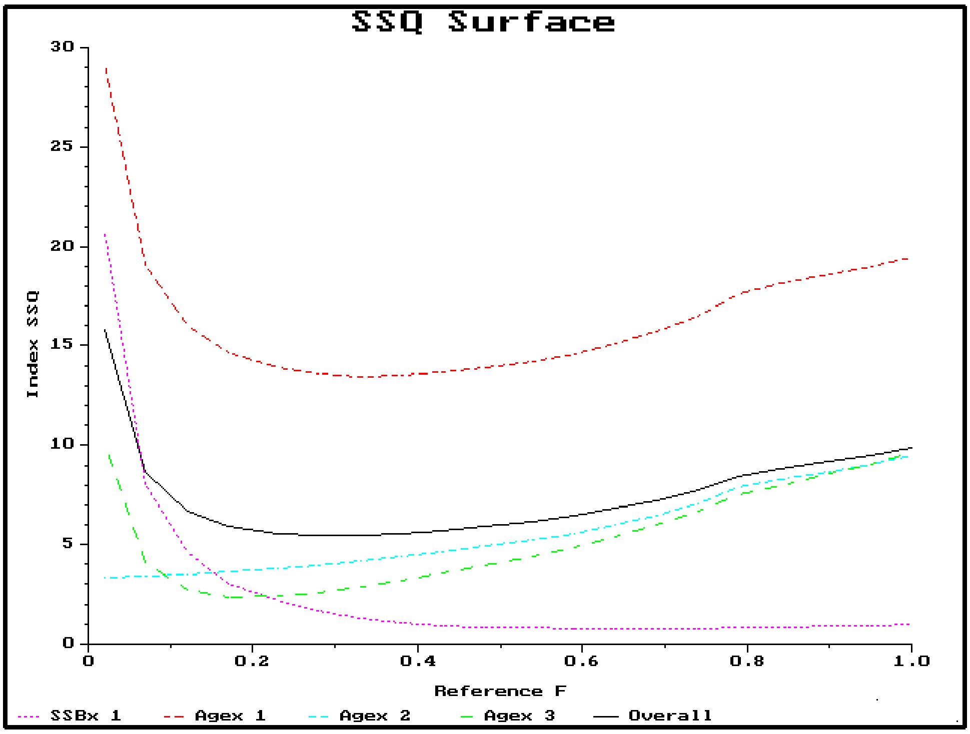
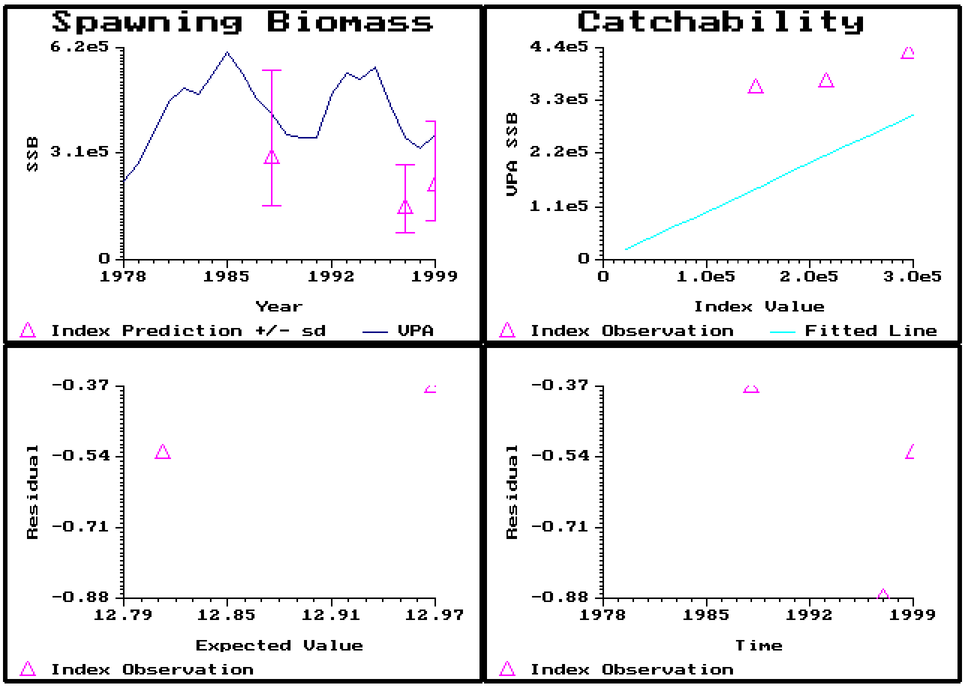


Figure 9.7.2.1 Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model. (SSBx1 is DEPM –absolute estimator-; Agex 1 is the Spanish Spring Acoustic survey time series –linear estimator-; Agex 2 is the Portuguese Spring Acoustic survey time series –linear estimator-; Agex 3 is the Portuguese Fall Acoustic survey time series –linear estimator-)

Tuning Diagnostics: Biomass index 1



PELTO94P SP MARCH ACOUSTIC SURVEY VIIIc+IXa Age 1

Press P to print screen, or any other key to continue

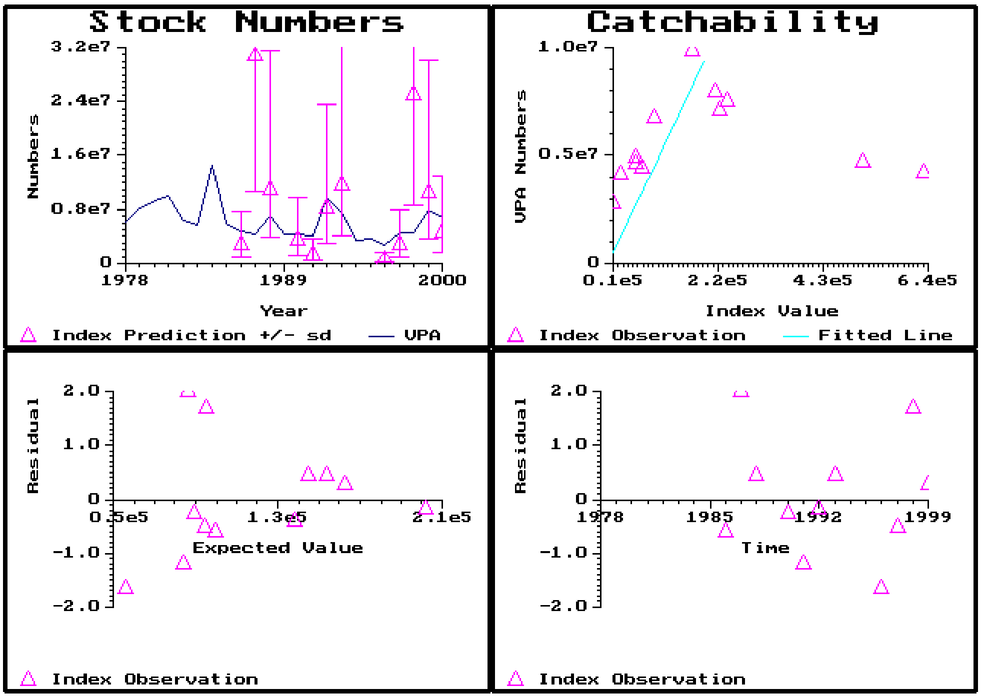
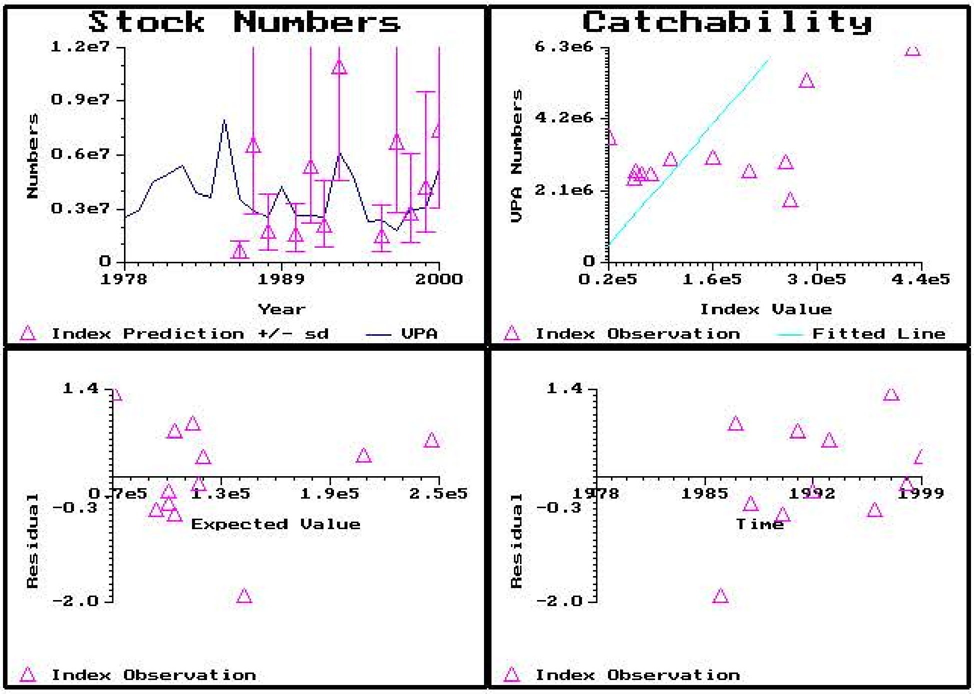


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX Age 2



FLT04: SP MARCH ACOUSTIC SURVEY VIIIc+IX Age 3

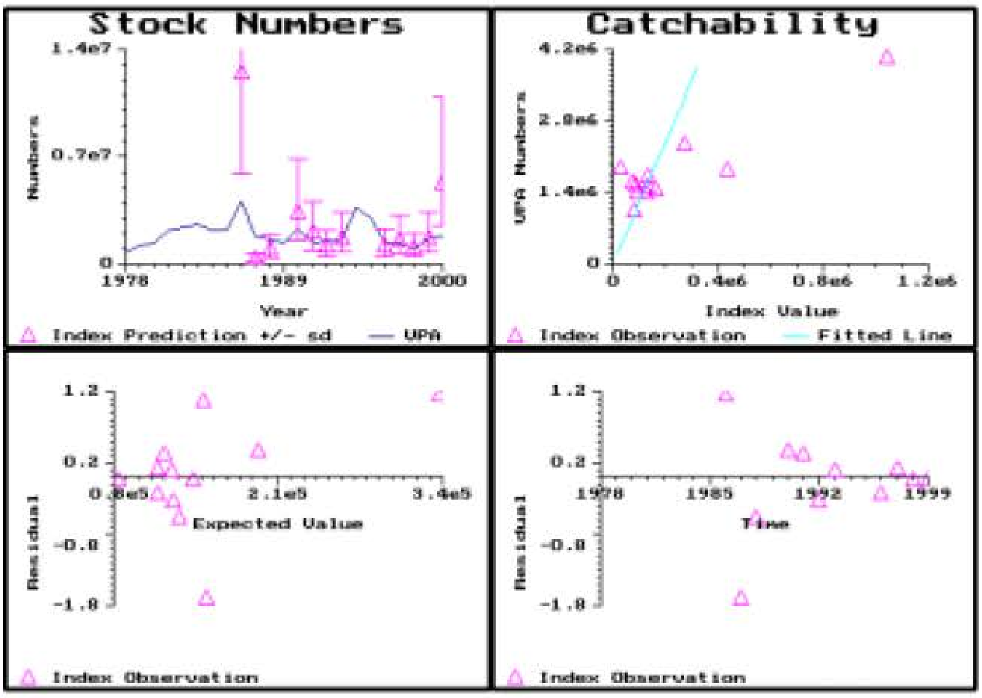
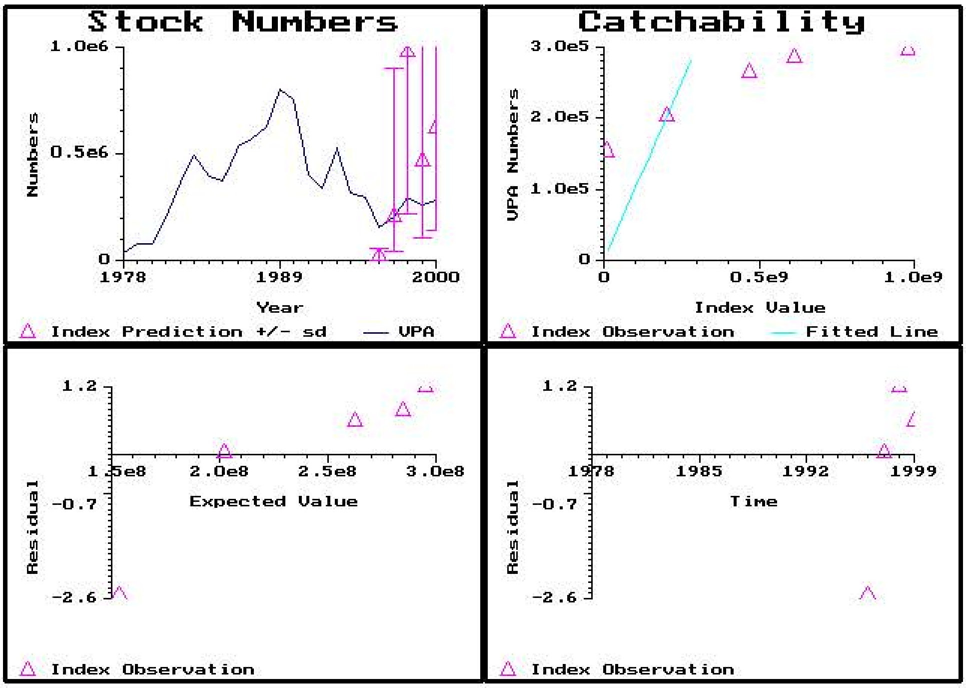


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



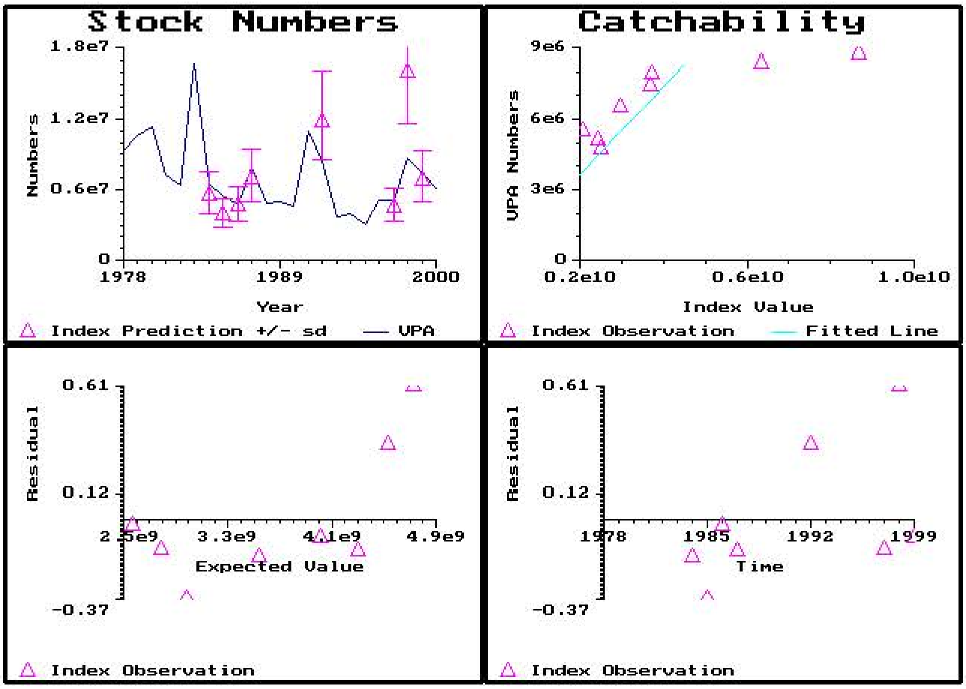
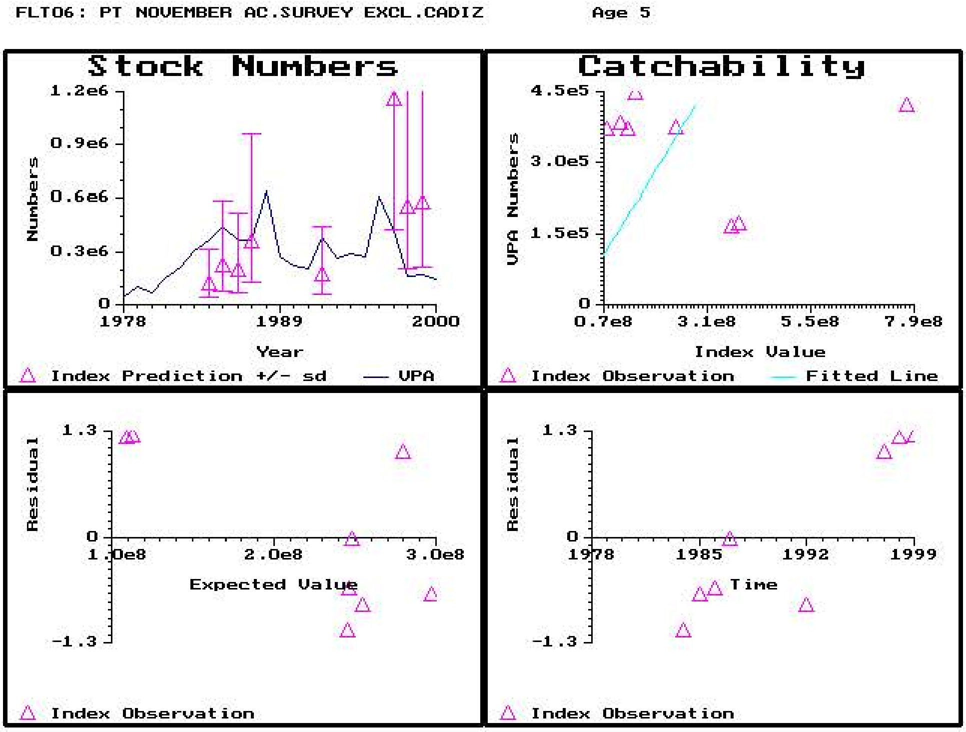


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.



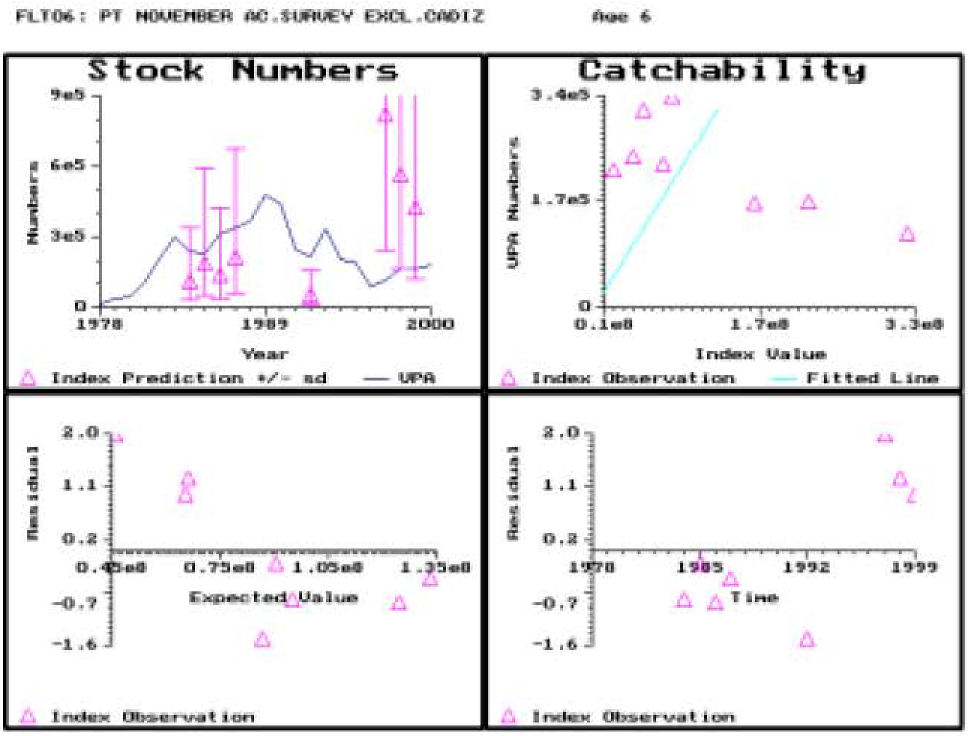


Figure 9.7.2.1 (cont): Sardine in Divisions VIIIc and IXa. ICA diagnostic plots for the assessment model.

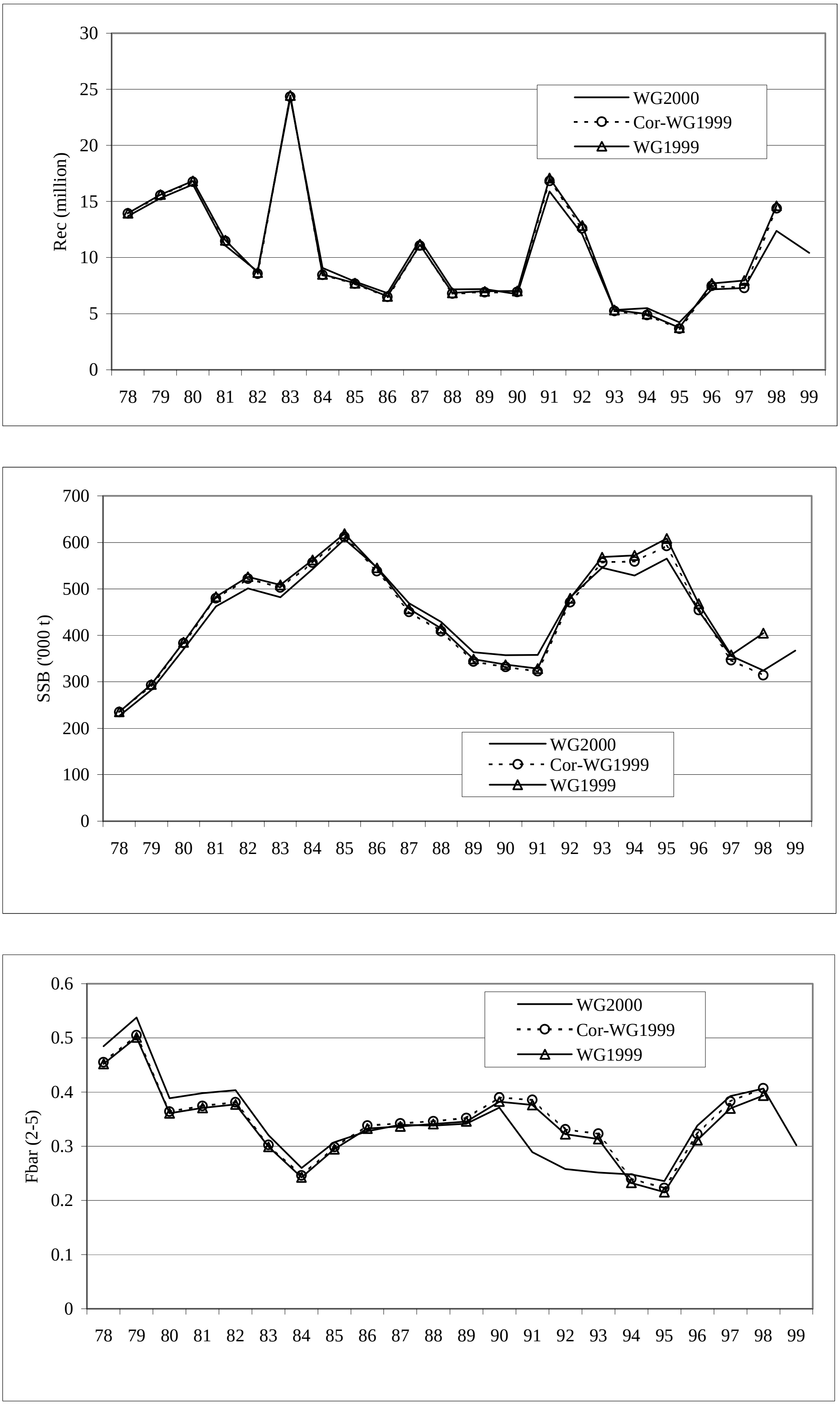


Figure 9.7.2.2: Comparative analysis of the assessment model. Dashed line corresponds to the estimation of the assessment model (with updated values for 1998 catch-at-age, 1998 weight-at-age in both stock catch). Line with triangle corresponds to the estimation of the last assessment.

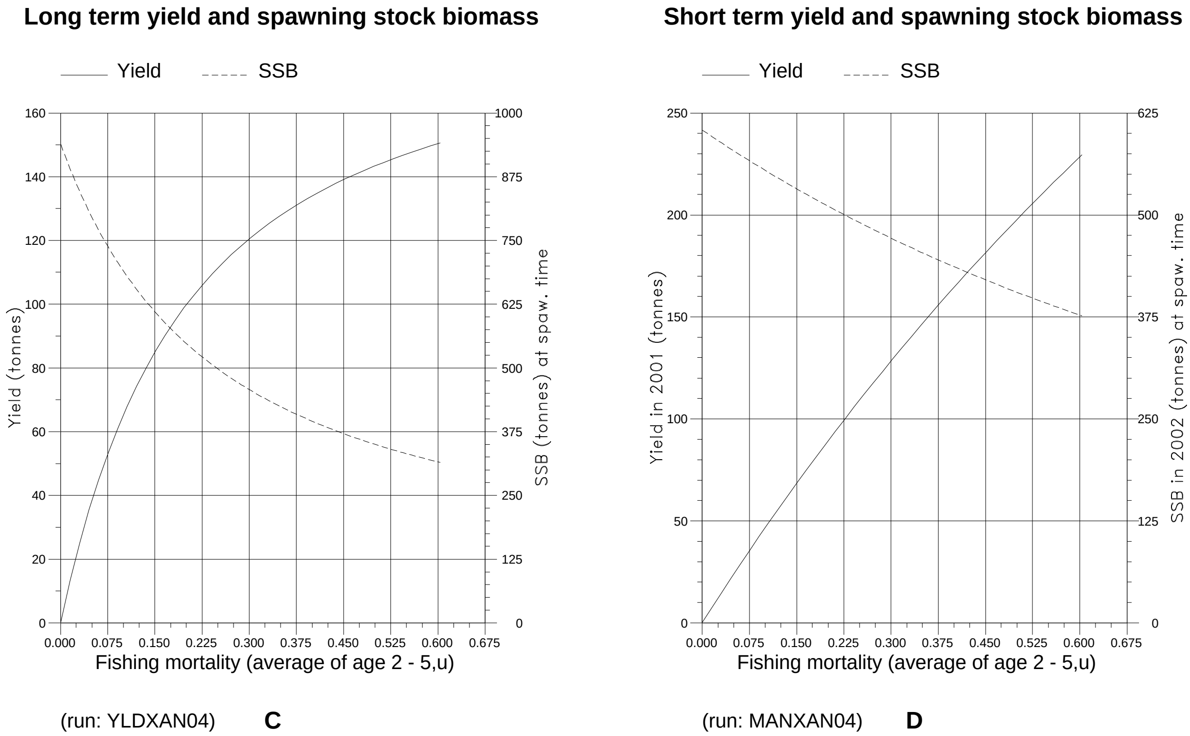

Long term yield and spawning stock biomass
Yield
SSB
Yield (tonnes)
SSB (tonnes) at spaw. time
Fishing mortality (average of age 2 - 5,u)
(run: YLDXAN04)
C
Short term yield and spawning stock biomass
Yield
SSB
Yield in 2001 (tonnes)
SSB in 2002 (tonnes) at spaw. time
Fishing mortality (average of age 2 - 5,u)
(run: MANXAN04)
D

Figure 9.11.1

10 ANCHOVY – GENERAL

10.1 Stock Units

The Working Group reviewed the basis for the discrimination of the stocks in Sub-area VIII and Division IXa. No detailed study has been made to discriminate sub-populations along the whole European Atlantic distribution of the anchovy. Morphological studies have shown large variability among samples of anchovies coming from different areas, from the central part of the Bay of Biscay to the West of Galicia (Prouzet and Metuzals, 1994, and Junquera, 1993). These authors explain that the variability is reflecting the different environments in the recruitment zones where the development of larvae and juveniles took place. They suggest that the population may be structured into sub-populations or groups with a certain degree of reproductive isolation. In the light of information like the well defined spawning areas of the anchovy at the South-east corner of the Bay of Biscay (Motos *et al*., 1996) and the complementary seasonality of the fisheries along the coasts of the Bay of Biscay (showing a general migration pattern; Prouzet *et al.*, 1991 and 1994), the Working Group 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). However, these informations are presently too scarce to change our opinion on the possibility to find a different stock unit in the North of the Bay of Biscay. This small stock 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 Working Group 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 dynamic on the anchovy in IXa and its possible connection with anchovies from other areas.

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 1991-1999. In Sub-area VIII during the first quarter, the main fishery (predominantly by the French fleet) was located around the Gironde estuary from 44°N up to 47°N. During the second quarter, the main landings (predominantly Spanish) were caught in the Southern part of the Bay of Biscay (south of 45°N.), mainly in Sub-areas VIIIb and VIIIc. During the third quarter, the fishery was spread in the Bay of Biscay: the Spanish one in the Center and in the South and for the first time in the North (VIIIa,b and c) and the French one in the Center and the North (VIIIa mainly). During the fourth quarter, the main fishery is located in the North of the Bay of Biscay 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 1999 were low and most of the fish was caught as usually during the first and fourth quarter in Sub-division Central North. The Portuguese catches peaked 1995 (7056 tonnes) and since then they remained low. The Spanish fishery in 1999 was mainly located in the Bay of Cadiz. During 1999, in that area, the landings decreased reaching a lower level than the historical maximum for this area (8977 t) observed in 1998 and are relatively stable throughout the year without undergoing any significant rise in spring-summer as it was usual. The decrease of Spanish catches in IXa North since the maximum level in 1995 (5,329 t) is continuing in 1999.

The distribution of fisheries in the Sub-area VIII is rather constant during this period: the main fishing areas appeared in VIIIc and VIIIb in Spring (mainly landings from the Spanish fishery) and in the VIIIb and VIIIa during the rest of the year (mainly French fishery). Since the bilateral agreement between France and Spain in 1992 (see chapter 10.2), there is an increase of the catches in the VIIIa, particularly during the second half of the year.

Since 1998, the distribution of fisheries in Division IXa was situated in the Gulf of Cadiz (Sub-Division IXa South, except in 1995, when it was mainly found in the northern part of Division Ixa (Sub-Division Ixa North and Central North).

Table 10.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters and total in the period 1991-1999.

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

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

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	
1999	1617	0	139	318	949			351	5750	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	
1999	692	30	723	12	98			0	4266	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	
1999	5942	96	957	413	8249			8529	10016	0

Not available

11 ANCHOVY - SUB-AREA VIII

11.1 ACFM Advice Applicable to 1999 and 2000

ICES advice from ACFM in November 1999 states: “ICES recommends that there be no fishing of anchovy until there is evidence of recruitment which would bring SSB above B_{pa}. The 1998 year class is known to be weak while the 1999 year class is predicted to be weak based on environmental conditions. SSB is expected to decrease to unacceptable levels due to poor recruitment. A survey in April 2000 will provide additional information on the strength of the 1999 year class and this information will be reviewed by ICES when available.”

As relevant factors to be considered in management, ICES further pointed out: “A strong reduction of the spawning biomass in 2000, linked to adverse environmental conditions, is expected to bring the stock below B_{pa}, even under conditions of no catches. For this reason, ICES advises that there should be no fishery. It is recognized that the state of the resource can change quickly, and therefore in-year monitoring and management could be appropriate.”

The values of reference points proposed by ICES are B_{pa} = 36,000 t and B_{lim} = 18,000 t.

This approach to management is intended by ICES to be "consistent with the precautionary approach" in that it seeks to achieve a low probability of falling below the B_{lim} reference point, in accordance with international agreements on the precautionary approach to fisheries.

STECF endorsed the ICES advice. However, STECF also pointed out that at least two management options were possible for 2000:

Option A: Closure of the fishery and opening, if there is evidence that SSB is estimated to be above B_{pa} in 2000.

A closure of the fishery will give the maximum protection to the spawning stock biomass. The fishery can be opened if after the April survey there is sufficient evidence that the then fully mature 1999 year class will result in bringing the spawning stock biomass above B_{pa} in 2000. However, the fishery season will be quite advanced by then and a very fast decision should therefore be taken. In order to guarantee this, STECF recommends that a decision process is set allowing the possible reopening of the fishery on the 1st of May based on the preliminary spawning stock biomass estimate available at the end of April. If the preliminary spawning stock biomass estimate is above $B_{pa,}$ then a TAC for 2000 can be adopted for the remainder of the year.

Option B: No closure of the fishery in 2000 until survey data confirm that spawning stock biomass is expected to fall below $B_{pa.}$

Maintaining the fishery at a low level until the verification of the level of spawning biomass would be an option to consider. This would imply the setting of a low TAC for 2000. Then, if the spawning stock biomass at the end of April is confirmed to be above B_{pa}, the TAC could be revised upwards. Otherwise, the fishery would be closed. The level of the TAC should be set at a lower value than the expected catches at status quo fishing mortality corresponding to a period up to 30 April. In view of the observed seasonal pattern of fishing, about 24% of the catch is taken by that date. A TAC of 3000 t would guarantee that there is a decrease in fishing mortality of 80% while it is also close to the expected catches by 30 April (about 24% of the status quo catch forecast).

Considering these advices and the necessity to protect as much as possible the future of the stock and the fishery economy of the Bay of Biscay, the fishery council adopted a provisional TAC fixed at 16,000 tonnes, the half of the usual precautionary TAC, for 2000.

The Commission also acknowledged the need to enhance scientific and technical knowledge in order to define precautionary reference points for the management of the stock of anchovy in the Bay of Biscay. So, a scientific meeting conducted by STECF was held at Brussels to analyze from a managerial point of view the risk analysis.

The principal conclusions of workshop (STECF-SGRST report, 2000) are based on the comparison of revenue and biological risk in both a high-risk scenario (B1 = 36 000t, intermediate harvest model) and a low-risk scenario (B1 = 9000t, recent historic harvest model), both being considered plausible.

The comparison indicated:

Under conditions of high underlying biological risk, imposing closures is effective at avoiding stock collapses and in maintaining revenue. The calculation is fairly robust to the choice of value at which to close the fishery, in the range 18000 to 36000 t. Average revenue in the longer term, is roughly doubled by adopting a policy of closing the fishery at low stock sizes.

Under conditions of low underlying biological risk, imposing closures at low stock sizes does not, in the longer term, have a large impact on revenue (max. about 10% reduction) compared with the unregulated case.

However, data do not permit a view as to whether the 'high risk' or 'low risk' situation is closer to reality and the range of high-risk scenarios has not been explored fully.

In order to secure and updated decision of the anchovy TAC for 2000, the Commission convened at Brussels a meeting (29-31 May) under the auspices of STECF in order to analyze:

- The results of the acoustic and egg surveys conducted in April and May;
- The commercial catch rates observed during the first months of 2000;
- As far as possible, any physical and oceanographic features, such as upwelling index, allowing a forecast of the strength of the 2000 year class.

The re-assessment of the state of the stock by STECF in May 2000 with the new information gathered (DEPM and Acoustic surveys and catch data) resulted in a substantial increase in the perceived stock size: about 50,000 t at spawning time in May compared with previous ICES estimates of 25,000 t.

Finally, the managers decided to revise the provisional TAC and to bring the level to the usual precautionary level: 33,000 tonnes.

11.2 The Fishery in 1999

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 (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 1999

In 1999 a total of 27,259 tonnes were caught in Subarea VIII (Table 11.2.1.1 and Figure 11.2.1.1). It is a 15.6% decrease compared to the level of 1998 catches. This decrease is due to the French fishery that had a 60 % decrease of these landings. At the contrary, the Spanish catches had a 55% increase. As usual, the main Spanish fishery took place in Spring (79%) and the main French fishery in the second half of the year (63 %) (Table 11.2.1.2 and Figure 11.2.1.2).

In 1999, as in other years, Spanish and French fisheries were well separated temporally and spatially. About 79% of the Spanish landings were caught in divisions VIIIc and VIIIb in Spring, while the French landings were caught in divisions

VIIIb in Winter (29.2 %) or in Summer and autumn in division VIIIa (63%) (Table 11.2.1.3). However, as mentioned previously, for the first time a significant number of Spanish purse seiners went in the North of the Bay of Biscay to catch anchovy during the summer and the beginning of autumn.

During the first half of 2000, total international catches reached 24,061 t (preliminary data) which is a higher level than the one reached for the same period in 1999. This increase is especially due to a good fishing season for the Spanish purse seiners. There has also been some increase in the level of French catches for the first semester. (see Tables 11.2.1.1 & 2).

11.2.2 Discard

It is believed than there is no discarding in the Spanish fishery and the discards have not been recorded in the French fishery.

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 2 age group largely predominates in the catches during the first semester. For the international catches, 2 year-old anchovies make up 51.2 % of the landings (61.5% for the first semester), followed by age 1 with 43.5%. As usually, the 0 and 3 age groups represented respectively a low proportion of the catches in 1999, respectively 3.6 and 1.8% for each category. Approximately 17% of the catches of anchovy (in numbers) consisted of immature fish prior to their first spawning in May.

The catches of anchovy corresponding to the Spanish live bait fishery for tuna fishing for the period 1987-1999 are given in Table 11.3.1.2. In 1999, catches at age 0 were higher than those of the previous year. Live bait catches of anchovy are rather variable depending on the availability of the different small pelagic species which are used as live bait by this tuna fishing.

Table 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, appeared during the second half of the year. The estimates of the catches at age on annual basis since 1987 is presented along with the inputs to the assessment in Table 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 bimodal distribution. For the French landings, the smaller group corresponds mainly to the production of small purse-seine and pelagic trawlers fishing close to the shore. (Figure 11.3.2.2).

For the third quarter, the French and Spanish landings had some different length distributions. This is probably due to the fact that the major part of the Spanish catches was made in the South of the Bay of Biscay whereas the French catches were made in the North. We can notice for the French catches a bimodal distribution, the inferior fraction corresponds to the anchovy caught off the coast by the smaller boats. (Figure 11.3.2.3)

For the fourth quarter, the size distribution of the French and Spanish landings were similar. That corresponds to productions caught off the North of the Bay of Biscay by the two fisheries. (Figure 11.3.2.4).

The series of mean weight at age in the fishery by half year, from 1987 to 1999, 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 and 1996, when no estimate of mean weight at age for the stock existed, the average of the rest of the years has been taken.

11.3.3 Maturity at Age

As reported in previous years' reports, anchovies are fully mature as soon as they are 1 year old, at the following Spring after they spawn. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Motos, 1994).

11.3.4 Natural Mortality

The natural mortality for this stock is high and probably variable. In previous Working Group report, estimates of natural mortality were obtained from consecutive estimates of the population in numbers at age supplied by the DEPM method and the catches taken between surveys (ICES 1992, Asses:17). For the purpose of the assessment applied in the Working Group, a natural mortality of 1.2, fixed value around the historical average, is adopted.

In the framework of an international project between France and Spain (Project 95/018), a statistical approach to get better estimates of natural mortality has been carried out. This approach used DEPM information and trends in CPUE of some French pelagic trawler fleet chosen as reference. In that study, we use as inputs the estimates given by the DEPM for the level of abundance of SSB. Given that level, we use as a decreasing trends the Z estimates calculated from the CPUE values of the French reference fleets. Finally, we try to appreciate the degree of convergence among the level of abundance in June of the next year calculated as indicated above and the level of SSB given by the DEPM for the next year. The main results are shown in the following table (after Prouzet *et al*, 1999).

Cohort	Z est.	Confidence interval of Z (90%)		F est.	Confidence interval of F (90%)		M est.	Confidence interval of M (90%)	
1986	1.16	0.75	1.57	0.59	0.34	0.97	0.57	0.13	0.98
1987	4.56	3.41	5.70	0.98	0.58	1.67	3.59	2.69	4.61
1988	1.93	1.70	2.17	0.63	0.50	0.78	1.30	1.05	1.54
1989	3.76	2.90	4.62	0.71	0.43	1.14	3.01	2.15	3.73
1990	1.94	1.68	2.21	1.2	0.87	1.67	0.74	0.36	1.05
1991	1.92	1.58	2.25	0.43	0.27	0.74	1.48	1.12	1.82
1993	2.67	2.18	3.16	1.01	0.68	1.54	1.65	1.07	2.14

From the results obtained, M (natural mortality) can vary widely among years and it seems that the assumption of a constant M use for the current management procedure is a strong simplification of the actual population dynamic.

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 2000, with a gap in 1993 (Table 11.4.1.1). A review of the most recent surveys since 1995 was presented in Uriarte *et al*. (WD1999) (for the years 1995, 1997, 1998 and 1999. This year a new WD (Uriarte *et al*., 2000) provides the final estimate of the Spawning Biomass in year 2000 according to the positive spawning area and the total egg production.

Besides, this document revises as well the results of the 1994 DEPM survey for Bay of Biscay anchovy assessment (Motos et al., 1995), according to the revision of the Spawning frequency AZTI is making of the whole set of DEPM surveys and the revision of the ageing procedures of the eggs and egg production estimates (Uriarte et al. 2000WD). The biomass estimate for that year turned out to be 60,062 t, which is as expected smaller (by about 10,000 t) than the one originally estimated by Motos et al.(op. cit.). This is mainly due to the drop in the egg production estimate.

The spawning area, and total egg production estimated from the survey in 2000 is presented in Table 11.4.1.1. The map of egg abundance and the positive spawning area is shown in Figure 11.4.1.1.

With the new estimate of biomass for 1994, the set of the DEPM biomass (SSB), spawning area (A) and egg production per surface unit (P0) was revisited to establish the best multiple relationship of the two latter to predict the SSB. This relationship was used to update the estimates for the 1996 and 1999 and produce the figure for the current year 2000. In all these years only the total Egg production is available, due to the lack of adult sampling. The model is similar to the one defined by Uriarte et al., 1999 (WD 1999) and similar to the one used in the previous year working group (ICES CM1999/ACFM:6). The model is such as:

$LN(SSB) = \alpha LN(P0) + \beta LN(A) + cste + \xi$,

With P0: daily egg production per 0.05 m^2 and A: positive spawning area. The constant term give us a mean estimate of the inverse of the daily fecundity. The parameters were fitted to the complete set of surveys (excluding the repeated June estimates of 1989 and 1990, for which there are other estimates produced by surveys in May) (Uriarte *et al*. WD2000):

Dependent variable: Ln BIOMASS

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-2,8227	1,01948	-2,76878	0,0277
Ln po	0,707834	0,159838	4,42845	0,0030
Ln sa	1,19684	0,102478	11,679	0,0000

R-squared = 97 %   R-squared (adjusted for d.f.) = 96 %, Standard Error of Est. = 0,137639
Mean absolute error = 0,0860291

The spawning area and the egg production estimates arising from the DEPM surveys are in Table 11.4.1.1.

That allows defining the following biomasses:

BIOMASS(tons)	1996	CV(%)	1999	CV(%)	1999+	CV(%)	2000	CV(%)
F(Po,SA)May	39,545	16.0	63,115	14.8	69,074	15.1	44,973	14.5

Summary of the Predictions for the SSB according to the different analysis. The log predictions were transformed to original scale including a biass correction factor as $SSB = \exp(\hat{y} + \frac{1}{2}\sigma^2)$. The estimate selected for 1999 is 1999+, which includes the addition for an extra area corresponding to a radial to the north of the surveying area because it was presumed that the northern edge of the spawning was not fully covered by the survey (Uriarte et al., WD2000).

These estimates turn out to be almost identical to the ones already provided to previous working groups and, in the case of 2000, almost identical to the one provided in May to the European Commission (ad hoc STECF meeting).

The 2000 estimate confirms a decreasing trend in the Biomass since 1998, similar to the one recorded during 1992-1996 (Figure 11.4.1.2). The drop of biomass is however not so sharp as the one predicted by ICES (2000/ACFM:5), and this is certainly due to a lesser decrease of recruitments (specially for 1999) than foreseen last year. The spatial distribution of the eggs production is not fully concordant with the biomass distribution obtained in the acoustic survey, while the egg survey suggest a stronger biomass in the south (young and old anchovies), the acoustic suggest a stronger biomass to the north mainly of one year old anchovies.

Since the beginning of the use of the DEPM survey to assess the status of the Bay of Biscay anchovy, the estimates provided for 1989 have been considered downward biased as suggested by their authors (Motos and Santiago, 1989). For these reasons, there have always been raised by 1 standard deviation of that estimate for the purposes of the assessment.

11.4.2 Acoustic surveys

The French acoustic surveys estimates that are available up to now (since 1983) are 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, a new acoustic survey was performed for anchovy in the French waters, mainly to study the behaviour of the species in the central part of the Bay (close to the Gironde estuary) and to investigate the relationships between ecology of anchovy and its environment.

According to the discussion which took place in 1993 (Anon. 1993/ Assess:7) the acoustic values are considered to be relative indices of abundance and the values of 1983 and 1984 seems to be underestimated.

In 2000, within the frame of the EU Study Project PELASSES, a series of co-ordinated acoustic surveys have been planned covering the continental shelf of 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 coast.

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 first survey (PELACUS 0300) was organised by the Spain (IEO). The survey track is shown in Figure 9.3.2 (see chapter 9.3 on the Sardine).

The survey was divided in two phases. First part from 17th March to 25th covering the most northern area (ICES Division VII) and from 28th March to 13th April covering the Spanish area. Data analysis is described in Porteiro *et al*. (1996). Basically echo-integrated energy (back-scattered energy expressed in m^2/nmi^2) is allocated into fish species by scrutinising of the echo-traces and/or according to the fish proportion found at the fishing stations weighted by a TS/length relationship.

