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International Council for the
Exploration of the Sea

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PART 1

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

ICES Headquarters, 21 June - 1 July 1994

This document is a report of a Working Group of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

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1 INTRODUCTION

1.1 Terms of Reference

At the 81st ICES Statutory Meeting in Dublin, Ireland in 1993, it was decided (C. Res. 1993/2:6:10) that the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (Chairman: Mr A. Eltink, Netherlands) should meet at ICES Headquarters from 21 June - 1 July 1994 to:

a) assess the status of and, if necessary, provide catch options for 1995 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 1995 for the sardine stock in Divisions VIIIc and IXa, and the anchovy stock 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 1993 by sub-division of the North Sea for those species in the multispecies model that are assessed by this Working Group).

In addition, NEAFC has requested ICES to assess the impact of *Ichthyophonus hoferi* disease on stocks of herring and other pelagic fish:

d) supply information on the effect of *Ichthyophonus* on all pelagic species.

The European Community must establish their mid-term management objectives by fishery or group of fisheries and the strategies by which they should be achieved. Regarding the difficulties of giving advice on this subject ICES should give priority in 1994 to the following 4 fisheries: roundfish, flatfish, herring and hake fisheries. At its consultations in September 1993, ACFM decided not to ask the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group to address this question in 1994. However, the mid-term management objectives have been regarded to be important and have therefore preliminary been discussed in preparation of next years Working Group meeting.

In this context ICES is requested (letter of J. Almeida Serra 20 September 1993):

e) 1) For each main fishery or group of fisheries, analyse where appropriate mid-term management objectives which could be considered more pertinent from a biological point of view. These objectives should be expressed in terms of target SSB and exploitation rates. Whenever a fishery affects stocks which are safely over a MBAL, a range of options should be given rather than a single objective.

2) For each fishery or group of fisheries, analyse the possible strategies required to achieve these objectives progressively, indicating the consequences, advantages and disadvantages.

3) For each fishery or group of fisheries, indicate whether it is more appropriate to manage directly the fishing effort instead of or as a complement of a management by TAC.

4) As the case may be, indicate when it is possible to fix TACs more than one year in advance and when the TAC can be defined on a multispecies basis. ICES is also requested to indicate when, due to technical interactions in mixed fisheries, TACs for the individual species which are taken together should be made compatible for a given management decision.

1.2 Participants

The Working Group met in Copenhagen with the following participants:

Pablo Abaunza	Spain
Sergei Belikov	Russia
Fatima Borges	Portugal
Chris Darby	UK (England)
Guus Eltink (**Chairman**)	Netherlands
Svein Iversen	Norway
Maria Manuel Martins	Portugal
John Molloy	Ireland
John Nichols	UK (England)
Ken Patterson	UK (Scotland)
Graça Pestana	Portugal
Carmela Porteiro	Spain
Patrick Prouzet	France
Karl-Johan Stæhr	Denmark
Andrés Uriarte	Spain
Begoña Villamor	Spain

Dr R.S. Bailey, ICES Fishery Secretary, and Mr H. Sparholt, ICES Fisheries Assessment Scientist, also participated in parts of the meeting.

2 QUALITY AND ADEQUACY OF FISHERY AND SAMPLING DATA

2.1 Sampling Data from Commercial Fishery

The Working Group again carried out a review of the sampling data presented by members on the commercial fisheries. A short summary of the data similar to that presented to the 1993 Working Group is shown for each species. As stated in previous reports there is a great variation in the sampling intensity carried out by individual countries. Intensive sampling is carried out by Spain and Portugal in many areas where landings, in comparison with those in other areas, are quite small. On the other hand many countries with substantial fisheries carry out no sampling programmes at all.

Mackerel

Total Catch	Total Catch Sampled	Samples	Measured	Aged
825,000	688,400	890	180,411	12,922

The following table shows the most important mackerel catching countries and some summarized details of their sampling programmes.

Country	Catch	Catch Sampled	Samples	Measured	Aged
Norway	224,000	224,000	161	116,629	2,036
UK (Scotland)	212,000	212,000	96	9,625	3,380
Ireland	95,000	95,000	32	6,417	2,031
Netherlands	70,000	66,500	99	7,806	2,420
Russia	49,600	49,600	8	5,600	625
Denmark	42,500	36,000	4	319	318
UK England	42,400	18,500	54	7,463	338
Germany	29,000	-	-	-	-
Spain	21,000	20,700	249	14,476	1,089
Faroes	15,000	-	-	-	-
France	10,000	-	-	-	-
Sweden	6,000	-	-	-	-
Latvia	4,700	-	-	-	-
Portugal	2,000	2,000	187	12,076	685
Others	1,700	-	-	-	-

Over 68,000 t of the total catch of 825,000 t is not sampled at all. In addition at least 50,000 t of mackerel caught by pelagic trawlers by Ireland are landed in Norway and are subjected to a very low sampling intensity. This low sampling may also apply to landings made into the Netherlands and Germany by fleets fishing to the west of Ireland.

Horse Mackerel

Total Catch	Total Catch Sampled	Samples	Measured	Aged
504,190	37,900	1,778	158,954	7,476

Detailed sampling of the horse mackerel catch still remains at a very low level except in the case of Portugal and the Netherlands. Age analysis is only carried out by four countries, who together take about 75% of the total catch. Although this figure may appear high and would indicate reasonable sampling intensity it includes Norway who, while taking 129,000 t, only aged 121 fish. Denmark, Germany and Ireland, all of whom have substantial catches, have little or no sampling programmes.

The following table shows the most important horse mackerel countries and summarized details of their sampling programmes:

Country	Catch	Catch sampled	Samples	Measured	Aged
Netherlands	188,700	179,000	124	14,831	3,063
Norway	128,900	127,000	12	1,285	121
Ireland	65,000	-	-	-	-
Spain	34,200	34,200	495	34,644	1,486
Germany	27,000	-	-	-	-
Portugal	26,000	25,700	1,139	107,144	3,692
Denmark	25,000	16,200	?	186	-
UK (Scotland)	8,700	-	-	-	-
UK (England)	6,500	2,000	8	864	-
France	5,300	-	-	-	-
Others	11,300	-	-	-	-

Sardines

Total Catch	Total Catch Sampled	Samples	Measured	Aged
149,600	143,200	813	68,225	4,821

The sampling programme carried out on sardines in 1993 was very similar to that in 1992. Detailed sampling is mainly carried out by Portugal and Spain who together take over 92% of the total catch. No sampling is carried out by France who take over 5,000 t in Sub-area VIII.

Summarized details of individual sampling programmes are shown below:

Country	Catch	Catch Sampled	Samples	Measured	Aged
Portugal	90,400	90,400	432	32,296	3,167
Spain	48,300	48,300	376	35,687	1,654
France	5,800	-	-	-	-
UK (England)	4,900	4,500	5	242	-

Anchovy

Total Catch	Total Catch Sampled	Samples	Measured	Aged
39,700	39,700	323	21,113	6,563

Sampling on anchovy is carried out by both France and Spain who together take all the total catch. Although overall sampling appears to be satisfactory there is only limited catches carried out in Divisions V11a and b in the third and fourth quarter. The sampling data from both countries are presented below:

Country	Catch	Catch Sampled	Samples	Measured	Aged
France	20,900	20,900	74	4,698	2,048
Spain	19,173	19,173	249	16,415	4,515

2.2 Catch data and Fleet data

Catch data

The quality of the catch data used as a basis for the mackerel assessments has been discussed by the 1993 Working Group (Anon. 1993d). Doubts have been expressed about the accuracy of the total catch figures reported by some of the major mackerel catching countries and the Working Group believe that the overall catch of Western mackerel may be seriously underestimated. In some of the larger fleets, although the number of vessels may have remained constant or even decreased in recent years, considerable increases have taken place in horse power, size of nets and catching efficiency. At the same time the national quotas and individual boat quotas have only increased slightly and there has been a decrease in the value of the catch due to depressed markets. In these circumstances underreporting of catches is a distinct possibility in order that vessels may remain commercially viable.

The quality of the catch data used in the horse mackerel assessments is believed to be better than that used in the mackerel assessment. This may be because at present there are no national quota and the size of the national catches is only restricted by market outlets. There is, however, the possibility of overestimating catches for a number of reasons. These include the need for countries to show large historical catches in the event of national quotas coming into operation, the possibility of mackerel being reported as horse mackerel and the necessity for some countries to record a large catch because the amounts permitted to be withdrawn under the EU compensatory scheme is based on a percentage of the total catch recorded. This last factor is the reason for the negative unallocated catches that occur in the 1993 catch tables.

The quality of the catch data used in the sardine and anchovy assessments appears to be satisfactory and no serious problems are thought to exist.

Fleet data

The 1993 Working Group felt that insufficient information is available about changes that may be taking place within individual fleets. It is possible that although actual numbers of vessels may remain constant, as already explained, technical improvements may effect significant changes in catching efficiency. The introduction of large nets with new material and more powerful detecting equipment may bring about changes in the exploitation pattern which may not become apparent for a number of years. For example it is possible using the more advanced fish sounders to determine the size composition of the shoals before fishing. It is, therefore, possible to target certain types of fish and in this way to alter exploitation patterns. For this reason the Working Group decided to collect information about individual fleets and to attempt to monitor changes as they occur. This aspect is discussed in more detail in Section 15.

2.3 Discards

The situation about information about "discards" has not changed in recent years and at present only one country - Netherlands supplies details. It has not been possible to apply this information to the total catches and so the present estimates of discards must be considered as a minimum. In the mackerel fisheries conducted in Divisions IIa and IVa discarding of small mackerel may be a serious problem because of the limited demand for fish less than 600 g. Discarding of small mackerel in Divisions IVb and IVc may also be serious and it is recommended that countries taking part in these fisheries should collect information as a matter of urgency.

There are no reports of any increase in discarding of horse mackerel in either the North Sea or Western horse mackerel stocks. There are also no reports of discarding in the anchovy fishery. In the sardine fishery unknown quantities of fish below the minimum landing size are discarded.

Projects, partly financed by the EU, were initiated in 1993, in order to collect information on all discards taken in the trawl and purse-seine fisheries throughout Sub-areas IV, VI, VII, VIII and IX. These projects will provide information on discards and the results should be made available for the 1995 meeting of this Group.

2.4 Age readings

The Working Group discussed the age readings of the four species that are assessed:-

Mackerel

The 1993 Working Group stated that there appeared to be reasonable confidence in the age readings for both the North Sea and Western Stocks. However, because of a possible difficulty in ageing older mackerel from the western stock and some obvious difficulties in ageing mackerel in Division IXa it was agreed to organize an otolith exchange scheme.

The results of this exchange scheme, which are discussed in Section 4.1, showed a very disappointing level of agreement between otolith readers particularly among the older fish. It is, therefore, recommended that a workshop on mackerel otoliths reading should be organized as a matter of urgency.

Horse Mackerel

Most of the horse mackerel age readings are carried out by the Netherlands, Portugal and Spain and this data is used to convert much of the catch data to numbers at age. As mentioned in previous working group reports there is a serious difficulty in interpreting the formation of the growth zones on the otoliths which may result in a misreading of one year. Figures were presented in the 1993 Working Group report which show the times of the year at which the opaque growth zone are laid down for the different age groups in different areas. These figures are meant as guide lines for horse mackerel otolith readers. This information has now been updated and extended to include otoliths from Division IXa and is presented in Figures 2.1-2.3.

Anchovy

The Working Group consider that age readings of anchovy otoliths are satisfactory.

Sardine

The 1993 Working Group considered that problems might exist in age readings of sardine otoliths. A workshop in Lisbon was, therefore, arranged and the results are discussed in Section 11.1. Problems were identified in the age interpretations by the less experienced readers particularly for the older fish. Although the results have not yet been completely analysed it appears that it may be necessary to hold an additional workshop.

2.5 Biological Data

Maturity Ogive

There are still major difficulties in selecting an appropriate maturity ogive for the western horse mackerel stock. This affects the accuracy of the assessments and is further discussed in Section 9.5.

3 REVIEW OF EGG PRODUCTION WORKSHOP

3.1 Review of the Mackerel/Horse Mackerel Egg Production Workshop Report

The Mackerel / Horse Mackerel Egg Production Workshop was held at the Instituto Español de Oceanografía in Vigo, Spain from 31 January - 4 February 1994 to:

a) coordinate the timing and planning of the 1995 and 1996 Mackerel / Horse Mackerel Egg Surveys in ICES Sub-areas IV and VI - IX for estimating spawning stock size;

b) evaluate the accuracy and precision of the estimates of spawning stock size from both the annual and daily egg production methods, and advise on the preferred method;

c) undertake a comprehensive review of survey and analytical techniques (consider techniques other than arithmetic averaging for estimating unsampled rectangles and consider how the vertical hauls with a much lower volume filtered have to be treated for the standard error estimation);

d) complete the analysis of the daily egg production method applied to the southern horse mackerel stock based on the 1992 egg and trawl survey data.

A brief summary of the most important items of the report of the Workshop is given below. However, for more details refer to Anon. (1994b).

The resources available for the 1995 egg survey (Table 3.1) are insufficient to allow both the Annual Egg Production Method (AEPM) and the Daily Egg Production Method (DEPM) to run together. ACFM commented that it would be premature to discontinue the AEPM until the DEPM has been shown to be successful in practice. Therefore it was decided to apply AEPM for the western and southern egg surveys in 1995 and for the North Sea mackerel survey in 1996. Only in 7 coverage the southern and western areas will be surveyed from February - July 1995 (Table 3.1). The North Sea area will be surveyed for mackerel eggs with 3 coverage in June and early July 1996. A manual of the AEPM for the 1995 surveys is presented together with a review of plankton sampling in the western area during earlier surveys.

The Workshop recommended that an improved adaptive sampling scheme should be adopted in future surveys, to guard against the possibility of very atypical spawning distributions as during the third coverage in 1992. Possible approaches of such an adaptive sampling strategy have been explored. The conclusions from these analyses using a Generalized Additive Model (GAM) are: a) a stopping rule, based upon shipboard evaluation of egg numbers, should be applied to decide when the distributional edge has been reached for determining when to move to the next transect b) reduction of the number of transects perpendicular to the 200m contour can be achieved when ship time is limited (the surplus shiptime can be used then to survey areas of high egg density more intensively) c) a model-based approach is better able to cope with a flexible survey design than the standard method. It does not require replicate sampling of individual rectangles, provides better estimates of egg numbers in unsampled areas between transects, and gives more precise estimation of total egg abundance.

For the DEPM new statistical methods were investigated for analysis of the egg production data of the 1992 western surveys. Using Generalized Additive Models (GAM) the coefficients of variation in the daily egg production estimates were reduced by an impressive degree. For mackerel, using GAM in place of the stratified approach reduced the CV of the egg abundance estimate from 7% to 4%. The corresponding decrease in the CV on the biomass estimate was from 13% to 9%. The revised variance of the egg production estimate accounts for just 25% of the variance of the biomass estimate instead of almost 60% previously. For horse mackerel use of GAM reduced the CV of the egg abundance estimate from 18% to 9% with a consequent decrease in the CV on the biomass estimate was from 22% to 18%. The revised variance of the egg production estimate accounts for just 33% of the variance of the biomass estimate, compared with almost 70% previously.

However, GAMs were not applied to the AEPM but similar gains in precision may be attained. At present, the bias and variance in the AEPM resulting from linear interpolation and integration of the annual egg production curve are not assessed so the variances for the DEPM are just indicative values. The Workshop recommended that a spatia-temporal GAM for analysing AEPM data should be developed and tested on the 1989 and 1992 data in preparation for analysing the 1995 survey data. It is anticipated that this analyses will require substantial commitment of a full time specialist. Without that commitment the data can not be analysed in that way!

The Workshop felt that the results of the comparisons between the DEPM and the AEPM for mackerel and horse mackerel in the western area should be made more widely available than the official Report on the Contract to the EC. The Workshop therefore recommended that the data should be published as an ICES Cooperative Research Report edited by I.G. Priede and A. Eltink.

Since the egg surveys of both 1995 and 1996 coincide with the usual timing of the assessment Working Group, the Workshop recommended that the assessment Working Group be postponed to a later date in 1995 and 1996.

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy endorses also all other recommendations made by the Mackerel/Horse Mackerel Egg Production Workshop.

4 MACKEREL - GENERAL

4.1 Mackerel Otolith Exchange

During 1994, 397 otoliths were exchanged between ten readers from Denmark, Ireland, the Netherlands, Norway, Portugal, Russia, Spain and UK (England and Scotland). The exchange has not yet been completed. The results of seven readers were presented in Villamor and Meixide (WD, 1994).

200 otoliths came from the western area (ICES Divisions VIa and VIIbc) and 197 came from the southern area (ICES Divisions VIIIc and IXa). The comparison of otolith readings from the two areas has been made separately.

The mean general agreement between readers was low in the two areas, 54% for the western area and 63% for the southern area. Agreement between readers varied between 44% and 76% for the western area and between 48% and 84% for the southern area. The greater agreement was observed in the age readings from the southern area, but this may be due to the fact that in the sample from the western area there was a greater number of old fish than in the sample of the southern area. The readers who show the largest agreement were those who were most experienced in mackerel otoliths readings.

It was found that there was little disagreement in ages below 5 years of age, but the disagreement increased considerably in the age range 5-9 years. At ages greater than 8 years, the differences show an increasing trend. The standard deviation by age groups increase noticeably for age groups over 9 years.

The bias plots of each reader with respect to the modal age presents great variability in the two samples, particularly in the ages of the older fish.

Wilcoxson's test shows that bias exists between most readers in the two samples. The absence of bias is a minimum requirement and in view of the results the Working Group recommend that a Mackerel otolith reading Workshop should be held early in 1995, to standardize age reading.

4.2 Stock Units

There is no new information on mackerel stock differentiation. Portugal and Spain have started tagging experiments in the southern area (SEFOS project) in 1994. This experiment together with the Norwegian tagging experiments in the area south west of Ireland will probably in the near future give valuable information about migration patterns and stock relations. In 1995 extensive egg surveys will be carried out both in the southern and western areas (Anon.,1994b). Until the information from tagging experiments and the egg surveys in 1995 becomes available the Working Group decided to maintain the currently adopted division between Western and Southern mackerel stocks. However, it has to be mentioned that there is no well established biological basis for this. Spanish egg surveys in 1988, 1990 and 1992 (Lago de Lanzos *et.al.*,1993) observed high mackerel egg production off the northern and northwestern Spanish coast. Data from the same period in the western egg survey in 1992 (Anon., 1993f) suggests that it might be difficult to determine a realistic boundary between a western and southern spawning areas.

Based on tagging experiments and egg surveys it is accepted that the North Sea stock is a separate unit independent of the Western stock, even though the distribution of the two stocks overlap.

4.3 Allocation of Catches to Stock

Since 1987 the Working Group has not been able to split catches taken in the North Sea and adjacent areas into their component stocks.

As for the years 1987-1992 the Working Group decided to allocate all mackerel caught in Sub-area IV, Divisions IIIa, IIa and Vb, Sub-areas VI and VII and Divisions VIIIa,b,d,e in 1993 to the western stock. The fishery in the North Sea, Skagerrak and Kattegat also exploits the North Sea stock. Because the North Sea stock is depleted, the catch of this stock forms an insignificant part of the total catch in this area. In 1990 the catch of the North Sea stock was estimated to be about 10 000 t (Anon., 1991d). This was based on estimates of total mortalities of four years old and older fish obtained from egg surveys in 1988 and 1990 (Iversen *et.al.*, 1991) and for the younger age groups from the last VPA carried out for the North Sea mackerel (Anon., 1985). The calculations demonstrated that the catches of North Sea mackerel increased from 6,000 t in 1988 to about 10,000 t in 1990.

Single coverage of the spawning areas in 1991 and 1992 (Anon., 1993f) indicated no significant changes in spawning stock size since 1990. Therefore the catch of North Sea mackerel has been assumed to be of the same level as in 1990 both in 1991 and 1992.

No egg surveys were carried out in the North Sea in 1993. Since this stock has been depleted for a long period the working group assumes a catch of 10,000 t North Sea mackerel in 1993 (see Section 18.1).

A new international egg survey with several coverage of the spawning area in the North Sea will be carried out in 1996 (Anon., 1994b).

4.4 Distribution of Juvenile Mackerel

The migration and distribution of juvenile mackerel was extensively reviewed by the Mackerel Working Group in 1990 (Anon., 1990c). This followed discussions at earlier meetings of the Working Group about the apparent changes in juvenile distribution since about 1981. The review was based on both commercial catch data and research vessel surveys. The review, which has been updated at each subsequent meeting of the Working Group, was principally to monitor the juvenile distribution in relation to the "mackerel box" in the south-west of the UK and to monitor the presence of western stock juveniles in the North Sea. In the latter context the more extensive programme of ICES coordinated quarterly bottom trawl surveys of the North Sea are particularly useful.

Distribution charts of first and second winter mackerel in the fourth quarter of 1993 and the first quarter of 1994 in the North Sea and western area, and of first and second winter mackerel in September - December in the southern area were presented to the Working Group (Walsh, WD. 1994). These distributions show no major changes from previous years and do not warrant further description. However, during the meeting provisional distributions of age 1 and age 2+ group mackerel became available from the IBTS of the North Sea in quarters 2 and 3 for 1992 and 1993. The abundance of age 1 and 2+ groups in the southern and central North Sea during quarters 2 and 3 1992 (Figures 4.1 to 4.4) shows a dramatic increase since the previous year (Figure 4.5 to 4.8), particularly along the Dutch coast. Most of these fish are considered to be of western stock origin and leave the North Sea during the fourth quarter (Figures 4.9 to 4.12). The distribution of juveniles will be kept under review at future Working Group meetings.

4.5 The Fishery in 1993

The mackerel fisheries in the Northeast Atlantic are assumed to exploit three different stock units - the western mackerel, the North Sea mackerel and the southern mackerel. It is difficult to establish biological differences between the three stocks and considerable mixing is believed to take place between the stocks in the various areas. Consequently it has been extremely difficult in recent years to accurately apportion the different catches to the correct stock.

The fisheries that are believed to take place on each stock unit are briefly described in Sections 5.1 and 6.1. The total mackerel catch estimated by the Working Group to have been taken from the three stocks in the various areas is shown in Table 4.1. This table shows the development of the various fisheries since 1969. The total estimated catch in 1993 is over 825,000 t which is the highest recorded since 1979. Prior to 1979 over 800,000 t were taken on a number of occasions. Indeed, prior to 1969 catches of over a million tonnes were taken for a short time in this area before the fishery collapsed.

During 1993 the largest catches were again taken from Sub-areas IV and Division IIIa - mainly from the northern part of Division IVa. The catches taken from this area have increased continuously in recent years. The catches from Sub-area VII (mainly from Divisions VIIj and h) and from Divisions VIII a,b,d and e, - also increased substantially in 1993 while the catches from Sub-area VI decreased slightly. Catches from Division VIIIc and IXa have remained very stable in recent years at about 20,000 t. Some alterations have been made to some recent reported catches from Division IXa. Table 4.1 also includes estimates of discards but these estimates are for one fleet only.

The main countries fishing mackerel in 1993 were Norway, UK (Scotland), Ireland, Netherlands and Russia. National catches are shown in Tables 5.1-5.3. The catches per quarter by Division and sub-area for 1993 are shown in Table 4.2. The catches in 1993 were very similar to those in recent years and reflected the annual migration pattern of the stocks. In the first quarter substantial catches were taken from Divisions IVa, VIa and Sub-area VII while fish were migrating to the spawning areas. Catches during the second quarter were considerably reduced and were mainly from the spawning grounds in Sub-area VII. During the third and fourth quarters the largest catches were taken from the Irish feeding and overwintering areas in Divisions IVa and IIa. The main catches in Division VIIIc followed the same pattern as previous years, and were mainly taken during the first and second quarters from spawning mackerel before these fish migrated out of these areas. Catches in Division IXa were highest during the third and fourth quarters and were based mainly on juveniles.

Management

The TACs agreed by the various management authorities for 1993 for the various fisheries and the preliminary total catches were as follows:-

Stock	**TAC recommended by ACFM**	**Agreed TAC**		**Catch**
North Sea Stock	Lowest possible level	83,150[1]	}730,000	805,300
Western Stock	670,000	646,850[2]		
Southern Stock	No advice given	36,570[3]		19,700

[1]This TAC is assumed to be mainly composed of Western stock mackerel which would be taken from Sub-area IV, Division IIIa and Division IIa. It also includes about 9,500 t of North Sea stock mackerel which would be taken in the North Sea.
[2]Includes EU TAC, Norwegian TAC and Faroes TAC.
[3]Division VIIIc, Sub-areas IX and X and CECAF Division 34.1.1 (EU waters only).

4.6 Distribution of the Mackerel Fisheries

The total international catches of mackerel in 1993, in ICES Sub-areas II, III, IV, V, VI, VII, VIII and IX, by quarter, are given in Table 4.2. The quarterly distributions described below are, therefore, based on information provided by Working Group members.

The distribution of the fishery by Sub-area or Division was rather similar to that in 1992. In 1993, more than the 48% of the total northeastern North Atlantic mackerel catches were taken in Division IVa (46% in 1990, 53% in 1991, and 47% in 1992).

The distribution of the fishery by quarter in 1993 differs slightly from that in 1992 (Anon., 1993d). In 1993, the main catches were taken in the fourth quarter as in 1988-1990 (Anon., 1989b, 1990c, 1991d) and 1992(Anon., 1993d). As in previous years, the smallest catches were in the second quarter.

The Working Group estimated the distribution of the fishery by ICES statistical rectangle, on the basis of quarterly data submitted by Denmark, Ireland, Germany, the Netherlands, Norway, Portugal, Russia, Spain and the United Kingdom (England and Wales, and Scotland, separately). This is shown in Figures 4.13a-d. These data cover about 93% of the catches, with a level of coverage similar to 1992.

First quarter

In the first quarter (237,600 t), the main catches were taken along the edge of the continental shelf to the west, and especially to the north of the British Isles, and off Ireland, during the migration to the spawning grounds. At the end of this quarter catches increased in the Bay of Biscay and Cantabrian Sea, as in previous years. (Figure 4.13a)

Second quarter

In the second quarter (62,200 t) the main reported catches were taken southwest of Ireland and in the Bay of Biscay and Cantabrian Sea along the edge of the continental shelf (Figure 4.13b).

Third quarter

In the third quarter (204,000 t), the major fishery took place in Division IIa and in the eastern part of Division IVa, as in 1992. Catches were reported from as far north as 71°N. In the Bay of Biscay and in the eastern Cantabrian Sea, the catches were negligible, as in previous years (Figure 4.13c).

Fourth quarter

In the fourth quarter (321,000 t), the main fishery was distributed as in previous years, shifting south-westwards from Division IIa and concentrating in the northwest of Division IVa. Smaller quantities were taken in the Channel. In the Bay of Biscay and Divisions VIIIc and IXa, the fishery was at a low level as in previous years. (Figure 4.13d). This figure is misleading because it contains significant catches reported as having been taken in the eastern part of Division VIa North - which were in fact taken from the eastern part of Division IVa.

4.7 Length Compositions by Fleet and Country

The 1993 annual length compositions by fleet were provided by Denmark, Ireland, Netherlands, Norway, Portugal Russia, Spain and United Kingdom (England and Wales, Scotland). Length distributions were available from all of the major fishing fleets in 1993 accounting for about 85% of the total landings.

The length distributions by country and fleet for 1993 are shown in Table 4.3.

5 NORTH SEA AND WESTERN MACKEREL (DIVISIONS IIa; IIIa; IVa-c; Vb; VIa-b; VIIa-k, AND VIIIa,b,d,e)

5.1 The Fishery in 1993

Norwegian Sea (Division IIa) and Division Vb

The catches taken from the Norwegian Sea (Division IIa) and from around the Faroes (Division Vb) are shown in Table 5.1. The total catches estimated to have been taken during 1993 was about 166,000 t which was the highest figure ever recorded for the fishery in this area and over 25,000 t higher than in 1993. Increased catches were recorded by both the Norwegian and Russian fleets who together took over 96% of the total catch. Most of these catches were taken from the summer fishery in Division IIa.

It is interesting to note the very northerly distribution of the catches taken during the second and third quarters which are taken by the Russian fleet. The catches taken from these areas do not include any estimates of "discards" which may be substantial depending on marketing conditions.

North Sea and Division IIIa

The catches taken from the fisheries in the North Sea, Skagerrak and Kattegat (Sub-areas IV and Division IIIa) are shown in Table 5.2. The total catch estimated to have been taken from these areas was 390,000 t which is about 27,000 t higher than that in 1992 and the highest recorded since 1969 (739,000 t). It is, however, again important to point out that the total catch in 1993 contains over 149,000 t of mackerel which were either misreported, discarded or could not be allocated to any particular country. Over 146,000 t is believed to have been taken in the first and fourth quarters of 1993 and was reported as having been taken in Division VIa. This practice arises because certain fleets are only allowed to take a proportion of their total quota from EU waters in Division IVa in the fourth quarter and because no fishing is permitted in this division in the first and second quarter. An estimate of discards of 2,700 t, provided by one fleet only, is believed to be considerably lower than the real figure. The catches recorded by countries in 1993 are very similar to those in recent years. Most countries appear to have slightly increased their catches in line with the increase in the overall TAC. However, the estimated catches for this area cannot be taken as an indication of the real catches taken by each country in the area because of the large amount of misreporting.

Western areas (Sub-areas VI and VII and Divisions VIIIa,b,d and e)

The catches estimated to have been taken from the Western areas (Sub-areas VI and VII and Divisions VIII a,b,d and e) are shown in Table 5.3. The total catch taken in 1993 is estimated to have been about 249,000 t which is slightly higher than that taken in 1992. The table also shows a negative misreported catch of 146,497 t which, as already explained, is the quantity of mackerel taken in Division IVa but reported as having been taken in Division VIa. The national catches taken during 1993 were very similar to those taken during 1992. These catches, however, should not be used to study trends in national fleets.

Most of the catches taken from Sub-areas VI and VII are taken during the first and second quarters as fish migrate to and from the main spawning areas in Divisions VIIb, VIIj and VIIk.

The quantities of discards are based on estimates provided by one fleet only.

The catches taken from Division VIIIa,b and e were estimated to have been about 4,800 t compared with about 6,000 t in 1992.

5.2 Catch in Numbers at Age

The catch in numbers at age by quarter for Divisions IIa, IIIa, IVa, IVb,c, VIa, VIIb,c,j,k, VIIa,e,f,g,h, VIId and VIIIa,b,d,e are shown in Table 5.4. The total catches in numbers for 1992 by age are given in Table 5.11. The percentage catch by numbers at age from 1982 to 1993 are given in Figure 5.1.

Countries providing sampling data were Denmark, Ireland, the Netherlands, Norway, Russia, Scotland and Spain. Catches for which there were no sampling data were converted to numbers at age using data from the most appropriate fleet working in the same or in the neighbouring area. The sampling intensity is discussed in Section 2.1.

5.3 Mean Length at Age and Mean Weight at Age

Mean length and weight at age in the catch in 1993

Mean lengths and mean weights at age in the catches by quarters in 1993 were provided by the countries mentioned in Section 5.2.

Weighted (by numbers) mean length and mean weight at age in the catches were made by Divisions by quarters for the western and North Sea areas and are shown in Table 5.5 and 5.6. The overall weights at age in the catches are given in Table 5.12.

Mean weight at age in the stock in 1993

Mean weights at age of the spawning stock at spawning time were estimated for 1993 by using samples from Dutch commercial freezer trawlers in Division VIIj in March, April and May (Table 5.13). There was no information of one year old mackerel in the Dutch samples. Therefore the same weight, 0.070 kg, as used previously (1981-1992) was also assumed for 1993.

Historical mean weights at age

In 1993 the Working Group (Anon., 1993d) thought the stock biomass in years before 1980 was poorly estimated from the numbers at age generated by the VPA. This was looked into by the Working Group this year and found to represent no problem.

5.4 North Sea Mackerel Stock

5.4.1 Fishery-independent information from egg surveys

The areas in the central part of the North Sea known as the main spawning area was surveyed 1991 and 1992, with a single coverage of the spawning area in June both years (Anon., 1993d). The daily egg production during the 1991 survey was estimated at $0.70*10^{12}$ eggs and during the 1992 survey $0.25*10^{12}$ eggs.

The last time the North Sea was covered several times to estimate the total egg production was in 1990 (Iversen *et al.*1991). The total egg production was then estimated at $53*10^{12}$ eggs. It is difficult to evaluate the state of the SSB based on one coverage of the spawning area. However, since the survey both years (1991 and 1992) were carried out in mid June, which is close to the peak spawning in previous years and only small amounts of eggs were observed the Working Group concluded that the SSB has not increased. 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 since 1990. The spawning stock in 1990 was estimated at 78,000 tonnes (Iversen et al.1991).

No mackerel egg survey has taken place in 1993 and 1994, but are planned for 1996.

5.4.2 Recruitment

Abundance indices from the International Young Fish Survey carried out during the first quarter are given in Table 5.7. The abundance of first winter mackerel in 1994 (year class 1993) was very low.

5.4.3 Assessment

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

5.4.4 Management measures and considerations

The Working Group consider this stock at present to be below a biologically safe limit. 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 at the optimum exploitation level.

The Working Group recommends that the North Sea should be closed to mackerel fishery until the Western stock enters the area in late July/early August. The Working Group thereby supports the recommendations made by ACFM in 1993:

> "There should be no fishing for mackerel in Division IIIa and IVb,c at any time of the year".

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

"the 30 cm minimum landing size at present in force in Division IIIa and sub-area IV should be maintained and the present by catch regulations should be continued".

The closure of Divisions IVb,c and IIIa the whole year will protect the North Sea stock in this area and juvenile Western fish which are numerous particularly in Divisions IVb,c during the second half of the year. This closure has resulted in increased discards of mackerel in the non-directed fisheries in these areas. At present vessels are permitted to take only 10% of their catch as mackerel by-catch.

5.4.5 Response to ACFM

The Working Group believes that there is still a stock of mackerel in the North Sea, separate from the stock which spawns in the western area. The existence of a spawning area in the North Sea, spatially and temporally separated from that of the western stock is considered to be irrefutable evidence of the continuing existence of the North Sea stock.. The last major egg survey in the North Sea was in 1990 (Iversen et al. 1991) when the total seasonal egg production was estimated at $53*10^{12}$ eggs. This gave rise to an estimated SSB of 78,000 tonnes. Single egg surveys were carried out in the North Sea in 1991 and in 1992 during the period of expected peak production (3rd/4th week of June). Production was estimated at $0.70*10^{12}$ eggs in 1991 compared with $0.25*10^{12}$ eggs for a similar period and area in 1992 (Anon., 1993f). The spawning in all three years occurred in the central North Sea in the area traditionally occupied by the North Sea spawning stock. The next egg survey of the North Sea will be in 1996.

Further evidence of the continued existence of the North Sea stock can be seen from the distribution of age 1 group mackerel taken on the International Bottom Trawl Surveys in the first quarter of the year in 1989 (Anon, 1989a), 1990 (Anon, 1990a), 1991 (Anon, 1991a), 1992 (Anon, 1992a) and 1993 (Anon, 1993a). They are found in the traditional nursery areas of the North Sea stock - in the Norwegian deep water and in the central North Sea. The distribution of 1 group and 2+ group mackerel from the same surveys in the second quarter of 1992 and 1993 (Figure 4.1, 4.2. and 4.5, 4.6.) also supports the continued existence of the North Sea stock because western fish are not there at that time. They have left the area for their spawning grounds and for the first half of the year the whole North Sea (Sub-area IV) is closed to a directed mackerel fishery. Divisions IVb and IVc are closed to directed mackerel fishing for the whole year. These measures avoid a directed fishery on North Sea mackerel and the Working Group therefore considers it to be an important protection measure for this stock. Indeed it is the only practicable measure available at present, even though, after many years of the closed season protection, there has been no apparent improvement in the SSB of the North Sea stock. Furthermore, the measure also affords protection to juvenile and adult fish of the western stock which enter Divisions IVb and IVc during the third quarter of the year (Figure 4.3 and 4.4) and leave during the fourth quarter (Figure 4.9 and 4.10). Their presence does, however, result in an unavoidably high by-catch of mackerel in Divisions IVb and IVc which will have a North Sea stock component. The 10% by-catch regulation means that many of these mackerel have to be discarded. The Working Group recommends that attempts are made to obtain estimates of the by-catch and discards of mackerel in Divisions IVb and Ivc. With the present migration pattern of the western stock, which moves into the northern North Sea (Division IVa) and into Division IIa after spawning, it is inevitable that some of the North Sea stock will be taken in the fishery which occurs in Division IVa up to 31 December and in illegal catches from that area during the first quarter of the year (see Figure 4.13 a). There are no means of obtaining a true estimate of the size of the North Sea component of this catch. The Working Group assumes a nominal 10,000 tonnes based on the last known SSB of 78,000 tonnes in 1990 in the North Sea stock (see also Section 4.3).

The 10,000 tonnes of mackerel nominally recorded as North Sea mackerel is not removed from the catches on which the Western stock is based. The reason for this apparent anomaly is that there is no means of obtaining the specific age composition of that component (see also section 4.3). Furthermore the Working Group does not consider 10,000 tonnes to be a significant amount in the context of the total catch from the Western stock.

For biological and assessment purposes, the Working Group at present considers mackerel and horse mackerel within the ICES area to be divided into three unit stocks: the North Sea stock, the Western stock and the Southern stock. (see sections 4.2 and 7.1). Differences between the geographical units currently used by management bodies and those used for ACFM advice are fully discussed and explained in Anon. (1992b). Figure 14.1 (mackerel) and 14.2 (horse mackerel) in that report show the management units used by ACFM, whilst the TAC units are listed in Table 14.1 (Anon., 1992b).

5.5 Western Mackerel Stock

5.5.1 Fishery Independent Information from Egg Surveys

ACFM noted some inconsistencies in Table 3.4 of the Mackerel Working Group Report (Anon., 1993a) and between that table and Table 5.2.6a of the Mackerel and Horse Mackerel Egg Production Report (Anon., 1993b). The differences, which concerned the 1986 and 1989 estimates of mackerel egg production and SSB, have now been resolved. In 1986 errors were generated during the transfer of the data base from an HP system to a VAX prior to transfer to Aberdeen. Four rows of stations on one survey were allocated to the wrong latitude. The corrected figures for 1986 are given in Table 5.8. In 1989 the discrepancies resulted from the inclusion in the earlier estimate of additional data to the east and south of the standard survey area. The correct figures in Table 5.8 (from Table 3.4 in Anon., 1993a) are derived from the standard sampling area for that year plus stations between 56°N and 60°N.

Production estimates using arithmetic fill in are not yet available for the 1977 and 1980 surveys. Some data for these years are missing on the new data base. The problem is currently being addressed and new estimates will be made available as soon as possible.

5.5.2 Recruitment

Recruitment indices for the western stock are calculated from the mean catch rates in the bottom trawl surveys carried out during the fourth quarter and the first quarter of the following year using the method of Dawson *et al.* (1988). The indices are given in Table 5.9. Data south of 45°30N are not included in these indices. Catch rates of first winter mackerel, 1993 year class , were extremely high. This year class was also observed to be very abundant in a Norwegian survey carried out during May 1994 north of Ireland and west of Shetland. The 1993 year class also appears to be very abundant in by-catches taken during the 1994 herring fishery north-west of Ireland from where fishermen have reported large shoals of mackerel. Catch rates of second winter mackerel (1993 year class) were also relatively high with an abundance rank close to that observed for the same year class as first winter fish.

The indices show a consistent and progressive increase since 1981. The 1993 datum for the 1-winter index is four times higher than that associated with the exceptionally strong 1984 year class. Furthermore, Figure 5.4 shows that the increasing trend in both index recruitment series is in conflict with the rather flat tendency that has been estimated by VPA methods in recent years. The index may not be spatially consistent. Coverage has varied from 36 to 147 rectangles being sampled, and yet no account of changes in survey coverage is made in the calculation of the recruitment index. Furthermore, the extension of the survey coverage into areas west of Ireland after 1994 has not been considered in the calculation of the index of abundance. The Working Group considered that the survey index in its present form is not usable as an index of recruitment, and recommends that it be recalculated in a way that removes the effect of changing spatial coverage before the next meeting of ACFM.

5.5.3 Uncertainty in the stock forecast input parameters for the 1993 W.G. projections

After analysing the sensitivity of stock forecasts to input parameters derived from a "tuned" Separable VPA, Anon. (1991d) concluded that forecasts could be made for two years after a Western mackerel stock assessment, without encountering 'serious problems'. Based on this advice the Working Group anticipated that an assessment would not be required this year.

However, an integrated catch analysis (ICA) of the Western mackerel stock, presented at the 1994 Working Group (Patterson 1994c WD), has shown opposing trends in the recruitment index values and the converged VPA estimates for both the 0- and 1- groups (Section 5.5.2). It was therefore agreed that the estimates of recruitment used for the 1993 stock forecasts should be rejected, and no further estimates of recruitment should be derived from the index until further analysis has resolved the discrepancies.

The ICA analysis also showed that it was possible to explain the high selection at age values at the older assessment ages, which were apparent in the previous years assessment, but which had been down- weighted. An improved fit of a separable VPA was achieved by the application of two selection patterns for the years 1972 - 1988 and 1989 - 1993. A summary of the model fitting procedure and results, is given in Appendix 2. Information collected from the fisheries in Divisions IIa and IVa suggests that this may be due to targeting, higher prices are paid for large fish, together with discarding of smaller fish.

The Working Group decided that a series of cross validation assessments and forecasts should be carried out, in order to examine the sensitivity of the predicted catches and SSB for 1994 and 1995 to the changes in selection and recruitment. The results indicate that the reference F used for 1993 in last year's prediction (0.271) was an underestimate and the 1993 value is now estimated as 0.30. In addition, if the agreed TAC's are taken in 1994 (850,000t, including discards and the Russian catches, and catches continue at the same level in 1995, the reference F will increase from 0.30 in 1993, to 0.35 in 1994 and 0.41 in 1995. The underlying cause of the differences between the 1993 and 1994 projections from the two assessments is the revision of the abundance estimates for the 1991 (x0.5) and 1992 year classes.

If the agreed TAC for 1994 and the anticipated catch for 1995 are taken, the increases in F will continue the recent upward trend in the rate of exploitation on this stock. The spawning stock biomass will reach a historic low in 1995. The Working Group decided that the new information should be brought to the attention of ACFM by the inclusion of a complete assessment and a description of the changes in estimated values.

5.5.4 Fishery independent information

At the last meeting of the Working Group, Darby (1993a WD) presented an XSA assessment of the Western mackerel stock, tuned to a data set from a groundfish survey carried out in the spawning area during March. The XSA results were used to validate the separable VPA estimates. This year the tuning files were updated and the comparison repeated. The survey catches at age for age groups 0 - 10 are given in Table 5.10.

5.5.5 Maturity at age

The maturity ogive assumes that 60% of 2 year old fish 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 or 1991 year classes should be similarly adjusted.

5.5.6 Fishing mortality and tuning of the VPA

Tables 5.11 to 5.13 show the catches in number, mean weights at age in the catch and mean weights at age in the stock.

During the Working Group meeting three procedures were available for an assessment of this stock, the traditional 'hand tuned' separable VPA, ICA using two selection patterns, and XSA. The three assessment methods showed close agreement in the estimated parameters and the Working Group decided that it would be appropriate to present the standard separable VPA assessment, in order to provide a methodology consistent with previous years. The results of the XSA and ICA assessments are presented in Appendix 2.

Assessments for this stock have traditionally been carried out by running a series of Separable VPAs over a range of reference age terminal fishing mortalities and using each run to calculate a VPA with input F values based on the terminal populations. The fishing mortality chosen for the final VPA was that which minimised the sum of squared residuals between the VPA estimates of SSB and those of the egg production surveys. The method is not consistent in its treatment of the catch at age data.

An assumption of the Lowestoft Separable VPA program used to perform the runs is that the exploitation pattern remains constant. Long term changes to the pattern are handled by down-weighting earlier years. Darby (1993b WD) showed that the exploitation pattern derived from the most recent years is then extended back to the years which were down weighted in the analysis. This could lead to incorrect population parameter estimates in those years.

Anon (1993d) described problems in fitting the selection at age pattern to the 1992 data. High selection values were observed for the 9 year old fish. For the final assessment, a selection value of 1.0 was used and the 1992 catches at age down weighted. Patterson (1994b WD) fitted a series of separable assessments over three year periods from 1984 to 1992, demonstrating that there has been a change in the exploitation pattern after 1988. He showed that an improved fit to the data set could be achieved by the use of two selection vectors and terminal selection values (Patterson 1994c WD): a terminal selection value of 1.0 prior to 1989 and 1.2 subsequently. At the Working Group the ICA assessment was repeated with the new 1993 data set with a modification to the fit of the model to the research vessel survey data. The results are presented in Appendix 2.

Using the information on selection at age derived from the ICA methodology, the terminal selection value for the standard 'tuned' separable VPA procedure was set at 1.2. A time series weighting giving most weight to the 5 most recent log catch ratios was applied to the analysis in order to be consistent with the ICA analysis.

In response to ACFM concerns about the time period over which the tuning is performed, total sum of squared residuals between the egg production surveys and the Separable VPA SSB estimates were calculated for two time periods. The complete time series of egg production surveys, and the period given the highest weight in the separable analysis, 1989 to 1993. Two egg production surveys were carried out during the later time period(1989 and 1992, Table 5.8). The sum of squares response curves are plotted in Figure 5.2, and show that the minima are in the same place. This is consistent with the observations recorded at the last meeting, where it was shown that the tuning is only sensitive to the sum of squared residuals contributed by the last two surveys. For both time periods the total sum of squares was minimised at a reference age terminal F of 0.293. Tables 5.14 and 5.15 present the diagnostic output and summary tables from the tuned separable VPA.

5.5.7 Recruitment

The recruitment indices for the Western stock have been examined in an ICA analysis which incorporates all available tuning data (Patterson 1994c WD). The results have established that the index values have an increasing trend with time, whereas the converged VPA estimates of recruitment have recently been declining (Section 5.5.2). The Working Group decided to not to use the index series for predicting recruitment to the stock until the discrepancy has been resolved.

5.5.8 Long-term trends

Figures 5.3 and 5.4 show that whilst the yield remained relatively stable between 1980 and 1990, the spawning stock biomass increased. This resulted from a sustained level of good recruitment. Since 1990 the yield and reference F have increased rapidly, they are now well above the long term mean. The SSB has continued a slow increase.

5.5.9 Biological reference points

Figures 5.5 and 5.6 show the results of the yield per recruit calculations. Fmax was estimated to be at a reference F of 0.661 and F0.1 at 0.182. Figure 5.7 illustrates the scatter plot of recruitment at age 0 against spawning stock biomass, together with the estimates of Fhigh (reference F 0.450) Fmed (0.157) and Flow (0.016). The reference F for 1993 is estimated as 0.30 between Fmed and Fhigh.

5.5.10 Catch forecast

In last years assessment, the recruitment in 1991 (6102 million), was derived from an RCT3 estimate. The new VPA estimate (3110 million) is closer to the geometric mean, (taken over the period of the assessment, 3517 million). It was therefore agreed that this value would not be replaced in the assessment. The VPA-estimated recruitment for 1992 (3067 million) is also close to the geometric mean and was left unchanged. The recruitment for 1993 is estimated by the VPA to be 9536 million fish. This was replaced by the geometric mean and brought forward to give the 1994 1 group abundance. It is accepted that the use of the geometric mean presents a cautious view of the 1993 recruitment.

The input variables for the stock forecasts are listed in Table 5.16. Apart from the recruitment and 1 group abundances, the VPA estimated abundances of all other ages, for 1994, were used as the starting populations in the prediction. The exploitation pattern used in the prediction was the smooth separable VPA F's scaled to give the equivalent reference F to that of the final VPA estimates for 1993. Weight at age in the stock and weight at age in the catch were taken to be an average of the values for the period 1984 - 1993. This down-weights recent values, recorded during a period of increasing exploitation, by including values recorded when the fishery was relatively stable.

A series of reference F values were defined by the Working Group as options for the stock projections.

		Reference F
Fsq	*Status quo* F (reference F in 1993)	0.300
F91-93	An average of reference F values for the period 1991-1993	0.248
F94	The fishing mortality predicted if the agreed TAC catch and estimated discards are taken in 1994 (850,000 t)	0.354
F95	The fishing mortality predicted for 1995 if the anticipated 1995 catch (= the 1994 TAC and estimated discards) is taken	0.410
Fman	The average reference F for the period 1981 to 1980, a period in the history of the fishery when yield, F and SSB remained relatively stable (a preferred long-term management option)	0.190

Tables 5.17 and 5.18 give the detailed management option tables for a 1994 status quo catch and a 1994 TAC (with discards) catch. Table 5.19 presents a summary of the prediction results. It shows that if the agreed TAC is taken (with discards) in 1994 and an equivalent yield removed in 1995, reference F will increase from the 1993 estimate of 0.30 to 0.35 in 1994 (18% above F 1993) and 0.41 in 1995 (37% above F 1993). SSB will decrease to 2.0 million tonnes in 1994, 1.8 million tonnes in 1995 and 1.6 million tonnes in 1996. Following a period of recovery (1981 - 1990) the catches will reduce the SSB to a historic low in 1995.

5.5.11 Comments on the assessment

In addition to the usual method of tuning the separable VPA assessment to the egg production estimates, two other assessment methodologies were available. Appendix 2 presents the results of the XSA assessment of the Western mackerel stock, tuned to research survey data, and the Integrated Catch Analysis (Anon.,1994a) which minimises the residuals between estimated and observed separable VPA catches, the egg surveys, and the research vessel data for ages 1-4, from each of the survey areas. The alternative approaches to the assessment of the stock allow a cross-validation of the separable VPA estimates for population abundance and fishing mortality at age.

Figure 5.8 compares the fishing mortality at age values estimated by the XSA with those from the VPA of the exact catch at age data, initialised by the separable VPA terminal populations. The XSA estimates are consistent with those of the separable VPA. The F at age vector derived from the XSA illustrates that for the oldest ages selection is higher than that of reference age 5. This is confirmation of the new choice for the terminal selection in the last year of the assessment.

Figure 5.9 compares the smooth fishing mortalities at age generated by the 'tuned' separable VPA and those from the ICA assessment. There is good correspondence between the values at all ages. The separable F values used in the 1993 forecast are also plotted on the figure. The higher terminal selection value has resulted in increased F values for ages above 6.

Figure 5.10 shows the population abundance at age predicted by XSA, ICA and the 1994 separable VPA. The population abundances used for the 1993 prediction (0 group GM 1972 - 1990, 1 and 2 group from RCT3 predictions) are also given. For the older ages there is good agreement between the values. ICA, which utilises the information provided by ages 1-5 from the research vessel survey, estimates population abundances that are in agreement with the XSA values at ages 5.

A retrospective plot of reference F for the 1993 and 1994 assessments (Figure 5.11), reveals that the new selection at age pattern has reduced reference F over the period 1989 to 1992.

The agreement between estimates derived from the three methods has established the assessment estimates for fishing mortality and population abundance appear to be fairly robust and some confidence can be placed in the results. As described in Appendix A2.2, the application of two selection at age vectors to the catch data set has led to removal of the pattern in the residuals and an improved fit of the separable VPA to the data set. In doing so it has provided an explanation for the problems encountered in the previous years assessment.

The differences in the stock projections for 1994 and 1995 between assessments are produced primarily by the over-estimation of recruitment through the application of a survey index that has not been corrected for an increase in coverage. Anon (1991d) performed a sensitivity analysis for status quo forecasts made using data emitted from this stock. The results revealed that the forecasts were sensitive to the estimates of the strength of the year class that recruited two years before the year of the assessment. The forecast made in 1993 was therefore sensitive to the accuracy of the estimate for the 1991 year class. In the 1993 assessment the 1991 VPA estimated recruitment (3110 million) was replaced by an RCT3 prediction which was twice as abundant (6102 million, the third largest in the history of the fishery), the current estimate is 3110 million. The results agree with the 1991 analysis (Anon., 1991d) and reveal the dependency of the 1994 and 1995 forecasts on the recruitment index. In Figure 5.10 it can be seen that the separable VPA estimate of the 1992 year class abundance is lower than the ICA and XSA estimates. These methodologies utilise additional information from the Western Approaches ground fish survey, and indicate that the year class strength may be above average. The forecasts for catch and population abundance made from the new assessment will be sensitive to this estimate of year class strength, in the same way that last years assessment was sensitive to the 1991 year class. When using the separable VPA-estimated population abundance, the 1995 catch may be underestimated. Given the recent increase in the exploitation rates on this stock, and the lack of a credible recruitment index, the choice represents a conservative approach to the stock projections.

5.5.12 Management measures and considerations

The management of the western stock 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 half of the year (see Section 5.4). The Working Group supports the continuation of this policy. However, there appears to be no reason why fishing on the western stock should not be permitted in Divisions IVa and IIa during the third and fourth quarters. Current restrictions impose severe constraints on the fisheries of some countries which have quotas for western mackerel with the result that large quantities of mackerel caught in Division IVa are misreported as having been caught in adjacent areas.

The catches from this stock have been increasing, with those of 1993 the highest on record. However, although the stock size is thought to have increased in recent years, fishing mortality is also showing a strong upward trend. The Working Group points out that the current fishing mortality is above Fmed and that spawning stock biomass is predicted to decrease to a historic low in 1995. In 1991 ACFM recommended that fishing mortality should be reduced from the levels then prevailing whereas the present assessment indicates that it has increased. This indicates that the TAC should be based on a fishing mortality below the current level. The Working Group also points out that catches have consistently exceeded the TAC for this stock.

