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

ICES Headquarters, Copenhagen, Denmark

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Part 1 of 2

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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 relationships, 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
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Denmark
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 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 | VIIIc 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. seiners | 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 and 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/II: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 VIIa,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 exists 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/II: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 (1.487×10^{15} eggs; S.E. 0.170×10^{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 2.37×10^6 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 MIHEP 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 (207.27×10^{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 used 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 distributional 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 to 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 authorities, the catches and the TACs recommended 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 |

¹Assumed 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.

²Division 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 VIIId 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.

| Age Groups | Areas | | | | | | | | | |
|------------|-------|------|-----|-------|-----|------------|--------------|------|-------------|-----------|
| | IIa | IIIa | IVa | IVb,c | VIa | VIIb,c,j,k | VIIa,e,f,g,h | VIId | VIIIa,b,d,e | VIIId,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 VIIId 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,c,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 covering 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/II: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 vitellogenic 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 VIIIb 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 approximately). 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) | | 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) |
|--|---|-------------|------------------------------------|---|--|---|
| | Geometric | Arithmetic | | | | |
| 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) | | 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) |
| | Geometric | Arithmetic | | | | |
| 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 |
| <p>a Egg survey data for period 3 included</p> <p>b Egg survey data for period 3 excluded</p> <p>c from Anon (1987) page 3</p> <p>d from Anon (1990)</p> <p>e with 8.8% atresia</p> <p>f with 10.2% atresia</p> <p>g Eaton (1989). Incomplete coverage in 1977</p> | | | | | | |
| Estimates by Generalized Additive Modelling (from Augustin et al WD 1996) | | | | | | |
| Egg Production x 10 ⁻¹⁵ | | | | | | |
| Year | Area | Mackerel | | | Horse mackerel | |
| 1995 | Western | GAM (no bc) | GAM (with bc) | | GAM (no bc) | GAM (with bc) |
| | | 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] |
| | | | | | | |
| <p>bc = bias correction</p> <p>Figures in italics are standard errors</p> <p>Figures in brackets are %cv's</p> | | | | | | |

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 | 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 available | 356,487 | - 356,487 |
| 1973 | 52,200 | - | 52,200 | 167,300 | - | 167,300 | 326,519 | - | 326,519 | 21,600 | | 567,619 | - 567,619 |
| 1974 | 64,100 | - | 64,100 | 234,100 | - | 234,100 | 298,391 | - | 298,391 | 6,800 | | 603,391 | - 603,391 |
| 1975 | 64,800 | - | 64,800 | 416,500 | - | 416,500 | 263,062 | - | 263,062 | 34,700 | | 779,062 | - 779,062 |
| 1976 | 67,800 | - | 67,800 | 439,400 | - | 439,400 | 303,842 | - | 303,842 | 10,500 | | 821,542 | - 821,542 |
| 1977 | 74,800 | - | 74,800 | 259,100 | - | 259,100 | 258,131 | - | 258,131 | 1,400 | 27,417 | 620,848 | - 620,848 |
| 1978 | 151,700 | 15,100 | 166,900 | 355,500 | 35,500 | 391,000 | 148,817 | - | 148,817 | 4,200 | 26,508 | 686,725 | 50,700 737,425 |
| 1979 | 203,300 | 20,300 | 223,600 | 398,000 | 39,800 | 437,800 | 152,323 | 500 | 152,823 | 7,000 | 22,475 | 783,098 | 60,600 843,698 |
| 1980 | 218,700 | 6,000 | 224,700 | 386,100 | 15,600 | 401,700 | 87,391 | - | 87,391 | 8,300 | 15,964 | 716,455 | 21,600 738,055 |
| 1981 | 335,100 | 2,500 | 337,600 | 274,300 | 39,800 | 314,100 | 64,172 | 3,216 | 67,388 | 18,700 | 18,053 | 710,325 | 45,516 755,841 |
| 1982 | 340,400 | 4,100 | 344,500 | 257,800 | 20,800 | 278,600 | 35,033 | 450 | 35,483 | 37,600 | 21,076 | 691,009 | 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 |

¹For 1976-1985 only Division IIa.

²Discards 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 |

¹Includes catches probably taken in the northern part of Division IVa.

²Preliminary.

³Russia.

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 ² | | | | -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 |

¹Includes catches taken in Division IVa, but misreported to Division VIa.

²Preliminary.

³Catches 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 |

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 | P. seine | Artisanal | Trawl | P. Trawl | Trawl | Handline | Commercial | P. seine | Artisanal | Trawl | P Seine | Trawl |
| Length cm | | | | | Pelagic trawl | | | | | | | | | | | | |
| 10 | | 0 | 0 | | | | | | | | | | | | | | |
| 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 |
| 34 | 17512 | 4578 | 5604 | 46900 | 9131 | 744 | 2452 | 703 | 21001 | 2001 | 263 | 7607 | 542 | 61 | | 130 | 89480 |
| 35 | 16817 | 5501 | 4099 | 47848 | 9602 | 756 | 3178 | 343 | 19403 | 946 | 183 | 11074 | 610 | 51 | | 104 | 95700 |
| 36 | 15965 | 4765 | 3957 | 39885 | 12998 | 737 | 3375 | 563 | 22646 | 388 | 193 | 9141 | 499 | 97 | | 57 | 54960 |
| 37 | 17022 | 4240 | 4233 | 38851 | 12637 | 914 | 3660 | 469 | 19696 | 151 | 149 | 9185 | 298 | 85 | | 41 | 69500 |
| 38 | 15181 | 3336 | 3632 | 33774 | 13924 | 1297 | 4517 | 1155 | 19702 | 20 | 112 | 5259 | 256 | 90 | | 2 | 50520 |
| 39 | 14919 | 3403 | 3117 | 27582 | 11770 | 2004 | 5106 | 626 | 19958 | 0 | 90 | 3448 | 85 | 74 | | 50 | 56900 |
| 40 | 9175 | 1829 | 2460 | 19486 | 9672 | 2078 | 4961 | 1105 | 18065 | 0 | 73 | 2003 | 64 | 83 | | 46 | 55080 |
| 41 | 4858 | 1172 | 1006 | 10268 | 6259 | 1984 | 3946 | 509 | 11835 | 0 | 21 | 612 | 4 | 50 | | 29 | 51290 |
| 42 | 2408 | 929 | 491 | 5166 | 3225 | 1595 | 2479 | 245 | 7671 | 0 | 7 | 280 | 4 | 21 | | 22 | 31740 |
| 43 | 899 | 89 | 416 | 1089 | 1499 | 928 | 1435 | 119 | 4204 | 0 | 4 | 72 | 0 | 22 | | 17 | 6110 |
| 44 | 520 | 71 | 42 | 50 | 678 | 593 | 705 | 88 | 2392 | 0 | 3 | 0 | 0 | 14 | | 3 | 6150 |
| 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 | |
| 53 | 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 | |
| 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 | 17848 | 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.

| Age | 2A 1 st Q | 3A 1 st Q | 4A 1 st Q | 4BC 1 st Q | 6A 1 st Q | 7BCJK 1 st Q | 7AEGH 1 st Q | 7D 1 st Q | 8ABUE 1 st Q | All areas 1 st Q |
|-------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|----------------------------|-------------------------|----------------------------|--------------------------------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 175 | 286 | 20,266 | 0 | 67 | 20,830 |
| 2 | 121 | 0 | 24,729 | 0 | 11,800 | 1,995 | 37,465 | 0 | 179 | 78,290 |
| 3 | 162 | 0 | 39,095 | 0 | 35,164 | 8,727 | 6,266 | 0 | 1,744 | 81,158 |
| 4 | 106 | 0 | 42,417 | 0 | 40,383 | 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 | 88,966 |
| 7 | 15 | 0 | 19,928 | 0 | 30,729 | 12,480 | 134 | 0 | 336 | 63,623 |
| 8 | 15 | 0 | 22,892 | 0 | 24,505 | 8,155 | 56 | 0 | 331 | 53,953 |
| 9 | 10 | 0 | 11,120 | 0 | 18,544 | 8,132 | 115 | 0 | 179 | 36,100 |
| 10 | 5 | 0 | 10,873 | 0 | 10,082 | 4,483 | 23 | 0 | 114 | 25,380 |
| 11 | 5 | 0 | 8,579 | 0 | 9,468 | 1,998 | 16 | 0 | 75 | 18,141 |
| 12 | 0 | 0 | 4,135 | 0 | 3,356 | 559 | 10 | 0 | 48 | 8,107 |
| 13 | 0 | 0 | 2,143 | 0 | 2,847 | 1,284 | 6 | 0 | 28 | 8,406 |
| 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 | 248,234 | 0 | 295,970 | 80,881 | 65,494 | 0 | 4,535 | 673,619 |
| Tonne | 195 | 1 | 103,914 | 0 | 117,193 | 40,091 | 8,854 | 0 | 1,809 | 271,857 |

| Age | 2A 2 nd Q | 3A 2 nd Q | 4A 2 nd Q | 4BC 2 nd Q | 6A 2 nd Q | 7BCJK 2 nd Q | 7AEGH 2 nd Q | 7D 2 nd Q | 8ABUE 2 nd Q | All areas 2 nd Q |
|-------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|----------------------------|-------------------------|----------------------------|--------------------------------|
| 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 | 12,718 | 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 | 4,389 | 0 | 1,289 | 1,423 | 21,800 | 69,480 | 0 | 38,581 | 8,470 | 143,392 |
| Tonne | 1,686 | 64 | 524 | 376 | 8,839 | 28,065 | 0 | 4,902 | 3,886 | 49,342 |

| Age | 2A 3 rd Q | 3A 3 rd Q | 4A 3 rd Q | 4BC 3 rd Q | 6A 3 rd Q | 7BCJK 3 rd Q | 7AEGH 3 rd Q | 7D 3 rd Q | 8ABUE 3 rd Q | All areas 3 rd Q |
|-------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|----------------------------|-------------------------|----------------------------|--------------------------------|
| 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 | 496 | 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 | 487 | 0 | 0 | 0 | 0 | 0 | 0 | 1,299 |
| Total | 261,733 | 1,568 | 127,893 | 8,159 | 7,973 | 0 | 0 | 0 | 896 | 408,222 |
| Tonne | 132,223 | 64 | 61,254 | 2,059 | 2,366 | 0 | 0 | 0 | 391 | 199,151 |

| Age | 2A 4 th Q | 3A 4 th Q | 4A 4 th Q | 4BC 4 th Q | 6A 4 th Q | 7BCJK 4 th Q | 7AEGH 4 th Q | 7D 4 th Q | 8ABUE 4 th Q | All areas 4 th Q |
|-------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|----------------------------|-------------------------|----------------------------|--------------------------------|
| 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 | 862 | 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 st Q | 3A 1 st Q | 4A 1 st Q | 4BC 1 st Q | 6A 1 st Q | 7BCJK 1 st Q | 7AEGH 1 st Q | 7D 1 st Q | 8ABUE 1 st Q | All areas 1 st Q |
|-------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|----------------------------|-------------------------|----------------------------|--------------------------------|
| 0 | 0 | 0 | 0 | 0 | 2,427 | 301 | 1,004 | 0 | 0 | 3,732 |
| 1 | 0 | 60 | 2,984 | 8,410 | 6,207 | 3,068 | 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 | 335,078 |
| 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 | 1,181 | 72,394 | 517 | 39,373 | 28,528 | 5,568 | 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 | 6,004 | 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 | 288,608 | 11,332 | 722,830 | 17,287 | 354,757 | 184,194 | 161,589 | 70,907 | 14,481 | 1,803,984 |
| Tonne | 134,104 | 5,766 | 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 | Ville East | Ville West | IXa North | Xa Centr-I | Xa Centr-I | IXa South | All areas |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Age | 1st Q | 1st Q | 1st Q | 1st Q | 1st Q | 1st Q | 1st Q |
| Age | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | 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 |

| | Ville East | Ville West | IXa North | Xa Centr-I | Xa Centr-I | IXa South | All areas |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Age | 2nd Q | 2nd Q | 2nd Q | 2nd Q | 2nd Q | 2nd Q | 2nd Q |
| Age | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | 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 |

| | Ville East | Ville West | IXa North | Xa Centr-I | Xa Centr-I | IXa South | All areas |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Age | 3rd Q | 3rd Q | 3rd Q | 3rd Q | 3rd Q | 3rd Q | 3rd Q |
| Age | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | 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 |

| | Ville East | Ville West | IXa North | Xa Centr-I | Xa Centr-I | IXa South | All areas |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Age | 4th Q | 4th Q | 4th Q | 4th Q | 4th Q | 4th Q | 4th Q |
| Age | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | catch('000) | 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.

| Age | 2A 1 st Q | 3A 1 st Q | 4A 1 st Q | 4BC 1 st Q | 6A 1 st Q | 7BCJK 1 st Q | 7A&FGH 1 st Q | 7D 1 st Q | 8ABDE 1 st Q | All areas 1 st Q |
|------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|-----------------------------|-------------------------|----------------------------|--------------------------------|
| length(cm) | length(cm) | length(cm) | length(cm) | 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 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1 | 0.0 | 0.0 | 26.5 | 0.0 | 20.2 | 20.5 | 28.2 | 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 | 3A 2 nd Q | 4A 2 nd Q | 4BC 2 nd Q | 6A 2 nd Q | 7BCJK 2 nd Q | 7A&FGH 2 nd Q | 7D 2 nd Q | 8ABDE 2 nd Q | All areas 2 nd Q |
|------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|-----------------------------|-------------------------|----------------------------|--------------------------------|
| length(cm) | length(cm) | length(cm) | length(cm) | 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 | 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 | 3A 3 rd Q | 4A 3 rd Q | 4BC 3 rd Q | 6A 3 rd Q | 7BCJK 3 rd Q | 7A&FGH 3 rd Q | 7D 3 rd Q | 8ABDE 3 rd Q | All areas 3 rd Q |
|------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|-----------------------------|-------------------------|----------------------------|--------------------------------|
| length(cm) | length(cm) | length(cm) | length(cm) | 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 | 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+ | 36.8 | 38.1 | 36.6 | 30.5 | 34.1 | 0.0 | 0.0 | 0.0 | 38.3 | 36.4 |

| Age | 2A 4 th Q | 3A 4 th Q | 4A 4 th Q | 4BC 4 th Q | 6A 4 th Q | 7BCJK 4 th Q | 7A&FGH 4 th Q | 7D 4 th Q | 8ABDE 4 th Q | All areas 4 th Q |
|------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------|-----------------------------|-------------------------|----------------------------|--------------------------------|
| length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | 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 | 42.6 | 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 | 38.2 | 35.8 | 30.8 | 32.3 | 32.5 | 31.1 | 29.8 | 39.0 | 34.1 |

| Age | 2A 1-4 Q | 3A 1-4 Q | 4A 1-4 Q | 4BC 1-4 Q | 6A 1-4 Q | 7BCJK 1-4 Q | 7A&FGH 1-4 Q | 7D 1-4 Q | 8ABDE 1-4 Q | All areas 1-4 Q |
|------------|-------------|-------------|-------------|--------------|-------------|----------------|-----------------|-------------|----------------|--------------------|
| length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | 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 | 39.0 | 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 | 38.4 | 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 | Villic East | Villic West | IXa North | Xa Centr-N | Xa Centr-S | IXa South | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Age | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q |
| | 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 | 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 |

| | Villic East | Villic West | IXa North | Xa Centr-N | Xa Centr-S | IXa South | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Age | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q |
| | 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 | 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 |

| | Villic East | Villic West | IXa North | Xa Centr-N | Xa Centr-S | IXa South | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Age | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q |
| | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | 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 |

| | Villic East | Villic West | IXa North | Xa Centr-N | Xa Centr-S | IXa South | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Age | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q |
| | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | length(cm) | 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 | 2A | 3A | 4A | 4BC | 6A | 7BCJK | 7AEFGH | 7D | 8ABDE | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Age | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q | 1 st Q |
| | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | 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 | 283 | 0 | 350 | 413 |
| 6 | 576 | 0 | 469 | 0 | 493 | 452 | 335 | 0 | 408 | 483 |
| 7 | 800 | 0 | 501 | 0 | 502 | 528 | 396 | 0 | 450 | 506 |
| 8 | 661 | 0 | 539 | 0 | 539 | 570 | 484 | 0 | 483 | 542 |
| 9 | 656 | 0 | 576 | 0 | 577 | 561 | 437 | 0 | 510 | 573 |
| 10 | 606 | 0 | 593 | 0 | 594 | 587 | 520 | 0 | 517 | 589 |
| 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 | 656 | 0 | 639 | 694 | 631 | 0 | 622 | 656 |
| 14 | 0 | 0 | 673 | 0 | 613 | 684 | 557 | 0 | 502 | 651 |
| 15+ | 0 | 0 | 714 | 0 | 616 | 795 | 665 | 0 | 691 | 695 |
| 0-15+ | 425 | 0 | 423 | 0 | 440 | 440 | 136 | 0 | 349 | 404 |

| Age | 2A | 3A | 4A | 4BC | 6A | 7BCJK | 7AEFGH | 7D | 8ABDE | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q | 2 nd Q |
| | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | 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 | 458 | 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 | 805 | 0 | 0 | 658 | 614 |
| 0-15+ | 386 | 0 | 413 | 262 | 406 | 404 | 0 | 134 | 454 | 336 |

| Age | 2A | 3A | 4A | 4BC | 6A | 7BCJK | 7AEFGH | 7D | 8ABDE | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q | 3 rd Q |
| | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 170 | 268 | 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 | 3A | 4A | 4BC | 6A | 7BCJK | 7AEFGH | 7D | 8ABDE | All areas |
|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q | 4 th Q |
| | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) |
| 0 | 0 | 0 | 0 | 0 | 0 | 76 | 71 | 0 | 0 | 73 |
| 1 | 0 | 252 | 265 | 164 | 157 | 148 | 155 | 157 | 0 | 164 |
| 2 | 0 | 341 | 296 | 220 | 265 | 206 | 203 | 266 | 0 | 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 | 497 | 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 | 3A | 4A | 4BC | 6A | 7BCJK | 7AEFGH | 7D | 8ABDE | All areas |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q | 1-4 Q |
| | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) | weight(g) |
| 0 | 0 | 0 | 0 | 0 | 0 | 76 | 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 | 418 | 509 | 598 |
| 10 | 704 | 682 | 621 | 0 | 580 | 567 | 520 | 0 | 517 | 606 |
| 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 | 798 |
| 0-15+ | 503 | 468 | 440 | 248 | 406 | 405 | 206 | 172 | 419 | 404 |

Table 2.13

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

| 1995 | Villic East 1 st Q weight(g) | Villic West 1 st Q weight(g) | IXa North 1 st Q weight(g) | IXa Centr-1 1 st Q weight(g) | IXa Centr-3 1 st Q weight(g) | IXa South 1 st Q weight(g) | All areas 1 st Q weight(g) |
|-------|---|---|---|---|---|---|---|
| Age | | | | | | | |
| 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 |

| | Villic East 2 nd Q weight(g) | Villic West 2 nd Q weight(g) | IXa North 2 nd Q weight(g) | IXa Centr-1 2 nd Q weight(g) | IXa Centr-3 2 nd Q weight(g) | IXa South 2 nd Q weight(g) | All areas 2 nd Q weight(g) |
|-------|---|---|---|---|---|---|---|
| Age | | | | | | | |
| 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 |

| | Villic East 3 rd Q weight(g) | Villic West 3 rd Q weight(g) | IXa North 3 rd Q weight(g) | IXa Centr-1 3 rd Q weight(g) | IXa Centr-3 3 rd Q weight(g) | IXa South 3 rd Q weight(g) | All areas 3 rd Q weight(g) |
|-------|---|---|---|---|---|---|---|
| Age | | | | | | | |
| 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 |

| | Villic East 4 th Q weight(g) | Villic West 4 th Q weight(g) | IXa North 4 th Q weight(g) | IXa Centr-1 4 th Q weight(g) | IXa Centr-3 4 th Q weight(g) | IXa South 4 th Q weight(g) | All areas 4 th Q weight(g) |
|-------|---|---|---|---|---|---|---|
| Age | | | | | | | |
| 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 |

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 |
| Spain | 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 |
| | 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 |
| Portugal | IXa CN | - | 0 | 236 | 229 | 223 | 156 | 165 | 281 | 228 | 137 | 914 | 543 | 378 | 913 |
| | 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 |

1st Winter Mackerel (Yr Class 1995) Nos/Hr Trawled - 4th Qu 1995

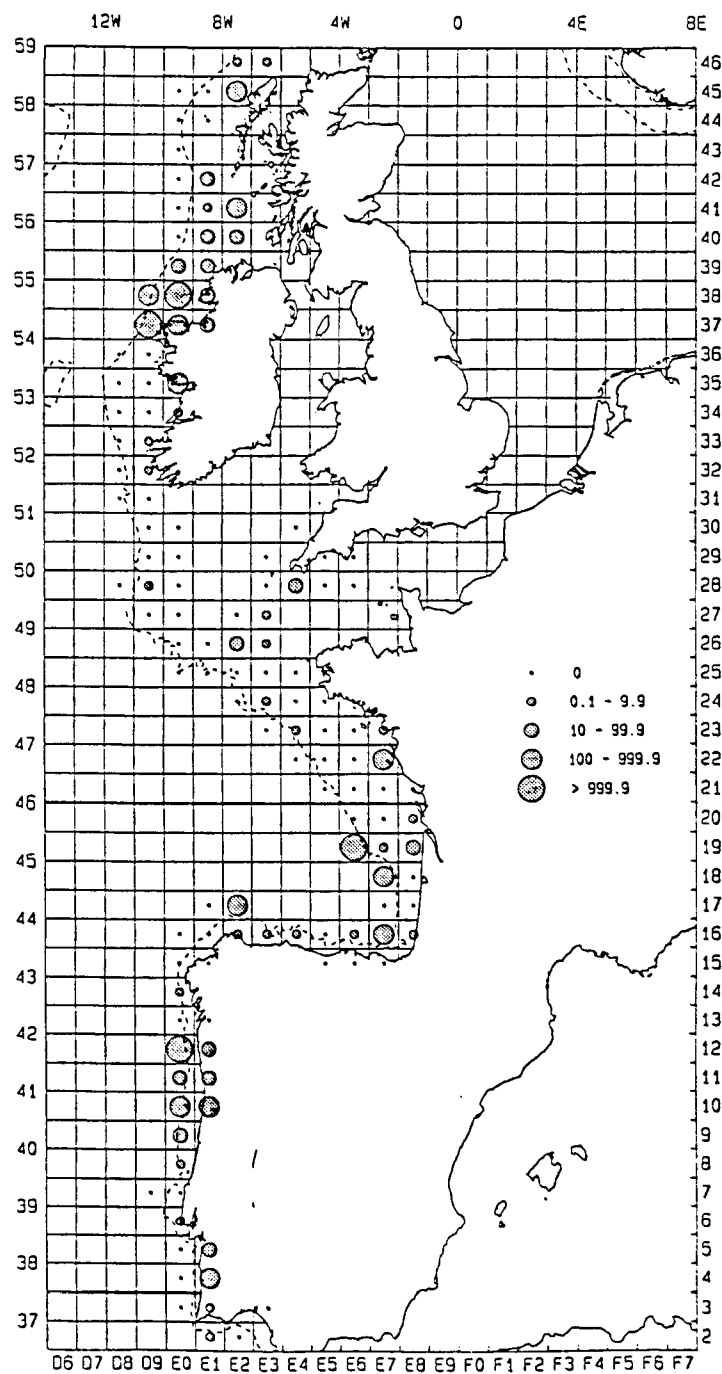


Figure 2.1. Catch rates of 1995 year-class mackerel (Age group 0) in international trawl surveys in the last quarter of 1995.

2nd Winter Mackerel (Yr Class 1994) Nos/Hr Trawled - 4th Qu 1995

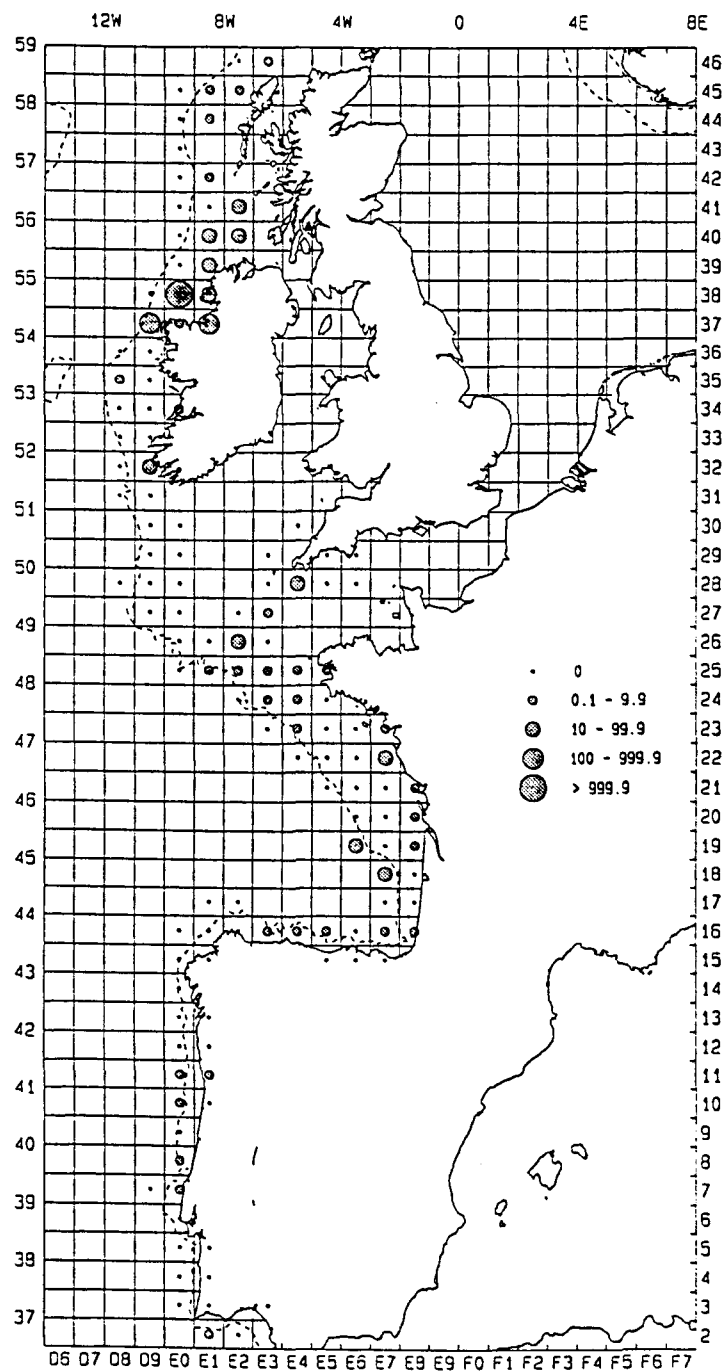


Figure 2.2. Catch rates of 1994 year-class mackerel (Age group 1) in international trawl surveys in the last quarter of 1995.

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

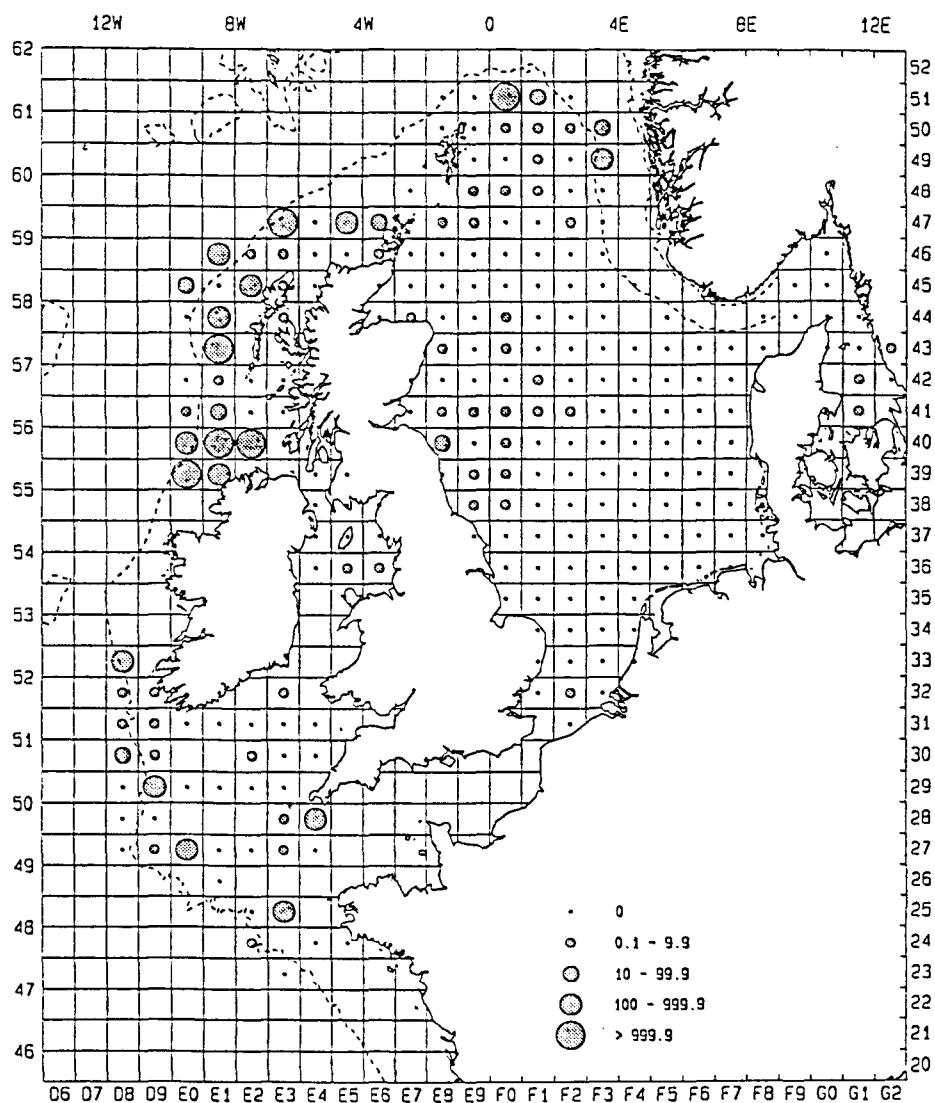


Figure 2.3. Catch rates of 1995 year-class mackerel (Age group 1) in international trawl surveys in the first quarter of 1996.

