Advisory Committee on Fishery Management

ICES CM1997/Assess:3

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

ICES Headquarters, Copenhagen, Denmark

13-22 August 1996

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

At the 83rd Statutory Meeting (1995 ICES Annual Science Conference) in Aalborg, Denmark, it was decided (C.Res.1995/2:13:9), in the terms of reference for this Working Group that we will meet at ICES Headquarters from 13–22 August 1996 to:

a) assess the status of and provide revised catch options for 1997 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 1997 for the sardine stock in Divisions VIIIc and IXa, and the anchovy stocks in Sub-area VIII and Division IXa;

c) provide data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1995 by statistical rectangle of the North Sea) for mackerel and horse mackerel;

d) provide estimates of the minimum biologically acceptable level of spawning stock biomass (MBAL) for as many stocks as possible, with an explanation of the basis on which the estimates are obtained;

e) prepare medium-term forecast under different management scenarios, including different levels of fishing mortality on juvenile mackerel, taking into account uncertainties in data and assessments and possible stock-recruitment relation-ships, and indicate the associated probability of the stocks falling or remaining below MBAL within a stated time period;

f) evaluate the effect of the mackerel box in relation to the need to protect juvenile mackerel, taking into account the impacts of all pelagic fisheries, including and excluding handling;

g) evaluate the likely effect on the exploitation of juvenile mackerel of changing or extending the boundaries of the existing mackerel box and closing other areas to mackerel fishing;

h) Define the data and information requirements for evaluating, and if possible carry out an evaluation of, the effects of an area closure or closures to protect juvenile sardine, taking into account different scenarios of recruitment and fishing mortality levels.

1.2 Participants

The Working Group met in Copenhagen with the following participants:

Pablo Abaunza	Spain
Sergei Belikov	Russia
Fátima Borges	Portugal
Pablo Carrera	Spain
Kevern Cochrane (Observer)	FAO (Rome)
Chris Darby	UK (England)
Georgi Daskalov	Norway
Guus Eltink	Netherlands
Svein Iversen	Norway
M. Manuel Martins	Portugal
John Molloy	Ireland
John Nichols	UK (England)
Kenneth Patterson	UK (Scotland)
Carmela Porteiro (Chairwoman)	Spain
Beatriz Roel	UK
Eugene A. Shamrai	Russia
Dankert Skagen	Norway
Eduardo Soares	Portugal

Karl-Johan Stæhr — Denmark
Andrés Uriarte — Spain
Begoña Villamor — Spain

1.3 Quality and Adequacy of Fishery and Sampling Data

1.3.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. 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. On the other hand sampling programmes on some of the large northern fisheries, particularly horse mackerel is very inadequate.

The sampling programme on the various species is summarized as follows.

Mackerel

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1995	755,000	642,400	1,008	102,383	14,481
1994	822,000	657,000	807	72,541	13,360
1993	825,000	688,400	890	80,411	12,922
1992	760,000	645,000	792	77,000	11,800

In mackerel it appears that over 85% of the total catch was covered by sampling. There are, however, a number of important mackerel catching countries which did not carry out any sampling programmes, e.g. Germany, Faroes, France and Sweden. On the other hand Spain and Portugal carry out intensive sampling programmes although their catches are comparatively small. The summarized details of the more important mackerel catching countries are shown in the following table.

Country	Catch	Catch covered by sampling programme	Samples	Measured	Aged
Norway	202,100	202,100	198	15,850	2,720
UK (Scotland)	163,170	159,000	71	6,012	3,290
Ireland	95,000	90,000	72	6,294	2,933
UK (Engl. + Wales)	54,000	29,200	25	3,957	425
Netherlands	50,400	50,400	67	5,506	1,675
Denmark	37,100	37,100	13	992	992
Russia	44,500	43,000	11	24,540	750
Spain	28,700	28,700	260	17,105	862
Germany	24,400	0	0	0	0
Faroes	31,000	0	0	0	0
France	11,800	0	0	0	0
Sweden	6,300	0	0	0	0
Portugal	2,900	2,900	291	22,125	834
Others	3,600	0	0	0	0
Total	**755,000**	**642,400**	**1,008**	**102,383**	**14,481**

Horse Mackerel

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

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1995	580,000	275,516	2,041	177,803	5,885
1994	447,153	272,100	1,453	134,269	6,571
1993	504,190	379,000	1,178	158,954	7,476
1992	436,500	195,450	1,803	158,447	5,797

During 1995 the detailed sampling of horse mackerel remained at a very low level. The only countries that carried out comprehensive sampling programmes were Netherlands, Portugal and Spain. Other countries, e.g. Ireland, Denmark and United Kingdom carry out no sampling programmes whatsoever. The lack of sampling data for large portions of the horse mackerel catch has a serious effect on the accuracy and reliability of the assessment.

The following table shows the most important horse mackerel catching countries and the summarized details of their sampling programme in 1995.

Country	Catch	Catch covered by sampling programme	Samples	Measured	Aged
Ireland	202,000	0	0	0	0
Netherlands	125,900	125,941	75	10,311	1,875
Norway	96,100	96,100	21	1,835	544
Spain	35,800	35,775	646	50,916	1,101
UK (England + Wales)	32,300	0	0	0	0
Denmark	31,200	0	0	0	0
Germany	20,000	0	0	0	0
Portugal	17,700	17,700	1,299	114,741	2,365
UK (Scotland)	15,000	0	0	0	0
Others	4,000	0	0	0	0
Total	**580,000**	**275,516**	**2,041**	**177,803**	**5,885**

Sardines

The sampling programmes carried out on sardines in 1995 was again very similar to the programmes of recent years and is summarized as follows.

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1995		108,900	716	59,444	4,991
1994	162,900	134,700	748	63,788	4,253
1993	149,600	143,200	813	68,225	4,821
1992	164,000	130,000	788	66,346	4,086

In general the overall sampling intensity remains at a satisfactory level and good coverage is maintained throughout the year. No sampling programmes are carried out by France or Denmark.

The summarized details of individual sampling programmes are shown below on the following page.

Country	Catch	Catch covered by sampling programme	Samples	Measured	Aged
Portugal	85,200	85,200	308	22,133	3,300
Spain	33,500	33,500	400	36,334	1,691
Denmark	10,000	0	0	0	0
France	?	?	?	?	?
UK (England)	6,900	0	8	977	0

Anchovy

The sampling programmes carried out on anchovy in 1995 are summarized below. The sampling levels are very similar to those of 1993 and 1994 although the number of fish aged has decreased considerably. However, sampling is stratified and appears to be satisfactory.

Year	Total catch	Catch covered by sampling programme	Samples	Measured	Aged
1995	42,104	?	?	?	?
1994	34,600	34,400	281	17,111	2,923
1993	39,700	39,700	323	21,113	6,563
1992	40,800	37,700	289	17,112	3,805

Considerable catches of anchovy were taken by Portugal in 1995 but were not subject to a sampling programme. The sampling data from Spain, who carry out a comprehensive programme is shown below. No details are available about the French programme in 1995.

Country	Catch	Catch covered by sampling programme	Samples	Measured	Aged
France	10,848	?	?	?	?
Spain	24,200	24,200	180	11,821	2,208
Portugal	7,056	0	0	0	0

1.3.2 Catch data

The 1995 Working Group discussed the possible underestimating of the mackerel catches due to quota restrictions and the misreporting of mackerel both by species and by area. It was concluded that the effect of underreporting on the accuracy of the assessment could not be quantified. There are still considerable doubts about the accuracy of the total catches taken by some of the major mackerel catching countries but it has not been possible to make any corrections. It is felt that, because of the reductions in the overall TACs and national quota, the underestimation of catches may increase. It is therefore again strongly recommended that all countries should make effort to provide reliable statistics. In 1995 a number of countries, e.g. France, Faroes, Sweden, Estonia, all of whom have directed mackerel fisheries, were unable to supply any data on the origin of their catches by statistical rectangle.

As stressed in the section on management consideration (Section 3.4.10) misreporting of mackerel by area is a serious problem between Division VIa and Division IVa during the month of January.

The Working Group considers that this problem could be solved without endangering the North Sea stock by allowing fishing in Division IVa during January.

There is again serious concern about the possible misreporting of mackerel and horse mackerel in the northern areas. The big increase in the horse mackerel catch may be a result of deliberate misreporting of mackerel and horse mackerel.

1.3.3 Discards

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). This factor was put forward as a possible factor in the very low abundance of the 1991 year class in the 1993 catches in numbers at age. The Working Group is, therefore, concerned that a high level of discards may still exist, although reports from the fishery in 1994 and 1995 suggest that, because of high prices paid for all mackerel, discarding in these years at any rate may be relatively small. At present, only one country (the Netherlands) supply information on levels of discards. Some information is also available about by-catch of mackerel from the Irish bottom trawl fisheries from the EU funded project (EU DGXIV, Study Contract 94/013).

An EU programme carried out by Spain studied the rate of discards of all species taken by the Spanish fleets, fishing in Sub-areas VI, VII, VIIIc and IXa. The results of this study for mackerel, horse mackerel and sardine are summarized below as estimated percentages of discards of total catch (Perez *et. al.* 1994).

Fleet	Species	VI,VII	VIIIa,b	VIIIc	VIIIb,c East	VIIc West	IXa
Trawlers	Horse mackerel	6.6	25.7	4.7			
Longliners	Horse mackerel	0.2	1.1	1			0.6
P. seiners	Horse mackerel				3.3	0.4	
Gillnet	Horse mackerel			0.2			
Trawlers	Mackerel	1.4	2.6				
P. seners	Mackerel				0.7	0.1	
Longliners	Mackerel		8.1	0.7			
Gillnet	Mackerel			0.5			
Trawlers	Sardine						0.6
P.seiners	Sardine					0.5	

As for mackerel only the Netherlands are collecting data about discards in the fishery for horse mackerel. Based on this it is impossible to estimate to what extent horse mackerel are discarded in the international fishery.

There are no data available on discards of anchovy, but it is assumed to be insignificant.

1.3.4 Fleet data

In 1993, the Working Group expressed concern that insufficient information was available about changes that may be taking place in the various national fleets. It was, therefore, decided that data should be collected about the different national fleets, particularly in relation to the introduction of new technical equipment, the improvement or increase in size of fishing nets and change in fleet capacity. It was felt that important information about the fishery effort was being lost without which it was difficult to determine changes in fish abundance. A certain amount of information on abundance was previously available from fluctuations in catches. However, this is not the case now because of the imposition of TACs and boat quotas. Decreases in stocks may therefore be difficult to detect because of rapid changes in efficiency. The Working Group therefore feels that data on fleet size and composition, e.g., size of vessels, type of vessel, overall horse power, size etc., should be updated each year. It is particularly important to note the introduction of new technical innovations which can revolutionize catching methods and may influence exploitation patterns, e.g., the use of extremely powerful and sensitive sonar systems, introduction of new an more efficient fishing gears, the increased carrying capacity of vessels now compared with similar sized vessels some years ago. The collection of such data should enable the development of the fisheries to be more easily understood in future years. Summary of data available to this years Working Group for various fleets are shown in Table 1.3.1.

1.3.5 Age reading

The quality of the age data for the various assessments depends on 1) the accuracy and precision of the age readings of each species, and 2) the sampling intensity which enables the catches to be converted into numbers at age. The Working Group examined the various species in respect to these factors. Factor 1 is dealt with in this section, but factor 2 is dealt with in section 1.3.1.

Mackerel

A mackerel otolith exchange in 1994 showed that the ageings were of a poor quality. Therefore an otolith workshop was held in February 1995 (Anon. 1995/H:1). This improved the quality considerably and the precision of the age readings achieved was acceptable for the Working Group.

Horse Mackerel

At last year's Working Group meeting (Anon. 1996/Assess:7) it was recommended that an otolith exchange should be carried out in 1996. The exchange has not been completed yet, because only one of the three otolith sets has been read by all readers. Results of the analysis of this completed set is presented in section 4.8. The catch in numbers at age data for 1995 are based on ageings of readers 1, 2 and 6 for the western horse mackerel and of readers 3 and 5 for the southern horse mackerel stock. The precision of the ageings and possible bias can be seen in the age bias plots of Figure 4.3.

As in recent years, the only countries carrying out age readings on otoliths of horse mackerel are the Netherlands, Spain, Portugal and Norway. For the western area the catches of the non-sampling countries use the age compositions of either the Netherlands or Norway (only for the Divisions IIa and IVa area) to raise these to their own catches. In some cases this causes serious problems, e.g. where in a certain area/period the Netherlands took only one sample because of low Dutch catches and the Dutch age composition was then raised to the high catches of non-sampling countries. The quality of the catch in numbers at age would improve considerably, if the non-sampling countries, with relatively high catches would start to age horse mackerel and would take samples for ageing relative to their catches. The text table below shows how the number of otolith readings relates to the catches by country for both the western and North Sea area in 1995:

Country	Catch (t)	Otoliths read
Ireland	203,000	0
Netherlands	125,000	1875
Norway	96,000	544
Denmark	56,000	0
England	32,000	0
Germany	20,000	0

Therefore the **Working Group strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.**

Sardine

In 1996 a sardine otolith exchange took place between Spain and Portugal, which confirmed that there was a good agreement in the ageings. Spain and Portugal have adequately sampled the catches for age in the southern area. No age compositions are available from sardine catches taken in Sub-area VII and Divisions VIIIa,b. However, these catches were not considered to be part of the stock unit assessed by this Working Group (Anon., 1996/Assess: 7), because they are not considered to belong to the stock units assessed by this Working Group.

Anchovy

The age readings of anchovy and the age sampling of all the catches appear to be satisfactory. Results of an otolith exchange are presented in section 9.4.

1.3.6 Biological Data

The main problems in respect to the biological data (except age reading), which are identified by the Working Group for the various species, are:

Mackerel

The proportion mature of 1-, 2- and 3-year old mackerel appears to be overestimated in the present maturity ogive and therefore needs to be further investigated, because it affects the accuracy of the assessment (see section 2.10).

Horse mackerel

The selection of an appropriate maturity ogive for the western horse mackerel stock still presents major difficulties. This affects the accuracy of the assessment (see section 6.5). There excists uncertainty about the level of natural mortality (see section 6.11).

Anchovy

The main biological problems for anchovy lies in understanding the migration of 0-group fish and their pre-recruit distribution. Information is also required about variations in natural mortality (M) as M may increase dramatically immediately after spawning has been completed. A better understanding is needed of seasonal growth in weight and length to modulate the time evolution over time of cohorts, because of the large seasonal changes in growth.

1.4 Review of the Mackerel/Horse Mackerel Egg Production Working Group (Anon. 1996/H:2)

Provisional estimates of egg production and SSB for mackerel and horse mackerel were reported in Anon. (1996 Assess:7). The estimates of egg production were based on the whole area sampled during the 1995 surveys. The starting and end dates of spawning, for the production curve, were the same as those used in previous years. The fecundity estimates and corrections for atresia were the same as those used for the previous survey in 1992.

At the Working Group meeting in April 1996 additional data were available which showed that the spawning of mackerel and horse mackerel in the western and southern areas started much earlier (10 February) than the date used for the analysis of previous western area surveys (11 March). A new end date of 31 July, based on observations, was used in preference to 16 July, the date calculated using the method adopted for previous years. It was noted that the peak of horse mackerel egg production occurred one sampling period earlier than in the two previous survey years and coincided with the peak production period for mackerel eggs.

The Working Group examined the fecundity and atresia estimates from the southern and western areas for mackerel and horse mackerel.

The data for mackerel in the western area showed that there was a reduction in fecundity compared with previous estimates. This reduction was not significant with respect to the 1992 estimate but was significantly lower than the 1989 estimate. The estimate of atresia for the western area mackerel (11.6%) showed an increase over the 1992 estimate of 8.8% which had been used for all previous years and in calculating the provisional estimate for 1995.

A new estimate of fecundity (1557 eggs/g female) for the western area horse mackerel was obtained by combining the data from 1989 and 1992 with the observations during the 1995 surveys. The estimate of atresia in the western horse mackerel was 3.4% compared with a value of 10% used to calculate annual potential fecundity in previous survey years. The reduction was generated by the use of the geometric mean instead of the arithmetic mean to calculate the level of atresia. This was considered to be a more accurate estimate of atresia and the Working Group therefore used the value for the 1995 survey data and recommended that it should be used to correct the historic series of biomass estimates.

A new estimate of fecundity was obtained for the southern area mackerel of 1344 eggs/g female. Samples collected for the estimation of atresia were unsuitable and the western area estimate was therefore used. New estimates of fecundity (1526 eggs/g female) and atresia (7.7%) for the southern horse mackerel were calculated from the 1995 survey data and used by the WG.

Using these new data the estimates of SSB changed from the provisional figures provided to the MHMSA Working Group in 1995. For the western mackerel the estimate of SSB increased from 1.97 to 2.47 million tonnes. For western horse mackerel the estimate increased from 1.64 to 1.71 million tonnes.

For the mackerel in the southern area the estimate of SSB changed from the provisional figure of 327,000 tonnes to 378,000 tonnes. The provisional figure for southern area horse mackerel was low, 46,450 tonnes and was based on a limited data set with the first survey period not available. Once all the data became available the estimate increased to 261,000 tonnes.

The estimates of mackerel and horse mackerel egg production and subsequent calculation of SSB were made separately for the western and southern areas. It was not possible to carry out a combined estimate for the North East Atlantic mackerel at the meeting. The reasons were, firstly that not all the southern area egg survey data were available before the start of the meeting and as a consequence the egg production and SSB estimates for the southern area were not made until the final day. Subsequently corrections were necessary, to the estimates of egg production in some rectangles, after the meeting. The Working Group also considered that it was important to provide a separate estimate of the western component in order to compare the historic series of egg survey estimates.

The area covered by the egg surveys in the western area in 1995 was greater than the area surveyed in 1992. This was the result of an adaptive sampling strategy based on the presence of either mackerel or horse mackerel eggs at the ends of the east/west sampling rows (Anon., 1994/H:4). This resulted in additional rectangles, to the west of the 1992 standard area, being sampled in 1995.

Western area mackerel and horse mackerel egg production estimates were produced based on the whole area surveyed in 1995.

The new start and end dates for egg production were also used in these estimates.

The egg production estimates were used to calculate the SSB using the 1995 values of fecundity and atresia for both species.

For direct comparability with the estimates of previous years the Working Group also calculated the egg production, of western area mackerel and horse mackerel, based only on the observations of production within the 1992 standard area. These estimates of egg production were based on the same start and end dates of spawning as used for previous surveys and not those observed in 1995. The estimates of SSB based on these egg production estimates were calculated using the new fecundity and atresia data obtained for both species in 1995.

In the southern area the egg production curve for mackerel was adjusted to take account of poor sampling coverage in period 1, (12 February to 6 March). There was evidence of a large spawning in the north of Spain not sampled by the surveys. The Working Group decided to use an interpolated value for period 2, 14 - 24 March, based on a weighted mean between the observed values in periods 1 (12 February to 6 March) and period 3 (23 March to 15 April).

For the southern horse mackerel the main spawning peak occurred in the Portuguese area during period 1 and it was noted that future surveys should start earlier. However, the main spawning in the Cantabrian Sea was in May/June. As a result, the poor sampling coverage in period 2 did not appear to have a major effect on the estimate of egg production of horse mackerel. There was no evidence of a large, unsampled spawning in the North of Spain at that time. The estimate of production for period 2, based only on sampling off the Portuguese coast, fits the pattern of spawning observed in periods 1 and 3.

Spawning stock biomass estimates were provided for southern area mackerel and horse mackerel, using the egg production estimates described above, and estimates of fecundity observed during the 1995 surveys. Samples collected for atresia were rejected and the estimate for the western area, rounded to 12% was used.

The Working Group also provided an estimate of total egg production of horse mackerel based on an interpolated value for period 2, consistent with the method used for mackerel, but did not recommend its use.

Preliminary results of an analysis of the 1989, 1992 and 1995 western area mackerel and horse mackerel egg productions, using a Generalized Additive Model (GAM), were presented to the Working Group. This work was carried out by the University of St Andrews Scotland under an EU contract. The GAM model, without bias correction, gave much lower estimates of egg production for both species than the traditional method. With an *ad hoc* bias correction the GAM estimates were much closer to those obtained by the traditional method. A bootstrap bias correction was applied to some of the data series. This appeared to work well for horse mackerel but the estimate of mackerel egg production in 1995 was substantially lower than the estimate from the traditional method. The advantages and disadvantages of the model were examined and listed. Many issues concerning the use of the GAM for these surveys remained unresolved at this meeting. It was agreed that the bias, precision and accuracy of the GAM and the traditional method should be evaluated and presented, as a Working Document, to the next meeting of the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group. The Working Document would also include results of the analysis of the southern area mackerel and horse mackerel egg production by GAM (see section 1.5).

New mackerel maturity data were presented for the western area, from samples taken from the Dutch commercial fishery and by the Dutch research vessel *Tridens* between 1985 and 1995. The effect on the maturity ogive of maturity state based on histological, as opposed to macroscopic, examination, was reviewed. The whole topic is presented in detail in section 2.10 of this report. The Working Group highlighted the need to analyze all the maturity data available from the extensive trawl survey carried out in conjunction with the egg surveys in 1992. It was agreed that the data would be analyzed by the University of Aberdeen and presented as a Working Document to the next meeting of the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group. This WD is reviewed in section 2.10 of this report.

1.5 Review of the Report on the Development of a Spatial-Temporal Model to Improve Annual Egg Production Assessments of Mackerel and Horse Mackerel

A working paper on a generalized additive model (GAM) approach to analysis of egg survey data was presented at the Mackerel/Horse Mackerel Egg Production Working Group (MHMEPWG) held in Aberdeen, Scotland from 25 March to 29 March 1996 (Anon. 1996/H:4). The MHMEPWG agreed that some outstanding issues, in particular the questions of relative bias, precision and accuracy (measured as mean square error) of the traditional and GAM methods, should be investigated further. It was also requested at the meeting that an analysis of the southern area mackerel and horse mackerel egg survey data should be undertaken and the results reported in a Working Document to be presented at the next meeting of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (MHMS&AWG). This report was received and reviewed by the 1996 MHMS&AWG.

It was agreed that GAM approaches to analysis of egg survey data represented an important and potentially useful development and should be explored further. At this stage the outstanding uncertainties in, and lack of validation of, the method, discussed below, precluded its use with confidence in the routine assessments. However, it was agreed by the MHMS&AWG that the available results of total egg production estimated by GAM for 1989, 1992 and 1995 for mackerel and horse mackerel, should be used in trial assessments and the output of these trials presented in the Working Group report as examples, but examples of unknown validity at this stage.

1.5.1 Problems identified with GAM

1. The Working Group agreed that there were still several important questions about the method which had not been answered and a number of decisions needed to be made concerning the application of GAM to egg survey data. These included features such as the selection of the degrees of freedom associated with the smoothing function, the most appropriate model for the error distribution, the definition of the outer spatial and temporal boundaries of spawning activity, the explanatory variables to be included in the model and the best approach to correcting the negative bias found to be associated with the use of GAM with egg survey data. At this stage, the sensitivity of the method to different model specifications of these features was not known.

2. In the report (Anon. 1996/H:4) received by the Working Group, no formal tests of model adequacy had been undertaken. While models had been evaluated by examination of plots of standardised deviance residuals and of spatial distribution of residuals summarized by months, these had not been formal or conclusive. Therefore the actual ability of the method to generate results of greater precision or accuracy had not yet been conclusively demonstrated.

3. A key problem associated with the use of GAM techniques is that they are statistically complex and require considerable expertise to apply. The contract with the statistical consultants to investigate the application of

the method had come to an end and there was only a limited number of people available within the Working Group who would have the expertise, at present, to undertake analyses using GAM methods.

1.5.2 Advantages of GAM

It was agreed that the advantages of the GAM method over the traditional method claimed in Anon. (1996/H:4) were valid, with minor modifications. The advantages can therefore be listed as follows.

1. By parsimoniously modelling spatial variation as trend rather than variance, the method has the potential to yield egg abundance estimates with higher precision than estimates from the traditional method.

2. The method has the potential to model complex trends in density with respect to space, time and other explanatory variables, facilitating insights into factors determining egg abundance.

3. It provides a formal means of extrapolating beyond the sampled region to the assumed boundaries of the spawning area.

4. It is comparatively insensitive to the assumed start and end times of spawning.

5. It does not require strong assumptions about the form of the egg production curve, and it is able to incorporate uncertainty due to estimation of the shape of the egg production curve.

In addition to the above, the potential role of the method as a means of guiding survey design was recognised. By appropriate sensitivity analyses, the important factors to be considered in survey design could be identified. In view of the very high costs of surveys, the benefits which would result from an ability to reduce survey effort without a loss in precision could substantially outweigh the costs associated with further contract work on GAM.

The role of point 2 above in generating greater insights into the processes determining egg distribution was emphasised.

1.5.3 Requirements before GAM could be incorporated into routine assessments

1. A primary requirement was for thorough testing, using Monte Carlo simulation techniques, to investigate whether the potential of GAM to achieve greater precision than the traditional method could be realised.

2. Also using Monte Carlo simulation studies, the sensitivity of GAM and of the traditional method to model specifications needed to be compared. These studies should focus particularly on the choice of smoothing functions, explanatory variables, error structure and bias correction.

In order to achieve these two requirements, formal tests of model adequacy would have to be developed, if not already available, and used in the comparisons. In addition, clearer methods of presenting model output, such as distribution of residuals, would be necessary.

If these exercises did demonstrate the superiority of GAM over the traditional method, further development of the approach for use in routine analysis of egg survey data would also be required. This would include the development of a framework for the efficient implementation of GAM that was readily comprehensible to likely users. This framework should include adequate documentation and stipulation of the procedure or procedures to be implemented in selecting model specifications such as the smoothing function, most appropriate explanatory variables and error structure for any given analysis.

1.5.4 Recommendation

It was reported that the funds originally received for the study had been exhausted and that any application for an extension of the project to achieve the above requirements was highly unlikely to be approved.

The MHMEPWG is requested to address the issues highlighted in Section 1.5.3.

Table 1.3.1 Summary of fleet data received for 1995.

Country	Main fishing area	Directed fishery	Kind of gear	Secondary species	Number of boats	Mean Length (min - max)	Mean Horse power (min - max)	Mean Crew size (min - max)	Comments
DENMARK			No changes						
NORWAY			No changes						
IRELAND	IVa, VI, VII	Mackerel	Single and paired pelagic trawl	Horse, mackerel, herring	17	49 (32-97)	2043 (634-5850)	12 (10-40)	**2 new vessels replaced New Sonar**
NETHERLANDS	VIA,VII.	Horse mackerel	stern trawler	Herring, mackerel	12	103 (71 - 120)	4802 (2699 - 7648)	35	Human cons. Frozen fish **New Sonar**
NETHERLANDS	Center and South of the North Sea	Herring in winter	Pelagic pair trawl or beam trawl in summer	Flat fish and round fish in summer	14	40 (30-51)	1229 (736-1472)	6	Human cons. **One ship replaced by larger**
PORTUGAL	IXA	Sardine	Purse seine	Horse mackerel, mackerel, anchovy	225	20.5 (10-29)	280 (35-751)	6	Human cons. and canned
SPAIN	VIIIc east	Anchovy, Tuna	Purse seine	Horse mackerel, sardine, mackerel	227	24 (16-33)	431 (106-950)	14	canned fish
SPAIN	VIIIc west	Sardine, Horse mackerel	Purse seine	Mackerel, anchovy	117	15.1	190.8		Human cons.
SPAIN	IXa north	Sardine, Horse mackerel	Purse seine	Mackerel	150	15	185		Human cons. **Fleet increased**
SPAIN	IXa south	Anchovy	Purse seine	sardine, Spanish mackerel	58	13 (7.9-20.2)	218 (49-624)	11	canned fish
SPAIN	VIIIc east	Demersal fish	Trawl	blue whiting, horse mackerel	33	25 (20-30)	478 (320-850)	11	fish meal and human cons. **Fleet increased**

Table 1.3 1 (continued)

SPAIN	VIIIc west	Demersal fish	Trawl	blue whiting, horse mackerel	51	28	516		human cons.
SPAIN	IXa north	Demersal fish	Trawl	blue whiting, horse mackerel	144	23	429		human cons. **Fleet increased**
SPAIN	IXa south	Shell fish and demersal fish	Trawl	Horse mackerel	286	14	207	6	human cons.
SPAIN	VIIIc east	Hake,	Gill net	Mackerel, horse mackerel	52	13 (4.2-22.5)	131	8	human cons.
SPAIN	VIIIc west	Hake, pollock	Gill net	red sea bream	85	15	165		human cons.
SPAIN	VIIIc east	Hake,mackerel, (Mar- Apr)	Long line and line	conger,red sea bream.	396	13	140	6	human cons. **Fleet increased**
SPAIN	IXa south	miscellaneous	hook and gill net	Sparidae, cephalopods, flat fish, h mac.	270	9	97	5	human cons.
SPAIN	IXa south	anchovy, Horse mackerel	trawl and purse seine	sardine, Spanish mackerel	64	12	141	6	human cons. **Fleet decreased**
RUSSIA	IIA	Mackerel	Pelagic trawl		6	63.5 (53.7 - 82.2)	2271	47	human cons.
RUSSIA	IIA	Mackerel	Pelagic trawl		2	59.1	2200	39	human cons.
RUSSIA	IIA	Mackerel	Pelagic trawl		36	101.8	6149	93	human cons.
UK (Engl. & Wales)	VIIe	Horse mackerel	Pelagic trawl	Mackerel, herring	40	22.8 (6.4-50.5)	531.2 (17.4-2373.6)		human cons.
UK (Engl. & Wales)	VIIe	Mackerel	Pelagic trawl	Herring, horse mackerel	19	25.4 (10.5-97.8)	1123.4 (114.0-6509)		human cons.

Table 1.3 1 (continued)

UK (Engl. & Wales)	VIIe	Mackerel	Purse seine	Horse mackerel, herring	29	45.7 (32.3-56.1)	1876.7 (737.6-3300)	human cons.
UK (Engl. & Wales)	VIIe	Mackerel	Handling	Sardine, herring	78	10.8 (4.1-23.0)	203.5 (4.0-650.4)	human cons.
UK (Engl. & Wales)	VIIe	Herring	Drift net	Mackerel, horse mackerel	17	10.7 (5.3-16.4)	167.6 (9.4-359.4)	human cons.
UK (Engl. & Wales)	VIIe	Herring	All forms of gill net	Mackerel, sardine	376	12.36 (4.3-43.6)	188.2 (6.7-1578.4)	human cons.

2 MACKEREL - GENERAL

2.1 Stock Units

The mackerel caught in North East Atlantic waters was until 1995 treated as belonging to three stocks, Western Southern and the North Sea stocks. Based on tagging experiments (Uriarte 1995) in the south east corner of the Bay of Biscay, in the North Sea and Western area (Bakken and Westgaard, 1986, Iversen and Skagen, 1989) and egg distributions the Working Group last year (Anon. 1996/Assess:7) decided to pool these units into one. The tagging experiments have demonstrated that mackerel from the different spawning areas are mixing in the North Sea and Norwegian Sea during the second half of the year (August-January). Since it is impossible to split the mackerel caught in these areas by stocks all the fish caught have been allocated to the Western stock. The catches of North Sea mackerel has been included in the assessment of Western mackerel since 1988 (Anon. 1989/Assess:11). Due to big differences in stock size levels this has negligible impact on the assessment of the Western stock. The size of the North Sea stock is about 3% of the Western stock.

Even if the three spawning units now are treated as one unit the Working Group considers it important to be able to follow the development of the egg production and spawning biomasses in the Western, Southern and North Sea spawning area separately.

2.2 Spawning Stock Biomass Estimates from Egg Surveys

2.2.1 North Sea Area

A series of surveys was carried out in the North Sea in 1996 by Denmark and Norway. The data analysis is not yet complete but the results will be reported in full to ACFM at their autumn meeting (see section 3.1.1). Preliminary results show that the egg production was very low indicating that the North Sea spawning stock still shows no signs of a recovery. However, the water temperatures observed during the surveys were very low and it is possible that spawning was delayed. This could have resulted in the peak of egg production being missed by these surveys.

2.2.2 Western area

The estimate of egg production (**1.487 x10^{15} eggs**; S.E. 0.170 x 10^{15}), using all the rectangle observations and the new start and end dates for spawning, observed during the 1995 surveys, was used. This estimate was based on an adaptive sampling strategy designed to cover the whole spawning area and to take into account any changes in distribution since the previous survey. The surveys are intended to measure the total spawning stock biomass. Therefore the egg production estimate based only on those rectangles within the 1992 standard area was not used. The new estimates of potential annual fecundity and atresia used by the MHMEPWG in their estimates of SSB were not used.

The estimate of fecundity (1473 eggs/g female) was not significantly different from the estimate in 1992 but was significantly different from the 1989 estimate. Therefore a mean of the 1992 and 1995 estimates, weighted by the inverse variance of the estimates, was used. The new estimate of 1511 eggs/g female was also used to recalculate the 1992 estimate of SSB. The Working Group recommended that the MHMEP Working Group address this issue at their next meeting and consider combining the data sets for 1992 and 1995.

The new estimate of atresia obtained in 1995 was based on a small and highly variable data set. The Working Group decided to take an arithmetic mean of the 1992 and 1995 data sets and use the new value of 10.2% for the 1995 survey estimate. The new value was also used in the recalculation of the 1992 estimate of SSB. The SSB calculated for 1995 was **2.37 x 10^6 tonnes**.

The historic data series is given in Table 2.1 with the changes made for fecundity and atresia to the 1992 estimates included. Two estimates of egg production and subsequent calculations of SSB are given for 1980. They are based on the inclusion and exclusion of the egg survey data in period 3 (Anon. 1994/H:4). The Working Group currently use the time series of estimates with the lower value for 1980 included (Anon. 1995/Assess:2). Table 2.1 is a revised version of Table 5.4.3 in Anon. (1996/H:2) with the SSB estimates currently used in the assessments. Estimates from the Generalized Additive Modelling (GAM) method, with and without bias correction, are also included in this table.

2.2.3 Southern area

This was the first series of surveys carried out in the southern area for the Annual Egg Production Method. There was very poor coverage of the survey area in sampling period 2 when only the Portuguese coast was sampled. There was evidence, from a few samples taken off the north coast of Spain, of high mackerel egg production in that area during period 2. The MHMEP Working Group calculated two production estimates, one based on the survey samples in period 2 (169.21×10^{12} eggs; S.E. 11.2×10^{12}) and the other based on an interpolation between the period 1 and period 3 productions (**207.27 $\times 10^{12}$eggs**; S.E. 12.59×10^{12}). The Working Group accepted the higher estimate for the calculation of SSB. An estimate of fecundity, of 1344 eggs/g female, was obtained from sampling during period 2. The samples taken for atresia were rejected and the estimate for the western area of 10.2% (section 2.2.2) was used. The resultant estimate of SSB for the southern area was **370,928 tonnes.** Using the lower estimate of egg production gave an SSB estimate of 302,813 tonnes.

2.3 Allocation of Catches to Stock

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 Northern Sea stock component separately but it has been believed to be less than 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. An international egg survey carried out in the North Sea during June 1996 provided a very low index of stock size in the area.

Prior to 1995 catches from Divisions VIIIc and IXa were all considered to belong to the southern mackerel stock, although no 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 present Working Group, the new population unit again being called the North-east Atlantic mackerel unit.

2.4 Bottom Trawl Surveys

Bottom trawl surveys which sample juvenile mackerel confirm the previous indications that the 1994 year class is low, and give an indication that the 1995 year class may be strong. Present analyses suggest that there are marked interannual changes in mackerel distribution in the North-South direction. Such changes in distribution appear to affect the catchability of the mackerel to the survey gear. By correcting for this change it appears feasible again to use the survey in order to forecast recruitment at age 2, but the statistical basis for making such a correction should be examined in more detail.

High catch rates of 1995 year class fish were obtained at some locations at the extreme north and south of the usual distribution of this stock, off North-West Ireland, in south of the Bay of Biscay and off northern Portugal. In contrast, catch rates in central parts of the distribution were rather low. Distribution charts are provided for the catches of the 1994 and 1995 year classes of mackerel in the fourth quarter of 1995 (Figures. 2.1 and 2.2) and the first quarter of 1996 (Figures. 2.3 and 2.4). In the first quarter of 1996 the distribution of 1995 year-class fish was similar to that observed in the preceding quarter (where comparable sampling was available), with particularly high abundance to the north-west of Ireland. Additional areas of abundant juvenile fish were found along the outer edge of the continental shelf as far as the Viking Bank. Fish were less abundant than usual around the South of Ireland and the Cornish peninsula.

The distribution of the 1994 year class in the fourth quarter (Figure 2.2) was very similar to that of the 1995 year class, while abundance was much lower, reinforcing indications from the previous winters' surveys that this year class is a weak one. The highest catch rates in this quarter were obtained around north-west Ireland. Catch rates of juvenile mackerel in the North Sea were low (Figures 2.3 and 2.4) do not indicate any significant recovery of that stock.

Catch rates of juvenile mackerel, as calculated by the method described by Dawson *et al.* (1988), are given in Table 2.2, including recent survey information for the last quarter of 1995 and the first quarter of 1996. The survey reported a large catch rate of 1995 year class fish in the winter of 1996, and this may be an indication that the 1995 year class will be a strong one. However, the Working Group does not consider the observation sufficiently reliable to be usd in quantitative predictions.

Conflicting trends exist in recruitment as estimated by the population model used for the stock assessment and the catch rates of juvenile mackerel in surveys (Anon. 1996/Assess:7; Anon. 1995/Assess:2). Although the conflict in the trends had been diminished by replacing the traditional estimates with year-class effects from a multiplicative model (fitted to mean catch rates in ICES rectangles), the deviation was still sufficiently strong to preclude use of the trawl surveys in the assessment. The underlying cause of the conflicting trends is not known. Information on mackerel recruitment surveys has only recently been prepared in database form, allowing some preliminary investigation into possible distributional changes and their possible effects on availability to the surveys.

There appears to be a strong and highly-variable interannual change in the distribution of the juveniles (Figure 2.5.). For example, in 1984, 1987 and 1993 a larger proportion of the juvenile population was found in the northern areas (VIa(N) and VI(S)) compared to other years. A simple approach was used to examine whether the differences between the Working Group's population model estimates of recruitment and the survey estimates might be explained in terms of ditributional changes. Firstly, a measure of the displacement of the centre of the distribution of the juvenile population, in the North-South direction, was calculated as:

$$Displacement_y = \frac{\sum_{lat} (Lat.Catch_{lat,y})}{\sum_{lat} Catch_{lat,y}} - 1/n \sum_y \left(\frac{\sum_{lat} (Lat.Catch_{lat,y})}{\sum_{lat} Catch_{lat,y}} \right)$$

where *lat* represents latitude, and '*Catch*' represents the catches in survey trawls in year y at the corresponding latitude.

Values so calculated (Table 2.3) were compared with the discrepancy between the traditional survey index of abundance (Table 2.2) and the most recent estimates of year-class strength from the assessment (Figure 2.6). The data scatter was interpreted as a simple dependence of the catchability of the fish in the surveys on the location of the juvenile shoals in the North - South direction each year. The fitted slope allows an *ad hoc* correction to be made to the observed survey catch rates in order to remove the effect of interannual distributional changes, so improving the coincidence of the surveys and the assessment model (Figure 2.7). The application of such a correction has a reasonable mechanistic basis, as one would expect that when fish are distributed further northwards, and hence in colder water, their swimming speed would be reduced and their catchability in trawls would be correspondingly higher. However, the statistical validity of the correction has not yet been tested.

The *ad hoc* corrected survey index shows good coincidence with the Working Group's estimates of year-class strength in recent years. This provides strong support for maintaining the assumption that the 1994 year class is a weak one.

The Working Group recommends further modelling work should be undertaken in order the explore further the use of distributional models for improving the use of the juvenile surveys for prediction of recruitment. Preliminary work indicates good prospects for deriving a robust index of abundance from the mackerel survey data, and the Working Group recommends that the surveys be continued.

2.5 The Fishery in 1995

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.4. This table shows the development of the fisheries in the different areas since 1969. The total estimated catch in 1995 was about 755,000 t which was approximately 80,000 t lower than the catch taken in 1994. The total catch maintains the high level of catches taken from the fishery in recent years. Estimates of discards are also shown. However, these estimates apply to one fleet only.

During 1995 the highest catches were again taken from Sub-area IV and Division IIIa - over 96% of these having been taken in Division IVa. There was, however, a considerable decrease in the catch taken from this area compared with that of 1994. The increased catches in Division IIa were apparently a result of increased effort in that area. Catches taken from Sub-areas VI and VII and from Division VIIIa,b,c,d,e were all similar to those in recent years. The catches taken in Divisions VIIIc and IXa have slowly increased in recent years and the 1995 catch of 27,600 t is the highest recorded since 1977. The amounts misreported during 1995 decreased compared with previous years. Over 106,000 t of mackerel were taken in Division IVa and were reported as having been taken in Division VIa - the corresponding figure for 1994 was 245,000 t. This decrease was due to increased monitoring of the fisheries but also due to the development of the fishery in the southern part of Division VIa during the fourth quarter.

The catches per quarter and per Sub-area and by Division are shown in Table 2.6. This table gives a good indication of the migration of the stocks. The quarterly distribution of the fisheries is similar to that of recent years. Over 37% of the total catch was taken during the 1st quarter as the shoals migrate through Sub-area VI to the main spawning areas in Sub-area VII. Only 8% of the total catch was taken in Quarter 2, most of it from Sub-areas VI and VII. During Quarter 3 the main catches were recorded from Division IIa and Division IVa from the shoals on the summer feeding areas. During Quarter 4 the main catches were recorded from the overwintering areas in Division IVa while considerable catches were also taken from a fishery in Division VIa South and from around the South-west Box. The main catches from Divisions VIIIc and IXa were taken in Quarter 2 - over 57% of the total being taken from Quarter 2 from Division VIIIc.

National catches

The national catches recorded by the various countries for the different areas are shown in Table 2.5a–d. As has been stated before these figures should not be used to study trends in national figures because of the degree of misreporting, and the high "unallocated" catches due to 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 2.5a) was believed to be about 135,000 t, which was considerably higher than that for 1994 (71,900 t). Most of the catch was taken by Norway and Russia.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.5b) was 323,000 t compared with 475,980 t in 1994. This decrease was mainly a result of a decrease in the amount of the misreported catch. The main catches were recorded by Norway (108,000 t), while substantial catches were also recorded by Denmark, the United Kingdom and the Faroes. Some slight revisions were made to the 1994 area distribution of catches.

The total catch recorded from the Western areas (Table 2.5c) was 270,000 t - including unallocated and misreported catches of minus 79,000 t. Approximately 107,000 t were believed to have been taken in Division IVa but reported as having been taken in Division VIa while over 28,000 t were considered "unallocated". The national catches have been very stable for a number of years.

The total catch recorded from Divisions VIIIc and IXa (Table 2.5d) was 27,400 t which is the highest recorded since before 1977. Most of this catch was taken by Spain (90%).

2.5.1 ACFM advice and management applicable to 1995 and 1996

The TACs agreed by the various management authorithies, the catches and the TACs rcommended by ACFM for 1995 and 1996 were as follows:

Stock	1995			1996	
	TAC recommended by ACFM	Agreed TAC	Catch	Recommended TAC	Agreed TAC
North Sea Stock	Lowest possible level	76,320[1]	?	see text	52,750[1]
Western Stock	530,000	608,08	728,000	see text	354,615
Southern Stock	No advice given	36,570[2]	27,600	see text	30,000[2]

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

The agreed TAC includes the agreements between EU, Norway and the Faroese. For 1996 ACFM recommended a significant reduction in fishing mortality to restore and maintain the SSB above historical low level by the time of spawning in 1997 or 1998. The recommendations were given for two areas, the Southern (Divisions VIIIc and IXa) and the Northern area (Divisions IIa, IIIa, IVa, Vb, VIIIabd and Sub areas VI,VII). The recommended TAC were:

To restore SSB at spawning time 1997: 4,000 tons in the Southern area and 144,000 tons in the Northern area.

To restore SSB at spawning time 1998: 8,000 tons in the Southern area and 280,000 tons in the Northern area.

It is important to note that while the recommended TACs are meant to apply to the total catch of mackerel in the total distribution area the actual agreed TACs do not apply to the catches taken in international waters. Catches in international waters are mainly taken by Russia in the Norwegian Sea (44,000 tons in 1995).

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 1995 and are again in force in 1996:

1. Prohibition of fishing in Division IVa during Quarters 1 and 2, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year. Norway opened for a small fishery in Division IVa the first quarter of 1995 and 1996;
2. Prohibition of a directed mackerel fishery in the "Cornwall Box";
3. Restrictions on the quantities of mackerel which could be taken east of 2° in Quarters 3 and 4 by some countries;
4. Minimum landing size of 30 cm for Sub-area IV, Division IIIa and 25 cm for Divisions VIIIc and IXa;

Various national measures such as closed seasons and boat quotas.

2.6 Distribution of the Mackerel Fisheries

The distribution of the mackerel catches taken in 1995 is shown per quarter and per Sub-area and Division in Table 2.6. More detailed information on catches, per statistical rectangle, based on logbook information is shown in Figures 2.8a–d. The information is incomplete because it is based only on catches from Netherlands, Norway, Ireland, Russia, Denmark, Spain, Portugal and United Kingdom (England). Only limited data were available for the United Kingdom (Scottish) catches.

First quarter 1995

Catches taken during this quarter totalled about 281,200 t. Considerable misreporting of catches takes place during this quarter between Division IVa and VIa and the data relating to these Divisions should be treated with caution. The distribution of the catches appear to be very similar to that of 1994 and reflects the migration of the shoals as they move away from the overwintering areas in the North Sea and IIa along the west of Scotland and Ireland and towards the spawning grounds south-west of Ireland and England. Small catches are also taken during this quarter in the western English Channel and along the Iberian Peninsula. The distribution is shown in Figure 2.8a.

Second quarter 1995

Catches during this quarter totalled about 63,200 t. The main catches were again taken from the spawning grounds south-west of Ireland. Small catches were again taken from the Iberian Peninsula, particularly in the south-eastern section of the Bay of Biscay. Some catches were also reported from the international waters in the Norwegian sea. The distribution was again very similar to that of 1994 and is shown in Figure 2.8b.

Third quarter 1995

Catches during this quarter totalled about 204,600 t. During this quarter the main catches were taken in the fisheries west of Norway where the distribution was again similar to 1994. Catches taken from the fishery in the international waters in the Norwegian sea were distributed over a very wide area and the general distribution in the fishery appeared to be more northerly than in 1994. Small catches were again taken from around the Iberian Peninsula, particularly along the west coast of Portugal. The distribution is shown in Figure 2.8c.

Fourth quarter 1995

Catches during this quarter totalled 206,600 t. The main catches were again taken west of Norway. However, there were considerably more catches taken in the western part of Division IVa than in 1994. Higher catches were also taken from north-west of Ireland than in 1994. Considerable catches were again taken from the western part of the English Channel. Small catches continued to be taken from around the Iberian Peninsula. The distribution is shown in Figure 2.8d.

2.7 Length Compositions by Fleet and Country

Length distributions of the 1995 catches by some of the various fleets were provided by Denmark, Ireland, Netherlands, Norway, Portugal, Russia, Spain and United Kingdom. The length distributions were available from most of the major fishing fleets and account for about 75% of all catches.

The length distributions by country and by fleet for 1995 are shown in Table 2.7. More detailed information on a quarterly basis is available on the Working Group files.

2.8 Catch in Numbers at Age

The catches in numbers at age by quarter for Divisions IIa; IIIa; IVa; IVb,c; VIa; VIIa,e,f,g,h; VIIb,c,j,k; VIId and VIIIa,b,d,e are shown in Table 2.8. The percentage catch by numbers at age from 1985 to 1995 is given in Figure 2.9.

The catch in number at age by quarter for mackerel from Divisions VIIIc and IXa for southern mackerel is given in Table 2.9 for 1995 and in Figure 2.10 for the period 1984–1995.

The overall age composition is mainly composed of 2–6 year old fish. These age groups constitute 72% of the total catches. The overall age compositions are reasonably consistent throughout most areas with the exceptions of Divisions IVb,c and Divisions VIIa,e,f,g,h and Division VIId. These three areas contain much higher numbers of 0 and 1 year old fish. The following text table shows the overall % (in numbers) distribution for different age groupings.

	Areas									
Age Groups	IIa	IIIa	IVa	IVb,c	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIId	VIIIa,b,d,e	VIIIc,IXa
0–1	+	1	+	49	2	2	23	24	1	24
2–6	74	79	76	48	66	68	75	2	52	44
6–15	26	20	24	3	32	30	2	1	47	32

Catches from Divisions VIIIc and IXa areas continue to be dominated by young mackerel and 0 and 1 group fish in 1995 constituted 24% of the catch in 1995. Fish in the age groups 2–6 constituted 44% of the catches while older age groups constituted 32%.

Age distributions of catches were provided by Denmark, Ireland, Netherlands, Norway, Portugal, Russia, Spain and United Kingdom. There were again some serious defects in the overall sampling of the catches. No age distributions were available from a number of countries who take substantial catches, e.g. the Faroes, France, Germany and Sweden. In addition, there were no samples to cover the entire catch from Division VIId (12,000 t). Catches for which there was no sampling data were converted into numbers at age using data from the most appropriate fleets. As in 1994 this procedure was not always desirable because of possible differences between fishing gears in the different areas.

The sampling intensity is further discussed in Section 1.3.1.

2.9 Mean Lengths at Age and Mean Weights at Age

Mean lengths

The mean lengths at age per quarter for 1995 for the Western area and for the Southern area are shown in Tables 2.10 and 2.11 respectively.

Mean weights

The mean weights at age in the catches per quarter for 1995 for the western and southern areas are shown in Tables 2.12 and 2.13 respectively. The mean weights at age in the stock for the western mackerel is shown in Table 3.6. These are based on samples obtained from Dutch freezer trawlers fishing on the spawning grounds west of Ireland. The mean weights at age in the stock for the southern mackerel are based on samples obtained during Quarter 1 and Quarter 4 and averaged over 1991–1994 the last three years. The same data set has been used since 1984. The data are as follows:

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

2.10 Maturity at age

At last years Working Group meeting (Anon. 1996/Assess:7) it was recommended that the assumptions about maturity at age of mackerel should be examined in more detail by the Egg Survey Working Group as maturity is critical to the fitting of the populations to egg survey biomasses. The maturity ogive assumes that 60% of 2 year old mackerel are mature. An exception was made in the case of the very large 1984 year class, for which 20% were assumed to be mature at age 2. This was based on a lower than average growth rate and a scarcity of mature fish of this year class during the 1986 egg survey. There is no evidence that the maturity ogives of the large 1987, 1989 and 1991 year classes should be similarly adjusted.

The present maturity ogive was constructed in 1985 (Anon. 1985) based on Dutch commercial and research vessel samples taken in April, May, June, July and August in Division VIa south of 57°N and Divisions VIIb,e,f,g,h,j during the period 1977-1984. These Dutch data were accepted as the most representative samples, because they were well distributed throughout both the spawning ground and the juvenile area. However, the shortcomings of this maturity ogive is that no weighting factors have been applied to the samples, depending on how many fish of a certain age group were distributed in the juvenile areas and how many in the spawning area. At the Egg Survey Working Group (Anon. 1996) new maturity ogives were presented based on Dutch commercial and research vessel samples from the same ICES Divisions but now coverering the time periods 1985-1995 and 1977-1995 (Table 2.15). The differences between the maturity ogives from period 1977-1984 and 1985-1995 are not large despite the fact that in recent years the samples were mainly taken from the adult area. The differences become even smaller when a maturity ogive is constructed over the whole period 1977-1995. The Egg Survey Working Group decided not to change the maturity ogive based on available information and because of uncertainties in estimating a maturity ogive and recommended that a maturity ogive be estimated from the biological samples collected during the surveys of the Daily Egg Production Method (DEPM) in 1992, when many hauls were carried out in the main distribution area of the adult mackerel at peak spawning time. Unfortunately large parts of the juvenile distribution area are not covered by these surveys.

The existing maturity ogive is based on macroscopically estimated maturity stages. However, histological analysis of the ovaries of younger fish showed that the macroscopically estimated proportion mature might be overestimated. A review was given on examples of abortive maturation in ovaries of mackerel and other fish species (Anon., 1996/H:2).

At this Mackerel, Horse Mackerel, Sardine and Anchovy Working Group meeting additional information on mackerel maturity ogives was presented:

- Newby and Watson (1996 WD) provided maturity data from the 1992 DEPM surveys.
- Iversen (1996 WD) presented mackerel maturity data from Norwegian mackerel tagging program southwest of Ireland.
- Witthames (1996 WD) provided mackerel maturity data from a histological method to compare maturity at age of 1 to 3 year old females from the years 1988, 1989 and 1991 from ICES Divisions VIIj (adult area) and VIIe (juvenile area).
- Villamor (pers. comm.) presented mackerel maturity data collected in 1993-1995 from Division VIIIc and IXa north (Spanish area).

- Martins (1996 WD) provided mackerel maturity data collected in 1986-1995 from Division IXa (Portuguese area).
- Maturity at age obtained from combined 1995 maturity data from Spain and Portugal.

The proportions mature at ages 2 and 3 obtained from the 1992 DEPM surveys and the Norwegian tagging program are higher than those as used by the Working Group (Table 2.15). The explanation for this is that the sampling mainly took place in the adult areas, while sampling should take place in accordance with the distribution pattern of both age group 2 and 3.

The histological maturity data indicate that proportions mature obtained from macroscopically estimated maturity stages are overestimating the proportions mature of especially age groups 1 to 3. This is due to the fact that a large proportion of the young fish, which start to mature, never actually spawn, because all vitollogenic oocytes become atretic. Furthermore, there appears to be a large difference between the proportions mature in the adult and juvenile areas. Based on present histological information none of the 0-group fish actually spawn.

For assessment purposes it is important that the maturity ogive represents the proportions of fish by age group that actually spawn, because the assessment is tuned to spawning stock biomasses obtained from egg surveys. This is especially the case when a strong year class enters age group 2.

In the southern area the proportions mature of age groups 1 to 3 are even much higher than in the western area, while the proportion mature of 1-year olds is highly variable (Table 2.15). The proportions mature for the southern area are also based on macroscopically estimated maturity stages and are therefore assumed to be overestimated.

The Working Group decided not to change the existing maturity ogives for both the western and southern areas, because of the uncertainties mentioned above. The Working Group, however, expresses the need for improved estimates of maturity ogives for assessment purposes, estimates of the precision with which these are estimated and sensitivities to the assumptions.

Histological analysis appears to be an prerequisite to estimate the proportion mature of ages 1–3. Therefore, the **Working Group recommends that during the next egg survey in 1998 both mackerel and horse mackerel ovaries be collected at peak spawning time in both the western and southern area in order to construct maturity ogives based on histological analysis. At the same time additional sampling should be carried out in the juvenile areas.**

2.11 Species Mixing

As in previous years there was also a Spanish fishery for Spanish mackerel, *Scomber japonicus*, in 1995 in the south of Division VIIIb and in Sub-division VIIIc east. The fishery took place mainly in autumn. Table 2.16 shows the Spanish mackerel landings by subdivision in the period 1982–1995. Landings in 1995 (2,558 t) in Sub-division VIIIc East increased compared to 1994 (1,903 t). In Division VIIIb landings were 247 t, a slight decrease compared to 1994. There was also a Spanish fishery for Spanish mackerel, mainly in the 3rd quarter, in Subdivision IXa North in 1995 (4,705 t). There is no misidentification of mackerel species in the Spanish fishery in Divisions VIIIbc and Sub-division IXa North.

In Sub-division IXa South , the Bay of Cadiz, there is a small Spanish fishery for mixed mackerel species with landings of 364 t in 1995. This was a decrease in comparison with previous years in which landings were around 1000 t. In the bottom trawl surveys carried out in the Gulf of Cadiz in 1995, catches of *S. Scombrus* were scarce or even non-existent, with *S. japonicus* making up 99% of the total of both species (M. Millán, pers. comm). Due to the uncertainties in the species proportions in the landings catches of *S. Scombrus* have never been included in mackerel landings reported to this Working Group by Spain.

Portuguese landings during 1982–1995 are also shown in Table 2.16.

Since the seventies there has been a Portuguese Spanish mackerel fishery. Mackerel and Spanish Mackerel are distributed along the Portuguese coast, (from 20 meters to 400 m aproximately). Spanish mackerel appears to be more abundant in the southern areas while mackerel appears more abundant in the North zone (Martins and Cardador 1996). This species is caught by purse seiners, artisanal fleet and trawl fleet.

In 1995 purse seiners accounted for 73% of total Portuguese landings (around 4,000 t); the population was composed of age classes between 0 and 12. Age 2, 3 and 4 contributed with the highest percentage of the landings (Martins, 1996).

Table 2.1 Spawning stock biomass for the western mackerel and western horse mackerel. Spawning stock biomass estimates are corrected for atresia. A sex ratio of 1:1 is assumed. The SSB was calculated from the total egg production based on arithmetic mean of unsampled rectangles if available.

Year	Total egg production (10^{-15}) (Mean used for unsampled rectangles) Geometric	Arithmetic	Total fecundity (eggs/g female)	Total fecundity corrected for atresia (eggs/g female)	Pre-spawning stock biomass ($x10^{-6}$ tonnes)	Spawning stock biomass ($x10^{-6}$ tonnes) (conv. f.x1.08)
Annual egg production method - western mackerel						
1977	1.98		1457 c	1329 e	2.98	3.22
1980	1.48 a		1457 c	1329 e	2.23	2.41
1980	1.84 b		1457 c	1329 e	2.77	2.99
1983	1.50	1.53	1457 c	1329 e	2.30	2.49
1986	1.15	1.24	1457 c	1329 e	1.87	2.02
1989	1.45	1.52	1608 d	1466 e	2.07	2.24
1992	1.83	1.94	1511	1357 f	2.86	3.09
1995	-	1.49	1511	1357 f	2.19	2.37

Year	Total egg production (10^{-15}) (Mean used for unsampled rectangles) Geometric	Arithmetic	Total fecundity (eggs/g female)	Total fecundity corrected for 3.4% atresia (eggs/g female)	Pre-spawning stock biomass ($x10^{-6}$ tonnes)	Spawning stock biomass ($x10^{-6}$ tonnes) (conv. f.x1.05)
Annual egg production method - western horse mackerel						
1977	0.533 g		1557	1504	0.71	0.74
1980	0.635 g		1557	1504	0.84	0.89
1983	0.381 g		1557	1504	0.51	0.53
1986	0.508 g		1557	1504	0.68	0.71
1989	1.54	1.63	1557	1504	2.17	2.28
1992	1.37	1.58	1557	1504	2.10	2.21
1995	-	1.226	1557	1504	1.63	1.71

a Egg survey data for period 3 included
b Egg survey data for period 3 excluded
c from Anon (1987) page 3
d from Anon (1990)
e with 8.8% atresia
f with 10.2% atresia
g Eaton (1989). Incomplete coverage in 1977

Estimates by Generalized Additive Modelling (from Augustin et al WD 1996)

		Egg Production x 10^{-15}				
Year	Area	Mackerel			Horse mackerel	
		GAM (no bc)	GAM (with bc)		GAM (no bc)	GAM (with bc)
1995	Western	0.854	1.623		0.886	1.554
		0.02	*0.05*		*0.09*	*0.24*
		[2.7]	[2.9]		[10.2]	[15.4]
	Southern	0.136	0.202		0.396	0.553
1992	Western	1.744	2.366		1.44	1.804
		0.05	*0.07*		*0.11*	*0.21*
		[2.6]	2.9		[7.5]	[11.9
1989	Western	1.373	3.027		1.308	1.635
		0.09	*0.12*		*0.09*	*0.14*
		[6.5}	[3.8]		[6.7]	[9.2]

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

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Table 2.2 Mean catch rates of juvenile mackerel in first-quarter and fourth-quarter demersal trawl surveys. Estimates from preliminary database supplied by Walsh (pers. comm.; Marine Laboratory, Aberdeen).

Year-Class	Mean Catch Rate (Fish/hr)
1985	63
1986	48
1987	297
1988	161
1989	294
1990	169
1991	358
1992	220
1993	517
1994	149
1995	1582*

* Preliminary; based on catch rates at ages 0 in the 4th quarter and 1 in the first quarter

Table 2.3 Estimates of the displacement of the centre of the distribution of juvenile mackerel (ages 0, 1 and 2) from their long-term mean location. Positive values indicate a northward shift.

Survey Year	Estimated Displacement (degrees latitude)
1987	-2.595
1988	-1.516
1989	-0.691
1990	-0.2503
1991	-1.037
1992	-1.751
1993	2.42
1994	1.504
1995	1.695
1996	2.367

Table 2.4 Catches of MACKEREL by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and Division IIIa			Divs. IIa,Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards[2]	Catch	Landings	Discards[2]	Catch	Landings	Discards[2]	Catch	Landings	Landings	Landings	[2]	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	Not	356,487	-	356,487
1973	52,200	-	52,200	167,300	-	167,300	326,519	-	326,519	21,600	available	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	691,009	25,350	716,359
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	308,140	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	640,772	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	322,000	730	323,400	135,500	27,600	747,879	7,721	755,600

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

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

Table 2.5a Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb), 1983-1995. (Data submitted by Working Group members.)

Country	1983	1984	1985	1986	1987[1]	1988[1]
Denmark	10,427	11,787	7,610	1,653	3,133	4,265
Faroe Islands	-	137	-	-	-	22
France	-	-	16	-	-	-
Germany, Fed. Rep.	5	-	-	99	-	380
German Dem. Rep.	-	-	-	16	292	-
Norway	38,453	82,005	61,065	85,400	25,000	86,400
Poland	-	-	-	-	-	-
United Kingdom	-	-	-	2,131	157	1,413
USSR	65	4,292	9,405	11,813	18,604	27,924
Discards	-	-	-	-	-	-
Total	48,950	98,222	78,096	101,112	47,186	120,404

Country	1989	1990	1991	1992	1993[2]	1994[2]	1995
Denmark	6,433	6,800	1,098	251	-	-	4,746
Estonia				216	-	3,302	1,925
Faroe Islands	1,247	3,100	5,793	3,347	1,167	6,258	9,032
France	11	-	23	6	6	5	5
Germany, Fed. Rep.	-	-	-	-	-	-	-
German Dem. Rep.	2,409	-	-	-	-	-	-
Latvia				100	4,700	1,508	389
Norway	68,300	77,200	76,760	91,900	110,500	140,708	93,315
Poland	-	-	-	-	-	-	-
Russia				42,440	49,600	28,041	44,537
United Kingdom	-	400	514	802	-	1,706	194
USSR	12,088	30,000	13,631[3]	-	-	-	-
Misreported[1]						-109,625	-18,647
Discards	-	2,300	-	-	-	-	
Total	90,488	118,700	97,819	139,062	165,973	71,903	135,493

[1]Includes catches probably taken in the northern part of Division IVa.
[2]Preliminary.
[3]Russia.

Table 2.5b Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and Division IIIa), 1983–1995. (Data submitted by Working Group members).

Country	1983	1984	1985	1986	1987[1]	1988
Belgium	93	68	-	49	14	20
Denmark	11,285	10,088	12,424	23,368	28,217	32,588
Faroe Islands	-	-	1,356	-	-	-
France	2,248	-	322	1,200	2,146	1,806
Germany, Fed. Rep.	10	112	217	1,853	474	177
Ireland	-	-	-	-	-	-
Netherlands	866	340	726	1,949	2,761	2,564
Norway	24,464	27,311	30,835	50,600	108,250	59,750
Sweden	1,903	1,440	760	1,300	3,162	1,003
United Kingdom	16	2	143	18	94	876
USSR	-	-	-	-	-	-
Unallocated, discards and misreported	96	202	3,656	162,822	136,737	233,532
Total	40,985	39,576	50,466	243,700	301,618	338,316
Misreported[3]				148,000	117,000	180,000

Country	1989	1990	1991	1992	1993[2]	1994[2]	1995
Belgium	37	-	125	102	191	351	106
Denmark	26,831	29,000	38,834	41,719	42,502	47,852	30,891
Estonia				400	-	-	-
Faroe Islands	2,685	5,900	5,338	-	11,408	11,027	17,883
France	2,200	1,600	2,362	956	1,480	1,570	1,599
Germany, Fed. Rep.	6,312	3,500	4,173	4,610	4,940	1,479	712
Ireland	8,880	12,800	13,000	13,136	13,206	9,032	5,607
Latvia				211	-	-	-
Netherlands	7,343	13,700	4,591	6,547	7,770	3,637	1,275
Norway	81,400	74,500	102,350	115,700	112,700	115,741	108,785
Sweden	6,601	6,400	4,227	5,100	5,934	7,099	6,285
United Kingdom	38,660	30,800	36,917	35,137	41,010	27,479	21,609
Russia	-	-	-	-	-	-	-
Romania	-	-	-	-	-	2,903	-
Unallocated, discards, and misreported	100,651	126,900	153,958	143,546	149,417	245,807	127,338
Total	281,600	305,100	365,875	367,164	390,558	473,977	322,099
Misreported[3]	92,000	126,000	130,000	127,000	146,697	245,157	106,987

[1] May includes catches taken in Division IIa.
[2] Preliminary.
[3] Catches reported as taken in Division VIa.

Table 2.5c 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	1983	1984	1985	1986	1987	1988
Belgium	+	+	-	+	-	-
Denmark	15,000	200	400	300	100	-
Faroe Islands	14,900	9,200	9,000	1,400	7,100	2,600
France	11,000	12,500	7,400	11,200	11,100	8,900
Germany, Fed. Rep.	23,000	11,200	11,800	7,700	13,300	15,900
Ireland	110,000	84,100	91,400	74,500	89,500	85,800
Netherlands	73,600	99,000	37,000	58,900	31,700	26,100
Norway	19,900	34,700	24,300	21,000	21,600	17,300
Poland	-	-	-	-	-	-
Spain	-	100	+	-	-	1,500
United Kingdom	182,900	198,300	205,900	156,300	200,700	208,400
USSR	+	200	+	-	-	+
Unallocated + misreported[1]	105,500	18,000	75,100	-98,701	-91,000	-175,300
Discard	11,300	12,100	4,500	-	-	5,800
Grand Total	567,100	479,600	467,700	232,599	284,000	377,000
Misreported[3]				-148,000	-117,000	-180,000

Country	1989[2]	1990	1991	1992	1993[2]	1994[2]	1995
Belgium	-	-	-	-	-	-	-
Denmark	1,000?	-	1,573	194	-	2,239	1,443
Estonia							361
Faroe Islands	1,100	1,000	4,095	-	2,350	4,283	4,248
France	12,700	17,400	10,364	9,109	8,296	9,998	10,178
Germany, Fed. Rep.	16,200	18,100	17,138	21,952	23,776	25,011	23,703
Ireland	61,100	61,500	64,827	76,313	81,773	79,996	72,927
Netherlands	24,000	24,500	29,156	32,365	44,600	40,698	34,514
Norway	700	-	-	-	600	2,552	-
Poland	-	-	-	-	-	-	-
Spain	1,400	400	4,020	2,764	3,162	4,126	4,509
United Kingdom	149,100	162,700	162,588	196,890	215,265	208,656	190,344
USSR	-	-	-	-	-	-	-
Unallocated + misreported[1]	-73,100	-114,500	-133,802	-125,528[1]	-146,697[1]	-130,133	-78,742
Discard	4,900	11,300	23,550	22,020	15,660	4,220	6,991
Grand Total	288,900	302,900	183,509	236,079	248,785	251,646	270,476
Misreported[3]	-92,000	-126,000	-130,000	-127,000	-146,697	-134,765	-106,987

[1]Includes catches taken in Division IVa, but misreported to Division VIa.
[2]Preliminary.
[3]Catches taken in Division IVa but reported for Division VIa.

Table 2.5d Landings (tonnes) of Mackerel in Divisions VIIIc and IXa, 1977-1995.
(Data submitted by Working Group members).

	Division VIIIc	Division IXa					
Years	**Spain**	**Portugal**	**Spain**	**Poland**	**USSR**	**Total**	**TOTAL**
1977	19,852	1,743	2,935	8	2,879	7,565	27,417
1978	18,543	1,555	6,221	-	189	7,965	26,508
1979	15,013	1,071	6,280	-	111	7,462	22,475
1980	11,316	1,929	2,719	-	-	4,648	15,964
1981	12,834	3,108	2,111	-	-	5,219	18,053
1982	15,621	3,018	2,437	-	-	5,455	21,076
1983	10,390	2,239	2,224	-	-	4,463	14,853
1984	13,852	2,250	4,206	-	-	6,456	20,308
1985	11,810	4,178	2,123	-	-	6,301	18,111
1986	16,533	6,419	1,837	-	-	8,256	24,789
1987	15,982	5,714	491	-	-	6,205	22,187
1988	16,844	4,388	3,540	-	-	7,928	24,772
1989	13,446	3,112	1,763	-	-	4,875	18,321
1990	16,086	3,819	1,406	-	-	5,225	21,311
1991	16,940	2,789	1,051	-	-	3,840	20,780
1992	12,043	3,576	2,427	-	-	6,003	18,046
1993	16,675	2,015	1,027	-	-	3,042	19,719
1994	21,146	2,158	1,741	-	-	3,899	25,045
1995	23,631	2,893	1,025	-	-	3,918	27,549

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Table 2.6 Catches of mackerel by Division and Sub-area in 1995. (Data submitted by Working Group members.)