The principal difficulty with this assessment is that the recruitment index and the catch at age data are in conflict. If recruitment had increased as the index indicates, then either the spawning stock biomass or the catches at age should be much higher. It has been assumed here that the recruitment surveys are incorrect. However it is also very possible that the converse is true : recruitment may be increasing, whilst catches at age are being grossly misreported, or large additional mortality may be caused by discarding or slippage. Informal reports of discarding, slippage and under-reporting of catches lend some credence to this view.

6 SOUTHERN MACKEREL (DIVISIONS VIIIc AND IXa)

6.1 The Fishery in 1993

Catches by division and country are given for the period 1977-1993 in Table 6.1. The figures indicate that the catch has been fairly stable in the range of 15,000-25-,000 t over the period 1980-1993. The total catch for both Divisions in 1993 was 19,720 t, at the same level as in previous years. However some changes were recorded by areas. In Division VIIIc there was an increase in the landings from around 12,000 t in 1992 to 17,000 t in 1993. In Division IXa there was a 50% decrease in both the Spanish and Portuguese catches from 6,000 t in 1992 to 3,000 t in 1993.

Mackerel is a by-catch species for all fleets except for handliners (hooks). The landings by gear and by country are given in Table 6.2. The handliners landings have been very stable for all the years. The market is one of the major factors regulating the catches of mackerel in Division VIIIc, because fishermen stop fishing when mackerel prices are low.

In 1993, as in previous years, the highest catches (88%) were taken in the first half of the year, and mainly in Division VIIIc east. In Division IXa, the main fishery took place in the second and third quarters. As in previous years Division VIIIc accounted for the greater part of the landings 17,000 t which is 85% of the total southern mackerel catch. In this area the main fishery takes places in March and April, during the spawning season. In the second half of the year adult fish practically disappear from this area and are not either found in Division IXa.

A Spanish fishery for the spanish mackerel, *Scomber japonicus*, also occurred in the south of Division VIIIb and in Sub-division VIIIc east, mainly in the autumn as in previous years. In 1993 the catches increased to 1983 t compared with 800 t in 1992. In 1993 a Spanish fishery for spanish mackerel also occurred in Division IXa North with a total catch of 2557 t. There is no misidentification of the species of mackerel in the Spanish fishery in Division VIIIb and c and Division IXa North.

In Division IXa south, The Gulf of Cadiz, there is also a small Spanish fishery for mixed mackerel species of about 800 t. Because of the uncertainties about the proportion of *S. scombrus* in the landings, they have been never been included in the catches of mackerel reported to this Working Group by Spain.

In Portugal the landings of spanish mackerel were 7333 t. These spanish mackerel are landed by all fleets but the purse seiners accounted for 79% of the total weight

6.2 Effort and Catch Per Unit Effort

The number of boats in the two major mackerel fleets - handliners and purse seiners has slowly decreased over the last ten years. However, up to now, no index of effort or CPUE are available from these fleets.

Catch per unit effort is provided for the following fisheries in an age desegregated form:

Portuguese commercial trawl fleet catch per unit effort since 1986 (Table 6.3) ('000 individuals/'000 hours);

Portuguese demersal trawl surveys since 1986 (Table 6.4) ('000 individuals per hour);

Spanish commercial CPUE series from the trawlers of Aviles since 1988 (Table 6.5) ('000/days*HP-/100));

Spanish demersal research trawl surveys since 1984 (Table 6.6) ('000 individuals/ hour);

Spanish commercial CPUE from the trawlers of La Coruña since 1988 (Table 6.7) ('000 individuals /(days*HP/100)).

6.3 Fishery-Independent Information from Egg-Surveys

Mackerel egg surveys in the Spanish part of the Southern mackerel area have been carried out from 1987 to 1992, but not always with the same geographical coverage. Surveys with similar geographical coverage undertaken in 1988, 1990 and 1992 indicated high egg production in the same area, that is off the north and northwest Spanish coast (Garcia *et al.*, 1991, Motos *et al.*, 1991, Franco *et al.*, 1993, Lago *et al.*, 1993).

Mackerel eggs occurred over all the area sampled, both on and off the continental shelf (Figure 6.1). Peak egg abundances were recorded to the south of 44^{0}30'N, in the central area of the Cantabrian sea and in Division VIIIc west (Lago *et al.*, 1993). Comparing the distribution of eggs (Figure 6.1) with the distribution of the fishery (Figure 4.1 b) which only takes place on the continental self, it seems that the fishery in the Cantabrian waters is operating on only on a fraction of the spawning population.

In 1988, a total daily egg production of $4.01*10^{12}$ eggs (CV=0.30) (Daily stage I egg production) was estimated for the area to the south of 44 ^{0} 30' N (VIIIc and IXa north) (Table 6.8). In 1990 and 1992 the estimates of daily egg production for this area were $5.27*10^{12}$ (CV=-0.25) and $9.24*10^{12}$ (CV=0.30) respectively. In 1992 the daily egg production of mackerel in the area south of 44^{0}30'N was equivalent to 43% of that in the western area at this time (Anon. 1993f).

Since horse mackerel was the objective of these surveys, and not mackerel, no adult parameter estimates were obtained for the southern stock of mackerel. However, assuming similar daily egg fecundity rates of spawning for the southern and the western mackerel (Table 5.8), the above DEP estimates would imply that a spawning biomass of 800 thousands of tonnes in 1992 had to be in the Division VIII c and Sub- division IX a north to account for that amount of eggs. Even assuming a higher spawning rates for the southern mackerel the spawning biomass in 1992 has to be somewhere between 400 and 800 thousands of tonnes.

6.4 Catch in Numbers at Age

The 1993 catch in numbers at age by quarter for Sub-divisions VIIIc east and west, IXa north and central+south are shown in Table 6.9. The figures from Portugal are not split into Sub-divisions (central north + central south + south) but are given as totals for that part of Division IXa which lies in Portuguese waters. Countries providing sampling data were Portugal and Spain. In the first half of the year, when most of the catches are taken, the 3+ group fish were the most abundant, forming 78% of the catch in Division VIIIc and 40% in Sub-division IXa North; however the 3+ age groups accounted for only 18% in Sub-Divisions IXa Central and South. In the second half of the year, 81% of the catches, over the whole Southern mackerel area, were made up of fish 0, 1 and 2 years old. Fish 3+ years old were very scarce in the catches, as in previous years. Mackerel older than 10 years were only present in Division VIIIc, except for the second quarter when they were also found in Sub- Division IXa North.

The total catches in numbers by age for the years 1982-1993 are given in Table 6.10.

These figures checked for the assessment showed large discrepancies between the SOP and the catches, mainly in 1984,1985 and 1988.

This has to be carefully investigated before the next Working Group meeting.

6.5 Mean Length at Age and Mean Weight at Age

Mean lengths and mean weights at age in the catches, by sub-division and quarter were provided by Portugal and Spain and are shown in Table 6.11 and Table 6.12. As for the catch in numbers, the mean weights at age for Portugal are not split into sub-divisions (central north + central south + south) but are given as totals for that part of Division IXa which lies in Portuguese waters.

6.6 Mean Weight in the Catch and Mean Weight in the Stock

The mean weights at age in the catch and the mean weights at age in the stock used for 1988, 1989 and 1990 were those published in the report of the Workshop on Mackerel in Divisions VIIIc and IXa (1991); the mean weights for 1984, 1987 and 1991-1993 were used as a mean of those three years for which the data were available.

6.7 Maturity at age

The data used was presented by Portugal as a mean of the best sampled years. The proportions of mature fish at each age have been considered to be constant over the assessment period:

Age	Mature (%)
0	0
1	45
2	89
3	95
4	100
5	100
6	100
7	100
8	100
9	100
10	100

6.8 Assessment

Tuning of the VPA

In general the quality of the data available for the assessment is poor. Severe SOP discrepancies (50 - 120%) are found in the catch at age data. Only three daily egg production surveys are available and with an absence of information about the shape of the spawning production curve and spawning fraction, the values can only be used for comparative purposes. The Working Group agreed that an attempt should be made to provide an assessment, with the aim of providing a qualitative analysis of the available data, to highlight deficiencies and establish where improvements in the data collection and preparation could be encouraged.

Two approaches were used to provide assessments of this stock, the XSA and ICA methods.

ICA method

In an attempt to examine any correlation between the daily egg production estimates and the VPA generated spawning stock biomasses, the ICA package was used to derive a separable fit - tuned to the DEP indices. The low number of observations meant that the values could only be used as absolute estimates of SSB in the year of the survey, and not for the preferred relative fit Given the SOP errors described in Section 6.4. The assumption was made that the catch at age data are measured with error. The program attempts the minimisation of the sum of squared residuals between the logarithms of estimated catches at age and those of the observed values and the logarithms of estimated SSB's and the DEP observations.

A solution was achieved but only at extremely low (<0-.01) values for fishing mortality. At this level the assessment becomes sensitive to the values used for natural mortality and the solution is poorly determined. The program cannot reconcile the large discrepancy between the SSB values derived from the separable model and the DEP estimates when they are used as absolute measures of abundance.

Strong patterns of residuals were noted in the ICA fits to the Portuguese trawl survey data sets, indicating that the assumption of a constant selection at age throughout the assessment time period may be violated, this was later confirmed by the XSA assessment described below.

XSA analysis

Given the known SOP errors in the catch at age data, an XSA assessment which treats the values as exact, has been included in the report with a large health warning. It is carried out to evaluate the information content of the series of the Spanish trawl fleet and research vessel survey CPUE indices provided at the Working Group.

Data sets were available for four fleets, three trawl fleets (two Spanish from La Coruna and Aviles and the Portuguese trawl fleet) and a bottom trawl survey. The time series are short, 7 years being the longest data series, and there are many missing values. In the assessments that follow the 1988 tuning data for all ages of all fleet were set to zero (missing). This removed a potential year effect in catchability, introduced by known inconsistencies in the catches at age for that year. SOP checks of the years 1984 and 1985 also revealed large inconsistencies for these years and they were excluded from the tuning analysis.

XSA assessments were carried out separately for each fleet in order to examine the log catchability residuals for evidence of outliers, trends and year effects. Year effects were found and also groups of adjacent ages exhibiting high positive or negative residuals. Patterns which are indicative of the changes in selection suggested by the ICA analysis.

The time series of estimates of F and SSB were examined for discrepancies between fleets. The series are plotted in Figures 6.2 and 6.3. It is apparent from the figures, that although the variation in estimated values is considerable (confidence limits fitted to the estimated values would increase the range of variation), the trends in the of stock parameters appear to be consistent between fleets.

With no apparent differences in the signals from the fleets and no clear trends in catchability, the fleets were used in a combined assessment The results of the assessment are presented in Tables 6.13 and 6.14.

The age above which catchability is considered to be independent of year class abundance and the age at which catchability is independent of age were determined using the XSA assessment procedures described in Darby and Flatman (1994). The age of full recruitment was chosen in order to utilise the strong correlation between the Avilles CPUE values at age 1 and the estimated VPA populations. The age at which catchability was held constant with age was chosen after examination of the log catchability values which are constant with age for ages above 8. A shrinkage c.v of 1.5 was applied to the assessment in order to introduce some stability without biasing the assessment estimates significantly. Table 6.13 shows that the mean F generally contributes <20% of the weight to the combined estimates.

An examination of the log catchability residuals for the fleets within the combined assessment reveals that there is a consistently high, negative, 1993 year effect. This may be an additional catch at age data anomaly or a change in catchability and/or availability (higher than expected). The year effect can also be seen in the F at age tables as a large increase in F in the most recent year. A plot of the selection at age relative to age 1 (Figure 6.4), reveals a strong increase in the selection on older fish during the period of the assessment This confirms the strong residuals noted in the ICA assessment.

6.9 Comments on the Assessment

The Working Group examined the summary table for the assessment and agreed that this could not be used as an indicator of trends within the fishery. There is no indication from the fishery which could explain an effort increase on this stock during recent years. It also should be taken into account that most of the fleets used for the tuning reflect a decrease in catches not coincident with the stable catches of the two major fleets for mackerel (Purse seiner and handliners, which account for 75% of the catches of the southern stock - Table 6.2) and for which no CPUE is available. In the future CPUE for the handliner should be submitted to this Working Group in order to support the assessment of the fishery.

The Assessment was run without any direct estimate of SSB, because no such figure was available. Nevertheless, the daily egg production estimates for Division VIIIc and for Sub-division IXa north (see Section 6.3) suggest a SSB in 1992 somewhere between 400-800 thousand tonnes in that part of the area of the southern stock distribution, well above the levels of biomass suggested by the analytical assessment (68,000 t). In 1988 and 1990 estimates of daily egg productions for the same area were about half of those calculated in 1992 at the same period of the year. In this case the fishery would be operating on a reduced fraction of the population.

The XSA method is based on VPA methodology, which assumes a closed population. The very high egg biomass suggested by the egg production estimate may indicate that this assumption is not met.

In fact, there are indications from the distributions of the fishery and of the eggs that suggest that the fishery in the Cantabrian Sea and Sub-division IXa north takes place only in a reduced area compared to the total spawning distribution in that area (Figure 4.13b and Figure 6.1). The fishery in Division VIIIc and Sub-division IXa north accounts for 85% of the landings and the boats only operate on the continental shelf, while the spawning takes place over and off the continental shelf and beyond the northern limit of Division VIIIc.

For all these reasons the Working Group considers the above analytical assessment very preliminary, with a strong possibility of largely overestimating true fishing mortality.

The analysis of southern mackerel was included in the report in order to identify difficulties and contradictions in the data. In this way the problems may be solved in the future. The inclusion of the assessment also follows the recommendation made by the ACFM in November 1993. Therefore this assessment should only be taken as a preliminary analysis of the available data due to the strong contradictions among the different sources of data. Consequently, no forecast was considered.

It should be noted for future work that the pattern of recruitment estimated for the stock seems to indicate the following: the values appear in pairs of high and low abundance, a feature which may indicate age reading difficulties.

6.10 Management Measures and Considerations

The Working Group is not in a position to make any analytical forecast of the stock and the catches for the near future because the assessment is considered very uncertain and therefore preliminary.

The stability of the effort and the catches of the major fisheries for mackerel in the Iberian peninsula (handliners, a direct fishery, and purse seiners, a by-catch one) for the last 10 years indicate that the stock is likely to continue to support catches at the same levels.

The low level of catches, the apparently small fishing areas compared with the extent of the spawning grounds and the high egg productions detected in the area allocated to the southern stock during the DEPM surveys of 1988, 1990 and 1992 suggest that catches may be a small fraction of the spawning biomass of mackerel in the area. Therefore it is likely that the fishery is operating within safe biological limits. However, the Working Group draws attention to the relatively high proportion of juveniles (in numbers) caught in the catches and the apparent change in the selection pattern.

The TAC for the southern mackerel, set at about 36,000 t, has never been completely taken. The mean catch in the last 15 years is about 20,000 t, with a maximum catch of 26,000 t. Some of the major reasons for the TAC not to have been taken are the low value of this species in the market and the fact that mackerel is a by-catch species for most of the fleets.

ACFM asked the Working Group to make a combined assessment of the southern and western mackerel. The Working Group considers that at present this is not possible because of the high mackerel egg production off the north coast of Spain. This generates a high biomass of mackerel which, if included, would strongly influence the western mackerel assessment. The Working Group is confident that the uncertainties surrounding the high egg production in this area will be resolved during the 1995 egg surveys and that a combined assessment will be possible thereafter.

7 HORSE MACKEREL - GENERAL

7.1 Stock Units

In later years the Working Group has considered the horse mackerel as separated in three stocks, the North Sea-, the Southern- and the Western stock (Anon., 1990b, 1991c). This separation is mainly based on the known distribution of eggs combined with the location and time of the different fisheries in recent years. However, there is no well established biological basis for such separation and should therefore be treated cautiously until more information is available. Spanish egg surveys in 1988, 1990 and 1992 (Franco *et al.*, 1993) observed high horse mackerel egg production off the northern and northwestern Spanish coast Data from the same period in the western egg survey in 1992 (Anon., 1993f) indicates that it might be difficult to determine a realistic border between a western and southern spawning area.

In 1994 Spain and Portugal started a tagging program (SEFOS project). New international egg surveys will be carried out in the western and southern areas in 1995 (Anon., 1994b). Hopefully, both the tagging experiments and the egg surveys will improve the basis for stock combination or stock separation.

7.2 Allocation of Catches to Stock

The distribution of the fishery in 1993 indicates no changes in the migration pattern compared to previous years. Therefore the Working Group allocated the catches in 1993 to the different stocks as in recent years:

Western stock: The catches in Divisions IIa, Vb, IVa, VIa, VIIa-c,e-k and VIIIa,b,d,e. Since 1990 the Danish, Norwegian and Swedish catches in Division IIIa have been allocated to the western stock. These catches are distributed both spatially and temporally closer to the catches in Division IVa than the catches in Divisions IVb,c.

North Sea stock: The catches in Divisions IVb,c, and VIId.

Southern stock: The catches in Divisions VIIc and IXa.

The catches by stock are given in Table 7.1.

7.3 Species Mixing

According to the Working Group recommendation (Anon., 1993d), special care was taken again in 1994 to ensure that catch and length distributions and numbers at age of *T. trachurus* provided to the Working Group did not include *T. mediterraneus* and *T. picturatus*. Spain provided data about *T. mediterraneus* and Portugal about *T. picturatus*.

In Divisions VIIIa,b and Sub-division VIIIc east, the total catches of *T. mediterraneus* were 6,226 t in 1993 (Table 7.2). These slightly increased compared with last year (5,918 t) (Anon., 1993d). 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 made in the second half of the year, principally in autumn, when the *T. trachurus* catches were lowest T. *mediterraneus* catches were lowest in spring.

Catches and length distributions of *T. mediterraneus* in the Spanish fishery in Divisions VIIIa,b and c were reported separately from the catches and length distributions of *T. trachurus*.

A fishery for *T. picturatus* occurred only in the southern part of Division IXa, as in previous years. Data on *T. picturatus* in the Portuguese fishery for the period 1986-1993 are given in Table 7.3. Catches and length distribution for the Portuguese fishery for *T. trachurus* in Division IXa do not include data for *T. picturatus*.

As there is information available about the amounts and distribution of the catches of *T. mediterraneus* and *T. picturatus* for at least five years (Anon., 1990b, 1991c, 1992b 1993d), and as the evaluations and assessments are made only 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 also for the other species.

The Working Group considers that special care should continue to be taken by all the countries that fish in Divisions VIIIa,b,c,d and IXa to ensure that catch and length distributions and numbers at age of *T. trachurus* provided to the Working Group do not include *T. mediterraneus and T. picturatus.*

7.4 The fishery in 1993

The total international catches of horse mackerel in the north eastern Atlantic are shown in Table 7.4 and Figure 7.1. The data in Table 7.4 covers the period 1979 to 1993 and gives the catches for the different Sub-areas. The data shown in Figure 7.1 shows the estimated catches taken from each stock from 1965 to 1993.

The total catch taken from all areas in 1994 was about 504,000 t which is the highest ever recorded. Most of this catch (over 360,000 t) was taken from the northern Sub-areas IV and VII from where the catches have continually increased in recent years. Catches from the southern areas VIII and IX, on the other hand, have remained comparatively constant.

The catches include an estimate of discards for one fleet. It must be remembered that this estimate only applies for one fleet and has not been used to calculate discards throughout the whole fishery. Figure 7.1 shows clearly the dramatic increase in the catches of the Western stock since 1983 and the rather constant catches taken from both the North Sea and southern stocks. It also shows the very large catches taken by the USSR fleet in the 1970 to 1978 period and the substantial catches which were taken from the southern stock in earlier years compared to recent times.

The TACs agreed for *Trachurus* spp. for the various areas in 1993 are shown below. ACFM did not, however, give any precise management advice about catch levels for these stocks in 1993.

Divisions IIa and Sub-area IV (EC waters only)	60,000 t
Division Vb (EC waters only, Sub-areas VI and VII, and Divisions VIIIa,b,d,e	250,000 t
Divisions VIIIc and IXa	73,000 t

The quarterly distribution of the horse mackerel catches by sub-division and sub-area for 1993 (data requested by the Multi-species Working Group) is shown in Table 7.5. As for mackerel the distribution of the catches throughout the year reflect the spawning and feeding migrations of the various stocks.

7.5 Distribution of the Horse Mackerel Fisheries

The total international catches of mackerel in 1993, in ICES Sub-areas II, III, IV, VI, VII, VIII and IX, by quarter, are given in Table 7.5. The quarterly distributions described below are, therefore, based on information provided by Working Group members.

The distribution of the fishery by Sub-area or Division was rather similar to that in 1992. In 1993, more than the 44% of the total northeastern North Atlantic horse mackerel catches were taken in Sub-area VII (43% in 1990, 51% in 1991, and 43% in 1992).

The distribution of the fishery by quarter in 1993 differs slightly from that in 1992 (Anon, 1993d). In 1993 the main catches were taken in the fourth quarter and the smallest catches in the second quarter as in previous years.

The Working Group estimated the distribution of the fishery by ICES statistical rectangles, on the basis of quarterly data submitted by Ireland, Germany, The Netherlands, Norway, Portugal, Spain and the United Kingdom (England and Wales). This is shown in Figures 7.2a-d. The data reported represent about 90% of the catches.

First quarter

In the first quarter (103,000 t), the main catches were taken along the edge of the continental shelf west of the British Isles and Ireland, in the Bay of Biscay and around the Iberian peninsula (Figure 7.2a).

Second quarter

In the second quarter (53,000 t), the main reported catches were taken southwest of Ireland and around the Iberian peninsula (Figure 7.2b).

Third quarter

In the third quarter (122,000 t), the major fishery continued to be in the Channel and to west of Ireland, and around the Iberian peninsula (Figure 7.2c).

Fourth quarter

The fourth quarter (225,000 t) was the most important for the catches in 1993. Two main fisheries appeared in two very distant areas, as in previous years: one in the north, mainly in Sub-area IV; the other in the Channel and in the more northern part of the Bay of Biscay. Scattered catches were also taken around the British Isles and off Ireland. The catches around the Iberian peninsula decreased in this quarter. (Figure 7.2d)

7.6 Length Compositions by Fleet and by Country

The 1993 annual length compositions by fleet were provided by Ireland, The Netherlands, Norway, Portugal, Spain and England (UK). These length distributions were available for all the major fishing fleets accounting for about 80% of the total landings in 1993.

The length distributions by country for each fleet (in millions) of fish per cm-length group are shown in Table 7.6.

8 NORTH SEA HORSE MACKEREL (DIVISIONS IIIa - EXCEPT WESTERN PART OF SKAGERRAK, - IVb,c AND VIId)

8.1 The Fishery in 1993

The horse mackerel catches estimated to have been taken during 1993 from the North Sea and Division IIIa are given in Table 8.1. Further details of these catches per quarter and per area are given in Tables 7.1, 7.4 and 7.5. All the catches taken from Divisions IVb, IVc, VIId and from Division IIIa (except from the western part of the Skagerrak) are assumed to belong to the North Sea stock. The catches taken from Division IVa and the western part of the Skagerrak are assumed to belong to the Western stock. The total catch taken from the North Sea and Division IIIa during 1993 was about 140,000 t compared with 113,000 t in 1992. Most of the increase was taken by Norway who in 1993 took over 90% of the total catch. The total catch includes a negative unallocated catch of 4,000 t. Approximately 135,000 t were taken from Division IVa mainly in the fourth quarter by directed Norwegian industrial fisheries and this catch was assumed to belong to the Western stock. The total catch taken from Divisions IVb,c and VIId was about 14,400 t and this is the total catch believed to have been taken from the North Sea stock. The comparable figure in 1992 was about 15,000 t. As in recent years most of the catches from he 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.

8.2 Fishery-Independent Information

8.2.1 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 out in the years 1992, 1993, and 1994.

8.2.2 Acoustic surveys

No acoustic estimates of the North Sea horse mackerel stock have been available from 1991 to 1993.

8.3 Age composition

Samples taken from the Dutch commercial catches and research vessel catches were available for the period 1987 - 1993. The Dutch samples cover only a small proportion of the total catch and are not considered representative of the total international catch. The data, however, give a rough indication of the age composition of the stock (Table 8.2 and Figure 8.1). The age composition obtained for 1993 from the Dutch commercial catches and research vessel catches shows the 1982 year class as very strong and the 1989 year class as relative strong.

8.4 Assessment

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

The egg surveys indicate a spawning stock biomass of more than 200,000 t for the years 1989, 1990, and 1991.

The strong 1982 year class and the relatively strong 1989 year class are recognised in the structure of the stock.

8.5 Management Measurement and Considerations

No forecast is available for 1995. The Working Group recommend, 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 in Division IIIa, the Kattegat and the eastern parts of the Skagerrak.

9 WESTERN HORSE MACKEREL (DIVISIONS IIa, IVa, Vb, VIa, VIIa-c, VIIe-k AND VIIIa,b,d,e)

9.1 The Fishery in 1993

The fishery on the Western horse mackerel stock is mainly carried out in Divisions IIa, IVa, VIa, VIIg, VIIe, VIIh, VIIj and VIIIa. The national catches taken by the countries fishing in these areas are shown in Tables 9.1-9.4, while additional information on the development of the fisheries by quarter and by Division is shown in Tables 7.1, 7.4 and 7.5.

<u>Sub-areas II and Division Vb</u> The national catches taken from Sub-area II and Division Vb are shown in Table 9.1. The total catch taken from this area in 1993 was only about 3,000 t compared with 13,000 t in 1992. The decrease was mainly caused by reduced catches reported by Faroe Islands.

<u>Sub-area IV and Division IIIa</u> The catches of Western horse mackerel taken from this area are already referred to in Section 8.1. The total catch is estimated to be about 135,000 t mainly taken by Norway in a directed industrial fishery in the fourth quarter.

<u>Sub-area VI</u> The catches taken from Division VI are shown in Table 9.2. The total catch taken is estimated to

have been about 54,000 t in 1993 compared with 41,000 t in 1992. Over 80% of the t catch is taken by irish vessels fishing in the southern part of Division VIa. The total catch includes a negative unallocated catch of about 7,000 t (explained in Section 2).

Sub-area VII The catches from this Sub-area - mainly from Divisions VIIb, e, h and j - are shown in Table 9.3. The total estimated catch in 1993 was about 221,000 t which is the highest recorded since 1979. Most of the 1993 catch was taken by the Netherlands (71% of the total). Substantial catches were also recorded by Denmark, France and Ireland. The table includes a negative unallocated catch of 4,000 t.

Sub-area VIII The catches from this Sub-area - mainly from Divisions VIIIa and VIIIe - are shown in Table 9.4. The total catch in 1993 is estimated to have been about 53,700 t which is very similar to that in 1992 (54,000 t). The main catches were taken by Spain (28,000 t) which in 1993 fished for a mixture of adults and juveniles in Division VIIIc and by the Netherlands (19,000 t) which fished mainly juveniles in Division VIIIa.

9.2 Fishery -Independent Information From Egg Surveys

Egg surveys have been carried out every third year, the last one in 1992 and the next will take place in 1995 (Anon., 1994b).

9.3 Catch in Numbers at Age

Sample data with age readings were only provided by two countries, the Netherlands and Norway. The Norwegian otoliths were also read by the Dutch reader. There were minor differences in interpreting the age. Since the Dutch reader is the most experienced the Norwegian readings were adjusted according to the Dutch ageing of the same otoliths. Catches from the other countries for which there were no sampling data 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 9.5. The total annual catch in numbers for 1993 is shown in Table 9.8. The sampling intensity is discussed in Section 2.1.

The strong 1982 year class has made up the main part of the international catches of western horse mackerel since 1984 (Fig. 9.1). In 1993 this year class contributed by 56% of the catches both by numbers and by weight.

9.4 Mean Length at Age and Mean Weight at Age

Mean weight and mean length at age in the catches in 1993

Mean weights and mean lengths at age in the catches by quarters in 1993 were provided only by the Netherlands (Division VIa, Sub-area IV, VII and VIII) and Norway (Division IVa). These data were applied to the catches from the other countries. The mean weight and mean length at age in the catches in 1993 are shown in Tables 9.6-9.8.

Mean weight at age in the stock in 1993

The mean weights at age of the stock at spawning time for 1993 are shown in Table 9.8. They are weighted means of the mean weight at age for the first and second quarters in Divisions VIIj,k and were based on fish in all maturity stages as obtained in samples from Dutch freezer trawlers.

Data of two, three and four years old horse mackerel were not obtained, but the average weights were assumed to be the same as in previous years (Table 9.8).

9.5 Maturity at age

Maturity ogives, based on Dutch data from the fishery on spawning fish (January-July) southwest of Ireland and from the fishery on immature fish in the English Channel area (October-December), have been used by previous working groups. A large number of samples obtained from both areas (13,764 fish) were collected between 1982 and 1993 from which it was expected that an appropriate maturity ogive could be constructed.

Because of growth differences between years the most abundant year classes, 1979, 1982 and 1987, have however only been used to calculate the ogives. However, it is apparent that very big differences occur between the ogives based on the data from the different areas and from the different seasons (Figure 9.2). It is probable that the proportion of mature fish present in the overall stock based on the samples examined between January and July is an overestimate because the samples come from an area of mainly adult distribution. It is also probable that the proportion of mature fish present in the overall stock, based on the samples obtained during the October to December period is underestimated, because the samples come from an area of juvenile distribution. The true maturity ogive is expected to be somewhere between the cures constructed for both areas. It is, however, difficult to weight the samples from the two areas without knowing the size of the adult and juvenile populations present in the areas. Considerable differences in the size of the SSB can arise depending on which maturity ogive is used. The Working Group were, however, unable to construct an appropriate ogive and decided not to alter the one already in use.

The Working Group recommends that further investigations should be carried out on the maturity of horse mackerel.

9.6 Fishing Mortality and Tuning of the VPA

At the last years Working Group an attempt was made at fitting a separable VPA to the Western horse mackerel catch at age data, and to tune this to the spawning stock abundance estimates derived from the egg production surveys. The catch at age data is dominated by the catches from the 1982 year class (Figure 9.1) and, the separable analysis failed to find a consistent selection at age pattern.

During the past year, data on the horse mackerel catch in numbers at age recorded by the MAFF R/V Cirodana during the Western ground fish survey, have been collated to provide a tuning data set. Unfortunately, the survey catches are not aged. Therefore in order to derive numbers at age an age length key from Dutch commercial sampling was used to separate the larger fish, whilst smaller fish were aged by analysis of the structure of the length frequency distributions. An XSA assessment tuned to the survey data set was attempted, but also failed to give a reliable solution. The log catchability at age is extremely sensitive to the 1982 year class effect. XSA was rejected as a suitable methodology.

One possible solution to the problem of the assessment of this data set is to make the assumption that the fishery and SSB are totally dependent on the two strongest year classes (1982 and 1987). The catches at age for these year classes were therefore extracted from the data matrix and a VPA performed on the two cohorts. The response surface of the sum of squared residuals between the estimated SSB and the egg production estimates was generated by varying the terminal F values for the two cohorts (Table 9.9). This achieves minima at a terminal F for the 1982 cohort of 0.175 and for the 1987 cohort at 0.06. However, Figure 9.3 shows that the response is very sensitive to the F for the 1982 year class, but the response to the F on the 1987 year class is very flat. Figure 9.4 shows cross sections through the surface at the minima. It is clear that the 1982 F minima is well defined but that of the 1987 F could potentially have a wide range of values. Without independent information of the level of fishing on the 1987 cohort a realistic assessment of this stock may not be possible.

9.7 Catch Forecast

A catch forecast (Table 9.10) has been carried out despite the absence of a VPA. The exploitation pattern could not be taken from the separable VPA. A flat topped exploitation pattern has been assumed, which has the same F' for thesdominant 1982 year class and the much weaker 1987 year class. The starting year in these predictions is 1992, because in that year an egg survey was carried out, which resulted in a spawning stock biomass estimate of 2.32 million tonnes. This has been tuned to the catches in 1992 and 1993, which were respectively 370 and 432 thousand tonnes. The age composition of the catch in 1993 could be used for tuning by setting the stock size at age in 1992 at the right level. The 1-group in the stock in 1993 was set at such level that it matched the percentage of the 1-group in the catch in 1993. After this tuning the observed age composition of the catch in 1992 can be compared with the predicted age composition in 1992 (Figure 9.5). A catch of 450 thousand tonnes in 1994 has been predicted by the Working Group. A constant weak recruitment of 500 million fish at age 1 has been assumed from 1994 onwards. The mean weights at age in the catch and in the stock are smoothed values obtained from predicted growth curves of both year classes. It was assumed that 80% of the 1987 year class was mature at age 5 in 1992 and that at age 6 they were fully mature in 1993. Figure 9.6 shows the predicted decrease in the spawning stock biomass of western horse mackerel if 300 thousand tonnes are caught each year in 1995-1997. According to this, the spawning stock will decrease below 500,000 t in 1998. This is the level considered to be the minimum level of safe biological limits for the stock.

9.8 Management Measures and Considerations

Based on the egg surveys in 1992 and the annual egg production method the spawning stock was estimated at 2.32 million tons which is the same level as estimated from the egg surveys in 1989 (2.39 million tons). The spawning stock in 1992 was considerably larger than expected from the prediction made in 1991 (Anon., 1991c) based on the 1982 year class and low recruitment. The Working Group last year (Anon., 1993d) explained this as since the 1982 year class was considered fully recruited to the spawning stock in 1989, new recruitment of considerable strength might have occurred since 1989. However the catch in numbers do not indicate a new strong year class recruiting to the stock (Figure 9.1), therefore the rich 1982 year class was probably not fully recruited to the spawning stock in 1989.

The VPA made by the Working Group in 1991 (Anon., 1991c) demonstrated that a spawning stock in the order of half a million tons was sufficient to produce the strong 1982 year class. Therefore the western horse mackerel is considered to be well within safe biological limits.

10 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

10.1 State of the Revisions of the Horse Mackerel Data Base

Last year the Working Group recommended a revision of the catch-in-numbers- at-age from 1985 backwards using the age reading methodology adopted in 1991 (Anon., 1991e). For 1984 the catch in numbers from the Spanish area have been revised and are already available, while the 1984 Portuguese catch in numbers are under revision.

10.2 The Fishery in 1993

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 57,428 t., which represents an increase of 15% compared with 1992 catches. This indicates an increasing trend in the catch from 45, 511 t. in 1991. The catch by country and by gear is shown in Table 10.1. Table 10.2 disaggregates the catch by country and quarter. It indicates that the proportion of trawl catches increased in recent years while the purse seiner' catch has decreased. This was possibly an impact on horse mackerel resulting from the sardine closed season for purse seines in Sub-divisions VIIIc-West and IXa North during the first quarter of the year. In general the major catches of horse mackerel occur during the third and fourth quarters in all the sub-divisions of the Southern area (see Table 10.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus*, 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 7.3). Figure 7.1 shows the evolution of the catches from 1965 to 1993.

10.3 Effort and Catch per Unit Effort

Table 10.3 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 Coruna) and in Sub-division VIIIc East (Aviles) from 1983 to 1993. In 1993 the catch rate of the trawl fleet in Subdivision VIIIc-West was 23% higher than the catch rate obtained in 1992. The catch rate reached by the Galician fleet (VIIIc West) in La Coruna, was the highest of the series from 1983 to 1993. The Cantabrian trawl fleet operating in the Division VIIIc East, from Aviles presents a catch rate similar to the low level shown in 1992. The trawl catch rates of 1992-1993 from the Portuguese trawl fleet fishing in Division IXa are not available at this meeting.

Table 10.4 indicates the catch rates from research vessel surveys in Kg per tow, only for comparison with the total biomass trend. A new survey series from Portugal is available in the Winter (February-March) from 1992-1993, which corresponds to the peak of the spawning season. This survey gave a high biomass index in 1993.

The 1993 June-July survey indicates an biomass index similar to the previous year while in October in the Portuguese area the biomass index was shown to be extremely high compared with the rest of the period. The Spanish October survey did not show any particular increase in the biomass compared with 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. The biomass indices estimated in the Portuguese area from June-July survey series and, in the Spanish area, from the September - October survey series are in good agreement.

10.4 Catch per Unit Effort at Age

CPUE at age from the Galician (La Coruna) 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 1993. The extremely strong 1982 year class is still very prominent in the data for both fleets at age-group 11 (Table 10.5). In 1993, the 1986 and 1991 year-classes were confirmed as strong giving high indices of abundance in the Galician fleet while in the Cantabrian trawl fleet they are also well represented.

10.5 Fishery-Independent Information.

10.5.1 Trawl Surveys

Table 10.6 shows the numbers at age per hour from the Spanish and Portuguese bottom trawl in the October surveys and from the Portuguese July survey. The October survey covered Sub-divisions VIIIc East, VIIIc West, IXa North (Spain) " from 20-500 m on board R/V "Cornide de Saavedra" and, Sub-divisions IXa Central North, Central South and South, in Portugal, from 20-750 m depth, on board R/V "Noruega". The same sampling methodology was used but there were differences in the gear design, as described in Anon. (1991c). The Portuguese March survey is a new series and it is carried out using the same methods. This survey time series is too short to be of use for tuning the VPA, this year. 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 by Borges (WD 1993) that the horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time. This explains the special characteristics of the composition of the catches, the lower natural availability of fish after first maturing which creates a peculiar "selection" pattern. The Spanish September/October survey series is available from 1985-1993 and the Portuguese October survey, from 1981-1993. Both are carried out during the recruitment season. In these surveys the 1993 year class appears to be very strong, and it is specially conspicuous in the Portuguese survey. In the Spanish Sept./Oct. survey in 1993 the strong 1986 and 1987 year classes are noticeable (Table 10.6). In the Portuguese July Survey the 1987 year class is well represented. The 1990 year class, shown to be strong by the CPUE of the Galicean and Cantabrian fleets, is confirmed as strong by the Portuguese Surveys. The 1982 year class is noticeable in all the survey series but is stronger in the Spanish bottom survey.

10.5.2 Egg surveys

Egg surveys were carried out in 1992 by DEPM in Divisions VIIIc and IXa. (Anon. 1994b) The estimate of the spawning biomass of horse mackerel in the Spanish area was revised according to the Daily Egg Production estimate following the Pennington method (1983). A spawning biomass of 398,000 t. (C.V. =0.33) was calculated. This new estimate reduces by 18% the spawning biomass preliminary estimate of 487,000 tonnes (Anon., 1993a: Porteiro *et al.* 1983). In the Portuguese area the horse mackerel spawning biomass was preliminarily estimated to be 360, 000 t. using the standard analysis. However this result has to be revised using other statistical analysis.

Caution must be taken on the interpretation of the results because the DEPM 1992 Egg survey in the Spanish and Portuguese area was covered with a time lag of three weeks, which generates problems in combining.

10.5.3 Acoustic surveys

ACFM questioned whether the acoustic surveys for sardine can provide any information on horse mackerel. The acoustic surveys for sardine already carried out previous years do not seem to have much use for horse mackerel. They have been designed only for sardine which is well detected at mid water. In general horse mackerel is distributed close to the bottom and mixing, at the upper limit with other species as the blue whiting and trumpet fish which makes the interpretation very difficult. *Acoustics can only be useful for horse mackerel in future acoustic surveys well designed for this species.*

10.6 Catch-in-Numbers at Age

The catch-in-numbers at age for 1993 are presented by quarter and area, disaggregated by Sub-division in Table 10.7. Table 10.13 presents the catch in numbers by year. They have been obtained by applying a quarterly ALK to each of the catch length distributions estimated from the samples of each Sub-division. The sampling intensity is discussed in Section 2.1.

10.7 Mean Length at Age and Mean Weight at Age

Tables 10.8 and 10.9 show the 1993 mean lengths and mean weights-at-age in the catch by quarter and Sub-division. Table 10.10 presents the weight at age in the stock and in the catch. *The data before 1985 have not yet been revised (see section 10.1) 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.* Figure 10.1 presents the weight-at-age over the period 1985-1993.

10.8 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 (Table 10.11).

10.9 Fishing Mortality and Tuning of the VPA

Fishing mortality coefficients were estimated using Extended Survivors Analysis (XSA) as shown in the following steps:

1. *XSA shrunk to the mean with a standard error of 0.5 was run for the 2 fleets and three surveys altogether:*

In 1985 the Portuguese October survey gave very high negative log catchability residuals compared to 1986-1992. The 1985 Portuguese survey series was therefore, excluded from the analysis.

2. *XSA shrunk to the mean with standard error of 0.5 was run separately for the fleets and for the surveys.*

This showed that 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.

3. *The two Spanish trawl fleets and the Portuguese July Survey were included in XSA and the shrinkage towards the mean with standard errors equal to 0.5 and 1.0 was run to analyse the sensitivity of the data:*

Extended Survivors Analysis (XSA) runs with differing levels of shrinkage (0.5 and 1.0) revealed that the strength of shrinkage has a significant effect on the standard errors of the log catchability. Stronger shrinkage (lower cv' increased the standard errors for all fleets. In order to examine the effect of the level of shrinkage on estimated parameters, retrospective runs were performed at shrinkage cv' of 0.5sand 1.0.

Figures 10.2, 10.3 and 10.4 illustrate the results for the shrinkage cv of 1.0. It can be seen in Figure 10.2 that for the reference Fbar (2-9) the estimate show extremely close agreement between years. However the pattern of exploitation to which this stock is subjected is complex with high selection on the younger and older ages and a reduced availability of 4 - 6 years old fish. Therefore the residual patterns were examined for the Fbar(0-3) and Fbar(7-11), the results are illustrated in Figures 10.3 and 10.4. At these ages the retrospective patterns show greater variation from year to year. There is also a marked contrast in the bias of the assessment estimates. The F on 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. These Figures also illustrates why strong shrinkage in XSA assessment will reduce the accuracy of the estimated parameters. Fbar(0-3) shows a decrease throughout the period of the assessment, the historical mean Fs over the last few years have been higher than the terminal estimates and stronger shrinkage will produce an upwards bias in the retrospective pattern and estimates for this year 's assessment. Fbar (7-11) has remained relatively stable in the last few years but was previously very low in 1987. The inclusion of this estimate in the F shrinkage mean results in an underestimation of bias for the older ages. As with the younger ages stronger shrinkage will increase the bias and reduce the accuracy of the terminal estimates.

The tuning diagnostics and final results are given in Tables 10.12-10.16. Figure 10.5 indicates the fish stock summary trends over the period 1985-1993 according to the final assessment.

10.10 Recruitment

The recruitment of 0-group in 1994 was taken as the geometric mean of the 1987-1991 period which corresponds to 1270 million fish. An RCT3 was attempted using the October survey series which were carried out at the time of recruitment, but there was no detectable relationship between the survey and cohort strength.

10.11 Long-Term Trends

The long-term yield per recruit and spawning biomass-per-recruit curves, against F, derived using the input data in Table 10.17, are shown in Figure 10.6. Table 10.18 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 0.22, which approximately corresponds to the level observed in 1993 (0.24).

10.12 Biological Reference Points

The reference mortality levels are shown in Figure 10.8 which gives the plot of spawning stock biomass versus recruitment at age 1 for the period 1986-1992 from the final VPA. The estimated F_{med} value is 0.12 and F_{high} corresponds to 0.31. The effect of the very strong 1982 year class seem to have set F_{med} to a lower level than it might be expected, nevertheless the available period is too short to define well the biological reference points.

10.13 Catch Forecast

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 1987-1991. Table 10.17 gives the input parameters and Tables 10.19a-c and Figure 10.7 show the results of the predictions for 1994. At $F_{status\ quo}$ (F93) the expected catch in weight for 1994 is 79, 528 tonnes . In 1995, assuming, the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 67, 939 tonnes. The spawning stock biomass would increase in 1994 from 178 thousand t in 1993 to 184 thousand t at F status quo level and to 185 thousand t if the agreed TAC of 73 thousand t is taken in 1994. The spawning stock biomass is expected to increase in 1995, at $F_{status\ quo}$ to 209 thousand t. The spawning stock biomass increases because the 1991, 1986, 1987, 1982 which are of good strength contribute to the biomass in 1994 and 1995.

10.14 Comments on Assessment

The new diagnostics implemented for XSA for each age by fleet showed much better than in previous years the effect of including or excluding each fleet. Because of this, the two October survey series, which presented high residuals were not included and this improved the fit of the model to the data. Furthermore, the peculiar exploitation pattern was at this time fitted by the VPA by adjusting the weight in the "shrinkage to the mean" of the XSA. Taking a mean F over all ages averages the biases and the retrospective analysis show close agreement between years as indicated in Figure 10.2.

10.15 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 $F_{status\ quo}$ has been constant over recent years. Table 10.20 summarizes several management options at: $F_{status\ quo}$, F corresponding to TAC constant equal to 73 thousand tonnes, F corresponding to TAC 1994 level, $F_{0.1}$ and $F_{max.}$.

11 SARDINE

11.1 Sardine Otolith Workshop 1994

At the last Working Group meeting a recommendation about reviewing the readings of sardine otolith was made. Only in the last two months (April and May) there was an exchange of otoliths among readers from Spain and Portugal and a workshop took place in Lisbon in June.

Initially it was programmed to analyse otoliths from sardines caught by Spanish and Portuguese fleets (about one thousand otoliths). Two months were not enough for that exchange and only Spanish otoliths were observed by all the readers.

The criteria for reading the sardine otoliths was established at a workshop in Tenerife-Spain (FAO,1979) and at the Standardization Seminar held in Vigo in 1981 (Anon., 1981)

The report of the workshop is in two sections. The first section analyses the results obtained from the otolith exchange programme involving 4 readers and about 5 hundred otoliths, the second one analyses the results from the workshop. A subsample of 150 otoliths was subjected to a second reading by the 5 readers present in the workshop.

This subsample was selected by half year and by sub-division, having 2 otoliths from sardines with length less than 20 cm, and 4 otoliths from sardines with higher lengths. The higher lengths have a more difficult otolith structure and there are more difficulties in attributing them to an age group.

The methodology used to compare the age reading results from all the readers by sub-division was a nonparametric statistical test, the Friedman two-way analysis of variance by range. The mean length and standard deviation for each reader, by sub-division and half year were also estimated.

In the analysis of the exchange of otoliths, one of the readers (R4) shows a tendency to attribute to older age groupss in comparison with other readers and the Friedman's test by sub-divisions indicates that the age reading results are significantly different between the readers.

The results of the sub-samples analysed in the workshop, the Friedman's test shows, no significant differences between the 5 readers in Sub-division IXa North. In the other two sub-divisions the age reading is significantly different among readers. A new run of Friedman's test was tried for the two sub-divisions but excluding the two less experience readers (R3 and R4). The results show no differences among readers in the two sub-divisions.

The experienced readers showed a better agreement among themselves than the new readers and the sardine age-length key used for assessment purposes had been obtained by the experienced readers (R1,R2,R5).

The criteria established to read sardine otoliths should continue to be used. The workshop recommended a more intensive study on otolith growth pattern and to continue the exchange of the sardine otoliths between Spain and Portugal.

11.2 Unit Stocks

For assessment purposes the sardines in Divisions VIIIc and IXa are regarded as one stock unit . The small catches of sardine in Divisions VIIIa-b were not included in the assessment, nor were the catches from sub-area VII.

11.3 The Fishery in 1992

From Sub-areas VII, VIII and IX landings were reported by UK (England and Wales), France , Spain, Portugal (Table 11.1).

Table 11.2. shows the annual landings of sardine by Sub-area (VII-IX) and Division 1981-1993. Like 1992, very small catches in 1993 were reported in Division IVc. Total annual landings from all Sub-areas have decreased from 214,000 in 1985 to 138,795 in 1993.

Table 11.3 gives the catch data by country for the period 1975 to 1993 from the sardine stock area (Divisions VIIIc and IXa). About 97% of the total catch in the stock in 1993 was taken by the purse seine fleets from Spain and Portugal (Table 11.4). Total landings for 1993 were at the same level for 1989-1990 and a little higher for 1991-1992 , the catches have increased in both countries, Spain and Portugal (Table 11.3).

For all available catch data (1940-1993) for this division (Figure 11.1) the total catch decreased from 1986 to 1992, following near-stable catches of about 200,000 t during the period 1980-1985. The highest landings occurred in 1961 (250,000 t) and the lowest in 1949 (67,000 t).

During 1993 the seasonal pattern of landings by the two countries was the same as reported in previous years with about 36% and 64% of the annual catches being landed in the 1 and 2 quarters of the year, respectively (Table 11.4).

11.4 Distribution of the Sardine Fishery

Figures 11.2a-d show the distribution of catches by quarter during 1993. For the last two years sardine landings by rectangle have been reporter by countries for Sub-area VII and Divisions VIIIa-b.

The distribution of catches in 1993 by quarter and area in Divisions VIIIc and IXa was similar to that in recent years, with 56% of the total catches from Sub-division IXa Central North and Central South (Table 11.5). As in previous years the catches in Division VIIIc east were the lowest.

11.5 Effort and Catch per Unit Effort

Table 11.6 gives the effort in fishing days and the catch per unit effort (tonnes/fishing day) for four different purse seiners fleets, from Spain and Portugal.

Figure 11.3 gives the CPUE (tonnes /fishing day) for the purse seine fleets by area. The CPUE trends for the fleets of Portugal (Division IXa Central +South), Vigo-Riveira (IXa North) and Santonia (Division VIIIc East) indicate a decrease from 1988 to 1992 with an increase in 1993. The CPUE of Sada fleet (Division VIIIc west) decreased from 1987 to 1991 and then there was a slight increase during the last two years.

11.6 Fishery-Independent Information

Acoustic surveys

Systematic acoustic surveys, to estimate the biomass of the Atlantic sardine stock present in the Spanish area in spring, began in 1986. Since 1991, with a new EK-500 echosounder and ecohintegrator, the area covered was extended to the 1000 m isobath to observe the distribution of the main pelagic species in the area The survey execution and the estimate calculations followed the methods adopted by the Planning Group for the Acoustic Surveys in ICES Sub-areas VIII and IX (Anon. 1986c).

The sardines detected were distributed along the continental shelf of the surveyed area (as far as 200m isobath). Nevertheless in 1988, 1990 and 1993 in western Cantabrian, sardine shoals were found in offshore waters; in the north of Galicia sardine were located over a rocky seabed close to the coast. In 1991 and 1992 sardines were only distributed near the coast in shallower waters

Different cruise tracks were used during this time series. The "zig-zag" track had a better degree of coverage than the perpendicular track design. In 1991, 1992 and 1993 the surveys were very good, for 1988 and 1990 they were normal and for 1986 and 1987 survey coverage was poor. The differences between degrees of coverage are mainly due to the differences in the cruise track (Per-Par, Zig-Zag) and in the number of integrated miles (Porteiro *et al.*, 1993).

The total biomass in April-May 1993 was estimated to be 126,000 t, corresponding to 1567 million fish. The highest concentrations of sardine were detected in the Cantabrian Sea close to the eastern part of Sub-division IXa North, with an estimated biomass of 18,000 t. This consisted mainly of the 1991 and 1992 year classes. The 1983 and 1987 year class are still important, representing 50% of the total catch. The 1993 survey indicates that the 1991 recruiting year class is a good one. It was found in all areas, especially in Galicia and the west Cantabrian sea.

Due to the technical problems with the Portuguese research vessel, it was not possible to carry any acoustic survey for sardine during 1993 in Portuguese waters.

Table 11.7 gives the abundance estimates of sardine from acoustic surveys from 1986 to 1993 carried out by Spain and Portugal. Table 11.7 also gives the total biomass (B) from acoustic surveys carried out by Spain and Portugal and the annual catches by countries.

The systematic acoustic surveys of spring sardine in the Spanish waters was stopped in 1994, in order to carry out an acoustic survey covering the Atlantic Iberian distribution area (ICES Sub-division VIIIc and Division IXa). Next September the Portuguese research vessel will carry out an acoustic survey along the Portuguese and Spanish Atlantic waters adopting the methodologies of the Planning Group for Acoustic Surveys in Sub-area VIII and Division IXa (Anon. 1986c).

Particular emphasis must be given to carrying out an acoustic survey which covers the entire area over which the sardine stock is distributed in Divisions VIIIc and IXa during the recruitment season in the second half of the year. These surveys should be conducted in September because this is the recruitment season. Furthermore good weather for acoustic surveys can normally be expected at that time. In previous years acoustic surveys programmed to take place in October/November have been abandoned because of the bad weather. The Working Group therefore recommended that acoustic surveys for sardine be carried out in Divisions VIIIc and IXa during September, covering the whole are of their distribution.

11.7 Length Compositions by Fleet and by Country

In 1993 the quarterly and annual catch length compositions by fleet were provided by Portugal and Spain in Divisions VIIIc and IXa (Table 11.8), and were provided by England (U.K) in Division VIIe (Table 11.9).

As in previous years, the smallest fish were caught off the west coast of Galicia (Sub-division IXa North) and the largest fish were caught in Divisions VIIIc and VIIe.

The mean length of fish caught was 23.2 cm in Division VIIe and 18.8 cm in Divisions VIIIc+IXa, the mean length being the smallest in Sub-division IXa north (18.6 cm).

11.8 Catch in Number at Age

Based on data submitted by Working Group members, the 1993 catch in number at age data were compiled by quarter and sub-divisions of Divisions VIIIc and IXa (Table 11.10).

The Portuguese data (catch in number, length composition, age length/ key) were collected on a quarterly basis by sub-division. The Spanish data were collected on a quarterly basis, using the length composition by quarter and the two half year age/length keys.

The 1993 catches of 0 -group were more important in Sub-division VIIIc west and Division IX a Central - South, northern and southern than in previous years. The catches of the 1-group in Divisions IXa north and IXa central-north are larger. The catches of 1-group in Division IXa central south increased in the 4th quarter. The oldest ages (above age group 6) occurred mainly in the catches of Division VIIIc .

The annual catch in number at age for the period 1976 to 1993 is presented in Table 11.11.