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

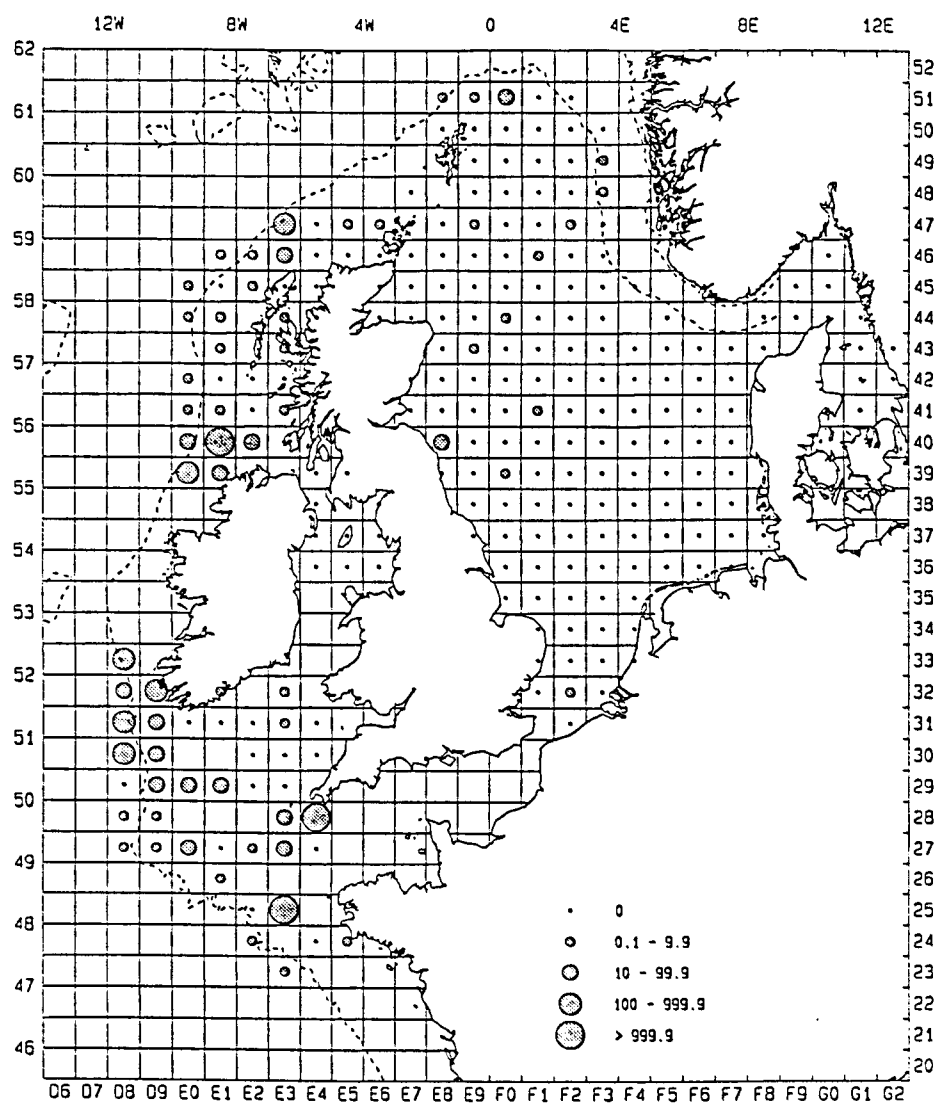


Figure 2.4. Catch rates of 1994 year-class mackerel (Age group 2) in international trawl surveys in the last quarter of 1995.

Annual Changes in First-Winter Mackerel Distribution

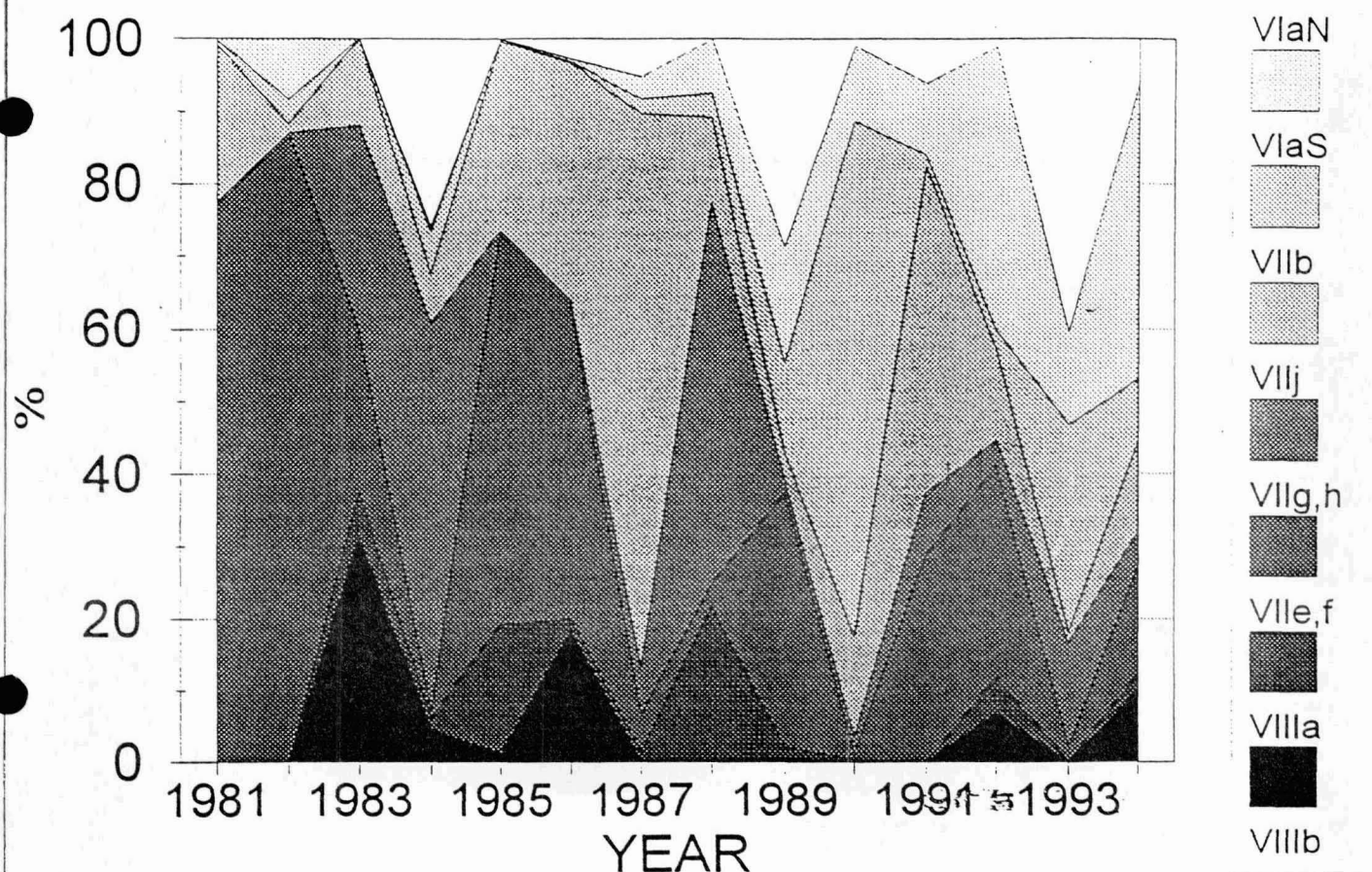


Figure 2.5. Percentage of 0-gp mackerel (sampled in the fourth quarter of the year) and of 1-gp mackerel (sampled in the first quarter of the year) found in demersal trawl surveys, by ICES Division; from VIa(N) (Northernmost) to VIIIb (Southernmost).

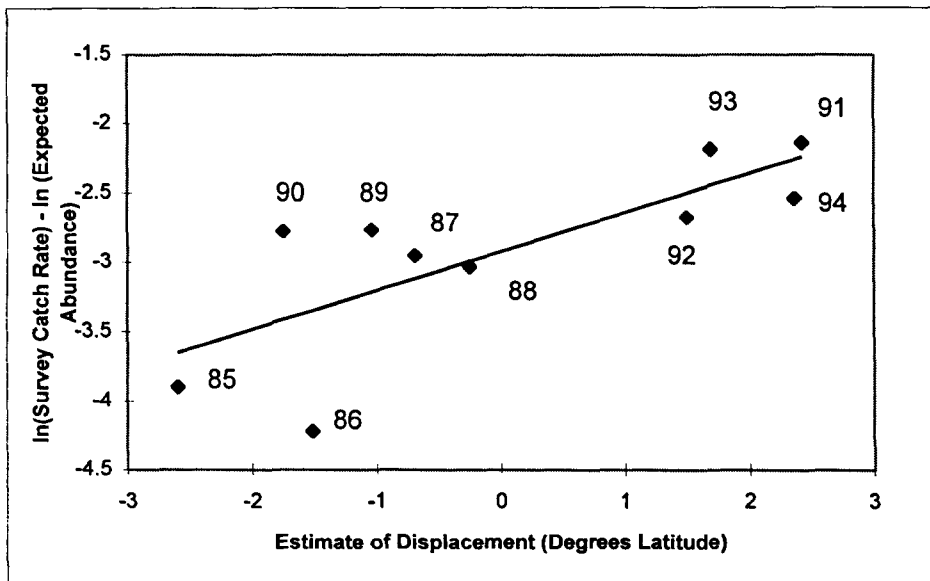


Figure 2.6. Data scatter and fitted relationship between the log residual of the survey estimates of abundance by year (Table 2.2) and the ICA estimates of year-class strength, compared with estimates of the displacement of the juvenile population in a North-South direction in each year (Table 2.3) Data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

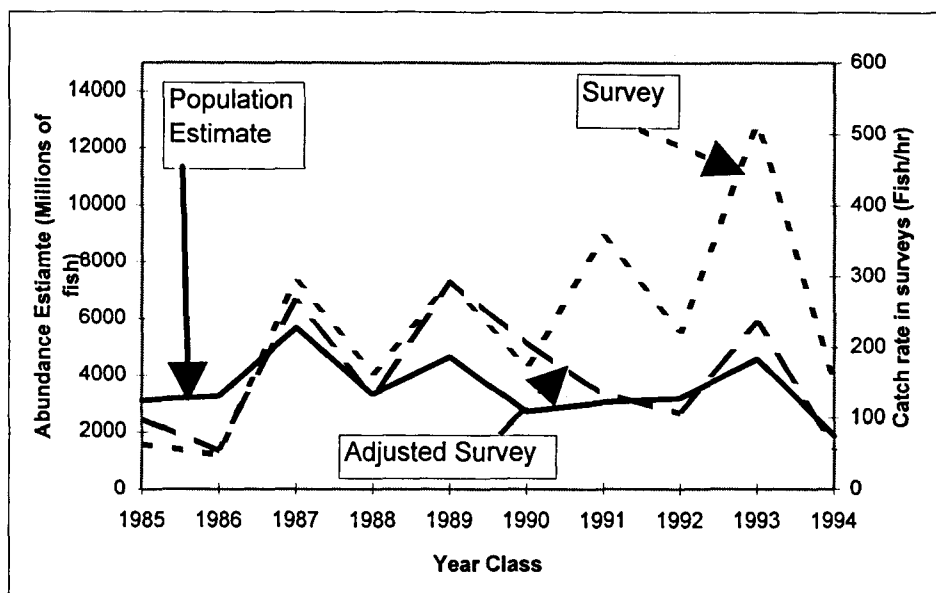


Figure 2.7. Comparison of ICA-estimated recruitments with *ad-hoc* adjusted recruitment index, and with unadjusted values.

Figure 2.8a Distribution of catches.

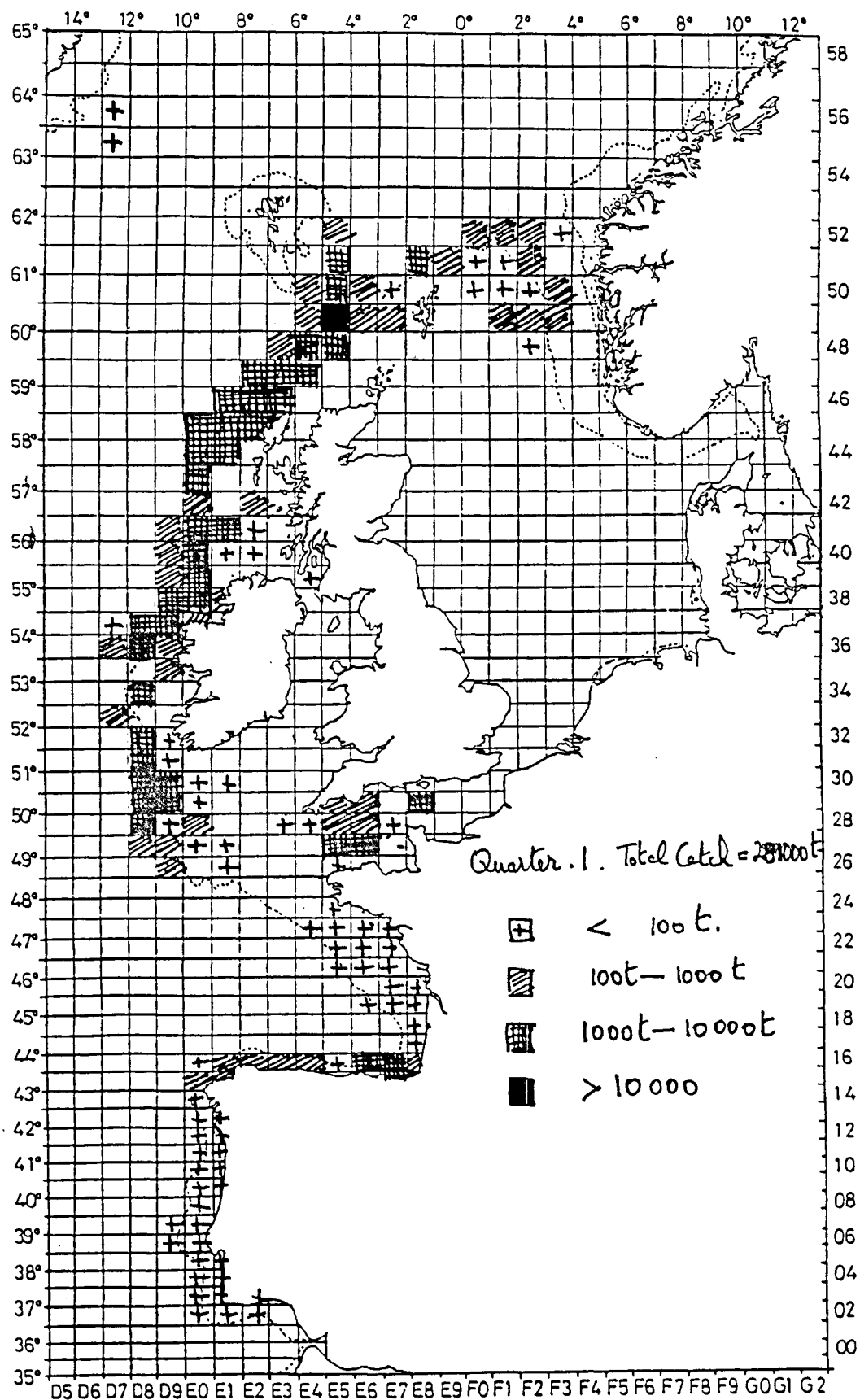


Figure 2.8b

Distribution of catches.

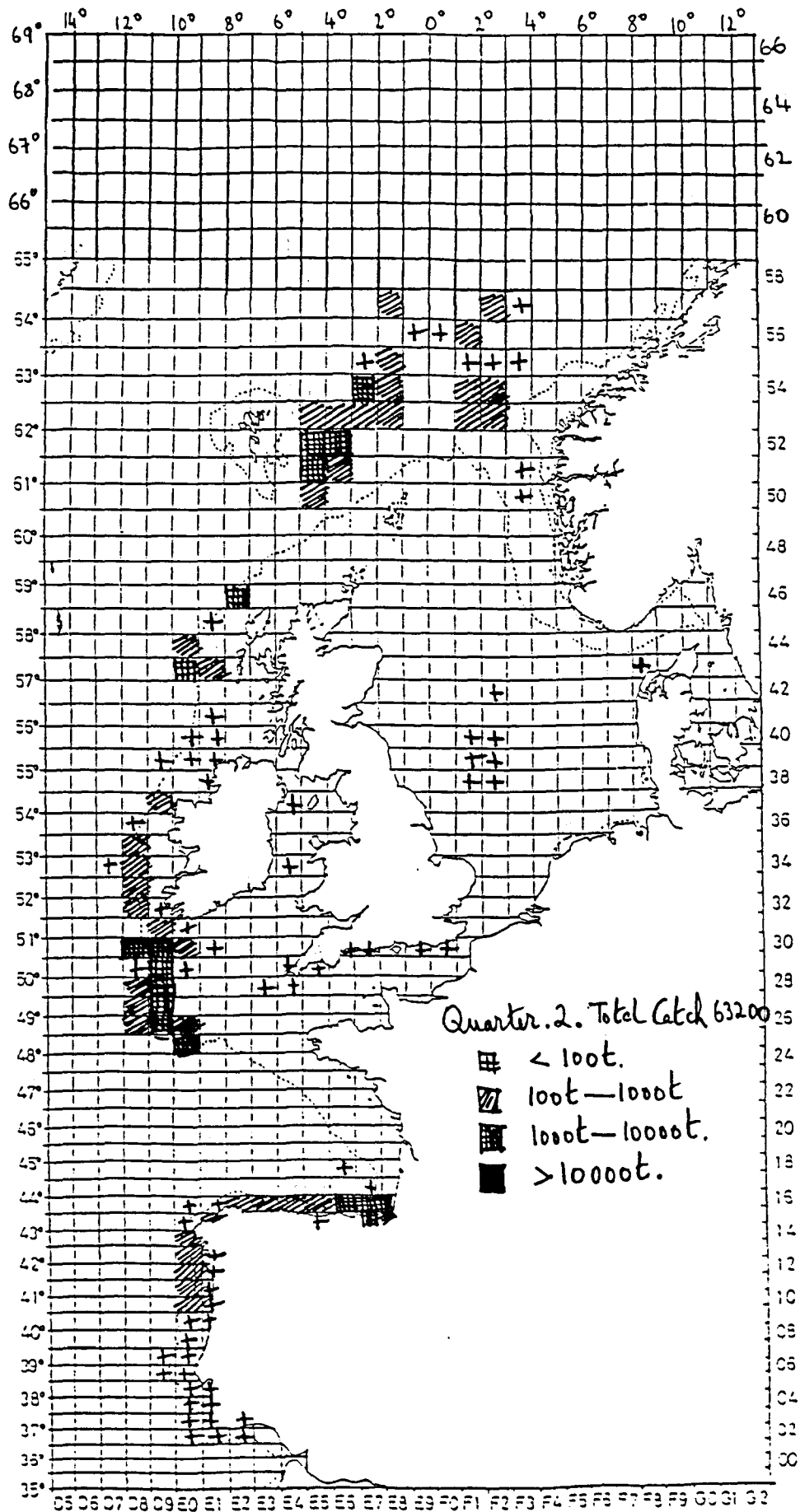


Figure 2.8c Distribution of catches.

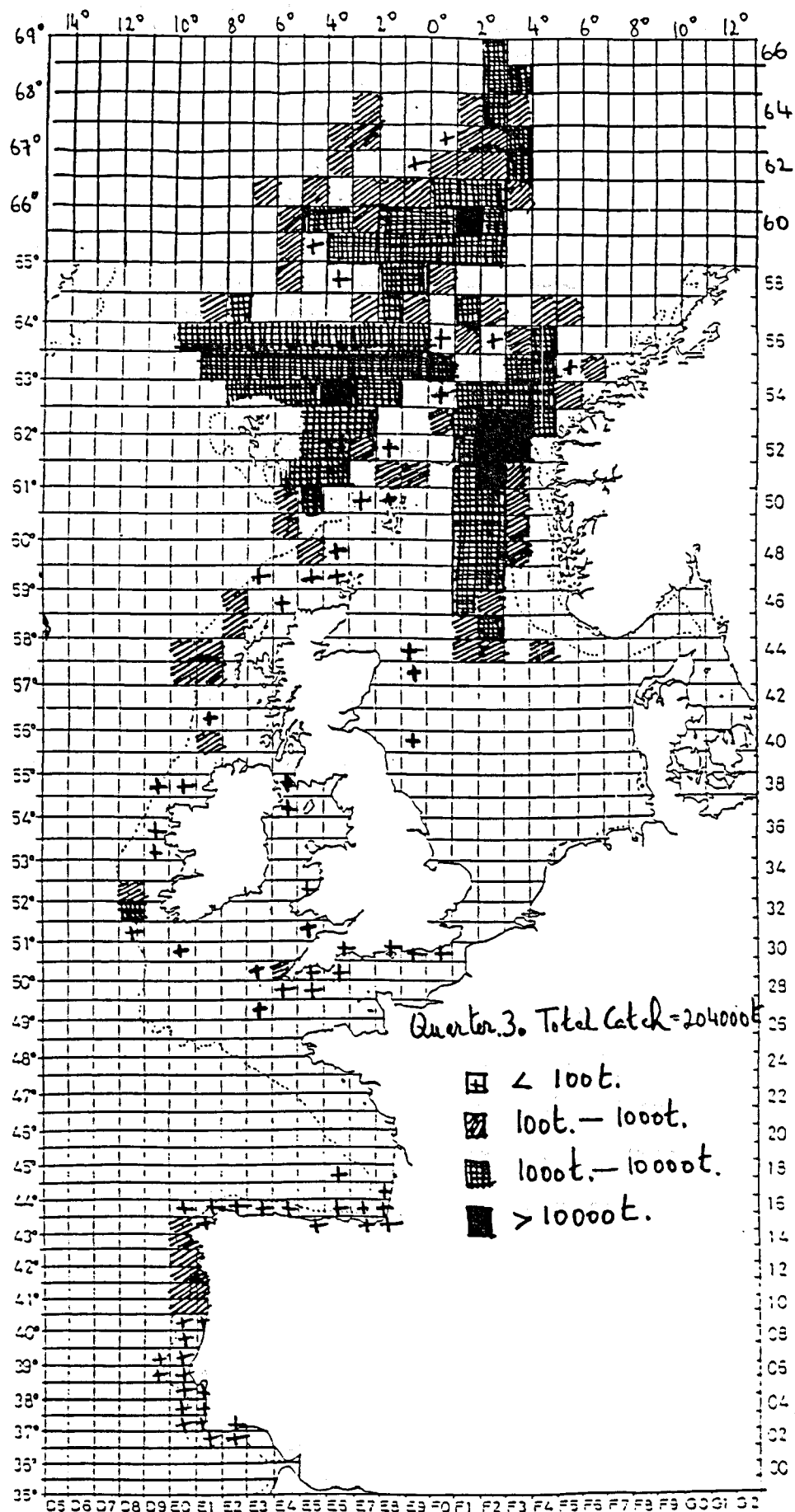
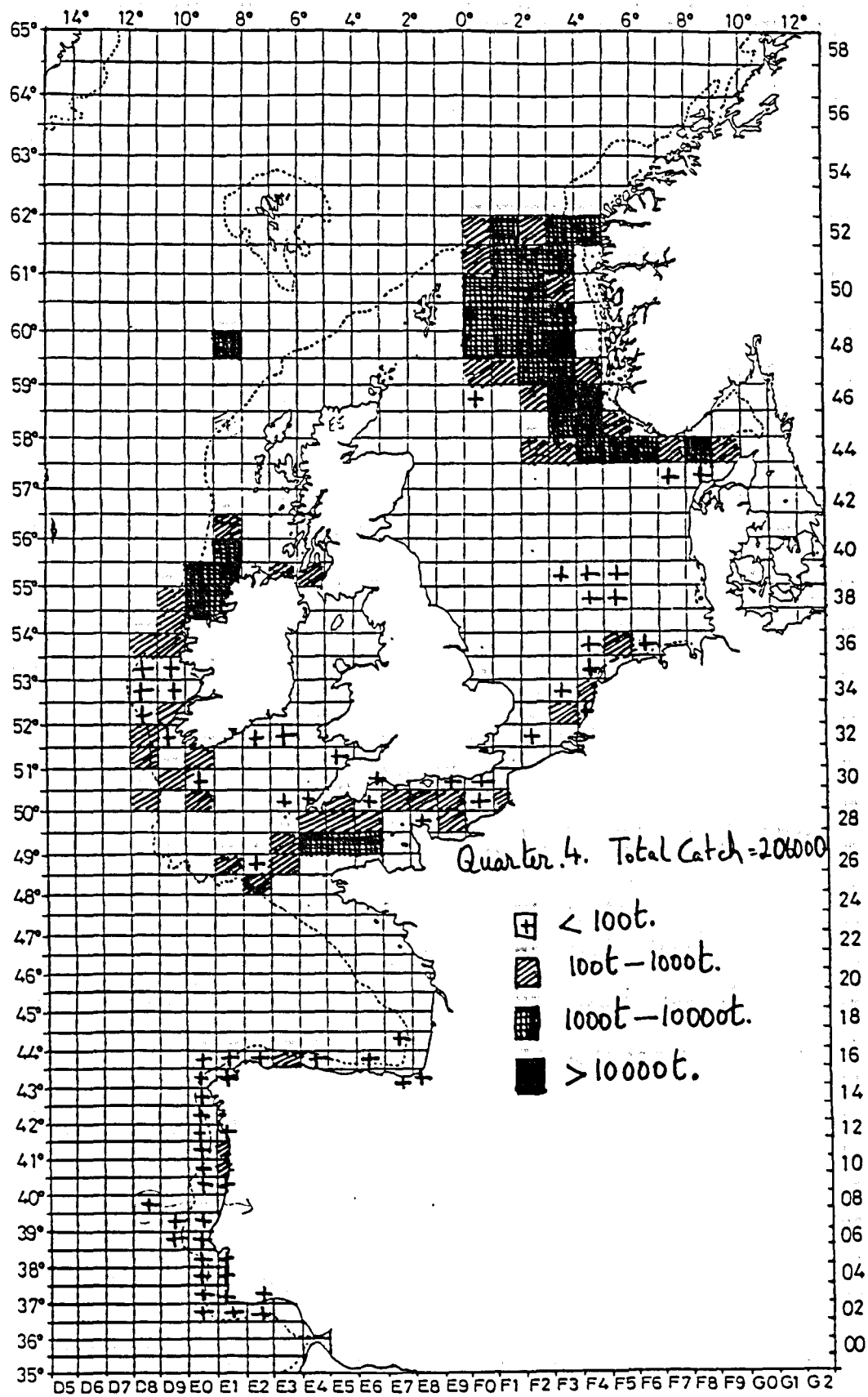


Figure 2.8d Distribution of catches.



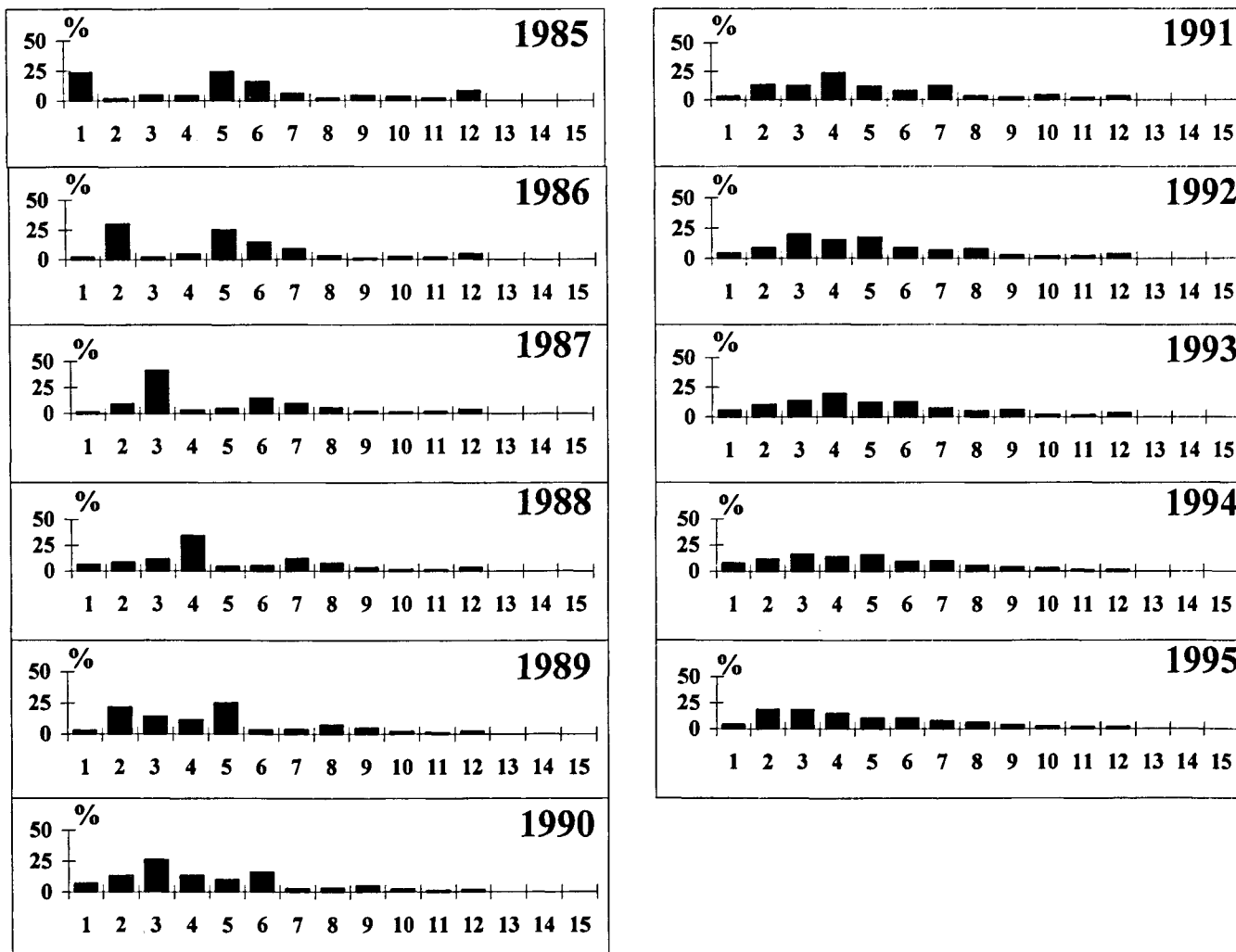


Figure 2.9 The age composition of the western mackerel in the international catches from 1985-1995. Age 12 is a plus group.