Division/ Sub-area	Quarter				Total
	1	2	3	4	
IIa + Vb	200	2,000	133,300	+	135,500
IVa	103,900	200	60,100	147,800	312,000
IVb		+	1,100	400	1,500
IVc	100	300	1,000	1,500	2,900
IIIa	+	300	500	4,800	5,600
VI	117,200	9,500	2,600	16,400	145,700
VII	51,100	30,000	3,300	34,200	118,600
VIIIa,b,d,e	1,600	3,900	400	300	6,200
Sub-total	274,100	46,200	202,300	205,400	728,000
VIIIc	6,300	16,000	900	500	23,700
IXa	800	1,000	1,400	700	3,900
Grand total	281,200	63,200	204,600	206,600	755,600

Catches rounded to nearest 100.
Catches less than 50 t = +.

Table 2.7 Length distribution (millions of fish) in 1995 catches by different fleets.

Country		SCOTLAND			NORWAY	Nether-		Spain		Ireland	UK (England & Wales)		Russia		Portugal		Denmark	
Gear	P. Seine	Others	Pr. Trawl		Total	lands												
Length cm					P.seine	Pelagic	P. seine	Artisanal	Trawl	P. Trawl	Trawl	Handline	Commercial	P.seine	Artisanal	Trawl	P Seine	Trawl
10		0	0			trawl												
11		0	0															
12	0	0	0															
13	0	0	0															
14	0	0	0															
15	0	0	0														1		
16	0	0	0			0	0	0	0					0	0	2		
17	0	0	0			0	0	0	0		172			0	0	1		
18	0	0	0		0	32	0	0	0	19	343		0	0	0	5		
19	0	0	0		0	77	40	0	330	83	0		0	0	0	56		
20	0	0	0		0	510	1356	0	548	91	0		0	122	0	62		
21	153	854	0		0	576	2634	0	471	19	160	1	0	219	0	67		
22	66	366	0		1	64	1745	0	168	19	245	5	0	609	0	67		
23	11	61	0		0	31	702	8	30	0	402	11	3	323	0	121		
24	11	61	0		0	111	195	23	143	202	2874	12	2	56	0	452		
25	98	68	0		4	1270	967	22	150	698	1305	40	27	178	0	743		
26	413	207	238		17	2385	900	27	118	2636	1568	113	225	178	0	544	770	
27	1727	624	173		55	3225	951	30	117	2061	1067	176	676	177	0	309		
28	3147	1594	1997		153	4221	74	113	164	1795	1152	241	1357	122	0	388		
29	4469	1779	2331		4165	2866	283	78	215	1593	1081	308	1837	205	0	435	770	
30	5174	2048	1799		12252	2273	206	339	477	5106	9308	3295	3245	233	14	457	6180	
31	5649	3134	2675		24461	3058	468	668	492	8334	1061	312	5291	392	17	490	26160	
32	11790	4379	4310		42724	5221	642	1197	596	16614	6496	330	7980	551	40	359	38300	
33	14728	5204	3508		47818	8596	487	1195	573	20497	4186	459	7162	619	42	184	60760	36
34	17512	4578	5604		46900	9131	744	2452	703	21001	2001	263	7607	542	61	130	89480	61
35	16817	5501	4099		47848	9602	756	3178	343	19403	946	183	11074	610	51	104	95700	158
36	15965	4765	3957		39885	12998	737	3375	563	22646	388	193	9141	499	97	57	54960	49
37	17022	4240	4233		38851	12637	914	3660	469	19696	151	149	9185	298	85	41	69500	85
38	15181	3336	3632		33774	13924	1297	4517	1155	19702	20	112	5259	256	90	2	50520	170
39	14919	3403	3117		27582	11770	2004	5106	626	19958	0	90	3448	85	74	50	56900	170
40	9175	1829	2460		19486	9672	2078	4961	1105	18065	0	73	2003	64	83	46	55080	85
41	4858	1172	1006		10268	6259	1984	3946	509	11835	0	21	612	4	50	29	51290	73
42	2408	929	491		5166	3225	1595	2479	245	7671	0	7	280	4	21	22	31740	49
43	899	89	416		1089	1499	928	1435	119	4204	0	4	72	0	22	17	6110	24
44	520	71	42		50	678	593	705	88	2392	0	3	0	0	14	3	6150	12
45	326	105	42		31	150	221	208	21	882	0	0	0	0	9	0	7350	
46	177	5	0		12	166	88	60	5	70	0	0	0	0	2	0		
47	0	0	0		+	646	51	10	0	207	0	0	0	0	1	0	1510	
48	0	0	0		+	0	30	15	0	0	0	0	0	0	0	0		
49	0	0	0		+	0	0	19	0	0	0	0	0	0	0	0		
50	0	0	0		+	0	0	0	0	0	0	0	0	0	1	0		
51	0					0	0	0	0	0	0	0	0	0	0	0		
52	0				0	0	0	0	0	0	0	0	0	0	0	0		
53	0				0	0	0	0	0	0	0	0	0	0	0	0		
54	0				0	0	0	0	0	0	0	0	0	0	0	0		
Total nos	163209	50403	50960		452647	126873	25669	40626	10543	227499	99679	3501	76486	6347	781	5286	70260	888
Tonnes	66149	18580	20365		202100	50426	7783	17846	3536	94700	17503	989	44534	1491	1142	1032	34496	480

Table 2.8 Catch in numbers ('000) at age by quarter and by Division for MACKEREL Sub-division II–VIII in 1995.

Mac Age	2A 1'st Q catch('000	3A 1'st Q catch('000	4A 1'st Q catch('000	4BC 1'st Q catch('000	6A 1'st Q catch('000	7BCJK 1'st Q catch('000	7AEFGH 1'st Q catch('000	7D 1'st Q catch('000	8ABDE 1'st Q catch('000	All areas 1'st Q catch('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	36	0	175	286	20,266	0	67	20,830
2	121	0	24,729	0	11,800	1,995	37,465	0	179	76,290
3	162	0	39,095	0	35,164	8,727	6,266	0	1,744	91,158
4	106	0	42,417	0	40,363	17,314	706	0	582	101,488
5	30	0	26,206	0	35,125	13,884	264	0	397	75,908
6	35	0	30,660	0	40,825	14,888	156	0	402	86,966
7	15	0	19,928	0	30,729	12,480	134	0	336	63,623
8	15	0	22,892	0	24,505	6,155	56	0	331	53,953
9	10	0	11,120	0	18,544	6,132	115	0	179	36,100
10	5	0	10,673	0	10,082	4,483	23	0	114	25,380
11	5	0	6,579	0	9,468	1,998	16	0	75	18,141
12	0	0	4,135	0	3,356	558	10	0	48	8,107
13	0	0	2,143	0	2,947	1,284	6	0	28	6,409
14	0	0	2,317	0	1,323	123	5	0	33	3,801
15+	0	0	3,302	0	1,562	574	4	0	21	5,463
Total	505	0	246,234	0	265,970	90,881	65,494	0	4,535	673,619
Tonne	195	1	103,914	0	117,193	40,091	8,854	0	1,609	271,857

Age	2A 2'nd Q catch('000	3A 2'nd Q catch('000	4A 2'nd Q catch('000	4BC 2'nd Q catch('000	6A 2'nd Q catch('000	7BCJK 2'nd Q catch('000	7AEFGH 2'nd Q catch('000	7D 2'nd Q catch('000	8ABDE 2'nd Q catch('000	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	732	0	0	0	11,380	4	12,116
2	1,048	0	79	333	862	469	0	21,037	21	23,848
3	1,398	0	387	131	2,639	5,638	0	3,502	868	14,563
4	918	0	235	94	4,616	15,640	0	382	655	22,540
5	262	0	185	68	2,639	14,190	0	132	731	18,207
6	306	0	135	20	5,207	12,716	0	60	1,205	19,649
7	131	0	53	29	2,372	7,703	0	44	1,325	11,656
8	131	0	100	8	1,304	4,387	0	0	1,328	7,258
9	87	0	77	8	1,733	2,456	0	44	859	5,265
10	44	0	4	0	0	2,084	0	0	541	2,673
11	44	0	9	0	429	1,876	0	0	382	2,739
12	0	0	1	0	0	1,045	0	0	218	1,264
13	0	0	1	0	0	392	0	0	129	522
14	0	0	2	0	0	405	0	0	114	520
15+	0	0	2	0	0	479	0	0	91	572
Total	4,369	0	1,269	1,423	21,800	69,480	0	36,581	8,470	143,392
Tonne	1,686	64	524	376	8,839	28,065	0	4,902	3,886	48,342

Age	2A 3'rd Q catch('000	3A 3'rd Q catch('000	4A 3'rd Q catch('000	4BC 3'rd Q catch('000	6A 3'rd Q catch('000	7BCJK 3'rd Q catch('000	7AEFGH 3'rd Q catch('000	7D 3'rd Q catch('000	8ABDE 3'rd Q catch('000	All areas 3'rd Q catch ('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	27	179	4,289	250	0	0	0	0	4,746
2	30,118	105	14,986	2,002	2,742	0	0	0	0	49,954
3	55,699	148	30,557	727	661	0	0	0	128	87,921
4	41,320	239	22,998	486	835	0	0	0	128	66,006
5	32,256	223	14,667	293	536	0	0	0	128	48,103
6	34,177	237	14,703	84	536	0	0	0	128	49,865
7	25,492	163	11,655	204	268	0	0	0	128	37,910
8	20,198	154	9,196	36	536	0	0	0	128	30,249
9	8,875	55	3,660	36	268	0	0	0	128	13,022
10	4,526	25	1,654	0	268	0	0	0	0	6,472
11	6,045	48	1,985	0	268	0	0	0	0	8,346
12	431	8	386	0	268	0	0	0	0	1,093
13	1,692	34	373	0	268	0	0	0	0	2,367
14	147	39	427	0	268	0	0	0	0	880
15+	758	63	467	0	0	0	0	0	0	1,289
Total	261,733	1,568	127,893	8,159	7,973	0	0	0	896	408,222
Tonne	132,223	858	61,254	2,059	2,366	0	0	0	391	199,151

Age	2A 4'th Q catch('000	3A 4'th Q catch('000	4A 4'th Q catch('000	4BC 4'th Q catch('000	6A 4'th Q catch('000	7BCJK 4'th Q catch('000	7AEFGH 4'th Q catch('000	7D 4'th Q catch('000	8ABDE 4'th Q catch('000	All areas 4'th Q catch ('000)
0	0	0	0	0	2,427	301	1,004	0	0	3,732
1	0	33	2,768	3,388	5,782	2,802	15,874	5,754	0	36,401
2	0	2,456	76,851	2,617	27,094	11,094	45,072	19,731	20	184,936
3	0	2,271	88,784	616	14,525	6,425	17,576	7,068	60	137,324
4	0	1,600	61,262	463	6,281	2,095	5,412	1,068	60	78,241
5	0	962	31,336	155	1,073	453	5,294	255	40	39,568
6	0	768	29,337	155	712	438	2,468	141	100	34,120
7	0	632	19,222	155	615	161	1,297	85	80	22,247
8	0	440	13,640	155	48	18	628	0	80	15,009
9	0	257	9,329	0	173	25	976	224	60	11,044
10	0	156	4,931	0	158	19	0	0	40	5,305
11	0	136	6,165	0	3	0	183	0	20	6,508
12	0	41	1,748	0	2	0	181	0	20	1,992
13	0	3	924	0	115	0	0	0	0	1,041
14	0	9	805	0	3	0	0	0	0	817
15+	0	0	333	0	2	0	131	0	0	466
Total	0	9,763	347,434	7,705	59,015	23,833	96,095	34,326	580	578,751
Tonne	0	4,833	147,808	1,871	16,445	6,454	24,329	7,275	271	209,286

Age	2A 1-4 Q catch('000	3A 1-4 Q catch('000	4A 1-4 Q catch('000	4BC 1-4 Q catch('000	6A 1-4 Q catch('000	7BCJK 1-4 Q catch('000	7AEFGH 1-4 Q catch('000	7D 1-4 Q catch('000	8ABDE 1-4 Q catch('000	All areas 1-4 Q catch ('000)
0	0	0	0	0	2,427	301	1,004	0	0	3,732
1	0	60	2,984	8,410	6,207	3,088	36,140	17,134	70	74,093
2	31,288	2,561	116,646	4,952	42,498	13,559	82,538	40,768	219	335,028
3	57,259	2,419	158,824	1,474	52,988	20,791	23,842	10,570	2,800	330,966
4	42,344	1,839	126,911	1,043	52,096	35,049	6,118	1,450	1,424	268,274
5	32,548	1,185	72,394	517	39,373	28,528	5,558	387	1,296	181,786
6	34,519	1,005	74,835	259	47,280	28,043	2,624	201	1,835	190,601
7	25,638	794	50,858	388	33,984	20,344	1,431	129	1,869	135,435
8	20,344	594	45,827	199	26,393	10,561	684	0	1,866	106,469
9	8,972	312	24,186	44	20,718	8,614	1,091	268	1,226	65,432
10	4,575	181	17,262	0	10,508	6,587	23	0	694	39,830
11	6,094	184	14,738	0	10,168	3,873	199	0	478	35,734
12	431	50	6,270	0	3,626	1,603	191	0	286	12,456
13	1,692	37	3,441	0	3,330	1,675	6	0	158	10,339
14	147	47	3,551	0	1,595	527	5	0	146	6,018
15+	758	64	4,104	0	1,564	1,052	135	0	112	7,789
Total	266,608	11,332	722,830	17,287	354,757	184,194	161,589	70,907	14,481	1,803,984
Tonne	134,104	5,756	313,500	4,306	144,843	74,610	33,183	12,177	6,158	728,637

Table 2.9 Catch in numbers ('000) at age by quarter and by Sub-division of SOUTHERN MACKEREL in 1995.

1995 Age	VIIIc East 1'st Q catch('000)	VIIIc West 1'st Q catch('000)	IXa North 1'st Q catch('000)	IXa Centr-N 1'st Q catch('000)	IXa Centr-S 1'st Q catch('000)	IXa South 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0		0		0
1	85	408	164		1,464		2,120
2	396	499	174		526		1,596
3	1,930	377	209		159		2,674
4	1,642	195	71		65		1,974
5	1,185	202	48		49		1,485
6	1,608	338	64		38		2,048
7	1,434	371	51		30		1,886
8	1,395	384	44		15		1,838
9	771	152	19		14		956
10	521	96	11		10		639
11	459	84	10		2		555
12	270	26	2		2		300
13	145	6	0		1		152
14	155	9	1		1		166
15+	133	11	0		1		146
Total	12,129	3,157	868		2,379		18,533
Tonnes	5,179	1,161	257		487		7,085

Age	VIIIc East 2'nd Q catch('000)	VIIIc West 2'nd Q catch('000)	IXa North 2'nd Q catch('000)	IXa Centr-N 2'nd Q catch('000)	IXa Centr-S 2'nd Q catch('000)	IXa South 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0		0		0
1	37	19	42		920		1,018
2	627	236	175		578		1,616
3	3,501	764	166		338		4,768
4	3,435	413	103		171		4,121
5	2,825	258	78		121		3,282
6	4,404	344	118		92		4,957
7	4,430	289	97		61		4,877
8	4,595	311	87		30		5,022
9	2,535	161	53		17		2,767
10	1,773	113	33		11		1,930
11	1,512	100	27		5		1,644
12	849	57	18		3		927
13	446	30	10		0		486
14	435	28	8		0		472
15+	441	24	6		1		472
Total	31,844	3,146	1,021		2,347		38,358
Tonnes	14,652	1,300	397		627		16,976

Age	VIIIc East 3'rd Q catch('000)	VIIIc West 3'rd Q catch('000)	IXa North 3'rd Q catch('000)	IXa Centr-N 3'rd Q catch('000)	IXa Centr-S 3'rd Q catch('000)	IXa South 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	370	4,761	274		1,168		6,573
1	40	128	2,122		830		3,120
2	66	735	246		851		1,897
3	86	628	37		514		1,267
4	31	152	11		245		439
5	17	58	4		114		193
6	22	51	4		77		154
7	15	23	2		43		83
8	13	12	1		21		47
9	6	6	1		8		21
10	4	2	0		22		28
11	4	3	0		7		15
12	2	1	0		7		10
13	2	0	0		1		3
14	1	1	0		0		2
15+	2	0	0		1		3
Total	680	6,562	2,702		3,910		13,855
Tonnes	124	732	339		1,067		2,262

Age	VIIIc East 4'th Q catch('000)	VIIIc West 4'th Q catch('000)	IXa North 4'th Q catch('000)	IXa Centr-N 4'th Q catch('000)	IXa Centr-S 4'th Q catch('000)	IXa South 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	815	2,180	27		1,432		4,454
1	82	53	206		837		1,178
2	138	57	21		546		761
3	224	59	2		254		539
4	86	31	1		104		223
5	41	16	0		52		109
6	46	19	0		32		97
7	26	14	0		21		61
8	18	11	0		7		37
9	8	5	0		2		16
10	4	3	0		7		14
11	5	3	0		4		12
12	2	1	0		3		6
13	3	0	0		0		3
14	2	0	0		0		2
15+	2	0	0		0		3
Total	1,502	2,452	257		3,303		7,514
Tonnes	264	218	32		712		1,226

Table 2.10 Length (cm) at age by quarter and by Division(s) for MACKEREL in Sub-areas II–VIII in 1995.

Mac Age	2A 1'st Q length(cm)	3A 1'st Q length(cm)	4A 1'st Q length(cm)	4BC 1'st Q length(cm)	6A 1'st Q length(cm)	7BCJK 1'st Q length(cm)	7AEFGH 1'st Q length(cm)	7D 1'st Q length(cm)	8ABDE 1'st Q length(cm)	All areas 1'st Q length(cm)
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	26.5	0.0	20.2	20.5	26.2	0.0	25.1	26.1
2	31.8	0.0	29.5	0.0	29.0	36.9	27.6	0.0	30.0	28.7
3	34.1	0.0	32.9	0.0	33.4	36.1	31.5	0.0	33.6	33.3
4	35.6	0.0	34.9	0.0	35.2	35.3	32.9	0.0	35.4	35.0
5	36.9	0.0	36.5	0.0	36.7	36.9	34.0	0.0	36.3	36.7
6	38.5	0.0	37.8	0.0	38.1	38.1	35.8	0.0	38.1	38.0
7	39.0	0.0	38.4	0.0	38.9	39.4	36.1	0.0	39.4	38.9
8	40.3	0.0	39.3	0.0	39.7	40.5	40.5	0.0	40.2	39.7
9	40.1	0.0	40.1	0.0	40.4	40.2	38.1	0.0	40.9	40.3
10	39.2	0.0	40.5	0.0	40.8	41.1	41.2	0.0	41.1	40.7
11	40.8	0.0	40.1	0.0	41.3	42.1	42.1	0.0	42.2	41.0
12	0.0	0.0	41.6	0.0	41.1	42.0	43.0	0.0	42.7	41.4
13	0.0	0.0	41.6	0.0	42.0	42.8	43.8	0.0	43.6	42.0
14	0.0	0.0	42.1	0.0	41.6	43.1	41.9	0.0	40.5	41.9
15+	0.0	0.0	42.7	0.0	41.6	44.5	44.4	0.0	44.7	42.6
0-15+	34.9	0.0	36.2	0.0	37.2	38.0	27.7	0.0	36.0	36.0

Age	2A 2'nd Q length(cm)	3A 2'nd Q length(cm)	4A 2'nd Q length(cm)	4BC 2'nd Q length(cm)	6A 2'nd Q length(cm)	7BCJK 2'nd Q length(cm)	7AEFGH 2'nd Q length(cm)	7D 2'nd Q length(cm)	8ABDE 2'nd Q length(cm)	All areas 2'nd Q length(cm)
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	28.4	27.8	0.0	0.0	0.0	26.2	23.9	26.3
2	29.5	0.0	32.3	31.1	28.5	32.3	0.0	27.6	31.3	27.9
3	32.6	0.0	32.8	32.9	33.2	33.7	0.0	31.5	34.2	33.0
4	33.9	0.0	33.9	36.9	34.3	35.4	0.0	32.8	36.9	35.1
5	36.0	0.0	37.3	38.0	36.2	37.0	0.0	33.5	37.9	36.9
6	37.0	0.0	37.1	36.4	38.0	38.0	0.0	34.3	39.1	38.0
7	36.8	0.0	38.5	39.3	40.9	38.4	0.0	33.5	39.7	39.0
8	38.9	0.0	39.4	41.5	40.3	39.6	0.0	0.0	40.5	39.9
9	40.5	0.0	40.5	42.5	41.5	39.8	0.0	36.9	40.9	40.6
10	42.5	0.0	40.7	0.0	0.0	40.4	0.0	0.0	41.1	40.6
11	38.1	0.0	41.3	0.0	41.5	40.9	0.0	0.0	42.2	41.1
12	0.0	0.0	42.2	0.0	0.0	41.5	0.0	0.0	42.9	41.7
13	0.0	0.0	42.3	0.0	0.0	44.7	0.0	0.0	43.7	44.4
14	0.0	0.0	44.5	0.0	0.0	44.4	0.0	0.0	41.5	43.8
15+	0.0	0.0	43.5	0.0	0.0	43.4	0.0	0.0	44.3	43.6
0-15+	33.3	0.0	35.4	30.6	36.8	37.4	0.0	27.6	39.3	34.7

Age	2A 3'rd Q length (cm	3A 3'rd Q length (cm	4A 3'rd Q length (cm	4BC 3'rd Q length (cm	6A 3'rd Q length (cm	7BCJK 3'rd Q length (cm	7AEFGH 3'rd Q length (cm	7D 3'rd Q length (cm	8ABDE 3'rd Q length (cm	All areas 3'rd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	27.0	32.0	28.0	26.6	0.0	0.0	0.0	0.0	28.0
2	31.7	29.6	32.2	30.9	30.0	0.0	0.0	0.0	0.0	31.7
3	34.1	35.5	34.4	32.7	34.2	0.0	0.0	0.0	34.6	34.2
4	35.8	36.8	35.9	36.5	35.8	0.0	0.0	0.0	36.6	35.8
5	37.3	37.5	37.3	38.0	37.2	0.0	0.0	0.0	37.6	37.3
6	38.6	38.3	38.5	36.4	37.0	0.0	0.0	0.0	38.7	38.6
7	39.2	39.0	39.4	39.4	36.9	0.0	0.0	0.0	39.5	39.2
8	40.2	40.1	40.1	41.5	37.6	0.0	0.0	0.0	40.4	40.2
9	40.5	40.6	40.9	42.5	37.2	0.0	0.0	0.0	40.8	40.5
10	40.6	41.4	41.7	0.0	37.8	0.0	0.0	0.0	0.0	40.8
11	41.0	41.9	41.3	0.0	37.6	0.0	0.0	0.0	0.0	41.0
12	42.9	42.7	43.1	0.0	37.4	0.0	0.0	0.0	0.0	41.6
13	42.6	45.1	41.8	0.0	37.8	0.0	0.0	0.0	0.0	41.9
14	43.5	44.7	44.5	0.0	38.7	0.0	0.0	0.0	0.0	42.6
15+	41.3	46.6	43.5	0.0	0.0	0.0	0.0	0.0	44.4	42.3
0-15+	36.6	38.1	36.6	30.5	34.1	0.0	0.0	0.0	38.3	36.4

Age	2A 4'th Q length(cm)	3A 4'th Q length(cm)	4A 4'th Q length(cm)	4BC 4'th Q length(cm)	6A 4'th Q length(cm)	7BCJK 4'th Q length(cm)	7AEFGH 4'th Q length(cm)	7D 4'th Q length(cm)	8ABDE 4'th Q length(cm)	All areas 4'th Q length(cm)
0	0.0	0.0	0.0	0.0	21.9	20.9	21.2	0.0	0.0	21.6
1	0.0	30.9	31.2	27.8	27.6	27.5	27.1	27.2	0.0	27.6
2	0.0	33.1	32.5	31.0	32.2	32.4	29.6	29.5	33.4	31.4
3	0.0	34.7	34.4	34.3	34.0	33.9	32.3	31.8	35.0	33.9
4	0.0	36.3	35.8	36.2	35.0	35.0	36.5	34.1	36.7	35.7
5	0.0	37.6	37.2	35.5	36.6	36.4	38.6	33.5	38.0	37.4
6	0.0	39.1	38.6	42.5	37.6	37.4	39.3	34.7	38.9	38.6
7	0.0	39.8	39.3	37.5	38.2	37.4	39.2	33.5	39.7	39.2
8	0.0	40.5	40.2	40.5	39.9	40.2	41.1	0.0	40.5	40.3
9	0.0	40.9	40.7	0.0	38.7	37.2	39.0	37.7	40.9	40.4
10	0.0	41.1	40.6	0.0	39.9	38.4	0.0	0.0	41.1	40.6
11	0.0	41.3	41.1	0.0	38.3	0.0	38.5	0.0	42.2	41.0
12	0.0	42.2	41.5	0.0	37.2	0.0	40.9	0.0	42.8	41.5
13	0.0	44.8	44.8	0.0	42.4	0.0	0.0	0.0	0.0	44.6
14	0.0	44.1	43.2	0.0	39.6	0.0	0.0	0.0	0.0	43.2
15+	0.0	46.5	44.6	0.0	38.9	0.0	39.5	0.0	29.5	43.1
0-15+	0.0	36.2	35.8	30.8	32.3	32.5	31.1	29.8	39.0	34.1

Age	2A 1-4 Q length(cm)	3A 1-4 Q length(cm)	4A 1-4 Q length(cm)	4BC 1-4 Q length(cm)	6A 1-4 Q length(cm)	7BCJK 1-4 Q length(cm)	7AEFGH 1-4 Q length(cm)	7D 1-4 Q length(cm)	8ABDE 1-4 Q length(cm)	All areas 1-4 Q length(cm)
0	0.0	0.0	0.0	0.0	21.9	20.9	21.2	0.0	0.0	21.6
1	0.0	29.1	31.2	27.9	27.3	26.8	26.6	26.5	25.0	27.0
2	31.7	33.0	31.8	31.0	31.1	33.1	28.7	28.5	30.4	30.6
3	34.0	34.8	34.0	33.4	33.6	34.8	32.1	31.7	33.9	33.8
4	35.7	36.3	35.5	36.4	35.1	35.3	36.1	33.8	36.3	35.4
5	37.2	37.5	37.0	37.2	36.7	36.9	38.4	33.5	37.4	37.0
6	38.6	38.9	38.2	40.0	38.0	38.0	39.1	34.6	38.8	38.2
7	39.2	39.6	39.0	38.6	39.0	39.0	38.9	33.5	39.6	39.0
8	40.2	40.4	39.8	40.7	39.7	40.1	41.1	0.0	40.4	39.9
9	40.5	40.9	40.4	42.5	40.4	40.1	38.9	37.6	40.9	40.4
10	40.6	41.1	40.6	0.0	40.7	40.8	41.2	0.0	41.1	40.7
11	41.0	41.4	40.7	0.0	41.2	41.5	38.8	0.0	42.2	41.0
12	42.9	42.3	41.7	0.0	40.8	41.6	41.0	0.0	42.9	41.5
13	42.6	45.1	42.5	0.0	41.7	43.2	43.8	0.0	43.7	42.4
14	43.5	44.6	42.6	0.0	41.1	44.1	41.9	0.0	41.3	42.4
15+	41.3	46.6	43.0	0.0	41.6	44.0	39.6	0.0	44.4	42.7
0-15+	36.6	36.4	36.1	30.6	36.3	37.0	29.7	28.7	38.2	35.4

Table 2.11 Length (cm) at age by quarter and by Sub-division of SOUTHERN MACKEREL in 1995.

1995 Age	VIIIc East 1'st Q length(cm)	VIIIc West 1'st Q length(cm)	IXa North 1'st Q length(cm)	Xa Centr-N 1'st Q length(cm)	Xa Centr-S 1'st Q length(cm)	IXa South 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	26.7	26.1	26.2		26.6		26.5
2	31.6	30.1	30.6		30.2		30.6
3	34.3	32.4	32.9		33.6		33.9
4	36.2	36.6	35.6		36.2		36.2
5	37.3	38.0	37.0		37.7		37.4
6	38.1	38.9	37.8		38.2		38.3
7	39.2	39.4	39.0		40.0		39.3
8	40.0	40.1	39.6		40.8		40.0
9	40.6	40.1	39.4		42.3		40.5
10	41.4	40.5	40.2		43.4		41.3
11	41.4	40.5	40.0		42.2		41.2
12	43.0	41.3	39.6		42.8		42.8
13	43.8	43.5	42.5		45.5		43.8
14	42.7	41.1	39.4		48.1		42.7
15+	44.2	41.8	40.5		47.8		44.0
0-15+	38.0	35.3	33.0		29.0		36.1

Age	VIIIc East 2'nd Q length(cm)	VIIIc West 2'nd Q length(cm)	IXa North 2'nd Q length(cm)	Xa Centr-N 2'nd Q length(cm)	Xa Centr-S 2'nd Q length(cm)	IXa South 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	29.1	27.6	28.3		27.5		27.6
2	31.6	31.6	29.9		31.8		31.5
3	34.3	33.8	33.4		34.3		34.2
4	36.5	35.7	36.2		36.0		36.4
5	37.6	36.8	37.3		37.3		37.5
6	38.6	38.0	38.1		38.0		38.6
7	39.5	39.3	39.2		39.4		39.5
8	40.2	40.1	39.8		40.3		40.2
9	40.8	40.7	40.6		41.2		40.8
10	41.4	41.5	41.3		42.1		41.4
11	41.5	41.5	41.2		41.9		41.5
12	42.9	42.9	42.6		41.3		42.9
13	43.7	43.7	43.3		45.5		43.7
14	42.8	42.7	42.2		47.4		42.8
15+	44.2	43.3	42.9		44.1		44.1
0-15+	38.8	37.0	36.0		31.8		38.2

Age	VIIIc East 3'rd Q length (cm	VIIIc West 3'rd Q length (cm	IXa North 3'rd Q length (cm	Xa Centr-N 3'rd Q length (cm	Xa Centr-S 3'rd Q length (cm	IXa South 3'rd Q length (cm	All areas 3'rd Q length(cm)
0	21.7	20.5	24.2		23.7		21.3
1	25.8	29.0	25.6		31.0		27.2
2	31.4	30.8	28.2		34.1		31.9
3	33.0	32.6	32.7		35.5		33.8
4	35.4	34.3	34.8		36.5		35.6
5	36.7	35.2	35.5		37.3		36.6
6	37.6	35.9	36.2		37.8		37.1
7	38.9	37.8	37.9		39.0		38.6
8	39.4	38.6	38.2		40.9		39.8
9	40.1	39.0	39.2		42.3		40.6
10	41.2	40.1	40.6		42.0		41.7
11	41.9	39.6	40.4		41.8		41.3
12	42.8	40.9	41.8		40.9		41.3
13	44.8	43.6	42.5		45.5		44.9
14	41.9	40.1	39.3		47.6		41.5
15+	45.4	43.0	42.4		43.8		44.7
0-15+	27.1	23.6	25.9		31.0		26.3

Age	VIIIc East 4'th Q length(cm)	VIIIc West 4'th Q length(cm)	IXa North 4'th Q length(cm)	Xa Centr-N 4'th Q length(cm)	Xa Centr-S 4'th Q length(cm)	IXa South 4'th Q length(cm)	All areas 4'th Q length(cm)
0	21.7	21.2	24.2		23.7		22.1
1	25.5	26.2	25.6		30.2		28.9
2	31.7	30.2	27.8		33.2		32.6
3	33.2	33.5	33.8		35.2		34.2
4	35.2	35.7	35.2		36.6		35.9
5	36.4	36.8	36.1		37.6		37.0
6	37.1	37.7	36.9		37.9		37.5
7	38.3	38.7	38.3		39.0		38.6
8	38.5	39.3	38.9		40.6		39.2
9	39.1	39.3	39.5		42.1		39.6
10	40.8	40.4	41.8		41.9		41.3
11	41.9	40.0	41.7		40.8		41.1
12	42.5	40.5	43.2		41.0		41.5
13	45.3	44.4	44.0		45.5		45.3
14	40.6	39.0	42.0		46.5		40.8
15+	45.6	42.3	43.9		43.5		45.2
0-15+	27.0	22.5	25.8		28.8		26.3

Table 2.12 Weight (g) at age by quarter and by Division for MACKEREL in Sub-areas II–VIII in 1995.

Mac Age	2A 1'st Q weight(g)	3A 1'st Q weight(g)	4A 1'st Q weight(g)	4BC 1'st Q weight(g)	6A 1'st Q weight(g)	7BCJK 1'st Q weight(g)	7AEFGH 1'st Q weight(g)	7D 1'st Q weight(g)	8ABDE 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	150	0	42	52	110	0	107	109
2	304	0	207	0	188	155	132	0	189	166
3	386	0	296	0	297	273	199	0	271	288
4	444	0	360	0	350	334	242	0	322	351
5	504	0	420	0	414	399	263	0	350	413
6	576	0	469	0	463	452	335	0	408	463
7	600	0	501	0	502	528	336	0	450	506
8	661	0	539	0	539	570	494	0	483	542
9	656	0	576	0	577	561	437	0	510	573
10	606	0	593	0	584	587	520	0	517	588
11	692	0	575	0	625	643	559	0	562	609
12	0	0	652	0	607	653	598	0	583	633
13	0	0	658	0	639	694	631	0	622	656
14	0	0	673	0	613	694	557	0	502	651
15+	0	0	714	0	616	795	665	0	681	695
0-15+	425	0	423	0	440	440	136	0	349	404

Age	2A 2'nd Q weight(g)	3A 2'nd Q weight(g)	4A 2'nd Q weight(g)	4BC 2'nd Q weight(g)	6A 2'nd Q weight(g)	7BCJK 2'nd Q weight(g)	7AEFGH 2'nd Q weight(g)	7D 2'nd Q weight(g)	8ABDE 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	197	172	0	0	0	110	91	114
2	259	0	253	309	183	231	0	132	214	144
3	364	0	324	309	283	271	0	199	287	268
4	389	0	361	416	315	328	0	237	366	328
5	468	0	478	474	385	391	0	245	402	392
6	532	0	469	420	445	425	0	284	440	433
7	524	0	536	508	532	447	0	245	462	467
8	568	0	550	561	530	483	0	0	494	496
9	704	0	583	571	556	493	0	405	509	520
10	795	0	662	0	0	523	0	0	517	527
11	551	0	690	0	586	558	0	0	561	563
12	0	0	733	0	0	568	0	0	592	572
13	0	0	743	0	0	714	0	0	628	693
14	0	0	885	0	0	639	0	0	540	618
15+	0	0	814	0	0	605	0	0	658	614
0-15+	386	0	413	262	406	404	0	134	454	336

Age	2A 3'rd Q weight (g)	3A 3'rd Q weight (g)	4A 3'rd Q weight (g)	4BC 3'rd Q weight (g)	6A 3'rd Q weight (g)	7BCJK 3'rd Q weight (g)	7AEFGH 3'rd Q weight (g)	7D 3'rd Q weight (g)	8ABDE 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	170	288	174	153	0	0	0	0	177
2	304	228	303	287	225	0	0	0	0	298
3	389	426	383	300	337	0	0	0	297	385
4	455	481	441	397	382	0	0	0	358	449
5	528	512	505	474	427	0	0	0	392	519
6	590	545	559	420	417	0	0	0	428	578
7	623	580	602	484	414	0	0	0	454	614
8	672	631	634	561	437	0	0	0	489	655
9	687	656	677	571	420	0	0	0	506	677
10	703	702	718	0	442	0	0	0	0	696
11	705	722	691	0	438	0	0	0	0	694
12	810	762	802	0	427	0	0	0	0	713
13	804	809	741	0	442	0	0	0	0	753
14	927	866	885	0	480	0	0	0	0	768
15+	751	955	813	0	0	0	0	0	662	783
0-15+	505	547	479	250	339	0	0	0	418	489

Age	2A 4'th Q weight(g)	3A 4'th Q weight(g)	4A 4'th Q weight(g)	4BC 4'th Q weight(g)	6A 4'th Q weight(g)	7BCJK 4'th Q weight(g)	7AEFGH 4'th Q weight(g)	7D 4'th Q weight(g)	8ABDE 4'th Q weight(g)	All areas 4'th Q weight(g)
0	0	0	0	0	76	57	71	0	0	73
1	0	252	265	164	157	148	155	157	0	164
2	0	341	296	226	265	260	205	203	266	257
3	0	384	364	364	319	306	270	253	310	339
4	0	448	418	387	353	345	404	315	361	409
5	0	515	481	355	413	389	487	292	403	478
6	0	566	544	676	449	404	511	326	435	537
7	0	606	573	435	476	403	513	292	462	564
8	0	655	625	565	548	557	589	0	492	623
9	0	645	647	0	498	427	487	418	509	624
10	0	679	647	0	553	481	0	0	516	644
11	0	672	668	0	494	0	479	0	563	662
12	0	816	680	0	428	0	576	0	590	673
13	0	862	763	0	679	0	0	0	0	754
14	0	806	773	0	455	0	0	0	0	772
15+	0	900	870	0	467	0	517	0	437	769
0-15+	0	455	426	242	279	271	253	212	441	361

Age	2A 1-4 Q weight(g)	3A 1-4 Q weight(g)	4A 1-4 Q weight(g)	4BC 1-4 Q weight(g)	6A 1-4 Q weight(g)	7BCJK 1-4 Q weight(g)	7AEFGH 1-4 Q weight(g)	7D 1-4 Q weight(g)	8ABDE 1-4 Q weight(g)	All areas 1-4 Q weight(g)
0	0	0	0	0	76	57	71	0	0	73
1	0	215	265	170	154	139	130	126	106	141
2	302	337	278	256	239	244	172	166	198	234
3	388	386	351	328	303	283	251	235	278	334
4	454	452	403	394	348	332	385	294	347	390
5	528	514	464	438	413	395	476	276	385	453
6	589	561	516	573	460	439	500	313	432	503
7	623	601	551	466	503	497	496	276	459	542
8	671	648	584	564	537	534	581	0	492	582
9	687	647	619	571	572	541	481	416	509	598
10	704	682	621	0	580	567	520	0	517	609
11	704	685	630	0	619	602	485	0	561	635
12	810	807	669	0	594	597	577	0	590	640
13	804	813	695	0	625	699	631	0	627	690
14	927	855	721	0	590	651	557	0	532	682
15+	751	955	738	0	616	709	521	0	662	708
0-15+	503	468	435	248	409	405	205	172	419	404

Table 2.13 Weight (g) at age by quarter and by Sub-division of SOUTHERN MACKEREL in 1995.

1995 Age	VIIIc East 1'st Q weight(g)	VIIIc Wes 1'st Q weight(g)	IXa North 1'st Q weight(g)	Xa Centr-N 1'st Q weight(g)	Xa Centr-S 1'st Q weight(g)	IXa South 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0		0		0
1	137	128	128		148		142
2	229	205	216		217		216
3	300	262	273		302		293
4	362	392	356		379		366
5	397	440	404		430		404
6	429	476	433		450		437
7	467	496	478		523		474
8	496	525	503		552		503
9	523	525	497		622		524
10	552	543	529		670		552
11	552	541	518		615		550
12	614	579	505		648		610
13	647	685	633		775		649
14	605	578	499		929		606
15+	668	604	542		915		665
0-15+	427	372	296		205		383

Age	VIIIc East 2'nd Q weight(g)	VIIIc Wes 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	Xa Centr-N 2'nd Q weight(g)	Xa Centr-S 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0		0		0
1	176	157	165		162		163
2	228	239	200		256		236
3	302	298	287		321		302
4	372	358	376		372		371
5	412	397	416		417		411
6	447	440	445		442		446
7	478	493	486		496		479
8	506	527	512		531		508
9	530	552	551		571		532
10	553	588	578		606		556
11	560	589	577		599		562
12	620	658	643		573		623
13	655	694	675		775		658
14	617	653	627		883		619
15+	677	678	653		708		677
0-15+	459	414	388		267		442

Age	VIIIc East 3'rd Q weight (g)	VIIIc Wes 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	Xa Centr-N 3'rd Q weight (g)	Xa Centr-S 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	69	57	99		103		67
1	124	183	119		251		157
2	234	219	165		335		265
3	275	265	269		384		314
4	346	314	328		417		374
5	388	344	354		449		410
6	418	366	377		471		426
7	457	433	436		518		482
8	475	465	448		609		532
9	502	481	495		683		565
10	545	528	547		663		634
11	591	507	540		654		603
12	620	566	601		609		606
13	740	688	633		863		768
14	591	534	495		1005		587
15+	758	663	627		762		748
0-15+	178	111	125		273		163

Age	VIIIc East 4'th Q weight(g)	VIIIc Wes 4'th Q weight(g)	IXa North 4'th Q weight(g)	Xa Centr-N 4'th Q weight(g)	Xa Centr-S 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	69	63	99		103		77
1	119	130	119		229		198
2	241	206	157		308		284
3	281	291	298		374		326
4	338	358	343		422		380
5	375	398	373		461		419
6	401	429	400		473		430
7	443	468	451		518		475
8	450	492	477		593		493
9	480	491	502		670		513
10	553	539	607		661		604
11	615	523	605		605		592
12	635	546	673		617		617
13	783	733	713		863		786
14	550	484	622		928		571
15+	802	627	705		743		788
0-15+	173	89	123		215		163

Table 2.14 Catch weights at age (kg) for the Southern Mackerel .

AGE/YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.031	0.055	0.063	0.089	0.055	0.042	0.092	0.075	0.051	0.077	0.046	0.071
1	0.059	0.092	0.122	0.183	0.081	0.100	0.118	0.160	0.190	0.116	0.167	0.160
2	0.228	0.189	0.249	0.251	0.218	0.197	0.207	0.208	0.265	0.200	0.205	0.246
3	0.248	0.299	0.289	0.291	0.251	0.267	0.256	0.242	0.279	0.307	0.262	0.303
4	0.303	0.339	0.390	0.398	0.286	0.357	0.310	0.294	0.325	0.326	0.352	0.370
5	0.344	0.408	0.401	0.442	0.326	0.392	0.365	0.333	0.366	0.360	0.379	0.409
6	0.378	0.484	0.404	0.474	0.342	0.472	0.401	0.400	0.404	0.401	0.422	0.443
7	0.392	0.502	0.567	0.560	0.388	0.499	0.475	0.439	0.435	0.443	0.457	0.478
8	0.457	0.593	0.512	0.602	0.395	0.511	0.494	0.485	0.463	0.469	0.498	0.507
9	0.451	0.596	0.417	0.638	0.406	0.544	0.525	0.508	0.480	0.499	0.525	0.530
10	0.441	0.609	0.567	0.624	0.480	0.545	0.507	0.521	0.537	0.491	0.536	0.556
11	0.465	0.607	0.649	0.652	0.494	0.591	0.565	0.517	0.544	0.518	0.579	0.560
12	0.345	0.646	0.528	0.449	0.492	0.565	0.540	0.746	0.595	0.597	0.626	0.619
13	0.406	0.636	0.526	0.519	0.543	0.626	0.729	0.674	0.523	0.590	0.629	0.657
14	0.504	0.679	0.000	0.663	0.549	0.579	0.553	0.667	0.718	0.578	0.625	0.616
15+	0.708	0.667	0.679	0.769	0.567	0.735	0.724	0.720	0.708	0.744	0.722	0.675
0-15+	0.060	0.153	0.286	0.329	0.161	0.186	0.231	0.281	0.200	0.294	0.280	0.352

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Table 2.15 Maturity ogives of mackerel for the western and southern areas.

AGE	1	2	3	4	5
WESTERN AREA					
Recent maturity ogive of **WG** Dutch maturity data 1977-84	**8%**	**60%**	**90%**	**97%**	**97%**
Dutch maturity data 1985-95	10%	56%	98%	100%	100%
Dutch maturity data 1977-95	8%	59%	92%	98%	99%
Maturity data 1992 DEPM weighted by egg production	-	69%	99%	97%	98%
Norwegian maturity data of '77, '83, '86, '89, '92 and '95	0%	74%	99%	99%	100%
Histological maturity data 1988, 1989 and 1991	0%	# 13-52%	# 82-98%	-	-
SOUTHERN AREA					
Recent maturity ogive of **WG** Portuguese maturity data	**45%**	**89%**	**95%**	**100%**	**100%**
Spanish maturity data '93 - '95	27%	86%	88%	88%	93%
Portug. maturity data '86 -'95	36%	94%	98%	99%	99%
Iberian maturity data 1995	71%	96%	98%	100%	100%

Lowest value obtained from juvenile area (VIIe) and highest value obtained from spawning ground (VIIj)

TABLE 2.16 *Scomber japonicus* landings in Divisions VIIIb, VIIIc and IXa during the period 1982 - 1995

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427	247
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558
	VIIIc West	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558
	IXa North	0	0	0	0	0	0	0	0	0	0	0	2557	7560	4705
	IXA South	-	-	-	-	-	-	-	-	-	-	895	800	1013	364
	Total											895	3357	8573	5068
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903	7874
	IXa CN	-	0	236	229	223	156	165	281	228	137	914	543	378	913
Portugal	IXa CS	-	244	3924	4777	3784	4932	838	2105	5792	6925	5264	5019	2474	1544
	IXa S	-	129	3899	4113	4177	3173	2813	4061	2547	3080	2803	1779	1578	1427
	Total Country	664	373	8059	9118	8184	8261	3816	6447	8568	10142	8981	7341	4430	3884

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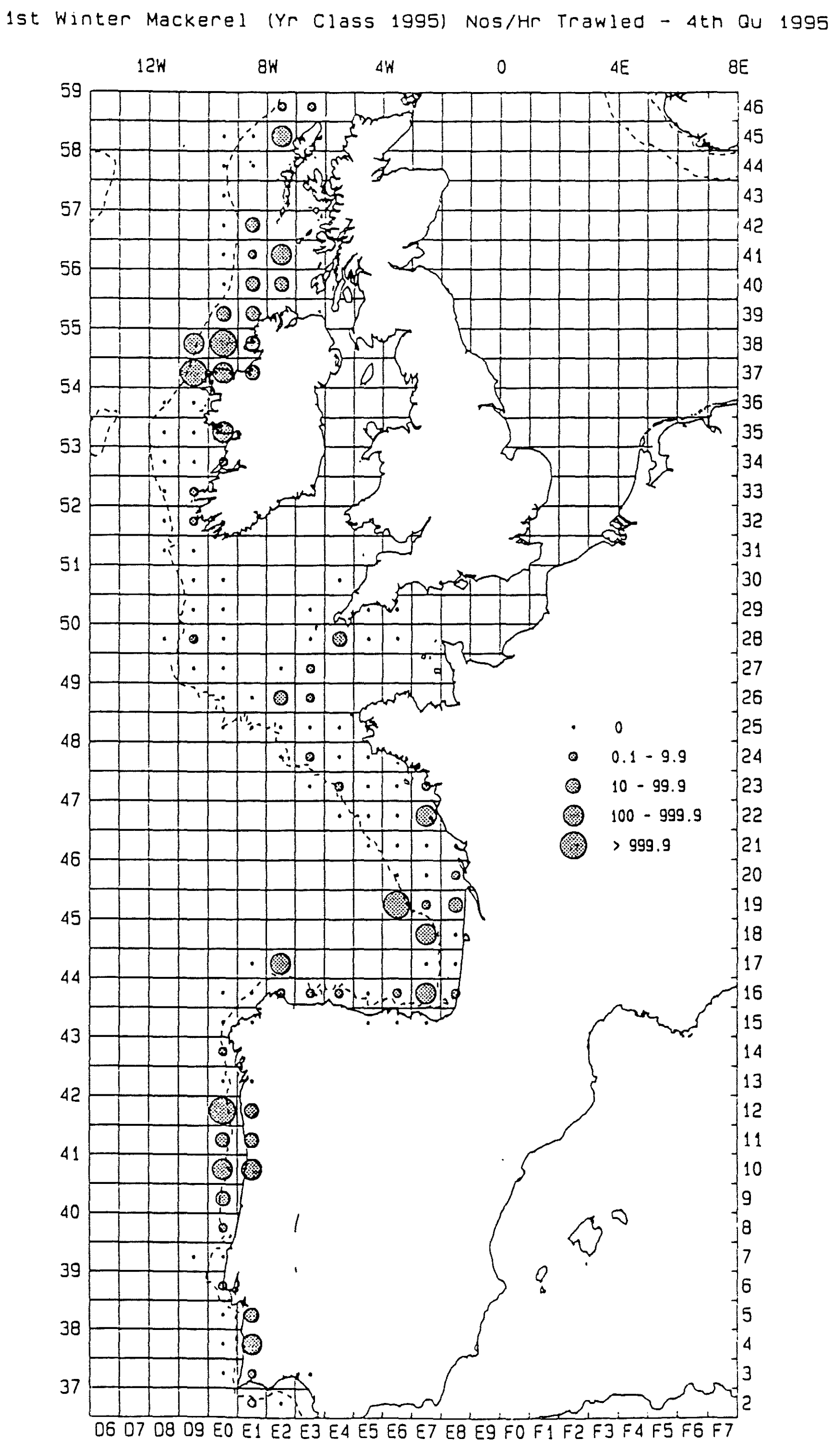


Figure 2.1. Catch rates of 1995 year-class mackerel (Age group 0) in international trawl surveys in the last quarter of 1995.

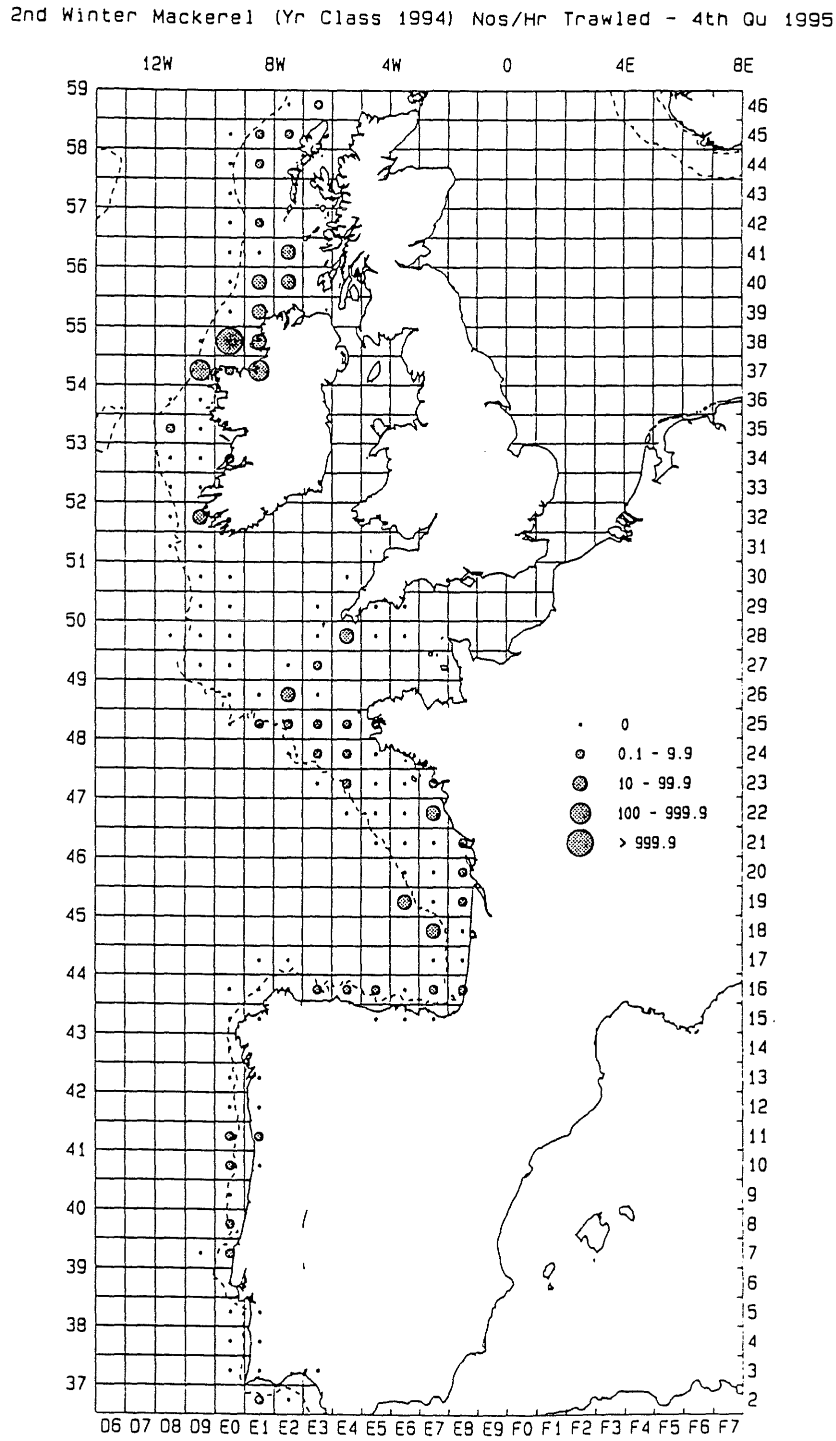


Figure 2.2. Catch rates of 1994 year-class mackerel (Age group 1) in international trawl surveys in the last quarter of 1995.

1st Winter Mackerel (Yr Class 1995) Nos/Hr Trawled - 1st Qu 1996

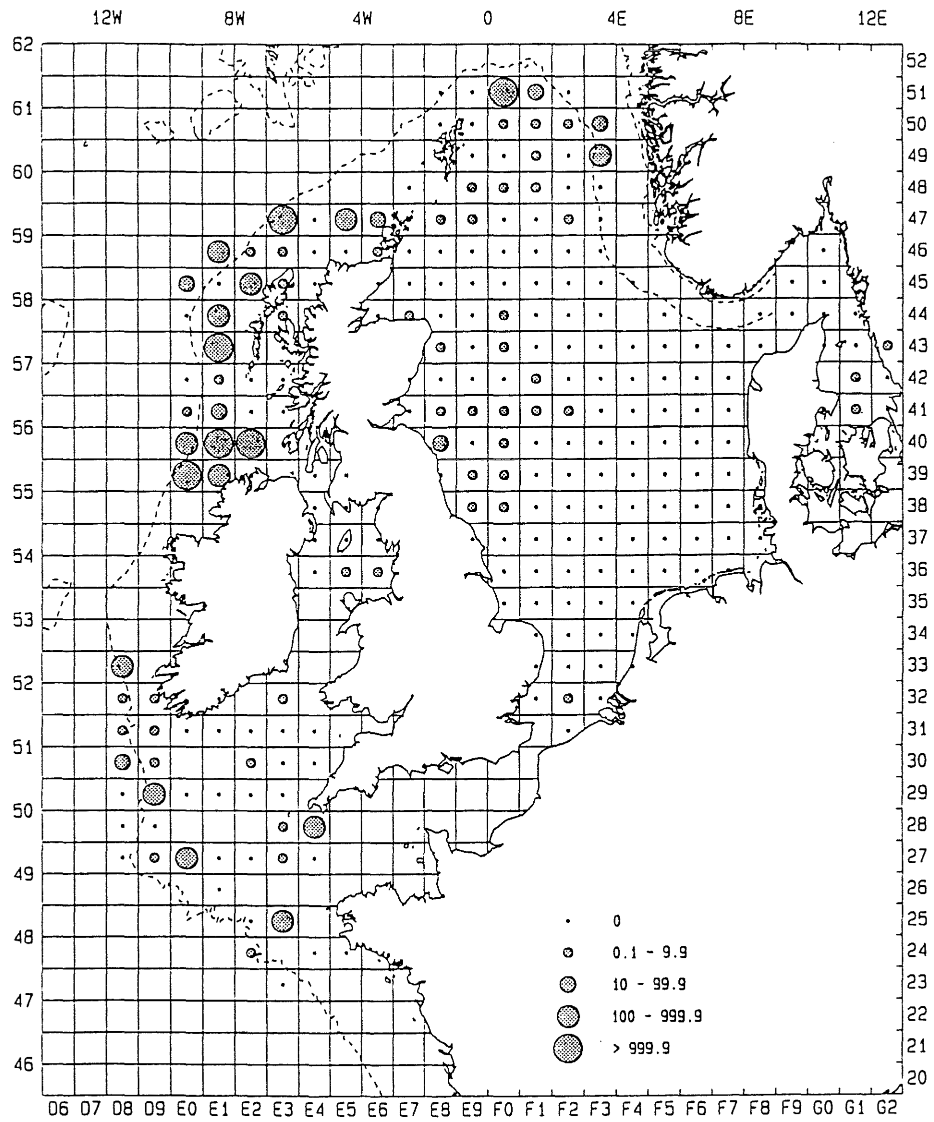


Figure 2.3. Catch rates of 1995 year-class mackerel (Age group 1) in international trawl surveys in the first quarter of 1996.

2nd Winter Mackerel (Yr Class 1994) Nos/Hr Trawled - 1st Qu 1996

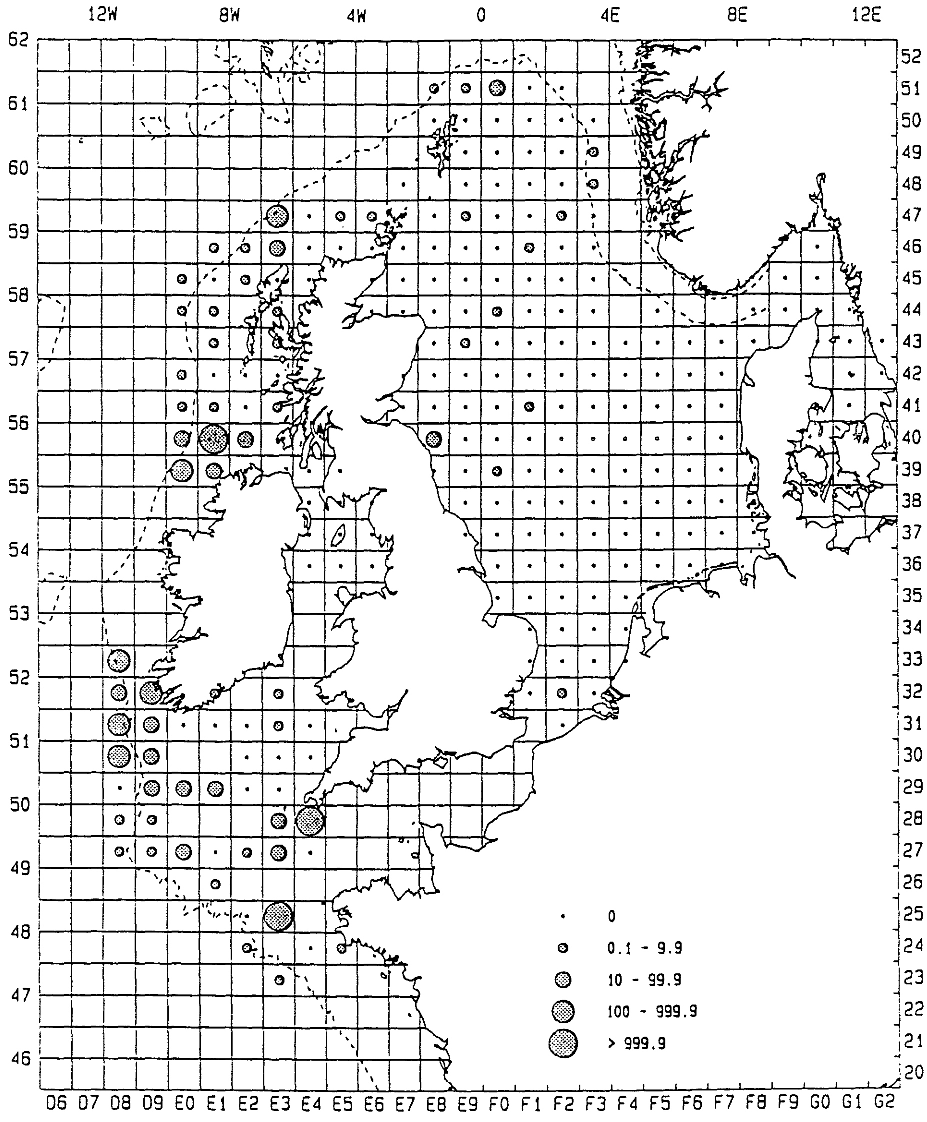


Figure 2.4. Catch rates of 1994 year-class mackerel (Age group 2) in international trawl surveys in the last quarter of 1995.

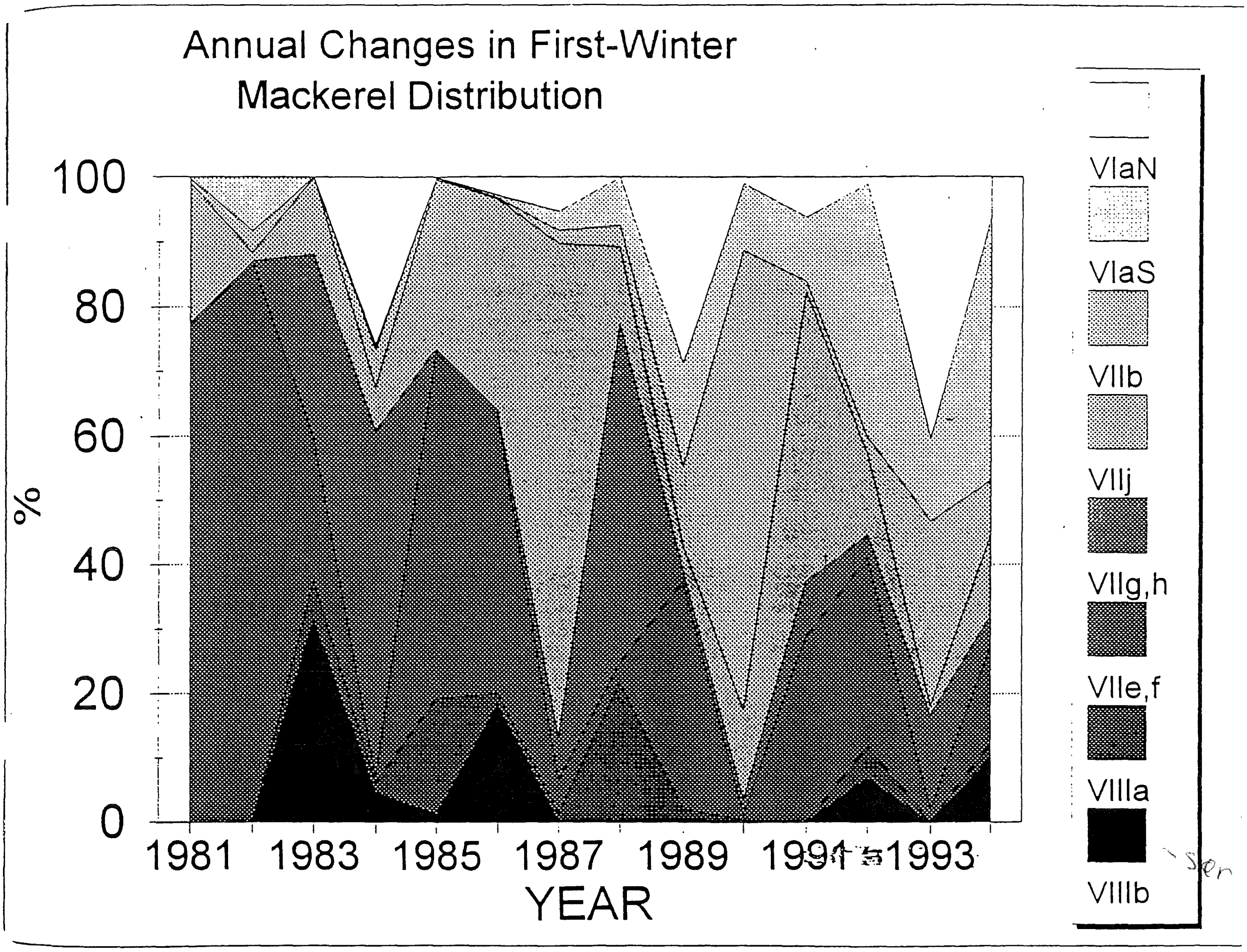


Figure 2.5. Percentage of 0 -gp mackerel (sampled in the fourth quarter of the year) and of 1-gp mackerel (sampled in the first quarter of the year) found in demersal trawl surveys, by ICES Division; from VIa(N) (Northernmost) to VIIIb (Southernmost).

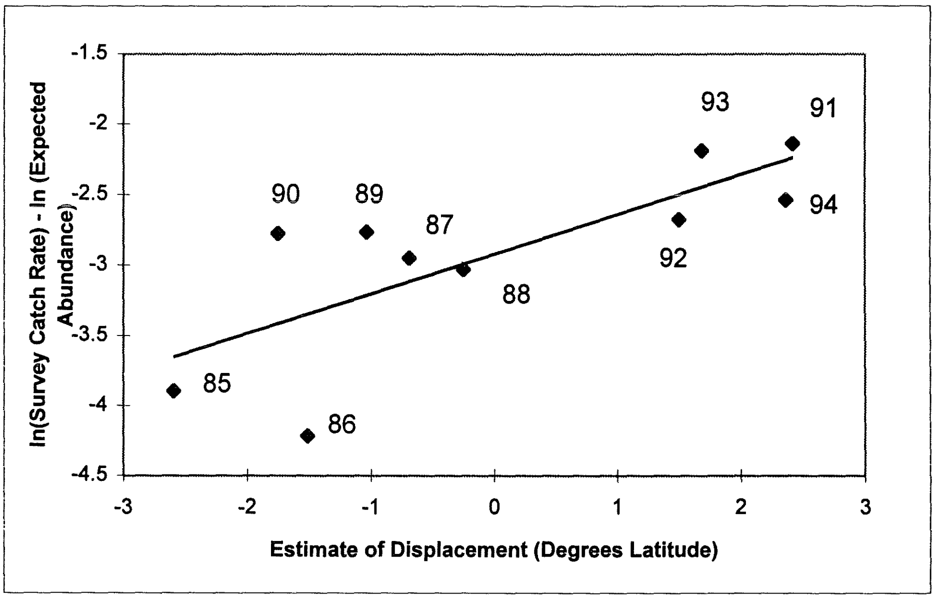


Figure 2.6. Data scatter and fitted relationship between the log residual of the survey estimates of abundance by year (Table 2.2) and the ICA estimates of year-class strength, compared with estimates of the displacement of the juvenile population in a North-South direction in each year (Table 2.3) Data points labelled with year-classes.

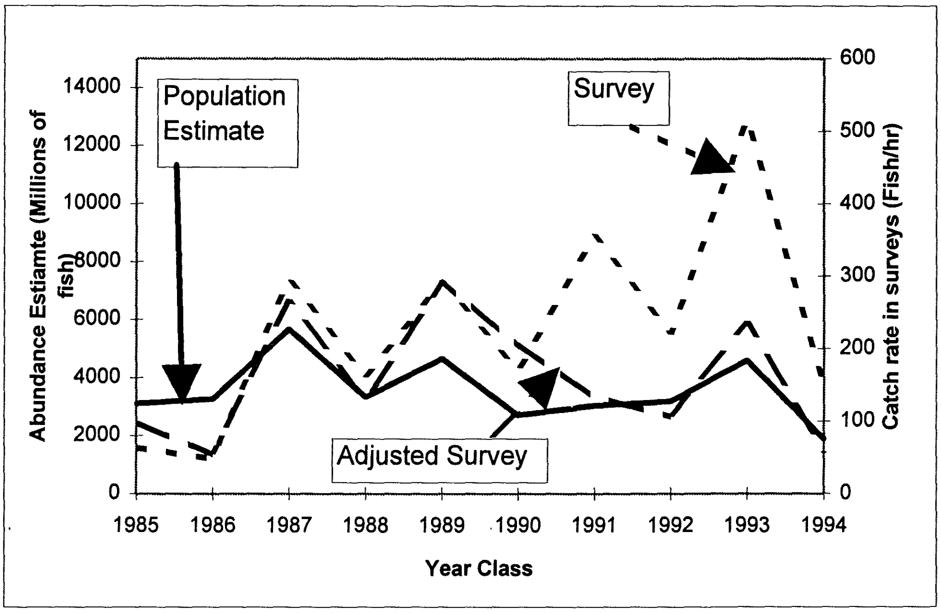


Figure 2.7. Comparison of ICA-estimated recruitments with *ad-hoc* adjusted recruitment index, and with unadjusted values.

Figure 2.8a Distribution of catches.