11.9 Mean Length at Age and Mean Weight at Age

The 1993, mean lengths at age in the catches by quarter were provided by Spain (Division VIIIc east, west and Division IX a north) and Portugal (Division IXa central-north, central-south and south) (Table 11.12)

The mean weights at age in the catch in 1993 were based on Spanish and Portuguese biological sampling. Table 11.13 shows the mean weight at age by sub-division and quarter. The 1993 mean weights at age in the catch are smaller than in 1992 but more similar to those from previous years (Table 11.14).

Table 11.15 shows the mean weights at age in the stock for the period 1976-1993. The 1993 mean weights at age in the stock have been calculated from commercial sampling during the period December 1992- January 1993. It seems that there are differences in the mean weight at age in the stock in 1993, which are higher than in previous years. In the late 1992 (November-December) acoustic surveys carried out in the Portuguese and Spanish waters the mean weight was also high (Dias *et al.*, 1993).

11.10 Maturity at Age

The maturity ogive for 1993 was estimated using the first quarter data from Portuguese and Spanish biological sampling (Table 11.16). Of a total of 983 individuals examined 667 were mature. The percentage of mature at age 1 in 1993 (47 %) is lower than for the same age in 1992 (79%). The lowest percentage of mature at age 1 (26%) was in 1989. In age 2 and older the percentage of mature fish in 1993 is similar to that in recent years.

11.11 Assessment

The available data for tuning the VPA are given in Table 11.17a-e. A value of M= 0.33 used for all ages and all years and the proportion of M and F before spawning was taken to be 0.25. Catch at age data for ages 0 to 6+ were available from the fishery and were included in the assessment.

The fishery independent data used for tuning the current was (1) Spanish Acoustic survey (1988-1991) and (2) Portuguese Acoustic surveys (1984-1992) (Tables 11.17-a,e).

The assessment of sardine was found to be problematic. In an example run, the XSA algorithm was found to be unstable when applied to these data (Text Table 1). In consequence and due to the lack of diagnostics indicating whether a reliable solution had been found, all further assessments were calculated with the ICA programmes, Patterson (1994). These programmes have been revised and tested by Anon. (1994a).

Text Table 1. SARDINE in Division VIIIc and IXa. XSA Estimates of terminal fishing mortalities on age 1-5 after varying number of iterations. Tricubic tapering applied, no F shrinkage used, catchability independent of stock size for all ages, and catchability independent of age above age 5.

No. Iterations	F 1	F 2	F 3	F 4	F 5
30	0.0767	0.1626	0.6802	0.2976	1.3048
60	0.0779	0.1671	0.7148	0.3157	1.6340
120	0.0794	0.1726	0.7635	0.3418	2.2171
240	0.0805	0.1777	0.8196	0.3699	3.1794
500	0.081	0.181	0.8603	0.3913	4.4745

Initial trial runs indicated that it is extremely difficult to discriminate between a situation of flat-topped selection and high fishing mortality, and one of relatively low selection at the older ages and relatively low mortality. This is because there are few fully-recruited age-groups, and terminal fishing mortality on the oldest ages is very sensitive to assumptions made about exploitation pattern. An initial run fitting a separable model to the catch at age matrix and using the acoustic surveys by Spain and Portugal as proportionate indices of stock size was attempted, using only information on ages 1-5. This indicated a flat-topped selection pattern from ages 3 to 6+, and fishing mortalities of approximately 0.5 at age 3. However, the Working Group noted that there are substantial numbers of fish aged between 6 and 12 years recorded in the Spanish acoustic survey. Such observations would be very unlikely if fishing mortality were indeed as high as 0.5 (with terminal selection constrained to be flat-topped). Terminal selection is often chosen by eye and by prejudice, but the Working Group decided to attempt to define terminal selection in a more objective fashion. The method used was as follows:

(1) A model was fitted to the data comprising the following components:

- Separable assumption for catches at age from 1986 to 1993, referenced to age 2.
- Age 1 was downweighted to 0.1, other ages were assigned a weight =1
- Age 6 was treated as a plus-group
- Terminal selection was varied from 0.5 to 1.30.

(2) The Spanish acoustic survey was included in the fit, assuming that the survey index of abundance is proportional to stock size (measured with lognormal error). Estimates of abundances of fish aged 6 to 10 were accumulated in a plus-group. All the true ages were assigned a prior weight=1; the plus-group was assigned a weight equal to the number of accumulated ages. The inclusion of a rather large plus-group in the model tends to lead to solutions with low fishing mortality.

(3) The Portuguese acoustic survey was included in the fit with equal weight to that of the Spanish survey. Few fish of age 6 and older are recorded in the Portuguese survey as this covers mostly the area of distribution of the younger fish, and so in this case the plus-group was given a weight equal to that on the true ages.

The objective function fitted with the model was:

$$\sum_{a,y}\lambda_a(\ln(C_{a,y}-\ln(\hat{C}_{a,y}))^2+$$
$$\sum_{a,y}\lambda_{SP}(\ln(ASP_{a,y}-\ln(Q.N^*_{a,y}))^2+$$
$$\sum_{a,y}\lambda_{PO}(\ln(APO_{a,y}-\ln(Q.N^*_{a,y}))^2$$

$$\lambda_a = 0.1 \textit{ for age } 0,\ 1 \textit{ for other ages}$$
$$\lambda_{SP} = 5 \textit{ for plus-group},\ 1 \textit{ for true ages}$$
$$\lambda_{PO}=1 \textit{ for all ages}$$

where C and Ĉ: observed and expected catches at age. ASP - Spanish Acoustic Survey. APO-Portuguese acoustic survey; lambda are the weighting factors in the model.

The terminal selection of best choice was found by repeating the model fit over a range of terminal S (relative to age 2) from 0.5 to 1.3, and seeking a best fit to the combined survey data. This is given in Text Table 2.

The best fit to the combined survey data was found at terminal S=1.25, but the sums of squares surface is extremely flat over the region 0.75 to 1.3. It is effective ly not possible to discriminate terminal selection by this method, but the best fit obtained at terminal S=1.25 was considered to be at least a terminal selection chosen by a method with some measure of objectivity.

Text Table 2. Unweighted sums of squares from the separable model, the Spanish acoustic survey and the Portuguese acoustic survey, for different assumed values of terminal selection on age 5 relative to age 2.

Terminal Selection	Separable SSQ	Spanish Acoustic SSQ	Portuguese Acoustic SSQ	SSQ for Both Surveys
0.5	4.13	26.42	22.72	49.14
0.75	3.24	25.83	17.74	43.57
1.0	3.00	25.99	15.12	41.11
1.1	2.982	26.13	14.41	40.54
1.15	2.980	26.21	14.11	40.32
1.20	2.691	26.29	13.84	40.13
1.25	2.987	26.38	13.59	39.97
1.3	3.125	27.96	13.85	41.81

Two views of this stock are presented here. The first (Figures 11.4a-e, Table 11.18) uses the conventional approach of attempting to fit a selection pattern which is flat over the last few ages (Flat, Terminal S =1.0 relative to age 3), and ignores plus-groups in the fitting. This leads to perceptions of high fishing mortalities (ca. 0.5) and a view of a heavily-exploited stock with a short lifespan. An alternative interpretation (Figures 11.5a-e, Table 11.19) includes the observation of high abundances of older fish in the Spanish acoustic surveys, and in which terminal selection is fixed at 1.25 relative to age (2 dome shaped, S = 1.25 relative to age 2). In this latter interpretation, the fishery is exerting a low fishing mortality on young fish, and a large stock of older fish exists in the area surveyed by the Spanish survey. The Working Group considered that these views are not statistically distinguishable, and decided to present the two assessments as representing a 'best' and a 'worst' case for the assessment.

11.12 Recruitment

Trends in recruitment are shown in Figures 11.4a) and 11.5a) for the two assessments presented in Section 11.11. The estimate of recruitment at age 0 from the model fit was high in 1991 but low in 1993. This is however due only to low catches at age 0 in 1993, which could be due to factors other than low cohort strength. There are no survey data for age 0 in 1993.

11.13 Long-Term Trends

The input data for the yield-per recruit and catch forecast are given in Tables 11.22a and 11.23a assuming the mean F for the years 1991-1993 (F status-quo) obtained for each assessment. Long-term trends in yield and spawning stock biomass against the average fishing mortality (ages 2-5) are given in Tables 11.20a and b and Figures 11.8 and 11.9. The two options produced different results.

11.14 Biological Reference Points

The fishing mortality levels Fhigh, Fmed and Flow were estimated from the plots of recruitment against SSB for both assessments (Figures 11.6 and 11.7).

For both assessments the spawning stock biomass shows a decline from 1985 to 1991 and a slight increase in 1992 and in 1993. The yield has declined since 1986 and the fishing mortality shows a decreasing trend from 1990. After 1983 no very strong year classes occurred, those of 1987 and 1991 appears to be good level.

For the option with S=1.0 the mean F(1991-1993) at age 2-5, is below the Fmed(0.0281)

11.15 Catch Forecast

Two sets of catch forecasts are presented, corresponding to the 'flat case' and to the 'dome shaped case' assessments. In both these sets of forecasts, the following baseline options were chosen: (Tables 11.22a and 11..23a):

- Terminal populations from the model fit for ages 2-6 were used as starting populations on 1 January 1994.
  - A geometric mean recruitment at age 0 from 1984 to 1992 was used.

- A geometric mean recruitment of age 0 fish, decremented by M and estimated F on this age group in 1993, was used as the estimate of age 1 fish in 1994.
- Mean catch weights, stock weights and maturity at age over the period 1991-1993 were used.

Forecasts corresponding to the following options were calculated: (Tables 11.22b-c and 11.23b-c:

1) Options for F in 1994
   - F in 1994 = F in 1993
   - F in 1994 = Mean F over 1991-1993

2) Options for F in 1995
   - F in 1995 = F in 1993
   - F in 1995 = Mean F over 1991-1993
   - F in 1995 = Range of options from 0 to 2.0 times F in 1993

Under conditions of fishing at the level of mean F from 1991 to 1993 would be expect.

Table 11.21 summarises the predictions carried out with the different Fs (*status quo*) (F1993 and F1991-93) for the period 1994-1996. Catch predictions for 1995 for the different options A (dome shaped, S = 1.25) and B (flat, S = 1.0) ranged values between 121,000 t and 160,000 t. The spawning stock biomass for both options are very different; in both hypothesis the SSB will decrease from 1995 to 1996.

11.16 Comments on Assessment

The Working Group views with some concern the importance to the assessment of the inclusion of the Spanish survey data on older fish. The assessment is highly sensitive to these observations, which in conventional assessments would be given little weight. In addition, statistical indeterminacy between a situation of high terminal selection and high F and one of lower terminal selection and low F arises because there appear to be few fully-recruited ages in the fishery, such that population abundances and fishing mortality are driven by prior choice of selection. Also M is assumed to be rather high in this stock, further worsening the convergence properties of the VPA.

$F_{status\ quo}$ stock projections and management options from the two assessments were calculated from each of the two assessments, and are presented in Tables 11.21, 11.22 and 11.23. This shows that the projected catch is not very sensitive to prior assumptions about selection pattern and the inclusion of the plus group.

Short-term projections based on small changes in fishing mortality are not very sensitive to the difference between the two assessments. Management considerations based on longer-term projections and yield per recruit calculations will be much more sensitive to the difference between the assessments.(See Section 16.1).

The choice between the two assessments performed for sardine will be done on the basis of the results from the next acoustic survey in Divisions VIIIc and IXa the next September and the results will be sent to the next ACFM meeting in November.

11.17 Management Measures and Considerations

The catches of sardine have been decreasing since 1986, with an increase in 1992. In the assessment with terminal S=1.0, the fishing mortality decreased from 1990 to 1992 and increased in 1993. In the assessment with terminal S=1.25 the fishing mortality decreased in 1991 and in 1992-1993, it remained at the same level.

For this stock:

S=1.0, values at age 3:

F_{high} >2, $F_{1991\text{-}1993}$=0.4313, F_{med} = 0.281, F_{low} = 0.-0438

The F_{sq} (0.4313) is above the F_{med}

S=1.25, values at age 2:

F_{high} >2, $F_{1991\text{-}1993}$ = 0.1982, F_{med} >2, F_{low} = 0.1377

The F_{sq} (0.1982) is below the F_{med}

In 1992 the Working Group addressed an EC request for advice whether the sardine fishery in Divisions VIIIc and IXa should be regulated by a TAC (Anon., 1992b), but no TAC has been implemented up to the present time.

12 ANCHOVY - GENERAL

12.1 Unit Stocks

Considering the phenotypic and genetic studies made and mainly the migration pattern of the anchovy in the Bay of Biscay (Prouzet & Metuzals 1994), the Working Group continued to consider the Bay of Biscay anchovy population as a single management unit in Sub-area VIII and assumed that anchovy off Portugal, the Division IXa were another management unit.

12.2 Distribution of the Anchovy Fisheries

Figures 12.1a-d sum up all the information on the fisheries directed towards anchovy in Sub-area VIII for 1993. During the first quarter, the main fishery (predominantly French fleet) is located around the Gironde estuary and alongside southern French coasts. During the second quarter, the main landings (predominantly Spanish) were caught off the southern part of the Bay of Biscay (south of 45°N.). During the second semester, the main fisheries (French fleet) were located in the north of the Bay of Biscay whereas small landings appeared along the Spanish coast (Spanish fleet).

Concerning Division IXa, the main fishery is the Spanish one which takes place in the Bay of Cadiz, in the south of this Division during the first semester.

12.3 Length Compositions by Fleet and by Country.

1993 annual length compositions of landings of the Bay of Biscay anchovy (Sub-area VIII) by fleet were provided by France and Spain (Table 12.1). Although the mean length of anchovies caught is very similar for the two countries, the length distributions show some differences especially for the first semester (Figures 12.2a and b). In the first quarter the Spanish purse seiners catch smaller anchovy than the French pelagic trawlers do. In the second quarter, the pelagic trawlers retire from the fishery and the French catches only correspond to the purse seiners which fish small anchovy close to the shore. On the other hand, the Spanish catches of the second quarter are characterized by bigger anchovies similar to those landed, in the first quarter, by the French pelagic trawlers. This is due to the normal pattern of availabity of anchovy to the purse seine fishery according to size over the spring fishing season (Uriarte & Motos, 1993). For the second semester, (Figures 12.2c and d), the fleets continued to catch medium size or big anchovies found in spring, except for the fourth quarter when the Spanish purse seiners caught very small anchovy (0 age group).

1993 Spanish length compositions of the catches of anchovy in Sub-Division IXa South are shown in Table 12.2 and Figure 12.3. The mean length and weight in the catch are lower than those recorded for the Bay of Biscay anchovy throughout the year. This year, a great decrease is observed in the number of juveniles captured (individuals with a length inferior to 10 cm), their proportion in the total landings decreased from 37% in 1992 to 19% in 1993. The Portuguese length distributions of anchovy in Division IXa is not available.
Section 12

13 ANCHOVY - SUB-AREA VIII

13.1 The Anchovy Fishery in 1993

13.1.1 Fleets, scheme of fishing and regulation

Two fleets operate on anchovy in the Bay of Biscay:

Spanish purse seine fleet : Operative mainly in the spring, when more than 80 % of the annual catches of Spain are usually taken. This spring fishery operates at the southeastern corner of the Bay of Biscay in divisions VIIIc and b. Spanish purse seiners are allowed to fish anchovy in Sub-division VIIIb only during the spring season and under a system of fishing licences (see more details in Anon. 1987), while Division VIIIa is closed to them for the whole year.

French Pelagic Trawlers: Operative in summer, autumn and winter. Untill 1992, it also operated in the spring season, but due to a bilateral agreement between France and Spain the spring is not presently used as fishing season by the pelagic trawlers. The major fishing areas are the VIII a and b in the first semester and VIIIa, mainly, during the second one. The VIIIc area is prohibited to the French pelagic fleet (Prouzet & Metuzals 1993).

There are also some purse-seiners located in the Basque country and in the southern part of Brittany.

This fishery is regulated with a TAC of 30,000 t. The formula for allocation is 10% for France (3,000 t) and 90% for Spain (27,000 t). However, since 1992, a bilateral agreement between France and Spain modifies every year the allocation between the two countries. More precisely, 6,000 t from the Spanish quota are allocated to the French fleet for the second half of the year, if the French midwater pelagic activity for anchovy stop during the main Spanish fishery in spring (from 20 March to 1 June).

13.1.2 Landings in Sub-area VIII

Under these circumstances, total international landings in Sub-area VIII amounted to 40,087 t in 1993 (Table 13.1 and Figure 13.1), the highest catch level since 1978. The French and the Spanish fisheries have achieved roughly the same landings : 19,173 t for the Spanish fishery (90 % in the spring fishery) and 20,914 t for the French fishery (70% in the second half of the year; the highest landings of the historical series) (Table 13.2).

No discards were observed in the Spanish fishery and the discards have not been recorded in the French fishery, although in the reported total French landings the catches withdrawn are included.

During the first half of 1994, total international catches reached 19,000 t (preliminary data).

13.1.3 Landings by divisions

In 1993, the Spanish and French fisheries were well separated geographically as in 1992. More than 70% of the Spanish landings were caught in Division VIIIc, mainly in spring, while more than 65% of the French landings were caught in Division VIIIa, mainly in summer and autumn (Table 13.3).

13.1.4 Landings by EU categories

The distribution of Spanish and French landings by EU market category in Sub-area VIII by quarter are given in Table 13.4. For the whole year combined the distributions by EU market category are rather different for the two countries. The French landings are characterised by a higher proportion of T2 category : 77.7% against 48.1%. Since 1989, the main EU market category for the two countries is T2 (30-51 fish per kg).

13.2 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 13.5 and Figure 13.2. The French fleet of midwater trawlers involved in the anchovy fishery has increased continuously over these years. In 1992 and in 1993, the number of pelagic trawlers is around half of the number of Spanish purse seiners. Table 13.5 shows that, during the last 5 years, the number of vessels in the French pelagic fleet for anchovy has more than doubled and at the same time their catches have reached the same level as the Spanish ones. These general observations indicate a sharp increase of fishing effort on anchovy in the Bay of Biscay since 1987, despite some decrease in the number of Spanish purse seiners. Although the pelagic trawlers are not allowed to fish anchovy in Division VIIIc, they have opened new fishing periods (autumn and winter mainly) and a new fishing ground in Division VIIIa, especially since 1990.

A rough evaluation of the Spanish and French efforts in terms of number of gears multiplied by the number of months of activity shows a comparable fishing power : around 430 vessel*months for the French fleet and around 500 vessel*months for the Spanish fleet. This observation further indicates that effort developped by the two countries is, at present, similar although the fishing pattern is different. Nowadays, twice the number of spanish purse seiners would be about the level of effort that existed in this fishery at the beginning of the seventies.

The CPUE of the purse seiners in the Spanish spring fishery on anchovy is linked to the anchovy abundance in the southern area of the Bay of Biscay and, less closely, to the evolution of the biomass of the whole population in the Bay of Biscay, as measured by the daily egg production method (Uriarte and Villamor, WD 1993). The preliminary index for the first half of 1994 shows a certain decrease in the CPUE of the total catch as well as that of the 1 year old anchovy compared to the ones estimated in 1992 and 1993 (Table 13.6, Figure 13.3). This seems to be linked to a lower level of recruitment in 1994.

13.3 Fishery-Independent Information

13.3.1 Egg surveys

Egg surveys to estimate the spawning stock biomass (SSB) of the Bay of Biscay anchovy through the Daily Egg Production Method (DEPM) were undertaken from 1987 to 1992. The final data from the 1992 survey and a summary of the results of the whole set of surveys were presented in 1993 (Motos and Uriarte, WD 1993). Table 13.7 presents these results. The highest SSB was observed in 1990 and 1992, due to strong recruitments of 1-year-old anchovies.

The surveys are considered to be unbiased and to produce absolute figures of biomass. The composition of the stock was derived for all these surveys, based on the adult sampling performed during the surveys. However, in 1987 and 1988 the adult sampling did not cover the whole spawning area of anchovy and therefore some asumptions about the composition of the population in the unsampled area had to be made. Because of this the age compositions for the DEPM surveys in 1987 and 1988 are less reliable than those of the following years.

In 1993, the Spanish DEPM surveys were stopped until a decision on the method of management is known. Because of this, no survey has been carried out and no SSB estimate is available for 1993. In 1994, a DEPM survey has been undertaken again thanks to the cooperation between France and Spain.

13.3.2 Acoustic surveys

The French acoustic surveys aimed at estimating the abundance of the Bay of Biscay anchovy were also stopped in 1993. The results of the surveys between 1983 and 1992 appear in Table 13.8. The figures for 1991 and 1992 were revised and updated for a FAR programme on anchovy. In 1993 and 1994, only observations concerning the ecology of anchovy, especially located close to the Gironde estuary (one of the major spawning area of the Bay of Biscay for anchovy), were made.

According to the discussion made in 1993 (Anon. 1993d) the acoustic values are considered to be relative index of abundance and the values of 1983 and 1984 seems to understimate the abundance of the stock in absolute values (or even in relative terms compared to the most recent results of the acoustic surveys).

13.3.3 Comparison of abundance indices

The agreement and discrepancies between these two kinds of surveys have been studied as part of a FAR program whose principal conclusions are :

The general trend in the estimates of anchovy biomass from the acoustic and DEPM methods is comparable between 1989 and 1992 but there was an anomaly in 1991 that has not been possible to explain. Both methods however, indicate a similar trend in the population (Table 13.9). A longer time series of surveys is necessary to fully evaluate the relative performance of both methods to estimate anchovy abundance in the Bay of Biscay.

13.4 Recruitment

Because the acoustic and egg surveys were stopped in 1993, no additional direct estimates of recruitment are available. The information provided by the data from the Spanish purse seine fishery in spring 1993 (see Table 13.6) suggested a medium or high recruitment of anchovies at age 1 in that year, comparable to those recorded in 1990 or 1992 (Anon. 1993). The annual catches of the international fishery in 1993 confirmed that indication. In 1994, the same CPUE from the Spanish spring fishery, suggests a decrease of the level of recruitment compared to the last two years.

In general, the results concerning 1992 and 1993 confirmed the high variability of recruitment for the anchovy stock in the Bay of Biscay (Figure 13.4). In 1991, as in 1989, significant recruitment was produced at low levels of spawning biomass.

13.5 Catch in Numbers at Age

In 1993 as in 1992, the international catches of anchovy (in numbers) consisted mainly of 1-year-old anchovies, making up 64% and 80% respectively for the first and second halves of the year (Table 13.10). For Spain and France, the contribution of the 1-group to the total landings was 70%. A rough calculation indicates that 16% of the total catches of age 1 were taken from the immatures prior to their first spawning of May.

The catches of anchovy in the live bait fishery for the period 1987-1993 are given in Table 13.11. Live bait catches of anchovy are rather variable depending on the availability of several small pelagic species in general and not only on anchovy. Catches of immatures for tuna fishing in recent years seems to be low compared to the period 1987-90.

Table 13.12 records the age composition of the international catches since 1989, on a half-yearly basis. As in 1990 and 1992, 1-year-old anchovies largely predominated in the 1993 catches. However, the preliminary information from the Spanish fishery in 1994 indicates that catches have been sustained by 2 years old anchovy in a higher extent than previous years (see Table 13.6)

The major recruitment of immatures to the fishery occurs in the first months of every year as 1-group, from January to the end of April, these fish becoming active spawners at the beginning of May. Catches of these immatures formed 20% of the total international catches in weight in 1992 (Anon., 1993d) and less in 1993. In the second half of the year, there are catches of immatures belonging to the age 0 group which vary in importance considerably between years.

Table 13.13 contains the available historical catches by age on an annual basis for the Bay of Biscay anchovy. The changes in age composition between the 1984 -1993 period and the earlier years could be related to a higher dependence of catches on recruitment in recent years. However, there also appears to have been some differences in the age - reading procedure, because age group 1 is rarely dominant in the landings prior to 1983. A revision of the age composition of the anchovy catches prior to 1983 has been done in the framework of a FAR program and the conclusions suggest that, effectively, in some of those past years, there were used different ageing criterias than the ones presently defined..

13.6 Mean Weight at Age and Mean Length at Age

Mean weight data are shown in Table 13.14. The French mean weights at age in the catches were based on biological sampling of scientific survey and commercial catches. Spanish mean weights at age were calculated from routine biological sampling of commercial catches.

Large differences were observed between the mean weight of age groups caught by the Spanish and the French fleets over the past year 1993. These differences can be explained by the different seasons and fishing groundsof the two fleets. For instance, during the first semester the French landings were made during the first three months while the Spanish ones were made during the last three months. In the second half of the year, the French landings were mainly caught off the VIIIa, whereas the Spanish ones were mainly caught in the VIIIc.

13.7 Maturity at Age

As reported in previous years' reports, all age groups are fully mature in spring. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Anon., 1992b)

13.8 Assessment: Natural and Fishing Mortalities

In previous years an assessment was implemented assuming that the biomass estimates from the DEPM were absolute figures free of errors. In that way fishing and natural mortlities were deduced, but the ACFM did not accept them because of the high variability of the results in F and M Table 13.15). The errors of the direct Biomass estimates could be influencing the highly variable estimates of natural mortality. This year a new assessment has been tried based on an Integrated statistical analysis of the different sources of data from the fishery and the stock (Catch at age data, Acoustic index and DEPM biomass estimates). The assessment is performed with the ICA programme (Patterson 1994). For every run the assumption of a constant natural mortality among years is required. The analysis is presented in Appendix 1 of this report together with a summary of the assessment performed in the previous years by this Working Group.

The main results of this assessment performed with the ICA program indicate that F and M estimates are very uncertain. Whatever natural mortality is used the fits remain rather similar. Therefore, the model underlying the ICA program does not allow to define a best constant natural mortality for that stock. The rate of exploitation of the fishery (F/Z) remains imprecise as far as it depends on the estimate of natural mortality used.

13.9 Trends in Biomass and Recruitment

The revision of the results of the acoustic and egg surveys does not change the conclusions made in last year's report, viz.:

- The stock size is at a greatly reduced level compared to the 1950s and 1960s. There is the possibility that the larger fleet which existed in those years could have led to overfishing, but it cannot be proved. The possibility that environmental factors have caused the reduction of the stock is also considered (Junquera, 1986).

- The analysis of the direct biomass estimates of anchovy shows a decrease of recruitments at high biomasses since 1987 (Figure 13.5); this could be due to a negative SSB/R relationship linked to density-dependent factors or it could be due to fluctuating environmental conditions affecting recruitment. Since the figure is based on only 6 years of observations (5 points), it is necessary to be very cautious and not to derive any definitive conclusions from that figure. Moreover, the observations collected from the fishery in 1993 seem to indicate that a significant recruitment was produce from the large spawning biomass of 1992.

For the time being, the Working Group noted that the large fluctuations in SSB observed during the last six years are mainly due to the variations in 1-year-old recruitment.

Underestimation of the variability of recruitment of the Bay of Biscay anchovy could be derived from the historical variation of Spanish catches (Figure 13.1 and Table 13.1). Historical average catches are 34,490 tonnes with a coefficient of variation (CV) of 68%. The 6 years of surveys indicate a mean recruitment of 1-year-olds at 1 June each year of 40,000 tonnes with a CV of 100%.

In the nineties Spanish catches have been increasing in relation to the eighties which seems to indicate that higher than average recruitments have been entering the population in this recent years compared to those of the past decade.

13.10 Catch Forecast

No forecast will be available since there is no direct estimation of the stock in 1993 and because, as mentioned last year, a proper catch forecast has to be based on the results of a survey performed at the beginning of the management year in question.

13.11 Biologically Safe Limits

Since the last Working Group meeting no new information has been gathered. The Working Group recalls, therefore, that, from a short-term point of view, the data obtained from acoustic or eggs surveys indicate that environmental factors may affect recruitment. The impact of the environment on the fluctuation of small pelagic stocks is commonly observed throughout the world.

The data available show that an SSB of 15,000- 20,000 t produced the highest recruitment in the period 1987-1992. This gives a reference for a minimum precautionary biomass level. However, no information is available on the size of year classes produced in the 1960s when the spawning stock size is likely to have been much larger than at present.

13.12 Comments on Assessment

Estimates of F and M are highly dependent on the direct estimates of biomass from the DEPM surveys. Improvement of the mortality estimates has to be made by taking into account the errors associated with the SSB estimates.

13.13 Management Measures and Considerations

The anchovy occurring in the Bay of Biscay is a short-lived species which is 100% mature at 1 year old. The Bay of Biscay anchovy is a small stock and the value of the catch can reach a very high level. The landings are used for canning and fresh consumption. The fleets are purse seiners and mid-water trawlers and these are very dependent on this resource for their survival. In this context, the scientific advice has to be very reliable and accurate, in order to avoid any unnecessary loss of catch to the fishermen.

The analysis of catch data at age shows since 1987 a decrease of the mean age of the catch. This fact associated with an increasing fishing effort seems to show an increase of the fishing mortality on that species in the recent years. The catches are currently exceeding the average catches managed on this anchovy since 1960. The past history of this fishery shows that a large fleet or high levels of effort cannot be sustained for a long period. Therefore, the necessity of managing the fishery is clear. The best way to manage this stock may be to regulate the effort by statistical TACs or by a system of fishing licences (Anon. 1992b).

Provisionally, the Working Group indicated procedures for managing the stock (Anon., 1993d), which can be summarized as follows:

- Quantitative management of the fishery: regulation of catch via an analytical TAC;

- Qualitative management of the fishery: fishing effort regulations including close seasons, close areas and technical measures to increase the spawning stock biomass.

Some additional comments can be added :

Quantitative management of the fishery seems to be possible (see Appendix 3 of Anon. 1993d for further explanation) but depends on obtaining reliable acoustic indices of the stock size every year prior to the spawning season. At least 3 further years acoustic and DEPM surveys would be required to evaluate fully the performance of the surveys and the management procedure. If managers decided to apply this kind of management, the acoustic surveys would have to be continued indefinitely, and DEPM surveys could be carried out about every 3 years.

At the moment, however, considering the uncertainties in the estimates of SSB, M and the Biologically Safe Limit, it would be difficult to manage this stock very effectively using absolute biomass estimates.

In the case of qualitative management of the fishery, some of the measures outlined can already be applied, i.e., size limits, closed periods and areas. However, precise definition of the allowable level of effort has to be further investigated. The number of fishing licences would have to be related to the expected average yield of the stock within safe biological limits. In order to estimate this level and to check performance of this management procedure, regular direct DEPM estimates for the stock will be necessary. If effort is set at medium or low levels the performance of qualitative management could be as good as that using quantitative methods. The DEPM monitoring could also be used to strengthen effort regulation and technical measures at low levels of SSB.

The Working Group recommands that a choice needs to be made from among the different scientific management procedures proposed here, and draws attention to the fact that scientific advice on this stock requires the adoption of routine monitoring of the stock by direct survey methods.

14 ANCHOVY IN DIVISION IXA

14.1 The Fishery in 1993

The Spanish fleet in the Bay of Cadiz is mainly composed of purse-seiners (Anon., 1992b) though currently there is another kind of fleet in the form of trawlers, prepared to fish for pelagic species, principally anchovies. This latter fleet works mainly in the first quarter of the year (Table 14.2). The catch of this fleet makes up around 17% of the total Spanish catch.

The Portuguese fleet is made up, mainly, of purse-seiners, some trawlers and artisanal ships which catch a very small quantity of anchovies (Anon., 1992b). The anchovy is not a target species of the Portuguese fleet.

14.1.1 Landings in Division IXa

The international catch in 1993 totalled 1,984 t (Table 14.1), which was lower than in previous years.

The Spanish catch in 1993 was 1,961 t (the lowest catch since 1988) and the Portuguese catch was 23 t (the lowest catch since 1943). As in previous years the Spanish catch made up 99 % of the total international catch.

As in previous years, the main season for the Spanish fishery was spring (March to June) with 86% of the total annual catch. (Table 14.3)

From 1943 to 1987 data on catches are only provided by Portugal and during this period the catches varied between 88 t and 12,610 t (Table 14.1). Data on the

Spanish catches for this period cannot be given since they have been combined with anchovy catches in the area off Morocco.

14.1.2 Landings by sub-division

The distribution of Spanish catches in 1993 was similar to those of previous years, with 99% of catches located in Sub-division IXa South (Bay of Cadiz) and the rest in Sub-division IXa North (west of Galicia). Catches in the Bay of Cadiz occurred mainly in spring (from March to June) (Table 14.4).

The Portuguese catches were taken from Division IXa Central North (95%) in autumn.

14.2 Effort and Catch per Unit Effort

The data provided for fishing effort and CPUE indices of anchovy in Division IXa relate to the Spanish purse seine fleet in the Bay of Cadiz. No Portuguese data are available.

Effort measured as the number of effective fishing trips made by three fleets in the Bay of Cadiz shows a decrease in all of them in 1993 (Table 14.5).

CPUE's descended in 1993, except for the multipurpose fleet from Barbate, which showed a slight increase (Table 14.6).

14.3 Fishery-Independent Information

14.3.1 Acoustic surveys

An acoustic survey was carried out in the Bay of Cadiz (Sub-division IXa South) from 5 to 10 of June 1993, to estimate anchovy abundances.

The survey covered the area between Ayamonte (latitude 07° 23'W) and Punta Camarinal (latitude 05° 48'W), following a zig-zag route between the isobaths of 20-500 m (Figure 14.1). The area covered by the evaluation was 2,866 mn^2, the area being divided into three sectors, West, Central and East, and 4 depthbathometric strata were considered in each: 20-50 m., 50-100 m., 100-200 m. and 200-500 m.

The methodology used was that adopted by the Planning Group for Acoustic Surveys in ICES Sub-areas VIII and IX (Anon., 1986c).

In Figure 14.1 and Table 14.7 anchovy distribution in June 1993 is shown. The anchovy is distributed throughout the area of study, between the isobaths of 20-50 m depth. The greatest concentrations were found around the mouths of large rivers, the Guadalquivir, Guadiana, Tinto and Odiel (central and western sectors, latitudes 07° 23'W - 6° 30'W).

The total biomass estimated in June 1993 was 6,569 t, corresponding to 462 million fish. The greatest abundances of anchovy were detected in the central sector (latitudes 06° 57'W - 06° 30'W) with an estimated biomass of 3,325 t.

The low number of recruits (specimens <10 cm) found in the survey is also observed in the study of the fishery where there has been a large fall in the number of juveniles caught, from 37% of those caught in 1992 to only 19% in 1993, which seems to indicate that there has been a poor annual recruitment.

14.4 Assessment

The data available at present are insufficient to make any assessment of this fishery.

14.5 Management Measures and Considerations

The measures of regulation are the same as in the previous year and are summarised by Millan and Villamor (WD 1992) (Anon. 1992b). As in 1992 the purse-seine fleet in the Bay of Cadiz stopped operating voluntarily from October to February.

Given the reduced knowledge of the biology and dynamics of this population, it is recommended that the precautionary TAC at the level of recent catches is appropriate in order to avoid an increase in effort.

15 CHANGES IN THE TARGET SPECIES AND FLEET STRUCTURE IN THE PELAGIC FISHERIES

In many fisheries assessed by the Working Group there is a lack of information about the structure of the fleets and the target species for the various fleets. The 1993 Working Group considered that this type of information could be highly important for understanding changes that are evident in various assessments. The Group, therefore, recommended that all countries taking part in any of the fisheries should provide data for the fleets involved.

It was considered that, although the number of vessels in fleets may have remained constant or even decreased, the changes that have taken place in the composition of the fleets may have had the effect of seriously increasing effort - e.g. increases in size of vessel, increased horse power, the use of much larger nets with stronger material. The Working Group felt that it was particularly important to monitor the introduction of more sophisticated fish detecting equipment - e.g. sonar and sounders which have the capability of determining the size distribution of shoals. It was felt that this latter factor may result in a change in exploitation which may not become apparent for a number of years. At present, because of depressed markets for many pelagic species vessels tend to be selective in regard to target species whereas in former years there was considerable flexibility between fleets. It was, therefore, also decided to note changes that have occurred in the utilization of catches or in the target species together with information on market fluctuations as it was felt that such information might help to clarify some of the change that have become evident in catches in recent years.

All countries were, therefore, asked to submit this data on all fleets for the years 1983, 1988 and 1993 by filling in a form sent to each country before the 1994 meeting of the Working Group.

All countries have delivered some data but for some fleets not all information is given for all years. Furthermore it has shown that the different information wanted has to be specified more clearly as there are different interpretations of questions between the countries, especially the definition of a fleet and when a ship qualifies as a member of a fleet.

The Working Group found, that even though all countries did not submit data for all years, it was possible to draw some interesting conclusions for some fleets. For example the number of Irish vessels participating in the mackerel and horse mackerel fisheries has remained constant since 1983. However, overall kW has increased from 7,500 kW to 22,700 kW, the average kW from 500 to 1417 and the average length from 29.8 m to 41.8 m. There has also been a dramatic increases in the size of nets used and in the strength of the material. A similar situation exists in the Dutch freezer trawler fleet whose fleet has decreased from 26 vessels in 1983 to 13 vessels in 1993 but the overall horse power has increased from 47,580 kW to 59,800 kW over the same period. Increases appear to have taken place in the numbers of UK(E & W) pair trawl vessels but there has been no increase in overall horse power evident in the Irish or Dutch fleets. In the Scottish mackerel fleet the number of pair trawlers has decreased in 1983- 1993 from 26 to 9 but the overall HP has only decreased from 14,378 hp to 9,171 hp. The number of Scottish purse seiners has also decreased over this period from 42 to 40 but the overall hp has increased from 45,000 hp to 75,000. Detailed information has also been provided by the Spanish fleets operating in 1993 but it is not yet possible to compare their data with previous years. Information was also supplied about the Danish pelagic trawl and purse-seine fleet, who in 1993 fished pelagic species for industrial purposes also for the French pelagic trawlers and purse-seine fleets fishing for anchovies. Details were also presented on the German pelagic freezer fleet for 1988 and 1993.

The Working Group concluded that the type of information presented will be extremely important in future years in detecting trends in fleet efficiency and in exploitation patterns.

The Working Group, therefore, recommends that a small group of working group members should by correspondence define the information that is required in order to combine the data from the various fleets and by doing so determine the effects that changes may have on individual stocks. Following that each country should complete or revise the description of their fleets if possible for the years 1983, 1988 and 1993. This data should subsequently be presented to the Working Group on a yearly basis. The data presented by each country for the 1994 Working Group have been placed on the Working Group file.

16 WORKING GROUP RESPONSE TO ADVICE REQUESTED BY THE E.U.

16.1 Mid-term Management Objectives

The Working Group reviewed the possibility of providing recommendations for management in the medium term. The precision with which stock projections can be calculated and advice can be given in the medium term is often strongly dependent on assumptions made about the form of the stock-recruit relationship and the variability about this. In pelagic stocks recruitment may often be strongly environmentally-driven, which is extremely difficult to model given short time series. On account of this, simple parameterisations of stock and recruitment such as geometric means or relationships estimated with associated variances may not be adequate. It was considered that the provision of medium-term projections with a calculation of uncertainty would depend on the availability of a stock assessment procedure that returns estimates of variance with known precision. Two assessment methods were available to the Working Group: XSA and ICA. The performance of the variance estimators of the former method has not been tested, and in any case this method has not yet been developed to allow the calculation of a variance-covariance matrix. Simulation testing of the ICA variance estimators has revealed that these can be biased in the range 1.30 to 1.7 (Appendix I to Anon., 1994). The Working Group considered that the availability of variance estimators with known distribution characteristics was necessary for a realistic calculation of the variance in the projected populations, and hence of the risks associated with different management options.

The precision of the pelagic stock assessments calculated by this Working Group is largely dependent on the precision with which the stock sizes are estimated by research vessel surveys of different types. As there are few and short data series, the variance of these surveys cannot be estimated within stock assessment models but must be calculated from the surveys themselves. At present this calculation is only made for egg production surveys, but such variance estimates should be provided for all the research vessel surveys used in the stock assessments. Variance estimates for the catch-at-age sampling would also be necessary. Such internal variance estimates are in any event required for a statistical assessment of population sizes and mortalities.

The Working Group considered that these matters could not be addressed during the meeting, but that advice should be provided at the next meeting of the Working Group. A sub-committee of the Working Group undertook to review the matter and to report before the next meeting.

Some preliminary calculations were nevertheless made and are presented in the following sections. Both a rather complex and a very simple method were used to model population trajectories in the medium term.

16.2 Medium-Term Projections for Sardine in Divisions VIIIc and IXa

Example calculations of medium-term projections for sardine are presented using a new method that is as yet untested (Patterson, 1994c, WD). The method relies on the following principal assumptions:

- Catches at age are lognormally distributed about a separable model.
- Acoustic survey indices of abundance are proportionate to population size, measured with lognormal error.
- Variances can be estimated internally, by iteration.
- Errors are independent and uncorrelated.
- Recruitment follows a Beverton and Holt relationship, with a lognormal error distribution.

An integrated assessment is calculated based on these assumptions. The following parameters are estimated simultaneously:

- Fishing mortality at reference age
- Selection at age [except for the last age and the reference age]
- Stock numbers at age
- Parameters of the stock-recruit relationship

These parameters are then used to construct medium-term trajectories for the exploited population in the conventional way. Recruitment in each year is estimated as:

$$N_{i,r} = \frac{a.SSB}{b+SSB} e^{\frac{\sigma^2}{2}}$$

where spawning stock biomass (SSB) is calculated in the conventional way, a and b are parameters of the stock-recruit relationship, and recruitment is at age r. Sigma is the variance about the stock-recruit relationship.

This approach is not strictly correct. There are observations neither of stock nor of recruitment, but these are treated as data although they are in fact quantities calculated elsewhere in the model. This is unavoidable unless the problem is reformulated in a completely different fashion, with recruitment treated as an annual deviation from a recruitment predicted by a stock-recruit model.

Consider the calculation of SSB in year y by conventional projection as a function g(X), where X is the vector of parameters estimated in the model, and comprising the F, S, N, and SRR parameter estimates. Assume the remaining parameters, natural mortality M, maturity ogive, etc. are estimated with no error. The variance-covariance matrix of X is a subset of the parameter variance-covariance matrix estimated in the ICA2 programme. Delta-method estimates of the variances of the projected SSBs are then:

$$Var(SSB_y) = \sum_{i=1}^{i=j} \left(\frac{dSSB_y}{dXi}\right)^2 Var(X_i) +$$
$$2\sum_{i=1}^{i=j-1} \sum_{k=1}^{k=i} \frac{dSSB_y}{dX_i} \frac{dSSB_y}{dX_k} CoVar(X_i X_k)$$

Variances of the catch can then be calculated in an exactly analogous fashion. The $dX_i/dSSB_y$ and dX_i/d(Fleet Catch) are estimated numerically. Risk is calculated by assuming SSB is normally distributed. The method depends strongly on the unbiased estimation of variances by the integrated analysis, and on the assumption of linearity made in the delta-method. More work is needed to test how well these approximations allow useful estimates of risk to be generated.

An example calculation will be presented for the case of the sardine. The objective function used was:

$$\sum_{a,y} \lambda_a (\ln(C_a,y) - \ln(F_y.S_a.\bar{N}_a,y))^2 +$$
$$\sum_{a,y} \lambda_{SP} (\ln(ASP_{a,y} - \ln(Q.N^*_{a,y}))^2 +$$
$$\sum_{a,y} \lambda_{PO} (\ln(APO_{a,y} - \ln(Q.N^*_{a,y}))^2 +$$
$$\sum_y \lambda_{SRR} (\ln(Recruitment_y) - \ln(\frac{a+\hat{SSB}_y}{b+\hat{SSB}_y}))^2$$

which is intermediate between the two assessments presented (Terminal S = 1.25 relative to age 2, but no plus-group included). λ_a were set to 0.1 for age 1 and to 1 for all other ages. All other λ were recalculated iteratively. A summary of results are given in Table 16.1. The variance-covariance matrix (40*40 parameters) is not printed for reasons of space.

The stock recruitment data are shown in Figure 16.1.

Some illustrative trajectories calculated starting from this assessment and associated variance-covariance matrix are shown in Figure 16.2 (assuming F for the next 10 years = F in 1993), Figure 16.3 assuming F for the next 10 years = 2.F in 1993, and Figure 16.4 (assuming F for the next 10 years = 0.5 F in 1993). For present purposes, the 'MBAL' used has been the estimated stock size in 1993, and hence the graphs show the estimated probability that stock size may fall below 1993 levels.

This approach to the calculation of risk may allow a consideration of the 'noise' about the model fit to be included in management considerations. In the case of the sardine however, the greatest source of uncertainty is not noise about the model, *it is uncertainty about the specification of the model.* Specifically, most uncertainty is introduced by the treatment of selection and of the plus-group: these change the perception of current fishing mortalities from ca. 0.2 to ca. 0.4. Stock trajectories so calculated by this method are therefore highly misleading and should not be used for management purposes. It is stressed that they are presented here only as an illustrative case to demonstrate a methodology that could be used where there is little uncertainty about the type of model to be fitted.

Furthermore, the method depends on the internal calculation of variances. In the present case, there are only a few data points from some surveys. This means that the fitting procedure is likely to be unstable, and that the variance estimates are unreliable. The method should strictly use variance estimates calculated from the surveys themselves.

In any event, this approach suggests that the noise in the assessment is such that catches and stock size cannot be predicted beyond about 1996.

16.3 Medium-Term Projections for the Western Mackerel

The assessment of the Western Mackerel stock is principally determined by the egg production estimate of biomass, and an estimate of the coefficient of variation of this measure of stock size is available (Anon. 1993f). Hence it was somewhat simplistically assumed that the precision of the estimates of population size in 1994 was the same as that of the egg survey in 1992, to which the assessment is tuned. Stock sizes on 1 January 1994 were projected forwards to 1999 under three different scenarios for F: (1) F from 1995 to 1999 = F in 1993; (2) F from 1995 to 1999 = 1.3 times F in 1993, and (3) F from 1995 to 1999 = 1.4 times F in 1993. These three scenarios cover situations of a return to low exploitation levels prior to 1994, to exploitation at the predicted 1995 level, and to a further slight increase in exploitation. Uncertainty about the projections was calculated by Monte Carlo simulations. In all three cases, the following conditions were defined:

(1) F in 1994 is = 1.14 times F in 1993.
(2) Recruitment was modelled as a lognormal random variate with a CV equal to that of the estimated recruitment from 1976 to 1991
(3) Error in the estimated populations was modelled as a lognormal random variate with a CV equal to the estimated CV of the egg production surveys.

Results are given in Figures 16.5 and 16.6. These show a surprising narrowing of the error bars in later years. This is due to the assumption of an uncorrelated random time-series of recruitment to a stock comprised of many age-groups and which is assumed to be exploited at a constant fishing mortality. After a few years, the only uncertainty in the projection arises from a relatively low level of noise from random fluctuations in recruitment.

The method presented here is considerably simpler that described in the foregoing section. It is also likely to provide more reliable estimates of the uncertainty in the stock projections on account of the external variance estimate which is available in this case. This calculation may be considered to provide an indication for management of likely trends in the fishery. All three projections indicate a decline in stock size from 1994 onwards. At higher levels of F, this stock size declines more rapidly. Catches under all three scenarios are projected to decline.

17 WORKING GROUP RESPONSE TO ADVICE REQUESTED BY NEAFC

17.1 Effect of *Ichthyophonus* Disease on Pelagic Species

The Working Group are not aware of any reports of the occurrence of *Ichthyophonus* disease in mackerel, horse mackerel, sardine or anchovy in the area covered by the Working Group.

Most of the Norwegian mackerel samples from the commercial fleet and research vessel catches in 1993 were screened for the presence of *Ichthyophonus* disease. No evidence of its presence was found. The Working Group are not aware of any other monitoring for the presence of the disease in either mackerel, horse mackerel, sardine or anchovy in the area covered by the Working Group. It seems likely that no other monitoring has been carried out and that if *Ichthyophonus* disease is present in any of these species it has not yet manifested itself as a noticeable problem.

18 DATA REQUESTED BY THE MULTISPECIES WORKING GROUP

18.1 Mackerel

18.1.1 Catch in numbers at age by quarter for the North Sea mackerel stock

As in the years 1987-1992 (Anon. 1988a, 1889b, 1990c, 1991d, 1992b, 1993d), the catch of North Sea mackerel in Sub-area IV and Division IIIa in 1993 were included in the catches of the western stock.

As no changes in the fisheries in Sub-area IV and Division IIIa have taken place in 1993 compared to 1992 and as the Norwegian egg survey in 1990, 1991 and 1992 indicates the spawning stock to be at a low but not changing level (Anon. 1993d), the total catch of the North Sea stock was assumed to be the same in 1993 as in 1990 and 1991 and 1992 (10,000 t). Based on a few samples from July taken by a Norwegian research vessel the age structure in the catch of North Sea Mackerel in 1993 seems to be the same as in 1992 with the same year classes dominating (Iversen, pers.com.). Based on this assumption and the mean weight in the catches from 1990 (Anon. 1992b) the catch in numbers for 1993 was estimated (Table 18.1). The catches in number are split by quarter for each of the years according to the quarterly total catches in Sub-area IV and Division IIIa.

18.1.2 Weight at age for the North Sea mackerel stock

The weights by age group obtained from the few available Norwegian research vessel samples taken in July 1993 (Iversen, pers.com.) were similar to the weights by age groups in last year's Working Group report (Anon. 1993d) concerning the second and third quarters. Therefore, the Working Group found no evidence for a change in the weight at age in the stock by quarters in 1993 and the weight at age are therefore estimated to be the same as in 1989 (Table 18.2).

18.1.3 Stock distribution by quarter

As there is no evidence of changes in migration of the North Sea stock, the Working Group decided to assume the same quarterly distribution of the two stocks in 1993 as during the period 1986-1992 (Table 18.3). As for previous years the Working Group assumes that no 0-group Western mackerel migrate into the North Sea.

18.2 Horse Mackerel

18.2.1 Catch in numbers at age by quarter for the North Sea horse mackerel stock

As explained in Section 8.3 the available samples from the commercial fishery are not representative of the majority of the catches, and it is not possible to give a reliable estimate of catch in numbers at age.

18.2.2 Weight at age for the North Sea horse mackerel stock

The weights at age in catches given in Table 18.4 are based on a few Dutch samples of research vessel and commercial catches in Divisions IVb and IVc. The weight at age in the stock should be taken as the estimated weight at age in the catches in the 2nd quarter, which, for most age groups, are based on a few samples.

18.2.3 Stock distribution by quarter

There is no information available about the amount of Western horse mackerel which migrate into the North Sea during the third and fourth quarters. In the period 1982-1986, the catches of horse mackerel in Division IVa were very low indicating little, if any, migration of western fish into the North Sea. From 1987 the catches in Division IVa started to increase and reached a maximum in 1990 corresponding to about 30% (113,000 t) of the total catch of the western stock. This increase was mainly due to the migration of the strong 1982 year class of western horse mackerel into the North Sea during the third and fourth quarters.

Based on the catches by division of the western horse mackerel (Table 7.5), the Working Group considers that between 5% and 65% of the western stock was present in the North Sea during the second half of 1993 (Table 18.5).

19 RECOMMENDATIONS

Egg Production Workshop

The most important recommendations made by the Egg Production Workshop and which were endorsed by the Working Group were as follows -

The Working Group recommends that a full time specialist should be employed in order to develop and use a spatia-temporal Generalized Additive Model for analysing the 1995 egg survey data.

The Working Group recommends that the results of the comparisons between the AEPM and DEPM for the western area should be published as an ICES Cooperative Research Report edited by I.G Priede and A.Eltink.

The Working Group recommends that the 1995 Assessment Working Group meeting be held at a later date in 1995 in order not to coincide with the egg surveys, and

The Working Group endorses all the other recommendations made by the Mackerel and Horse Mackerel Egg Production Workshop, which met in Vigo, Spain 31 January to 4 February 1994.

Mackerel

The Working Group recommends that a mackerel otolith reading workshop should take place in Vigo, Spain 8 to 14 February 1995.

The Working Group recommends that attempts are made to obtain estimates of the by-catch and discards of mackerel in Divisions IVb and IVc.

The Working Group recommends that the recruitment survey indices for mackerel should be re-calculated taking into consideration changes in both the survey effort and in the area coverage. This should be done as soon as possible and reported to ACFM at their next meeting.

The Working Group recommends catches at age for the southern area should be revised from 1984 due to the problems found with the SOPs in some of those years.

The Working Group recommends that effort and catch per unit of effort data from the main fleets fishing mackerel in the southern area should be reported to this WG in order to support the assessment of the stock.

Horse mackerel

The Working Group recommends that further investigations be carried out on the maturity at age of horse mackerel.

The Working Group recommends that the TAC's, and any other management regulations for horse mackerel which might be established in the future, should only be related to *T. trachurus* and not to *Trachurus spp.* in general as at present.

Sardine

The Working Group recommends that acoustic surveys for sardine, covering the whole area of their distribution in Divisions VIIIc and IXa, should be carried out during September each year.

The Working Group recommends the continuation of the sardine otolith exchange programme between readers from Spain and Portugal.

Anchovy

The Working Group recommends that a choice should be made between the different management procedures proposed, and draws attention to the fact that scientific advice on this stock requires the adoption of routine monitoring of the stock by direct survey methods.

The Working Group recommends that an estimate of F and M should be made for the anchovy stock taking into account the precision of the SSB estimates from the direct survey methods.

General

The Working Group recommends that quantitative information on discarding is sought for all species and stocks and reported to the next meeting of the Working Group.

The Working Group recommends that the Methods Working Group should be asked to evaluate the ICA programme and advise on its application (see Appendix 2).