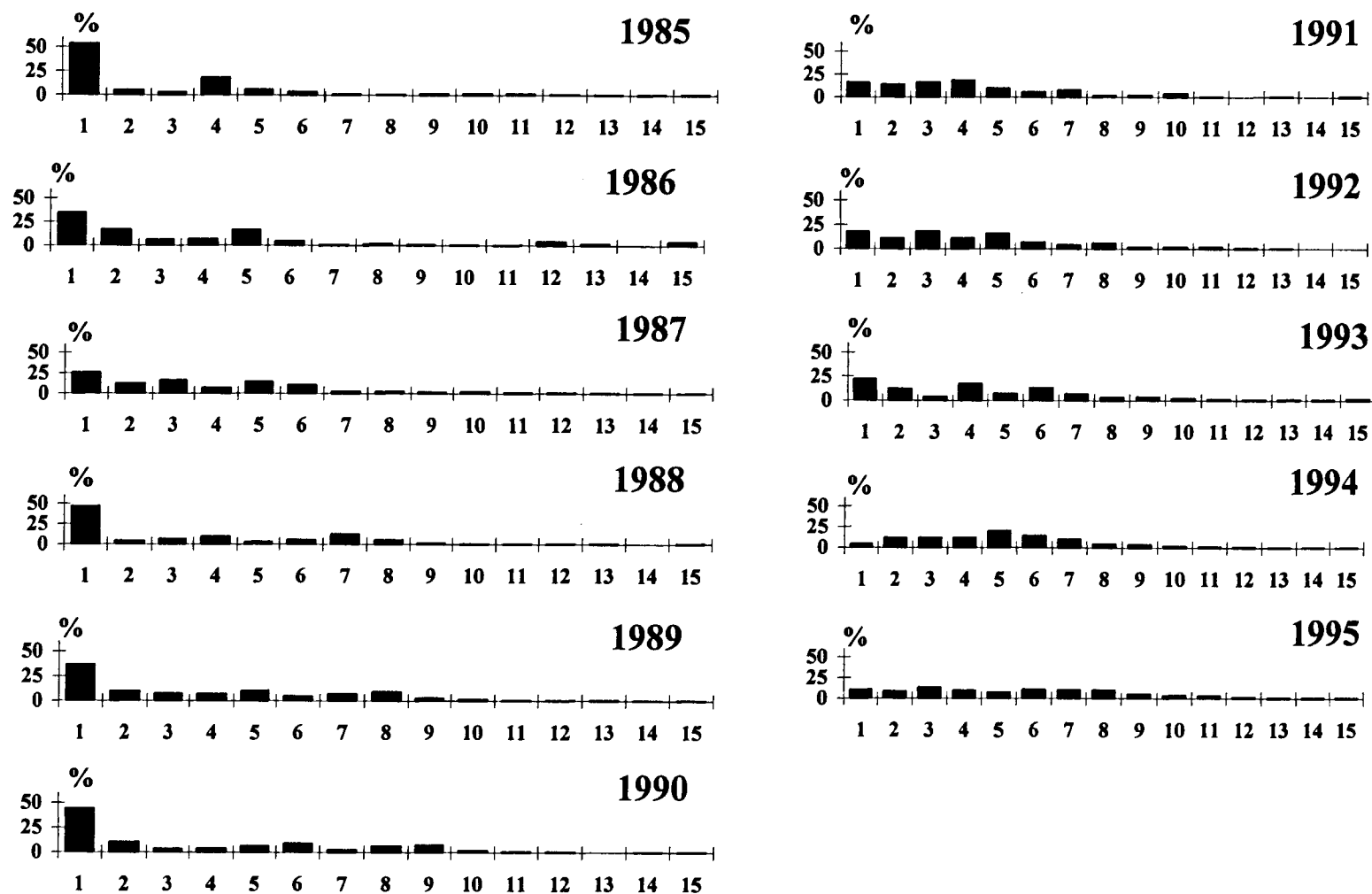


Figure 2.10 The age composition of the southern mackerel in the international catches from 1985-1995.
Age 15 is a plus group.

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° – 3° C lower 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:

$$\begin{aligned} & \sum_{a=0}^{11} \sum_{y=1986}^{1989} \lambda_a (\ln(C_{a,y}) - \ln(F_y \cdot S1_a \cdot \bar{N}_{a,y}))^2 + \\ & \sum_{a=0}^{11} \sum_{y=1990}^{1995} \lambda_a (\ln(C_{a,y}) - \ln(F_y \cdot S2_a \cdot \bar{N}_{a,y}))^2 + \\ & \sum_{y=1984}^{1989} \sum (\ln(EPB_y) - \ln(\sum_a N_{a,y} \cdot O_{a,y} \cdot W_{a,y} \cdot \exp(-PF \cdot F_y \cdot S1_a - PM \cdot M)))^2 + \\ & \sum_{y=1992}^{1995} \sum (\ln(EPB_y) - \ln(\sum_a N_{a,y} \cdot O_{a,y} \cdot W_{a,y} \cdot \exp(-PF \cdot F_y \cdot S2_a - PM \cdot M)))^2 \end{aligned}$$

subject to the constraints

$$\begin{aligned} S1_5 &= S2_5 = 1.0 \\ S1_{11} &= 1.0 \\ S2_{11} &= 1.2 \end{aligned}$$

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:

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

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 estimates 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

$$\begin{aligned} & \sum_{a=0}^{a=11} \sum_{y=1986}^{y=1988} \lambda_a (\ln(C_{a,y}) - \ln(F_y \cdot S_{1a} \cdot \bar{N}_{a,y}))^2 + \\ & \sum_{a=0}^{a=11} \sum_{y=1989}^{y=1995} \lambda_a (\ln(C_{a,y}) - \ln(F_y \cdot S_{2a} \cdot \bar{N}_{a,y}))^2 + \\ & \sum_{y=1984}^{y=1986} \sum (\ln(EPB_y) - \ln(\sum_a N_{a,y} \cdot O_{a,y} \cdot W_{a,y} \cdot \exp(-PF \cdot F_y \cdot S_{1a} - PM \cdot M)))^2 + \\ & \sum_{y=1989}^{y=1995} \sum (\ln(EPB_y) - \ln(\sum_a N_{a,y} \cdot O_{a,y} \cdot W_{a,y} \cdot \exp(-PF \cdot F_y \cdot S_{2a} - PM \cdot M)))^2 \end{aligned}$$

subject to the constraints

$$\begin{aligned} S_{15} &= S_{25} = 1.0 \\ S_{111} &= 1.0 \\ S_{211} &= 1.2 \end{aligned}$$

where

\bar{N} - 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 ($0.61 \times F_{95}$). 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.
- Recruitment Function.

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:

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

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 $F_{95} = 0.29$ 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. F_{max} 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 F_{94} . 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, |

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| 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 | | | | | |
| 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 | 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: $\log(\text{Observed Catch}) - \log(\text{Expected Catch})$, 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: $\log(\text{Observed Index}) - \log(\text{Expected Index})$

| 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 |

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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 x10 ⁶ | Recruits tonnes | Total B tonnes | Spawn B tonnes | Landings | 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.

| YEAR | SPAIN | | | | PORTUGAL |
|------|---|---|--|--|--|
| | TRAWL | | HOOK (HAND-LINE) | | TRAWL |
| | AVILES (Subdiv.VIIIc East) (HP*fishing days*10 ⁻²) | LA CORUNA (Subdiv.VIIIc West) (Av. HP*fishing days*10 ⁻²) | SANTANDER (Subdiv.VIIIc East) (N° fishing trips) | SANTONA (Subdiv.VIIIc East) (N° fishing trips) | VIGO (Subdiv.IXa North) (N° fishing trips) |
| | ANUAL | ANUAL | MARCH to MAY | MARCH to MAY | 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 |
| 1989 | 8063 | 29628 | - | 605 | 153 |
| 1990 | 8492 | 29578 | 322 | 509 | 161 |
| 1991 | 7677 | 26959 | 209 | 724 | 66 |
| 1992 | 12693 | 26199 | 70 | 698 | 286 |
| 1993 | 7635 | 29670 | 151 | 1216 | - |
| 1994 | 9620 | 39590 | 130 | 1926 | - |
| 1995 | 6146 | 41452 | 217 | 1696 | - |

- Not available

Table 3.12 SOUTHERN MACKEREL. CPUE series in commercial fisheries.

| YEAR | SPAIN | | | | PORTUGAL |
|------|--|--|---|---|--|
| | TRAWL | | HOOK (HAND-LINE) | | TRAWL |
| | AVILES (Subdiv.VIIIc East) (Kg/HP*fishing days*10 ⁻²) | LA CORUNA (Subdiv.VIIIc West) (Kg/Av. HP*fishing days*10 ⁻²) | SANTANDER (Subdiv.VIIIc East) (Kg/N° fishing trips) | SANTONA (Subdiv.VIIIc East) (Kg/N° fishing trips) | VIGO (Subdiv.IXa North) (t/N° fishing trips) |
| | ANUAL | ANUAL | MARCH to MAY | MARCH to MAY | 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 |
| 1989 | 19.0 | 43.0 | - | 1427.5 | 2.1 |
| 1990 | 82.7 | 59.0 | 739.6 | 1924.4 | 2.7 |
| 1991 | 68.2 | 54.6 | 632.9 | 1394.4 | 2.0 |
| 1992 | 35.1 | 19.7 | 905.6 | 856.4 | 3.9 |
| 1993 | 12.8 | 19.2 | 613.3 | 1790.9 | - |
| 1994 | 57.2 | 41.4 | 2388.5 | 1590.6 | - |
| 1995 | 94.9 | 34.0 | 3136.1 | 1987.9 | - |

- Not available

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 |

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 |

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 |

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| 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 | 1984 | 1985 |
|------|-------|-------|
| AGE | | |
| 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 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| AGE | | | | | | | | | | |
| 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: $\log(\text{Observed Catch}) - \log(\text{Expected Catch})$, 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 |

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.

Mackerel in the North East Atlantic

Multi fleet prediction: Summary table

| Year | Western | | | | Southern | | | | International | | | |
|------|----------|-------------|------------------|-----------------|----------|-------------|------------------|-----------------|---------------|-------------|------------------|-----------------|
| | 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 |

| Year | Total | | Stock size | Stock biomass | 1 January | | Spawning time | |
|------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | Catch in numbers | Catch in weight | | | 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

Mackerel in the North East Atlantic

Multi fleet prediction: Summary table

| Year | Western | | | | Southern | | | | International | | | |
|------|----------|-------------|------------------|-----------------|----------|-------------|------------------|-----------------|---------------|-------------|------------------|-----------------|
| | 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 |

| Year | Total | | | | 1 January | | Spawning time | |
|------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | 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

Multi fleet prediction: Summary table

| Year | Western | | | | Southern | | | | International | | | |
|------|----------|-------------|------------------|-----------------|----------|-------------|------------------|-----------------|---------------|-------------|------------------|-----------------|
| | 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 |

| Year | Total | | | | 1 January | | Spawning time | |
|------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | 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

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.

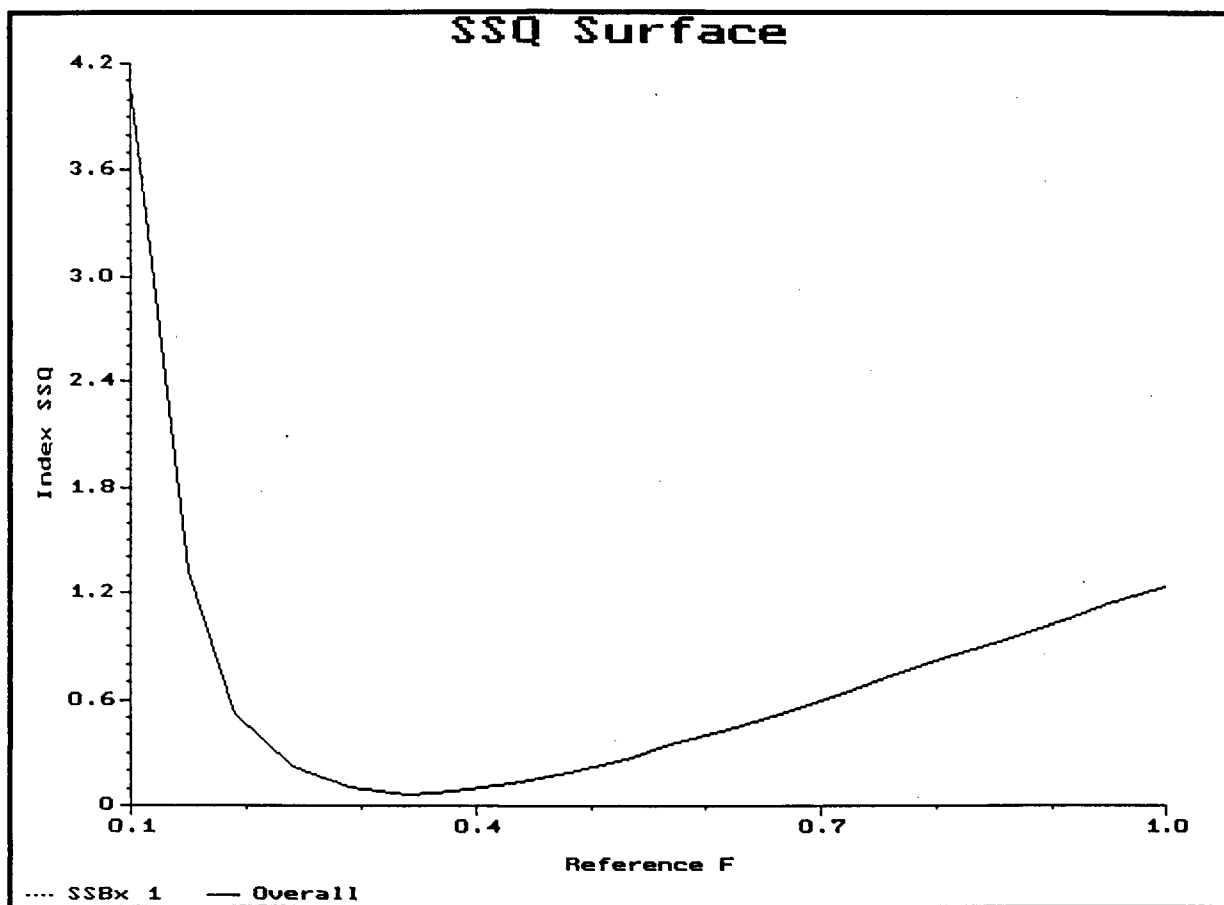


Figure 3.1 The sum of squares surface for the ICA fit to the Western mackerel.

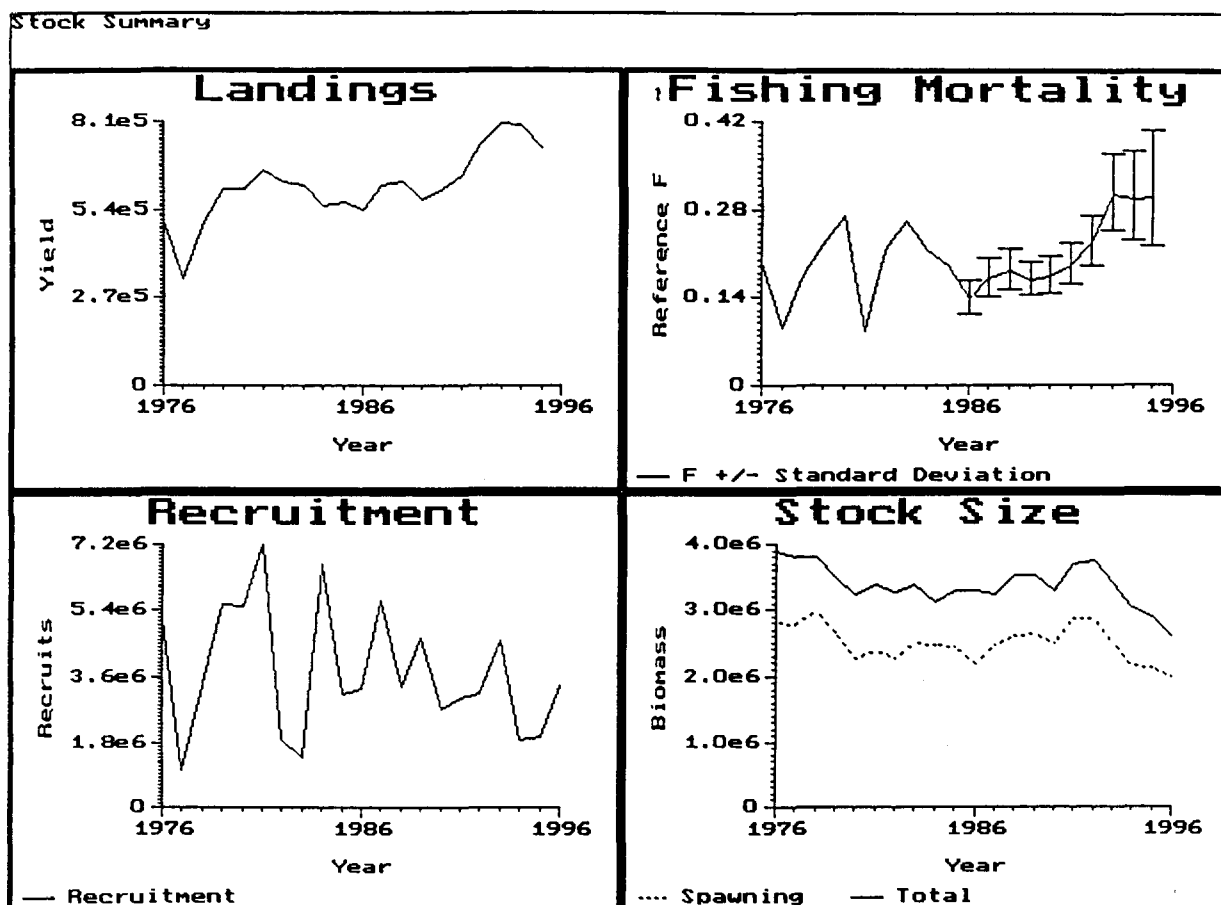


Figure 3.2 The long term trends in stock parameters for the Western mackerel

Separable Model Diagnostics

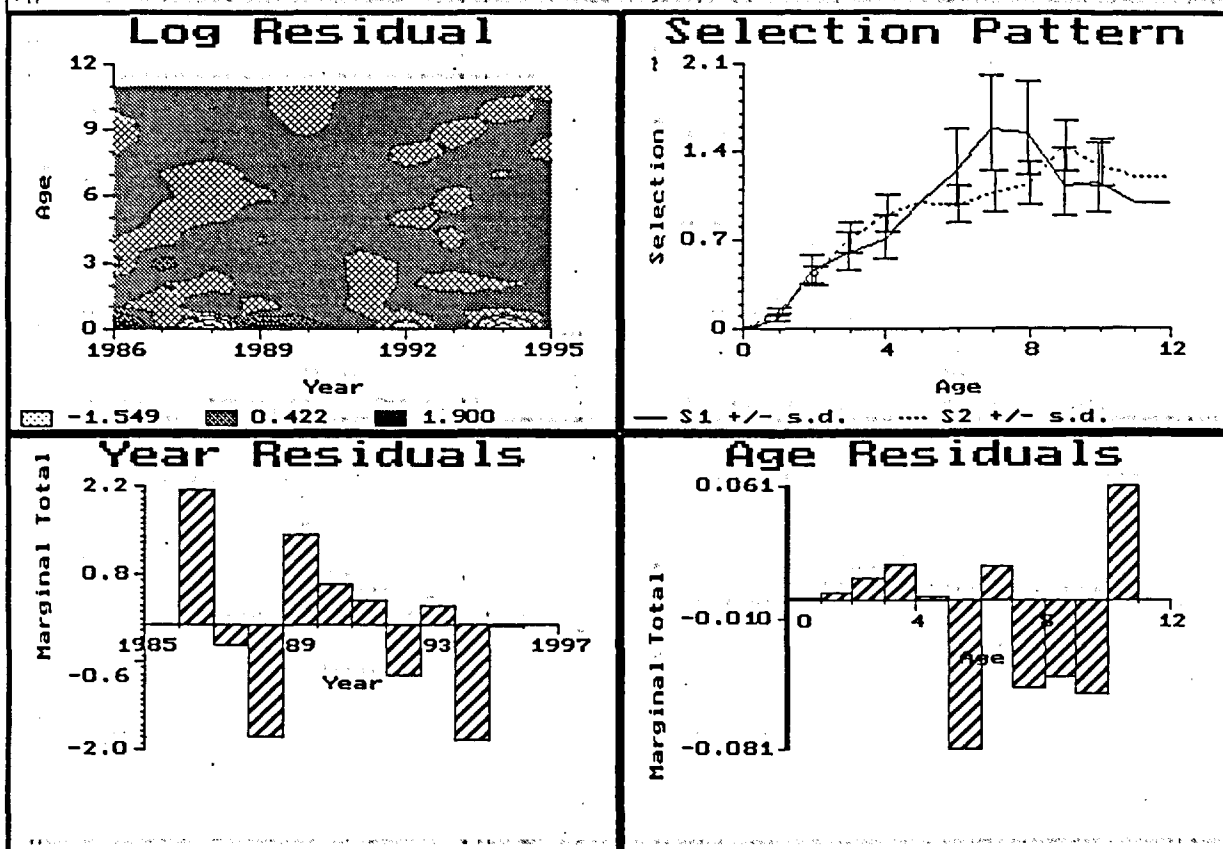


Figure 3.3 The catch at age residuals and selection at age as fitted by ICA to the Western mackerel data.

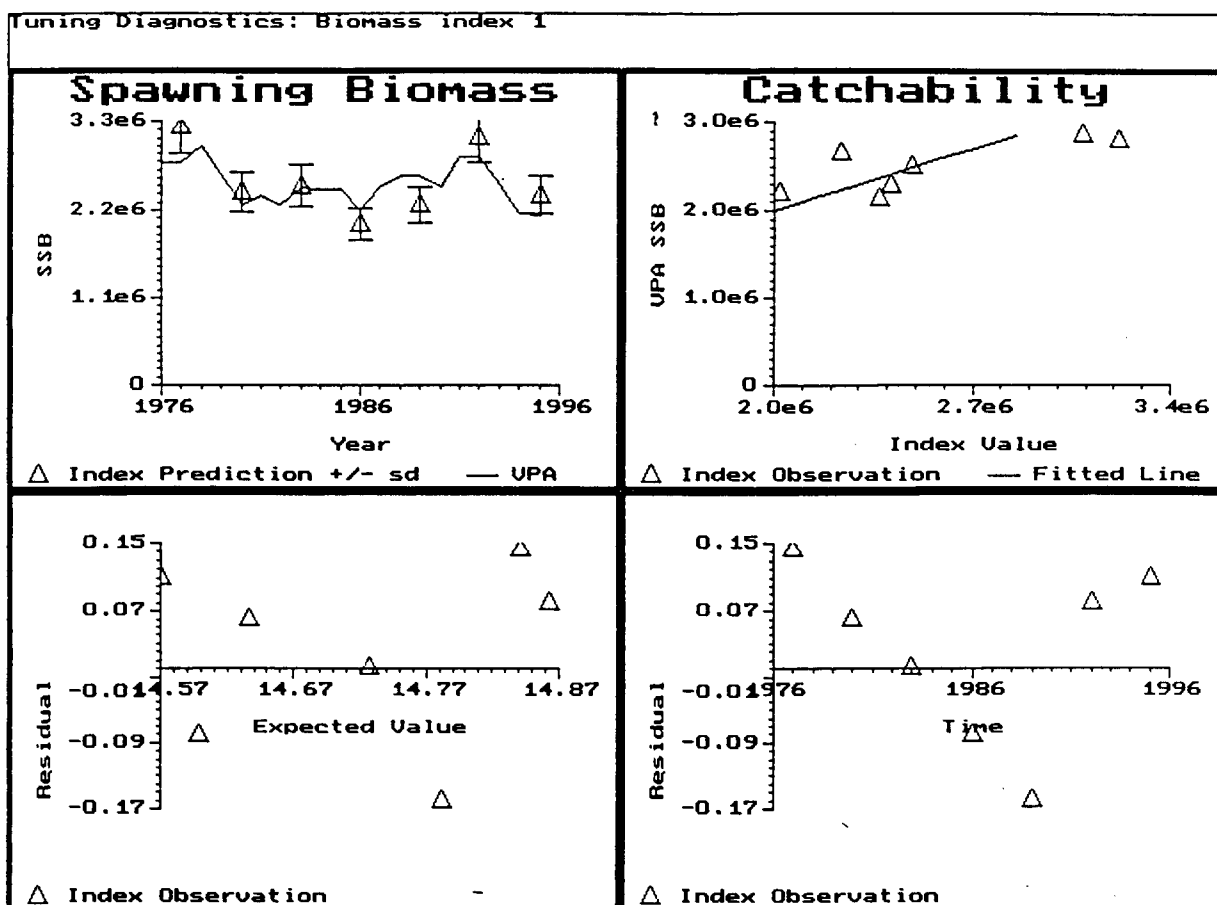
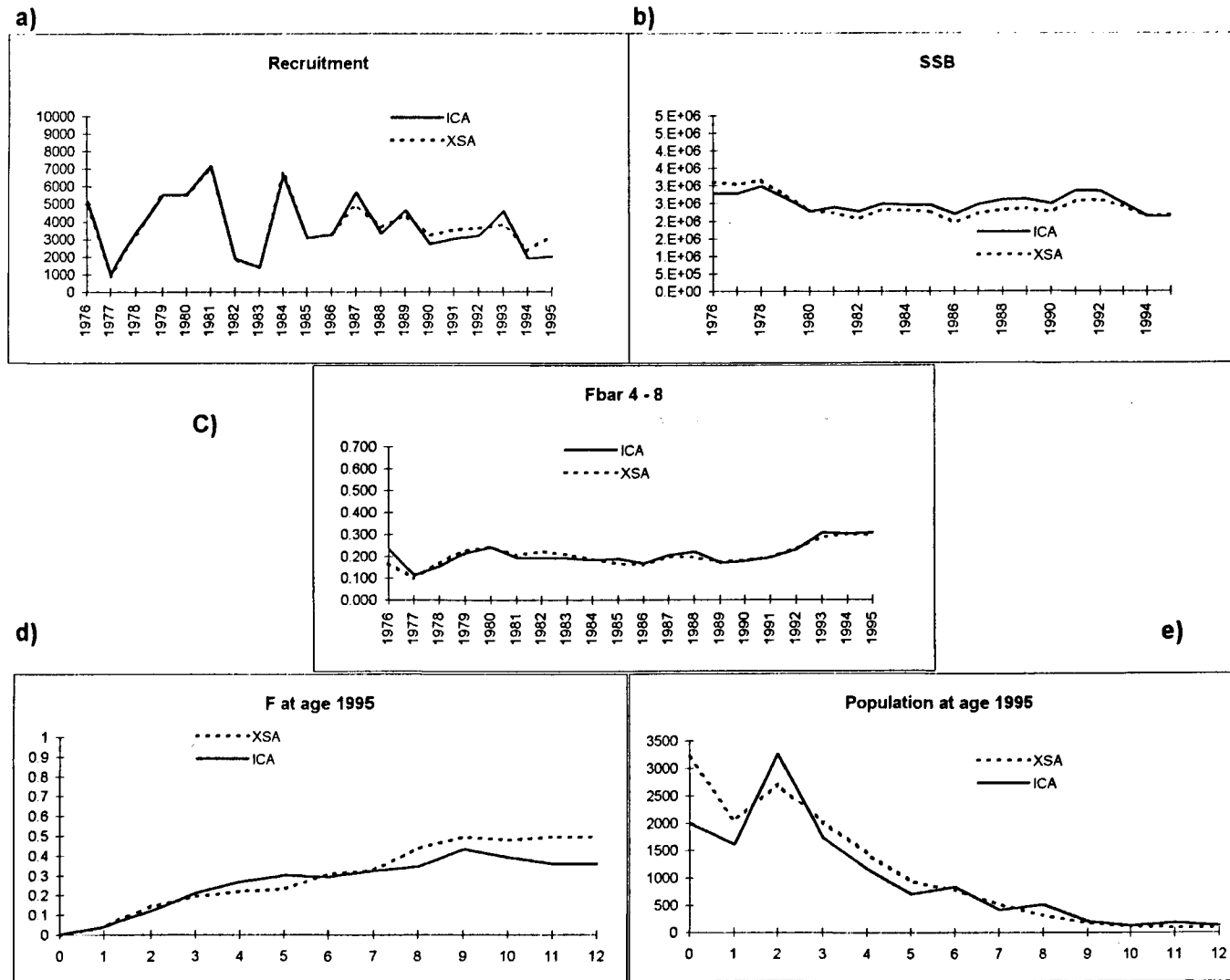


Figure 3.4 The diagnostics for the egg production index as fitted by ICA to the Western mackerel data.