Anchovy was found in the northern part of the Bay of Biscay (off the Brittany coasts). In addition a scarce distribution was also located in the English area. In the Spanish area anchovy was found in a low density in the inner part of the Bay of Biscay. On the contrary, few isolated echo-traces with high density were found close to Cape Peñas (5°30’W) as shown in Figure 11.4.2.1.

Anchovy eggs from CUFES were only found in the inner part of the Bay of Biscay (Figure 11.4.2.1). Both the acoustic and the egg distributions were similar.

For assessment purposes, two different weight/length relationships were calculated.

A total of 4 949 tonnes corresponding to 262 millions fish were estimated in the French area. Figure 11.4.2.2 shows the length distributions from three different areas. In the inner part of the Bay of Biscay, only 574 tonnes, corresponding to 29 million fish were estimated.

Concerning those fish of the western part, in spite the smaller distribution area, the high density led an estimation of 5,853 t.

A second survey (PEL2000) was conducted from 18th April to 14th May 2000 and, following the previous one, covered from the Spanish/French border to Brest. The methodology was similar to that used in the previous survey.

Acoustic energy allocated to anchovy is shown in Figure 11.4.2.3. According to that, main output for the acoustic assessment is shown in the text table below:

Zone	Area (milles²)	Biomass (t)	Coef. Var.
Gironde	1460	22600	9.8 %
Offshore of Gironde	2300	16100	32.8 %
Centre	750	400	32.8 %
South	2180	8600	33.7 %
Total	**6690**	**47700**	

The Biomass is estimated to 47700 t but probably underestimated (Jacques Massé, pers.comm.).

Most of the fish belonged to age group 1. Figure 11.4.2.4. shows the length distributions of anchovies sampled during the scientific survey. As usually, the smallest fish have been caught close to the Gironde estuary.

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 French mid-water trawlers involved in the anchovy fishery has increased continuously up to 1994. Afterwards this fleet has been slightly decreasing. Therefore, it seems that after the rapid increase of the French fishing effort since 1984, we observe a certain reduction of the fishing effort for the last years, according to the decrease in the number of vessels involved in the fishery. That is confirmed in 1999. The main French fishing effort is concentrated in the central and northern part of the Bay of Biscay in the second half of the year, whereas for the Spanish fishery, the main fishing season takes place during the first half of the year in the south-eastern part of the Bay.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different. The current effort may be at the level that existed in this fishery at the beginning of the 1970's (Anon. 1996/Assess:2).

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). As an example, the indices for the first half of 1997 and 1998 showed strong decreases of CPUE for the total catch, suggesting a decrease of the population in these two recent years. The DEPM estimates of biomass showed, however, that this was not the case. For 1999, we noticed an increase of the global CPUE (in tons per boat per day) and particularly a large increase of the catch per unit of effort for the 2 years old, which is one of the highest, recorded on the 1987-1999 period. These levels are in agreement with the DEPM estimates made in 1998 and confirm the presence of a relevant population of 2 years old in the Bay of Biscay during the first part of the year 1999. On the other hand, the CPUE at age 1 is at a low level.

In 2000 the preliminary CPUE of Spanish purse seines reveal a strong increase in the catch per boat of anchovies at age 1, and a rather relevant presence of the two years old. In general for this spring fishery the catchability seems to have increased in this year due to the general good weather that prevail over late April, May and June. This made that only a single day of fishing were lost due to bad weather along the fishing season.

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 methodology to validate and to treat the data is given in Prouzet and Lissardy (2000). Table 11.5.3. gives the catch per trip in number of 1 year old anchovy for three different harbours, located in the South (Bayonne), in the Center (Saint-Gilles Croix de Vie) and in the Central-North (La Turballe) of the Bay of Biscay. Two fleets were chosen as reference: Saint-Gilles-Croix-de-Vie (LS), La Turballe (SN) fishing harbours because their fishing behaviour correspond to that observed during the first quarter 2000.

A deviance analysis made on the following model: $DEPMbiomass \approx a * \log(meancpue) + b + \varepsilon$ in using as dependant variable the series of DEPM biomass of age 1 (see Table 10.4.1.1) and as independent variables the series of mean cpue of age 1 for the first quarter from La Turballe and Saint-Gilles Croix de Vie fishing harbours weighted by their number of observations (Table 11.5.3) showed that 81% of the deviance of the DEPM biomass is explained by the variation of mean catch per trip. The results are shown in Table 11.5.4.

In 2000, from information gathered on the location of anchovy catches[1], we estimated the main fishing areas for anchovy during the first quarter. As generally observed, the fishing zone was centred on the Gironde estuary between 46°15 North down to the latitude of the Bassin d'Arcachon: 44°45 North. Figure 11.5.1., shows the fluctuation of the catches according to the day of fishing. This fluctuation can be strong some days. Figure 11.5.2 shows the trends of the mean catch per trip for these 2 fleets. We can notice a decrease of catches per trip through January with the lowest levels in February then followed by a significant increase in March. The trend of the catch fluctuations is the same for the two fishing fleets: Saint-Gilles Croix de Vie (LS) and La Turballe (SN).

Table 11.5.5. gives the statistic summary of the data collected on these CPUE. The catch per trip were very high even when we applied a correction factor of 71% for the percentage of 1 year old anchovy in the catches. This is difficult presently to know if the high level of catch per trip is due to a strong abundance of anchovy in winter or mainly to a change in the behaviour of the fishing fleet in 2000 (change of behaviour due to a possible closure of the fishery at the end of June 2000).

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 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 indexes are available to this Working Group:

One is the Upwelling index of Borja *et al*. (1996; 1998), which was mainly based on last years prediction. 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 Working Group confirmed that relationship. The estimates of this Upwelling since 1986 are reported in Table 11.6.1, updated with the 2000 estimate). That Upwelling index was used for the first time in 1999 to predict the Recruitment of the Bay of Biscay anchovy in 2000, given the indications of a very weak recruitment entering the fishery with the potential reduction of the Biomass below 36,000 t. From the assessment performed in 1999, the variation of the index explained about 57.5 % (Adjusted R2 for d.f) of the variance of the Recruitment estimated from 1986 to 1997 (by a multiplicative model). The direct linear comparison between the upwelling Index and the anchovy population at age 1 estimates of DEPM surveys show that Upwelling explained about 54 % of recruitment variation (R = 0.734). The prediction made in 1999 turned to be far below the recruitment now is being estimated to have entered the fishery in 2000, but figure is not outside the confidence limits of the predictions made by the model as fitted last year (Figure 11.6.1). Assuming that the current estimate of recruitment at age 0 occurring in 1999 is close to reality (as provided in the assessment adopted below -section 12.8-), we have updated the above relationships with the new estimates for recruitment at ages 0 and 1 in 1998 and 1999. The coefficient of determination R^2 (adjusted for d.f.=12) of the multiplicative model for age 0 drops to 43.1%, being still significant. But now the best model turned out to be a linear model, not on the log scale but on the linear scale, for which the coefficient of determination (adjusted) reaches the value of 51.7%. Table 11.6.2. shows the fitted model to the recruitment at age 0. In practice the fitting to the multiplicative or linear models do not have major implications in the result of any forecast.

The second index relating environment with the recruitment of anchovy is provided by Petitgas et al. (WD2000). 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. Many variables were constructed to describe the variations of Gironde river plume, coastal upwelling and stratification / turbulence processes. A hierarchical procedure was implemented to test for the best regression model (Allain et al. 1999). Linear regressions with each set of 1, 2…7 variables are adjusted to the recruitment index. Among the "best" regressions according to the R^2 criterion (highest R^2 for a fixed number of parameters), they selected the models which variables are all significant according to a Student's t test. The fit was made on the series of abundance 1986-1998.

The variables and corresponding physical processes selected by this procedure for the period 1986-1998 are, in order of their explanatory power:

[1] Professional fishermen indicated the precise locations of their catches for each fishing trip. So it was possible to define the main fishing zones for anchovy during the first quarter.

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). These upwelling events are caused by moderate and intermittent easterly to north-easterly winds. Their influence appears always positive and especially crucial in March-May (before the peak spawning), according to the examples of the 2 best recruitment years 1992 and 1998. This variable is therefore rather similar to the one produced by Borja et al. (1996, 1998) on the sole basis of wind data.

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 sereral and could have caused important larvae mortality (after the peak spawning) responsible for the bad recruitments in 1987, 1988 and 1990.

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 the week.

The environmental indexes were regressed by these authors on the ICES estimates at age 1 of anchovy on January 1 of year y, as reported in the ICES report. Petitgas et al. considered the period 1986-1998, given in the 1998 ICES report. Values are in numbers of fish (the unit being 10^6). The series of values was regressed on environmental indices constructed for spring of year y-1. The relationship built upon the two retained variables explained above turned out to be highly significant for the period 1986-1998 (R^2 =75.2%). However the inclusion of the two most recent recruitment estimates up to age 1 in 2000 dropped down the R^2 to 65.5% (and to 59.5 when adjusted for d.f.).

Because the model has 2 covariates, UPW with a positive effect and SBD with a negative one, low R is mainly due to SDB and not so much to UPW. Since 1998, summers have shown low UPW and no SBD and therefore, Petitgas' model tend to predict average recruitment values.

The Working Group examined this new index and pointed out the risks of using a binary variable which was selected from the available data of the short series of years 1986-98. It was considered that it might be too soon to make a direct use of this new index as had been done with the other. In any case, the ecological explanation given by this model to the occurrence of strong failure in the recruitment, when de-stratification takes place in early summer, fits well with the most recent recruitment that entered in the fishery and gives an explanation to the strong deviance of the forecast recruitment in 1999 by Borja's model and the actual recruitment estimated.

Table 11.6.1 gives the environmental indexes supplied by Petitgas et al. since 1986 and presents the coefficient of determination of their upwelling and predictions on this Working Group assessment estimates. It is interesting to note that the upwelling index arising from the hydrodynamic model of IFREMER gives a rather different perception of this phenomena during summer 2000 than the one describing Borja`s index. Figure 11.6.2 presents the general fitting of the environmental versus the population at age 0 estimates produced by the assessment performed this year. Table 11.6.2 gives the parameters fitted for linear simple or multiple models on age 0 from the assessment and their associated forecasts.

In last year working groups it was agreed that, since the environmental indexes do not estimate recruitment abundance directly (as surveys indexes do) but are just descriptors of the environment, they should not used as tuning data for the assessment and might only be considered to improve the projections of the fishery in next future. Their reliability as predictors should thus be re-evaluated every year from its fitting to the recruitment estimates provided by the assessment.

11.7 State of the Stock

11.7.1 Data exploration and Models of assessment

In this stock, natural mortality is believed to be high (but variable) and close to or higher than fishing mortality. For that reason, in a VPA the strength of the year classes will be conditional on the assumed natural mortality. The assessment of the anchovy fishery performed up to now has been based on fitting a separable selection model for fishing mortality with the auxiliary information provided by the direct estimates of biomass and population in numbers at age. The acoustic and egg surveys performed by France and Spain have allowed such analysis. Although the CPUE of the Spanish purse seiners is available, it has never been included in the assessment because of the likely changes in the catchability of these types of fleets, possibly inversely to the size of the stock (Csirke 1989).

The first step to assess the anchovy population in Subarea VIII was the comparison between the last year assessment and the one produced in a similar way (same tuning indexes and weighting factors) after adding the most recent fishery and survey indexes. This is shown in Figure 11.7.1.1, both assessments are very consistent. This assessment is an Integrated Catch at Age analysis, with a separable model of fishing mortality from 1987 to 1997 (with the ICA package, Patterson and Melvin 1996). This assessment, as those made in the previous years, reveals several puzzling results that deserve some analysis and considerations: there are large standard deviations between the catches at age and the separable model estimates (0.452) and between the auxiliary information to the population at age estimates (see table 11.7.1.1). This result in a poor Coefficient of determination of catches (in tonnes), which only attains 67%, and moderate fitting to the DEPM absolute estimates of spawning biomass (Coeff R2=67%).

In addition the data, as pointed out by ACFM, might be partly in contradiction: On one hand, the residuals to the DEPM are often positive specially for age 2 (indicating an estimate of the population at age 2 higher than the one modelled. On the other, the residuals from the catches at age 2 to the separable model are often negative (being caught less than expected by the separable model). These two sources of information (DEPM and Catches at age) might be partly in contradiction. The major problem of this summarised in Table 11.7.1.1.

In order to solve the problems that the current assessment implies, the Working Group explored the following approaches:

Analysis of individual residuals to search for potential outliers in the catches at age: The analysis consist on checking the statistical significance of the reduction in WSSQ that the elimination (strong down weighting) of a single catch at age produces in the total fitting of the separable model. This is made with an F test for the ratio between the reduction achieved in the WSSQ versus the residual variance remaining after the new fitting under the assumption of normal residuals (implicit in ICA). This is similar to the F tests in stepwise regressions (Wonnacott & Wonnacott 1981, Drapper & Smith 1981).

Sensitivity analysis of the weighting factors for the catches at age: In Table 11.7.1.2 three sets of catch at age weighting factors are presented. The first one is the weighting so far applied in the previous years, medium down weighting of age 0 and strong down weighting of ages 4 and 5 due to their scarce abundance in the catches. The first alternative try a stronger down weighting of age 0, because of the scarce separability of the catches of that age group. Catches at age 0 are made in different periods, areas and by different fleets and purposes than the rest of the anchovy catches. Half of those catches are made as live bait for the Spanish tuna boats and they catch only the amount required for tuna fishing, which depend as well upon the availability of other small pelagics, therefore this catch may be misleading sensu separable.

The second alternative weighting reduces the weight at age 3 to 0.1, this because of the fact that this age group supposes, on average for the last 13 years, less than 5% of the total international catch (both in numbers and tonnes, Table 11.7.1.2) and is mainly caught only during the first half of the year. The idea is increasing the precision of the separable model on ages 1 and 2 at the expenses of age 3.

Setting the selectivity of age 4 (the last true age in the catches) equal to the one calculated for age 3: This should reduce strongly the residuals at age 4, although due to the weighting factors the residuals in this age do not affect significantly the assessment.

Searching for residuals in the matrix of catches at age

Table 11.7.1.3 show the reduction in WSSQ of the assessment of reference achieved by the alternate omission of the catches at age 1 to 3 in the whole set of cage analysis of the assessment of reference (by a strong down weighting to 0.0001). Several residuals produce significant reduction in the total WSSQ and the most important comes from the catches at age 3 in 1991. This catches at age 3 as the rest of the 1998 cohort were revised upward in the revision of the catches at age made in 1997 (Uriarte et al. WD1997). By then they were already put in doubt because they were in strong contradiction with the DEPM population estimates. The current analysis also shows that they are as well in contradiction with the separable fishing pattern model. The benefits of omitting the catch at age 3 in 1991 can be seen in Table 11.7.1.4 (Column B): The log standard residual of the catches at age to the separable model are significantly reduced and the coefficient of determination of catches at age improves greatly. Figure 11.7.1.1 compared the results of this assessment with the two former ones.

Changing the weighting factors at age 0 and 3 and the selectivity at age 4

The two most trivial next changes are setting weighting factor at age 0 equal to 0.01 and letting S4 be equal to the convergence value of S3. Those two changes appear in columns C and D of Table 11.7.1.4. The reduction in the weighting factor produces a significant reduction of the WSSQ. This factor has changed from 0.1 (in the previous assessments) to 0.01. On the other hand, setting the selectivity at age 4 (the last true age group) equal to the selectivity to age 3 is not significant, which might be already expected since the weighting factor of this age group is already very low 0.01. The selectivity selected for age 4 such that it equal the one at age 3 was established by direct minimization in an excel workbook. The reduction so far achieved is only due to the down-weighting of the age 0 residuals and the reduction of the residuals to age 4, but the fitting of the other ages do not improve (see Table 11.7.1.5), neither to the DEPM.

Next step was down weighting the age 3 in the analysis. This is shown in Table 11.7.1.4 (columns E and F). Although the reduction in WSSQ necessarily significant (due to the smaller weighting): There is some improvement in the residuals for the separable model. The improvement is shown in Table 11.7.1.5 in the sense that catches at age 1 and 2 improve their fitting to the separable model at the expenses mainly of age 3. There is also some improvements in the fitting to the DEPM population estimates at age 3 and 2 (including a small reduction of the biass) and in the fitting to the acoustic (Table 11.7.1.4).

In this way this exploratory analysis show that the fitting to the separable model can be improved at the expenses of the ages 0 and 3, which can be considered marginal ages (in %) of the catch. Therefore the Working Group adopted the assessment based on considering age 3 in 1991 as an outlier and down weighting ages 0 and 3 to 0.01 and 0.1.

On the use of the auxiliary variables

Tuning the assessment using the DEPM and acoustic indexes both as aggregated indices of biomass and as aged structured indices was already discussed in previous years (ICES CM1999). Although the age structured index turn out to contain the most valuable information, the Working Group decided to let the information provided by the surveys tune the assessment in both ways as Biomass (in tons) and as age disaggregated indexes (in number) of the Spawning Population.

This year the Working Group decided to revisit this use of the auxiliary information. Figures 11.7.1.3 and 4 show the sensitivity of the assessment to the isolated use of acoustic or DEPM auxiliary information for the assessment. The use of the relative acoustic indexes as the sole source for the assessment drops down the SSB estimates and increases the fishing mortality. The use of the DEPM surveys alone (as absolute estimators) produce biomass and recruitments rather similar to the assessment of reference mentioned above (as last year but with down weighting factors for ages 0 and 1). This result simply evidence that the assessment is being driven by the use of the DEPM surveys as absolute estimates of Biomass and Population at age. In last year Working Group it was shown that when the DEPM series are taken entirely as relative then recruitment and biomasses decrease and fishing mortality increases substantially, as happens with the acoustic index. It suffices to consider a few years of the DEPM surveys as absolute to scale the whole assessment. Given the fact that the most recent years of the DEPM surveys are fully updated and revised for this Working Group)(since the 1994 estimate), those years taken as absolute estimations suffice to “anchor” the assessment on its current result. The other conclusion arising from Figure 11.7.1.4 is that the population at age estimates and SSB values from the DEPM surveys do not contain exactly the same information concerning the fishing mortality. Therefore its double use (as numbers and SSB) is justified.

Much of the above results and analysis are based on the idea that the DEPM surveys are usually unbiased and absolute estimators of biomass and its value and robustness should prevail over the assumption of separable fishing model. In fact we attribute the bad fitting of ages 1 and 2 to the non separability of fishing mortality for ages 0 and 3 and not to errors in the DEPM. All the assessment must be admitted rely on the confidence given to each source of data. Since the short living species has no covergence property via VPA to their true values, this means that only the auxiliary information supports the assessment. Therefore in no case we can escape to the subjective judgement of the robustness of the surveys, and so it will be in future. Therefore the Working Group concluded, as in previous years, to make use of all the auxiliary information available.

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 from 1987 to 1999 (with the ICA package, Patterson and Melvin 1996).

Inputs for the final assessment are summarised in Table 11.7.2.1. The assessment uses as tuning data the DEPM (1987-2000) and the Acoustic (1989-2000) figures as biomass and as population numbers at age estimates. The Acoustic and DEPM estimates are considered as relative and absolute estimates respectively and are down-weighted to 0.5 (because of the double use made of the indexes). For 1996 and 1999, the DEPM SSB biomasses included in the assessment are the ones obtained from the combined log-linear model of spawning area and Daily egg production per unit area explained in section 11.4.1.

The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier at this working group (Anon., 1995/Assess:2). The assessment starts in 1987 when the DEPM began to be applied. The separable model of fishing mortality is applied over the whole set of years (1987-99) (13 years). However the catch data of 1987 and 1988 are down-weighted in the analysis because for those years, the French catch at age data are considered to be more unreliable than for the rest of the years. In addition, the DEPM population as numbers at age estimates for those years, were not as reliable as for the following ones.

Ages 0, 4 and 5+ are heavily down-weighted (to 0.01) due to the small fraction of the catch they represent and to the large imprecision of the estimates. Age 3 is also down weighted to 0.1 again due to is low percentage in the catch and the improvement get through this in the fitting of the separable model to ages 1 and 2 (see previous section). The strong down weighting of ages 0, 4 and 5+ should assure that they do not interfere with the assessment of the other true ages.

The model was fitted to all these inputs by a non-linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=87}^{y=99}\lambda_{a,y}\left(Ln\left(C_{a,y}\right)-Ln\left(F_y\cdot S_a.\overline{N}_{a,y}\right)\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1987}^{y=2000}\left[Ln\left(SSB_{DEPM}\right)-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2$$

$$+\sum_{y=87}^{98}\ \sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right)-Ln\left(N_{a,y}\cdot\exp\left(-P_F\cdot F_y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989,91,92,97}^{98,2000}\left[Ln\left(SSB_{acoustic}\right)-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2+$$

$$+\sum_{y=89,91,92}^{97,2000}\ \sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right)-Ln\left(Q_{a,y}\cdot N_{a,y}\cdot\exp\left(-P_F\cdot F_Y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

with constraints on : $S_2 = S_4 = 0.7923$ and $F_{2000} = F_{1999}$

and $\overline{N}$: average exploited abundance over the year
N : population abundance on the first of January
N_0 : number of 0 group anchovy
O : maturity ogive, percentage of maturity
M : Natural Mortality
F_Y : Annual fishing mortality for the separable model
S_a : selection at age for the separable model
P_F and P_M : respectively proportion of *F* and *M* occurring until mid spawning time
$C_{a,Y}$: catches at age *a* the year *Y*
Q_a and $Q_{a,Y}$: catchability coefficients for the acoustic survey
SSB_{DEPM} and SSB_{acoust} : Spawning Biomass estimates from DEPM and Acoustic methods
SP_{DEPM} and SP_{acoust} : Spawning populations at age from DEPM and acoustic methods
$\lambda_{a,Y}$: 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 factor for the indices and/or ages (all equal a priori to 0.5)(see last portion of table 10.8.2.1)

Results of the assessment are presented in Table 11.7.2.2 and Figure 11.7.2.1.

The assessment thus defined is rather similar to the one implemented in 1999 for the period 1987-1998, with the exception of the severe down weighting of ages 0 and 3.

Comparison of results with the assessment and projections made last year.

Table 11.7.2.3 shows that anchovy assessments for the Bay of Biscay have been closely consistent in recent years. However small changes have happened between the previous and the current year assessment (Table 11.7.2.4 and

Figure 11.7.2.2). ICES forecasted a continuous decrease of biomass from 1998 to 2000. The current assessment confirms the decrease of biomass from 1998 to 1999, but results in a comparable figure for 2000. The estimate of biomass for 1998 decreases in comparison with the last years assessment (by about 26%), whereas the current perception of the biomass in 2000 (46750) greatly exceeds (by 86%) the forecasted biomass for this year (of 25000t). This is due to a different perception of the strength of the most recent year classes. The 1997 year class, although still very strong, is reduced by about 25%, whereas the predicted very weak 1998 and 1999 year classes are now perceived as low and at medium recruitment levels respectively. These estimates have increased 64% for the 1998 year class and 186% for the 1999 year class. This led to an underestimate of the expected biomass for 2000 from the last year assessment. According to the ICES forecast the spawning stock biomass was expected to be between 11 000 and 45 000 t with 95% probability. The new estimate is just in excess of the upper range of this expected range. The change in the perception of the stock size is marginally outside of the estimated range of precision of the survey and assessment methods currently used to provide advice on this stock, as calculated by ICES, therefore significantly different.

The ICA estimate of biomass in year 2000 is 46750 t, that is mainly due to the tuning biomass indexes used as inputs for this year in the assessment. This estimate of biomass for 2000 is based on a projection of the fishery during the current year with a fishing mortality equal to the one estimated for 1999 so that the indexes of biomasses from the surveys are fitted.

11.7.3 Reliability of the assessment and uncertainty of the estimation

The assessment is primarily driven by the Spawning Biomass estimates produced by the DEPM, this is the longest and most consistent independent estimate of the population in absolute terms. As shown in the exploratory analysis the adoption of the DEPM estimates as absolute figures allows scaling the whole analysis in the definition of recruitment, biomass and fishing mortality. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (1999). The log-variance of the populations estimates from the model versus the tuning indices seems reasonable, but the strong variations in abundance from year to year suggested by the direct DEPM estimates are not followed in parallel by the model (see Figure 11.7.2.1). The model tends to smooth annual variability in biomass. The separable model presents rather high level of absolute residuals both across years and ages, performing the best for age 1 and 2 (the most important age group in catches). These two ages have improved their fitting in comparison to the last year assessment.

There are changes in the fishing mortality in 1991 and 1992 mainly due to the down weighting of age 3 in 1991 what has lead to an improvement of the separable model.

The Working Group considers that this assessment shows reasonably well the recent trends in population abundance and fishing mortality according to the information available. From the output stock summary the only reference about the stock size has to be the spawning biomass and not the total stock size because the latter includes the biomass of the age 0 group at the beginning of every year (when it does not exist). The stock summary of this assessment is presented in Figure 11.7.3.1.

Table 11.7.2.3 shows that anchovy assessments for the Bay of Biscay have been closely consistent in recent years. However the reliability of recruitment estimates based on catches at age 0 for the last year are not reliable.

11.8 Catch Prediction

Predictions for catch and population for anchovy can be very problematic. This is due to three major factors:

- The predicted population is heavily dependent on new recruitment
- There is no discernible stock recruit relationship
- The fishery is principally on age 1 fish

These factors should be borne in mind in considering the two projections (2000 and 2001) detailed below.

Projection for 2000 made in 1999

The forecast for 2000 (made at the 1999 Working Group) was based on predictions for ages 0 and 1 in 1999. The prediction for age 1 was based on averaging the estimates provided for this age group by the assessment model and the estimate predicted using the upwelling index (Borja et al 1996 & 1998). Predictions for age 1 fish in 1999 from ICA were based on the catches of the 1998 year class at age 0. These were extremely low compared to historical values, leading to the perception that this year class (1998) was very weak. The inclusion of the upwelling index in the calculation indicated that this was an underestimate, but did not bring the estimate up to the level calculated in 2000. The current assessment gave a 64% greater abundance of that year class, and showed a strong negative residual for age 0 in 1998.

The underestimate may be due to the nature of the fishery for age 0 fish. The market demand for this size of fish is generally very low. Additionally, this age group is implicated in catches taken for live bait for the tuna fishery. These live bait catches are not specifically targeted on anchovy but cover all small pelagics. While this does not explain the unusually low catch level of 0 group anchovy in this year, it does indicate why such low levels may not necessarily indicate a low level of recruitment. Therefore, it was decided not to use these catch data in the context of the separable model to forecast year class strengths in the current assessment.

The prediction of the 1999 year class at age 0 was entirely based on the upwelling index. The new estimate of this year class made in 2000 was approximately 186 % higher than this prediction. This discrepancy was, however, within the 95% probability range of the prediction (see Figure 11.6.2). The combined effect of the two consecutive underestimates of consecutive recruitments resulted in the poor prediction in comparison to the current estimate of the SSB in 2000.

It is clear from the above that the upwelling index has limited value in the prediction of absolute recruitment levels. This is, at least in part, due to the relatively short time series of SSB estimates available to parameterise the index model. The standard error around the index will be greater following the inclusion of the data point for this year, however, the relationship remains statistically significant. One solution may be to use the index as a qualitative rather than an absolute measure.

Projection for 2001 made in 2000

Given all the above information it is possible to define the problems and requirements for stock prediction in anchovy:

- The fishery and the population are largely dependent on the number of age 1 fish in the population.

- But the fishery for age 0 in the previous year provides very little information about the abundance of age 1 in the present year. This means that prediction of stock abundance is dependent on the prediction of the level of recruitment.

- As there is no valid stock recruit relationship it is impossible to predict recruitment from the current SSB. So some other indicator for predicted recruitment is required.

- One possible indicator would be one using environmental information. Two possible candidates would be the upwelling index described by Borja (Borja et al. 1996, 1998, WD2000) or the slightly more complex stratification/upwelling index proposed by Petitgas et al (Allain 1999, WD 2000). Neither of these indices are currently fully reliable indicators of recruitment. The Borja index worked well for recruitment in 1998 but was much less accurate in 1999. Conversely, the Petitgas index worked well in 1999 but was less accurate in 1998.

- There are protocols for combining more than one, imperfect recruitment indices. For instance, Shepherd (1997) proposed combination using inverse variance weighting. However, such a combined index is untested on this stock, and the two indices are also measures of the same environmental phenomena, and there may be correlation problems. For these reasons it was not felt that such a combined index could be proposed at present.

- This leads to the conclusion that it would be incautious to rely on these environmental indices for the time being. However, the Working Group recognises that in the case of the stock scenario presented by anchovy, 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.

Given the inability to predict recruitment from catches, stock or environmental indices the Working Group felt that any prediction of future abundance would have to be based on some calculation from historical recruitment. The Working Group also agreed that in the face of this uncertainty, management should be conducted in a two-stage process. In the first stage a prediction would be made based on the most recent estimate of stock biomass and on a mean calculated from the recruitment time series 1986 – 1999. This could then be used by managers to set TACs for the first half of the coming year. A second assessment would be carried out following the completion of the acoustic and DEPM surveys in that year and a modified TAC set for the second half of that year.

The Working Group considered a variety of ways of calculating the mean recruitment to be used in the first stage of this process. The Working Group felt that, for the time being until more information becomes available, this calculated mean should be conservative, as the managers would have the ability to update TACs at the second stage. It was agreed that the most appropriate value, for the time being, would be a mean of the recruitments lower than arithmetic mean over the time series (8,653 million). This effectively means that the calculated value will tend to be an underestimate in 75% of cases. The chances of getting a lower recruitment than this value would therefore be 25%. The inputs and outputs of this project are in Tables 11.8.1 and 2. For prediction purposes, the recruitment at age 0 in the subsequent years would be set equal to the geometric mean 1986 to 1999 (12,175 million) and the status quo fishing mortality is set equal to the latest 5 years (1995-1999) instead of only the latest 3 years, due to the pronounced interannual fluctuations of the fishing mortality of this fishery.

An additional prediction is also presented, in which the conventional assumption of a recruitment at the geometric mean is applied. The short life span of the anchovy, implies that the development of the stock and its tolerance to exploitation is heavily dependent on the recruitment. The recruitment is poorly known and can vary over a large range. For the time being the working group does not consider the use of the geometric mean recruitment in the short term prediction to be compatible with the precautionary approach. The Working Group recommends further examination of plausible harvest control rules and that this should be made available to this Working Group in 2001. The inputs and outputs for this second projection are in Tables 11.8.3 and 4.

Weights at age in the catches would be set at the average values recorded since 1987 and weights in the stock are the average value input to the assessment since 1990 (the first year of accurate assessment of this parameter. A total catch constraint of 35,000 t for 2000 is assumed, consistent with the development of the fishery in 1999 (Table 11.2.1.3).

11.9 (Short-term risk analysis)

11.10 Medium term predictions

The analysis of the last year was not repeated. The fishing mortality is still considered to be within safe biological limits.

11.11 (Long-Term Yield)

11.12 Uncertainty in assessment

See 11.7.3

11.13 Reference points for management purposes

Reference points (B_{pa} & B_{lim}) have been defined in previous Working Group reports (ICES CM 1998/ Assess 6:). In view of the Working Group proposal for two stage management it is felt that these may not be entirely appropriate in this context. The following text describes the reference points as they are presently defined. It should be recognised that these may require modification in the future.

In the last year report (ICES CM 1998/ Assess 6:), the Working Group estimated the value of B_{lim} equal to 18,000 tonnes of anchovy which correspond to the minimum biomass below which no observations and no considerations on the dynamic of that stock have been made. The Working Group defined another precautionary level that was the B_{pre}: precautionary biomass. This level was defined as the double of B_{lim} and set at 36,000 tonnes.

B_{lim}: which is the level of biomass below which the stock has a high probability of collapse. Preliminary, it could be defined as the lowest estimated spawning stock biomass (from the assessment) over the past ten years (18,000 tonnes in 1989 according to Table 10.1.6 in Working Group report CM1998/Assess: 6).

That definition was consistent with the definition of MBAL previously accepted for this stock (set between 15,000 and 20,000 tonnes corresponding to the lowest DEPM estimates of the historical series observed in 1989 and 1991 during the period 1987-1998).

Bpa: Management of this stock has been guided by the need to withstand two successive years of poor recruitment, implying that catches may have to be reduced if the SSB reaches 36000 t. This value was adopted by ACFM as Bpa. However, in last years advise, ACFM interpreted this values as a limit point triggering closure of the fishery, rather than as a Bpa. The Working Group considers that SSB below 36000 t and above Blim should trigger a reduction in the fishery if there is indications of another poor year class, rather than its closure.

For the future, a harvest control rule as outlined in Section 11.14 should complement the precautionary framework.

11.14 Harvest Control Rules

One of the major problem for the fishery management of the Bay of Biscay anchovy is the long and short term fluctuation in biomass linked to variability in recruitment mainly driven by environmental factors.

The Working Group considered the possibility of making a concrete proposal of harvest control rules for the management of the fishery, but it was judged to be premature for several reasons. The basics for Harvest control rules on the Bay of Biscay anchovy were agreed by the Working Group, but the election of some concrete formulation was believed to be out of the scope of the Working Group. Instead a broad frame HCR could be proposed to managers for them to select those which can best reconcile the interests of fishermen subject to the management with the sustainability of the population from a biological point of view.

The Bay of Biscay anchovy is a small population, exploited by seasonal fisheries from two countries. The strong dependency of these fishermen on that resource means that whichever of the many harvest control rules envisaged, they will have a great impact on the different fisheries and communities. Because of this, the Working Group considers that its role must be to build up a general frame for the simulation of Harvest Control rules. This will then allow the different parties; fishermen and managers involved in the fishery, to make informed decisions for future management.

In these conditions, the Working Group considers that a real and effective management of that stock can be attained by using the scientific surveys to monitor the level of biomass and the recruitment indices to predict low recruitment level.

So, in order to avoid relying too much on the recruitment prediction based on an environmental index, the Working Group proposes that the annual TAC will be set in two steps. The idea of reviewing the management advice for short-lived species on the basis of information obtained during the fishing season is not new (as for south African anchovy COCHRANE 1998, or Capelin ICES CM ACFM:18). In South Africa a two stages TAC recommendation has been used to manage the local anchovy resource since the early 1990s (Cochrane *et al.* 1998). The approach taken is to provide an initial TAC based on a biomass estimate obtained by means of acoustics and to review this TAC when an estimate of recruitment becomes available in the middle of the season. Both the TAC initial and the TAC revised are computed by applying simple formulae to the survey estimates of biomass and recruitment. However, those apparently simple formulae are the result of a long process, which involved scientists and managers. The formulae are part of a management procedure (Butterworth et al. 1993) tested by means of computer simulations and finalised in consultation with industry and public representatives.

In the case of the Bay of Biscay anchovy the general proposed two stages are the following:

- a preliminary TAC for the year operative for the first part of the year (n+1) from January to June (until its update, see revised TAC). This TAC should be based on the biomass estimates of the year (n) called $B1_{(n)}$ and the qualitative level of recruitment in September the year (n) called Rsept(n). So the preliminary TAC call TACprelim is defined as Tacprelim= f(B1(n),Rsept(n)). The qualitative level of Rsept is based either on the value of the environmental index after Borja et al (WD 2000) (Called upindex(1)),or the best of the two available environmental indexes (upwelling iupindex(1) and upindex(2), the latter corresponding to the environmental index after Petitgas et al (WD 2000).

- a revised final TAC operative over the second part of the year from June to December and based on the biomass assessed the year (n+1) called $B2_{(n+1)}$. So this final TAC called revised TAC is defined as $TAC_{revised}$ = TAC2 = $f[B2_{(n+1)}]$.

A working document (Prouzet, WD 2000) giving an example of a detailed harvest rules and retrospective analysis on recent history of the fishery, is presented and the Working Group thinks that it is a useful approach.

11.15 Management Measures and Considerations

The general framework of the anchovy management in the Bay of Biscay has been defined in the last working group report and this general framework remains presently valid. (See ICES CM1999\Assess: 6, for more details). As mentioned then, the assessment suggests that the current level of fishing mortality could be sustained in the long term provided that a step towards a more conservative approach is taken when the stock is at a low level. This seems presently to be the case according to the current assessment (mean $F_{(97\text{-}99)}$ = 0.49, largely inferior to F_{pa}). However, the large variability of abundance due to the fluctuation of environmental factors makes the stock difficult to manage as the prediction of this recruitment is still uncertain. This implies the monitoring of the stock each year from direct estimation methods to validate our prediction on the recruitment and to correct if, necessary, our perception on the trend of the population. This suggests that it is necessary for the short-term management to be more active and to define the outlines of the fishery regulation as we proposed in section 11.14. These outlines have to be discussed inside an ad hoc study group in the framework of the ICES and EU community and consider not only the biological problems, but also the economical ones. That means some discussions not only among scientists but also with the fishery managers.

The history of the exploitation of this stock in relation to the proposed precautionary reference points is shown at Figure 11.15.1. The Bay of Biscay anchovy is a short-living species that is totally mature at 1 year old. Although the Bay of Biscay anchovy constitute a small stock, catches from this resource are economically very valuable. The Figure 11.15.1 shows two rapid variations of the abundance at constant F during two periods: 1991 to 1995 and 1997 up to now. Presently the mean F is lower than the mean F observed during the 1990-1996 period and the abundance estimated in 2000 is higher than B_{pa}.

For 2001, the estimates from the upwelling index give a large possibility of biomass. It seems difficult to give an accurate figure for the moment. It is the reason why a two step management plan seems the only solution for a positive management of that very valuable resource in the Bay of Biscay.

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	7,000	17,061		24,061 (*)
AVERAGE (1960-99)	5,638	28,145	318	33,886

(*) Preliminary data up to july for the French fishery and to June for the Spanish fishery

Table 11.2.1.2. Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII) (without live bait catches)

COUNTRY: **FRANCE** 1000 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
Average 87-99	1172	1010	567	466	714	867	757	1637	2485	1735	1011	55	12472
in percentage	9.4%	8.1%	4.5%	3.7%	5.7%	7.0%	6.1%	13.1%	19.9%	13.9%	8.1%	0.4%	100%
Average 92-99	1652	1366	840	200	320	1238	1121	2146	3086	2450	1542	25	15982
in percentage	10.3%	8.5%	5.3%	1.3%	2.0%	7.7%	7.0%	13.4%	19.3%	15.3%	9.6%	0.2%	100%

COUNTRY: **SPAIN**

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4133	3677	514	81	54	28	457	202	265	9864
1988	6	0	28	786	2931	3204	292	98	421	118	136	246	8266
1989	2	2	25	258	4295	795	90	510	116	198	1610	273	8173
1990	79	6	2085	1328	9947	2957	1202	3227	2278	123	16	10	23258
1991	100	40	23	1228	5291	1663	91	60	34	265	184	596	9573
1992	360	384	340	3458	13068	3437	384	286	505	63	94	89	22468
1993	102	59	1825	3169	7564	4488	795	340	198	65	546	23	19173
1994	0	9	149	5569	3991	5501	1133	181	106	643	198	74	17554
1995	0	0	35	5707	11485	1094	50	9	6	152	48	365	18951
1996	48	17	138	1628	9613	5329	1206	298	266	152	225	17	18937
1997	43	1	81	2746	2672	877	316	585	1898	331	203	185	9939
1998	35	235	493	371	4602	1083	1518	44	47	3	22	1	8455
1999	8	26	52	4626	4214	1396	1037	26	911	207	615	27	13144
Average 87-99	60	60	441	2693	6412	2488	630	440	524	214	315	167	14443
in percentage	0.4%	0.4%	3.1%	18.6%	44.4%	17.2%	4.4%	3.0%	3.6%	1.5%	2.2%	1.2%	100%
Average 92-99	75	92	389	3409	7151	2901	805	221	492	202	244	98	16078
in percentage	0.5%	0.6%	2.4%	21.2%	44.5%	18.0%	5.0%	1.4%	3.1%	1.3%	1.5%	0.6%	100%

Table 11.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 1999 (with live bait catches)

COUNTRIES	DIVISIONS	QUARTERS				CATCH (t)	
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	674	751	1425	10.8%
	VIIIb	21	3098	351	0	3471	26.4%
	VIIIc	65	7138	949	98	8249	62.8%
	TOTAL	87	10236	1974	849	13145	100
	%	0.7%	77.9%	15.0%	6.5%	100.0%	
FRANCE	VIIIa	0	0	5076	3515	8591	62.9%
	VIIIb	3987	1071	0	0	5058	37.1%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	3987	1071	5076	3515	13649	100.0%
	%	29.2%	7.8%	37.2%	25.8%	100.0%	
INTERNATIONAL	VIIIa	0	0	5750	4266	10016	37.4%
	VIIIb	4008	4169	351	0	8529	31.8%
	VIIIc	65	7138	949	98	8249	30.8%
	TOTAL	4074	11307	7050	4364	26794	100.0%
	%	15.2%	42.2%	26.3%	16.3%	100.0%	

Table 11.3.1.1: ANCHOVY catch at age in thousands for 1999 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**	**VIIIabc**	**VIIIabc**	**VIIIbc**
	0	0	0	7,596	4,230	11,826
	1	6,556	127,855	51,208	15,199	200,818
	2	843	230,541	26,782	10,052	268,217
	3	18	10,034	525	0	10,577
	4	0	108	0	0	108
	TOTAL(n)	7,416	368,538	86,111	29,481	491,546
	W MED.	11.91	28.37	23.53	28.92	27.31
	CATCH. (t)	86.5	10236.2	1973.6	848.2	13,144.5
	SOP	88.4	10456.1	2026.3	852.6	13,423.4
	VAR. %	102.13%	102.15%	102.67%	100.52%	102.12%
FRANCE	**AGE**	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**
	0	0	0	3,108	22,192	25,300
	1	51,345	34,311	85,355	70,761	241,771
	2	127,443	21,185	80,391	24,869	253,888
	3	7,710	0	0	0	7,710
	4	0	0	0	0	0
	TOTAL(n)	186,498	55,496	168,854	117,822	528,669
	W MED.	21.60	20.05	29.67	32.89	26.53
	CATCH. (t)	3,987.2	1,070.7	5,075.8	3,515.5	13,649.2
	SOP	4,028.8	1,112.7	5,009.4	3,875.2	14,026.0
	VAR. %	101.04%	103.92%	98.69%	110.23%	102.76%
	QUARTERS	**1**	**2**	**3**	**4**	**Annual total**
TOTAL	**AGE**	**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**	**VIIIbc**
Sub-area VIII	0	0	0	10,704	26,422	37,127
	1	57,900	162,167	136,562	85,960	442,589
	2	128,286	251,726	107,173	34,921	522,105
	3	7,727	10,034	525	0	18,286
	4	0	108	0	0	108
	TOTAL(n)	193,914	424,034	254,965	147,303	1,020,215
	W MED.	21.23	27.28	27.60	32.10	26.91
	CATCH. (t)	4,074	11,307	7,049	4,364	26,794
	SOP	4,117	11,569	7,036	4,728	27,449
	VAR. %	101.07%	102.32%	99.81%	108.34%	102.45%

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
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
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
2	1,461	203	1,496	139	0	0		477	209	522	58	0	810
3	912	3	0	0	0	0		0	0	0	0	0	0
Total	37,068	115,140	13,930	33,677	26,452	16,435	23,717	14,102	21,248	14,724	41,375	16,169	38,825
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5	465.126
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

Table 11.3.1.3 Catches at age of anchovy of the fishery in the Bay of Biscay on half year basis [illegible]

Units: Thousands [illegible]

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999	
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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Catches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var. SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Catch Spain	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var. SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

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
Age 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Catch France	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Var. SOP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual Catch		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]

Table 11.3.2.1. Length distribution ('000) of anchovy in Divisions VIIIa,b,c by country, by year, quarters and Sub-divisions in 1999.