The Working Group recommends that a small group of Working Group members, working by correspondence, should define the information that is required to combine the data from the various fleets in order to determine the effects that changes have on individual stocks. Following that, each country should complete or revise the description of their fleets for the years 1983, 1988 and 1993. These data should be updated annually and presented each year to the Working Group.

The Working Group recommends that if a TAC is set for a stock then it should only apply to those areas where the stock is fished.

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Table 3.1 Planned research vessel deployment for the 1995 Mackerel / Horse Mackerel Egg Surveys in the western and southern area.

Coverage	Country	Area	Ship	Week number(s)	Period	Survey mid-point	Latitude to be covered
1	Portugal	South	Capricornio	3, 4	6 - 19 Feb	12 - 13 Feb	36°N-41°30'N
2	Portugal	South	Capricornio	10, 11, 12	6 Mar - 26 Mar	16 March	36°N-43°N
3	Portugal Spain Germany	South South/West West	Capricornio Cornide Walther Herwig	14 13, 14, 15 13, 14, 15	27 Mar - 16 Apr	6 April	36°N-39°N 39°N-45°N 45°N-55°N
4	England Scotland	South/West West	Cirolana Scotia	17, 18, 19 17, 18, 19	24 Apr - 14 May	4 May	43°N-49°30'N 48°30'N-56°N
5	Ireland Netherlands Spain	West West South/West	Lough Foyle Tridens Cornide	21, 22, 23 21, 22 20, 21	15 May - 11 June	28 - 29 May	49°30'N-58°N 46°30'N-50°N 43°N-47°N
6	Norway Netherlands	West West	G. O. Sars Tridens	24, 25, 26 24, 25, 26	12 June - 2 July	22 June	49°30'N-58°N 44°N-50°N
7	Scotland	West	Charter	27, 28, 29	3 July - 23 July	13 July	44°N-57°N

Table 4.1 Catches of MACKEREL by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and Division IIIa			Divs. IIa,Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards[2]	Catch	Landings	Landings	Landings	Discards	Catch
1969	4,800	-	4,800	66,300	-	66,300	739,182	-	739,182	+		810,282	-	810,282
1970	3,900	-	3,900	100,300	-	100,300	322,451	-	322,451	163		426,814	-	426,814
1971	10,200	-	10,200	122,600	-	122,600	243,673	-	243,673	358		376,831	-	376,831
1972	10,000	-	10,000	157,800	-	157,800	188,599	-	188,599	88	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

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

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

Table 4.2 Catches of mackerel by Division and Sub-area in 1993. (Data submitted by Working Group members.)

Division/ Sub-area	Quarter				Total
	1	2	3	4	
IIa + Vb	900	11,300	120,800	32,900	165,900
IVa	67,800	400	62,800	250,900	381,900
IVb	-	100	1,200	100	1,400
IVc	+	400	1,200	700	2,300
IIIa	-	100	3,700	1,100	4,900
VI	108,900	4,600	5,700	17,000	136,200
VII	51,100	32,500	6,700	17,500	107,800
VIIIa,b,d,e	2,100	2,300	200	200	4,800
Sub-total	230,800	51,700	202,300	320,400	805,200
VIIIc	6,200	9,600	600	300	16,700
IXa	600	900	1,100	500	3,100
Grand total	237,600	62,200	204,000	321,200	825,000

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

Table 4.3 Annual length distribution (millions) of MACKEREL catches by fleet and country in 1993.

Length (cm)	Denmark	Ireland	Netherland	Norway		Russia	UK (England)			UK (Scotland)			Spain			Portugal		
	P. seine	Pr trawl	Pel Trwl	Ind.fish.	P.seine	Trawl	Pel Trwl	Handline	P. seine	P.seine	Pair Tr	Others	P. seine	Trawl	Artisan*	P. seine	Trawl	Artisan
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-
16	-	-	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-
17	-	-	1.14	-	-	-	-	-	-	-	-	-	0.02	0.00	-	-	0.00	-
18	-	0.20	1.59	-	-	-	0.05	-	-	-	-	-	0.46	0.00	-	-	0.04	-
19	-	1.33	0.53	-	-	-	1.30	-	-	-	-	-	1.52	0.08	-	-	0.24	-
20	-	6.23	1.76	-	-	-	2.48	-	-	-	-	-	0.70	0.06	-	-	0.45	0.04
21	-	5.85	1.26	-	-	-	0.52	0.00	-	0.10	0.03	0.02	0.23	0.11	0.03	-	1.56	0.26
22	-	5.61	0.22	-	-	-	0.71	0.00	-	0.06	0.01	0.01	0.64	0.04	0.04	-	1.09	0.15
23	-	1.22	0.12	-	-	-	0.05	0.01	-	-	-	-	1.48	0.05	0.02	-	0.38	0.02
24	-	2.04	-	-	-	-	0.63	0.01	-	0.17	0.04	0.01	3.01	0.03	0.17	-	0.03	0.00
25	-	7.38	1.79	-	0.00	0.17	5.58	0.03	-	0.01	-	-	2.98	0.17	0.15	0.00	0.03	0.01
26	0.10	8.70	8.85	-	0.00	-	21.75	0.08	-	0.01	-	-	2.48	0.16	0.30	-	0.06	0.02
27	0.65	6.58	6.96	-	0.00	0.71	25.79	0.17	-	0.62	0.17	0.16	1.20	0.27	0.17	0.00	0.10	0.01
28	0.10	5.98	7.55	-	0.07	1.94	15.57	0.24	-	2.05	0.54	0.32	0.82	0.22	0.11	-	0.14	0.01
29	0.10	10.20	8.77	-	0.07	0.53	9.62	0.34	-	5.75	1.00	0.64	0.40	0.24	0.10	0.07	0.20	0.01
30	0.75	21.81	6.98	-	3.93	0.53	7.11	0.46	-	11.48	2.02	1.72	0.50	0.27	0.15	0.08	0.16	0.01
31	0.65	27.77	9.30	-	8.23	1.59	5.44	0.54	-	17.36	3.27	2.78	0.41	0.36	0.24	0.05	0.18	0.04
32	1.73	27.97	10.92	-	17.58	3.70	3.98	0.45	-	22.14	4.52	3.53	0.74	0.43	0.46	0.13	0.16	0.02
33	1.96	24.67	14.56	-	24.28	8.47	2.33	0.37	-	23.77	5.24	4.86	0.97	0.65	1.23	0.20	0.20	0.05
34	7.99	22.70	19.26	-	38.03	10.76	0.78	0.31	-	26.57	5.74	4.64	1.51	0.85	1.89	0.31	0.19	0.12
35	8.43	23.62	18.24	-	43.16	16.05	0.47	0.26	-	26.99	6.71	6.26	1.34	0.76	2.68	0.40	0.13	0.15
36	12.32	23.34	23.94	-	51.62	17.46	0.30	0.20	-	26.34	7.54	6.54	1.44	0.55	3.00	0.28	0.13	0.17
37	8.87	21.43	17.48	-	58.50	10.41	0.10	0.09	-	22.96	6.36	5.08	1.36	0.42	3.65	0.16	0.08	0.22
38	8.55	18.18	15.34	-	58.00	6.70	0.03	0.08	-	19.75	4.53	4.58	1.62	0.38	4.07	0.16	0.04	0.14
39	4.98	13.47	13.76	-	48.10	3.35	0.01	0.08	-	15.84	4.32	4.41	1.17	0.23	2.83	0.08	0.02	0.09
40	4.64	10.28	9.15	-	32.87	2.47	0.01	0.04	-	10.65	1.94	2.08	1.62	0.15	2.33	0.05	0.01	0.06
41	2.80	4.61	5.29	-	16.51	2.65	0.01	0.01	-	6.87	1.85	1.66	1.28	0.09	1.45	0.00	0.00	0.04
42	2.80	3.67	2.74	-	9.24	0.53	0.01	0.01	-	3.73	1.41	0.87	0.40	0.09	0.83	0.00	0.00	0.02
43	1.40	1.67	1.95	-	3.37	-	0.00	0.00	-	2.23	0.65	0.32	0.37	0.01	0.49	0.00	0.00	0.01
44	0.86	0.82	1.11	-	0.87	-	0.00	-	-	1.47	0.40	0.15	0.33	0.02	0.24	0.00	0.00	0.00
45	-	0.36	0.82	-	0.49	-	0.00	0.00	-	0.69	0.10	0.01	0.05	0.02	0.08	-	0.00	0.00
46	-	0.11	-	-	0.21	-	0.00	-	-	0.41	0.07	0.01	0.05	0.01	0.01	-	-	-
47	-	-	-	-	0.09	-	-	-	-	0.03	0.00	0.01	0.48	0.00	0.01	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	0.11	0.00	-	-	-	-
50	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-
51	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-
52	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.00	-	-	-	-
53	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-
54	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-
56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Numbers	69.76	307.82	212.53	-	415.21	88.02	104.64	3.77	-	248.03	58.44	50.66	31.81	6.72	26.74	1.98	5.63	1.68
Tonnes	37150	94979	70750	-	223800	49600	15805	1534	-	118333	23752	24337	8337	1940	10422	684	808	523

* Handline and gillnet

Table 5.1 Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb), 1982-1992.
(Data submitted by Working Group members.)

Country	1982	1983	1984	1985	1986	1987[1]
Denmark	1,008	10,427	11,787	7,610	1,653	3,133
Faroe Islands	180	-	137	-	-	-
France	8	-	-	16	-	-
Germany, Fed. Rep.	-	5	-	-	99	-
German Dem. Rep.	-	-	-	-	16	292
Ireland	-	-	-	-	-	-
Norway	34,540	38,453	82,005	61,065	85,400	25,000
Poland	231	-	-	-	-	-
UK (England & Wales)	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	2,131	157
USSR	1,641	65	4,292	9,405	11,813	18,604
Discards	-	-	-	-	-	-
Total	37,608	48,950	98,222	78,096	101,112	47,186

Country	1988[1]	1989	1990	1991	1992[2]	1993[2]
Denmark	4,265	6,433	6,800	1,098	251	-
Estonia					216	-
Faroe Islands	22	1,247	3,100	5,793	3,347	1,167
France	-	11	-	23	6	6
Germany, Fed. Rep.	380	-	-	-	-	-
German Dem. Rep.	-	2,409	-	-	-	-
Ireland	-	-	-	-	-	-
Latvia					100	4,700
Norway	86,400	68,300	77,200	76,760	91,900	110,500
Poland	-	-	-	-	-	-
Russia					42,440	49,600
UK (England & Wales)	-	-	+	-	1	-
UK (Scotland)	1,413	-	400	514	801	-
USSR	27,924	12,088	30,000	13,631[3]	-	-
Discards	-	-	2,300	-	-	-
Total	120,404	90,488	118,700	97,819	139,062	165,973

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

Table 5.2 Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and Division IIIa), 1982-1992. (Data submitted by Working Group members.)

Country	1982	1983	1984	1985	1986	1987[1]
Belgium	102	93	68	-	49	14
Denmark	2,034	11,285	10,088	12,424	23,368	28,217
Faroe Islands	720	-	-	1,356	-	-
France	3,041	2,248	-	322	1,200	2,146
Germany, Fed. Rep.	28	10	112	217	1,853	474
Ireland	-	-	-	-	-	-
Netherlands	390	866	340	726	1,949	2,761
Norway	27,966	24,464	27,311	30,835	50,600	108,250
Sweden	692	1,903	1,440	760	1,300	3,162
UK (Engl. & Wales)	16	16	2	143	18	94
UK (Scotland)	44	4	13	7	541	19,763
UK (N.Ireland)	-	-	-	-	-	-
USSR	-	-	-	-	-	-
Unallocated, discards and misreported	450	96	202	3,656	162,822	136,737
Total	35,483	40,985	39,576	50,466	243,700	301,618
Misreported[3]					148,000	117,000

Country	1988	1989	1990	1991	1992[2]	1993[2]
Belgium	20	37	-	125	102	191
Denmark	32,588	26,831	29,000	38,834	41,719	42,502
Estonia					400	-
Faroe Islands	-	2,685	5,900	5,338	-	11,408
France	1,806	2,200	1,600	2,362	956	1,480
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940
Ireland	-	8,880	12,800	13,000	13,136	13,206
Latvia					211	-
Netherlands	2,564	7,343	13,700	4,591	6,547	7,770
Norway	59,750	81,400	74,500	102,350	115,700	112,700
Sweden	1,003	6,601	6,400	4,227	5,100	5,934
UK (Engl. & Wales)	160	5,618	1,300	2,671	2,258	2,262
UK (Scotland)	616	33,042	28,100	33,991	32,879	38,747
UK (N.Ireland)	100	-	1,400	255	-	1
USSR	-	-	-	-	-	-
Unallocated, discards, and misreported	233,532	100,651	126,900	153,958	143,546	149,417
Total	338,316	281,600	305,100	365,875	367,164	390,558
Misreported[3]	180,000	92,000	126,000	130,000	127,000	146,697

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

Table 5.3 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	1982	1983	1984	1985	1986	1987
Belgium	-	+	+	-	+	-
Denmark	15,000	15,000	200	400	300	100
Faroe Islands	11,100	14,900	9,200	9,000	1,400	7,100
France	12,300	11,000	12,500	7,400	11,200	11,100
Germany, Fed. Rep.	11,200	23,000	11,200	11,800	7,700	13,300
Ireland	109,700	110,000	84,100	91,400	74,500	89,500
Netherlands	67,200	73,600	99,000	37,000	58,900	31,700
Norway	19,000	19,900	34,700	24,300	21,000	21,600
Poland	-	-	-	-	-	-
Spain	-	-	100	+	-	-
UK (Engl. & Wales)	82,900	62,000	30,000	9,600	9,100	25,200
UK (N.Ireland)	9,600	800	10,600	12,200	9,700	10,700
UK (Scotland)	147,400	120,100	157,700	184,100	137,500	164,800
USSR	-	+	200	+	-	-
Unallocated + misreported	97,300	105,500	18,000	75,100	-98,701	-91,000
Discard	24,900	11,300	12,100	4,500	-	-
Grand Total	607,700	567,100	479,600	467,700	232,599	284,000
Misreported[3]					-148,000	-117,000

Country	1988	1989[2]	1990	1991	1992[2]	1993[2]
Belgium	-	-	-	-	-	-
Denmark	-	1,000?	-	1,573	194	-
Faroe Islands	2,600	1,100	1,000	4,095	-	2,350
France	8,900	12,700	17,400	10,364	9,109	8,296
Germany, Fed. Rep.	15,900	16,200	18,100	17,138	21,952	23,776
Ireland	85,800	61,100	61,500	64,827	76,313	81,773
Netherlands	26,100	24,000	24,500	29,156	32,365	44,600
Norway	17,300	700	-	-	-	600
Poland	-	-	-	-	-	-
Spain	1,500	1,400	400	4,020	2,764	3,162
UK (Engl. & Wales)	24,100	14,700	19,200	25,500	29,978	40,111
UK (N.Ireland)	8,900	11,000	12,800	2,995	2,238	1,476
UK (Scotland)	175,400	123,400	130,700	134,093	164,674	173,678
USSR	+	-	-	-	-	-
Unallocated + misreported	-175,300	-73,100	-114,500	-133,802	-125,528[1]	-146,697[1]
Discard	5,800	4,900	11,300	23,550	22,020	15,660
Grand Total	377,000	288,900	302,900	183,509	236,079	248,785
Misreported[3]	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697

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

Table 5.4 Catch in numbers ('000) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1993.

1993 Age	IIa 1'st Q catch('000)	IIIa 1'st Q catch('000)	IVa 1'st Q catch('000)	IVb,c 1'st Q catch('000)	VIa 1'st Q catch('000)	VIIb,c,j,k 1'st Q catch('000)	VIIa,e,f,g,h 1'st Q catch('000)	VIId 1'st Q catch('000)	VIIIa,b,d,e 1'st Q catch('000)	All areas 1'st Q catch('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	86	6	269	0	1	4,573	25	4,960
2	53	0	2,787	45	12,897	2,732	1,045	913	220	20,692
3	75	0	19,044	24	33,169	7,076	3,118	913	169	63,589
4	159	0	33,642	6	61,489	30,742	10,395	0	1,388	137,821
5	309	0	25,000	6	33,668	14,169	3,117	607	992	77,867
6	447	0	26,729	0	44,437	19,616	3,117	306	1,526	96,179
7	142	0	13,798	1	19,613	7,996	1,039	0	403	42,993
8	159	0	10,102	1	15,103	3,831	0	0	262	29,459
9	147	0	14,251	3	22,210	10,205	1,038	306	509	48,670
10	47	0	2,965	0	6,672	1,488	2,077	0	201	13,450
11	47	0	3,396	1	5,773	607	1,038	0	77	10,940
12	33	0	3,047	0	6,061	2,696	0	0	7	11,844
13	37	0	2,164	0	3,560	2,136	0	0	1	7,899
14	3	0	1,061	0	3,654	230	0	0	1	4,950
15+	12	0	1,283	1	3,917	589	0	0	7	5,810
Total	1,670	0	159,355	95	272,493	104,113	25,986	7,620	5,790	577,122
Tonnes	934	0	67,726	20	108,855	41,061	8,055	1,768	2,121	230,540

Age	IIa 2'nd Q catch('000)	IIIa 2'nd Q catch('000)	IVa 2'nd Q catch('000)	IVb,c 2'nd Q catch('000)	VIa 2'nd Q catch('000)	VIIb,c,j,k 2'nd Q catch('000)	VIIa,e,f,g,h 2'nd Q catch('000)	VIId 2'nd Q catch('000)	VIIIa,b,d,e 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	19	241	19,923	0	0	5,207	16	25,407
2	647	6	308	1,035	3,154	698	24	1,040	87	6,998
3	909	31	89	460	1,013	6,319	71	1,040	335	10,268
4	1,920	51	186	112	1,724	22,362	236	0	1,135	27,727
5	3,739	29	90	108	861	15,870	71	691	920	22,380
6	5,417	31	175	6	1,029	12,782	71	349	1,516	21,376
7	1,718	35	49	33	324	6,511	24	0	453	9,147
8	1,920	14	23	29	107	4,575	0	0	370	7,038
9	1,779	19	85	52	696	4,341	24	349	591	7,935
10	566	4	5	0	266	2,035	48	0	239	3,162
11	566	4	5	28	179	1,968	24	0	117	2,891
12	404	1	15	10	171	1,333	0	0	11	1,945
13	445	3	0	1	201	991	0	0	2	1,643
14	40	1	4	0	7	126	0	0	2	180
15+	141	2	2	25	3	410	0	0	56	640
Total	20,211	230	1,055	2,141	29,657	80,322	594	8,676	5,850	148,735
Tonnes	11,310	122	383	464	4,606	30,145	184	2,013	2,283	51,510

Age	IIa 3'rd Q catch('000)	IIIa 3'rd Q catch('000)	IVa 3'rd Q catch('000)	IVb,c 3'rd Q catch('000)	VIa 3'rd Q catch('000)	VIIb,c,j,k 3'rd Q catch('000)	VIIa,e,f,g,h 3'rd Q catch('000)	VIId 3'rd Q catch('000)	VIIIa,b,d,e 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	0	0	0	49	0	0	0	0	0	49
1	0	6	273	928	12,043	244	4,769	5,050	44	23,358
2	3,851	187	6,780	1,772	8,141	2,179	2,357	1,009	44	26,320
3	19,819	962	13,331	1,910	2,034	1,622	683	1,009	44	41,415
4	47,509	1,562	22,701	1,269	2,169	1,330	1,454	0	177	78,171
5	36,038	887	16,065	881	1,101	936	408	673	89	57,077
6	35,151	943	16,876	525	325	392	0	336	86	54,635
7	26,098	1,087	16,819	93	257	1,535	143	0	44	46,077
8	16,113	419	7,655	224	145	702	132	0	0	25,389
9	21,241	575	8,448	43	102	350	132	336	44	31,271
10	1,535	112	1,899	60	110	2	0	0	4	3,723
11	3,220	112	2,498	29	85	176	43	0	4	6,168
12	3,307	37	569	3	478	336	0	0	4	4,736
13	919	87	1,279	1	14	675	0	0	4	2,979
14	950	31	477	2	26	0	0	0	0	1,486
15+	283	62	995	70	39	0	0	0	0	1,450
Total	216,037	7,073	116,665	7,859	27,069	10,478	10,121	8,414	592	404,307
Tonnes	120,790	3,749	62,830	2,355	5,734	3,060	2,101	1,953	177	202,749

Age	IIa 4'th Q catch('000)	IIIa 4'th Q catch('000)	IVa 4'th Q catch('000)	IVb,c 4'th Q catch('000)	VIa 4'th Q catch('000)	VIIb,c,j,k 4'th Q catch('000)	VIIa,e,f,g,h 4'th Q catch('000)	VIId 4'th Q catch('000)	VIIIa,b,d,e 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	0	0	0	26	2,831	0	9,474	0	742	13,074
1	0	20	2,756	788	2,507	0	48,617	5,544	706	60,938
2	3,362	296	96,651	847	23,259	0	23,097	1,108	137	148,756
3	7,809	446	130,633	280	8,561	0	38	1,108	56	148,930
4	13,446	499	115,169	302	7,593	0	6,608	0	94	143,712
5	8,661	302	67,733	164	4,828	0	67	739	29	82,523
6	6,925	288	65,789	170	1,451	0	10	369	37	75,039
7	7,326	195	37,575	70	2,174	0	10	0	8	47,358
8	4,177	110	26,750	1	2,700	0	10	0	8	33,756
9	3,999	152	25,144	27	1,550	0	10	369	13	31,262
10	3,022	39	12,299	27	1,634	0	10	0	0	17,031
11	2,253	25	5,275	39	517	0	46	0	0	8,156
12	2,267	17	3,880	78	583	0	0	0	5	6,829
13	682	20	4,034	39	517	0	10	0	0	5,301
14	421	11	2,306	30	517	0	0	0	0	3,286
15+	512	17	4,040	26	0	0	0	0	0	4,595
Total	64,861	2,436	600,034	2,914	61,222	0	88,006	9,236	1,838	830,547
Tonnes	32,935	1,128	250,893	793	16,954	0	14,923	2,144	249	320,019

Table 5.5 Length (cm) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1993.

1993 Age	IIa 1'st Q length(cm)	IIIa 1'st Q length(cm)	IVa 1'st Q length(cm)	IVb,c 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)	VIId 1'st Q length(cm)	VIIIa,b,d,e 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	28.8	23.5	24.9	0.0	27.1	28.1	27.1	27.9
2	27.5	0.0	30.7	29.3	30.3	30.1	27.5	31.5	29.8	30.2
3	31.3	0.0	32.5	32.3	32.5	32.8	32.5	33.5	33.1	32.5
4	33.3	0.0	34.9	33.7	34.8	34.8	33.5	0.0	34.9	34.8
5	34.6	0.0	35.8	35.2	36.0	36.2	34.5	36.5	36.1	35.9
6	35.7	0.0	37.7	0.0	37.2	38.0	35.5	35.5	37.4	37.5
7	36.1	0.0	38.0	38.5	37.7	39.1	36.5	0.0	39.0	38.0
8	36.8	0.0	38.4	35.5	38.4	38.8	39.4	0.0	40.6	38.5
9	37.3	0.0	39.6	38.0	39.6	39.6	34.5	42.5	38.5	39.5
10	38.1	0.0	39.9	0.0	40.0	42.5	38.0	0.0	41.6	40.0
11	39.7	0.0	40.2	41.5	41.3	40.9	35.5	0.0	42.3	40.4
12	39.3	0.0	40.3	0.0	41.1	42.4	0.0	0.0	45.6	41.2
13	40.0	0.0	40.1	0.0	41.4	42.2	0.0	0.0	46.6	41.2
14	41.7	0.0	41.6	0.0	41.3	42.3	0.0	0.0	46.5	41.4
15+	41.1	0.0	43.7	49.5	43.5	43.8	0.0	0.0	45.5	43.6
0-15+	35.5	0.0	36.6	31.4	36.4	36.9	34.1	30.7	36.7	36.3

Age	IIa 2'nd Q length(cm)	IIIa 2'nd Q length(cm)	IVa 2'nd Q length(cm)	IVb,c 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)	VIId 2'nd Q length(cm)	VIIIa,b,d,e 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	23.6	25.7	23.2	21.8	0.0	26.2	28.1	25.8	23.1
2	27.5	30.9	29.7	29.0	28.0	31.5	27.5	31.5	30.3	29.1
3	31.3	34.0	32.7	32.1	32.2	34.0	32.5	33.5	32.6	33.4
4	33.3	35.8	34.9	33.9	34.9	35.0	33.5	0.0	35.8	34.9
5	34.6	36.9	35.8	35.4	36.1	36.1	34.5	36.5	36.5	35.9
6	35.7	38.0	38.1	37.8	37.2	37.4	35.5	35.5	37.7	37.0
7	36.1	38.7	38.5	38.1	39.2	38.3	36.5	0.0	39.7	38.0
8	36.8	39.6	38.4	35.7	38.1	39.1	39.0	0.0	40.6	38.5
9	37.3	40.0	39.8	38.0	40.0	39.1	34.5	42.5	38.7	38.9
10	38.1	41.0	41.9	39.3	43.2	40.3	38.0	0.0	41.7	40.2
11	39.7	41.5	41.3	41.2	45.6	42.2	35.5	0.0	42.6	41.9
12	39.3	40.7	40.6	40.9	43.1	41.1	0.0	0.0	45.6	40.9
13	40.0	41.9	0.0	38.6	41.7	41.9	0.0	0.0	46.5	41.3
14	41.7	40.1	41.5	39.9	39.9	42.8	0.0	0.0	46.5	42.4
15+	41.1	45.3	42.4	49.5	39.5	44.8	0.0	0.0	46.5	44.3
0-15+	35.5	37.2	34.5	30.5	25.8	36.8	34.1	30.7	37.5	34.0

Age	IIa 3'rd Q length (cm)	IIIa 3'rd Q length (cm)	IVa 3'rd Q length (cm)	IVb,c 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)	VIId 3'rd Q length (cm)	VIIIa,b,d,e 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	0.0	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	23.5
1	0.0	23.6	28.3	26.4	26.3	27.9	27.1	28.1	26.5	26.9
2	32.0	30.9	30.5	30.7	29.0	30.4	29.7	31.5	30.8	30.2
3	34.0	34.0	34.4	33.1	32.1	31.9	32.1	33.5	32.8	33.9
4	34.9	35.8	36.0	35.0	33.2	33.6	33.7	0.0	34.0	35.1
5	36.0	36.9	37.2	36.0	34.6	34.4	35.2	36.5	35.6	36.3
6	37.2	38.0	38.1	36.0	37.4	35.4	0.0	35.5	36.9	37.4
7	38.5	38.7	38.8	36.6	37.2	36.0	34.3	0.0	38.7	38.5
8	38.8	39.6	39.9	35.1	38.0	35.9	38.5	0.0	0.0	39.0
9	39.6	40.0	40.1	38.4	39.5	38.0	35.5	42.5	38.0	39.8
10	41.9	41.0	41.3	36.9	39.0	40.5	0.0	0.0	41.4	41.4
11	41.3	41.5	41.5	40.3	39.1	36.7	34.5	0.0	41.8	41.2
12	42.3	40.7	41.3	40.0	41.4	38.0	0.0	0.0	45.6	41.8
13	43.5	41.9	41.7	38.5	41.2	39.0	0.0	0.0	46.5	41.7
14	43.0	40.1	40.4	39.5	39.4	0.0	0.0	0.0	46.5	42.1
15+	45.5	45.3	44.6	46.3	44.0	0.0	0.0	0.0	46.3	44.9
0-15+	36.8	37.2	37.3	32.8	29.2	33.9	29.7	30.7	34.7	36.0

Age	IIa 4'th Q length(cm)	IIIa 4'th Q length(cm)	IVa 4'th Q length(cm)	IVb,c 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)	VIId 4'th Q length(cm)	VIIIa,b,d,e 4'th Q length(cm)	All areas 4'th Q length(cm)
0	0.0	0.0	0.0	23.1	20.9	0.0	19.7	0.0	20.7	20.0
1	0.0	29.1	27.8	28.5	26.7	0.0	27.4	28.1	27.5	27.5
2	31.5	32.0	31.7	31.7	30.3	0.0	30.8	31.5	29.5	31.3
3	34.3	34.0	33.6	32.2	32.8	0.0	35.2	33.5	32.4	33.6
4	35.1	35.8	35.5	34.0	34.1	0.0	34.8	0.0	33.7	35.4
5	37.1	36.9	36.7	36.0	35.0	0.0	35.5	36.5	34.9	36.6
6	37.3	38.4	38.1	36.5	36.6	0.0	37.5	35.5	36.1	38.0
7	38.6	38.8	38.4	34.6	36.3	0.0	35.5	0.0	35.9	38.3
8	38.7	39.5	39.3	38.4	36.3	0.0	38.5	0.0	36.1	39.0
9	39.6	40.4	40.1	36.2	38.2	0.0	37.5	42.5	35.9	40.0
10	39.9	41.0	40.7	35.2	39.4	0.0	38.5	0.0	41.3	40.4
11	41.0	42.6	42.0	37.9	38.5	0.0	36.2	0.0	41.5	41.5
12	41.8	41.3	41.7	36.9	37.4	0.0	0.0	0.0	35.4	41.3
13	43.0	41.9	41.5	36.0	40.5	0.0	38.5	0.0	46.5	41.6
14	44.9	41.4	41.6	39.2	37.5	0.0	0.0	0.0	46.5	41.4
15+	45.5	44.1	43.0	37.5	0.0	0.0	0.0	0.0	46.2	43.3
0-15+	37.1	36.4	35.7	32.1	32.3	0.0	28.0	30.7	25.8	34.7

Table 5.6 Weight (g) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1993.

1993 Age	IIa 1'st Q weight(g)	IIIa 1'st Q weight(g)	IVa 1'st Q weight(g)	IVb,c 1'st Q weight(g)	VIa 1'st Q weight(g)	VIIb,c,j,k 1'st Q weight(g)	VIIa,e,f,g,h 1'st Q weight(g)	VIId 1'st Q weight(g)	VIIIa,b,d,e 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	174	82	111	0	136	159	137	156
2	262	0	225	170	213	190	127	229	184	208
3	389	0	280	231	269	251	242	263	258	269
4	466	0	354	258	336	316	285	0	307	332
5	519	0	390	330	376	361	313	438	341	376
6	568	0	466	0	422	431	363	336	382	434
7	589	0	478	428	440	479	400	0	440	459
8	606	0	493	314	469	465	452	0	499	478
9	637	0	550	455	522	488	339	720	422	520
10	669	0	558	0	540	647	436	0	535	540
11	718	0	566	566	590	550	370	0	569	560
12	754	0	607	0	590	634	0	0	714	605
13	740	0	567	0	609	618	0	0	765	601
14	816	0	644	0	609	615	0	0	765	617
15+	720	0	734	1098	718	672	0	0	713	717
0-15+	559	0	425	230	400	394	308	232	366	399

Age	IIa 2'nd Q weight(g)	IIIa 2'nd Q weight(g)	IVa 2'nd Q weight(g)	IVb,c 2'nd Q weight(g)	VIa 2'nd Q weight(g)	VIIb,c,j,k 2'nd Q weight(g)	VIIa,e,f,g,h 2'nd Q weight(g)	VIId 2'nd Q weight(g)	VIIIa,b,d,e 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	150	155	84	74	0	122	159	117	92
2	262	266	222	164	161	198	127	229	179	188
3	389	379	279	228	254	279	242	263	228	281
4	466	456	352	272	326	311	285	0	326	324
5	519	509	377	336	349	351	313	438	354	382
6	568	564	481	483	402	396	363	336	394	440
7	589	599	501	431	447	435	400	0	463	466
8	606	648	494	332	442	459	446	0	495	500
9	637	667	565	457	506	460	339	720	429	514
10	669	715	688	512	665	499	436	0	541	546
11	718	744	646	557	753	569	370	0	582	609
12	754	702	616	569	679	541	0	0	720	599
13	740	762	0	464	563	529	0	0	765	591
14	816	673	655	542	523	559	0	0	765	619
15+	720	921	711	1097	501	683	0	0	795	717
0-15+	559	531	364	216	155	375	309	232	391	346

Age	IIa 3'rd Q weight (g)	IIIa 3'rd Q weight (g)	IVa 3'rd Q weight (g)	IVb,c 3'rd Q weight (g)	VIa 3'rd Q weight (g)	VIIb,c,j,k 3'rd Q weight (g)	VIIa,e,f,g,h 3'rd Q weight (g)	VIId 3'rd Q weight (g)	VIIIa,b,d,e 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	0	92	0	0	0	0	0	92
1	0	150	196	138	145	152	145	159	127	149
2	304	266	250	217	202	209	196	229	204	232
3	410	379	395	295	261	238	239	263	250	378
4	463	456	464	363	295	292	307	0	282	451
5	539	509	520	401	332	326	387	438	326	521
6	582	564	572	408	459	329	0	336	367	573
7	626	599	609	383	455	342	359	0	427	607
8	625	648	664	337	489	330	472	0	0	625
9	684	667	673	486	552	413	334	720	403	675
10	782	715	728	441	525	573	0	0	528	739
11	848	744	757	553	534	357	282	0	548	785
12	918	702	716	584	532	390	0	0	716	815
13	898	762	760	459	618	393	0	0	765	719
14	940	673	689	570	545	0	0	0	765	847
15+	981	921	903	802	806	0	0	0	754	911
0-15+	560	531	535	298	212	292	207	232	312	501

Age	IIa 4'th Q weight(g)	IIIa 4'th Q weight(g)	IVa 4'th Q weight(g)	IVb,c 4'th Q weight(g)	VIa 4'th Q weight(g)	VIIb,c,j,k 4'th Q weight(g)	VIIa,e,f,g,h 4'th Q weight(g)	VIId 4'th Q weight(g)	VIIIa,b,d,e 4'th Q weight(g)	All areas 4'th Q weight(g)
0	0	0	0	89	67	0	48	0	56	53
1	0	197	166	175	158	0	144	159	143	147
2	276	279	261	252	224	0	226	229	194	250
3	378	349	323	250	278	0	415	263	264	323
4	411	425	396	331	322	0	326	0	286	390
5	498	476	455	424	335	0	400	438	318	452
6	506	548	508	410	383	0	547	336	357	504
7	571	570	534	322	360	0	452	0	386	532
8	578	608	582	535	383	0	465	0	393	566
9	632	659	621	371	429	0	520	720	369	614
10	640	691	640	334	483	0	472	0	523	624
11	699	782	715	445	407	0	392	0	535	688
12	747	702	712	388	384	0	0	0	377	692
13	819	750	691	357	518	0	477	0	765	688
14	862	713	686	486	421	0	0	0	765	665
15+	915	872	769	442	0	0	0	0	752	784
0-15+	508	464	418	272	277	0	169	232	135	385

Table 5.7. 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	28[p]	**

Notes: Data for survey years 1970-74 based on standard area south of 59°30'N, 1975-92 based on standard area south of 61°30'N; *Values dominated by catch in one or two rectangles only; **Data not yet available; [p] provisional value

Table 5.8 Spawning stock biomass estimates for WESTERN MACKEREL and WESTERN HORSE MACKEREL for both the AEPM and the DEPM. Spawning stock biomass estimates of the AEPM are corrected for atresia. A sex ratio of 1:1 is assumed. The spawning stock biomass was calculated from the total egg production based on arithmetic mean for unsampled rectangles if available.

WESTERN MACKEREL

	ANNUAL EGG PRODUCTION METHOD						DAILY EGG PROD. METHOD		
Year	Total egg prod. ($x 10^{-15}$) mean for unsampled rectangles geom.	arithm.	Total fecundity (eggs/g female)	Total fecundity **corrected for 8.8% atresia** (eggs/g female)	Pre-spawning stock biomass ($x 10^{-6}$ tonnes)	Spawning stock biomass (conv.f. 1.08) ($x 10^{-6}$ tonnes)	Daily egg prod. ($x 10^{-12}$)	Spawning stock biomass (only fish with hyaline ovaries) ($x 10^{-6}$ tonnes)	Spawning stock biomass (conv.f. 0.959) ($x 10^{-6}$ tonnes)
1977	1.98		1457 @	1329	2.98	**3.22**	-	-	-
1980*	1.84		1457 @	1329	2.77	**2.99**	-	-	-
1980#	1.48		1457 @	1329	2.23	**2.41**			
1983	1.50	1.53	1457 @	1329	2.30	**2.49**	-	-	-
1986	1.15	1.24	1457 @	1329	1.86	**2.01**	-	-	-
1989	1.45	1.52	1608 $	1467	2.07	**2.24**	22.40	2.35	**2.25**
1992	1.83	1.94	1569	1431	2.71	**2.93**	23.56	1.96	**1.88**

@ from Anon., 1987b page 3
$ from Anon., 1990c
* excluding period 3
# including period 3

WESTERN HORSE MACKEREL

	ANNUAL EGG PRODUCTION METHOD						DAILY EGG PROD. METHOD		
Year	Total egg prod. ($x 10^{-15}$) mean for unsampled rectangles geom.	arithm.	Total fecundity @ (eggs/g female)	Total fecundity **corrected for 10% atresia** (eggs/g female)	Pre-spawning stock biomass ($x 10^{-6}$ tonnes)	Spawning stock biomass (conv.f. 1.05) ($x 10^{-6}$ tonnes)	Daily egg prod. ($x 10^{-12}$)	Spawning stock biomass (only fish with hyaline ovaries) ($x 10^{-6}$ tonnes)	Spawning stock biomass (conv.f. 0.974) ($x 10^{-6}$ tonnes)
1977	0.533 #		1589	1430	0.75	**0.78**	-	-	-
1980	0.635 #		1589	1430	0.89	**0.93**	-	-	-
1983	0.381 #		1589	1430	0.53	**0.56**	-	-	-
1986	0.508 #		1589	1430	0.71	**0.75**	-	-	-
1989	1.54	1.63	1589	1430	2.28	**2.39**	-	-	-
1992	1.37	1.58	1589	1430	2.21	**2.32**	14.79	1.89	**1.84**

Eaton (1989). In 1977 incomplete coverage.
@ fecundity estimate from Eltink and Vingerhoed (1993).

Table 5.9 Abundance indices of Western mackerel in sub-areas VI and VII north of 45°30´N and west of 0°W, based on surveys over the period October-March.

Survey year	Rects sampled	Total area indices							
		Arith mean nos/hr				Trimmed arith mean nos/hr			
		1st winter		2nd winter		1st winter		2nd winter	
1981	65	125	(8)	50	(9)	72	(8)	28	(9)
1982	63	6	(12)	78	(8)	2	(13)	6	(12)
1983	36	4	(13)	46	(10)	3	(12)	29	(8)
1984	78	149	(6)	8	(13)	89	(6)	2	(13)
1985	88	37	(11)	210	(5)	25	(11)	92	(7)
1986	96	89	(10)	37	(11)	52	(10)	27	(10)
1987	115	110	(9)	25	(12)	71	(9)	21	(11)
1988	126	192	(3)	570	(1)	104	(5)	224	(2)
1989	126	162	(5)	138	(7)	116	(3)	109	(6)
1990	147	126	(7)	399	(2)	76	(7)	340	(1)
1991	113	493	(2)	190	(6)	343	(2)	143	(5)
1992	125	176	(4)	233	(4)	109	(4)	191	(3)
1993	104	636	(1)	236	(3)	497	(1)	122	(4)

Trimmed means (by single top and bottom values); (x) = rank; 1st winter = 0/1 gp; 2nd winter = 1/2 gp

Indices north and south of 52°30´N

Survey year	1st winter			2nd winter		
	Arith mean nos/hr		Ratio	Arith means nos/hr		Ratio
	North	South	N:S	North	South	N:S
1981	3	258	.01	1	104	.01
1982	3	14	.21	8	228	.04
1983	-	5	-	-	55	-
1984	137	161	.85	*	14	.02
1985	*	85	<.01	26	453	.06
1986	14	178	.08	21	57	.37
1987	30	187	.16	5	43	.12
1988	43	318	.14	108	972	.11
1989	253	106	2.39	179	133	1.35
1990	227	58	3.91	292	470	.62
1991	199	734	.27	29	322	.09
1992	236	136	1.74	218	243	.90
1993	947	337	2.81	341	136	2.51

- = insufficient data; * = < .5

Note: Abundance indices were calculated from rectangles sampled north of 45°30´N and west of 0°W

Table 5.10 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	0.990	0.060	0.605	5.653	3.893	4.065	0.471	0.155	0.160	0.300	0.309
1985	1.195	3.834	0.037	0.967	6.160	4.359	1.933	0.349	0.345	0.364	0.113
1986	0.960	0.425	9.023	0.212	0.330	1.551	1.381	0.954	0.186	0.062	0.121
1987	1.381	4.690	0.534	8.785	0.042	0.318	0.679	0.560	0.201	0.023	0.010
1988	1.680	35.998	2.181	4.418	18.127	2.789	3.952	3.081	2.959	2.155	0.652
1989	1.733	20.391	14.990	6.750	6.138	11.672	0.982	0.679	1.851	1.941	1.507
1990	1.788	3.398	8.516	17.646	5.952	2.388	3.550	0.191	0.274	0.371	0.270
1991	1.800	4.458	33.120	12.132	10.437	4.686	3.495	4.641	0.499	0.166	0.689
1992	1.740	1.856	5.568	13.775	5.655	2.610	0.580	0.609	0.812	0.087	0.203
1993	1.800	8.400	7.290	8.160	5.949	2.250	1.050	0.930	0.300	0.300	0.000

ICES area VIIh

Data standardised to total numbers per hour.

	Effort	Age 1	2	3	4	5	6	7	8	9	10
1984	1	41.118	440.713	760.175	451.060	584.927	5.162	0.000	0.189	0.234	0.145
1985	1	212.420	22.920	120.900	275.240	148.870	36.510	12.770	3.130	7.300	5.902
1986	1	1.964	43.059	11.860	9.580	18.220	15.770	10.930	0.260	0.043	0.185
1987	1	13.360	20.010	73.200	4.330	9.320	40.670	27.380	13.220	2.492	0.227
1988	1	3.040	48.460	165.455	268.911	17.650	50.990	41.417	30.290	4.560	6.810
1989	1	223.000	209.308	130.923	41.692	36.923	6.846	0.000	3.154	0.000	0.154
1990	1	3.620	63.982	117.466	33.213	3.801	8.869	1.357	3.801	2.534	2.353
1991	1	16.230	1251.920	437.470	216.320	18.170	0.000	9.250	6.670	0.000	0.000
1992	1	0.000	138.000	459.000	50.000	20.000	23.000	7.000	1.000	0.000	0.500
1993	1	104.000	171.000	149.000	141.000	22.000	7.000	3.000	1.000	2.000	0.000

Table 5.11 Catch numbers at age for the Western mackerel (Numbers x 10**-6).

YEAR	1972	1973
AGE		
0	2	0
1	12	34
2	12	49
3	29	64
4	508	116
5	0	582
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
+gp	0	0
TOTALNUM	563	845
TONSLAND	171	219
SOPCOF %	77	69

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
0	1	1	34	2	10	80	20	38	2	0
1	87	53	279	154	31	351	485	266	203	44
2	24	104	185	290	564	62	469	506	436	713
3	124	95	322	154	425	603	75	225	484	445
4	109	306	171	166	244	366	381	32	184	392
5	192	192	289	51	258	217	282	175	25	130
6	567	144	119	140	72	233	145	159	137	20
7	0	1246	280	64	152	87	158	100	109	91
8	0	0	439	89	57	154	52	117	85	71
9	0	0	0	159	83	71	140	35	87	47
10	0	0	0	0	211	75	44	139	24	49
11	0	0	0	0	0	189	48	29	90	19
+gp	0	0	0	0	0	0	115	176	148	126
TOTALNUM	1103	2141	2117	1268	2107	2486	2414	1997	2012	2147
TONSLAND	298	491	507	326	504	606	605	662	624	614
SOPCOF %	72	57	74	85	80	79	75	95	89	91

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
0	1	0	18	2	0	24	5	5	2	13
1	15	234	26	23	99	43	109	47	75	115
2	80	16	398	148	127	307	202	203	151	203
3	662	49	30	654	175	203	408	195	347	264
4	375	420	64	52	505	163	205	363	261	387
5	238	243	332	79	67	356	152	182	298	240
6	92	158	194	237	78	46	247	125	153	247
7	16	59	120	149	179	54	41	192	112	146
8	51	16	38	84	112	106	45	50	136	96
9	39	42	11	33	52	67	80	42	50	119
10	25	33	29	18	19	31	32	68	36	37
11	21	20	20	25	12	14	16	29	40	28
+gp	44	80	60	61	52	35	27	52	68	66
TOTALNUM	1659	1372	1339	1565	1478	1449	1569	1553	1728	1961
TONSLAND	551	561	538	615	628	567	606	646	742	805
SOPCOF %	98	101	101	98	100	100	100	99	100	100

Table 5.12 Catch weights at age (kg) for the Western mackerel.

YEAR	1972	1973
AGE		
0	0.066	0.066
1	0.137	0.137
2	0.158	0.158
3	0.241	0.241
4	0.416	0.314
5	0	0.437
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
+gp	0	0
SOPCOFAC	0.7692	0.6888

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
0	0.066	0.066	0.066	0.066	0.000	0.000	0.066	0.066	0.066	0.066
1	0.137	0.137	0.137	0.137	0.137	0.137	0.131	0.131	0.131	0.178
2	0.158	0.158	0.158	0.158	0.158	0.158	0.248	0.248	0.248	0.216
3	0.241	0.241	0.241	0.241	0.241	0.241	0.283	0.283	0.283	0.270
4	0.314	0.314	0.314	0.314	0.314	0.314	0.343	0.343	0.343	0.306
5	0.334	0.334	0.334	0.334	0.334	0.334	0.373	0.373	0.373	0.383
6	0.472	0.398	0.398	0.398	0.398	0.398	0.455	0.455	0.455	0.425
7	0	0.480	0.410	0.410	0.410	0.410	0.497	0.497	0.497	0.430
8	0	0	0.508	0.503	0.503	0.503	0.508	0.508	0.508	0.491
9	0	0	0	0.511	0.511	0.511	0.539	0.539	0.539	0.542
10	0	0	0	0.511	0.511	0.511	0.573	0.573	0.573	0.608
11	0	0	0	0	0	0.511	0.573	0.573	0.573	0.608
+gp	0	0	0	0	0	0	0.573	0.573	0.573	0.608
SOPCOFAC	0.7246	0.5699	0.7434	0.855	0.8021	0.7897	0.7527	0.9456	0.8908	0.9063

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
0	0.069	0.000	0.000	0.049	0.071	0.061	0.061	0.060	0.055	0.053
1	0.137	0.151	0.166	0.176	0.157	0.154	0.167	0.155	0.164	0.136
2	0.176	0.273	0.245	0.222	0.260	0.238	0.234	0.255	0.238	0.241
3	0.294	0.349	0.339	0.318	0.326	0.321	0.337	0.332	0.334	0.317
4	0.324	0.418	0.421	0.399	0.390	0.377	0.380	0.397	0.398	0.377
5	0.341	0.416	0.473	0.478	0.462	0.434	0.425	0.426	0.462	0.437
6	0.429	0.434	0.444	0.513	0.537	0.455	0.469	0.471	0.497	0.486
7	0.538	0.520	0.456	0.492	0.567	0.546	0.530	0.508	0.534	0.530
8	0.468	0.544	0.541	0.496	0.563	0.596	0.558	0.556	0.557	0.550
9	0.561	0.562	0.593	0.577	0.568	0.579	0.612	0.612	0.599	0.585
10	0.619	0.627	0.546	0.635	0.617	0.582	0.611	0.635	0.654	0.599
11	0.636	0.666	0.692	0.634	0.627	0.649	0.592	0.651	0.667	0.651
+gp	0.636	0.704	0.692	0.721	0.705	0.742	0.717	0.708	0.670	0.680
SOPCOFAC	0.9759	1.0094	1.0055	0.9766	1.0037	0.9996	1.0006	0.9871	1	1.0005

Table 5.13 Stock weights at age (kg) for the Western mackerel.

YEAR		1972	1973
AGE			
	0	0	0
	1	0.113	0.113
	2	0.131	0.131
	3	0.201	0.201
	4	0.38	0.251
	5	0	0.41
	6	0	0
	7	0	0
	8	0	0
	9	0	0
	10	0	0
	11	0	0
+gp		0	0

YEAR		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE											
	0	0	0	0	0	0	0	0	0	0	0
	1	0.113	0.113	0.113	0.113	0.095	0.095	0.095	0.07	0.07	0.07
	2	0.131	0.131	0.131	0.131	0.15	0.15	0.15	0.172	0.108	0.156
	3	0.201	0.201	0.201	0.201	0.215	0.215	0.215	0.241	0.202	0.22
	4	0.251	0.251	0.251	0.251	0.275	0.275	0.275	0.3	0.26	0.261
	5	0.264	0.264	0.264	0.264	0.32	0.32	0.32	0.3	0.379	0.322
	6	0.44	0.316	0.316	0.316	0.355	0.355	0.355	0.359	0.329	0.36
	7	0	0.47	0.38	0.38	0.38	0.38	0.38	0.401	0.388	0.384
	8	0	0	0.49	0.412	0.4	0.4	0.4	0.412	0.417	0.42
	9	0	0	0	0.511	0.42	0.42	0.42	0.427	0.425	0.497
	10	0	0	0	0.511	0.485	0.485	0.485	0.413	0.46	0.453
	11	0	0	0	0	0	0.485	0.485	0.509	0.513	0.55
+gp		0	0	0	0	0	0	0.485	0.509	0.513	0.55
	1										

YEAR		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE											
	0	0	0	0	0	0	0	0	0	0	0
	1	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	2	0.187	0.15	0.164	0.139	0.146	0.176	0.128	0.149	0.216	0.193
	3	0.246	0.292	0.261	0.233	0.233	0.238	0.213	0.227	0.257	0.264
	4	0.283	0.3	0.29	0.268	0.302	0.299	0.28	0.307	0.309	0.311
	5	0.305	0.328	0.345	0.363	0.327	0.342	0.331	0.356	0.359	0.357
	6	0.379	0.366	0.337	0.371	0.434	0.363	0.365	0.408	0.4	0.416
	7	0.429	0.421	0.395	0.392	0.455	0.419	0.405	0.431	0.424	0.458
	8	0.421	0.44	0.467	0.402	0.436	0.468	0.393	0.506	0.464	0.464
	9	0.465	0.448	0.441	0.459	0.46	0.441	0.42	0.547	0.489	0.48
	10	0.515	0.554	0.451	0.483	0.528	0.451	0.514	0.574	0.523	0.512
	11	0.497	0.579	0.472	0.442	0.606	0.496	0.514	0.574	0.556	0.597
+gp		0.5493	0.5991	0.5675	0.5469	0.6445	0.585	0.514	0.574	0.582	0.561

Table 5.14 The Separable VPA tuning diagnostics for the Western Mackerel assessment.

Title: Western Mackerel 1994 W.G.

At 23/08/1994 15:21

Separable analysis
from 1972 to 1993 on ages 0 to 11
with Terminal F of .293 on age 5 and Terminal S of 1.200

Initial sum of squared residuals was 520.477 and
final sum of squared residuals is 109.592 after 114 iterations

Matrix of Residuals

Years / Ages	1972/73
0/ 1	0.347
1/ 2	0.014
2/ 3	-0.959
3/ 4	-0.944
4/ 5	0.099
5/ 6	0.148
6/ 7	0.233
7/ 8	0.223
8/ 9	0.247
9/10	0.076
10/11	0.066
TOT	0.005
WTS	0.001

Years	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
0/ 1	-4.669	-0.236	-2.288	1.073	0.685	-0.225	1.184	0.198	1.316	-0.123
1/ 2	1.661	1.27	0.06	0.521	0.111	0.59	0.664	0.736	0.463	-0.322
2/ 3	-0.281	-0.618	-0.536	0.017	0.308	0.463	0.006	0.775	0.273	0.188
3/ 4	-0.182	-0.467	-0.309	0.184	-0.075	0.355	0.329	0.578	0.109	0.102
4/ 5	-0.353	-0.327	0.136	0.519	-0.26	0.107	-0.089	0.277	-0.053	0.027
5/ 6	0.092	0.443	0.467	-0.059	-0.253	-0.001	-0.043	-0.024	-0.151	-0.211
6/ 7	0.149	-0.551	-0.602	-0.09	0.088	-0.215	0.017	-0.143	0.06	0.071
7/ 8	0.137	0.22	1.086	0.419	0.277	-0.068	0.106	-0.242	-0.179	0.072
8/ 9	0.158	0.236	0.051	0.308	0.232	-0.268	-0.299	-0.149	-0.042	0.239
9/10	-0.014	0.063	-0.124	-0.893	-0.299	-0.118	-0.101	-0.721	-0.145	0.051
10/11	-0.023	0.057	-0.126	-0.896	-0.016	-0.117	-0.135	-0.332	-0.086	-0.282
TOT	0.004	0.003	0.002	0.001	0.001	0.001	0	0	0	0
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Years	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	TOT	WTS
0/ 1	-3.42	-3.19	-3.744	2.998	-0.578	-2.011	1.523	0.965	0.461	-0.928	0	0.093
1/ 2	0.224	0.876	0.499	-0.538	-0.632	-0.169	-0.56	0.492	-0.003	0.235	0	0.317
2/ 3	0.179	0.693	-0.309	0.003	0.193	-0.23	-0.015	0.43	-0.11	-0.075	0	0.44
3/ 4	-0.035	0.36	-0.245	-0.359	0.305	-0.005	-0.051	0.196	-0.184	0.044	0	0.543
4/ 5	0.085	0.139	0.049	-0.23	-0.406	0.066	-0.175	-0.006	0.094	0.022	0	0.839
5/ 6	-0.157	0.02	-0.055	0.234	-0.234	-0.006	0.024	-0.025	-0.021	0.029	0	0.981
6/ 7	-0.162	0.14	0.085	0.245	0.109	0.07	-0.138	0.111	-0.006	-0.036	0	0.84
7/ 8	0.128	-0.366	0.216	0.315	0.095	0.21	-0.099	-0.366	0.208	0.044	0	0.602
8/ 9	0.158	-0.106	0.179	0.123	0.303	0.207	0.008	-0.085	-0.148	0.016	0	1
9/10	0.016	-0.313	0.009	-0.683	0.178	0.011	0.3	-0.168	-0.147	0.006	0	0.623
10/11	0.212	-0.283	0.111	-0.058	0.016	-0.138	0.23	-0.257	0.222	-0.054	0	0.755
TOT	0	0	0	0	0	0	0	0	0	0	-6.101	
WTS	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		

Fishing Mortalities (F)

	1972	1973
F-values	0.0523	0.075

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
F-values	0.1013	0.1557	0.2136	0.135	0.2025	0.2673	0.2582	0.2078	0.1984	0.1845

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
F-values	0.1529	0.1392	0.1405	0.1722	0.1855	0.177	0.174	0.1943	0.2287	0.293

Selection-at-age (S)

	0	1
S-values	0.0051	0.1232

	2	3	4	5	6	7	8	9	10	11
S-values	0.4113	0.7017	0.9161	1	1.002	1.097	1.1963	1.3475	1.2815	1.2

Table 5.15a The Separable VPA results from the Wesrtern Mackerel assessment

Title: Western Mackerel 1994 W.G.