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



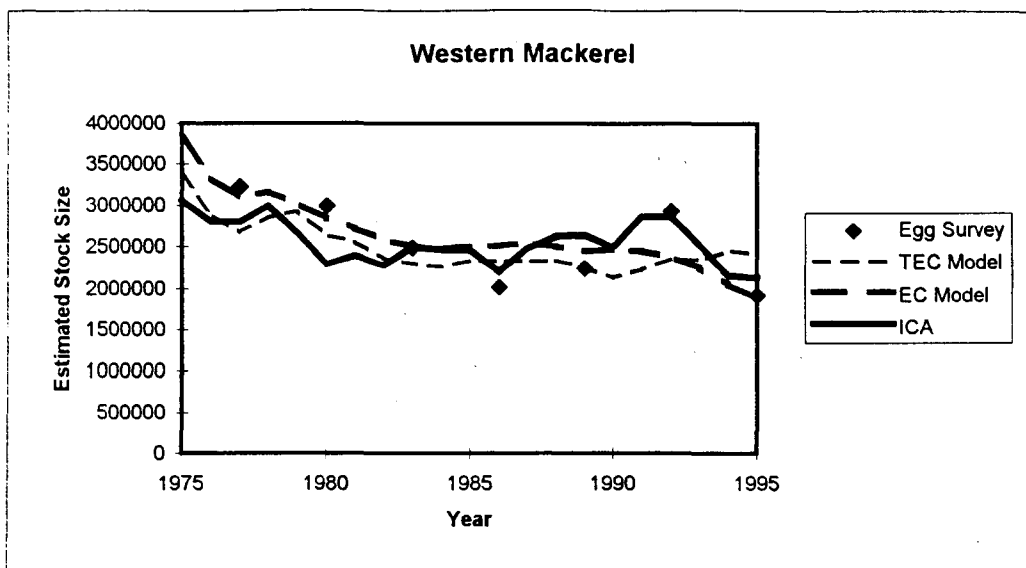


Figure 3.6 Western Mackerel. Biomass estimates from egg surveys and from three population models. 'TEC', biomass-dynamic model using estimates of mortality from Norwegian tag returns, egg survey estimates of biomass, and reported catches. 'EC', biomass-dynamic model using egg survey estimates and catches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

Western Mackerel : GAM and Traditional Egg Production estimates

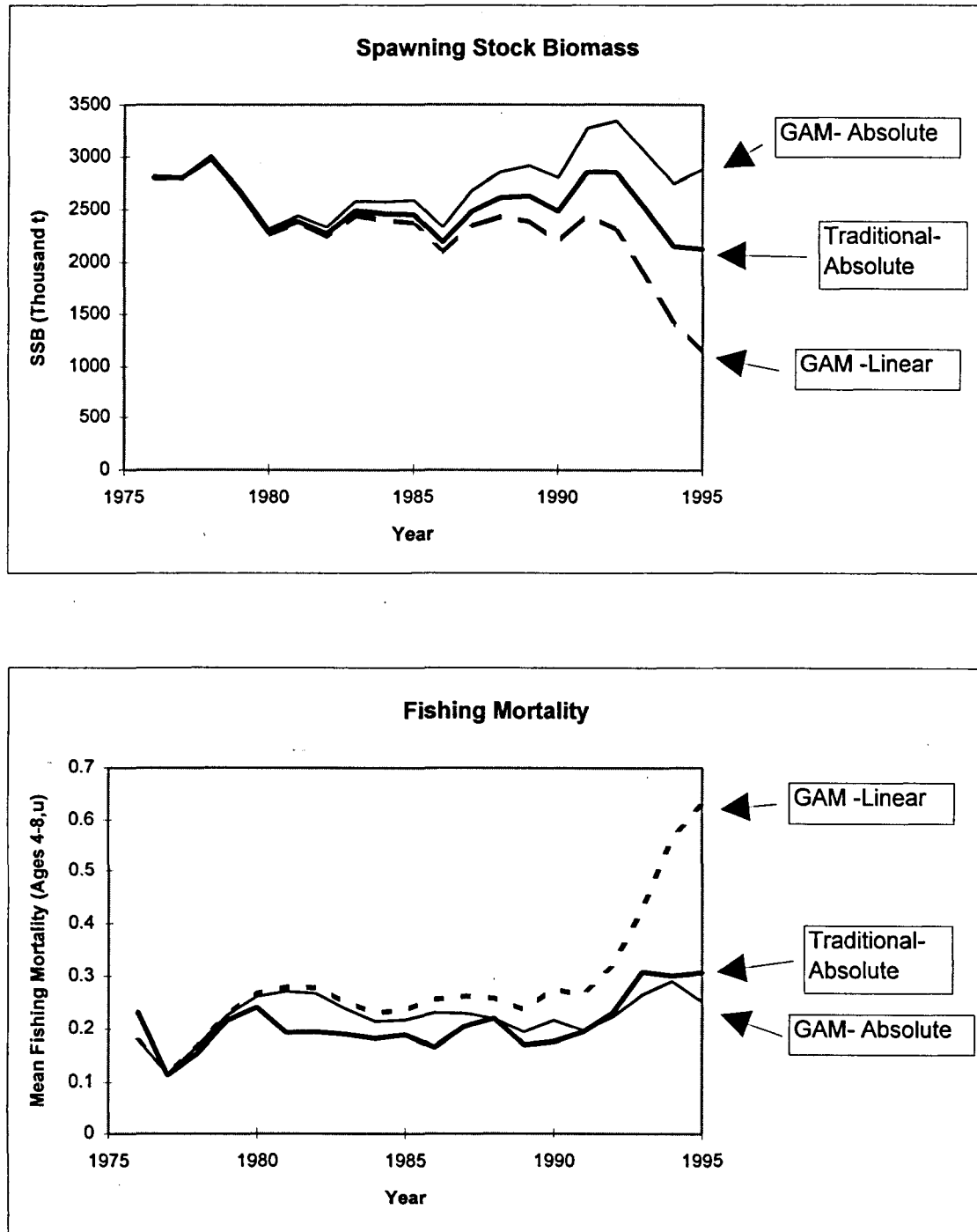


Figure 3.7

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.

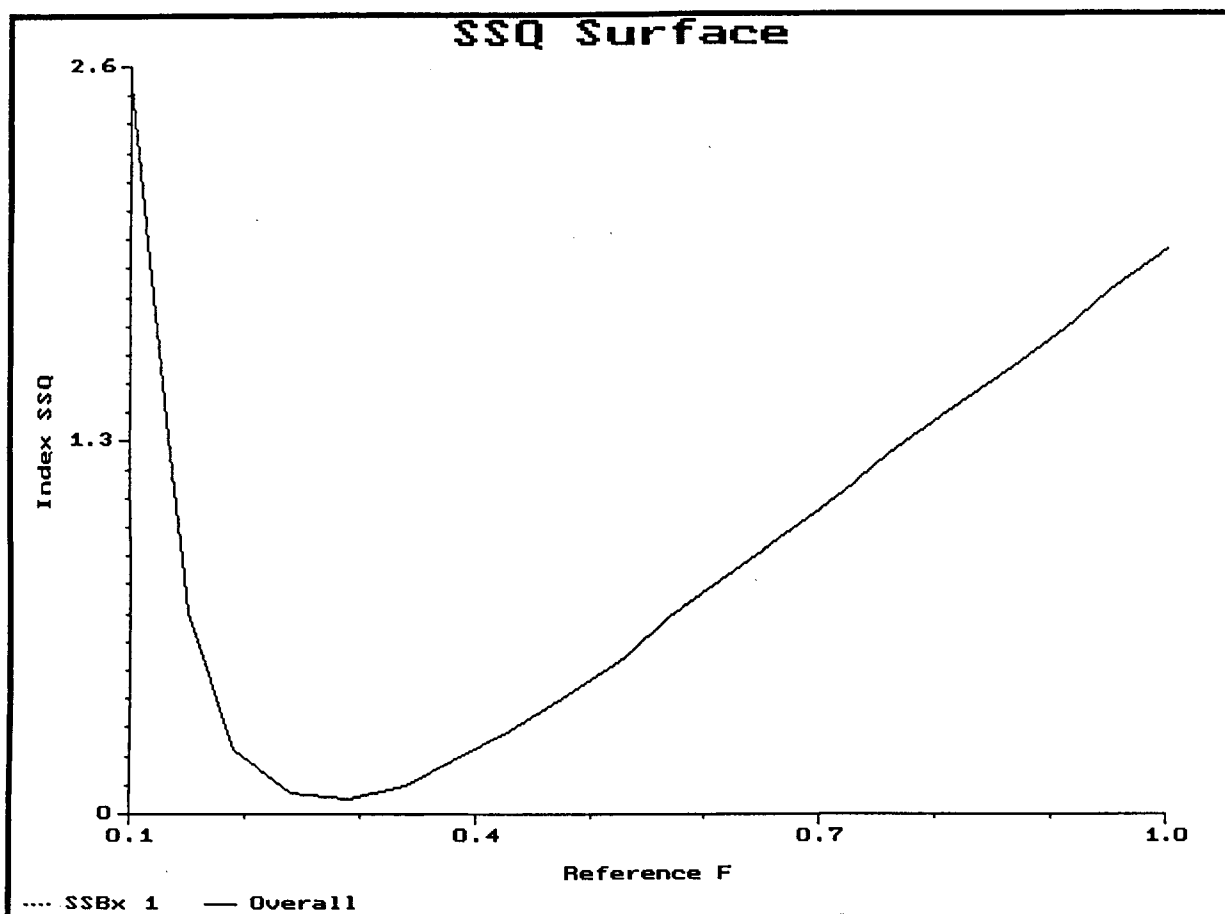


Figure 3.8 The sum of squares surface for the ICA fit to the North East Atlantic mackerel.

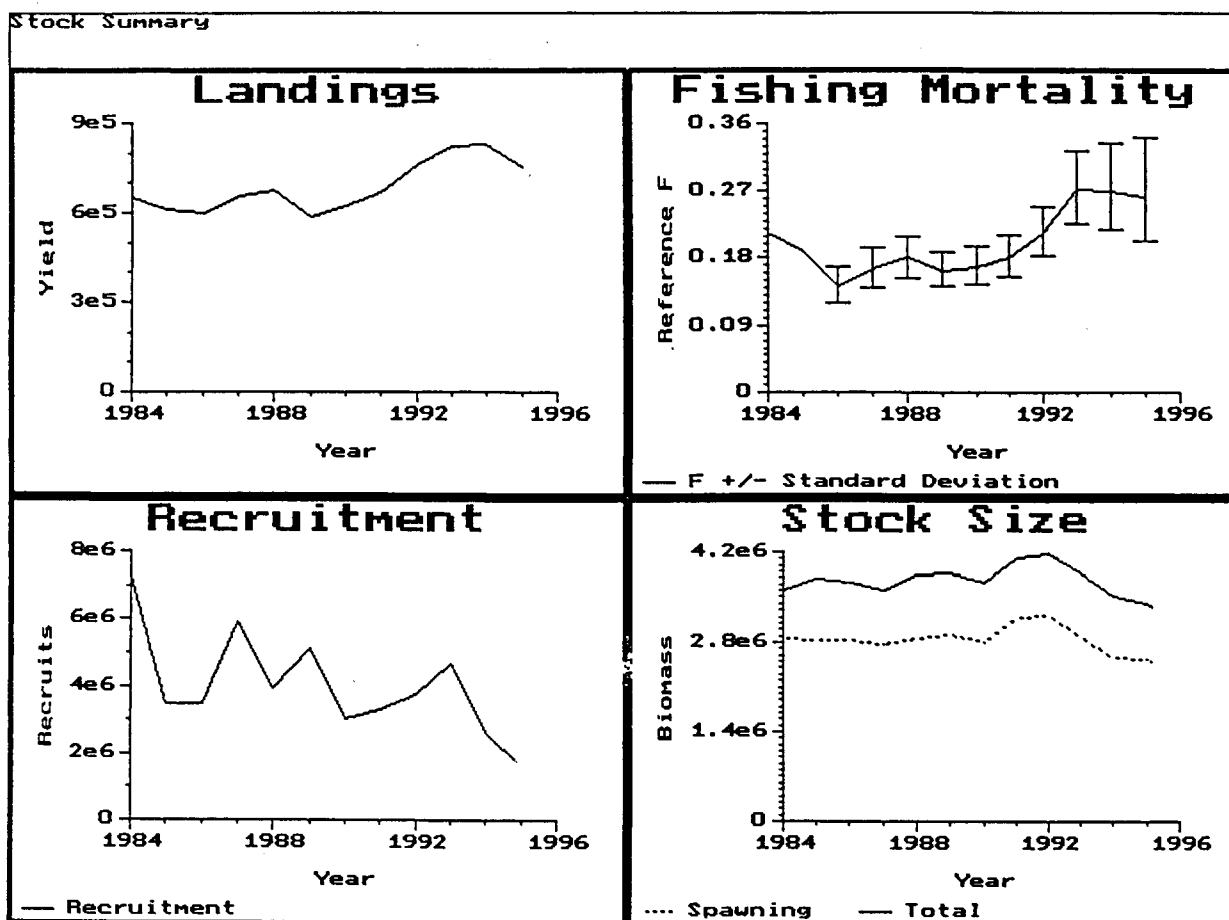


Figure 3.9 The long term trends in stock parameters for the North East Atlantic mackerel.

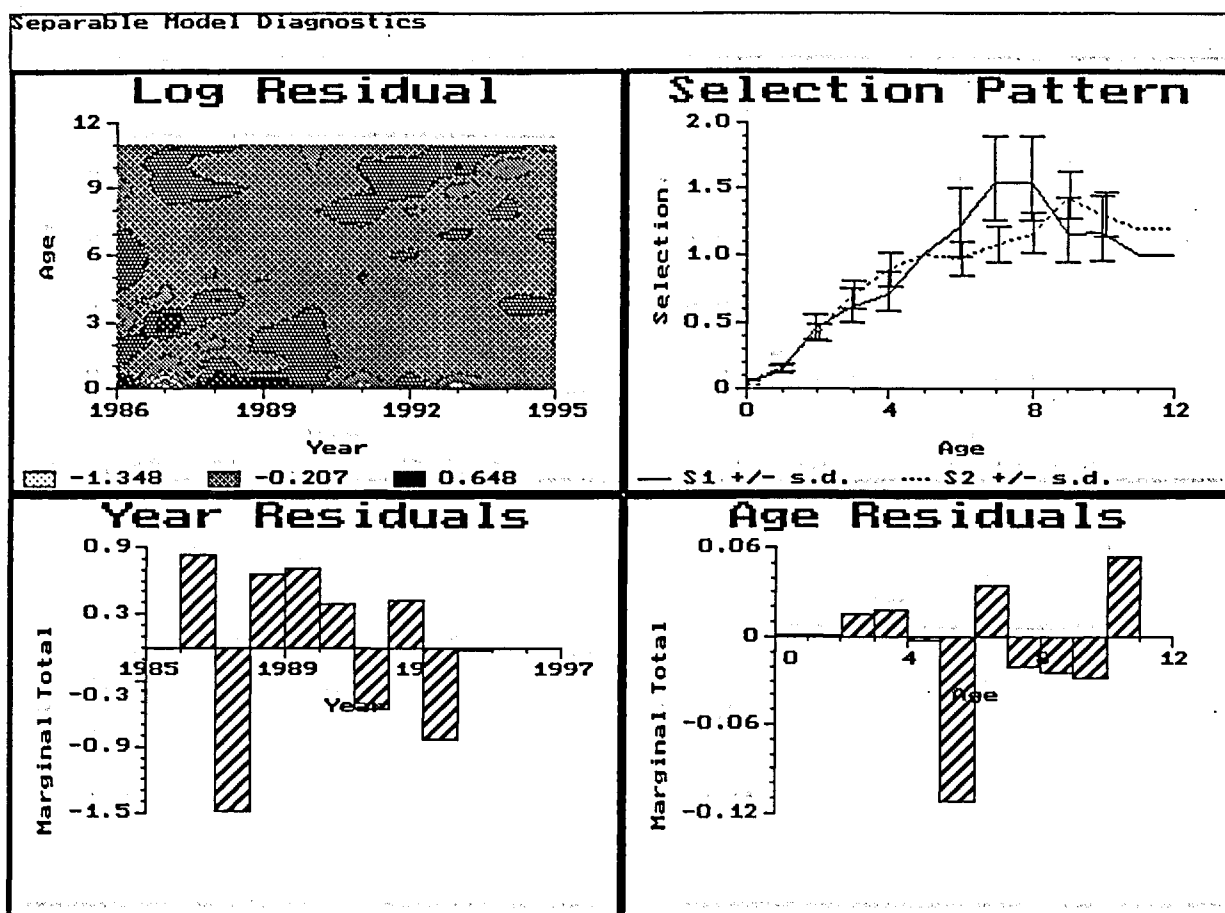


Figure 3.10 The catch at age residuals and selection at age as fitted by ICA fit to the North East Atlantic mackerel data.

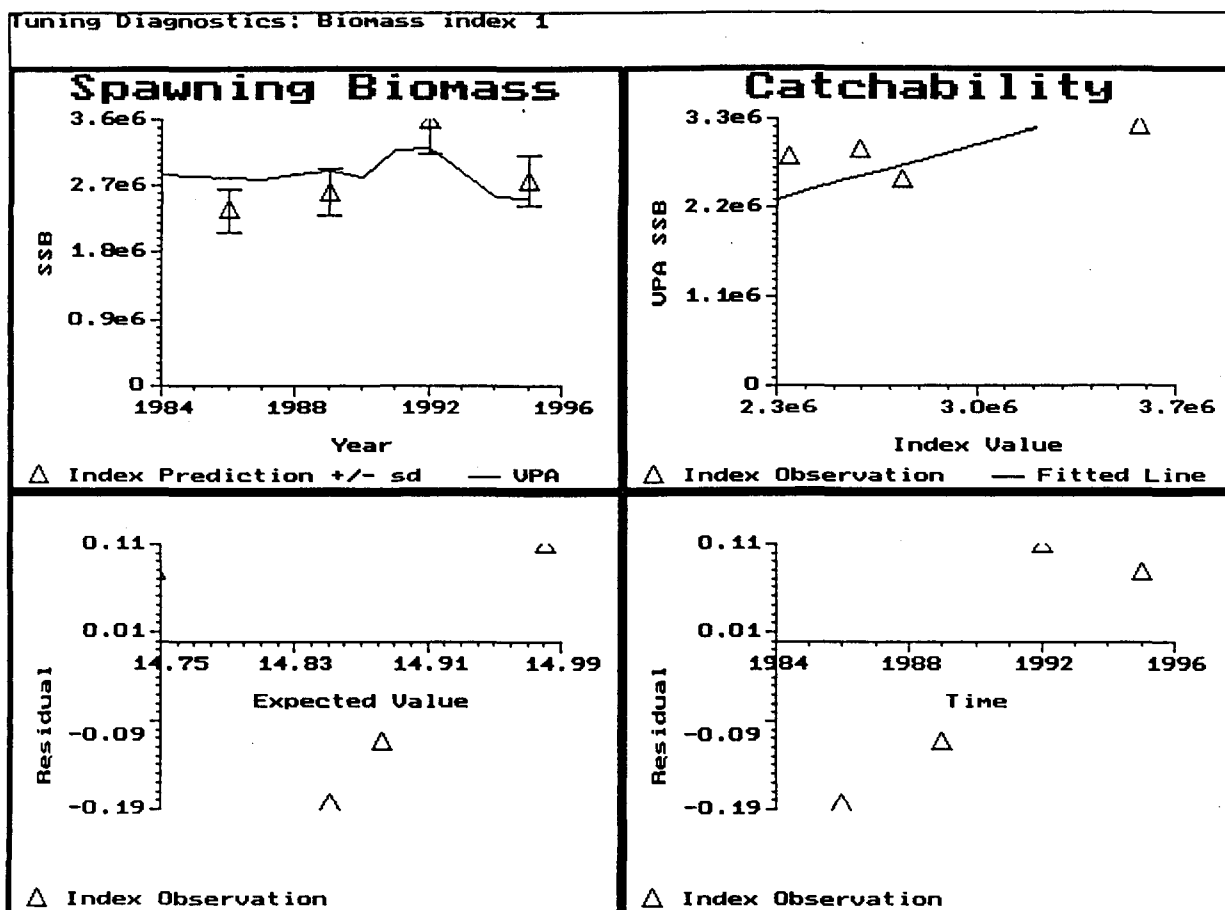


Figure 3.11 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic mackerel data.

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

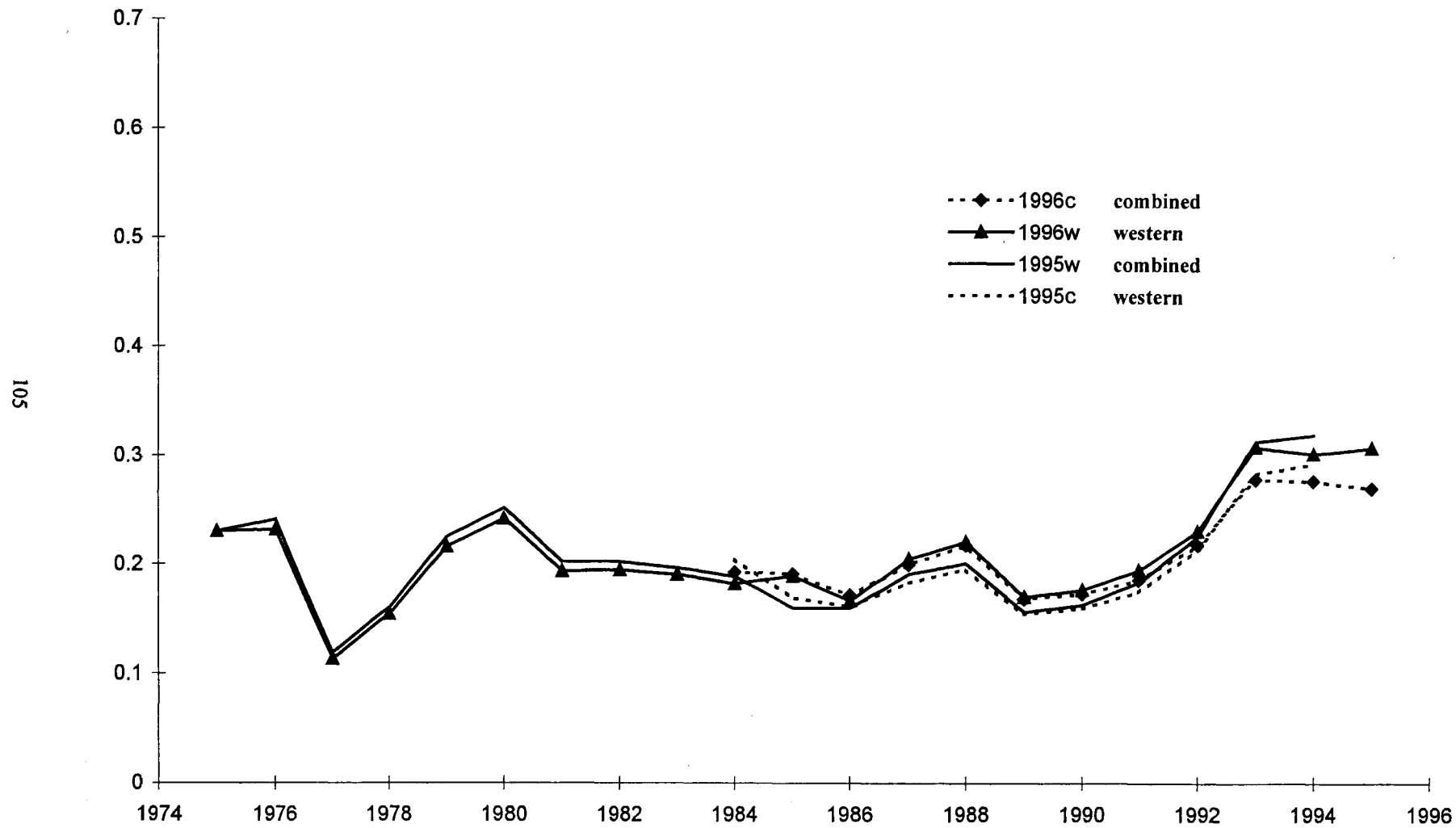


Figure 3.13 A comparison between the NEA mackerel SSB estimates derived from the ICA fits for 1995 and 1996

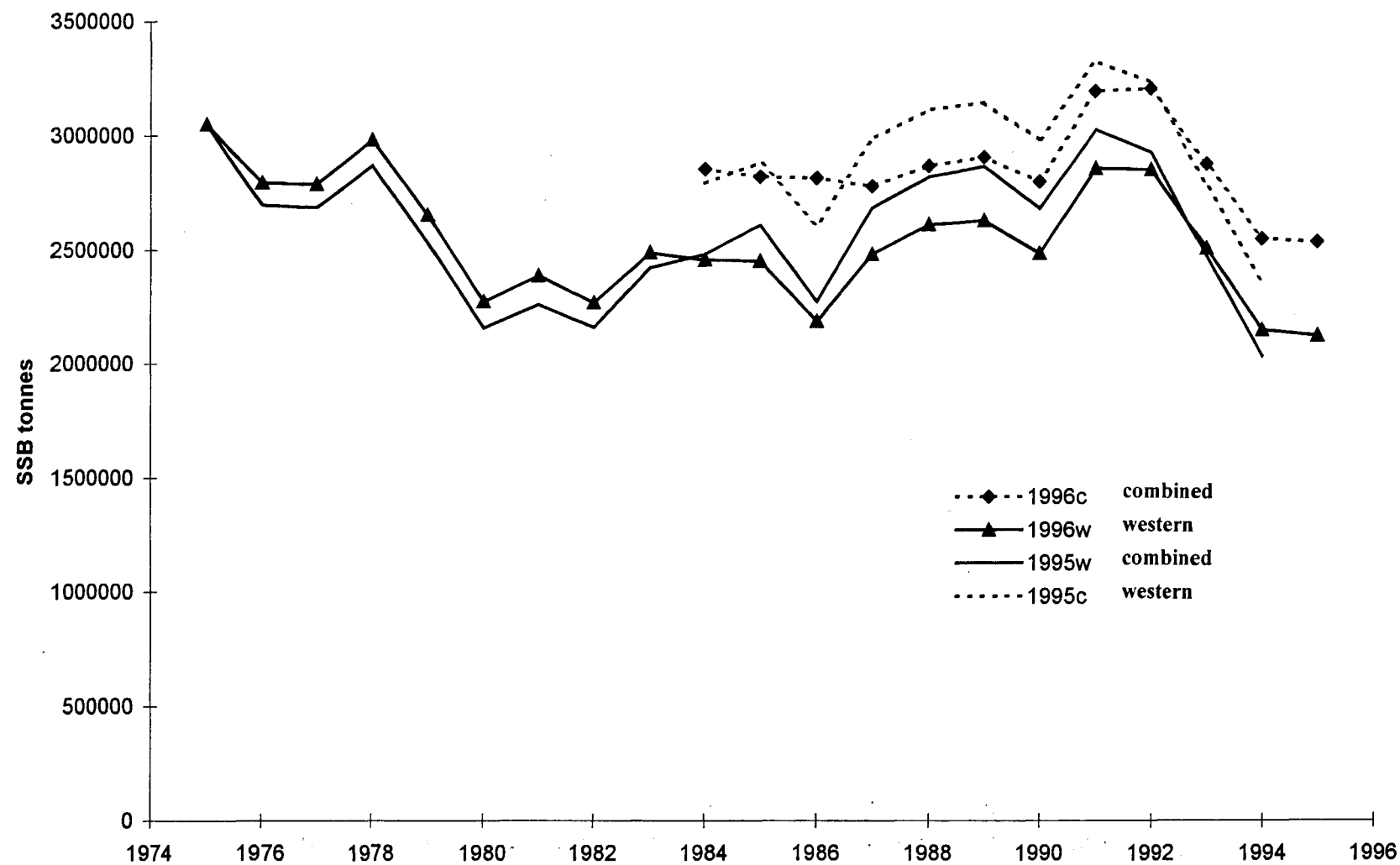


Figure 3.14 The medium term projection results for a constant TAC option of a catch equivalent to that taken in 1995 from the North East Atlantic mackerel.

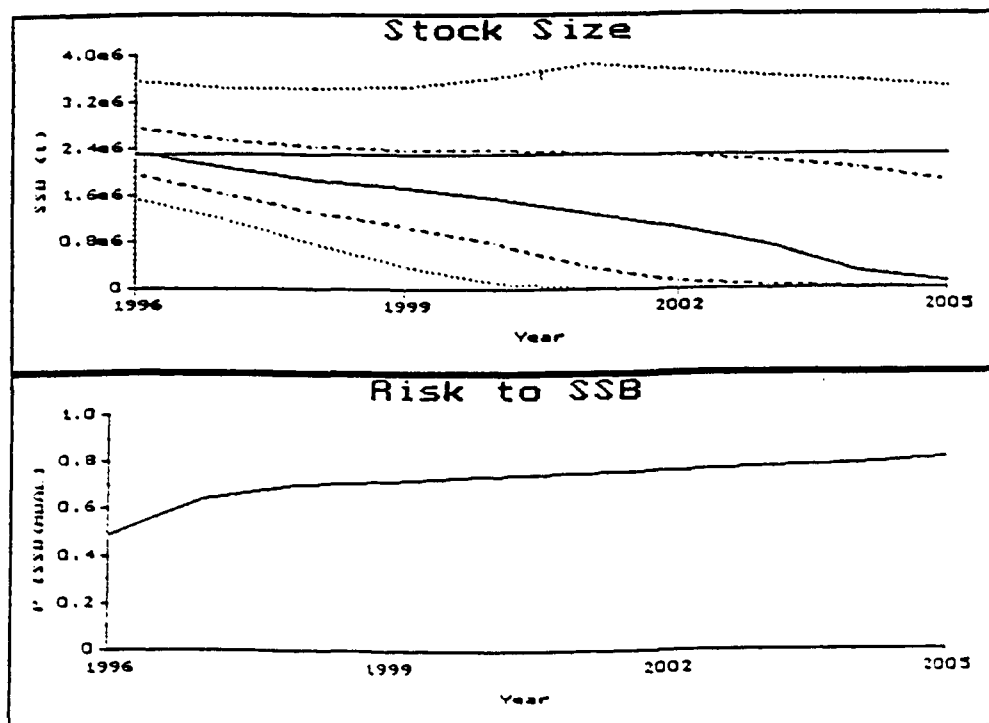
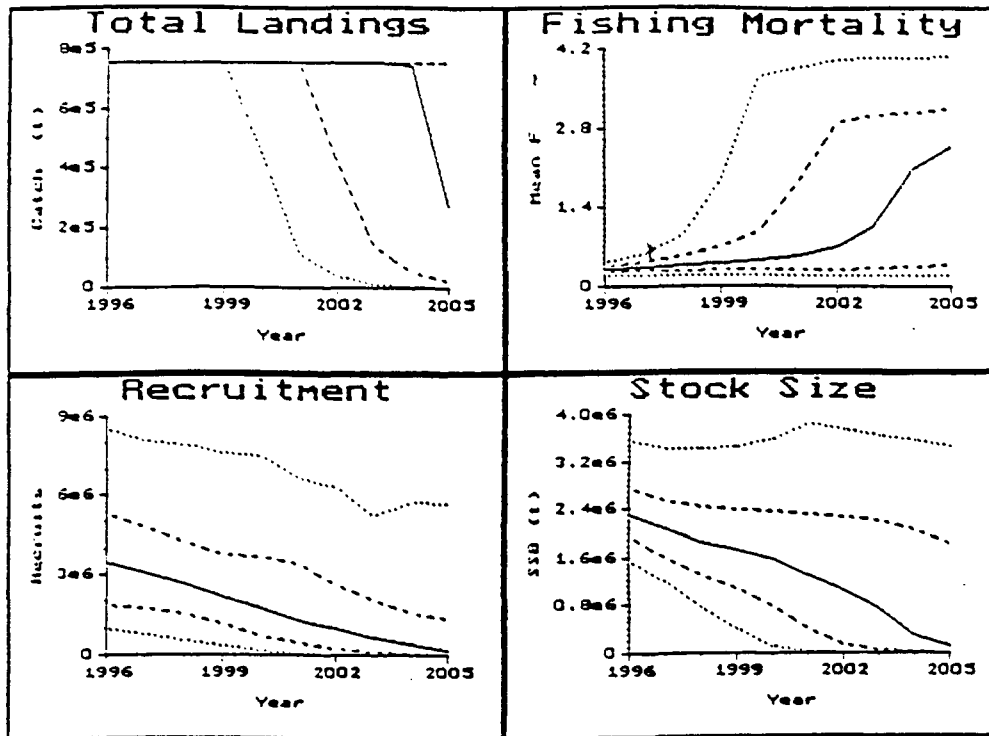


Figure 3.15 The medium term projection results for a constant TAC option of a catch of 500,000t from the North East Atlantic mackerel.