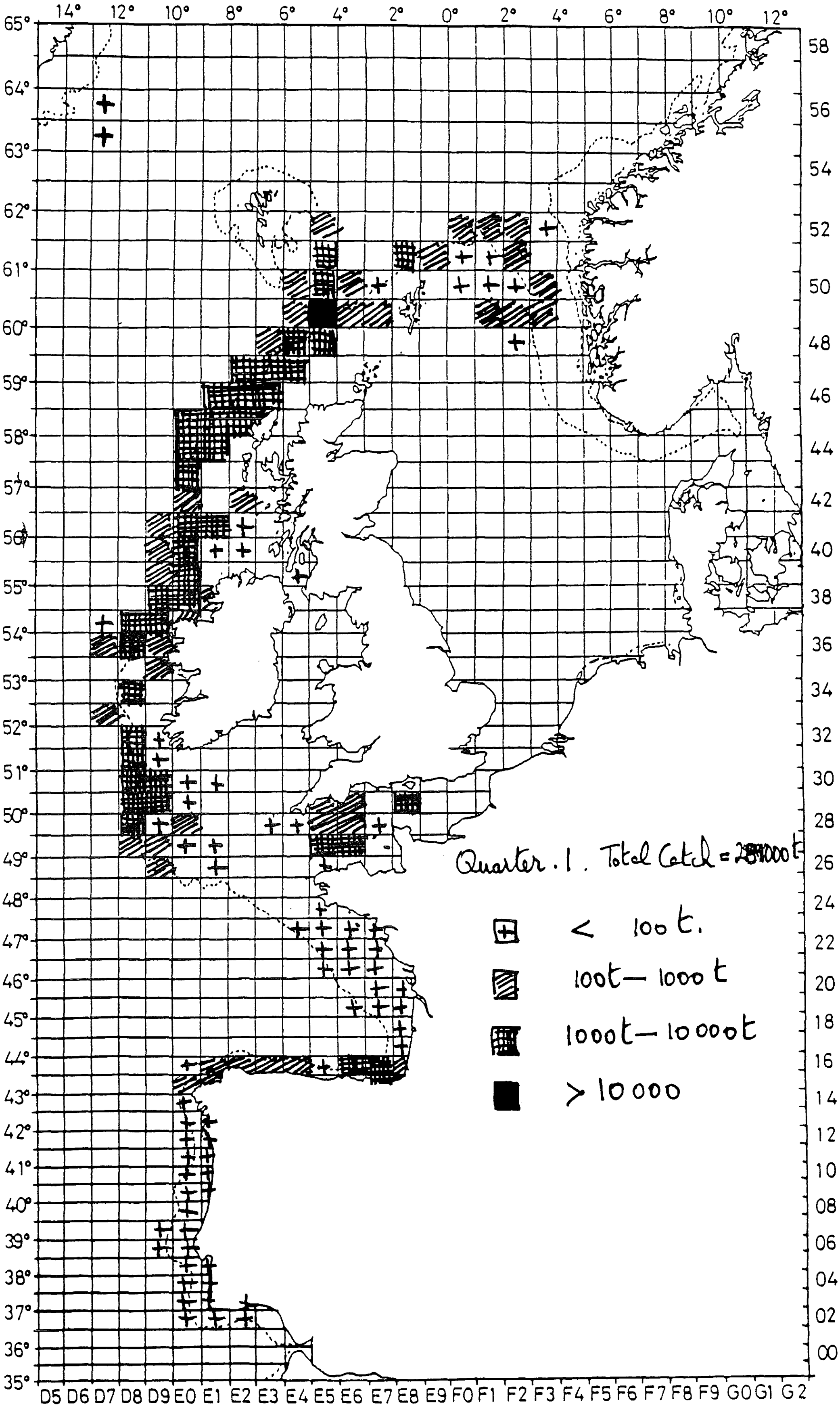


Figure 2.8b Distribution of catches.

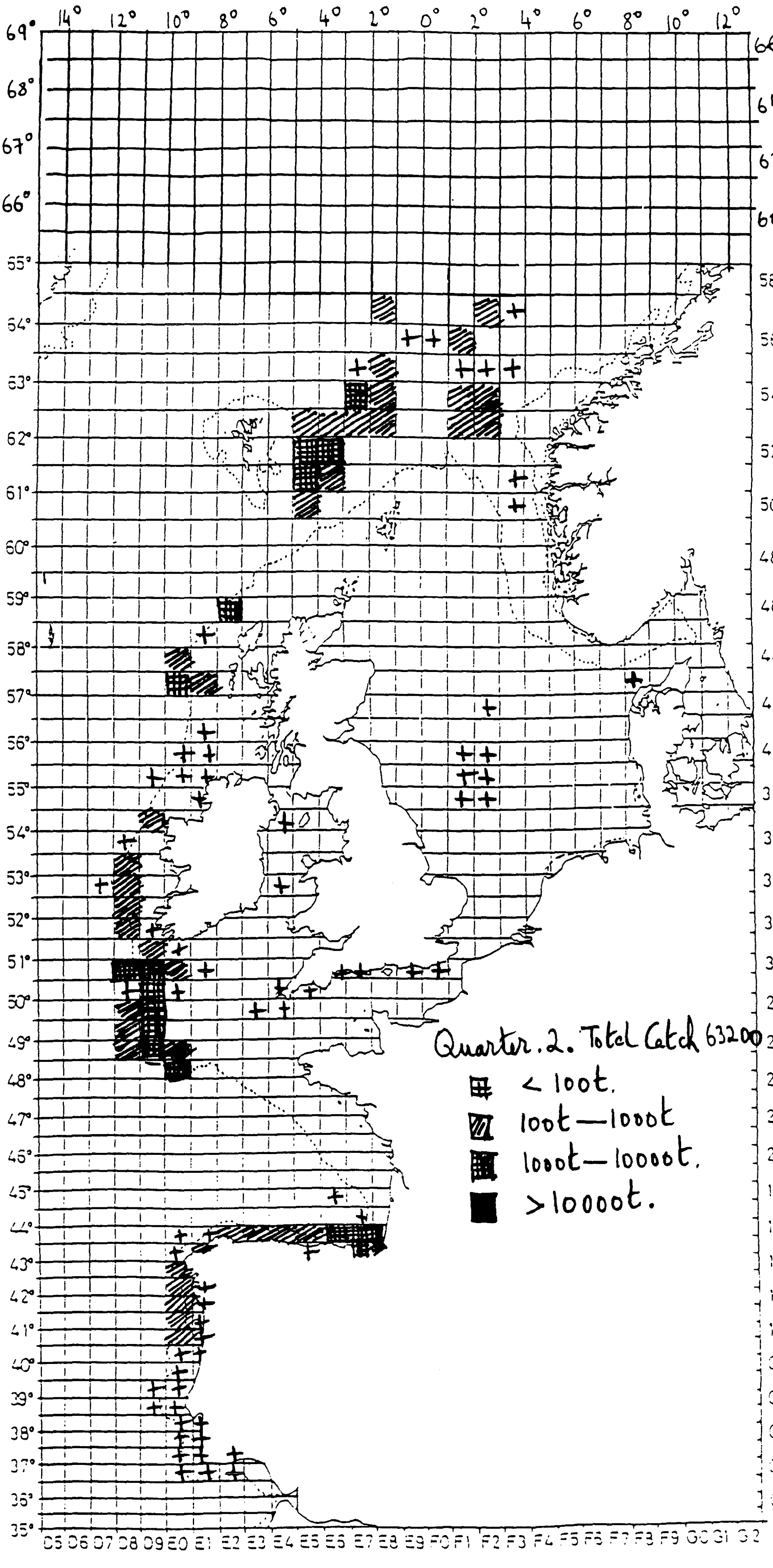


Figure 2.8c Distribution of catches.

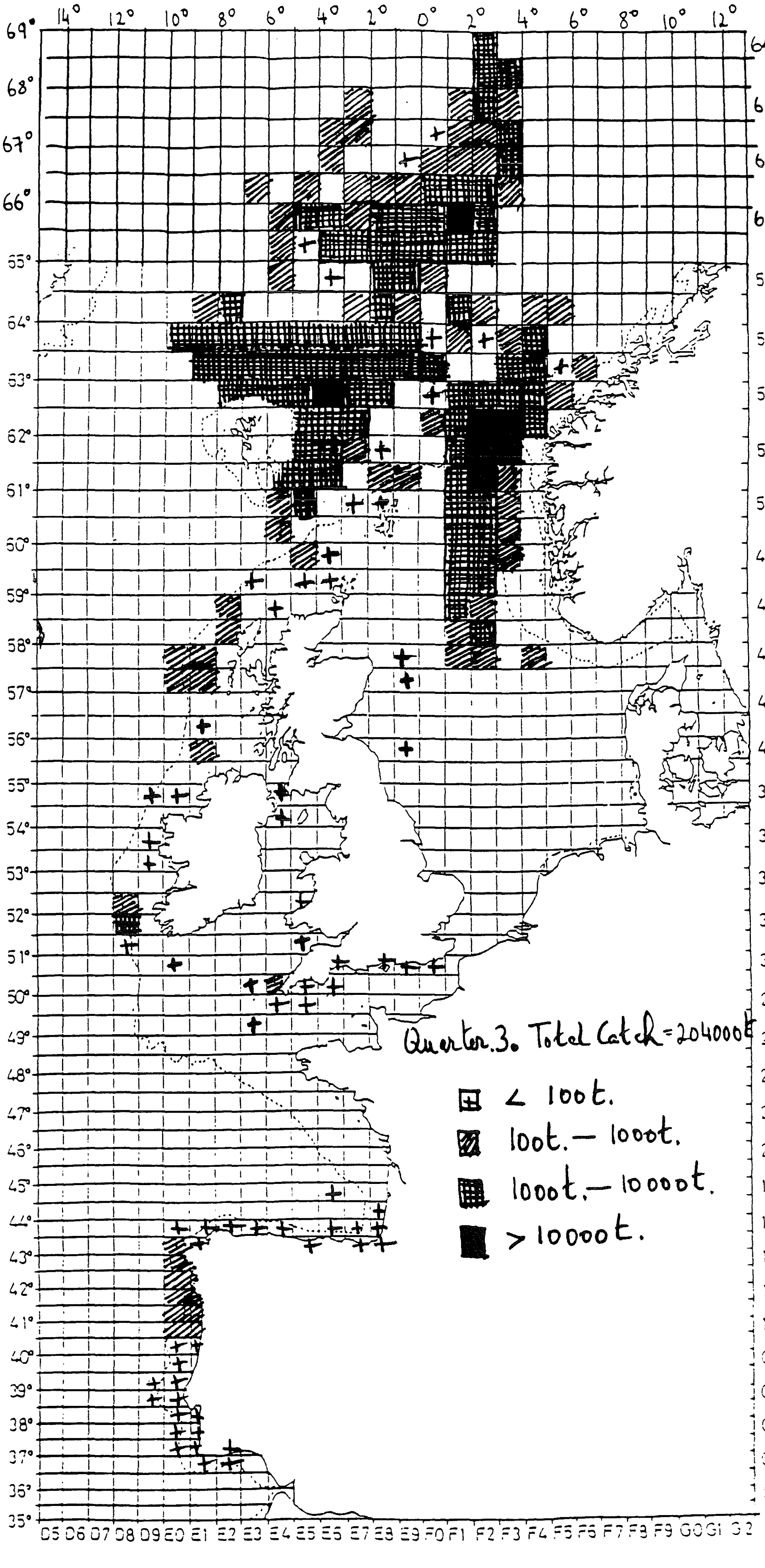
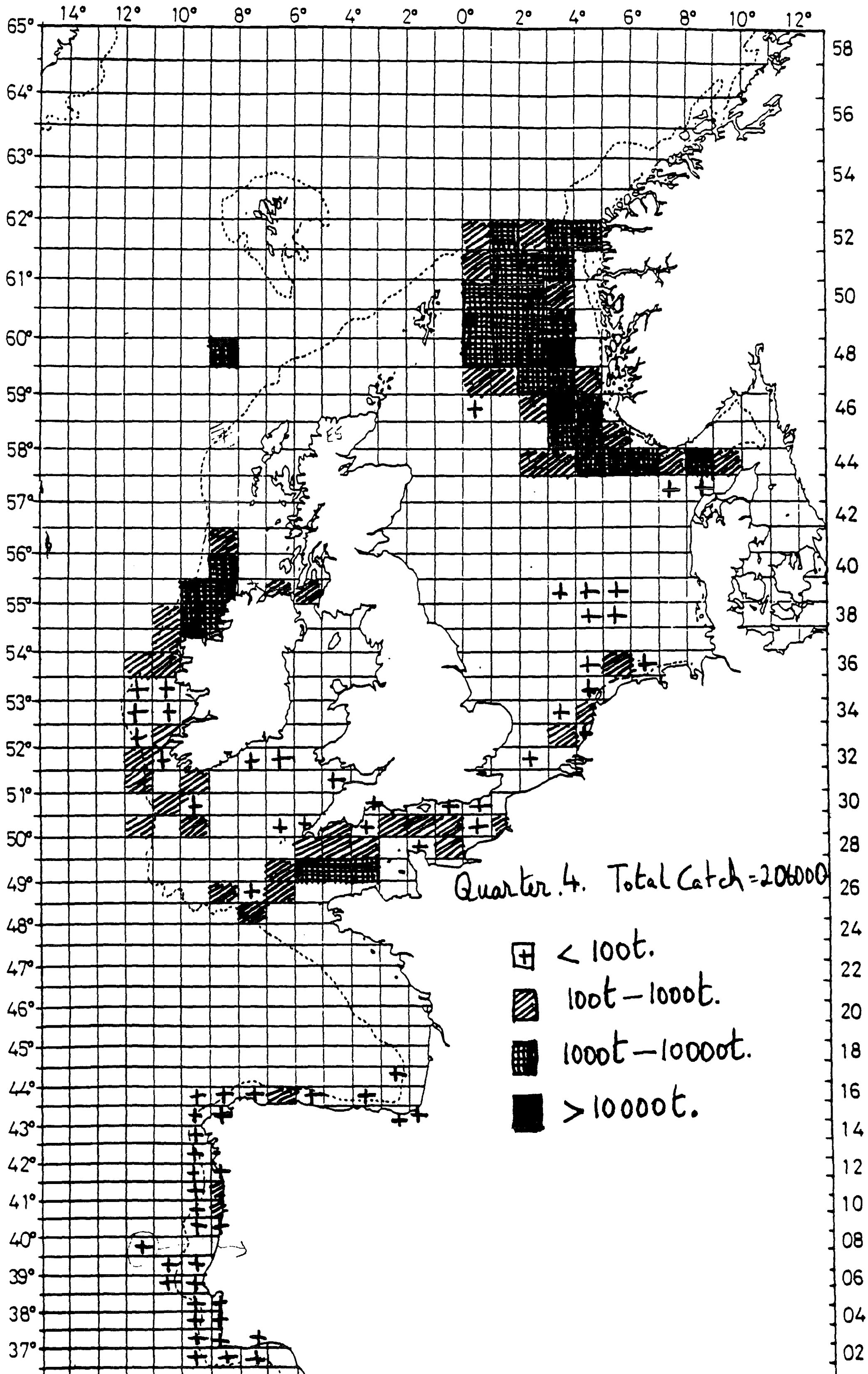


Figure 2.8d Distribution of catches.



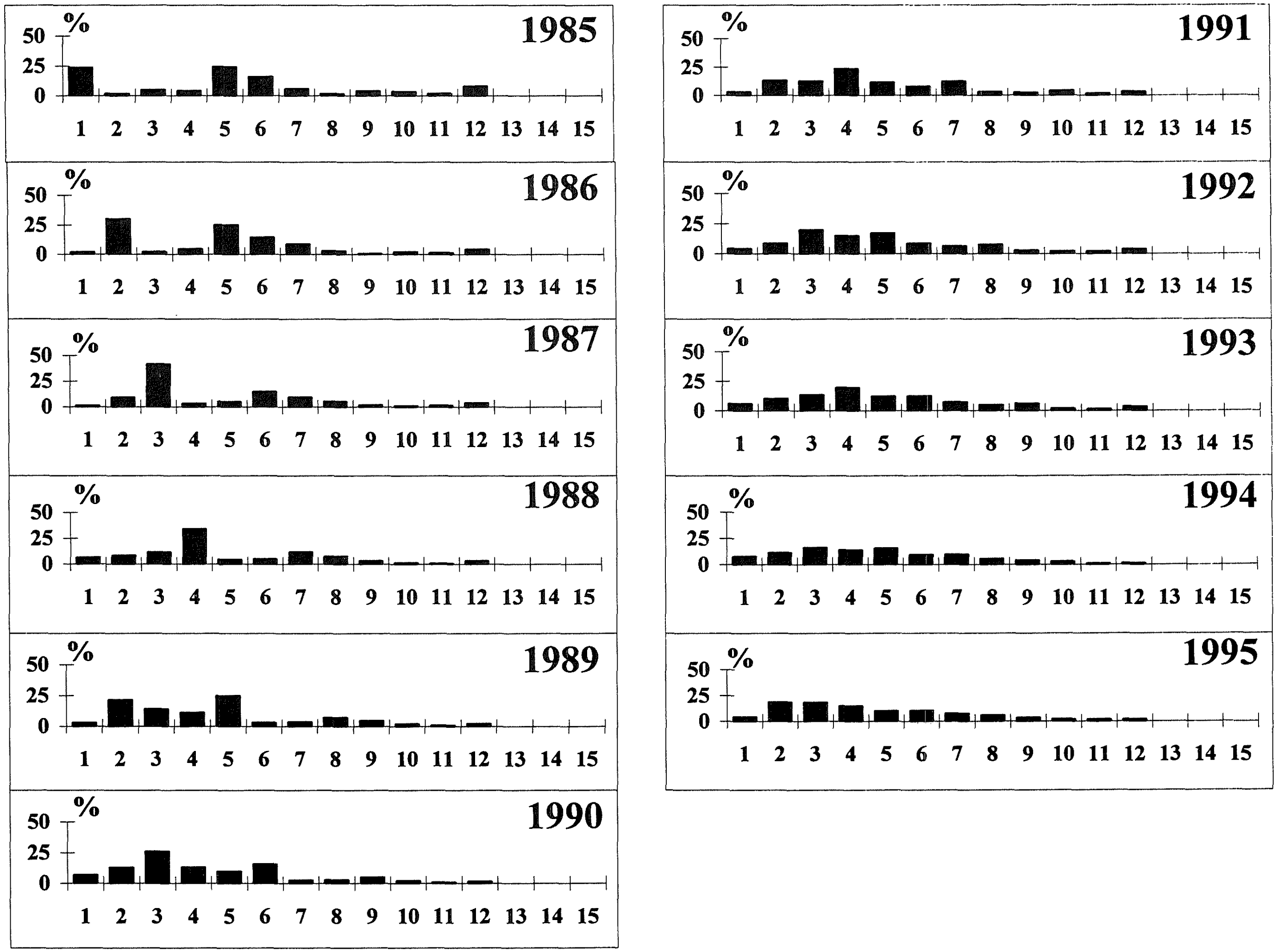


Figure 2.9 The age composition of the western mackerel in the international catches from 1985-1995. Age 12 is a plus group.

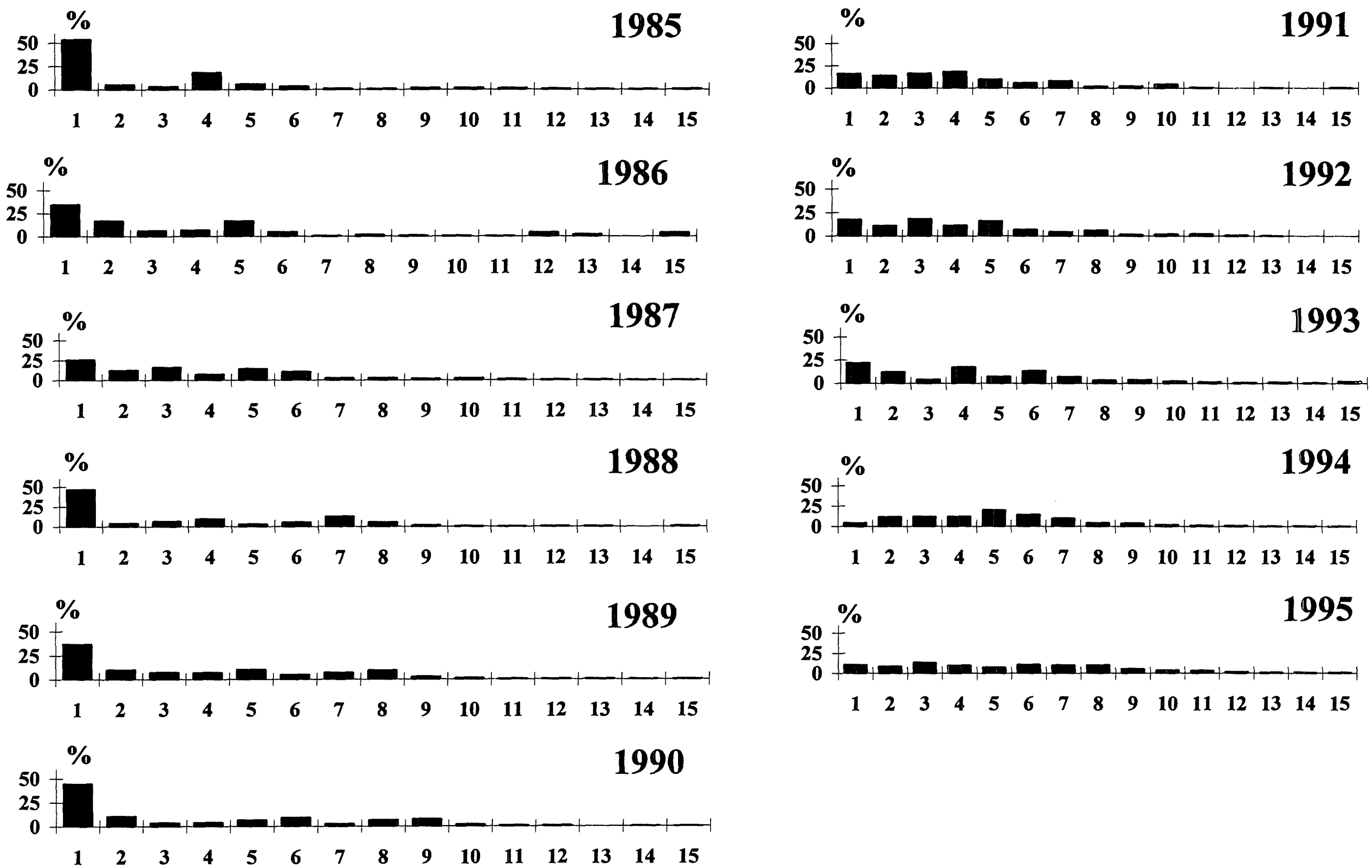


Figure 2.10 **The age composition of the southern mackerel in the international catches from 1985-1995. Age 15 is a plus group.**

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3 NORTH SEA, WESTERN AND SOUTHERN MACKEREL (DIVISIONS IIA, IIIA, IVA–C, VB, VIA-B, VIIA-K, VIII A,B,C,E AND IXA)

3.1 North Sea Mackerel

3.1.1 Fishery independent information from egg surveys

The last time the North Sea was covered several times to estimate the total egg production was in 1990 (Iversen *et al.* 1991) with an estimated total egg production of $53*10^{12}$, corresponding to a SSB of 78,000 t. The areas in the central North Sea known as the main spawning area was surveyed in 1991 and 1992, with a single coverage of the spawning area in June both years (Anon. 1993/H:4). The daily egg production was estimated at $0.70*10^{12}$ eggs and during the 1992 survey $0.25 *10^{12}$ eggs. If the spawning curve in 1992 was similar to the one observed in 1990 and the fecundity as given in Iversen and Adoff (1983) the spawning stock might have decreased from 1990 to 1992.

It is difficult to evaluate the state of the SSB based on one coverage of the spawning area. However, since the surveys in both years (1991 and 1992) were carried out in mid June, which is close to the peak spawning in the previous years and only small amounts of eggs were observed the Working Group has concluded that the SSB has not increased.

In the period 7 June to 2 July 1996 Mackerel egg surveys were conducted in the North Sea by Denmark and Norway. During this period the area a *priori* known to be the major spawning area in the North Sea were covered three times. Only few eggs were found over the total survey area (Iversen and Stæhr pers. com.) indicating that the North Sea Mackerel stock still are at a very low level. However the water temperatures observed during the surveys were 2^{o}–3^{o} C lover than in previous years and it is possible that spawning was delayed. The result of the surveys will be reported to the ACFM meeting in October-November 1996.

3.1.2 Recruitment

Abundance indices from the International Young Fish Survey carried out during the first quarter are given in Table 3.1. The abundance indices have been low since the early 1970s and there are no evidence of any improvement in recruitment.

3.1.3 Assessment

No assessment of the North Sea stock of Mackerel has been done since the egg survey in 1990.

The spawning stock biomass and the catches for the North Sea mackerel Stock for the period 1966 to 1995 are given in Table 3.2 and show no evidence of stock recovery.

3.1.4 Management measures and considerations

The stock has been at a severely depleted level for many years. As for the recent years, the management policy therefore should reflect the necessity of providing maximum protection for the North Sea spawning stock until it shows some evidence of recovery, while at the same time allowing fishing on the western stock to be continued.

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. However in recent years the Western stock has still been present in Division IVa in January. Restriction on fishing in January has therefore resulted in large scale misreporting from this area to Division VIa. To allow a fishery during January could solve this misreporting problem. However this would have implications for the overwintering North Sea component in that area. The distribution of the overwintering North Sea component is not clearly known. The Working Group recommends that this is further investigated.

The Working Group endorses the recommendations made by ACFM in 1995:

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

- 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 1995 but the reported landings of Mackerel in Div. IIIa and IVb,c for 1995 might be seriously under-estimated due to discarded by-catch.

3.2 Western Mackerel

3.2.1 Fishery independent information

A revised spawning stock biomass estimate of 2.37 million tonnes of Western mackerel, a 20% increase from the provisional estimate of 1.97 million t, is available from the egg surveys carried out in 1995. The derivation of the estimate is discussed in Section 2.2 which also explains the reason for the increase and includes a complete time series of egg survey biomass estimates (Table 2.1).

Table 3.3 presents the catches of mackerel by the MAFF Western Approaches March ground fish survey, carried out in each year since 1984. In 1994, due to gear failure, only a limited area within VIIj was covered. The catches at length were raised to provide a survey index value for the whole of VIIj. Screening of the raised 1994 values, within an XSA fit, revealed large negative log catchability residuals at all ages. The 1994 survey data is therefore treated as missing. In 1996 the research vessel used to collect the times series suffered winch failure and the trawl was transferred to a replacement vessel which completed the survey without complications. The substitution of the research vessel may have introduced a catchability year effect, the 1996 data are considered to be of qualitative rather than quantitative value.

3.2.2 Recruitment

Anon. (1995b) compared estimates of recruitment derived from the recruitment index for the Western stock with the estimates derived from an ICA analysis which incorporated all available assessment information. The results established that the index values have an increasing trend with time, whereas the estimates of recruitment have recently been declining.

During this meeting the trawl survey data set was re-examined (Section 2.4). The new index shows close agreement with the ICA estimates of recruitment and will provide information about the strength of a year class occurring two years prior to the date of the assessment which is the year class estimate to which stock forecasts are most sensitive.

3.2.3 Maturity at age

The assumptions about maturity made by the Working Group in previous years were retained for the present assessment. The values are given in the text table below. They are constant for each year of the assessment, apart from the 2 year old fish in 1996, the 1984 year class, for which the maturity was reduced from 60% to 20%.

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

The underlying assumption of constant maturity at age in all years and the 1986 reduction, should be examined in detail. They are critical to the fitting of the populations to the egg surveys. The shape of the sum of squares surface is sensitive to the maturity-at-age values used in the years of the egg surveys. Accurate estimation of maturity, by microscopic rather than macroscopic methods, so that atresia at the younger ages is incorporated into the values, must be carried out in each year of the forthcoming egg surveys.

3.2.4 Stock assessment

Tables 3.4 to 3.6 show the catches in number, mean weights at age in the catch and mean weights at age in the stock. The catch at age data were screened using separable VPA, there were no large residuals or aberrant patterns within the residuals from the fit to recent years.

As was established last year, when a power relationship between catchability and population abundance is used, the index values from the Western Approaches survey at ages 1–4 show good agreement with the estimated population abundances at these ages. However, the standard errors are high and the slope of the relationship near the origin is severe. The fitted Q and k parameters of the power function have correlation of 0.9995. This produces extreme sensitivity in the predicted population abundances when the survey indices are low with correspondingly large variances, and the 1995 VIIj survey estimates are extremely low when compared with previous years. Therefore, the survey was removed from the analysis until the effect of using the power model for catchability has been examined further.

ICA fits using both 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. Two selection patterns were used, a terminal selection of 1.0 for the period 1986 - 1989 and 1.2 for 1990 - 1995. The first period is a modification to that used last year, excluding the 1985 catch data. This removes a large residual created by a 0 (missing) catch of 0-group in that year, reducing the variance and bias of the log catch residuals from the separable fit.

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

$$\sum_{a=0}^{a=11}\sum_{y=1986}^{y=1989}\lambda_a(\ln(C_{a,y}) - \ln(F_y . S1_a . \overline{N}_{a,y}))^2 +$$

$$\sum_{a=0}^{a=11}\sum_{y=1990}^{y=1995}\lambda_a(\ln(C_{a,y} - \ln(F_y . S2_a . \overline{N}_{a,y}))^2 +$$

$$\sum_{y=1984}^{y=1989}\Sigma(\ln(EPB_y) - \ln(\Sigma_a N_{a,y} . O_{a,y} . W_{a,y} . \exp(-PF . F_y . S1_a - PM . M))^2 +$$

$$\sum_{y=1992}^{y=1995}\Sigma(\ln(EPB_y) - \ln(\Sigma_a N_{a,y} . O_{a,y} . W_{a,y} . \exp(-PF . F_y . S2_a - PM . M))^2$$

subject to the constraints

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

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 1986-1989 and 1990-1995, referenced to age 5
λ - weighting factor set to 0.1 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

Tables 3.7a and b and Figures 3.1–3.4 present the ICA diagnostic output. Tables 3.8, 3.9 and 3.10 present the estimated fishing mortalities and population numbers-at-age and stock summary.

3.2.5 Comments on the assessment

Mean F on ages 4-8 is estimated to have been 0.307 in 1995 and 0.301 in 1994 (6% lower than estimated in last year's assessment (F_{94} = 0.319). This results from both the addition of the new catch data and also the increase in the egg production estimate of the 1995 spawning stock biomass (+20%). However, mean F over the period 1991 to 1994 (0.26) is unchanged.

Figure 3.2 shows that whilst the yield remained relatively stable between 1980 and 1990, the spawning stock biomass increased slowly. This resulted from a sustained level of good recruitment. Between 1990 and 1993 the yield and reference F increased rapidly, they have stabilised in 1994 and 1995 but are well above the long term mean. Since 1992 the SSB has declined sharply and in 1995 is, once again, estimated to be at a historical low (2.13 million t).

The 1994 year class was estimated to be extremely low in last years assessment and was taken to be an average of the three lowest recruitments. Both the new ICA fit and the index of abundance derived from roundfish surveys confirm that the 1994 recruitment is weak.

Comparative calculations using XSA on a trawl survey data set and two approaches to biomass dynamic models (Section 3.2.6) provide similar perceptions of stock dynamics to the working group's assessment model estimates. This suggests the assessment is robust to the choice of assessment model, but it may be quite sensitive to the assumptions made in the treatment of the egg survey information (Section 3.2.7).

3.2.6 Comparative assessments

As in previous years the ICA assessment was cross-validated using an XSA assessment tuned to the Western Approaches ground fish survey. The estimated SSB values, recruitment, fishing mortality in the final year and the time series of exploitation show close agreement with the ICA results (Figure 3.5a,b,c,d,e). The main difference being the fishing mortality at the older ages in the final year for which the survey data is known to be extremely noisy. The output from the run is included in the Working Group files.

Western Mackerel

The Working Group explored the use of two simple biomass-dynamic models, being time series forms of the Schaefer model, one of conventional form and one of Caddy-Csirke form based on tagging mortality estimates. Results obtained are closely similar to those of the age-structured assessment, and suggest that estimates of stock size from models of this type may perform as well as the conventional assessments, with a much lower cost in terms of data collection and computation.

Writing

B_t Biomass in year t
C_t Catch in year t
r, K : parameters of the Schaefer surplus-production model
e : observation error, distributed as $N(0,\sigma^2)$
EPB_t : Egg production estimate of biomass

The conventional model fitted to egg surveys and to catches (EC model) was:

$$B_{t+1} = B_t - C_t + rB_t (1 - B_t / K)$$

by a simple nonlinear minimisation of:

$$\Sigma_t ((\ln(EPB_t) - \ln(B_t))^2$$

with respect to the parameters r and K, subject to the constraint B_{1975}=K.

A time-series of smoothed Jolly-Seber estimates of total mortality Z_t was derived from Norwegian tagging experiments (Skagen, WD 1996). An alternative model was formulated using this mortality estimate, introducing a single additional parameter for natural mortality M, and writing fishing mortality $F_t = Z_t - M$:

The 'tag-egg-catch' (TEC) model fitted was:

$$B_{t+1} = B_t - F_t \cdot B_t + rB_t(1 - B_t / K)$$

by minimising

$$\sum_t ((\ln(EPB) - \ln(B_t))^2 + \sum_t ((\ln(C_t) - \ln(F_t \cdot B_t))^2$$

with respect to parameters r, K and M, again subject to the constraint B_{1975}=K.

Estimated time trends in stock size compared with the conventional age-structured assessment estiamtes are given in Figure 3.6. This shows that the stock size estimates are very robust to the choice of population dynamics model, and that the management advice is also robust to the choice of model. Of the three estimates, the 'TEC' model fit does not show the same decline in stock size in the last two years as do the other two models. This is most likely due to the use of a five-year running mean of tag estimates of mortality, and the use of alternative approaches that do not impose such a restriction is suggested.

In some areas of fisheries science principally outside ICES, substantial doubts have been expressed about the appropriateness of using very highly-parameterised age-structured models. Although these incorporate much detail about the dynamics of the stock being assessed, they may attempt to estimate so many parameters that the overall performance of the models for assessing fish stocks may be worse than that of simpler models which estimate fewer models more reliably (Ludwig and Walters, 1985, 1989; Punt, 1991). In some areas, the use of age-structured assessment models has been abandoned in favour of models that only use biomass information (Payne and Punt, 1995; Butterworth *et al.* 1993). Such models appear to be as useful as age-structured models also in the assessment of anchovy (Roel and Cochrane, WD 1996). In consequence, the Working Group suggests that the robustness and precision of stock size estimates made using biomass-dynamics models be further evaluated, and their use for management purposes should be examined.

3.2.7 Consequences of using GAM estimates of egg production

Estimates of mackerel egg production based on a generalised additive modelling approach were provided by Augustin et al. (WD 1996) and are commented on in Section 1.5. Two additional assessment calculations have been made to explore the sensitivity of perceptions of stock size and fishing mortality to the method used for calculating egg production, and its subsequent use in the assessment model. The Working Group's assessment model (Section 3.2.4) was used, replacing the traditional egg production estimates with the GAM bias-corrected estimates (Table 2.1). This showed strong residual patterns, indicating that the data were not consistent with the assumed value of natural mortality. The model was therefore fitted again, assuming a linear relationship between the GAM-based estimates of stock size and the fitted populations. This resulted in an improved model fit that showed no clear pattern in the residuals. The assessment based on traditional egg production estimates is robust to this alternative model of the relationship between the egg-based estimates of stock size and the fitted populations (Anon. 1996/Assess:7). Summary results of the two model fits are given in Figure 3.7, which shows that using the GAM-based biomass estimates and assuming a linear relationship of these to stock size would lead to much lower estimates of biomass and correspondingly higher estimates of fishing mortality.

The relative accuracy of the 'GAM' and the traditional estimates is not known at present. However it is of some concern that the assessment is apparently quite sensitive to the use of this alternative treatment of the egg survey information, and the Working Group would welcome further studies to elucidate the cause of the differing perceptions in stock size brought about by the treatment of the data used by Augustin *et al.* (WD 1996).

3.3 Southern Mackerel Component

3.3.1 Effort and catch per unit effort

Table 3.11 shows 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 1995 and from 1990 to 1995 respectively, for which mackerel is the target species from March to May. The table also shows the effort of the Aviles and La Coruña trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 1995 and the Vigo purse-seine fleet (Sub-division IXa North) from 1983 to 1992 for which mackerel is a by catch. The Spanish trawl fleet effort corresponds to the total annual effort of the fleet for which demersal species is the main target. Portuguese Mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988–1994 is also included and as in Spain mackerel is a by catch.

Table 3.12 shows the CPUE corresponding to the fleets referred to in Table 3.11. The Spanish trawl and purse-seine fleets show fluctuations during the periods considered, while the hand-line fleets are relatively stable, although a considerable increase was observed for the fleet of Santander in 1994 and 1995. The Portuguese trawl fleet shows a relative stability. The catches per effort, expressed as the numbers fish at each age group, for the various fleets is shown in Table 3.13.

The percentage age composition of the catches for 1985 - 1995 is shown in Figure 2.10.

The series of the Spanish CPUE of the commercial fleets indicate that there are seasonal fluctuations in the abundance of adults and juveniles mackerel in Division VIIIc and Subdivision IXa North and also confirm that seasonal and spatial variation of the fishery is related to the spatial variation of the abundance of this species in that area. (Villamor *et al.*, in press).

3.3.2 Surveys

Mackerel egg surveys carried out in the Spanish and Portuguese area are discussed in Section 2.2.

Table 3.14 shows the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 1995 in September-October and the numbers at age per hour trawl (* 1000) Portuguese bottom trawl Autumn surveys from 1986 to 1995.

The two sets of Autumn surveys covered Sub-divisions VIIIc East, VIIIc West and IXa North (Spain) from 20-500 m depth and Sub-divisions IXa Central North, Central South and South (Portugal), from 20–750 m depth. The same sampling methodology was used in both surveys but there were differences in the gear design.

The data of the bottom trawl surveys indicate that mackerel were very scarce. This may be explained because of the gear used in these surveys, in which the main aim was to obtain the hake recruitment index, and also because the season in which these surveys are carried out is a time when abundance of the species is very low in this area (Villamor et al., submitted). The catches of these autumn surveys consist mainly of juveniles, both on the Spanish coast and Portuguese coast (Martins *et al. op. cit.*).

3.4 North East Atlantic (NEA) Mackerel

3.4.1 Fishery independent information

Egg production survey estimates of spawning stock biomass in 1995 of 2.37 million t for the western area and 0.371 million t for the southern area are presented in Section 2.2. This represents an overall 19% revision of the preliminary values (1.97,0.33) for 1995. The ratio of the two values (0.16) is similar to that calculated for the 1992 egg surveys (0.19). Taking into account that the 1992 value is the more uncertain of the two, all of the western area egg survey estimates of spawning stock biomass since 1984 were raised by 16% to provide an abundance estimate for the combined stock.

For reasons described in Section 3.2.1 the Western Approaches survey was not used within the analysis but as a qualitative estimate of recent recruitments.

3.4.2 Recruitment

During this meeting the trawl survey data set was re-examined. (Section 2.4). The new index shows close agreement with the ICA estimates of recruitment. The working group anticipates that further modelling studies with this data series should provide an predictive index for recruitment with known precision.

3.4.3 Data preparation

The analysis was restricted to the years 1984–1995. The data series for the southern area is only available for this period and the stock spawning in the North Sea had been reduced to near the present low level by 1984, so its contribution to the catch at age data was negligible.

For the North Sea stock, only data for 1984–1987 were included, since data for the North Sea have been included in the data for the Western stock from 1988 onwards.

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

Weights in the stock and maturity ogives were obtained as averages weighted by the relative proportion of the egg production spawning stock biomass within the respective areas. For the North Sea spawners, the biomass estimates by egg surveys since 1984 range from 37 to 133 thousand t (Anon. 1989), which corresponds to approximately 1.5% to 4.5% of the combined North Sea and Western spawners. Thus, for combining the North Sea and Western stock data, weighting factors of 0.03 and 0.97 respectively were applied. Weighting factors of 0.16 and 0.84 were used for the Southern and Western data. The resulting maturity ogive is given below.

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0.14	0.65	0.91	0.97	0.97	0.99	1	1

Natural mortality was taken as 0.15 and the proportions of F and M before spawning were 0.4.

3.4.4 Stock assessment

Tables 3.15 to 3.17 show the catches in number, mean weights at age in the catch and mean weights at age in the stock.

A similar procedure to that used for the assessment of the Western mackerel was used for the combined assessment. A terminal selection of 1.0 was used for the period 1986–1988, a terminal selection of 1.2 for the years after 1988. Both were calculated relative to the reference fishing mortality at age 5.

The model was fitted by a nonlinear minimisation of

$$\sum_{a=0}^{a=11}\sum_{y=1986}^{y=1988}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S1_a.\overline{N}_{a,y}))^2 +$$
$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=1995}\lambda_a(\ln(C_{a,y} - \ln(F_y.S2_a.\overline{N}_{a,y}))^2 +$$
$$\sum_{y=1984}^{y=1986}\Sigma(\ln(EPB_y) - \ln(\Sigma_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S1_a - PM.M))^2 +$$
$$\sum_{y=1989}^{y=1995}\Sigma(\ln(EPB_y) - \ln(\Sigma_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a - PM.M))^2$$

subject to the constraints

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

where

N bar - mean exploited population abundance over the year
N - population abundance on 1 January
O - proportion of fish mature at each age
M - Natural mortality
F - fishing mortality at age 5
S1, S2 - selection at age over the time periods 1986–1988 and 1989–1995, referenced to age 5
λ - weighting factor set to 0.1 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

Parameter estimates and their standard deviations are listed in Tables 3.18a and b and illustrated in Figures 3.8 - 3.11. Tables 3.19, 3.20 and 3.21 present the estimated fishing mortalities, population numbers-at-age and stock summary.

3.4.5 Comments on the assessment

Mean F on ages 4-8 is estimated to have been 0.27 in 1995 and 0.28 in 1994 (8% lower than estimated in last year's assessment (F_{94} = 0.292). This results from both the addition of the new catch data and also the increase in the egg production estimate of the 1995 spawning stock biomass (+19%). Mean F over the period 1991 to 1994 (0.20) is unchanged. Figures 3.12 and 3.13 illustrate the changes in the time series of estimates of F and reference SSB between the 1995 and 1996 assessments.

Figure 3.8 shows that as with the Western mackerel the yield remained relatively stable between 1984 and 1990, with a slow increase in spawning stock biomass. This resulted from a sustained sequence of good recruitment. Between 1990 and 1992 the yield and reference F increased rapidly, they have been stable since 1993 but are well above the mean. Since 1992 the SSB has declined sharply and in 1995 is, once again, estimated to be at a historical low (2.54 million t).

Anon. (1991) performed a sensitivity analysis for status quo forecasts made using data from this stock. The results revealed that the forecasts were sensitive to the estimates of the strength of the year class that recruited two years before the year of the assessment. The forecast made this year will be sensitive to the estimate of recruitment in 1994. The 1994 year class was estimated to be extremely low in last years assessment and was taken to be an average of the three lowest recruitments. Both of the new ICA fits and the index of abundance derived from groundfish surveys confirm that the 1994 recruitment is weak. The 1995 year class is estimated to be weak by the ICA fit but this is not considered to be reliable as it is based on one catch at age value from the 1995 0-group.

Comments on the robustness of the assessment made in the Western area also apply to this assessment.

3.4.6 Catch predictions

Table 3.22 presents the input values for the catch forecasts. Apart from the 1995 and 1996 year classes, the ICA-estimated abundances at all ages were used as the starting populations in the prediction. The recruitment for 1995 is estimated to be 1,592 million. Information from the English groundfish survey and from the Spanish and Portuguese catches indicate that the 1995 year class may be strong. However, the predictive value of these data series is unknown. A precautionary approach is to assume that the 1995 year class is of average strength. Therefore, the geometric mean (3,711 million) was used for the 1995 recruitment. Recruitments in 1996, 1997 and 1998 were taken to be the geometric mean (1975–1993) calculated for Western mackerel, raised by the average ratio (1.095) of the estimated western and southern area recruitments for the period 1984–1994.

Catch forecasts have been calculated for the provision of area based TACs. Three "fleets" have been defined, corresponding to the exploitation of the western area including the North Sea (Western), the southern area (Southern) and an international waters (International). The latter corresponds to the catches taken in area IIa which are unregulated.

The exploitation pattern used in the prediction was the separable ICA F's for the final year. This was subdivided into partial Fs for each fleet using the ratio of the fleet catch at each age and the total catch at each age. Weight at age in the catch was taken as an average of the values for the period 1993–1995 for each area. Weight at age in the stock from an average (1993–1995) of the combined data.

The anticipated TAC restricted catch for the Western area in 1996 is 425,000 t (0.61 x F95). The Southern area has a TAC of 30,000 t. Catches in this area have recently been increasing, however, this level has never been achieved. Catches in International waters which are not subject to a TAC, have recently averaged 45,000 t.

Three single option summary tables are presented and summarised below. The calculated forecasts predict that SSB will continue to decline for the next two years with a recovery in 1998. However, the recovery is sensitive to the estimate of the 1995 year class abundance, which is taken to be the geometric mean for the time series.

Year	Status quo (F95)		Constant TAC		TAC 1996 F= 0.15, 97,98	
	Ref F	SSB	Ref F	SSB	Ref F	SSB
1996	0.27	2.34	0.18	2.41	0.18	2.41
1997	0.27	2.21	0.18	2.44	0.15	2.46
1998	0.27	2.16	0.18	2.51	0.15	2.59

If the fishing mortality in 1996 had not been reduced from recent levels then it is estimated that the SSB would have continued its rapid decline to a new historic low for 1998 of 2.16 million t (Table 3.23).

The following tables illustrate 500,000 t TAC restrictions for 1996. In Table 3.24 the TAC restriction is followed by a constant catch option for 1997 and 1998 of 500,000 t. SSB continues to be reduced in 1996 but then begins to recover in 1998, to just below the level estimated for 1995. Table 3.25 follows the TAC restriction with a constant F strategy. The value of F used, 0.15, is that agreed between the EU and Norway for 1997. The predicted SSB values are reduced to a lesser extent in 1996 and 1997 than the constant TAC scenario, but recover to the 1995 level in 1998.

Three management option tables are presented. They present the outcome of applying reductions in fishing mortality to combinations of the three areas after a 500,000 t TAC restriction in 1996. Table 3.26 presents *status quo* F in the Southern and International areas with a range of factors for F97 in the Western area. Table 3.27 presents *status quo* F in the International area and a range of factors for F97 in the Western and Southern areas. Table 3.28 presents a range of F97 values for all three areas.

The forecasts for the three scenarios are in close agreement for the predicted SSB values. This results from the dominant effect of the exploitation in the Western area on the forecast SSB estimates. The reference F's in the International and Southern areas are so low that for the range of F multipliers used in the forecast their catches make no significant impact on the predicted SSB.

3.4.7 Medium-term predictions

Medium-term predictions were made using the methodology described in Anon. (1996/Assess:7). The input parameters were estimated as follows:

- Stock population parameters (Fishing mortality, selection, population abundance at age) were taken directly from the ICA fit (Section 3.4.4).
- The estimate of the variance-covariance matrix provided by the ICA programme was used as the estimate of uncertainty in the stock population parameters.
- Mean weights at age in the catches and the fleet partial-F ratio at age were calculated as from the proportions in the 1995 catches and were assumed to be known precisely.
- The means of the maturity ogive and weights in the stock were estimated from observations from 1993 to 1995.
- RecruitmentFunction.

A simple, robust and precautionary approach to modelling recruitment was adopted. It is assumed that if recruitment falls below the lowest spawning stock biomass estimate, then a linear dependency is assumed to hold. Uncertainty about such a relationship was also modelled.

This model was formulated on the basis of making the simplest assumptions about recruitment that are consistent with the available data and with obvious constraints that are necessary from theoretical grounds. Firstly, there is no detectable dependency of recruitment on stock size over the range of stock size estimates available. Attempts to fit such functions having proved unsuccessful, it becomes necessary to retain the assumption that, over the observed range of stock sizes, the recruitment is independent of stock size. A geometric mean recruitment has been used as the estimate of central tendency over this range of stock sizes. An additional necessary constraint is that when stock size is zero, recruitment is also zero. The dependency of recruitment on stock size in the region between the lowest observed stock size (Recruitment = Geometric mean) and stock size = zero (Recruitment = zero). The simplest model satisfying these constraints, chosen by Ockham's (1319) razor, is a linear dependency of recruits on stock size in this region.

Stochastic variation of recruitment about the model for medium-term prediction purposes was modelled in different ways separately for the regions of stock size above and below the lowest observed stock size. In the region over which stock sizes have been observed and recruitment is assumed to be stock-independent, pseudo-recruitments R' were drawn from a distribution as:

$$R' = \exp(\frac{1}{n}\Sigma_y(\ln(R_y)) + \varepsilon')$$

where R_y are the estimated recruitments over the n years, and the epsilon' are resampled with replacement from the historic distribution of recruitments about their geometric mean.

For lower stock sizes, a different approach was used. For each pseudo recruitment, a new estimate of the inflection point of the stock-recruit relationship (the recruitment at the lowest observed stock size) was drawn from a distribution having as its mean the geometric mean of observed recruitments, and with variance equal to the estimated variance of the observed recruitments. A pseudo recruitment was then generated using the generated inflection point (and assuming a linear dependency of recruitment on stock size down to the origin) and perturbed with an error resampled from log residuals with replacement, as above.

Medium-term prediction have been calculated for the following options:

Catch constraints for 10 years ahead:

C1995	Catch as in 1995 (755600 tonnes)
C1996	Catch as expected for 1996 (500000 tonnes)

F - constraints for 20 years ahead:

F95	F as in 1995 (0.29)
F96	F as expected for 1996 (0.17)
F15	F = 0.15, which has been agreed by EU and Norway as a TAC that is consistent with a fishing mortality of 0.15 in 1997 unless future scientific advice requires modification of the agreement (Brussels 9th Dec. 1995).

The two measures of F considered as target reference fishing mortalities in section 3.4.10.2 (F_{med} = 0.17 and $F_{0.1}$= 0.175 from the western assessment) have not been simulated, since they are very close to the F1996.

An MBAL of 2,300,000 tonnes was used (see Section 3.4.10.2).

With the catch constraints (Figures 3.14 and 3.15), there is a risk that the stock becomes too small to enable the target catch to be taken. For the C1995 option this appears in the first simulations in 1999, and the risk of this happening reaches 50% by 2003. Even at the lower catch restriction C1996, there is a small probability of not being able to support the catch towards the end of the 10 year period. In the median, the C1995 leads to a rapid decrease in stock and recruitment, while the medians for the C1996 option were stable or increase slightly.

The F constraint at F95 = 0.29 led to a considerable risk of SSB falling below MBAL (Figure 3.16), around 60% most of the period. At the lower fishing mortalities this risk was considerably lower (10 - 20%) and decreased with time. Under these options the catches increased to a range of 350 - 700000 tonnes, slightly higher for F = 0.17 (Figure 3.17) than for F = 0.15 (Figure 3.18).

3.4.8 Long-term yield

Table 3.29 presents the yield per recruit and short term forecasts for the all areas. Fmax is estimated to be at a combined reference F of 0.54. However, for pelagic species F_{max} is generally estimated to be at levels of reference F well beyond sustainable levels and should not be used as a fishing mortality target. $F_{0.1}$, which from the western mackerel assessment is estimated at 0.175, is a possible long-term management target for this stock.

The time series of stock and recruitment estimates for this management unit are short and the estimation of F_{med}, F_{high} and F_{low} for short time series will be biased if the stock has previously been reduced to a low level. For this reason the F reference have been calculated for both the western area assessment, Figure 3.19 and the NEA mackerel, Figure 3.20. The values are compared below.

	Western	NEA
F_{high}	0.409	0.391
F_{med}	0.173	0.147
F_{low}	0.005	0.125

Current F is between F_{med} and F_{high}. The fishing mortality forecast for 1996 under the TAC restriction is 0.179.

3.4.9 Reference points for management, MBAL and fishing mortality targets

There is no clear relationship between stock and recruitment neither for the combined stock nor for the Western mackerel. According to the experience from the North Sea mackerel, there is a possibility for a permanent recruitment failure if the SSB becomes sufficiently low, but nothing is known as to the level of SSB where this may take place. The precautionary approach would therefore be to avoid letting the SSB decline below the level where the historical data indicate a normal recruitment.

In the last year's Working Group report, an MBAL of 2.3 million tonnes was adopted for the NEA mackerel stock. This was arrived at by taking the lowest SSB on record for the western stock (i.e. 2.0 million tonnes, and increasing it by 15% to account for the southern component.

This MBAL is not suitable as a limit reference point because it is not known how strong an action is needed if the SSB drops below this level and it is not intended as a target reference point.

As discussed by the Comprehensive Working Group (Anon. 1996/Assess:20), responsible harvesting of a stock in accordance with international agreements would imply that the long term fishing mortality should have only a small probability of exceeding a level which is the lowest of F_{med}, F_{max}, and F_{MSY}.

For the mackerel, F_{max} is poorly defined, and a precautionary approach would be to apply $F_{0.1}$. A simple approach to the F_{MSY} would be to represent it by F_{max} or $F_{0.1}$, which would result if it is assumed that the recruitment is independent of the SSB. Another approach is to apply a simple production model (Section 3.2.6)

Still another approach would be to use a fraction (e.g. 30%) of the virgin SSB as a guideline to a target SSB. Again assuming constant recruitment the virgin SSB can be obtained by multiplying the SSB per recruit at F=0 with this recruitment.

The resulting fishing mortalities and corresponding SSB's, assuming a constant recruitment at the geometric mean of the historical ones, are presented in the text table below:

Ref. point.	Fishing mortality	Corresponding SSB (mill. tonnes)
$F_{0.1}$	0.175	2.86
F_{med}	0.173	2.89
F_{MSY} (catch + eggs)	0.24	2.29
F_{MSY} (tags + eggs)	0.30	1.94
$F_{30\%Virg}$	0.22	2.46

The present value of 2.3 million tonnes is in line with these numbers. Since the stock is still declining from year to year, use of the all time low SSB as MBAL implies decreasing the MBAL as the stock decreases. Because of this, and because most of the approaches attempted above give higher values, the WG decided to retain the present value of 2.3 million tonnes SSB for MBAL. The analysis above also indicates that a more appropriate target value for the management would be SSB around 2.8 million tonnes, corresponding to a fishing mortality of approximately 0.18.

In the longer term F in the order of 0.15 - 0.2 will result in a low risk of going below the MBAL level and is likely to optimise the long term yield. F's at the 1995 level imply a far greater risk of exceeding MBAL.

3.4.10 Management measures and considerations

In 1995 ACFM recommended a reduction in F to a fishing mortality 60% below that of 1994. If the 1996 TAC restriction is followed, the current stock forecast indicates that the 1996 F (0.179) will be 35% below F94. Medium term forecasts predict that this combined with a fishing mortality of 0.15 in 1997, will lead to an initial decline and subsequent recovery of SSB. The Working Group points out that catches have consistently exceeded the TAC and this forecast is therefore considered to be optimistic.

In the longer term, F in the order of 0.15 - 0.2 will result in a low risk of going below the MBAL level and is likely to improve the long term yield. F's at the 1995 level imply a far greater risk of falling below MBAL.

The management of the Western component in recent years has reflected the need to protect the North Sea spawning stock by recommending that there should be no fishing for mackerel in Divisions IIIa and IVb,c at any time of year and in Division IVa for the first seven months of the year (see Section 3.1).

The catches from this management unit have been increasing, with those of the period 1993–1995 the highest on record. Fishing mortality has recently shown a strong upward trend but has now stabilised. This years assessment has confirmed the relatively high levels of F and the recent rapid decline in the spawning stock biomass. The upwards revision of the egg survey estimates has raised the level of recent spawning stock biomass estimates but has not altered the perception of the state of the stock.

The Working Group points out that the current fishing mortality has been above F_{med} and that, even with the anticipated TAC restriction in 1996, the spawning stock biomass is predicted to decrease to a historic low in 1996 and 1997 with a recovery in 1998. The recovery forecast is sensitive to the estimate of the 1995 year class abundance, which is taken to be the geometric mean for the time series.

In conjunction with the new practise of including the international catches in the forecasts for this stock, the TAC should be applied to **all** areas including international waters.

Table 3.1 Mackerel abundance indices from the North Sea International Young Fish surveys. Values are mean numbers per 10 hr.

Year	First winter	Second winter
1970	6536	13
1971	3250	576
1972	13	226
1973	28	2
1974	14	12
1975	165	1
1976	4	2
1977	14	<.5
1978	23	<.5
1979	2	<.5
1980	<.5	<.5
1981	1	<.5
1982	1	1
1983	19	52
1984	1	4
1985	7	0
1986	5	21
1987	89*	<.5
1988	13	1
1989	11	17
1990	350	12
1991	69*	2
1992	160*	4
1993	10	8
1994	22	1
1995	+	**

Notes: Data for survey years 1970-1974 based on standard area south of 59°30'N, 1975-1992 based on standard area south of 61°30'N; *Values dominated by catch in one or two rectangles only; ** Data not yet available; + To few agings for calculation of an indices by age.

Table 3.2 North Sea Mackerel (Weight in '000 t).

Year	Spawning Stock Biomass	Landings
1965	2850 $	208
1966	2700 $	530 *
1967	1900 $	930 *
1968	1500 $	822 *
1969	1113 "	739 *
1970	550 "	323 *
1971	580 "	243 *
1972	1249 "	125 +
1973	1097 "	226 +
1974	1036 "	190 +
1975	826 +	138 +
1976	700 +	165 +
1977	583 +	188 +
1978	436 +	103 +
1979	336 +	66 +
1980	258 +	61 +
1981	189 +	60 +
1982	162 +	40 +
1983	168 +	43 +
1984	133 #	67 +
1985		35 +
1986	45 #	25 +
1987		3 +
1988	37 #	6
1989		7
1990	78 #	10
1991		- **
1992		- **
1993		- **
1994		- **
1995		- **
Average	805	206

$ Hamre, J. 1980 Rapp.P.-v. Reun.Cons.Int.Explor.Mer. 177:212–242
* Report of the Mackerel Working Group 1975. ICES CM 1975/H:3
" Report of the Mackerel Working Group 1981. ICES CM 1981/H:7
+ Report of the Mackerel Working Group 1989. ICES CM 1989/H:7
# Estimations based on Mackerel Egg Surveys
** Assumed by the Working Group to be 10,000 t as in 1990

Table 3.3 The effort and catch in numbers of Mackerel recorded by the M.A.F.F. Western approaches groundfish surveys in two ICES areas.

ICES area VIIj

Catch in total numbers(000's). Effort in total hours(000's)

	Effort	Age 1	2	3	4	5	6		8	9	10
1984	0.99	0.06	0.61	5.65	3.89	4.07	0.47	0.16	0.16	0.30	0.31
1985	1.20	3.83	0.04	0.97	6.16	4.36	1.93	0.35	0.35	0.36	0.11
1986	0.96	0.43	9.02	0.21	0.33	1.55	1.38	0.95	0.19	0.06	0.12
1987	1.38	4.69	0.53	8.79	0.04	0.32	0.68	0.56	0.20	0.02	0.01
1988	1.68	36.00	2.18	4.42	18.13	2.79	3.95	3.08	2.96	2.16	0.65
1989	1.73	20.39	14.99	6.75	6.14	11.67	0.98	0.68	1.85	1.94	1.51
1990	1.79	3.40	8.52	17.65	5.95	2.39	3.55	0.19	0.27	0.37	0.27
1991	1.80	4.46	33.12	12.13	10.44	4.69	3.50	4.64	0.50	0.17	0.69
1992	1.74	1.86	5.57	13.78	5.66	2.61	0.58	0.61	0.81	0.09	0.20
1993	1.80	8.40	7.29	8.16	5.95	2.25	1.05	0.93	0.30	0.30	0.00
1994	1.20	1.05	0.27	1.12	0.91	1.63	0.88	0.34	0.07	0.14	0.06
1995	2.04	0.06	1.08	2.62	2.01	0.70	0.49	0.21	0.19	0.06	0.16
1996	1.74	3.31	4.13	6.99	2.43	1.48	0.52	0.44	0.37	0.40	0.61

ICES area VIIh

Data standardised to total numbers per hour.

	Effort	Age 1	2	3	4	5	6	7	8	9	10
1984	1.00	41.12	440.71	760.18	451.06	584.93	5.16	0.00	0.19	0.23	0.15
1985	1.00	212.42	22.92	120.90	275.24	148.87	36.51	12.77	3.13	7.30	5.90
1986	1.00	1.96	43.06	11.86	9.58	18.22	15.77	10.93	0.26	0.04	0.19
1987	1.00	13.36	20.01	73.20	4.33	9.32	40.67	27.38	13.22	2.49	0.23
1988	1.00	3.04	48.46	165.46	268.91	17.65	50.99	41.42	30.29	4.56	6.81
1989	1.00	223.00	209.31	130.92	41.69	36.92	6.85	0.00	3.15	0.00	0.15
1990	1.00	3.62	63.98	117.47	33.21	3.80	8.87	1.36	3.80	2.53	2.35
1991	1.00	16.23	1251.92	437.47	216.32	18.17	0.00	9.25	6.67	0.00	0.00
1992	1.00	0.00	138.00	459.00	50.00	20.00	23.00	7.00	1.00	0.00	0.50
1993	1.00	104.00	171.00	149.00	141.00	22.00	7.00	3.00	1.00	2.00	0.00
1994	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	1.00	156.30	1528.00	614.90	432.30	134.10	57.30	8.70	7.20	0.00	0.00
1996	1.00	306.40	6298.70	6566.30	565.90	236.60	46.80	25.10	44.60	7.20	48.90

Table 3.4 : Western mackerel catch numbers at age (Thousands)

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
0,	34200,	2000,	10300,	79500,	19500,	38300,	2000,	-1,	510,	-1,
1,	279400,	153500,	31300,	351100,	484500,	266100,	203000,	43600,	15240,	234300,
2,	184900,	289500,	563800,	61600,	468700,	506400,	435900,	712700,	79510,	16000,
3,	322300,	154000,	425000,	602500,	75200,	225100,	483600,	444600,	661830,	49100,
4,	170600,	166000,	243700,	365500,	381300,	31700,	184100,	391600,	374600,	420300,
5,	288800,	51000,	258300,	217200,	282000,	174800,	24700,	130400,	238200,	242600,
6,	118600,	140000,	71900,	233100,	145200,	158500,	136600,	20200,	92000,	158400,
7,	279700,	64400,	151900,	86800,	158400,	99500,	108600,	91300,	15540,	58900,
8,	438800,	89400,	56700,	154200,	52400,	116600,	84500,	70900,	51470,	16200,
9,	0,	158500,	83200,	70500,	139600,	35300,	87000,	47100,	39270,	42000,
10,	0,	0,	210800,	74600,	43600,	138700,	24400,	48900,	25120,	33000,
11,	0,	0,	0,	189100,	47900,	29400,	90300,	19100,	21390,	20400,
+gp,	0,	0,	0,	0,	115400,	176100,	147600,	126200,	44240,	80300,
TOTALNUM,	2117300,	1268300,	2106900,	2485700,	2413700,	1996500,	2012300,	2146599,	1658920,	1371499,
TONSLAND,	507178,	325974,	503913,	605744,	604761,	661762,	623819,	614287,	550929,	561292,
SOPCOF %,	74,	85,	80,	79,	75,	95,	89,	91,	98,	101,

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0,	18100,	2490,	290,	24440,	5350,	4890,	1720,	13120,	470,	3732,
1,	25700,	22920,	99010,	42830,	108600,	47120,	74950,	114660,	144460,	74093,
2,	397800,	148430,	127260,	306860,	202330,	202680,	150920,	202770,	215110,	335028,
3,	29900,	653570,	175410,	203330,	408090,	194870,	347320,	264200,	301070,	330966,
4,	63600,	51930,	505090,	163430,	205270,	362780,	261110,	387430,	261030,	268274,
5,	331900,	79310,	66500,	356460,	152060,	181810,	298330,	239850,	289740,	181786,
6,	193900,	237420,	77910,	45930,	247400,	125010,	152640,	247230,	176280,	190601,
7,	119500,	148770,	179240,	54010,	40620,	192280,	111840,	145580,	183830,	135435,
8,	38300,	83910,	111520,	105720,	44980,	49740,	135550,	95640,	103530,	106469,
9,	11100,	32980,	51640,	66660,	79980,	42010,	50340,	119140,	77460,	65432,
10,	28600,	17970,	19260,	31410,	31510,	67940,	35560,	37370,	56430,	39830,
11,	20200,	24680,	12310,	13570,	15890,	29220,	39770,	28150,	19610,	35734,
+gp,	60100,	60770,	52430,	34800,	26970,	52380,	67500,	65570,	56370,	36602,
TOTALNUM,	1338700,	1565150,	1477870,	1449450,	1569050,	1552730,	1727550,	1960710,	1885390,	1803982,
TONSLAND,	537615,	615380,	628000,	567400,	605937,	646169,	742305,	805039,	797688,	728637,
SOPCOF %,	101,	98,	100,	100,	100,	99,	100,	100,	100,	100,

Table 3.5 Western mackerel catch weights at age (kg)

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	.0660,	.0660,	.0000,	.0000,	.0660,	.0660,	.0660,	.0660,	.0690,	.0000,
1,	.1370,	.1370,	.1370,	.1370,	.1310,	.1310,	.1310,	.1780,	.1370,	.1510,
2,	.1580,	.1580,	.1580,	.1580,	.2480,	.2480,	.2480,	.2160,	.1760,	.2730,
3,	.2410,	.2410,	.2410,	.2410,	.2830,	.2830,	.2830,	.2700,	.2940,	.3490,
4,	.3140,	.3140,	.3140,	.3140,	.3430,	.3430,	.3430,	.3060,	.3240,	.4180,
5,	.3340,	.3340,	.3340,	.3340,	.3730,	.3730,	.3730,	.3830,	.3410,	.4160,
6,	.3980,	.3980,	.3980,	.3980,	.4550,	.4550,	.4550,	.4250,	.4290,	.4340,
7,	.4100,	.4100,	.4100,	.4100,	.4970,	.4970,	.4970,	.4300,	.5380,	.5200,
8,	.5080,	.5030,	.5030,	.5030,	.5080,	.5080,	.5080,	.4910,	.4680,	.5440,
9,	.0000,	.5110,	.5110,	.5110,	.5390,	.5390,	.5390,	.5420,	.5610,	.5620,
10,	.0000,	.5110,	.5110,	.5110,	.5730,	.5730,	.5730,	.6080,	.6190,	.6270,
11,	.0000,	.0000,	.0000,	.5110,	.5730,	.5730,	.5730,	.6080,	.6360,	.6660,
+gp,	.0000,	.0000,	.0000,	.0000,	.5730,	.5730,	.5730,	.6080,	.6360,	.7040,
SOPCOFAC,	.7434,	.8550,	.8021,	.7897,	.7527,	.9456,	.8908,	.9063,	.9759,	1.0094,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	.0000,	.0490,	.0710,	.0610,	.0610,	.0600,	.0550,	.0530,	.0540,	.0730,
1,	.1660,	.1760,	.1570,	.1540,	.1670,	.1550,	.1640,	.1360,	.1350,	.1400,
2,	.2450,	.2220,	.2600,	.2380,	.2340,	.2550,	.2380,	.2410,	.2570,	.2360,
3,	.3390,	.3180,	.3260,	.3210,	.3370,	.3320,	.3340,	.3170,	.3410,	.3340,
4,	.4210,	.3990,	.3900,	.3770,	.3800,	.3970,	.3980,	.3770,	.3910,	.3890,
5,	.4730,	.4780,	.4620,	.4340,	.4250,	.4260,	.4620,	.4370,	.4510,	.4520,
6,	.4440,	.5130,	.5370,	.4550,	.4690,	.4710,	.4970,	.4860,	.5170,	.5020,
7,	.4560,	.4920,	.5670,	.5460,	.5300,	.5080,	.5340,	.5300,	.5460,	.5430,
8,	.5410,	.4960,	.5630,	.5960,	.5580,	.5560,	.5570,	.5500,	.5930,	.5820,
9,	.5930,	.5770,	.5680,	.5790,	.6120,	.6120,	.5990,	.5850,	.5850,	.5990,
10,	.5460,	.6350,	.6170,	.5820,	.6110,	.6350,	.6540,	.5990,	.6290,	.6100,
11,	.6920,	.6340,	.6270,	.6490,	.5920,	.6510,	.6670,	.6510,	.6830,	.6350,
+gp,	.6920,	.7210,	.7050,	.7420,	.7170,	.7080,	.6700,	.6800,	.7140,	.6560,
SOPCOFAC,	1.0055,	.9767,	1.0037,	.9996,	1.0006,	.9871,	1.0000,	1.0004,	1.0002,	1.0007,

Table 3.6 Western mackerel stock weights at age (kg)

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.1130,	.1130,	.0950,	.0950,	.0950,	.0700,	.0700,	.0700,	.0700,	.0700,
2,	.1310,	.1310,	.1500,	.1500,	.1500,	.1720,	.1080,	.1560,	.1870,	.1500,
3,	.2010,	.2010,	.2150,	.2150,	.2150,	.2410,	.2020,	.2200,	.2460,	.2920,
4,	.2510,	.2510,	.2750,	.2750,	.2750,	.3000,	.2600,	.2610,	.2830,	.3000,
5,	.2640,	.2640,	.3200,	.3200,	.3200,	.3000,	.3790,	.3220,	.3050,	.3280,
6,	.3160,	.3160,	.3550,	.3550,	.3550,	.3590,	.3290,	.3600,	.3790,	.3660,
7,	.3800,	.3800,	.3800,	.3800,	.3800,	.4010,	.3880,	.3840,	.4290,	.4210,
8,	.4900,	.4120,	.4000,	.4000,	.4000,	.4120,	.4170,	.4200,	.4210,	.4400,
9,	.0000,	.5110,	.4200,	.4200,	.4200,	.4270,	.4250,	.4970,	.4650,	.4480,
10,	.0000,	.5110,	.4850,	.4850,	.4850,	.4130,	.4600,	.4530,	.5150,	.5540,
11,	.0000,	.0000,	.0000,	.4850,	.4850,	.5090,	.5130,	.5500,	.4970,	.5790,
+gp,	.0000,	.0000,	.0000,	.0000,	.4850,	.5090,	.5130,	.5500,	.5470,	.6010,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,
2,	.1640,	.1390,	.1460,	.1760,	.1280,	.1490,	.2160,	.1930,	.1750,	.1510,
3,	.2610,	.2330,	.2330,	.2380,	.2130,	.2270,	.2570,	.2640,	.2300,	.2590,
4,	.2900,	.2680,	.3020,	.2990,	.2800,	.3070,	.3090,	.3110,	.2890,	.3160,
5,	.3450,	.3630,	.3270,	.3420,	.3310,	.3560,	.3590,	.3570,	.3530,	.3920,
6,	.3370,	.3710,	.4340,	.3630,	.3650,	.4080,	.4000,	.4160,	.4070,	.4450,
7,	.3950,	.3920,	.4550,	.4190,	.4050,	.4310,	.4240,	.4580,	.4680,	.4930,
8,	.4670,	.4020,	.4360,	.4680,	.3930,	.5060,	.4640,	.4640,	.4640,	.5060,
9,	.4410,	.4590,	.4600,	.4410,	.4200,	.5470,	.4890,	.4800,	.4720,	.5460,
10,	.4510,	.4830,	.5280,	.4510,	.5140,	.5740,	.5230,	.5120,	.5500,	.5020,
11,	.4720,	.4420,	.6060,	.4960,	.5140,	.5740,	.5560,	.5970,	.6120,	.6270,
+gp,	.6120,	.5590,	.6840,	.5850,	.5140,	.5740,	.5820,	.5610,	.5680,	.6330,

Table 3.7a ICA diagnostic output for the Western mackerel assessment.