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR	1972	1973
AGE		
0	0.0009	0
1	0.0029	0.0218
2	0.007	0.0134
3	0.0128	0.0439
4	0.0665	0.0604
5	0	0.0961
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
+gp	0.0694	0.0982
FBAR 4-8	0.0133	0.0313

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
0	0.0004	0.0002	0.0072	0.0021	0.0033	0.0156	0.0038	0.0057	0.0011	0
1	0.0243	0.0191	0.0733	0.0382	0.0397	0.1413	0.118	0.0616	0.0359	0.0291
2	0.0186	0.0348	0.0821	0.0959	0.1815	0.097	0.268	0.1648	0.1287	0.1613
3	0.0398	0.0886	0.1362	0.0864	0.1882	0.2835	0.1559	0.1883	0.2214	0.1776
4	0.0925	0.1244	0.2157	0.0914	0.1812	0.2317	0.2757	0.0863	0.2192	0.2654
5	0.1278	0.222	0.1568	0.0874	0.1897	0.2301	0.266	0.1855	0.0851	0.2252
6	0.1211	0.1264	0.1963	0.1006	0.162	0.247	0.2243	0.2221	0.2046	0.0882
7	0	0.3968	0.3618	0.1473	0.1431	0.2827	0.2501	0.2234	0.2206	0.1939
8	0	0	0.2227	0.177	0.177	0.2	0.2604	0.2782	0.2834	0.2073
9	0	0	0	0.1108	0.2348	0.3274	0.2648	0.265	0.3256	0.2387
10	0	0	0	0	0.1994	0.3222	0.3262	0.4297	0.2792	0.2897
11	0	0	0	0	0	0.2612	0.3334	0.3597	0.5202	0.3462
+gp	0.1214	0.3289	0.1876	0.099	0.189	0.2612	0.3334	0.3597	0.5202	0.3462
FBAR 4-8	0.0683	0.1739	0.2307	0.1207	0.1706	0.2383	0.2553	0.1991	0.2026	0.196

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	FBAR 91-93
AGE											
0	0.0001	0	0.0058	0.0005	0.0001	0.0057	0.0021	0.0017	0.0006	0.0015	0.0013
1	0.0133	0.0413	0.0107	0.0087	0.023	0.0166	0.0299	0.0218	0.0307	0.0479	0.0334
2	0.0647	0.0164	0.0867	0.0748	0.0577	0.0875	0.0961	0.068	0.0853	0.1029	0.0854
3	0.2092	0.0491	0.0366	0.1895	0.1128	0.1167	0.1521	0.1197	0.1507	0.1995	0.1567
4	0.2109	0.1884	0.0788	0.0781	0.2074	0.1383	0.1567	0.1859	0.2204	0.2365	0.2143
5	0.2419	0.1944	0.2109	0.1264	0.1288	0.2094	0.1747	0.1918	0.2171	0.3049	0.2379
6	0.232	0.2375	0.2222	0.2171	0.1668	0.1169	0.2081	0.2012	0.2309	0.2656	0.2326
7	0.086	0.216	0.2678	0.2507	0.239	0.1581	0.1362	0.2342	0.2633	0.3388	0.2788
8	0.1511	0.1151	0.2011	0.2882	0.285	0.2046	0.1812	0.2324	0.2435	0.3552	0.277
9	0.1606	0.168	0.1022	0.2519	0.273	0.2602	0.2226	0.2425	0.367	0.3302	0.3132
10	0.1829	0.1863	0.1563	0.2257	0.2162	0.2509	0.1784	0.2822	0.3143	0.481	0.3592
11	0.1875	0.2098	0.1575	0.1858	0.2251	0.2201	0.1836	0.2361	0.2508	0.4144	0.3004
+gp	0.1875	0.2098	0.1575	0.1858	0.2251	0.2201	0.1836	0.2361	0.2508	0.4144	
FBAR 4-8	0.1844	0.1903	0.1961	0.1921	0.2054	0.1655	0.1714	0.2091	0.235	0.3002	

Table 5.15b The Separable VPA results from the Wesrtern Mackerel assessment

Title: Western Mackerel 1994 W.G.

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-6

YEAR	1972	1973
AGE		
0	1960	4528
1	4668	1685
2	1877	4007
3	2497	1604
4	8491	2122
5	0	6838
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
+gp	0	0
TOTAL	19493	20784

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
0	3475	4945	5154	1009	3338	5526	5591	7236	1900	1447
1	3897	2990	4255	4405	867	2864	4682	4794	6192	1634
2	1419	3274	2525	3404	3649	717	2140	3582	3880	5142
3	3403	1199	2721	2002	2662	2619	560	1409	2614	2936
4	1321	2814	944	2044	1580	1898	1698	412	1005	1803
5	1719	1037	2139	655	1606	1135	1296	1109	326	694
6	5347	1302	715	1574	517	1143	776	855	793	257
7	0	4077	988	506	1225	378	769	534	589	556
8	0	0	2360	592	376	914	245	515	367	407
9	0	0	0	1626	427	271	644	163	336	238
10	0	0	0	0	1252	291	168	425	107	209
11	0	0	0	0	0	883	181	104	238	70
+gp	0	0	0	0	0	0	436	625	389	462
TOTAL	20581	21638	21801	17816	17498	18638	19187	21763	18737	15856

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	GMST 72-91	AMST 72-91
AGE													
0	7251	3022	3347	5447	3260	4641	2744	3110	3067	(9536)	0	3517	3946
1	1246	6240	2601	2864	4686	2805	3972	2357	2672	2638	(8195)	3104	3485
2	1366	1058	5154	2215	2444	3941	2375	3318	1985	2230	2164	2564	2874
3	3766	1102	896	4068	1769	1985	3108	1857	2668	1569	1732	2009	2239
4	2116	2630	903	743	2897	1360	1521	2298	1418	1975	1106	1660	2030
5	1190	1475	1875	718	592	2026	1019	1119	1642	979	1342	843	1428
6	477	804	1045	1307	545	448	1415	737	795	1138	621	443	1003
7	203	326	546	720	905	397	343	989	519	543	751	240	703
8	394	160	226	360	482	614	292	258	673	343	333	126	428
9	285	292	123	159	232	312	430	209	176	454	207	73	287
10	161	209	212	96	106	152	207	297	141	105	281	43	195
11	134	116	149	156	66	74	102	149	192	89	56	25	121
+gp	278	456	443	385	279	189	173	267	327	207	168		
TOTAL	18867	17889	17520	19237	18262	18945	17701	16964	16275	21806	16957		

Table 5.15c The Separable VPA results from the Wesrtern Mackerel assessment

Title: Western Mackerel 1994 W.G.

Table 16 Summary (without SOP correction)

Traditional VPA Terminal populations from weighted Separable populations

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4 - 8
1972	1960	4502	3472	171	0.0492	0.0133
1973	4528	4374	3517	219	0.0624	0.0313
1974	3475	4448	3483	298	0.0856	0.0683
1975	4945	4316	3209	491	0.1531	0.1739
1976	5154	3918	2835	507	0.1789	0.2307
1977	1009	3796	2792	326	0.1168	0.1207
1978	3338	3736	2936	504	0.1716	0.1706
1979	5526	3426	2597	606	0.2333	0.2383
1980	5591	3085	2124	605	0.2848	0.2553
1981	7236	3097	2135	662	0.3100	0.1991
1982	1900	2922	1950	624	0.3199	0.2026
1983	1447	3239	2355	614	0.2608	0.1960
1984	7251	3100	2435	551	0.2263	0.1844
1985	3022	3278	2408	561	0.2331	0.1903
1986	3347	3315	2131	538	0.2523	0.1961
1987	5447	3227	2454	615	0.2508	0.1921
1988	3260	3407	2522	628	0.2490	0.2054
1989	4641	3432	2552	567	0.2223	0.1655
1990	2744	3205	2406	606	0.2518	0.1714
1991	3110	3566	2742	646	0.2357	0.2091
1992	3067	3636	2764	742	0.2686	0.2350
1993	(9536)**	3315	2452	805	0.3283	0.3002
Arith. Mean	4161	3561	2649	540	0.2157	0.1795
Units	(Millions)	('000 t)	('000 t)	('000 t)		

** Replaced by the 1972 - 1991 Geometric Mean (3517)

Table 5.16

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Prediction with management option table: Input data

Year: 1994								
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	3517.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0015	0.048
1	3022.000	0.1500	0.0800	0.4000	0.4000	0.070	0.0355	0.156
2	2164.000	0.1500	0.6000	0.4000	0.4000	0.165	0.1185	0.238
3	1732.000	0.1500	0.9000	0.4000	0.4000	0.246	0.2021	0.327
4	1106.000	0.1500	0.9700	0.4000	0.4000	0.295	0.2639	0.388
5	1342.000	0.1500	0.9700	0.4000	0.4000	0.341	0.2880	0.435
6	621.000	0.1500	0.9900	0.4000	0.4000	0.384	0.2886	0.474
7	751.000	0.1500	1.0000	0.4000	0.4000	0.423	0.3160	0.522
8	333.000	0.1500	1.0000	0.4000	0.4000	0.446	0.3446	0.543
9	207.000	0.1500	1.0000	0.4000	0.4000	0.465	0.3881	0.585
10	281.000	0.1500	1.0000	0.4000	0.4000	0.511	0.3691	0.613
11	56.000	0.1500	1.0000	0.4000	0.4000	0.533	0.3456	0.647
12+	168.000	0.1500	1.0000	0.4000	0.4000	0.582	0.3456	0.668
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1995								
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	3517.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0015	0.048
1	.	0.1500	0.0800	0.4000	0.4000	0.070	0.0355	0.156
2	.	0.1500	0.6000	0.4000	0.4000	0.165	0.1185	0.238
3	.	0.1500	0.9000	0.4000	0.4000	0.246	0.2021	0.327
4	.	0.1500	0.9700	0.4000	0.4000	0.295	0.2639	0.388
5	.	0.1500	0.9700	0.4000	0.4000	0.341	0.2880	0.435
6	.	0.1500	0.9900	0.4000	0.4000	0.384	0.2886	0.474
7	.	0.1500	1.0000	0.4000	0.4000	0.423	0.3160	0.522
8	.	0.1500	1.0000	0.4000	0.4000	0.446	0.3446	0.543
9	.	0.1500	1.0000	0.4000	0.4000	0.465	0.3881	0.585
10	.	0.1500	1.0000	0.4000	0.4000	0.511	0.3691	0.613
11	.	0.1500	1.0000	0.4000	0.4000	0.533	0.3456	0.647
12+	.	0.1500	1.0000	0.4000	0.4000	0.582	0.3456	0.668
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1996								
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	3517.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0015	0.048
1	.	0.1500	0.0800	0.4000	0.4000	0.070	0.0355	0.156
2	.	0.1500	0.6000	0.4000	0.4000	0.165	0.1185	0.238
3	.	0.1500	0.9000	0.4000	0.4000	0.246	0.2021	0.327
4	.	0.1500	0.9700	0.4000	0.4000	0.295	0.2639	0.388
5	.	0.1500	0.9700	0.4000	0.4000	0.341	0.2880	0.435
6	.	0.1500	0.9900	0.4000	0.4000	0.384	0.2886	0.474
7	.	0.1500	1.0000	0.4000	0.4000	0.423	0.3160	0.522
8	.	0.1500	1.0000	0.4000	0.4000	0.446	0.3446	0.543
9	.	0.1500	1.0000	0.4000	0.4000	0.465	0.3881	0.585
10	.	0.1500	1.0000	0.4000	0.4000	0.511	0.3691	0.613
11	.	0.1500	1.0000	0.4000	0.4000	0.533	0.3456	0.647
12+	.	0.1500	1.0000	0.4000	0.4000	0.582	0.3456	0.668
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : H1
Date and time: 08SEP94:10:57

Table 5.17

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Prediction with management option table

Year: 1994					Year: 1995					Year: 1996	
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	0.3002	2850689	2064525	737740	0.0000	0.0000	2678273	2124295	0	3146414	2543584
.	.	.	.	.	0.0500	0.0150	.	2112944	38211	3114647	2500925
.	.	.	.	.	0.1000	0.0300	.	2101659	75914	3083307	2459089
.	.	.	.	.	0.1500	0.0450	.	2090439	113117	3052388	2418058
.	.	.	.	.	0.2000	0.0600	.	2079284	149827	3021883	2377817
.	.	.	.	.	0.2500	0.0751	.	2068192	186051	2991787	2338348
.	.	.	.	.	0.3000	0.0901	.	2057165	221796	2962093	2299636
.	.	.	.	.	0.3500	0.1051	.	2046201	257070	2932796	2261665
.	.	.	.	.	0.4000	0.1201	.	2035301	291878	2903889	2224420
.	.	.	.	.	0.4500	0.1351	.	2024463	326227	2875368	2187886
.	.	.	.	.	0.5000	0.1501	.	2013688	360125	2847226	2152048
.	.	.	.	.	0.5500	0.1651	.	2002974	393578	2819458	2116893
.	.	.	.	.	0.6000	0.1801	.	1992322	426592	2792059	2082406
.	.	.	.	.	0.6500	0.1951	.	1981732	459173	2765023	2048574
.	.	.	.	.	0.7000	0.2102	.	1971202	491329	2738344	2015382
.	.	.	.	.	0.7500	0.2252	.	1960733	523064	2712019	1982819
.	.	.	.	.	0.8000	0.2402	.	1950324	554385	2686041	1950871
.	.	.	.	.	0.8500	0.2552	.	1939975	585298	2660405	1919526
.	.	.	.	.	0.9000	0.2702	.	1929685	615809	2635108	1888771
.	.	.	.	.	0.9500	0.2852	.	1919454	645924	2610143	1858595
.	.	.	.	.	1.0000	0.3002	.	1909282	675648	2585505	1828985
.	.	.	.	.	1.0500	0.3152	.	1899169	704986	2561191	1799931
.	.	.	.	.	1.1000	0.3302	.	1889113	733945	2537196	1771420
.	.	.	.	.	1.1500	0.3453	.	1879115	762530	2513514	1743442
.	.	.	.	.	1.2000	0.3603	.	1869174	790747	2490142	1715987
.	.	.	.	.	1.2500	0.3753	.	1859291	818599	2467075	1689043
.	.	.	.	.	1.3000	0.3903	.	1849464	846093	2444308	1662600
.	.	.	.	.	1.3500	0.4053	.	1839693	873234	2421838	1636648
.	.	.	.	.	1.4000	0.4203	.	1829978	900027	2399659	1611177
.	.	.	.	.	1.4500	0.4353	.	1820319	926477	2377768	1586178
.	.	.	.	.	1.5000	0.4503	.	1810715	952588	2356161	1561641
.	.	.	.	.	1.5500	0.4653	.	1801166	978366	2334834	1537556
.	.	.	.	.	1.6000	0.4804	.	1791671	1003815	2313782	1513915
.	.	.	.	.	1.6500	0.4954	.	1782231	1028940	2293001	1490709
.	.	.	.	.	1.7000	0.5104	.	1772845	1053745	2272489	1467929
.	.	.	.	.	1.7500	0.5254	.	1763512	1078235	2252240	1445566
.	.	.	.	.	1.8000	0.5404	.	1754233	1102415	2232252	1423612
.	.	.	.	.	1.8500	0.5554	.	1745007	1126289	2212519	1402059
.	.	.	.	.	1.9000	0.5704	.	1735833	1149861	2193040	1380899
.	.	.	.	.	1.9500	0.5854	.	1726712	1173135	2173810	1360125
.	.	.	.	.	2.0000	0.6004	.	1717643	1196117	2154825	1339727
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : H1
Date and time : 08SEP94:10:57
Computation of ref. F: Simple mean, age 4 - 8
Basis for 1994 : F factors

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Mackerel in the Western Area (Fishing Areas VI, VII and VIII)

Prediction with management option table

Year: 1994					Year: 1995					Year: 1996	
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
1.1800	0.3543	2850689	2024584	850768	0.0000	0.0000	2585224	2039364	0	3057306	2460745
.	.	.	.	.	0.0500	0.0150	.	2028523	36617	3026839	2419817
.	.	.	.	.	0.1000	0.0300	.	2017745	72750	2996780	2379674
.	.	.	.	.	0.1500	0.0450	.	2007029	108405	2967121	2340301
.	.	.	.	.	0.2000	0.0600	.	1996374	143591	2937858	2301681
.	.	.	.	.	0.2500	0.0751	.	1985780	178313	2908984	2263799
.	.	.	.	.	0.3000	0.0901	.	1975247	212579	2880494	2226639
.	.	.	.	.	0.3500	0.1051	.	1964775	246395	2852383	2190187
.	.	.	.	.	0.4000	0.1201	.	1954363	279767	2824644	2154429
.	.	.	.	.	0.4500	0.1351	.	1944010	312702	2797273	2119349
.	.	.	.	.	0.5000	0.1501	.	1933717	345206	2770264	2084935
.	.	.	.	.	0.5500	0.1651	.	1923483	377285	2743612	2051173
.	.	.	.	.	0.6000	0.1801	.	1913307	408946	2717311	2018049
.	.	.	.	.	0.6500	0.1951	.	1903190	440195	2691357	1985550
.	.	.	.	.	0.7000	0.2102	.	1893131	471037	2665745	1953664
.	.	.	.	.	0.7500	0.2252	.	1883129	501478	2640469	1922378
.	.	.	.	.	0.8000	0.2402	.	1873185	531525	2615525	1891680
.	.	.	.	.	0.8500	0.2552	.	1863297	561182	2590908	1861558
.	.	.	.	.	0.9000	0.2702	.	1853466	590455	2566613	1832001
.	.	.	.	.	0.9500	0.2852	.	1843692	619350	2542636	1802996
.	.	.	.	.	1.0000	0.3002	.	1833973	647872	2518972	1774533
.	.	.	.	.	1.0500	0.3152	.	1824310	676027	2495616	1746600
.	.	.	.	.	1.1000	0.3302	.	1814702	703819	2472564	1719188
.	.	.	.	.	1.1500	0.3453	.	1805149	731255	2449813	1692285
.	.	.	.	.	1.2000	0.3603	.	1795650	758338	2427356	1665881
.	.	.	.	.	1.2500	0.3753	.	1786206	785075	2405191	1639966
.	.	.	.	.	1.3000	0.3903	.	1776816	811469	2383312	1614531
.	.	.	.	.	1.3500	0.4053	.	1767479	837527	2361717	1589565
.	.	.	.	.	1.4000	0.4203	.	1758196	863252	2340400	1565059
.	.	.	.	.	1.4500	0.4353	.	1748965	888649	2319358	1541005
.	.	.	.	.	1.5000	0.4503	.	1739787	913723	2298587	1517392
.	.	.	.	.	1.5500	0.4653	.	1730661	938479	2278084	1494213
.	.	.	.	.	1.6000	0.4804	.	1721588	962921	2257843	1471458
.	.	.	.	.	1.6500	0.4954	.	1712566	987054	2237862	1449119
.	.	.	.	.	1.7000	0.5104	.	1703595	1010881	2218136	1427187
.	.	.	.	.	1.7500	0.5254	.	1694676	1034408	2198663	1405655
.	.	.	.	.	1.8000	0.5404	.	1685807	1057639	2179438	1384514
.	.	.	.	.	1.8500	0.5554	.	1676989	1080576	2160459	1363758
.	.	.	.	.	1.9000	0.5704	.	1668221	1103226	2141721	1343377
.	.	.	.	.	1.9500	0.5854	.	1659503	1125592	2123221	1323365
.	.	.	.	.	2.0000	0.6004	.	1650834	1147677	2104955	1303714
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : H1
Date and time : 08SEP94:10:57
Computation of ref. F: Simple mean, age 4 - 8
Basis for 1994 : F factors

Table 5.19 Forecast based on different catch levels of the Western mackerel Stock
Calculated using the program MSFPMO

Year: 1994						Year: 1995						Year: 1996	
F Type	F Factor	Reference F	Stock Biomass	Sp. Stock Biomass	Catch in weight	F Type	F Factor	Reference F	Stock Biomass	Sp. Stock Biomass	Catch in weight	Stock Biomass	Sp. Stock Biomass
F91 - 93	0.826	0.248	2,850,689	2,103,788	623,949	Fman	0.633	0.190	2,771,932	2,064,625	467,379	2,847,908	2,123,329
						F91 - 93	0.826	0.248		2,022,317	595,116	2,742,023	1,992,567
						Fsq	1.000	0.300		1,985,098	704,479	2,651,423	1,883,039
						F94	1.180	0.354		1,947,309	812,673	2,561,845	1,776,928
Fsq	1.000	0.300	2,850,689	2,064,426	738,381	Fman	0.633	0.190	2,677,646	1,984,856	448,566	2,772,974	2,059,086
						F91 - 93	0.826	0.248		1,944,384	571,231	2,671,203	1,933,325
						Fsq	1.000	0.300		1,908,777	676,278	2,584,099	1,827,948
						F94	1.180	0.354		1,872,623	780,229	2,497,953	1,725,822
F94	1.180	0.354	2,850,689	2,024,469	851,508	Fman	0.633	0.190	2,584,498	1,906,099	430,016	2,698,834	1,995,535
						F91 - 93	0.826	0.248		1,867,436	547,680	2,601,120	1,874,709
						Fsq	1.000	0.300		1,833,418	648,471	2,517,465	1,773,428
						F94	1.180	0.354		1,798,873	748,235	2,434,706	1,675,235
						F95	1.373	0.410		1,762,617	850,180	2,350,188	1,577,046

Table 6.1 Landings (tonnes) of MACKEREL in Divisions VIIIc and IXa, 1977-1993. (Data submitted by Working Group members.)

Division VIIIc

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Spain	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533	15,982	16,844	13,446	16,086	16,940	12,043	16,675
Total	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533	15,982	16,844	13,446	16,086	16,940	12,043	16,675

Division IXa

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Portugal	1,743	1,555	1,071	1,929	3,108	3,018	2,239	2,250	4,178	6,419	5,714	4,388	3,112	3,819	2,692	3,576	2,015
Spain	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123	1,837	491	3,540	1,763	1,406	1,051	2,427	1,027
Poland	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
USSR	2,879	189	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	7,565	7,965	7,462	4,648	5,219	5,455	4,463	6,456	6,301	8,256	6,205	7,928	4,875	5,225	3,743	6,003	3,042

Divisions VIIIc + IXa

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total	27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111	24,789	22,187	24,772	18,321	21,311	20,683	18,046	19,720

Table 6.2 Spanish and Portuguese landings of MACKEREL by gear (tonnes) in Divisions VIIIc and IXa, 1985-1992. (Data submitted by Working Group members.)

Division VIIIc

Gear	1985	1986	1987	1988	1989	1990	1991	1992	1993
Spain	11,810	16,533	15,982	16,845	13,446	16,086	16,940	12,043	16,675
Purse seine	4,208	2,105	4,277	7,413	5,659	5,370	6,994	5,153	7,197
Trawl	1,135	2,850	1,900	2,321	2,273	3,842	3,340	1,690	1,392
Hook	6,371	11,323	9,739	6,799	5,208	6,532	6,224	5,003	7,627
Gillnet	96	255	66	312	306	343	382	197	459

Division IXa

Gear	1985	1986	1987	1988	1989	1990	1991	1992	1993
Spain	2,123	1,837	491[1]	3,540	1,763	1,406	1,052	2,427	1,027
Purse seine	1,221	1,436	254[1]	2,644	1,151	910	604	2,189	710
Trawl	902	401	237[1]	896	612	496	448	238	317
Artisanal	-	-	-	-	-	-	-	-	-
Portugal	4,178	6,419	5,714	4,388	3,112	3,509	2,692	3,576	2,015
Purse seine	13	1,511	1,564	1,623	1,458	1,470	330	1,183	684
Trawl	3,658	3,544	2,840	2,006	1,408	1,960	1,757	1,586	808
Artisanal	507	1,364	1,310	759	246	389	627	807	523

[1]Estimated catch does not include Riveira landing port.

Table 6.3. SOUTHERN MACKEREL. Portuguese commercial trawler catch and effort.

		Ages										
Year	Effort	0	1	2	3	4	5	6	7	8	9	10
1986	155.3	4461	19839	5440	26589	219	95	33	16	1	0	3
1987	161.3	1868	8767	1784	851	236	383	26	33	24	1	24
1988	127.6	8007	4819	651	556	96	18	2	0	2	0	0
1989	179.5	5792	6027	1001	467	177	51	16	5	7	5	3
1990	101.7	2346	4835	1998	113	23	10	4	4	.09	.18	.18
1991	238.7	257	3089	2690	1398	208	95	57	17	5	5	0
1992	170.2	672	2428	1207	862	394	146	61	27	56	19	85
1993	130.7*	1317	3188	611	241	214	45	12	7	2	.4	1

* - preliminary

Table 6.4. SOUTHERN MACKEREL. Catch per unit effort from Portuguese demersal trawl surveys.

a. Age-disaggregated information (Catch nos (.10^3) per hour trawling)

	Ages				
Year	0	1	2	3	4
1990	1689	3500	953	30	9
1991	586	338	21	0	0
1992	125101	1587	631	13	13
1993	52323	385	115	47	75

b. Age-aggregated information (Catch nos (.10^3) per hour trawling)

1986	4853
1987	42582
1988	111731
1989	48260
1990	6184
1991	945
1992	127358
1993	52946

Table 6.5. SOUTHERN MACKEREL. Catch and effort Spanish trawl fleet from Aviles.

Year	Effort	Ages 0	1	2	3	4	5	6	7	8	9
1988	9047	0	333	25	78	126	28	34	31	15	6
1989	8063	0	535	201	66	38	53	17	23	29	7
1990	8492	1834	6690	145	123	147	158	181	21	24	17
1991	7677	95	2419	592	205	108	99	57	55	16	14
1992	12693	236	1495	329	122	65	115	56	38	52	16
1993	7635	3	31	48	8	49	20	37	20	11	13

Table 6.6. SOUTHERN MACKEREL. Abundance estimates from Spanish bottom trawl survey.

Year	Ages 0	1	2	3	4	5	6	7	8	9
1984	1.467	.2	.106	.371	.149	.209	.039	.013	.029	.018
1985	2.653	1.598	.016	.055	.370	.138	.085	.03	.017	.029
1986	.026	.174	.140	.022	.026	.06	.025	.002	.0	.004
1987										
1988	.286	.028	.027	.014	.021	.005	.01	.012	.004	.001
1989	.510	.0	.02	.0	.04	.02	.0	.01	.0	.0
1990	.4	.94	.04	.0	.01	.02	.0	.0	.0	.0
1991	.13	.27	.22	.27	.34	.07	.03	.01	.03	.0
1992	19.9	.48	.16	.15	.09	.03	.01	.0	.0	.0
1993	.071	1.256	.789	.026	.063	.018	.008	.002	.002	.002

Table 6.7. SOUTHERN MACKEREL. Catch and effort by the Spanish trawl fleet from La Coruña.

Year	Effort	Ages 0	1	2	3	4	5	6	7	8	9
1988	28119	0	6095	584	625	594	167	239	444	195	53
1989	29628	462	482	719	345	289	541	231	355	444	117
1990	29578	27	4535	939	175	235	370	624	184	409	405
1991	26959	1	39	454	573	839	551	445	504	165	165
1992	26199	1	154	102	298	251	355	128	61	84	25
1993	29670	0	307	440	118	528	188	265	98	41	33

Table 6.8. SOUTHERN MACKEREL. Estimates of daily egg production of stage I from egg surveys. (Lago *et al.* 1993).

Year	Daily Egg Production	C.V
1988	4.01 . 10^ 12	0.30
1990	5.27 . 10^ 12	0.25
1992	9.24 . 10^ 12	0.22

Table 6.9 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1993.

1993 Age	VIIIc East 1'st Q catch('000	VIIIc West 1'st Q catch('000	IXa North 1'st Q catch('000	IXa Centr- 1'st Q catch('000	IXa Centr- 1'st Q catch('000	IXa South 1'st Q catch('000	All areas 1'st Q atch ('000)
0	0	0	0	0	0	0	0
1	77	410	47	2,923	0	0	3,457
2	264	250	70	399	0	0	983
3	273	89	50	160	0	0	572
4	2,605	312	212	119	0	0	3,248
5	1,245	93	64	36	0	0	1,438
6	2,756	97	60	10	0	0	2,923
7	1,648	28	11	6	0	0	1,693
8	852	11	4	2	0	0	869
9	1,016	8	1	2	0	0	1,027
10	617	4	0	2	0	0	623
11	438	3	0	0	0	0	441
12	285	0	0	0	0	0	285
13	346	1	0	0	0	0	347
14	147	0	0	0	0	0	147
15+	81	0	0	0	0	0	81
Total	12,650	1,306	519	3,659	0	0	18,134
Tonne	5,876	292	144	476	0	0	6,788

Age	VIIIc East 2'nd Q catch('000	VIIIc West 2'nd Q catch('000	IXa North 2'nd Q catch('000	IXa Centr- 2'nd Q catch('000	IXa Centr- 2'nd Q catch('000	IXa South 2'nd Q catch('000	All areas 2'nd Q atch ('000)
0	0	0	0	0	0	0	0
1	260	4,444	582	1,363	0	0	6,649
2	1,301	2,461	416	468	0	0	4,646
3	741	76	21	304	0	0	1,142
4	5,502	504	109	241	0	0	6,356
5	2,422	207	41	99	0	0	2,769
6	4,589	357	69	49	0	0	5,064
7	2,318	141	32	44	0	0	2,535
8	1,081	61	18	26	0	0	1,186
9	1,114	48	21	11	0	0	1,194
10	719	32	12	11	0	0	774
11	438	16	10	0	0	0	464
12	238	4	10	0	0	0	252
13	275	5	10	0	0	0	290
14	124	3	2	0	0	0	129
15+	354	4	11	0	0	0	369
Total	21,476	8,363	1,364	2,614	0	0	33,817
Tonne	8,219	1,417	278	580	0	0	10,494

Age	VIIIc East 3'rd Q catch('000	VIIIc West 3'rd Q catch('000	IXa North 3'rd Q catch('000	IXa Centr- 3'rd Q catch('000	IXa Centr- 3'rd Q catch('000	IXa South 3'rd Q catch('000	All areas 3'rd Q atch ('000)
0	0	51	4,541	448	0	0	5,040
1	34	973	761	296	0	0	2,064
2	103	773	90	402	0	0	1,368
3	22	137	0	380	0	0	539
4	124	214	0	546	0	0	884
5	39	46	0	55	0	0	140
6	55	45	0	32	0	0	132
7	25	14	0	24	0	0	63
8	10	5	0	7	0	0	22
9	9	3	0	2	0	0	14
10	6	2	0	2	0	0	10
11	3	1	0	0	0	0	4
12	1	0	0	0	0	0	1
13	1	0	0	0	0	0	1
14	1	0	0	0	0	0	1
15+	1	0	0	0	0	0	1
Total	434	2,264	5,392	2,193	0	0	10,283
Tonne	130	433	430	657	0	0	1,650

Age	VIIIc East 4'th Q catch('000	VIIIc West 4'th Q catch('000	IXa North 4'th Q catch('000	IXa Centr- 4'th Q catch('000	IXa Centr- 4'th Q catch('000	IXa South 4'th Q catch('000	All areas 4'th Q atch ('000)
0	22	65	916	191	0	0	1,194
1	105	309	626	275	0	0	1,315
2	142	117	167	243	0	0	669
3	34	39	0	151	0	0	224
4	38	121	0	163	0	0	322
5	13	49	0	26	0	0	88
6	19	86	0	18	0	0	123
7	9	38	0	14	0	0	61
8	4	19	0	6	0	0	29
9	3	19	0	3	0	0	25
10	2	12	0	3	0	0	17
11	1	7	0	0	0	0	8
12	0	4	0	0	0	0	4
13	0	5	0	0	0	0	5
14	0	2	0	0	0	0	2
15+	0	3	0	0	0	0	3
Total	392	895	1,709	1,092	0	0	4,088
Tonne	87	224	175	302	0	0	788

Table 6.10 Mackerel in Divisions VIIIc and IXa. Catch in numbers ('000 t) at age groups in 1982-1992.

Age	1982[1]	1983[1]	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Age
0	10,966	4,507	292,138	98,495	25,632	4,559	118,385	46,069	15,320	5,015	42,454	6,234	0
1	6,638	6,045	15,633	48,877	34,832	17,132	44,313	16,829	28,285	9,984	9,468	13,484	1
2	8,242	4,474	4,208	3,699	10,302	8,104	4,137	5,634	7,000	8,542	5,136	7,665	2
3	3,009	6,190	8,838	2,102	4,180	10,623	6,364	3,429	2,567	10,759	8,773	2,478	3
4	1,619	5,205	4,755	10,537	2,608	4,697	9,544	3,667	2,723	12,491	5,299	10,809	4
5	1,000	1,011	6,488	3,341	9,232	9,540	3,114	6,110	4,632	6,708	7,742	4,434	5
6	1,675	324	1,647	2,051	2,682	7,028	5,523	2,546	6,602	4,083	3,338	8,241	6
7	4,675	420	932	723	227	1,712	12,974	4,043	1,927	5,571	2,068	4,352	7
8	3,900	2,238	1,584	525	1,099	1,824	5,603	4,972	4,715	1,325	2,908	2,107	8
9	2,700	1,683	1,542	1,025	449	1,082	1,822	1,861	5,464	1,376	877	2,259	9
10+	11,795	3,364	2,554	3,479	6,489	3,849	577	593	1,531	2,890	1,072	1,423	10
							284	154	697	523	1,186	917	11
							752	112	596	56	428	542	12
							713	246	57	108	195	643	13
							124	59	136	79	14	279	14
							931	334	145	361	68	454	15+
Total	56,219	35,461	340,319	174,854	97,732	70,150	215,160	96,658	82,397	69,871	91,026	66,322	
Tonnes	21,076	14,853	20,308	18,111	24,789	22,123	24,534	18,225	21,001	20,780	18,046	19,720	

[1]Spanish data only from Division VIIIc.

Table 6.11 Weight (g) at age by quarter and by sub-division

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	0	0
1	96	85	83	83	0	0	84
2	231	198	222	271	0	0	238
3	281	257	265	330	0	0	290
4	324	302	307	347	0	0	322
5	365	323	317	374	0	0	360
6	411	361	335	431	0	0	408
7	452	404	367	511	0	0	451
8	478	417	362	616	0	0	477
9	504	459	426	669	0	0	504
10	498	454	0	669	0	0	498
11	520	483	0	0	0	0	520
12	601	0	0	0	0	0	601
13	595	521	0	0	0	0	595
14	589	0	0	0	0	0	589
15+	766	0	0	0	0	0	766
0-15+	419	222	278	128	0	0	342

Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	Xa Centr- 2'nd Q weight(g)	IXa Centr- 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	115	119	112	96	0	0	113
2	203	144	161	309	0	0	179
3	270	277	270	351	0	0	292
4	323	327	316	361	0	0	325
5	356	353	346	394	0	0	357
6	398	385	393	440	0	0	397
7	437	419	443	480	0	0	437
8	462	437	477	511	0	0	462
9	494	475	505	539	0	0	494
10	483	466	514	539	0	0	484
11	516	504	520	0	0	0	516
12	592	551	611	0	0	0	592
13	584	550	596	0	0	0	584
14	566	523	566	0	0	0	565
15+	701	554	625	0	0	0	697
0-15+	383	170	204	220	0	0	310

Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	Xa Centr- 3'rd Q weight (g)	IXa Centr- 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	119	71	68	0	0	71
1	116	154	124	266	0	0	158
2	199	188	165	353	0	0	236
3	262	244	0	380	0	0	341
4	303	286	0	367	0	0	339
5	339	324	0	468	0	0	384
6	380	360	0	501	0	0	402
7	423	397	0	518	0	0	453
8	449	416	0	631	0	0	499
9	488	459	0	737	0	0	515
10	477	461	0	737	0	0	523
11	517	500	0	0	0	0	513
12	586	0	0	0	0	0	586
13	577	0	0	0	0	0	577
14	547	0	0	0	0	0	547
15+	640	0	0	0	0	0	640
0-15+	295	193	80	300	0	0	161

Age	VIIIc East 4'th Q weight(g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	Xa Centr- 4'th Q weight(g)	IXa Centr- 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	97	107	99	112	0	0	101
1	161	145	123	213	0	0	150
2	196	180	167	278	0	0	216
3	238	252	0	393	0	0	345
4	304	318	0	387	0	0	351
5	340	353	0	498	0	0	394
6	390	394	0	524	0	0	412
7	432	428	0	549	0	0	457
8	452	465	0	696	0	0	511
9	478	498	0	789	0	0	529
10	470	491	0	789	0	0	539
11	505	522	0	0	0	0	520
12	0	573	0	0	0	0	573
13	0	579	0	0	0	0	579
14	0	567	0	0	0	0	567
15+	0	582	0	0	0	0	582
0-15+	222	251	114	282	0	0	199

Table 6.12 Length (cm) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1993.

1993 Age	VIIIc East 1'st Q length(cm)	VIIIc West 1'st Q length(cm)	IXa North 1'st Q length(cm)	IXa Centr- 1'st Q length(cm)	IXa Centr- 1'st Q length(cm)	IXa South 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	24.0	22.4	22.4	23.0	0.0	0.0	22.9
2	31.8	29.9	31.2	32.8	0.0	0.0	31.7
3	34.0	32.7	33.0	34.8	0.0	0.0	33.9
4	35.5	34.5	34.7	35.4	0.0	0.0	35.3
5	36.8	35.3	35.1	36.1	0.0	0.0	36.6
6	38.2	36.6	35.7	37.6	0.0	0.0	38.1
7	39.4	38.0	36.9	39.5	0.0	0.0	39.4
8	40.2	38.4	36.7	41.8	0.0	0.0	40.2
9	40.9	39.7	38.7	42.8	0.0	0.0	40.9
10	40.7	39.6	0.0	42.8	0.0	0.0	40.7
11	41.3	40.4	0.0	0.0	0.0	0.0	41.3
12	43.3	0.0	0.0	0.0	0.0	0.0	43.3
13	43.2	41.5	0.0	0.0	0.0	0.0	43.2
14	43.0	0.0	0.0	0.0	0.0	0.0	43.0
15+	47.0	0.0	0.0	0.0	0.0	0.0	47.0
0-15+	38.3	30.1	33.2	25.2	0.0	0.0	34.9

Age	VIIIc East 2'nd Q length(cm)	VIIIc West 2'nd Q length(cm)	IXa North 2'nd Q length(cm)	IXa Centr- 2'nd Q length(cm)	IXa Centr- 2'nd Q length(cm)	IXa South 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	24.9	25.3	24.8	23.1	0.0	0.0	24.8
2	30.4	26.9	27.9	34.5	0.0	0.0	28.7
3	33.5	33.5	33.2	36.1	0.0	0.0	34.2
4	35.4	35.5	35.1	36.4	0.0	0.0	35.4
5	36.5	36.4	36.1	37.5	0.0	0.0	36.5
6	37.9	37.4	37.7	38.9	0.0	0.0	37.9
7	39.0	38.5	39.2	40.1	0.0	0.0	39.0
8	39.8	39.0	40.2	41.0	0.0	0.0	39.8
9	40.7	40.2	41.0	41.7	0.0	0.0	40.7
10	40.3	39.9	41.2	41.7	0.0	0.0	40.3
11	41.2	41.0	41.4	0.0	0.0	0.0	41.2
12	43.1	42.3	43.7	0.0	0.0	0.0	43.1
13	42.9	42.2	43.4	0.0	0.0	0.0	42.9
14	42.5	41.5	42.6	0.0	0.0	0.0	42.5
15+	45.5	42.3	44.1	0.0	0.0	0.0	45.4
0-15+	37.1	27.8	29.2	29.3	0.0	0.0	33.9

Age	VIIIc East 3'rd Q length (cm	VIIIc West 3'rd Q length (cm	IXa North 3'rd Q length (cm	IXa Centr- 3'rd Q length (cm	IXa Centr- 3'rd Q length (cm	IXa South 3'rd Q length (cm	All areas 3'rd Q length(cm)
0	0.0	25.3	21.1	22.2	0.0	0.0	21.2
1	25.1	27.5	25.6	31.8	0.0	0.0	27.4
2	30.0	29.5	28.2	35.1	0.0	0.0	31.1
3	33.1	32.2	0.0	35.9	0.0	0.0	34.8
4	34.6	33.9	0.0	35.7	0.0	0.0	35.1
5	35.9	35.3	0.0	38.2	0.0	0.0	36.6
6	37.3	36.6	0.0	38.9	0.0	0.0	37.4
7	38.6	37.9	0.0	39.2	0.0	0.0	38.7
8	39.3	38.4	0.0	41.5	0.0	0.0	39.8
9	40.4	39.7	0.0	43.3	0.0	0.0	40.6
10	40.2	39.8	0.0	43.3	0.0	0.0	40.7
11	41.2	40.9	0.0	0.0	0.0	0.0	41.1
12	42.9	0.0	0.0	0.0	0.0	0.0	42.9
13	42.7	0.0	0.0	0.0	0.0	0.0	42.7
14	42.0	0.0	0.0	0.0	0.0	0.0	42.0
15+	44.0	0.0	0.0	0.0	0.0	0.0	44.0
0-15+	33.8	29.5	21.9	32.5	0.0	0.0	26.3

Age	VIIIc East 4'th Q length(cm)	VIIIc West 4'th Q length(cm)	IXa North 4'th Q length(cm)	IXa Centr- 4'th Q length(cm)	IXa Centr- 4'th Q length(cm)	IXa South 4'th Q length(cm)	All areas 4'th Q length(cm)
0	23.7	24.4	23.8	25.0	0.0	0.0	24.0
1	28.0	27.0	25.5	30.3	0.0	0.0	27.1
2	29.9	29.0	28.4	32.4	0.0	0.0	30.3
3	31.9	32.5	0.0	36.0	0.0	0.0	34.8
4	34.6	35.1	0.0	36.1	0.0	0.0	35.5
5	35.9	36.3	0.0	38.5	0.0	0.0	36.9
6	37.6	37.7	0.0	39.2	0.0	0.0	37.9
7	38.9	38.8	0.0	39.6	0.0	0.0	39.0
8	39.5	39.8	0.0	42.2	0.0	0.0	40.3
9	40.2	40.8	0.0	43.7	0.0	0.0	41.1
10	40.1	40.6	0.0	43.7	0.0	0.0	41.1
11	41.0	41.5	0.0	0.0	0.0	0.0	41.4
12	0.0	42.8	0.0	0.0	0.0	0.0	42.8
13	0.0	42.9	0.0	0.0	0.0	0.0	42.9
14	0.0	42.6	0.0	0.0	0.0	0.0	42.6
15+	0.0	43.0	0.0	0.0	0.0	0.0	43.0
0-15+	30.7	31.6	24.9	32.1	0.0	0.0	28.8

Table 6.13 The tuning diagnostic results for the 1993 Southern Mackerel XSA Assessment

Lowestoft VPA Version 3.1

27/06/1994 13:09

Extended Survivors Analysis

SOUTHERN MACKEREL (VIIIC + IXa)

CPUE data from file c:\data\scal\comb88.dat

Catch data for 9 years. 1985 to 1993. Ages 0 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Portuguese trawl fle	1986	1993	0	9	0.01	0.5
Spanish trawl fleet	1988	1993	0	9	0	1
Spanish bottom Trawl	1985	1993	0	9	0.832	0.834
Spanish trawl fleet	1988	1993	0	9	0	0.5

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 >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 4 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 40 iterations

Total absolute residual between iterations
39 and 40 = .00117

Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 3	0.1461	0.2266	0.2113	0.1544	0.2766	0.2646	0.4762	0.5158	0.4748	0.4924
Iteration 4	0.146	0.2265	0.2112	0.1542	0.2768	0.2648	0.4762	0.5156	0.4747	0.4924

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Continued

Table 6.13 continued

Regression weights

0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.63	0.253	0.029	0.804	0.285	0.289	0.074	0.438	0.146
1	0.374	0.447	0.253	0.401	0.228	0.268	0.293	0.184	0.227
2	0.092	0.118	0.165	0.084	0.076	0.132	0.114	0.227	0.211
3	0.039	0.136	0.162	0.179	0.088	0.043	0.291	0.156	0.154
4	0.131	0.059	0.211	0.203	0.141	0.089	0.282	0.215	0.277
5	0.118	0.154	0.298	0.2	0.183	0.25	0.31	0.267	0.265
6	0.15	0.125	0.16	0.266	0.236	0.291	0.344	0.236	0.476
7	0.077	0.021	0.104	0.463	0.3	0.266	0.403	0.277	0.516
8	0.103	0.153	0.222	0.536	0.305	0.642	0.279	0.358	0.475
9	0.102	0.114	0.21	0.34	0.319	0.606	0.364	0.285	0.492

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XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1985	2.27E+05	1.69E+05	4.51E+04	5.94E+04	9.23E+04	3.23E+04	1.58E+04	1.05E+04	5.78E+03	1.13E+04
1986	1.24E+05	1.04E+05	9.99E+04	3.54E+04	4.92E+04	6.96E+04	2.47E+04	1.17E+04	8.34E+03	4.49E+03
1987	1.73E+05	8.27E+04	5.74E+04	7.64E+04	2.66E+04	3.99E+04	5.14E+04	1.88E+04	9.89E+03	6.16E+03
1988	2.31E+05	1.45E+05	5.53E+04	4.19E+04	5.59E+04	1.85E+04	2.55E+04	3.77E+04	1.46E+04	6.82E+03
1989	2.00E+05	8.90E+04	8.33E+04	4.37E+04	3.01E+04	3.93E+04	1.31E+04	1.68E+04	2.04E+04	7.34E+03
1990	6.58E+04	1.30E+05	6.10E+04	6.64E+04	3.45E+04	2.25E+04	2.81E+04	8.89E+03	1.07E+04	1.30E+04
1991	7.58E+04	4.24E+04	8.52E+04	4.60E+04	5.48E+04	2.71E+04	1.51E+04	1.81E+04	5.86E+03	4.86E+03
1992	1.29E+05	6.06E+04	2.73E+04	6.54E+04	2.96E+04	3.56E+04	1.71E+04	9.21E+03	1.04E+04	3.82E+03
1993	4.95E+04	7.17E+04	4.34E+04	1.87E+04	4.82E+04	2.05E+04	2.34E+04	1.16E+04	6.01E+03	6.26E+03

Estimated population abundance at 1st Jan 1994

0.00E+00	3.68E+04	4.92E+04	3.02E+04	1.38E+04	3.14E+04	1.36E+04	1.25E+04	5.99E+03	3.22E+03

Taper weighted geometric mean of the VPA populations:

1.22E+05	8.99E+04	5.77E+04	4.67E+04	4.28E+04	3.10E+04	2.18E+04	1.43E+04	9.44E+03	6.55E+03

Standard error of the weighted Log(VPA populations) :

0.5735	0.4412	0.4065	0.4355	0.3916	0.4069	0.4179	0.4636	0.4354	0.4045

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Continued

Log catchability residuals.