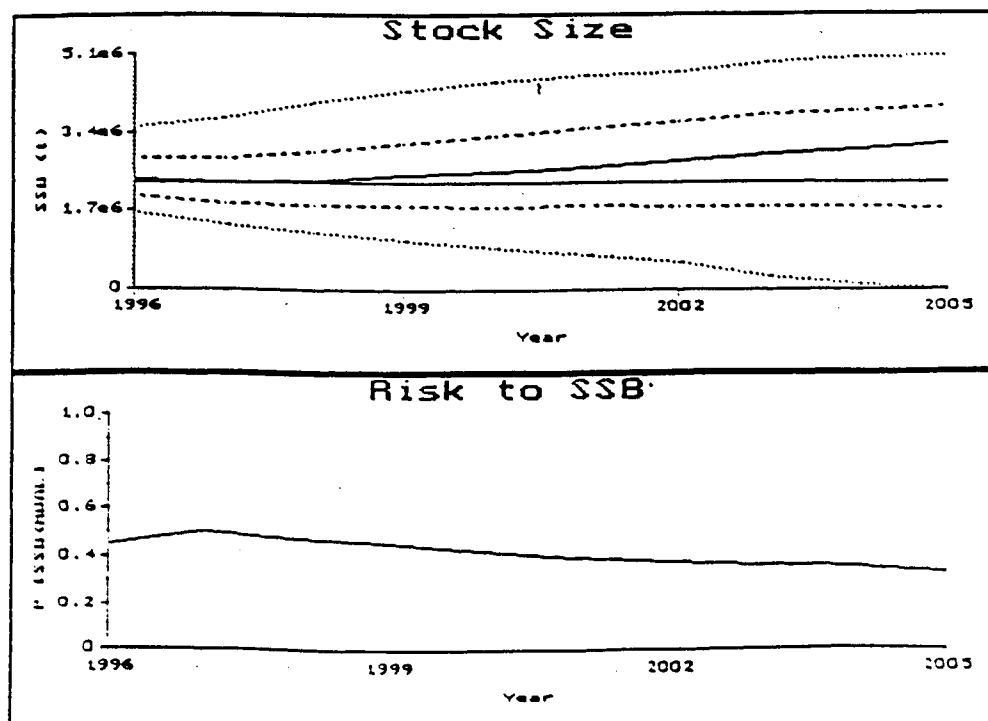
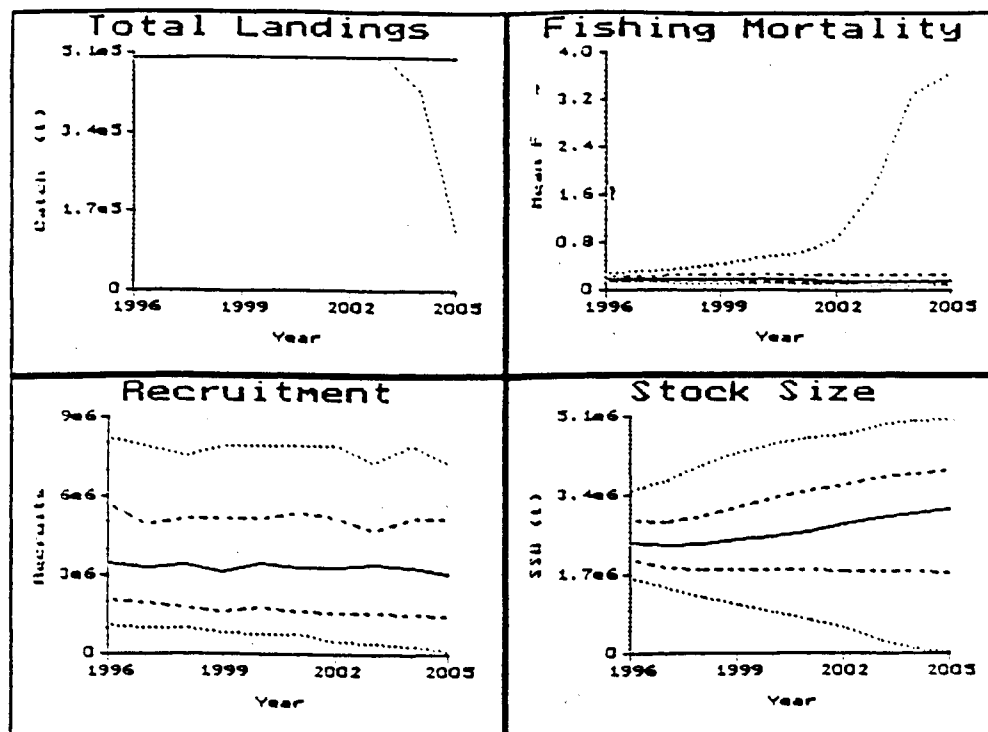


Figure 3.16 The medium term projection results for a constant F option $F = F_{1995}$ for the North East Atlantic mackerel.

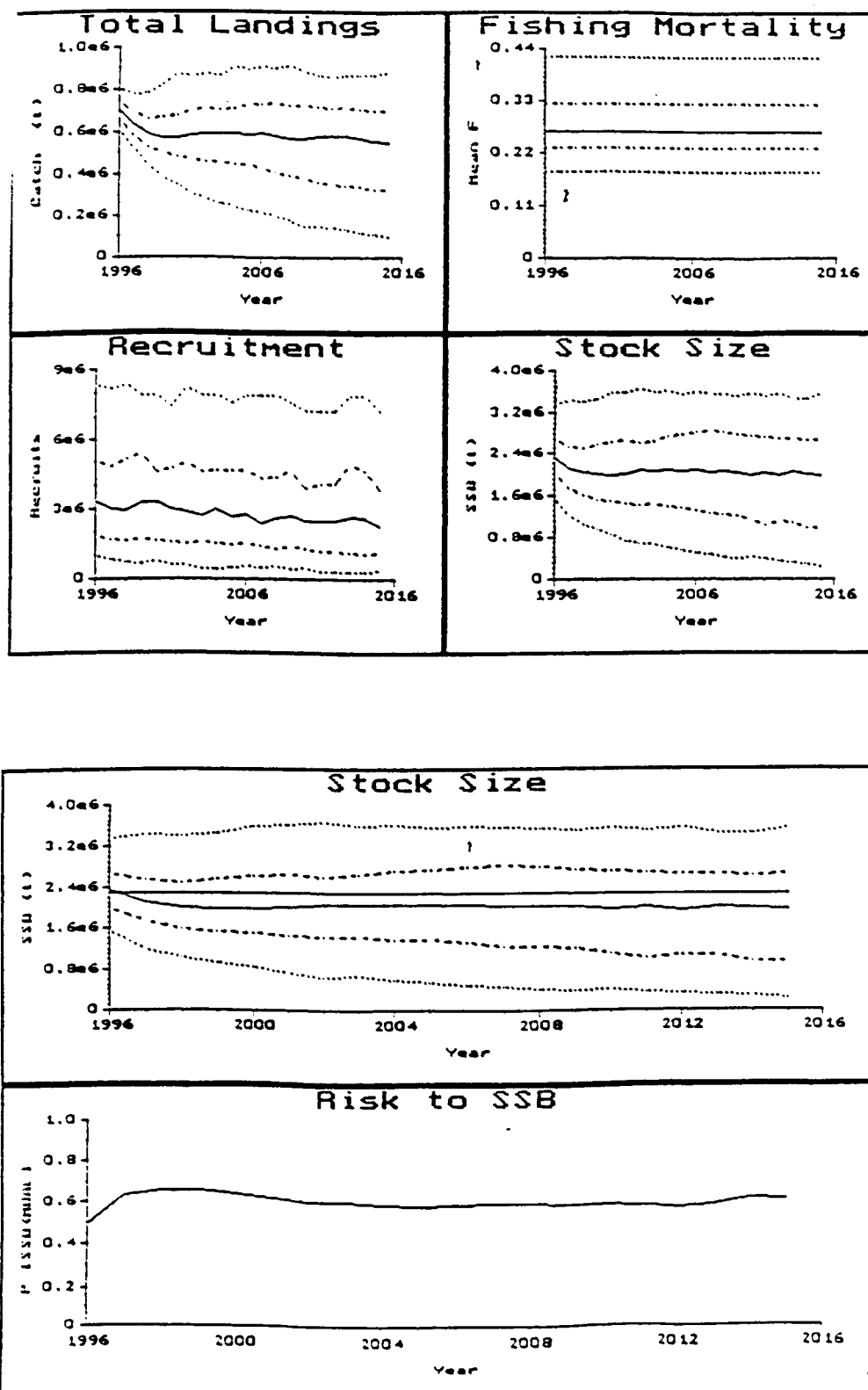


Figure 3.17 The medium term projection results for a constant F option $F = F_{1996}$, the fishing mortality required to achieve a catch of 500,000t, for the North East Atlantic mackerel.

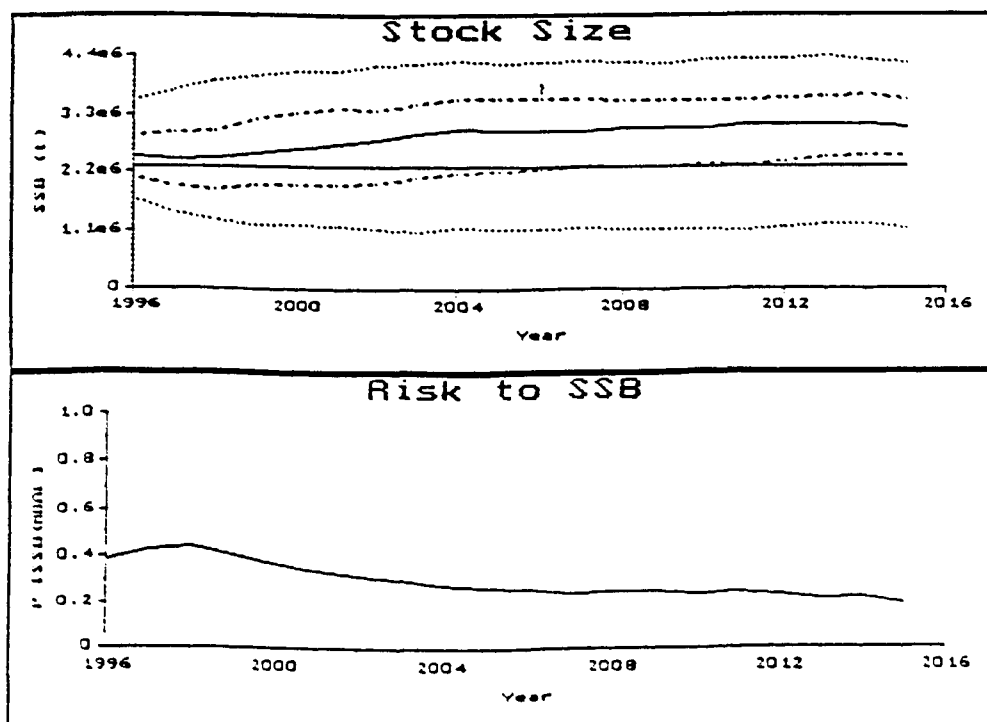
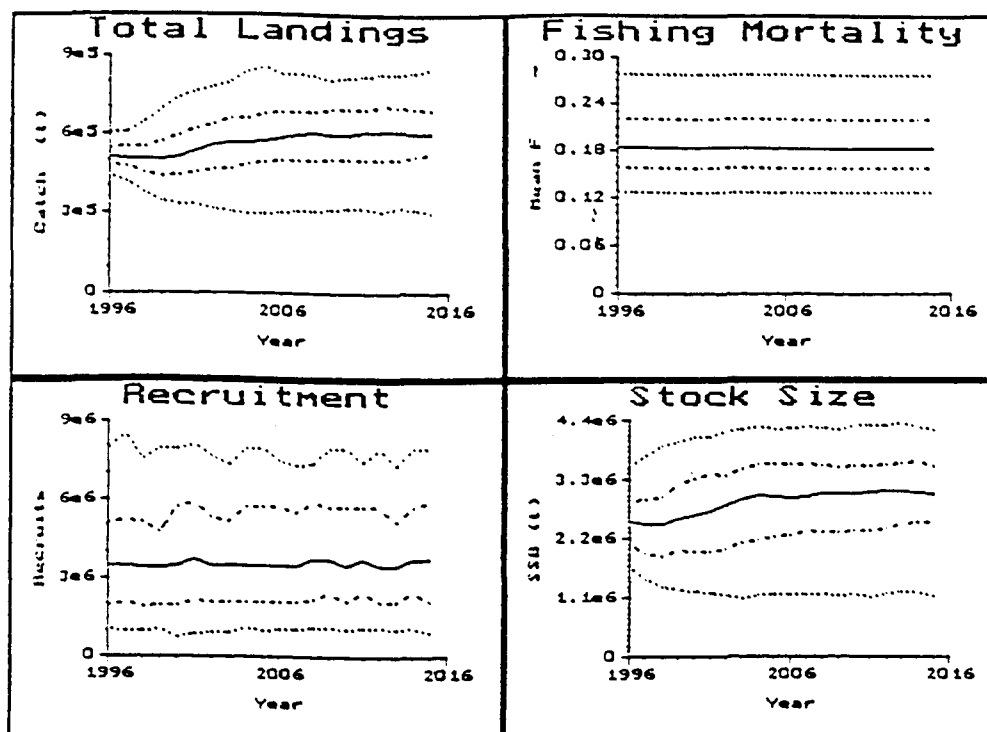


Figure 3.18 The medium term projection results for a constant F option $F = 0.15$ for the North East Atlantic mackerel.

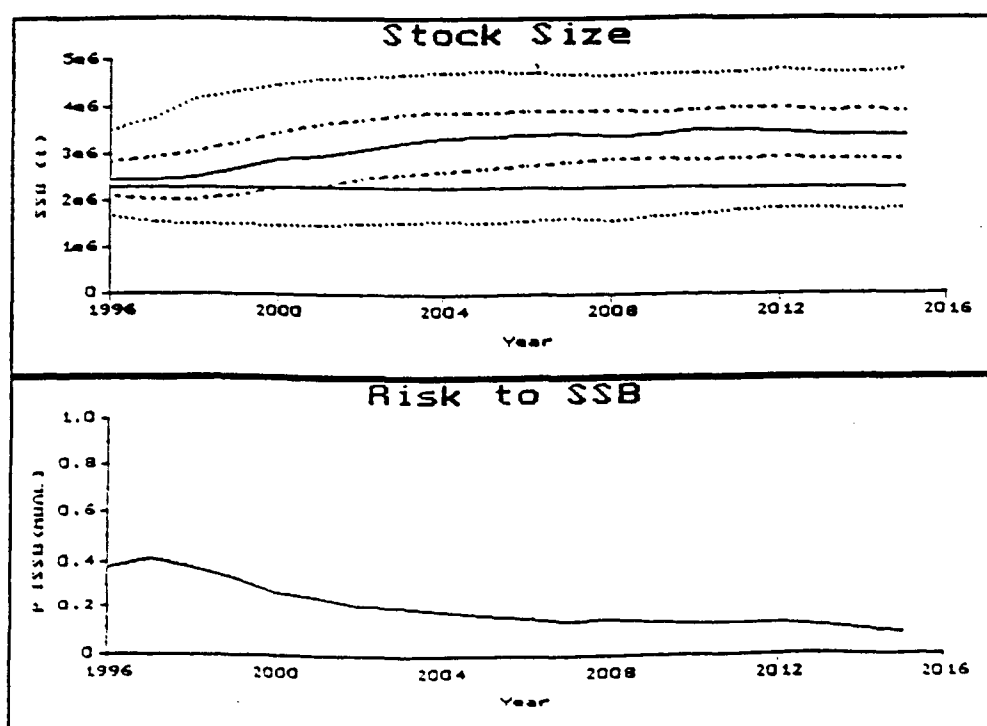
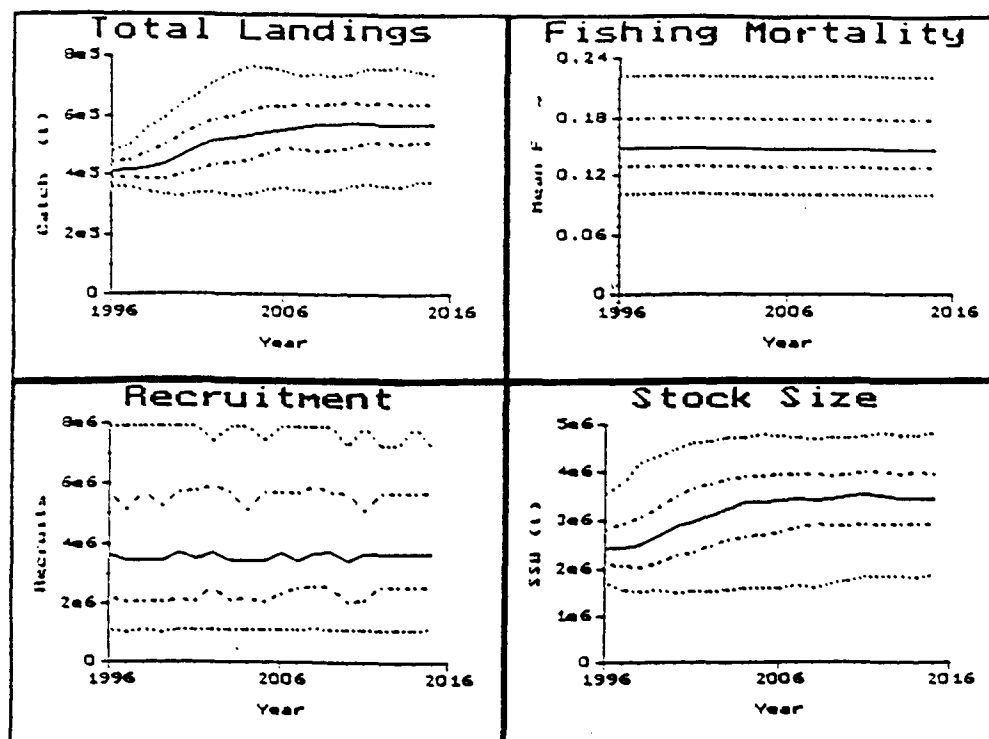


Figure 3.19 The NEAC Mackerel stock-recruitment relationship

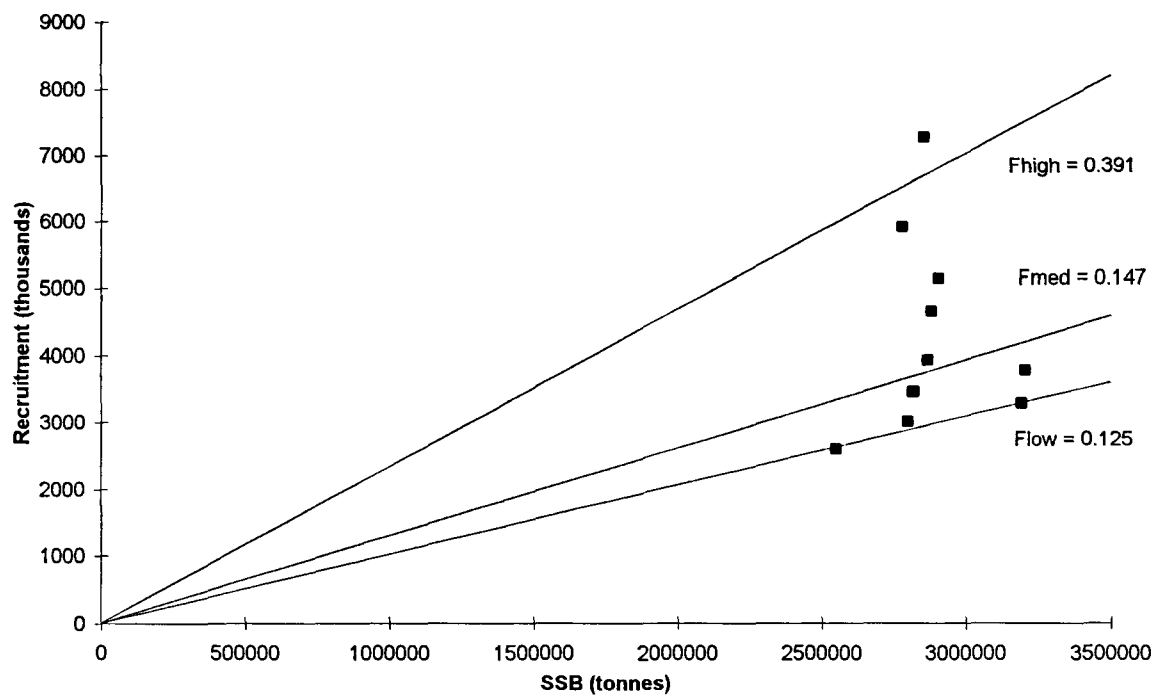
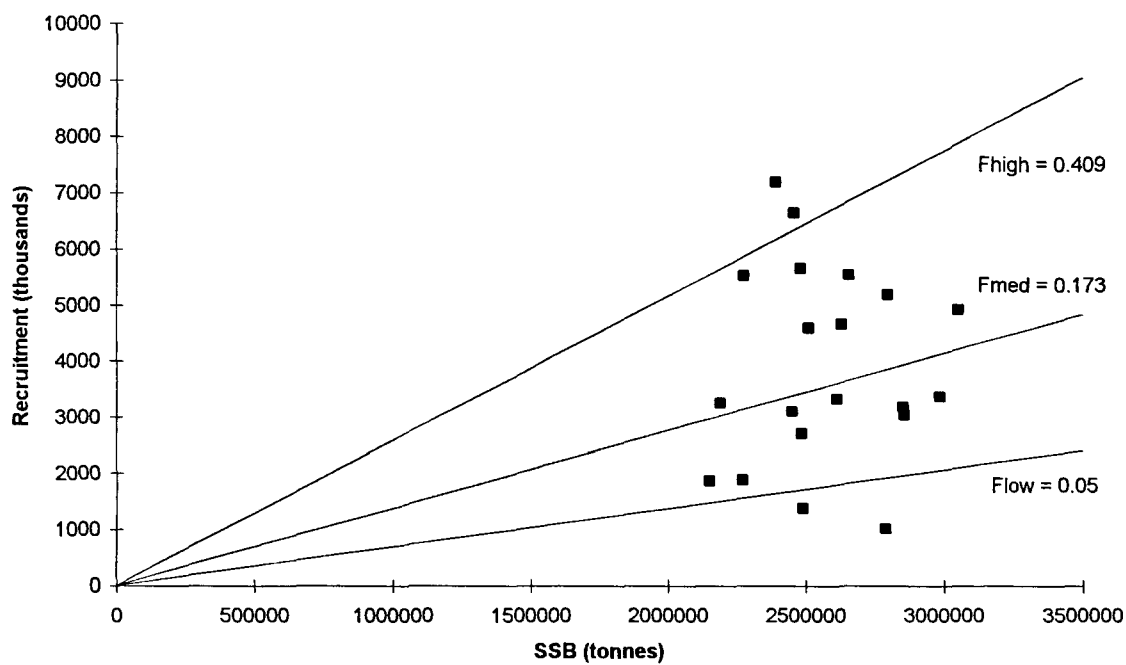


Figure 3.20 The Western mackerel stock-recruitment relationship



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 (1.226×10^{15} eggs; S.E. 0.205×10^{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 1.71×10^6 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 175.383×10^{12} eggs (S.E. 9.47×10^{12}). The alternative egg production, not used by the WG and based on an interpolated production for period 2, was 172.744×10^{12} eggs (S.E. 7.99×10^{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 advise 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 western 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 Ireland.

Third quarter, 107,000 t. This is 20% more than in 1994. The main catches were taken to the west and north 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 | VIIId | 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 |

¹Norwegian and Danish catches are included in the Western horse mackerel.

²Norwegian catches in Division IVb included in the Western horse mackerel.

³Divisions IIIa and IVb,c combined.

Table 4.2

Catches (t) of *Trachurus trachurus* and *Trachurus mediterraneus* in Divisions Villab, Villc and IXa in the period 1989-1995.

| | Divisions | Sub-Divisions | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|-------------------------|-----------|---------------|-------|-------|-------|-------|-------|-------|-------|
| <i>T. trachurus</i> | Villab | | 2904 | 4306 | 4030 | 3445 | 2431 | 1262 | 815 |
| | Villc | Villc East | 8478 | 7505 | 4907 | 8299 | 11519 | 9697 | 7045 |
| | | Villc 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 |
| <i>T. mediterraneus</i> | Villab | | 23 | 298 | 2122 | 1123 | 649 | 1573 | 2271 |
| | Villc | Villc East | 3903 | 2943 | 5020 | 4804 | 5576 | 3344 | 4585 |
| | | Villc 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) | % |
| <i>Trachurus mediterraneus</i> | VIIIab | | 356 | 77.4 | 452 | 51.5 | 38 | 24.8 | 1425 | 89.3 | 2271 | 73.6 |
| | VIIIc | VIIIc East | 1320 | 47.0 | 470 | 17.3 | 1046 | 32.9 | 1749 | 59.6 | 4585 | 39.4 |
| | | East of 3°W | 506 | 70.2 | 225 | 20.4 | 441 | 45.5 | 1044 | 79.1 | 2216 | 53.9 |
| | | West of 3°W | 814 | 39.0 | 245 | 15.2 | 605 | 27.4 | 705 | 43.6 | 2369 | 31.5 |
| <i>Trachurus trachurus</i> | VIIIab | | 104 | 22.6 | 426 | 48.5 | 115 | 75.2 | 170 | 10.7 | 815 | 26.4 |
| | VIIIc | VIIIc East | 1487 | 53.0 | 2246 | 82.7 | 2130 | 67.1 | 1188 | 40.4 | 7051 | 60.6 |
| | | East of 3°W | 215 | 29.8 | 876 | 79.6 | 528 | 54.5 | 276 | 20.9 | 1895 | 46.1 |
| | | West of 3°W | 1272 | 61.0 | 1370 | 84.8 | 1602 | 72.6 | 912 | 56.4 | 5156 | 68.5 |
| Total | VIIIab | | 460 | | 878 | | 153 | | 1595 | | 3086 | |
| | VIIIc | VIIIc East | 2807 | | 2716 | | 3176 | | 2937 | | 11636 | |
| | | East of 3°W | 721 | | 1101 | | 969 | | 1320 | | 4111 | |
| | | West of 3°W | 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 |
|-------------------------|--------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <i>T. trachurus</i> (*) | IXa | 28,526 | 19,554 | 25,125 | 25,226 | 19,959 | 17,497 | 22,653 | 25,747 | 19,061 | 17,698 |
| <i>T. picturatus</i> | 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 |

¹Preliminary.