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1986	.1370	.1126	.1666
2	1987	.1685	.1399	.2030
3	1988	.1812	.1515	.2167
4	1989	.1672	.1422	.1967
5	1990	.1736	.1473	.2046
6	1991	.1913	.1617	.2263
7	1992	.2267	.1900	.2706
8	1993	.3026	.2481	.3691
9	1994	.2966	.2336	.3767
10	1995	.3019	.2228	.4089

Separable Model: Selection (S) by age

11	0	.0040	.0022	.0071	.0067	.0043	.0103
12	1	.0787	.0614	.1010	.1370	.1121	.1675
13	2	.4582	.3590	.5847	.4059	.3380	.4874
14	3	.5903	.4630	.7525	.7030	.5915	.8356
15	4	.6974	.5474	.8885	.8930	.7570	1.0536
	5	1.0000	Fixed : Reference age				
16	6	1.2442	.9787	1.5816	.9709	.8311	1.1341
17	7	1.5823	1.2464	2.0088	1.0736	.9224	1.2495
18	8	1.5503	1.2197	1.9704	1.1432	.9862	1.3252
19	9	1.1319	.8919	1.4365	1.4388	1.2475	1.6594
20	10	1.1606	.9170	1.4689	1.3016	1.1249	1.5060
	11	1.0000	Fixed : last true age		1.2000		Also fixed

Separable Model: Populations in year 1995

31	0	1993795.	660301.	6020313.
32	1	1612946.	1019006.	2553069.
33	2	3263851.	2306233.	4619101.
34	3	1723822.	1277519.	2326042.
35	4	1158085.	874177.	1534199.
36	5	704048.	536676.	923617.
37	6	827549.	636484.	1075970.
38	7	419300.	323629.	543255.
39	8	506639.	392794.	653480.
40	9	199138.	153370.	258565.
41	10	123958.	93184.	164894.
42	11	180664.	133614.	244282.

Separable Model: Populations at age 11

43	1986	169195.3094	118957.5533	240649.3068
44	1987	161768.6154	121856.6389	214753.0505
45	1988	64272.1674	50022.8702	82580.4573
46	1989	82156.3585	65097.1859	103686.0065
47	1990	123555.4473	99320.6761	153703.6312
48	1991	147575.9567	119177.3680	182741.6006
49	1992	200750.3845	162971.1818	247287.3819
50	1993	74636.1045	60156.5702	92600.8262
51	1994	48835.6703	38093.9144	62606.3961

SSB Index catchabilities
SSB Index 1 was used as absolute estimator.
No fitted catchability for this index.

Table 3.7b ICA diagnostic output for the Western mackerel(cont).

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals: log(Observed Catch) - log(Expected Catch), and weights in the analysis

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
0	2.393	-0.108	1.271	-2.307	-0.567	1.289	0.834	0.546	-0.321	-1.246	0.100
1	-0.052	0.003	-0.111	-0.403	-0.056	0.668	-0.303	-0.246	-0.032	-0.083	1.000
2	0.020	0.208	0.179	0.055	-0.646	0.434	-0.326	0.026	0.434	-0.191	1.000
3	-0.209	-0.230	0.000	0.161	-0.077	0.216	0.512	-0.341	0.196	0.044	1.000
4	-0.101	0.101	-0.129	0.006	0.039	0.052	-0.034	-0.024	0.192	0.216	1.000
5	0.284	0.138	0.063	-0.013	0.045	-0.066	0.061	-0.139	-0.250	-0.308	1.000
6	0.097	-0.172	-0.143	-0.148	-0.020	0.053	0.053	-0.068	0.329	0.050	1.000
7	0.101	0.036	-0.302	0.011	-0.056	-0.057	0.051	-0.152	0.093	0.034	1.000
8	-0.270	0.359	0.248	-0.114	0.133	0.105	-0.144	-0.034	-0.115	-0.036	1.000
9	-0.191	0.075	-0.033	-0.428	0.380	0.283	-0.631	-0.012	-0.102	0.036	1.000
10	0.122	-0.066	0.151	-0.113	0.173	0.079	-0.492	0.363	0.000	0.199	1.000
11	-0.044	0.075	0.051	0.061	-0.028	0.224	-0.259	-0.001	0.058	-0.360	1.000
Wts	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

Biomass Index Residuals: log(Observed Index) - log(Expected Index)

Idx	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.000	0.143	-1.000	-1.000	0.058	-1.000	-1.000	0.000	-1.000	-1.000

1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
-0.081	-1.000	-1.000	-0.160	-1.000	-1.000	0.080	-1.000	-1.000	0.108

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1986 to 1995

Variance	:	.2939
Skewness test statistic	:	.3705
Kurtosis test statistic	:	30.9822
Partial chi-square	:	2.7596
Probability of chi-square	:	1.0000
Degrees of freedom	:	41

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Index used as absolute measure of abundance.

Variance	:	.0102
Skewness test statistic	:	.0427
Kurtosis test statistic	:	-.7200
Partial chi-square	:	.0050
Probability of chi-square	:	1.0000
Number of observations	:	7
Degrees of freedom	:	7
Weight in the analysis	:	1.0000

Table 3.8 Western mackerel fishing mortality at age.

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.0071	.0021	.0033	.0155	.0038	.0058	.0011	.0000	.0001	.0000	.0005	.0007	.0007	.0011	.0012	.0013	.0015	.0020	.0020	.0020
1	.0717	.0380	.0396	.1395	.1174	.0623	.0361	.0293	.0138	.0451	.0108	.0133	.0143	.0229	.0238	.0262	.0311	.0415	.0406	.0414
2	.0802	.0937	.1801	.0969	.2638	.1639	.1303	.1624	.0650	.0171	.0628	.0772	.0830	.0679	.0705	.0776	.0920	.1228	.1204	.1225
3	.1355	.0843	.1831	.2806	.1556	.1846	.2200	.1801	.2109	.0494	.0809	.0995	.1070	.1176	.1220	.1345	.1594	.2128	.2085	.2122
4	.1977	.0909	.1761	.2240	.2721	.0862	.2139	.2632	.2145	.1903	.0955	.1175	.1264	.1493	.1550	.1708	.2025	.2703	.2649	.2696
5	.1242	.0791	.1886	.2223	.2549	.1824	.0850	.2185	.2394	.1985	.1370	.1685	.1812	.1672	.1736	.1913	.2267	.3026	.2966	.3019
6	.1781	.0775	.1447	.2451	.2149	.2103	.2005	.0880	.2234	.2344	.1704	.2097	.2254	.1624	.1685	.1857	.2201	.2938	.2880	.2931
7	.3784	.1313	.1070	.2459	.2476	.2117	.2062	.1893	.0858	.2061	.2167	.2667	.2867	.1795	.1864	.2053	.2434	.3249	.3184	.3241
8	.2783	.1878	.1549	.1429	.2177	.2747	.2647	.1908	.1468	.1149	.2124	.2613	.2809	.1912	.1984	.2186	.2592	.3460	.3391	.3451
9	.1406	.1449	.2525	.2767	.1761	.2112	.3201	.2186	.1455	.1624	.1550	.1908	.2051	.2406	.2498	.2752	.3262	.4354	.4268	.4343
10	.1441	.0918	.2751	.3550	.2602	.2512	.2093	.2829	.1643	.1659	.1590	.1956	.2103	.2177	.2259	.2489	.2951	.3939	.3861	.3929
11	.1242	.0791	.1886	.3998	.3825	.2650	.2433	.2378	.1820	.1844	.1370	.1685	.1812	.2007	.2083	.2295	.2721	.3632	.3559	.3622
12	.1242	.0791	.1886	.3998	.3825	.2650	.2433	.2378	.1820	.1844	.1370	.1685	.1812	.2007	.2083	.2295	.2721	.3632	.3559	.3622

Table 3.9 Western mackerel population numbers at age(Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	5190	1010	3379	5549	5532	7192	1892	1389	6649	3102	3258	5667	3328	4662	2708	3036	3183	4598	1878	1994	3354
1	4346	4436	868	2898	4703	4744	6155	1626	1196	5722	2670	2802	4875	2863	4008	2328	2610	2736	3949	1613	1713
2	2580	3482	3676	718	2170	3599	3837	5110	1359	1015	4708	2273	2380	4136	2408	3369	1952	2177	2259	3264	1332
3	2734	2050	2729	2642	561	1435	2629	2899	3739	1096	859	3806	1811	1886	3326	1932	2683	1532	1657	1724	2485
4	1022	2055	1622	1956	1718	413	1027	1816	2084	2606	898	682	2966	1401	1443	2534	1453	1969	1066	1158	1200
5	2659	722	1615	1170	1346	1126	326	713	1201	1447	1854	703	522	2249	1038	1064	1839	1022	1293	704	761
6	781	2021	574	1151	807	898	808	258	493	814	1021	1392	511	375	1638	751	756	1262	650	828	448
7	952	563	1610	427	775	560	626	569	203	340	554	741	971	351	274	1191	537	522	809	419	531
8	1939	561	425	1245	288	521	390	438	405	161	238	384	489	628	252	196	835	362	325	507	261
9	0	1263	400	313	929	199	341	258	312	301	123	166	255	318	446	178	135	555	221	199	309
10	0	0	941	268	204	670	139	213	178	232	220	91	118	178	215	299	116	84	309	124	111
11	0	0	0	615	162	136	449	97	138	130	169	162	64	82	124	148	201	75	49	181	72
12	0	0	0	0	389	812	734	640	286	512	505	421	340	206	154	274	304	231	202	129	186

Table 3.10 The Western mackerel stock summary (without SOP)

STOCK SUMMARY

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Fbar 4-8
1976	5190	3895234	2795970	507178	0.1814	0.231
1977	1010	3804656	2789910	325974	0.1168	0.113
1978	3379	3792770	2985138	503913	0.1688	0.154
1979	5549	3491945	2653938	605744	0.2282	0.216
1980	5532	3247973	2273748	604761	0.2660	0.241
1981	7192	3364161	2389925	661762	0.2769	0.193
1982	1892	3253412	2270154	623819	0.2748	0.194
1983	1389	3377769	2489304	614287	0.2468	0.190
1984	6649	3120234	2458286	550929	0.2241	0.182
1985	3102	3287790	2451648	561292	0.2289	0.189
1986	3258	3300104	2189537	537615	0.2455	0.166
1987	5667	3224780	2481489	615380	0.2480	0.205
1988	3328	3504458	2613569	628000	0.2403	0.220
1989	4662	3523629	2629130	567400	0.2158	0.170
1990	2708	3293746	2484827	605937	0.2439	0.176
1991	3036	3690396	2856368	646169	0.2262	0.194
1992	3183	3736369	2851837	742305	0.2603	0.230
1993	4598	3408811	2510200	805039	0.3207	0.308
1994	1878	3030137	2149731	797688	0.3711	0.301
1995	1994	2891465	2126436	728637	0.3427	0.307

Table 3.11 **SOUTHERN MACKEREL. Effort data by fleets.**

	SPAIN					PORTUGAL
	TRAWL		HOOK (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	60601
1989	8063	29628	-	605	153	53428
1990	8492	29578	322	509	161	49532
1991	7677	26959	209	724	66	45467
1992	12693	26199	70	698	286	78272
1993	7635	29670	151	1216	-	48565
1994	9620	39590	130	1926	-	39062
1995	6146	41452	217	1696	-	44463

- Not available

Table 3.12 **SOUTHERN MACKEREL. CPUE series in commercial fisheries.**

	SPAIN					PORTUGAL
	TRAWL		HOOK (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	33.1
1989	19.0	43.0	-	1427.5	2.1	26.4
1990	82.7	59.0	739.6	1924.4	2.7	39.6
1991	68.2	54.6	632.9	1394.4	2.0	38.6
1992	35.1	19.7	905.6	856.4	3.9	20.3
1993	12.8	19.2	613.3	1790.9	-	16.6
1994	57.2	41.4	2388.5	1590.6	-	20.7
1995	94.9	34.0	3136.1	1987.9	-	24.6

- Not available

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Table 3.13 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

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

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

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

IXa trawl fleet (Portugal) (Catch numbers * 1000)

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	60601	8076	4510	536	457	76	14	3	0	1	0	0	0	0	0	0	0
1989	53428	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	49532	2841	5729	1967	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	45467	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	78272	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	48565	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	39062	650	1128	1446	342	125	94	65	21	4	1	2	0	1	0	0	0
1995	44463	1001	2690	983	295	99	59	46	40	25	17	16	8	5	0	0	1

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Table 3.14 **SOUTHERN MACKEREL. CPUE at age from surveys.**

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

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

October Portugal Survey, Bottom trawl survey (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+
1986	1	515	2759	1004	512	36	14	9	4	0	0	0
1987	1	1026	23280	14792	2939	545	0	0	0	0	0	0
1988	1	86467	24547	354	328	35	11	0	0	0	0	0
1989	1	11643	28427	4707	3452	22	9	0	0	0	0	0
1990	1	1344	2991	1753	89	5	1	0	0	0	0	0
1991	1	309	374	288	185	32	19	15	6	1	1	0
1992	1	123551	2738	664	302	57	14	5	0	0	0	0
1993	1	52323	385	115	47	75	0	0	0	0	0	0
1994	1	12211	1771	297	106	42	49	18	14	0	0	0
1995	1	318598	9076	282	110	31	10	5	2	0	0	0

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Table 3.15 Mackerel in the North East Atlantic MHMWG 1996. Catch numbers at age (1000's).

YEAR	1984	1985
AGE		
0	288397	81220
1	32024	267056
2	86397	20745
3	685128	57933
4	389079	442205
5	252475	250432
6	98442	164050
7	22171	61922
8	62052	19424
9	48110	47223
10	37627	37341
11	30221	26774
+gp	69450	96961
TOTALNUM	2101573	1573286
TONSLAND	648084	614275
SOPCOF %	101	101

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	48519	7417	55119	65400	24246	10007	43447	19354	25368	14759
1	56423	40203	145969	64263	140534	58459	83583	128144	147315	81529
2	412124	156970	131606	312739	209848	212521	156292	210319	221489	340898
3	37262	664649	182062	207689	410751	206421	356209	266677	306979	340215
4	74302	56789	514809	167588	208146	375451	266591	398240	267420	275031
5	353451	89173	69720	362469	156742	188623	306143	244285	301346	186855
6	201927	245038	83498	48696	254015	129145	156070	255472	184925	197856
7	122477	150876	192215	58116	42549	197888	113899	149932	189847	142342
8	41322	86027	117130	111251	49698	51077	138458	97746	106108	113413
9	13137	34862	53464	68240	85447	43415	51208	121400	80054	69191
10	31825	19696	19803	32228	33041	70839	36612	38794	57622	42441
11	22298	25796	12601	13904	16587	29743	40956	29067	20407	37960
+gp	78775	63267	54975	35814	27905	52986	68205	68217	57551	39753
TOTALNUM	1493842	1640763	1632971	1548397	1659509	1626575	1817673	2027647	1966431	1882242
TONSLAND	602128	654805	676288	585921	625611	667883	760351	825036	827712	756186
SOPCOF %	103	100	104	100	100	99	100	100	101	100

Table 3.16 Mackerel in the North East Atlantic MHMWG 1996. Catch weights at age (Kg).

YEAR	1984	1985
AGE		
0	.0310	.0550
1	.1020	.1440
2	.1840	.2620
3	.2950	.3570
4	.3260	.4180
5	.3440	.4170
6	.4310	.4360
7	.5420	.5210
8	.4800	.5550
9	.5690	.5640
10	.6280	.6290
11	.6360	.6790
+gp	.6630	.7100
SOPCOFAC	1.0057	1.0070

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	.0390	.0760	.0550	.0490	.0850	.0680	.0510	.0610	.0460	.0720
1	.1460	.1790	.1330	.1360	.1560	.1560	.1670	.1340	.1360	.1430
2	.2450	.2230	.2590	.2370	.2330	.2530	.2390	.2400	.2550	.2340
3	.3350	.3180	.3230	.3200	.3360	.3270	.3330	.3170	.3390	.3330
4	.4230	.3990	.3880	.3770	.3790	.3940	.3970	.3760	.3900	.3900
5	.4710	.4740	.4560	.4330	.4230	.4230	.4600	.4360	.4480	.4520
6	.4440	.5120	.5240	.4560	.4670	.4690	.4950	.4830	.5120	.5010
7	.4570	.4930	.5550	.5430	.5280	.5060	.5320	.5270	.5430	.5390
8	.5430	.4980	.5550	.5920	.5520	.5540	.5550	.5480	.5900	.5770
9	.5910	.5800	.5620	.5780	.6060	.6090	.5970	.5830	.5830	.5940
10	.5520	.6340	.6130	.5810	.6060	.6300	.6510	.5950	.6270	.6060
11	.6940	.6350	.6240	.6480	.5910	.6490	.6630	.6470	.6780	.6310
+gp	.6880	.7180	.6970	.7390	.7130	.7080	.6690	.6790	.7130	.6720
SOPCOFAC	1.0301	.9978	1.0394	1.0000	.9992	.9885	.9996	1.0006	1.0105	.9999

Table 3.17 Mackerel in the North East Atlantic MHMWG 1996. Stock weights at age (Kg).

YEAR / AGE	1984	1985
0	.0000	.0000
1	.0870	.0870
2	.1980	.1680
3	.2570	.2950
4	.2970	.3110
5	.3210	.3400
6	.3890	.3780
7	.4350	.4290
8	.4350	.4510
9	.4740	.4600
10	.5210	.5540
11	.5080	.5750
+gp	.5730	.6110

YEAR / AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0870	.0860	.0840	.0840	.0840	.0840	.0840	.0840	.0840	.0840
2	.1800	.1580	.1610	.1870	.1460	.1640	.2210	.2010	.1860	.1660
3	.2700	.2460	.2440	.2480	.2270	.2390	.2640	.2700	.2410	.2660
4	.3020	.2840	.3100	.3070	.2910	.3140	.3160	.3180	.2990	.3220
5	.3530	.3680	.3360	.3480	.3390	.3600	.3630	.3610	.3580	.3910
6	.3540	.3820	.4330	.3730	.3740	.4110	.4040	.4180	.4100	.4420
7	.4070	.4040	.4550	.4240	.4120	.4350	.4290	.4580	.4660	.4870
8	.4730	.4190	.4450	.4720	.4080	.5040	.4680	.4680	.4680	.5040
9	.4550	.4700	.4680	.4520	.4340	.5420	.4920	.4850	.4780	.5410
10	.4690	.4950	.5310	.4650	.5190	.5700	.5260	.5170	.5490	.5080
11	.4880	.4620	.5970	.5040	.5190	.5700	.5550	.5900	.6020	.6150
+gp	.5860	.5690	.6470	.5970	.5370	.5860	.5920	.5740	.5790	.6350

Table 3.18a ICA diagnostic output for the NEA mackerel assessment.

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1986	.1425	.1203	.1689
2	1987	.1656	.1409	.1947
3	1988	.1800	.1540	.2104
4	1989	.1643	.1424	.1895
5	1990	.1691	.1462	.1954
6	1991	.1815	.1564	.2107
7	1992	.2137	.1826	.2500
8	1993	.2722	.2283	.3244
9	1994	.2708	.2199	.3334
10	1995	.2642	.2042	.3418

Separable Model: Selection (S) by age

11	0	.0420	.0255	.0693	.0380	.0261	.0552
12	1	.1326	.1070	.1644	.1542	.1295	.1836
13	2	.4511	.3654	.5570	.4117	.3512	.4826
14	3	.6057	.4912	.7468	.6973	.6003	.8100
15	4	.7084	.5749	.8730	.8904	.7717	1.0272
	5	1.0000	Fixed : Reference age				
16	6	1.2187	.9908	1.4989	.9720	.8502	1.1111
17	7	1.5472	1.2590	1.9013	1.0749	.9434	1.2248
18	8	1.5511	1.2612	1.9075	1.1627	1.0240	1.3202
19	9	1.1687	.9520	1.4349	1.4383	1.2715	1.6269
20	10	1.1843	.9668	1.4508	1.3057	1.1509	1.4813
	11	1.0000	Fixed : last true age		1.2000		Also fixed

Separable Model: Populations in year 1995

31	0	1592439.	616053.	4116305.
32	1	2205860.	1490068.	3265501.
33	2	3252828.	2410061.	4390301.
34	3	2042076.	1575489.	2646845.
35	4	1279609.	1002986.	1632524.
36	5	815053.	645049.	1029862.
37	6	965911.	770665.	1210622.
38	7	526648.	421542.	657962.
39	8	563461.	452495.	701639.
40	9	226577.	180779.	283979.
41	10	147166.	115140.	188100.
42	11	208066.	160705.	269384.

Separable Model: Populations at age 11

43	1986	179526.6814	132434.3463	243364.5821
44	1987	169976.9897	132965.6256	217290.5735
45	1988	68852.0981	55395.8522	85577.0104
46	1989	84503.4911	68993.9544	103499.5034
47	1990	127659.1632	105434.2367	154568.9756
48	1991	156620.1806	129742.0219	189066.5846
49	1992	219409.2482	182442.6400	263866.0468
50	1993	84960.3159	70176.7837	102858.1661
51	1994	56586.2838	45553.5128	70291.1217

SSB Index catchabilities
SSB Index 1 was used as absolute estimator.
No fitted catchability for this index.

Table 3.18b ICA diagnostic output for the NEA mackerel assessment.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals: log(Observed Catch) - log(Expected Catch), and weights in the analysis

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.933	0.358	1.182	-2.059	-0.529	1.182	0.778	0.467	-0.329	-1.179
1	-0.060	0.005	-0.516	-0.391	-0.042	0.638	-0.285	-0.198	-0.020	-0.072
2	0.029	0.217	0.199	0.066	0.221	0.280	-0.312	-0.031	0.406	-0.211
3	-0.204	-0.197	0.006	0.138	-0.092	0.177	0.251	-0.189	0.195	0.047
4	-0.131	0.097	-0.130	0.000	0.021	0.042	-0.025	-0.012	0.097	0.293
5	0.181	0.154	0.058	-0.035	0.056	-0.074	0.072	-0.119	-0.236	-0.274
6	-0.233	-0.118	-0.147	-0.187	0.037	0.088	0.051	-0.037	0.305	0.030
7	0.109	0.041	0.136	-0.010	-0.073	-0.060	-0.032	-0.110	0.108	0.013
8	-0.265	0.337	0.213	-0.121	-0.261	0.043	-0.090	-0.021	-0.092	-0.098
9	-0.117	0.122	-0.040	-0.387	0.394	0.275	0.010	-0.016	-0.161	0.065
10	0.106	-0.076	0.075	-0.082	0.156	0.052	-0.507	0.332	0.000	-0.004
11	0.089	0.062	0.096	0.058	-0.030	0.160	-0.203	0.035	0.058	-0.328
Wts	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

```
Separable model fitted from 1986 to 1995
Variance                    :      .1321
Skewness test statistic     :    -5.2685
Kurtosis test statistic     :    18.1734
Partial chi-square          :      .9725
Probability of chi-square   :     1.0000
Degrees of freedom          :         41
```

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Index used as absolute measure of abundance.

```
Variance                    :      .0154
Skewness test statistic     :     -.6124
Kurtosis test statistic     :     -.6349
Partial chi-square          :      .0044
Probability of chi-square   :     1.0000
Number of observations      :          4
Degrees of freedom          :          4
Weight in the analysis      :     1.0000
```

Table 3.19 NEA mackerel ICA estimated fishing mortality at age.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.0437	.0256	.0060	.0070	.0076	.0062	.0064	.0069	.0081	.0103	.0103	.0100
1	.0266	.0492	.0189	.0220	.0239	.0253	.0261	.0280	.0330	.0420	.0418	.0408
2	.0643	.0205	.0643	.0747	.0812	.0676	.0696	.0747	.0880	.1120	.1115	.1088
3	.2065	.0531	.0863	.1003	.1090	.1145	.1179	.1266	.1490	.1898	.1888	.1842
4	.2142	.1888	.1010	.1173	.1275	.1463	.1505	.1616	.1902	.2423	.2411	.2353
5	.2445	.1969	.1425	.1656	.1800	.1643	.1691	.1815	.2137	.2722	.2708	.2642
6	.2282	.2346	.1737	.2018	.2194	.1597	.1643	.1764	.2077	.2645	.2632	.2568
7	.1102	.2075	.2205	.2562	.2785	.1766	.1817	.1951	.2297	.2925	.2911	.2840
8	.1639	.1263	.2211	.2569	.2792	.1910	.1966	.2111	.2484	.3164	.3148	.3072
9	.1646	.1713	.1666	.1936	.2104	.2363	.2431	.2611	.3073	.3914	.3895	.3800
10	.1707	.1759	.1688	.1961	.2132	.2145	.2207	.2370	.2790	.3553	.3535	.3450
11	.1880	.1671	.1425	.1656	.1800	.1971	.2029	.2178	.2564	.3266	.3249	.3171
12	.1880	.1671	.1425	.1656	.1800	.1971	.2029	.2178	.2564	.3266	.3249	.3171

Table 3.20 Nea mackerel ICA estimated population numbers at age (Millions).

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	7259.	3454.	3442.	5892.	3910.	5127.	3000.	3278.	3764.	4626.	2589.	1592.	3783.
1	1315.	5981.	2897.	2945.	5036.	3340.	4385.	2566.	2802.	3214.	3940.	2206.	1357.
2	1493.	1102.	4900.	2447.	2480.	4232.	2803.	3677.	2148.	2334.	2652.	3253.	1823.
3	3945.	1205.	929.	3955.	1954.	1968.	3404.	2250.	2937.	1693.	1796.	2042.	2511.
4	2167.	2762.	984.	734.	3079.	1508.	1510.	2604.	1706.	2178.	1205.	1280.	1462.
5	1250.	1505.	1968.	765.	562.	2333.	1122.	1118.	1907.	1214.	1471.	815.	870.
6	518.	842.	1064.	1469.	558.	404.	1704.	815.	803.	1326.	796.	966.	539.
7	228.	355.	573.	770.	1033.	386.	296.	1244.	588.	561.	876.	527.	643.
8	441.	176.	248.	396.	513.	673.	278.	213.	881.	402.	361.	563.	341.
9	341.	322.	134.	171.	264.	334.	479.	197.	148.	592.	252.	227.	357.
10	258.	249.	234.	97.	122.	184.	227.	323.	130.	94.	344.	147.	133.
11	189.	187.	180.	170.	69.	85.	128.	157.	219.	85.	57.	208.	90.
12	435.	677.	638.	445.	359.	215.	163.	291.	324.	263.	222.	157.	229.

Table 3.21 NEA mackerel stock summary

STOCK SUMMARY

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Fbar 4-8
1984	7259	3602984	2856140	648084	0.2269	0.192
1985	3454	3789347	2821708	614275	0.2177	0.191
1986	3442	3736146	2817671	602128	0.2137	0.172
1987	5892	3601752	2779065	654805	0.2356	0.200
1988	3910	3843553	2868859	676288	0.2357	0.217
1989	5127	3874316	2905725	585921	0.2016	0.168
1990	3000	3722432	2800990	625611	0.2234	0.172
1991	3278	4110730	3194544	667883	0.2091	0.185
1992	3764	4160868	3205899	760351	0.2372	0.218
1993	4626	3862868	2879113	825036	0.2866	0.278
1994	2589	3519970	2548935	827712	0.3247	0.276
1995	1592	3391522	2538097	756186	0.2979	0.270

Mackerel in the North East Atlantic

Multi fleet prediction: Input data

1996	Western		Southern		International							
Age	Exploit. pattern	Weight in catch	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	0.0030	0.060	0.0070	0.065	0.0000	0.000	3711.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0370	0.137	0.0040	0.148	0.0000	0.000	3163.000	0.1500	0.1400	0.4000	0.4000	0.084
2	0.1060	0.245	0.0020	0.217	0.0010	0.302	1823.000	0.1500	0.6500	0.4000	0.4000	0.184
3	0.1740	0.331	0.0050	0.290	0.0050	0.388	2511.000	0.1500	0.9100	0.4000	0.4000	0.259
4	0.2210	0.386	0.0060	0.349	0.0080	0.453	1462.000	0.1500	0.9700	0.4000	0.4000	0.313
5	0.2410	0.447	0.0070	0.383	0.0160	0.527	870.000	0.1500	0.9700	0.4000	0.4000	0.370
6	0.2310	0.502	0.0090	0.422	0.0160	0.589	539.000	0.1500	0.9900	0.4000	0.4000	0.423
7	0.2490	0.540	0.0140	0.459	0.0210	0.622	643.000	0.1500	1.0000	0.4000	0.4000	0.470
8	0.2570	0.575	0.0190	0.491	0.0310	0.671	341.000	0.1500	1.0000	0.4000	0.4000	0.480
9	0.3420	0.590	0.0210	0.518	0.0180	0.686	357.000	0.1500	1.0000	0.4000	0.4000	0.501
10	0.3000	0.613	0.0210	0.528	0.0240	0.702	133.000	0.1500	1.0000	0.4000	0.4000	0.525
11	0.2920	0.656	0.0190	0.552	0.0070	0.704	90.000	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.2790	0.683	0.0250	0.644	0.0130	0.812	229.000	0.1500	1.0000	0.4000	0.4000	0.596
Unit	-	Kilograms	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

1997	Western		Southern		International							
Age	Exploit. pattern	Weight in catch	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	0.0030	0.060	0.0070	0.065	0.0000	0.000	3711.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0370	0.137	0.0040	0.148	0.0000	0.000	.	0.1500	0.1400	0.4000	0.4000	0.084
2	0.1060	0.245	0.0020	0.217	0.0010	0.302	.	0.1500	0.6500	0.4000	0.4000	0.184
3	0.1740	0.331	0.0050	0.290	0.0050	0.388	.	0.1500	0.9100	0.4000	0.4000	0.259
4	0.2210	0.386	0.0060	0.349	0.0080	0.453	.	0.1500	0.9700	0.4000	0.4000	0.313
5	0.2410	0.447	0.0070	0.383	0.0160	0.527	.	0.1500	0.9700	0.4000	0.4000	0.370
6	0.2310	0.502	0.0090	0.422	0.0160	0.589	.	0.1500	0.9900	0.4000	0.4000	0.423
7	0.2490	0.540	0.0140	0.459	0.0210	0.622	.	0.1500	1.0000	0.4000	0.4000	0.470
8	0.2570	0.575	0.0190	0.491	0.0310	0.671	.	0.1500	1.0000	0.4000	0.4000	0.480
9	0.3420	0.590	0.0210	0.518	0.0180	0.686	.	0.1500	1.0000	0.4000	0.4000	0.501
10	0.3000	0.613	0.0210	0.528	0.0240	0.702	.	0.1500	1.0000	0.4000	0.4000	0.525
11	0.2920	0.656	0.0190	0.552	0.0070	0.704	.	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.2790	0.683	0.0250	0.644	0.0130	0.812	.	0.1500	1.0000	0.4000	0.4000	0.596
Unit	-	Kilograms	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

(cont.)

Table 3.22 Mackerel in the North East Atlantic multifleet prediction input data.

Mackerel in the North East Atlantic

Multi fleet prediction: Input data

(cont.)

1998	Western		Southern		International							
Age	Exploit. pattern	Weight in catch	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	0.0030	0.060	0.0070	0.065	0.0000	0.000	3711.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0370	0.137	0.0040	0.148	0.0000	0.000	.	0.1500	0.1400	0.4000	0.4000	0.084
2	0.1060	0.245	0.0020	0.217	0.0010	0.302	.	0.1500	0.6500	0.4000	0.4000	0.184
3	0.1740	0.331	0.0050	0.290	0.0050	0.388	.	0.1500	0.9100	0.4000	0.4000	0.259
4	0.2210	0.386	0.0060	0.349	0.0080	0.453	.	0.1500	0.9700	0.4000	0.4000	0.313
5	0.2410	0.447	0.0070	0.383	0.0160	0.527	.	0.1500	0.9700	0.4000	0.4000	0.370
6	0.2310	0.502	0.0090	0.422	0.0160	0.589	.	0.1500	0.9900	0.4000	0.4000	0.423
7	0.2490	0.540	0.0140	0.459	0.0210	0.622	.	0.1500	1.0000	0.4000	0.4000	0.470
8	0.2570	0.575	0.0190	0.491	0.0310	0.671	.	0.1500	1.0000	0.4000	0.4000	0.480
9	0.3420	0.590	0.0210	0.518	0.0180	0.686	.	0.1500	1.0000	0.4000	0.4000	0.501
10	0.3000	0.613	0.0210	0.528	0.0240	0.702	.	0.1500	1.0000	0.4000	0.4000	0.525
11	0.2920	0.656	0.0190	0.552	0.0070	0.704	.	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.2790	0.683	0.0250	0.644	0.0130	0.812	.	0.1500	1.0000	0.4000	0.4000	0.596
Unit	-	Kilograms	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

Notes: Run name : SPRCDD01
Date and time: 21AUG96:21:26

Table 3.22 (Cont'd) Mackerel in the North East Atlantic multifleet prediction input data.

The SAS System 21:25 Wednesday, August 21, 1996

Mackerel in the North East Atlantic

Multi fleet prediction: Summary table

	Western				Southern				International			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1996	1.0000	0.2398	1599159	645899	1.0000	0.0110	92125	26972	1.0000	0.0184	70298	39186
1997	1.0000	0.2398	1533184	609439	1.0000	0.0110	87666	25003	1.0000	0.0184	66821	37372
1998	1.0000	0.2398	1504727	591158	1.0000	0.0110	85351	23653	1.0000	0.0184	63190	34741
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1996	1761583	712057	15872000	3165318	8501430	2735011	7349259	2337063
1997	1687671	671813	15743874	3041292	8182552	2581103	7087402	2208086
1998	1653268	649552	15701829	2988762	8101858	2518931	7029390	2158267
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCDD01
Date and time : 21AUG96:21:26
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.23 Multifleet prediction summary table for the Mackerel in the North East Atlantic, assuming status quo F (F95) in 1996, 1997 and 1998

Multi fleet prediction: Summary table

	Western				Southern				International			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1996	0.6759	0.1621	1118014	453449	0.6759	0.0074	63902	18933	0.6759	0.0124	49466	27618
1997	0.6676	0.1601	1122113	453099	0.6676	0.0073	62882	18642	0.6676	0.0123	50216	28259
1998	0.6511	0.1561	1123569	454195	0.6511	0.0072	62002	18329	0.6511	0.0120	49366	27476
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1996	1231381	500000	15872000	3165318	8501430	2735011	7555258	2411675
1997	1235211	500000	16232953	3225543	8639824	2759049	7688338	2435301
1998	1234937	500000	16540046	3318569	8896594	2839264	7931160	2511004
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCDD01
Date and time : 21AUG96:21:26
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Prediction basis : TAC constraints

Table 3.24 Multifleet prediction summary table for the Mackerel in the North East Atlantic, assuming a TAC constraint catch of 500,000 tonnes in 1996, 1997 and 1998

Mackerel in the North East Atlantic

The SAS System

Multi fleet prediction: Summary table

	Western				Southern				International			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1996	0.6335	0.1519	1048214	424987	1.0744	0.0118	101521	30074	1.1043	0.0203	80776	45083
1997	0.5600	0.1343	952541	385041	0.5600	0.0062	53184	15822	0.5600	0.0103	42711	24035
1998	0.5600	0.1343	994937	404170	0.5600	0.0062	54560	16314	0.5600	0.0103	44075	24573
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1996	1230511	500144	15872000	3165318	8501430	2735011	7558377	2411824
1997	1048436	424898	16233749	3226572	8647165	2760478	7765285	2462146
1998	1093573	445057	16713246	3385058	9060738	2903824	8137898	2590332
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCDD01
Date and time : 03SEP96:18:48
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.25 Multifleet prediction summary table for the Mackerel in the North East Atlantic, assuming a TAC constraint of 500,000 tonnes in 1996 and F=0.15 in 1997 and 1998.

Table 3.26 Multifleet management option table for the Mackerel in the North East Atlantic, assuming a TAC constraint of 500,000 tonnes in 1996 and status quo F for the Southern and International areas.

Multi fleet prediction with mangement option table

Year: 1996											
Western			Southern			International			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.6335	0.1519	425000	1.0744	0.0118	30074	1.1043	0.0203	45083	500157	3165318	2411820
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1997												Year: 1998	
Western			Southern			International			Total				
F Factor	Reference F	Catch in weight	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	1.0000	0.0110	29834	1.0000	0.0184	45573	75406	3226561	2576456	3694018	2989854
0.1000	0.0240	71912	1.0000	0.0110	29511	1.0000	0.0184	45030	146453	.	2553836	3631443	2907428
0.2000	0.0480	142262	1.0000	0.0110	29193	1.0000	0.0184	44497	215951	.	2531429	3570244	2827585
0.3000	0.0719	211086	1.0000	0.0110	28881	1.0000	0.0184	43972	283938	.	2509234	3510386	2750240
0.4000	0.0959	278421	1.0000	0.0110	28574	1.0000	0.0184	43455	350450	.	2487247	3451839	2675309
0.5000	0.1199	344301	1.0000	0.0110	28272	1.0000	0.0184	42948	415521	.	2465468	3394571	2602712
0.6000	0.1439	408761	1.0000	0.0110	27975	1.0000	0.0184	42448	479185	.	2443894	3338552	2532370
0.7000	0.1679	471835	1.0000	0.0110	27683	1.0000	0.0184	41957	541475	.	2422523	3283752	2464211
0.8000	0.1918	533555	1.0000	0.0110	27396	1.0000	0.0184	41474	602425	.	2401353	3230142	2398160
0.9000	0.2158	593953	1.0000	0.0110	27113	1.0000	0.0184	40998	662064	.	2380382	3177695	2334148
1.0000	0.2398	653060	1.0000	0.0110	26835	1.0000	0.0184	40530	720425	.	2359608	3126382	2272107
1.1000	0.2638	710905	1.0000	0.0110	26562	1.0000	0.0184	40070	777537	.	2339030	3076176	2211973
1.2000	0.2878	767520	1.0000	0.0110	26293	1.0000	0.0184	39617	833430	.	2318644	3027053	2153683
1.3000	0.3117	822931	1.0000	0.0110	26029	1.0000	0.0184	39171	888131	.	2298450	2978986	2097176
1.4000	0.3357	877168	1.0000	0.0110	25768	1.0000	0.0184	38733	941669	.	2278446	2931950	2042393
1.5000	0.3597	930258	1.0000	0.0110	25512	1.0000	0.0184	38301	994071	.	2258629	2885922	1989278
1.6000	0.3837	982227	1.0000	0.0110	25260	1.0000	0.0184	37876	1045364	.	2238998	2840877	1937776
1.7000	0.4077	1033102	1.0000	0.0110	25013	1.0000	0.0184	37458	1095573	.	2219550	2796793	1887835
1.8000	0.4316	1082908	1.0000	0.0110	24769	1.0000	0.0184	37047	1144723	.	2200285	2753647	1839402
1.9000	0.4556	1131669	1.0000	0.0110	24528	1.0000	0.0184	36642	1192839	.	2181201	2711417	1792430
2.0000	0.4796	1179411	1.0000	0.0110	24292	1.0000	0.0184	36243	1239946	.	2162294	2670081	1746871
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCDD02
Date and time : 03SEP96:18:38
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Basis for 1996 : F factors

Table 3.27 Multifleet management option table for the Mackerel in the North East Atlantic, assuming a TAC constraint of 500,000 tonnes in 1996 and status quo F for the International area.

Multi fleet prediction with mangement option table

Year: 1996											
Western			Southern			International			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.6335	0.1519	425000	1.0744	0.0118	30074	1.1043	0.0203	45083	500157	3165318	2411820
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1997												Year: 1998	
Western			Southern			International			Total				
F Factor	Reference F	Catch in weight	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	1.0000	0.0184	45856	45856	3226561	2586607	3723651	3027028
0.1000	0.0240	72242	0.1000	0.0011	2968	1.0000	0.0184	45280	120491	.	2562877	3657520	2939739
0.2000	0.0480	142839	0.2000	0.0022	5868	1.0000	0.0184	44715	193422	.	2539382	3592909	2855326
0.3000	0.0719	211830	0.3000	0.0033	8702	1.0000	0.0184	44160	264692	.	2516120	3529781	2773687
0.4000	0.0959	279256	0.4000	0.0044	11472	1.0000	0.0184	43614	334342	.	2493089	3468097	2694724
0.5000	0.1199	345157	0.5000	0.0055	14180	1.0000	0.0184	43077	402414	.	2470286	3407823	2618343
0.6000	0.1439	409569	0.6000	0.0066	16826	1.0000	0.0184	42550	468945	.	2447708	3348922	2544453
0.7000	0.1679	472530	0.7000	0.0077	19414	1.0000	0.0184	42032	533976	.	2425354	3291361	2472967
0.8000	0.1918	534076	0.8000	0.0088	21943	1.0000	0.0184	41523	597541	.	2403221	3235105	2403801
0.9000	0.2158	594241	0.9000	0.0099	24417	1.0000	0.0184	41022	659680	.	2381306	3180123	2336874
1.0000	0.2398	653060	1.0000	0.0110	26835	1.0000	0.0184	40530	720425	.	2359608	3126382	2272107
1.1000	0.2638	710565	1.1000	0.0121	29201	1.0000	0.0184	40046	779813	.	2338124	3073851	2209426
1.2000	0.2878	766790	1.2000	0.0132	31515	1.0000	0.0184	39571	837876	.	2316853	3022502	2148757
1.3000	0.3117	821766	1.3000	0.0143	33778	1.0000	0.0184	39104	894647	.	2295790	2972303	2090032
1.4000	0.3357	875523	1.4000	0.0154	35992	1.0000	0.0184	38644	950158	.	2274936	2923227	2033182
1.5000	0.3597	928091	1.5000	0.0165	38158	1.0000	0.0184	38192	1004441	.	2254287	2875247	1978144
1.6000	0.3837	979499	1.6000	0.0176	40277	1.0000	0.0184	37748	1057524	.	2233841	2828334	1924853
1.7000	0.4077	1029776	1.7000	0.0187	42351	1.0000	0.0184	37311	1109438	.	2213596	2782463	1873251
1.8000	0.4316	1078949	1.8000	0.0198	44381	1.0000	0.0184	36881	1160211	.	2193550	2737608	1823279
1.9000	0.4556	1127045	1.9000	0.0209	46368	1.0000	0.0184	36459	1209872	.	2173702	2693743	1774881
2.0000	0.4796	1174090	2.0000	0.0220	48312	1.0000	0.0184	36043	1258446	.	2154048	2650846	1728003
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCDD02
Date and time : 03SEP96:18:38
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Basis for 1996 : F factors

Table 3.28 Multifleet management option table for the Mackerel in the North East Atlantic, assuming a TAC constraint of 500,000 tonnes in 1996.

Multi fleet prediction with mangement option table

Year: 1996											
Western			Southern			International			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.6335	0.1519	425000	1.0744	0.0118	30074	1.1043	0.0203	45083	500157	3165318	2411820
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1997												Year: 1998	
Western			Southern			International			Total				
F Factor	Reference F	Catch in weight	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	0.0000	0.0000	0	0	3226561	2599710	3757269	3073599
0.1000	0.0240	72663	0.1000	0.0011	2987	0.1000	0.0018	4563	80213	.	2574542	3686973	2980106
0.2000	0.0480	143573	0.2000	0.0022	5901	0.2000	0.0037	9005	158478	.	2549639	3618397	2889884
0.3000	0.0719	212776	0.3000	0.0033	8745	0.3000	0.0055	13328	234848	.	2524998	3551492	2802811
0.4000	0.0959	280318	0.4000	0.0044	11520	0.4000	0.0074	17535	309373	.	2500616	3486215	2718769
0.5000	0.1199	346243	0.5000	0.0055	14228	0.5000	0.0092	21630	382102	.	2476490	3422522	2637644
0.6000	0.1439	410593	0.6000	0.0066	16872	0.6000	0.0110	25616	453082	.	2452618	3360371	2559328
0.7000	0.1679	473410	0.7000	0.0077	19453	0.7000	0.0129	29496	522360	.	2428997	3299721	2483715
0.8000	0.1918	534735	0.8000	0.0088	21973	0.8000	0.0147	33274	589981	.	2405623	3240532	2410704
0.9000	0.2158	594605	0.9000	0.0099	24433	0.9000	0.0166	36951	655988	.	2382494	3182764	2340199
1.0000	0.2398	653060	1.0000	0.0110	26835	1.0000	0.0184	40530	720425	.	2359608	3126382	2272107
1.1000	0.2638	710136	1.1000	0.0121	29182	1.1000	0.0202	44015	783333	.	2336962	3071346	2206339
1.2000	0.2878	765869	1.2000	0.0132	31474	1.2000	0.0221	47408	844751	.	2314553	3017623	2142808
1.3000	0.3117	820295	1.3000	0.0143	33713	1.3000	0.0239	50711	904719	.	2292378	2965178	2081433
1.4000	0.3357	873448	1.4000	0.0154	35900	1.4000	0.0258	53928	963275	.	2270435	2913976	2022133
1.5000	0.3597	925360	1.5000	0.0165	38037	1.5000	0.0276	57059	1020456	.	2248721	2863985	1964832
1.6000	0.3837	976064	1.6000	0.0176	40125	1.6000	0.0294	60109	1076298	.	2227234	2815173	1909458
1.7000	0.4077	1025591	1.7000	0.0187	42166	1.7000	0.0313	63078	1130836	.	2205971	2767510	1855940
1.8000	0.4316	1073972	1.8000	0.0198	44161	1.8000	0.0331	65970	1184103	.	2184930	2720965	1804209
1.9000	0.4556	1121236	1.9000	0.0209	46111	1.9000	0.0350	68785	1236133	.	2164108	2675509	1754201
2.0000	0.4796	1167412	2.0000	0.0220	48018	2.0000	0.0368	71528	1286958	.	2143503	2631113	1705853
-	-	Tonnes	-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCDD02
Date and time : 03SEP96:18:38
Computation of ref. F: Western: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
International: Simple mean, age 4 - 8
Basis for 1996 : F factors

Mackerel in the North East Atlantic

The SAS System

22:44 Wednesday, August 21, 1996

Multi fleet yield per recruit: Summary table

Western			Southern			International			Total			1 January		Spawning time	
F Factor	Reference F	Catch in weight	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	0.0000	0.0000	0.000	0.000	7.179	2271.822	5.088	2134.868	4.791	2010.543
0.2000	0.0480	79.573	0.2000	0.0022	4.047	0.2000	0.0037	6.179	89.799	5.938	1604.879	3.856	1470.186	3.561	1354.536
0.4000	0.0959	116.230	0.4000	0.0044	5.347	0.4000	0.0074	8.689	130.267	5.249	1255.441	3.175	1122.862	2.882	1014.153
0.6000	0.1439	135.816	0.6000	0.0066	5.780	0.6000	0.0110	9.620	151.216	4.802	1041.394	2.736	910.796	2.445	807.779
0.8000	0.1918	147.253	0.8000	0.0088	5.909	0.8000	0.0147	9.812	162.974	4.483	896.741	2.425	768.007	2.136	669.763
1.0000	0.2398	154.299	1.0000	0.0110	5.933	1.0000	0.0184	9.649	169.881	4.241	792.164	2.191	665.188	1.903	571.022
1.2000	0.2878	158.766	1.2000	0.0132	5.925	1.2000	0.0221	9.322	174.013	4.049	712.786	2.006	587.472	1.720	496.847
1.4000	0.3357	161.616	1.4000	0.0154	5.915	1.4000	0.0258	8.926	176.456	3.891	650.294	1.856	526.555	1.572	439.048
1.6000	0.3837	163.400	1.6000	0.0176	5.913	1.6000	0.0294	8.509	177.822	3.759	599.691	1.731	477.450	1.449	392.719
1.8000	0.4316	164.455	1.8000	0.0198	5.924	1.8000	0.0331	8.097	178.475	3.646	557.793	1.625	436.977	1.345	354.746
2.0000	0.4796	164.996	2.0000	0.0220	5.948	2.0000	0.0368	7.700	178.645	3.548	522.472	1.533	403.016	1.255	323.053
2.2000	0.5276	165.169	2.2000	0.0242	5.984	2.2000	0.0405	7.326	178.478	3.462	492.247	1.453	374.093	1.177	296.204
2.4000	0.5755	165.070	2.4000	0.0264	6.031	2.4000	0.0442	6.975	178.076	3.385	466.057	1.382	349.151	1.108	273.172
2.6000	0.6235	164.771	2.6000	0.0286	6.087	2.6000	0.0478	6.648	177.506	3.316	443.120	1.319	327.410	1.047	253.200
2.8000	0.6714	164.323	2.8000	0.0308	6.151	2.8000	0.0515	6.344	176.817	3.253	422.842	1.263	308.285	0.992	235.721
3.0000	0.7194	163.761	3.0000	0.0330	6.221	3.0000	0.0552	6.061	176.043	3.197	404.770	1.212	291.322	0.943	220.298
3.2000	0.7674	163.114	3.2000	0.0352	6.298	3.2000	0.0589	5.799	175.210	3.145	388.546	1.165	276.169	0.898	206.591
3.4000	0.8153	162.403	3.4000	0.0374	6.378	3.4000	0.0626	5.555	174.337	3.097	373.888	1.122	262.546	0.858	194.332
3.6000	0.8633	161.644	3.6000	0.0396	6.463	3.6000	0.0662	5.328	173.435	3.052	360.568	1.083	250.227	0.820	183.303
3.8000	0.9112	160.849	3.8000	0.0418	6.551	3.8000	0.0699	5.117	172.517	3.011	348.401	1.047	239.030	0.786	173.330
4.0000	0.9592	160.027	4.0000	0.0440	6.642	4.0000	0.0736	4.920	171.590	2.972	337.233	1.014	228.803	0.754	164.269
-	-	Grams	-	-	Grams	-	-	Grams	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

```
Notes: Run name             : YLDCDD01
       Date and time        : 21AUG96:22:45
       Computation of ref. F: Western:       Simple mean, age 4 - 8
                              Southern:      Simple mean, age 4 - 8
                              International: Simple mean, age 4 - 8
       Recruitment          : Single recruit
```

Table 3.29 Multifleet yield per recruit table for the Mackerel in the North East Atlantic.

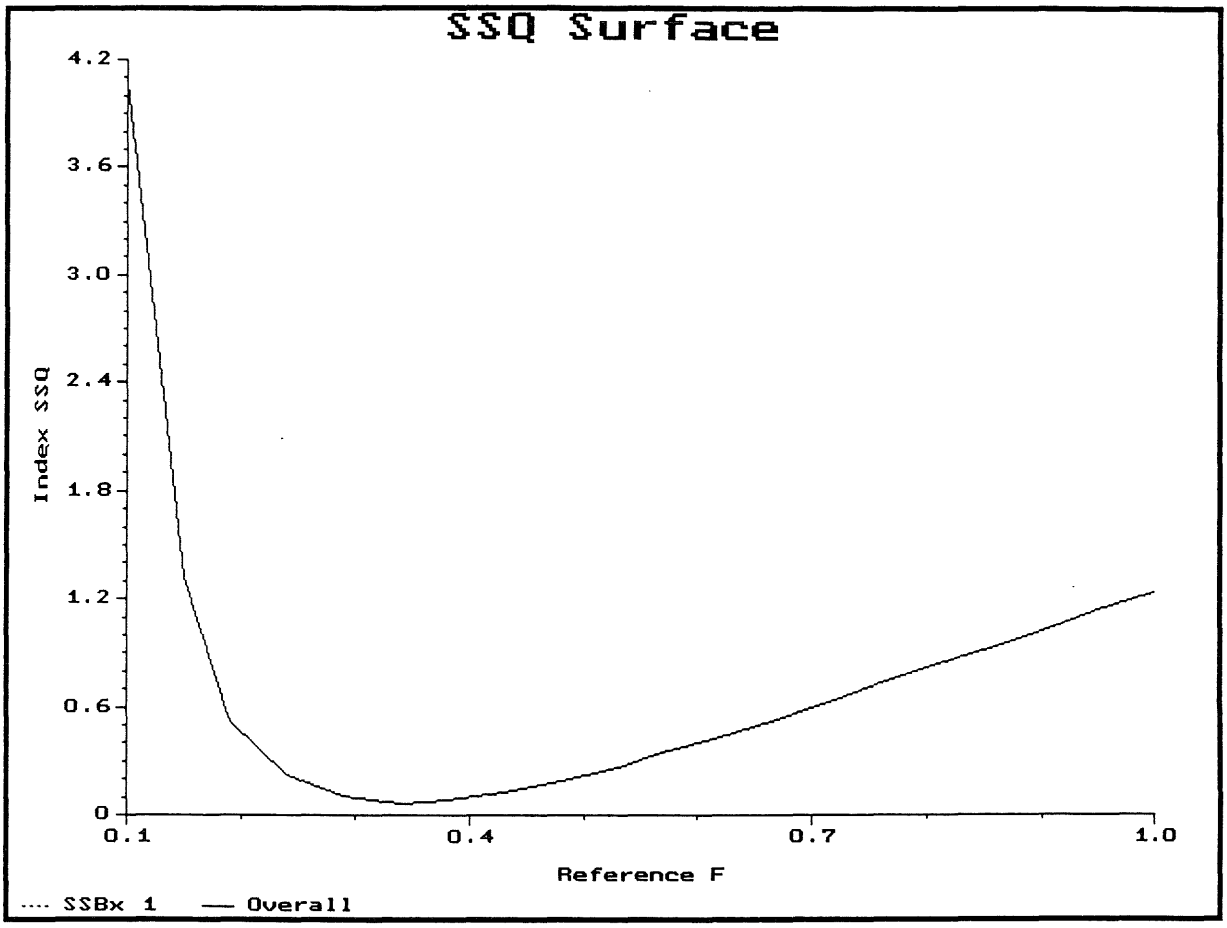


Figure 3.1 The sum of squares surface for the ICA fit to the Western mackerel.

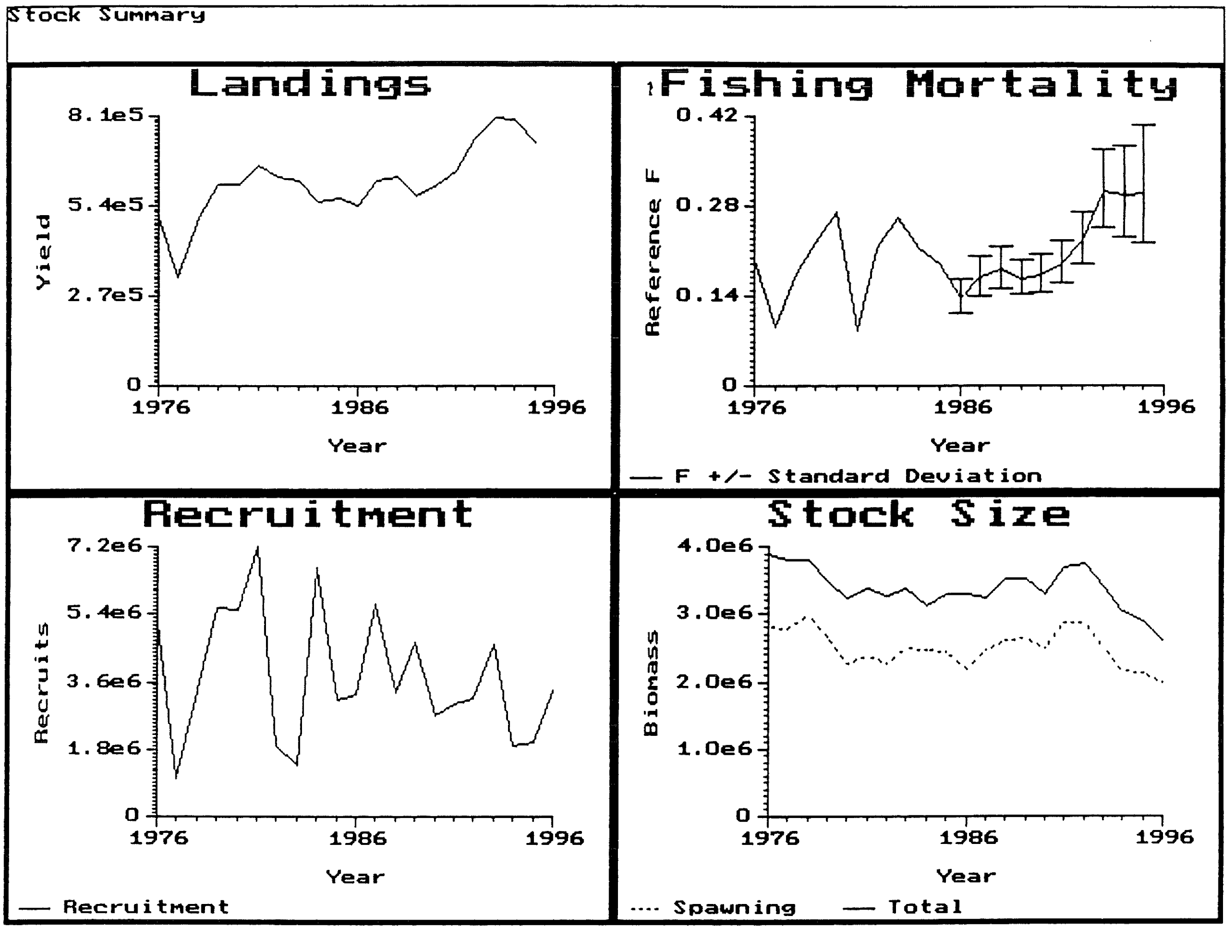


Figure 3.2 The long term trends in stock parameters for the Western mackerel

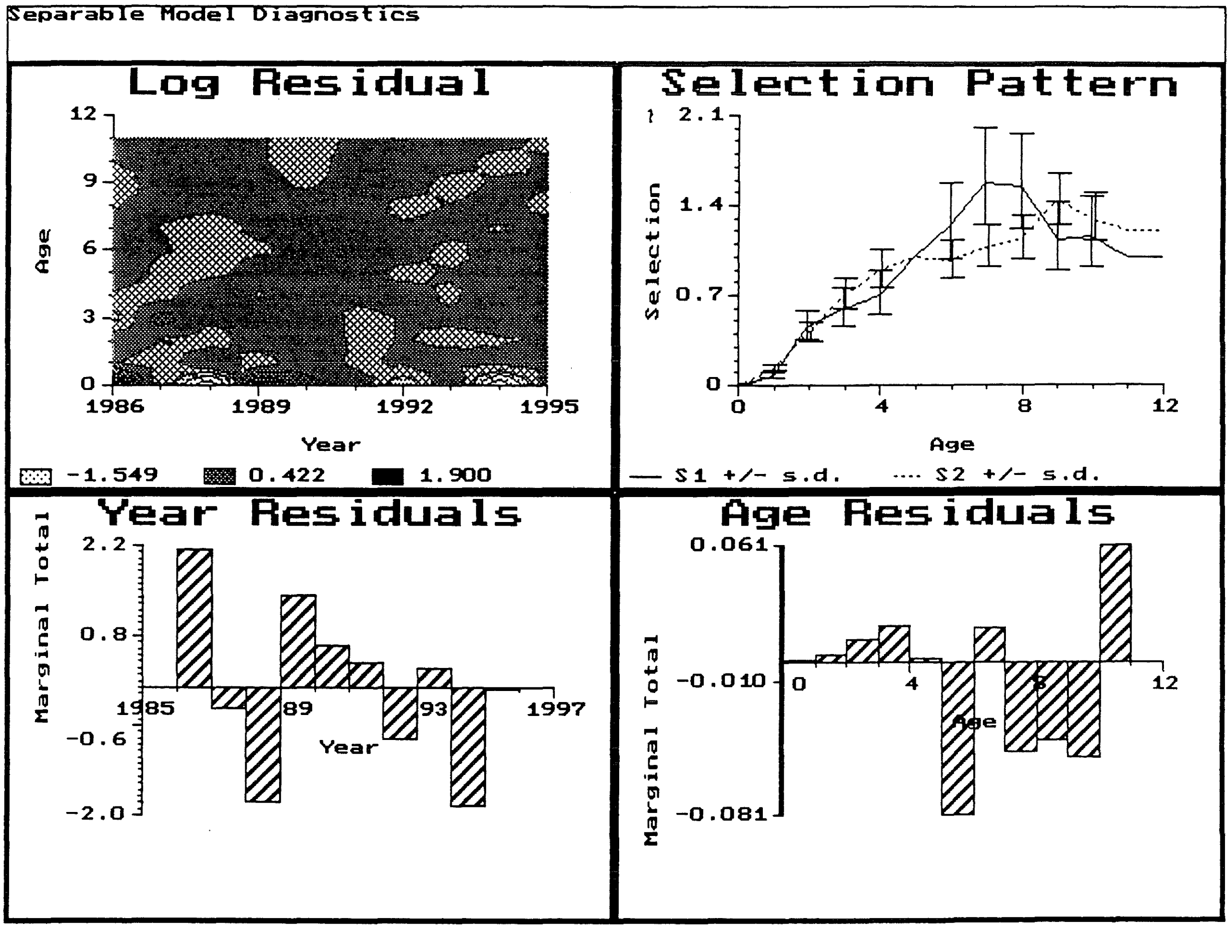


Figure 3.3 The catch at age residuals and selection at age as fitted by ICA to the Western mackerel data.

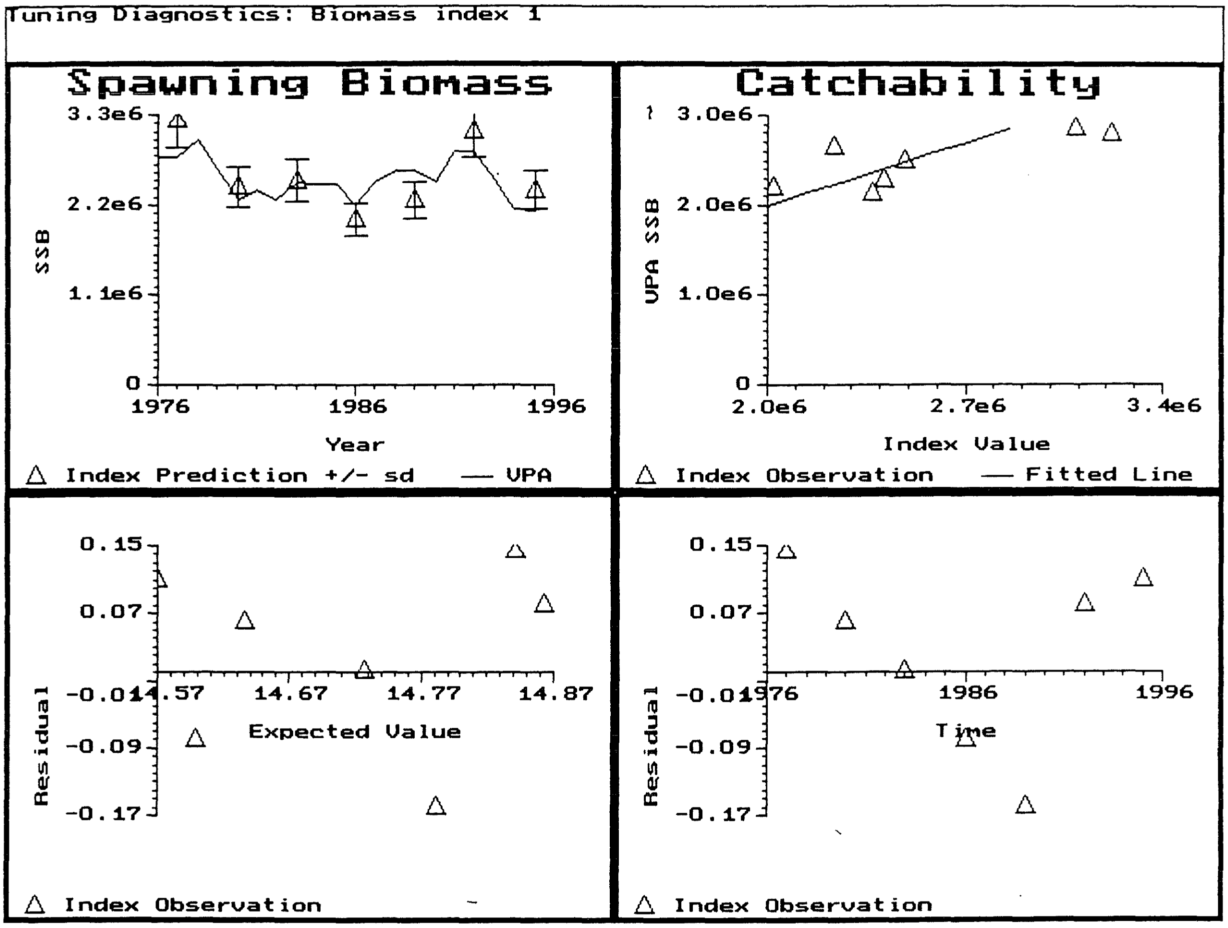
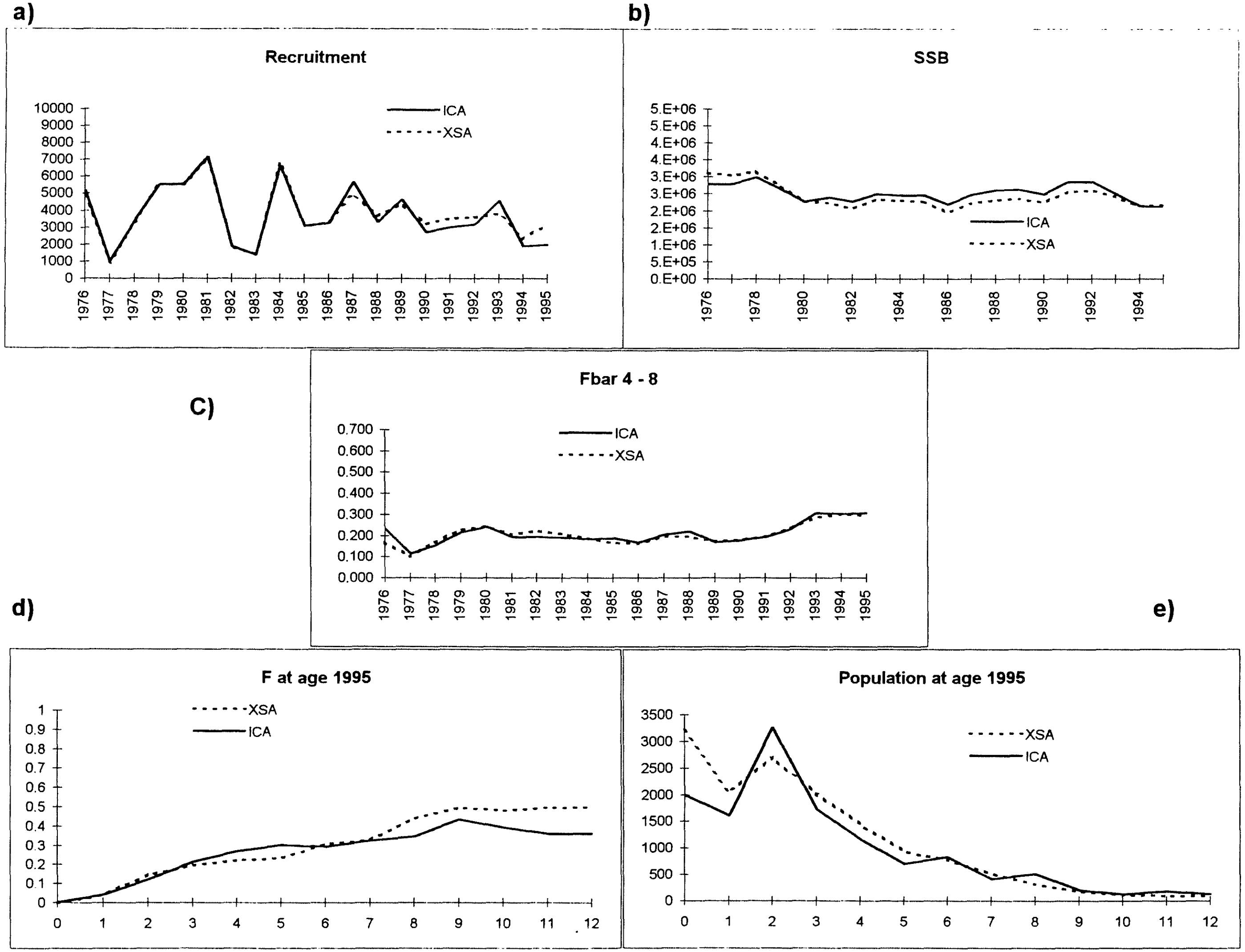


Figure 3.4 The diagniostics for the egg production index as fitted by ICA to the Western mackerel data.