	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
4				0		0		0
4.5				0		0		0
5				0		0		0
5.5				0		0		0
6				0		0		0
6.5				0		0		0
7			0	0	0	0	0	0
7.5			0	0	0	0	0	0
8		115	0	0	0	0	0	0
8.5		287	0	0	0	0	0	0
9		747	0	0	0	0	0	0
9.5	0	460	60	0	0	47	0	0
10	0	750	302	0	130	173	0	0
10.5	867	474	1368	1	529	337	0	0
11	2601	120	2506	314	2711	313	0	24
11.5	7803	482	3582	1128	4303	785	0	28
12	7802	456	6062	6356	4600	1109	0	219
12.5	8777	648	2824	11887	2912	1921	82	209
13	15818	714	3903	20201	1750	6995	1043	987
13.5	16906	600	4313	25484	3464	9447	1952	1577
14	22215	506	3943	32107	7725	12155	1894	2139
14.5	15088	313	4271	26520	7463	10201	6088	2898
15	17181	245	7442	27316	18157	9557	8875	2953
15.5	26033	172	5137	27302	16198	9585	14928	2904
16	21412	141	3476	36240	17030	8887	22986	3491
16.5	11271	131	2219	36990	21575	4882	22407	2971
17	7255	32	2251	44327	15597	4770	16542	3879
17.5	4329	10	901	30947	11437	2624	12032	1997
18	1317	9	468	22841	10147	1471	5641	1928
18.5	261	1	213	12065	8346	545	2488	653
19	104	4	128	4805	4536	263	573	622
19.5	0	0	85	1298	3460	39	0	172
20	0	0	43	293	3140	0	0	0
20.5	0	0	0	114	3140	0	0	0
21	0	0	0	0	756	0	0	0
21.5	0		0		0		0	
22	0		0		0		0	
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number ('000)	187041	7416	55496	368538	169108	86108	117531	29653
Catch (t)	87	3987	1071	10236	5076	1074	3515	849
Mean Length (cm)	14.51	11.88	13.98	15.63	16.05	14.82	16.23	15.82
Mean Weight (g)	21.6	11.91	20.05	28.37	29.67	23.53	32.89	28.92

Table 11.3.2.2. Mean weight at age in the national and international catches of anchovy in Sub-Area VIII on half year basis

Units: grams

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999	
Sources	Anon. (1989 & 1990)		Anon. (1989)		Anon. (1991)		Anon. (1991)		Anon. (1992)		Anon. (1993)		Anon. (1995)		Anon. (1996)		Anon. (1997)		Anon. (1998)		Anon. (1999)		Anon. (2000)		WG 2001	
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
Age 0	0.0	17.7	0.0	6.1	2.2	13.7	0.0	7.4	0.0	14.4	0.0	12.6	0.0	12.7	0.0	14.3	0.0	16.1	0.0	13.0	0.0	17.6	0.0	10.2	0.0	19.1
1	21.0	21.8	20.5	25.6	19.5	24.9	20.6	19.0	18.5	22.1	19.6	23.0	16.4	20.7	16.8	25.5	22.5	28.9	18.1	22.2	14.4	20.6	17.8	24.7	17.6	21.6
2	30.0	34.7	30.3	30.4	28.5	36.2	28.5	27.7	35.2	28.6	30.8	28.8	27.5	28.4	26.8	32.1	30.3	31.3	26.3	27.7	26.9	30.1	24.3	27.7	29.6	32.6
3	37.7	39.2	34.5	44.5	29.7	40.7	44.5	40.0	38.2	39.5	37.7	27.4	30.5	0.0	30.7	39.9	36.4	36.4	39.0	35.8	32.6	28.7	31.9	28.7	34.7	36.9
4	41.0	40.0	37.6	0.0	37.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	36.1	45.1	38.7	0.0	0.0	37.4	0.0	47.6	0.0
5	42.0	0.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	27.2	20.0	24.5	10.2	20.4	15.6	27.1	24.0	22.1	21.1	21.7	23.5	19.6	21.3	22.3	24.3	28.9	25.9	22.2	21.6	17.3	19.5	22.5	24.3	24.1	21.7
SOP	11,706	2,106	8,030	3,695	7,567	3,431	10,816	14,750	14,993	4,830	20,234	11,407	24,218	16,207	22,480	11,140	25,038	8,625	21,398	13,120	10,672	11,027	13,398	17,737	15,092	12,235
mean weight 1+	29.2	26.3	30.0	44.5	26.7	42.1	44.8	40.6	36.2	36.1	37.7	27.4	30.6	30.4	30.7	30.0	36.5	35.4	36.6	36.3	30.0	28.7	31.9	30.7	34.6	36.9

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
Age 0	0.0	17.8	0.0	4.7	0.0	12.8	0.0	2.1	0.0	14.5	0.0	13.0	0.0	12.3	0.0	14.2	0.0	16.1	0.0	11.3	0.0	10.0	0.0	10.2	0.0	19.4
1	21.4	21.8	21.3	27.7	20.6	26.9	20.6	24.4	18.6	18.4	21.6	18.3	16.4	19.5	16.7	18.6	24.8	25.1	15.9	19.3	18.1	21.6	24.2	24.7	18.6	24.3
2	30.0	39.3	32.4	35.7	29.3	38.1	28.9	28.0	29.3	22.4	32.8	24.4	29.4	28.8	29.2	31.4	34.2	22.4	31.9	28.9	28.0	27.4	33.3	30.3	33.6	31.8
3	38.0	39.2	34.6	44.6	27.7	42.1	44.8	40.0	34.4	39.1	33.6	27.4	41.7	0.0	40.0	30.0	38.2	36.4	40.2	36.7	41.7	28.7	35.3	43.1	42.6	36.9
4	41.0	40.0	37.6	0.0	37.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	28.1	48.1	38.7	0.0	0.0	37.0	0.0	52.6	0.0
5	42.0	0.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	28.0	18.1	24.2	5.4	24.7	14.9	31.3	23.6	23.4	14.9	22.2	17.9	26.5	15.5	26.6	18.2	32.4	16.5	22.1	17.7	17.1	17.7	22.8	27.9	26.2	21.7
SOP	8,041	1,030	6,811	1,470	5,222	2,068	10,265	7,334	7,908	1,537	20,354	1,629	17,222	2,276	19,424	2,492	22,703	903	18,698	2,170	8,386	2,597	6,748	1,809	10,544	3,344
mean weight 1+	28.6	26.3	30.3	44.6	27.3	42.7	44.8	40.6	34.4	39.1	33.6	27.4	41.3	41.3	30.0	36.6	38.1	35.9	41.0	36.3	41.7	28.7	38.1	43.1	42.1	36.9

FRANCE

					Old values		Old values		Old values		Old values		Old values		Old values		Old values		Old values							
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
Age 0	0.0	13.0	0.0	10.1	0.0	17.0	0.0	11.0	0.0	15.6	0.0	12.3	0.0	10.0	0.0	11.6	0.0	13.1	0.0	13.7	0.0	13.4	0.0	0.0	0.0	21.5
1	20.4	22.3	19.6	24.3	18.6	24.6	20.6	23.2	18.7	27.1	17.9	23.0	13.1	21.1	14.8	25.7	17.2	27.6	15.8	23.8	14.9	20.0	14.5	23.8	16.5	20.2
2	28.7	27.3	28.1	29.0	26.0	29.8	28.6	26.1	22.9	30.1	27.9	29.4	25.1	28.4	22.4	36.3	24.6	31.1	23.5	27.3	24.9	32.0	30.8	27.1	24.8	34.3
3	35.4	0.0	34.0	0.0	31.7	0.0	27.5	0.0	27.8	0.0	27.7	0.0	27.5	0.0	27.7	0.0	31.4	0.0	30.5	0.0	26.5	0.0	29.3	28.1	27.1	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	21.4	21.4	21.4	26.8	21.9	17.8	21.1	23.4	21.6	26.8	19.9	24.6	17.7	22.7	18.8	26.4	20.6	26.7	18.7	22.8	17.7	20.1	19.8	24.2	21.2	21.5
SOP	3,364	1,077	1,817	3,971	1,923	489	2,287	7,510	6,992	2,094	5,087	9,862	10,962	13,890	8,210	8,675	5,127	7,947	4,784	10,950	4,082	7,940	6,333	15,916	5,142	8,882

TABLE 11.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(from MOTOS & URIARTE WD1993, MOTOS et al. 1995 ; URIARTE et al. WD 1999; URIARTE et al WD 2000)

YEAR		1987	1988	1989(*)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
															(prelimina
Period of year		2 - 7 June	21 - 28 Ma	10 - 21 Ma	4 - 15 May	6May-07Ju	6May-13Ju	No survey	May-3Jun	11 - 25 Ma	18 - 30 May	9 - 21 May	18 May - 8	22 May - 5 June	
Positive area (km2)		23850	45384	17546	59757	24264	67796		48735	31189	28448	50133	73131	51019	37883
Surveyed area (km2)		34934	59840	37930	79759	84032	92782		60330	51698	34294	59587	83156	61533	63192
Po (Egg per 0.05 m^2)(A+)		4.6	5.52	2.08	3.78	2.55	4.27		3.93	4.975	4.87	2.69	3.825	3.65	3.45
Total Daily egg production		2.20	5.01	0.73	5.02	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	97239	19276	90720	--	60062	54700	39545	51176	101976	69074	44973
	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 11.4.2.1. Evaluation of Anchovy abundance index from French acoustic surveys in the Bay of Biscay.

	1983	1984	1989 (2)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4	13/4-30/4		15/5-27/5			6/5-22/5	20/5-7/6		18/04 - 14/
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	*na*	2300(3)	*na*	*na*	1726(3)	9400 5600 (3)	*na*	6690(*)
Density (t/nm(**2))	15.4	10.3	3,0	4.5-32.2 (4	23.6	32.8	*na*	14.5	*na*	*na*	36.5	10.2	*na*	
Biomass (t)	50,000	38,500	15,500	)-110,000 (	64,000	89,000	*na*	35,000	*na*	*na*	63000	57000	*na*	47700(**)
Number (10**(-6))	2,600	2,000	805	300-7,500 (	3,173	9,342	*na*	*na*	*na*	*na*	3351	*na*	*na*	
Number of 1-group (10**(-6	1,800 (1)	600	400	100-7,500 (	1,873	9,072	*na*	*na*	*na*	*na*	2481	*na*	*na*	
Number of age 2-group (10	800	1,400	405	0 -200 (4)	1,300	270	*na*	*na*	*na*	*na*	870	*na*	*na*	
Anchovy mean weight	19.2	19.3	19.3	*na*	20.2	9.5	*na*	*na*	*na*	*na*	18.8	*na*	*na*	

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems
(*) area where anchovy shools have been detected
(**) underestimation
last version July 2000 by Jacques Masse

Table 11.5.1: Evolution of the French and Spanish fleets for ANCHOVY in Subarea VIII (from Working Group members). Units: Numbers of boats.

	France			Spain	
Year	P. seiner	P. trawl	Total	P. seiner	total
1960	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

* provisional
(1) Only St. Jean de Luz and Hendaya.
(2) Maximun number of potential boats; the number of pelagic trawling gears is rough of this number due to the fishing in pairs of mid-water trawlers.
n/a = Not available.

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)						
													(Provisional)	
YEAR	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
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
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
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
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
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
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
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
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

in thousands

* CPUE values for the years 1988-89 are updapted acording to the revised catches at age of Spring from Uriarte et al. WD 1997

Table 11.5.3.: Statistics summary for the catch per trip during the first quarter for Saint-Gilles Croix de Vie, La Turballe and Bayonne fishing harbours from 1988 to 1998.(From Prouzet and Lissardy,2000)

Bayonne fishing harbour (BA)

Toutes zones	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nb observation	3	1	4	101	307	224	176	5	3	2	7
Nb marées	3	1	4	101	315	224	212	18	9	15	13
Minimum	5040	13090	141079	26478	20343	6477	11351	8496	13297	9185	15725
1° Quartile	11138		145225	108697	170212	40463	52656	21706	18111		46161
Moyenne	52072		185322	265726	329483	65424	117989	39505	32772	10249	110352
Médiane	17237		179388	225872	280067	60382	97755	44575	22924		80654
3° Quartile	75587		219485	401054	456634	82008	173160	45839	42509		184209
Maximum	133938	13090	241435	876198	1369256	172592	428951	76912	62094	11312	215347
SE moyenne	41084		24708	18664	12724	2464	6213	11712	14922	1063	31502
LCL moyenne				228698	304444	60569	105727				
UCL moyenne				302754	354521	70279	130251				

Saint-Gilles Croix de Vie fishing harbour (LS)

Toutes zones	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nb Observation	2	21	3	21	18	14	17	16	11	10	23
Nb marées	12	29	9	172	107	170	135	103	81	83	257
Minimum	2743	7549	11051	1031	1696	2233	2454	14046	4613	2262	27716
1° Quartile		38448	12608	15368	19510	11224	101296	50020	15526	12344	135986
Moyenne	7042	109189	15209	37251	221004	17849	119441	69305	75749	57879	192023
Médiane		93076	14165	23931	153455	18731	124098	71246	41279	32776	179322
3° Quartile		162644	17287	63069	318251	24032	148050	77707	106957	108244	237372
Maximum	11340	333806	20410	102458	950032	38023	243986	160709	252730	159851	468924
SE moyenne	4298	20195	2752	7143	60653	2820	13980	9223	24594	18052	22230
LCL moyenne		67063.96	3369.291	22351.449	93038.191	11755.509	89804.97	49646.98	20951.53	17043.73	145921.12
UCL moyenne		151314.51	27047.959	52150.815	348970.135	23941.788	149076.33	88962.93	130547.18	98714.61	238124.77

La Turballe fishing harbour (SN)

Toutes Zones	1991	1992	1993	1994	1995	1996	1997	1998
Nb Observation	91	78	196	315	206	254	214	220
Nb marées	149	117	227	347	241	256	241	230
Minimum	523	4100	1580	6362	128	1385	3337	21341
1° Quartile	33347	38233	6631	21063	2645	11902	41815	120807
Moyenne	40733	161715	17503	35491	39854	38423	94139	195335
Médiane	44570	76166	11273	33575	26575	22046	78844	202944
3° Quartile	50310	255727	25006	42559	58401	56213	136274	270592
Maximum	70950	777248	109547	123849	202164	314029	414559	389314
SE moyenne	1511	20303	1155	1118	2999	2454	4685	5799
LCL moyenne	37731	121286	15225	33292	33941	33589	84905	183906
UCL moyenne	43735	202144	19781	37690	45768	43257	103373	206764

Table 11.5.4. Percentage of DEPMbiomass deviance explained by the variation of the mean catch per trip of the French pelagic fleet in using a semi-logarithmic model. (From Prouzet and Lissardy, 2000).

Equation coefficients

	Values	Standard Error
Origin (b)	-22964.1	3426.1
log(Moy) (a)	2310.4	305.5

model equation : $biom = 2310.4 \times log(Moy) - 22964.1 + \varepsilon$

Results from deviance analysis.

	ddl	Residual Deviance	Residuals ddl	Deviance	Pseudo F	Proba ($F<F_{crit}$)	R^2
NULL			14	3624459722			0.81
log(Moy)	1	2953100247	13	671359475	57.18	4.1×10^{-6}	

Table 11.5.5: Statistics summary of the landings per trip for the two French main pelagic trawler fleets (LS and SN) operating during the first quarter 2000 for anchovy in the Bay of Biscay (after Prouzet and Lissardy, 2000).

	Saint-Gilles Croix de Vie (LS)	La Turballe (SN)	Whole fleet
Mean Weight (kg)	6436.9	5314.7	5791.3
SE mean (95% C.I.)	303.8 (5836.3 – 7037.4)	189.6 (4940.8 – 5688.6)	171.4 (5454.3 – 6128.4)
Mean number	332880	256976	282706
SE mean (95% C.I.)	17930(297302 – 368458)	8994 (239236 - 274714)	8739 (265506 – 299905)
Median weight (kg)	6165	5000	5410
1^{st} Quartile	3567.5	3300	3350
3^{rd} Quartile	9862.5	8400	8400
Median number	365000	242105	282380
1^{st} Quartile	187732	157519	162202
3^{rd} Quartile	485357	400000	400000

Tabla 11.6.1: Series of Upwelling indexes from Borja et al. (1996,98 6 WD2000) and Allain et al. (1999) & Petitgas et al (WD2000) including the Destratification variable

	WD2000	WD2000		Results from previous WG Reports					Assessm	WD2000		DEPM estimates
	Borja's et al. (1996,9	Petitgas et al. (WD2000)		Age 0 in the assessment				WG2000	in year Y+	Prediction of P.Petitgas		in year Y+1
									WG2000	Fitted for the period 86-97		WG2000
Year	Upwelling	Upwelling	SBD	1,996	1,997	1,998	1,999	2,000	Age_1 Serie	Adjusted		Age 1 Series
1986	617.5	20.49	0	5,901	6,164	6,483	6,461	5845.1	1756.1	3268.7		656.0
1987	508.4	47.25	1	8,276	8,267	7,424	7,447	8702.5	2597.6	2065.9		2349.0
1988	473.2	35.88	1	3,310	3,641	4,294	4,387	3473.2	1038.0	1363.2		346.9
1989	970.9	45.45	0	21,395	21,990	19,052	19,082	19651.7	5889.1	4811.4		5613.0
1990	905.9	50	1	7,272	7,506	7,206	7,319	7586.5	2266.8	2235.9		670.5
1991	1,076.3	110.74	0	27,393	28,271	27,767	28,402	27632.0	8223.5	8845.9		5571.0
1992	1,128.8	47.16	0	27,677	28,003	25,764	25,305	24102.8	7182.3	4917.2		
1993	570.9	53.03	0	15,551	14,455	13,877	13,334	12789.1	3827.0	5279.9		2030.1
1994	905.0	29.2	0	14,273	12,335	10,454	10,275	10405.3	3111.4	3807.5		2257.0
1995	1,204.0	74.99	0	14,963	14,650	14,051	13,397	14513.7	4336.7	6636.6		
1996	973.0	50.17	0		17,065	21,443	20,231	18197.0	5432.6	5102.9		3242.6
1997	1,230.5	100.04	0			30,950	34,648	25830.1	7742.4	8184.7		5466.7
1998	461.0	58.49	0				2,977	7841.4	2357.6	*5617.3*	Predicition	
1999	402.0	32.68	0					12582.4	3822.3	*4022.5*	Prediction	
2000	391.0	51.21	0							*5167.4*	Prediction	
								Age 0	Age 1			Age 1
							Geometric Mean:	12174	3645		Geometric Mean:	
							Arithmetic mean:	14225	4256		Arithmetic mean:	
							CV	54.4%	54.2%		CV	

Retrospective analysis of the Upwelling index performances

Coeff.Determination for age 0:	1986-96	1986-97	1986-98	1986-99	1986-00
with Borja's Upwelling index	51.5%	51.5%	58.6%	62.6%	55.4%
Petiga`'s Upwelling index	34.0%	36.0%	53.0%	47.7%	49.7%

Coeff.Determination for age 1:

Borja's Inc	Petitga's Multiple Index	
60.3%	75.2%	1986-1997
61.9%	65.5%	1986-1998
55.1%	65.5%	1986-1999

FORECAS	Linear models on assessment estimates			
(Actual fitting)	Borja's Inc	Petitga's Multiple Index		
Age 0	Upwelling	Upwelling	Multiple index	
1986-1999	55.4%	49.7%	65.0%	1986-1999
Adjusted for d.f.	51.7%	45.5%	59.5%	Adjusted for d.f.
ction for age 0 2000	*6034*	*13634*	*15298*	Prediction
CV for prediction	98.7%	43.4%	33.7%	CV for prediction

Linear models on assessment estimates			**FORECASTS**
Borja's Inc	Petitga's Multiple Index		(Actual fitting)
Upwelling	Multiple index		**Age 1**
55.3%	65.8%	1986-1999	1986-1999
51.6%	59.5%	Adjusted for d.f.	Adjusted for d.f.
1809	*4577*	Prediction	Prediction for age 1 2001
98.6%	33.6%	CV for prediction	CV for prediction

Table 11.6.2: Linear models fitted to age 0 between the environmental indexes and the assessment adopted by this Working Group in Sept.2000. (14 pairs of data)

a) Boja's et al. Upwelling Index (1986,1998)

```
Regression Analysis - Linear model: Y = a + b*X
-----------------------------------------------------------------------------
Dependent variable: Age_0
Independent variable: UpwellingAZTI  (Borja's et al Index
-----------------------------------------------------------------------------
                               Standard         T
Parameter       Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
Intercept       -1497.37         4317.4      -0.346823         0.7347
Slope            19.2621        4.98788        3.86179         0.0023
-----------------------------------------------------------------------------
Correlation Coefficient = 0.744396    R-squared = 55.4125 percent
R-squared (adjusted for d.f.) = 51.6969 percent  Standard Error of Est. = 5375.88

Forecast        Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Year             Value    for Forecast    for Forecast    for Forecast
  200          6034.12          5955.1        -6940.96         19009.2
----------------------------------------------------------------------
```

b) Petitgas et al Upwelling Index (WD2000)

```
Multiple Regression Analysis
-----------------------------------------------------------------------------
Dependent variable: Age_0
-----------------------------------------------------------------------------
                                       Standard         T
Parameter               Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
CONSTANT                 2732.51        3672.62       0.744023         0.4712
UpwelIfremer             212.949        61.8924        3.44063         0.0049
-----------------------------------------------------------------------------
R-squared = 49.66 percent      R-squared (adjusted for d.f.) = 45.465 percent
Standard Error of Est. = 5712.15   Mean absolute error = 4400.9

Forecast:       Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Row              Value    for Forecast    for Forecast    for Forecast
------------------------------------------------------------------------
    15         13637.6          5915.1         749.691         26525.5
------------------------------------------------------------------------
```

c) Petitgas et al Upwelling and destratification Multiple model (WD2000)

```
Multiple Regression Analysis
-----------------------------------------------------------------------------
Dependent variable: Age_1
-----------------------------------------------------------------------------
                                       Standard         T
Parameter               Estimate         Error       Statistic        P-Value
-----------------------------------------------------------------------------
CONSTANT                 1699.38        1022.49          1.662         0.1247
UpwelIfremer             56.1941        16.2808        3.45157         0.0054
Destratif               -2222.16        978.687       -2.27055         0.0443
-----------------------------------------------------------------------------
R-squared = 65.757 percent      R-squared (adjusted for d.f.) = 59.531 percent
Standard Error of Est. = 1471.26      Mean absolute error = 980.34

Forecast        Fitted     Stnd. Error  Lower 95.0% CL  Upper 95.0% CL
Row              Value    for Forecast    for Forecast    for Forecast
------------------------------------------------------------------------
    15         4577.09         1539.17         1189.38         7964.79
------------------------------------------------------------------------
```

Table 11.7.1.1: Log Residuals to the Separable Model and DEPM from the Assessment of Reference (see text)

As made in the last year WG.

A) Catch at age

ln(x)-ln(y)

Year\ ages	0	1	2	3	4	5	Total
1987	0.495	0.050	-0.025	-0.068	-0.928	0.000	-0.5
1988	2.516	0.383	-0.261	-0.340	-1.940	0.000	0.4
1989	1.054	-0.235	-0.315	0.282	-1.641	0.000	-0.9
1990	-0.409	0.256	0.259	-0.245	-1.500	0.000	-1.6
1991	-0.805	-0.484	-0.759	0.691	-1.950	0.000	-3.3
1992	-1.122	-0.315	0.417	-0.153	-0.554	0.000	-1.7
1993	0.429	0.096	-0.014	-0.256	-1.202	0.000	-0.9
1994	0.428	0.086	-0.169	0.125	-0.807	0.000	-0.3
1995	-0.280	-0.041	-0.186	0.253	-1.391	0.000	-1.6
1996	-0.051	-0.160	-0.109	0.076	-1.919	0.000	-2.2
1997	0.387	0.085	-0.156	-0.104	-0.956	0.000	-0.7
1998	-1.402	0.127	0.011	-0.263	-0.207	0.000	-1.7
1999	0.278	0.322	-0.030	-0.526	-1.536	0.000	-1.5
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.5	0.2	-1.3	-0.5	-16.5	0.0	-16.7
Observaciones	13	13	13	13	13		65
Unweighted Squared log residuals of ...				Wy*(ln(x)-ln(y))^2			
Total USQR	12.40	0.77	1.08	1.27	24.71	0.00	40.24
Weighted Squared log residuals of ...				Wa*Wy*Wty*(ln(x)-ln(y))^2			
Total WSQR	0.91	0.70	1.05	1.21	0.22	0.00	4.09390

B) Log residuals for the fitting to the DEPM surveys.

Year\ ages	1	2	3 +	Total	SSB
1987	-0.390	0.477	0.103	0.1894	-0.2658
1988	0.723	0.376	0.351	1.4493	0.5132
1989	-0.606	0.375	-0.350	-0.5813	-0.3545
1990	0.704	0.585	0.100	1.3882	0.5276
1991	-0.292	-0.036	-1.197	-1.5243	-0.4242
1992	0.392	0.687	-0.511	0.5680	0.2179
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.100	0.404	-0.637	-0.1332	0.0288
1995	0.502	0.273	-0.406	0.3691	0.2257
1996	0.000	0.000	0.000	0.0000	0.0321
1997	0.332	0.766	-0.216	0.8817	0.2488
1998	0.245	0.496	0.289	1.0298	0.1300
1999	0.000	0.000	0.000	0.0000	0.1880
2000	0.000	0.000	0.000	0.0000	-0.0986
Total	1.7088	4.4020	-2.4741	3.6368	0.9691
TOTAL USSQ	2.20716	2.39512	2.66103	7.26331	1.14219
Total WSSQ	0.7357	0.7984	0.8870	2.4211	0.5711
Observaciones	10	10	10	30	13
Parámetros	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0736	0.0798	0.0887	0.0807	0.0439
Poderac.media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2207	0.2395	0.2661	0.2421	0.0879
Coefficient R2	86.8%	88.6%	74.8%		77.8%

Table 11.7.1.2: Weighting factors for the catches at age percentages of those ages in the Catch

Catch in weight	age 0	age 1	age 2	age 3	age 4	age 5
Average 87-99	4.4%	60.0%	31.1%	3.6%	0.5%	0.3%
Weighting factors	Wf0	Wf1	Wf2	Wf3	Wf4	Wf5
Previous	0.1	1	1	1	0.01	0.01
Alternative 1	0.01	1	1	1	0.01	0.01
Alternative 2	0.01	1	1	0.1	0.01	0.01

Table 11.7.1.3: Reduction in WSSQ by eliminating Year/Age Cage Observation and F ratio test

Initial WSSQ: 8.8218

Sensitivity Analysis of the catch at age matrix

a) Reduction in WSSQ by eliminating Year/Age Cage Observation

	Edad 1	Edad 2	Edad 3
1987	0.0006	0.0003	0.0257
1988	0.1160	0.0570	0.1199
1989	0.1433	0.1800	0.2351
1990	0.1041	0.1351	0.1172
1991	0.4177	1.0130	1.1720
1992	0.0394	0.4053	0.0144
1993	0.0276	0.0007	0.2737
1994	0.0010	0.0567	0.0052
1995	0.0008	0.0403	0.1469
1996	0.0562	0.0094	0.0174
1997	0.0052	0.0351	0.0275
1998	0.0264	0.0058	0.1623
1999	0.7183	0.0139	0.6718

b) Probability of the reductions in WSSQ (F.ratio test)

	Edad 1	Edad 2	Edad 3
1987	0.939	0.956	0.615
1988	0.284	0.454	0.276
1989	0.234	0.182	0.126
1990	0.311	0.248	0.282
1991	0.040	0.001	0.000
1992	0.535	0.044	0.706
1993	0.602	0.934	0.099
1994	0.921	0.455	0.821
1995	0.927	0.529	0.228
1996	0.457	0.761	0.679
1997	0.821	0.557	0.603
1998	0.610	0.811	0.205
1999	0.007	0.712	0.009

Table 11.7.1.4: Summary results of assessments of anchovy, changing the weighting factors at age 0 and 3 and the selectivity at age 4.
A- Assessment of reference similar to the one produced in last year, updating data, B- Down-weighting age 3 in 1991 to 0.0001
C- as B down-weighting age 0 to 0.01, D- as C but selectivity at 4 equal to age 3, E and F as D down weighting age 3 to 0.2 and to 0.1 respectively

RUN	A	B	C	D	E	F
Natural Mortality	1.20	1.20	1.20	1.20	1.20	1.20
NMM2+ (factor)	1.00	1.00	1.00	1.00	1.00	1.00
Slectivity at age 4	1.00	1.00	1.00	=Sel_3	=Sel_3	=Sel_3
Fitting summary						
Total Weighted squared residuals	8.8220	7.6497	6.7485	6.6921	5.5543	5.3491
Catches (Cages)	4.095	2.984	2.051	1.886	1.358	1.392
DEPM SSB (t)	0.571	0.581	0.581	0.588	0.645	0.600
DEPM SPages (1-3+)	2.421	2.557	2.551	2.655	2.231	2.054
Acoustic SSB (t)	0.751	0.688	0.673	0.671	0.571	0.562
Acoust. SPages (1-2+)	0.984	0.839	0.891	0.892	0.749	0.742
SSQ Total	*8.822*	*7.650*	*6.748*	*6.692*	*5.554*	*5.349*
SSQ Catches	*4.095*	*2.984*	*2.051*	*1.886*	*1.358*	*1.392*
SSQ tunning indices	*4.727*	*4.665*	*4.698*	*4.806*	*4.196*	*3.957*
Residual Variance	*0.0991*	*0.0860*	*0.0758*	*0.0752*	*0.0631*	*0.0601*
Observaciones	*125*	*125*	*125*	*125*	*125*	*125*
Parámetros	*36*	*36*	*36*	*36*	*37*	*36*
Degrees of freedom (d.f.)	*89*	*89*	*89*	*89*	*89*	*89*
Reducction in d.f.		*0*	*0*	*0*	*0*	*0*
Reducction in SSQ		*1.17*	*0.90*	*0.06*	*1.14*	*0.21*
F ratio for Red_SSQ		*13.64*	*11.89*	*0.75*	*18.03*	*3.41*
Probability of F		*0.0004*	*0.0009*	*0.3888*	*0.0001*	*0.0680*
Another fitting statics						
Coeficiente R2 Catch in tonnes	70.2%	89.3%	89.0%	89.2%	93.0%	91.8%
Coeficiente R2 Biomas DEPM	77.7%	72.5%	71.9%	71.6%	74.6%	75.4%
Coeficiente R2 Biomas Acustic	20.2%	24.3%	25.4%	25.5%	29.7%	29.6%
Log error estandard Cages	*0.4721*	*0.4030*	*0.3390*	*0.3251*	*0.3218*	*0.3333*
Log error estandard DEPM SSB	*0.2964*	*0.2991*	*0.2991*	*0.3007*	*0.3150*	*0.3039*
Log error estandard DEPM Pop. Age 1	*0.4698*	*0.4607*	*0.4643*	*0.4672*	*0.4287*	*0.4472*
Log error estandard DEPM Pop. Age 2	*0.4893*	*0.5417*	*0.5427*	*0.5488*	*0.5395*	*0.4960*
Log error estandard DEPM Pop. Age 3+	*0.5160*	*0.5111*	*0.5053*	*0.5263*	*0.4614*	*0.4126*
Log error estandard Acustic SSB	*0.5004*	*0.4790*	*0.4738*	*0.4731*	*0.4364*	*0.4326*
Log error estandard Acústica Pop. Age 1	*0.5190*	*0.4301*	*0.4138*	*0.4134*	*0.4425*	*0.4563*
Log error estandard Acústica Pop. Age 2+	*0.6218*	*0.6119*	*0.6504*	*0.6512*	*0.5508*	*0.5350*
Total Marginal residuals of age 2 in DEPM	4.4017	4.65	4.61	4.67	4.64	4.13
Weighting factos age 0	0.1000	0.1000	0.0100	0.0100	0.0100	0.0100
Weighting factos age 1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Weighting factos age 2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Weighting factos age 3	1.0000	1.0000	1.0000	1.0000	0.2000	0.1000
Weighting factos age 4	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Weighting age3 in 1991	1.0000	0.0001	0.0001	0.0001	0.0001	0.0001
Weighting factor DEPM	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
Weighting factor DEPM age 1	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor DEPM age 2	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor DEPM age 3+	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor Acoustic	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
Weighting factor Acoustic age 1	0.5	0.5	0.5	0.5	0.5	0.5
Weighting factor Acoustic age 2+	0.5	0.5	0.5	0.5	0.5	0.5

Table 11.7.1.5: Residuals to the Separable Model and to the DEPM of the assessments cases where catches at age 0 and 3 and increasingly down weighted.

Case B: Update of last year working group, down weighting age 3(1991) to 0.0001

W3=W2=W1=1

Catch at age log Residuals

Year\ ages	0	1	2	3	4	5	Total
1987	0.457	-0.023	-0.097	-0.061	-0.852	0.000	-0.4
1988	2.701	0.328	-0.307	-0.222	-2.152	0.000	0.2
1989	0.926	-0.145	-0.404	0.336	-1.805	0.000	-1.1
1990	-0.771	-0.077	0.281	-0.272	-1.706	0.000	-2.5
1991	-2.546	-0.246	-0.412	1.742	-1.542	0.000	-1.0
1992	-1.032	-0.260	0.330	-0.174	-0.179	0.000	-1.4
1993	0.405	0.097	-0.009	-0.236	-1.530	0.000	-1.2
1994	0.415	0.055	-0.218	0.254	-1.097	0.000	-0.6
1995	-0.262	-0.045	-0.195	0.372	-1.651	0.000	-1.7
1996	-0.028	-0.165	-0.123	0.958	-2.104	0.000	-2.3
1997	0.432	0.088	-0.195	-0.027	-1.226	0.000	-0.9
1998	-1.377	0.111	-0.037	-0.162	-0.413	0.000	-1.9
1999	0.212	0.282	-0.059	-0.424	-1.686	0.000	-1.7
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.5	0.0	-1.4	1.2	-17.7	0.0	-16.4
Observaciones	13	13	13	13	13		65
Unweighted Squared log residuals of ...				Wy*(ln(o)-ln(y))^2			
Total USQR	13.04	0.42	0.76	3.78	28.78	0.00	46.78
Weighted Squared log residuals of ...				Wa*Wy*Wy*(ln(o)-ln(y))^2			
Total WSQR	0.93	0.37	0.71	0.72	0.28	0.00	2.98425

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.412	0.455	0.103	0.1468	-0.3487
1988	0.727	0.771	0.281	1.3845	0.6110
1989	-0.352	0.448	-0.346	-0.2452	-0.1782
1990	0.806	1.075	0.306	2.1863	0.6362
1991	-0.328	-0.634	-0.803	-1.1660	-0.4391
1992	0.387	0.532	-0.775	0.1344	0.1822
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.077	0.360	-0.769	-0.3412	-0.0162
1995	0.477	0.252	-0.541	0.1878	0.1867
1996	0.000	0.000	0.000	0.0000	-0.0036
1997	0.316	0.726	-0.370	0.6748	0.2279
1998	0.377	0.482	0.223	0.9848	0.1400
1999	0.000	0.000	0.000	0.0000	0.2396
2000	0.000	0.000	0.000	0.0000	-0.0839
Total	1.9906	4.6635	-2.6853	3.9161	1.1910
OTAL USSQ	2.12296	2.85444	2.01274	7.00999	1.35277
Total WSSQ	0.7076	0.9791	0.6709	2.3587	0.5614
Observaciones	10	10	10	30	13
Parametros	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0708	0.0979	0.0671	0.0862	0.0447
Padanc media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2123	0.2984	0.2013	0.2587	0.0894
Log standard deviations	0.460736	0.541705	0.51115	0.505634	0.299066

Case D: as B but down weighting Cage 0 to 0.01 and SeB=SeD=0.4769

W3=W2=W1=1

Catch at age

Year\ ages	0	1	2	3	4	5	Total
1987	0.560	0.084	-0.037	-0.031	-0.180	0.000	0.7
1988	2.626	0.436	-0.262	-0.190	-1.662	0.000	1.3
1989	0.944	-0.105	-0.405	0.264	-1.318	0.000	-0.6
1990	-0.626	-0.089	0.288	-0.287	-1.342	0.000	-2.3
1991	-0.542	-0.256	-0.379	1.645	-0.997	0.000	-0.3
1992	-1.148	-0.324	0.276	-0.169	0.418	0.000	-0.9
1993	0.496	0.090	-0.004	-0.212	-0.885	0.000	-0.5
1994	0.438	0.080	-0.247	0.307	-0.529	0.000	-0.1
1995	-0.248	-0.039	-0.193	0.340	-1.036	0.000	-1.2
1996	-0.023	-0.152	-0.130	0.183	-1.688	0.000	-1.8
1997	0.459	0.080	-0.181	-0.004	-0.628	0.000	-0.3
1998	-1.540	0.091	-0.090	-0.237	0.185	0.000	-1.6
1999	0.299	0.197	-0.012	-0.274	-1.076	0.000	-0.9
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.7	0.1	-1.3	1.4	-10.3	0.0	-8.4
Observaciones	13	13	13	13	13		65
Unweighted Squared log residuals of ...					Wy*(ln(o)-ln(y))^2		
Total USQR	14.67	0.48	0.68	4.06	13.63	0.00	33.52
Weighted Squared log residuals of ...					Wa*Wy*Wy*(ln(o)-ln(y))^2		
Total WSQR	0.11	0.38	0.65	0.63	0.12	0.00	1.88810

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.403	0.437	0.058	0.0940	-0.2642
1988	0.744	0.760	0.183	1.2688	0.6149
1989	-0.317	0.456	-0.437	-0.2979	-0.1622
1990	0.838	1.137	0.278	2.2254	0.6603
1991	-0.367	-0.006	-0.838	-1.2004	-0.4274
1992	0.390	0.579	-0.747	0.1217	0.1753
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.065	0.317	-0.786	-0.3838	-0.0170
1995	0.483	0.239	-0.619	0.1034	0.1679
1996	0.000	0.000	0.000	0.0000	-0.0346
1997	0.312	0.725	-0.406	0.6308	0.2236
1998	0.266	0.495	0.318	1.0084	0.1068
1999	0.000	0.000	0.000	0.0000	0.1836
2000	0.000	0.000	0.000	0.0000	-0.0681
Total	2.0323	4.6702	-3.1238	3.5786	1.1679
TOTAL USSQ	3.10233	3.01145	2.78981	7.90300	1.17661
Total WSSQ	0.7274	1.0096	0.9233	2.6545	0.5878
Observaciones	10	10	10	30	13
Parametros	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0727	0.1004	0.0923	0.0885	0.0452
Padanc media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.2182	0.3011	0.2770	0.2655	0.0904
Log standard deviations	0.46715	0.54877	0.52629	0.51522	0.30071

Case F: as D but down weighting W3=0.1

W3=0.1

Catch at age

Year\ ages	0	1	2	3	4	5	Total
1987	0.442	0.205	-0.138	-0.439	-0.489	0.000	-0.4
1988	2.640	0.138	-0.308	-0.995	-1.758	0.000	-0.2
1989	1.206	0.114	-0.255	0.379	-1.287	0.000	0.1
1990	-0.687	-0.170	0.173	-1.079	-1.341	0.000	-3.3
1991	-2.376	-0.204	-0.292	1.387	-1.081	0.000	-0.6
1992	-1.067	-0.323	0.196	-0.823	0.279	0.000	-1.7
1993	0.311	-0.010	-0.088	-0.942	-1.199	0.000	-1.9
1994	0.358	0.034	-0.078	-0.074	-0.610	0.000	-0.4
1995	-0.268	-0.027	-0.084	0.172	-0.737	0.000	-0.9
1996	-0.033	-0.147	-0.061	-0.129	-1.292	0.000	-1.7
1997	0.661	0.105	-0.126	-0.593	-0.356	0.000	-0.3
1998	-1.388	0.149	-0.155	-0.901	-0.198	0.000	-2.4
1999	-0.064	0.088	-0.154	-1.255	-1.706	0.000	-3.1
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Totales	1.6	0.0	-1.2	-5.3	-11.8	0.0	-16.8
Observaciones	13	13	13	13	13		65
Unweighted Squared log residuals of ...					Wy*(ln(o)-ln(y))^2		
Total USQR	13.27	0.32	0.32	6.61	15.12	0.00	37.67
Weighted Squared log residuals of ...					Wa*Wy*Wy*(ln(o)-ln(y))^2		
Total WSQR	0.10	0.29	0.33	0.81	0.13	0.00	1.4551

DEPM Log residuals

Year\ ages	1	2	3 +	Total	SSB
1987	-0.268	0.395	0.112	0.1286	-0.2540
1988	0.823	0.622	0.282	1.4261	0.4481
1989	-0.368	0.231	-0.282	-0.3468	-0.2542
1990	0.802	1.011	0.250	2.0626	0.6267
1991	-0.412	-0.110	-0.731	-1.2527	-0.4901
1992	0.415	0.433	-0.727	0.1230	0.2179
1993	0.000	0.000	0.000	0.0000	0.0000
1994	0.143	0.532	-0.364	0.3104	0.1068
1995	0.479	0.283	-0.135	0.6271	0.2536
1996	0.000	0.000	0.000	0.0000	-0.0647
1997	0.194	0.565	-0.402	0.3568	0.1036
1998	0.326	0.392	0.082	0.7986	0.1541
1999	0.000	0.000	0.000	0.0000	0.3113
2000	0.000	0.000	0.000	0.0000	-0.0168
Total	1.9116	4.0949	-1.6251	4.1715	1.1521
TOTAL USSQ	1.99081	2.42132	1.57298	5.99179	1.20110
Total WSSQ	0.6625	0.8071	0.5243	1.9937	0.6005
Observaciones	10	10	10	30	13
Parametros	0	0	0	0	0
DF	10	10	10	30	13
Variance	0.0662	0.0807	0.0524	0.0665	0.0462
Padanc media	0.3333	0.3333	0.3333	0.3333	0.50
Variance 2	0.1987	0.2421	0.1573	0.1994	0.0924
Log standard deviations	0.44575	0.49206	0.39661	0.44651	0.30396

Table 11.7.2.1.: Inputs for the anchovy assessment (subarea VIII)

Output Generated by ICA Version 1.4 **Assesssment downweighting W0=0.01 and W3=0.1**

Anchovy in subarea VIII - Bay of Biscay

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	35.5
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	433.9
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	531.6
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	19.1
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	1.0
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

Predicted Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	24.5	10.7	54.0	41.4	126.4	111.9	46.6	42.0	65.2	113.1	69.7	15.7	37.8
1	276.0	443.0	160.3	1617.7	539.6	1992.1	1419.6	821.8	731.2	1319.5	820.9	897.5	392.4
2	192.7	130.2	173.6	114.1	432.9	184.6	569.5	592.8	324.3	304.2	202.1	292.9	618.4
3	51.3	27.8	15.2	38.8	7.3	38.7	13.6	67.9	64.5	36.0	10.1	22.1	66.7
4	23.9	8.2	3.6	3.8	2.9	0.8	3.3	1.8	8.5	8.4	1.4	1.2	5.5

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.018500
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.021900
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030500
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900
5	.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
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000	.012000
1	.021700	.022600	.021000	.016200	.016800	.015400	.016000	.017100	.019000	.016400	.011900	.014600	.016400
2	.033000	.029800	.029000	.029500	.028000	.031700	.027000	.025800	.031100	.028700	.026600	.029900	.028700
3	.038000	.034100	.033000	.034600	.034000	.031700	.033000	.032300	.034100	.033600	.037400	.036900	.033500
4	.041000	.042500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.040000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	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
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
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
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

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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
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

Table 11.7.2.1 (Cont'd)

INDICES OF SPAWNING BIOMASS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97

x 10 ^ 3

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	999990.	999990.	15500.	999990.	64000.	89000.	999990.	35000.	999990.	999990.	63000.	57000.	999990.	47700.

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

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0	*******	*******	2517.0
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0	*******	*******	331.0

x 10 ^ 3

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0049	0.0053	0.0047	0.0094	0.0079	0.0080	0.0063	0.0069	0.0077	0.0107	0.0046	0.0035	0.0052
1	0.3046	0.3319	0.2971	0.5901	0.4949	0.5022	0.3943	0.4362	0.4862	0.6733	0.2913	0.2168	0.3250
2	0.7014	0.7642	0.6840	1.3586	1.1395	1.1563	0.9079	1.0044	1.1194	1.5501	0.6708	0.4991	0.7483
3	0.6166	0.6719	0.6013	1.1944	1.0018	1.0166	0.7982	0.8830	0.9841	1.3628	0.5897	0.4388	0.6578
4	0.5557	0.6055	0.5419	1.0764	0.9028	0.9161	0.7193	0.7958	0.8869	1.2282	0.5315	0.3954	0.5929
5	0.5557	0.6055	0.5419	1.0764	0.9028	0.9161	0.7193	0.7958	0.8869	1.2282	0.5315	0.3954	0.5929

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	8703.	3473.	19652.	7587.	27632.	24103.	12789.	10405.	14514.	18197.	25830.	7841.	12582.	11469.
1	1752.	2608.	1041.	5891.	2264.	8257.	7202.	3828.	3112.	4338.	5422.	7744.	2354.	3770.
2	614.	389.	564.	233.	983.	416.	1505.	1462.	745.	576.	666.	1220.	1878.	512.
3	180.	92.	55.	86.	18.	95.	39.	183.	161.	73.	37.	103.	223.	268.
4	91.	29.	14.	9.	8.	2.	10.	5.	23.	18.	6.	6.	20.	35.
5	34.	4.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	4.	4.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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
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
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
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
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

Table 11.7.2.1 (Cont'd)

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	37280.	40585.	21582.	51967.	31477.	72976.	999990.	53953.	43317.	41559.	46158.	87437.	51230.	46750.

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	999990.	999990.	21730.	999990.	31692.	73475.	999990.	54322.	999990.	999990.	46474.	88034.	999990.	47070.