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 | | | | | | | | | |

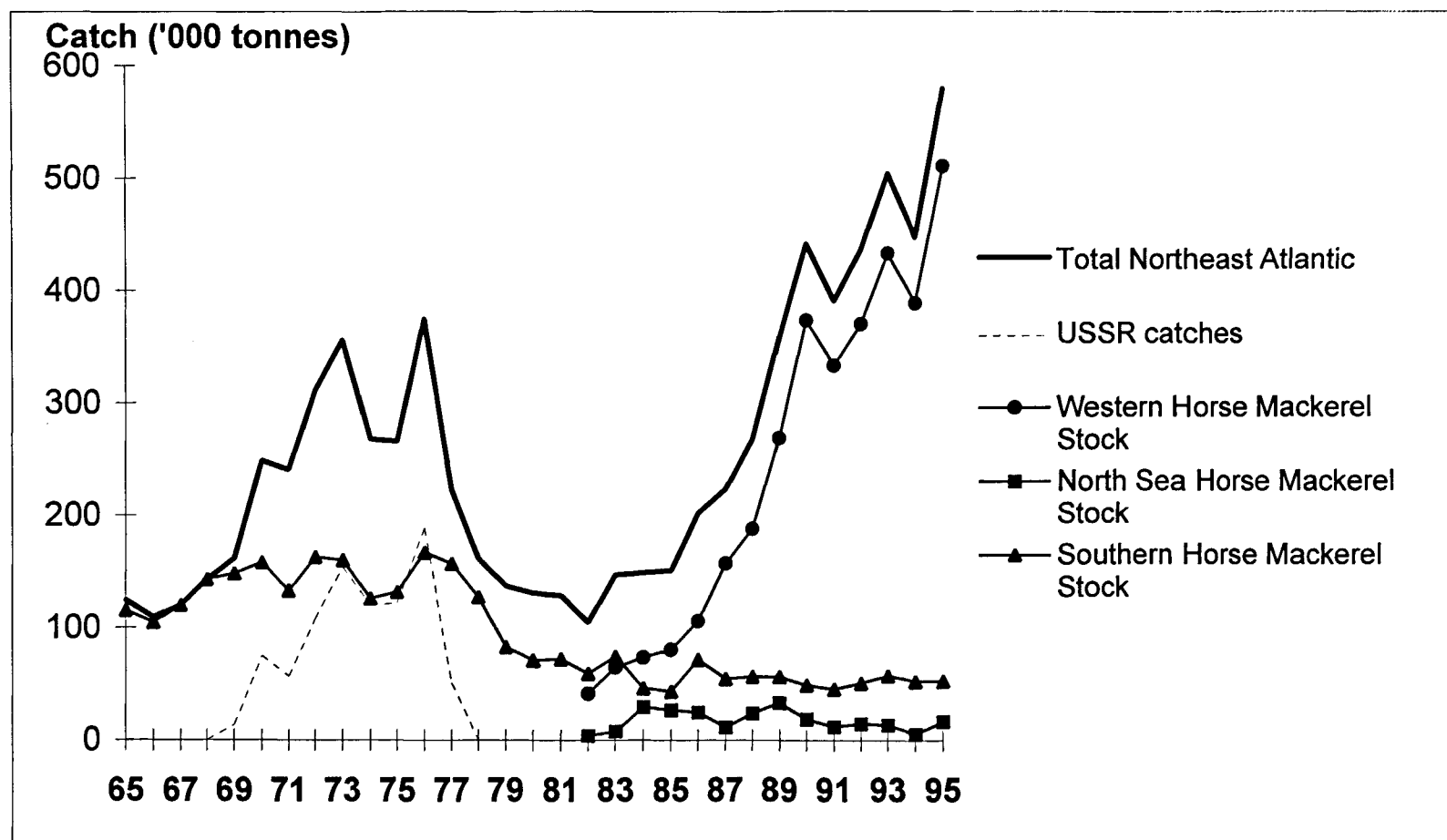


Figure 4.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 1995. The catches taken by the USSR catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catch in the northeast Atlantic.

Figure 4.2a Distribution of horse mackerel fishery.

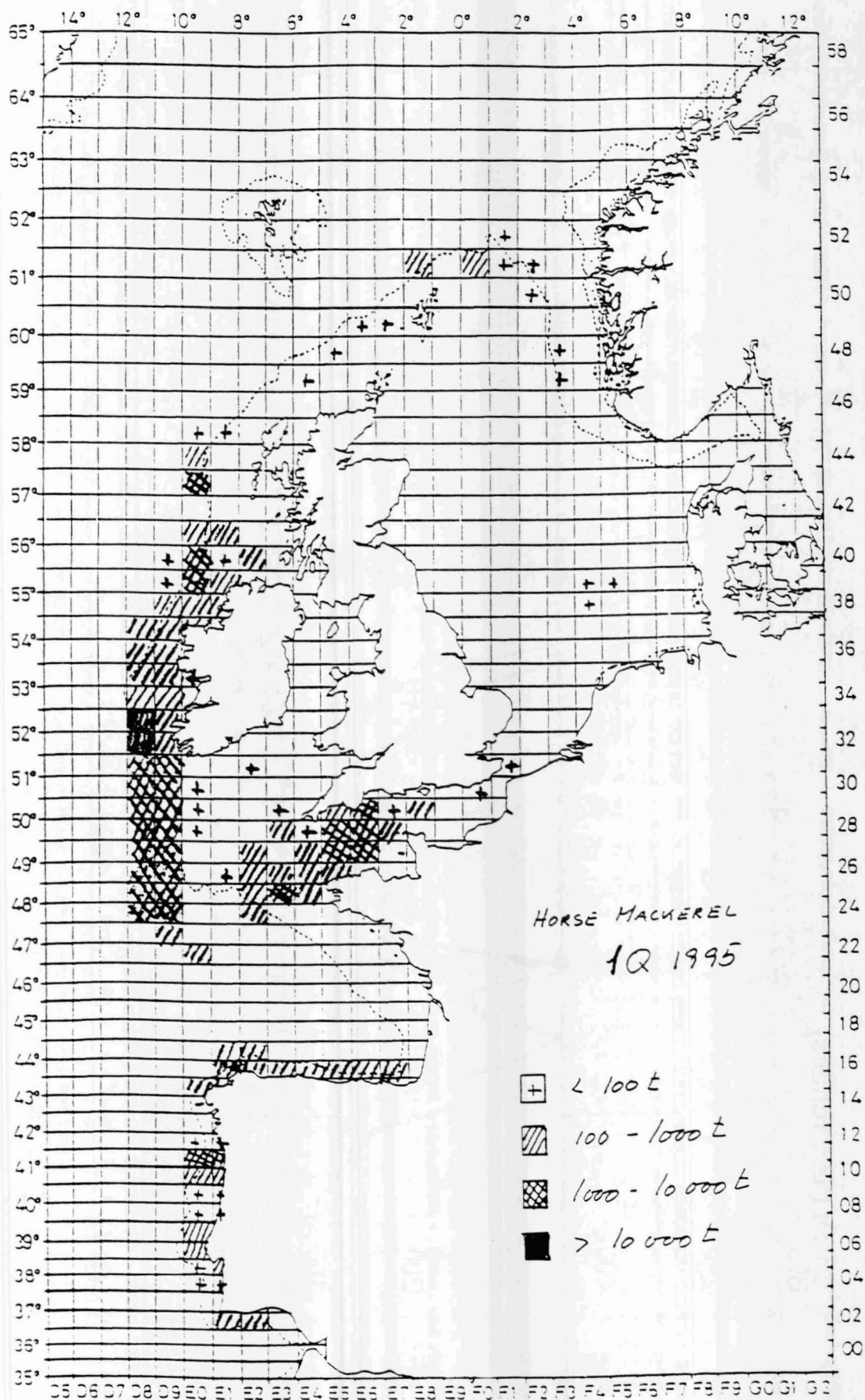


Figure 4.2b Distribution of horse mackerel fishery.

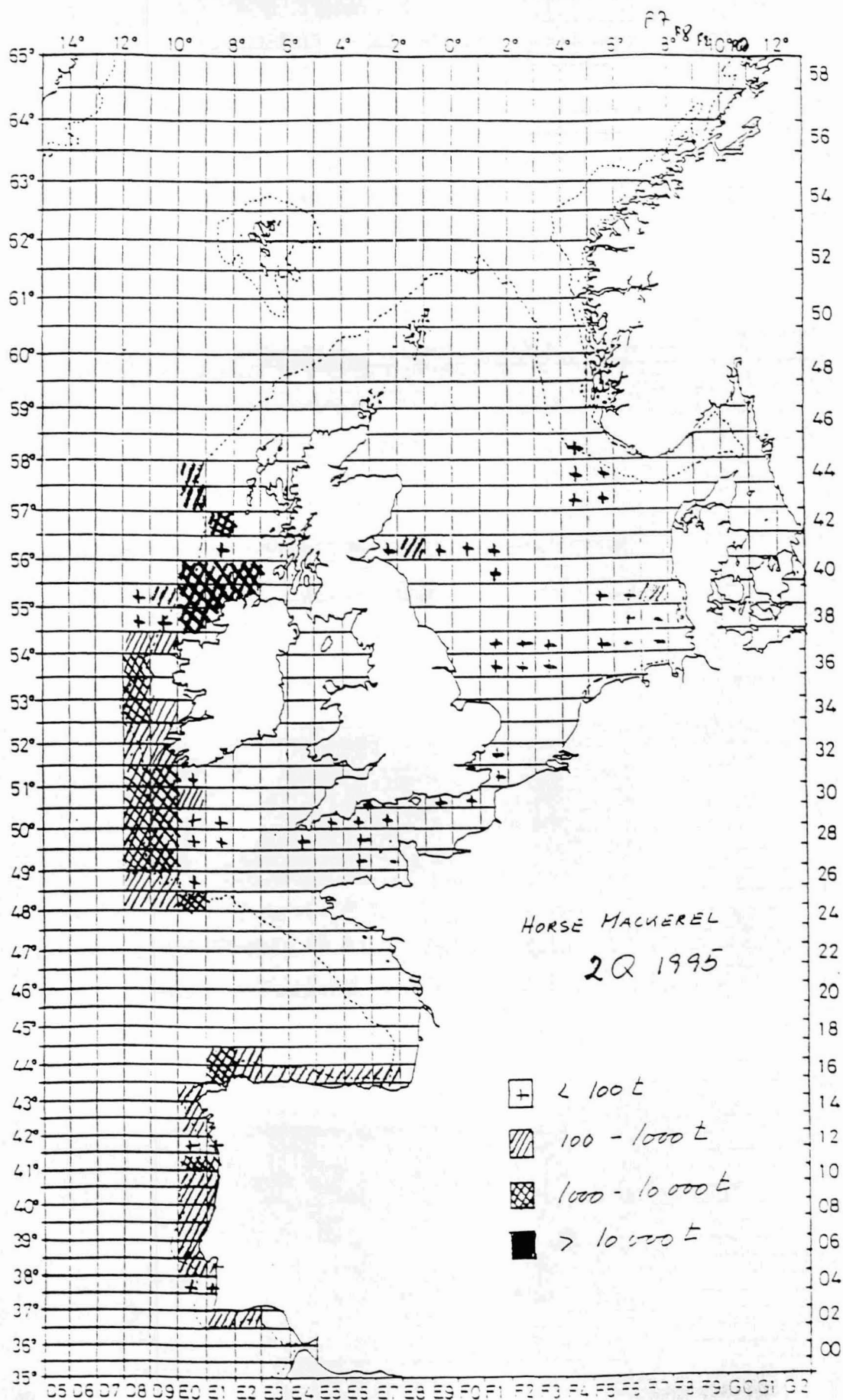


Figure 4.2c Distribution of horse mackerel fishery.

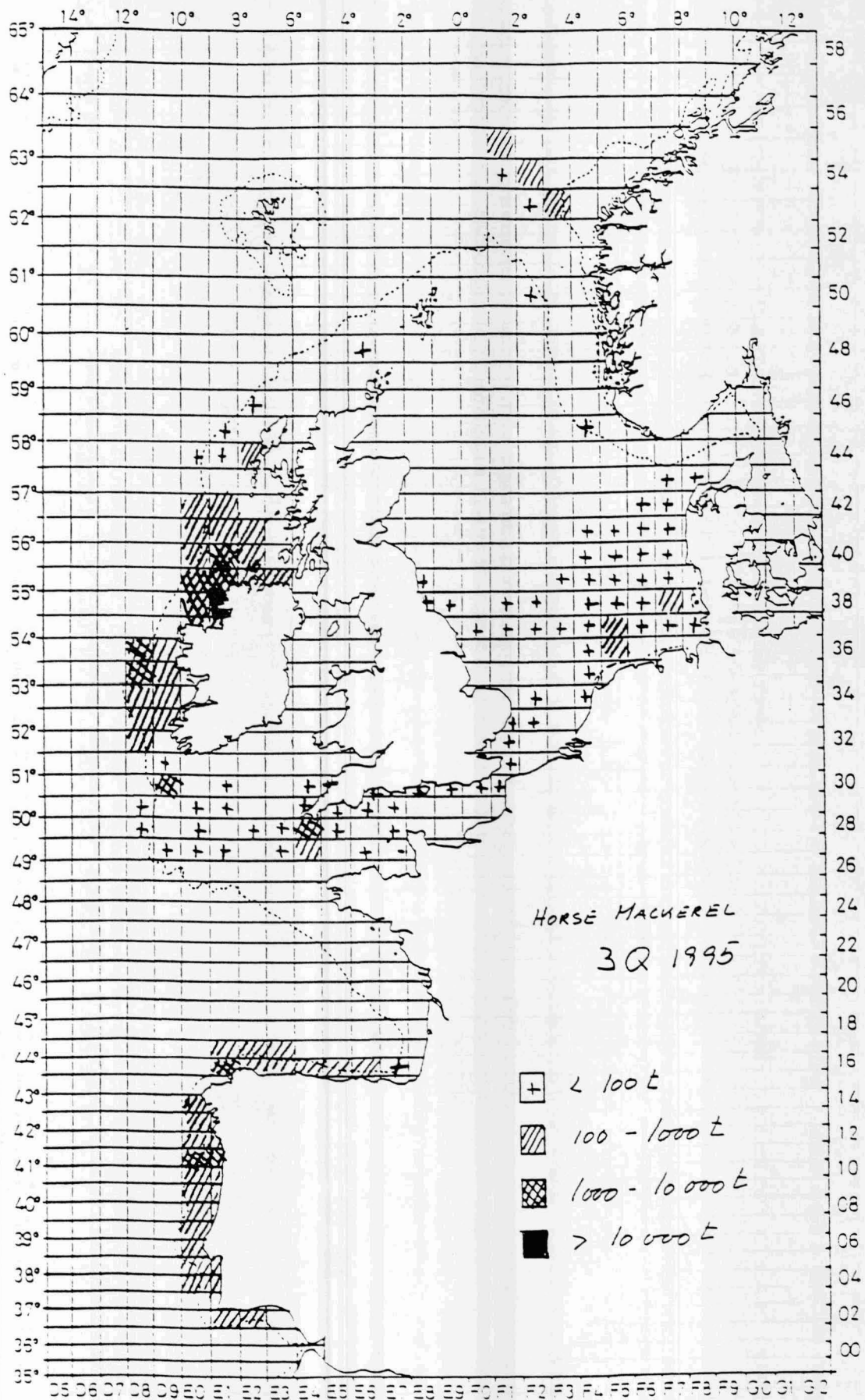
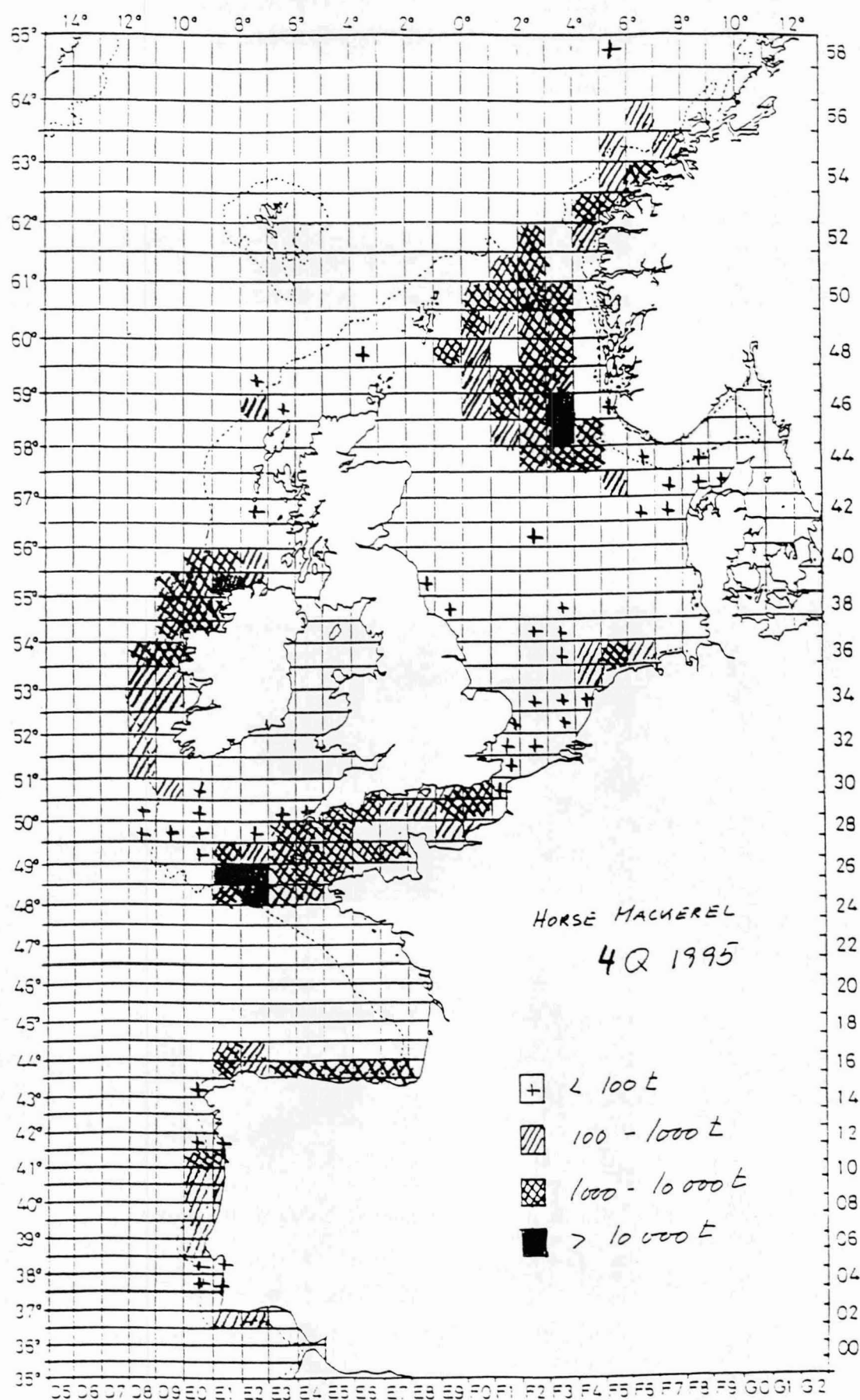


Figure 4.2d Distribution of horse mackerel fishery.



HORSE MACKEREL OTOLITH EXCHANGE 1996 SET B

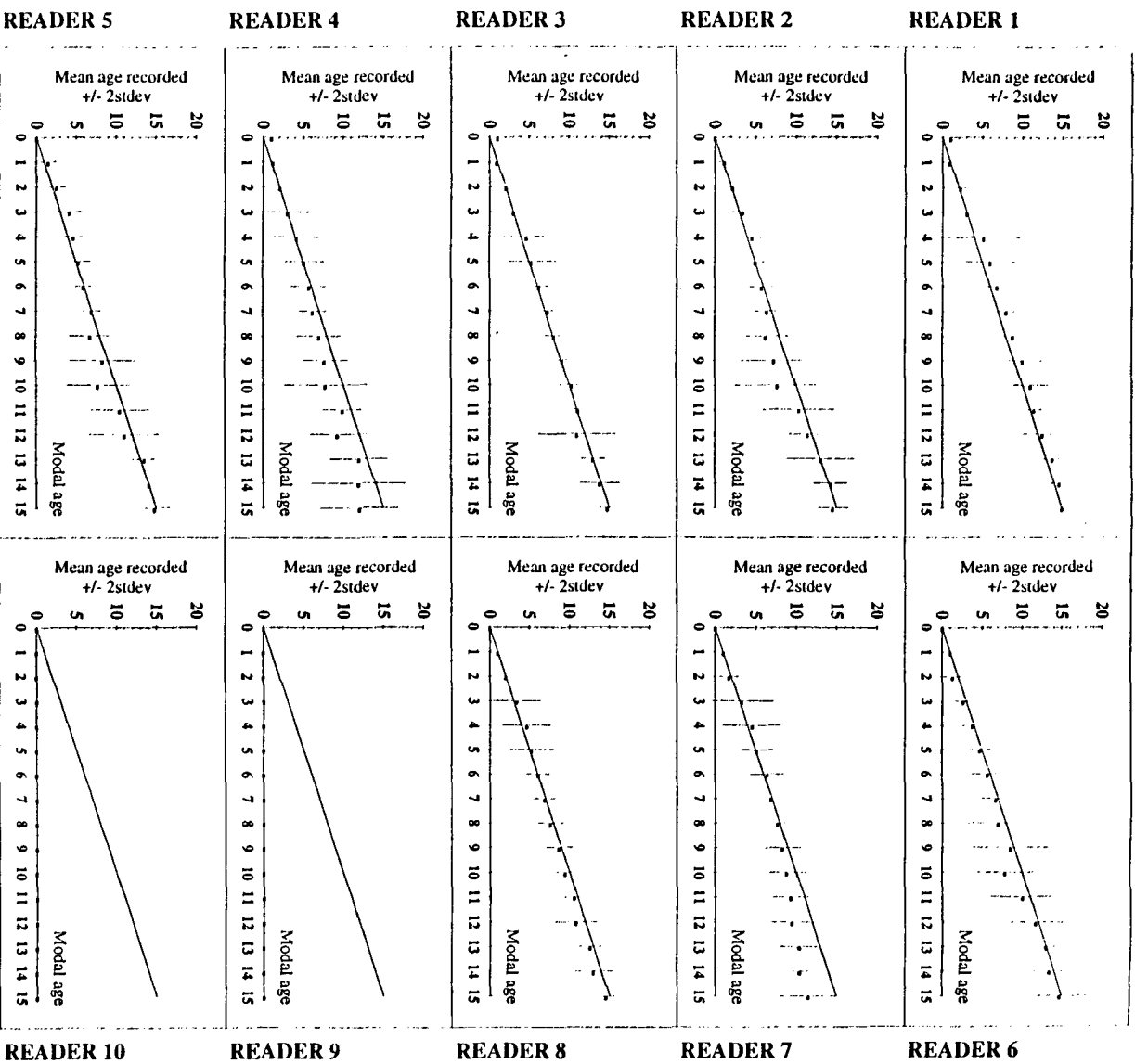


Figure 4.3
In above age bias plots the mean age recorded +/- 2stdev of each age reader is plotted against the modal age.

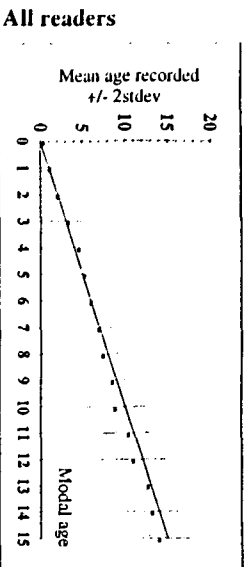


Figure 4.4
In above age bias plots the mean age recorded +/- 2stdev of all age readers is plotted against the modal age.

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 there 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.

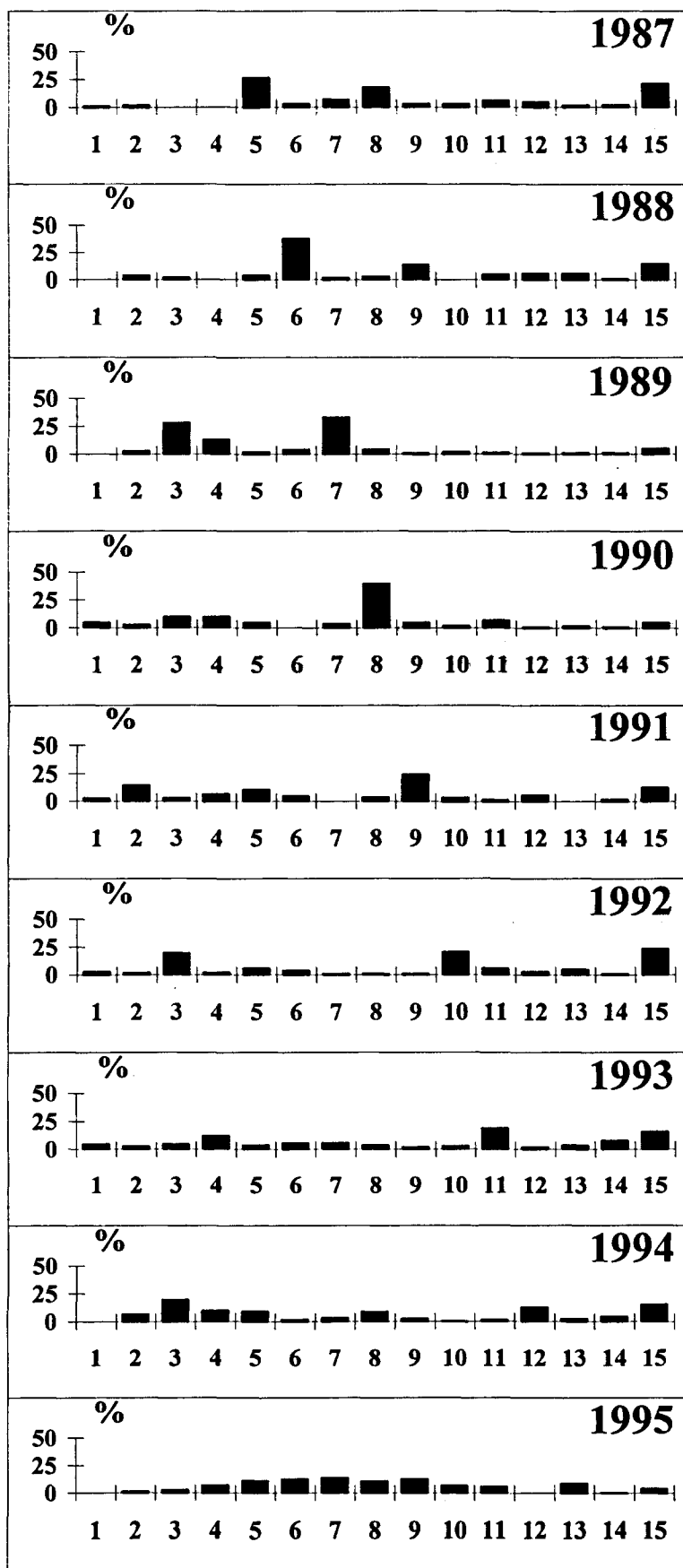


Figure 5.1 The age composition of the North Sea horse mackerel based on commercial and research vessel samples from 1987-1995.

6 WESTERN HORSE MACKEREL (DIVISIONS IIA, IIIA (WESTERN PART), IVA, VB, VIA, VIIA-C, VII E-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 Ila, 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 Ila 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 66×10^9 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:

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

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 assessment 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 considerably 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-examination 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 |

¹Preliminary.

²Included in Sub-area IV.

³Includes catches in Division Vb.

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 |

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

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 |

¹Preliminary.

²Included in Sub-area VII.

³Includes Divisions IIIa, IVa,b and VIb.

⁴Includes 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 |

¹Provisional.

²Includes Sub-area VI.

³Includes 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 |

¹Preliminary.

²Included 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 | Ila 1 st Q catch('000) | IVa 1 st Q catch('000) | Vla 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) |
|--------|---|---|---|--|--|---|---|
| Age | | | | | | | |
| 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 | 1,763 | 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 |

| | Ila 2 nd Q catch('000) | IVa 2 nd Q catch('000) | Vla 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) |
|--------|---|---|---|--|--|---|---|
| Age | | | | | | | |
| 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 |

| | Ila 3 rd Q catch('000) | IVa 3 rd Q catch('000) | Vla 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) |
|--------|---|---|---|--|--|---|---|
| Age | | | | | | | |
| 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 |

| | Ila 4 th Q catch('000) | IVa 4 th Q catch('000) | Vla 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) |
|--------|---|---|---|--|--|---|---|
| Age | | | | | | | |
| 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 | 620 | 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 |

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

| 1995 | 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) |
|-------|-----------------------------|-----------------------------|-----------------------------|------------------------------------|--------------------------------------|-------------------------------------|-----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|-----------------------------|-----------------------------|-----------------------------|------------------------------------|--------------------------------------|-------------------------------------|-----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|------------------------------|------------------------------|------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|-----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|-----------------------------|-----------------------------|-----------------------------|------------------------------------|--------------------------------------|-------------------------------------|-----------------------------------|
| Age | | | | | | | |
| 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 |

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

| 1995 | 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) |
|-------|----------------------------|----------------------------|----------------------------|-----------------------------------|------------------------------------|------------------------------------|----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|----------------------------|----------------------------|----------------------------|-----------------------------------|------------------------------------|------------------------------------|----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|-----------------------------|-----------------------------|-----------------------------|------------------------------------|-------------------------------------|-------------------------------------|----------------------------------|
| Age | | | | | | | |
| 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 |

| | 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) |
|-------|----------------------------|----------------------------|----------------------------|-----------------------------------|------------------------------------|------------------------------------|----------------------------------|
| Age | | | | | | | |
| 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 |

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 |

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 |

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 |

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 |

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) | | | | | | | | | | | | | | |
| Mean F (5-14) , W | | | | | | | | | | | | | | |

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 |

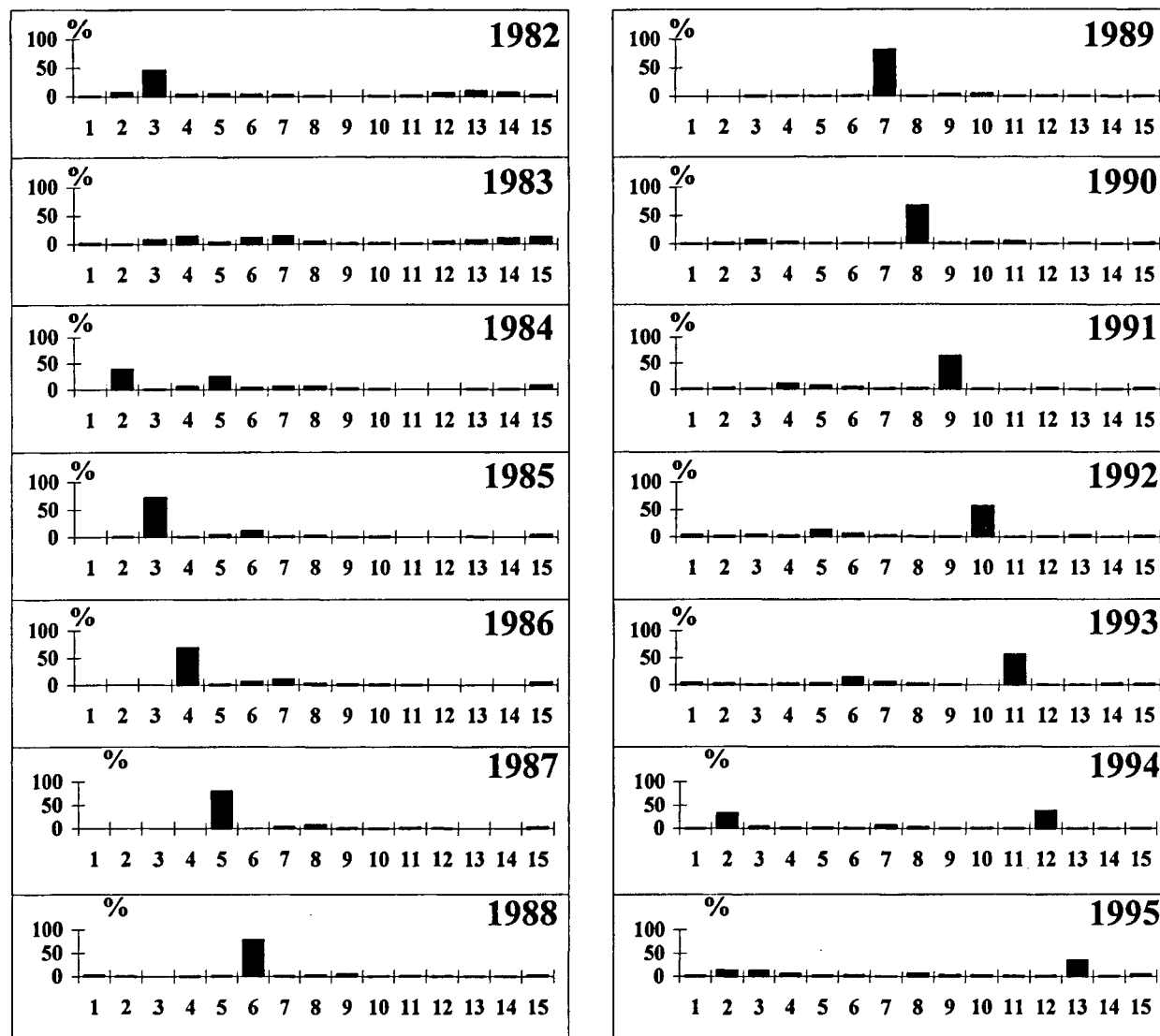


Figure 6.1 The age composition of the western horse mackerel in the international catches from 1982-1995. Age 15 is a plus group.