Fleet : Portuguese trawl fle

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	99.99	1.36	-0.35	99.99	1.06	1.69	-2.9	-1.45	0.75
1	99.99	0.52	0.23	99.99	-0.12	-0.29	0.08	-0.24	-0.09
2	99.99	0.69	0.1	99.99	-0.98	0.61	-0.29	0.42	-0.47
3	99.99	3.76	-0.48	99.99	-0.65	-1.93	0.17	-0.37	-0.12
4	99.99	-0.01	0.68	99.99	0.14	-1.48	-0.54	1.03	0.21
5	99.99	-0.47	1.47	99.99	-0.66	-1.15	0.08	0.56	0.2
6	99.99	0.3	-0.7	99.99	0.09	-1.48	0.96	1.21	-0.4
7	99.99	0.29	0.53	99.99	-1.31	-0.33	-0.42	1.03	-0.23
8	99.99	-2.11	0.88	99.99	-1.16	-4.22	-0.54	1.66	-0.84
9	99.99	99.99	-1.83	99.99	-0.47	-3.73	-0.34	1.56	-2.48

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
Mean Log	-8.5757	-9.024	-10.3971	-11.0922	-11.8903	-11.8903	-11.8903	-11.8903
S.E(Log q	0.6179	1.7122	0.8344	0.8638	0.9556	0.7679	2.1783	2.2969

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.43	-0.288	8.15	0.09	7	1.87	-9.17
1	0.57	1.225	9.2	0.63	7	0.31	-7.67

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.31	-0.381	7.83	0.25	7	0.87	-8.58
3	-3.38	-0.866	16.53	0.01	7	5.92	-9.02
4	-15.61	-0.873	12.68	0	7	13.31	-10.4
5	0.83	0.218	10.97	0.25	7	0.78	-11.09
6	-2.94	-1.825	4.46	0.04	7	2.37	-11.89
7	9.15	-0.87	32.26	0	7	7.14	-11.96
8	1.58	-0.166	14.71	0.02	7	3.26	-12.79
9	-0.35	-3.258	7.23	0.6	6	0.38	-13.1
1							

Continued

Fleet : Spanish bottom Trawl

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.27	-1.54	99.99	99.99	-0.55	0.44	-0.34	1.75	-0.18
1	0.48	-1.41	99.99	99.99	99.99	0.06	-0.17	0.01	0.94
2	-1.57	-0.17	99.99	99.99	-1.97	-0.92	0.44	1.35	2.47
3	-0.7	-1.02	99.99	99.99	99.99	99.99	1.36	0.31	-0.2
4	0.93	-1.16	99.99	99.99	-0.17	-1.73	1.49	0.72	-0.07
5	1.22	-0.35	99.99	99.99	-0.85	-0.24	0.88	-0.27	-0.24
6	1.48	-0.21	99.99	99.99	99.99	99.99	0.65	-0.67	-1.01
7	0.79	-2.08	99.99	99.99	-0.6	99.99	-0.58	99.99	-1.66
8	0.84	99.99	99.99	99.99	99.99	99.99	1.54	99.99	-1.03
9	0.7	-0.35	99.99	99.99	99.99	99.99	99.99	99.99	-1.06

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
Mean Log	-13.0853	-13.0366	-13.1207	-13.364	-13.364	-13.364	-13.364	-13.364
S.E(Log q	1.616	0.9422	1.1605	0.7278	1.0017	1.452	1.4835	0.9781

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	0.49	0.62	11.81	0.24	7	1.12	-12.05
1	1.1	-0.125	11.52	0.3	6	0.88	-11.51

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	-1.5	-1.191	7.79	0.05	7	2.34	-13.09
3	0.73	0.346	12.37	0.37	5	0.78	-13.04
4	0.47	0.872	11.85	0.37	7	0.56	-13.12
5	1.71	-0.51	15.47	0.1	7	1.33	-13.36
6	-0.53	-1.436	7.96	0.25	5	0.47	-13.36
7	0.78	0.103	13.21	0.08	5	1	-14.22
8	-0.02	-1.286	8.61	0.66	3	0.02	-12.94
9	0.43	0.801	10.89	0.74	3	0.44	-13.66
1							

Continued

Table 6.13 continued

Fleet : Spanish trawl fleet

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	99.99	99.99	99.99	99.99	99.99	3.07	-0.03	0.01	-3.02
1	99.99	99.99	99.99	99.99	-0.7	2.39	2.25	0.45	-4.38
2	99.99	99.99	99.99	99.99	-0.33	-0.37	0.79	0.9	-0.99
3	99.99	99.99	99.99	99.99	0.01	0.14	1.23	-0.2	-1.17
4	99.99	99.99	99.99	99.99	-0.35	0.79	0.21	-0.21	-0.45
5	99.99	99.99	99.99	99.99	-0.59	1.04	0.51	-0.13	-0.83
6	99.99	99.99	99.99	99.99	-0.71	0.86	0.45	-0.25	-0.36
7	99.99	99.99	99.99	99.99	-0.63	-0.15	0.26	0.01	-0.25
8	99.99	99.99	99.99	99.99	-0.59	-0.04	0.1	0.23	-0.21
9	99.99	99.99	99.99	99.99	-0.99	-0.59	0.19	0.03	-0.07

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
Mean Log	-14.5788	-15.3807	-15.1804	-14.8496	-14.7392	-14.7392	-14.7392	-14.7392
S.E(Log q	0.8191	0.8618	0.5101	0.7723	0.6388	0.3722	0.3383	0.5801

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	0.36	0.426	12.76	0.18	4	1.05	-15.49
1	1.39	-0.102	14.21	0.02	5	3.21	-13.37

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.31	-0.244	15.73	0.17	5	1.23	-14.58
3	0.51	1.232	13.07	0.68	5	0.41	-15.38
4	0.92	0.082	14.81	0.27	5	0.54	-15.18
5	3.06	-0.435	24.34	0.01	5	2.65	-14.85
6	0.47	1.143	12.15	0.61	5	0.29	-14.74
7	1.07	-0.11	15.26	0.47	5	0.41	-14.89
8	1.57	-1.23	18.07	0.61	5	0.47	-14.84
9	3.38	-1.565	29.9	0.13	5	1.4	-15.02
1							

Continued

Table 6.13 Continued

Fleet : Spanish trawl fleet

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	99.99	99.99	99.99	99.99	3.12	1.39	-2.01	-2.42	99.99
1	99.99	99.99	99.99	99.99	-0.11	0.07	0.03	0.02	-0.01
2	99.99	99.99	99.99	99.99	0.06	0.65	-0.32	-0.62	0.25
3	99.99	99.99	99.99	99.99	0.22	-0.88	0.83	-0.19	0.02
4	99.99	99.99	99.99	99.99	-0.09	-0.44	0.51	-0.07	0.08
5	99.99	99.99	99.99	99.99	-0.03	0.17	0.49	-0.21	-0.42
6	99.99	99.99	99.99	99.99	0.05	0.29	0.68	-0.69	-0.34
7	99.99	99.99	99.99	99.99	0.24	0.22	0.64	-0.8	-0.62
8	99.99	99.99	99.99	99.99	0.28	0.92	0.62	-0.58	-0.84
9	99.99	99.99	99.99	99.99	-0.03	0.71	0.83	-0.81	-1.1

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
Mean Log	-15.0476	-15.3043	-14.7852	-14.4724	-14.2895	-14.2895	-14.2895	-14.2895
S.E(Log q	0.4953	0.6221	0.3434	0.3484	0.5361	0.6234	0.7691	0.8764

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	0.34	0.546	14.26	0.26	4	1.05	-19.38
1	0.25	7.869	12.28	0.97	5	0.08	-15.56

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	0.74	0.628	13.97	0.66	5	0.4	-15.05
3	1.64	-0.589	18.25	0.22	5	1.11	-15.3
4	0.53	1.896	12.78	0.84	5	0.14	-14.79
5	0.94	0.088	14.22	0.42	5	0.38	-14.47
6	1.18	-0.158	15.11	0.2	5	0.73	-14.29
7	0.46	1.42	11.68	0.7	5	0.25	-14.35
8	0.75	0.399	12.94	0.46	5	0.64	-14.21
9	0.55	0.847	11.83	0.54	5	0.49	-14.37
1							

Continued

Table 6.13

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Portuguese trawl fle	77668	2.007	0	0	1	0.021	0
Spanish trawl fleet	1795	2.78	0	0	1	0.011	0
Spanish bottom Trawl	30819	1.258	0	0	1	0.055	0
Spanish trawl fleet	1	0	0	0	0	0	0
P shrinkage mean	89942	0.44				0.513	0.062
F shrinkage mean	12520	0.5				0.4	0.38

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
36817	0.31	0.52	5	1.661	0.146

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Portuguese trawl fle	43898	0.331	0.172	0.52	2	0.265	0.251
Spanish trawl fleet	9013	2.394	2.14	0.89	2	0.004	0.87
Spanish bottom Trawl	152772	0.84	0.347	0.41	2	0.038	0.079
Spanish trawl fleet	48021	0.299	0.193	0.64	2	0.326	0.232
P shrinkage mean	57703	0.41				0.221	0.196
F shrinkage mean	39362	0.5				0.146	0.276

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
49224	0.18	0.12	10	0.647	0.227

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Age 2 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
Portuguese trawl fle	21619	0.313	0.23	0.74	3	0.3	0.284
Spanish trawl fleet	12839	0.833	0.27	0.32	3	0.047	0.441
Spanish bottom Trawl	44143	0.698	0.728	1.04	3	0.059	0.149
Spanish trawl fleet	32236	0.263	0.141	0.54	3	0.428	0.199
F shrinkage mean	52525	0.5				0.166	0.127

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30241	0.18	0.15	13	0.827	0.211

Continued

Table 6.13 Continued

Age 3 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
Portuguese trawl fle	16591	0.314	0.142	0.45	4	0.248	0.13
Spanish trawl fleet	12893	0.633	0.681	1.08	4	0.081	0.164
Spanish bottom Trawl	15323	0.614	0.304	0.5	4	0.076	0.14
Spanish trawl fleet	12238	0.25	0.169	0.67	4	0.423	0.172
F shrinkage mean	14034	0.5				0.172	0.152

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13803	0.17	0.11	17	0.654	0.154

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Age 4 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
Portuguese trawl fle	25621	0.285	0.113	0.39	5	0.214	0.33
Spanish trawl fleet	27011	0.425	0.297	0.7	4	0.13	0.316
Spanish bottom Trawl	33741	0.545	0.141	0.26	5	0.066	0.26
Spanish trawl fleet	31427	0.211	0.11	0.52	5	0.455	0.277
F shrinkage mean	48937	0.5				0.134	0.186

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
31440	0.15	0.08	20	0.529	0.277

Age 5 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
Portuguese trawl fle	16813	0.284	0.21	0.74	5	0.178	0.219
Spanish trawl fleet	10976	0.386	0.303	0.78	5	0.13	0.318
Spanish bottom Trawl	16603	0.545	0.405	0.74	4	0.071	0.221
Spanish trawl fleet	12574	0.192	0.186	0.97	5	0.493	0.283
F shrinkage mean	14954	0.5				0.127	0.243

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13565	0.14	0.1	20	0.739	0.265

Continued

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Age 6 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
Portuguese trawl fle	8084	0.42	0.285	0.68	6	0.115	0.666
Spanish trawl fleet	11380	0.346	0.124	0.36	5	0.18	0.514
Spanish bottom Trawl	8733	0.552	0.512	0.93	4	0.076	0.629
Spanish trawl fleet	11780	0.218	0.203	0.93	5	0.44	0.5
F shrinkage mean	24084	0.5				0.188	0.276

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12532	0.16	0.13	21	0.794	0.476

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1986

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Portuguese trawl fle	6234	0.301	0.273	0.91	7	0.165	0.499
Spanish trawl fleet	5889	0.28	0.203	0.72	5	0.27	0.522
Spanish bottom Trawl	3919	0.525	0.552	1.05	5	0.062	0.708
Spanish trawl fleet	4995	0.225	0.246	1.09	5	0.333	0.592
F shrinkage mean	9853	0.5				0.17	0.343

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5988	0.15	0.13	23	0.849	0.516

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Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1985

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Portuguese trawl fle	4622	0.334	0.291	0.87	7	0.113	0.353
Spanish trawl fleet	3047	0.236	0.146	0.62	5	0.395	0.496
Spanish bottom Trawl	2561	0.53	0.282	0.53	6	0.05	0.567
Spanish trawl fleet	2861	0.238	0.262	1.1	5	0.268	0.521
F shrinkage mean	3681	0.5				0.174	0.426

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3218	0.15	0.1	24	0.639	0.475

Continued

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1984

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Portuguese trawl fle	2060	0.452	0.41	0.91	7	0.074	0.702
Spanish trawl fleet	3960	0.242	0.128	0.53	5	0.415	0.425
Spanish bottom Trawl	1446	0.647	0.189	0.29	5	0.056	0.896
Spanish trawl fleet	2846	0.295	0.289	0.98	5	0.218	0.552
F shrinkage mean	3845	0.5				0.237	0.435

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3295	0.18	0.11	23	0.625	0.492

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Table 6.14 Output of the XSA analysis on southern mackerel 1985-1993.

Run title : SOUTHERN MACKEREL (VIIIC + IXa)

At 27/06/1994 13:12

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	FBAR 91-93
AGE										
0	0.6296	0.2528	0.0288	0.8041	0.2852	0.2889	0.074	0.4378	0.146	0.2192
1	0.3742	0.4467	0.2528	0.4013	0.228	0.2684	0.2926	0.1844	0.2265	0.2345
2	0.0925	0.1178	0.1651	0.0841	0.0757	0.1321	0.1143	0.2271	0.2112	0.1842
3	0.0389	0.1361	0.1623	0.1789	0.0883	0.0425	0.2907	0.1561	0.1542	0.2003
4	0.1313	0.0589	0.2111	0.2033	0.1406	0.089	0.2819	0.2145	0.2768	0.2577
5	0.1182	0.1542	0.2979	0.1997	0.1835	0.2504	0.3099	0.2672	0.2648	0.2806
6	0.1503	0.1245	0.1595	0.2658	0.2356	0.2915	0.3445	0.2358	0.4762	0.3522
7	0.0773	0.0211	0.1035	0.4635	0.2997	0.2661	0.4031	0.2771	0.5156	0.3986
8	0.103	0.1531	0.2217	0.5356	0.3045	0.6417	0.2792	0.3582	0.4747	0.3707
9	0.1025	0.1141	0.2098	0.3398	0.3193	0.606	0.3639	0.2846	0.4924	0.3803
+gp	0.1025	0.1141	0.2098	0.3398	0.3193	0.606	0.3639	0.2846	0.4924	
FBAR 2- 7	0.1014	0.1021	0.1832	0.2325	0.1706	0.1786	0.2907	0.2296	0.3165	

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Run title : SOUTHERN MACKEREL (VIIIC + IXa)

At 27/06/1994 13:12

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	GMST 85-91	AMST 85-91
	AGE												
	0	227253	123680	172810	230959	200148	65805	75831	129073	49464	0	141225	156641
	1	168759	104220	82673	144510	88957	129529	42426	60615	71708	36817	100384	108725
	2	45138	99907	57388	55263	83269	60953	85245	27254	43388	49224	67199	69595
	3	59408	35419	76433	41876	43727	66444	45969	65446	18693	30241	51017	52754
	4	92275	49183	26607	55931	30139	34455	54807	29584	48191	13803	45182	49057
	5	32293	69646	39912	18544	39286	22539	27130	35585	20547	31440	32701	35621
	6	15840	24695	51380	25502	13072	28145	15102	17127	23445	13565	22420	24819
	7	10474	11730	18767	37703	16826	8889	18100	9210	11645	12532	15702	17499
	8	5782	8344	9886	14565	20415	10732	5863	10410	6009	5988	9839	10798
	9	11346	4490	6163	6817	7338	12959	4862	3817	6262	3218	7186	7710
	+gp	38423	64735	21844	12584	5877	7436	14118	12838	11721	9460		
0	TOTAL	706992	596051	563864	644254	549055	447885	389452	400961	311074	206288		

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Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 7
1985	227253	140323	111243	18111	0.1628	0.1014
1986	123680	151374	128373	24789	0.1931	0.1021
1987	172810	126866	102523	22187	0.2164	0.1832
1988	230959	124021	90084	24772	0.275	0.2325
1989	200148	101712	80518	18321	0.2275	0.1706
1990	65805	100148	77948	21311	0.2734	0.1786
1991	75831	95071	76637	20780	0.2711	0.2907
1992	129073	86504	68195	18046	0.2646	0.2296
1993	49464	77433	60450	19720	0.3262	0.3165
Arith. Mean	141669	111495	88441	20893	0.2456	0.2006
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

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Table 7.1 Landings and discards of HORSE MACKEREL (t) by year and division, for the North Sea, Western and Southern horse mackerel.(Data submitted by Working Group members.)

Year	North Sea horse mackerel					Western horse mackerel							Southern horse mackerel			Total
	IIIa	IVb,c	Discards	VIId	Total	IIa	IVa	VIa	VIIa-c,e-k	VIIIa,b,d,e	Discards	Total	VIIIc	IXa	Total	All stocks
1982	- 2,788[3]	-		1,247	4,035	-	-	6,283	32,231	3,073	-	41,587	19,610	39,726	59,336	104,958
1983	- 4,420[3]	-		3,600	8,020	412	-	24,881	36,926	2,643	-	64,862	25,580	48,733	74,313	147,195
1984	- 25,893[3]	-		3,585	29,478	23	94	31,716	38,782	2,510	500	73,625	23,119	23,178	46,297	149,400
1985	1,138	22,897		2,715	26,750	79	203	33,025	35,296	4,448	7,500	80,551	23,292	20,237	43,529	150,830
1986	396	19,496		4,756	24,648	214	776	20,343	72,761	3,071	8,500	105,665	40,334	31,159	71,493	201,806
1987	436	9,477		1,721	11,634	3,311	11,185	35,197	99,942	7,605	-	157,240	30,098	24,540	54,638	223,512
1988	2,261	18,290		3,120	23,671	6,818	42,174	45,842	81,978	7,548	3,740	188,100	26,629	29,763	56,392	268,163
1989	913	25,830		6,522	33,265	4,809	85,304[2]	34,870	131,218	11,516	1,150	268,867	27,170	29,231	56,401	358,533
1990	14,872[1]	17,437		1,325	18,762	11,414	112,753[2]	20,794	182,580	21,120	9,930	373,463	25,182	24,023	49,205	441,430
1991	2,725[1]	11,400		600	12,000	4,487	63,869[2]	34,415	196,926	25,693	5,440	333,555	23,733	21,778	45,511	391,066
1992	2,374[1]	13,955	400	688	15,043	13,457	101,752	40,881	180,937	29,329	1,820	370,550	24,243	26,713	50,955	436,548
1993	850[1]	3,895	930	8,792	13,617	3,168	134,908	53,782	204,318	27,519	8,600	433,145	25,483	31,945	57,428	504,190

[1]Norwegian and Danish catches are included in the Western horse mackerel.
[2]Norwegian catches in Division IVb included in the Western horse mackerel.
[3]Divisions IIIa and IVb,c combined.

Table 7.2 Catches (t) and percentages (%) of *Trachurus mediterraneus* in relation to total landings of *Trachurus trachurus* in Divisions VIIIa,b, VIIIc and IXa in 1993.

	Trachurus mediterraneus										*T. trachurus*
	1Q		2Q		3Q		4Q		Total		Total
	(t)	%	(t)	(%)	(t)	(%)	(t)	(%)	(t)	(%)	(t)
Div. VIIIc	1,727	26.9	341	4.3	1,099	13.4	2,408	39.6	5,576	17.9	25,482
Sub-div. VIIIc East		90.4									
East of 3°W	1,330	16.6	330	17.8	713	53.6	1,669	89.6	4,042	62.1	2,462
West of 3°W	397		11511	0.5	386	12.6	739	27.6	1,534	14.5	9,057
		0.0									
Sub-div. VIIIc West	0		0	0.0	0	0.0	0	0.0	0	0.0	13,963
		0.0									
Sub-div. IXa north	0		0	0.0	0	0.0	0	0.0	0	0.0	6,198
Sub-div. IXa central north		0.0									
central south	0		0	0.0	0	0.0	0	0.0	0	0.0	25,747
south											
		41.2									
Div. VIIIa,b (Spain)	50.7		60	8.7	42	6.9	40	7.2	649	21.1	2,431

Table 7.3 Catches (t) of *Trachurus trachurus* and *Trachurus picturatus* in ICES Division IXa, Sub-area X, and in CECAF Division 34.1, in the period 1986-1993.

		1986	1987	1988	1989	1990	1991	1992	1993
Trachurus trachurus (*)	Div. IXa	28,526	19,554	25,125	25,226	19,959	17,497	22,653	25,747
Trachurus picturatus	Div. IXa	367	181	2,370	2,394	2,012	1,700	1,035	1,028
	Div. X Azorean area	3,331	3,020	3,079	2,866	2,510	1,274	1,255	1,732
	34.1.1 Madeira's area	2,006	1,533	1,687	1,564	1,863	1,161	792	530

(*) As estimated by the Working Group.

Table 7.4 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[1]
II + Vb	4,487	13,457	3,168
IV + IIIa	77,994	113,141	140,383
VI	34,455	40,921	53,822
VII	201,326	188,135	221,120
VIII	49,426	54,186	53,753
IX	21,778	26,713	31,944
Total	389,466	436,553	504,190

[1]Preliminary.

Table 7.5 Quarterly catches of HORSE MACKEREL ('000 t) by division and sub-area in 1992. (Data submitted by Working Group members).

Division	Quarter				Total
	1	2	3	4	
IIa+Vb	1	-	2	+	3
IIIa	-	-	1	+	1
IVa	1	1	3	130	135
IVb,c VIId	+	1	3	9	13
VIa	7	5	34	8	54
VIIa-c,e-k	73	27	57	54	211
VIIIa-b,d,e	10	3	4	11	28
VIIIc	5	8	7	6	26
IXa	6	8	11	7	32
Sum	103	53	112	225	503

Catches to nearest thousand t.
+ = Catches less than 500 t.

Table 7.6 Annual length distributions (millions) of HORSE MACKEREL catches by fleet and country in 1993.

Length (cm)	Netherlands Pel. tr.	Norway P.seine	Spain Trawl	Spain P.seine	Spain Hook	Spain Gillnet	Portugal Trawl	Portugal P.seine	Portugal Artisanal	UK (ENGLAND) Trawl
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	-	-	-	0.03	-	-	-	-	-	-
9	-	-	0.27	0.05	-	-	0.00	-	-	-
10	-	-	0.56	0.73	-	-	0.02	-	-	-
11	-	-	1.23	0.55	-	-	0.02	0.89	0.03	-
12	-	-	1.21	3.02	-	-	0.09	3.22	0.63	-
13	1.68	-	1.76	4.56	-	-	0.96	2.28	1.36	-
14	10.86	-	3.09	5.72	-	-	7.66	7.81	1.51	-
15	30.85	-	3.16	7.31	-	-	33.60	39.69	1.50	-
16	20.17	-	7.71	14.18	0.06	-	56.05	35.13	0.88	-
17	10.12	-	10.50	14.31	0.15	0.00	53.61	18.66	0.91	-
18	7.49	-	7.11	7.26	0.09	0.00	40.21	5.58	0.84	-
19	8.13	-	2.70	4.12	0.00	0.00	23.54	1.76	0.92	-
20	8.79	-	0.81	3.54	0.27	0.00	13.59	1.16	1.39	0.04
21	11.10	-	0.46	1.77	0.19	0.01	9.08	0.43	1.45	0.39
22	12.50	-	0.62	1.46	0.08	0.01	5.08	0.54	1.02	0.38
23	15.72	-	0.83	1.99	0.13	0.03	2.11	0.46	0.80	0.55
24	37.58	-	1.73	3.80	0.09	0.04	2.00	0.46	1.23	1.31
25	147.41	-	2.50	6.06	0.04	0.09	1.88	0.31	0.98	1.69
26	262.47	-	2.63	9.41	0.04	0.16	2.37	0.42	1.35	2.02
27	214.40	-	5.11	8.93	0.05	0.19	2.44	0.46	2.29	2.67
28	157.19	-	10.54	9.88	0.04	0.15	2.43	0.55	2.73	1.10
29	72.35	2.00	11.01	7.87	0.04	0.08	2.04	0.42	2.96	0.58
30	35.03	15.00	9.74	6.65	0.04	0.04	1.52	0.50	2.70	0.25
31	27.53	42.00	8.02	4.58	0.04	0.02	1.25	0.27	2.68	0.27
32	26.11	79.00	5.08	2.81	0.05	0.02	0.91	0.31	1.97	0.09
33	21.01	83.00	3.41	1.92	0.05	0.02	0.46	0.08	2.08	0.09
34	18.08	47.00	2.56	1.09	0.06	0.02	0.23	-	2.22	0.07
35	10.13	33.00	1.82	1.03	0.05	0.01	0.22	-	1.36	0.05
36	6.63	26.00	1.40	1.02	0.05	0.02	0.14	-	1.15	0.04
37	2.72	15.00	0.84	1.07	0.03	0.01	0.10	-	0.49	0.01
38	0.56	7.00	0.32	0.97	0.02	0.01	0.07	-	0.20	0.01
39	1.31	2.00	0.16	0.69	0.01	0.00	0.05	-	0.10	0.01
40	0.25	2.00	0.08	0.42	0.00	0.00	0.02	-	0.04	-
41	0.01	-	0.03	0.27	0.00	0.00	0.00	-	0.02	-
42	-	-	0.01	0.20	0.00	0.01	-	-	0.02	0.01
43	-	-	-	-	-	-	-	-	0.01	-
44	-	-	-	-	-	-	-	-	-	-
45+	-	-	-	-	-	-	-	-	-	-
Total	1178.17	353.00	109.00	139.28	1.66	0.94	263.71	121.38	39.78	11.64
Tonnes	186500	128900	16708	17057	238	171	14706	4679	6363	1893

Table 8.1 Landings (t) of HORSE MACKEREL in Sub-area IV by country.(Data submitted by Working Group members.)

Country	1979	1980	1981	1982	1983	1984
Belgium	9	8	34	7	55	20
Denmark	496	199	3,576	1,612	1,590	23,730
Faroe Islands	-	260	-	-	-	-
France	221	292	421	567	366	827
Germany, Fed.Rep.	376	+	139	30	52	+
Ireland	-	1,161	412	-	-	-
Netherlands	88	101	355	559	2,029[4]	824[4]
Norway	199	119	2,292	7	322	94
Poland	-	-	-	-	2	-
Sweden	+	-	-	-	-	-
UK (Engl. + Wales)	23	11	15	6	4	3
UK (Scotland)	+	-	-	-	-	489
USSR	-	-	-	-	-	-
Total	1,412	2,151	7,245	2,788	4,420	25,987

Country	1985	1986	1987	1988	1989	1990	1991	1992[7]	1993[1]
Belgium	13	13	9	10	10	13	-	+	74
Denmark	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]	20,605[2]	6,982[2]	7,755	6,120
Estonia	-	-	-	-	-	-	-	293	-
Faroe Islands	-	-	-	-	-	942	340	-	360
France	298	231[3]	189[3]	784[3]	248	220	174	162	302
Germany, Fed.Rep.	+	-	3	153	506	2,469[6]	5,995	2,801	1,570
Ireland	-	-	-	-	-	687	2,657	2,600	4,086
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172	1,970	3,852	3,000	2,470
Norway[2]	203	776	11,728[5]	34,425[5]	84,161	117,903[2]	50,000[2]	96,000	126,800
Poland	-	-	-	-	-	-	-	-	-
Sweden	-	2[2]	-	-	-	102	953[2]	800	697
UK (Engl. + Wales)	71	3	339	373	10	10	132	4	115
UK (N. Ireland)	-	-	-	-	-	-	350	-	-
UK (Scotland)	998	531	487	5,749	2,093	458	7,309	996	1,059
USSR	-	-	-	-	-	-	-	-	-
Unallocated + discards	-	-	-	-	-12,482[5]	-317[5]	-750[5]	-278	-3,270
Total	24,238	20,746	20,895	62,892	112,047	145,062	77,994	113,141	140,383

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

Table 8.2 Age composition (%) in commercial and research vessel catches of North Sea horse mackerel taken by the Netherlands in 1987-1993

	Year						
Age	1987	1988	1989	1990	1991	1992	1993
0	0	0	1	0	2	0	2
1	1	0	0	5	3	3	5
2	2	4	3	3	15	2	3
3	0	2	28	10	3	20	5
4	0	0	13	10	7	2	12
5	28	4	2	5	11	6	4
6	3	38	4	0	5	4	6
7	7	2	33	4	0	1	6
8	19	3	4	40	4	1	4
9	3	14	1	5	24	1	2
10	3	0	2	2	4	21	3
11	6	5	1	7	2	6	19
12	5	6	1	1	6	3	2
13	2	6	1	2	0	5	4
14	2	1	1	1	2	1	8
15+	23	15	5	5	13	24	16

Table 9.1 Landings (t) of HORSE MACKEREL in Sub-area II. (Data as submitted by Working Group members.)

Country	1979	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-	-
France	+	-	-	-	-	1
Germany, Fed.Rep.	2	-	+	-	-	-
Norway	-	-	-	-	412	22
USSR	-	-	-	-	-	-
Total	2	-	+	-	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[1]
Faroe Islands	1,115[3]	9,157[3]	1,068
Denmark	-	-	-
France	-	-	-
Germany	-	-	-
Norway	3,200	4,300	2,100
Russia	172	-	-
UK (England + Wales)	-	-	-
Total	4,487	13,457	3,168

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

Table 9.2 Landings (t) of HORSE MACKEREL in Sub-area VI by country. (Data submitted by Working Group members.)

Country	1979	1980	1981	1982	1983	1984
Denmark	443	734	341	2,785	7	-
Faroe Islands	-	-	-	1,248	-	-
France	151	45	454	4	10	14
Germany, Fed. Rep.	155	5,550	10,212	2,113	4,146	130
Ireland	-	-	-	-	15,086	13,858
Netherlands	6,910	2,385	100	50	94	17,500
Norway	-	-	5	-	-	-
Spain	20	-	-	-	-	-
UK (Engl. + Wales)	73	9	5	+	38	+
UK (Scotland)	39	1	17	83	-	214
USSR	-	-	-	-		-
Total	7,791	8,724	11,134	6,283	24,881	31,716

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	-	-	769	1,655	973	615	-	42	-
Faroe Islands	4,014	1,992	4,450[3]	4,000[3]	3,059	628	255	-	820
France	13	12	20	10	2	17	4	3	+
Germany, Fed. Rep.	191	354	174	615	1,162	2,474	2,500	6,281	10,023
Ireland	27,102	28,125	29,743	27,872	19,493	15,911	24,766	32,994	44,802
Netherlands	18,450	3,450	5,750	3,340	1,907	660	3,369	2,150	590
Norway		83	75	41	-	-	-	-	-
Spain		-[2]	-[2]	-[2]	-[2]	-[2]	1	3	-
UK (Engl. + Wales)	996	198	404	475	44	145	1,229	577	144
UK (N.Ireland	-	-	-	-	-	-	1,970	723	-
UK (Scotland)	1,427	138	1,027	7,834	1,737	267	1,640	86	4,523
USSR	-	-	-	-	-	44	-	-	-
Unallocated + discards	-19,168	-13,897	-7,255	-	6,493	143	-1,278	-1,940	-6,960[4]
Total	33,025	20,455	35,157	45,842	34,870	20,904	34,455	40,919	53,942

[1]Preliminary.
[2]Included in Sub-area VII.
[3]Includes Divisions IIIa, IVa,b and VIb.
[4]Includes a negative unallocated catch of -7,000 t.

Table 9.3 Landings (t) of HORSE MACKEREL in Sub-area VII by country. Data submitted by the Working Group members.)

Country	1979	1980	1981	1982	1983	1984
Belgium	3	-	1	1	-	-
Denmark	4,287	5,045	3,099	877	993	732
France	4,407	1,983	2,800	2,314	1,834	2,387
Germany, Fed.Rep.	5,333	2,289	1,079	12	1,977	228
Ireland	-	-	16	-	-	65
Netherlands	25,174	23,002	25,000	27,500[2]	34,350	38,700
Norway	959	394	-	-	-	-
Spain	676	50	234	104	142	560
UK (Engl. + Wales)	2,686	12,933	2,520	2,670	1,230	279
UK (Scotland)	-	1	-	-	-	1
USSR	-	-	-	-	-	-
Total	43,525	45,697	34,749	33,478	40,526	42,952

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993[1]
Faroe Islands	-	-	-	-	-	28	-	-	-
Belgium	+	+	2	-	-	+	-	-	-
Denmark	1,477[2]	30,408[2]	27,368	33,202	34,474	30,594	28,888	18,984	16,978
France	1,881	3,801	2,197	1,523	4,576	2,538	1,230	1,198	1,001
Germany, Fed.Rep.	-	5	374	4,705	7,743	8,109	12,919	12,951	15,684
Ireland	100	703	15	481	12,645	17,887	19,074	15,568	16,363
Netherlands	33,550	40,750	69,400	43,560	43,582	111,900	104,107	109,197	157,110
Norway	-	-	-	-	-	-	-	-	-
Spain	275	137	148	150	14	16	113	106	54
UK (Engl. + Wales)	1,630	1,824	1,228	3,759	4,488	13,371	6,436	7,870	6,090
UK (N.Ireland)	-	-	-	-	-	-	2,026	1,690	587
UK (Scotland)	1	+	2	2,873	+	139	1,992	5,008	3,123
USSR	120	-	-	-	-	-	-	-	-
Unallocated + discards	-	-	-	-	28,368	7,614	24,541	15,563	4,010[3]
Total	39,034	77,628	100,734	90,253	138,890	192,196	201,326	188,135	221,000

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

Table 9.4 Landings (t) of HORSE MACKEREL in Sub-area VIII by country. (Data submitted by Working Group members.)

Country	1979	1980	1981	1982	1983	1984
Denmark	127	-	-	-	-	-
France	4,240	3,361	3,711	3.073	2,643	2,489
Netherlands	-	-	-	-	-	-[2]
Spain	42,766	34,134	36,362	19,610	25,580	23,119
UK (Engl. + Wales)	22	-	+	1	-	1
USSR	-	-	-	-	-	20
Total	47,155	37,495	40,073	22,683	28,223	25,629

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993[1]
Danmark	-	446	3,283	2,793	6,729	5,726	1,349	5,778	1,955
France	4,305	3,534	3,983	4,502	4,719	5,082	6,164	6,220	4,010
Germany	-	-	-	-	-	-	80	62	-
Netherlands	-[2]	-[2]	-[2]	-	-	6,000	12,437	9,339	19,000
Spain	23,292	40,334	30,098	26,629	27,170	25,182	23,733	27,688	27,921
UK (Engl. + Wales)	143	392	339	253	68	6	70	88	123
USSR	-	656	-	-	-	-	-	-	-
Unallocated + discards	-	-	-	-	-	1,500	2,563	5,011	700
Total	27,740	45,362	37,703	34,177	38,686	43,496	46,396	54,186	53,709

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

Table 9.5 Catch in numbers ('000) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1993.

1993 Age	IIa 1'st Q catch('000	IVa 1'st Q catch('000)	VIa 1'st Q catch('000)	VIIb,c,j,k 1'st Q catch('000)	VIIa,e,f,g,h 1'st Q catch('000)	VIIIa,b,d,e 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	1,821	1,017	2,839
4	0	0	0	0	8,195	4,579	12,774
5	0	0	0	1,867	10,016	5,597	17,480
6	0	0	0	17,967	34,601	19,333	71,901
7	61	28	0	4,600	18,211	10,176	33,075
8	61	28	0	5,836	5,463	3,053	14,441
9	30	14	0	2,634	0	0	2,678
10	0	0	0	433	0	0	433
11	2,513	1,495	5,914	183,356	58,275	32,562	284,115
12	30	29	0	866	0	0	925
13	61	28	1,690	532	0	0	2,310
14	182	114	5,914	10,326	0	0	16,535
15+	91	43	7,593	4,056	0	0	11,783
Total	3,028	1,780	21,110	232,473	136,582	76,316	471,289
Tonne	1,068	600	7,125	54,321	18,670	10,435	92,219

Age	IIa 2'nd Q catch('000	IVa 2'nd Q catch('000)	VIa 2'nd Q catch('000)	VIIb,c,j,k 2'nd Q catch('000)	VIIa,e,f,g,h 2'nd Q catch('000)	VIIIa,b,d,e 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	75	0	75
4	0	0	0	0	337	0	337
5	0	0	0	1,120	411	2,593	4,124
6	0	0	0	10,301	1,421	6,914	18,637
7	0	0	0	5,043	748	864	6,655
8	0	0	0	3,923	224	0	4,147
9	0	0	0	1,792	0	0	1,792
10	0	0	0	448	0	0	448
11	0	3,335	4,127	108,800	2,393	11,237	129,892
12	0	152	0	448	0	0	599
13	0	0	1,179	1,792	0	0	2,971
14	0	303	4,127	1,792	0	0	6,222
15+	0	0	5,299	1,792	0	0	7,090
Total	0	3,790	14,731	137,248	5,609	21,609	182,988
Tonne	0	1,046	4,972	26,409	767	2,740	35,934

Age	IIa 3'rd Q catch('000	IVa 3'rd Q catch('000)	VIa 3'rd Q catch('000)	VIIb,c,j,k 3'rd Q catch('000)	VIIa,e,f,g,h 3'rd Q catch('000)	VIIIa,b,d,e 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	663	0	663
2	0	0	0	0	1,326	0	1,326
3	0	0	0	0	0	0	0
4	0	0	0	462	8,869	1,182	10,513
5	0	0	1,316	3,209	11,538	1,182	17,245
6	0	0	14,499	15,097	56,627	8,984	95,208
7	91	0	2,640	5,981	20,009	4,965	33,685
8	91	0	6,588	10,114	7,543	473	24,808
9	45	0	3,956	2,747	2,221	236	9,206
10	0	0	0	437	0	0	437
11	3,765	7,723	93,582	120,460	68,995	6,620	301,144
12	45	351	0	0	0	0	397
13	91	0	2,640	0	0	0	2,730
14	272	702	3,956	1,337	0	0	6,267
15+	136	0	2,640	0	0	0	2,776
Total	4,536	8,776	131,816	159,844	177,790	23,642	506,404
Tonne	1,600	2,422	33,862	30,407	26,327	3,726	98,344

Age	IIa 4'th Q catch('000	IVa 4'th Q catch('000)	VIa 4'th Q catch('000)	VIIb,c,j,k 4'th Q catch('000)	VIIa,e,f,g,h 4'th Q catch('000)	VIIIa,b,d,e 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	416	79,029	14,146	93,591
2	0	0	0	278	47,353	566	48,196
3	0	0	0	25	3,626	1,132	4,783
4	0	0	0	126	23,463	5,658	29,248
5	0	0	306	513	35,618	8,487	44,923
6	0	0	3,365	1,512	91,287	25,462	121,626
7	28	7,455	613	475	30,179	11,882	50,632
8	28	7,455	1,529	319	10,238	2,829	22,398
9	14	3,727	918	160	6,185	566	11,570
10	0	0	0	122	1,813	0	1,935
11	1,177	309,368	21,719	7,788	107,708	14,146	461,906
12	14	3,727	0	13	746	0	4,501
13	28	7,455	613	0	0	0	8,096
14	85	22,364	918	218	0	0	23,585
15+	43	11,182	613	0	0	0	11,837
Total	1,418	372,732	30,593	11,964	437,245	84,873	938,825
Tonne	500	131,889	7,859	2,229	53,225	11,339	207,041

Table 9.6 Length (cm) at age of WESTERN HORSE MACKEREL quarter and by Division(s) in 1993.

1993 Age	IIa 1'st Q length(cm)	IVa 1'st Q length(cm)	VIa 1'st Q length(cm)	VIIb,c,j,k 1'st Q length(cm)	VIIa,e,f,g,h 1'st Q length(cm)	VIIIa,b,d,e 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	24.0	24.0	24.0
4	0.0	0.0	0.0	0.0	24.6	24.6	24.6
5	0.0	0.0	0.0	27.9	25.8	25.8	26.0
6	0.0	0.0	0.0	28.7	26.0	26.0	26.7
7	30.2	30.2	0.0	28.3	26.8	26.8	27.1
8	30.8	30.8	0.0	28.3	26.5	26.5	27.3
9	32.1	32.1	0.0	28.6	0.0	0.0	28.6
10	0.0	0.0	0.0	32.5	0.0	0.0	32.5
11	33.3	33.1	33.1	31.1	27.0	27.0	29.8
12	33.7	33.6	0.0	31.0	0.0	0.0	31.2
13	34.0	34.0	36.0	36.1	0.0	0.0	36.0
14	36.4	35.8	35.8	35.2	0.0	0.0	35.4
15+	37.9	37.9	38.1	37.6	0.0	0.0	37.9
0-15+	33.5	33.4	35.9	31.0	26.4	26.4	29.2

Age	IIa 2'nd Q length(cm)	IVa 2'nd Q length(cm)	VIa 2'nd Q length(cm)	VIIb,c,j,k 2'nd Q length(cm)	VIIa,e,f,g,h 2'nd Q length(cm)	VIIIa,b,d,e 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	24.0	0.0	24.0
4	0.0	0.0	0.0	0.0	24.6	0.0	24.6
5	0.0	0.0	0.0	27.3	25.8	25.8	26.2
6	0.0	0.0	0.0	27.7	26.0	26.4	27.1
7	0.0	0.0	0.0	28.9	26.8	26.5	28.2
8	0.0	0.0	0.0	28.9	26.5	0.0	28.7
9	0.0	0.0	0.0	28.0	0.0	0.0	28.0
10	0.0	0.0	0.0	29.0	0.0	0.0	29.0
11	0.0	32.6	33.1	29.6	27.0	26.0	29.4
12	0.0	33.5	0.0	34.0	0.0	0.0	33.9
13	0.0	0.0	36.0	33.2	0.0	0.0	34.3
14	0.0	34.0	35.8	34.1	0.0	0.0	35.2
15+	0.0	0.0	38.1	36.5	0.0	0.0	37.7
0-15+	0.0	32.7	35.9	29.6	26.4	26.1	29.7

Age	IIa 3'rd Q length (cm)	IVa 3'rd Q length (cm)	VIa 3'rd Q length (cm)	VIIb,c,j,k 3'rd Q length (cm)	VIIa,e,f,g,h 3'rd Q length (cm)	VIIIa,b,d,e 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	18.5	0.0	18.5
2	0.0	0.0	0.0	0.0	21.0	0.0	21.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	28.5	25.3	25.9	25.5
5	0.0	0.0	28.6	27.2	25.8	26.3	26.3
6	0.0	0.0	29.1	27.9	26.6	26.5	27.2
7	30.2	0.0	29.0	28.8	26.7	27.1	27.3
8	30.8	0.0	30.7	27.9	26.9	28.0	28.3
9	32.1	0.0	29.5	28.8	26.6	27.5	28.6
10	0.0	0.0	0.0	29.5	0.0	0.0	29.5
11	33.3	32.6	31.7	28.7	26.8	27.0	29.3
12	33.7	33.5	0.0	0.0	0.0	0.0	33.5
13	34.0	0.0	31.5	0.0	0.0	0.0	31.6
14	36.4	34.0	34.2	33.5	0.0	0.0	34.1
15+	37.9	0.0	35.0	0.0	0.0	0.0	36.1
0-15+	33.5	32.7	31.3	28.6	26.5	26.8	28.6

Age	IIa 4'th Q length(cm)	IVa 4'th Q length(cm)	VIa 4'th Q length(cm)	VIIb,c,j,k 4'th Q length(cm)	VIIa,e,f,g,h 4'th Q length(cm)	VIIIa,b,d,e 4'th Q length(cm)	All areas 4'th Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	16.0	16.5	15.5	16.4
2	0.0	0.0	0.0	22.2	22.0	23.5	22.1
3	0.0	0.0	0.0	25.0	24.7	25.5	24.9
4	0.0	0.0	0.0	25.6	25.3	26.2	25.4
5	0.0	0.0	28.6	26.5	26.2	27.0	26.4
6	0.0	0.0	29.1	27.3	26.7	26.8	26.8
7	30.2	30.2	29.0	27.4	26.7	27.4	27.4
8	30.8	30.8	30.7	27.3	27.0	27.5	28.6
9	32.1	32.1	29.5	30.9	27.5	27.5	29.2
10	0.0	0.0	0.0	29.4	27.3	0.0	27.5
11	33.3	33.3	31.7	29.1	27.0	27.3	31.6
12	33.7	33.7	0.0	27.5	27.5	0.0	32.7
13	34.0	34.0	31.5	0.0	0.0	0.0	33.8
14	36.4	36.4	34.2	34.0	0.0	0.0	36.3
15+	37.9	37.9	35.0	0.0	0.0	0.0	37.7
0-15+	33.5	33.5	31.3	28.1	24.3	25.1	28.3

Table 9.7 Weight (g) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1993.

1993 Age	IIa 1'st Q weight(g)	IVa 1'st Q weight(g)	VIa 1'st Q weight(g)	VIIb,c,j,k 1'st Q weight(g)	VIIa,e,f,g,h 1'st Q weight(g)	VIIIa,b,d,e 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	110	110	110
4	0	0	0	0	113	113	113
5	0	0	0	160	128	128	131
6	0	0	0	175	130	130	141
7	257	257	0	167	144	144	147
8	274	274	0	162	134	134	146
9	316	316	0	179	0	0	181
10	0	0	0	281	0	0	281
11	347	332	256	232	145	145	206
12	364	317	0	225	0	0	232
13	364	364	314	364	0	0	328
14	428	393	341	351	0	0	349
15+	471	471	405	419	0	0	411
0-15+	353	337	338	232	137	137	196

Age	IIa 2'nd Q weight(g)	IVa 2'nd Q weight(g)	VIa 2'nd Q weight(g)	VIIb,c,j,k 2'nd Q weight(g)	VIIa,e,f,g,h 2'nd Q weight(g)	VIIIa,b,d,e 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	110	0	110
4	0	0	0	0	113	0	113
5	0	0	0	145	128	120	128
6	0	0	0	158	130	129	145
7	0	0	0	181	144	131	171
8	0	0	0	180	134	0	177
9	0	0	0	160	0	0	160
10	0	0	0	168	0	0	168
11	0	276	256	191	145	127	189
12	0	272	0	291	0	0	286
13	0	0	314	279	0	0	293
14	0	290	341	300	0	0	327
15+	0	0	405	377	0	0	398
0-15+	0	277	338	192	137	127	196

Age	IIa 3'rd Q weight (g)	IVa 3'rd Q weight (g)	VIa 3'rd Q weight (g)	VIIb,c,j,k 3'rd Q weight (g)	VIIa,e,f,g,h 3'rd Q weight (g)	VIIIa,b,d,e 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	56	0	56
2	0	0	0	0	80	0	80
3	0	0	0	0	0	0	0
4	0	0	0	189	130	145	134
5	0	0	215	170	140	163	152
6	0	0	216	177	149	154	164
7	257	0	200	197	148	159	163
8	274	0	238	176	155	185	187
9	316	0	214	195	144	158	190
10	0	0	0	195	0	0	195
11	347	276	266	192	163	163	209
12	364	272	0	0	0	0	283
13	364	0	274	0	0	0	277
14	428	290	308	335	0	0	317
15+	471	0	331	0	0	0	338
0-15+	353	277	258	190	148	158	195

Age	IIa 4'th Q weight(g)	IVa 4'th Q weight(g)	VIa 4'th Q weight(g)	VIIb,c,j,k 4'th Q weight(g)	VIIa,e,f,g,h 4'th Q weight(g)	VIIIa,b,d,e 4'th Q weight(g)	All areas 4'th Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	31	34	27	33
2	0	0	0	83	82	101	83
3	0	0	0	128	125	130	126
4	0	0	0	131	126	143	129
5	0	0	215	149	140	157	144
6	0	0	216	167	152	154	155
7	257	257	200	163	153	160	171
8	274	274	238	169	156	166	202
9	316	316	214	248	160	158	216
10	0	0	0	193	149	0	152
11	347	347	266	201	156	160	290
12	364	364	0	154	154	0	329
13	364	364	274	0	0	0	357
14	428	428	308	373	0	0	423
15+	471	471	331	0	0	0	464
0-15+	353	353	258	186	122	134	220

Table 9.8 Catch in numbers, mean length and mean weight in catch and mean weight in stock of Western horse mackerel in 1993.

Age	Catch in numbers (millions)	Mean length (cm)	Mean weight (kg) in catch	Mean weight (kg) in stock
0	0	-	-	-
1	94.25	16.4	0.033	-
2	49.52	22.0	0.083	-
3	7.70	24.6	0.120	0.050
4	52.87	25.2	0.126	0.080
5	83.77	26.3	0.142	0.153
6	307.37	26.9	0.154	0.166
7	124.05	27.4	0.163	0.173
8	65.79	28.2	0.183	0.172
9	25.25	28.8	0.199	0.170
10	3.25	28.6	0.177	0.206
11	1177.06	30.3	0.238	0.211
12	6.42	32.6	0.308	0.258
13	16.11	33.8	0.327	0.288
14	52.61	35.6	0.376	0.338
15+	33.49	37.6	0.421	0.405

Table 9.9 The sum of squared residuals between estimated SSB and egg production estimates generated by variation of terminal F on the 1982 and 1987 cohorts.

	0.06	0.07	0.075	0.1	0.125	0.15	0.175	0.2	0.225	0.25	0.275	0.3	0.325
0.0075	56.108	39.429	33.579	16.804	9.501	5.783	3.690	2.428	1.629	1.105	0.752	0.509	0.341
0.01	48.155	32.811	27.495	12.590	6.407	3.436	1.876	1.014	0.526	0.250	0.100	0.026	0.001
0.02	37.364	24.023	19.509	7.406	2.905	1.054	0.295	0.033	0.010	0.107	0.261	0.441	0.630
0.03	34.071	21.398	17.150	5.982	2.042	0.564	0.072	0.009	0.142	0.363	0.619	0.883	1.144
0.04	32.482	20.142	16.028	5.327	1.667	0.376	0.017	0.054	0.265	0.548	0.854	1.161	1.457
0.05	31.546	19.407	15.373	4.953	1.461	0.282	0.002	0.100	0.357	0.677	1.014	1.346	1.664
0.06	30.931	18.925	14.944	4.710	1.330	0.226	6.47E-05	0.137	0.426	0.771	1.128	1.477	1.809
0.07	30.494	18.584	14.641	4.541	1.241	0.190	0.002	0.168	0.479	0.841	1.213	1.574	1.916
0.08	30.169	18.330	14.416	4.416	1.176	0.166	0.006	0.193	0.520	0.896	1.279	1.649	1.999
0.09	29.918	18.134	14.243	4.320	1.127	0.147	0.010	0.214	0.554	0.940	1.331	1.709	2.064
0.1	29.717	17.978	14.104	4.244	1.088	0.134	0.014	0.231	0.582	0.976	1.374	1.757	2.117
0.11	29.554	17.851	13.992	4.183	1.057	0.123	0.018	0.246	0.605	1.006	1.410	1.797	2.161
0.12	29.418	17.745	13.898	4.132	1.032	0.114	0.021	0.258	0.624	1.031	1.439	1.831	2.198
0.13	29.303	17.656	13.820	4.089	1.010	0.107	0.024	0.269	0.641	1.053	1.465	1.860	2.230
0.14	29.205	17.580	13.752	4.052	0.992	0.101	0.027	0.279	0.656	1.072	1.487	1.884	2.257
0.15	29.120	17.514	13.694	4.020	0.977	0.096	0.030	0.287	0.669	1.088	1.506	1.906	2.281
0.16	29.046	17.457	13.643	3.993	0.963	0.092	0.032	0.295	0.680	1.102	1.523	1.925	2.302
0.17	28.980	17.406	13.598	3.969	0.951	0.089	0.035	0.301	0.690	1.115	1.538	1.942	2.320
0.18	28.922	17.361	13.559	3.947	0.941	0.085	0.037	0.307	0.699	1.127	1.552	1.957	2.336
0.19	28.871	17.321	13.523	3.928	0.931	0.083	0.039	0.313	0.707	1.137	1.564	1.971	2.351

Table 9.10 Inputs and outputs of a prediction for the Western HORSE MACKEREL assuming a certain exploitation pattern.
Input values are printed in italics and the calculated values are in plain characters.
In 1992 tuned to SSB of 2.32 million tonnes from egg survey and to a catch of 370 000 tonnes.
In 1993 tuned to catch of 432 000 tonnes and to catch age composition.
Constant weak recruitment of 500 million fish at age 1 from 1994 onwards.