Predicted Age-Structured Index Values

DEPM SURVEYS (Ages 1 to 3+) Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	857.4	1260.0	511.0	2517.2	1012.0	3678.6	*******	1759.6	1397.2	*******	2670.2	3950.9
2	248.8	153.1	230.4	69.1	323.7	135.7	*******	513.2	247.7	*******	274.0	544.5
3	130.6	51.6	31.1	31.3	10.2	34.8	*******	71.2	66.6	*******	20.0	52.4

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	681.8	*******	1400.5	5097.9	*******	*******	*******	*******	3558.8	*******	*******	2450.4
2	492.7	*******	685.4	349.5	*******	*******	*******	*******	553.3	*******	*******	626.9

x 10 ^ 3

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069
1	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343	0.4343
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
3	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791	0.8791
4	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923
5	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923	0.7923

Table 11.7.2.2. Results for the anchovy assessment (Sub area VIII)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	8702500	183447	37279	15308	0.4106	0.5409	99
1988	3473190	120223	40585	15581	0.3839	0.5893	100
1989	19651690	296209	21582	10614	0.4918	0.5274	100
1990	7586510	181598	51966	34272	0.6595	1.0477	99
1991	27631950	481087	31476	19634	0.6238	0.8787	101
1992	24102750	432766	72975	37885	0.5191	0.8917	100
1993	12789070	311185	81638	40293	0.4936	0.7001	99
1994	10405300	265507	53953	34631	0.6419	0.7745	99
1995	14513690	263014	43316	30115	0.6952	0.8632	99
1996	18196970	309336	41558	34373	0.8271	1.1954	100
1997	25830090	393986	46158	22337	0.4839	0.5173	99
1998	7841350	247896	87436	31617	0.3616	0.3849	102
1999	12582420	251910	51230	26794	0.5230	0.5770	98

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 1999
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 36
Number of observations : 125
Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1987	0.7014	24	0.4347	1.1319	0.5495	0.8954	0.7226
2	1988	0.7642	23	0.4868	1.1998	0.6072	0.9620	0.7848
3	1989	0.6840	18	0.4717	0.9917	0.5659	0.8267	0.6964
4	1990	1.3586	17	0.9663	1.9103	1.1418	1.6166	1.3793
5	1991	1.1395	16	0.8172	1.5889	0.9617	1.3501	1.1560
6	1992	1.1563	18	0.7969	1.6779	0.9563	1.3982	1.1774
7	1993	0.9079	18	0.6271	1.3145	0.7517	1.0966	0.9242
8	1994	1.0044	17	0.7081	1.4248	0.8403	1.2005	1.0205
9	1995	1.1194	19	0.7713	1.6247	0.9256	1.3537	1.1398
10	1996	1.5501	16	1.1315	2.1236	1.3201	1.8202	1.5703
11	1997	0.6708	19	0.4593	0.9795	0.5529	0.8137	0.6834
12	1998	0.4991	21	0.3282	0.7590	0.4030	0.6181	0.5107
13	1999	0.7483	24	0.4642	1.2062	0.5865	0.9547	0.7708
Separable Model: Selection (S) by age								
14	0	0.0069	71	0.0017	0.0279	0.0034	0.0141	0.0089
15	1	0.4343	10	0.3559	0.5300	0.3924	0.4807	0.4366
	2	1.0000	Fixed : Reference Age					
16	3	0.8791	25	0.5338	1.4478	0.6816	1.1339	0.9081
	4	0.7923	Fixed : Last true age					
Separable model: Populations in year 1999								
17	0	12582421	28	7156914	22120891	9435059	16779685	13114713
18	1	2353631	26	1407091	3936900	1810300	3060033	2436112
19	2	1877847	17	1339633	2632297	1580616	2230973	1905933
20	3	223149	20	147916	336646	180918	275237	228114
21	4	19930	24	12220	32503	15528	25579	20560
Separable model: Populations at age								
22	1987	91401	188	2290	3646870	13935	599477	535907
23	1988	29329	85	5520	155836	12509	68768	42168
24	1989	14105	33	7276	27341	10062	19771	14932
25	1990	9010	28	5185	15655	6797	11943	9375
26	1991	7815	32	4113	14849	5632	10843	8245
27	1992	1992	32	1046	3795	1434	2768	2103
28	1993	10328	33	5306	20105	7353	14509	10942
29	1994	5339	34	2692	10589	3765	7572	5675
30	1995	22775	31	12316	42115	16644	31165	23923
31	1996	18160	34	9240	35687	12865	25633	19271
32	1997	5649	44	2367	13481	3624	8804	6233
33	1998	6152	32	3234	11703	4432	8541	6493

SSB Index catchabilities
DEPM

Table 11.7.2.2 (Cont'd)

Absolute estimator. No fitted catchability.
Acoustic
Linear model fitted. Slopes at age :

34	2	Q	1.007	14	.8761	1.546	1.007	1.345	1.176

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 :

35	1	Q	1.011	19	.8359	1.821	1.011	1.505	1.258
36	2	Q	1.333	20	1.096	2.435	1.333	2.002	1.668

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.440	2.645	1.204	-0.889	-0.378	-1.069	0.308	0.356	-0.270	-0.035	0.649	-1.351	-0.063
1	0.205	0.137	0.114	-0.170	-0.204	-0.323	-0.010	0.034	-0.027	-0.147	0.104	0.149	0.101
2	-0.118	-0.205	-0.255	0.172	-0.292	0.196	-0.069	-0.078	-0.064	-0.061	-0.126	-0.150	-0.151
3	-0.441	-0.966	0.279	-1.079	1.387	-0.823	-0.942	-0.074	0.172	-0.130	-0.560	-0.901	-1.252
4	-0.474	-1.770	-1.286	-1.341	-1.080	0.275	-1.195	-0.610	-0.727	-1.292	-0.356	-0.196	-1.704

SPAWNING BIOMASS INDEX RESIDUALS
DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.2386	0.4476	-0.2550	0.6266	-0.4904	0.2176	*******	0.1073	0.2333	-0.0497	0.1032	0.1538	0.2988	-0.0388

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	*****	******	-0.3378	*****	0.7028	0.1917	*****	-0.4396	****	*****	0.3043	-0.4347	*****	0.0133

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	0.623	-0.388	0.802	-0.412	0.415	*******	0.143	0.480	*******	0.194	0.325
2	0.285	0.522	0.232	1.012	-0.109	0.433	*******	0.533	0.284	*******	0.565	0.333
3	0.084	0.275	-0.202	0.244	-0.753	-0.733	*******	-0.367	-0.138	*******	-0.422	0.072

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.5333	*******	0.2907	0.5764	*******	*******	*******	*******	-0.3608	*******	*******	0.0268
2	-0.1961	*******	0.6401	-0.2581	*******	*******	*******	*******	0.4526	*******	*******	-0.6386

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
Separable model fitted from 1987 to 1999

Variance	0.0455
Skewness test stat.	-4.2352
Kurtosis test statistic	-0.0847
Partial chi-square	0.1317
Significance in fit	0.0000
Degrees of freedom	32

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	0.0460
Skewness test stat.	0.9859
Kurtosis test statistic	-0.3791
Partial chi-square	0.0561
Significance in fit	0.0000
Number of observations	13
Degrees of freedom	13

Table 11.7.2.2 (Cont'd)

```
Weight in the analysis               0.5000
   DISTRIBUTION STATISTICS FOR   Acoustic
 Linear catchability relationship assumed
 Last age is a plus-group
 Variance                            0.0933
Skewness test stat.                  0.4263
Kurtosis test statistic             -0.5951
Partial chi-square                   0.0527
Significance in fit                  0.0000
Number of observations                    7
Degrees of freedom                        6
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                0.0663    0.0808    0.0542
Skewness test stat.      1.2182    1.8214   -1.8134
Kurtosis test statisti  -0.7673   -0.4346   -0.2947
Partial chi-square       0.0462    0.0681    0.0541
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


  DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)
 Linear catchability relationship assumed
 Age                          1         2
 Variance                0.0780    0.1057
Skewness test stat.      0.0469    0.1190
Kurtosis test statisti  -0.6594   -0.6834
Partial chi-square       0.0215    0.0318
Significance in fit      0.0001    0.0001
Number of observations        5         5
Degrees of freedom            4         4
Weight in the analysis   0.3750    0.3750

 ANALYSIS OF VARIANCE
 Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        47.9750     125          36   89   0.5390
Catches at age                         37.6610      65          33   32   1.1769
  SSB Indices
  DEPM                                  1.1964      13           0   13   0.0920
  Acoustic                              1.1198       7           1    6   0.1866
   Aged Indices
DEPM SUVEYS (Ages 1 to 3+)              6.0384      30           0   30   0.2013
ACOUSTIC SURVEYS (ages 1 to 2+)         1.9595      10           2    8   0.2449
 Weighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         2.9804     125          36   89   0.0335
Catches at age                          1.4549      65          33   32   0.0455
  SSB Indices
  DEPM                                  0.2991      13           0   13   0.0230
  Acoustic                              0.2799       7           1    6   0.0467
   Aged Indices
DEPM SUVEYS (Ages 1 to 3+)              0.6709      30           0   30   0.0224
ACOUSTIC SURVEYS (ages 1 to 2+)         0.2756      10           2    8   0.0344
```

Table 11.7.2.3a. -Stock: Anchovy Sub-area VIII

Assessment Quality Control Diagram 1

Average F(1-3,u)													
Date of assessment	Year												
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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

Remarks: Assessments of 1996-2000 performed using ICA.

Table 11.7.2.3b. - 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
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

Remarks: Assessments of 1996-2000 performed using ICA.

Table 11.7.2.3c. - 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
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	(53503)				
1998	27519	19112	55649	28391	69737	88690	60978	45126	40617	54783	(88135)			
1999	37070	23389	55844	28794	71236	87618	58755	43727	37098	49641	118593	(59477)		
2000	40585	21582	51966	31476	72975	81638	53953	43316	41558	46158	87436	51230	(46750)	

Remarks: Assessments of 1996-2000 performed using ICA. In brackets the SSB estimate for the year of the assessment is presented.

Table 11.7.2.4: Comparisons between the assessment made in 1999 and in 2000 by this WG

Type of Assesmet	Assessment from ICES (2000)			Updated assessment Similar to 1999 assessment with a new year of data and down weighting ages 0 to 0.01 and age 3 to 0.1		
Assessment Year	**Age 0**	**F anual**	**SSB**	**Age 0**	**F anual**	**SSB**
1987	7,447	0.5496	37,813	8,703	0.541	37,279
1988	4,387	0.5007	37,070	3,473	0.589	40,585
1989	19,082	0.5807	23,389	19,652	0.527	21,582
1990	7,319	0.6146	55,844	7,587	1.048	51,966
1991	28,402	1.2581	28,794	27,632	0.879	31,476
1992	25,305	0.8625	71,236	24,103	0.892	72,975
1993	13,334	0.5659	87,618	12,789	0.700	81,638
1994	10,275	0.6792	58,755	10,405	0.775	53,953
1995	13,397	0.8612	43,727	14,514	0.863	43,316
1996	20,231	1.2382	37,098	18,197	1.195	41,558
1997	34,648	0.4856	49641	25,830	0.517	46,158
1998	4,774	0.2511	118593	7,841	0.385	87,436
1999	4,394	0.251	59484	12,582	0.579	51,230
2000			25178		0.579	46,750
Geomet. mean(10y)	12,843	0.704	48,849	12,906	0.743	47,512

Table 11.8.1 Inputs for the Catch option Predictions for the Anchovy in Sub Area VIII. Fishing Mortality pattern as the average of the last five years (1995-1999). Case of average recruitment below the arithmetic mean of the total series (1986-1999, as shown in table 11.6.1) (resulting in 8653 millions at age 0).

The SAS System 12:27 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	8653.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	3770.000	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	512.000	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	268.000	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	35.000	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	4.000	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001 & 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND04

Date and time: 23SEP00:12:30

Table 11.8.2 Catch option Predictions for the Anchovy in Sub Area VIII. Case of average recruitment below the arithmetic mean of the total series (1986-1999, as shown in table 11.6.1) (resulting in 8653 millions at age 0).

The SAS System 12:27 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.5253	1.0798	193150	39573	35000	0.0000	0.0000	212754	39058	0	239306	56023
.	.	.	.	.	0.1000	0.0708	.	38188	2312	237778	53834
.	.	.	.	.	0.2000	0.1416	.	37341	4513	236337	51794
.	.	.	.	.	0.3000	0.2124	.	36516	6611	234978	49889
.	.	.	.	.	0.4000	0.2832	.	35712	8612	233696	48108
.	.	.	.	.	0.5000	0.3540	.	34929	10522	232484	46440
.	.	.	.	.	0.6000	0.4248	.	34166	12346	231339	44876
.	.	.	.	.	0.7000	0.4956	.	33423	14089	230256	43407
.	.	.	.	.	0.8000	0.5663	.	32698	15757	229231	42024
.	.	.	.	.	0.9000	0.6371	.	31993	17353	228260	40722
.	.	.	.	.	1.0000	0.7079	.	31305	18883	227340	39494
.	.	.	.	.	1.1000	0.7787	.	30634	20349	226468	38333
.	.	.	.	.	1.2000	0.8495	.	29980	21755	225640	37234
.	.	.	.	.	1.3000	0.9203	.	29343	23104	224853	36193
.	.	.	.	.	1.4000	0.9911	.	28721	24401	224106	35205
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND04
Date and time : 23SEP00:12:30
Computation of ref. F: Simple mean, age 1 - 3
Basis for 2000 : TAC constraints

Table 11.8.3 Inputs for the Catch option Predictions for the Anchovy in Sub Area VIII.

Case of Geometric mean Recruitment (1986-1999) at 12174 millions.

The SAS System 11:10 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay)

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	3770.000	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	512.000	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	268.000	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	35.000	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	4.000	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001 & 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	12174.000	1.2000	0.0000	0.4000	0.3750	12.444	0.0063	12.200
1	.	1.2000	1.0000	0.4000	0.3750	15.922	0.3987	20.800
2	.	1.2000	1.0000	0.4000	0.3750	28.703	0.9180	29.000
3	.	1.2000	1.0000	0.4000	0.3750	34.178	0.8071	34.500
4	.	1.2000	1.0000	0.4000	0.3750	40.500	0.7274	40.000
5+	.	1.2000	1.0000	0.4000	0.3750	42.000	0.9180	42.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND02

Date and time: 23SEP00:11:11

Table 11.8.4 Catch option Predictions for the Anchovy in Sub Area VIII. Case of Geometric mean Recruitment (1986-1999) at 12174 millions.

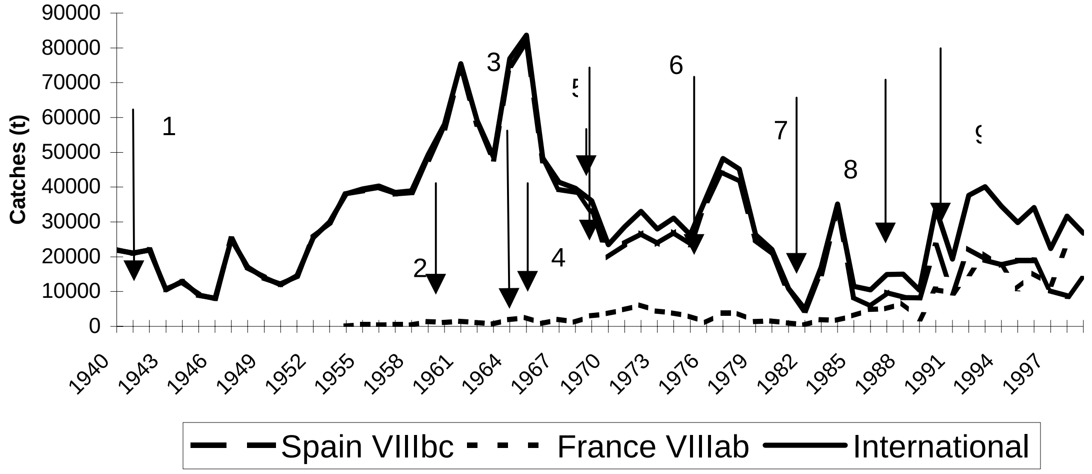
The SAS System 11:10 Saturday, September 23, 2000

Anchovy in Sub-area VIII (Bay of Biscay) Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.5110	1.0697	236967	39689	35000	0.0000	0.0000	229615	49809	0	248435	61844
.	.	.	.	.	0.1000	0.0708	.	48767	2818	246548	59225
.	.	.	.	.	0.2000	0.1416	.	47751	5509	244763	56786
.	.	.	.	.	0.3000	0.2124	.	46760	8081	243073	54512
.	.	.	.	.	0.4000	0.2832	.	45793	10541	241472	52389
.	.	.	.	.	0.5000	0.3540	.	44849	12896	239955	50405
.	.	.	.	.	0.6000	0.4248	.	43928	15151	238517	48548
.	.	.	.	.	0.7000	0.4956	.	43029	17311	237152	46807
.	.	.	.	.	0.8000	0.5663	.	42151	19383	235856	45174
.	.	.	.	.	0.9000	0.6371	.	41294	21372	234625	43639
.	.	.	.	.	1.0000	0.7079	.	40458	23281	233455	42195
.	.	.	.	.	1.1000	0.7787	.	39641	25115	232343	40834
.	.	.	.	.	1.2000	0.8495	.	38844	26877	231284	39551
.	.	.	.	.	1.3000	0.9203	.	38065	28573	230277	38339
.	.	.	.	.	1.4000	0.9911	.	37305	30205	229317	37192
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND02
Date and time : 23SEP00:11:11
Computation of ref. F: Simple mean, age 1 - 3
Basis for 2000 : TAC constraints

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 (1992-1999) for the French and Spanish anchovy fisheries in Sub-area VIII

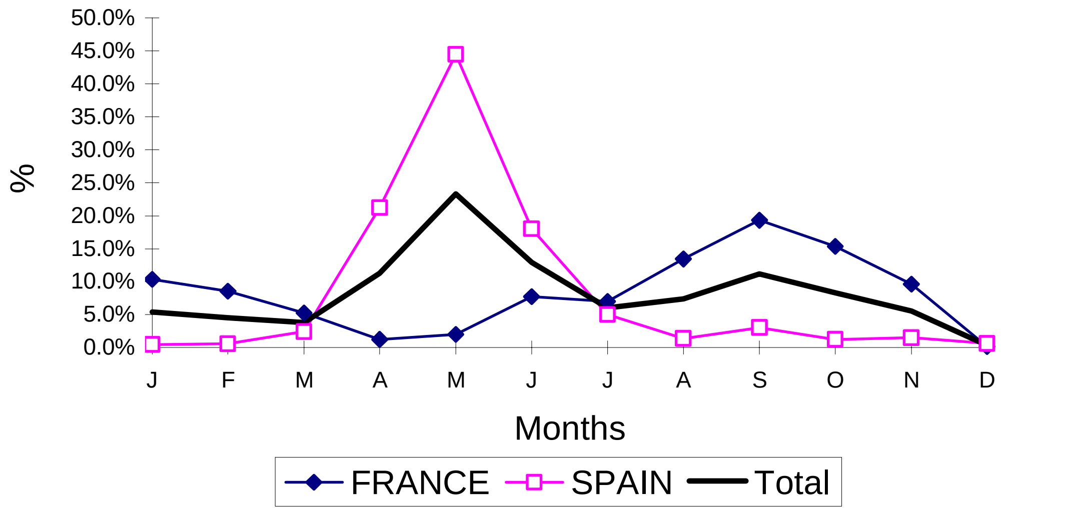


Figure 11.3.2.1 -First Quarter-

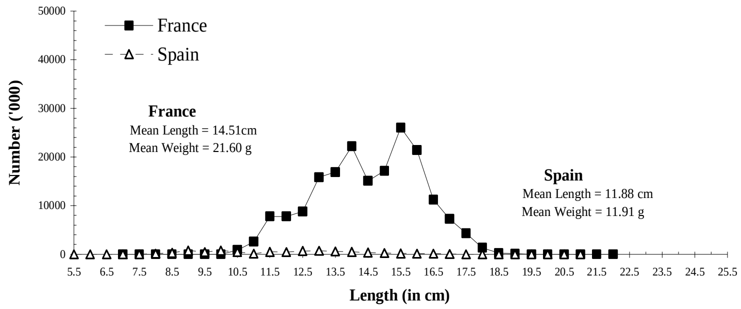


Figure 11.3.2.3 -Third Quarter-

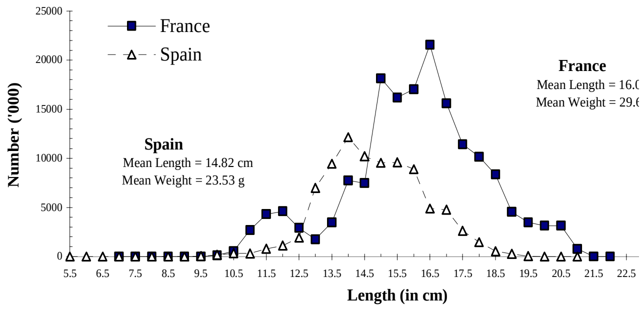


Figure 11.3.2.2 - Second Quarter

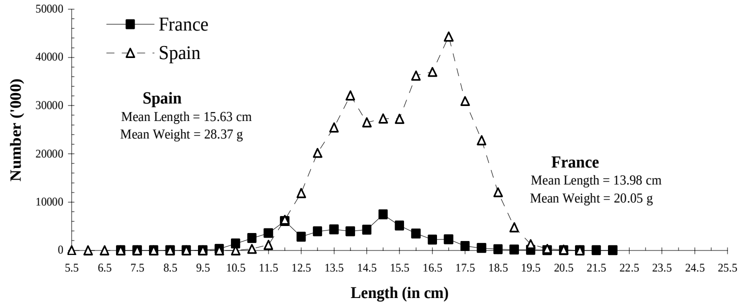
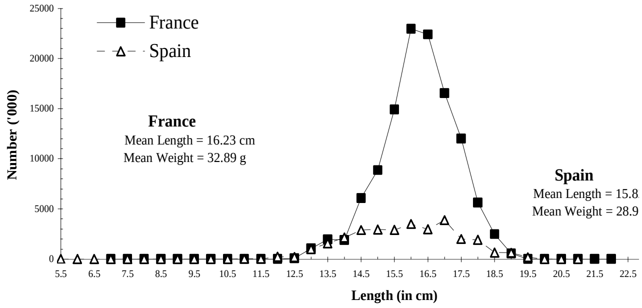


Figure 11.3.2.4 -Fourth Quarter-



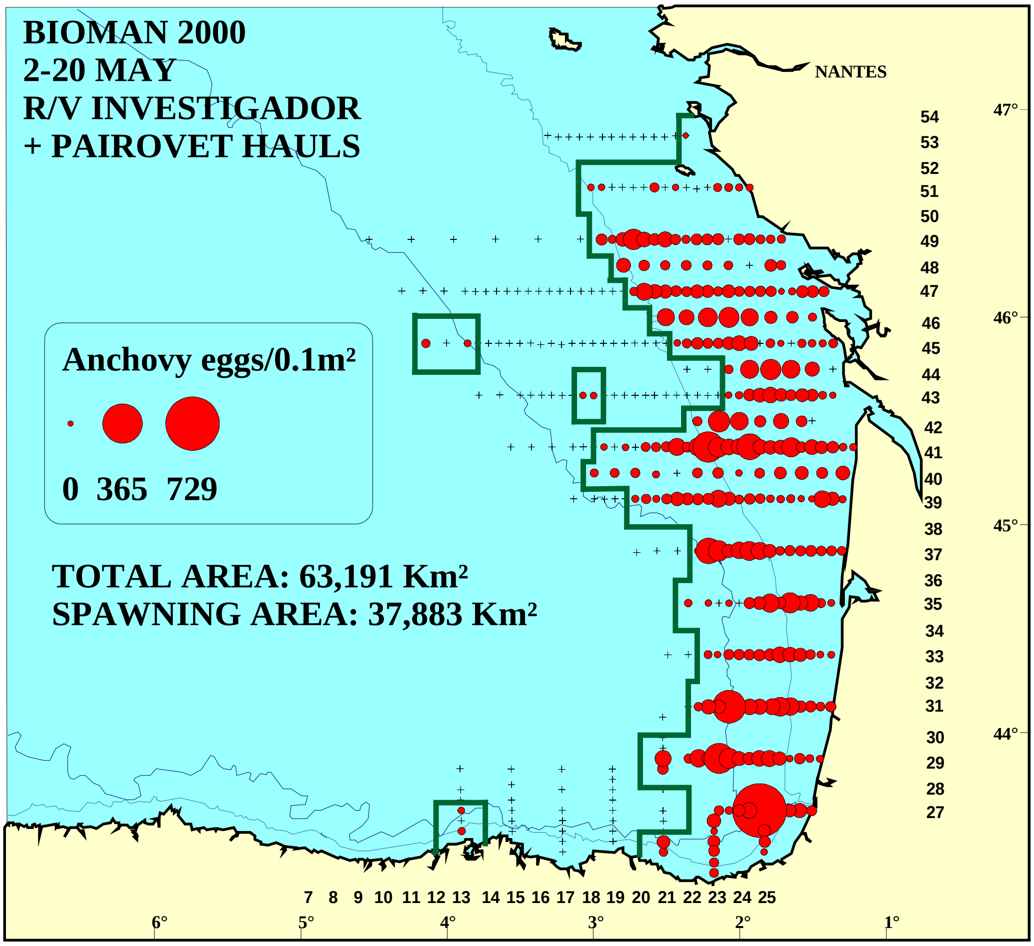


Figure 11.4.1.1: Anchovy Egg/0.1m² distribution found during BIOMAN 2000.
Solid line encloses the positive spawning area

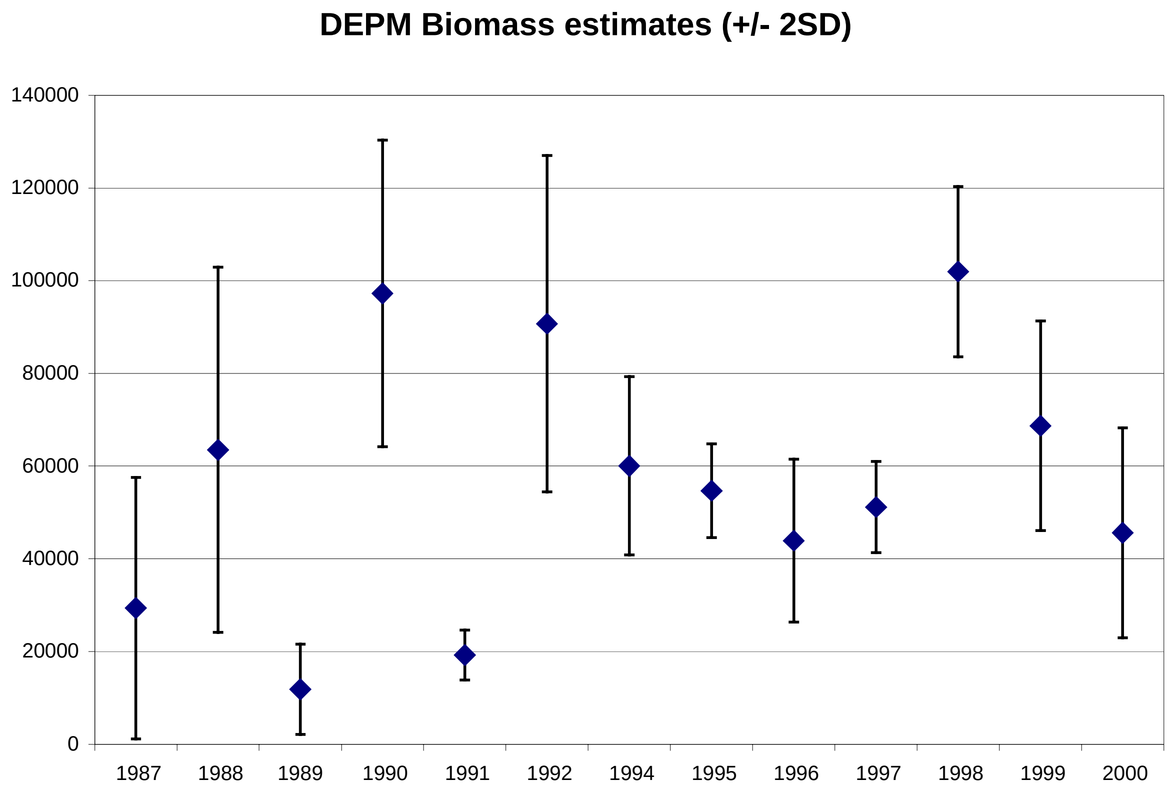


Figure 11.4.1.2: Series of Biomass estimates obtained from the Egg surveys since 1987 Uriarte et al WD2000. Most of them are full DEPM estimates, except in 1996, 1999 and 2000 which were deduced indirectly from the relationship of biomass with the spawning area and daily egg production per surface unit (P0).

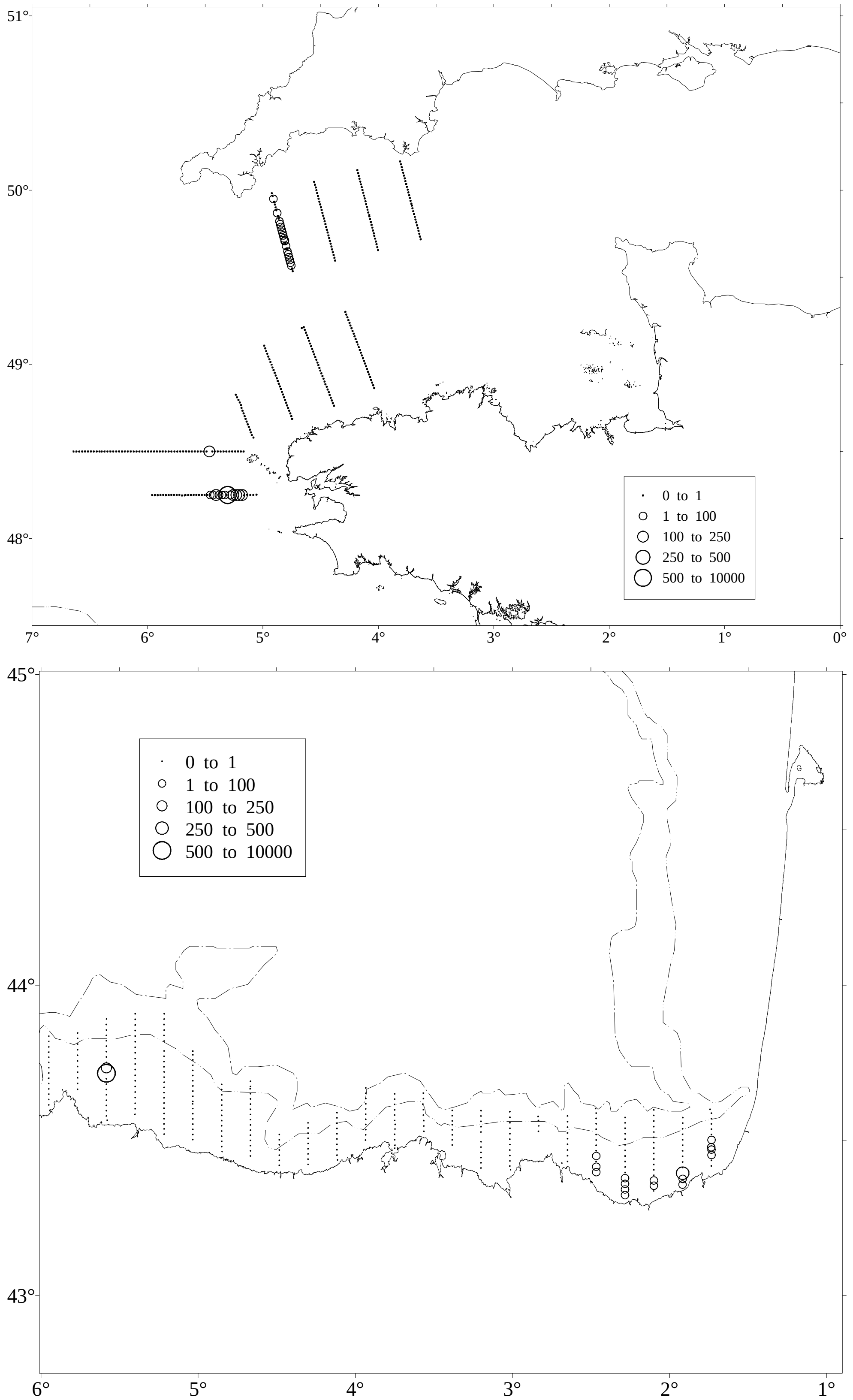
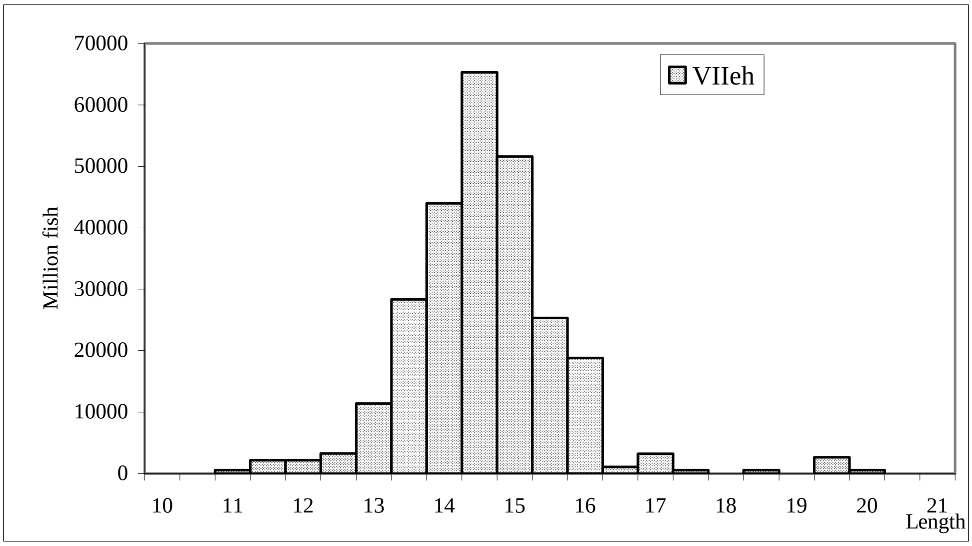
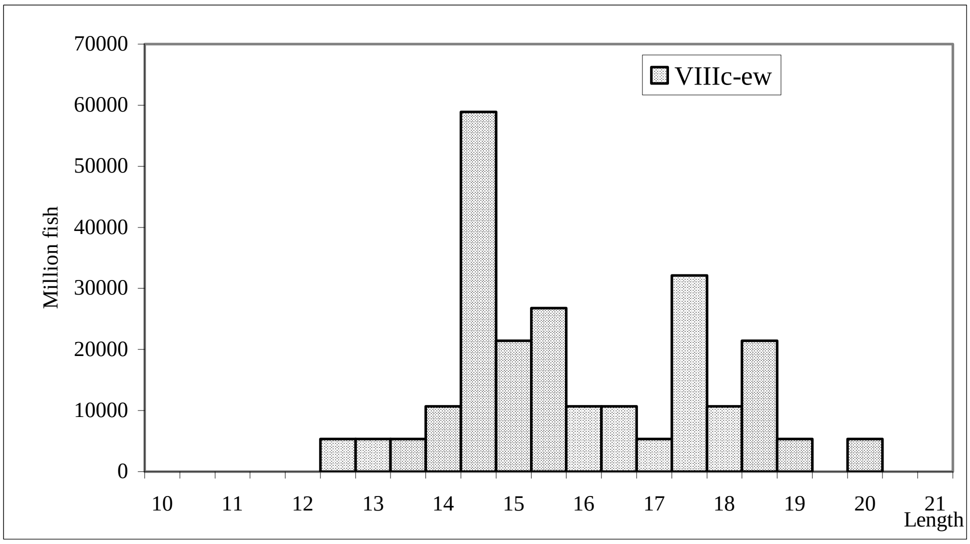


Figure 11.4.2.1: Acoustic energy allocated to anchovy during the acoustic survey PELACUS 0300





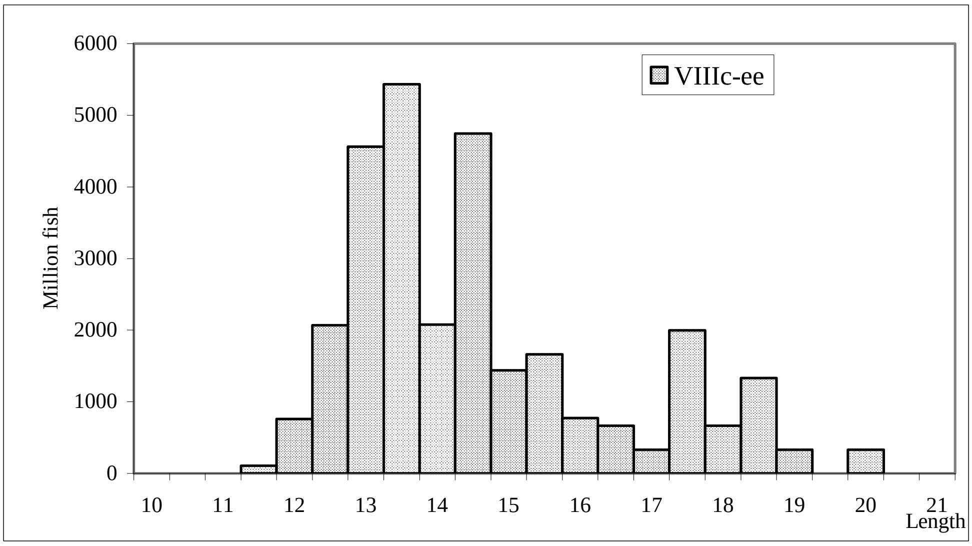


Figure 11.4.2.2: Estimated fish number at length class by ICES Sub-Division during the survey Pelacus 0300

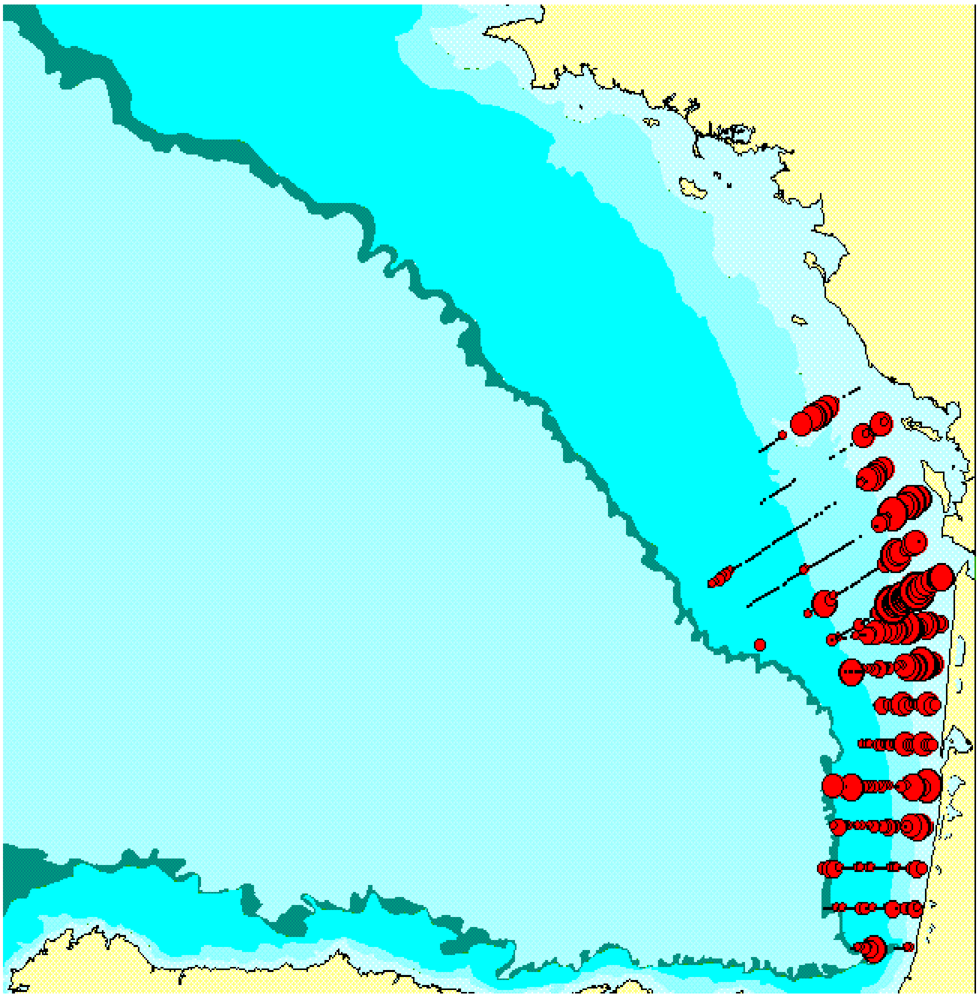


Figure 11.4.2.3. : Anchovy energies distribution during the survey PELASSES 2000 (after Massé, 2000).

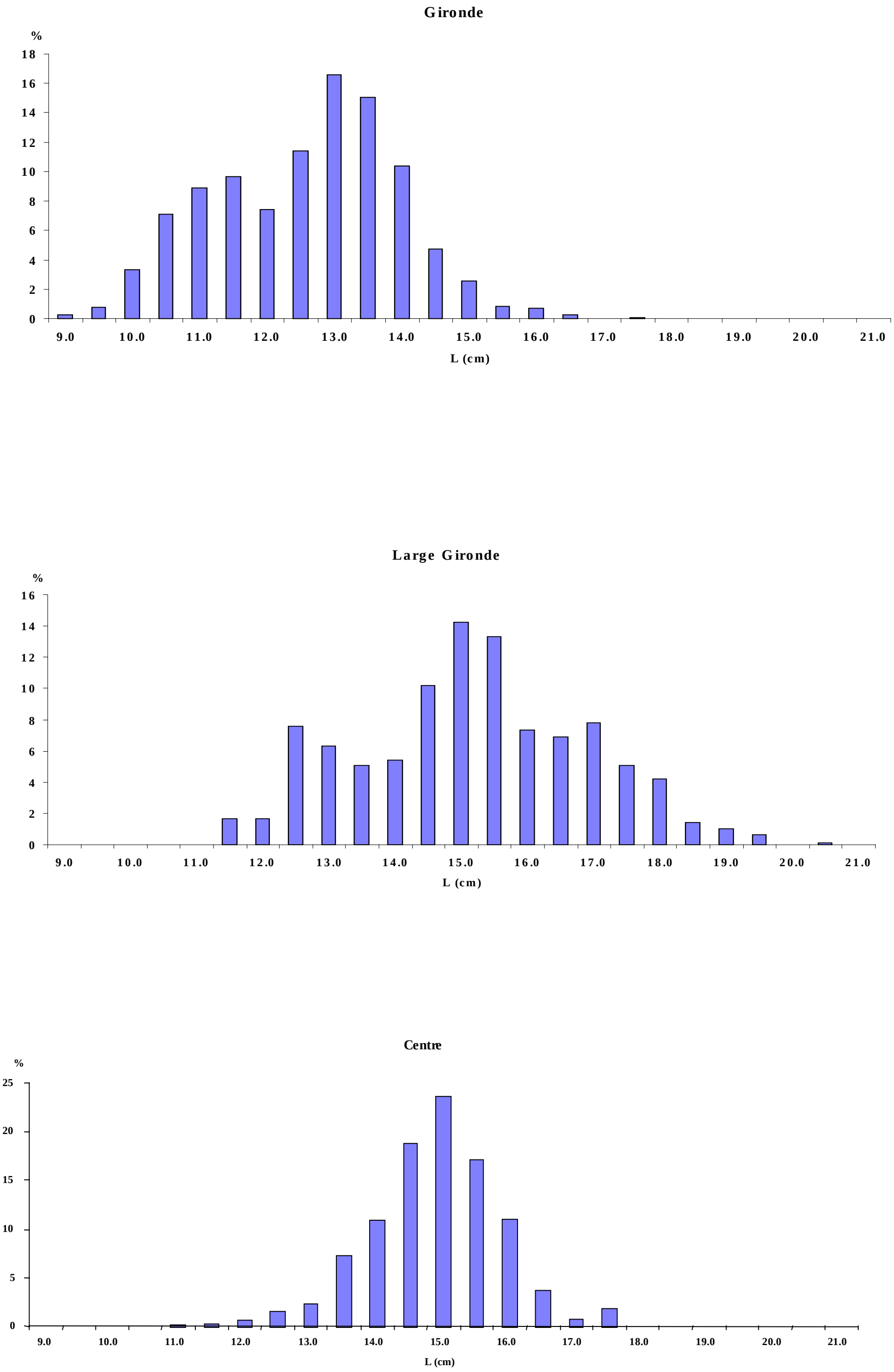


Figure 11.4.2.4. : Length distributions of anchovy sampled during the survey PELASSES 2000 in the Bay of Biscay (after Masse, WD 2000).