Western Horse Mackerel : Stock Summary

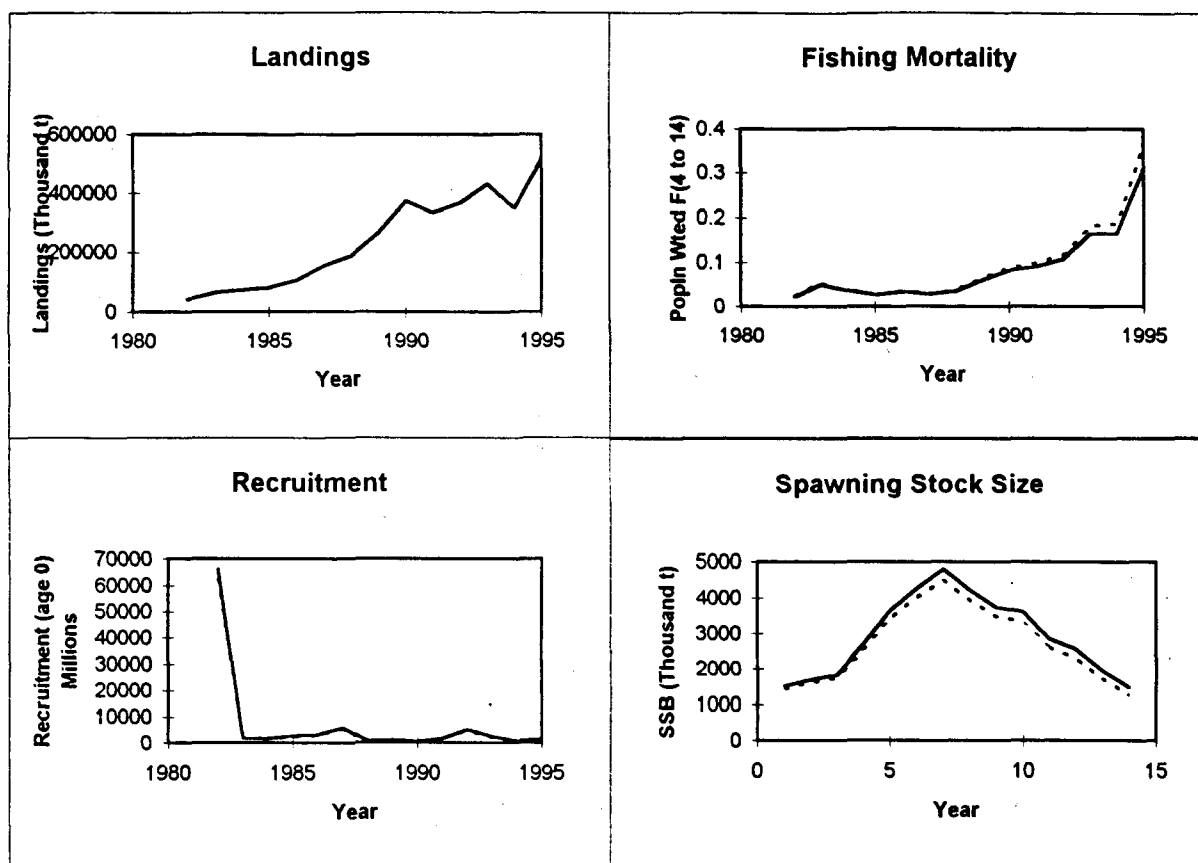


Figure 6.2 Western Horse Mackerel. Summary of landings, fishing mortality, recruitment and spawning biomass. Full lines, ADAPT estimates obtained on fitting to traditional annual egg production estimates. Broken lines, estimates obtained fitting to GAM estimates of egg production.

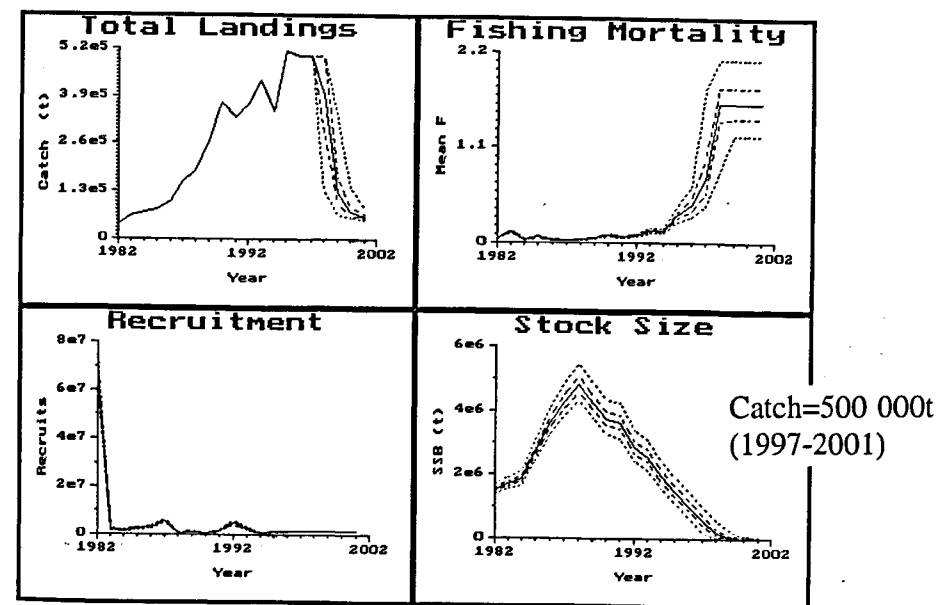
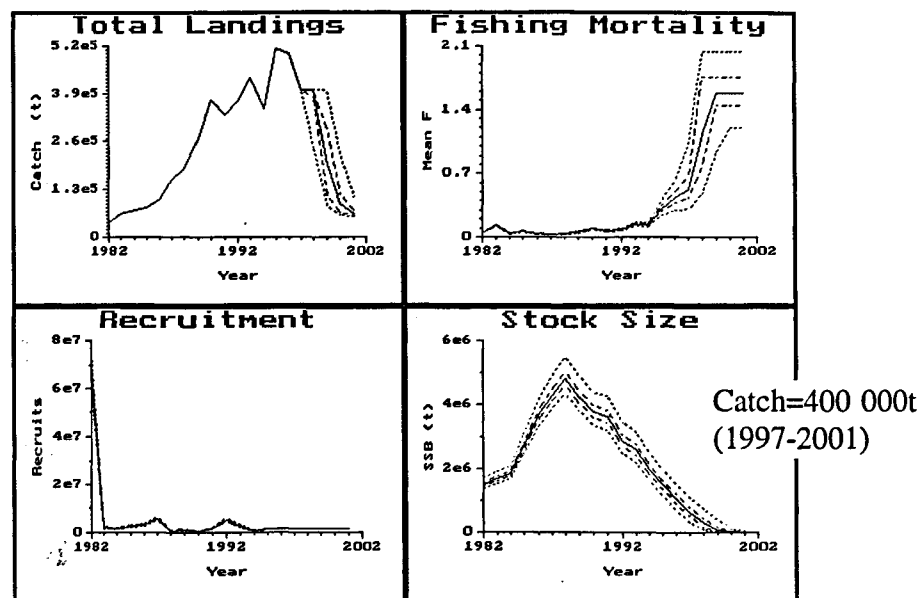
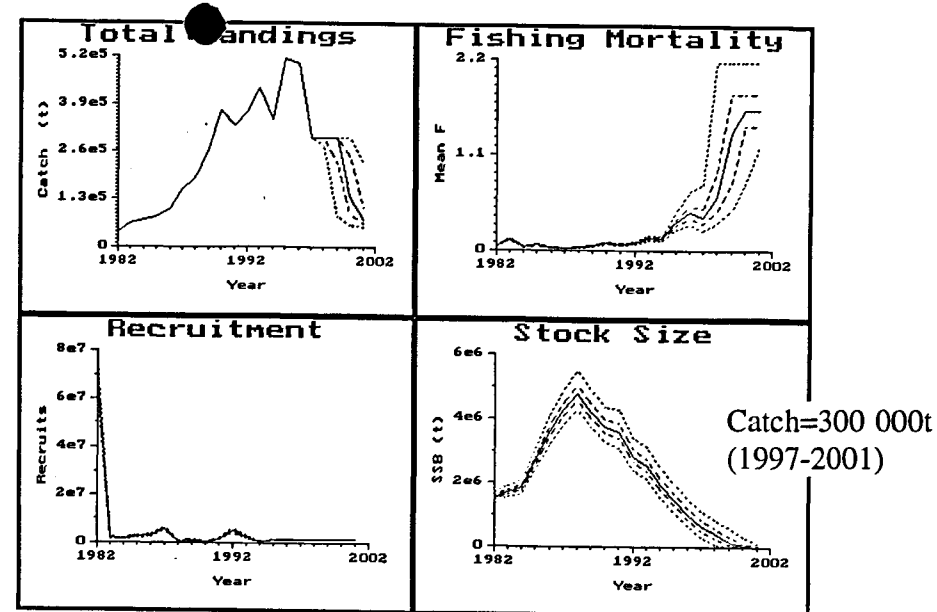
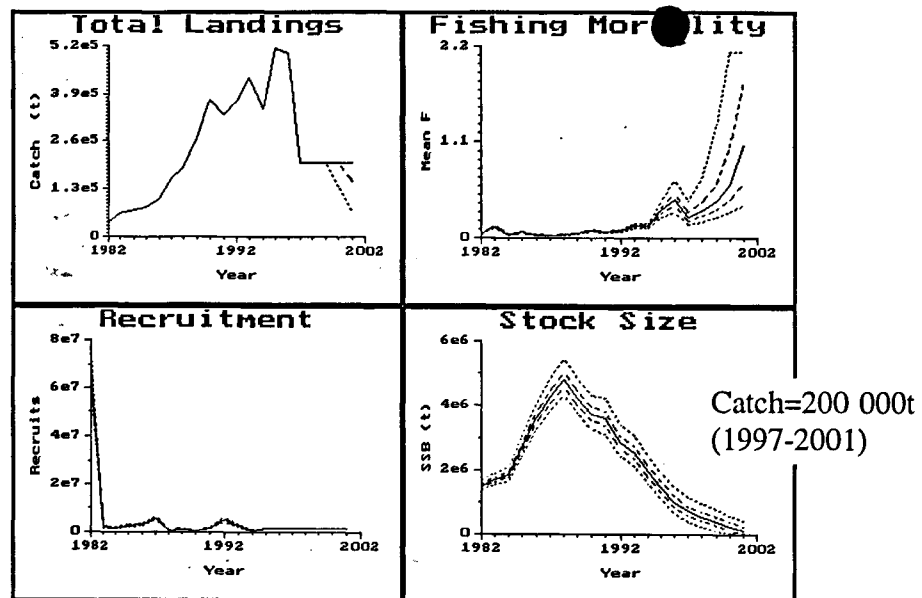


Figure 6.3. Western Horse Mackerel. Uncertainty in assessment and in medium-term projections. Landings, fishing mortality, recruitment and spawning stock size estimates for four levels of annual catch constraint over the period 1997-2001. Full lines, medians. Dashed lines, 25th and 75th percentiles. 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.

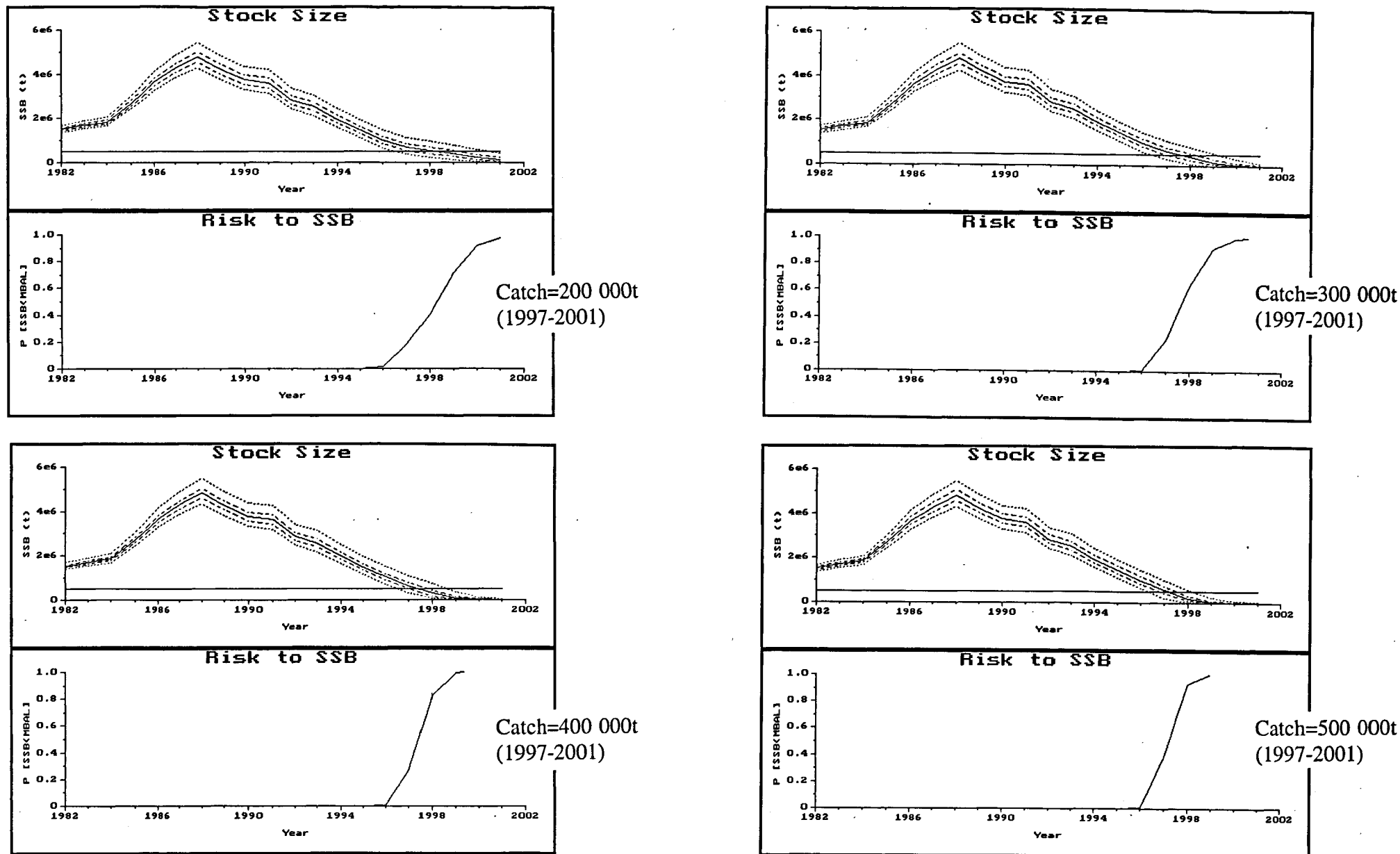


Figure 6.4. Western Horse Mackerel. Estimates of stock size in assessment (1982-1995) and in medium-term projections (1982-2001), compared with the assumed MBAL of 500 000t, for four levels of catch constraint over the period 1997-2001. **Upper panels**, trajectories of estimates of spawning stock size.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

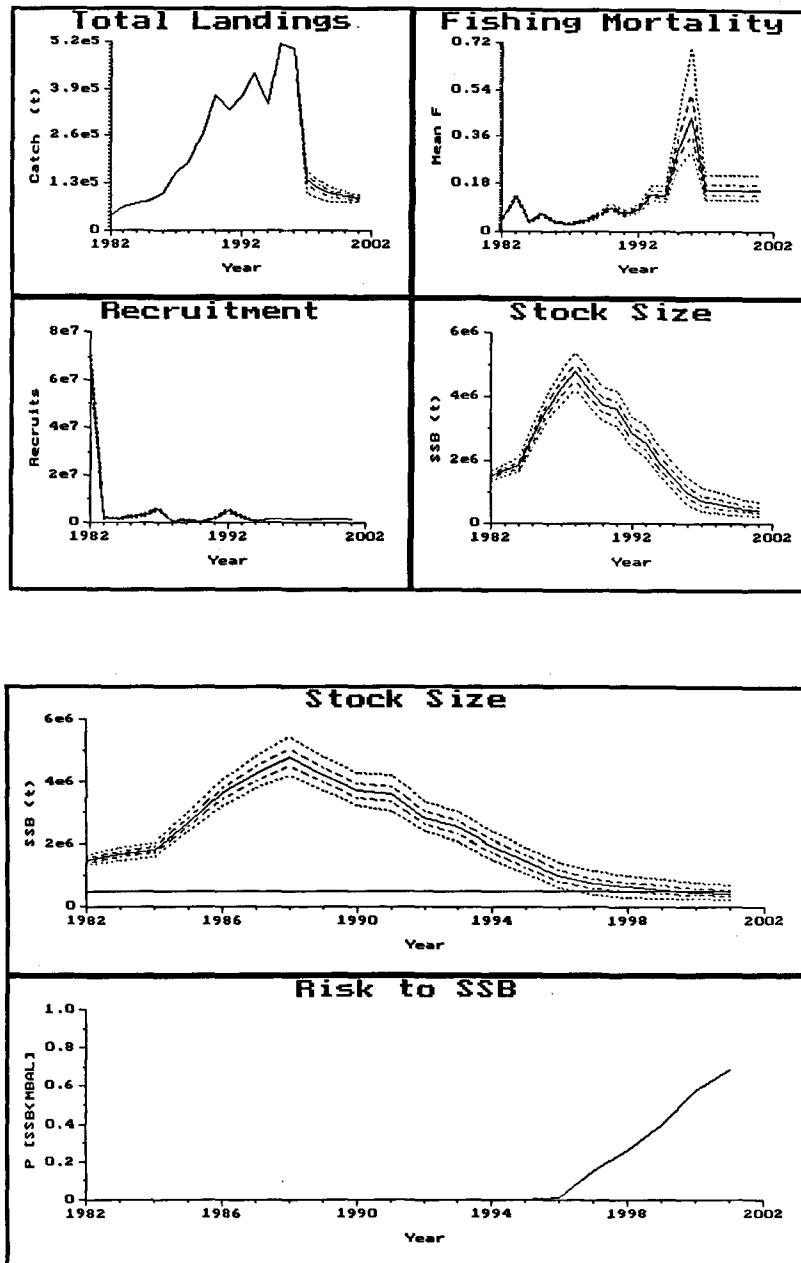
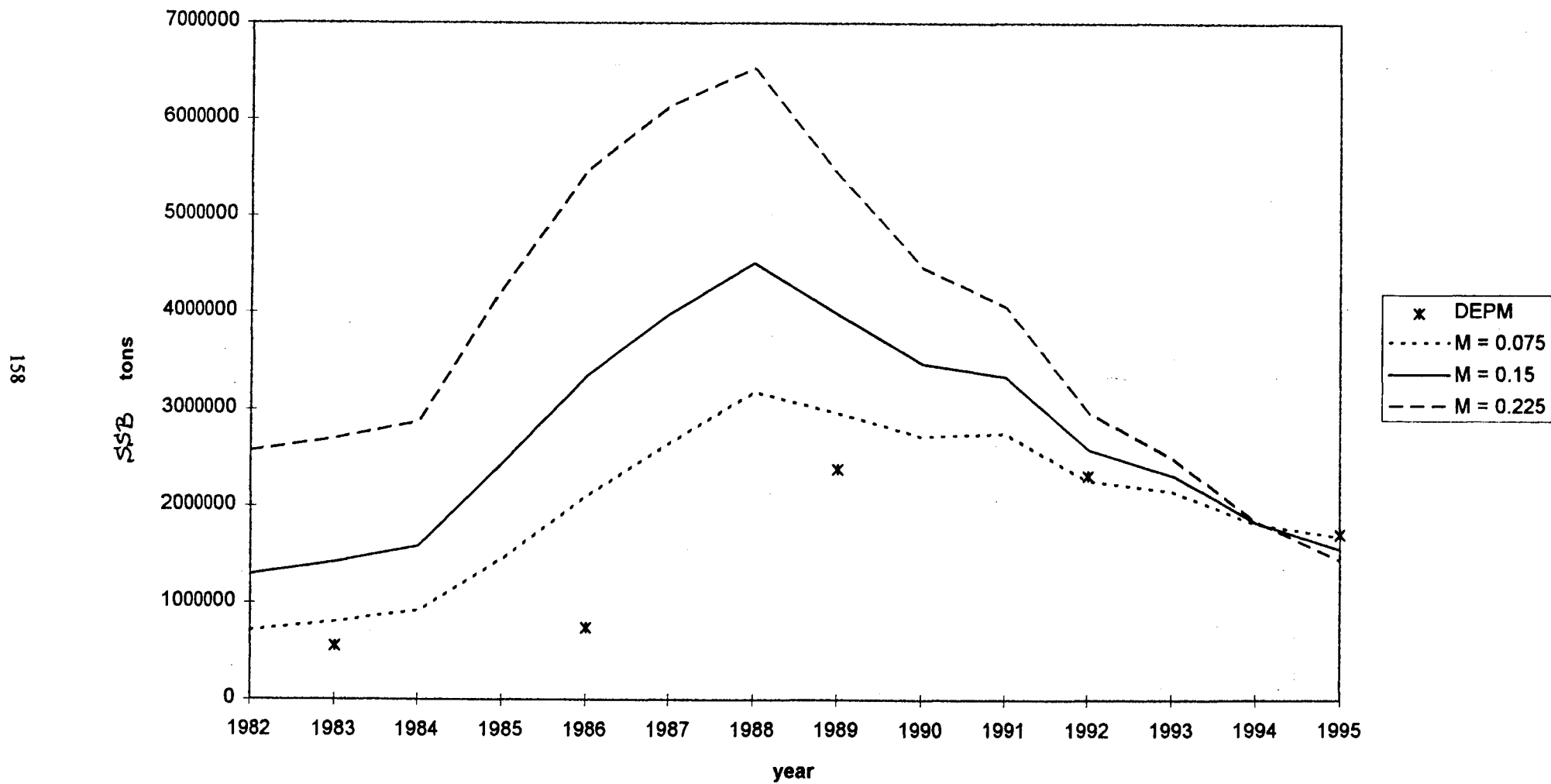


Figure 6.5. Western Horse Mackerel. Uncertainty in the assessment and in medium-term projections. **Upper panels,** Landings, fishing mortality, recruitment and spawning stock size estimates for a fishing mortality multiplier constraint (relative to 1995) equivalent to fishing at $F=M=0.15$ over the 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



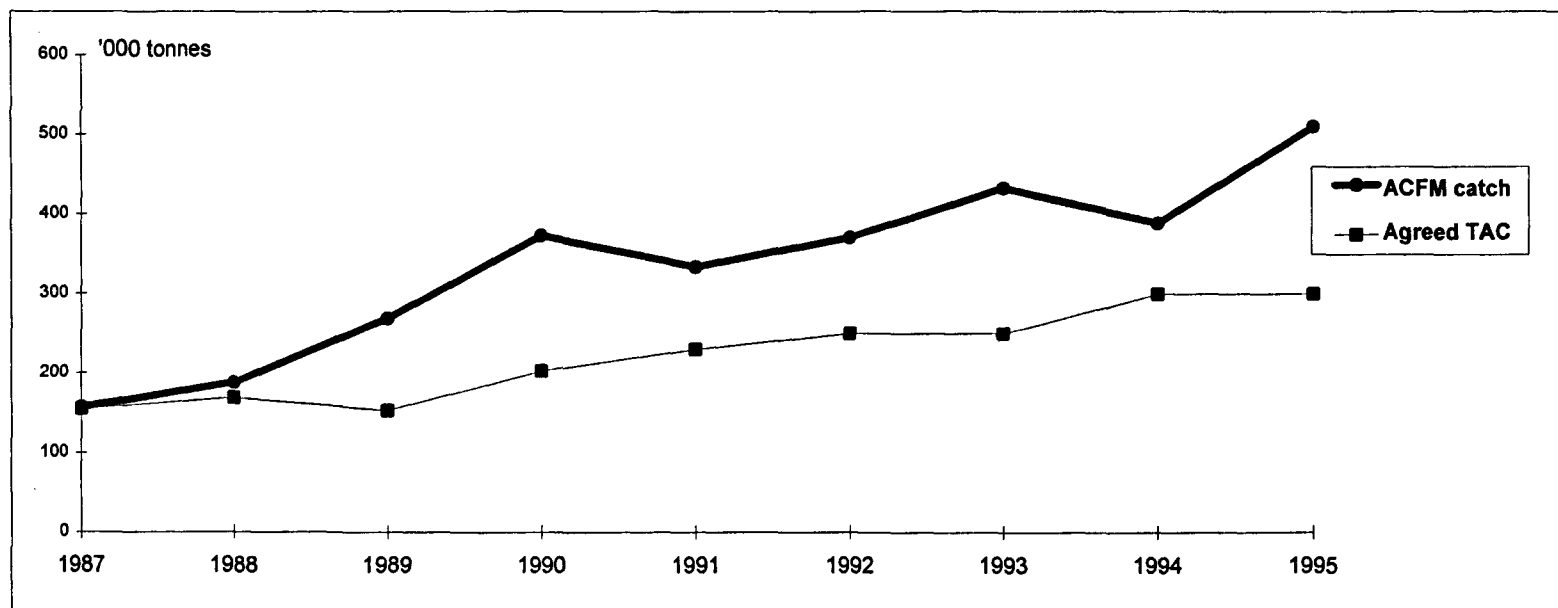


Figure 6.7 Catches compared to the agreed TAC's over the period 1987 - 1995.
The international catches (ACFM catches) overshoot in all years the agreed TAC's.

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 inappropriate 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 $F_{\text{status quo}}$ 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: $F_{\text{status quo}}$, 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 $F_{\text{status quo}}$ (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 |

¹Estimated value.