WESTERN HORSE MACKEREL

YEAR = *1992* Stock-size-factor = *0.968* F-factor = *0.927*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (%)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1991	1	*0.01*	0.01	7.55	0.4%	0.11	*881*	0	0	0	0	0	*0.15*	*0.00*	*0.014*	*0.000*
1990	2	*0.06*	0.06	5.35	0.3%	0.49	*106*	5	11	1	10	0	*0.15*	*0.10*	*0.092*	*0.050*
1989	3	*0.09*	0.08	38.17	2.0%	4.47	*513*	41	205	16	185	15	*0.15*	*0.40*	*0.117*	*0.080*
1988	4	*0.12*	0.11	67.28	3.4%	9.35	*687*	72	412	43	367	38	*0.15*	*0.60*	*0.139*	*0.105*
1987	5	*0.15*	0.14	312.11	16.0%	44.63	*2585*	326	2068	261	1815	229	*0.15*	*0.80*	*0.143*	*0.126*
1986	6	*0.15*	0.14	125.08	6.4%	19.64	*1036*	156	1036	156	909	137	*0.15*	*1.00*	*0.157*	*0.151*
1985	7	*0.15*	0.14	65.46	3.4%	10.67	*542*	81	542	81	476	71	*0.15*	*1.00*	*0.163*	*0.150*
1984	8	*0.15*	0.14	24.55	1.3%	4.22	*203*	32	203	32	178	28	*0.15*	*1.00*	*0.172*	*0.158*
1983	9	*0.15*	0.14	4.68	0.2%	1.10	*39*	6	39	6	34	5	*0.15*	*1.00*	*0.235*	*0.160*
1982	10	*0.15*	0.14	1191.15	61.0%	235.85	*9864*	1815	9864	1815	8661	1594	*0.15*	*1.00*	*0.198*	*0.184*
1981	11	*0.15*	0.14	5.84	0.3%	1.68	*48*	14	48	14	42	12	*0.15*	*1.00*	*0.288*	*0.292*
+	12+	*0.15*	0.14	104.04	5.3%	37.76	*862*	220	862	220	756	193	*0.15*	*1.00*	*0.363*	*0.255*
		F(5-11)W=	0.139	1951	100%	370	17366	2769	15290	2646	13434	2324				

YEAR = 1993 F-factor = *1.381*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (% numbers)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1992	1	0.01	0.01	104.45	4.5%	3.45	*8200*	0	0	0	0	0	*0.15*	*0.00*	*0.033*	*0.000*
1991	2	0.06	0.08	55.53	2.4%	4.61	751	38	75	4	68	3	*0.15*	*0.10*	*0.083*	*0.050*
1990	3	0.09	0.12	9.42	0.4%	1.13	87	7	35	3	31	2	*0.15*	*0.40*	*0.120*	*0.080*
1989	4	0.12	0.17	57.73	2.5%	7.27	406	43	244	26	211	22	*0.15*	*0.60*	*0.126*	*0.105*
1988	5	0.15	0.21	92.20	4.0%	13.09	529	81	423	65	361	55	*0.15*	*0.80*	*0.142*	*0.153*
1987	6	0.15	0.21	337.20	14.7%	52.94	1936	273	1936	273	1648	232	*0.15*	*1.00*	*0.157*	*0.141*
1986	7	0.15	0.21	135.13	5.9%	22.03	776	134	776	134	661	114	*0.15*	*1.00*	*0.163*	*0.173*
1985	8	0.15	0.21	70.72	3.1%	12.87	406	70	406	70	346	59	*0.15*	*1.00*	*0.182*	*0.172*
1984	9	0.15	0.21	26.52	1.2%	5.28	152	26	152	26	130	22	*0.15*	*1.00*	*0.199*	*0.170*
1983	10	0.15	0.21	5.05	0.2%	0.89	29	6	29	6	25	5	*0.15*	*1.00*	*0.177*	*0.206*
1982	11	0.15	0.21	1286.93	56.0%	263.82	7388	1418	7388	1418	6291	1208	*0.15*	*1.00*	*0.205*	*0.192*
1981	12	0.15	0.21	6.31	0.3%	1.94	36	9	36	9	31	8	*0.15*	*1.00*	*0.308*	*0.258*
+	13+	0.15	0.21	112.40	4.9%	42.94	645	225	645	225	549	192	*0.15*	*1.00*	*0.382*	*0.349*
		F(5-12)W=	0.207	2300	100%	432	21341	2330	12145	2259	10351	1924				

(continued)

Table 9.10 (continued)

YEAR = 1994 F-factor = *1.756*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (%)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1993	1	0.01	0.02	8.08		0.27	*500*	0	0	0	0	0	*0.15*	*0.00*	*0.033*	*0.000*
1992	2	0.06	0.11	647.26		53.72	6961	348	696	35	621	31	*0.15*	*0.10*	*0.083*	*0.050*
1991	3	0.09	0.16	80.95		9.71	595	48	238	19	207	17	*0.15*	*0.40*	*0.120*	*0.080*
1990	4	0.12	0.21	11.66		1.47	66	7	40	4	34	4	*0.15*	*0.60*	*0.126*	*0.105*
1989	5	0.15	0.26	63.91		9.08	296	45	237	36	197	30	*0.15*	*0.80*	*0.142*	*0.153*
1988	6	0.15	0.26	79.89		12.30	370	61	370	61	307	51	*0.15*	*1.00*	*0.154*	*0.166*
1987	7	0.15	0.26	292.20		49.38	1354	207	1354	207	1124	172	*0.15*	*1.00*	*0.169*	*0.153*
1986	8	0.15	0.26	117.10		21.31	543	93	543	93	451	78	*0.15*	*1.00*	*0.182*	*0.172*
1985	9	0.15	0.26	61.29		12.20	284	48	284	48	236	40	*0.15*	*1.00*	*0.199*	*0.170*
1984	10	0.15	0.26	22.98		4.07	107	22	107	22	88	18	*0.15*	*1.00*	*0.177*	*0.206*
1983	11	0.15	0.26	4.38		1.04	20	4	20	4	17	4	*0.15*	*1.00*	*0.238*	*0.211*
1982	12	0.15	0.26	1115.18		235.30	5169	1023	5169	1023	4292	850	*0.15*	*1.00*	*0.211*	*0.198*
1981	13	0.15	0.26	5.47		1.79	25	7	25	7	21	6	*0.15*	*1.00*	*0.327*	*0.288*
+	14+	0.15	0.26	97.40		38.28	451	163	451	163	375	135	*0.15*	*1.00*	*0.393*	*0.360*
		F(5-13)W= 0.263		2608		450	16743	2078	9535	1724	7969	1434				

YEAR = 1995 F-factor = *1.395*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (%)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1994	1	0.01	0.01	6.43		0.21	*500*	0	0	0	0	0	*0.15*	*0.00*	*0.033*	*0.000*
1993	2	0.06	0.08	31.56		2.62	423	21	42	2	38	2	*0.15*	*0.10*	*0.083*	*0.050*
1992	3	0.09	0.13	591.73		71.01	5392	431	2157	173	1905	152	*0.15*	*0.40*	*0.120*	*0.080*
1991	4	0.12	0.17	62.73		7.90	437	46	262	28	227	24	*0.15*	*0.60*	*0.126*	*0.105*
1990	5	0.15	0.21	8.08		1.15	46	7	37	6	31	5	*0.15*	*0.80*	*0.142*	*0.153*
1989	6	0.15	0.21	34.44		5.30	196	33	196	33	167	28	*0.15*	*1.00*	*0.154*	*0.166*
1988	7	0.15	0.21	43.05		7.02	245	42	245	42	208	36	*0.15*	*1.00*	*0.163*	*0.173*
1987	8	0.15	0.21	157.47		28.50	896	147	896	147	762	125	*0.15*	*1.00*	*0.181*	*0.164*
1986	9	0.15	0.21	63.11		12.56	359	61	359	61	305	52	*0.15*	*1.00*	*0.199*	*0.170*
1985	10	0.15	0.21	33.03		5.85	188	39	188	39	160	33	*0.15*	*1.00*	*0.177*	*0.206*
1984	11	0.15	0.21	12.39		2.95	70	15	70	15	60	13	*0.15*	*1.00*	*0.238*	*0.211*
1983	12	0.15	0.21	2.36		0.73	13	3	13	3	11	3	*0.15*	*1.00*	*0.308*	*0.258*
1982	13	0.15	0.21	600.98		131.01	3419	701	3419	701	2908	596	*0.15*	*1.00*	*0.218*	*0.205*
1981	14	0.15	0.21	2.95		1.11	17	6	17	6	14	5	*0.15*	*1.00*	*0.375*	*0.338*
+	15+	0.15	0.21	52.49		22.10	299	121	299	121	254	103	*0.15*	*1.00*	*0.421*	*0.405*
		F(5-14)W= 0.209		1703		300	12500	1673	8200	1375	7053	1176				

(continued)

Table 9.10 (continued)

YEAR = 1996 F-factor = *1.730*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (%)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1995	1	0.01	0.02	7.97		0.26	*500*	0	0	0	0	0	*0.15*	*0.00*	*0.033*	*0.000*
1994	2	0.06	0.10	38.91		3.23	424	21	42	2	38	2	*0.15*	*0.10*	*0.083*	*0.050*
1993	3	0.09	0.16	44.91		5.39	335	27	134	11	117	9	*0.15*	*0.40*	*0.120*	*0.080*
1992	4	0.12	0.21	714.48		90.02	4094	430	2456	258	2091	220	*0.15*	*0.60*	*0.126*	*0.105*
1991	5	0.15	0.26	67.80		9.63	318	49	255	39	212	32	*0.15*	*0.80*	*0.142*	*0.153*
1990	6	0.15	0.26	6.83		1.05	32	5	32	5	27	4	*0.15*	*1.00*	*0.154*	*0.166*
1989	7	0.15	0.26	29.13		4.75	137	24	137	24	114	20	*0.15*	*1.00*	*0.163*	*0.173*
1988	8	0.15	0.26	36.41		6.63	171	29	171	29	142	24	*0.15*	*1.00*	*0.182*	*0.172*
1987	9	0.15	0.26	133.18		25.30	625	109	625	109	520	91	*0.15*	*1.00*	*0.190*	*0.175*
1986	10	0.15	0.26	53.37		9.45	251	52	251	52	208	43	*0.15*	*1.00*	*0.177*	*0.206*
1985	11	0.15	0.26	27.93		6.65	131	28	131	28	109	23	*0.15*	*1.00*	*0.238*	*0.211*
1984	12	0.15	0.26	10.47		3.23	49	13	49	13	41	11	*0.15*	*1.00*	*0.308*	*0.258*
1983	13	0.15	0.26	2.00		0.65	9	3	9	3	8	2	*0.15*	*1.00*	*0.327*	*0.288*
1982	14	0.15	0.26	508.27		114.36	2387	504	2387	504	1985	419	*0.15*	*1.00*	*0.225*	*0.211*
1981	15	0.15	0.26	2.49		1.05	12	5	12	5	10	4	*0.15*	*1.00*	*0.421*	*0.405*
+	16+	0.15	0.26	44.39		18.69	208	84	208	84	173	70	*0.15*	*1.00*	*0.421*	*0.405*
		F(5-15)W= 0.260		1729		**300**	9684	1382	6900	1165	5795	**975**				

YEAR = 1997 F-factor = *2.220*

Year class (years)	Age (years)	Relative F	Absolute F	Catch in numbers (millions)	Catch in percentage (%)	Catch in weight ('000 tonnes)	Stock size (millions)	Stock biomass ('000 tonnes)	1st of January SP. ST. size (millions)	1st of January SP. ST. biomass ('000 tonnes)	Spawning time SP. ST. size (millions)	Spawning time SP. ST. biomass ('000 tonnes)	Natural mortality	Maturity ogive	Weight in the catch (kg)	Weight in the stock (kg)
1996	1	0.01	0.02	10.20		0.34	*500*	0	0	0	0	0	*0.15*	*0.00*	*0.033*	*0.000*
1995	2	0.06	0.13	49.06		4.07	423	21	42	2	37	2	*0.15*	*0.10*	*0.083*	*0.050*
1994	3	0.09	0.20	55.51		6.66	329	26	132	11	113	9	*0.15*	*0.40*	*0.120*	*0.080*
1993	4	0.12	0.27	53.73		6.77	247	26	148	16	123	13	*0.15*	*0.60*	*0.126*	*0.105*
1992	5	0.15	0.33	756.09		107.36	2863	438	2290	350	1843	282	*0.15*	*0.80*	*0.142*	*0.153*
1991	6	0.15	0.33	55.84		8.60	211	35	211	35	170	28	*0.15*	*1.00*	*0.154*	*0.166*
1990	7	0.15	0.33	5.62		0.92	21	4	21	4	17	3	*0.15*	*1.00*	*0.163*	*0.173*
1989	8	0.15	0.33	23.99		4.37	91	16	91	16	73	13	*0.15*	*1.00*	*0.182*	*0.172*
1988	9	0.15	0.33	29.99		5.97	114	19	114	19	91	16	*0.15*	*1.00*	*0.199*	*0.170*
1987	10	0.15	0.33	109.68		21.72	415	76	415	76	334	61	*0.15*	*1.00*	*0.198*	*0.184*
1986	11	0.15	0.33	43.95		10.46	166	35	166	35	134	28	*0.15*	*1.00*	*0.238*	*0.211*
1985	12	0.15	0.33	23.00		7.09	87	22	87	22	70	18	*0.15*	*1.00*	*0.308*	*0.258*
1984	13	0.15	0.33	8.63		2.82	33	9	33	9	26	8	*0.15*	*1.00*	*0.327*	*0.288*
1983	14	0.15	0.33	1.64		0.62	6	2	6	2	5	2	*0.15*	*1.00*	*0.375*	*0.338*
1982	15	0.15	0.33	418.58		96.27	1585	344	1585	344	1275	277	*0.15*	*1.00*	*0.230*	*0.217*
1981	16	0.15	0.33	2.05		0.86	8	3	8	3	6	3	*0.15*	*1.00*	*0.421*	*0.405*
+	17+	0.15	0.33	36.56		15.39	138	56	138	56	111	45	*0.15*	*1.00*	*0.421*	*0.405*
		F(5-16)W= 0.333		1684		**300**	7238	1134	5488	1001	4429	**806**				

Table 10.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984-1993 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

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

Table 10.2 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

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

Table 10.3 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries

Year	Division IXa (Portugal) Trawl Kg/h	Division VIIIc (Spain) Trawl Sub-div. VIIIc Este Aviles Kg/Hp.day. 10^{-2}	Division VIIIc (Spain) Trawl Sub-div. VIIIc West La Coruna Kg/Hp.day. 10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.40
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

Table 10.4 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

Year	Portugal IXa (20-500 m depth) Bottom trawl (20-mm codend) Kg/h March	kg/h Jun-Jul	kg/h Oct	Spain (20-500m depth) kg/30 minutes Sept-Oct
1979		12.2[2]	5.5[2]	-
1980		20.6[2]	2.5[2]	-
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[2]	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[1]	35.6[1]	235.3[1]	18.11[1]

[1]Covering only part of Divisions IXa+VIIIc, area defined by 41°50' N - 08°00'W, and less than 200 m depth.
[2]Codend mesh size 40 mm.

Table 10.5.- CPUE at age from fleets

Horse mackerel in Fishing Areas VIIIc and IXa

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

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
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

Horse mackerel in Fishing Areas VIIIc and IXa

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

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
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

able 10.6.- CPUE at age from surveys

Oct Pt. Survey, Bottom trawl survey (code: FLT03) (Catch: Millions)

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
1985	1	70.580	60.151	2.837	1.144	0.618	0.240	0.096	0.025
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

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	0.001	0.006	0.004	0.015	0.003	0.003	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

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

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
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

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

Jul Pt. Survey, bottom trawl survey (code: PJSCA) (Catch: numbers) (Effort: arbitrary)

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
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

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

Table 10.7 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1993.

1993 Age	VIIIc East 1'st Q catch('000)	VIIIc West 1'st Q catch('000)	IXa North 1'st Q catch('000)	IXa Centr-N 1'st Q catch('000)	IXa Centr-S 1'st Q catch('000)	IXa South 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	2,368	154	9	1,654	993	741	5,919
2	5,482	8,045	2,617	32,797	5,493	3,872	58,306
3	834	652	226	9,313	2,489	1,766	15,280
4	594	711	98	1,773	1,613	1,022	5,811
5	482	726	165	858	1,398	574	4,203
6	493	948	159	974	1,539	578	4,691
7	1,583	2,763	436	1,016	1,199	496	7,493
8	540	500	335	491	459	195	2,520
9	802	1,345	277	510	435	178	3,547
10	118	80	14	440	343	133	1,128
11	2,418	2,395	1,062	875	405	215	7,370
12	69	7	8	224	136	41	485
13	48	14	3	20	4	0	89
14	31	3	3	14	2	0	53
15+	253	223	86	16	2	0	580
Total	16,115	18,566	5,498	50,975	16,510	9,811	117,475
Tonnes	2,213	2,457	876	3,058	1,612	785	11,001

Age	VIIIc East 2'nd Q catch('000)	VIIIc West 2'nd Q catch('000)	IXa North 2'nd Q catch('000)	IXa Centr-N 2'nd Q catch('000)	IXa Centr-S 2'nd Q catch('000)	IXa South 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0
1	5,745	385	336	11,333	10,087	6,981	34,867
2	3,646	17,404	8,589	32,559	21,161	16,699	100,058
3	1,546	1,087	223	15,171	1,155	1,702	20,884
4	1,757	884	146	3,288	608	540	7,223
5	1,494	926	265	946	583	490	4,704
6	1,538	1,118	278	545	672	518	4,669
7	4,638	3,183	858	287	563	453	9,982
8	814	928	531	153	307	247	2,980
9	2,143	1,570	485	160	336	275	4,969
10	135	126	59	256	373	307	1,256
11	4,071	3,901	1,924	349	514	425	11,184
12	42	34	40	94	64	41	315
13	19	32	11	114	37	18	231
14	18	17	19	70	7	1	132
15+	139	427	19	78	12	2	677
Total	27,745	32,022	13,783	65,403	36,479	28,699	204,131
Tonnes	3,755	3,878	1,593	3,234	1,755	1,412	15,627

Age	VIIIc East 3'rd Q catch('000)	VIIIc West 3'rd Q catch('000)	IXa North 3'rd Q catch('000)	IXa Centr-N 3'rd Q catch('000)	IXa Centr-S 3'rd Q catch('000)	IXa South 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	1,126	6	576	1,942	0	0	3,650
1	1,333	2,880	9,626	12,133	2,826	4,267	33,065
2	1,121	2,954	4,598	40,932	8,617	12,440	70,662
3	2,197	1,651	117	27,342	4,802	3,448	39,557
4	2,768	1,748	250	6,209	2,948	1,080	15,003
5	2,924	2,621	331	1,605	1,447	812	9,740
6	2,420	2,075	144	1,523	1,089	940	8,191
7	3,194	3,553	1,659	644	489	484	10,023
8	654	863	480	974	403	337	3,711
9	611	874	876	922	311	221	3,815
10	324	406	282	769	184	45	2,010
11	2,749	3,387	2,432	1,002	259	32	9,861
12	23	53	34	189	33	2	334
13	0	46	2	165	22	0	235
14	20	150	75	92	8	0	345
15+	15	426	77	111	16	0	645
Total	21,479	23,693	21,559	96,554	23,464	24,108	210,847
Tonnes	3,426	4,037	2,360	5,529	1,590	1,264	18,206

Age	VIIIc East 4'th Q catch('000)	VIIIc West 4'th Q catch('000)	IXa North 4'th Q catch('000)	IXa Centr-N 4'th Q catch('000)	IXa Centr-S 4'th Q catch('000)	IXa South 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	203	19	354	1,839	2,312	2,342	7,069
1	3,741	5,975	1,663	6,600	4,058	5,438	27,475
2	3,917	5,572	1,858	11,947	5,079	5,238	33,611
3	967	2,206	258	11,592	2,359	2,079	19,461
4	898	2,457	176	3,012	699	368	7,610
5	1,020	2,080	351	641	341	79	4,512
6	751	1,781	169	1,414	532	113	4,760
7	1,639	2,558	1,155	1,792	478	138	7,760
8	443	459	355	1,125	211	77	2,670
9	533	537	505	1,072	74	42	2,763
10	220	283	194	663	35	24	1,419
11	1,853	2,713	1,556	1,431	53	41	7,647
12	11	71	15	412	2	8	519
13	3	13	0	303	1	4	324
14	25	104	30	133	0	1	293
15+	42	185	30	145	0	0	402
Total	16,266	27,013	8,669	44,121	16,234	15,992	128,295
Tonnes	2,125	3,592	1,368	3,889	930	688	12,592

Table 10.8 Length (cm) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1993.

1993 Age	VIIIc East 1'st Q length(cm)	VIIIc West 1'st Q length(cm)	IXa North 1'st Q length(cm)	IXa Centr-N 1'st Q length(cm)	IXa Centr-S 1'st Q length(cm)	IXa South 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	13.8	16.2	14.9	15.3	13.5	13.9	14.2
2	17.0	17.9	20.3	16.6	16.2	15.9	16.9
3	24.0	23.2	22.1	19.3	20.5	20.7	20.1
4	26.5	27.6	29.0	22.3	23.1	22.7	23.8
5	28.4	28.6	30.6	24.7	24.9	24.6	26.1
6	28.9	28.8	30.6	27.0	26.7	26.8	27.6
7	29.6	28.8	30.8	28.8	28.3	28.3	29.0
8	32.3	30.5	31.6	30.0	29.7	29.5	30.7
9	30.6	29.2	31.1	30.1	30.3	30.1	30.0
10	35.1	30.8	33.5	31.2	30.1	30.8	31.2
11	32.8	30.1	32.1	31.9	31.6	31.4	31.6
12	36.3	36.4	36.4	33.1	32.8	32.6	33.5
13	37.7	38.2	37.0	37.1	36.6	0.0	37.6
14	36.1	36.2	36.3	37.7	36.7	0.0	36.6
15+	38.9	40.3	40.2	37.4	36.7	0.0	39.6
0-15+	23.4	24.1	25.9	18.6	21.5	20.2	21.0

Age	VIIIc East 2'nd Q length(cm)	VIIIc West 2'nd Q length(cm)	IXa North 2'nd Q length(cm)	IXa Centr-N 2'nd Q length(cm)	IXa Centr-S 2'nd Q length(cm)	IXa South 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	13.2	16.2	15.7	16.1	15.3	15.6	15.3
2	17.6	17.7	17.5	16.7	15.7	16.0	16.7
3	24.8	22.6	20.3	19.1	19.6	19.0	19.7
4	26.7	27.4	29.3	20.8	22.5	22.5	23.5
5	27.8	28.9	30.5	23.2	24.7	24.6	26.5
6	28.3	28.9	30.0	25.8	26.9	26.9	27.9
7	28.4	29.2	30.8	28.1	28.7	28.8	28.9
8	31.3	31.4	32.1	29.2	29.2	29.4	31.0
9	28.8	29.8	31.0	30.5	30.1	30.1	29.5
10	31.6	33.5	34.5	32.2	31.6	31.5	32.0
11	30.7	31.3	32.5	32.3	31.8	31.8	31.4
12	36.4	36.2	36.3	34.9	33.5	33.0	34.9
13	37.3	38.0	36.5	36.4	34.3	33.6	36.1
14	36.2	38.0	36.1	37.8	35.7	36.2	37.0
15+	40.5	40.2	36.9	37.6	35.6	35.9	39.8
0-15+	24.0	23.0	22.3	17.9	17.1	17.4	19.6

Age	VIIIc East 3'rd Q length (cm)	VIIIc West 3'rd Q length (cm)	IXa North 3'rd Q length (cm)	IXa Centr-N 3'rd Q length (cm)	IXa Centr-S 3'rd Q length (cm)	IXa South 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	11.1	14.5	14.0	9.0	0.0	0.0	10.5
1	15.8	17.4	15.8	16.5	16.1	16.0	16.2
2	20.1	18.8	16.9	16.8	16.4	16.2	16.8
3	26.3	25.8	23.0	18.4	18.8	17.6	19.1
4	26.9	27.5	31.5	20.6	21.9	22.9	23.2
5	28.1	28.7	31.3	22.9	23.8	25.1	26.6
6	27.9	28.4	30.6	27.6	26.6	27.1	27.8
7	29.3	29.7	32.3	28.7	26.9	26.8	29.7
8	30.3	30.5	32.4	29.2	28.7	28.2	30.0
9	30.8	31.0	32.8	29.9	29.5	28.6	30.9
10	30.8	30.8	33.1	31.7	31.5	30.2	31.5
11	30.1	31.5	32.8	31.8	31.5	31.0	31.5
12	35.7	37.5	36.3	34.5	34.2	32.5	35.2
13	0.0	38.5	38.5	35.9	34.3	0.0	36.3
14	35.3	39.4	35.7	37.4	35.5	0.0	37.7
15+	35.5	39.9	35.9	37.3	35.5	0.0	38.8
0-15+	26.3	26.8	21.2	18.3	19.4	17.9	20.4

Age	VIIIc East 4'th Q length(cm)	VIIIc West 4'th Q length(cm)	IXa North 4'th Q length(cm)	IXa Centr-N 4'th Q length(cm)	IXa Centr-S 4'th Q length(cm)	IXa South 4'th Q length(cm)	All areas 4'th Q length(cm)
0	11.7	14.3	12.4	12.5	12.4	12.7	12.5
1	17.2	17.1	17.0	16.9	16.7	16.4	16.9
2	19.0	18.1	19.2	18.0	17.4	17.6	18.1
3	24.7	25.8	22.4	19.4	13.1	18.9	19.6
4	27.3	26.7	30.8	20.8	22.1	21.1	23.8
5	28.6	27.7	30.4	24.7	25.2	24.3	27.5
6	28.1	27.6	29.8	27.7	27.2	27.6	27.7
7	30.5	29.8	31.7	28.9	28.1	28.7	29.9
8	31.0	31.0	31.6	30.0	28.9	29.3	30.4
9	31.8	31.9	32.3	32.2	30.6	31.2	32.0
10	31.4	32.2	32.1	32.5	30.4	31.5	32.2
11	31.3	31.4	32.1	33.1	31.1	32.0	31.8
12	36.2	36.3	36.0	34.2	33.0	33.3	34.6
13	38.5	38.5	0.0	34.9	33.3	33.5	35.1
14	36.7	37.4	35.6	35.9	0.0	34.5	36.5
15+	38.3	38.7	36.2	37.9	0.0	0.0	38.2
0-15+	23.9	24.0	25.2	20.8	17.2	17.1	21.2

Table 10.9 Weight (g) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1993.

1993 Age	VIIIc East 1'st Q weight(g)	VIIIc West 1'st Q weight(g)	IXa North 1'st Q weight(g)	IXa Centr-N 1'st Q weight(g)	IXa Centr-S 1'st Q weight(g)	IXa South 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	23	37	30	29	20	22	25
2	44	50	71	37	35	33	40
3	113	107	91	58	70	72	87
4	151	171	195	89	99	94	111
5	184	188	228	121	124	119	145
6	191	190	227	156	151	154	167
7	210	192	233	191	180	180	195
8	265	224	249	216	208	203	230
9	230	198	239	229	221	217	217
10	339	239	298	242	235	231	249
11	281	218	259	257	251	245	252
12	367	368	370	286	279	272	297
13	409	424	388	403	386	0	408
14	361	363	367	422	389	0	379
15+	447	495	490	412	389	0	471
0-15+	137	134	159	60	96	80	94

Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	IXa Centr-N 2'nd Q weight(g)	IXa Centr-S 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	18	37	34	34	29	30	29
2	47	48	47	37	31	33	38
3	118	99	74	56	62	56	63
4	149	166	201	72	92	93	108
5	169	194	226	101	120	119	152
6	178	193	215	139	156	155	173
7	181	200	232	178	188	190	192
8	241	243	261	198	199	202	235
9	189	211	237	227	216	215	205
10	252	301	320	263	250	248	261
11	230	246	269	266	256	254	246
12	363	364	366	336	297	283	332
13	391	417	372	383	319	300	371
14	357	357	360	426	358	374	394
15+	502	493	386	420	355	365	481
0-15+	135	123	116	50	48	50	77

Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	IXa Centr-N 3'rd Q weight (g)	IXa Centr-S 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	6	27	24	7	0	0	9
1	34	46	35	36	34	33	36
2	69	59	42	39	36	34	39
3	145	142	104	50	54	44	59
4	156	167	249	70	85	97	105
5	176	188	242	98	109	127	155
6	172	185	229	168	152	159	171
7	199	208	263	188	157	153	208
8	220	223	267	198	189	177	214
9	231	236	275	212	205	186	233
10	230	232	284	254	246	217	248
11	216	252	276	254	247	236	248
12	341	403	366	326	315	271	342
13	0	433	433	365	336	0	376
14	332	467	351	413	352	0	417
15+	338	481	357	410	352	0	447
0-15+	159	174	109	56	68	52	86

Age	VIIIc East 4'th Q weight(g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	IXa Centr-N 4'th Q weight(g)	IXa Centr-S 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	11	26	17	16	17	19	17
1	43	43	44	39	37	36	40
2	59	53	61	47	42	40	48
3	125	139	94	59	57	55	71
4	164	153	233	72	88	76	114
5	188	172	223	121	128	115	168
6	177	169	211	169	160	168	171
7	225	211	250	192	176	187	213
8	235	236	248	215	191	201	224
9	252	256	263	266	227	240	259
10	245	265	262	272	235	248	264
11	242	249	261	288	239	261	257
12	362	368	357	316	284	292	325
13	431	433	0	335	292	295	339
14	384	402	348	365	0	323	378
15+	432	444	367	433	0	0	433
0-15+	131	133	157	88	55	43	98

Table 10.10.- Southern horse mackerel weight at age

Horse mackerel in Fishing Areas VIIIc and IXa

Mean Weight of Stock (Kilograms)

(WEST)

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

Mean Weight of Catch (Kilograms)

(WECA)

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

Horse mackerel in Fishing Areas VIIIc and IXa

Table 10.11.- Proportion Mature at Year Start

(MATPROP)

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	0.00	0.00	0.04	0.27	0.63	0.81	0.90	0.95	0.97	0.98	0.99	1.00	1.00	1.00	1.00	1.00
1982	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	1.00	1.00	1.00
1983	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	1.00	1.00	1.00
1984	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	1.00	1.00	1.00
1985	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	1.00	1.00	1.00
1986	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	1.00	1.00	1.00
1987	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	1.00	1.00	1.00
1988	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	1.00	1.00	1.00
1989	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	1.00	1.00	1.00
1990	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	1.00	1.00	1.00
1991	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	1.00	1.00	1.00
1992	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	1.00	1.00	1.00
1993	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	1.00	1.00	1.00

Table 10.12.- XSA diagnostics.

Extended Survivors Analysis

Horse mackerel in Fishing Areas VIIIc and IXa (run name: JUREL35)

CPUE data from file /users/ifad/ifapwork/wg_201/hom_soth/FLEET.P35

Catch data for 9 years. 1985 to 1993. Ages 0 to 12.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT01: 8c West trawl,	1985,	1993,	0,	11,	.000,	1.000
FLT02: 8c East trawl,	1985,	1993,	0,	11,	.000,	1.000
PJS: Jul Pt. Survey,,	1989,	1993,	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 100 iterations

Total absolute residual between iterations
99 and 100 = .00125

Final year F values

Age ,	0,	1,	2,	3,	4,	5,	6,	7,	8,	9
Iteration 99,	.0173,	.1090,	.1141,	.3788,	.2509,	.1479,	.1564,	.1831,	.2848,	.3913
Iteration **,	.0174,	.1088,	.1138,	.3784,	.2509,	.1477,	.1563,	.1831,	.2848,	.3912

Age ,	10,	11
Iteration 99,	.3359,	.2489
Iteration **,	.3359,	.2489

Regression weights
, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993
0,	.302,	.296,	.052,	.150,	.312,	.066,	.009,	.039,	.017
1,	.444,	.584,	.516,	.381,	.280,	.340,	.123,	.096,	.109
2,	.218,	.238,	.459,	.128,	.151,	.273,	.229,	.268,	.114
3,	.052,	.243,	.240,	.170,	.170,	.176,	.091,	.246,	.378
4,	.130,	.099,	.154,	.114,	.229,	.087,	.134,	.105,	.251
5,	.104,	.186,	.084,	.148,	.171,	.122,	.088,	.122,	.148
6,	.079,	.126,	.208,	.123,	.231,	.106,	.159,	.097,	.156
7,	.163,	.396,	.129,	.238,	.090,	.187,	.175,	.227,	.183
8,	.121,	.411,	.125,	.195,	.230,	.175,	.250,	.191,	.285
9,	.180,	.291,	.205,	.377,	.385,	.289,	.206,	.424,	.391
10,	.221,	.356,	.147,	.675,	.864,	.275,	.439,	.243,	.336
11,	.436,	.503,	.129,	.441,	.570,	.687,	.383,	.462,	.249

Table 10.12.- XSA diagnostics.

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7		
1985	1.63E+06	8.94E+05	4.66E+05	1.71E+06	2.32E+05	1.59E+05	1.01E+05	5.28E+04	3.75E+04	4.11E+04
1986	2.59E+06	1.04E+06	4.94E+05	3.23E+05	1.40E+06	1.75E+05	1.24E+05	8.02E+04	3.86E+04	2.86E+04
1987	1.13E+06	1.65E+06	4.98E+05	3.35E+05	2.18E+05	1.09E+06	1.25E+05	9.37E+04	4.64E+04	2.21E+04
1988	9.45E+05	9.23E+05	8.50E+05	2.71E+05	2.27E+05	1.61E+05	8.63E+05	8.76E+04	7.09E+04	3.53E+04
1989	9.74E+05	7.00E+05	5.43E+05	6.44E+05	1.97E+05	1.74E+05	1.19E+05	6.56E+05	5.94E+04	5.02E+04
1990	8.06E+05	6.14E+05	4.56E+05	4.02E+05	4.67E+05	1.35E+05	1.26E+05	8.15E+04	5.16E+05	4.06E+04
1991	3.94E+06	6.50E+05	3.76E+05	2.99E+05	2.90E+05	3.69E+05	1.03E+05	9.78E+04	5.82E+04	3.73E+05
1992	1.28E+06	3.36E+06	4.95E+05	2.57E+05	2.35E+05	2.18E+05	2.91E+05	7.53E+04	7.07E+04	3.90E+04
1993	6.72E+05	1.06E+06	2.63E+06	3.26E+05	1.73E+05	1.82E+05	1.66E+05	2.27E+05	5.17E+04	5.03E+04

Estimated population abundance at 1st Jan 1994

, .00E+00, 5.68E+05, 8.19E+05, 2.03E+06, 1.92E+05, 1.16E+05, 1.35E+05, 1.22E+05, 1.63E+05, 3.35E+04,

Taper weighted geometric mean of the VPA populations:

, 1.30E+06, 1.04E+06, 6.17E+05, 4.00E+05, 2.92E+05, 2.28E+05, 1.69E+05, 1.16E+05, 6.95E+04, 4.90E+04,

Standard error of the weighted Log(VPA populations) :

, .5809, .5475, .6044, .5748, .6339, .6483, .6979, .7701, .8054, .8281,

YEAR	AGE 10	11
1985	2.51E+04	9.80E+03
1986	2.95E+04	1.73E+04
1987	1.84E+04	1.78E+04
1988	1.55E+04	1.37E+04
1989	2.08E+04	6.77E+03
1990	2.94E+04	7.55E+03
1991	2.62E+04	1.92E+04
1992	2.61E+05	1.45E+04
1993	2.20E+04	1.76E+05

Estimated population abundance at 1st Jan 1994

, 2.93E+04, 1.35E+04,

Taper weighted geometric mean of the VPA populations:

, 3.03E+04, 1.70E+04,

Standard error of the weighted Log(VPA populations) :

, .8616, .9835,

Table 10.12.- XSA diagnostics.

Log catchability residuals.

Fleet : FLT01: 8c West trawl

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	-.27	-.95	1.76	-.62	-3.37	2.52	.82	99.99	99.99
1	-.93	.65	-.45	1.27	1.39	1.05	-2.71	.04	-.34
2	.43	-.33	.57	.51	-.76	.45	-.42	-.27	-.09
3	.63	1.30	1.15	.67	.44	-.22	-2.79	-.93	.13
4	-.83	.54	1.53	.37	.48	-.21	-.89	-1.46	.53
5	-.10	-.08	1.00	.18	.17	-.81	-.91	-.01	.62
6	-.03	-.31	.75	.26	-.13	-.59	-.26	-.01	.33
7	-.23	-.53	.34	-.16	-.28	-.18	.23	.24	.47
8	.04	-.31	-.63	-.42	.05	.15	.37	.12	.55
9	-.08	-.59	.15	-.43	.71	-.71	.01	.40	.45
10	-.24	.42	.21	-.17	1.52	-.14	.46	.37	-.35
11	-.21	.08	.01	-.15	-.05	-.29	-.04	-.04	.10

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	-18.7198	-19.2103	-18.7593	-18.3303	-18.0324	-17.5923	-17.4612	-16.9406	-16.9406	-16.9406
S.E(Log q)	.4913	1.2785	.9332	.6159	.4000	.3395	.3814	.4967	.6324	.1446

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	-1.75	-1.777	-1.75	.08	7	2.21	-23.27
1	.83	.177	19.06	.15	9	1.42	-20.11

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	.96	.130	18.51	.62	9	.51	-18.72
3	.63	.700	16.87	.35	9	.83	-19.21
4	.95	.089	18.46	.34	9	.95	-18.76
5	.72	1.157	16.64	.72	9	.43	-18.33
6	.85	.815	17.14	.82	9	.35	-18.03
7	.99	.072	17.52	.84	9	.36	-17.59
8	.92	.479	16.96	.85	9	.37	-17.46
9	.93	.334	16.50	.77	9	.49	-16.94
10	.94	.225	16.35	.71	9	.59	-16.70
11	.92	2.257	16.43	.99	9	.09	-17.00

Table 10.12.- XSA diagnostics.

Fleet : FLT02: 8c East trawl

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	-2.46	.79	-2.04	3.63	2.72	-1.72	.67	-1.88	99.99
1	.36	.06	-.60	.02	.23	-.21	-.03	.23	-.02
2	1.31	.35	.97	-1.70	-.96	1.01	2.14	-2.35	-.50
3	.09	.56	.74	-1.14	-.37	.94	-.53	-.35	.15
4	-1.25	.55	.30	-.82	.51	-.11	.66	-.56	.57
5	-.56	.13	.77	-.41	.43	-.18	-.12	.08	-.17
6	-.13	-.24	.80	.05	.09	.07	-.33	-.07	-.22
7	.14	-.19	.10	-.17	-.17	.48	-.30	-.01	.12
8	.58	.06	-.34	.07	.11	.56	-.18	-.33	-.44
9	.16	-.49	.11	.53	.84	-.38	-.63	-.03	-.10
10	.26	-.38	-.14	1.11	1.85	.20	-.97	-.23	-1.24
11	.05	-1.28	-.30	.90	-.71	.28	-1.09	-.87	-.50

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	-16.9614	-17.1878	-17.5987	-17.5975	-17.6979	-17.4937	-17.3479	-16.7693	-16.7693	-16.7693
S.E(Log q)	1.5196	.6795	.6929	.4056	.3320	.2434	.3748	.4822	.9831	.8199

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.06	-.036	21.40	.05	8	2.55	-20.96
1	-.60	-7.974	11.78	.79	9	.30	-17.30

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	11.94	-1.000	56.66	.00	9	18.14	-16.96
3	.86	.367	16.57	.50	9	.62	-17.19
4	.82	.531	16.69	.57	9	.60	-17.60
5	.70	2.339	16.04	.90	9	.23	-17.60
6	.98	.092	17.60	.82	9	.35	-17.70
7	1.08	-.615	17.96	.90	9	.27	-17.49
8	.82	1.342	16.25	.90	9	.29	-17.35
9	1.31	-1.131	18.61	.67	9	.62	-16.77
10	1.31	-.536	18.68	.32	9	1.35	-16.72
11	1.16	-.502	18.35	.60	9	.86	-17.16

Table 10.12.- XSA diagnostics.

Fleet : PJS: Jul Pt. Survey,

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	99.99	99.99	99.99	99.99	5.64	5.17	-3.87	5.97	-12.74
1	99.99	99.99	99.99	99.99	-.21	.07	-.03	-.05	.22
2	99.99	99.99	99.99	99.99	-.08	.59	-.52	-.06	.07
3	99.99	99.99	99.99	99.99	.18	-.19	-1.95	.08	1.88
4	99.99	99.99	99.99	99.99	1.14	-.59	-1.24	-.33	1.02
5	99.99	99.99	99.99	99.99	-.09	.09	-1.27	-.50	1.76
6	99.99	99.99	99.99	99.99	-.40	-.38	-.52	-1.29	2.57
7	99.99	99.99	99.99	99.99	-1.39	.11	-.19	.17	1.27
8	99.99	99.99	99.99	99.99	-.24	-1.50	-.04	-.19	1.94
9	99.99	99.99	99.99	99.99	-.04	-.10	-1.43	.65	.91
10	99.99	99.99	99.99	99.99	.17	-.57	.59	-.78	-1.21
11	99.99	99.99	99.99	99.99	.53	.36	.88	1.32	-3.13

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	-9.1280	-9.2580	-9.8133	-10.0237	-9.9190	-9.9676	-9.4214	-9.1602	-9.1602	-9.1602
S.E(Log q)	.3962	1.3689	1.0401	1.1232	1.4913	.9528	1.2397	.9110	.8361	1.7922

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	4.71	-.542	-2.57	.01	5	9.55	-10.49
1	.46	4.186	11.45	.95	5	.18	-8.68

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	.92	.297	9.46	.83	5	.42	-9.13
3	.69	.204	10.37	.13	5	1.08	-9.26
4	-1.07	-1.822	15.26	.21	5	.88	-9.81
5	-1.25	-1.305	14.97	.10	5	1.29	-10.02
6	1.54	-.168	8.84	.03	5	2.65	-9.92
7	1.91	-.886	8.17	.24	5	1.87	-9.97
8	15.70	-1.861	-20.05	.01	5	15.29	-9.42
9	5.66	-2.990	-.05	.12	5	2.98	-9.16
10	1.27	-.559	9.24	.60	5	1.02	-9.52
11	-5.47	-3.066	13.63	.07	5	5.55	-9.17

Table 10.12.- XSA diagnostics.

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	2.,	13.008,	.000,	.00,	1,	.001,	.000
P shrinkage mean ,	1040248.,	.55,,,,				.768,	.010
F shrinkage mean ,	81177.,	1.00,,,,				.230,	.116

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
567915.,	.48,	9.04,	3,	18.845,	.017

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	580293.,	1.506,	.000,	.00,	1,	.017,	.150
FLT02: 8c East trawl,	783551.,	.317,	.203,	.64,	2,	.387,	.113
PJS: Jul Pt. Survey,,	1018776.,	.300,	.153,	.51,	2,	.433,	.088
P shrinkage mean ,	616521.,	.60,,,,				.119,	.142
F shrinkage mean ,	339028.,	1.00,,,,				.043,	.245

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
818547.,	.20,	.13,	7,	.649,	.109

Table 10.12.- XSA diagnostics.

Age 2 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,	1933463.,	.484,	.117,	.24,	3,	.158,	.119
FLT02: 8c East trawl,	2445812.,	.390,	.135,	.35,	3,	.225,	.095
PJS: Jul Pt. Survey,,	1999862.,	.247,	.075,	.31,	3,	.576,	.115
F shrinkage mean ,	1040680.,	1.00,,,,				.042,	.210

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2025077.,	.19,	.07,	10,	.383,	.114

Age 3 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,	148125.,	.465,	.423,	.91,	4,	.144,	.468
FLT02: 8c East trawl,	175674.,	.299,	.270,	.90,	4,	.330,	.407
PJS: Jul Pt. Survey,,	198700.,	.245,	.219,	.89,	4,	.469,	.368
F shrinkage mean ,	472431.,	1.00,,,,				.057,	.171

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
192181.,	.18,	.15,	13,	.871,	.378

Age 4 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,	96006.,	.427,	.312,	.73,	5,	.182,	.296
FLT02: 8c East trawl,	122212.,	.300,	.282,	.94,	5,	.335,	.239
PJS: Jul Pt. Survey,,	109671.,	.247,	.218,	.88,	5,	.424,	.264
F shrinkage mean ,	230662.,	1.00,,,,				.059,	.134

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
115957.,	.17,	.14,	16,	.805,	.251

Age 5 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,	137821.,	.360,	.479,	1.33,	6,	.203,	.145
FLT02: 8c East trawl,	122510.,	.241,	.175,	.73,	6,	.434,	.162
PJS: Jul Pt. Survey,,	149961.,	.243,	.343,	1.41,	5,	.326,	.134
F shrinkage mean ,	154110.,	1.00,,,,				.037,	.131

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
135173.,	.15,	.16,	18,	1.065,	.148

Table 10.12.- XSA diagnostics.

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

Year class = 1987

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: 8c West trawl,	119880.,	.279,	.207,	.74,	7,	.304,	.159
FLT02: 8c East trawl,	125430.,	.205,	.147,	.72,	7,	.534,	.153
PJS: Jul Pt. Survey,,	113464.,	.375,	.432,	1.15,	5,	.130,	.168
F shrinkage mean ,	134053.,	1.00,,,,				.032,	.144

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
122377.,	.15,	.11,	20,	.757,	.156

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

Year class = 1986

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: 8c West trawl,	189572.,	.221,	.169,	.76,	8,	.356,	.159
FLT02: 8c East trawl,	149431.,	.172,	.098,	.57,	8,	.568,	.198
PJS: Jul Pt. Survey,,	147850.,	.570,	.541,	.95,	5,	.052,	.200
F shrinkage mean ,	161873.,	1.00,,,,				.024,	.184

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
162855.,	.13,	.09,	22,	.714,	.183

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

Year class = 1985

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: 8c West trawl,	40434.,	.202,	.144,	.71,	9,	.386,	.241
FLT02: 8c East trawl,	27190.,	.166,	.100,	.60,	9,	.542,	.340
PJS: Jul Pt. Survey,,	64321.,	.573,	.424,	.74,	5,	.046,	.158
F shrinkage mean ,	47480.,	1.00,,,,				.027,	.209

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
33460.,	.12,	.09,	24,	.748,	.285

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1984

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: 8c West trawl,	31696.,	.189,	.127,	.67,	9,	.391,	.366
FLT02: 8c East trawl,	26747.,	.158,	.111,	.71,	9,	.530,	.421
PJS: Jul Pt. Survey,,	36453.,	.551,	.269,	.49,	5,	.051,	.325
F shrinkage mean ,	34857.,	1.00,,,,				.028,	.338

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
29254.,	.12,	.07,	24,	.630,	.391

Table 10.12.- XSA diagnostics.

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1983

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	14798.,	.195,	.130,	.67,	9,	.413,	.311
FLT02: 8c East trawl,	13862.,	.170,	.154,	.91,	9,	.471,	.329
PJS: Jul Pt. Survey,,	9141.,	.533,	.394,	.74,	5,	.076,	.464
F shrinkage mean ,	8267.,	1.00,,,,				.040,	.502

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
13512.,	.13,	.10,	24,	.766,	.336

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1982

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	132731.,	.169,	.087,	.51,	9,	.523,	.225
FLT02: 8c East trawl,	122548.,	.165,	.158,	.96,	9,	.399,	.241
PJS: Jul Pt. Survey,,	30191.,	.520,	.333,	.64,	5,	.052,	.746
F shrinkage mean ,	107360.,	1.00,,,,				.026,	.271

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
118417.,	.12,	.10,	24,	.874,	.249

Table 10.13.- Catch in numbers by year

Horse mackerel in Fishing Areas VIIIc and IXa

Catch in Numbers (Millions)

(CANUM)

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

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

Landings (Tonnes)

(CATON)

Year	Total
1981	72235
1982	59336
1983	74313
1984	46297
1985	43535
1986	71258
1987	52747
1988	55888
1989	56396
1990	49207
1991	45511
1992	50956
1993	57428

(run name: JUREL35)

Table 10.14.-

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	FBAR 91-93
AGE										
0,	.3017,	.2964,	.0522,	.1498,	.3124,	.0664,	.0087,	.0392,	.0174,	.0218,
1,	.4440,	.5839,	.5158,	.3807,	.2799,	.3403,	.1226,	.0958,	.1088,	.1091,
2,	.2183,	.2380,	.4589,	.1282,	.1507,	.2725,	.2293,	.2677,	.1138,	.2036,
3,	.0516,	.2434,	.2400,	.1704,	.1704,	.1764,	.0915,	.2457,	.3784,	.2385,
4,	.1299,	.0992,	.1537,	.1136,	.2292,	.0865,	.1344,	.1045,	.2509,	.1633,
5,	.1045,	.1859,	.0835,	.1479,	.1715,	.1217,	.0875,	.1223,	.1477,	.1192,
6,	.0787,	.1264,	.2080,	.1233,	.2311,	.1060,	.1586,	.0971,	.1563,	.1373,
7,	.1628,	.3964,	.1285,	.2381,	.0904,	.1873,	.1751,	.2266,	.1831,	.1949,
8,	.1214,	.4110,	.1245,	.1952,	.2297,	.1746,	.2502,	.1908,	.2848,	.2419,
9,	.1799,	.2906,	.2052,	.3769,	.3852,	.2891,	.2062,	.4239,	.3912,	.3404,
10,	.2211,	.3557,	.1471,	.6754,	.8643,	.2752,	.4394,	.2427,	.3359,	.3393,
11,	.4362,	.5034,	.1290,	.4405,	.5696,	.6865,	.3828,	.4623,	.2489,	.3646,
+gp,	.4362,	.5034,	.1290,	.4405,	.5696,	.6865,	.3828,	.4623,	.2489,	
FBAR 1-11,	.1953,	.3122,	.2177,	.2719,	.3065,	.2469,	.2071,	.2254,	.2363,	
FBAR 0- 3,	.2539,	.3404,	.3167,	.2073,	.2284,	.2139,	.1130,	.1621,	.1546,	
FBAR 7-11,	.2243,	.3914,	.1469,	.3852,	.4278,	.3225,	.2908,	.3093,	.2888,	

Table 10.15.-

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	GMST 85-91
AGE											
0,	1629565,	2585668,	1129674,	945150,	974338,	806478,	3943271,	1279754,	671675,	0,	1457019,
1,	894281,	1037330,	1654666,	922852,	700359,	613609,	649518,	3364515,	1059163,	567915,	875858,
2,	466488,	493724,	497936,	850310,	542839,	455622,	375797,	494526,	2631275,	818547,	510724,
3,	1710685,	322757,	334962,	270847,	643784,	401878,	298610,	257163,	325668,	2025077,	452258,
4,	231860,	1398322,	217774,	226793,	196600,	467283,	289967,	234544,	173127,	192181,	330041,
5,	159327,	175260,	1089842,	160731,	174237,	134552,	368859,	218188,	181839,	115957,	237241,
6,	100781,	123528,	125257,	862870,	119317,	126334,	102537,	290874,	166173,	135173,	154271,
7,	52829,	80180,	93695,	87561,	656494,	81508,	97802,	75310,	227189,	122377,	108920,
8,	37534,	38639,	46424,	70917,	59396,	516198,	58175,	70654,	51677,	162855,	70336,
9,	41058,	28612,	22050,	35280,	50213,	40632,	373126,	38987,	50251,	33460,	49179,
10,	25075,	29522,	18417,	15458,	20830,	29403,	26193,	261312,	21963,	29254,	22977,
11,	9800,	17302,	17804,	13683,	6772,	7554,	19219,	14528,	176438,	13512,	12216,
+gp,	29082,	38062,	49322,	41060,	28949,	24559,	34304,	35819,	27576,	136923,	
TOTAL,	5388368,	6368903,	5297821,	4503511,	4174129,	3705611,	6637382,	6636179,	5764013,	4353229,	

Table 10.16.-

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,	1629565,	289870,	118630,	43535,	.3670,	.1953,	.2539,	.2243,
1986,	2585668,	328164,	173551,	71258,	.4106,	.3122,	.3404,	.3914,
1987,	1129674,	345422,	196181,	52747,	.2689,	.2177,	.3167,	.1469,
1988,	945150,	335146,	201019,	55888,	.2780,	.2719,	.2073,	.3852,
1989,	974338,	319853,	195983,	56396,	.2878,	.3065,	.2284,	.4278,
1990,	806479,	313415,	202301,	49207,	.2432,	.2469,	.2139,	.3225,
1991,	3943271,	300810,	200949,	45511,	.2265,	.2071,	.1130,	.2908,
1992,	1279755,	376189,	189563,	50956,	.2688,	.2254,	.1621,	.3093,
1993,	671675,	402261,	177670,	57428,	.3232,	.2363,	.1546,	.2888,
Arith. Mean ,	1551731,	334570,	183983,	53658,	.2971,	.2466,	.0000,	.3097,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

Table 10.17.- Input data for the predictions

Horse mackerel in Fishing Areas VIIIc and IXa
Horse mackerel in Fishing Areas VIIIc and IXa

Prediction with management option table: Input data

Year: 1994								
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	1270.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0237	0.016
1	568.000	0.1500	0.0000	0.2500	0.2500	0.032	0.1148	0.032
2	819.000	0.1500	0.0400	0.2500	0.2500	0.055	0.2150	0.050
3	2025.000	0.1500	0.2700	0.2500	0.2500	0.075	0.2513	0.081
4	192.000	0.1500	0.6300	0.2500	0.2500	0.105	0.1723	0.116
5	116.000	0.1500	0.8100	0.2500	0.2500	0.127	0.1260	0.149
6	135.000	0.1500	0.9000	0.2500	0.2500	0.154	0.1453	0.167
7	122.000	0.1500	0.9500	0.2500	0.2500	0.176	0.2063	0.183
8	163.000	0.1500	0.9700	0.2500	0.2500	0.213	0.2560	0.200
9	33.000	0.1500	0.9800	0.2500	0.2500	0.240	0.3602	0.204
10	29.000	0.1500	0.9900	0.2500	0.2500	0.269	0.3591	0.234
11	14.000	0.1500	1.0000	0.2500	0.2500	0.304	0.3858	0.242
12+	137.000	0.1500	1.0000	0.2500	0.2500	0.318	0.3858	0.293
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1995								
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	1270.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0237	0.016
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.1148	0.032
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2150	0.050
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.2513	0.081
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1723	0.116
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.1260	0.149
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.1453	0.167
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.2063	0.183
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.2560	0.200
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.3602	0.204
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.3591	0.234
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3858	0.242
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.3858	0.293
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1996								
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	1270.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0237	0.016
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.1148	0.032
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2150	0.050
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.2513	0.081
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1723	0.116
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.1260	0.149
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.1453	0.167
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.2063	0.183
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.2560	0.200
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.3602	0.204
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.3591	0.234
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3858	0.242
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.3858	0.293
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : JUREL3
Date and time: 01JUL94:15:02

Horse mackerel in Fishing Areas VIIIc and IXa
Horse mackerel in Fishing Areas VIIIc and IXa

Table 10.18.- Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0	0	9117536	1244697	4793468	1057503	4617042	1018581
0.1000	0.0236	146331	24054	8144143	988398	3888705	807897	3720767	772288
0.2000	0.0471	250093	37738	7454410	818004	3264210	643774	3104337	611122
0.3000	0.0707	329071	45947	6929798	696257	2801677	527909	2649460	497905
0.4000	0.0943	392118	51012	6511314	604782	2442326	441960	2297368	414333
0.5000	0.1178	444167	54166	6166077	533462	2153471	375838	2015393	350351
0.6000	0.1414	488209	56104	5874169	476266	1915375	323536	1783811	299981
0.7000	0.1650	526175	57245	5622721	429369	1715334	281254	1589936	259447
0.8000	0.1885	559379	57849	5402982	390225	1544749	246467	1425186	226246
0.9000	0.2121	588753	58085	5208747	357075	1397554	217434	1283511	198654
1.0000	0.2356	614982	58064	5035460	328659	1269323	192913	1160502	175446
1.1000	0.2592	638582	57863	4879676	304052	1156732	171994	1052849	155725
1.2000	0.2828	659953	57534	4738728	282556	1057223	153995	958011	138822
1.3000	0.3063	679414	57115	4610505	263638	968787	138396	873993	124226
1.4000	0.3299	697219	56634	4493305	246880	889818	124789	799204	111541
1.5000	0.3535	713577	56109	4385736	231949	819013	112856	732353	100453
1.6000	0.3770	728661	55555	4286644	218578	755299	102338	672380	90714
1.7000	0.4006	742617	54984	4195060	206550	697785	93027	618407	82121
1.8000	0.4242	755569	54403	4110163	195686	645719	84754	569693	74510
1.9000	0.4477	767620	53818	4031251	185836	598465	77377	525615	67745
2.0000	0.4713	778863	53235	3957718	176876	555481	70778	485638	61712
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : JUREL2
Date and time : 01JUL94:11:15
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.4439
F-max factor : 0.9389
F-0.1 reference F : 0.1046
F-max reference F : 0.2213
Recruitment : 1270 (Millions)

Horse mackerel in Fishing Areas VIIIc and IXa
Horse mackerel in Fishing Areas VIIIc and IXa

a) **Table 10.19.-** Prediction with management option table

Year: 1994					Year: 1995					Year: 1996	
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	0.2356	390512	183517	79392	0.0000	0.0000	375012	218961	0	440343	274971
.	.	.	.	.	0.1000	0.0236	.	217663	7528	431865	267390
.	.	.	.	.	0.2000	0.0471	.	216374	14883	423585	260047
.	.	.	.	.	0.3000	0.0707	.	215093	22070	415498	252932
.	.	.	.	.	0.4000	0.0943	.	213821	29094	407600	246040
.	.	.	.	.	0.5000	0.1178	.	212558	35959	399884	239361
.	.	.	.	.	0.6000	0.1414	.	211303	42668	392346	232887
.	.	.	.	.	0.7000	0.1650	.	210057	49227	384982	226613
.	.	.	.	.	0.8000	0.1885	.	208819	55639	377786	220531
.	.	.	.	.	0.9000	0.2121	.	207590	61907	370755	214634
.	.	.	.	.	1.0000	0.2356	.	206369	68036	363885	208916
.	.	.	.	.	1.1000	0.2592	.	205156	74029	357170	203371
.	.	.	.	.	1.2000	0.2828	.	203951	79889	350607	197992
.	.	.	.	.	1.3000	0.3063	.	202754	85621	344192	192775
.	.	.	.	.	1.4000	0.3299	.	201566	91226	337921	187714
.	.	.	.	.	1.5000	0.3535	.	200385	96710	331791	182803
.	.	.	.	.	1.6000	0.3770	.	199213	102073	325797	178038
.	.	.	.	.	1.7000	0.4006	.	198048	107320	319937	173413
.	.	.	.	.	1.8000	0.4242	.	196891	112454	314207	168924
.	.	.	.	.	1.9000	0.4477	.	195742	117476	308604	164566
.	.	.	.	.	2.0000	0.4713	.	194600	122391	303123	160335
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : JUREL3
Date and time : 01JUL94:11:09
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1994 : F factors

b) Prediction with management option table

Year: 1994					Year: 1995					Year: 1996	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.9095	0.2143	390512	184613	73000	0.0000	0.0000	382418	223936	0	447960	280962
.	.	.	.	.	0.1000	0.0236	.	222606	7689	439306	273206
.	.	.	.	.	0.2000	0.0471	.	221285	15201	430855	265693
.	.	.	.	.	0.3000	0.0707	.	219973	22541	422602	258415
.	.	.	.	.	0.4000	0.0943	.	218670	29714	414541	251364
.	.	.	.	.	0.5000	0.1178	.	217376	36725	406667	244532
.	.	.	.	.	0.6000	0.1414	.	216091	43576	398976	237911
.	.	.	.	.	0.7000	0.1650	.	214814	50274	391462	231493
.	.	.	.	.	0.8000	0.1885	.	213546	56820	384120	225273
.	.	.	.	.	0.9000	0.2121	.	212287	63220	376947	219242
.	.	.	.	.	1.0000	0.2356	.	211036	69478	369937	213394
.	.	.	.	.	1.1000	0.2592	.	209793	75596	363087	207724
.	.	.	.	.	1.2000	0.2828	.	208559	81579	356393	202224
.	.	.	.	.	1.3000	0.3063	.	207333	87430	349849	196889
.	.	.	.	.	1.4000	0.3299	.	206116	93152	343453	191714
.	.	.	.	.	1.5000	0.3535	.	204907	98749	337201	186693
.	.	.	.	.	1.6000	0.3770	.	203705	104223	331088	181821
.	.	.	.	.	1.7000	0.4006	.	202512	109578	325112	177093
.	.	.	.	.	1.8000	0.4242	.	201327	114818	319268	172504
.	.	.	.	.	1.9000	0.4477	.	200150	119944	313554	168049
.	.	.	.	.	2.0000	0.4713	.	198981	124959	307966	163724
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : JUREL3
Date and time : 01JUL94:10:56
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1994 : TAC constraints

Table 10.19c

Horse mackerel in Fishing Areas VIIIc and IXa

Horse mackerel in Fishing Areas VIIIc and IXa

Single option prediction: Detailed tables

Year: 1994 F-factor: 1.0000 Reference F: 0.2356

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0237	27630	451	1270000	0	0	0	0	0
1	0.1148	57287	1841	568000	18176	0	0	0	0
2	0.2150	147527	7430	819000	45045	32760	1802	29903	1645
3	0.2513	419167	34112	2025000	151875	546750	41006	494559	37092
4	0.1723	28280	3275	192000	20160	120960	12701	111596	11718
5	0.1260	12772	1905	116000	14732	93960	11933	87695	11137
6	0.1453	16984	2836	135000	20790	121500	18711	112853	17379
7	0.2063	21173	3871	122000	21472	115900	20398	106023	18660
8	0.2560	34296	6855	163000	34719	158110	33677	142849	30427
9	0.3602	9310	1901	33000	7920	32340	7762	28467	6832
10	0.3591	8161	1910	29000	7801	28710	7723	25279	6800
11	0.3858	3883	939	13000	3952	13000	3952	11370	3457
12+	0.3858	40918	11993	137000	43566	137000	43566	119825	38104
Total		827389	79320	5622000	390208	1400990	203231	1270420	183251
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1995 F-factor: 1.0000 Reference F: 0.2356

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0237	27630	451	1270000	0	0	0	0	0
1	0.1148	107665	3459	1067497	34160	0	0	0	0
2	0.2150	78512	3954	435860	23972	17434	959	15914	875
3	0.2513	117687	9577	568547	42641	153508	11513	138854	10414
4	0.1723	199673	23124	1355635	142342	854050	89675	787934	82733
5	0.1260	15316	2284	139100	17666	112671	14309	105159	13355
6	0.1453	11074	1849	88022	13555	79220	12200	73582	11332
7	0.2063	17439	3188	100482	17685	95458	16801	87322	15369
8	0.2560	17975	3593	85432	18197	82869	17651	74871	15947
9	0.3602	30642	6255	108609	26066	106436	25545	93691	22486
10	0.3591	5575	1305	19812	5330	19614	5276	17270	4646
11	0.3858	5206	1259	17430	5299	17430	5299	15245	4634
12+	0.3858	26218	7684	87780	27914	87780	27914	76775	24415
Total		660612	67985	5344206	374826	1626471	227142	1486618	206206
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 1.0000 Reference F: 0.2356

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0237	27630	451	1270000	0	0	0	0	0
1	0.1148	107665	3459	1067497	34160	0	0	0	0
2	0.2150	147555	7432	819154	45053	32766	1802	29909	1645
3	0.2513	62631	5097	302573	22693	81695	6127	73896	5542
4	0.1723	56061	6492	380613	39964	239786	25178	221224	23228
5	0.1260	108140	16128	982131	124731	795526	101032	742486	94296
6	0.1453	13279	2217	105551	16255	94996	14629	88236	13588
7	0.2063	11370	2079	65516	11531	62240	10954	56936	10021
8	0.2560	14805	2959	70364	14987	68253	14538	61665	13135
9	0.3602	16060	3278	56924	13662	55786	13389	49105	11785
10	0.3591	18350	4295	65206	17540	64554	17365	56839	15290
11	0.3858	3557	860	11908	3620	11908	3620	10415	3166
12+	0.3858	18389	5390	61569	19579	61569	19579	53850	17124
Total		605492	60139	5259006	363776	1569079	228213	1444561	208821
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 10.20 Single option prediction: Summary table

F status quo

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	1.0000	0.2356	827389	79320	5622000	390208	1400990	203231	1270420	183251
1995	1.0000	0.2356	660612	67985	5344206	374826	1626471	227142	1486618	206206
1996	1.0000	0.2356	605492	60139	5259006	363776	1569079	228213	1444561	208821
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : B02
Date and time : 01JUL94:12:00
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

F corresponding to constant TAC

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.9105	0.2145	760581	73000	5622000	390208	1400990	203231	1277285	184333
1995	1.0585	0.2494	706802	73000	5405774	382148	1661283	232246	1513724	210092
1996	1.2370	0.2915	735122	73000	5269388	365741	1581965	230081	1441102	208019
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : B02
Date and time : 01JUL94:12:35
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

F corresponding to $F_{TAC\ 1994}$

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.9105	0.2146	760615	73003	5622000	390208	1400990	203231	1277282	184333
1995	0.9105	0.2146	616421	63821	5405743	382144	1661265	232243	1525467	211933
1996	0.9105	0.2146	569315	57263	5352710	376019	1630360	237708	1506909	218466
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

F_{max}

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.9389	0.2212	781947	75023	5622000	390208	1400990	203231	1275100	183989
1995	0.9389	0.2212	630709	65175	5386081	379804	1650140	230611	1513024	210098
1996	0.9389	0.2212	581087	58213	5322612	372079	1610643	234649	1486821	215354
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

$F_{0.1} \simeq F_{med}$

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.4439	0.1046	390177	37684	5622000	390208	1400990	203231	1313714	190089
1995	0.4439	0.1046	342429	36580	5747718	423106	1855889	260930	1746145	244723
1996	0.4439	0.1046	330535	35503	5900075	448786	1993812	294664	1881676	277250
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 11.1 Landings (t) of SARDINE by country. (Data provided by the Working Group members.