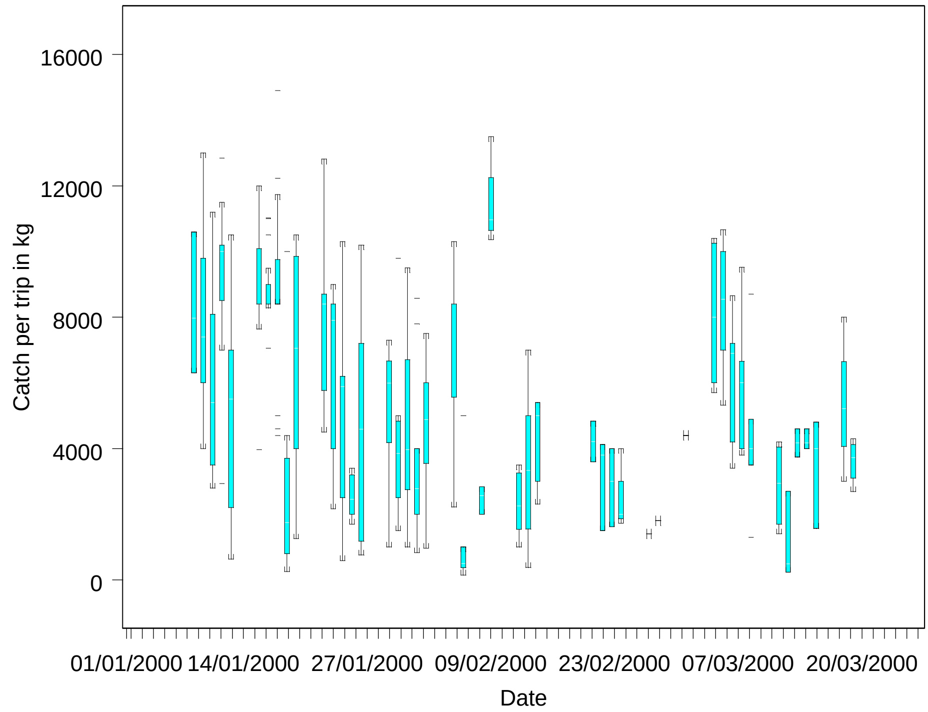


Figure 11.5.1: boxplots showing the daily variation of anchovy catch per trip (in kg) of the French pelagic fleet during the first quarter in 2000

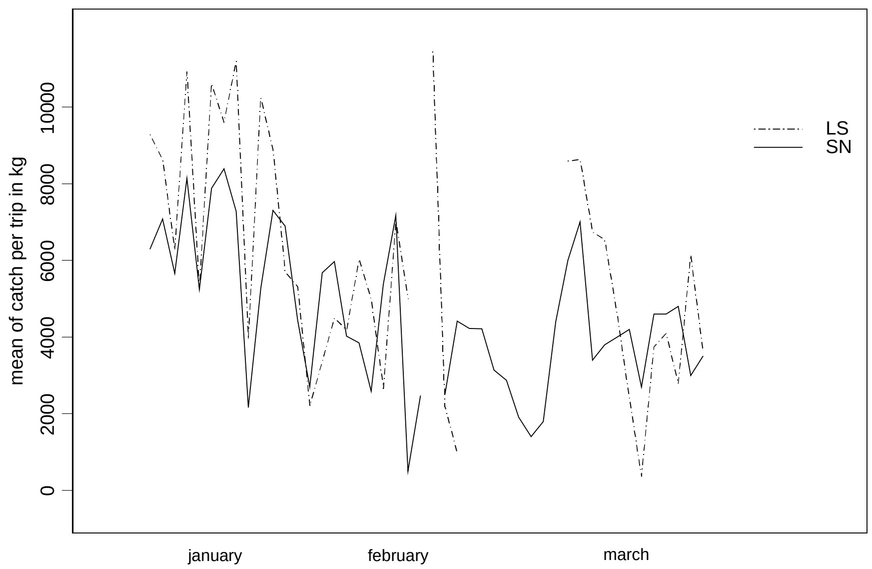
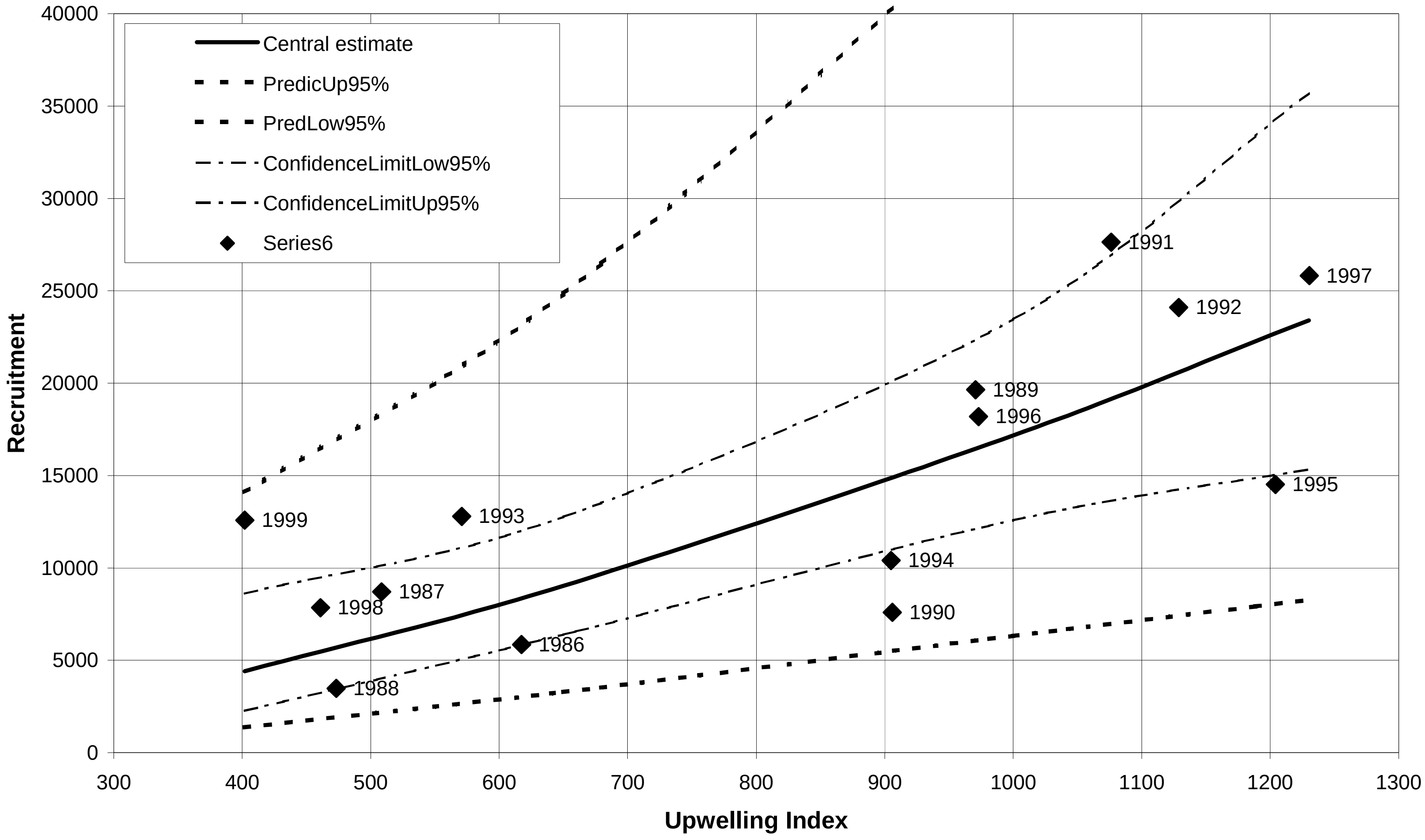
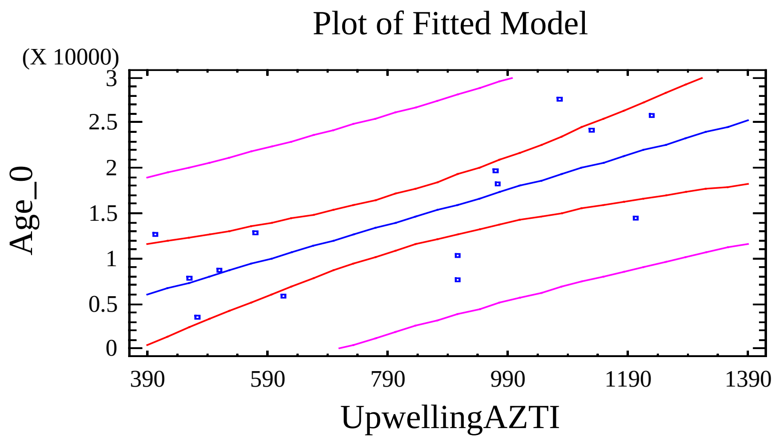


Figure 11.5.2: mean daily variation of the anchovy catch per trip for the French pelagic fleet during the winter fishing season in 2000 LS (Saint-Gilles Croix de Vie) and SN (La Turballe)

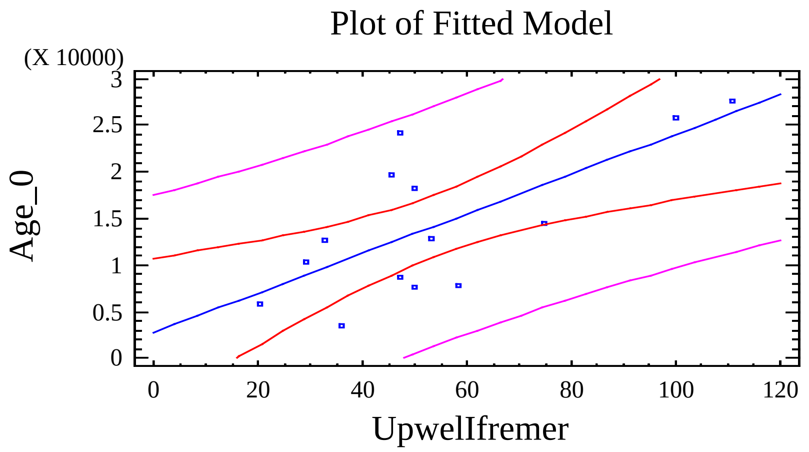
Figure 11.6.1: Predictive model in 1999 in comparison with the actual assessment



a) Borja's *et al*. Upwelling Index (1986,1998)



b) Use of Upwelling Index defined in Petitgas et al (WD2000)



c) Petitgas et al Upwelling and destratification Multiple model (WD2000)

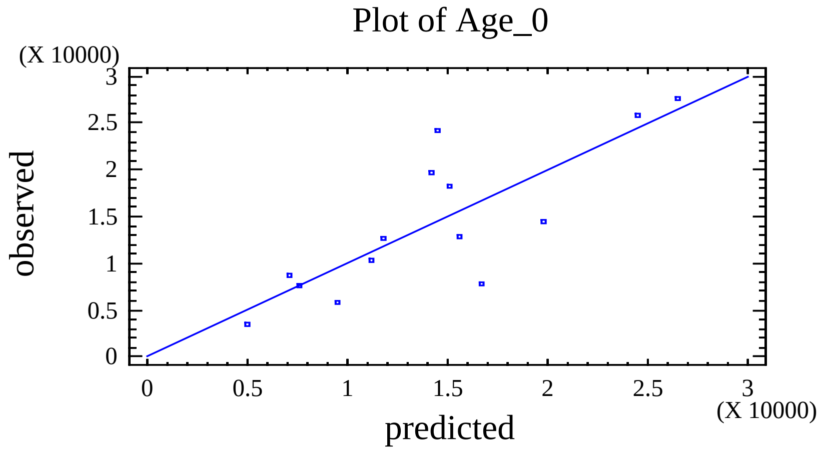


Figure 11.6.2: Linear models fitted to age 0 between the environmental indexes and the assessment adopted by this Working Group in Sept.2000. (14 pairs of data).

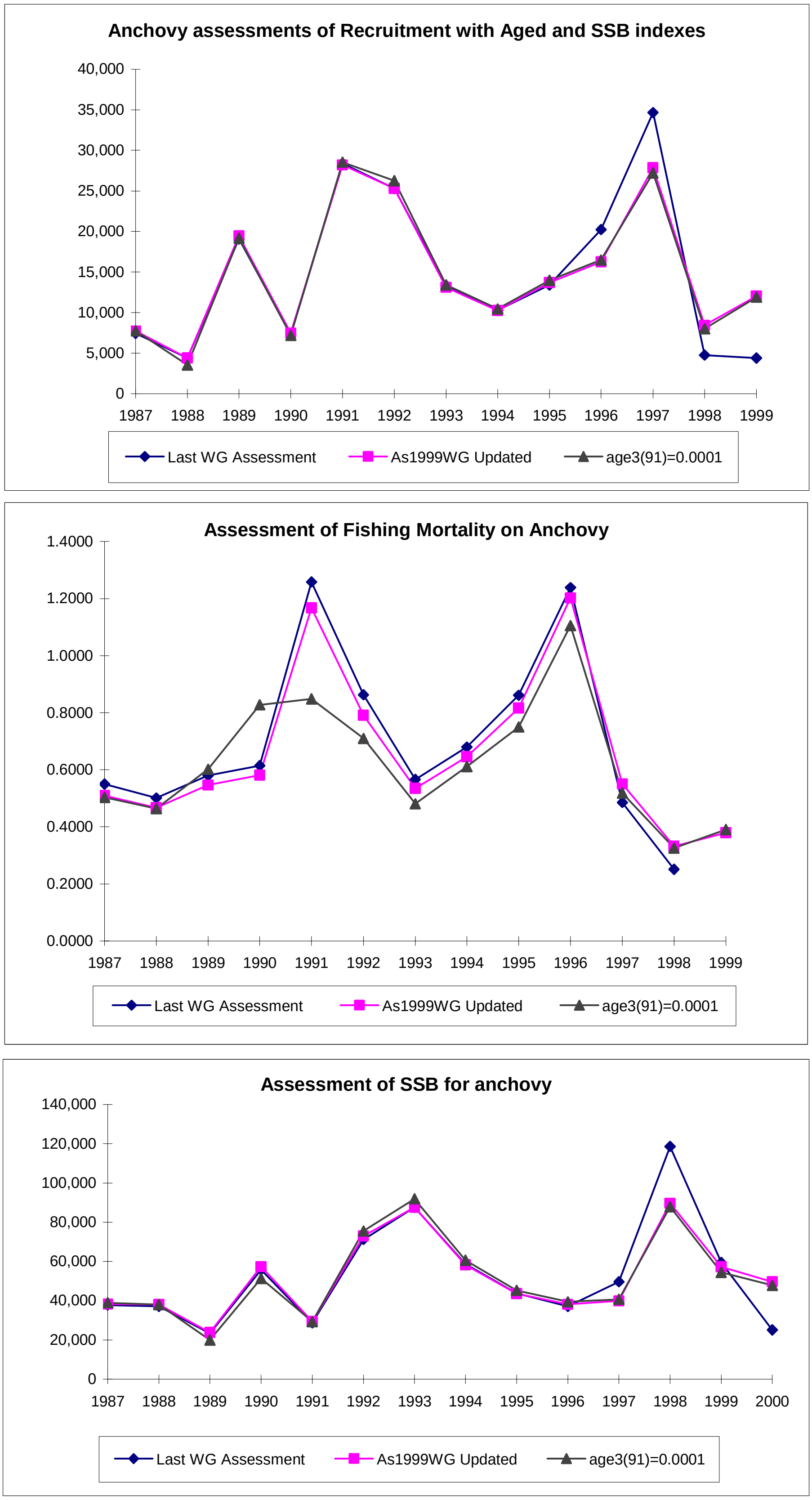


Figure 11.7.1.1: Comparison of Last year assessment versus the new updated data for the anchovy Concerning New the new information available and down weighting age 3 in 1991.

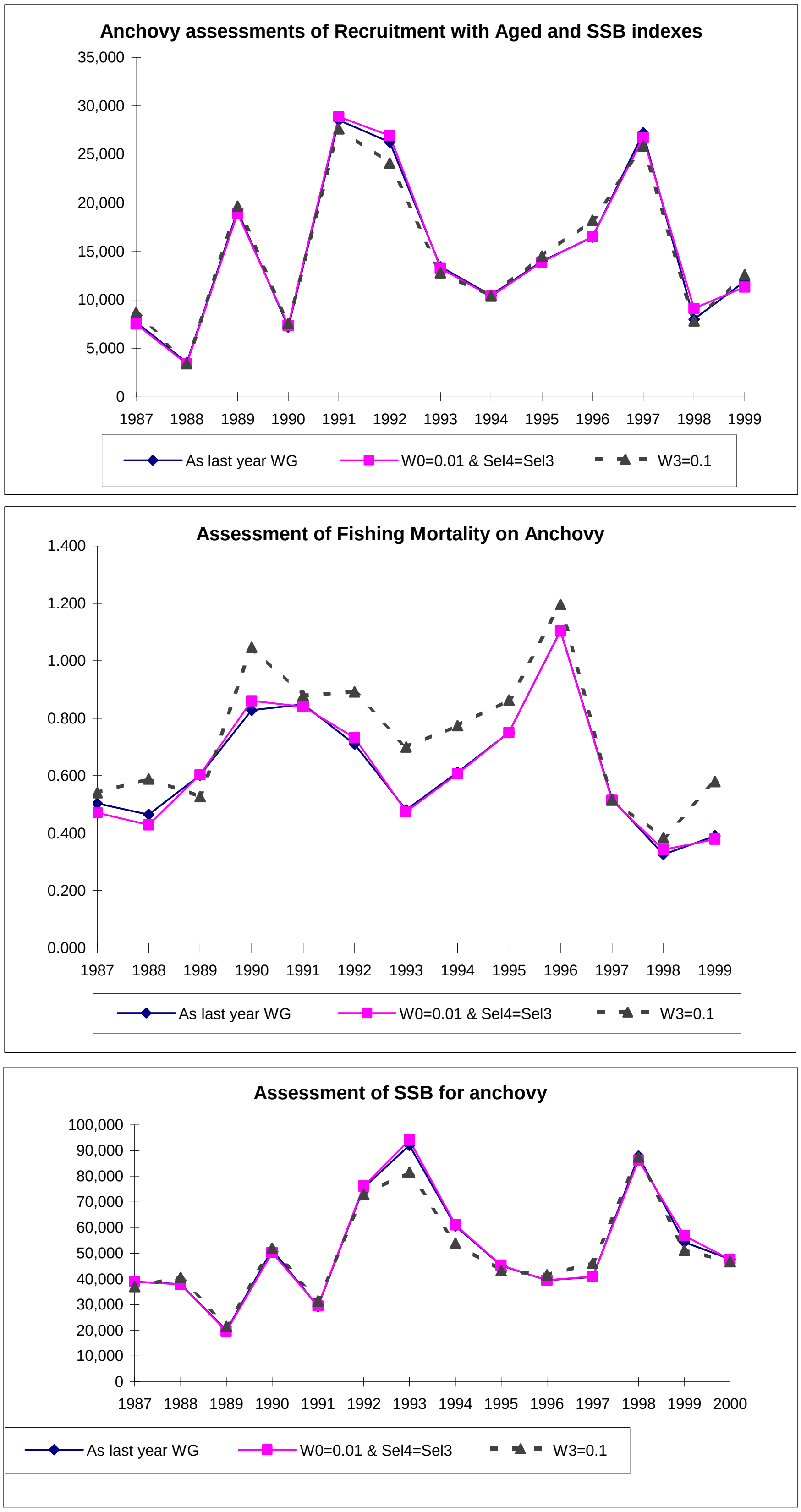


Figure 11.7.1.2: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning different weighting factors

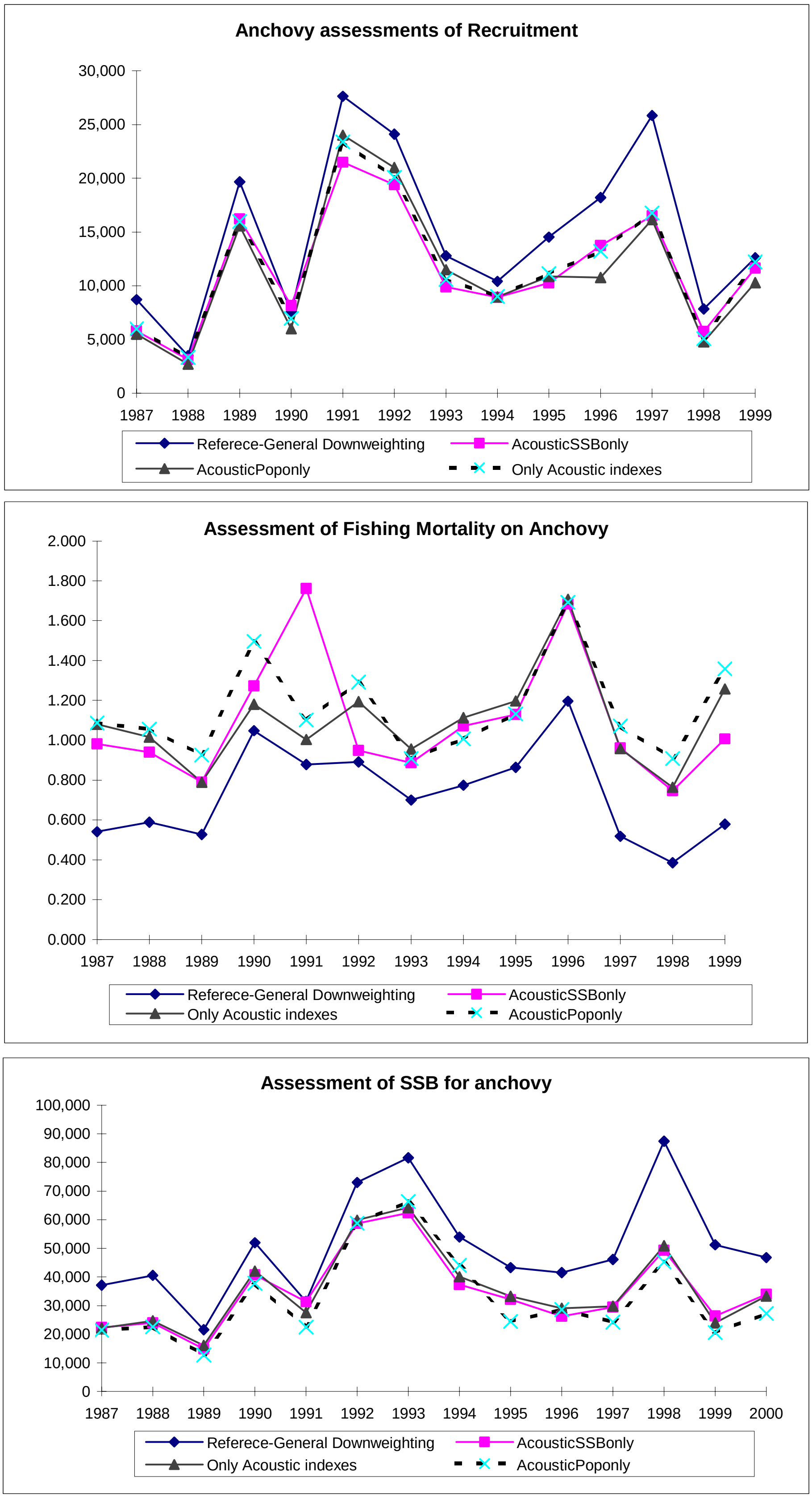
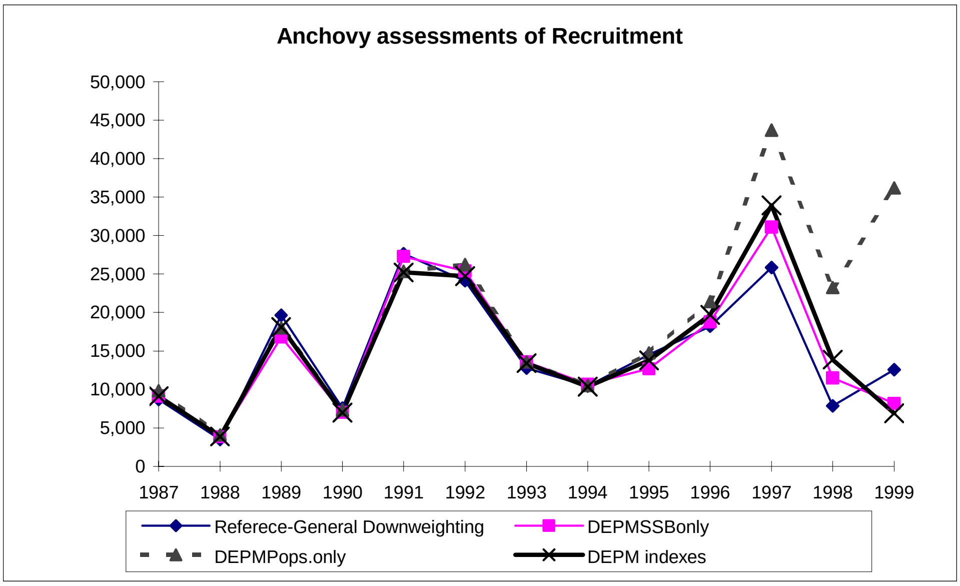
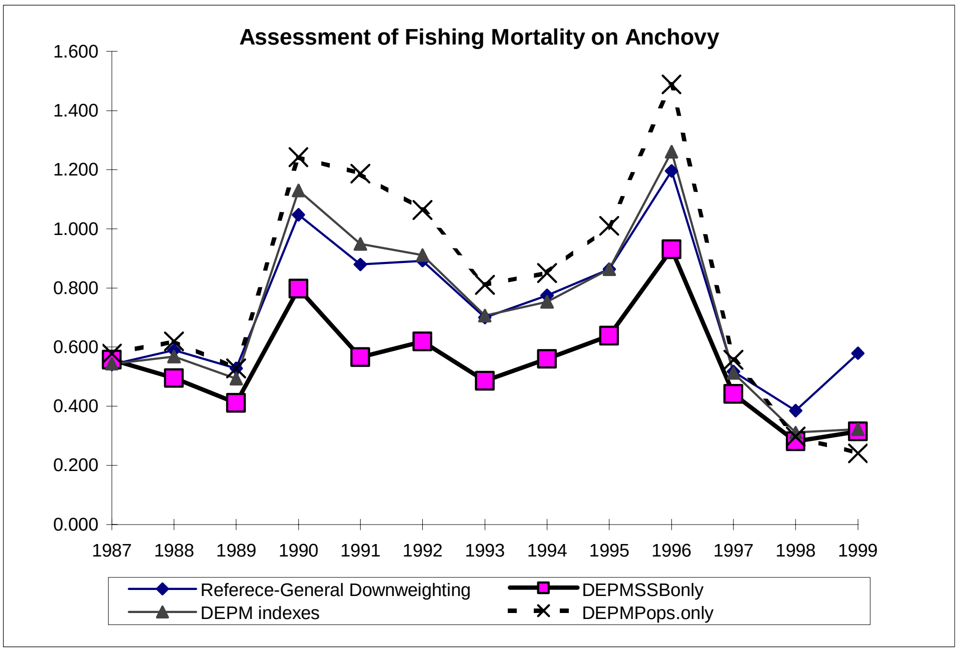


Figure 11.7.1.3: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning The sole use of Acoustic index in comparison with the standard assesment of reference





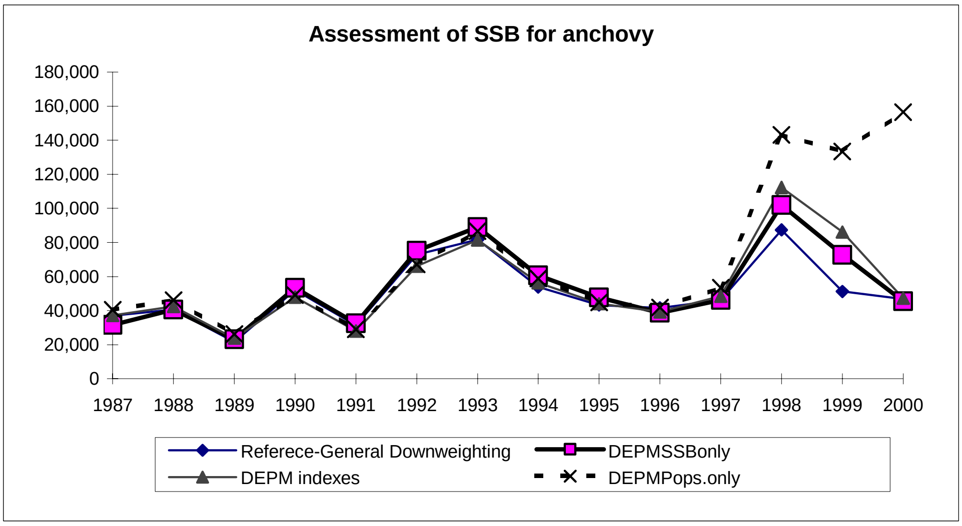
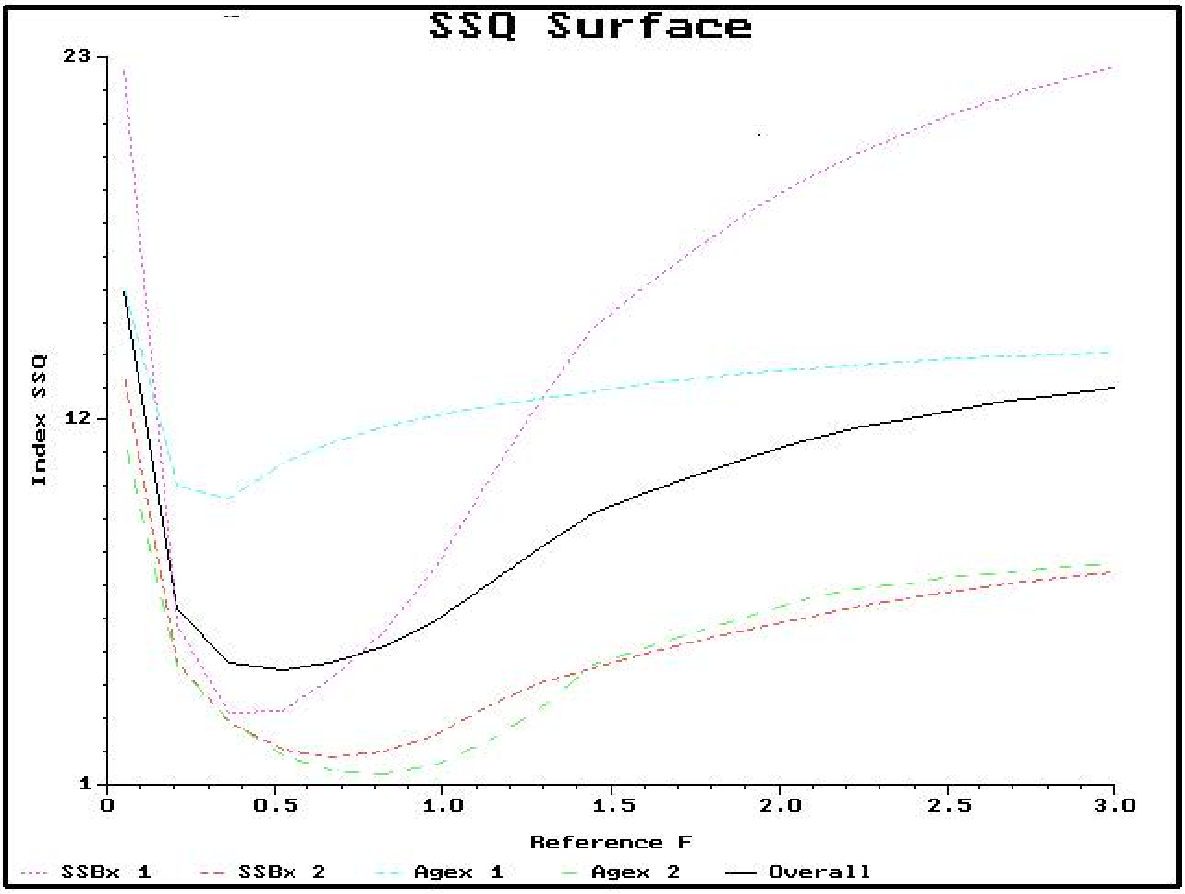
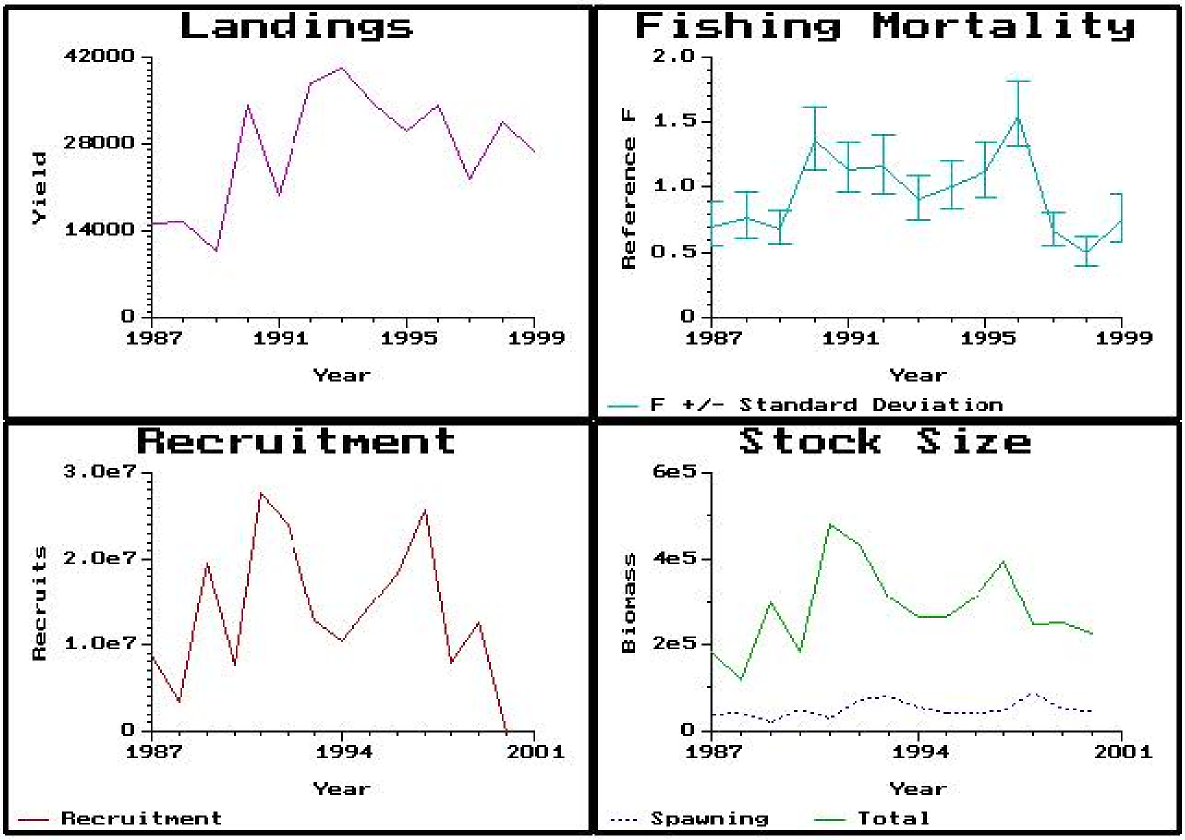


Figure 11.7.1.4: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning The sole use of DEPM index in comparison with the standard assesment of reference

Figure 11.7.2.1 Output figures from the assessment of the Anchovy in Subarea VIII



Stock Summary
Press P to print screen, or any other key to continue



Figures 11.7.2.1 (Cont….)

Separable Model Diagnostics
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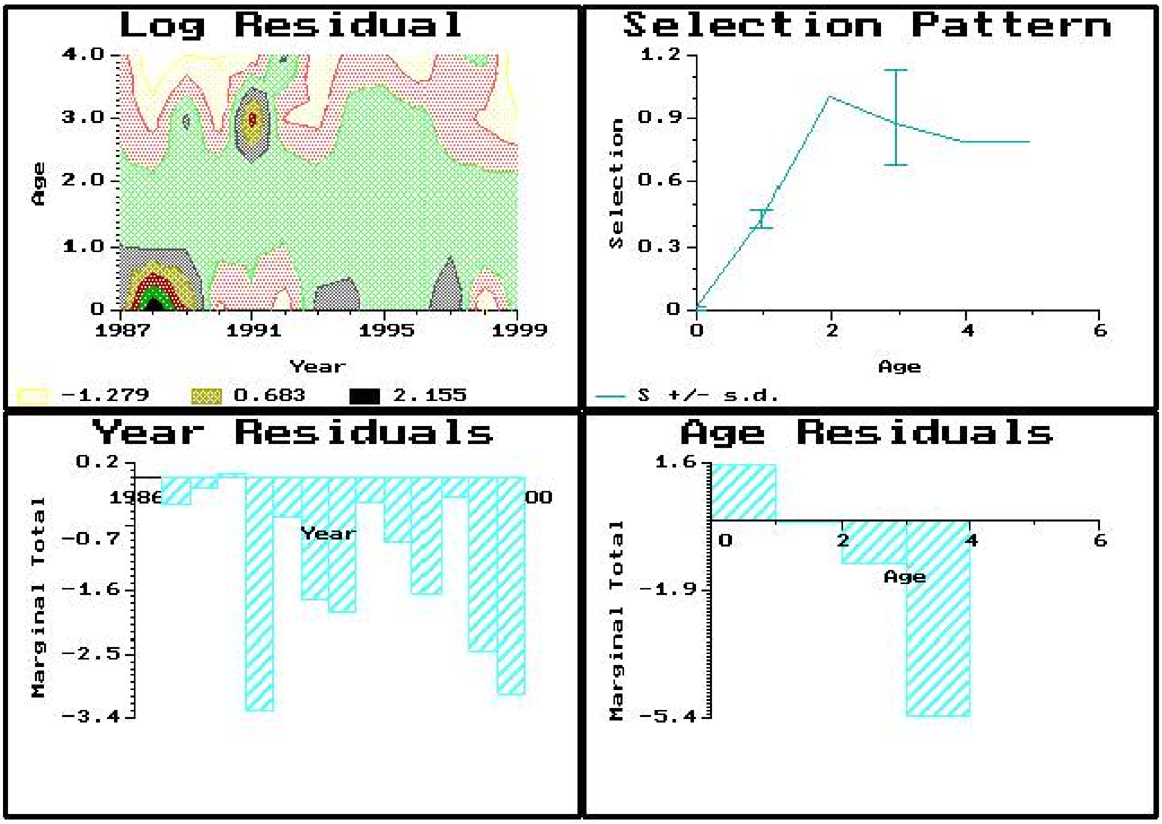

Tuning Diagnostics: Biomass index 1
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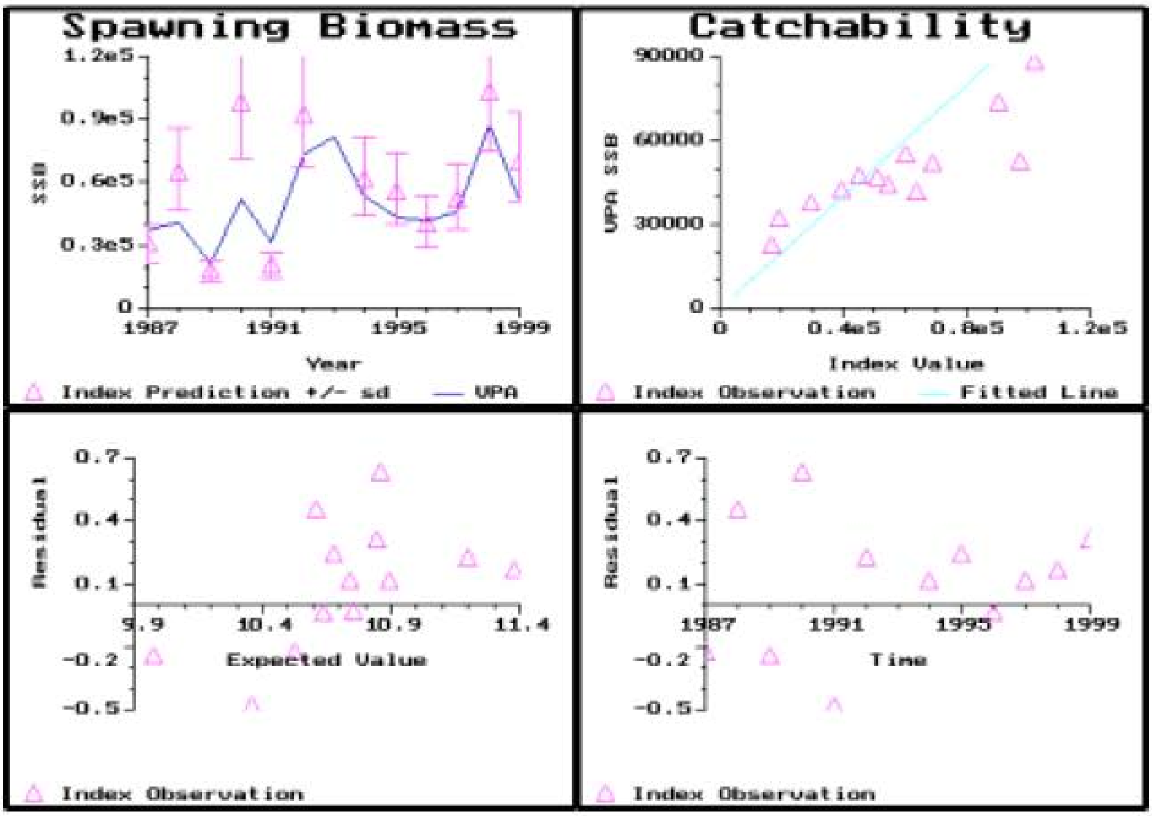
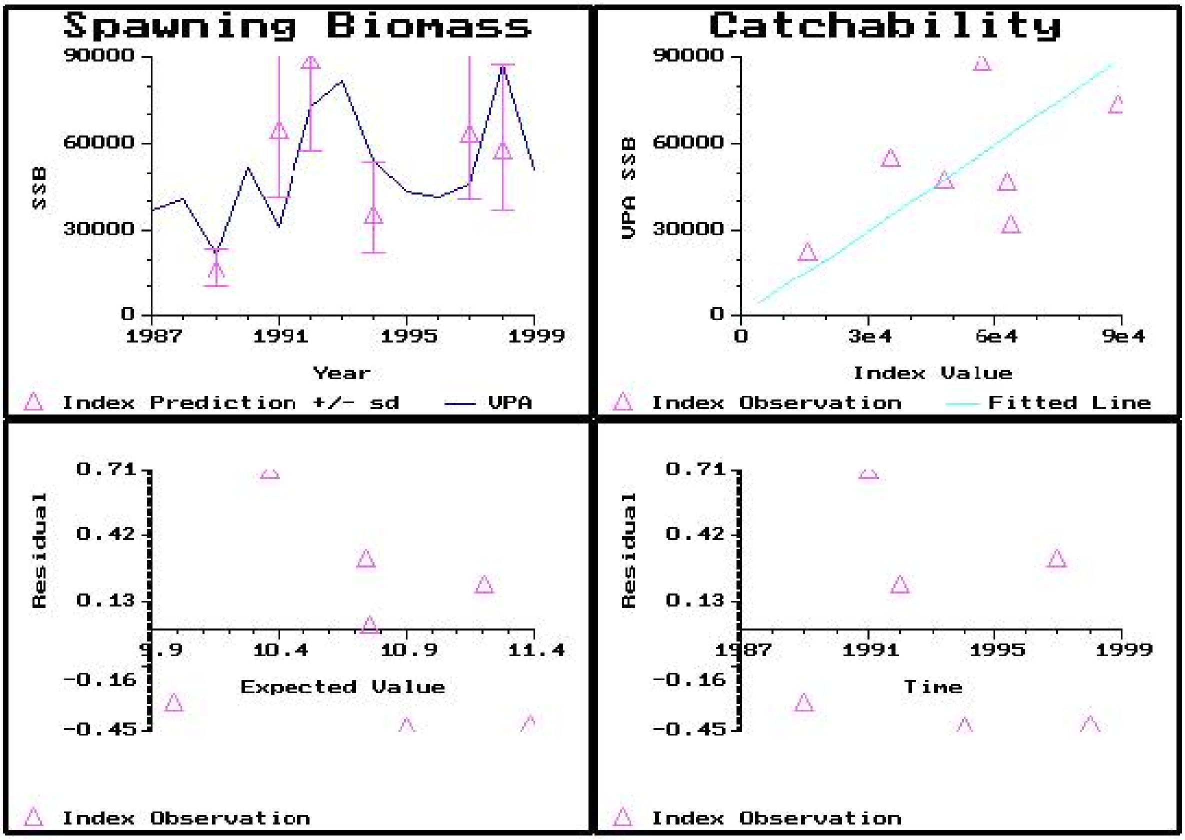


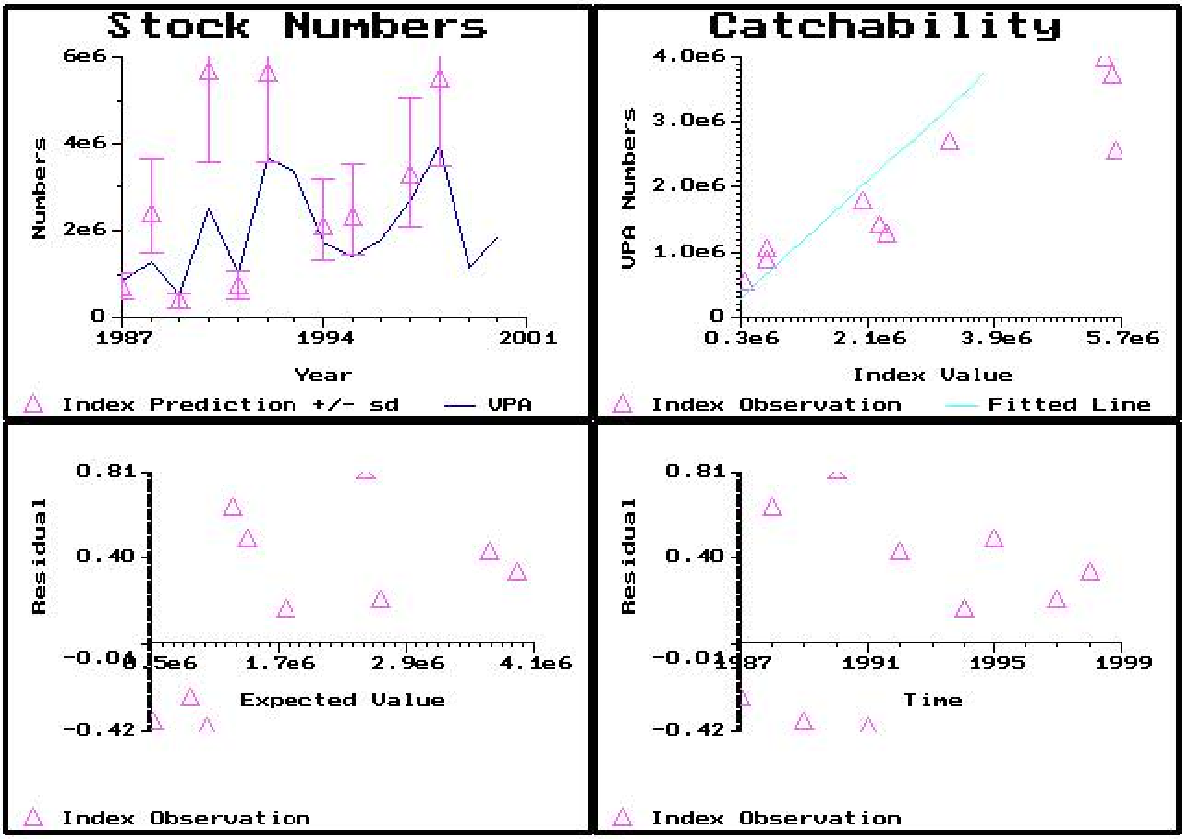
Figures 11.7.2.1 (Cont….)