²Not 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.

| Year | Portugal IXa (20-500 m depth) | | | Spain (20-500m depth) |
|------|-------------------------------|-------------------|------------------|---------------------------|
| | Bottom trawl (20-mm codend) | | | |
| | 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 |

¹Codend 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 | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|--------|-------------|-------------|-----------|------------|------------|-----------|-----------|
| Age | 1'st Q | 1'st Q | 1'st Q | 1'st Q | 1'st Q | 1'st Q | 1'st Q |
| | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 |
| 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|--------|-------------|-------------|-----------|------------|------------|-----------|-----------|
| Age | 2'nd Q | 2'nd Q | 2'nd Q | 2'nd Q | 2'nd Q | 2'nd Q | 2'nd Q |
| | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 |
| 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|--------|-------------|-------------|-----------|------------|------------|-----------|-----------|
| Age | 3'rd Q | 3'rd Q | 3'rd Q | 3'rd Q | 3'rd Q | 3'rd Q | 3'rd Q |
| | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 |
| 0 | 1,455 | 727 | 437 | | | | 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|--------|-------------|-------------|-----------|------------|------------|-----------|-----------|
| Age | 4'th Q | 4'th Q | 4'th Q | 4'th Q | 4'th Q | 4'th Q | 4'th Q |
| | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | atch('000 | 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 | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Age | 1 st Q length(cm) | 1 st Q length(cm) | 1 st Q length(cm) | 1 st Q length(cm) | 1 st Q length(cm) | 1 st Q length(cm) | 1 st Q 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Age | 2 nd Q length(cm) | 2 nd Q length(cm) | 2 nd Q length(cm) | 2 nd Q length(cm) | 2 nd Q length(cm) | 2 nd Q length(cm) | 2 nd Q 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Age | 3 rd Q length (cm) | 3 rd Q length (cm) | 3 rd Q length (cm) | 3 rd Q length (cm) | 3 rd Q length (cm) | 3 rd Q length (cm) | 3 rd Q 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Age | 4 th Q length(cm) | 4 th Q length(cm) | 4 th Q length(cm) | 4 th Q length(cm) | 4 th Q length(cm) | 4 th Q length(cm) | 4 th Q 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 | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Age | 1 st Q weight(g) | 1 st Q weight(g) | 1 st Q weight(g) | 1 st Q weight(g) | 1 st Q weight(g) | 1 st Q weight(g) | 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Age | 2 nd Q weight(g) | 2 nd Q weight(g) | 2 nd Q weight(g) | 2 nd Q weight(g) | 2 nd Q weight(g) | 2 nd Q weight(g) | 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|--------------------------------|
| Age | 3 rd Q weight (g) | 3 rd Q weight (g) | 3 rd Q weight (g) | 3 rd Q weight (g) | 3 rd Q weight (g) | 3 rd Q weight (g) | 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 |

| | Villic East | Villic West | IXa North | IXa C. Nor | IXa C. Sou | IXa South | All areas |
|-------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Age | 4 th Q weight(g) | 4 th Q weight(g) | 4 th Q weight(g) | 4 th Q weight(g) | 4 th Q weight(g) | 4 th Q weight(g) | 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, Last, | First, Last, | Alpha, | Beta |
|-----------------------|--------------|--------------|--------|-------|
| | year, year, | age, age | | |
| 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)

| YEAR , | 0, | AGE 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,

| YEAR , | 10, | AGE 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: XSAMF03/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,

| | 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 YEAR, | Stock number at age (start of year) 1985, | Numbers*10**-3 |
|-------------------|--|----------------|
| 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 YEAR, | Stock number at age (start of year) | | | | | Numbers*10**-3 | | | | | | |
|-------------------|-------------------------------------|----------|----------|----------|----------|----------------|----------|----------|----------|----------|----------|-------|
| | 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

| F Factor | Reference F | Catch in numbers | Catch in weight | Stock size | Stock biomass | 1 January | | Spawning time | |
|-------------|----------------|---------------------|--------------------|---------------|------------------|------------------|---------------------|------------------|---------------------|
| | | | | | | 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 | | Spawning time | |
|------|----------|-------------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | | | | | | | Sp.stock size | Sp.stock biomass | Sp.stock size | 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 | | Spawning time | |
|------|----------|-------------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | | | | | | | Sp.stock size | Sp.stock biomass | Sp.stock size | 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 | | Spawning time | |
|------|----------|-------------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| | | | | | | | Sp.stock size | Sp.stock biomass | Sp.stock size | 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} | | | | | | | 1 January | | Spawning time | |
|-----------|----------|-------------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| Year | F Factor | Reference F | Catch in numbers | Catch in weight | Stock size | Stock biomass | Sp.stock size | Sp.stock biomass | Sp.stock size | Sp.stock biomass |
| 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} | | | | | | | 1 January | | Spawning time | |
|-----------|----------|-------------|------------------|-----------------|------------|---------------|---------------|------------------|---------------|------------------|
| Year | F Factor | Reference F | Catch in numbers | Catch in weight | Stock size | Stock biomass | Sp.stock size | Sp.stock biomass | Sp.stock size | Sp.stock biomass |
| 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

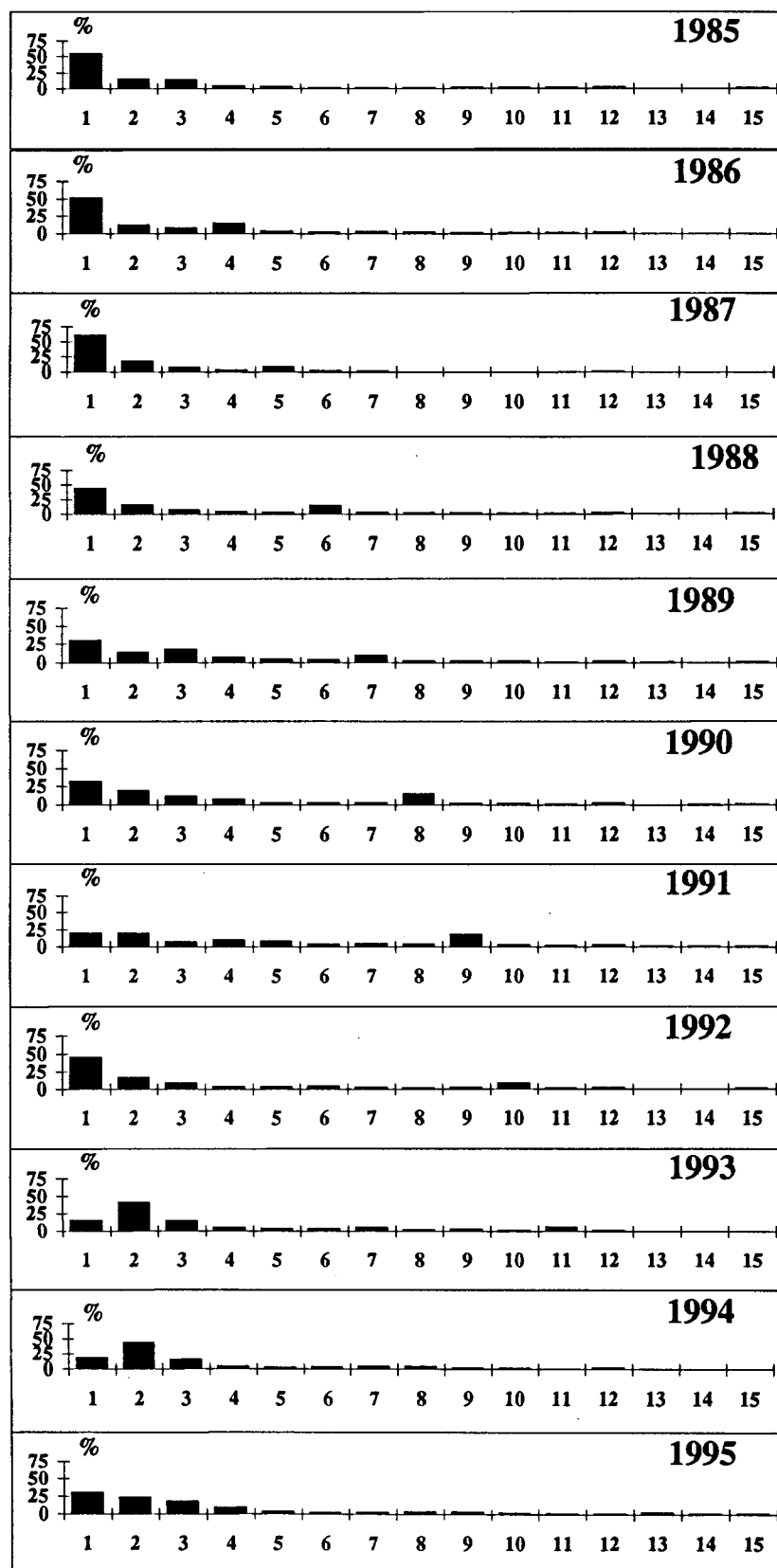


Figure 7.1

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

Southern horse mackerel

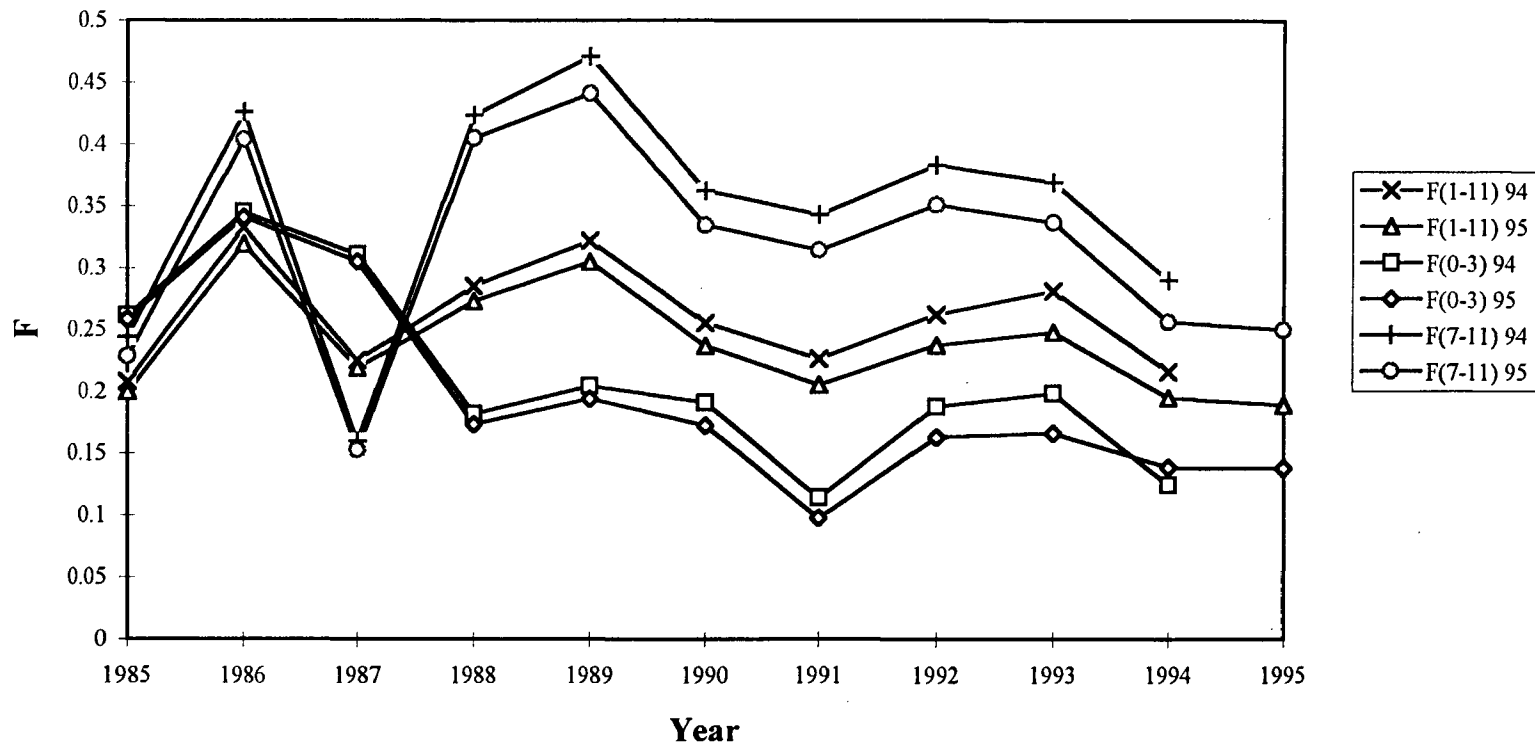
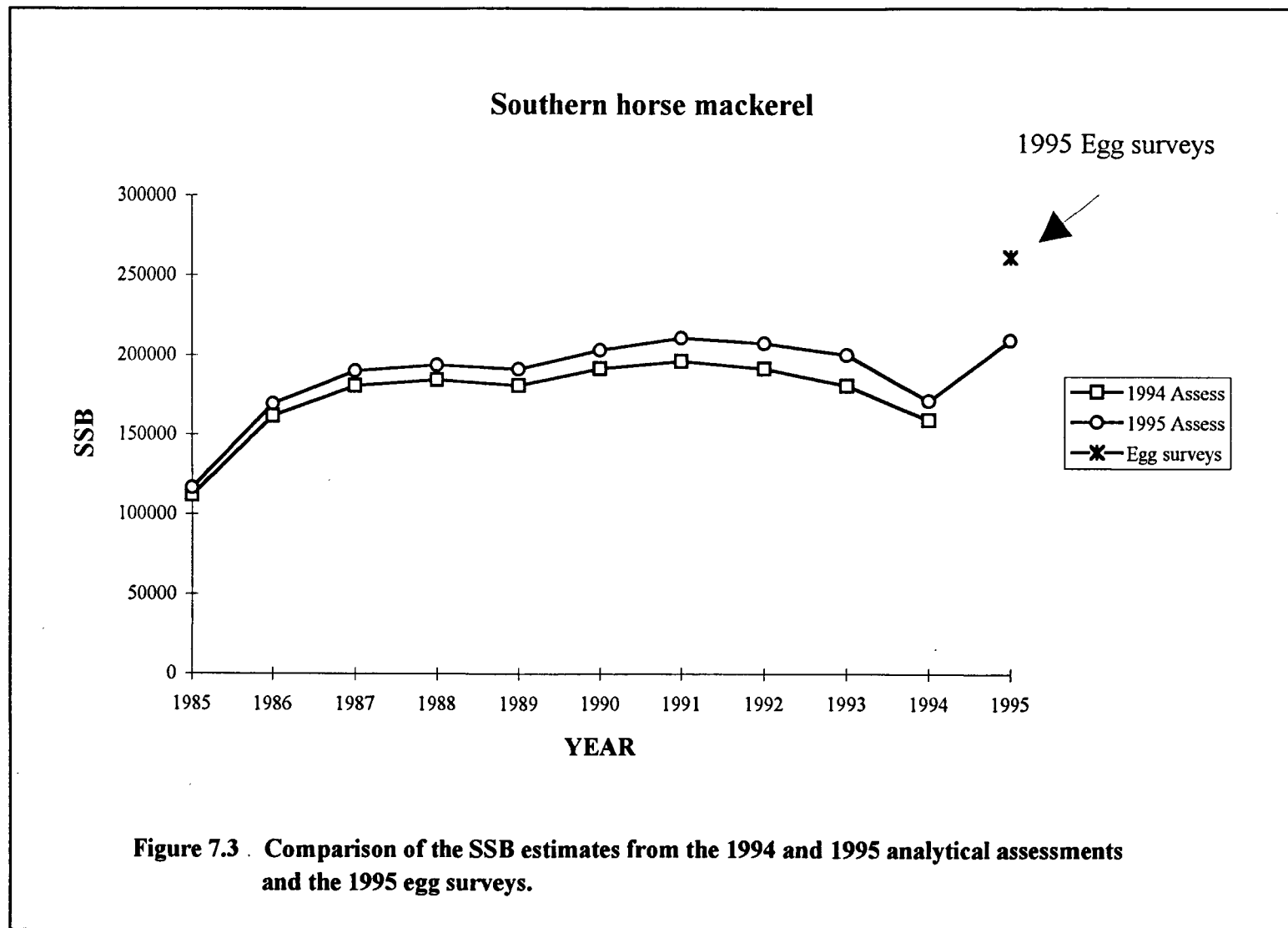


Figure 7.2 Comparison of the 1994 and 1995 assessments for different F's bar



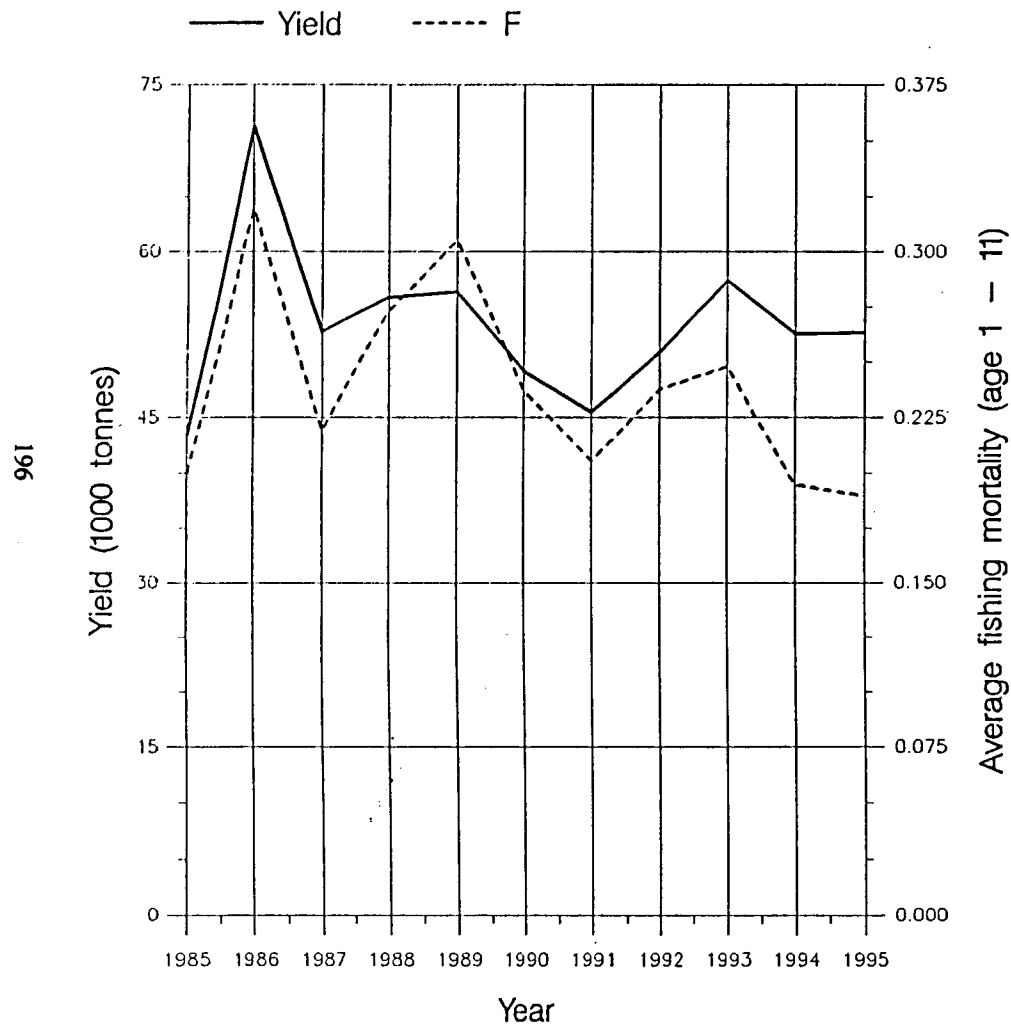
Fish Stock Summary

Figure 7.4

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

17-8-1996

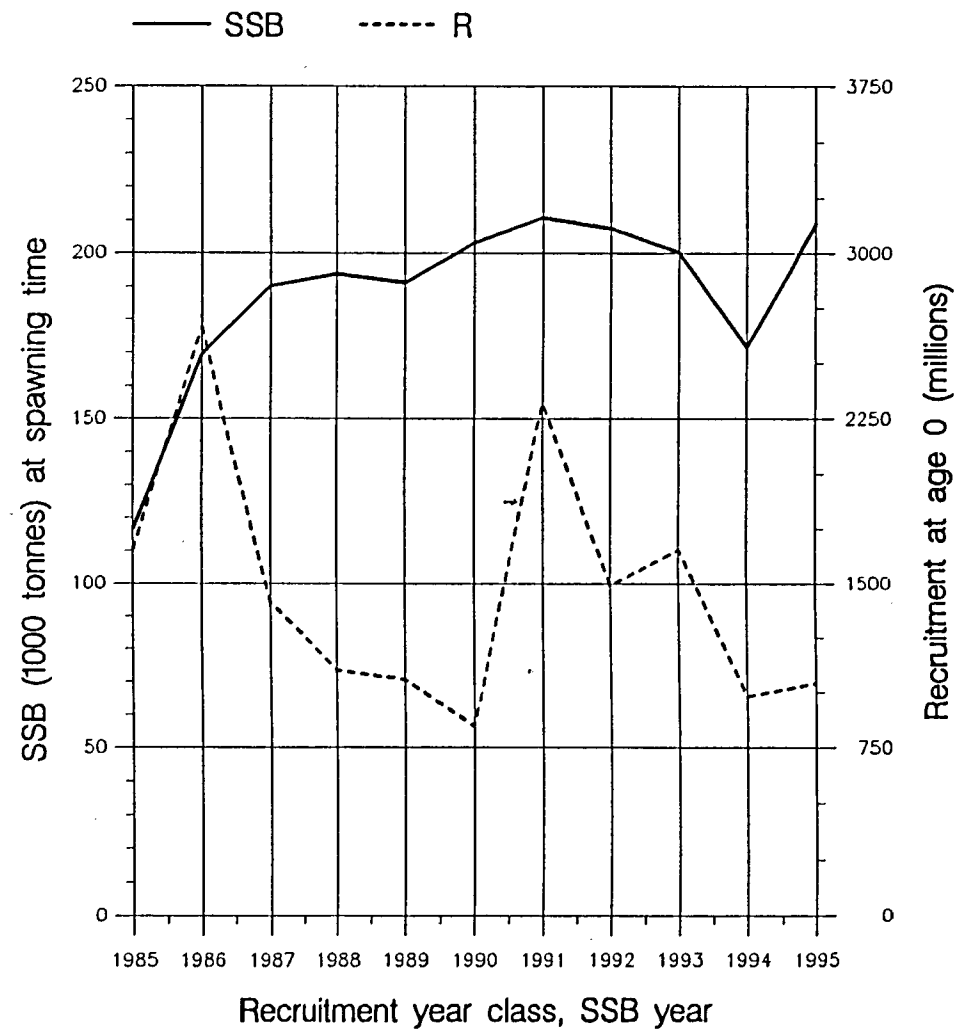
Yield and fishing mortality



(run: XSAMFB03)

A

Spawning stock and recruitment



(run: XSAMFB03)

B

Fish Stock Summary

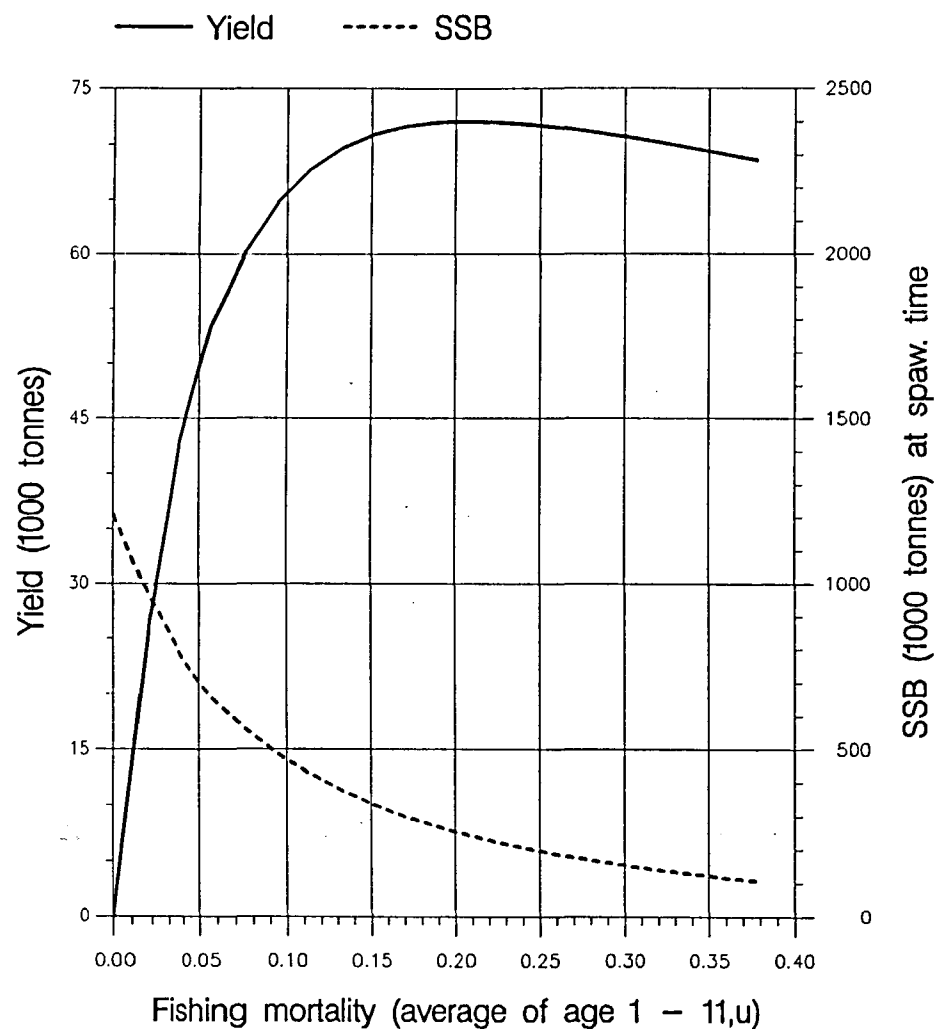
Figure 7.4c-d

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

19 - 8 - 1996

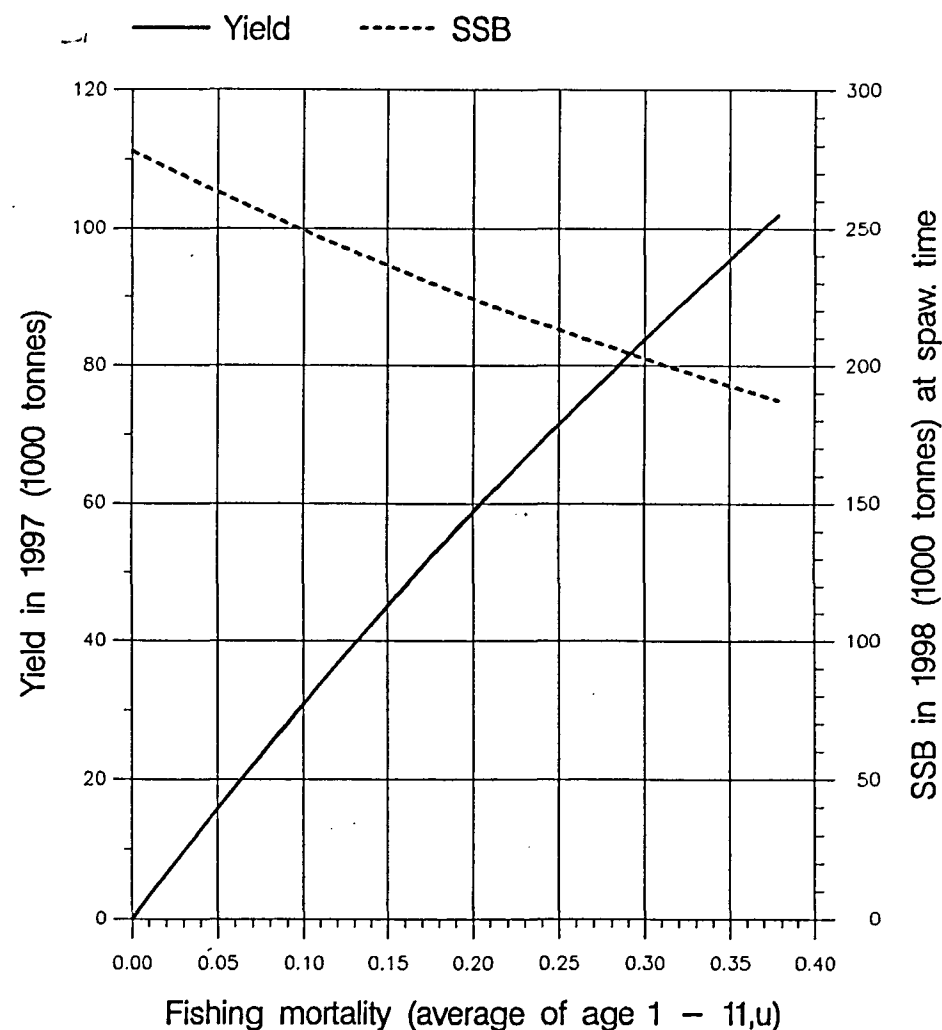
Long term yield and spawning stock biomass

Short term yield and spawning stock biomass



(run: YIELDREC)

C



(run: FB2)

D

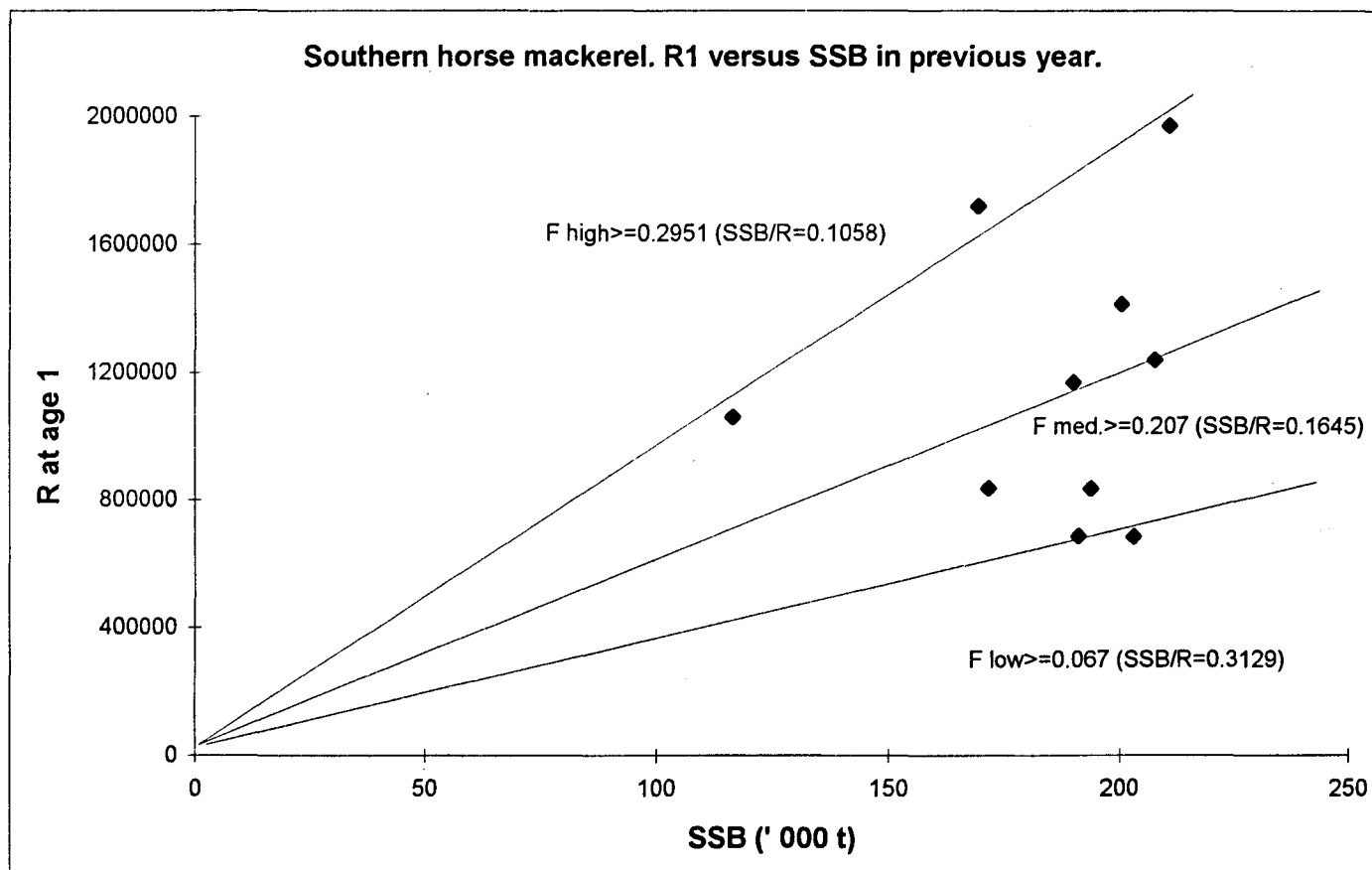


Figure 7.5 Recruits (age 1) versus Spawning Stock Biomass in previous year.