Figure 3.5a,b,c,d,e A comparison between the XSA and ICA assessments of the Western Mackerel



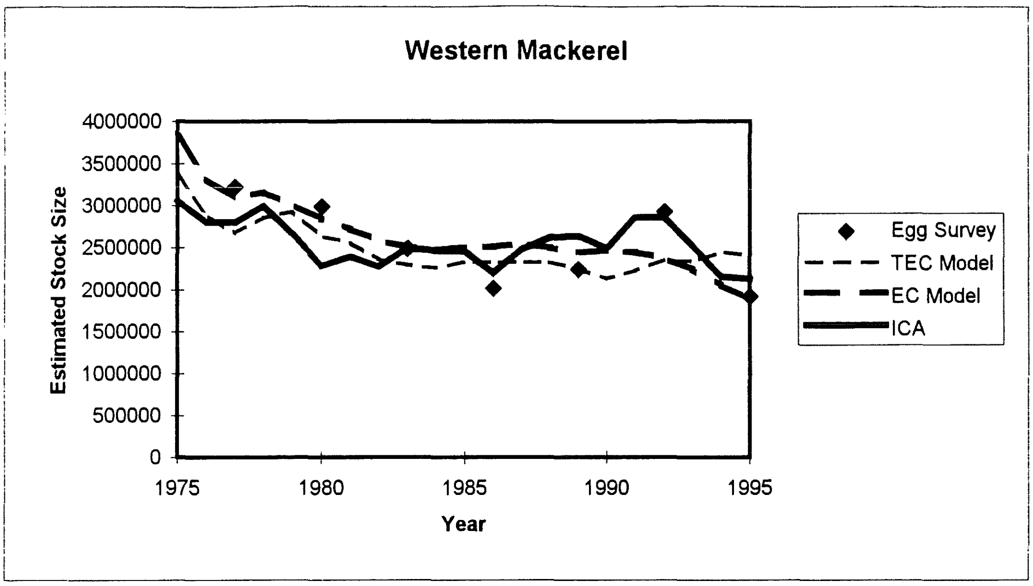
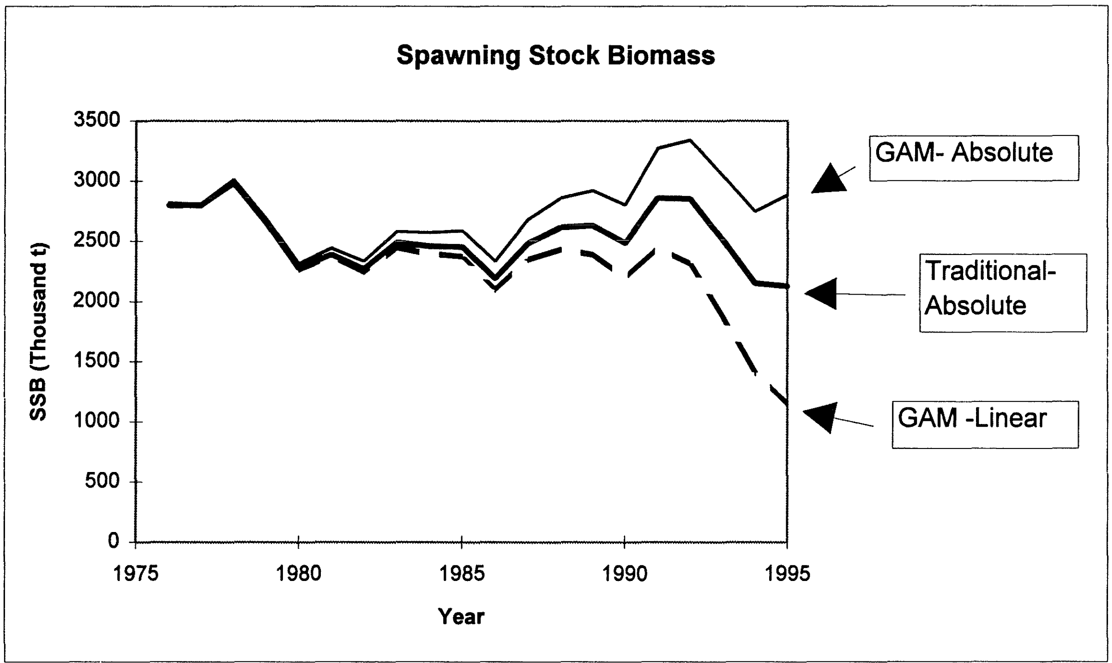


Figure 3.6 Western Mackerel. Biomass estimates from egg surveys and from three population models. 'TEC', biomass-dynamic model using estimates of mortality from Norwegian tag returns, egg survey estimates of biomass, and reported catches. 'EC', biomass-dynamic model using egg survey estimates and catches only. ICA, Working Group's conventional age-structured model.

Western Mackerel : GAM and Traditional Egg Production estimates



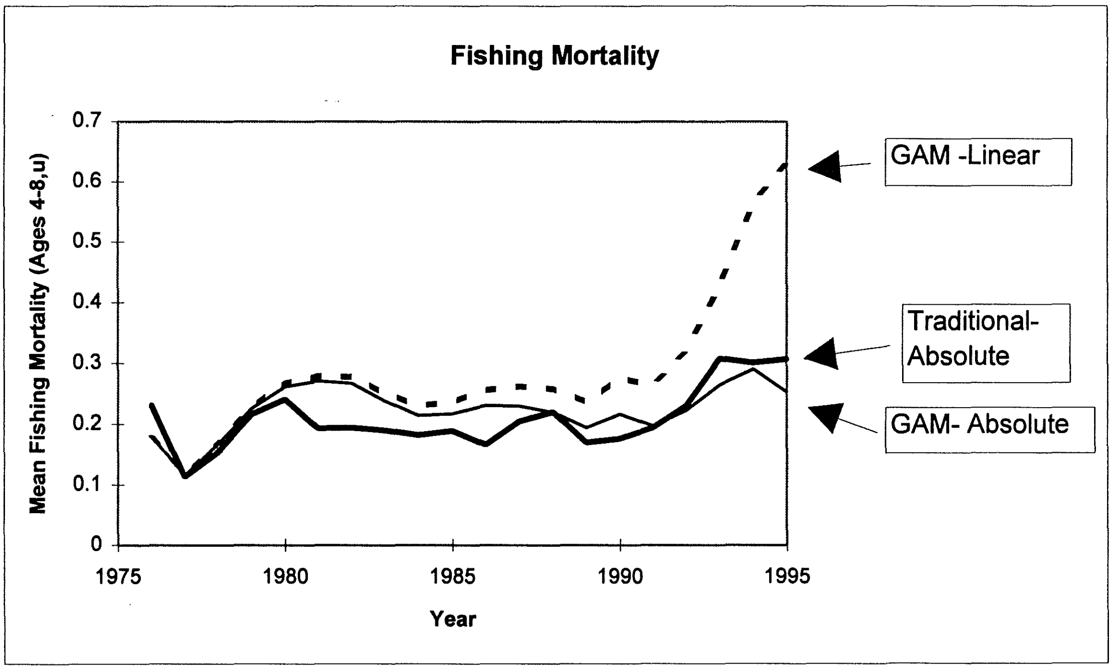


Figure 3.7 Western Mackerel. Comparison of stock assessment calculations made using the Working Group's age-structured assessment model, using either the traditional egg production estimates (as absolute measures of stock size), or the estimates of stock size derived by Augustin *et al.* (WD, 1996) using a generalised additive modelling (GAM) approach (Table 2.1). The GAM estimates were tested as either absolute or linear proportional estimates of stock size.

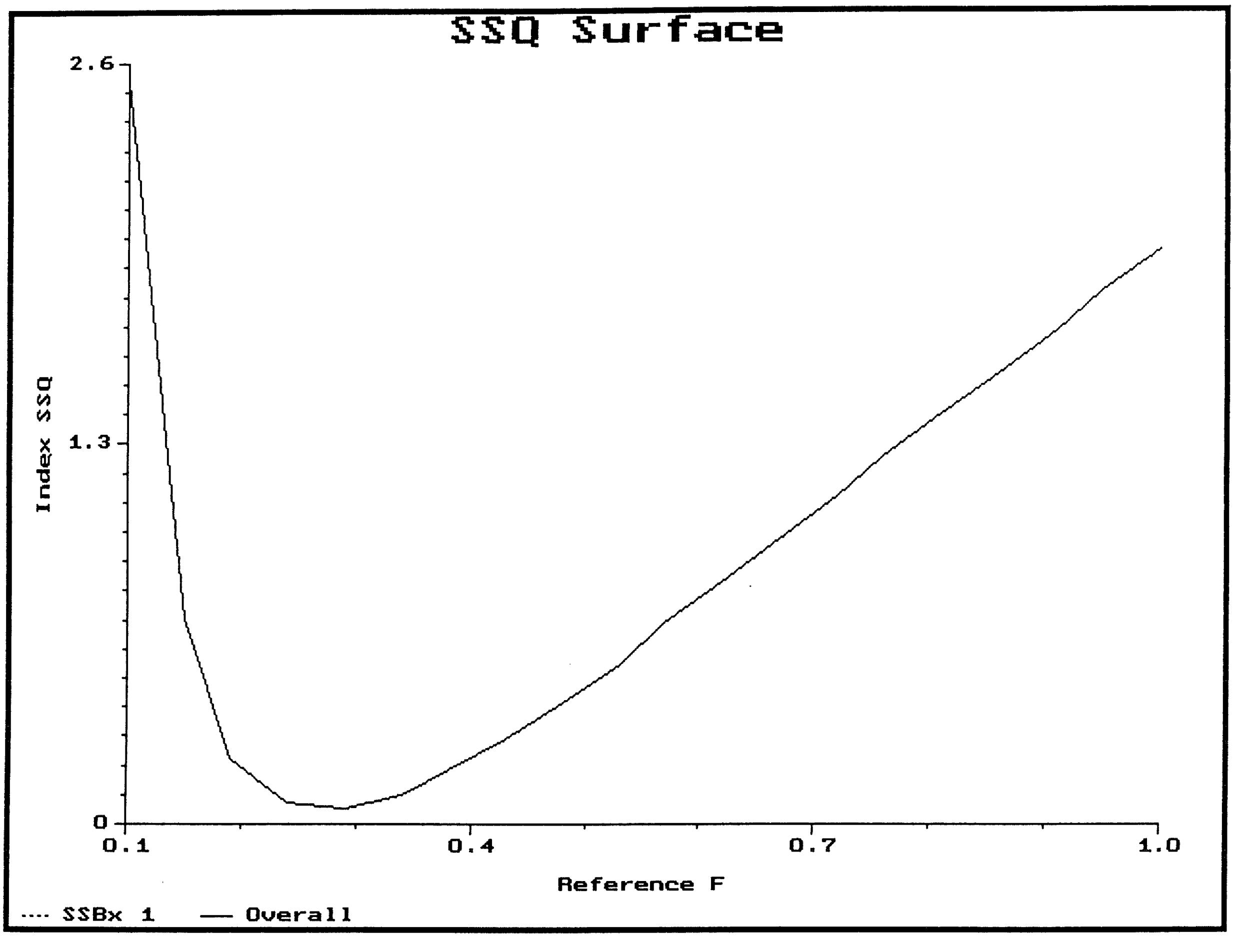


Figure 3.8 The sum of squares surface for the ICA fit to the North East Atlantic mackerel.

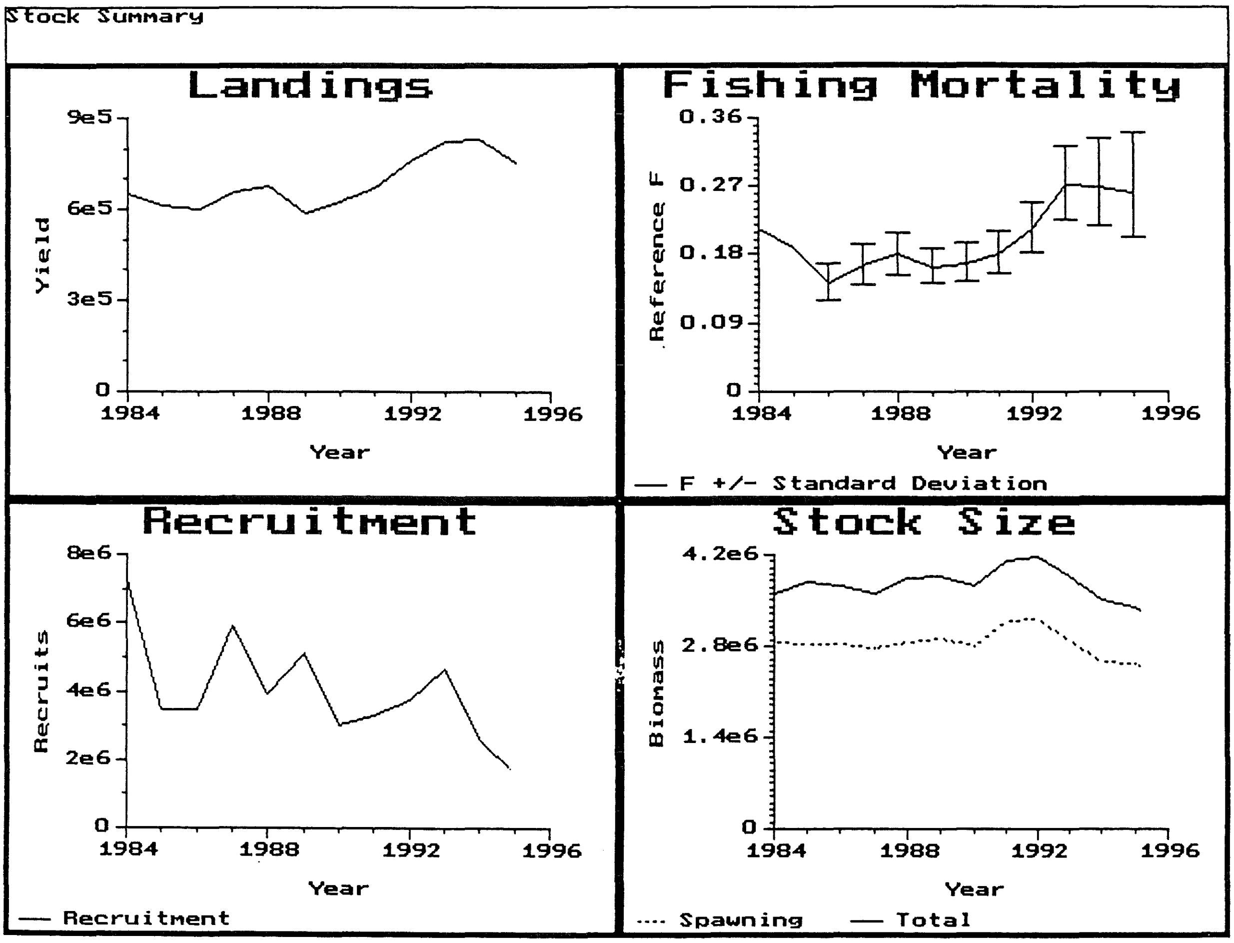


Figure 3.9 The long term trends in stock parameters for the North East Atlantic mackerel.

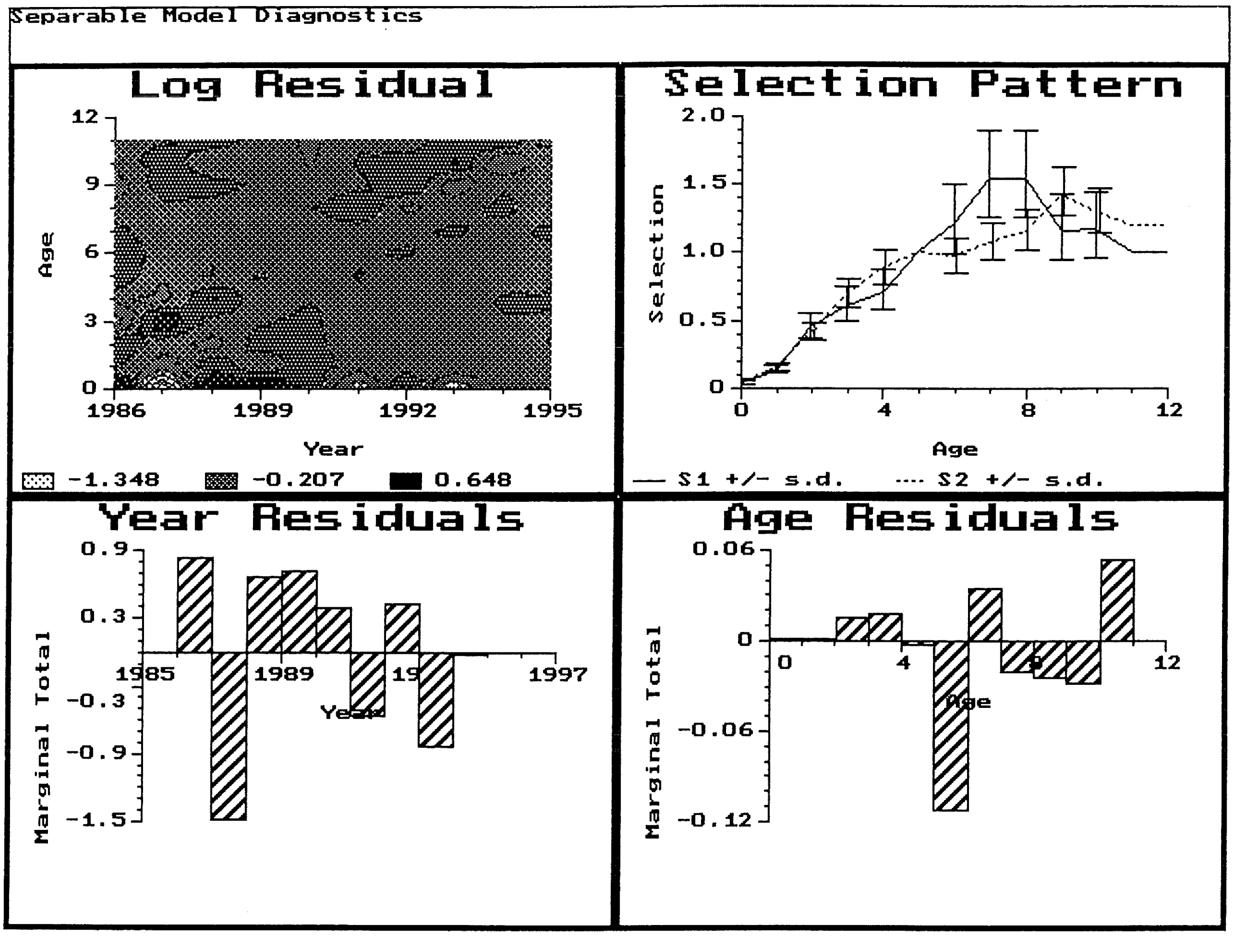


Figure 3.10 The catch at age residuals and selection at age as fitted by ICA fit to the North East Atlantic mackerel data.

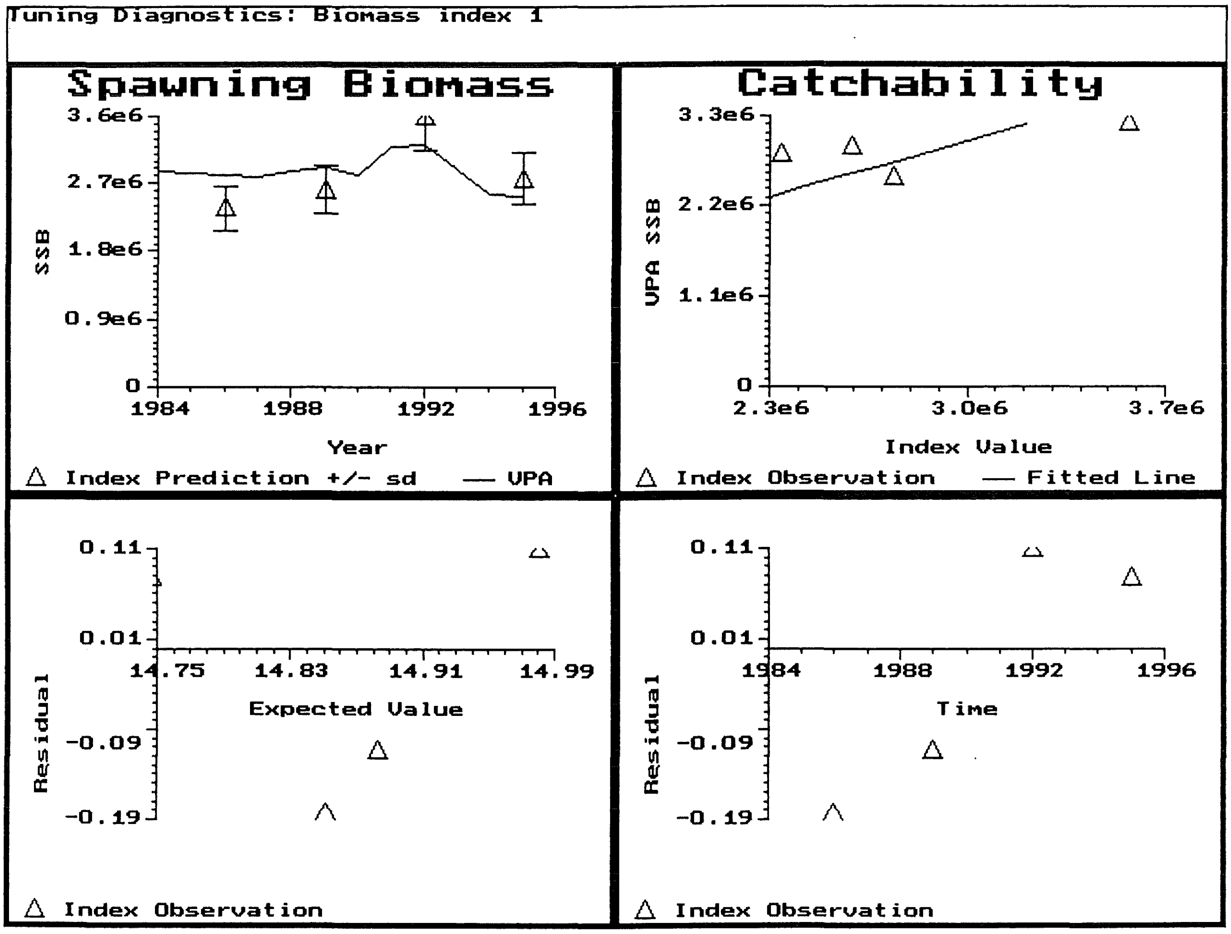


Figure 3.11 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic mackerel data.

Figure 3.12 A comparison between the NEA mackerel estimates of reference F derived from the ICA fits for 1995 and 1996

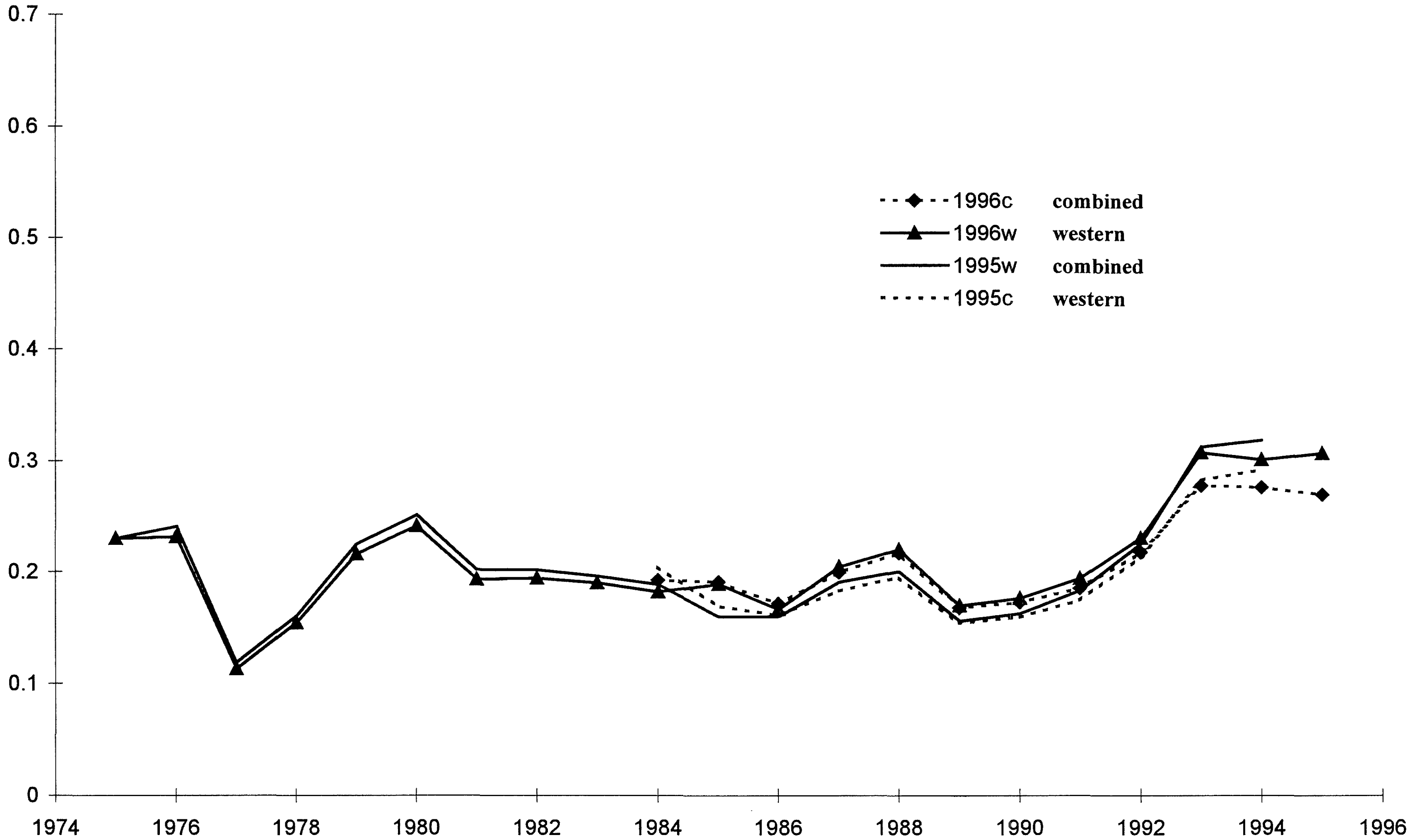


Figure 3.13 A comparison between the NEA mackerel SSB estimates derived from the ICA fits for 1995 and 1996

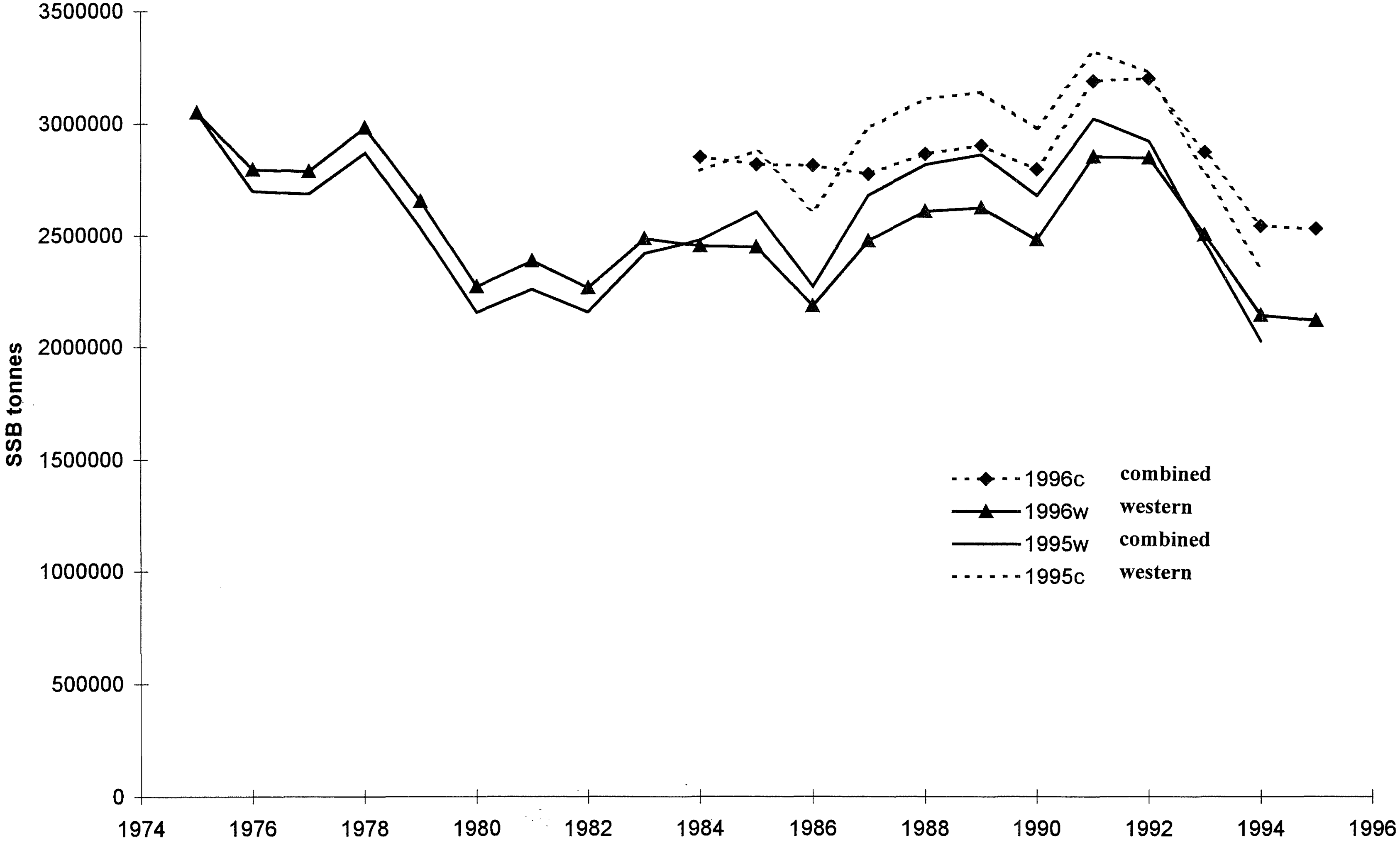


Figure 3.14 The medium term projection results for a constant TAC option of a catch equivalent to that taken in 1995 from the North East Atlantic mackerel.

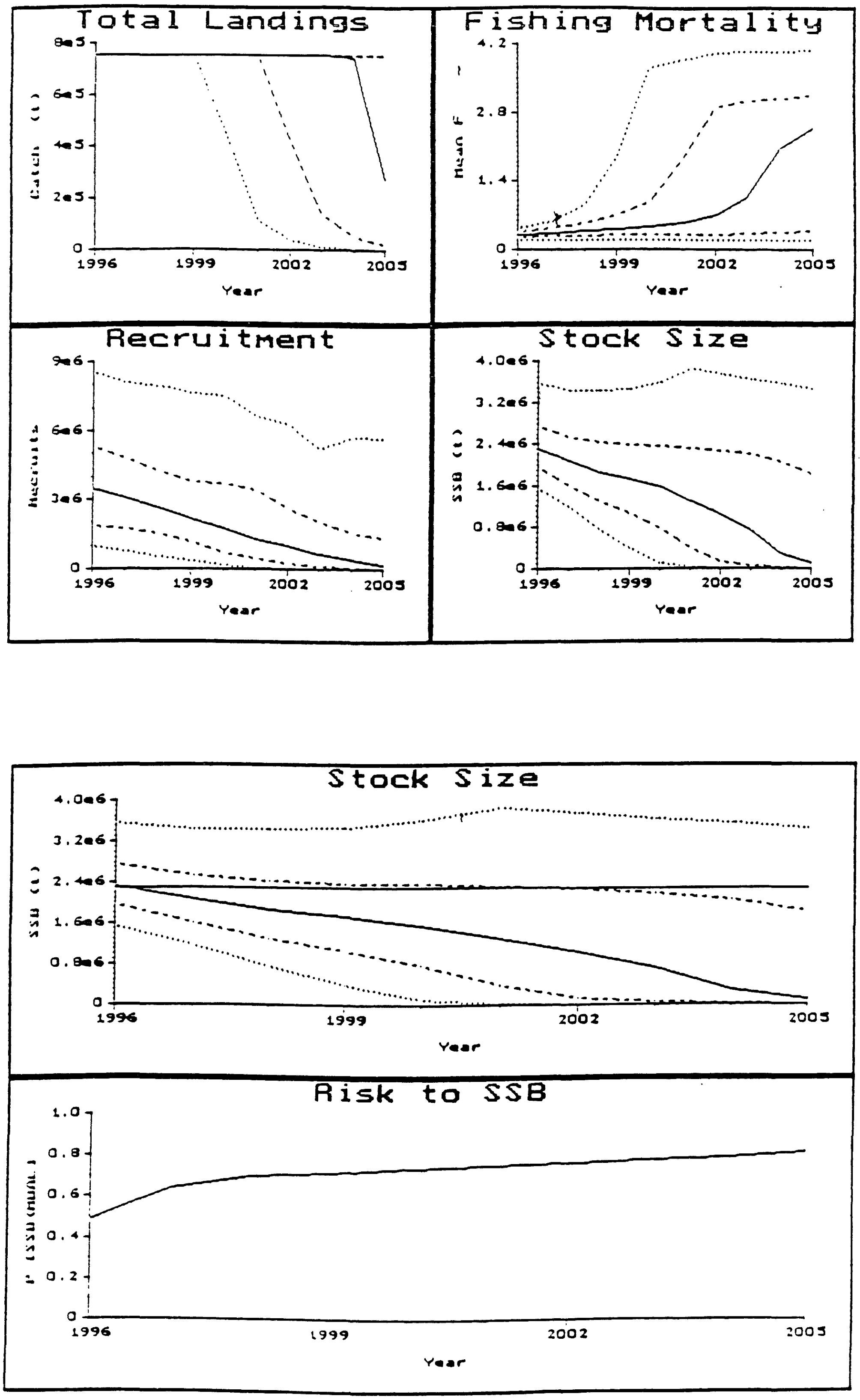
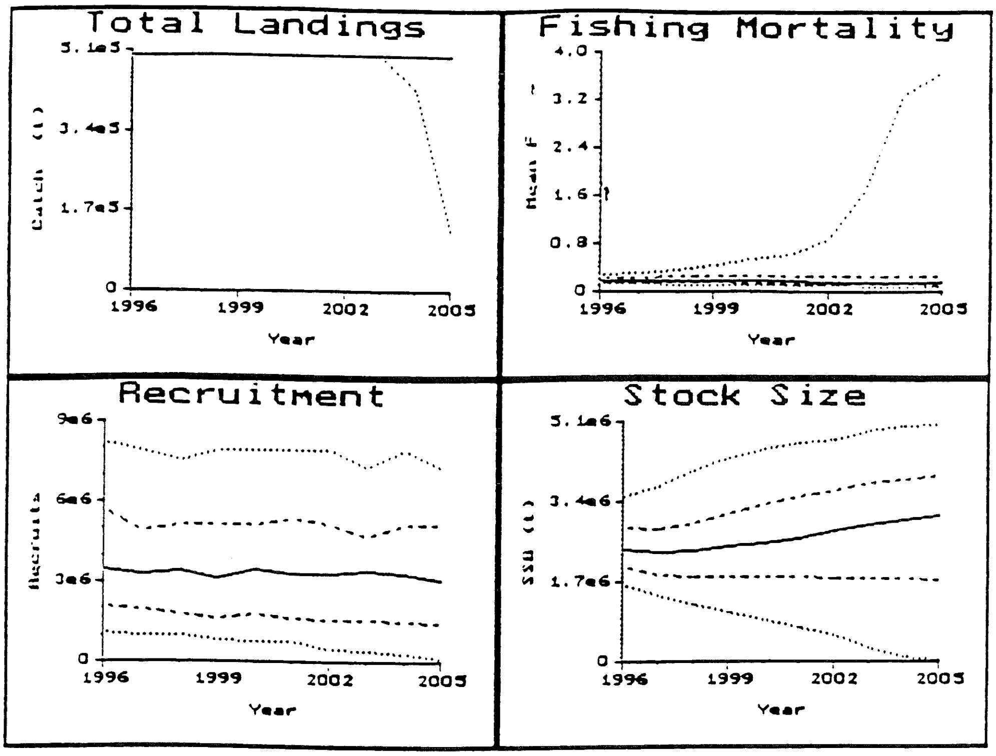


Figure 3.15 The medium term projection results for a constant TAC option of a catch of 500,000t from the North East Atlantic mackerel.



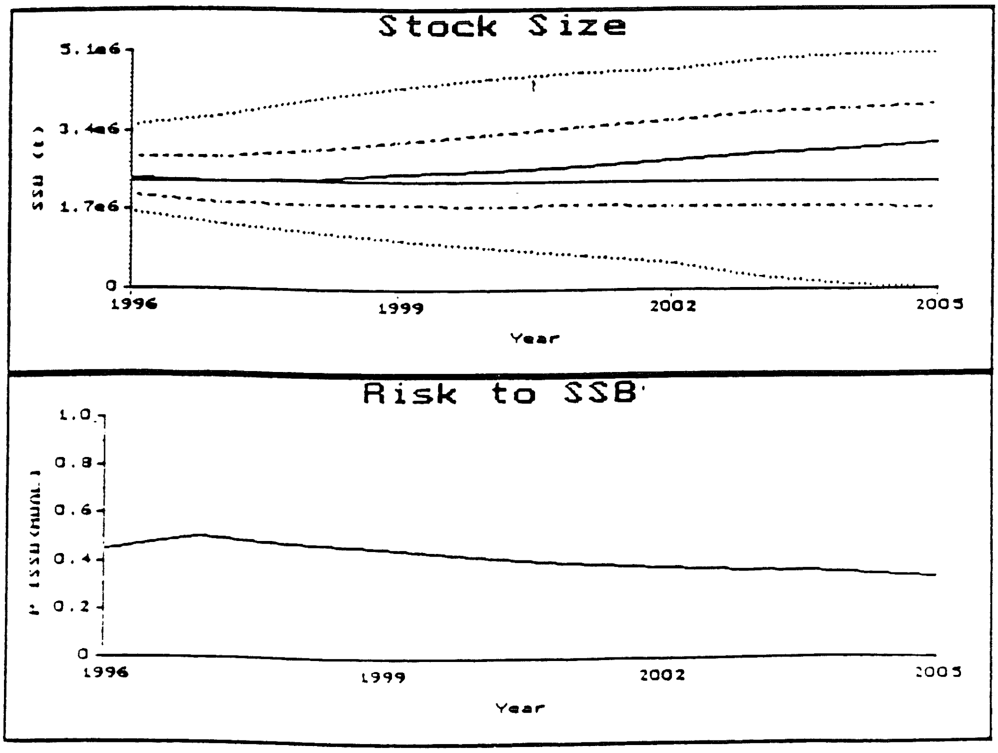


Figure 3.16 The medium term projection results for a constant F option F = F 1995 for the North East Atlantic mackerel.

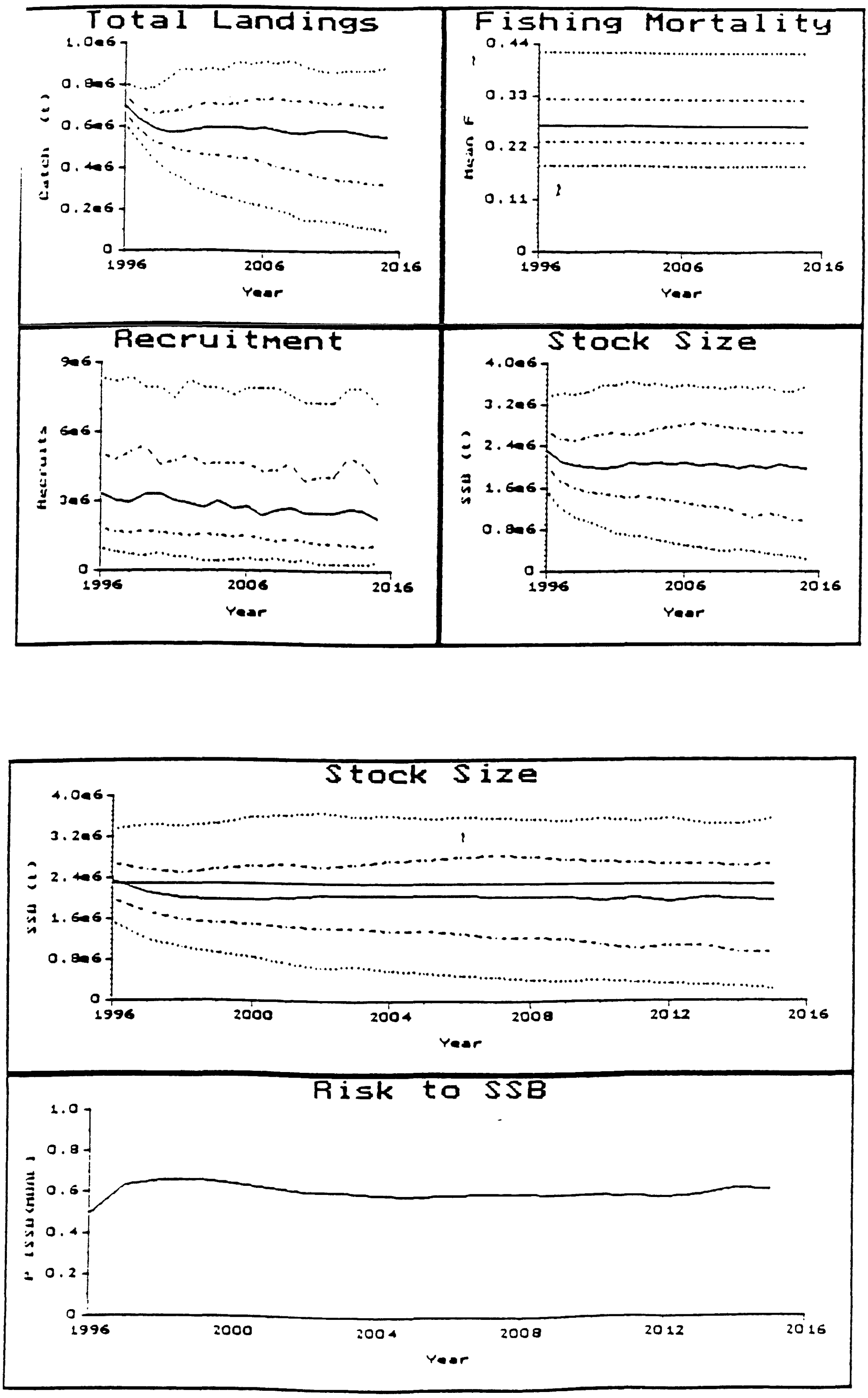


Figure 3.17 The medium term projection results for a constant F option F = F 1996, the fishing mortality required to achieve a catch of 500,000t, for the North East Atlantic mackerel.

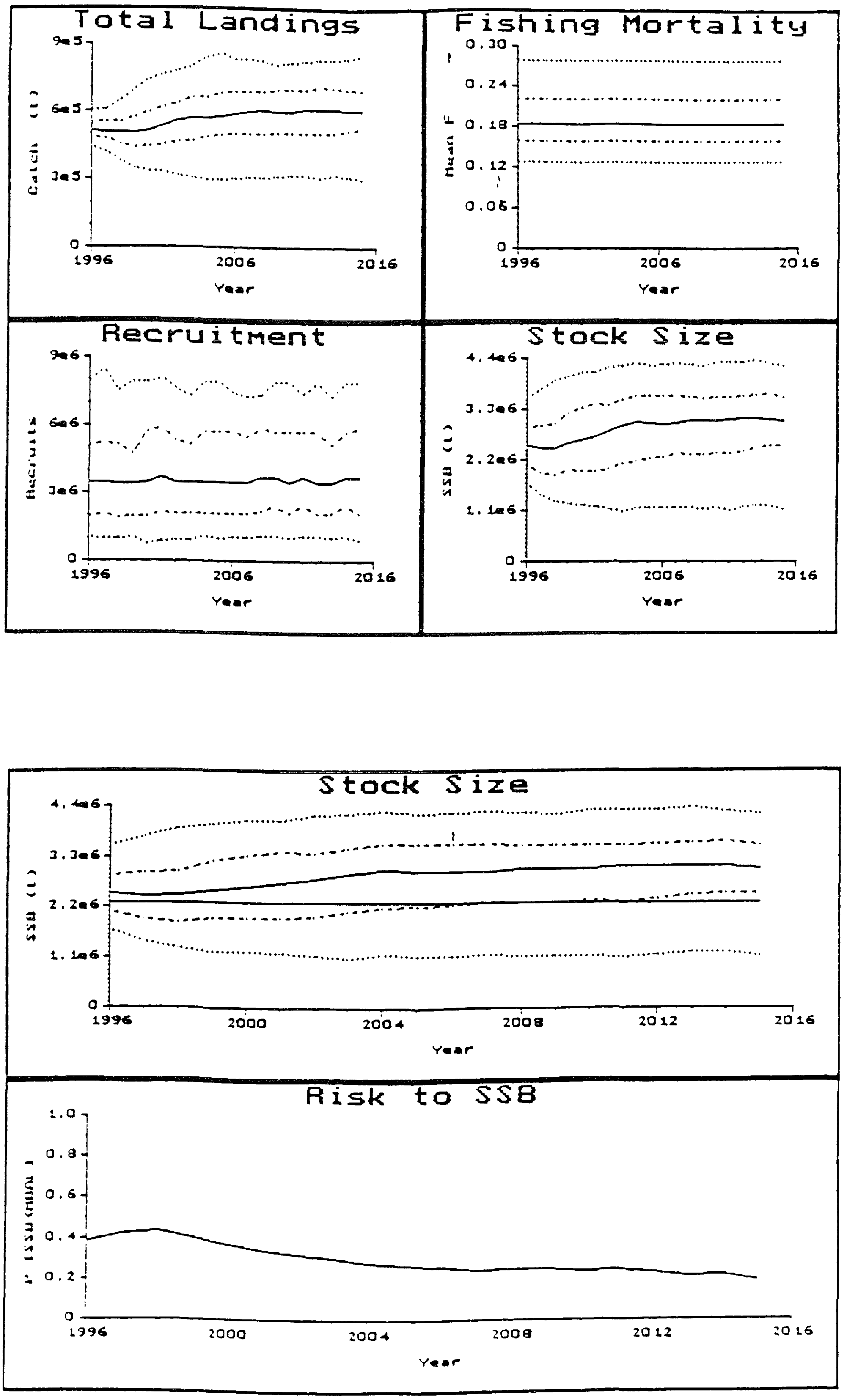


Figure 3.18 The medium term projection results for a constant F option F = 0.15 for the North East Atlantic mackerel.

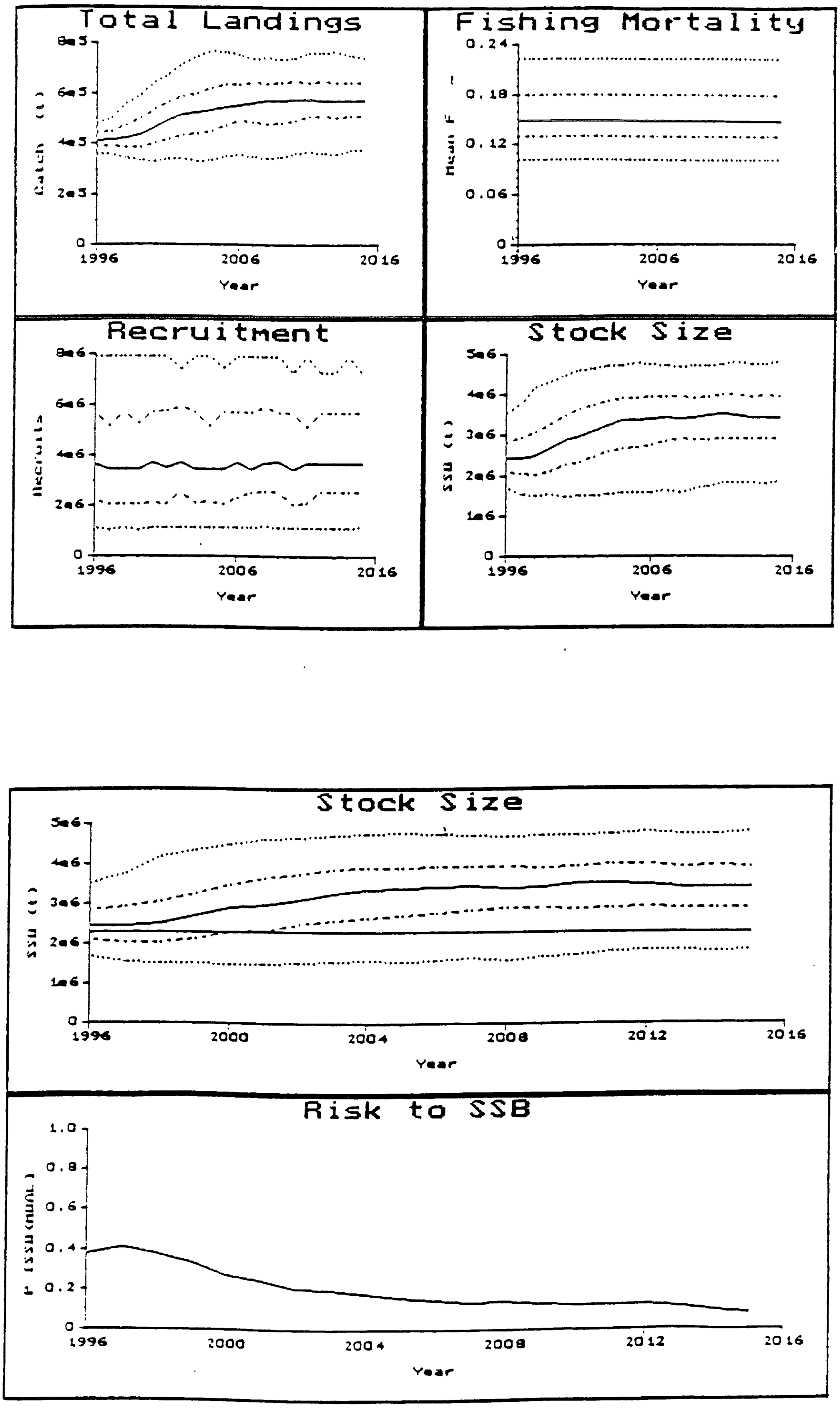


Figure 3.19 The NEAC Mackerel stock-recruitment relationship

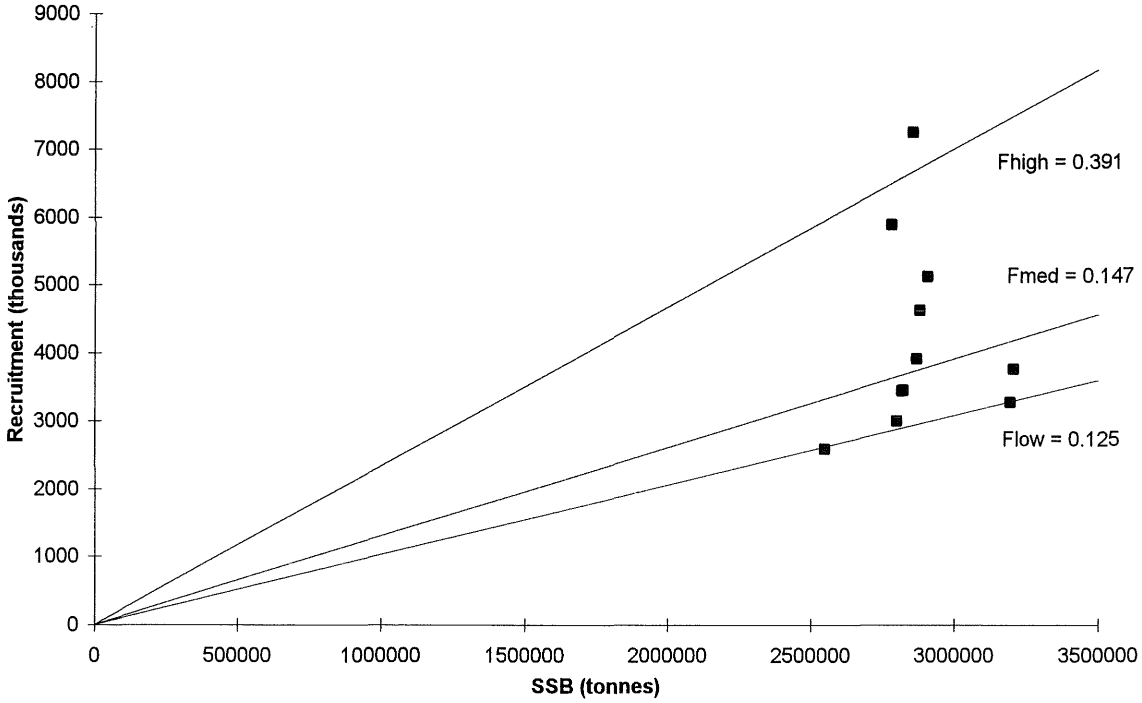
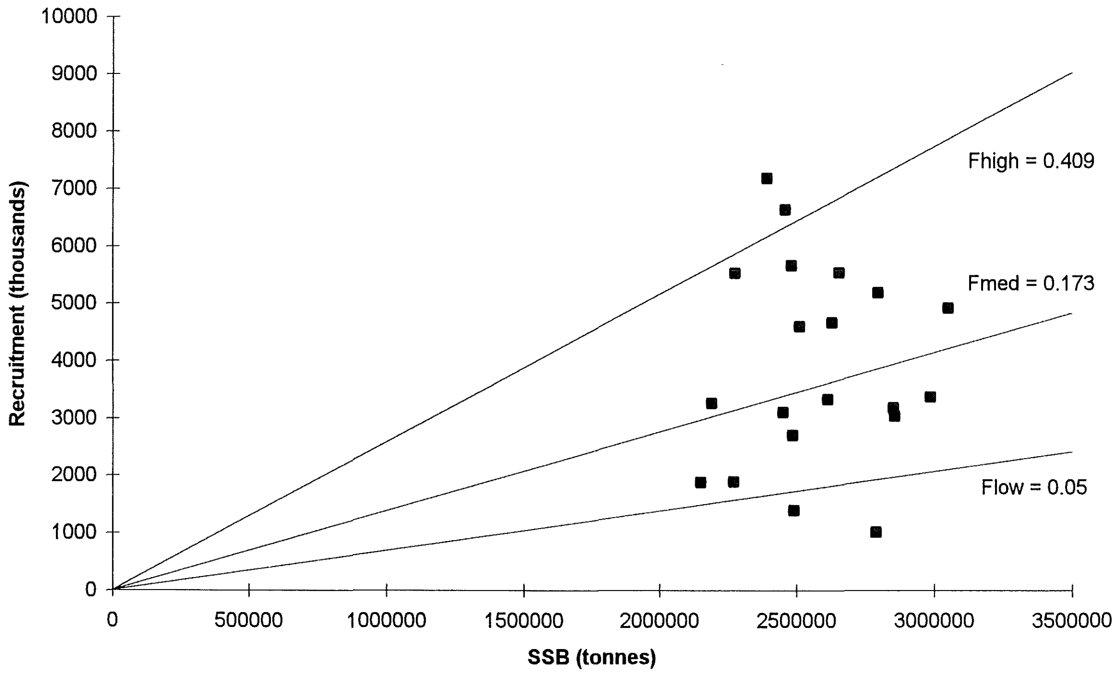


Figure 3.20 The Western mackerel stock-recruitment relationship



4 HORSE MACKEREL - GENERAL

4.1 Stock Units

In recent years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three stocks, the North Sea, the Southern and the Western stock (Anon. 1990/Assess:24; Anon. 1991/Assess:22). However, there is no well established biological basis for this. This separation is based on the observed egg distribution combined with the location and time of the different fisheries in recent years. In particular data from the western egg survey in 1992 and 1995 (Anon. 1993, Anon. 1996) indicate that it might be difficult to determine a realistic border between a western and southern spawning area. In 1994 horse mackerel were tagged in Portuguese and Spanish waters. However, so far no tags have been recovered (Borges and Porteiro pers. comm.).

The 1982 year class is the strongest in all three stock units, while other year classes seem to be represented differently in the catches (Figures 5.1, 6.1 and 7.1). The proportion of the 1982 year class in the 1995 western catches is high compared with the North Sea area and also with the southern area where the proportion is lowest. The 1987 year class is the second strongest year class in the western area, while in the North Sea area and the southern area the 1986 year class seems to be more abundant than the 1987 year class.

There is no new information on which to base a change in the stock-separation used previously, Therefore the Working Group considers the horse mackerel in the northeast Atlantic to consist of three units, Southern, Western and North Sea horse mackerel. However, it should be noted that there are no other data than the egg surveys and catch distributions on which to base this separation.

4.2 Spawning Stock Biomass Estimates from Egg Surveys

4.2.1 North Sea area

No egg surveys covering the spawning of horse mackerel have been carried out since 1991 and none are currently planned for the future.

4.2.2 Western area

Two alternative egg production estimates from the 1995 surveys were provided by the MHMEP Working Group (Anon. 1996/H:2), one based on the sampled area in 1995 and the other on the rectangles sampled within the standard area surveyed in 1992. These estimates were also based on different start and end times of spawning. The egg production estimate (**1.226 x10^{15} eggs;** S.E. 0.205 x 10^{15}), based on the area surveyed in 1995 and the new observed start and end times for production, were used by this Working Group (see comments in section 2.2.2).

The new estimates of both fecundity (**1577 eggs /g female**) and atresia (3.4%), obtained from combining the data from the 1989, 1992 and 1995 surveys, were used in the calculation of SSB for 1995. The traditional method estimate of SSB for 1995 was **1.71 x 10^6 tonnes.** The previous survey estimates, going back to 1977, were also adjusted using the new fecundity and atresia values. The historic data series is given in Table 2.1. which includes estimates of egg production obtained by the use of a Generalized Additive Modelling method.

4.2.3 Southern area

This was the first series of surveys carried out in the southern area for the Annual Egg Production Method (Anon. 1996/H:2). Total seasonal production of eggs, calculated on the observed period productions and with the observed start and end times was **175.383 x 10^{12} eggs** (S.E. 9.47 x 10^{12}). The alternative egg production, not used by the WG and based on an interpolated production for period 2, was 172.744 x 10^{12} eggs (S.E. 7.99 x 10^{12}). The fecundity, estimated during the 1995 surveys, was 1,526 eggs /g female (S.E. 44). A value of **7.7%** atresia (S.E. 1.5) was calculated in 1995. The annual potential fecundity corrected for atresia and used in the estimate of SSB was **1,408 eggs /g female** (S.E. 46).

The spawning stock biomass estimate for horse mackerel in the southern area in 1995 was **261,000 tonnes.**

4.3 Allocation of Catches to Stock

ACFM in its November meeting asked this Working Group to reevaluate the distribution of the North Sea stock and in particular to advice on whether the eastern part of Division IIIa still needs to be kept within the stock distribution area. Based on the assumed migration pattern of westen horse mackerel the stock enters Division IVa the third quarter and leaves back to western area late in the fourth quarter. Since 1990 the Danish, Norwegian and Swedish catches in the Division IIIa the third and fourth quarter have been allocated to the western stock. The catches in this area since 1990 have been distributed both spatially (western part of Division IIIa) and temporally (third and fourth quarter) closer to the catches in Division IVa than the catches in Divisions IVb,c. Therefore these catches has been allocated to the Western stock. In 1995 only 240 t were reported caught in Division IIIa in the second, third and fourth quarter. The catches from the second quarter (112 t) were allocated to the North Sea stock. There are no information were these catches were taken in Division IIIa. The catches from the third quarter (29 t) might as well be allocated to the North Sea stock (Figure 4.2c).

Until new and more extensive data than the present information are available the Working Group is unable to evaluate the question raised by ACFM more precisely.

The spatial and temporal distribution in the fishery in 1995 (Figure 4.2a–d) remained unchanged from previous years. Therefore the Working Group allocated the catches in 1995 to the different stocks as in recent years:

Western stock (Divisions IIa, western part of IIIa, Vb, IVa, VIa, VIIa-c,e-k and VIIIa,b,d,e)

North Sea stock (Divisions IVb,c and VIId and eastern part of Division IIIa)

Southern stock (Division VIIIc and IXa)

The catches by stock are given in Table 4.1 and Figure 4.1.

4.4 Species Mixing

The set TAC for horse mackerel should only apply *Trachurus trachurus* and according to the Working Group recommendation (Anon. 1996), 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*.

In Divisions VIIIa,b and Sub-division VIIIc East, the total catch of *T. mediterraneus* was 6,856 t in 1995. In Division VIIIab the figure has increased with respect to 1994, remaining at the mean level for the period 1991-1994, and in Sub-division VIIIc East it has increased with respect to 1994, remaining at the mean level for the period 1989–1995 (Table 4.2).

In both areas, more than 95% of the catches were obtained by purse seiners as in previous years. Although the *T. mediterraneus* fishery took place throughout the year, the main catches were taken in the second half of the year, mainly in autumn (Table 4.3), 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*.

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 1986–1994 are given in Table 4.4. Catches and length distributions for the Portuguese fishery of *T. trachurus* in Division IXa do not include data for *T. picturatus*.

As there is information available on the amounts and distribution of catches of *T. mediterraneus* and *T. picturatus* for at least seven years (Anon. 1990, 1991, 1992, 1993, 1995 and 1996), and as the evaluations and assessments are only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *T. trachurus spp.* in general, as is the case at present . It would then be appropriate to set TACs for the other species as well.

4.5 The Fishery in 1995

The total international catches of horse mackerel in the North East Atlantic are shown in Table 4.5 and Figure 4.1. The total catch taken from all areas in 1995 is 75,000 tons larger than the record high catch of 504,000 tons in 1993. Ireland, Denmark and the Netherlands have a directed trawl fishery for horse mackerel while Norway has a directed purse seine fishery. Spain and Portugal have a directed trawl and purse seine fishery.

Only one country provides data for discards. Therefore the amount of discards given in Table 4.1 are not representative for the total fishery in the respective areas

4.6 Distribution of the Horse Mackerel Fisheries

The distribution of the fisheries are given in Figure 4.2 a-d. These figures are based on data provided by Denmark, Germany, Ireland, Netherlands, Norway, Portugal, Spain and UK (England and Wales) covering 97% of the total catch. The total catch was allocated to quarters using the data given by the above countries and are given in Table 4.6. As in previous years most of the catches were taken in Sub-area VII. In 1995 the catches in this area increased by 130,000 t since last year and as usual the main catches were taken in the fourth quarter.

First quarter, 121,000 t. The main catches were taken along the continental shelf west of Ireland and the British Isles, in the western Channel, in the Bay of Biscay and around the Iberian Peninsula (Figure 4.2a).

Second quarter, 92,000 t. This is about 50,000 t more than in 1994. The main catches were as usual taken south west of Ireland, in the Bay of Biscay and around the Iberian peninsula (Figure 4.2b). Compared with the first quarter the most intensive fishing area has moved from south west of Ireland to north of Irland.

Third quarter, 107,000 t. This is 20% more than in 1994. The main catches were taken to the west and north of of Ireland, in the Channel and around the Iberian peninsula. Some catches were also taken in the Norwegian Sea and in the southern part of the North Sea (Figure 4.2c).

Fourth quarter, 260,000 t. This is 20% more than in 1994 and 85,000 tons were taken in the northern part of the North Sea (Division IVa), while the rest were taken west of Ireland, in the Channel, in the Bay of Biscay and around the Iberian Peninsula (Figure 4.2d).

4.7 Length Compositions by Fleet and by Country

The 1995 annual length compositions by fleet were provided by Ireland (third and fourth quarter), England and Wales (UK landings only), The Netherlands, Norway, Portugal and Spain. These length distributions cover about 70% of the total landings in 1995.

The length distribution by country for each fleet (in millions) of fish per cm-length group are shown in Table 4.7.

4.8 Otolith Exchange in 1996

At last years Working Group meeting (Anon. 1996/Assess:7) it was recommended that an horse mackerel otolith exchange should be carried out. This exchange would be organised by A. Eltink of the Netherlands Institute for Fisheries Research in the Netherlands.

In an earlier otolith exchange the whole otolith set got lost. Three sets of otoliths have therefore now been prepared for the 1996 exchange:

1) One set containing only otoliths of the extremely strong 1982 year class, which have been collected during the period 1983–1995. This set can be used as validation set to estimate the accuracy of the ageings, since the age of each otolith is fairly certain.

2) One set containing otoliths collected during the first half of the year of which the otoliths have only hyaline edges (a mixture of year classes, because the 1982 year class might be a special case).

3) One set containing otoliths collected during the second half of the year of which the otoliths have both opaque and hyaline edges (a mixture of year classes, because the 1982 year class might be a special case).

Sets 2 and 3 can only be used to estimate the precision of the ageings and can be used to analyse whether there exist difficulties in the interpretation of the outer edge, causing mainly differences in the ageing of one year.

Up to this Working Group meeting only otolith set 3 has been read by all readers. Age bias plots by reader (Figure 4.3) and one for all readers combined (Figure 4.4) show the precision of the age readings of this set. The age readings of each reader and of the group are compared to the modal age. Some readers obtain a quite high precision, while two readers have an increasing bias with age (underestimating) in their readings from age 7 onwards. It is also surprising that three readers have a bias (underestimating) in their readings only in the age range of 8–12 and not for ages 13–15. Only one reader has a bias in which all ages in the age range of 4–14 are overestimated.

Only some countries present age readings to the Working Group (see Section 1.3.1 and 1.3.5). Therefore, the precision of the age readings of the whole group is not representative for the precision of the age readings presented to this Working Group. Only readers 1, 2 and 6 presented age readings for the western horse mackerel stock and readers 3 and 5 for the southern horse mackerel stock to the Working Group.

The Working Group decided to wait for the analysis of all three otolith sets, before a decision would be taken on whether or not a workshop should be held.

Table 4.1 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	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

[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.

Table 4.2 Catches (t) of *Trachurus trachurus* and *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and IXa in the period 1989-1995.

	Divisions	Sub-Divisions	1989	1990	1991	1992	1993	1994	1995
T. trachurus	VIIIab		2904	4306	4030	3445	2431	1262	815
	VIIIc	VIIIc East	8478	7505	4907	8299	11519	9697	7045
		VIIIc west	17802	17676	18827	15945	13963	14451	20489
		Total	26280	25181	23734	24244	25482	24148	27534
	IXa	IXa North	13028	4065	4275	4059	6198	9380	7442
		IXa C, N & S	25231	19958	14497	22653	25747	19061	17698
		Total	38259	24023	18772	26712	31945	28441	25140
T. mediterraneus	VIIIab		23	298	2122	1123	649	1573	2271
	VIIIc	VIIIc East	3903	2943	5020	4804	5576	3344	4585
		VIIIc west	0	0	0	0	0	0	0
		Total	3903	2943	5020	4804	5576	3344	4585
	IXa	IXa North	0	0	0	0	0	0	0
		IXa C, N & S	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0

Table 4.3 Catches (t) and percentages (%) of *Trachurus mediterraneus* in relation to total landings of *Trachurus trachurus* in Divisions VIIIab and VIIIc in 1995.

			Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total	
	Divisions	**Sub-Divisions**	**(t)**	**(%)**	**(t)**	**(%)**	**(t)**	**(%)**	**(t)**	**(%)**	**(t)**	**%**
Trachurus mediterraneus	**VIIIab**		356	77.4	452	51.5	38	24.8	1425	89.3	2271	73.6
		VIIIc East	1320	47.0	470	17.3	1046	32.9	1749	59.6	4585	39.4
	VIIIc	East of 3ºW	506	70.2	225	20.4	441	45.5	1044	79.1	2216	53.9
		West of 3ºW	814	39.0	245	15.2	605	27.4	705	43.6	2369	31.5
Trachurus trachurus	**VIIIab**		104	22.6	426	48.5	115	75.2	170	10.7	815	26.4
		VIIIc East	1487	53.0	2246	82.7	2130	67.1	1188	40.4	7051	60.6
	VIIIc	East of 3ºW	215	29.8	876	79.6	528	54.5	276	20.9	1895	46.1
		West of 3ºW	1272	61.0	1370	84.8	1602	72.6	912	56.4	5156	68.5
Total	**VIIIab**		460		878		153		1595		3086	
		VIIIc East	2807		2716		3176		2937		11636	
	VIIIc	East of 3ºW	721		1101		969		1320		4111	
		West of 3ºW	2086		1615		2207		1617		7525	

Table 4.4 Catches (t) of *Trachurus trachurus* and *Trachurus picturatus* in ICES Division IXa, Subarea X, and in CECAF Division 34.1, in the period 1986-1995.

	Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
T. trachurus (*)	**IXa**	28,526	19,554	25,125	25,226	19,959	17,497	22,653	25,747	19,061	17,698
T. picturatus	**IXa**	367	181	2,370	2,394	2,012	1,700	1,035	1,028	1,045	728
	X Azorean area	3,331	3,020	3,079	2,866	2,510	1,274	1,255	1,732	1,778	-
	34.1.1 Madeira's area	2,006	1,533	1,687	1,564	1,863	1,161	792	530	297	-

(*) As estimated by the Working Group.
(-) Not available

Table 4.5 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[1]
II + Vb	4,487	13,457	3,168	759	13,133
IV + IIIa	77,994	113,141	140,383	112,580	98,745
VI	34,455	40,921	53,822	69,616	83,595
VII	201,326	188,135	221,120	200,256	330,705
VIII	49,426	54,186	53,753	35,500	28,709
IX	21,778	26,713	31,944	28,442	25,147
Total	389,466	436,553	504,190	447,153	580,034

[1]Preliminary.

Table 4.6 Quarterly catches (1000 t) of HORSE MACKEREL by Division and Sub-division in 1995.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	0	2.8	10.3	13.1
IIIa		0.1	+	0.1	0.2
IVa	1.7	0	3.1	85.8	90.6
IVbc, VIId	0.6	0.5	2.8	12.8	16.7
VIa	8.9	17.5	56.8	0.5	83.7
VIIa-c,e-k	99.9	58.7	24.2	139.2	322
VIIIabde	0.5	0.4	0.1	0.2	1.2
VIIIc	4.4	8.3	9.1	5.7	27.5
IXa	4.9	6.7	7.8	5.7	25.1
Sum	120.9	92.2	106.7	260.3	580.1

Table 4.7 Annual length distributions (millions) of HORSE MACKEREL catches by fleet and country in 1994.

	Netherlands	Eng.&Wales	Norway	Spain				Portugal			Ireland
	Pelagic	Pel.trawl	Purse	Purse	Demersal	gill	hook	Artisan.	trawl	Purse	Pel.trawl
cm	trawl	UK landings	seine	seine	trawl	net				seine	3+4 Q
5											
6											
7											
8											
9									0.00		
10				0.10					0.00		
11				0.68	0.01				0.08		
12				4.59	0.40			0.01	1.06		
13				18.54	1.31		0.00		2.15		
14				33.06	0.98		0.00	0.06	8.92		
15	32.15			32.98	0.71		0.00	0.21	7.28		
16	86.82			37.47	1.22	0.00	0.00	0.03	7.05	0.01	
17	70.19			35.53	2.23	0.01	0.00	0.05	11.86	0.05	
18	70.09	0.00		20.98	3.44	0.02	0.00	0.07	14.59	0.05	
19	71.43	0.00		13.44	3.13	0.02	0.00	0.10	15.74	1.50	
20	63.46	0.66		11.96	2.66	0.03	0.00	0.19	13.38	6.18	1.02
21	58.62	2.97		11.69	2.22	0.04	0.00	0.65	9.93	9.84	1.02
22	66.30	3.63		15.30	2.26	0.04	0.00	0.88	6.42	7.67	5.63
23	67.25	5.61		14.97	1.61	0.06	0.00	1.16	4.70	2.66	1.84
24	45.77	3.30		15.74	1.20	0.04	0.01	0.82	3.88	1.24	21.48
25	52.93	5.94		15.26	1.18	0.04	0.02	0.70	3.12	0.86	12.28
26	52.59	7.61		9.96	1.49	0.04	0.03	0.58	2.25	0.50	47.57
27	75.24	10.01		5.69	1.82	0.03	0.04	0.50	2.21	0.33	60.35
28	79.16	8.72		4.67	5.48	0.02	0.08	0.37	2.60	0.09	128.89
29	60.92	6.06		4.24	6.69	0.03	0.08	0.30	3.05	0.21	164.69
30	34.69	3.06	1.25	3.46	6.72	0.03	0.08	0.34	3.34	0.25	104.34
31	17.94	5.82	13.78	2.56	4.21	0.05	0.07	0.36	3.39	0.81	37.85
32	14.95	6.48	14.90	1.83	3.85	0.04	0.04	0.34	2.75	0.87	11.25
33	14.17	5.82	46.74	1.33	2.98	0.04	0.03	0.42	1.75	0.12	1.53
34	9.68	4.12	45.68	0.67	2.62	0.03	0.04	0.54	1.45		
35	10.61	1.70	54.66	0.43	2.38	0.02	0.05	0.58	0.96		0.51
36	2.58	1.37	35.41	0.32	1.42	0.02	0.03	0.45	0.76		
37	1.13	2.40	14.85	0.14	1.12	0.01	0.03	0.41	0.43		
38	1.81	0.67	8.01	0.11	0.80	0.01	0.01	0.27	0.30		
39	0.70	0.34	4.61	0.05	0.49	0.00	0.01	0.16	0.12		
40			3.47	0.04	0.20	0.00	0.00	0.08	0.05		
41				0.01	0.06	0.00	0.00	0.04	0.01		
42+		0.34		0.02	0.02			0.08	0.00		
sum	1061.18	86.63	243.36	317.82	66.91	0.64	0.65	10.75	135.58	33.24	600.25
1000 t	125.94	16.89	96.10	23.24	12.30	0.11	0.17	2.13	12.62	2.95	124.39
		0.00=<5000									

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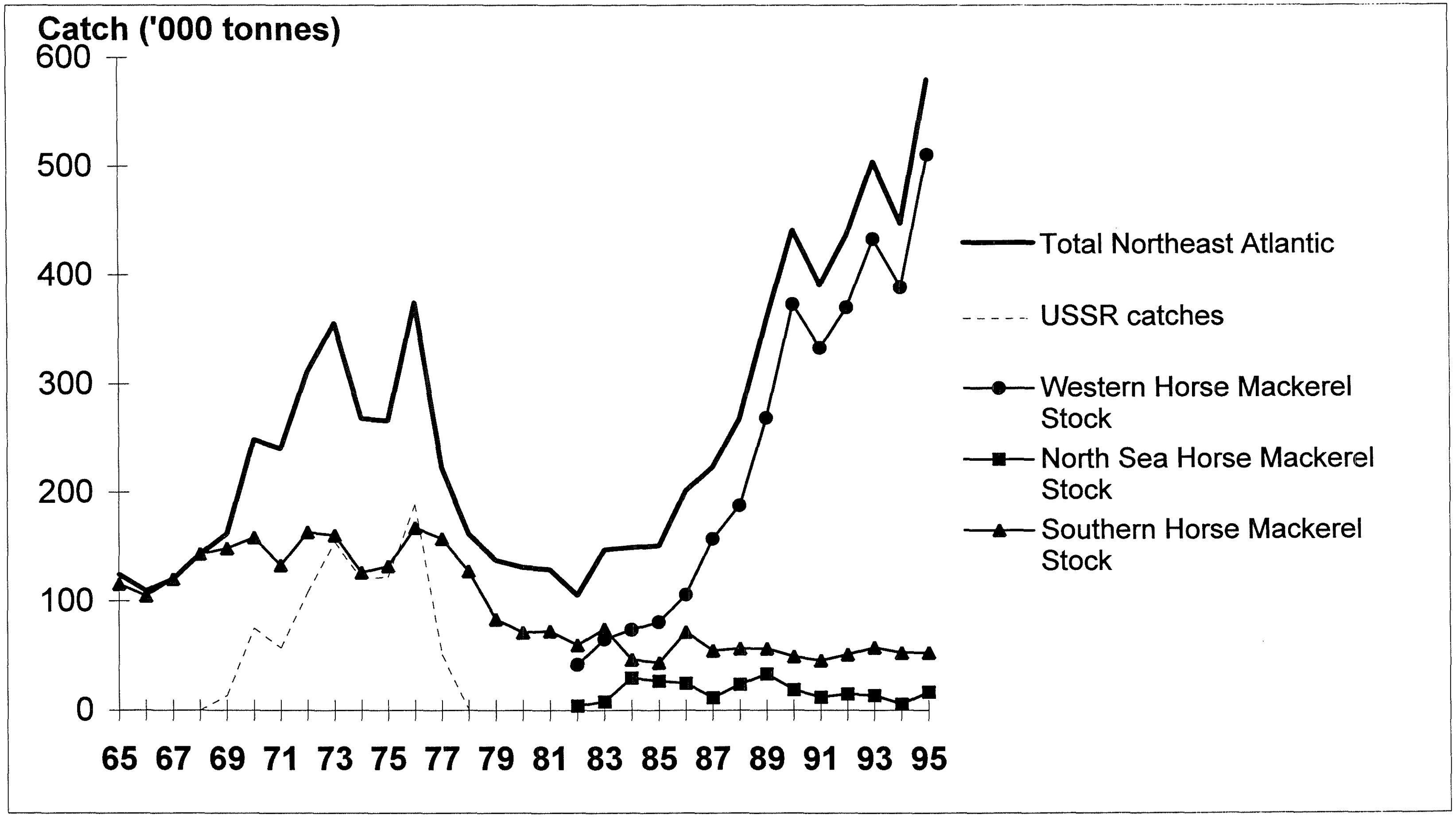


Figure 4.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 1995. The catches taken by the USSR catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catche in the northeast Atlantic.

Figure 4.2a Distribution of horse mackerel fishery.

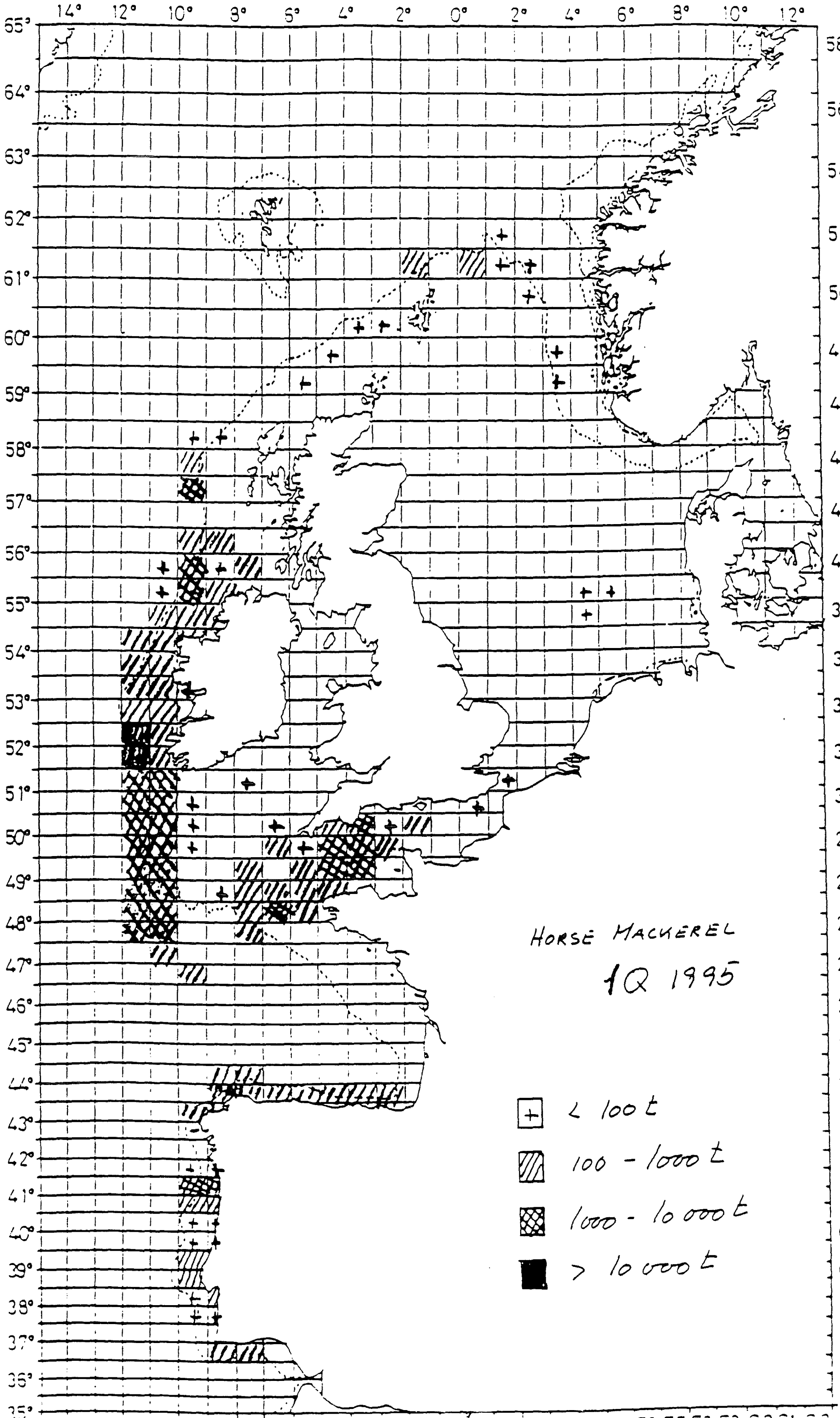


Figure 4.2b Distribution of horse mackerel fishery.

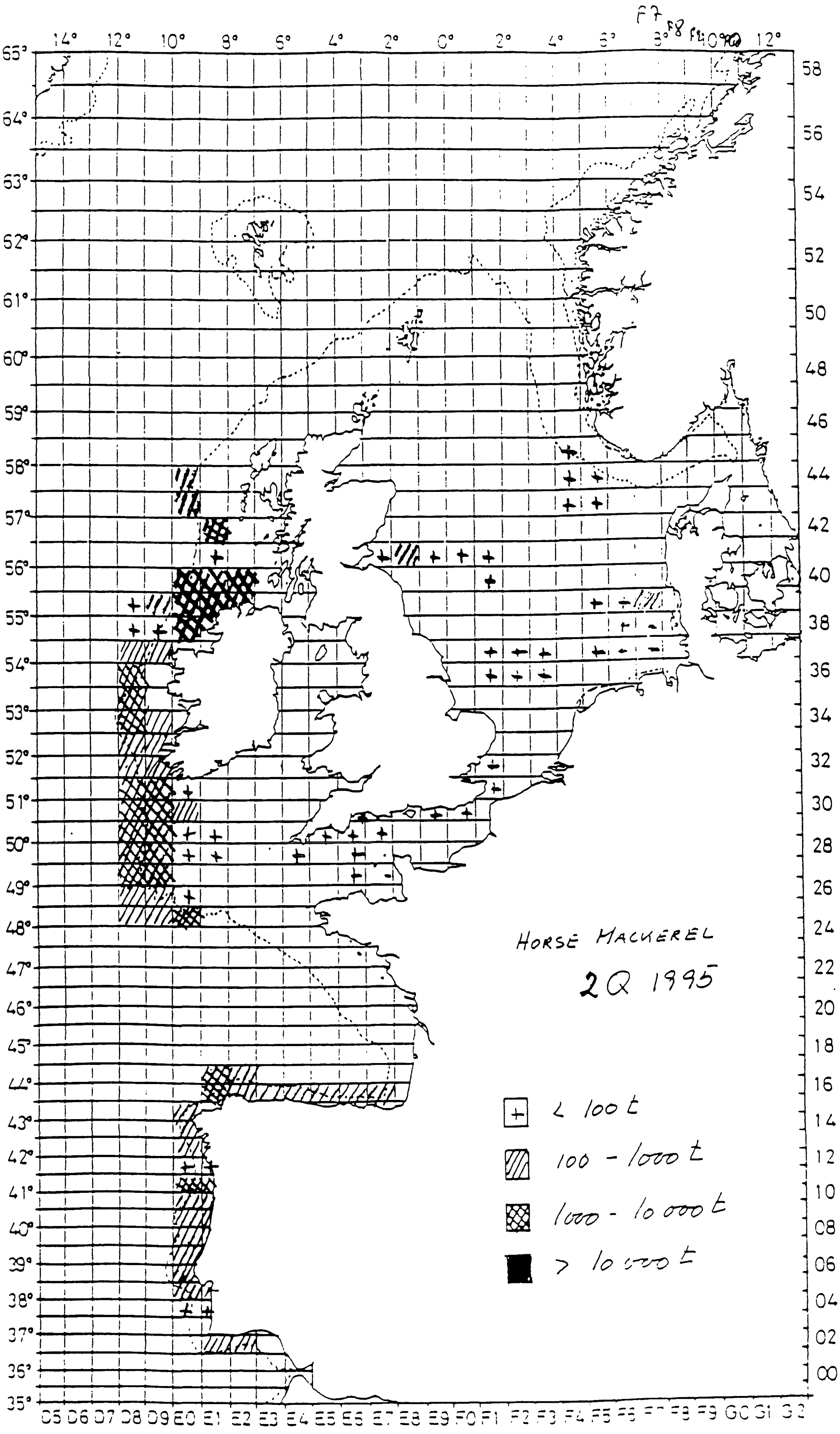


Figure 4.2c Distribution of horse mackerel fishery.

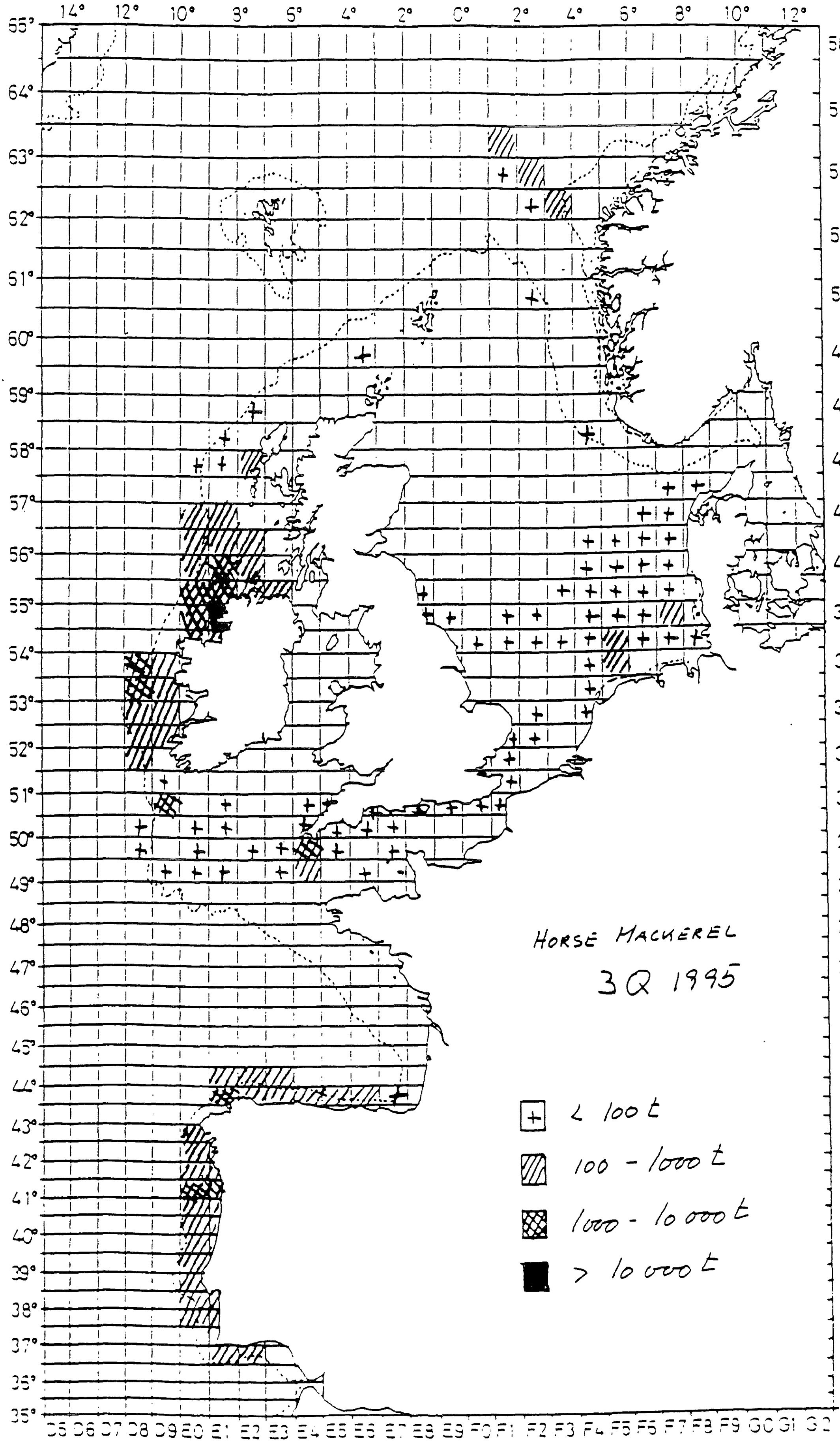
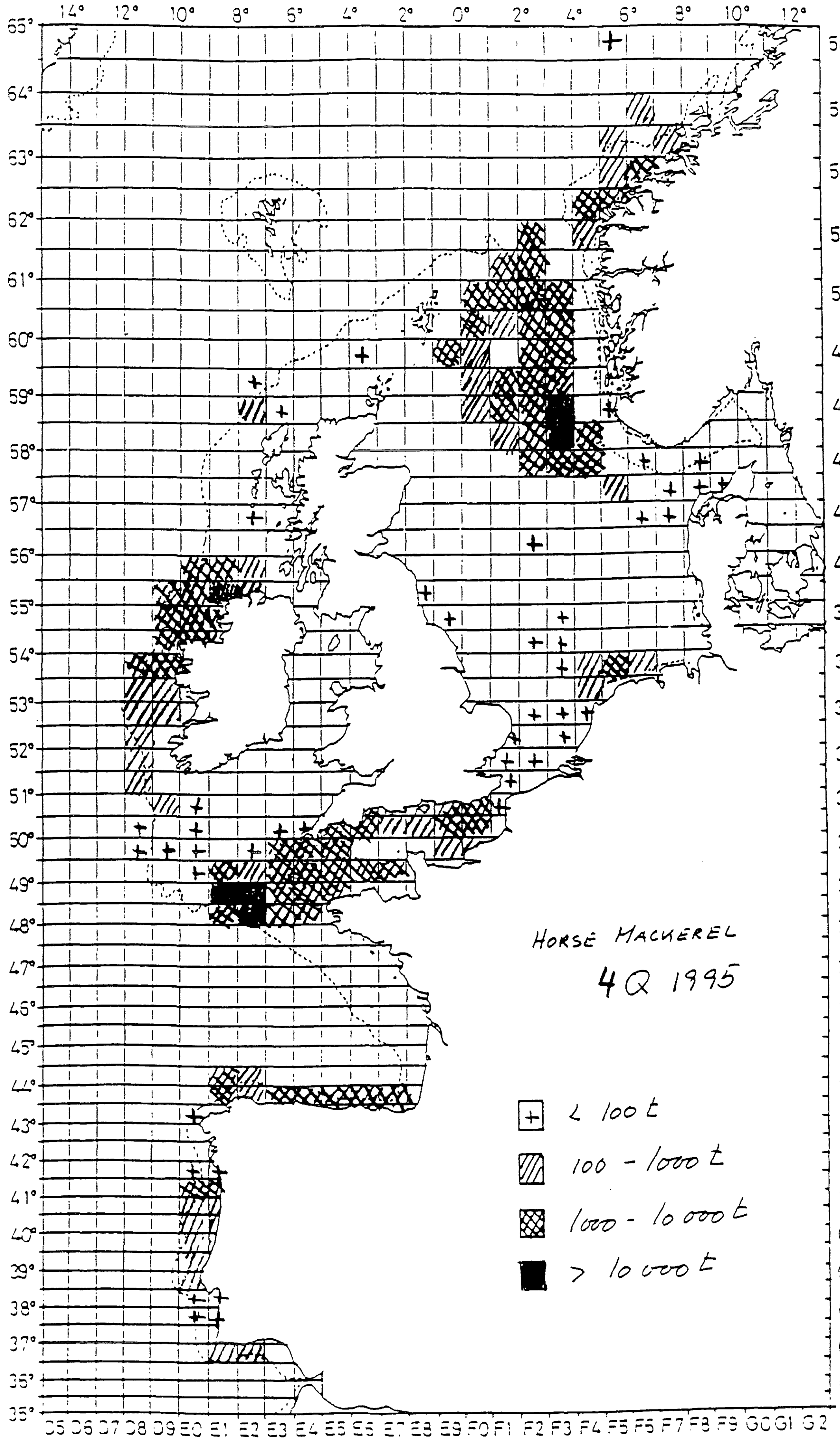


Figure 4.2d Distribution of horse mackerel fishery.



HORSE MACKEREL OTOLITH EXCHANGE 1996 SET B

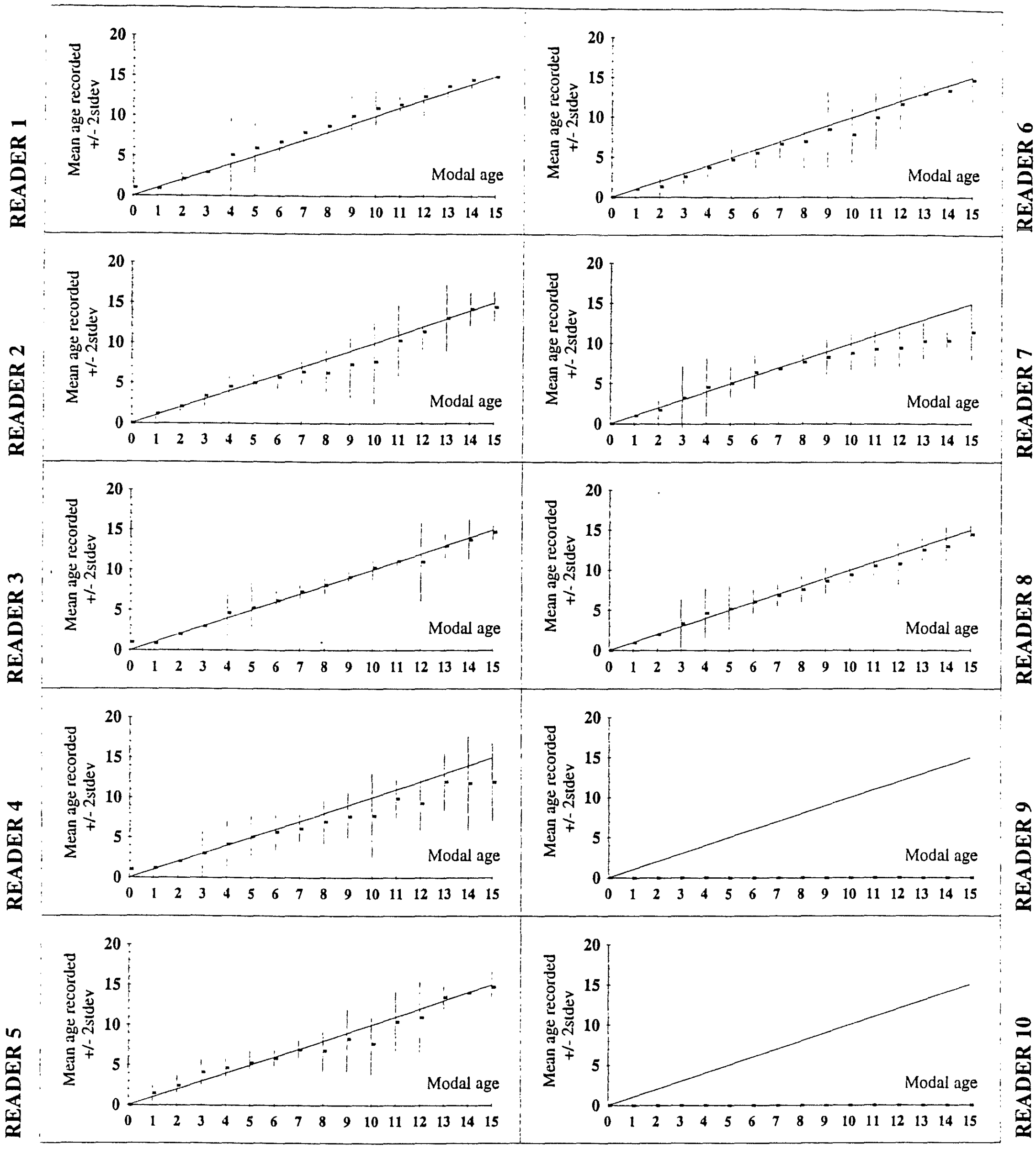


Figure 4.3 In above age bias plots the mean age recorded +/- 2stdev of each age reader is plotted against the modal age.

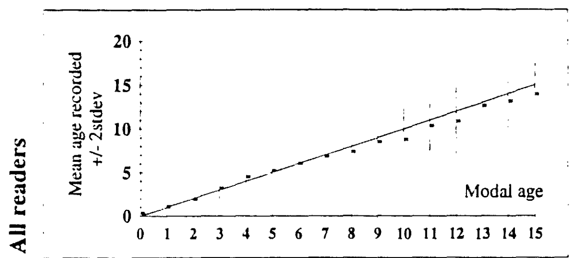


Figure 4.4 In above age bias plots the mean age recorded +/- 2stdev of all age readers is plotted against the modal age.

5 NORTH SEA HORSE MACKEREL (DIVISIONS IIIA - EXCEPT WESTERN PART OF SKAGERRAK - IVB,C AND VIID)

5.1 The Fishery in 1995

The total catch taken from the North Sea and Division IIIa during 1995 was about 99,000 t compared to 133,000 t in 1994 (Table 6.2). However, only catches taken in Divisions IIIa - except western part of Skagerrak - IVb,c and VIId are regarded to belong to the North Sea horse mackerel stock (see section 4.3). Table 4.1 shows the catches of this stock from 1982–1995. The total catch taken from this stock in 1995 was about 17,000 t, which is a considerable increase compared to the catch of about 6,000 t in 1994. In the latest years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId. However, in 1995 at least 70% of the catch has been taken for human consumption.

5.2 Fishery Independent Information

5.2.1 Egg surveys

Horse mackerel egg surveys in the North Sea have been carried out from 1988 to 1991 and the spawning stock biomass estimated were respectively 120, 217, 255 and 247 thousand tonnes (Eltink, 1992). The 1988 estimate was regarded to be an underestimate. No egg surveys were carried out in the years 1992–1996.

5.2.2 Acoustic surveys

No acoustic estimates of the North Sea horse mackerel stock have been available from 1991–1996.

5.3 Age Composition

Samples taken from the Dutch commercial catches and research vessel catches were available for the period 1987–1995. The Dutch samples cover only a small proportion of the total, but give a rough indication of the age composition of the stock (Figure 5.1).

The strength of the 1982 year class in the central and southern North Sea does not seem as strong as in the western area (compare Figure 5.1 with 6.1) and the 1987 year class can not be recognized as a strong year class as is the case in the western area. Year classes 1992 and 1993 are abundant in the western catches, but not in the North Sea area.

5.4 Assessment

As the available biological samples are not considered to be representative of the total catch, no estimates of the catch in numbers were made and it was not possible to do an analytical assessment.

The egg surveys carried out in 1989, 1990 and 1991 resulted in an average spawning stock biomass of 240,000 t over this period (Eltink, 1992).

The strong 1982 year class and relatively strong 1986 and 1989 year classes are recognized in the structure of the stock (Figure 5.1).

The **Working Group recommends that more research be carried out on the North Sea horse mackerel stock** in order to be able to assess this stock.

5.5 Reference Points for Management Purpose

5.5.1 MBAL

MBAL can not be defined with the very little current information about this stock.

5.5.2 Fishing mortality targets

No assessment has been carried out for this stock, since no catch in numbers at age data are available. Therefore a fishing or total mortality target can not be used as is proposed for the western horse mackerel (see Section 6.12.2).

5.6 Management Measures and Considerations

No forecast is available for 1996.

This stock appears to be underexploited based on the following evidence:

The catch ranged from 4,000–33,000 t during the period 1982–1995, while the average SSB from the egg surveys from 1989–1991 was estimated at 240,000 t. There is a high abundance of the 15 plus group (Figure 5.1). The Y/SSB ratio during the period of the 1989–1991 is only 0.09.

A precautionary TAC might be set at 1/5 of the average SSB of 240,000 t from period 1989–1991, which corresponds to approximately 50,000 t. At least the TAC of 60,000 t for 1996 should not be set any higher in the following years unless the is enough evidence that this stock can sustain this constant catch.

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

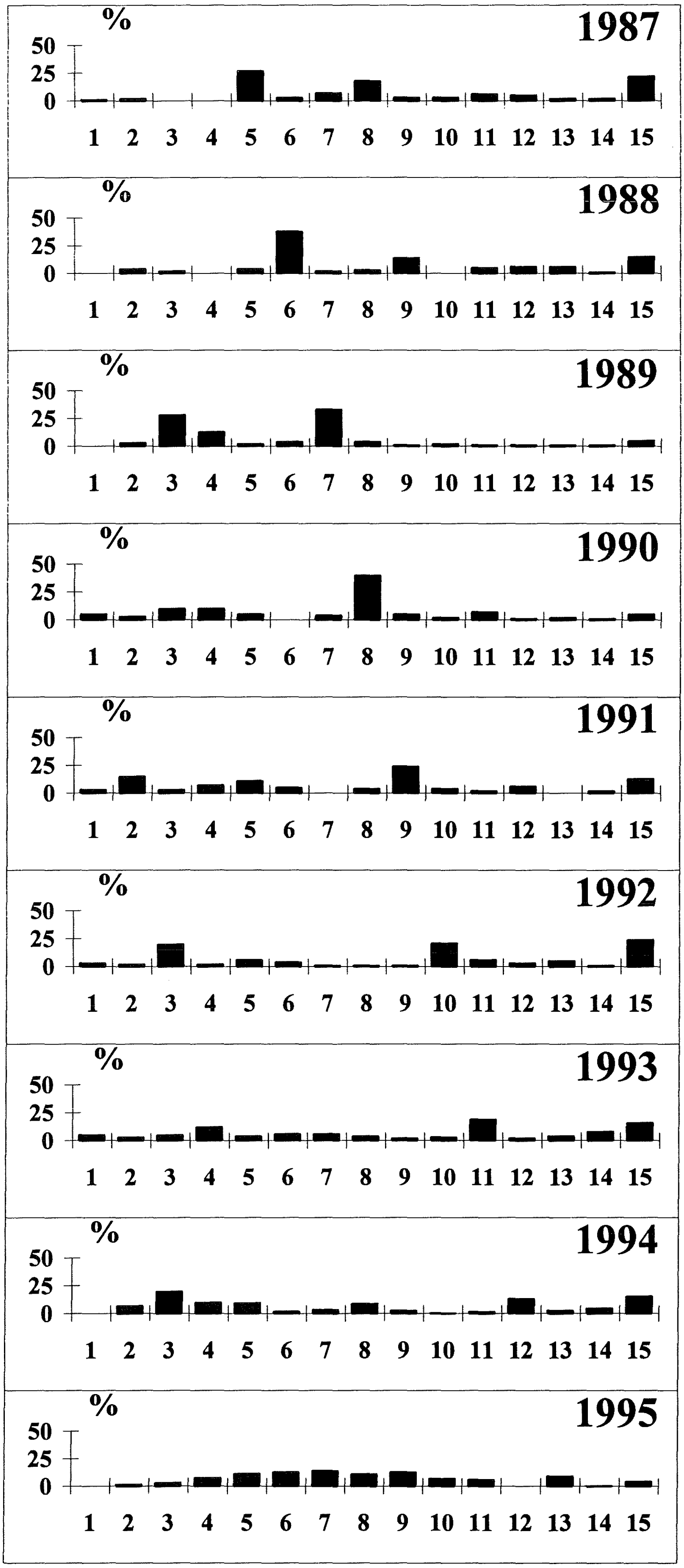


Figure 5.1 The age composition of the North Sea horse mackerel based on commercial and research vessel samples from 1987-1995.

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6 WESTERN HORSE MACKEREL (DIVISIONS IIA, IIIA (WESTERN PART), IVA, VB, VIA, VIIA-C, VIIE-K AND VIIIA,B,D,E)

6.1 The Fishery in 1995

The fishery for the western horse mackerel stock is mainly carried out in Divisions IIa, IIIa (western part), IVa, VIa, VIIe,g,h,j and VIIIa. The national catches taken by the countries fishing these areas are shown in Tables 6.1–6.5, while additional information on the development of the fisheries by quarter and division is shown in Tables 4.1, 4.4 and 4.5 and in Figures 4.2a–d.

Sub-areas II and Division Vb

The national catches taken in this area are shown in Table 6.1. After the drop in catch level to 750 t in 1994 the catches in 1995 is back to the high level of 1993 (13,000 t).

Sub-area IV and Division IIIa (western part)

The total catch of Western horse mackerel in this area was estimated to be about 98,000 t (Table 6.2), mainly taken by a directed fishery for horse mackerel in the fourth quarter in Division IVa by Norwegian purse seiners.

Sub-area VI

The catches taken in Division VI are shown in Table 6.3. The catches have increased from 21,000 t in 1990 to historical high level of 83,500 t in 1995. The main part of the catches are taken by Ireland in a directed trawl fishery for horse mackerel.

Sub-area VII

The catches taken from this area are mainly from Divisions VIIb,e,h,j and are shown in Table 6.4. The catches in 1995 increased by 130,000 t since 1994 and are the highest on record.

Sub-area VIII

The catches from this area are mainly taken in Divisions VIIIa,b,d,e and given in Table 6.5. The catches in these areas increased until 1993 but are now reduced to the level of 1985. Spain is the major fishing nation for horse mackerel in this area and caught 99% of the catches in 1995.

6.2 Fishery Independent Information from Egg Surveys

Horse mackerel egg surveys in the North Sea have been carried out from 1988 to 1991 (Eltink, 1992), but no egg surveys were carried since.

6.3 Catch in Numbers at Age

Sample data with age readings were as in previous years only provided by two countries, the Netherlands (Division VIa, Sub-areas IV, VII and VIII) and Norway (Divisions IIa and IVa). Catches from the other countries were converted to numbers at age using the most appropriate Dutch or Norwegian data.

The catch in numbers at age by quarter and Divisions for western horse mackerel are shown in Table 6.6. The total annual catch in numbers for 1995 is shown in Table 6.9. The sampling intensity is discussed in Section 1.3.

The strong 1982 year class has made up the major part of the international catches since 1984 (Figure 6.1). In 1994 this year class contributed 38% by numbers and 56% by weight and 35% by numbers and 50% by weight of the total catches in 1995. Last year's Working Group (Anon. 1996/Assess:7) indicated that the 1992 year class might be of significant strength because it contributed 33% by numbers of the total catches in 1994. In 1995 this yearclass contributed only 15% and the 1993 year class 18% by numbers.

6.4 Mean Length at Age and Mean Weight at Age

Mean weight and mean length at age in the catches in 1995

Mean weights and mean lengths at age in the catches by quarters in 1994 were provided only by the Netherlands and Norway. These data were applied to the catches from the other countries. The mean weight and mean length at age in the catches in 1995 are shown in Tables 6.7-6.8. The mean weight at age in the catches for several age groups was 10-30% smaller than in 1994.

Mean weight at age in the stock

The mean weights at age in the stock at spawning time for 1995 are shown in Table 6.9. The mean weight at age are as usual based on fish in all maturity stages sampled from the Dutch freezer trawlers the first and second quarter in Divisions VIIj and VIIk. In 1994 the weight in stock was based on Dutch data from Division VIIj only since no data were available from Division VIIk.

Data for two years old horse mackerel were not obtained, but average weight was assumed to be the same as in previous years (Table 6.9).

6.5 Maturity at Age

The proportion mature at age has not been changed, because of the difficulties in estimating it. The proportion mature can be estimated for each year in both the spawning area and the juvenile area. However, the proportion mature for the whole area of distribution can only be estimated if the proportions mature estimated in both areas are weighted according to the numbers of fish present in the spawning and juvenile areas. A proportion mature estimated from all samples taken in the area of stock distribution is regarded as inappropriate.

The large disagreement between the spawning stock biomass estimate of 2.28 million tonnes from the egg survey in 1989 (Table 2.1) and the spawning stock biomass of 4.2 million tonnes from the 'ADAPT'-assessment (Table 6.20) can be explained by changing the assumed value for the proportion of the 1982 year class that were mature in 1989 from 1.0 to 0.74. However, the assumed value of 1.0 was retained unchanged for the assessment calculation. No changes were made to the maturity ogive from 1987 onwards. The problems in estimating the proportion mature at age are similar to those of mackerel (see Section 3.2.3).

Assumptions about maturity at age of horse are critical to the fitting of the populations to the egg survey biomasses, especially when strong year classes appear in the partly mature age groups (see section 6.6). Therefore, the **Working Group recommends that during the next egg survey in 1998 both mackerel and horse mackerel ovaries be collected at peak spawning time in both the western and southern area in order to construct maturity ogives based on histological analysis. At the same time additional sampling should be carried out in the juvenile areas.**

6.6 Stock Assessment

Fitting a population model for this stock presents particular problems which have been documented by Anon. (1995/Assess:2) and Anon. (1996/Assess:7). In summary, the stock is dominated by two cohorts. The 1982 cohort is estimated to have had an abundance at age 0 of around $66x10^9$ individuals compared with more typical recruitments between 1% and 10%. The 1987 cohort is the next most abundant cohort and is estimated to have numbered around 5 billion. Furthermore, there are indications from the recent catches at age that the 1992 cohort is also rather strong, but the strength of the estimate of this cohort depends on assumptions about recent exploitation pattern.

A separable model is not appropriate to assess this stock. There is good evidence from residual patterns that the fishery concentrated on the abundant cohorts since 1982, which violates the assumption of separability. No age-disaggregated indices of abundance are available, hence conventional VPA-tuning methods (e.g. XSA) cannot be used. Furthermore, because of density-dependent effects and spatial sampling problems the proportion mature of the abundant cohorts is highly uncertain. This strongly affects the reliability of the 1986 and 1989 egg surveys as measures of stock size (Anon. 1994/H:4).

The method chosen to assess this stock is 'ADAPT'-type method (Gavaris, 1988) in which an arbitrary choice of selection pattern is made. This method has previously been used to estimate the size of this stock and associated mortality rates (Anon. 1995/Assess:7). The use of this method also allows 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. Given population abundance N, fishing mortality F, natural mortality M, weights at age W, and maturity at age O, 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:

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

where subscripts a and y denote age and year respectively.

The model is fitted to the traditional egg production estimates of biomass (Table 2.1) for 1992 and for 1995. A calculation was made for illustrative purposes using GAM estimates (Augustin *et al.*, 1996 WD), but as these estimates have not yet been shown to be more accurate than traditional estimates, this calculation is provided only to show the sensitivity of the assessment to the choice of method for calculating egg production.

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, and were chosen by Anon. (1996/Assess:7) and are retained here.

- Selection pattern in 1995 and later years is equal to 1 on ages 5 and older;
- Selection on ages 0 to 5 in 1995 and later years set to mean from previous 5 years (1990 to 1994);
- Natural mortality, weights at age in the stock and in the catch are assumed known precisely;
- Maturity ogive is assumed to be known precisely;
- Fishing mortality on the oldest age taken as an arithmetic mean from age 6 to the penultimate true age 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 Anon. (1996/Assess:7). 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 is given in Table 6.10–6.17 and the fitted populations, fishing mortalities and stock sizes are given in Table 6.18–6.20. Figure 6.2 shows the estimates of spawning stock biomass, recruitment, catch and fishing mortality over the period 1982–1995, which are also listed in Table 6.21.

6.7 Comparison with GAM Egg Production Estimate

Population parameter estimates obtained using GAM estimates of egg production are given in Figure 6.2 as dashed lines, for comparative purposes only. The assessment calculation is clearly very robust to the choice of either the traditional or the GAM estimates of egg production.

6.8 Risk Analysis and Medium-Term Projections

A very simple parametric bootstrap approach to the assessment of the consequences of management action under uncertainty is used here. Only uncertainty in the egg survey biomass estimates is considered, and all other parameters and observations are assumed to be known precisely and the model is assumed to be correctly formulated. This approach considerably underestimates the uncertainty in the stock projections, but is considered preferable to presenting a purely deterministic view of stock dynamics.

A catch of 500,000 t was assumed for 1996.

The ADAPT assessment model described above was used to fit 1000 VPA populations to the catch at age data for each of 1000 Monte-Carlo simulations of pseudo-egg surveys, assuming a lognormal error distribution and a coefficient of variation of 20%. The population vectors were then projected forwards through 1997 to 2001 under a range of constant-catch options from 200,000 t to 500 000t annually.

The conservative approach to modelling forthcoming recruitment used by Anon. (1996/Assess:7) was retained here. Recruitments in 1995 and later years were assumed equal to the geometric mean of the weak year classes (1981, 1983–1986, 1988–1991) as estimated in the ADAPT procedure (= 1291 million).

Percentiles of the simulations of stock size falling above and below the MBAL were used as estimates of the risk of the stock falling below this level. Results of these simulations are given in Figure 6.3 and 6.4. An additional simulation was calculated with a constant fishing mortality multiplier constraint (relative to 1995) corresponding to fishing at a target mortality of F = M = 0.15, beginning in 1997 (Figure 6.5).

The simulations indicate that for constant catch levels between 300,000 t and 500,000 t, both stock size and catch will decline rapidly in the forthcoming few years. If catches were to be reduced to 200,000 t annually, the decline would be somewhat slower. The associated risks to the stock, in terms of the probability that the stock will fall below MBAL in each forthcoming year, are plotted in Figure 6.4. This shows for catches of 300,000 t the stock will fall below MBAL with approximately 50% probability in 1998. For catches of 400,000 t, this probability increases to approximately 80% and there is an estimated 30% risk that the stock will fall below MBAL by 1997. At catch levels of 500,000 t, there is approximately a 50% probability that the stock will fall below MBAL in 1997. However, a reduction in catches to 200,000 t would permit the stock to maintain a 50% probability of being above MBAL until 1999.

Fishing at a target fishing mortality rate of 0.15 leads to a slower decline in stock size and a lower risk of falling below MBAL, at a cost of a progressive reduction in catches from 135,000 t down to 86,000 t in 2001. However, these calculations are sensitive to the assumed value for maximum fishing mortality imposed on the stock. This is particularly the case for higher levels of catch constraint, which cannot be maintained unless extremely high values of fishing mortality (in excess of 1.5) are allowed in the projections. Such values may not be feasible in practice. the consequences of attempting to remove catches exceeding 200,000 t cannot therefore be predicted in the medium term, but it appears likely that a rapid depletion in stock size would occur.

The calculations are also of course highly sensitive to the assumed values of natural mortality, which is not known for this stock.

6.9 Long-Term Yield

Given the strong dependence of this stock on infrequent, very strong year-classes it is not considered appropriate to calculate reference points from yield per recruit considerations.

6.10 Reference Points for Management Purposes

6.10.1 MBAL

This stock relies heavily on one or a few very large year classes (at present the 1982 year class). In this situation, reference points that refer to stock-recruitment relationships are not relevant, except that one should not permit the stock to fall below a level which by experience is able to produce a strong year class. This level has been taken as the MBAL by the WG. The spawning stock size estimate from VPA in 1982 was estimated by the Working Group in 1991 to be approximately 500,000 t (Anon. 1991/Assess:22). However, due to the low fishing mortalities on this stock in the 1980s, VPA estimates of stock size are very unreliable and estimates as high as 1.2 million tonnes are plausible (Anon. 1996/Assess:7). To overcome this problem, the Working Group proposes the use of the egg survey estimate of stock size in 1983, being 530,000 t. (Table 2.1). For convenience and in view of the known imprecision of the egg survey estimates, this value is rounded to 500,000 t, and hence the previous value should be retained if an estimate of MBAL is required.

6.10.2 Target fishing mortality

In this stock the last strong year class is now being depleted. At present in 1996, it amounts to approximately 700,000 tonnes in the stock. A precautionary approach would therefore be to reduce the fishing mortality to a level by which the MBAL will be sustained by an average low recruitment. With the low recruitment of 1291 millions (as average over age 1), a long-term equilibrium spawning stock biomass of 500,000 tonnes corresponds to a fishing mortality of 0.11. This level is approximately 2/3 of M as for some of the other stocks in this report.

Also because of the obviously highly uncertain recruitment dynamics in this stock as well as problems of estimating stock size, the Working Group again indicates a preference for a fishing-mortality based reference point to be used for management purposes in the future.

Maintaining fishing mortality below or equal to natural mortality may be an appropriate and cautious approach for managing a stock whose recruitment dynamics are so variable and poorly known. Hence, a management strategy to maintain fishing mortality below 0.15 would be appropriate.

6.11 Comments on Assessment

The present assessment indicates a substantial upward revision in the estimate of fishing mortality from that calculated by Anon. (1996/Assess:7), from 0.16 to 0.32. This is due in very large part to the revision of the preliminary estimate of catches taken in 1995 from 300,000 t to the reported value of 511,000 t.

The assessment of this stock depends on the correct specification of natural mortality and the maturity ogive. The former is assigned an assumed value and the latter may not be measured accurately, hence the assessment model used may be subject to substantial bias. The potential magnitude of this bias for assumptions of the natural mortality rate was investigated by a simple test in which the assessement was repeated for values of M of 50% higher and lower than the routinely used value of M = 0.15. The use of different values of M in the VPA generated markedly different assessments of the spawning biomass of the stock since 1982 (Figure 6.6). The estimated values of F also showed similar sensitivity to M. These preliminary sensitivity results indicate that a lower natural mortality rate could resolve the substantial discrepancies between the model estimates of spawning biomass and the egg survey biomass estimates in the 1980s. A lower natural mortality rate would also make the assumed proportions mature at age more realistic, since they appeared to deviate considerbly from the actual values. The maturity ogive is also uncertain, which amplifies the uncertainty of the estimate of the strength of the apparently relatively strong 1992 and 1993 year classes, since their age in 1995 correspond to the steepest part of the maturity ogive. A possible change to the value of M for future assessments will be examined by further sensitivity analyses, including to the maturity ogive, and re-examinition of the biological basis for the current selection of M. Therefore, **the Working Group recommends that at its next meeting results of sensitivity analyses should be presented, which particularly re-examine the biological basis for the current selection of M.**

6.12 Management Considerations

This assessment calculation indicates that the western horse mackerel stock is still largely dependent on a single cohort. Catches from that cohort have increased substantially in 1995, with a concomitant rise in fishing mortality. Maintaining catch rates at 1995 levels seems unlikely to be a sustainable option. A continuation of the catch level of 500,000 t will result in that MBAL being reached in 1997. A reduction in catch rates to levels corresponding to a fishing mortality below natural mortality, of the order of 220,000 t in 1997, should allow the stock to remain above MBAL for the forthcoming five years, and so improve the likelihood of another strong year-class recruiting to the fishery in that period.

The TAC set by the EU for western horse mackerel is not divided by national quota. This stock is considered by the EU to be purely an EU stock. The fishery managed by the EU will only be closed if the catches of all EU member states overshoot the agreed TAC. The catches of western horse mackerel in Divisions IIa, IIIa and IVa by non-EU countries are not counted against TAC, despite all recommendations made by ACFM that the TACs should apply to all areas where the stock is fished. Figure 6.7 shows that the total catches of western horse mackerel taken by EU and non-EU countries overshoot the agreed TAC most years considerably. The agreed TACs have been increasing over the period 1987 to 1994 despite a rapid decrease in spawning stock size during this period.

Table 6.1 Landings (t) of HORSE MACKEREL in Sub-area II. (Data as submitted by Working Group members.)

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	-	-	-	-	1
Germany, Fed.Rep.	-	+	-	-	-
Norway	-	-	-	412	22
USSR	-	-	-	-	-
Total	-	+	-	412	23

Country	1985	1986	1987	1988	1989	1990
Faroe Islands	-	-	-	-	-	964[3]
Denmark	-	-	39	-	-	-
France	1	-[2]	-[2]	-[2]	-	-
Germany, Fed.Rep.	-	-	-	64	12	+
Norway	78	214	3,272	6,285	4,770	9,135
USSR	-	-	-	469	27	1,298
UK (England + Wales)	-	-	-	-	-	17
Total	79	214	3,311	6,818	4,809	11,414

Country	1991	1992	1993	1994	1995[1]
Faroe Islands	1,115[3]	9,157[3]	1,068	-	-
Denmark	-	-	-	-	200
France	-	-	-	55	-
Germany	-	-	-	-	-
Norway	3,200	4,300	2,100	4	11,300
Russia	172	-	-	700	1,633
UK (England + Wales)	-	-	-	-	-
Total	4,487	13,457	3,168	759	13,133

[1]Preliminary.
[2]Included in Sub-area IV.
[3]Includes catches in Division Vb.

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Table 6.2 Landings (t) of HORSE MACKEREL in Sub-area IV by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	8	34	7	55	20
Denmark	199	3,576	1,612	1,590	23,730
Faroe Islands	260	-	-	-	-
France	292	421	567	366	827
Germany, Fed.Rep.	+	139	30	52	+
Ireland	1,161	412	-	-	-
Netherlands	101	355	559	2,029[4]	824
Norway	119	2,292	7	322	[4]
Poland	-	-	-	2	94
Sweden	-	-	-	-	-
UK (Engl. + Wales)	11	15	6	4	-
UK (Scotland)	-	-	-	-	3
USSR	-	-	-	-	489
Total	2,151	7,245	2,788	4,420	25,987

Country	1985	1986	1987	1988	1989
Belgium	13	13	9	10	10
Denmark	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]
Estonia	-	-	-	-	-
Faroe Islands	-	-	-	-	-
France	298	231[3]	189[3]	784[3]	248
Germany, Fed.Rep.	+	-	3	153	506
Ireland	-	-	-	-	-
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172
Norway[2]	203	776	11,728[5]	34,425[5]	84,161
Poland	-	-	-	-	-
Sweden	-	2[2]	-	-	-
UK (Engl. + Wales)	71	3	339	373	10
UK (N. Ireland)	-	-	-	-	-
UK (Scotland)	998	531	487	5,749	2,093
USSR	-	-	-	-	-
Unallocated + discards	-	-	-	-	-12,482[5]
Total	24,238	20,808	20,895	62,877	112,047

Country	1990	1991	1992[7]	1993	1994	1995[1]
Belgium	13	-	+	74	57	51
Denmark	20,605[2]	6,982[2]	7,755	6,120	3,921	2,432
Estonia	-	-	293	-		17
Faroe Islands	942	340	-	360	275	-
France	220	174	162	302		-
Germany, Fed.Rep.	2,469[6]	5,995	2,801	1,570	1,014	1,600
Ireland	687	2,657	2,600	4,086	415	220
Netherlands	1,970	3,852	3,000	2,470	1,329	5,285
Norway[2]	117,903[2]	50,000[2]	96,000	126,800	94,000	84,747
Poland	-	-	-	-		-
Sweden	102	953[2]	800	697	2,087	-
UK (Engl. + Wales)	10	132	4	115	389	478
UK (N. Ireland)	-	350	-	-		-
UK (Scotland)	458	7,309	996	1,059	7,582	3,650
USSR	-	-	-	-		-
Unallocated + discards	-317[5]	-750[5]	-278	-3,270	1,511	-28
Total	145,062	77,994	114,133	140,383	112,580	98,505

[1]Preliminary. [2]Includes Division IIIa. [3]Includes Division IIa. [4]Estimated from biological sampling. [5]Assumed to be misreported. [6]Includes 13 t from the German Democratic Republic. [7]Includes a negative unallocated catch of -4,000 t.

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Table 6.3 Landings (t) of HORSE MACKEREL in Sub-area VI by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985
Denmark	734	341	2,785	7	-	-
Faroe Islands	-	-	1,248	-	-	4,014
France	45	454	4	10	14	13
Germany, Fed. Rep.	5,550	10,212	2,113	4,146	130	191
Ireland	-	-	-	15,086	13,858	27,102
Netherlands	2,385	100	50	94	17,500	18,450
Norway	-	5	-	-	-	
Spain	-	-	-	-	-	
UK (Engl. + Wales)	9	5	+	38	+	996
UK (N. Ireland)						-
UK (Scotland)	1	17	83	-	214	1,427
USSR	-	-	-		-	-
Unallocated + discards						-19,168
Total	8,724	11,134	6,283	24,881	31,716	33,025

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995[1]
Denmark	-	769	1,655	973	615	-	42	-	294	106
Faroe Islands	1,992	4,450[3]	4,000[3]	3,059	628	255	-	820	80	-
France	12	20	10	2	17	4	3	+	-	-
Germany, Fed. Rep.	354	174	615	1,162	2,474	2,500	6,281	10,023	1,430	1,368
Ireland	28,125	29,743	27,872	19,493	15,911	24,766	32,994	44,802	65,564	120,124
Netherlands	3,450	5,750	3,340	1,907	660	3,369	2,150	590	341	2,326
Norway	83	75	41	-	-	-	-	-	-	-
Spain	-[2]	-[2]	-[2]	-[2]	-[2]	1	3	-	-	-
UK (Engl. + Wales)	198	404	475	44	145	1,229	577	144	109	208
UK (N.Ireland	-	-	-	-	-	1,970	723	-	-	-
UK (Scotland)	138	1,027	7,834	1,737	267	1,640	86	4,523	1,760	789
USSR	-	-	-	-	44	-	-	-	-	-
Unallocated + discards	-13,897	-7,255	-	6,493	143	-1,278	-1,940	-6,960[4]	-51	-41,326
Total	20,455	35,157	45,842	34,870	20,904	34,456	40,469	53,942	69,527	83,595

[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 6.4 Landings (t) of HORSE MACKEREL in Sub-area VII by country. Data submitted by the Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	-	1	1	-	-
Denmark	5,045	3,099	877	993	732
France	1,983	2,800	2,314	1,834	2,387
Germany, Fed.Rep.	2,289	1,079	12	1,977	228
Ireland	-	16	-	-	65
Netherlands	23,002	25,000	27,500[2]	34,350	38,700
Norway	394	-	-	-	-
Spain	50	234	104	142	560
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279
UK (Scotland)	1	-	-	-	1
USSR	-	-	-	-	-
Total	45,697	34,749	33,478	40,526	42,952

Country	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-
Belgium	+	+	2	-	-
Denmark	1,477[2]	30,408[2]	27,368	33,202	34,474
France	1,881	3,801	2,197	1,523	4,576
Germany, Fed.Rep.	-	5	374	4,705	7,743
Ireland	100	703	15	481	12,645
Netherlands	33,550	40,750	69,400	43,560	43,582
Norway	-	-	-	-	-
Spain	275	137	148	150	14
UK (Engl. + Wales)	1,630	1,824	1,228	3,759	4,488
UK (N.Ireland)	-	-	-	-	-
UK (Scotland)	1	+	2	2,873	+
USSR	120	-	-	-	-
Unallocated + discards	-	-	-	-	28,368
Total	39,034	77,628	100,734	90,253	135,890

Country	1990	1991	1992	1993	1994	1995[1]
Faroe Islands	28	-	-	-	-	-
Belgium	+	-	-	-	1	-
Denmark	30,594	28,888	18,984	16,978	41,605	28,300
France	2,538	1,230	1,198	1,001	-	-
Germany, Fed.Rep.	8,109	12,919	12,951	15,684	14,828	17,436
Ireland	17,887	19,074	15,568	16,363	15,281	58,011
Netherlands	111,900	104,107	109,197	157,110	92,903	116,126
Norway	-	-	-	-	-	-
Spain	16	113	106	54	29	25
UK (Engl. + Wales)	13,371	6,436	7,870	6,090	12,418	31,641
UK (N.Ireland)	-	2,026	1,690	587	119	-
UK (Scotland)	139	1,992	5,008	3,123	9,015	10,522
USSR	-	-	-	-	-	-
Unallocated + discards	7,614	24,541	15,563	4,010[3]	14,057	68,644
Total	192,196	201,326	188,135	221,000	200,256	330,705

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

Table 6.5 Landings (t) of HORSE MACKEREL in Sub-area VIII by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	3,361	3,711	3.073	2,643	2,489
Netherlands	-	-	-	-	-[2]
Spain	34,134	36,362	19,610	25,580	23,119
UK (Engl. + Wales)	-	+	1	-	1
USSR	-	-	-	-	20
Total	37,495	40,073	22,683	28,223	25,629

Country	1985	1986	1987	1988	1989
Denmark	-	446	3,283	2,793	6,729
France	4,305	3,534	3,983	4,502	4,719
Germany	-	-	-	-	-
Netherlands	-[2]	-[2]	-[2]	-	-
Spain	23,292	40,334	30,098	26,629	27,170
UK (Engl. + Wales)	143	392	339	253	68
USSR	-	656	-	-	-
Unallocated + discards	-	-	-	-	-
Total	27,740	45,362	37,703	34,177	38,686

Country	1990	1991	1992	1993	1994	1995[1]
Denmark	5,726	1,349	5,778	1,955	-	340
France	5,082	6,164	6,220	4,010	28	-
Germany	-	80	62	-		-
Netherlands	6,000	12,437	9,339	19,000	7,272	-
Spain	25,182	23,733	27,688	27,921	25,409	28,349
UK (Engl. + Wales)	6	70	88	123	753	20
USSR	-	-	-	-		-
Unallocated + discards	1,500	2,563	5,011	700	2,038	-
Total	43,496	46,396	54,186	53,709	35,500	28,709

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

Table 6.6 Catch in numbers ('000) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1995.

1995 Age	IIa 1'st Q catch('000)	IVa 1'st Q catch('000)	VIa 1'st Q catch('000)	VIIb,c,j,k 1'st Q catch('000)	VIIa,e,f,g,h 1'st Q catch('000)	VIIIa,b,d,e 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	99,413	7,751	4,016	33	111,213
4	0	0	0	3,613	2,061	59	5,734
5	0	0	0	368	159	0	527
6	0	0	0	3,163	1,753	0	4,916
7	0	0	0	3,726	2,125	43	5,893
8	0	232	0	42,633	22,269	407	65,541
9	0	232	0	12,859	7,335	194	20,620
10	0	464	4,518	10,391	5,834	115	21,321
11	0	232	0	1,111	634	69	2,046
12	0	0	0	1,909	634	0	2,543
13	0	4,421	9,036	204,602	107,252	1,373	326,685
14	0	0	0	798	0	23	821
15+	0	232	0	10,434	5,260	62	15,988
Total	0	5,814	112,966	303,358	159,331	2,378	583,847
Tonnes	0	1,658	8,857	65,437	34,448	452	110,852

Age	IIa 2'nd Q catch('000)	IVa 2'nd Q catch('000)	VIa 2'nd Q catch('000)	VIIb,c,j,k 2'nd Q catch('000)	VIIa,e,f,g,h 2'nd Q catch('000)	VIIIa,b,d,e 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	4,265	0	31	4,296
4	0	0	0	7,712	0	56	7,768
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	5,536	0	40	5,577
8	0	0	2,491	52,839	0	384	55,714
9	0	0	0	25,148	0	183	25,330
10	0	0	0	14,892	0	108	15,001
11	0	0	0	8,984	0	65	9,049
12	0	0	1,221	0	0	0	1,221
13	0	0	45,718	178,274	0	1,294	225,286
14	0	0	0	2,993	0	22	3,015
15+	0	0	12,357	8,084	0	59	20,501
Total	0	0	61,787	308,728	0	2,241	372,757
Tonnes	0	0	17,486	58,685	44	426	76,641

Age	IIa 3'rd Q catch('000)	IVa 3'rd Q catch('000)	VIa 3'rd Q catch('000)	VIIb,c,j,k 3'rd Q catch('000)	VIIa,e,f,g,h 3'rd Q catch('000)	VIIIa,b,d,e 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	37,107	0	37,107
2	0	0	0	0	37,107	0	37,107
3	0	0	0	0	18,553	8	18,562
4	0	0	0	0	0	15	15
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	1,654	0	11	1,665
8	107	431	31,179	13,865	0	104	45,686
9	194	431	10,422	9,986	0	49	21,083
10	272	862	0	9,986	0	29	11,149
11	198	431	20,800	3,882	0	18	25,329
12	67	0	0	13,865	0	0	13,932
13	5,735	8,213	104,001	39,299	0	349	157,598
14	48	0	31,179	0	0	6	31,233
15+	648	431	62,401	4,452	0	16	67,948
Total	7,269	10,801	259,981	96,989	92,767	605	468,412
Tonnes	2,800	3,109	56,779	18,962	5,232	115	86,997

Age	IIa 4'th Q catch('000)	IVa 4'th Q catch('000)	VIa 4'th Q catch('000)	VIIb,c,j,k 4'th Q catch('000)	VIIa,e,f,g,h 4'th Q catch('000)	VIIIa,b,d,e 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	13,736	0	13,736
2	0	0	0	0	374,305	0	374,305
3	0	0	0	0	248,755	13	248,768
4	0	0	0	0	184,640	24	184,664
5	0	0	0	0	52,286	0	52,286
6	0	0	0	0	80,649	0	80,649
7	0	0	0	4,729	8,545	17	13,291
8	395	3,287	260	.39,631	19,350	164	63,088
9	718	5,965	87	28,543	5,415	78	40,805
10	1,003	8,337	0	28,543	10,399	46	48,328
11	730	6,064	173	11,096	3,537	28	21,628
12	246	2,042	0	39,631	2,916	0	44,835
13	21,165	175,927	866	112,330	24,519	553	335,360
14	177	1,470	260	0	1,662	9	3,579
15+	2,392	19,886	520	12,727	9,970	25	45,520
Total	26,826	222,979	2,166	277,229	1,040,684	957	1,570,841
Tonnes	10,333	85,888	473	54,200	85,031	182	236,107

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Table 6.7 Length (cm) at age of WESTERN HORSE MACKEREL by quarter and Division in 1995

1995 Age	IIa 1'st Q length(cm)	IVa 1'st Q length(cm)	VIa 1'st Q length(cm)	VIIb,c,j,k 1'st Q length(cm)	VIIa,e,f,g,h 1'st Q length(cm)	VIIIa,b,d,e 1'st Q length(cm)	All areas 1'st Q length(cm)
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
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	21.2	21.2	21.1	22.7	21.2
4	0.0	0.0	0.0	25.3	25.3	26.1	25.3
5	0.0	0.0	0.0	24.7	23.5	0.0	24.3
6	0.0	0.0	0.0	27.5	27.3	0.0	27.4
7	0.0	0.0	0.0	27.9	27.9	27.9	27.9
8	0.0	27.5	0.0	29.0	29.0	28.4	29.0
9	0.0	30.5	0.0	29.4	29.4	29.2	29.4
10	0.0	32.5	27.5	29.5	29.5	29.8	29.1
11	0.0	31.5	0.0	29.2	29.2	29.1	29.5
12	0.0	0.0	0.0	30.4	31.2	0.0	30.6
13	0.0	32.8	29.0	30.6	30.6	29.8	30.6
14	0.0	0.0	0.0	33.7	0.0	32.8	33.7
15+	0.0	36.5	0.0	35.9	35.9	32.9	35.9
0-15+	0.0	32.6	22.1	30.1	30.1	29.4	28.5

Age	IIa 2'nd Q length(cm)	IVa 2'nd Q length(cm)	VIa 2'nd Q length(cm)	VIIb,c,j,k 2'nd Q length(cm)	VIIa,e,f,g,h 2'nd Q length(cm)	VIIIa,b,d,e 2'nd Q length(cm)	All areas 2'nd Q length(cm)
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
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	22.7	0.0	22.7	22.7
4	0.0	0.0	0.0	26.1	0.0	26.1	26.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	27.9	0.0	27.9	27.9
8	0.0	0.0	32.0	28.4	0.0	28.4	28.6
9	0.0	0.0	0.0	29.2	0.0	29.2	29.2
10	0.0	0.0	0.0	29.8	0.0	29.8	29.8
11	0.0	0.0	0.0	29.1	0.0	29.1	29.1
12	0.0	0.0	35.5	0.0	0.0	0.0	35.5
13	0.0	0.0	33.6	29.8	0.0	29.8	30.6
14	0.0	0.0	0.0	32.8	0.0	32.8	32.8
15+	0.0	0.0	35.5	32.9	0.0	32.9	34.5
0-15+	0.0	0.0	34.0	29.4	0.0	29.4	30.1

Age	IIa 3'rd Q length (cm)	IVa 3'rd Q length (cm)	VIa 3'rd Q length (cm)	VIIb,c,j,k 3'rd Q length (cm)	VIIa,e,f,g,h 3'rd Q length (cm)	VIIIa,b,d,e 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	16.8	0.0	16.8
2	0.0	0.0	0.0	0.0	19.1	0.0	19.1
3	0.0	0.0	0.0	0.0	21.5	22.7	21.5
4	0.0	0.0	0.0	0.0	0.0	26.1	26.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	27.5	0.0	27.9	27.5
8	30.9	27.5	27.5	26.6	0.0	28.4	27.2
9	31.3	30.5	27.5	28.8	0.0	29.2	28.2
10	31.5	32.5	0.0	28.2	0.0	29.8	28.6
11	32.4	31.5	28.5	28.6	0.0	29.1	28.6
12	31.3	0.0	0.0	28.9	0.0	0.0	29.0
13	34.0	32.8	29.3	28.7	0.0	29.8	29.5
14	35.5	0.0	30.2	0.0	0.0	32.8	30.2
15+	36.8	36.5	30.7	30.0	0.0	32.9	30.7
0-15+	34.0	32.6	29.4	28.4	18.7	29.4	27.2

Age	IIa 4'th Q length(cm)	IVa 4'th Q length(cm)	VIa 4'th Q length(cm)	VIIb,c,j,k 4'th Q length(cm)	VIIa,e,f,g,h 4'th Q length(cm)	VIIIa,b,d,e 4'th Q length(cm)	All areas 4'th Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	16.8	0.0	16.8
2	0.0	0.0	0.0	0.0	18.3	0.0	18.3
3	0.0	0.0	0.0	0.0	20.6	22.7	20.6
4	0.0	0.0	0.0	0.0	22.0	26.1	22.0
5	0.0	0.0	0.0	0.0	24.9	0.0	24.9
6	0.0	0.0	0.0	0.0	25.1	0.0	25.1
7	0.0	0.0	0.0	27.5	27.7	27.9	27.6
8	30.9	30.9	27.5	26.6	27.1	28.4	27.0
9	31.3	31.3	27.5	28.8	26.6	29.2	28.9
10	31.5	31.5	0.0	28.2	27.1	29.8	28.6
11	32.4	32.4	28.5	28.6	28.4	29.1	29.8
12	31.3	31.3	0.0	28.9	28.5	0.0	29.0
13	34.0	34.0	29.3	28.7	27.9	29.8	31.8
14	35.5	35.5	30.2	0.0	27.5	32.8	31.4
15+	36.8	36.8	30.7	30.0	27.8	32.9	32.9
0-15+	34.0	34.0	29.4	28.4	21.1	29.4	24.5

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Table 6.8 Weight (g) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1995.