Tuning Diagnostics: Biomass index 2



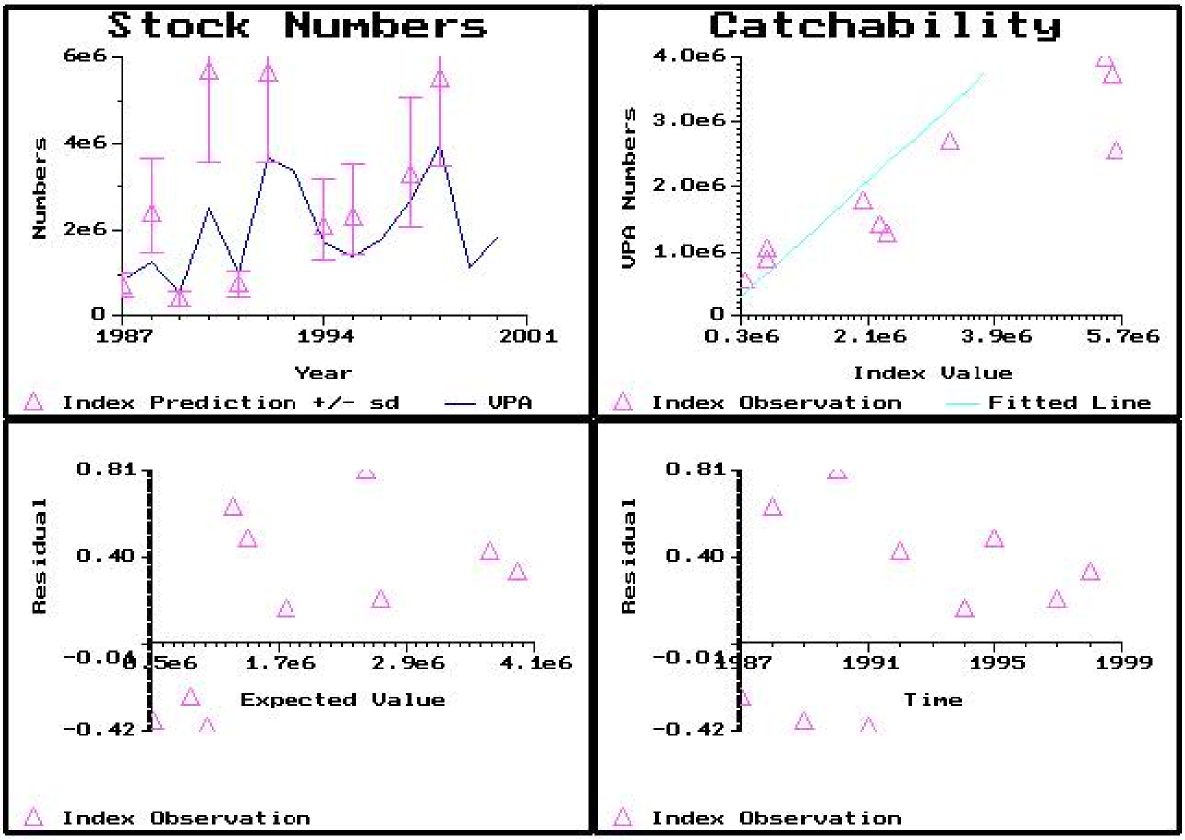
DEPM SUVEYS (Ages 1 to 3+)

Age 1

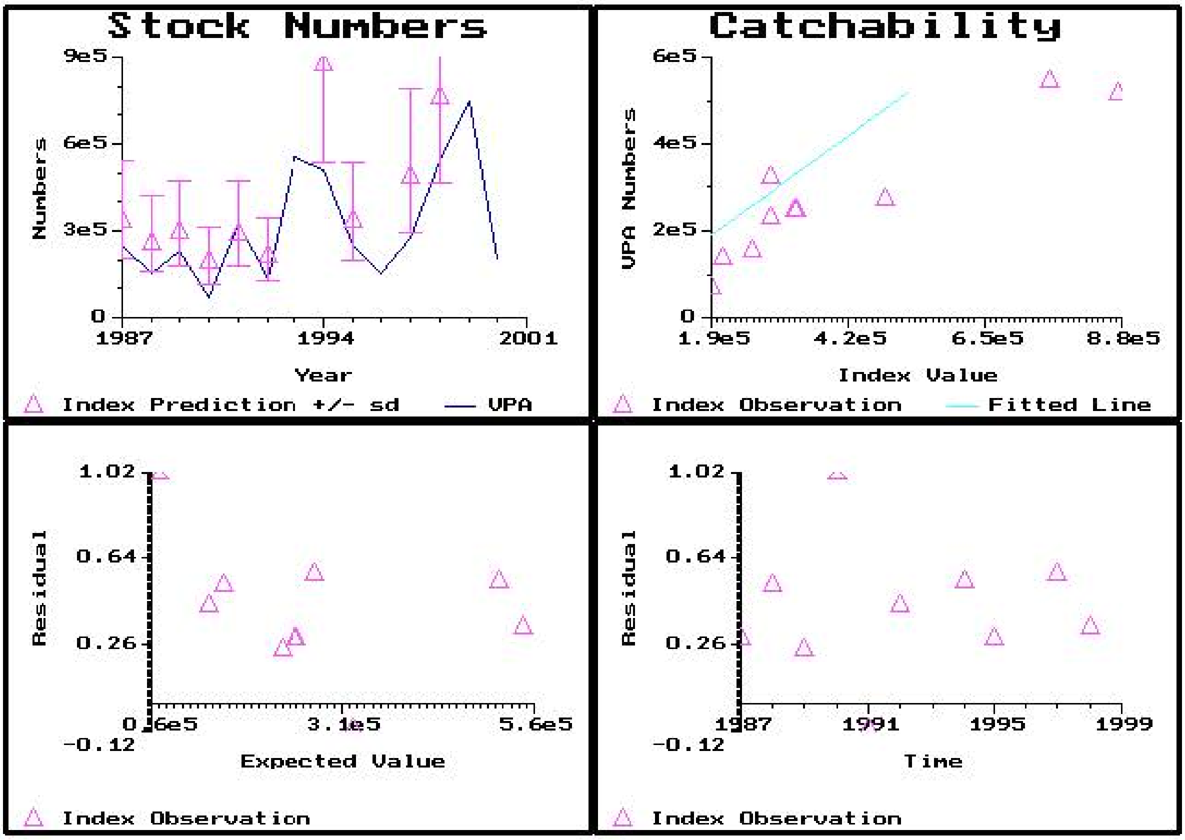


Figures 11.7.2.1 (Cont….)

DEPM SUVEYS (Ages 1 to 3+) Age 1

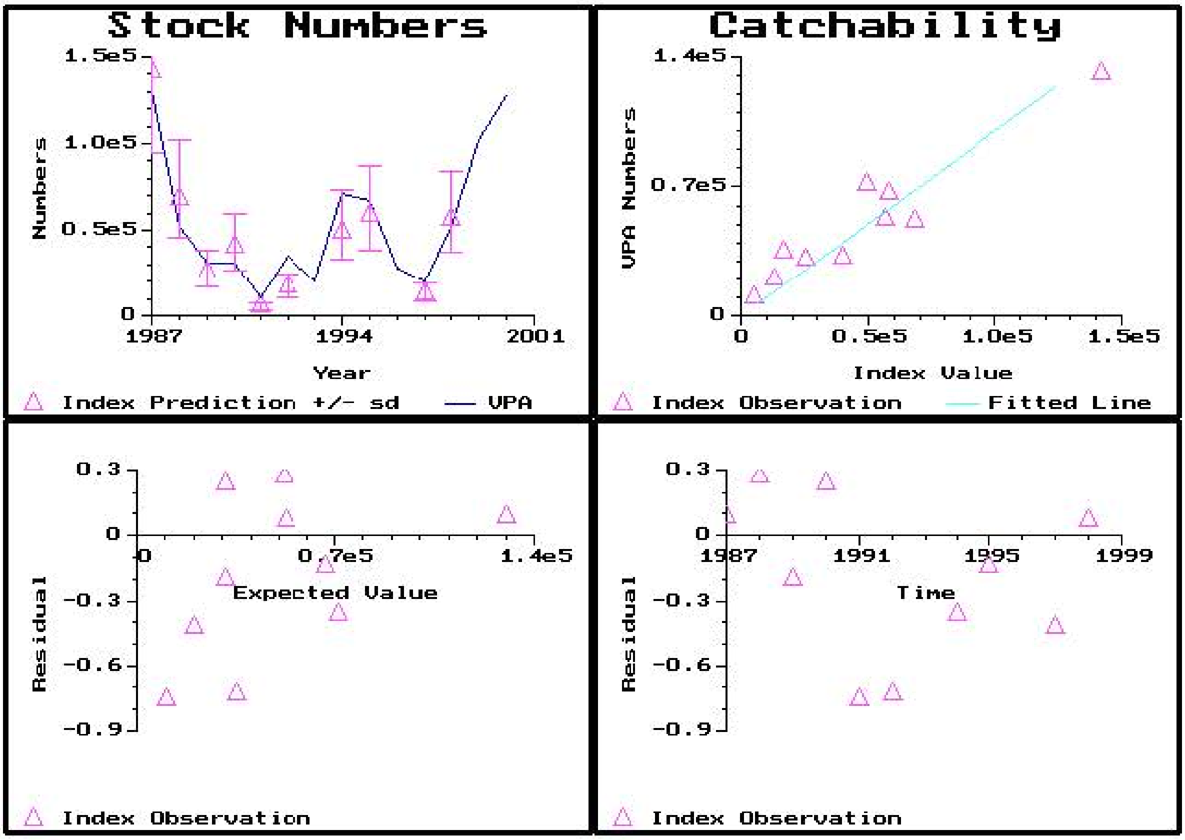


DEPM SUVEYS (Ages 1 to 3+) Age 2

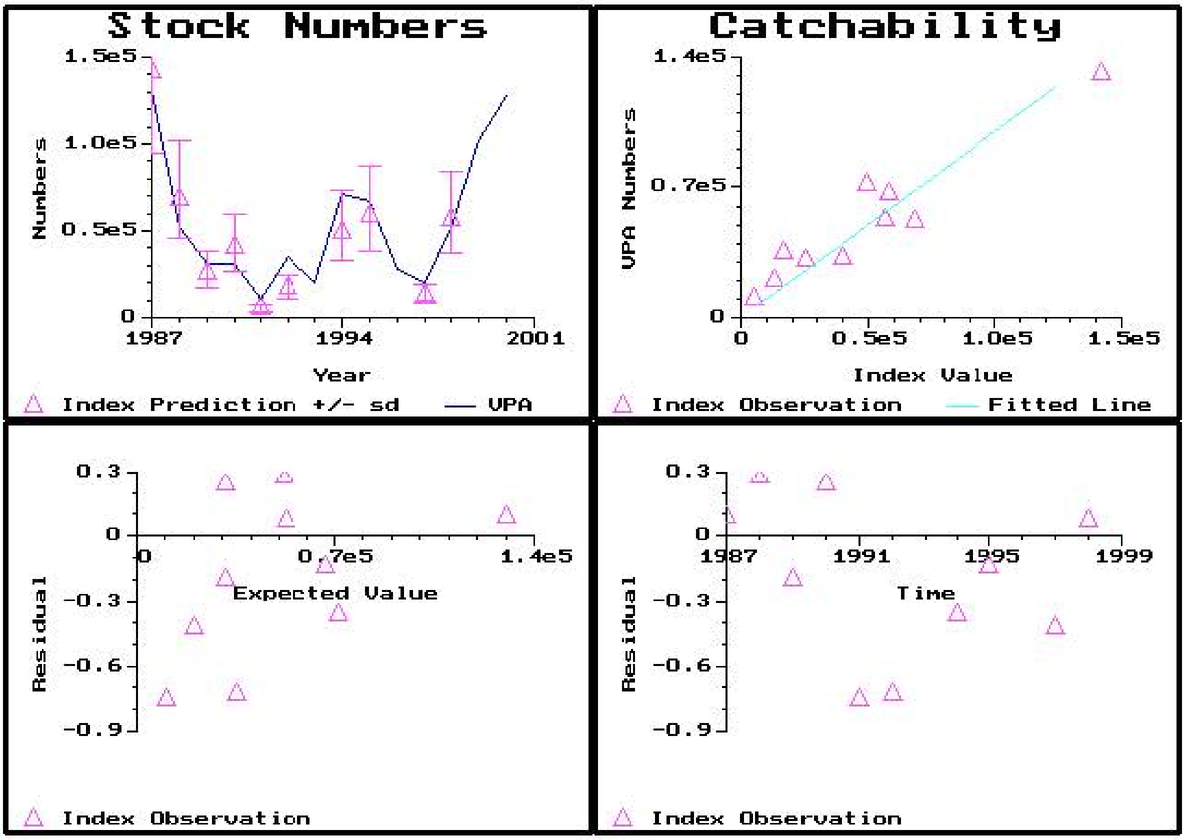


Figures 11.7.2.1 (Cont….)

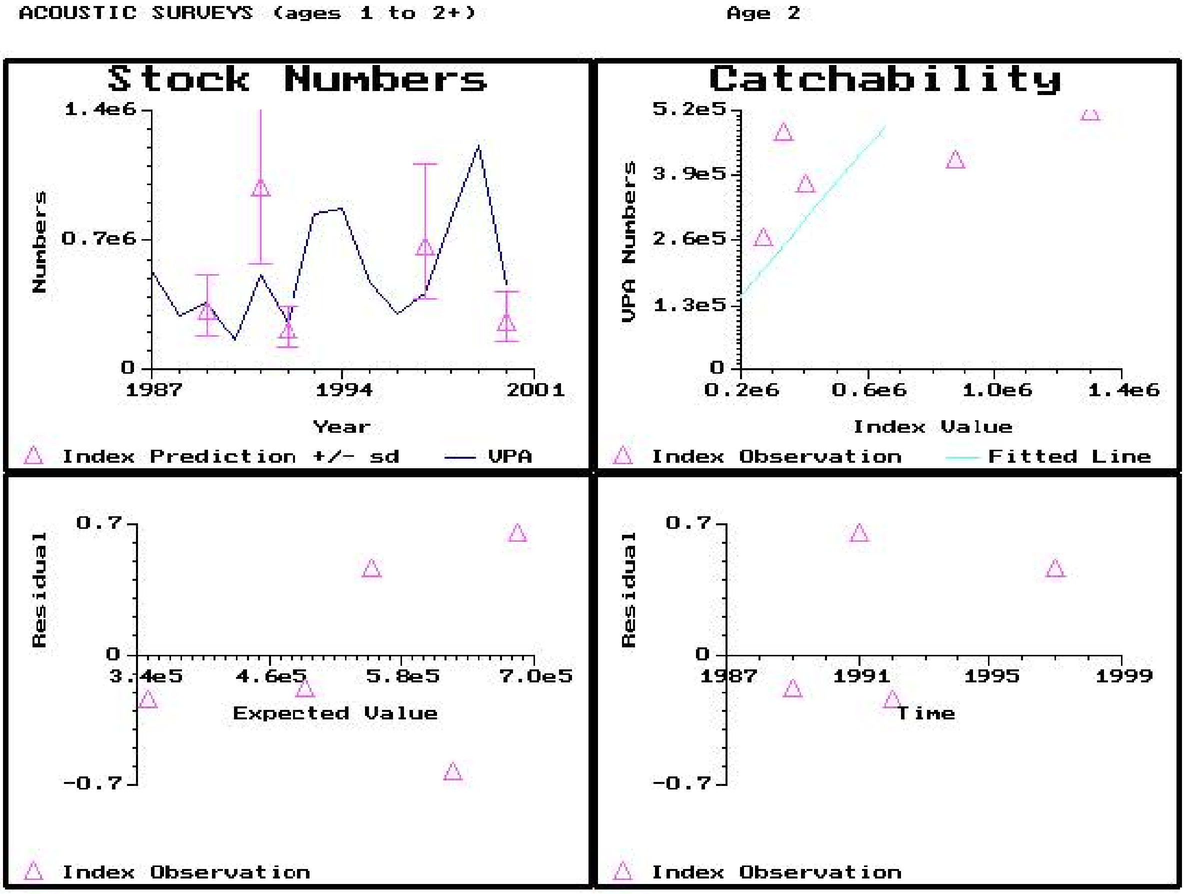
DEPM SUVEYS (Ages 1 to 3+) Age 3



DEPM SUVEYS (Ages 1 to 3+) Age 3



Figures 11.7.2.1 (Cont….)



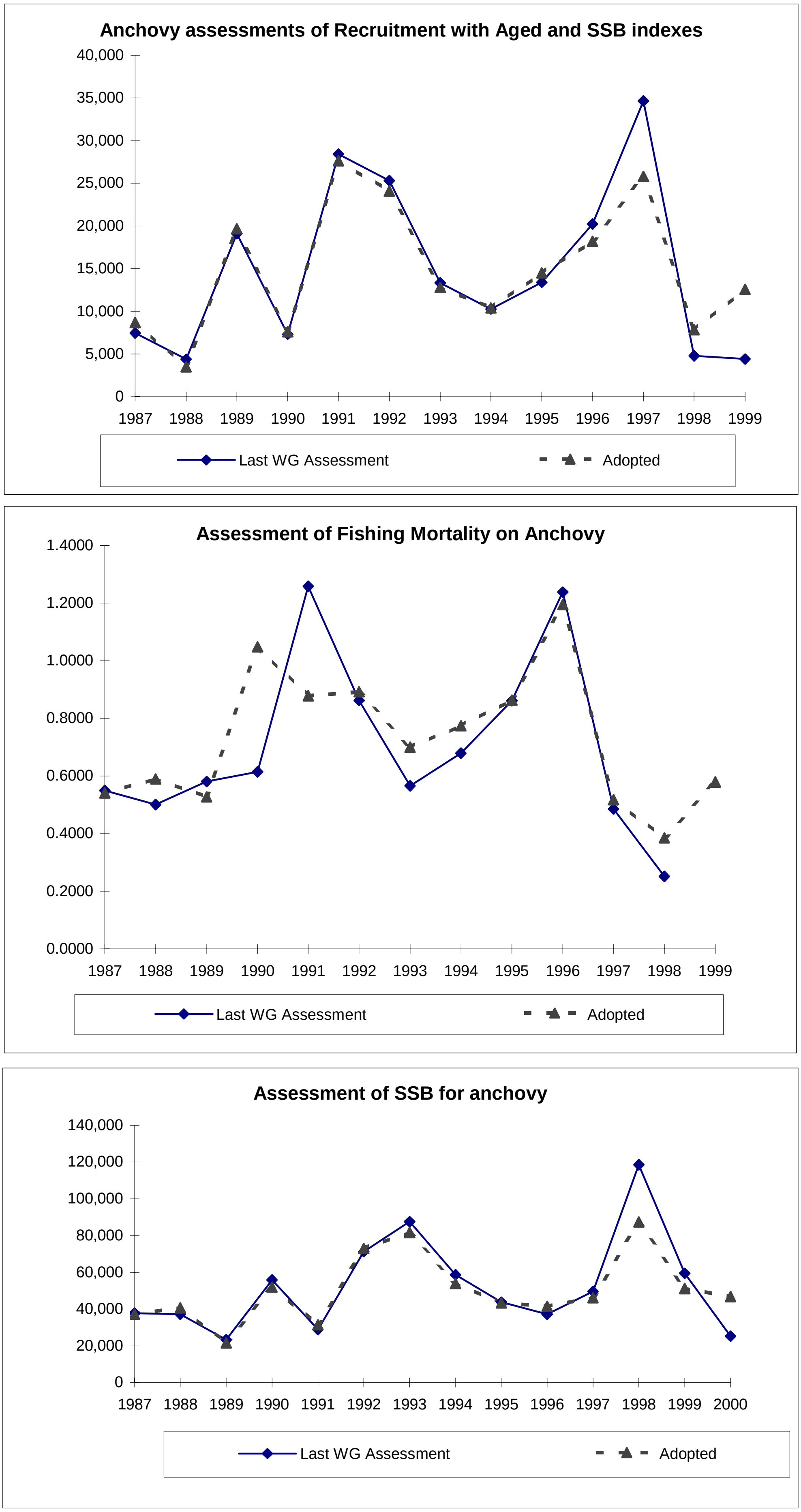


Figure 11.7.2.2: Comparison of last year assessment with the adopted one this year Concerning Anchovy in Subarea VIIII

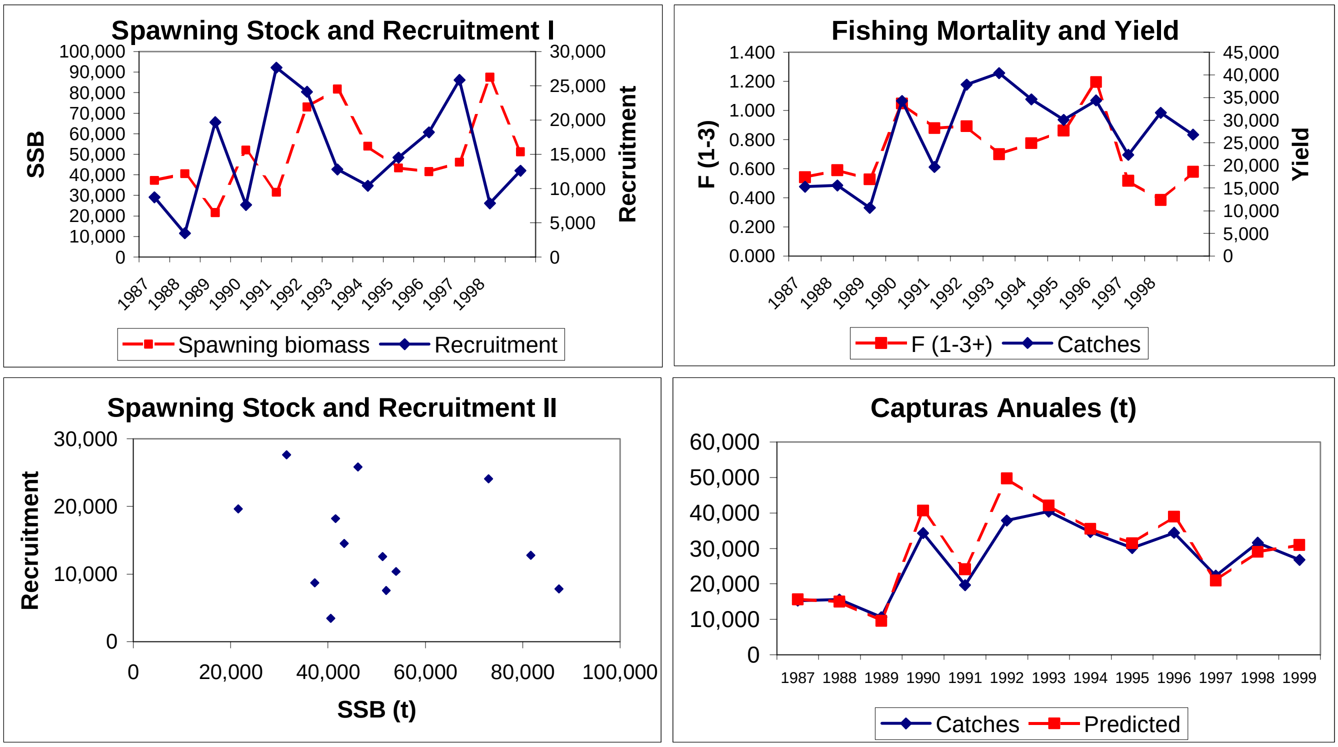
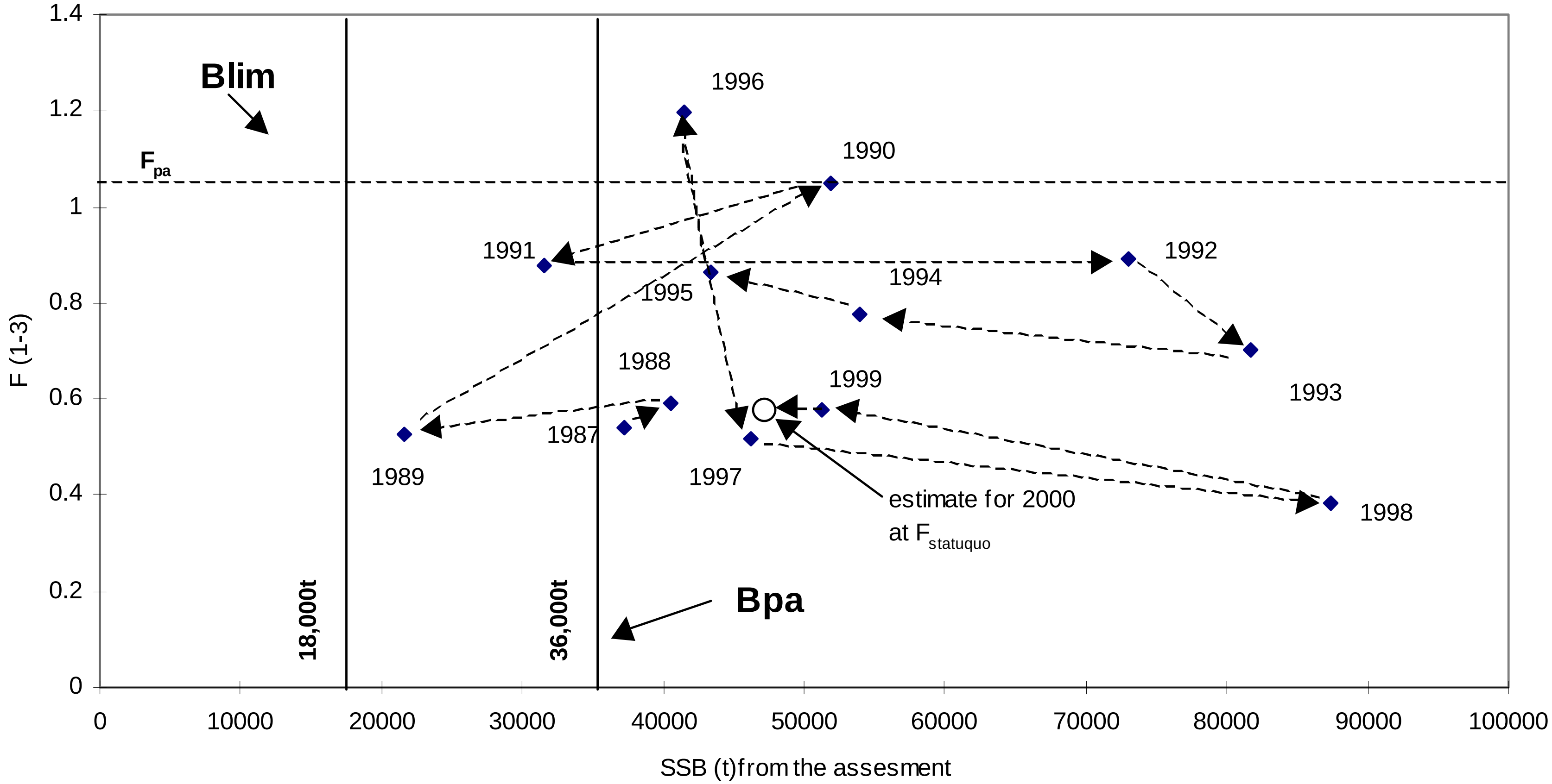


Figure 11. 7.3.1. Fish stock Summary - Anchovy in Sub-area VIII (Bay of Biscay).

Figure 11.15.1: Trajectory of the Bay of Biscay anchovy fishery since 1987



12 ANCHOVY IN DIVISION IXA

12.1 ACFM Advice Applicable to 1999 and 2000

The advice given by ACFM was the following: If a traditional TAC is required it should be set at the average landings since 1988, excluding 1995, that is, 4,600 t in 1999 and 2000. For 2000, ACFM 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 in Division IXa was 13,000 tonnes for 1999 and 10,000 tonnes for 2000.

No management objectives have been articulated for this stock. The current TAC is almost three times higher than the average of catches of recent years (excluding 1995 and 1998), which is 4,600 t. In 1998, the catch of 11,000 t was over twice this level. It is recognised that the state of the resource can change quickly, and therefore an in-year monitoring and management would be appropiate. Lack of biological information for this stock hampers the provision of advice on more appropriate management measures. Monitoring of the stock would require regular sampling together with information from a series of acoustic and egg surveys.

12.2 The Fishery in 1999

In 1999 the anchovy fishery in Division IXa was once more situated in the Gulf of Cadiz (Sub-division IXa South) as is usual in this area, except in 1995, when it was mainly found in the northern part of Division IXa (Figure 12.2.1.1). Anchovy is the target species of the Spanish purse-seine fleet in the Gulf of Cadiz. The Spanish and Portuguese purse-seine fleets in the northern part of Division IXa target anchovy when abundance is high, due to high market prices, as occurred in 1995 (ICES 1997/ Assess:3). In 1999, the anchovy fishery in the northern part of Division IXa was low, as is usual in this area.

The increase in anchovy abundance in the northern part of Division IXa in 1995 may have been due to a variation in thermohaline conditions in the coastal waters northwest of the Iberian Peninsula, less saline and warmer than in preceding years (Diaz del Río et al., 1996 and ICES 1997/C:3), thus creating more favourable conditions for reproduction and larval survival. Before 1995 and since 1996 a change in the previously described trend occurred, with lower temperatures and increased salinity being registered (ICES 1997/C:3, ICES 1998/C:8 and ICES 1999/C:8).

The Spanish fleet in the Gulf of Cadiz is mainly made up of purse-seiners, though there is currently another kind of fleet present in the form of trawlers, whose usual target species is the deep-sea rose shrimp (*Parapenaeus longirostris*). Some of these trawlers switch to targeting anchovy in years when the yield of shrimps is low. The Spanish fleet in the west of Galicia is composed of purse-seiners. The Portuguese fleet is mainly made up of purse-seiners, with some trawlers and artisanal ships fishing a very small quantity of anchovies (Table 12.2.1.2).

12.2.1 Landings in Division IXa

The total catch in 1999 was 7,408 t (Table 12.2.1.1 and Figure 12.2.1.1), which represents a 32.4% decrease compared to the level of 1998 catches (10,962 t). Nevertheless, the catch in 1999 is still higher than the average catch levels registered in this area since 1988 (excluding 1995 and 1998). The decreased catches in 1999 are explained by the decrease experienced by the Spanish catches in the Gulf of Cadiz (Sub-division IXa South), where the anchovy fishery mainly takes place.

The Spanish catches also decreased in 1999 (6,000 t) with respect to 1998 (9,349 t) due to the aforementioned decrease in catches in the Gulf of Cadiz (Sub-division IXa South). Thus, Gulf of Cadiz catches decreased to 5,587 t in 1999, breaking the increasing trend which started since 1996 and culminated in the historical maximum for this area in 1998 (8,977 t). The average catch in the Gulf of Cadiz between 1988 and 1998 is about 4,200 t. The Spanish catches in Sub-division IXa North (413 t) have showed a slight increase with respect to those recorded in 1998 (371 t). However, these catches are still lower than those in 1995 (5,329 t), remaining at the low levels usually found in the area. The Portuguese catch in 1999 (1,408 t) slightly decreased with respect to 1998 (1,613 t) and fell respect to 1995 (7,056 t), (Table 12.2.1.1 and Figure 12.2.1.1).

Table 12.2.1.2 shows the catch by fishing gear and by country. In both countries the main part of the catch was taken using purse-seine, this gear accounting for 84% in the Spanish fishery and 96% in the Portuguese one. Spanish trawl catches of anchovy from the Gulf of Cadiz decreased from 1,148 t in 1998 to 993 t in 1999, although their relative importance in the whole anchovy fishery in this area has increased up to 18% in 1999 (13% in 1998).

From 1943 to 1987, catch data were only provided by Portugal, which varied between 88 t and 12,610 t (Table 12.2.1.1). The Portuguese annual landings alternate between periods of high catches (1936-1940, 1942-1948, 1955-1957, 1962-1966 and 1995) and periods of very low catch levels (1927-1936, 1966-1976, 1979-1984 and 1987-1994) (Pestana, 1996). For this same period, the Spanish catch data from the Gulf of Cadiz (Sub-division IXa South) cannot be provided since they have been combined with anchovy catches in the area of Morocco, whereas catches in Galician waters (Sub-division IXa North) are not available. The historical series of Spanish catches started in 1988 for the Gulf of Cadiz, and in 1989 for the Galician waters. Total Spanish catches from Division IXa ranged between 1,824 t (1996) and 9,349 t (1998).

12.2.2 Landings by Sub-division

Since 1988, the anchovy fishery in Division IXa was situated in the Gulf of Cadiz (Sub-division IXa South), except in 1995, when it was mainly found in the northern part of Division IXa (Sub-division IXa North and Central-North).

The distribution of Spanish catches in 1999 was similar to that of the years 1988-1994 and 1996-1998 (ICES 1992/Assess:17, ICES 1993/Assess: 19, ICES 1995/Assess: 2, ICES 1996/Assess: 7, ICES 1998/Assess: 6, ICES 1999/ACFM:6 and ICES 2000/ACFM:5) and completely different to that of 1995 (ICES 1997/Assess: 3). In 1999, the greatest catches (93%) were found in Sub-division IXa South (Gulf of Cadiz), and the rest (7%) in Sub-division IXa North (West of Galicia). Catches in the Gulf of Cadiz take place throughout the year, usually increasing in spring and summer. In 1998, however, catches were relatively stable throughout the year without undergoing any significant rise in spring-summer. This seasonal pattern was also evidenced in 1999, although autumn catches showed a lesser relative importance than in the precedent year. The small catches in Sub-division IXa North occurred mainly in the first and third quarters.(Table 12.2.2.1).

The greatest contribution to Portuguese annual landings came from IXa South during the period 1943-1967 (mean value 4,526 t).Thereafter, landings decreased to 386 t (mean value) from 1968 to 1983, and to 32 t (mean value) from 1984 to 1991. From 1992 to 1995, landings were less than 1 tonne, in 1996-1997 they were 32 t (mean value). In 1998, Portuguese landings from IXa South increased to 566 t, then decreasing to 355 t in 1999. In Sub-division IXa Central-North there were alternate periods of relatively high and low landings. After 1984, landings of Sub-division IXa Central-North made the greatest contribution to total annual landings (mean value 1,116 t). The mean percentage of landings by Sub-division (1970-1995) is 70% of the total in IXa Central-North, 5% in IXa Central-South and 20% in IXa South. The same landing pattern occurs in Sub-divisons IXa Central-North and Central-South during the period from 1970-1994 and in 1995 (Pestana, WD 1996). In 1996-1999, catches in Sub-division IXa Central-North and Central-South fell, but maintained the same pattern of catches as in the period 1970-1995.

Most of the Portuguese landings were made between May and October (mean 1927-1994). The 1995 landings show a different evolution with two very important periods, from April to June and from August to December. (Pestana, 1996). In 1996-1999, catches are taken mainly in the first and fourth quarters (Table 12.2.2.1).

12.3 Fishery-Independent Information

12.3.1 Acoustic surveys

In 1993, a Spanish acoustic survey to estimate anchovy abundance was carried out off 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 acoustic surveys have been conducted in this area by Spain. In Sub-division IXa North, Spain has been conducting acoustic surveys aimed at sardine since 1983, but no anchovy schools were detected (Carrera et al., WD 1999; Carrera, WD 2000).

In previous years, information on anchovy from the Portuguese sardine egg- and acoustic surveys in Division IXa was not available as there is no research project for anchovy in Portugal. Nevertheless, the updated information provided by IPIMAR from the November 1998 and March 1999 acoustic surveys for sardine has provided data about anchovy distribution and abundance (Morais, WD 2000). 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 32,959 t in November 1998, and 25,359 t in March 1999 (Table 12.3.1.1, Figure 12.3.1.3 and 12.3.1.4). The biggest concentrations of anchovy occurred in the Gulf of Cadiz (Spanish waters of the Sub-division IXa South), which accounted for 90% of total estimated biomass in both surveys (30,092 t and 24,763 t, respectively). As deduced from the integration values, large portions of such concentrations were composed by very dense schools located near the bottom and in depths between 50 and 90 m. Nevertheless, other surveys should be analysed to confirm whether this behavior is exceptional or not.

Off the Portuguese shelf, large concentrations of anchovy were found only in the area in front of Lisbon (Sub-division IXa Central-South), rendering biomass estimates of 1,951 t (November 1998) and 406 t (March 1999). Only low anchovy concentrations were found in small areas in the rest of the shelf(Table 12.3.1.1, Figure 12.3.1.3 and 12.3.1.4).

The anchovy size composition in the Sub-division IXa Central-North was clearly dominated by smaller anchovies (≤12.5 cm TL) than the ones found in Sub-division IXa Central-South, where anchovies larger than 13 cm TL were predominant. These differences were more noticeable during the November 1998 survey (Figure 12.3.1.5).

In the Sub-division IXa South, 71% (November 1998) and 59% (March 1999) of the Gulf of Cadiz anchovies were between 12 and 14 cm TL, although juveniles (5.5-8.0 cm TL) were also present (5% of total numbers) in the November 1998 survey. The size composition of the Algarvian anchovy was only available from the November 1998 survey, where 91% of the anchovies were between 11-14 cm TL (Figure 12.3.1.5).

12.4 Biological Data

12.4.1 Catch numbers at age

Catches at age of anchovy for the whole Division IXa are not available. The only available estimates were provided by Spain for anchovy catches in the Gulf of Cadiz (Sub-division IXa South) for the period 1996-1999. These data have been presented for the first time in this Working Group (Millán and Ramos, WD 2000).

Portugal has not provided estimates of length or age composition of anchovy landings in Sub-divisions IXa Central (north and south) and South (Algarve). Catches at age were only provided for the Spanish fishery in Sub-division IXa North in 1995, and these catches consisted of age 1 anchovies (ICES 1997/Assess:3). Catches at age of anchovy from this Sub-division are not normally available since commercial landings used to be insignificant, making very difficult the biological sampling of commercial catches. A few otolith samples were also collected in 1999, following the same procedure as in 1998. However, catches at age estimates are not presented owing to the small number of sampled otoliths and their failure to cover the whole length range. They were not considered representative of the population. Further, samples did not cover all quarters in the year. In the 1999 sample, 58.8% of anchovies were found to be age 1, 40.0% age 2 and 1.2% age 3 (B. Villamor, pers. comm.).

Difficulties experienced in recent years in age determination of the Gulf of Cadiz anchovy using otolith examination has also prevented from providing catch at age estimates of the Spanish landings in this area. In 1997 and 1998, an otolith exchange for the Gulf of Cadiz anchovy was carried out within the International Project co-funded by the European Commission entitled European Fish Ageing Network (EFAN), which aims at solving the difficulties involved in age reading. The conclusions reported from this exercise confirmed the existence of problems in the interpretation of both the otolith edge and the annual rings, which led to state the need for establishing more standarised ageing criteria for the species in this area (García Santamaría, 1998). Bearing in mind these problems, Millán and Ramos (WD 2000) have presented estimates of the age composition of Gulf of Cadiz anchovy landings from 1996 to 1999. The authors have corroborated the above problems in anchovy ageing and, therefore, such estimates must be considered as preliminary.

The age composition of the Gulf of Cadiz anchovy landings from 1996 to 1999 is presented in Table 12.4.1.1 and Figures 12.4.1.1 and 12.4.1.2. The Gulf of Cadiz anchovy fishery is supported by the 0, 1 and 2 age-groups. These results differ from those obtained from the EFAN exercise, in which older anchovies of 3 and 4 years old were also identified. By applying length frequency analysis methods to the 1989-1993 data series, Bellido *et al.* (2000) also conclude that the fishery is mainly supported by the 0, 1 and 2 age-groups, 2 year-old fish making up for only 3% of the fishery (pooled data for the whole series).

Following the estimates given in the WD, the contribution of the 0 and 1 age groups in 1996 and 1997 was different to that observed in 1998 and 1999 (Figure 12.4.1.1). In the first two years, the percentage composition of both age groups in landings was similar, with percentages around 50% each, whereas in the two following years 1 year-old anchovies largely dominated the landings, representing 69% and 73%, respectively.

Recruits showed a decreasing trend in relative numbers and weights during the period analysed, the lowest percentage (22%) being recorded in 1999. However, the highest catches in number and weight at age 0 in absolute terms were landed in 1998 and the lowest ones in 1999.

The success of the Gulf of Cadiz anchovy fishery is mainly related to the high abundance of the 1 year-old anchovies (Figure 12.4.1.2). This fact became apparent in 1998 and 1999, when 1 year-old anchovies (1997 and 1998 year classes) made up for 78% and 81% of the landings.

The 2 year-old anchovies were poorly represented in the landings, ranging between 1% (1996 and 1998) and 8% (1997). In 1999, this age group made up for about 5% of the total catch in numbers.

Landings of the 0 age-group anchovies were restricted to the second half in the year, whereas those of 1 and 2 year-old anchovies were present throughout the year, although they were 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 1999 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 1999 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 from 1988 to 1999. Figure 12.4.2.2 compares length distributions in Sub-divisions IXa South and IXa North from 1995 to 1999.

In 1999, as in previous years, a large number of juveniles were captured (individuals less than 10 cm long) in Sub-division IXa South 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 catch in Sub-division IXa South are smaller than those recorded from Sub-division IXa North (Table 12.4.2.2 and Figures 12.4.2.1 and 12.4.2.2).

Mean Length- and Mean Weight at Age in Landings

Mean length- and mean weight at age data for the whole Division IXa are not available for 1999 for the same reasons as explained previously (see Section 12.4.1).

Mean length and mean weight at age for 1 year-old fish in the catch of Sub-division IXa North in 1995 were 15.6 cm and 26.0 g respectively (ICES 1997/Assess:3). From the small samples of otoliths obtained in Sub-division IXa North in 1999, mean lengths were 15.5 cm, 17.6 cm and 17.9 cm for ages 1, 2 and 3 respectively (B. Villamor, pers. comm.). These mean lengths at age were almost identical to those estimated from the 1998 otolith sample (ICES 2000/ACFM: 5)

Mean lengths were estimated at 9.3 cm for age 0, 12.4 cm for age 1, 13.7 cm for age 2, 15.0 cm for age 3 and 15.5 for age 4 from the sample of otoliths of the Gulf of Cadiz anchovies (Sub-division IXa South) used in the EFAN otolith exchange (García Santamaría, 1999). As previously cited, Millán and Ramos (WD 2000) only recorded anchovies not older than 2 years. The annual and quarterly estimates of mean length- and mean weight at age in the 1996-1999 Spanish landings are showed in Tables 12.4.2.3 and 12.4.2.4. The smallest annual mean length- and mean weight at ages 0 and 1 were recorded in 1996 (6.3 cm and 6.9 cm; 2 g and 3 g).

An increase in the mean length (from 7.6 cm to 8.3 cm) was observed in the 0 age group between 1997 and 1998. A decrease to 7.4 cm was noted in 1999. The mean weight of this age group after 1996 varied between 3g (1997, 1999) and 4 g (1998).

Since 1997 onwards, the mean length at age 1 was mantained at around 10 cm, its mean weight ranging between 7 g (1998) and 9 g (1999). The mean length of the two year-old anchovies ranged between 13.6 cm and 14.3 cm, showing a stable inter-annual trend throughout the four-year period. Conversely, annual mean weights at age 2 showed a decreasing trend, from 19 g in 1996 to 16 g in 1998, but then increasing up to 18 g in 1999.

Seasonally, 0 age-group anchovies are larger and heavier in the fourth quarter. The 1 and 2 year-old anchovies showed 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 study undertaken over a four-year period (1989-1992) in the Spanish waters of the Gulf of Cadiz (Sub-division IXa South) show that the anchovy 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 reached 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).

Recent data from the Portuguese acoustic surveys in November 1998 and March 1999 (Morais, pers. comm.) indicated that 45% of anchovies in November 1998 and 78% in March 1999 were mature in the Algarve-Gulf of Cádiz area. 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 (see section 12.3.1 and Morais, WD 2000). 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.

12.5 Effort and Catch per Unit Effort

Data provided on fishing effort (number of effective fishing trips) and CPUE indices of anchovy in Division IXa correspond to the Spanish purse-seine fleet in the Gulf of Cadiz from 1988 to 1999, and to the Spanish purse-seine fleet in Sub-division IXa North from 1995 to 1999 (Table 12.5.1 and 12.5.2). No Portuguese data are available.

The effort and CPUE series of the Barbate single-purpose fleet in the Gulf of Cadiz experienced a strong declining trend from 1991 to 1995, this last year registering the lowest values for both variables. The decrease in fishing effort was not evident in the remaining Spanish fleets which showed fluctuating effort levels. However, their CPUE series also exhibited decreasing trends. Since 1996 onwards, an increase in effort is observed in the Barbate single-purpose and Sanlucar fleets, with a considerable increase in CPUE in the Barbate single-purpose fleet (Figure 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 (Figure 12.5.2).

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

Despite new biological information presented this year, no assessment of this stock can be made for the following reasons:

Catch-at-age data are only available for one part of the stock (Spanish Gulf of Cadiz), and this data series is still short (1996-1999).

The series of biomass estimates from acoustic surveys is also very short.

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 (see Sections 12.3 and 12.4), support the view that the populations inhabiting these areas may have different biological characteristics and dynamics.

Anchovy biomass in Division IXa was estimated at 32,959 t in November 1998 and at 25,359 t in March 1999 from acoustic surveys, 90% of these estimated biomass corresponded to the Gulf of Cadiz in both surveys (30,092 t and 24,763 t respectively). Anchovy biomass in the Gulf of Cadiz was estimated as 6,569 t in an acoustic survey in 1993.

Because of the lack of a more complete biological information, the state of the stock is unknown. By analogy with the anchovy stock in Sub-area VIII, it seems that this stock will fluctuate widely due to variations in recruitment largely driven by environmental factors.

12.8 Catch Preditions

No catch preditions 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 were the same as for the previous year and are summarised by Millan and Villamor (WD 1992). It must be pointed out that the purse-seine fleet in the Gulf of Cadiz did not observe the normal voluntary closure of three months in 1997, 1998 and 1999 (ICES 1992/Assess:17, ICES 1993/Assess:19, ICES 1995/Assess: 2, ICES 1996/Assess: 7, ICES 1997/Assess: 3 and ICES 1998/Assess: 6). The fleet probably continued fishing because of higher anchovy abundance.