1995 Age	IIa 1'st Q weight(g)	IVa 1'st Q weight(g)	VIa 1'st Q weight(g)	VIIb,c,j,k 1'st Q weight(g)	VIIa,e,f,g, 1'st Q weight(g)	VIIIa,b,d,e 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	67	66	65	76	67
4	0	0	0	115	115	130	115
5	0	0	0	119	96	0	112
6	0	0	0	155	151	0	153
7	0	0	0	169	169	157	169
8	0	191	0	185	186	171	185
9	0	244	0	193	193	183	193
10	0	285	153	192	192	198	186
11	0	277	0	185	185	188	196
12	0	0	0	204	229	0	210
13	0	288	165	225	226	197	224
14	0	0	0	320	0	262	318
15+	0	405	0	367	371	269	369
0-15+	0	286	78	215	215	190	189

Age	IIa 2'nd Q weight(g)	IVa 2'nd Q weight(g)	VIa 2'nd Q weight(g)	VIIb,c,j,k 2'nd Q weight(g)	VIIa,e,f,g, 2'nd Q weight(g)	VIIIa,b,d,e 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	76	0	76	76
4	0	0	0	130	0	130	130
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	157	0	157	157
8	0	0	262	171	0	171	175
9	0	0	0	183	0	183	183
10	0	0	0	198	0	198	198
11	0	0	0	188	0	188	188
12	0	0	330	0	0	0	330
13	0	0	268	197	0	197	211
14	0	0	0	262	0	262	262
15+	0	0	340	269	0	269	312
0-15+	0	0	283	190	0	190	205

Age	IIa 3'rd Q weight (g)	IVa 3'rd Q weight (g)	VIa 3'rd Q weight (g)	VIIb,c,j,k 3'rd Q weight (g)	VIIa,e,f,g, 3'rd Q weight (g)	VIIIa,b,d,e 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	38	0	38
2	0	0	0	0	59	0	59
3	0	0	0	0	91	76	91
4	0	0	0	0	0	130	130
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	188	0	157	188
8	311	191	187	158	0	171	179
9	318	244	193	202	0	183	199
10	323	285	0	200	0	198	209
11	344	277	218	205	0	188	218
12	317	0	0	211	0	0	211
13	383	288	212	196	0	197	218
14	418	0	227	0	0	262	227
15+	482	405	245	240	0	269	248
0-15+	385	286	218	196	57	190	186

Age	IIa 4'th Q weight(g)	IVa 4'th Q weight(g)	VIa 4'th Q weight(g)	VIIb,c,j,k 4'th Q weight(g)	VIIa,e,f,g, 4'th Q weight(g)	VIIIa,b,d,e 4'th Q weight(g)	All areas 4'th Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	37	0	37
2	0	0	0	0	51	0	51
3	0	0	0	0	74	76	74
4	0	0	0	0	87	130	87
5	0	0	0	0	126	0	126
6	0	0	0	0	128	0	128
7	0	0	0	188	166	157	174
8	311	311	187	158	157	171	167
9	318	318	193	202	148	183	214
10	323	323	0	200	153	198	213
11	344	344	218	205	170	188	243
12	317	317	0	211	167	0	213
13	383	383	212	196	172	197	304
14	418	418	227	0	155	262	282
15+	482	482	245	240	168	269	343
0-15+	385	385	218	196	82	190	150

Table 6.9 Catch in numbers, mean length and mean weight in catch and mean weight in stock of western horse mackerel in 1995

Age	Catch in nunmbers (Millions)	Mean length (cm)	Mean weight (kg) in catch	in stock
0	0.000			
1	50.843	16.8	0.038	
2	411.412	18.4	0.052	0.050
3	382.838	20.8	0.073	0.066
4	198.181	22.3	0.089	0.119
5	52.812	24.9	0.126	0.096
6	85.565	25.2	0.130	0.152
7	26.425	27.7	0.170	0.166
8	230.028	28.0	0.176	0.178
9	107.838	28.9	0.200	0.187
10	95.799	28.9	0.204	0.197
11	58.051	29.2	0.222	0.187
12	62.531	29.2	0.215	0.229
13	1044.929	30.8	0.246	0.218
14	38.647	30.6	0.237	0.272
15+	149.957	32.4	0.298	0.348

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Table 6.10. Western Horse Mackerel. (a) Catch in number at age (Thousands)

Age	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565
7	6013	37775	29105	9808	79428	34886	10613	1159550	19305	19000	42840	124050	205842	26425
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799
11	4473	2428	0	263	2255	16252	14301	12629	95505	13060	12000	1177060	21847	58051
12	12560	12204	486	659	746	7484	15158	21975	14040	51200	22750	6420	909325	62531
13	19489	17142	1337	2888	619	1173	4537	12471	32496	9710	69970	16110	9861	1044929
14	13205	27505	3866	970	211	168	4285	8162	16935	9000	12110	52610	14411	38647
15+	5579	33335	38732	27005	37295	27613	28378	16468	53023	49400	32200	33490	37138	149957

Table 6.11. Western Horse Mackerel. (b) Historic weight at age in the catches (Kg)

Age	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

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Table 6.12. Western Horse Mackerel. (c) Weight at age in the catches (Kg), assumed for projections.

Age	Year 1996	1997	1998	1999	2000	2001
0	0.015	0.015	0.015	0.015	0.015	0.015
1	0.036	0.036	0.036	0.036	0.036	0.036
2	0.062	0.062	0.062	0.062	0.062	0.062
3	0.100	0.100	0.100	0.100	0.100	0.100
4	0.113	0.113	0.113	0.113	0.113	0.113
5	0.142	0.142	0.142	0.142	0.142	0.142
6	0.145	0.145	0.145	0.145	0.145	0.145
7	0.167	0.167	0.167	0.167	0.167	0.167
8	0.184	0.184	0.184	0.184	0.184	0.184
9	0.193	0.199	0.199	0.199	0.199	0.199
10	0.220	0.208	0.220	0.220	0.220	0.220
11	0.245	0.245	0.220	0.245	0.245	0.245
12	0.254	0.254	0.254	0.233	0.254	0.254
13	0.301	0.301	0.301	0.301	0.243	0.301
14	0.260	0.318	0.318	0.318	0.318	0.252
15+	0.366	0.266	0.271	0.274	0.278	0.280

Table 6.13. Western Horse Mackerel. (d) Historic weight at age in the stock (Kg)

Age	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

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Table 6.14. Western Horse Mackerel. (e) Weight at age in the stock (Kg), assumed for projections.

Age	Year 1996	1997	1998	1999	2000	2001
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0.050	0.050	0.050	0.050	0.050	0.050
3	0.075	0.075	0.075	0.075	0.075	0.075
4	0.108	0.108	0.108	0.108	0.108	0.108
5	0.130	0.130	0.130	0.130	0.130	0.130
6	0.174	0.174	0.174	0.174	0.174	0.174
7	0.168	0.168	0.168	0.168	0.168	0.168
8	0.187	0.187	0.187	0.187	0.187	0.187
9	0.193	0.190	0.190	0.190	0.190	0.190
10	0.192	0.208	0.192	0.192	0.192	0.192
11	0.194	0.194	0.220	0.194	0.194	0.194
12	0.230	0.230	0.230	0.233	0.230	0.230
13	0.253	0.253	0.253	0.253	0.243	0.253
14	0.260	0.271	0.271	0.271	0.271	0.252
15+	0.341	0.266	0.271	0.274	0.278	0.280

Table 6.15. Western Horse Mackerel. (f) Historical proportions of fish spawning at age and year.

Age	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.0	0.0	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
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
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
4	1.0	1.0	0.9	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5	1.0	1.0	1.0	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6	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
7	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
8	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
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	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
11	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
12	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
13	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
14	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
15	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

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Table 6.16. Western Horse Mackerel. (g) Assumed values of proportions of fish spawning at age and year, as used in projections.

Age	Year 1996	1997	1998	1999	2000	2001
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
2	0.1	0.1	0.1	0.1	0.1	0.1
3	0.4	0.4	0.4	0.4	0.4	0.4
4	0.6	0.6	0.6	0.6	0.6	0.6
5	0.8	0.8	0.8	0.8	0.8	0.8
6	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0
12	1.0	1.0	1.0	1.0	1.0	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0
14	1.0	1.0	1.0	1.0	1.0	1.0
15	1.0	1.0	1.0	1.0	1.0	1.0

Table 6.17. Western Horse Mackerel. (h). Assumed scalars used in the ADAPT analysis.

Natural Mortality	0.15 /yr
Proportion of fishing mortality before spawning	0.45
Proportion of natural mortality before spawning	0.45

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Table 6.18. Western Horse Mackerel. Results of ADAPT analysis (a) Estimated historical fishing mortality

Age	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0020	0.0026	0.0000	0.0041	0.0052
1	0.0017	0.0001	0.0000	0.0009	0.0000	0.0000	0.0053	0.0000	0.0193	0.0488	0.0636	0.0233	0.0077	0.1113
2	0.0087	0.0013	0.0040	0.0028	0.0000	0.0002	0.0025	0.0000	0.0853	0.0576	0.0740	0.0462	0.2630	0.2754
3	0.0205	0.0169	0.0032	0.0120	0.0010	0.0000	0.0012	0.0103	0.0395	0.0349	0.1014	0.0290	0.1231	0.1841
4	0.0083	0.0101	0.0234	0.0038	0.0148	0.0025	0.0045	0.0129	0.0375	0.0698	0.1601	0.1043	0.2473	0.3391
5	0.0097	0.0138	0.0358	0.0329	0.0081	0.0269	0.0196	0.0066	0.0288	0.1024	0.1156	0.4088	0.1029	0.4266
6	0.0096	0.0411	0.0252	0.0294	0.0580	0.0026	0.0355	0.0184	0.0159	0.0772	0.1162	0.1976	0.2099	0.3087
7	0.0127	0.0545	0.0454	0.0172	0.0360	0.0527	0.0186	0.0609	0.0322	0.0365	0.0602	0.1749	0.1864	0.3087
8	0.0039	0.0322	0.0456	0.0235	0.0391	0.0417	0.0651	0.0227	0.0851	0.0424	0.0328	0.1173	0.1709	0.3087
9	0.0148	0.0097	0.0337	0.0101	0.0344	0.0248	0.0393	0.1283	0.0882	0.0980	0.0437	0.0714	0.0849	0.3087
10	0.0589	0.2785	0.0150	0.0257	0.0276	0.0215	0.0256	0.0610	0.2166	0.0676	0.1148	0.0095	0.1481	0.3087
11	0.1080	0.1654	0.0000	0.0015	0.0096	0.0489	0.0461	0.0456	0.0969	0.0573	0.0472	0.1699	0.0771	0.3087
12	0.0711	0.4463	0.0428	0.0753	0.0049	0.0379	0.0558	0.0878	0.0621	0.0655	0.1269	0.0305	0.1817	0.3087
13	0.0787	0.1242	0.0746	0.3577	0.0892	0.0090	0.0276	0.0565	0.1715	0.0529	0.1137	0.1181	0.0569	0.3087
14	0.0447	0.1440	0.0353	0.0676	0.0373	0.0299	0.0392	0.0602	0.0961	0.0622	0.0819	0.1111	0.1395	0.3087
15	0.0447	0.1440	0.0353	0.0676	0.0373	0.0299	0.0392	0.0602	0.0961	0.0622	0.0819	0.1111	0.1395	0.3087
Mean F (5-14)	0.0412	0.1310	0.0353	0.0641	0.0344	0.0296	0.0372	0.0548	0.0893	0.0662	0.0853	0.1409	0.1358	0.3205
Mean F (5-14) , W	0.0230	0.0497	0.0358	0.0263	0.0330	0.0279	0.0356	0.0585	0.0819	0.0904	0.1070	0.1636	0.1663	0.3114

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Table 6.19. Western Horse Mackerel. Results of ADAPT analysis (b) Estimated population abundance (Thousands of fish on 1 January)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	66269800	1960090	1675970	2542510	3106840	5700480	750223	1249870	513968	1703090	5122020	2494840	605650	1500200	1500200
1	1560310	57038900	1687060	1442520	2188360	2674080	4906450	645012	1075780	442376	1462870	4397050	2147330	519143	1284560
2	1779370	1340630	49088600	1452070	1240410	1883540	2301530	4200800	555167	908215	362629	1181470	3697250	1834020	399771
3	4854150	1518250	1152380	42080700	1246280	1067630	1620790	1975980	3615660	438773	737954	289856	971025	2446310	1198540
4	1016400	4093150	1284900	988736	35785700	1071650	918920	1393320	1683270	2991450	364703	573900	242347	738938	1751530
5	1002480	867569	3487450	1080330	847804	30347500	920081	787348	1183860	1395470	2401210	267458	445020	162885	453095
6	898913	854531	736525	2896060	899793	723858	25426900	776524	673209	990052	1084170	1841170	152953	345574	91505.7
7	514326	766307	705911	618173	2420520	730789	621427	21120900	656157	570278	788873	830772	1300520	106723	218435
8	308363	437112	624577	580622	522978	2009770	596683	525033	17105000	546873	473240	639312	600324	929020	67459
9	20552.9	264371	364317	513596	488121	432891	1659210	481189	441763	13521200	451161	394163	489371	435528	587227
10	21092.2	17429.6	225359	303166	437599	405929	363462	1373020	364277	348127	10551000	371708	315877	386906	275294
11	46991.2	17115.1	11355.2	191076	254308	366405	341959	304930	1111850	252474	280058	8096640	316920	234452	244560
12	196875	36305.4	12485.3	9773.51	164217	216795	300313	281080	250757	868562	205210	229932	5880160	252546	148195
13	277154	157821	19999.4	10295.9	7801.9	140651	179664	244442	221582	202825	700161	155573	191956	4220180	159632
14	324980	220502	119974	15975.5	6196.88	6142.06	119973	150434	198842	160662	165579	537873	118993	156085	2667550
15	137301	267240	1201970	444762	1095320	1009530	794536	303522	622570	881855	440269	342394	306651	605635	197320

Table 6.20. Western Horse Mackerel. Results of ADAPT analysis (c) Estimated spawning stock size (Tonnes at spawning time)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Egg surv.											2210000			1710000
Fitted:	1505742	1689764	1838914	2689809	3626567	4266991	4802074	4227016	3739577	3605915	2841012	2545355	1943854	1472160

TABLE 6.21 Stock summary table for western horse mackerel.

Year	SSB ('000t)	F(5-14)	Yield ('000t)	Recruitment at age 1 (millions)
1982	1506	.041	41.6	1560
1983	1690	.131	64.9	57039
1984	1839	.035	73.6	1687
1985	2690	.064	80.6	1443
1986	3627	.034	105.7	2188
1987	4267	.030	157.2	2674
1988	4802	.037	188.1	4906
1989	4227	.055	268.9	645
1990	3740	.089	373.5	1076
1991	3606	.066	333.6	442
1992	2841	.085	370.6	1463
1993	2545	.141	433.1	4397
1994	1944	.136	388.9	2147
1995	1472	.320	510.6	519

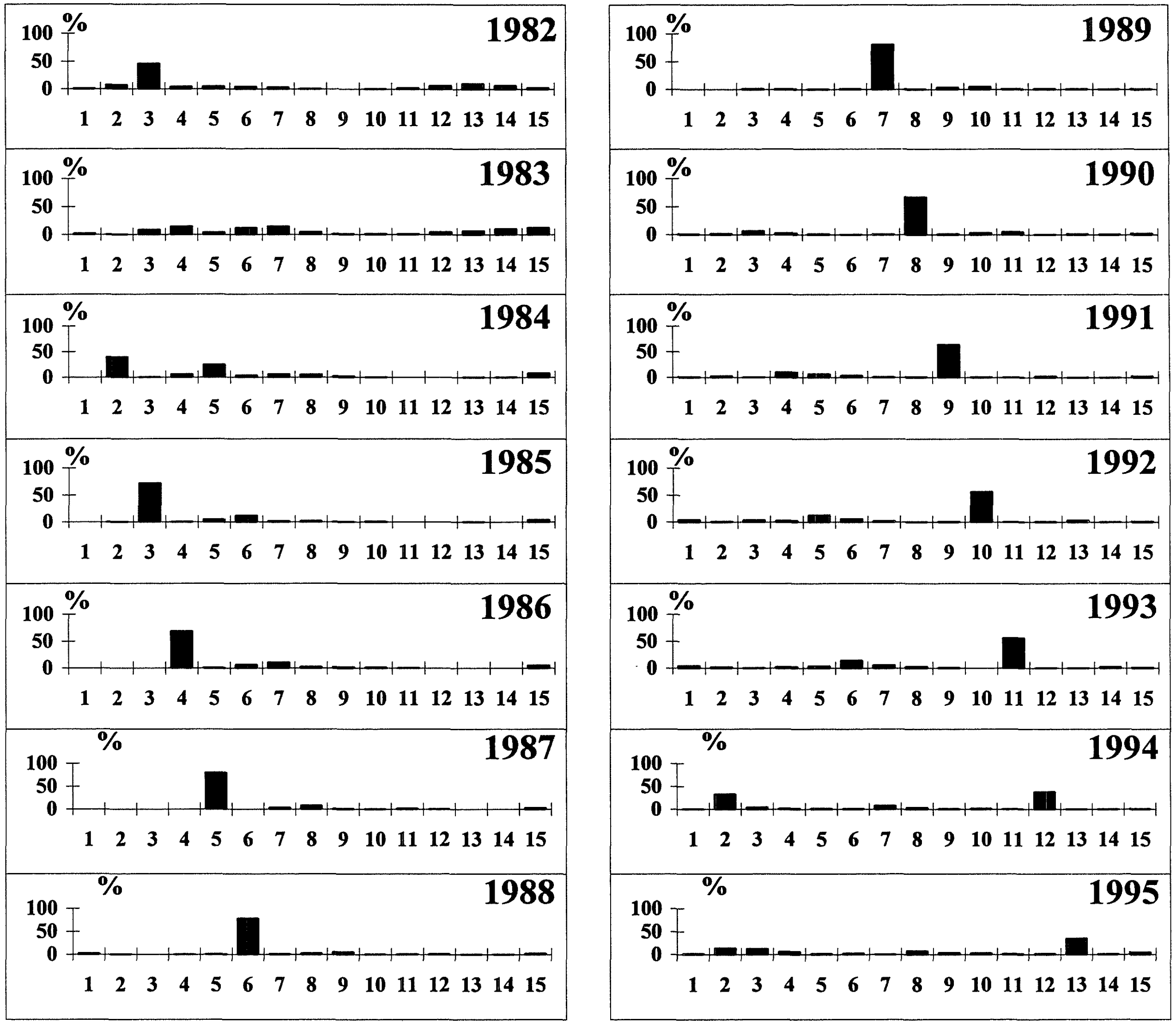


Figure 6.1 The age composition of the western horse mackerel in the international catches from 1982- Age 15 is a plus group.

Western Horse Mackerel : Stock Summary

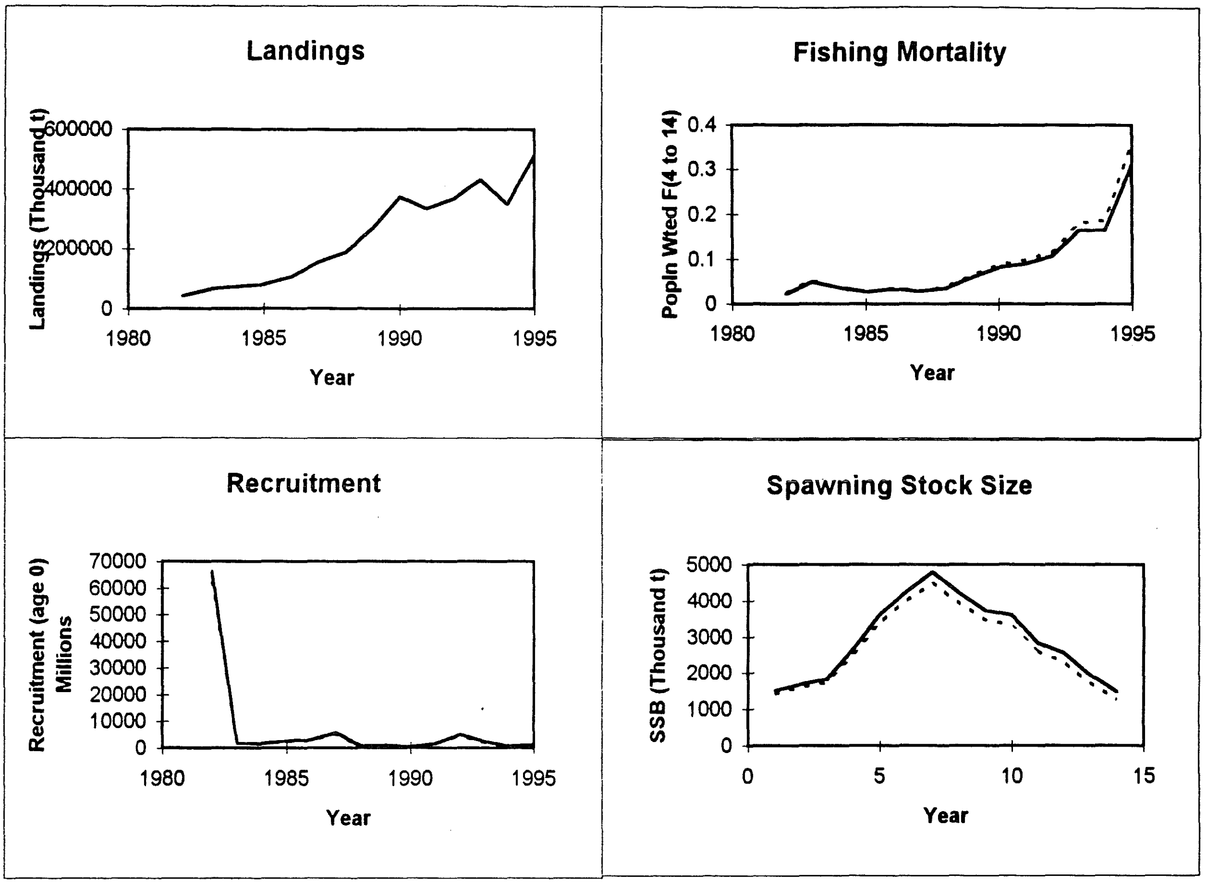


Figure 6.2 Western Horse Mackerel. Summary of landings, fishing mortality, recruitment and spawning biomass. Full lines, ADAPT estimates obtained on fitting to traditional annual egg production estimates. Broken lines, estimates obtained fitting to GAM estimates of egg production.

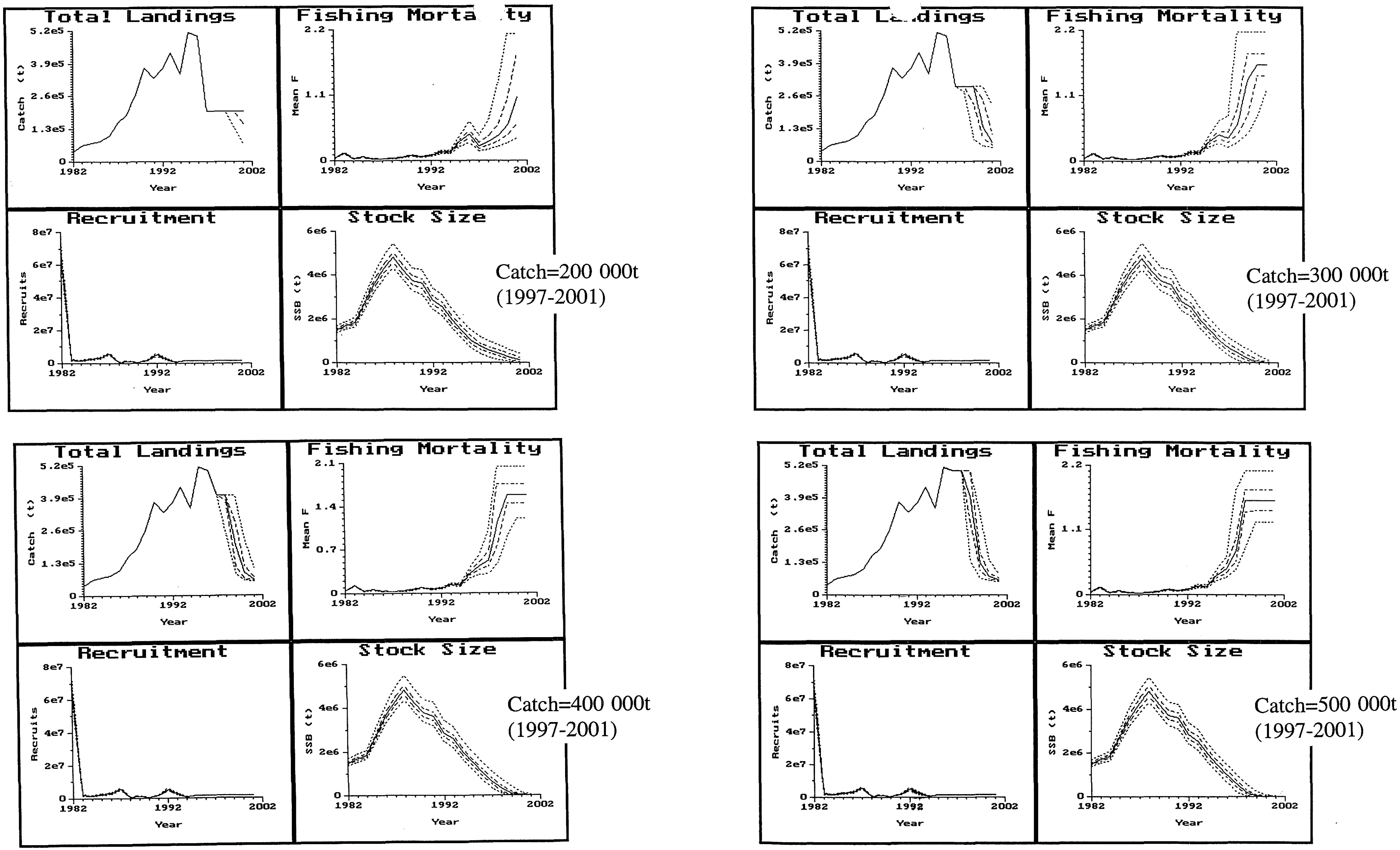


Figure 6.3. Western Horse Mackerel. Uncertainty in assessment and in medium-term projections. Landings, fishing mortality, recruitment and spawning stock size estimates for four levels of annual catch constraint over the period 1997-2001. Full lines, medians. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. Fishing mortality in the projections constrained to be less than 5 times fishing mortality in 1995. Catch constrained to 500 000t in 1996.

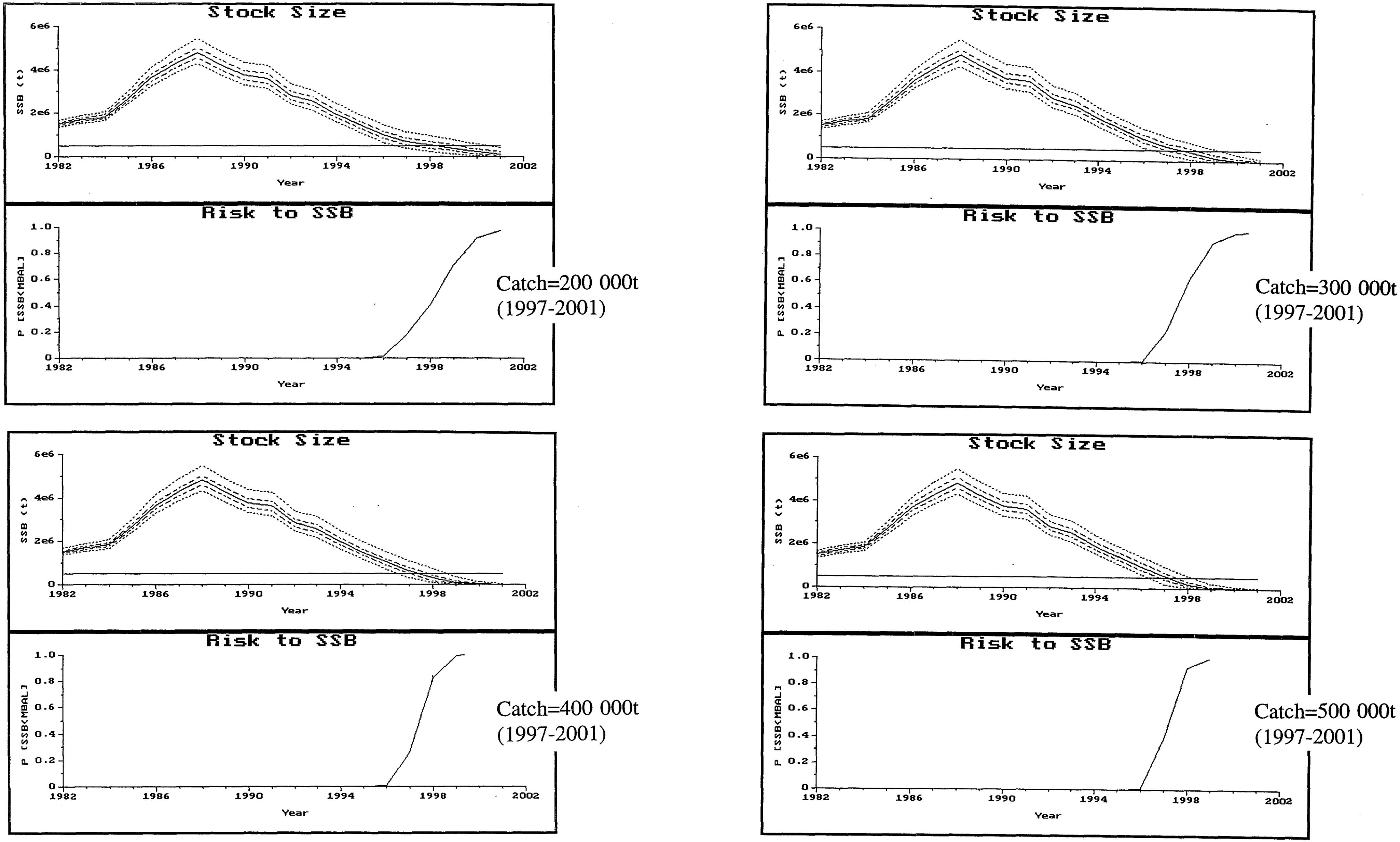


Figure 6.4. Western Horse Mackerel. Estimates of stock size in assessment (1982-1995) and in medium-term projections (1982-2001), compared with the assumed MBAL of 500 000t, for four levels of catch constraint over the period 1997-2001. **Upper panels,** trajectories of estimates of spawning stock size. Full lines, medians. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. **Lower panels,** estimated probability of the stock size being be[illegible] MBAL by year. Catch constrained to 500 [illegible]0t in 1996.

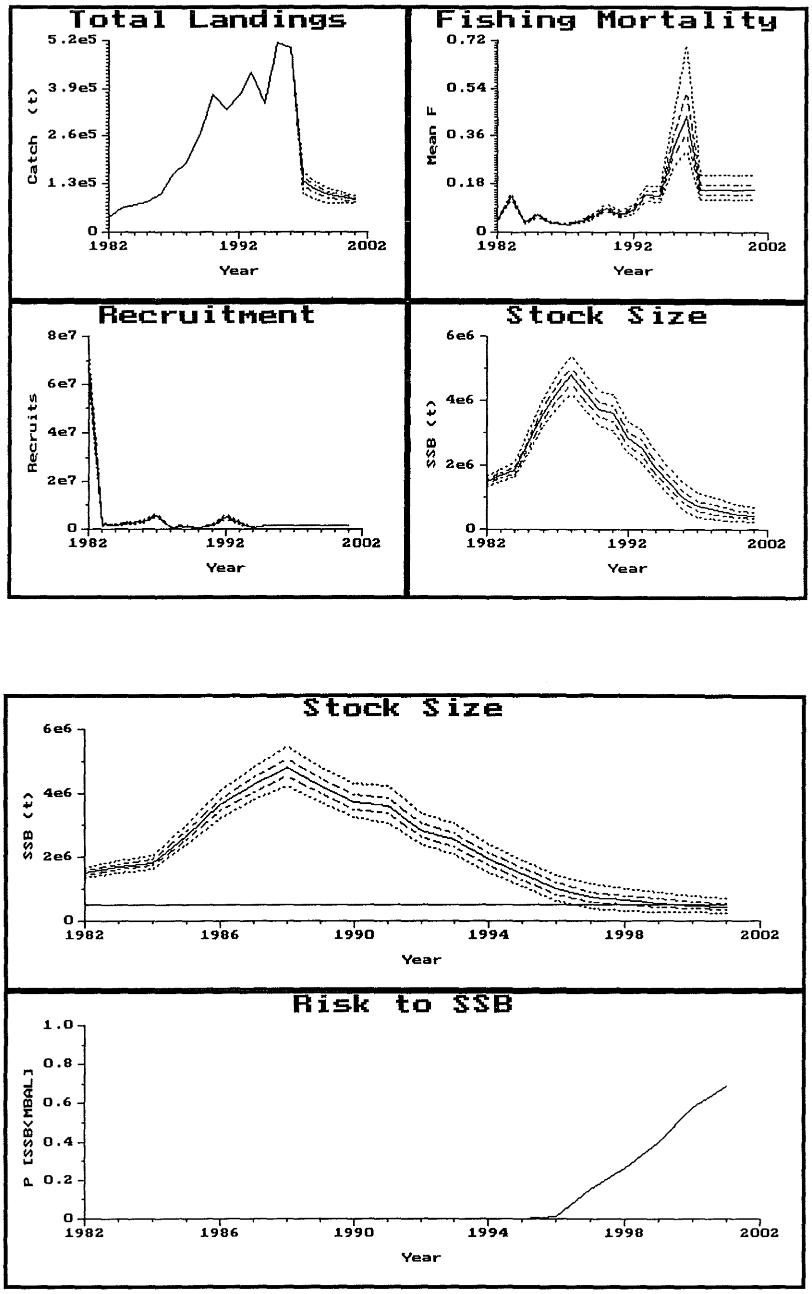
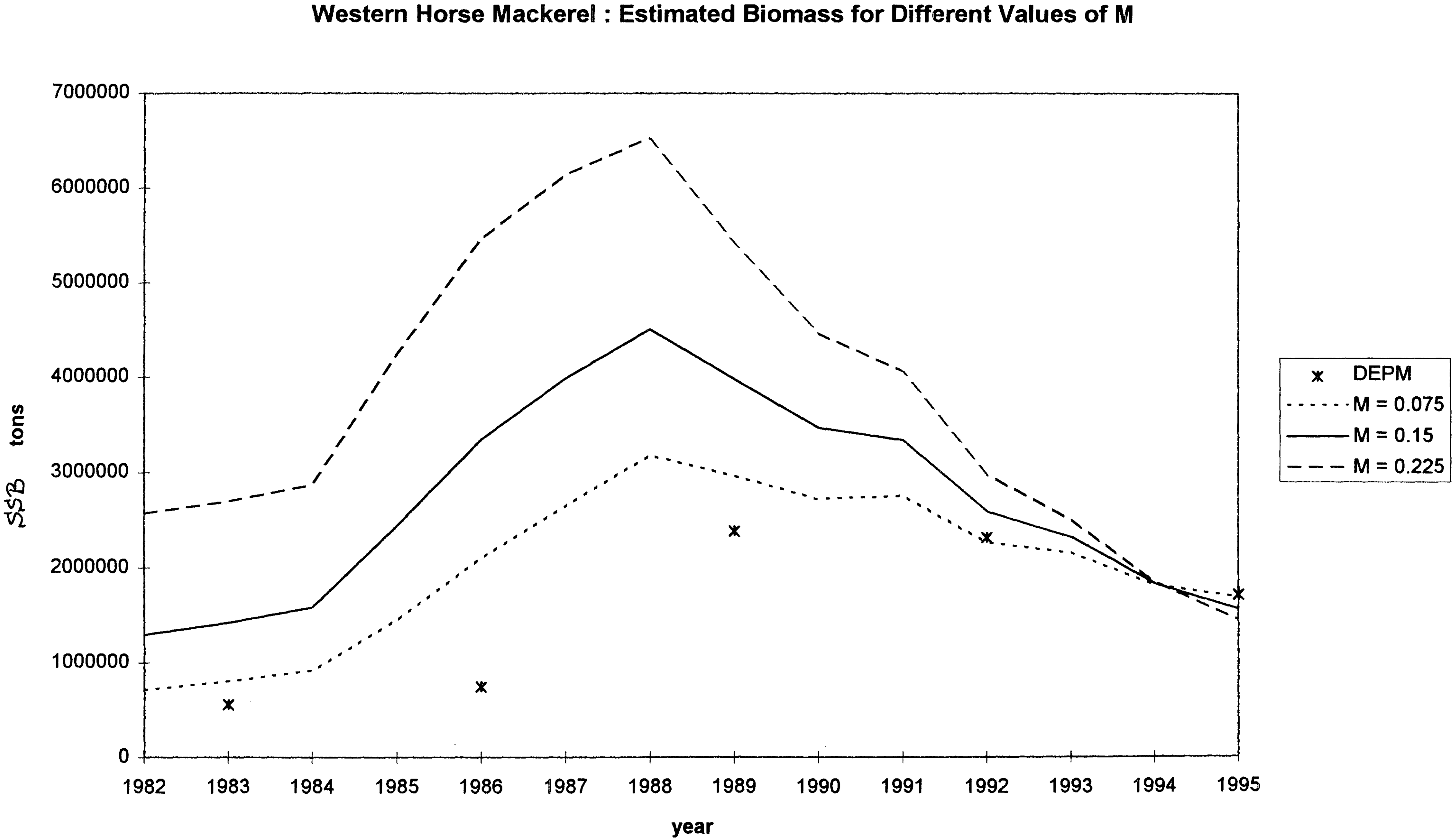


Figure 6.5. Western Horse Mackerel. Uncertainty in the assessment and in medium-term projections. **Upper panels,** Landings, fishing mortality, recruitment and spawning stock size estimates for a fishing mortality multiplier constraint (relative to 1995) equivalent to fishing at F=M=0.15 over the period 1997-2001. **Lower panels,** trajectories of stock size estimates, and the estimated probability of the stock size being below the MBAL of 500 000t by year. Full lines, medians. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. Catch constrained to 500 000t in 1996.

Figure 6.6


Western Horse Mackerel : Estimated Biomass for Different Values of M
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
SSB tons
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
year
DEPM
M = 0.075
M = 0.15
M = 0.225

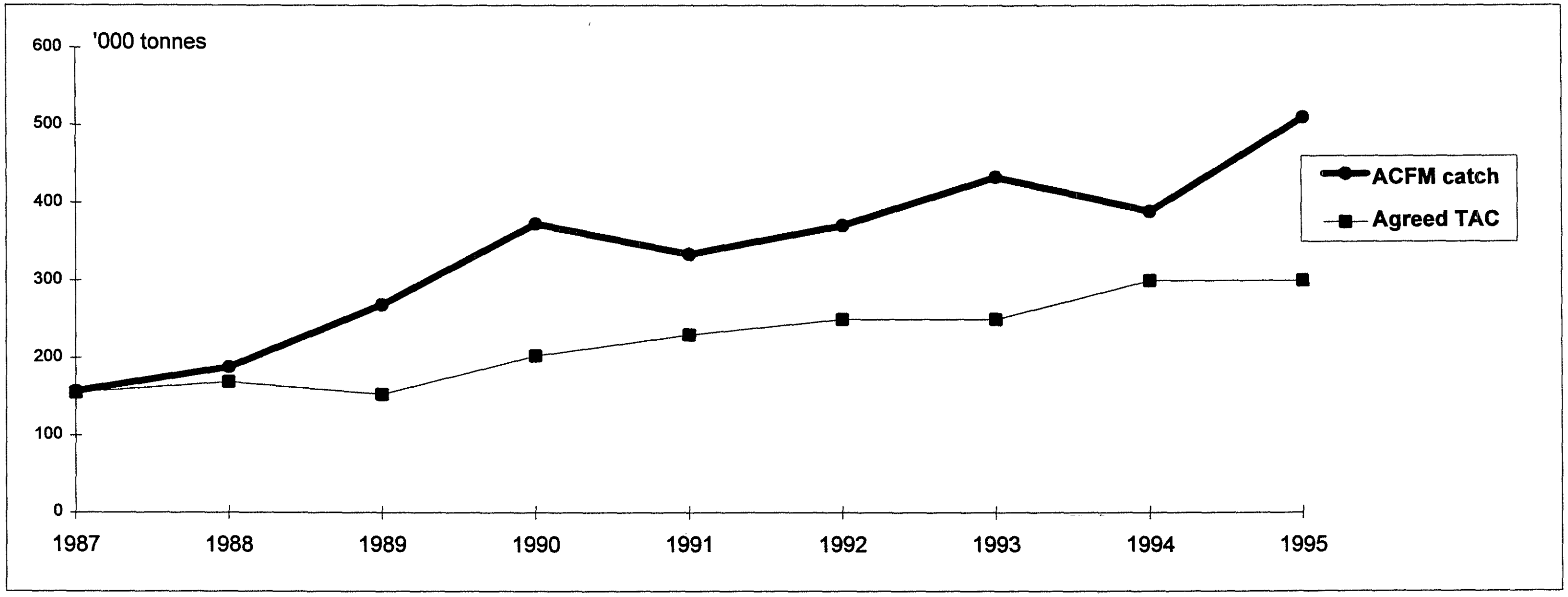


Figure 6.7 Catches compared to the agreed TAC's over the period 1987 - 1995. The international catches (ACFM catches) overshoot in all years the agreed TAC's.

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIC AND IXA)

7.1 The Fishery in 1995

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 52,681 t, in 1995 which represents the same level reached in 1994. The catch by country and gear is shown in Table 7.1. The Portuguese catches show a decrease of 7% compared with the 1994 catches. In this year the fall is due to the lower catches obtained by the Portuguese purse seine and artisanal fleets. Spanish catches show a slight increase since 1991. The proportion of the catches by gear presents the same pattern than in 1994, being the purse seiner catches the most important ones in the Spanish area (66% of the catches) whereas in the Portuguese waters the trawler's catches are the majority, representing the 71% of the Portuguese total catch.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.* 1995; Villamor *et al.* 1996). Although the second and third quarters show relatively higher catches than the first and fourth (see Table 7.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus* in the area, not only *Trachurus trachurus* L. which is the species at present under assessment by this Working Group. The reported catch, therefore always has to be revised by the Working Group in order to eliminate species of horse mackerel other than *Trachurus trachurus* (see Section 4.4).

7.2 Effort and Catch per Unit Effort

Table 7.3 presents the commercial catch rates from the trawl fleet fishing in Sub-divisions of IXa Central North, Central South and South (Portugal) from 1979 to 1990 and trawl fleets from Spain fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Aviles) from 1983 to 1995. In 1995 the catch rate of the trawl fleet in Sub-division VIIIc West was 9 % lower than the catch rate obtained in 1994, continuing with the decrease observed in that year in spite of there are no major changes in the effort (in fact, it has been quite stable since 1988). The Aviles trawl fleet operating in Sub-division VIIIc East presents a small drop in the catch rate compared with the high level reached in 1994. Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are not available since 1991, because the effort data series is under revision.

Table 7.4 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. No data are available in 1995 from the Portuguese short time series in winter time. The 1995 June-July survey indicates a biomass index much lower than the previous year (80% decrease) while in October in the Portuguese area the biomass index was shown to be higher compared with that of 1994 . The 1993 biomass index of that series was confirmed to indicated an extremely high value as compared with the rest of the series. The Spanish October survey showed a similar level in the biomass since 1992. The Portuguese and Spanish area was covered at the same time of the year which was Sept./October in the Spanish northern Sub-divisions and October/November in the Portuguese southern Sub-divisions.

Catch per unit effort at age

CPUE at age from the Galician (La Coruña) bottom trawl fleet (Sub-division VIIIc West) and from the Cantabrian (Aviles) trawl fleet fishing in Sub-division VIIIc East are available from 1984 to 1995. The extremely strong 1982 year class is still very prominent in the data for both fleets at age group 13 (Table 7.5). In 1995, the 1986 year class was confirmed as being strong, giving high indices of abundance in both fleets.

7.3 Fishery Independent Information

7.3.1 Trawl surveys

Table 7.6 shows the number at age from the Spanish and Portuguese bottom trawl in the October surveys and from the Portuguese July 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 Anon. (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 the horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time (Anon. 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.

The Spanish September/October survey series is available from 1985 to 1995 and the Portuguese October survey, from 1981–1995. Both are carried out during fourth quarter when the recruits have entered the area. In these surveys the recruitment (age 0) values in 1995 are very low specially if we compare with the extremely high level reached in 1994 in the Spanish survey and in 1993 in the Portuguese survey. In the Spanish Sept./Oct. survey in 1995 the 1986 year class is still abundant (Table 7.6). In the Portuguese July survey there is a strong fall in the 1995 abundance index observed in all the ages comparing with those obtained in 1994 in spite the same vessel, sampling and gear methodology was used. The 1982 year class is conspicuous in all the survey series but is stronger in the October Spanish bottom trawl survey.

7.3.2 Egg surveys

This was the first series of surveys carried out in the southern area for the Annual Egg Production Method (Anon. 1996/H:2) as explained in Section 1.4. Results of the Southern area egg Surveys are given in Section 4.2.3. The provisional estimate of 1995 SSB for the southern horse mackerel from those surveys was 261,000 tonnes.

7.4 Catch in Numbers at Age

The catch in numbers at age for 1995 are presented by quarter and area, disaggregated by Sub-division VIIIc East, VIIIc West and IXa North (Table 7.7). In Sub-divisions IXa Central North, IXa Central South and IXa South only the catch in numbers from trawl catches were available disaggregated by Sub-division. The purse seine and artisanal catches were not sampled by Sub-division in the Portuguese area, so the catch in numbers from all gears and quarters is only available for the total Portuguese area, as it is shown in Table 7.7. Table 7.10 and Figure 7.1 present the catch in numbers by year. The 1982 year class is well represented in the catch in numbers at age matrix. The 1986 year class is strong but does not reach the extreme high level of the 1982 year class. The 1991 and 1992 year classes are shown as strong in the catches as 2 and 3 age- groups.

Catch in numbers at age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Sub-division. The sampling intensity is discussed in section 1.3. The data before 1985 have not yet been revised according to the approved ageing methodology. So, they have been considered unappropriate for a VPA and have not been included in the analytical assessment.

7.5 Mean Length at Age and Mean Weight at Age

Tables 7.8 and 7.9 show the 1995 mean lengths and mean weights at age in the catch by quarter and Sub-division for the Spanish data and by quarter and total area for the Portuguese data. Table 7.11 presents the weight at age in the stock and in the catch. 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.

7.6 Maturity at Age

The proportions of fish mature at each age have been considered to be constant over the assessment period. The maturity ogive has been smoothed as ACFM requested in 1992.

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	1.00	1.00

7.7 Fishing Mortality and Tuning of the VPA

Fishing mortality coefficients were estimated using Extended Survivors Analysis (XSA). In accordance with last year assessment, the XSA parameters were set at catchability independent of age for ages equal or greater than 9 years old, level of shrinkage with standard error of 1.00, plus group 12. The two October survey series presented very high residuals in the analysis. The Spanish September/October Survey and the Portuguese October/November Surveys were therefore excluded from the analysis as in last year's assessment. The strength of shrinkage has a significant effect on the standard errors of the log catchability (Anon. 1995/Assess:2) . Stronger shrinkage (lower cv's) increases the standard errors for all fleets.

Comparison of the 1994 and 1995 assessments (Figure 7.2) illustrates the results of the fishing mortality estimates using XSA. It may be seen that for the reference F bar (1-11) the estimate shows close agreement with the last year assessment. Given the pattern of exploitation this stock is subjected to high selection on the younger and older ages and a reduced availability of 4-6 years old fish in the catches the estimates at F bar (0-3) and F bar (7-11) were also compared with last year assessment showing good agreement.

The F of the younger ages is generally under-estimated by the assessment and F of the older ages over-estimated. Taking a mean F over all the ages averages the biases. As described in Anon. (1996/Assess:7), strong shrinkage in XSA assessment reduces the accuracy of the estimated parameters.

Comparison of the spawning stock biomass estimated for the present assessment and 1994 assessment is shown in Figure 7.3. The biomass level estimated by this year and last year's analytical assessment are in close agreement from 1994 backwards. The 1995 SSB estimate is at a higher level than 1994 and is consistent with the egg production survey SSB estimate for 1995.

The tuning diagnostics and final results are given in Tables 7.12–7.15. Figure 7.4 indicates the fish stock summary trends over the period 1985–1995 according to the final assessment.

7.8 Recruitment

The October survey series which was carried out at the time of recruitment does not show any detectable relationship between the survey and cohort strength. In 1994 the Spanish October survey indicated high recruitment at age 0 and the Portuguese October Survey estimated low recruitment for the 1994 year class (Table 7.6). In 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate. The recruitment of 0-group in 1996 was taken as the geometric mean of 1985–1993 VPA estimates which corresponds to 1485 million fish.

7.9 Catch Predictions

The terminal population in 1994 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 1985–1993. The exploitation pattern was taken as the arithmetic mean of the last three years rescaled to the level of the 1995 F bar of the final year fishing mortality estimates (Table 7.13). Table 7.16 gives the input parameters and Tables 7.18a–c and Figure 7.4d show the results of the short term predictions of the catch and spawning stock biomass.

At $F_{status\ quo}$ (F95) the expected catch in weight for 1996 is 60,129 tonnes. In 1997, assuming, the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 58,238 tonnes. The spawning stock biomass is expected to increase from 209 thousand tonnes in 1995 to 225 thousand tonnes in 1996 at $F_{status\ quo}$ level and to 222 thousand tonnes if the agreed TAC of 73 thousand tonnes is taken in 1996. The spawning stock biomass is expected to increase in 1997, at $F_{status\ quo}$ to 235 thousand tonnes. The spawning stock biomass increases because the 1993, 1992, 1991, 1987, 1986 year classes which are of good strength contribute to the spawning stock biomass.

7.10 Short-Term and Medium-Term Risk Analysis

An attempt was made to estimate the probability (risk) of stock biomass, catches and fishing mortality passing a certain level were to be carried out for this stock using the ICPROJ described in Patterson, (Anon. 1995/Assess:2). However problems were encountered when using the output files from the final XSA to start the risk analysis. These format problems could not be solved during this meeting. As there was insufficient time to properly evaluate other methods, it was not possible to present a medium term prediction for this stock.

7.11 Long-Term Yield

The long-term yield per recruit and spawning biomass-per-recruit curves, against F, derived using the input data in Table 7.16 are shown in Figure 7.4. Table 7.17 presents the yield per recruit summary table. $F_{0.1}$ at reference age (1-11) is estimated to be 0.10, and F_{max} to be 0.21, which approximately corresponds to the F_{max} level estimated last year.

The biological reference points were estimated and shown in Figure 7.5 which gives the plot of the recruitment at age 1 versus the spawning stock biomass in the previous year, from the final VPA. The estimated F_{med} value is 0.21 and F_{high} corresponds to 0.30. The present level of $F_{status\ quo}$ of 0.19 is below the F_{med} level.

7.12 Comments on Assessment

This assessment is consistent with last year's assessment. As explained in last year reports (Anon. 1995/Assess:2; Anon. 1996/Assess:7) the two October survey series which presented high residuals were not included and this improved the fit of the model to the data. The spawning stock biomass estimated from the 1995 egg surveys is in agreement with the 1995 SSB level estimated using the two commercial fleets and the July survey series.

7.13 Reference Points for Management Purpose

7.13.1 MBAL

The extremely strong 1982 year class is contributing for the SSB during the period available 1985–1995. The lowest biomass attained during the period was in 1985, which in the same year gave rise to a medium recruitment. The MBAL cannot be defined to this stock as the SSB - recruitment series data is too short and there is no apparent relationship. So if an MBAL is required one possibility is the lowest recorded SSB estimated in the time series.

7.13.2 Fishing mortality targets

In this stock the F_{med} and F_{max} level coincide. The Working Group considers that the fishing mortality target should not exceed the F_{max}.

7.14 Management Measures and Considerations

The Working Group considers that the TAC should not be applied to *Trachurus* spp combined but only to *Trachurus trachurus*, the Atlantic horse mackerel. The F reference which was constant over recent years has shown a decrease in 1994 and 1995. Table 7.19 summarizes several management options at: $F_{status\ quo}$, F corresponding to TAC equal to 73 thousand tonnes, F corresponding to TAC 1995 level, and to F_{med} and F_{max}.

Given the indication of low recruitments in 1994 and 1995 it is advisable to manage the stock at $F_{status\ quo}$ (0.19) which is close to F_{med} (0.21) and F_{max} (0.21).

Table 7.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984-1995 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

[1]Estimated value.
[2]Not available by gear.

Table 7.2 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

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

Table 7.3 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Division IXa (Portugal)	Division VIIIc (Spain)	
	Trawl	Trawl	
		Sub-div. VIIIc East Aviles	Sub-div. VIIIc West La Coruña
	kg/h	kg/Hp.day. 10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.4
1984	55.9	142.94	135.87
1985	24.4	131.22	118.00
1986	41.6	116.90	130.84
1987	71.0	109.02	176.65
1988	91.1	88.96	146.63
1989	69.5	98.24	172.84
1990	98.9	125.35	146.27
1991	n.a.	106.42	145.09
1992	n.a.	73.70	163.12
1993	n.a.	71.47	200.50
1994	n.a.	137.56	136.75
1995	n.a.	130.44	124.11

Table 7.4 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[1]	5.5[1]	-
1980		20.6[1]	2.5[1]	-
1981		11.6	1.8	-
1982		42.1	36.9	-
1983		79.1	24.6	37.97
1984		-	-	51.98
1985		9.5	3.8	20.93
1986		4.8	23.5	10.14
1987		-	6.9	-
1988		-	26.0	12.05
1989		14.9	11.7	15.48
1990		14.4	21.5	9.62
1991		11.8	16.9	4.92
1992	17.5	38.0	40.8	20.30
1993	100.24	35.6	235.3	18.11
1994	n.a.	49.3	12.4	21.61
1995	n.a.	9.8	18.9	21.99

[1]Codend mesh size 40 mm.

Table 7.5 CPUE at age from fleets

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

FLT01: 8c West trawl fleet (La Coruna) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	32E3	1	356	644	124	38	38	8	87	30	42	5	6	1	6	3	12
1985	3E4	3	12	134	399	19	42	39	25	27	43	22	8	3	1	3	27
1986	27E3	3	79	58	118	400	40	31	22	15	15	41	16	6	10	2	33
1987	23E3	1	33	113	92	143	672	76	61	13	22	20	16	8	2	1	13
1988	28E3	5	167	258	58	58	51	408	40	29	22	11	11	16	4	2	9
1989	3E4	23	152	48	115	56	57	38	299	40	103	78	6	2	23	2	16
1990	3E4	1	84	128	37	71	17	27	39	394	21	27	5	6	6	7	15
1991	27E3	1	1	41	2	20	39	27	65	49	376	37	17	12	2	9	5
1992	26E3	0	191	60	10	9	54	99	48	46	51	361	12	6	3	0	8
1993	3E4	0	34	467	39	51	95	87	210	56	79	16	209	1	0	1	1
1994	26E3	2	79	270	12	8	20	92	146	165	34	18	4	45	1	0	1
1995	28E3	0	7	122	84	37	25	36	64	129	102	33	12	2	47	1	1

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

FLT02: 8c East trawl fleet (Aviles) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	1E4	4	882	759	141	42	39	11	65	18	31	3	4	1	6	3	11
1985	9856	1	167	613	574	13	18	16	13	17	21	14	4	4	1	4	19
1986	11E3	36	223	271	174	527	42	19	14	10	8	9	2	1	1	0	2
1987	8309	1	244	350	166	48	396	40	19	7	9	6	5	3	1	1	4
1988	9047	181	264	53	23	18	19	148	14	17	22	15	12	22	6	5	27
1989	8063	65	275	62	105	50	42	18	100	13	38	35	1	1	18	2	15
1990	8492	1	726	373	257	72	19	21	24	192	10	13	3	4	4	4	9
1991	7677	39	495	882	41	85	51	10	12	9	67	3	2	1	1	1	1
1992	13E3	2	35	21	65	34	60	63	20	16	19	114	3	1	1	0	7
1993	7635	0	215	462	77	44	23	18	42	6	14	2	35	1	0	0	1
1994	9620	1	47	632	12	6	17	69	118	135	25	14	3	38	1	0	0
1995	6146	1	182	441	141	70	32	25	39	89	71	31	12	4	37	1	1

Table 7.6 CPUE at age from surveys

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

FLT03: Oct Pt Survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	1	706.196	123.479	82.500	70.046	12.621	2.445	0.313	0.552
1987	1	95.243	24.377	29.541	12.419	9.802	5.673	1.163	0.519
1988	1	29.416	704.046	54.984	20.207	13.920	6.472	21.741	8.294
1989	1	377.665	93.538	40.406	20.064	6.196	3.956	3.847	2.395
1990	1	508.494	269.582	28.907	16.472	17.014	9.822	1.794	1.187
1991	1	336.245	97.414	14.704	13.411	14.272	6.571	3.895	2.275
1992	1	677.806	500.049	184.896	34.300	15.932	8.153	6.113	6.745
1993	1	1733.340	214.230	328.440	111.630	37.010	2.160	0.950	0.950
1994	1	4.217	9.499	75.879	44.908	19.693	5.142	2.013	1.022
1995	1	6.972	9.386	148.650	56.402	26.310	8.156	3.383	0.709

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.003
1986	0.370	0.238	0.189	0.286	0.181	0.126	0.051	0.115
1987	0.487	0.368	0.225	0.165	0.248	0.047	0.022	0.019
1988	1.834	0.878	0.298	0.030	0.001	0.001	0.001	0.001
1989	0.662	0.320	0.430	0.398	0.162	0.139	0.012	0.004
1990	3.577	2.600	1.532	0.624	0.770	0.266	0.239	0.179
1991	2.331	1.951	1.006	0.405	0.350	0.238	0.220	0.185
1992	4.196	3.251	3.805	0.497	0.702	0.178	0.082	0.086
1993	0.670	0.860	0.570	1.340	0.370	0.220	0.070	0.050
1994	0.850	0.534	0.234	0.189	0.126	0.089	0.053	0.030
1995	0.527	0.383	0.260	0.219	0.227	0.228	0.221	0.215

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

FLT04: Oct Sp. Survey,bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050
1986	1	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110
1987	1	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979
1988	1	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050
1989	1	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040
1990	1	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090
1991	1	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640
1992	1	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360
1993	1	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072
1994	1	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632
1995	1	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049

Table 7.6 (cont.) CPUE at age from surveys

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

PJS: Jul Pt. Survey, bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1989	1	81.913	38.356	45.522	60.648	26.998	5.846	3.164	6.634
1990	1	82.175	51.605	69.397	26.157	12.393	5.588	3.670	3.515
1991	1	17.429	53.094	19.479	3.507	3.906	3.978	2.495	3.128
1992	1	109.178	1822.950	39.701	21.081	7.980	5.013	3.427	3.348
1993	1	1.810	263.390	263.800	150.040	20.840	39.560	89.150	31.340
1994	1	54.981	408.262	232.995	110.935	49.988	34.724	38.438	20.985
1995	1	5.410	38.571	16.132	23.071	26.699	12.233	5.577	2.071

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1989	3.042	3.716	1.440	0.793	0.613	0.214	0.157	0.244
1990	7.745	3.001	1.363	0.695	0.758	0.445	0.356	0.470
1991	3.566	7.637	3.537	3.574	2.288	2.491	0.508	0.413
1992	3.879	5.616	9.998	3.988	5.772	3.205	1.038	0.481
1993	22.690	9.530	0.520	0.640	0.050	0.020	0.000	0.000
1994	5.725	3.905	3.550	3.193	5.485	1.883	1.057	0.867
1995	0.540	0.270	0.223	0.158	0.263	0.115	0.091	0.103

Table 7.7 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1995.

1995 Age	VIIIc East 1'st Q atch('000	VIIIc West 1'st Q atch('000	IXa North 1'st Q atch('000	IXa C. Nor 1'st Q atch('000	IXa C. Sou 1'st Q atch('000	IXa South 1'st Q atch('000	All areas 1'st Q atch ('000)
0	0	0	0		0		0
1	647	0	4,808		1,620		7,075
2	3,415	5,177	5,056		6,717		20,365
3	1,036	4,032	4,307		13,420		22,795
4	543	2,133	1,507		7,999		12,182
5	295	896	454		1,311		2,956
6	247	679	128		506		1,560
7	326	848	70		271		1,515
8	1,141	2,590	429		444		4,604
9	1,009	1,944	515		581		4,049
10	592	803	362		544		2,301
11	146	257	80		558		1,041
12	65	45	65		287		462
13	676	762	566		227		2,231
14	16	5	3		221		245
15+	33	15	10		235		293
Total	10,187	20,186	18,360		34,941		83,674
Tonnes	1,482	2,904	1,664		3,240		9,290

Age	VIIIc East 2'nd Q atch('000	VIIIc West 2'nd Q atch('000	IXa North 2'nd Q atch('000	IXa C. Nor 2'nd Q atch('000	IXa C. Sou 2'nd Q atch('000	IXa South 2'nd Q atch('000	All areas 2'nd Q atch ('000)
0	0	0	0		0		0
1	8,191	25,382	15,538		6,602		55,713
2	2,720	24,912	16,711		5,519		49,862
3	365	10,628	750		8,899		20,642
4	610	6,663	132		8,094		15,499
5	478	2,697	55		3,232		6,462
6	641	1,424	59		2,039		4,163
7	1,282	2,507	47		1,629		5,465
8	2,576	3,174	387		1,134		7,271
9	1,941	2,440	561		1,407		6,349
10	656	363	440		837		2,296
11	224	154	149		627		1,154
12	56	4	170		475		705
13	672	383	942		362		2,359
14	13	2	17		371		403
15+	23	4	37		655		719
Total	20,448	80,737	35,995		41,882		179,062
Tonnes	2,243	6,085	2,000		4,618		14,946

Age	VIIIc East 3'rd Q atch('000	VIIIc West 3'rd Q atch('000	IXa North 3'rd Q atch('000	IXa C. Nor 3'rd Q atch('000	IXa C. Sou 3'rd Q atch('000	IXa South 3'rd Q atch('000	All areas 3'rd Q atch ('000)
0	1,455	727	437		0		2,619
1	13,357	33,400	7,196		6,614		60,567
2	275	12,098	2,647		10,698		25,718
3	131	16,097	2,222		10,251		28,701
4	574	4,121	352		7,584		12,631
5	467	811	163		2,970		4,411
6	669	849	192		2,139		3,849
7	1,004	1,845	351		1,247		4,447
8	1,543	2,279	619		782		5,223
9	1,265	1,339	575		922		4,101
10	369	452	360		1,441		2,622
11	173	236	309		1,511		2,229
12	22	40	92		2,614		2,768
13	883	1,580	747		1,213		4,423
14	4	15	22		872		913
15+	1	6	19		996		1,022
Total	22,192	75,895	16,303		51,854		166,244
Tonnes	2,130	7,014	1,825		6,038		17,007

Age	VIIIc East 4'th Q atch('000	VIIIc West 4'th Q atch('000	IXa North 4'th Q atch('000	IXa C. Nor 4'th Q atch('000	IXa C. Sou 4'th Q atch('000	IXa South 4'th Q atch('000	All areas 4'th Q atch ('000)
0	387	133	3		370		893
1	6,209	27,353	1,853		2,372		37,787
2	272	10,217	7,886		10,411		28,786
3	541	8,895	3,555		8,220		21,211
4	508	2,135	222		4,330		7,195
5	249	330	67		1,522		2,168
6	345	413	75		830		1,663
7	559	858	180		584		2,181
8	789	1,110	326		608		2,833
9	615	726	332		591		2,264
10	193	268	265		605		1,331
11	130	152	390		568		1,240
12	28	38	161		684		911
13	496	844	654		710		2,704
14	8	10	40		748		806
15+	1	5	37		732		775
Total	11,330	53,487	16,046		33,885		114,748
Tonnes	1,190	4,486	1,960		3,802		11,438

Table 7.8 Length (cm) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1995.

1995	VIIIc East	VIIIc West	IXa North	IXa C. Nor	IXa C. Sou	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	13.8	0.0	13.8		14.5		14.0
2	18.5	19.7	18.7		19.1		19.1
3	21.2	22.1	22.2		20.6		21.2
4	25.0	24.7	24.0		21.8		22.7
5	26.9	26.0	24.9		24.2		25.1
6	29.5	29.0	28.6		25.8		28.0
7	28.9	29.0	28.0		28.0		28.8
8	31.0	30.3	32.2		30.9		30.7
9	31.5	30.6	32.9		31.8		31.3
10	32.5	31.9	33.4		32.1		32.3
11	32.8	31.4	34.3		33.3		32.8
12	36.6	36.2	36.1		34.9		35.4
13	33.9	32.8	34.5		35.6		33.8
14	40.0	39.3	38.9		36.3		36.6
15+	40.0	38.7	38.8		36.9		37.4
0-15+	24.6	25.3	20.6		21.7		22.7

	VIIIc East	VIIIc West	IXa North	IXa C. Nor	IXa C. Sou	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	13.7	14.2	14.1		15.6		14.3
2	15.8	17.6	16.2		17.9		17.1
3	24.4	22.3	20.3		21.0		21.7
4	26.7	24.8	24.2		23.1		24.0
5	27.9	25.4	26.2		25.6		25.7
6	28.8	27.7	31.6		27.2		27.7
7	28.6	28.4	28.6		28.7		28.5
8	29.8	29.4	32.9		30.3		29.9
9	30.0	29.3	34.0		31.1		30.3
10	32.1	31.2	34.6		32.0		32.4
11	31.6	30.1	35.4		33.0		32.7
12	36.7	37.2	36.4		34.5		35.1
13	32.8	30.7	35.4		35.0		33.8
14	39.9	39.8	39.7		35.5		35.8
15+	39.1	39.9	38.9		37.3		37.5
0-15+	21.4	19.5	16.9		22.8		19.9

	VIIIc East	VIIIc West	IXa North	IXa C. Nor	IXa C. Sou	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm	length (cm	length (cm	length (cm	length (cm	length (cm	length(cm)
0	14.9	15.1	15.3		0.0		15.0
1	16.2	17.2	16.7		16.9		16.9
2	19.7	21.5	21.0		19.4		20.6
3	25.3	24.2	23.8		20.8		23.0
4	28.2	26.4	26.8		22.4		24.1
5	29.9	29.2	31.2		24.4		26.1
6	29.9	29.6	31.2		26.0		27.7
7	29.7	28.6	31.6		27.3		28.7
8	30.3	29.5	32.2		29.3		30.0
9	30.9	31.1	33.0		30.6		31.2
10	32.4	32.7	34.0		32.0		32.5
11	32.5	33.2	36.0		32.1		32.8
12	36.1	36.3	37.1		32.3		32.5
13	31.3	30.2	34.0		34.0		32.1
14	36.7	37.2	37.2		35.1		35.2
15+	39.0	39.3	40.2		36.0		36.1
0-15+	20.7	21.4	22.1		23.2		21.9

	VIIIc East	VIIIc West	IXa North	IXa C. Nor	IXa C. Sou	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	15.1	14.7	15.2		14.1		14.6
1	16.4	17.6	18.8		16.4		17.4
2	20.6	20.8	20.8		19.6		20.4
3	25.1	24.1	22.9		21.5		22.9
4	27.2	26.3	26.5		23.0		24.4
5	29.3	29.9	30.1		24.6		26.1
6	29.6	30.0	30.9		25.9		27.9
7	29.3	28.9	31.5		29.0		29.2
8	30.1	29.9	33.3		28.8		30.1
9	30.9	31.6	34.3		30.5		31.5
10	32.8	33.1	36.0		32.7		33.5
11	33.5	34.3	37.4		33.2		34.7
12	36.3	36.9	37.8		34.5		35.2
13	31.4	30.7	36.3		35.1		33.3
14	36.7	37.1	37.3		35.8		35.9
15+	38.5	39.9	40.3		36.0		36.2
0-15+	21.6	20.8	23.4		22.9		21.9

Table 7.9 Weight (g) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1995.