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 catches (excluding 1995 and 1998) is recommended. The mean catches from the period 1988-1999 (excluding 1995 and 1998) are about 4,900 t.

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

(-) Not available
(0) Less than 1 tonne

Table 12.2. 1.2 ANCHOVY IXa. Catches (t) by gear and by country in 1988-1999.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594
Trawl IX a South	0.0	0.0	0.0	0.0	0.0	330	152	75	224	190	1148	993
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408
Trawl					4	9	1		56	46	37	43
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346
Artisanal					1	1	3		94	7	35	20
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409

* Portugal data without separate the catch by gear

Table 12.2.2.1 Anchovy catches (t) in Division IXa by country and Subdivisions in 1999.

COUNTRY	SUBDIVISIONS	QUARTER 1 C(t)	QUARTER 1 %	QUARTER 2 C(t)	QUARTER 2 %	QUARTER 3 C(t)	QUARTER 3 %	QUARTER 4 C(t)	QUARTER 4 %	ANUAL C (t)	ANUAL %
SPAIN	**IXa North**	76	18.4	7	1.8	318	76.9	12	2.9	413	6.9
	IXa South	1335	23.9	1982	35.5	1582	28.3	687	12.3	5587	93.1
	TOTAL	1411	23.5	1990	33.2	1900	31.7	699	11.6	6000	
PORTUGAL	**IXa Central North**	91	9.5	4	0.4	139	14.5	723	75.5	957	68.0
	IXa Central South	65	68.2	0	0.2	0	0.2	30	31.3	96	6.8
	IXa South	303	85.3	13	3.5	35	9.8	5	1.3	355	25.2
	TOTAL	460	32.6	17	1.2	174	12.4	758	53.8	1408	
TOTAL	**IXa North**	76	18.4	7	1.8	318	76.9	12	2.9	413	5.6
	IXa Central North	91	9.5	4	0.4	139	14.5	723	75.5	957	12.9
	IXa Central South	65	68.2	0	0.2	0	0.2	30	31.3	96	1.3
	IXa South	1638	27.6	1995	33.6	1617	27.2	692	11.6	5942	80.2
	TOTAL	1871	25.3	2006	27.1	2074	28.0	1457	19.7	7408	

Table 12.3.1.1. Estimated abundance in number (millions) and biomass (tonnes) from the 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 (t)	313	1951	603	2867	30092	32959
March 1999	**Number**	22	15	*	37	2079	2116
	Biomass (t)	190	406	*	596	24763	25359

* 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.

Table 12.4.1.1. Spanish catches in numbers at age (in thousands) of Gulf of Cadiz anchovy for 1996-1999, by year and quarter.

YEAR		QUARTERS				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	413465	71074	317216
	1	12772	130880	11550	7281	327614
	2	13	882	826	333	4249
	Total (n)	12785	131761	425842	78688	649078
	Catch (t)	41	807	585	348	1780
	SOP	36	742	619	299	1680
	VAR.%	88.11	92.06	105.87	85.97	94.36
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	237283	96475	273842
	1	67055	123878	69278	19430	330348
	2	22601	9828	11649	745	53737
	Total (n)	89656	133706	318211	116650	657927
	Catch (t)	906	1110	2006	578	4600
	SOP	844	1273	1923	596	4590
	VAR.%	93.07	114.71	95.88	103.07	99.78
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	75708	360599	432554
	1	325407	384529	220869	84729	1017658
	2	11066	879	1316	0	14889
	Total (n)	336473	385408	297893	445329	1465102
	Catch (t)	1773	2113	2514	2579	8977
	SOP	1923	2128	2599	2655	9299
	VAR.%	108.46	100.72	103.41	102.95	103.59
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0	0	0	40549	84234	140055
	1	249922	115218	86931	20276	458099
	2	10982	18701	2450	146	30085
	Total (n)	260904	133919	129931	104656	628239
	Catch (t)	1335	1983	1582	687	5587
	SOP	1330	1756	1391	673	5111
	VAR.%	99.61	88.60	87.90	98.02	91.48

Table 12.4.2.1: Length distribution ('000) of ANCHOVY in Division IXa by country and Sub-divisions in 1999.

	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
Length (cm)	**SPAIN IXa North**	**PORTUGAL IXa C,CN,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa C,CN,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa C,CN,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa C,CN,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa C,CN,S**	**SPAIN IXa South**
3.5	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
4	0	-	1831	0	-	0	0	-	0	0	-	0	0	-	1831
4.5	0	-	15819	0	-	0	0	-	1236	0	-	0	0	-	17055
5	0	-	38804	0	-	0	0	-	2296	0	-	0	0	-	41100
5.5	0	-	34062	0	-	0	0	-	2119	0	-	0	0	-	36181
6	0	-	17339	0	-	0	0	-	1854	0	-	173	0	-	19366
6.5	0	-	16299	0	-	0	0	-	2914	0	-	1208	0	-	20421
7	0	-	11705	0	-	0	0	-	3974	0	-	2070	0	-	17749
7.5	0	-	5577	0	-	0	0	-	7647	0	-	5865	0	-	19089
8	0	-	1862	0	-	134	0	-	7363	0	-	11475	0	-	20835
8.5	0	-	1603	0	-	554	0	-	4464	0	-	9103	0	-	15724
9	0	-	2350	0	-	1072	0	-	2501	0	-	9015	0	-	14937
9.5	0	-	3593	0	-	2005	0	-	1498	0	-	10390	0	-	17487
10	0	-	5977	0	-	4585	0	-	2176	0	-	10792	0	-	23530
10.5	0	-	8935	0	-	5913	0	-	3478	0	-	13156	0	-	31482
11	0	-	9936	0	-	8294	0	-	7644	0	-	7719	0	-	33593
11.5	0	-	15791	0	-	11202	0	-	8584	0	-	4427	0	-	40004
12	0	-	21447	0	-	20221	0	-	8678	0	-	5267	0	-	55614
12.5	0	-	22351	0	-	25349	0	-	11085	0	-	7599	0	-	66384
13	0	-	14835	0	-	17713	0	-	16058	0	-	4020	0	-	52625
13.5	76	-	6386	0	-	16773	16	-	14220	1	-	1340	92	-	38719
14	218	-	2432	0	-	10084	27	-	9776	1	-	670	246	-	22962
14.5	360	-	1453	0	-	5626	133	-	5985	5	-	184	497	-	13247
15	839	-	400	20	-	2830	208	-	3397	8	-	184	1075	-	6811
15.5	339	-	118	71	-	1564	721	-	741	28	-		1160	-	2422
16	196	-		92	-	659	1320	-	229	51	-		1658	-	889
16.5	90	-		71	-	227	2185	-	18	84	-		2430	-	246
17	45	-		10	-		2086	-		80	-		2221	-	0
17.5	178	-		0	-		1482	-		57	-		1717	-	0
18	134	-		0	-		878	-		34	-		1045	-	0
18.5	59	-		0	-		325	-		12	-		397	-	0
19	164	-		0	-		147	-		6	-		317	-	0
19.5	89	-		0	-		46	-		2	-		138	-	0
20	0	-		0	-		0	-		0	-		0	-	0
20.5	0	-		0	-		0	-		0	-		0	-	0
21	0	-		0	-		0	-		0	-		0	-	0
21.5	0	-		0	-		0	-		0	-		0	-	0
22	0	-		0	-		0	-		0	-		0	-	0
Total N	2787	-	260904	265	-	134805	9574	-	129938	367	-	104656	12993	-	630304
Catch (T)	76	460	1335	7	17	1983	318	174	1582	12	758	687	413	1408	5587
L avg (cm)	16.0	-	8.7	16.2	-	12.7	17.1	-	11.4	17.1	-	10.2	16.8	-	10.4
W avg (g)	27.3	-	5.1	27.3	-	14.7	33.2	-	12.2	33.2	-	6.6	31.8	-	8.9

Table 12.4.2.2: Annual Length distribution ('000) of ANCHOVY in Division IXa from 1988 to 1999.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999	
Length (cm)	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South
3.5											1349						
4			4011	258	1						12677						1831
4.5		127	16601	3306	26	22					67819		1333		4656		17055
5	128	452	29122	43814	80	22					160894		11492		25825		41100
5.5	170	813	43716	77144	345	66					129791		38722		57086		36181
6		994	39979	43378	921	180					52812		53185		82442		19366
6.5		1207	37909	24724	2337	611	5488				33640		50275		76694		20421
7	255	2391	29592	15470	3567	1862	12009				32469		62492		68074		17749
7.5	351	5764	27140	16574	5993	3561	18391		439		19088		42120		43197		19089
8	3163	24708	24315	16633	12777	4083	23533		439		8949		45120		32964		20835
8.5	8073	62795	33427	15724	18240	2626	22031		447		11776		36200		47796		15724
9	12602	52082	46239	19735	14461	3843	20272		3108		12007		20009	156	78561		14937
9.5	21594	42387	74823	30742	20684	6848	14835		9805		6844		13611	367	106350		17487
10	34293	67553	95844	39474	31524	7100	23726		11823		4887		8951	754	132106		23530
10.5	49922	69793	96132	71062	31870	9496	27521		14966		7156		12231	1486	150718		31482
11	63848	68387	72419	83835	31776	9401	28394		8575		17343		22647	2047	158806		33604
11.5	55186	55528	63427	81931	31150	11636	33602		7105		21738		27353	1477	133585		40004
12	60928	41099	44273	77372	34504	24713	26439	74	4565		17855		39131	1267	99586		55614
12.5	37457	34212	28509	51932	29185	32918	30192	711	3606		11544		45267	1178	76285		66384
13	22608	17989	15263	43309	17040	26293	15732	3049	1855	8	6450	374	46852	2737	44979		52625
13.5	8149	11505	10619	25316	5725	12681	8517	3381	1544	12	4468	997	38183	2403	25038	92	38719
14	4270	7747	4689	17842	3378	5318	5719	14998	935	258	3880	2004	19127	3038	11847	246	22962
14.5	474	3190	1206	5211	2180	2535	4763	25944	135	335	1990	422	11268	2813	5712	497	13247
15	3896	2245	605	1987	315	943	3612	46371	138	375	790	48	6370	1976	2080	1075	6811
15.5	2436	1671	318	944	922	510	874	42244	6	226	703	40	3764	890	579	1160	2422
16	2126	4676	340	1533	355	56	813	44171		227	159	33	2224	560	138	1658	889
16.5	1690	7271	565	2087	271		368	14369		151		10	296	330		2430	246
17	1096	4349	373	1655	95		182	8378		104		10		438		2221	
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
Catch (T)	4263	5336	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587
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
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

Table 12.4.2.3. Mean length (±SD) at age (TL, in cm) in the Spanish catches of Gulf of Cadiz anchovy on a yearly and quarterly basis (1996-1999).

YEAR		**QUARTERS**				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			5.6 (0,8)	7.3 (1,9)	6.3 (1,9)
	1	7.4 (1,9)	8.5 (3,5)	12.9 (1,0)	13.7 (0,6)	6.9 (2,8)
	2	14.0 (0,4)	13.9 (0,4)	15.2 (0,5)	15.6 (0,2)	14.3 (0,7)
	Total	7.4 (1,9)	8.5 (3,5)	5.8 (1,5)	7.9 (2,7)	6.6 (2,5)
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.1 (1,4)	8.1 (1,8)	7.6 (1,6)
	1	10.0 (2,5)	10.5 (2,5)	13.1 (1,0)	13.0 (0,9)	10.2 (3,0)
	2	13.4 (0,6)	14.0 (0,6)	15.0 (0,8)	15.1 (0,4)	13.8 (0,9)
	Total	10.9 (2,6)	10.8 (2,6)	8.7 (3,0)	8.9 (2,5)	9.4 (3,0)
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.1 (1,9)	8.8 (2,1)	8.3 (2,2)
	1	9.5 (1,8)	9.2 (2,2)	11.9 (1,1)	12.2 (0,9)	10.2 (2,1)
	2	13.23 (0,6)	14.0 (0,4)	15.0 (0,5)		13.6 (0,8)
	Total	9.6 (1,9)	9.2 (2,2)	10.7 (2,5)	9.5 (2,3)	9.7 (2,3)
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			7.7 (1,6)	9.3 (1,3)	7.4 (2,2)
	1	8.2 (3,1)	12.2 (1,2)	12.7 (1,3)	12.5 (0,7)	10.7 (2,8)
	2	13.4 (0,7)	14.1 (0,7)	15.2 (0,4)	14.9 (0,2)	14.0 (0,9)
	Total	8.4 (3,3)	12.5 (1,3)	11.2 (2,8)	10.0 (1,7)	10.1 (3,1)

Table 12.4.2.4. Mean weight (±SD) at age (in g) in the Spanish catches of Gulf of Cadiz anchovy on a yearly and quarterly basis (1996-1999).

YEAR		QUARTERS				
1996	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			1.1 (0,6)	2.6 (2,0)	1.9 (2,4)
	1	2.8 (2,0)	5.6 (4,7)	14.2 (3,4)	15.3 (2,2)	3.1 (4,3)
	2	17.6 (1,5)	17.0 (1,5)	23.1 (2,2)	22.8 (0,9)	18.9 (3,2)
	Total	2.8 (2,1)	5.6 (4,8)	1.5 (2,5)	3.9 (4,4)	2.6 (3,8)
1997	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			2.6 (1,6)	3.4 (2,7)	3.1 (2,3)
	1	7.3 (4,5)	8.8 (5,2)	15.1 (3,5)	13.1 (3,0)	8.5 (5,8)
	2	15.6 (2,5)	18.6 (2,7)	22.8 (3,6)	21.3 (1,9)	17.5 (3,7)
	Total	9.4 (5,4)	9.5 (5,6)	6.0 (6,5)	5.1 (4,7)	7.0 (6,1)
1998	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			2.6 (2,3)	4.7 (2,9)	4.1 (2,9)
	1	5.44 (2,8)	5.5 (3,6)	10.7 (3,0)	11.2 (2,7)	7.2 (3,9)
	2	13.78 (1,9)	18.7 (1,8)	21.6 (2,2)		16.1 (3,1)
	Total	5.7 (3,2)	5.5 (3,7)	8.7 (4,6)	6.0 (3,9)	6.3 (4,0)
1999	**AGE**	**1**	**2**	**3**	**4**	**Annual total**
	0			3.2 (2,2)	5.1 (2,0)	3.1 (2,8)
	1	4.7 (4,7)	12.1 (3,7)	13.9 (4,0)	11.7 (2,1)	9.0 (5,3)
	2	14.6 (2,7)	19.5 (3,5)	23.5 (1,9)	19.9 (0,8)	17.8 (3,6)
	Total	5.1 (5,0)	13.1 (4,5)	10.7 (6,3)	6.4 (3,3)	8.1 (2,8)

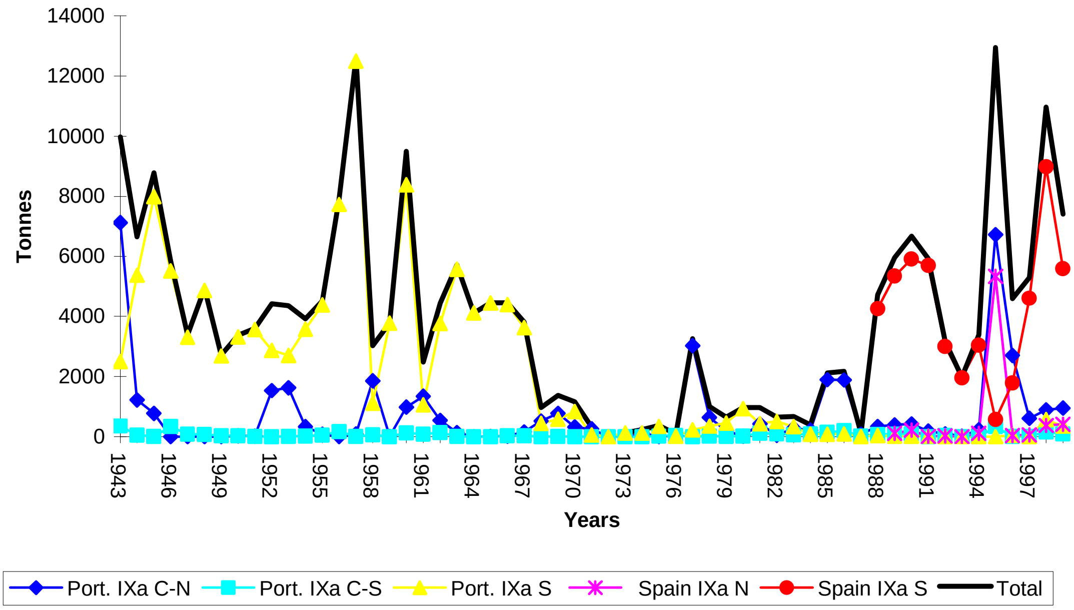
Table 12.5.1 ANCHOVY in Division IXa. Effort data : Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) number of fishing trips.

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE	BARBATE	SAN LUCAR	I. CRISTINA	I.CRISTINA	VIGO	RIVEIRA
Year	Single purpose	Multi purpose	Multi purpose	Single purpose	Multi purpose		
	No. fishing trip					No. fishing trip	
1988	3958	17	210	-	-	-	-
1989	4415	39	234	-	-	-	-
1990	4622	92	660	-	-	-	-
1991	3981	40	919	-	-	-	-
1992	3450	116	583	-	-	-	-
1993	2152	5	225	-	-	-	-
1994	1625	69	899	196	28	-	-
1995	528	17	377	22	17	1537	252
1996	1595	89	1659	76	55	32	3
1997	2207	115	1738	75	13	31	23
1998	2153	-	2234	177	30	134	269
1999	1762	9	2167	330	257	51	85

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

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
	BARBATE	BARBATE	SAN LUCAR	I. CRISTINA	I.CRISTINA	VIGO	RIVEIRA
Year	Single purpose	Multi purpose	Multi purpose	Single purpose	Multi purpose		
	kg/No. fishing trip					kg/No. fishing trip	
1988	1047	461	420	-	-	-	-
1989	1139	534	943	-	-	-	-
1990	1128	287	643	-	-	-	-
1991	1312	339	456	-	-	-	-
1992	819	173	300	-	-	-	-
1993	641	268	225	-	-	-	-
1994	1326	262	398	204	174	-	-
1995	377	134	166	52	25	2509	2286
1996	497	315	246	137	157	847	4
1997	1580	306	288	134	163	1068	639
1998	3144	-	221	242	197	1489	512
1999	2162	219	241	134	150	1088	1585

Figure 12.2.1.1: Portuguese and Spanish annual landings of Anchovy in Division IXa since 1943



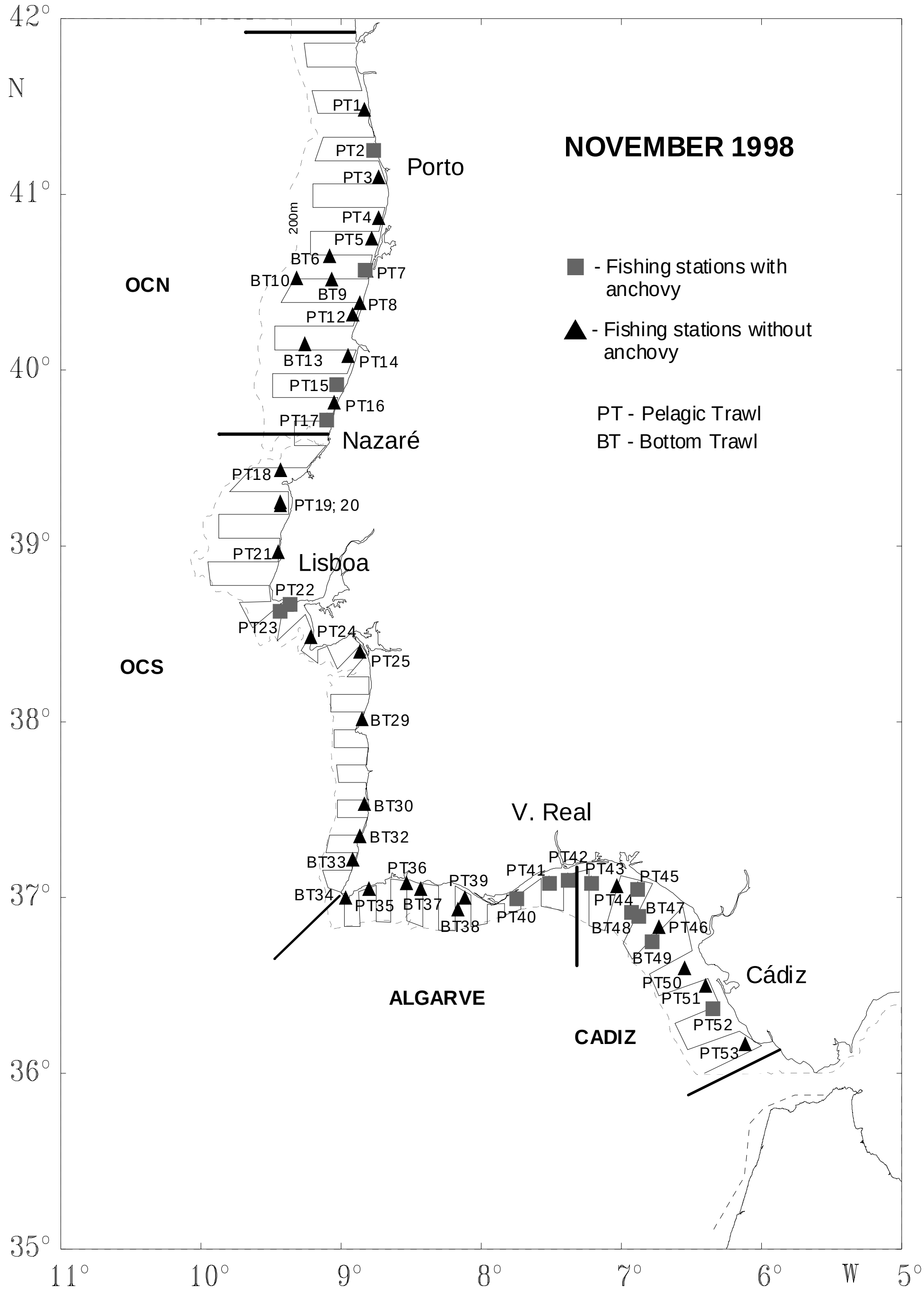


Figure 12.3.1.1. Survey track design and location of trawl stations (with and without anchovy) in November 1998 acoustic survey.

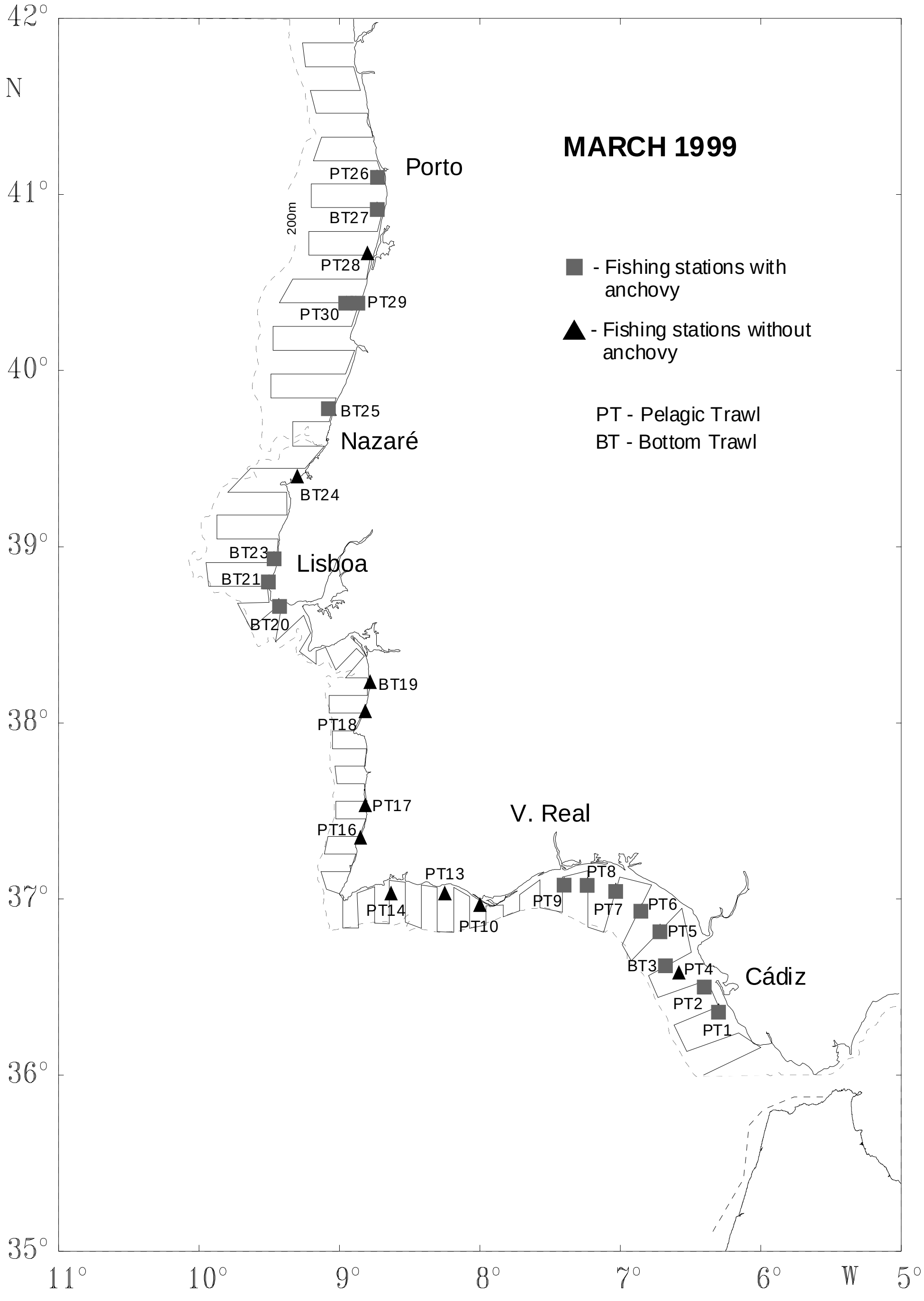


Figure 12.3.1.2 - Survey track design and location of trawl stations (with and without anchovy) in March 1999 acoustic survey.

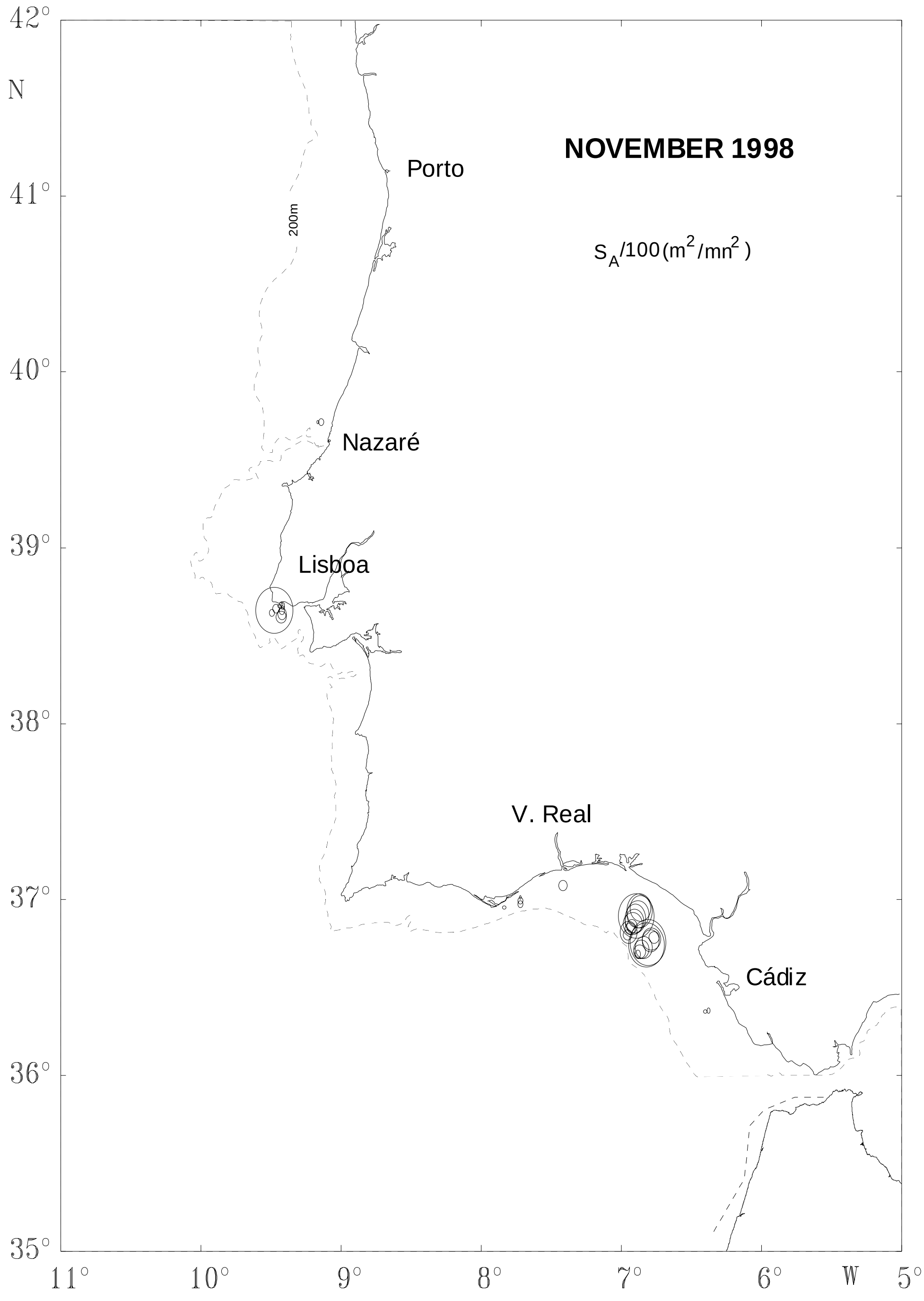


Figure 12.3.1.3 – Acoustic energy distribution per nautical mile during the November 1998 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

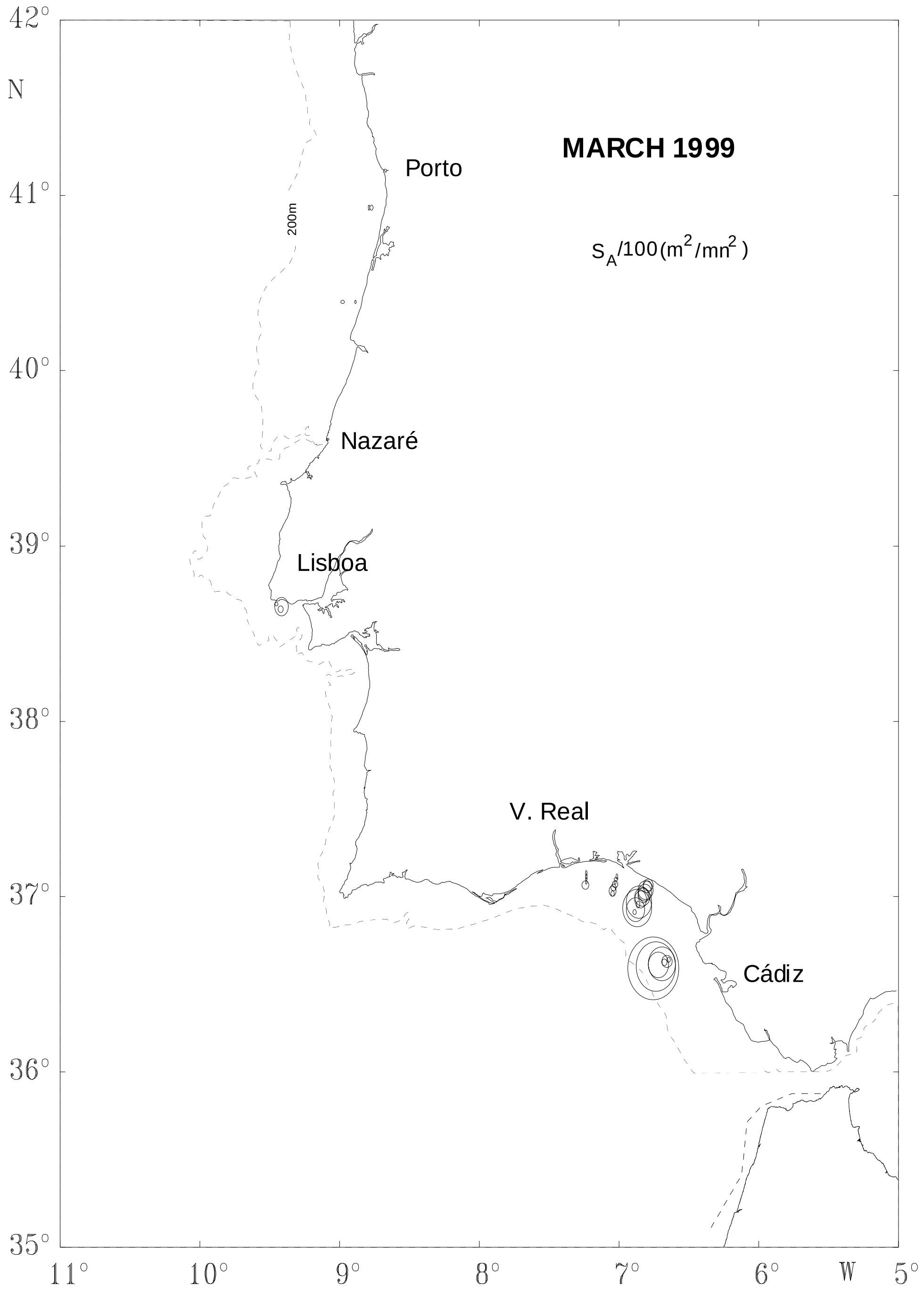


Figure 12.3.1.4 – Acoustic energy distribution per nautical mile during the March 1999 survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

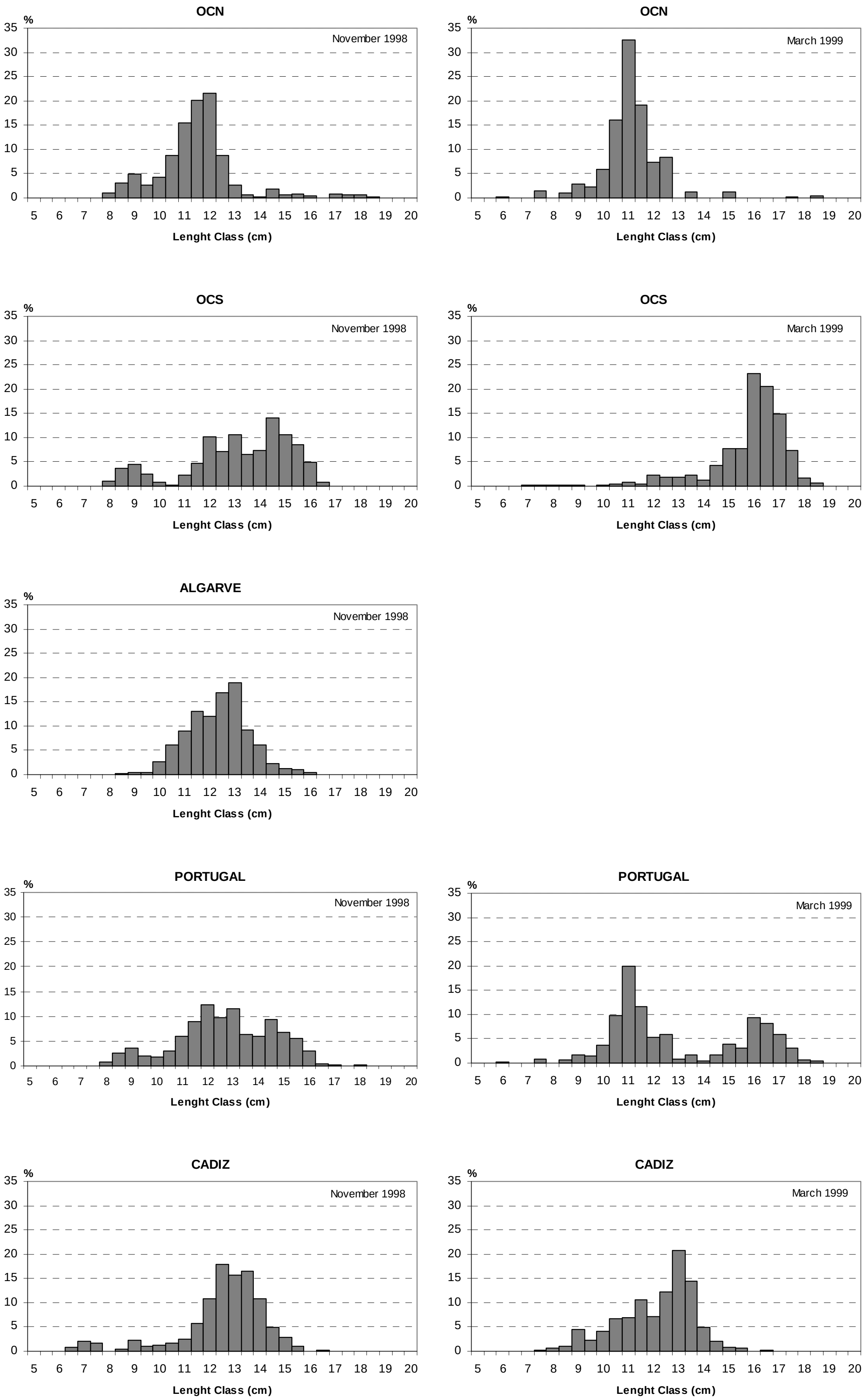


Figure 12.3.1.5 – Distribution of length class frequency (%) by region during the November 1998 and March 1999 acoustic surveys.

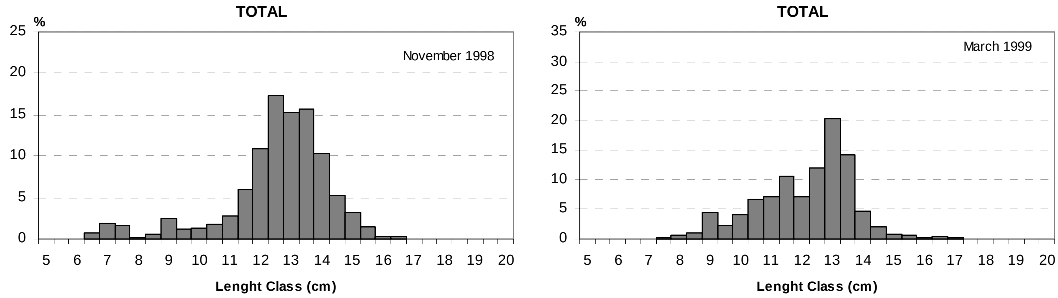


Figure 12.3.1.5 (cont.) – Distribution of length class frequency (%) for the total area during the November 1998 and March 1999 surveys.

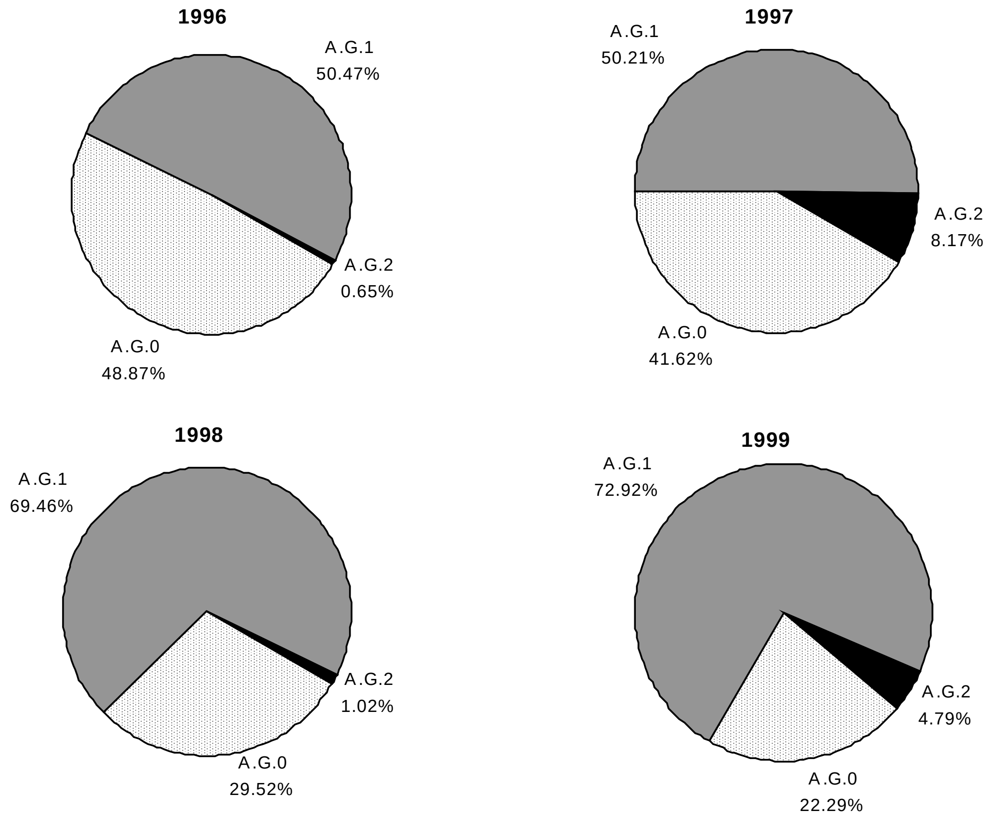


Figure 12.4.1.1. Annual relative numbers at age in the catches of Gulf of Cadiz anchovy (1996-1999).

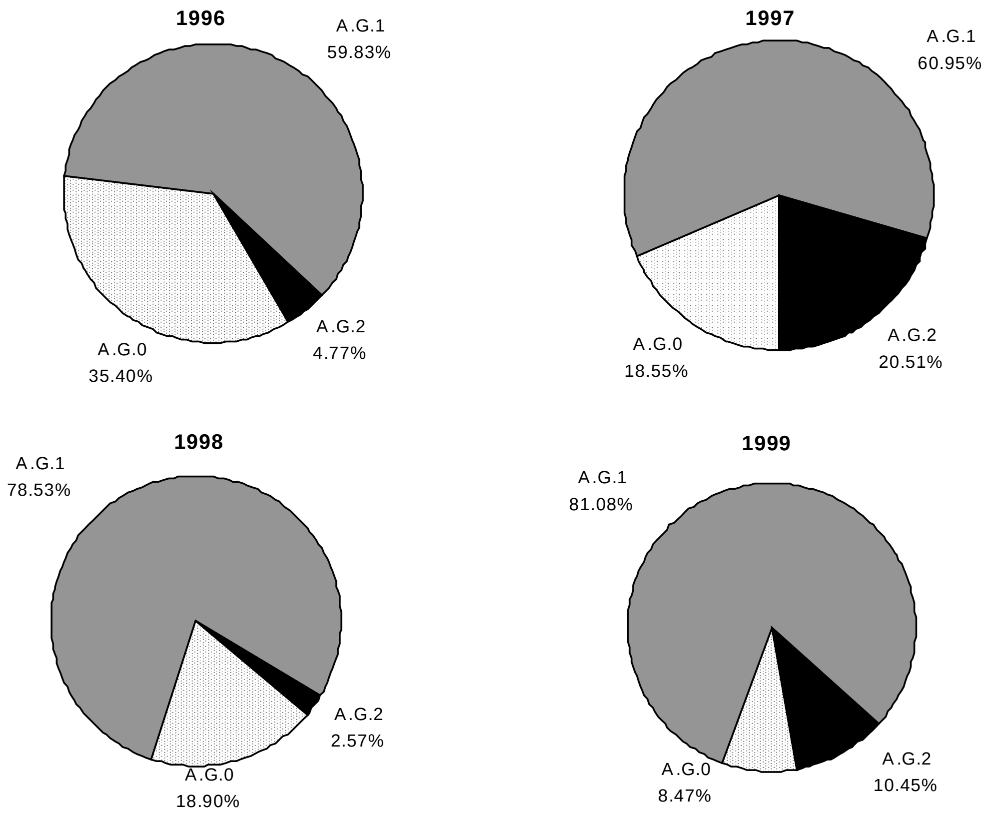


Figure 12.4.1.2. Annual relative weights at age in the Spanish catches of Gulf of Cadiz anchovy (1996-1999).

Figure 12.4.2.1: Length distribution ('000) of landings of ANCHOVY in Sub-divisions IXa South(Gulf of Cadiz) and IXa North (Western Galicia) by quarter in 1999

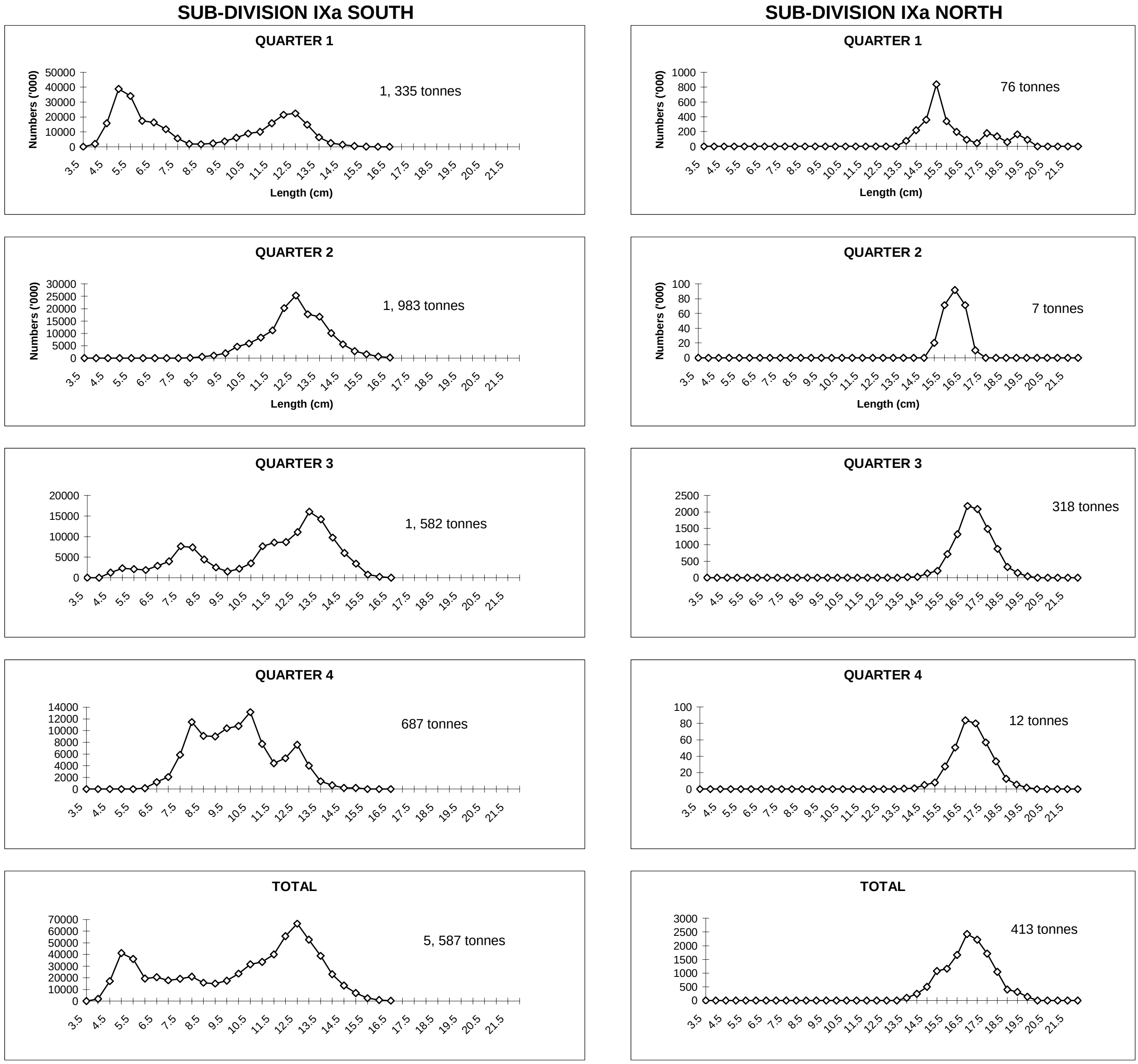
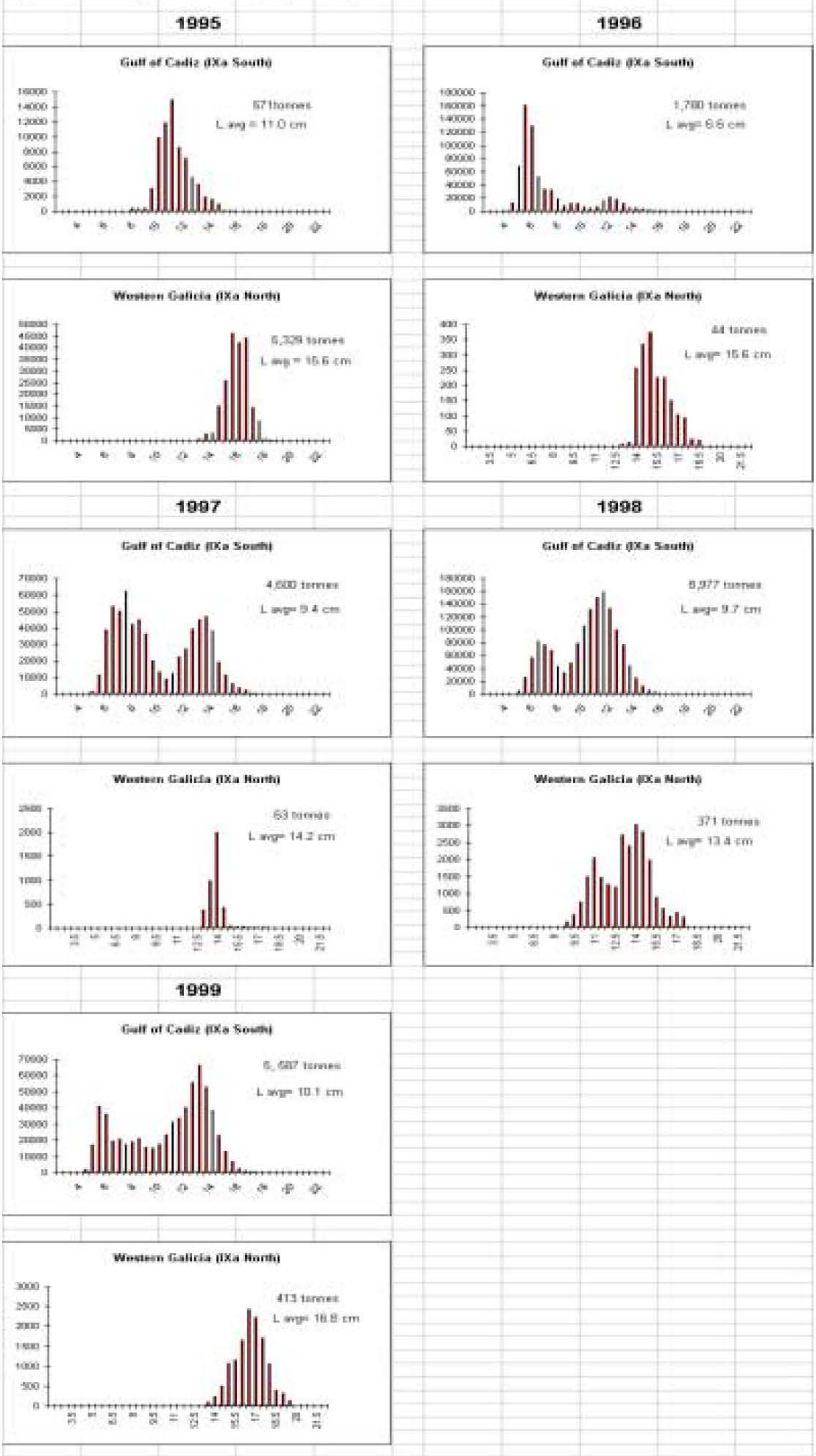
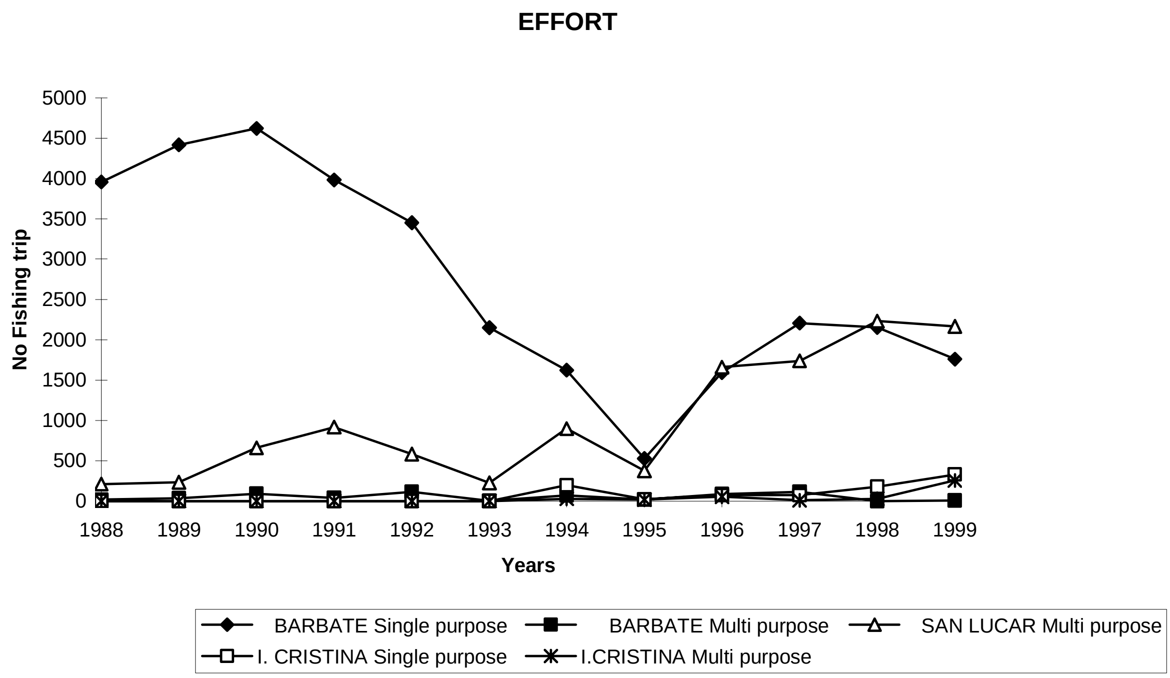


Figure 12.4.2.2 Length distribution ('000) of Anchovy in Sub-division IXa South and IXa North. 1995-1999





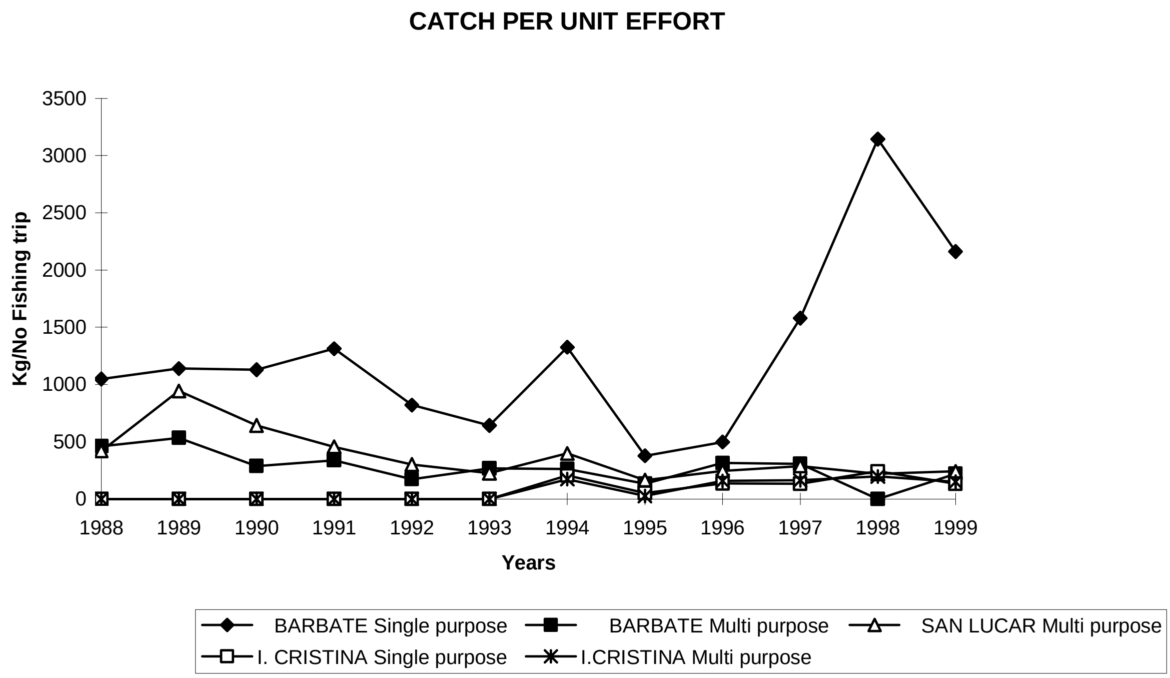
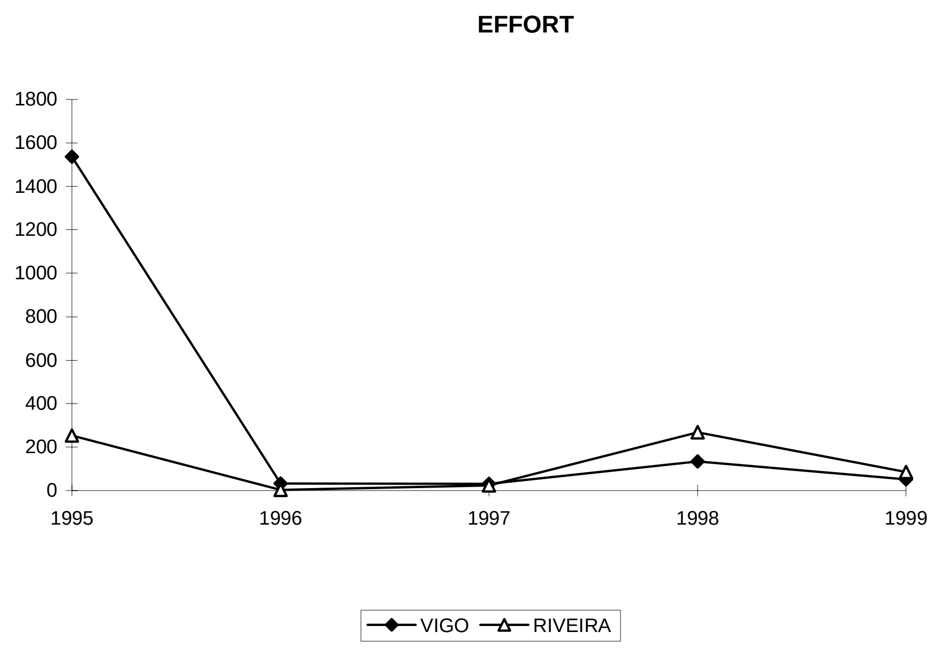


Figure12.5.1 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) Effort and CPUE series in comercial fisheries.



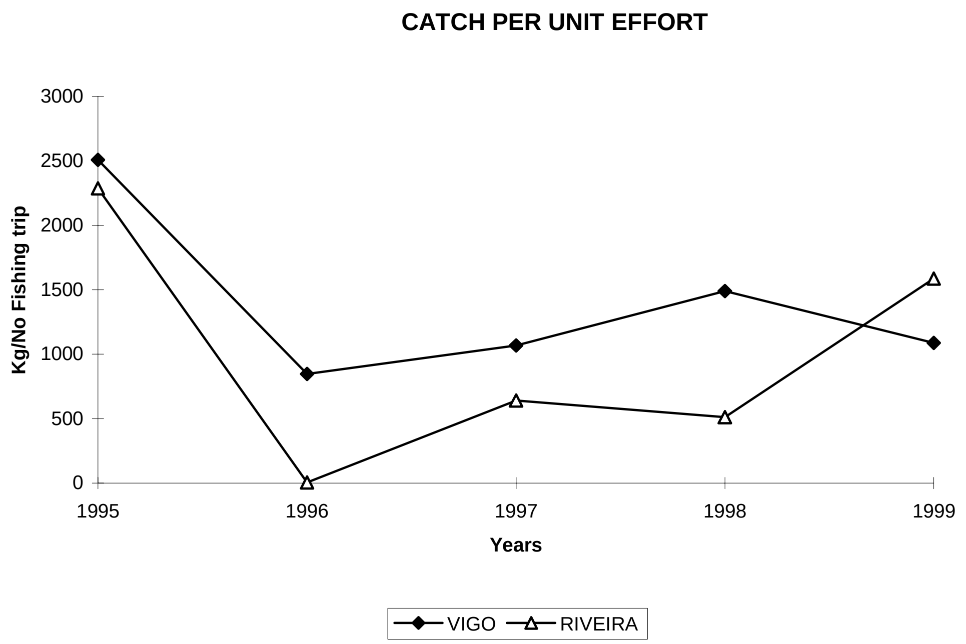


Figure12.5.2 ANCHOVY in Division IXa. Spain IXa North (Galician West) Effort and CPUE series in commercial fisheries.

13 RECOMMENDATIONS

General

The Working Group recommended that Dankert Skagen, who was only appointed for a term of one year, be appointed as chairman of the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group for a new term of 3 years.

The Working Group strongly recommends that the collection programme outlined by Working Group on Mackerel and Horse Mackerel Egg Surveys in response to T.o.R. c) (see above) be carried out in full. Furthermore the Working Group recommends that the collection of data on primary adult parametrs – fecundity and atresia – be carried out on an annual basis. To this end all institutes which are in a position to collect adult fish in the western spawning area in the first quater are encouraged to do, following preservation protocols designated by CEFAS.

The Working Group recommends that a directory be allocated on the ICES server to store relevant documentation and the most recent version of exchange sheets and programmes used to aggregate the data, and that these items be available over the ICES web server.

Mackerel & Horse Mackerel

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 to combine the horse mackerel fecundity estimates from Division IXa with those already presented for Division VIIIc, to obtain, as soon as possible, an estimation of the southern horse mackerel SSB from 1998 egg survey.

The Working Group recommends that the assessment data be prepared before next years Working Group meeting in order to be able to do an assessment fot the North East Atlantic Mackerel over the period 1972-2000 at it next meeting.

Sardine

The Working Group recommends that observers should be placed on vessels in order estimate discards in fisheries where mackerel discarding is perceived to be a problem.

The Working Group strongly recommends the creation of a Study Group on the Estimation of Sardine and Anchovy Spawning Stock Biomass by the Daily Egg Production Method, in order to carry on the studies already started in this area in a context profiting of the different experiences in the two species.

The Working Group recommends that studies for sardine stock identification should be continued in order to clarify the population structure within the current stock limits and the relationships with adjacent areas.

Considering current uncertainty in stock assessment and the inadequacy of the current model to explain all variability in the stock dynamics, the Working Group recommends the exploration of alternative assessment methods.

The Working Group recommends to carry on the application of the Daily Egg Production Method (DEPM) in Divisions VIIIc and IXa according to the sardine peak of spawning season in each of these areas.

The Working Group recommends that Portugal continues to perform the November acoustic survey which coincides with the spawning aggregation of sardine in the Portuguese area of Division IXa.

The Working Group also recommends to the continuation of joint acoustic surveys covering the in Divisions VIIIc and IXa each year in March-April. In order to understand the population distribution of sardine these surveys also must investigate the adjacent areas, mainly the French coast.

The Working Group recommends that all the member countries should make available the information of sardine in their waters concerning surveys, catch compositions and eggs and larvae distribution.

The Working Group recommends the implementation of studies on daily increments on age rings of sardine otoliths due to the occurrence of changes in the structure of younger sardine otoliths. This raised problems in allocation in the appropriate age groups.

The Working Group recommends the revision of the maturity at age and the adoption of a common definition of mature fish for DEPM estimation and for the calculation of stock maturity ogives.

The Working Group recommends the revision of the weights at age in the stock.

The Working Group recommends that an Workshop on Sardine Biological Sampling procedures for maturity at-age and weight-at age be held.

The Working Group recommends that an exchange of sardine otoliths be carried out routinely each year.

Anchovy

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.

Bay of Biscay anchovy should be monitoring with the DEPM and acoustic surveys.

The Working Group recommends further examination of plausible harvest control rules and that this should be made available to this Working Group in 2001.

The management of the Bay of Biscay anchovy requires an ad hoc process between scientists and managers to define and simulate a range of harvest control rules, so as that managers and interested bodies can make a proper discussion about the implications of those harvest control rules which lead ultimately to the adoption of an agreed management for future.

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 off Portuguese waters.

The Working Group recommends to undertake studies on the past history of the fishery on the Bay of Biscay anchovy, in order to build up a linger time series of anchovy catch at age and effort data to permit a fuller understanding of the stock dynamics and under varying environmental and fishery conditions.

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.

Since anchovy seems to exhibit biological differences along the Division IXa, the Working Group also recommends, if possible, to make available the results from the genetic studies which are currently in progress. Biological samples from this area have been provided by the 2000 acoustic surveys carried out under the PELASSES Project.

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15 ABSTRACTS OF WORKING DOCUMENTS

Abaunza, P., Fariña, A. C., Murta, A.

Applying Biomass Dynamic Models to the southern horse mackerel stock (Atlantic waters of Iberian Peninsula). A comparison with VPA-based methods. WD 2000.

Document available from: Pablo Abaunza, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain. Email: pablo.abaunza@st.ieo.es

The horse mackerel, an important target species in the fisheries of the Northeast Atlantic, is currently subject to assessment and management programmes in the ICES area. The current method used in the stock assessment of the Southern horse mackerel is based on VPA, using time series of catch-at-age data and CPUE from 1985 to present. The application of biomass-dynamic models to the assessment and catch prediction of this stock was never attempted before. In this paper, a production model was applied to the Southern horse mackerel stock. To quantify uncertainty in parameter estimates bootstrap confidence intervals were computed, which showed that estimates could be looked as reliable. The bootstrap standard deviations of Ft, r, q, MSY and F_{MSY} were not very high, despite the lack of trends in the effort series available. The current level of fishing mortality for 1998 was estimated inadequate for the sustainability of the resource, being well above F_{MSY} according to the biomass-dynamic models, and above F_{pa} according to the age-structured model. Both models showed a good agreement in the evolution of fishing mortality and in the perception of the state of the stock. Differences existed in the evolution of biomass estimates especially through the last years, in which the age-structured model showed an increasing trend. The estimates of MSY and F_{MSY} were in accordance with the precautionary approach philosophy. The biomass-dynamic model used here proved useful to be applied to the Southern horse mackerel stock, giving complementary information to the age-structured model, both in the perception of the state of the stock and in the definition of management targets.

Abaunza, P., Murta, A., Teia, A., Molloy, J., Nascetti, G., Mattiucci, S., Cimmaruta, R., Magoulas, A., Sanjuan, A., MacKenzie, K., Iversen, S., Dahle, G., Gordo, L., Zimmermann, C., Stransky, C., Santamaria, M.T., Ramos, P., Quinta, R.

HOMSIR: An international project on horse mackerel stock identification research in the ICES area and in the Mediterranean Sea. WD 2000.

Document available from: Pablo Abaunza, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain. Email: pablo.abaunza@st.ieo.es

The aim of this project is to assess the stock structure of the horse mackerel, which is an important target species in many north-east Atlantic and Mediterranean fisheries. The project will provide information currently lacking for an effective definition of horse mackerel stock boundaries, and will evaluate the status of the horse mackerel populations. The overall objective will be achieved integrating the results from several techniques such as genetic markers, other biological tags like morphometric studies and the use of parasites, physical tagging and life history traits (growth, reproduction and distribution). The genetic stock assessment will be performed by means of five different genetic approaches comprising the analysis of allozymes, the mitochondiral DNA and the microsatellite DNA. The proposed research will therefore set-up and improved multi-disciplinary tool for fish stock identification, and an exhaustive knowledge of horse mackerel stock structure, in order to allow an enhanced management of horse mackerel resource in European Union waters in short, medium and long term.

Borges, M.F., Santos, A. M. P., Crato, N., Mendes, H. and Mota, B.

Sardine catches and climatic changes off Portugal in the last decades. WD 2000.

Document available from: Maria F. Borges, Instituto de Investigação das Pescas e do Mar (IPIMAR), Av. Brasília, 1449-006 Lisboa, Portugal. Email: mfborges@ipimar.pt

Decades changes have been observed in the annual catch of sardine. Long-term changes have also been observed in alongshore winds off Portugal in the last decades. During sardine spawning season, north winds that favour upwelling lead to unfavourable conditions for egg and larval survival.

By using time series analysis, we investigated the effect of NAO conditions on the recruitment strength of sardine population in the period from 1946-1991. We also investigated the time lag between recruitment strength and its turnout in catches.

Our time series retrospective analysis lead to the possibility of forecasting sardine recruitment by using key environmental variables – the winter wind conditions during winter. We conclude that when winter north wind overpasses a certain limit, then resulting recruitment is forced to a lower bound.

Borja, A.

Report on anchovy recruitment in the Bay of Biscay. WD 2000.

Document available from: Angel Borja, AZTI, Avda. Satrustegui nº8, 20008 San Sebastián, Basque Country, Spain. Email: aborja@azti.es

Recruitment of anchovy in the Bay of Biscay is related primarily with the March-July upwelling in the southern corner of the area and potentially with turbulence.

In this document are presents results used these assuming to derive an upwelling index and turbulence data, giving a consistent result for long time-series data from 1967 to 2000, when compared with recruitment series based on CPUE.

For the series between 1967 and 1995 the correlation between recruitment and upwelling explains about 59-63% of the variance. However when including the last three years, the explained variance falls to 50-56%.

Has tried to incorporate new data about turbulence from other areas and has found that the turbulence in 44ºN 4ºW has significant values in a multiple regression, increasing the explained variance in 11% for the long time series 1967-2000.

The new upwelling data obtained for year 2000 is 391, after two years of very low upwelling. This makes possible that the recruitment at age 0 for this year 2000 will be low.

Borja, A., Uriarte, A. and Egaña, J.

Environmental factors affecting recruitment of the mackerel, *Scomber scombrus L. 1758*, along the North-eastern Atlantic coasts of Europe. WD 2000.

Document available from: Angel Borja, AZTI, Avda. Satrustegui nº8, 20008 San Sebastián, Basque Country, Spain. Email: aborja@azti.es

Research group has studied successfully the relationships between some environmental processes (turbulence, upwelling, the North Atlantic Oscillation): and the recruitment of some Atlantic species, such as the anchovy, the bluefin or the albacore.

Results show that the southern pre-spawning migration pattern of the Atlantic mackerel is directed towards areas with low turbulence mixing at spawning time, providing a “stable environment”, for egg and larvae survival. In the southern areas, where the spawning starts, the turbulence conditions of pre-spawning and spawning periods has the largest influence on the success of recruitment; this is probably related to the more ‘stable’ weather in the subsequent months and for the remainder of the year. In contrast, in the northern areas, the role of turbulence over the whole of the year becomes increasingly more relevant; this is probably related to the high levels of turbulence during autumn and winter, which may become limiting to the survival of juveniles.

At least 48% of the variability in the Atlantic mackerel recruitment may be explained by means of environmental variables, such as turbulence and NAO. Other variables, such as upwelling, are not statistically significant; however, they are potential future areas of research.

Good recruitments are related with environmental conditions (mainly low turbulence) in the spawning areas and periods; similarly, with conditions during the subsequent months, up to the start of the following year.

Carrera P.

Acoustic survey PELACUS 0300 within the frame of pelasses: sardine abundance estimates. WD 2000.

Document available from: Pablo Carrera, Instituto Español de Oceanografía. P.O. Box 130, 15080 A Coruña, Spain. Email: pablo.carrera@co.ieo.es

This survey was the main activity of the PELASSES project. Part of the information got from this survey is still under treatment. Next steps will be the set up of the CUFES system and their calibration against the PairoVet tows; if this calibration was successful, DEPM would use CUFES as egg sampler, allowing a better coverage of the egg distribution area. As well as this calibration, new attempts for assessment aiming to improve the precision will be done by incorporating auxiliary variables such us Primary Production, egg distribution, etc.

First analysis of the available information revealed that:

a) The performance of the CUFES as anchovy and sardine egg sampler was good.
b) Sardine biomass increased but only in VIIIc.
c) No indication of a good 1999 year class was achieved
d) Sardine in VII was scarce, but the egg distribution was wider than that of the adults
e) In spring, anchovy is also present in VII Division
f) When mackerel is found with zooplankton masses, its biomass estimation could be over estimated.
g) 1999 mackerel year class seems to be good

In 2000, CUFES provided sardine and egg information from Gibraltar to the English Channel. Nevertheless, the spawning period of anchovy is narrower compared to that of sardine and it stars in mid May. Thus the number of anchovy eggs collected during this survey was low.

In VII, the most important fish species was sprat which was caught in almost of the fishing station. In this area sardine was scarce, in spite the wider but low density distribution of the eggs.

Mackerel use to be find associated with plankton layers. It seems to be possible distinguish the thick plankton layers from the mackerel, the problem arises when both are mixing in a single layer. It seems that the mackerel abundance was higher.

Chernook, V.I., Zabavnikov, V.B., Troyanovsky F.M. and Shamray E.A.

Preliminary Results of Complex Airborne Research Conducted by PINRO on Distribution and Biomass Estimation of Mackerel in 2000. WD 2000.

Document available from: Vladimir I. Chernook, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia. Email: inter@pinro.murmansk.ru

This working document presents the preliminary results of the Russian annual aierborne research carried out during summer 2000. These surveys covered the southern part of Norwegian Sea from 62° up to 72° N and between 18° W and 10° E.

Thermal, hydrodynamic and bioproductive processes in the Norwegian Sea were characterised by the late beginning of spring and summer processes.

Feeding migration of mackerel to the southern Norwegian Sea began by 7-12 days later compared to the usual pattern and was mainly of eastern.

Number of feeding “surface mackerel” reduced in the total abundance of the registered schools and the number of “deeper schools” in 5-20 m increased.

Costa, A. M.

Working Document. WD 2000.

Document available from: Ana Maria Costa, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1400, Lisboa, Portugal. Email: eamcosta@ipimar.pt

FILE NOT AVAILABLE

In this working document the final results of total fecundity and atresia of horse mackerel of the portuguese coast in 1998, determined with the histometric method are presents. Only tables and pictures are available.

Eltink, A., de Boois, I. and Wiegerinck, H.

Preliminary estimates of horse mackerel fecundity in 2000 and the planning of the fecundity sampling in 2001. WD 2000.

Document available from: Guus Eltink, RIVO-DLO, P.O.Box 68, 1970 AB IJmuiden, Netherlands. Email: guus@rivo.dlo.nl

Up to now horse mackerel has been assumed to be a determinate spawner.

In 1998 the horse mackerel fecundity was estimated much lower compared to earlier years. This was expected be due to exceptional early spawning in 1998 and it was assumed that spawning fish had been used for the fecundity estimation. An important fact is that horse mackerel can not easily be recognised in histological slides of the ovaries as having spawned in the current season. This is caused by the long time interval between two batches of spawning. It is that long that the post-ovulatory-follicles (POF’s) can have disappeared before other stages of spawning activity (migrating nucleus stage, hyaline oocyte stage) appear. Therefore, fecundity sampling should be carried out before any spawning takes place, because as soon as spawning starts individual fish can not be identified any more as not having spawned yet.

In 2000 a small scale test sampling for fecundity was carried out as a test case for the sampling in 2001, which is the year in which the extensive international egg surveys will be carried out. The aim was to follow the changes in fecundity over time until the beginning of spawning season in order to estimate the most appropriate time for fecundity sampling. Results showed that fecundity was still low in March when spawning started, indicating that horse mackerel might an indeterminate spawner.

A sampling scheme for fecundity estimation has been proposed for the 2001 egg surveys based on the results of this test sampling in 2000.

Iversen S. A., Skogen M. and Svendsen E.

A prediction of the Norwegian catch level of horse mackerel in 2000. WD 2000.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O.Box 1870, Nordnes, 5817 Bergen, Norway. Email: sveini@imr.no

Norway has since 1987 been the main fishing nation for horse mackerel in the northern part of the North Sea and Norwegian Sea. This fishery is carried out in the Norwegian economical zone in the second half of the year. This fishery is considered to exploit the western stock. It is shown that there is good correlation between the modelled winter influx of Atlantic water to the North Sea and the catch levels of horse mackerel in The Norwegian purse seine fishery the following autumn. The modelled inflow in 1999 was calculated at 2.22 Sverdrup corresponding to a predicted catch of 42,000 t. The actual Norwegian catch in 1999 was 46,600 t. The modelled inflow of Atlantic water the first quarter of 2000 was 2.4 Sverdrup corresponding to a predicted catch of 60,000 t.

Marques V.

Sintesis of the Portuguese Acoustic Surveys in the ICES Sub-Area IXa, carried out in November 1999 and March 2000. WD 2000.

Document available from: Vítor Marques, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal. Email: vmarques@ipimar.pt

This paper presents the main results of the Portuguese acoustic surveys carried out during November 1999 and March 2000. These surveys covered the Portuguese continental shelf and the Gulf of Cadiz waters.

About 35 % of the Gulf of Cadiz area were not covered, in March 2000 survey, due to bad weather.

Sardines juveniles were predominant between Caminha and Nazaré (OCNorte zone). Between Nazaré and Cabo da Roca adults were predominant. In front of Lisbon, between Cabo da Roca and Cabo Espichel, mainly juveniles were fished. From South of Cabo Espichel and V. Real de Santo António, only sardine adults were captured. In Gulf of Cadiz the fishing samples are bimodal with a class of little juveniles and another adults class.

Millan, M. and Ramos, F.

Preliminary estimates of catch in numbers, mean weight- and mean length at age in the 1996-1999 Spanish landings of Gulf of Gadiz anchovy (Sub-division IXa South). WD 2000.

Document available from: Milagros Millán, Instituto Español de Oceanografía. Unidad de Cádiz. Puerto pesquero, Muelle de Levante s/n, P.O. Box 2609, 11006 Cádiz, Spain. Email: milagros.millan@cd.ieo.es

This working document reports preliminary estimates of the age composition and mean length- and mean weight at age of the Spanish total landings of Gulf of Cadiz anchovy for 1996-1999. Age readings were carried out on 4 754 otoliths, which were monthly collected throughout the 4-year period, and assuming 1 January as birthday. As previously stated (EFAN otolith exchange exercise), the identification of true annual rings showed specially difficult due to the presence of many false marks, which are laid down with some degree of periodicity (spring and/or summer hyaline rings). During the analysed period, the Gulf of Cadiz anchovy fishery was based on the fishing of 0, 1 and 2 age-group anchovies, the 1-year-old ones being the better represented and the 2 year-old fish the less. The success of the Gulf of Cadiz anchovy fishery largely depends on the strength of the year class. Thus, the data support that the historical maximum of landings reached in 1998 is explained by a probable exceptional strength of the 1997 year class and the good recruitment to the fishery in that year. Intra- and inter-annual variations of both the mean length- and weight at age are also documented.

Morais A.

Abundance Estimation, Biological Aspects and Distribution of Anchovy (Engraulis encrasicholus) in Portuguese Continental Waters and the Bay of. WD 2000.

Document available from: Alexandre Morais, Instituto de Investigação das Pescas e do Mar (IPIMAR), Av. Brasília, 1449-006, Lisboa, Portugal, Email: amorais@ipimar.pt

This work presents results from two acoustic surveys in the Portuguese area and Bay of Cadiz carried out in November 1998 and March 1999 with R. V. "Noruega". This working document provides abundance estimates of anchovy (Engraulis encrasicholus) by length classes and its distribution in the survey area. It also describes some aspects of anchovy biology (Length-weight relationships and maturity-length ogives) in that area. Anchovy total estimated abundance was 33 thousand tonnes (2.5 x 106 individuals) in November 1998 and 25.5 thousand tonnes (2.1 x 106 individuals) in March 1999. In both surveys, more than 90% of the total biomass estimated was present in Cadiz. The maturity data obtained during the November 1998 survey shows significant differences between the Portuguese Occidental shelf and the area of Algarve and Bay of Cadiz. Finally, in both surveys rare demersal formations of dense anchovy concentrations were observed at moderate depths (50-90 m) in the Bay of Cadiz.

Murta, A. and Abaunza, P.

Has horse mackerel been more abundant than it is now in Iberian waters? WD 2000.

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According to the assessments carried out by this working group, the horse mackerel biomass in the Atlantic waters of Portugal and Spain attained a maximum in 1998. From 1985 to 1998 the estimated biomass presents an increasing trend. Nevertheless, historical catches around 2.5 times the current catch level were recorded between 1962 and 1978. This took us to suspect that in a broader time scale the biomass variation estimated from the assessment may have little meaning. Also, given the current catches, which are very low as compared with those from 1962 to 1978 there is the possibility of the stock to be severely depleted.

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. The catches from 1962-1978 appear exceptionally high when looking to the whole time series.

Petitgas, P., Allain, G., Lazure, P.

A recruitment index for anchovy in 2001 in Biscay. WD 2000.

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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 Working Group 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 report of the ICES Working Group. For predicting anchovy abundance at age1 for 1999, 2000 and 2001, environmental indices have been extracted from the hydrodynamic model and the regression model used in extrapolation mode. The prediction for 2001 is an average recruitment.

Prouzet, P.

An example of determination of harvest rules for the management of anchovy in the Bay of Biscay. WD 2000.

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A preliminary annual TAC (TAC1) applied on the first part of the year (n+1) from January to June and set to zero when the revised one is defined. This TAC should be based on the biomass estimates of the year (n) called B1(n) and the qualitative level of recruitment in September the year (n) called Rsept(n). So the preliminary TAC, call TACprelim is defined as Tacprelim= f(B1(n),Rsept(n)). The qualitative level of Rsept is based either on the value of the environmental index after Borja et al (WD 2000) (called upindex(1)),or the best of the two available environmental indexes {upindex(1) and upindex(2), the latter corresponding to the environmental index after Petitgas et al (WD 2000)}.

A revised final TAC operative over the second part of the year from June to December and based on the biomass assessed the year (n+1) called B2(n+1). So this TAC called revised TAC is defined as TACrevised = TAC2 = f[B2(n+1)].

Reid D.

Documenting changes in western mackerel migtration timing 1997-2000. WD 1999.

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The western mackerel undertakes a pre-spawning migration from the eastern North Sea, in the vicinity of the Viking Bank, to their spawning areas west of the British Isles and in the Bay of Biscay. In the 1970s and 1980s this migration occurred initially in the months of August and September. During this period the migration has been later and more off-shore. But 1997 the migration could be shown to start as late as the middle to the end of February. This WD presents evidence from an acoustic survey in January 2000 and assembled commercial data from 1997-2000 from a number of EU countries that the timing of migration is again changing. The main conclusion is that in 2000 the migration started much earlier than in previous years and that this may be part of a general ternd to earlier migrations.

It seems likely that there has been a major change in some aspect of the ocean climate to stimulate this change, although to date no obvious candidate has been implicated. This will be investigated.

Skagen D. W.

Trial assessment for NEA mackerel using ICA and AMCI. WD 2000.

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Assessment of the NEA mackerel has at times been problematic, since the only data available apart from catches at age are SSB measurements every third years. In last years Working Group a new programme AMCI was presented, which can make use of tag return data in addition to catches and SSB measurements. The program has been exxtended since then, and now offers a range of options for combining different kinds of information from different sources, into an assessment of a fish stock. The program includes a self contained parametric model for the population, functions for describing the relations between the population and the observations, and a selection of measures of the deviations of modelled data from the observations. The document gives a short description of the program and the options that are possible. Some trial runs are presented, showing that in general, the assessment is quite robust to model formulations.

Stratoudakis, Y. And Fryer, R.

Adult survey design and implications for sardine (Sardina pilchardus) DEPM estimation off Portugal. WD 2000.

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In the absence of adequate model-based estimators, estimation of spawning biomass from the Daily Egg Production Method (DEPM) is entirely based on the selected survey design, using design-based estimators. Judgement sampling and survey post-stratification have been recommended as ways of achieving sampling proportional to local fish densities and reliable estimation of spawning biomass when there are spatial differences in the DEPM adult parameters. Here, we discuss these concepts, demonstrate the impact of post-stratification on the DEPM estimation of sardine (Sardina pilchardus) spawning biomass off Portugal, and propose sensible designs for future surveys. Post-stratifying the Portuguese 1999 DEPM survey into two strata (western and southern) increases the SSB estimate by at least 100 Kt, nearly 50% more than the original (unstratified) estimate. This large difference led us to explore the impact of adult survey design and estimation in a simulation exercise. We constructed a series of populations consisting of two strata, in which fish abundance and mean spawning fraction in each stratum were allowed to vary widely, and where egg production, sex ratio and batch fecundity were assumed known without error. We then sampled each population using simple random sampling and various forms of stratified random sampling (allocation proportional to survey area, to fish abundance, and optimal allocation). Ignoring spatial structure in spawning fraction led to very biased and imprecise estimates of fish abundance. In the population scenario that most closely resembles the 1999 Portuguese DEPM survey, the bias was –25%, suggesting that unstratified estimation underestimates the true SSB. Stratified random sampling with allocation proportional and optimal allocation outperformed allocation proportional to area and were robust to moderate levels of misallocation. We believe that future adult surveys for DEPM would benefit by adopting an a priori stratified design, in which stratum effort is allocated according to the sardine abundance estimate from the most recent acoustic survey.

Uriarte A., Motos L., Santos M., Ibaibarriaga, L. and Prouzet P.

Estimates of spawning biomass of the Bay of Biscay Anchovy (Engraulis encrasicolus, L.) in 2000 and review of the assessment of biomass in 1994 and estimates in 1996 and 1999. WD 2000.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

This document includes the estimates arising from the 2000 May survey. Biomass estimate for this year was derived in May from the spawning area/biomass relationship using the extension of the spawning area found in survey and it was reported to STECF. Now the estimate of the SSB is based on its relationship with the spawning area (SA) and Daily egg production per surface unit (Po) which is the best model to estimate SSB. (EU project 96/034, ANNEX 5) and it is presented in this document.

Biomass estimates for 1996 and 1999 were derived from the spawning area/biomass relationship using the extension of the spawning area found during the 1996 and 1999 DEPM anchovy surveys, respectively. Additioally, SSN as a function of Po and Sa is presented. Changes on the results for 1994 involves modification for 1996 and 1999.

Uriarte, A., Villamor, B. and Martins, M.

Estimates of Catches at age of mackerel for the southern fleets between 1972 and 1983 and comparison of alternative procedures. WD 2000.

Document available from: Andres Uriarte, Instituto Tecnológico Pesquero y Alimentario, Avda. Satrustegui no.8, 20008 San Sebastián, Gipuskoa, Basque Country, Spain. Email: andres@rp.azti.es

Since 1995, ICES has acknowledged the necessity of carrying out a single assessment of mackerel for a population unit called Northeast Atlantic mackerel, putting together all European Atlantic mackerel (ICES CM 1996). The catches at age of mackerel caught in the western area are known since 1972, however the catches at age from the southern area are only known since 1984 and for this area total landings in tonnes are only known since 1977. Partly due to these reasons, so far the assessment of NEAM starts in 1984, whereas the assessment of the so called “western” mackerel goes back to 1972. ICES seeks for a complete historical perspective of the whole NEAM similar to the one produced for the western mackerel.

The current paper presents:

a) a recovery of statistical data since 1972 of the catches in tonnes produced by the southern fleets and landed in Spain and Portugal which have not previously been reported to the ICES Working Group.
b) An estimate of the catches at age of mackerel landed in the southern area covering the period 1972-1984, which is based on the fitting of separable models for the Divisions VIIIBC and IXa and
c) A comparison of the separable catch estimates with other simpler methods of estimating the corresponding catches at age for the southern area.

The aim of this effort is allowing for a complete historical perspective of the whole NEAM starting back in 1972, similar to the one produced for the western mackerel.

The idea of obtaining the unknown catches at age of mackerel from the southern fleets by a separable model comes from the procedures used by Cook and Reeves in 1993 to estimate unknown catches at age for certain years of the industrial fishery catches of Norway pout.

Vasilyev, D., Belikov, S. and Shamray E.

Tuning of natural mortality for Northeast Atlantic Mackerel. WD 2000.

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Spawning stock size estimates based on catch-at-age analysis for Northeast Atlantic Mackerel in recent years were generally lower than estimates based on egg surveys. The purpose of the this paper was to test the hypothesis that the above mentioned discrepancy may be caused by underestimated value of natural mortality (0.15), traditionally used in the assessment. Since it is always difficult to estimate the value of natural mortality together with other parameters of separable model it was decided to split the available information into two parts and to use catch-at-age data only for estimating of parameters of separable model (on this stage different values of M are taken as “known”). The estimates of SSB, based on egg survey, are used afterwards to choose the “best” value of M. A separable model named ISVPA was chosen for analysis of catch-at-age data because its minimization procedure, based on some principles of robust statistics, in some cases helps to produce unique solution using the catch-at-age data of real quality (high level of noise) without auxiliary information. The ISVPA-derived estimates of total biomass, SSB and recruitment are rather similar to results of ICA. The best fit with respect to egg survey SSB estimates was achieved for M=0.19.

Villamor, B. and Lucio, P.

A short note on the historical allocation by stocks of mackerel catches from divisions VIIIc and IXa. WD 2000.

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This paper describes the cases of misreporting of the official Spanish catches from Division VIIIc in the early years of the western mackerel assessment. This note is an extract of the reports of the Mackerel Working Groups (1974-1995), Sardine Working Group and Pelagics in Division VIIIc and IXa and Horse Mackerel Working Group (1985-1988).

Zimmermann C.

Western Horse Mackerel: Short and Medium-Term Predictions by ADAPT 2000-2005. WD 2000.

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The aim of this working document is to document the short and medium term projections for this stock using the ADAPT-method, as these data are not included in the Working Group report. The same was done in the last two years (WD Sparre & Zimmermann, Working Group MHSA 1998, WD Zimmermann, Working Group MHSA 1999). The agreed predictions for the Western Horse Mackerel were calculated using diferent approaches and are given in Sec. 6.5 of the Working Group report.

Zimmermann, C., Kelly, C., Abaunza, P., Carrera, P., Eltink, A., Iversen, S., Murta, A., Reid, D., Silva, A., Uriarte, A., Villamor, B.

Whitelist on the functionality and properties of an input application for the submission and processing of commercial catch and sampling data within the ICES enviroment. WD 2000.

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Historic data on catches and sampling of commercial catches at a disaggregated level and the subjective decisions to fill in missing information by the species co-ordinators have not been well documented by the different ICES Working Groups in the past. There was also no consistent storage of the disaggregated data at ICES. The need for changing this was stated by several ICES groups and defined in the ICES Code of Practice for Data Handling.

HAWorking Group and MHSA strongly recommended to ICES since 1998 that a standard application should be developed, preferably as a database-standalone, to ease data input, evaluation and documentation. This should be possibly used by all Working Groups, starting with the pelagics as soon as possible.

In late 2000, ICES stated that it intends to implement a standard system for data submission and storage, and asked the MHSA do produce a detailed list of the needed functionality of such an input application. The list presented here is the first attempt to support ICES in its effort to start with the development.