1995 Age	VIIIc East 1'st Q weight(g)	VIIIc West 1'st Q weight(g)	IXa North 1'st Q weight(g)	IXa C. Nor 1'st Q weight(g)	IXa C. Sou 1'st Q weight(g)	IXa South 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0		0		0
1	23	0	24		24		24
2	55	65	59		57		59
3	82	90	91		70		78
4	127	123	113		83		96
5	160	144	127		113		129
6	206	195	191		138		178
7	192	194	175		177		190
8	235	220	263		236		229
9	247	226	280		257		243
10	270	255	291		265		267
11	279	246	314		297		283
12	377	365	361		340		351
13	306	277	319		360		305
14	484	461	446		379		388
15+	485	440	443		399		412
0-15+	146	144	91		92		111

Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	IXa C. Nor 2'nd Q weight(g)	IXa C. Sou 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0		0		0
1	23	25	25		30		25
2	35	49	37		47		44
3	123	93	72		74		85
4	153	125	116		99		112
5	175	134	149		133		137
6	191	171	251		160		170
7	186	182	187		187		184
8	210	200	279		219		211
9	216	199	306		237		222
10	259	237	323		259		268
11	250	216	342		282		275
12	380	395	371		325		341
13	282	229	343		339		307
14	480	477	472		355		365
15+	453	483	445		415		418
0-15+	111	75	55		111		84

Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	IXa C. Nor 3'rd Q weight (g)	IXa C. Sou 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	29	30	31		0		30
1	37	44	41		39		42
2	64	83	78		59		72
3	132	116	111		73		100
4	179	149	156		90		115
5	213	200	239		116		146
6	212	206	240		141		173
7	209	189	251		162		191
8	222	206	265		200		217
9	234	239	282		228		241
10	267	275	307		261		271
11	272	290	363		262		280
12	360	367	390		267		273
13	243	224	312		312		267
14	379	392	394		345		347
15+	449	460	490		372		375
0-15+	96	93	112		117		103

Age	VIIIc East 4'th Q weight(g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	IXa C. Nor 4'th Q weight(g)	IXa C. Sou 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	30	28	31		26		28
1	38	47	57		37		45
2	74	76	75		61		70
3	128	115	100		80		99
4	162	147	151		97		118
5	200	213	217		118		145
6	206	214	235		139		176
7	201	196	250		174		196
8	217	215	292		190		219
9	235	250	314		226		249
10	276	285	362		278		296
11	296	319	403		294		332
12	368	384	412		330		348
13	247	236	373		346		300
14	379	389	397		367		369
15+	433	482	496		375		382
0-15+	106	84	122		112		100

Table 7.10 Catch in numbers by year

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

CANUM: Catch in Numbers (Millions)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1981	53.700	315.700	136.200	58.800	20.400	47.800	34.800	23.000
1982	104.700	122.600	115.000	77.700	27.000	22.200	28.000	28.300
1983	182.300	1109.10	74.800	24.400	22.600	31.500	34.900	20.600
1984	12.200	71.100	459.700	40.700	3.800	8.900	21.600	20.000
1985	393.697	297.486	84.887	79.849	26.197	14.665	7.075	7.363
1986	615.298	425.659	96.999	64.701	122.560	27.584	13.610	24.346
1987	53.320	618.570	170.015	66.303	28.789	81.020	21.825	10.485
1988	121.951	271.052	94.945	39.364	22.598	20.507	92.897	17.212
1989	242.537	158.646	70.438	93.590	37.363	25.474	22.839	52.657
1990	48.100	164.206	100.833	60.289	35.931	14.307	11.786	12.913
1991	31.786	69.544	71.451	24.222	33.833	28.678	13.952	14.578
1992	45.629	285.197	107.761	51.971	21.596	23.308	24.973	14.167
1993	10.719	101.326	262.637	95.182	↑35.647	23.159	22.311	35.258
1994	9.435	113.345	264.744	93.214	23.624	11.374	18.612	22.740
1995	3.512	161.142	124.731	93.349	47.507	15.997	11.235	13.608

Year	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	24.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	27.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	20.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	18.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	3.981	6.270	4.614	3.214	2.702	1.699	0.864	4.334
1986	12.080	6.694	8.198	6.349	5.838	3.244	2.023	2.963
1987	5.042	3.795	2.337	1.999	1.666	0.951	1.029	1.906
1988	11.669	10.279	7.042	4.523	6.050	2.514	1.379	3.717
1989	11.308	14.892	11.182	2.728	2.243	4.266	1.456	3.791
1990	76.713	9.463	6.562	3.481	2.568	2.017	2.430	4.409
1991	11.948	64.501	8.641	5.671	3.933	1.970	2.113	2.164
1992	11.384	12.496	52.251	4.989	4.043	2.480	1.815	4.045
1993	11.881	15.094	5.813	36.062	1.653	0.879	0.823	2.304
1994	26.587	8.207	5.142	2.546	10.266	1.291	1.001	1.210
1995	19.931	16.763	8.550	5.664	4.846	11.717	2.367	2.809

Table 7.11 Southern horse mackerel mean weight at age

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

WEST: Mean Weight in Stock (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1982	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1983	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1984	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1985	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1986	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1987	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1988	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1989	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1990	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1991	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1992	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1993	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1994	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1995	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381

: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

WECA: Mean Weight in Catch (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.023	0.040	0.067	0.097	0.174	0.254	0.292	0.341	0.407	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1982	0.020	0.033	0.082	0.115	0.152	0.226	0.261	0.296	0.363	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1983	0.013	0.028	0.061	0.125	0.159	0.225	0.267	0.294	0.361	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1984	0.015	0.025	0.049	0.080	0.124	0.178	0.246	0.275	0.331	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1985	0.014	0.027	0.070	0.091	0.117	0.132	0.152	0.182	0.249	0.264	0.284	0.312	0.320	0.344	0.357	0.378
1986	0.016	0.029	0.055	0.076	0.104	0.137	0.185	0.194	0.209	0.290	0.301	0.319	0.329	0.339	0.349	0.349
1987	0.024	0.031	0.049	0.058	0.096	0.106	0.131	0.161	0.198	0.211	0.246	0.302	0.288	0.352	0.361	0.358
1988	0.027	0.036	0.066	0.082	0.111	0.126	0.156	0.156	0.202	0.239	0.249	0.275	0.314	0.333	0.327	0.355
1989	0.016	0.041	0.062	0.089	0.109	0.132	0.152	0.189	0.200	0.203	0.248	0.320	0.345	0.359	0.375	0.389
1990	0.016	0.035	0.047	0.076	0.124	0.130	0.155	0.170	0.182	0.214	0.260	0.272	0.316	0.345	0.368	0.388
1991	0.016	0.033	0.063	0.102	0.133	0.151	0.168	0.173	0.193	0.196	0.233	0.236	0.280	0.304	0.323	0.372
1992	0.018	0.029	0.048	0.078	0.105	0.141	0.162	0.173	0.182	0.191	0.214	0.240	0.278	0.313	0.341	0.387
1993	0.015	0.034	0.040	0.064	0.109	0.155	0.171	0.202	0.225	0.225	0.255	0.250	0.321	0.364	0.397	0.461
1994	0.021	0.036	0.058	0.069	0.097	0.142	0.182	0.205	0.226	0.250	0.276	0.299	0.295	0.343	0.363	0.391
1995	0.029	0.036	0.058	0.091	0.110	0.139	0.173	0.189	0.218	0.235	0.273	0.291	0.305	0.290	0.362	0.392

Table 7.12. XSA diagnostics

Extended Survivors Analysis

Horse mackerel South (run: XSAMFB03/X03)

CPUE data from file /users/fish/ifad/ifapwork/wgmhsa/hom_soth/FLEET.X03

Catch data for 11 years. 1985 to 1995. Ages 0 to 12.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT01: 8c West trawl,	1985,	1995,	0,	11,	.000,	1.000
FLT02: 8c East trawl,	1985,	1995,	0,	11,	.000,	1.000
PJS: Jul Pt. Survey,,	1989,	1995,	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 30 iterations

Total absolute residual between iterations
29 and 30 = .00240

Final year F values

Age ,	0,	1,	2,	3,	4,	5,	6,	7,	8,	9
Iteration 29,	.0036,	.2329,	.1291,	.1867,	.0695,	.1128,	.1034,	.1005,	.1352,	.1437
Iteration 30,	.0036,	.2328,	.1289,	.1864,	.0694,	.1126,	.1034,	.1004,	.1350,	.1436

Age ,	10,	11
Iteration 29,	.4286,	.4434
Iteration 30,	.4279,	.4428

Table 7.12 XSA diagnostics

Regression weights

, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
0,	.287,	.041,	.127,	.284,	.063,	.015,	.034,	.007,	.010,	.004
1,	.569,	.491,	.288,	.229,	.299,	.116,	.170,	.092,	.090,	.233
2,	.245,	.439,	.120,	.106,	.211,	.193,	.251,	.220,	.347,	.129
3,	.263,	.249,	.161,	.158,	.118,	.068,	.199,	.346,	.107,	.186
4,	.102,	.169,	.119,	.213,	.079,	.085,	.075,	.193,	.127,	.069
5,	.189,	.086,	.166,	.181,	.112,	.079,	.074,	.103,	.082,	.113
6,	.128,	.212,	.127,	.266,	.113,	.144,	.087,	.089,	.107,	.103
7,	.397,	.130,	.243,	.093,	.223,	.188,	.202,	.162,	.117,	.100
8,	.419,	.125,	.198,	.236,	.181,	.312,	.208,	.246,	.168,	.135
9,	.313,	.211,	.378,	.391,	.300,	.216,	.590,	.440,	.253,	.144
10,	.372,	.161,	.705,	.867,	.281,	.463,	.257,	.570,	.247,	.428
11,	.520,	.137,	.501,	.617,	.691,	.395,	.503,	.268,	.496,	.443

XSA population numbers (Thousands)

	AGE									
YEAR ,	0,	1,	2,	3,	4,	5,	6,	7,		
1986 ,	2.66E+06,	1.06E+06,	4.81E+05,	3.01E+05,	1.37E+06,	1.73E+05,	1.23E+05,	8.01E+04,	3.80E+04,	2.68E+04,
1987 ,	1.41E+06,	1.72E+06,	5.15E+05,	3.24E+05,	1.99E+05,	1.06E+06,	1.23E+05,	9.28E+04,	4.64E+04,	2.15E+04,
1988 ,	1.10E+06,	1.17E+06,	9.06E+05,	2.86E+05,	2.17E+05,	1.45E+05,	8.40E+05,	8.59E+04,	7.02E+04,	3.52E+04,
1989 ,	1.06E+06,	8.35E+05,	7.54E+05,	6.92E+05,	2.10E+05,	1.66E+05,	1.06E+05,	6.37E+05,	5.80E+04,	4.96E+04,
1990 ,	8.46E+05,	6.86E+05,	5.71E+05,	5.84E+05,	5.09E+05,	1.46E+05,	1.19E+05,	6.97E+04,	4.99E+05,	3.94E+04,
1991 ,	2.32E+06,	6.83E+05,	4.38E+05,	3.98E+05,	4.46E+05,	4.05E+05,	1.12E+05,	9.17E+04,	4.80E+04,	3.59E+05,
1992 ,	1.49E+06,	1.97E+06,	5.24E+05,	3.11E+05,	3.20E+05,	3.53E+05,	3.22E+05,	8.36E+04,	6.54E+04,	3.02E+04,
1993 ,	1.65E+06,	1.24E+06,	1.43E+06,	3.51E+05,	2.19E+05,	2.56E+05,	2.82E+05,	2.54E+05,	5.88E+04,	4.57E+04,
1994 ,	9.82E+05,	1.41E+06,	9.73E+05,	9.88E+05,	2.14E+05,	1.56E+05,	1.98E+05,	2.22E+05,	1.86E+05,	3.96E+04,
1995 ,	1.04E+06,	8.36E+05,	1.11E+06,	5.92E+05,	7.64E+05,	1.62E+05,	1.23E+05,	1.54E+05,	1.70E+05,	1.35E+05,

Estimated population abundance at 1st Jan 1996

, .00E+00, 8.95E+05, 5.71E+05, 8.42E+05, 4.23E+05, 6.15E+05, 1.25E+05, 9.58E+04, 1.20E+05, 1.28E+05,

Taper weighted geometric mean of the VPA populations:

, 1.36E+06, 1.07E+06, 7.01E+05, 4.92E+05, 3.40E+05, 2.30E+05, 1.76E+05, 1.28E+05, 8.31E+04, 5.12E+04,

Standard error of the weighted Log(VPA populations) :

, .3631, .3642, .4172, .5399, .6233, .6108, .6564, .7279, .8228, .8289,

	AGE	
YEAR ,	10,	11,
1986 ,	2.84E+04,	1.69E+04,
1987 ,	1.69E+04,	1.69E+04,
1988 ,	1.50E+04,	1.24E+04,
1989 ,	2.08E+04,	6.38E+03,
1990 ,	2.88E+04,	7.52E+03,
1991 ,	2.51E+04,	1.87E+04,
1992 ,	2.49E+05,	1.36E+04,
1993 ,	1.44E+04,	1.66E+05,
1994 ,	2.54E+04,	7.02E+03,
1995 ,	2.65E+04,	1.71E+04,

Estimated population abundance at 1st Jan 1996

, 1.01E+05, 1.49E+04,

Taper weighted geometric mean of the VPA populations:

, 2.79E+04, 1.53E+04,

Standard error of the weighted Log(VPA populations) :

, .8069, .9276,

Table 7.12 XSA diagnostics

Log catchability residuals.

Fleet : FLT01: 8c West trawl

Age	1985
0	-.53
1	-.28
2	.50
3	.98
4	-.42
5	.12
6	.02
7	-.22
8	.00
9	-.07
10	-.24
11	-.23

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	-1.30	1.87	-1.31	-4.93	2.95	1.77	99.99	99.99	.95	99.99
1	.39	-.41	.53	.79	.76	-1.07	.06	-.25	.01	-.46
2	-.28	.54	.46	-1.10	.21	-.58	-.32	.59	.60	-.48
3	1.71	1.52	.94	.69	-.29	-2.76	-.81	.37	-1.84	.60
4	.95	2.02	.81	.81	.09	-.95	-1.39	.66	-1.08	-.91
5	.15	1.25	.51	.43	-.68	-.79	-.30	.48	-.48	-.34
6	-.25	.81	.34	.05	-.48	-.31	-.06	-.19	.35	-.18
7	-.54	.35	-.14	-.26	-.02	.30	.12	.34	.21	-.31
8	-.39	-.73	-.50	-.02	.08	.50	.10	.30	.31	.08
9	-.54	.15	-.46	.70	-.70	.03	.70	.53	-.13	-.37
10	.43	.28	-.15	1.50	-.15	.48	.40	.15	-.33	.26
11	.08	.04	-.05	.01	-.31	-.03	.02	.14	-.43	-.30

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-18.7364	-19.5373	-19.1545	-18.5467	-18.0794	-17.5857	-17.3631	-16.9136	-16.9136	-16.9136
S.E(Log q)	.5957	1.4160	1.0860	.6168	.3663	.2964	.3700	.5041	.5724	.2199

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	-2.36	-1.215	-7.49	.03	8	2.85	-23.27
1	.41	1.030	16.53	.28	11	.62	-20.28

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	.75	.685	17.41	.48	11	.46	-18.74
3	1.60	-.409	23.41	.05	11	2.38	-19.54
4	1.47	-.527	22.17	.14	11	1.67	-19.15
5	.73	1.131	16.85	.68	11	.44	-18.55
6	.87	.760	17.32	.82	11	.33	-18.08
7	.99	.084	17.52	.86	11	.31	-17.59
8	.89	.771	16.72	.87	11	.34	-17.36
9	1.04	-.174	17.15	.72	11	.55	-16.91
10	.95	.249	16.33	.74	11	.51	-16.67
11	.89	1.971	16.23	.98	11	.15	-17.01

Table 7.12 XSA diagnostics

Fleet : FLT02: 8c East trawl

Age	1985
0	-1.19
1	.27
2	1.29
3	.51
4	-.92
5	-.46
6	-.21
7	-.01
8	.39
9	.02
10	.12
11	-.11

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.29	-1.00	2.14	1.71	-.49	.59	-.90	99.99	-.73	-.54
1	-.02	-.65	-.22	.06	-.16	.00	.33	-.22	.42	.12
2	.29	.84	-1.85	-1.40	.67	1.89	-2.50	.08	.60	.46
3	1.04	1.18	-.80	-.05	.94	-.44	-.17	.46	-2.78	.68
4	.89	.71	-.46	.76	.12	.52	-.57	.63	-1.60	.00
5	.24	.89	-.20	.58	-.17	-.12	-.33	-.44	-.49	.57
6	-.30	.74	.01	.15	.06	-.50	-.25	-.86	.62	.52
7	-.35	-.05	-.31	-.30	.49	-.39	-.28	-.16	.75	.45
8	-.17	-.59	-.17	-.11	.35	-.21	-.50	-.84	.85	.96
9	-.58	-.03	.37	.69	-.51	-.75	.13	-.15	.26	.47
10	-.50	-.21	.98	1.69	.06	-1.09	-.34	-.88	.12	1.40
11	-1.41	-.41	.86	-.80	.12	-1.23	-.96	-.60	-.02	.90

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	-16.8761	-17.5847	-17.9150	-17.6929	-17.6254	-17.3332	-17.0961	-16.6021	-16.6021	-16.6021
S.E(Log q)	1.3876	1.1643	.8078	.4812	.5028	.4117	.5980	.4654	.9288	.8483

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	.56	.378	18.17	.10	10	1.24	-21.35
1	-.44	-4.923	12.29	.59	11	.32	-17.51

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	2.87	-.564	23.28	.01	11	4.15	-16.88
3	2.72	-.865	25.28	.03	11	3.21	-17.58
4	.71	.912	16.44	.56	11	.58	-17.91
5	.79	1.029	16.56	.75	11	.38	-17.69
6	1.18	-.569	18.62	.56	11	.62	-17.63
7	.97	.156	17.16	.77	11	.42	-17.33
8	.69	2.193	15.32	.86	11	.35	-17.10
9	1.15	-.673	17.46	.72	11	.55	-16.60
10	1.22	-.448	17.84	.35	11	1.17	-16.48
11	1.18	-.512	18.21	.52	11	.95	-16.92

Table 7.12 XSA diagnostics

Fleet : PJS: Jul Pt. Survey,

Age	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
0 ,	99.99,	99.99,	99.99,	-.59,	-.30,	-.38,	-1.02,	1.29,	-.19,	1.11
1 ,	99.99,	99.99,	99.99,	-.15,	.14,	.12,	.08,	-.02,	-.03,	-.15
2 ,	99.99,	99.99,	99.99,	-.30,	.46,	-.56,	.01,	.88,	1.22,	-1.72
3 ,	99.99,	99.99,	99.99,	.30,	-.39,	-2.05,	.07,	2.00,	.52,	-.49
4 ,	99.99,	99.99,	99.99,	1.06,	-.69,	-1.71,	-.67,	.74,	1.60,	-.33
5 ,	99.99,	99.99,	99.99,	-.25,	-.21,	-1.59,	-1.22,	1.18,	1.54,	.47
6 ,	99.99,	99.99,	99.99,	-.41,	-.47,	-.78,	-1.55,	1.84,	1.37,	-.09
7 ,	99.99,	99.99,	99.99,	-1.34,	.31,	-.10,	.07,	1.17,	.88,	-1.08
8 ,	99.99,	99.99,	99.99,	.31,	-.94,	.71,	.42,	2.31,	-.26,	-2.55
9 ,	99.99,	99.99,	99.99,	.42,	.38,	-.94,	1.45,	1.47,	.61,	-3.35
10 ,	99.99,	99.99,	99.99,	.62,	-.10,	1.09,	-.28,	-.21,	.96,	-1.74
11 ,	99.99,	99.99,	99.99,	1.06,	.81,	1.36,	1.85,	-2.62,	2.29,	-1.64

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,	-9.2621,	-9.4650,	-9.8012,	-9.8087,	-9.7647,	-9.9885,	-9.9432,	-9.6031,	-9.6031,	-9.6031
S.E(Log q),	.9950,	1.2292,	1.1702,	1.1719,	1.2126,	.9317,	1.5207,	1.7055,	.9807,	1.9224,

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,	-.59,	-1.418,	16.01,	.14,	7,	.97,	-10.72,
1,	.29,	5.239,	12.38,	.92,	7,	.13,	-8.73,

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,	.75,	.331,	10.35,	.26,	7,	.81,	-9.26,
3,	.98,	.015,	9.54,	.11,	7,	1.32,	-9.46,
4,	-1.54,	-2.257,	17.29,	.14,	7,	1.39,	-9.80,
5,	-1.29,	-1.848,	15.49,	.12,	7,	1.27,	-9.81,
6,	.60,	.584,	10.66,	.31,	7,	.77,	-9.76,
7,	1.45,	-.583,	9.09,	.26,	7,	1.43,	-9.99,
8,	-6.55,	-1.904,	22.36,	.01,	7,	8.27,	-9.94,
9,	-2.93,	-2.162,	15.45,	.06,	7,	3.91,	-9.60,
10,	1.18,	-.331,	9.41,	.40,	7,	1.26,	-9.56,
11,	-3.49,	-2.756,	11.45,	.07,	7,	4.47,	-9.17,

Table 7.12 XSA diagnostics

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: 8c East trawl,	522210.,	1.339,	.000,	.00,	1,	.056,	.000
PJS: Jul Pt. Survey,,	2716393.,	1.103,	.000,	.00,	1,	.083,	.000
P shrinkage mean ,	1071929.,	.36,,,,				.760,	.003
F shrinkage mean ,	124383.,	1.00,,,,				.101,	.026

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
894731.,	.32,	.49,	4,	1.557,	.004

Age 1 Catchability dependent on age and year class strength

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	384544.,	.669,	.299,	.45,	2,	.069,	.328
FLT02: 8c East trawl,	613732.,	.326,	.197,	.60,	2,	.292,	.218
PJS: Jul Pt. Survey,,	488497.,	.288,	.010,	.04,	2,	.374,	.267
P shrinkage mean ,	701296.,	.42,,,,				.226,	.193
F shrinkage mean ,	899142.,	1.00,,,,				.039,	.154

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
570720.,	.18,	.10,	8,	.526,	.233

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	648821.,	.453,	.248,	.55,	2,	.190,	.164
FLT02: 8c East trawl,	1285389.,	.359,	.009,	.02,	2,	.290,	.086
PJS: Jul Pt. Survey,,	772409.,	.281,	.389,	1.38,	3,	.473,	.140
F shrinkage mean ,	415956.,	1.00,,,,				.046,	.245

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
841849.,	.20,	.19,	8,	.963,	.129

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	548724.,	.436,	.296,	.68,	3,	.181,	.147
FLT02: 8c East trawl,	371527.,	.310,	.203,	.65,	4,	.338,	.210
PJS: Jul Pt. Survey,,	413839.,	.275,	.245,	.89,	4,	.424,	.190
F shrinkage mean ,	473162.,	1.00,,,,				.058,	.168

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
423132.,	.18,	.12,	12,	.670,	.186

Table 7.12 XSA diagnostics

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	588710.,	.415,	.403,	.97,	5,	.208,	.072
FLT02: 8c East trawl,	594127.,	.334,	.446,	1.33,	5,	.310,	.072
PJS: Jul Pt. Survey,,	683361.,	.270,	.141,	.52,	5,	.431,	.063
F shrinkage mean ,	371274.,	1.00,,,,				.051,	.112

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
614857.,	.19,	.17,	16,	.919,	.069

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	78460.,	.382,	.212,	.56,	6,	.231,	.173
FLT02: 8c East trawl,	121944.,	.279,	.355,	1.27,	6,	.414,	.115
PJS: Jul Pt. Survey,,	175247.,	.276,	.256,	.93,	6,	.306,	.081
F shrinkage mean ,	157244.,	1.00,,,,				.049,	.090

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
124603.,	.17,	.17,	19,	.955,	.113

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	79130.,	.269,	.169,	.63,	7,	.379,	.124
FLT02: 8c East trawl,	103620.,	.257,	.222,	.86,	7,	.374,	.096
PJS: Jul Pt. Survey,,	118195.,	.280,	.202,	.72,	7,	.212,	.085
F shrinkage mean ,	91246.,	1.00,,,,				.035,	.108

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
95785.,	.16,	.11,	22,	.703,	.103

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	114688.,	.203,	.205,	1.01,	8,	.449,	.104
FLT02: 8c East trawl,	141858.,	.214,	.175,	.82,	8,	.361,	.085
PJS: Jul Pt. Survey,,	100900.,	.276,	.313,	1.14,	7,	.167,	.118
F shrinkage mean ,	64459.,	1.00,,,,				.023,	.179

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
119610.,	.13,	.12,	24,	.923,	.100

Table 7.12 XSA diagnostics

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	124720.,	.181,	.123,	.68,	9,	.534,	.138
FLT02: 8c East trawl,	144357.,	.205,	.244,	1.19,	9,	.372,	.121
PJS: Jul Pt. Survey,,	99166.,	.475,	.566,	1.19,	7,	.071,	.171
F shrinkage mean ,	73774.,	1.00,,,,				.023,	.224

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
127988.,	.13,	.13,	26,	.969,	.135

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1986

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	109053.,	.174,	.118,	.68,	10,	.528,	.133
FLT02: 8c East trawl,	105789.,	.199,	.160,	.80,	10,	.389,	.137
PJS: Jul Pt. Survey,,	55768.,	.509,	.582,	1.14,	7,	.058,	.246
F shrinkage mean ,	35750.,	1.00,,,,				.025,	.361

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
100814.,	.13,	.11,	28,	.869,	.144

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1985

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	15831.,	.177,	.092,	.52,	11,	.534,	.406
FLT02: 8c East trawl,	14231.,	.212,	.186,	.88,	11,	.353,	.443
PJS: Jul Pt. Survey,,	10300.,	.520,	.520,	1.00,	7,	.070,	.571
F shrinkage mean ,	17991.,	1.00,,,,				.043,	.365

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
14874.,	.13,	.10,	30,	.758,	.428

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1984

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	8536.,	.169,	.105,	.62,	11,	.646,	.480
FLT02: 8c East trawl,	9874.,	.218,	.147,	.67,	11,	.263,	.427
PJS: Jul Pt. Survey,,	11816.,	.560,	.374,	.67,	7,	.050,	.368
F shrinkage mean ,	26230.,	1.00,,,,				.041,	.183

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
9444.,	.13,	.09,	30,	.663,	.443

Table 7.13 -

Run title : Horse mackerel South (run: XSAMFB03/X03)

At 17-Aug-96 13:29:49

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1985,
AGE	
0,	.2966,
1,	.4536,
2,	.2323,
3,	.0528,
4,	.1315,
5,	.1053,
6,	.0787,
7,	.1652,
8,	.1289,
9,	.1861,
10,	.2260,
11,	.4385,
+gp,	.4385,
FBAR 1-11,	.1999,
FBAR 0- 3,	.2588,
FBAR 7-11,	.2289,

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	FBAR 93-95
AGE											
0,	.2866,	.0415,	.1271,	.2838,	.0633,	.0149,	.0336,	.0070,	.0104,	.0036,	.0070,
1,	.5688,	.4905,	.2878,	.2293,	.2985,	.1162,	.1696,	.0923,	.0904,	.2328,	.1385,
2,	.2452,	.4393,	.1198,	.1061,	.2111,	.1934,	.2508,	.2204,	.3472,	.1289,	.2322,
3,	.2634,	.2493,	.1606,	.1576,	.1180,	.0678,	.1989,	.3461,	.1072,	.1864,	.2132,
4,	.1016,	.1693,	.1189,	.2134,	.0792,	.0852,	.0755,	.1928,	.1270,	.0694,	.1297,
5,	.1886,	.0857,	.1657,	.1808,	.1118,	.0795,	.0739,	.1028,	.0821,	.1126,	.0992,
6,	.1275,	.2117,	.1269,	.2655,	.1126,	.1439,	.0874,	.0891,	.1066,	.1034,	.0997,
7,	.3969,	.1298,	.2434,	.0934,	.2229,	.1879,	.2017,	.1623,	.1169,	.1004,	.1266,
8,	.4191,	.1247,	.1975,	.2361,	.1811,	.3125,	.2077,	.2456,	.1677,	.1350,	.1828,
9,	.3131,	.2108,	.3776,	.3913,	.2997,	.2156,	.5901,	.4396,	.2528,	.1436,	.2787,
10,	.3720,	.1615,	.7048,	.8671,	.2813,	.4632,	.2567,	.5702,	.2465,	.4279,	.4149,
11,	.5200,	.1366,	.5010,	.6173,	.6914,	.3947,	.5029,	.2675,	.4961,	.4428,	.4022,
+gp,	.5200,	.1366,	.5010,	.6173,	.6914,	.3947,	.5029,	.2675,	.4961,	.4428,	
FBAR 1-11,	.3196,	.2190,	.2731,	.3053,	.2371,	.2055,	.2377,	.2481,	.1946,	.1894,	
FBAR 0- 3,	.3410,	.3051,	.1738,	.1942,	.1727,	.0981,	.1632,	.1664,	.1388,	.1379,	
FBAR 7-11,	.4042,	.1527,	.4049,	.4411,	.3353,	.3148,	.3518,	.3370,	.2560,	.2500,	

Table 7.14

Run title : Horse mackerel South (run: XSAMFB03/X03)

At 17-Aug-96 13:29:49

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1985,
AGE	
0,	1653269,
1,	879310,
2,	441436,
3,	1674736,
4,	229228,
5,	158154,
6,	100703,
7,	52122,
8,	35477,
9,	39807,
10,	24583,
11,	9759,
+gp,	28960,
TOTAL,	5327547,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	GMST
AGE												
0,	2661286,	1414796,	1101196,	1058169,	845687,	2323585,	1489128,	1653783,	981934,	1042985,	0,	14849
1,	1057732,	1719751,	1168258,	834669,	685762,	683265,	1970441,	1239373,	1413479,	836405,	894731,	10664
2,	480838,	515495,	906329,	754063,	571224,	437900,	523572,	1431384,	972734,	1111437,	570720,	6224
3,	301194,	323871,	285961,	692000,	583679,	398110,	310616,	350668,	988343,	591625,	841849,	4539
4,	1367381,	199214,	217246,	209609,	508782,	446445,	320184,	219134,	213519,	764197,	423132,	3291
5,	172994,	1063211,	144757,	166020,	145749,	404578,	352870,	255550,	155539,	161860,	614857,	2492
6,	122519,	123306,	839948,	105568,	119262,	112174,	321618,	282094,	198468,	123321,	124603,	1762
7,	80112,	92827,	85883,	636766,	69674,	91715,	83605,	253650,	222102,	153556,	95785,	1124
8,	38031,	46366,	70169,	57952,	499217,	47989,	65415,	58816,	185609,	170068,	119610,	659
9,	26842,	21527,	35230,	49569,	39389,	358510,	30220,	45742,	39601,	135089,	127988,	451
10,	28445,	16893,	15007,	20786,	28849,	25123,	248732,	14418,	25367,	26471,	100814,	276
11,	16878,	16878,	12372,	6384,	7517,	18743,	13607,	165610,	7016,	17063,	14874,	160
+gp,	37123,	46752,	37098,	27275,	24437,	33448,	33531,	25877,	37674,	65070,	45412,	
TOTAL,	6391374,	5600884,	4919457,	4618829,	4129226,	5381584,	5763540,	5996100,	5441386,	5199149,	3974372,	

Table 7.15

Run title : Horse mackerel South (run: XSAMFB03/X03)

At 17-Aug-96 13:29:49

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 1-11,	FBAR 0- 3,	FBAR 7-11,
1985,	1653268,	283829,	116591,	43535,	.3734,	.1999,	.2588,	.2289,
1986,	2661285,	321492,	169502,	71258,	.4204,	.3196,	.3410,	.4042,
1987,	1414795,	340120,	190106,	52747,	.2775,	.2190,	.3051,	.1527,
1988,	1101196,	338303,	193886,	55888,	.2883,	.2731,	.1738,	.4049,
1989,	1058169,	332932,	191207,	56396,	.2949,	.3053,	.1942,	.4411,
1990,	845687,	334206,	203126,	49207,	.2422,	.2371,	.1727,	.3353,
1991,	2323586,	327742,	210773,	45511,	.2159,	.2055,	.0981,	.3148,
1992,	1489128,	361792,	207544,	50956,	.2455,	.2377,	.1632,	.3518,
1993,	1653782,	375125,	200289,	57428,	.2867,	.2481,	.1664,	.3370,
1994,	981934,	355075,	171793,	52588,	.3061,	.1946,	.1388,	.2560,
1995,	1042985,	382548,	209133,	52681,	.2519,	.1894,	.1379,	.2500,
Arith. Mean ,	1475074,	341197,	187632,	53472,	.2912,	.2390,	.0000,	.3161,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

Table 7.16 Input data for the predictions

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Prediction with management option table: Input data

Year: 1996								
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	1484.920	0.1500	0.0000	0.2500	0.2500	0.000	0.0063	0.029
1	894.731	0.1500	0.0000	0.2500	0.2500	0.032	0.1243	0.036
2	570.720	0.1500	0.0400	0.2500	0.2500	0.055	0.2084	0.058
3	841.849	0.1500	0.2700	0.2500	0.2500	0.075	0.1914	0.091
4	423.132	0.1500	0.6300	0.2500	0.2500	0.105	0.1164	0.110
5	614.857	0.1500	0.8100	0.2500	0.2500	0.127	0.0890	0.139
6	124.603	0.1500	0.9000	0.2500	0.2500	0.154	0.0895	0.173
7	95.785	0.1500	0.9500	0.2500	0.2500	0.176	0.1136	0.189
8	119.610	0.1500	0.9700	0.2500	0.2500	0.213	0.1641	0.218
9	127.988	0.1500	0.9800	0.2500	0.2500	0.240	0.2502	0.235
10	100.814	0.1500	0.9900	0.2500	0.2500	0.269	0.3724	0.273
11	14.874	0.1500	1.0000	0.2500	0.2500	0.304	0.3610	0.291
12+	45.412	0.1500	1.0000	0.2500	0.2500	0.329	0.3610	0.314
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1997								
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	1484.920	0.1500	0.0000	0.2500	0.2500	0.000	0.0063	0.029
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.1243	0.036
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2084	0.058
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1914	0.091
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1164	0.110
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0890	0.139
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0895	0.173
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1136	0.189
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1641	0.218
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.2502	0.235
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.3724	0.273
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3610	0.291
12+	.	0.1500	1.0000	0.2500	0.2500	0.329	0.3610	0.314
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
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	1484.920	0.1500	0.0000	0.2500	0.2500	0.000	0.0063	0.029
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.1243	0.036
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2084	0.058
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1914	0.091
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1164	0.110
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0890	0.139
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0895	0.173
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1136	0.189
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1641	0.218
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.2502	0.235
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.3724	0.273
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3610	0.291
12+	.	0.1500	1.0000	0.2500	0.2500	0.329	0.3610	0.314
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : FB2
Date and time: 19AUG96:12:23

Table 7.17 Yield per recruit summary table

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0	0	10660481	1474789	5604659	1255916	5398376	1209691
0.1000	0.0189	146266	26963	9687493	1210789	4701906	998702	4504291	955695
0.2000	0.0378	253516	43237	8974498	1028657	4056162	823005	3866874	782944
0.3000	0.0567	337355	53555	8417497	894463	3563588	694918	3382290	657560
0.4000	0.0756	405798	60291	7963052	790891	3170898	597144	2997259	562270
0.5000	0.0946	463417	64753	7580718	708165	2847789	519926	2681484	487339
0.6000	0.1135	513024	67713	7251750	640336	2575650	457334	2416363	426854
0.7000	0.1324	556460	69652	6963889	583571	2342346	405551	2189770	377017
0.8000	0.1513	594988	70880	6708712	535283	2139572	362005	1993411	335269
0.9000	0.1702	629515	71604	6480198	493657	1961415	324895	1821381	299823
1.0000	0.1891	660708	71968	6273888	457381	1803523	292921	1669338	269392
1.1000	0.2080	689079	72070	6086387	425476	1662596	265121	1533994	243021
1.2000	0.2269	715024	71982	5915044	397201	1536076	240760	1412801	219988
1.3000	0.2459	738862	71755	5757746	371977	1421936	219274	1303741	199736
1.4000	0.2648	760850	71427	5612774	349349	1318537	200216	1205188	181826
1.5000	0.2837	781202	71025	5478711	328950	1224540	183229	1115811	165907
1.6000	0.3026	800095	70571	5354369	310482	1138829	168023	1034504	151697
1.7000	0.3215	817681	70080	5238743	293699	1060466	154360	960340	138963
1.8000	0.3404	834089	69565	5130971	278395	988655	142044	892532	127514
1.9000	0.3593	849430	69033	5030309	264399	922711	130910	830404	117188
2.0000	0.3782	863802	68493	4936109	251564	862044	120816	773374	107851
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YIELDREC
Date and time : 19AUG96:12:06
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.5074
F-max factor : 1.0984
F-0.1 reference F : 0.0960
F-max reference F : 0.2077
Recruitment : 1485 (Millions)

Table 7.18 Prediction with management option table

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Table 7.18a

Prediction with management option table

Year: 1996					Year: 1997					Year: 1998	
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	0.1891	384499	224603	60129	0.0000	0.0000	393568	245301	0	465708	289219
.	.	.	.	.	0.1000	0.0189	.	244237	6366	458826	283148
.	.	.	.	.	0.2000	0.0378	.	243180	12604	452085	277248
.	.	.	.	.	0.3000	0.0567	.	242129	18716	445482	271512
.	.	.	.	.	0.4000	0.0756	.	241085	24705	439013	265934
.	.	.	.	.	0.5000	0.0946	.	240047	30575	432676	260509
.	.	.	.	.	0.6000	0.1135	.	239014	36329	426466	255233
.	.	.	.	.	0.7000	0.1324	.	237988	41969	420380	250099
.	.	.	.	.	0.8000	0.1513	.	236969	47499	414416	245103
.	.	.	.	.	0.9000	0.1702	.	235955	52921	408571	240240
.	.	.	.	.	1.0000	0.1891	.	234947	58238	402841	235506
.	.	.	.	.	1.1000	0.2080	.	233945	63453	397223	230896
.	.	.	.	.	1.2000	0.2269	.	232949	68567	391715	226407
.	.	.	.	.	1.3000	0.2459	.	231960	73584	386314	222033
.	.	.	.	.	1.4000	0.2648	.	230975	78506	381017	217773
.	.	.	.	.	1.5000	0.2837	.	229997	83335	375823	213621
.	.	.	.	.	1.6000	0.3026	.	229024	88074	370727	209574
.	.	.	.	.	1.7000	0.3215	.	228058	92724	365729	205629
.	.	.	.	.	1.8000	0.3404	.	227096	97288	360826	201783
.	.	.	.	.	1.9000	0.3593	.	226141	101768	356015	198032
.	.	.	.	.	2.0000	0.3782	.	225191	106166	351294	194374
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : FB2
Date and time : 19AUG96:12:57
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1996 : F factors

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Table 7.18b

Prediction with management option table

Year: 1996					Year: 1997					Year: 1998	
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
1.2429	0.2351	384499	222175	73000	0.0000	0.0000	379771	235579	0	451555	277985
.	.	.	.	.	0.1000	0.0189	.	234569	6097	444955	272203
.	.	.	.	.	0.2000	0.0378	.	233565	12072	438489	266582
.	.	.	.	.	0.3000	0.0567	.	232568	17928	432154	261115
.	.	.	.	.	0.4000	0.0756	.	231576	23668	425947	255799
.	.	.	.	.	0.5000	0.0946	.	230590	29294	419864	250626
.	.	.	.	.	0.6000	0.1135	.	229610	34810	413903	245594
.	.	.	.	.	0.7000	0.1324	.	228635	40219	408060	240696
.	.	.	.	.	0.8000	0.1513	.	227667	45522	402332	235929
.	.	.	.	.	0.9000	0.1702	.	226704	50723	396717	231287
.	.	.	.	.	1.0000	0.1891	.	225746	55825	391211	226767
.	.	.	.	.	1.1000	0.2080	.	224795	60829	385813	222365
.	.	.	.	.	1.2000	0.2269	.	223849	65738	380519	218077
.	.	.	.	.	1.3000	0.2459	.	222908	70554	375327	213899
.	.	.	.	.	1.4000	0.2648	.	221973	75280	370235	209827
.	.	.	.	.	1.5000	0.2837	.	221044	79918	365239	205858
.	.	.	.	.	1.6000	0.3026	.	220119	84470	360338	201989
.	.	.	.	.	1.7000	0.3215	.	219201	88938	355530	198216
.	.	.	.	.	1.8000	0.3404	.	218287	93323	350811	194536
.	.	.	.	.	1.9000	0.3593	.	217379	97629	346181	190947
.	.	.	.	.	2.0000	0.3782	.	216476	101856	341637	187445
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : FB2
Date and time : 19AUG96:12:57
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1996 : TAC constraints

Table 7.18c

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Single option prediction: Detailed tables

Year: 1996	F-factor: 1.0000		Reference F: 0.1891			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0063	8661	251	1484920	0	0	0	0	0
1	0.1243	97266	3502	894731	28631	0	0	0	0
2	0.2084	99958	5798	570720	31390	22829	1256	20872	1148
3	0.1914	136505	12422	841849	63139	227299	17047	208704	15653
4	0.1164	43238	4756	423132	44429	266573	27990	249398	26187
5	0.0890	48674	6766	614857	78087	498034	63250	469148	59582
6	0.0895	9917	1716	124603	19189	112143	17270	105625	16266
7	0.1136	9565	1808	95785	16858	90996	16015	85192	14994
8	0.1641	16844	3672	119610	25477	116022	24713	107260	22846
9	0.2502	26391	6202	127988	30717	125428	30103	113486	27237
10	0.3724	29243	7983	100814	27119	99806	26848	87587	23561
11	0.3610	4204	1223	14874	4522	14874	4522	13090	3979
12+	0.3610	12836	4031	45412	14942	45412	14942	39966	13150
Total		543302	60129	5459295	384499	1619416	243956	1500329	224603
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1997	F-factor: 1.0000		Reference F: 0.1891			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0063	8661	251	1484920	0	0	0	0	0
1	0.1243	138067	4970	1270056	40642	0	0	0	0
2	0.2084	119113	6909	680089	37405	27204	1496	24872	1368
3	0.1914	64668	5885	398815	29911	107680	8076	98871	7415
4	0.1164	61144	6726	598365	62828	376970	39582	352681	37032
5	0.0890	25663	3567	324175	41170	262582	33348	247352	31414
6	0.0895	38533	6666	484148	74559	435733	67103	410409	63203
7	0.1136	9793	1851	98065	17259	93162	16397	87220	15351
8	0.1641	10363	2259	73590	15675	71382	15204	65991	14056
9	0.2502	18015	4234	87369	20968	85621	20549	77469	18593
10	0.3724	24881	6792	85776	23074	84918	22843	74521	20046
11	0.3610	16901	4918	59792	18177	59792	18177	52622	15997
12+	0.3610	10222	3210	36165	11900	36165	11900	31828	10473
Total		546024	58238	5681325	393568	1641209	254674	1523838	234947
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1998	F-factor: 1.0000		Reference F: 0.1891			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0063	8661	251	1484920	0	0	0	0	0
1	0.1243	138067	4970	1270056	40642	0	0	0	0
2	0.2084	169079	9807	965375	53096	38615	2124	35306	1942
3	0.1914	77060	7012	475242	35643	128315	9624	117818	8836
4	0.1164	28966	3186	283468	29764	178585	18751	167078	17543
5	0.0890	36291	5044	458427	58220	371326	47158	349789	44423
6	0.0895	20316	3515	255260	39310	229734	35379	216383	33323
7	0.1136	38050	7192	381034	67062	361983	63709	338897	59646
8	0.1641	10610	2313	75342	16048	73081	15566	67562	14391
9	0.2502	11084	2605	53753	12901	52678	12643	47663	11439
10	0.3724	16984	4637	58553	15751	57968	15593	50871	13684
11	0.3610	14380	4184	50873	15465	50873	15465	44772	13611
12+	0.3610	16271	5109	57565	18941	57565	18941	50661	16669
Total		585819	59826	5869867	402843	1600723	254954	1486799	235508
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 7.19

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Single option prediction: Summary table

F *status quo*

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
1996	1.0000	0.1891	543302	60129	5459295	384499	1619416	243956	1500329	224603
1997	1.0000	0.1891	546024	58238	5681325	393568	1641209	254674	1523838	234947
1998	1.0000	0.1891	585819	59826	5869867	402843	1600723	254954	1486799	235508
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 19AUG96:11:39
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

F corresponding to constant TAC

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
1996	1.2429	0.2351	661754	73000	5459295	384499	1619416	243956	1486327	222175
1997	1.3515	0.2556	696308	73000	5572102	379771	1580813	244581	1449699	222426
1998	1.3815	0.2613	739413	73000	5637319	372694	1467766	232326	1345723	211534
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 19AUG96:11:39
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

F corresponding to $F_{TAC\ 1995}$

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
1996	1.2429	0.2351	661749	72999	5459295	384499	1619416	243956	1486327	222176
1997	1.2429	0.2351	645858	67816	5572106	379772	1580815	244581	1455386	223445
1998	1.2429	0.2351	681236	67691	5683817	378282	1490752	236272	1373299	216273
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 19AUG96:14:05
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.19 (Cont'd)

F_{med}

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
1996	1.0950	0.2071	590210	65236	5459295	384499	1619416	243956	1494832	223649
1997	1.0950	0.2071	586352	62155	5638056	388092	1617259	250664	1496606	230360
1998	1.0950	0.2071	624820	63121	5795430	392974	1556593	247432	1441128	227737
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 19AUG96:17:12
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

F_{max}

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
1996	1.0980	0.2077	591679	65396	5459295	384499	1619416	243956	1494659	223619
1997	1.0980	0.2077	587598	62275	5636701	387921	1616509	250539	1495756	230217
1998	1.0980	0.2077	626015	63220	5793115	392668	1555223	247199	1439713	227497
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 20AUG96:21:42
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

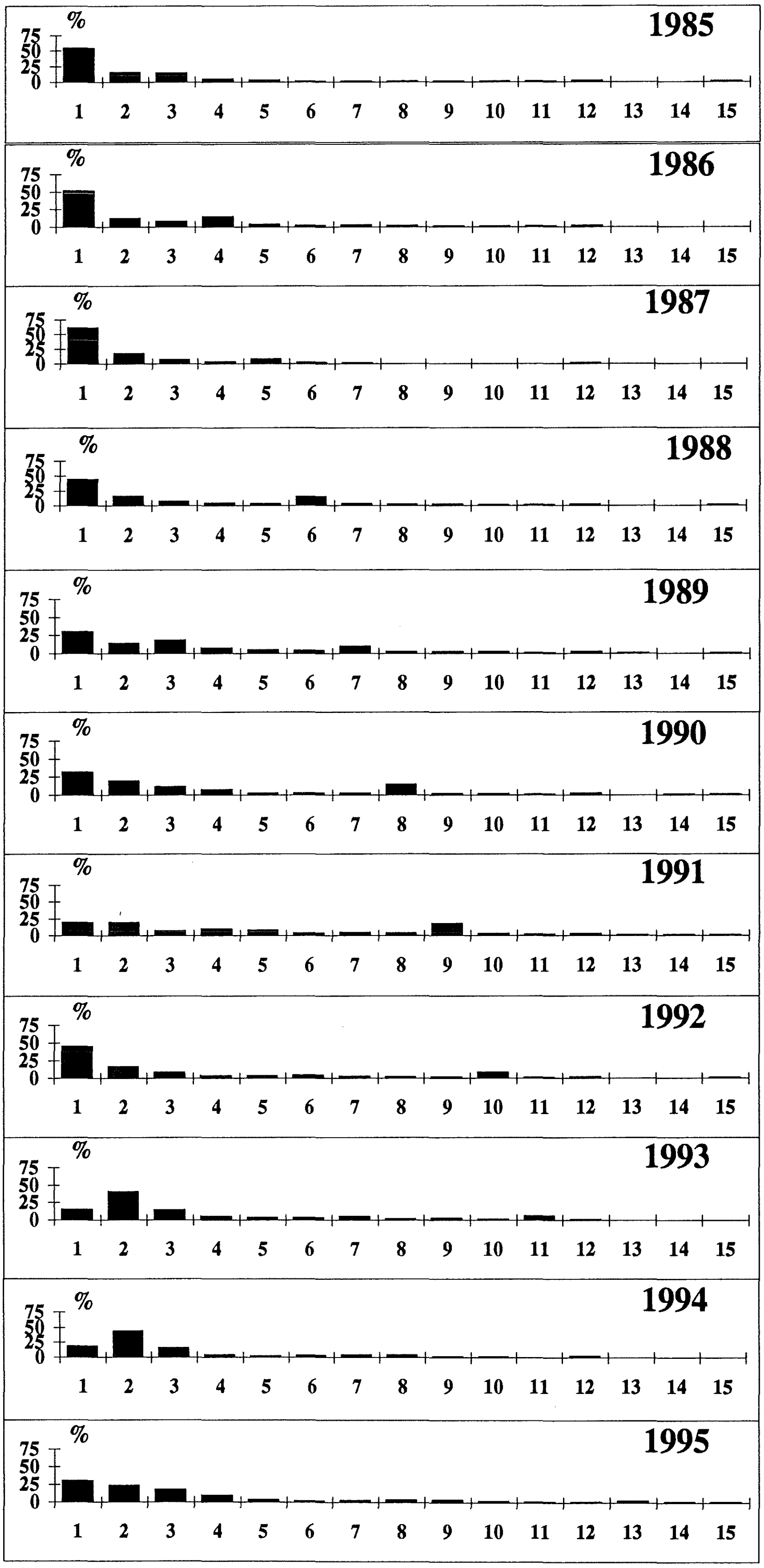


Figure 7.1 The age composition of southern horse mackerel in the international catches from 1985-1995. Age 15 is a plus group.

21/08/96 14:17 G:\ACFM\WGMHSA96\GUUS\AGE_SHOR.XLS

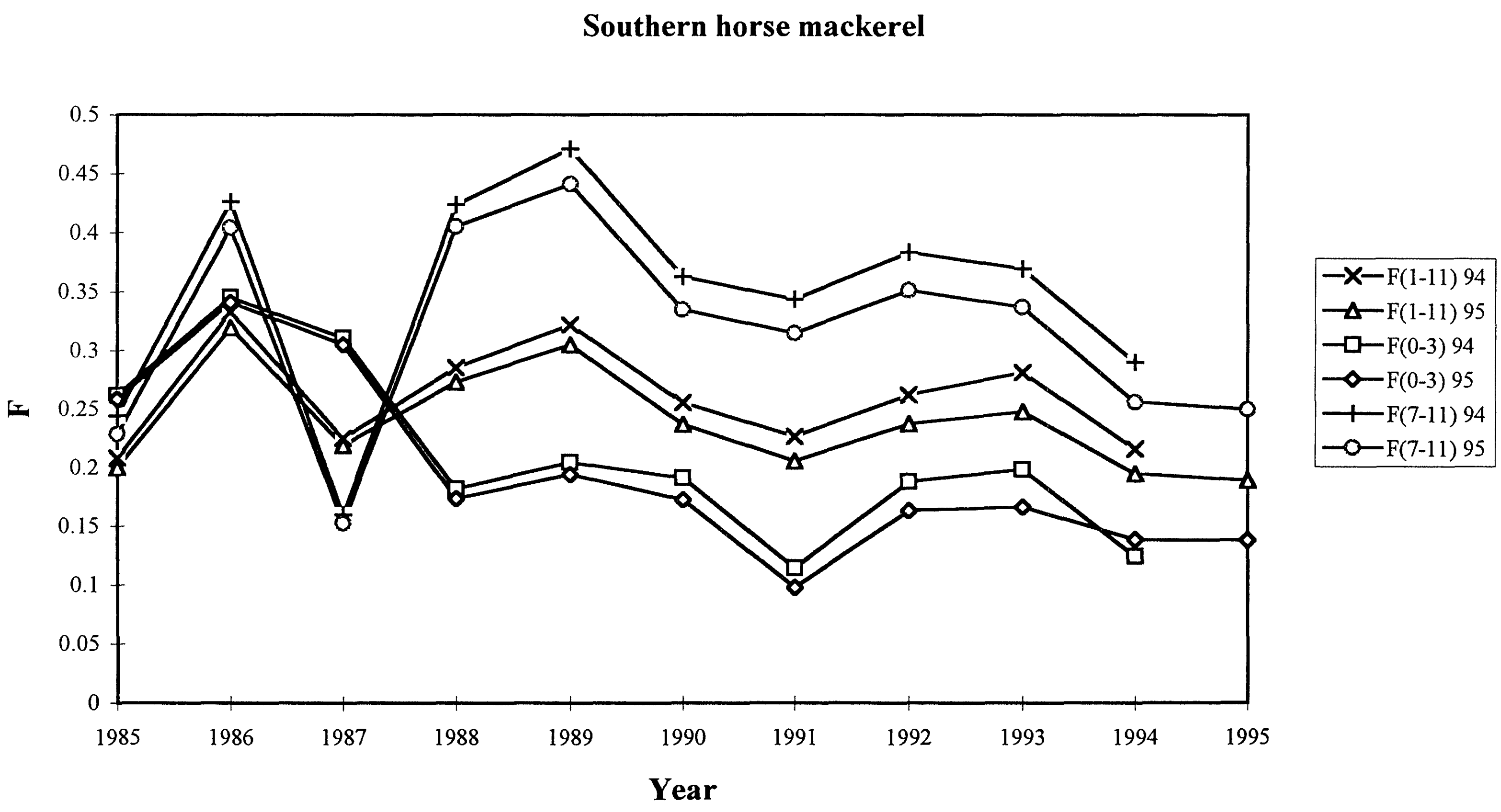


Figure 7.2 Comparison of the 1994 and 1995 assessments for different F's bar

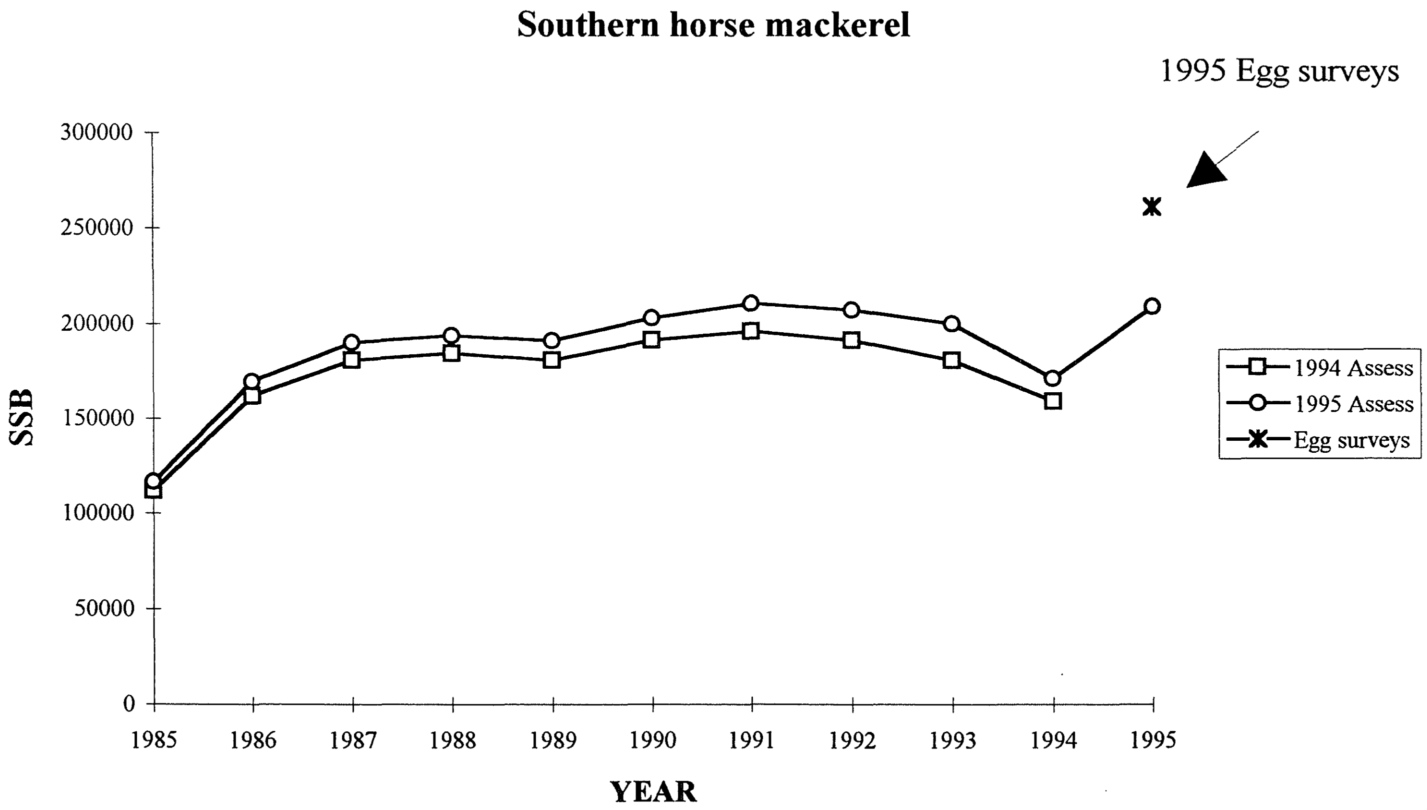


Figure 7.3 . Comparison of the SSB estimates from the 1994 and 1995 analytical assessments and the 1995 egg surveys.

Figure 7.4

Fish Stock Summary
Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)
17 – 8 – 1996

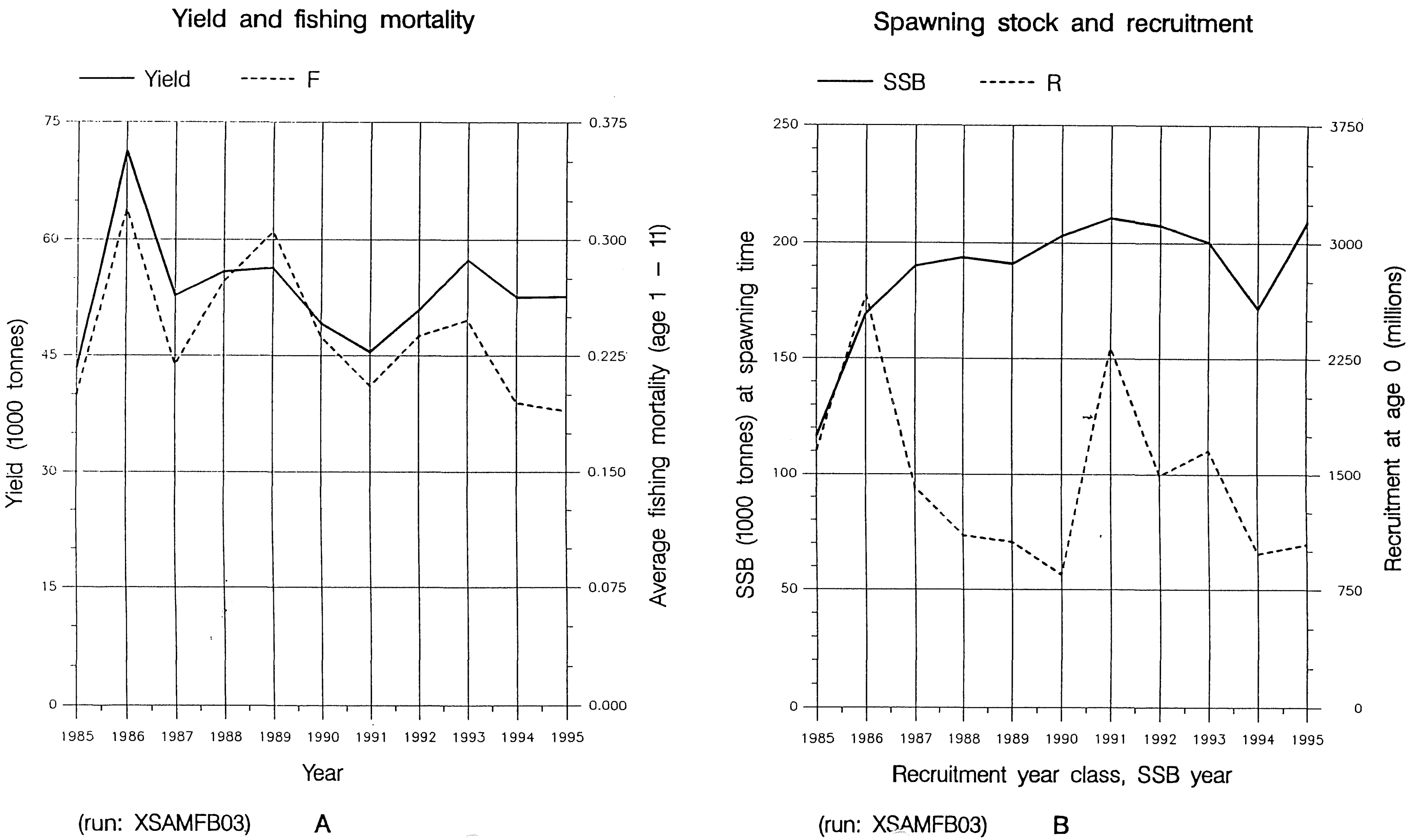
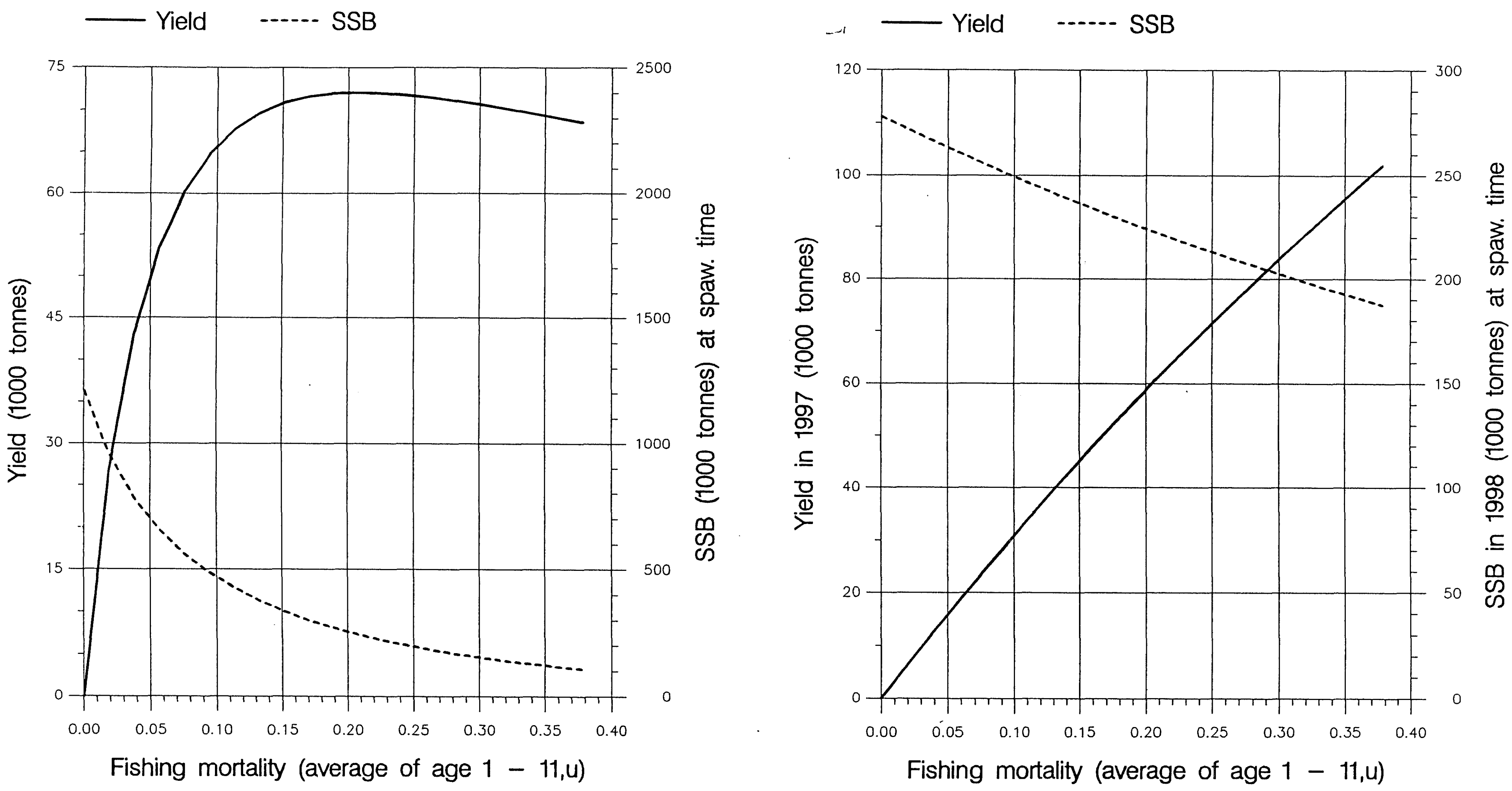


Figure 7.4c–d

Fish Stock Summary
Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)
19 – 8 – 1996

Long term yield and spawning stock biomass

Short term yield and spawning stock biomass



(run: YIELDREC) C

(run: FB2) D

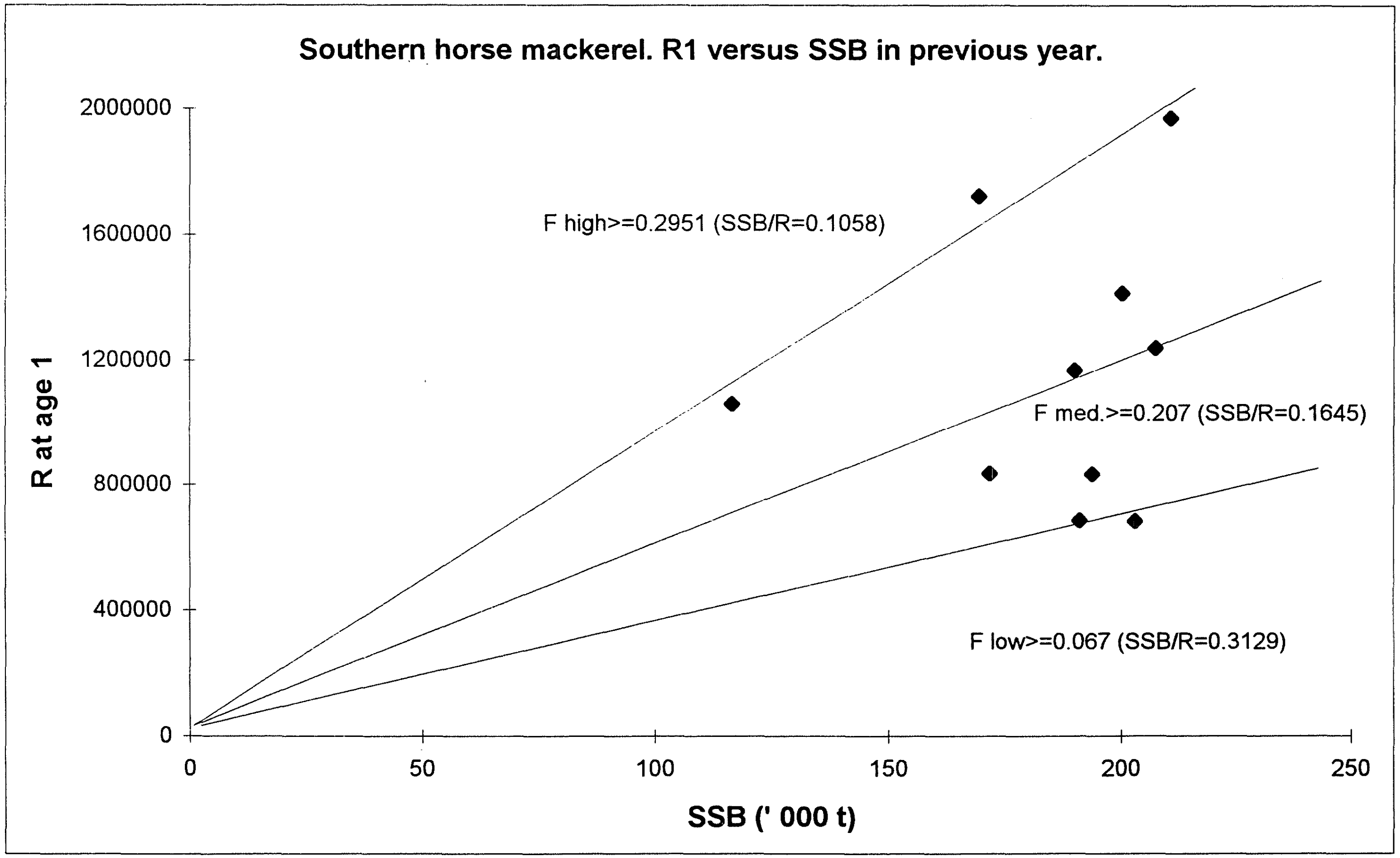


Figure 7.5 Recruits (age 1) versus Spawning Stock Biomass in previous year.