SARDINE VII

Country	1981	1982	1983	1984	1985	1986	
France	1,124	907	803	809	2,089	2,570	
UK (England & Wales)							
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Denmark					-	17,843	
France	965	2,586	1,141	1,107	1,957	1,769	585
UK (England & Wales)					3,011	4,494	4,917
Netherlands				-	-	42	-
Total				**1,107**	**4,968**	**24,148**	**5,502**

SARDINE VIII

Country	1975	1976	1977	1978	1979	1980	
France							
Spain	50,260	51,901	36,149	43,522	18,271	35,787	
	1981	1982	1983	1984	1985	1986	
France	9,676	5,928	6,467	4,491	8,169	10,229	
Spain	33,550	31,756	32,374	217,970	25,907	39,195	
Total	**43,226**	**37,684**	**38,841**	**32,461**	**34,076**	**49,424**	
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
France	7,708	7,808	8,976	8,485	9,637	8,713	5,329
Spain	36,377	40,944	29,856	27,500	20,735	26,160	24,486
UK England & Wales						1	-
Total	**44,085**	**48,752**	**38,832**	**35,985**	**30,372**	**34,874**	**29,815**

SARDINE IX

Country	1975	1976	1977	1978	1979	1980	1981
Portugal	95,877	79,649	79,819	86,553	91,294	106,302	113,253
Spain	12,236	10,140	9,782	12,915	43,876	49,593	65,330
Total	**108,113**	**89,789**	**89,601**	**96,468**	**135,170**	**155,895**	**178,583**
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
Portugal	100,859	85,922	95,110	111,709	103,451	90,1214	93,591
Spain	71,889	62,843	79,606	66,491	37,960	42,234	24,005
Total	**172,748**	**148,765**	**174,716**	**178,200**	**141,411**	**132,448**	**117,596**
	1989	**1990**	**1991**	**1992**	**1993**		
Portugal	91,091	92,404	92,638[1]	83,315	90,404		
Spain	16,179	19,253	14,383	16,579	23,905		
Total	**107,270**	**111,657**	**107,021**	**99,894**	**114,309**		

[1]Portuguese catches of 1991 included 5,492 t of discards.
(-)Unknown catches.

Table 11.2 Annual landings (t) of SARDINE by Division and Sub-area. (Data provided by the Working Group members).

Division	1981	1982	1983	1984	1985	1986
VIId	172	59	211	147	465	512
VIIe	952	828	590	661	1,624	2,058
VIIf	-	20	-	-		
VIIg		-	-	1	-	
VIIh			2	-		
Total VII	**1,124**	**907**	**803**	**809**	**2,089**	**2,570**
VIIIa	8,482	5,928	6,013	4,472	8,090	10,186
VIIIb	1,194		454	19	79	77
VIIIc	35,550	31,756	32,374	27,970	25,907	39,195
VIIId						
Total VIII	**45,226**	**37,684**	**38,841**	**32,461**	**34,076**	**49,458**
Total IXa	**178,583**	**172,748**	**148,765**	**174,716**	**178,200**	**141,411**
TOTAL YEAR	224,933	211,339	188,409	207,986	214,365	193,439

Division	1987	1988	1989	1990	1991	1992	1993
IVc					-	8	19
VIa					-	1	
VIId	67	29	93	64	170	153	127
VIIe	682	438	91	808	4,687	19,299[1]	5,298
VIIf					-	335	6
VIIg					-	0	0
VIIh	216	2,119	957	235	110	4	71
Total VII	**965**	**2,586**	**1,141**	**1,107**	**4,968**	**19,682**	**5,502**
VIIIa	7,631	7,770	8,885	8,381	9,113	8,565	4,703
VIIIb	77	38	85	104	482	141	548
VIIIc	36,377	40,944	29,862	27,500	20,735	26,166	24,486
VIIId					42	2	78
Total VIII	**44,085**	**48,752**	**38,832**	**35,985**	**30,372**	**34,874**	**29,815**
Total IXa	**132,448**	**117,596**	**107,270**	**111,657**	**107,021**	**99,894**	**114,309**
TOTAL YEAR	177,498	168,934	147,243	148,749	142,361	154,569	149,645

Sub-area VII - 1981-1990 only French data were available.
[1]17,507 t from Divisions VIId + VIIe, caught by Denmark.
(-) Unknown catches.

Table 11.3 Annual landings (t) of SARDINE in Divisions VIIIc and IXa by country.

Country	1976	1977	1978	1979	1980	1981
Portugal	79,649	79,819	83,553	91,294	106,302	113,253
Spain	62,041	45,931	56,437	62,147	85,380	100,880
Total	141,690	125,750	139,990	153,441	191,682	214,133
	1982	1983	1984	1985	1986	1987
Portugal	100,859	85,922	95,110	111,709	103,451	90,214
Spain	103,645	95,217	107,576	92,398	77,155	78,611
Total	204,504	181,139	202,686	204,107	180,606	168,825
	1988	1989	1990	1991	1992	1993
Portugal	93,591	91,091	92,404	92,638[1]	83,315	90,404
Spain	64,949	46,035	46,753	35,118	42,739	48,391
Total	158,540	137,126	139,157	127,756	126,054	138,795

[1]Discards included.

Table 11.4 SARDINE (VIIIc + IXa).
Quarterly catches (t) by gear by country and fleets in 1993. (Provided by the Working Group members).

Country/Quarter	1st	2nd	3rd	4th	Year
Total	17,021	32,450	46,149	43,176	138,795
Spain (VIIIc+IXa):					
Purse-seine	6,639	14,012	16,657	11,083	48,391
Portugal (IXa):	10,382	18,438	29,492	32,093	90,404
Purse-seine:					
- Portuguese waters	9,872	17,872	28,294	30,727	86,765
- Spanish waters	5	5	16	22	48
Artisanal	308	556	1,182	1,248	3,294
Trawl	196	5	0	96	298

Table 11.5 SARDINE (VIIIc + IXa)
Total nominal catches (t), by quarter and areas of Divisions VIIIc and IXa during 1993.

Area	1st	2nd	3rd	4th	Total 1992
VIIIc East	3,193	890	1,865	2,013	7,961
VIIIc West	1,039	3,797	7,437	4,252	16,525
IXa North	2,407	9,325	7,355	4,818	23,905
IXa Central-North	2,106	9,426	15,736	20,015	47,284
IXa Central-South	5,935	5,954	10,444	8,026	29,959
IXA South (>7° 24'W)	2,340	3,057	3,712	4,051	13,160
Total	17,020	32,450	46,149	43,176	138,795

Table 11.6 SARDINE (Divisions VIIIc + IXa).
Effort (fishing day) and CPUE (ton/fishing day) series in commercial fisheries (P. seine).

Year	Spain						Portugal	
	VIIIc East (Santona)		VIIIc West (Sada)		IXa N (Vigo + Riveira)		IXa Central + South	
	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/fday
1982					7,685	4.87		
1983					7.863	4.01		
1984					8,369	4.65		
1985					5,731	4.86		
1986					3,541	4.23		
1987			4,455	2.07	4,099	4.71		
1988			4,192	2.34	3,601	2.75	22,080	3.91
1989	314	4.10	4,008	1.95	3,059	2.45	21,432	3.93
1990	389	3.65	3,465	1.55	3,488	2.80	25,710	3.50
1991	394	3.13	2,891	0.93	3,279	2.44	21,798	3.56
1992	570	1.63	2,619	1.42	3.790	2.44	26,418	2.97
1993	498	1.70	2,054	2.07	4,758	2.66	21,659	3.61

Table 11.7 Sardine in Divisions VIIIc and IXa. Abundance estimates from acoustic surveys 1986-1993.

Age	1986				1987			1988			1990	1991	1992	1992	1993
	Spain Divs. VIIIc and IXa	Portugal Division IXa			Spain Divs. IIIc and IXa	Portugal Division IXa		Spain Divs. VIIIa and IXa	Portugal Division IXa		Spain Divs. VIIIc and IXa(N)	Spain Divs. VIIIc and IXa(N)	Spain Divs. VIIIc & IXa(N)	Portugal Div. IXa	Spain Divs. VIIIc & IXa(N)
	Mar	Mar	Aug	Dec	Mar	Aug	Nov	Apr	Mar	Aug	Apr	Mar/Apr	Apr/May	Nov	Apr
0	-	-	4,007	2,493	-	4,546	3,715	-	-	3,139	-	-	-	4,637	-
1	55	2,344	2,729	1,612	44	1,203	2,379	221	7,743	1,823	69	25	159	5,944	242
2	21	4,025	2,492	1,670	36	1,408	1,344	63	2,684	989	56	150	76	1,205	324
3	1,040	1,544	718	658	4	1,102	928	72	1,617	802	274	126	85	817	92
4	215	518	21	323	398	670	666	64	1,447	426	55	314	29	307	83
5	409	471	0	127	118	163	236	858	804	70	88	51	115	38	83
6	279	21	0	50	85	46	49	175	425	90	134	79	24	1	267
7	192	-	-	0	98	30	31	310	104	-	249	56	20	0	27
8	50	-	-	-	40	-	-	342	-	-	70	345	12	-	74
9	36	-	-	-	14	-	-	53	-	-	49	29	57	-	71
10	12	-	-	-	7	-	-	18	-	-	46	71	3	-	226
11	3	-	-	-	1	-	-	-	-	-	23	6	9	-	79
12	-	-	-	-	-	-	-	-	-	-	8	2	-	-	-
6+	572	21	0	50	245	76	80	898	529	90	445	588	125	1	744
Total biomass(B)	161	318	332	283	65	316	323	176	481	243	97	106	45	564	126
Annual catch (Y)	77		103		79		90	65	94		47	35	43	83	24
Y/B	0.479	0.325	0.312	0.366	1.209	0.285	0.279	0.369	0.195	0.385	0.482	0.331	0.950	0.147	0.190
Year	1986				1987			1988			1990	1991	1992		1993

Numbers in millions.
Biomass in thousand tonnes.

Table 11.8 Sardine in Divisions VIIIc and IXa. Catch length composition ('000) by country and quarter in 1993

	QUARTER 1				QUARTER 2				QUARTER 3				QUARTER 4				TOTAL			
	PORTUGAL	SPAIN			PORTUGAL	SPAIN			PORTUGAL	SPAIN			PORTUGAL	SPAIN			PORTUGAL	SPAIN		
Length (cm)	Seine IXa	Seine IXa	Seine VIIIc	Total	Seine IXa	Seine IXa	Seine VIIIc	Total	Seine IXa	Seine IXa	Seine VIIIc	Total	Seine IXa	Seine IXa	Seine VIIIc	Total	Seine IXa	Seine IXa	Seine VIIIc	Total
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5	0	0	0	0	0	0	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	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	1020	1020	0	0	340	340	0	0	1360	1360
9	0	0	0	0	0	0	0	0	0	0	1360	1360	0	0	453	453	0	0	1813	1813
9.5	0	0	0	0	0	0	0	0	0	0	11221	11221	0	0	3740	3740	0	0	14961	14961
10	0	0	0	0	0	0	0	0	0	0	8501	8501	0	0	2833	2833	0	0	11334	11334
10.5	0	0	0	0	0	0	0	0	0	0	10201	10201	0	0	3400	3400	0	0	13601	13601
11	0	59	0	59	0	0	0	0	0	0	1020	1020	0	0	340	340	0	59	1360	1419
11.5	0	350	1050	1399	0	0	834	834	0	0	340	340	0	0	113	113	0	350	2337	2687
12	0	820	3032	3852	0	0	2410	2410	0	0	680	680	0	0	227	227	0	820	6349	7168
12.5	0	1415	5019	6434	0	0	4023	4023	0	0	340	340	0	62	113	175	0	1477	9495	10972
13	0	2124	3388	5512	0	0	2710	2710	0	25	0	25	0	141	0	141	0	2290	6098	8387
13.5	0	1315	983	2298	0	0	902	902	0	0	0	0	0	123	0	123	0	1439	1885	3323
14	0	1174	450	1624	0	0	297	297	0	94	0	94	0	380	0	380	0	1648	746	2394
14.5	0	989	663	1652	0	0	585	585	0	131	0	131	0	289	0	289	0	1410	1247	2657
15	0	1927	822	2749	0	86	924	1009	0	249	0	249	0	389	0	389	0	2650	1746	4396
15.5	0	1846	544	2390	0	635	1364	1998	0	370	0	370	0	454	0	454	0	3305	1908	5213
16	0	2445	313	2758	0	5003	996	5999	0	1909	20	1929	0	860	0	860	0	10217	1329	11546
16.5	0	3318	171	3490	0	10867	889	11756	0	3171	93	3263	0	1568	29	1597	0	18924	1182	20105
17	0	3049	89	3137	0	28795	813	29608	0	9645	669	10314	0	3638	586	4224	0	45126	2157	47283
17.5	0	3394	187	3581	0	27620	665	28285	0	11335	1837	13172	0	3666	1648	5314	0	46015	4337	50352
18	0	5062	649	5711	0	38117	1739	39856	0	21676	4319	25995	0	8081	3385	11466	0	72937	10091	83028
18.5	0	8609	764	9373	0	37450	3283	40733	0	25008	7055	32064	0	12219	4720	16939	0	83286	15823	99109
19	0	5699	2270	7969	0	18411	6757	25168	0	20995	14039	35034	0	14510	8440	22950	0	59616	31505	91121
19.5	0	2185	2375	4561	0	10150	7561	17711	0	11877	16835	28712	0	7330	10647	17977	0	31543	37418	68961
20	0	3618	1980	5597	0	10511	8246	18757	0	14210	17516	31726	0	15366	12207	27573	0	43704	39949	83653
20.5	0	1183	2381	3563	0	2456	8480	10936	0	2393	14575	16969	0	3034	9882	12916	0	9066	35318	44384
21	0	1173	3558	4731	0	1686	6849	8535	0	2833	12056	14889	0	2560	8180	10740	0	8252	30644	38895
21.5	0	364	4793	5157	0	376	5638	6013	0	851	8644	9495	0	904	6749	7653	0	2495	25824	28319
22	0	1768	6687	8455	0	988	4916	5903	0	1786	8901	10687	0	3596	6147	9743	0	8137	26651	34788
22.5	0	377	6512	6890	0	99	3624	3723	0	235	4846	5081	0	566	4859	5425	0	1277	19841	21118
23	0	200	5671	5871	0	46	2661	2707	0	306	3017	3323	0	194	3996	4190	0	746	15344	16091
23.5	0	27	4923	4950	0	0	786	786	0	0	1050	1050	0	32	1941	1973	0	59	8700	8759
24	0	57	2347	2405	0	0	608	608	0	233	227	460	0	81	652	733	0	371	3834	4206
24.5	0	0	1338	1338	0	0	145	145	0	0	115	115	0	0	296	296	0	0	1895	1895
25	0	0	844	844	0	0	0	0	0	0	0	0	0	0	168	168	0	0	1012	1012
25.5	0	0	79	79	0	0	0	0	0	0	0	0	0	0	82	82	0	0	161	161
26	0	0	1	1	0	0	2	2	0	0	0	0	0	0	46	46	0	0	49	49
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N	0	54546	63884	118430	0	193296	78705	272001	0	129333	150497	279829	0	80042	96220	176263	0	457217	389306	846523
Catch(t	0	2407	4232	6639	0	9325	4687	14012	0	7355	9302	16657	0	4818	6265	11083	0	23905	24486	48391
L		17.8	19.8	18.9		18.4	19.3	18.6		18.9	18.1	18.5		19.3	19.4	19.4		18.6	19.0	18.8

Table 11.9 Sardine in Division VIIe. Catch length composition ('000) by quarter and by ger during 1993.

Length (cm)	Quarter 1 England	Quarter 4 England	Total
	Trawl VIIe	Trawl VIIe	
15			
15.5			
16			
16.5			
17			
17.5			
18	138		138
18.5			
19	138		138
19.5	982	238	1220
20	560	629	1189
20.5	496	391	886
21	1,918	238	2,156
21.5	2,909	510	3,419
22	3,533	932	4,465
22.5	1,918	1,185	3,103
23	3,597	2,135	5,732
23.5	1,891	2,797	4,688
24	1,689	3,423	5,112
24.5	781	1,744	2,525
25	762	1,102	1,865
25.5	487	782	1,269
26	276	986	1,262
26.5		357	357
27			
27.5			
28			
28.5			
Total N	22,074	17,449	39,523
Catch (t)	2,478	1,933	4,411
$\bar{L}$	22.7	23.8	23.2

Table 11.10 Catch in numbers ('000) at age by quarter and by sub-division of SARDINE in 1993.

1993 Age	VIIIc East 1'st Q catch('000)	VIIIc West 1'st Q catch('000)	IXa North 1'st Q catch('000)	IXa Centr-N 1'st Q catch('000)	IXa Centr-S 1'st Q catch('000)	IXa South 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	2,962	14,038	24,262	29,455	36,443	481	107,641
2	3,510	3,183	15,024	18,683	36,139	10,898	87,437
3	2,753	2,494	7,438	6,078	34,449	11,872	65,084
4	3,200	1,392	2,482	3,227	15,571	13,440	39,312
5	4,543	1,299	2,092	2,068	10,603	4,624	25,219
6	7,687	1,798	1,888	699	3,462	2,564	18,098
7	1,474	300	410	87	564	663	3,498
8	1,870	329	406	0	0	0	2,605
9	1,617	78	35	0	0	0	1,730
10	6,209	711	421	0	0	0	7,341
11	961	81	49	0	0	0	1,091
12	1,292	102	40	0	0	0	1,434
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	38,078	25,806	54,547	60,287	137,231	44,542	360,490
Tonne	3,193	1,039	2,407	2,106	5,935	2,340	17,020

Age	VIIIc East 2'nd Q catch('000)	VIIIc West 2'nd Q catch('000)	IXa North 2'nd Q catch('000)	IXa Centr-N 2'nd Q catch('000)	IXa Centr-S 2'nd Q catch('000)	IXa South 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0
1	5,125	13,027	69,288	75,397	7,387	3,050	173,274
2	2,221	15,525	74,136	110,118	13,263	27,158	242,421
3	1,205	10,474	31,086	26,109	38,342	24,020	131,236
4	1,176	6,641	6,696	11,211	37,358	11,722	74,804
5	1,233	6,216	5,564	7,378	16,805	3,118	40,314
6	1,740	6,809	3,978	1,149	1,932	1,094	16,702
7	329	1,417	979	38	935	311	4,009
8	347	909	1,263	0	0	0	2,519
9	155	362	12	0	0	0	529
10	863	2,003	240	0	0	0	3,106
11	115	308	45	0	0	0	468
12	170	335	8	0	0	0	513
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	14,679	64,026	193,295	231,400	116,022	70,473	689,895
Tonne	890	3,797	9,325	9,426	5,954	3,057	32,450

Age	VIIIc East 3'rd Q catch('000)	VIIIc West 3'rd Q catch('000)	IXa North 3'rd Q catch('000)	IXa Centr-N 3'rd Q catch('000)	IXa Centr-S 3'rd Q catch('000)	IXa South 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	22	37,765	2,921	570	3,618	27	44,923
1	1,602	12,201	41,827	30,391	2,289	5,360	93,670
2	4,974	32,214	52,404	109,711	91,191	58,319	348,813
3	3,819	19,141	19,179	96,540	55,380	14,192	208,251
4	2,649	10,122	5,536	30,476	27,800	2,615	79,198
5	1,710	6,374	2,616	10,563	6,542	170	27,975
6	3,278	8,062	3,537	1,852	1,340	170	18,239
7	501	1,306	269	0	63	0	2,139
8	944	1,432	354	0	40	0	2,770
9	396	563	149	0	0	0	1,108
10	1,037	1,949	374	0	0	0	3,360
11	288	611	76	0	0	0	975
12	230	304	91	0	0	0	625
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	21,460	132,044	129,333	280,103	188,263	80,853	832,046
Tonne	1,865	7,437	7,355	15,736	10,044	3,712	46,149

Age	VIIIc East 4'th Q catch('000)	VIIIc West 4'th Q catch('000)	IXa North 4'th Q catch('000)	IXa Centr-N 4'th Q catch('000)	IXa Centr-S 4'th Q catch('000)	IXa South 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	68	11,570	2,639	361	27,778	469	42,885
1	3,605	5,961	19,539	85,843	65,540	7,148	187,636
2	7,392	17,521	31,248	220,341	55,152	40,493	372,147
3	4,812	11,058	13,920	30,334	18,906	18,857	97,887
4	2,970	6,040	5,022	17,740	12,577	7,546	51,895
5	2,053	3,945	2,491	7,233	1,269	372	17,363
6	3,279	5,947	3,419	393	93	138	13,269
7	539	927	350	393	0	0	2,209
8	808	1,452	571	0	0	0	2,831
9	342	627	219	0	0	0	1,188
10	1,395	2,438	349	0	0	0	4,182
11	327	671	114	0	0	0	1,112
12	171	301	160	0	0	0	632
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	27,761	68,458	80,041	362,638	181,315	75,023	795,236
Tonne	2,013	4,252	4,818	20,015	8,026	4,051	43,176

Sardine in Fishing Areas VIIIc and IXa

Table 11.11 Catch in Numbers (Millions)

(CANUM)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1976	420	1871	1426	252	71	12	3	0
1977	844	2421	954	110	22	3	1	0
1978	854	2145	913	281	127	40	16	0
1979	643	1479	935	423	187	93	36	0
1980	842	1997	1542	372	155	47	30	0
1981	1021	1920	1720	666	192	102	76	0
1982	60	769	1854	701	350	130	129	0
1983	1061	553	838	795	322	140	139	0
1984	109	3289	470	488	295	176	116	0
1985	258	527	2343	457	290	197	101	0
1986	238	702	987	903	322	194	166	0
1987	1401	512	615	520	521	147	170	0
1988	439	979	525	428	303	291	189	0
1989	244	512	895	381	215	198	183	61
1990	234	562	488	680	275	142	104	142
1991	1574	456	404	380	256	72	26	79
1992	490	985	423	317	175	108	19	61
1993	88	562	1051	502	245	111	66	52

Table 11.12 Length (cm) at age by quarter and by sub-division of SARDINE in 1993.

1993 Age	VIIIc East 1'st Q length(cm)	VIIIc West 1'st Q length(cm)	IXa North 1'st Q length(cm)	IXa Centr-N 1'st Q length(cm)	IXa Centr-S 1'st Q length(cm)	IXa South 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	15.6	13.0	15.8	13.5	14.0	15.7	14.2
2	20.9	19.9	18.8	18.1	17.7	17.6	18.2
3	21.4	20.0	19.2	19.3	19.0	18.8	19.2
4	21.7	21.1	19.9	20.6	20.3	19.8	20.3
5	22.4	21.4	20.4	21.4	20.9	20.4	21.1
6	22.7	21.8	21.0	22.1	21.5	21.2	22.0
7	22.6	21.9	20.6	23.2	22.2	21.5	22.0
8	23.3	22.2	20.1	0.0	0.0	0.0	22.7
9	23.9	23.2	23.2	0.0	0.0	0.0	23.9
10	23.5	22.8	22.4	0.0	0.0	0.0	23.4
11	23.7	22.4	22.1	0.0	0.0	0.0	23.5
12	23.5	23.3	23.2	0.0	0.0	0.0	23.5
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	22.0	16.6	17.8	16.3	17.7	19.1	18.0

Age	VIIIc East 2'nd Q length(cm)	VIIIc West 2'nd Q length(cm)	IXa North 2'nd Q length(cm)	IXa Centr-N 2'nd Q length(cm)	IXa Centr-S 2'nd Q length(cm)	IXa South 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	15.8	13.7	17.6	16.4	13.2	16.6	16.5
2	19.6	20.0	18.5	18.1	18.1	17.5	18.3
3	20.6	20.1	18.9	19.5	19.1	18.6	19.1
4	21.0	20.9	19.5	20.6	20.2	19.5	20.2
5	21.8	21.1	19.7	21.0	20.7	20.1	20.7
6	22.2	21.5	20.0	21.2	21.4	20.9	21.1
7	22.1	21.5	19.8	23.7	22.0	21.5	21.3
8	22.6	21.7	19.1	0.0	0.0	0.0	20.5
9	23.4	23.1	22.1	0.0	0.0	0.0	23.2
10	22.9	22.7	22.0	0.0	0.0	0.0	22.7
11	23.0	22.4	21.4	0.0	0.0	0.0	22.5
12	23.3	23.2	23.1	0.0	0.0	0.0	23.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	19.4	19.3	18.4	17.9	19.3	18.4	18.5

Age	VIIIc East 3'rd Q length (cm)	VIIIc West 3'rd Q length (cm)	IXa North 3'rd Q length (cm)	IXa Centr-N 3'rd Q length (cm)	IXa Centr-S 3'rd Q length (cm)	IXa South 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	17.1	10.3	16.4	14.7	16.4	15.6	11.3
1	19.3	19.1	18.3	17.6	16.9	17.0	18.1
2	20.0	19.8	18.9	18.6	18.4	17.9	18.6
3	20.9	20.3	19.4	19.7	19.2	18.7	19.5
4	21.4	20.9	20.1	20.8	20.2	19.3	20.5
5	21.6	21.1	20.2	21.1	21.0	20.6	21.0
6	22.1	21.6	20.4	21.5	21.5	20.6	21.4
7	22.1	21.7	21.7	0.0	22.3	0.0	21.8
8	22.6	22.5	22.6	0.0	22.8	0.0	22.6
9	22.7	22.7	22.9	0.0	0.0	0.0	22.7
10	22.8	22.6	23.0	0.0	0.0	0.0	22.7
11	22.9	22.1	21.5	0.0	0.0	0.0	22.3
12	22.6	22.5	22.4	0.0	0.0	0.0	22.5
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	21.1	17.5	18.9	19.2	19.0	18.0	18.8

Age	VIIIc East 4'th Q length(cm)	VIIIc West 4'th Q length(cm)	IXa North 4'th Q length(cm)	IXa Centr-N 4'th Q length(cm)	IXa Centr-S 4'th Q length(cm)	IXa South 4'th Q length(cm)	All areas 4'th Q length(cm)
0	17.3	10.3	15.4	15.0	14.8	16.0	13.6
1	18.7	19.3	18.5	17.6	16.5	17.8	17.4
2	19.8	19.9	19.2	19.1	18.3	18.6	19.0
3	20.6	20.4	19.8	20.3	19.8	19.5	20.0
4	21.3	21.0	20.5	20.8	20.9	20.1	20.7
5	21.4	21.3	20.6	21.2	22.0	20.8	21.2
6	22.0	21.9	21.0	23.2	23.8	21.4	21.7
7	22.0	22.0	21.8	23.2	0.0	0.0	22.2
8	22.7	22.8	22.4	0.0	0.0	0.0	22.7
9	22.9	22.9	22.5	0.0	0.0	0.0	22.8
10	23.3	23.2	22.6	0.0	0.0	0.0	23.2
11	22.9	22.9	21.7	0.0	0.0	0.0	22.8
12	22.7	22.7	22.3	0.0	0.0	0.0	22.6
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	20.7	18.9	19.3	19.0	17.5	18.9	18.7

Table 11.13 Weight (g) at age by quarter and by sub-division of SARDINE in 1993.

1993 Age	VIIIc East 1'st Q weight(g)	VIIIc West 1'st Q weight(g)	IXa North 1'st Q weight(g)	IXa Centr- 1'st Q weight(g)	IXa Centr- 1'st Q weight(g)	IXa South 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	27	15	28	18	20	28	21
2	68	59	49	44	41	40	45
3	74	60	53	53	51	49	52
4	77	70	58	66	62	58	62
5	85	73	63	74	68	63	71
6	89	79	69	82	75	71	81
7	88	79	66	95	82	75	81
8	97	83	61	0	0	0	90
9	104	95	96	0	0	0	103
10	99	90	85	0	0	0	97
11	102	85	81	0	0	0	100
12	99	97	95	0	0	0	99
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	83	40	42	35	44	53	47

Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	IXa Centr- 2'nd Q weight(g)	IXa Centr- 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	30	15	42	30	16	32	33
2	58	59	49	41	41	37	44
3	68	60	52	52	49	45	50
4	71	70	58	61	58	52	59
5	80	73	59	65	62	57	64
6	84	79	62	67	68	64	72
7	84	79	60	95	75	69	73
8	89	83	64	0	0	0	69
9	100	95	83	0	0	0	96
10	93	90	82	0	0	0	90
11	95	85	75	0	0	0	86
12	97	97	95	0	0	0	97
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	60	57	48	41	51	43	47

Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	IXa Centr- 3'rd Q weight (g)	IXa Centr- 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	42	8	37	25	34	30	12
1	63	61	52	42	37	39	49
2	71	69	59	51	48	45	52
3	82	75	65	60	55	51	60
4	89	82	72	70	64	56	70
5	92	85	73	74	72	68	77
6	99	91	76	77	77	68	87
7	99	93	93	0	86	0	94
8	106	105	106	0	92	0	105
9	107	108	112	0	0	0	108
10	110	107	113	0	0	0	109
11	111	99	90	0	0	0	102
12	106	106	104	0	0	0	106
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	86	56	59	56	63	46	56

Age	VIIIc East 4'th Q weight(g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	IXa Centr- 4'th Q weight(g)	IXa Centr- 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	44	10	32	27	26	33	22
1	54	59	53	44	36	45	43
2	64	65	59	56	49	51	55
3	71	70	64	67	62	59	65
4	78	76	70	73	73	65	72
5	79	78	71	77	86	72	77
6	85	85	76	101	108	78	83
7	85	86	83	101	0	0	88
8	93	94	90	0	0	0	93
9	95	96	91	0	0	0	95
10	100	99	92	0	0	0	99
11	95	96	82	0	0	0	94
12	93	94	89	0	0	0	93
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	73	62	60	55	44	54	64

Sardine in Fishing Areas VIIIc and IXa

Table 11.14 Mean Weight of Catch (Kilograms)

(WECA)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1976	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1977	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1978	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1979	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1980	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1981	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1982	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1983	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1984	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1985	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1986	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1987	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1988	0.017	0.034	0.052	0.060	0.068	0.072	0.079	0.093
1989	0.013	0.035	0.052	0.059	0.066	0.071	0.087	0.093
1990	0.024	0.032	0.047	0.057	0.061	0.067	0.070	0.096
1991	0.020	0.031	0.058	0.063	0.073	0.074	0.087	0.097
1992	0.018	0.045	0.055	0.066	0.070	0.079	0.083	0.091
1993	0.017	0.037	0.051	0.058	0.066	0.071	0.081	0.093

Sardine in Fishing Areas VIIIc and IXa

Table 11.15 Mean Weight of Stock (Kilograms)

(WEST)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1976	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1977	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1978	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1979	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1980	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1981	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1982	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1983	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1984	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1985	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1986	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1987	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1988	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1989	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1990	0.000	0.015	0.038	0.050	0.064	0.067	0.077	0.086
1991	0.000	0.019	0.042	0.050	0.064	0.067	0.079	0.086
1992	0.000	0.027	0.036	0.050	0.062	0.071	0.075	0.088
1993	0.000	0.022	0.045	0.057	0.064	0.069	0.076	0.091

Table 11.16 Sardine in Fishing Areas VIIIc and IXa

Proportion Mature at Year Start

(MATPROP)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1976	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.23	0.83	0.91	0.92	0.94	0.97	1.00
1990	0.00	0.60	0.81	0.88	0.89	0.94	0.97	1.00
1991	0.00	0.74	0.91	0.96	0.97	1.00	1.00	1.00
1992	0.00	0.79	0.91	0.95	0.98	1.00	1.00	1.00
1993	0.00	0.47	0.93	0.94	0.97	0.99	1.00	1.00

Table 11.17a

Sardine in Fishing Areas VIIIc and IXa

FLT01: Fleet 1-Spanish Acoustic Survey - Spring (Catch: millions) (code: FLT01)

Year	Effort	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
1986	1	55	21	1040	215	409	279	192	50	36	12	3
1987	1	44	36	4	398	118	85	98	40	14	7	1
1988	1	221	63	72	64	858	175	310	342	53	18	0
1989	1	0	0	0	0	0	0	0	0	0	0	0
1990	1	69	56	274	55	88	134	249	70	49	46	23
1991	1	25	150	126	314	51	79	56	345	29	71	6
1992	1	159	78	85	29	115	24	20	13	57	3	9
1993	1	242	324	92	83	83	267	27	74	71	226	79

Table 11.17b

Sardine in Fishing Areas VIIIc and IXa

FLT02: Fleet 2-Portuguese Purse Seiners (Catch: millions) (code: FLT02)

Year	Effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6
1988	22080	372	640	411	271	192	61	21
1989	21432	50	444	653	288	153	129	23
1990	25740	103	431	398	470	213	97	67
1991	21798	911	277	325	315	158	48	12
1992	26418	178	634	356	253	143	37	4
1993	21659	28	302	685	324	165	61	13

Table 11.17c

Sardine in Fishing Areas VIIIc and IXa

FLT03: Fleet 3-Spanish P. Seiners (IXa North)(Catch: millions) (code: FLT03)

Year	Effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5
1982	7685	22	137	254	159	98	23
1983	7867	580	107	133	146	58	18
1984	8369	134	657	91	107	81	24
1985	5731	16	39	444	71	75	60
1986	3541	8	26	31	100	20	27
1987	4099	489	22	29	20	49	8
1988	3601	19	89	22	17	13	32
1989	3059	55	25	72	18	11	7
1990	3488	70	56	28	50	12	7
1991	3279	311	50	6	3	7	2
1992	3790	150	91	11	8	3	7
1993	4758	3	82	91	38	11	7

Table 11.17d

Sardine in Fishing Areas VIIIc and IXa

FLT04: Fleet 4-Spanish P. Seiners (VIIIc West) (Catch: millions) (code: FLT04)

Year	Effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5
1987	4455	0	1	6	10	44	13
1988	4192	0	11	7	23	18	34
1989	4008	0	2	25	12	10	13
1990	3465	0	2	5	23	7	6
1991	3891	1	2	3	2	8	2
1992	2619	3	35	5	5	2	6
1993	2054	1	7	19	13	7	5

Table 11.17e

Sardine in Fishing Areas VIIIc and IXa

FLT06: Fleet 6-Portuguese acoustic survey-Nov/Dec (Catch:millions) (code: FLT06)

Year	Effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6
1984	1	2957	5733	1152	1037	528	76	40
1985	1	2063	2744	4548	1083	839	144	61
1986	1	2493	1612	1670	658	323	127	50
1987	1	3715	2379	1344	929	666	237	49
1988	1	0	0	0	0	0	0	0
1989	1	0	0	0	0	0	0	0
1990	1	0	0	0	0	0	0	0
1991	1	0	0	0	0	0	0	0
1992	1	4638	5944	1205	818	307	38	1

Table 11.18 Outputs from ICA program (Flat, S=1.0 relative to age 3; +gp. in Spanish survey not included)

AGE - STRUCTURED INDICES

INDEX : 1 from 1986 to 1993

	1986	1987	1988	1989	1990	1991	1992	1993
1	.550E+02	.440E+02	.221E+03	-.100E+01	.690E+02	.250E+02	.159E+03	.242E+03
2	.210E+02	.360E+02	.630E+02	-.100E+01	.560E+02	.150E+03	.780E+02	.324E+03
3	.104E+04	-.100E+01	.720E+02	-.100E+01	.274E+03	.126E+03	.850E+02	.920E+02
4	.215E+03	.398E+03	.640E+02	-.100E+01	.550E+02	.314E+03	.290E+02	.830E+02
5	.409E+03	.118E+03	.858E+03	-.100E+01	.880E+02	.510E+02	.115E+03	.830E+02
6	.572E+03	.245E+03	.898E+03	-.100E+01	.445E+03	.588E+03	.125E+03	.744E+03

INDEX : 2 from 1984 to 1992

	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.296E+04	.206E+04	.249E+04	.372E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.464E+04
1	.573E+04	.274E+04	.161E+04	.238E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.594E+04
2	.115E+04	.455E+04	.167E+04	.134E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.121E+04
3	.104E+04	.108E+04	.658E+03	.929E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.818E+03
4	.528E+03	.839E+03	.323E+03	.666E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.307E+03
5	.760E+02	.144E+03	.127E+03	.237E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.380E+02
6	.400E+02	.610E+02	.500E+02	.490E+02	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.100E+01

FISHING MORTALITY

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	.0510	.0985	.0799	.0533	.0706	.1165	.0092	.0562	.0152	.0465	.0777	.0736	.0802	.0843	.0982	.0752	.0710	.0888
1	.5123	.5343	.4504	.2226	.2679	.2625	.1385	.1253	.2849	.1087	.1581	.1497	.1631	.1714	.1997	.1528	.1444	.1805
2	.9156	.6405	.4639	.4234	.4453	.4560	.5117	.2542	.1716	.3941	.2645	.2504	.2728	.2867	.3341	.2557	.2417	.3020
3	.8492	.1791	.4612	.4784	.3458	.4115	.3976	.5083	.2671	.2908	.4126	.3907	.4257	.4474	.5212	.3990	.3771	.4712
4	2.2141	.1808	.3758	.7721	.3762	.3518	.4645	.3742	.4197	.2915	.4210	.3986	.4343	.4564	.5317	.4070	.3847	.4807
5	1.4462	.6875	.6821	.6191	.5271	.5382	.5032	.3998	.4225	.6566	.4126	.3907	.4257	.4474	.5212	.3990	.3771	.4712
6	1.4462	.6875	.6821	.6191	.5271	.5382	.5032	.3998	.4225	.6566	.4126	.3907	.4257	.4474	.5212	.3990	.3771	.4712

(continued)

Table 11.18 (continued)

NUMBERS AT AGE (Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	9907.	10531.	13030.	14528.	14470.	10867.	7710.	22740.	8456.	6663.	5982.	10136.	5914.	5966.	5697.	13663.	7582.	1213.	6190.
1	5403.	6768.	6860.	8649.	9903.	9693.	6954.	5492.	15454.	5987.	4573.	3979.	6770.	3924.	3942.	3713.	9112.	5077.	798.
2	2724.	2327.	2852.	3144.	4977.	5446.	5360.	4353.	3483.	8356.	3861.	2807.	2463.	4135.	2377.	2321.	2291.	5669.	3047.
3	505.	784.	882.	1289.	1480.	2292.	2481.	2310.	2427.	2109.	4051.	2131.	1571.	1348.	2232.	1223.	1292.	1293.	3014.
4	89.	155.	471.	400.	575.	753.	1092.	1199.	999.	1336.	1134.	1128.	1036.	738.	619.	953.	590.	637.	580.
5	18.	7.	93.	233.	133.	284.	381.	493.	593.	472.	717.	535.	930.	483.	336.	262.	456.	289.	283.
6	4.	2.	37.	90.	85.	211.	378.	490.	391.	242.	570.	611.	633.	588.	296.	92.	70.	204.	221.

STOCK SUMMARY

Year	Recruits	Total B	Spawn B	Landings	Yld/SSB
	x10^6	tonnes	tonnes	tonnes	
1976	9907.	217019.	137495.	141690.	1.0305
1977	10531.	239742.	162843.	125750.	.7722
1978	13030.	294634.	207983.	139990.	.6731
1979	14528.	361752.	257298.	153441.	.5964
1980	14470.	463849.	336913.	191682.	.5689
1981	10867.	550410.	407262.	214133.	.5258
1982	7710.	556544.	422152.	204504.	.4844
1983	22740.	510775.	400532.	181139.	.4522
1984	8456.	619239.	455476.	202686.	.4450
1985	6663.	648535.	506768.	204107.	.4028
1986	5982.	582356.	464324.	180606.	.3890
1987	10136.	479097.	383035.	168825.	.4408
1988	5914.	451046.	346557.	158540.	.4575
1989	5966.	408229.	271112.	137126.	.5058
1990	5697.	346597.	236320.	139157.	.5889
1991	13663.	315637.	242248.	127756.	.5274
1992	7582.	466486.	349929.	126054.	.3602
1993	1213.	517882.	367567.	138795.	.3776

(continued)

Table 11.18 (continued)

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1986	.4126	.3534	.4819
2	1987	.3907	.3344	.4565
3	1988	.4257	.3628	.4995
4	1989	.4474	.3814	.5249
5	1990	.5212	.4417	.6150
6	1991	.3990	.3319	.4797
7	1992	.3771	.3076	.4624
8	1993	.4712	.3601	.6165

Separable Model: Selection (S) by age

9	0	.1884	.1408	.2520
10	1	.3830	.3347	.4383
11	2	.6409	.5664	.7252
	3	1.0000	Fixed : Reference age	
12	4	1.0201	.9245	1.1256
	5	1.0000	Fixed : last true age	

Separable Model: Populations in year 1993

13	0	1213359.	534628.	2753761.
14	1	5077210.	3806994.	6771238.
15	2	5669481.	4499213.	7144142.
16	3	1293377.	1048436.	1595544.
17	4	637185.	512027.	792935.
18	5	288780.	228307.	365272.

Separable Model: Populations at age 5

19	1986	717448.2151	567211.4370	907478.0721
20	1987	535066.3178	440784.4722	649514.6324
21	1988	930193.3390	768799.4358	1125468.6301
22	1989	482579.0005	399790.9013	582510.7350
23	1990	336054.8548	278818.6758	405040.5344
24	1991	261677.7202	213352.9575	320948.1136
25	1992	455862.7490	368288.5902	564260.8854

Age-structured index catchabilities

Age-Structured Index 1

Linear model fitted. Slopes at age:

26	1 Q	.19721E-04	.15540E-04	.25028E-04
27	2 Q	.29185E-04	.23094E-04	.36882E-04
28	3 Q	.11751E-03	.90967E-04	.15180E-03
29	4 Q	.15499E-03	.12047E-03	.19940E-03
30	5 Q	.41156E-03	.31304E-03	.54109E-03
31	6 Q	.20767E-02	.24742E-05	.17431E+01

Age-Structured Index 2

Linear model fitted. Slopes at age:

32	0 Q	.56082E-03	.42329E-03	.74303E-03
33	1 Q	.73200E-03	.55361E-03	.96788E-03
34	2 Q	.76853E-03	.58132E-03	.10160E-02
35	3 Q	.72032E-03	.54303E-03	.95551E-03
36	4 Q	.82909E-03	.62159E-03	.11059E-02
37	5 Q	.38050E-03	.28278E-03	.51199E-03
38	6 Q	.15182E-03	.11372E-03	.20268E-03

(continued)

Table 11.18 (continued)

RESIDUALS ABOUT THE MODEL FIT

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

Age	1986	1987	1988	1989	1990	1991	1992	1993	
1	-.47287E+00	.64817E+00	.78623E+00	-.84528E+00	-.13114E+00	-.23476E+00	.82509E+00	.25053E+00	.10000E+00
2	.14264E+00	-.13177E+00	-.46127E-01	-.13394E-01	.38199E-01	.11629E+00	.39469E-01	-.92150E-01	.10000E+01
3	-.37749E-01	.46066E-01	-.16543E+00	-.32306E-01	.11383E-01	-.95504E-01	-.81105E-01	.27706E+00	.10000E+01
4	-.21034E+00	-.83691E-01	-.17296E+00	-.14120E+00	.21966E+00	.18571E+00	.19692E+00	.13134E-01	.10000E+01
5	-.10617E+00	.92074E-01	-.69160E-01	-.29181E-01	.31340E-01	-.61966E-01	.30045E-02	-.97273E-01	.10000E+01
6	.75838E-01	-.13206E+00	.15180E-12	-.24449E+00	-.18858E+00	.18006E+00	.15486E+00	.17034E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

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

Aged Index 1

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-.35295E+00	-.43941E+00	.64695E+00	-.10000E+01	.34220E-01	-.93458E+00	.15251E-01	.10305E+01
2	-.15076E+01	-.65387E+00	.42977E-01	-.10000E+01	-.21389E-01	.96471E+00	.31990E+00	.85528E+00
3	.99694E+00	-.10000E+01	-.72236E+00	-.10000E+01	.29076E+00	.79547E-01	-.37524E+00	-.26965E+00
4	.41946E+00	.49815E+00	-.69852E+00	-.10000E+01	-.30722E+00	.96830E+00	-.94143E+00	.61264E-01
5	.54118E+00	-.41490E+00	.10262E+01	-.10000E+01	-.20528E+00	-.53609E+00	-.28440E+00	-.12668E+00
6	-.51189E+00	-.14349E+01	-.16135E+00	-.10000E+01	-.77415E-01	.13380E+01	.50133E-01	.79745E+00

(continued)

Table 11.18 (continued)

Aged Index 2

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.16850E+00	-.26278E+00	.61923E-01	-.70192E-01	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.43976E+00
1	-.13853E+00	-.82139E-01	-.30119E+00	.21975E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.30232E+00
2	-.40181E+00	.29221E+00	-.51639E-01	.37628E-01	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.12390E+00
3	.32685E-02	.20770E+00	-.83584E+00	.13224E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.49300E+00
4	.20960E+00	.26935E+00	-.40743E+00	-.23411E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.16283E+00
5	-.42555E+00	.64735E+00	-.11172E+00	.78617E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.89608E+00
6	.26828E+00	.13753E+01	.10501E+00	-.32565E-02	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.17451E+01

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1986 to 1993

Variance : .1202
Skewness test statistic : 1.2476
Kurtosis test statistic : 4.5565
Partial chi-square : .2107
Probability of chi-square : 1.0000
Degrees of freedom : 25

(continued)

Table 11.18 (continued)

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age :	1	2	3	4	5	6
Variance :	.4455	.7445	.3640	.4723	.3241	.7969
Skewness test stat. :	.2747	-.6507	.5652	-.0591	1.0328	-.0521
Kurtosis test stat. :	-.4992	-.3395	-.3296	-.6769	-.3050	-.3110
Partial chi-square :	.6112	1.0047	.3330	.6057	.3635	.8049
Prob. of chi-square :	.9962	.9854	.9970	.9963	.9991	.9919
Number of data :	7	7	6	7	7	7
Degrees of freedom :	6	6	5	6	6	6
Weight in analysis :	1.0000	1.0000	1.0000	1.0000	1.0000	.0010

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

Age :	0	1	2	3	4	5	6
Variance :	.0749	.0641	.0666	.2506	.0910	.5084	1.2550
Skewness test stat. :	.7718	.1212	-.5661	-.9211	-.4409	-.0287	-.4888
Kurtosis test stat. :	-.2757	-.6980	-.2877	-.1215	-.7062	-.6876	-.2048
Partial chi-square :	.0375	.0321	.0349	.1435	.0582	.4467	2.4605
Prob. of chi-square :	.9998	.9999	.9998	.9975	.9996	.9785	.6517
Number of data :	5	5	5	5	5	5	5
Degrees of freedom :	4	4	4	4	4	4	4
Weight in analysis :	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 11.19. Outputs from ICA program (dome shaped, S=1.25 relative to age 2, older fish in the Spanish acoustic surveys included)

AGE - STRUCTURED INDICES

INDEX : 1 from 1986 to 1993

	1986	1987	1988	1989	1990	1991	1992	1993
1	.550E+02	.440E+02	.221E+03	-.100E+01	.690E+02	.250E+02	.159E+03	.242E+03
2	.210E+02	.360E+02	.630E+02	-.100E+01	.560E+02	.150E+03	.780E+02	.324E+03
3	.104E+04	-.100E+01	.720E+02	-.100E+01	.274E+03	.126E+03	.850E+02	.920E+02
4	.215E+03	.398E+03	.640E+02	-.100E+01	.550E+02	.314E+03	.290E+02	.830E+02
5	.409E+03	.118E+03	.858E+03	-.100E+01	.880E+02	.510E+02	.115E+03	.830E+02
6	.572E+03	.245E+03	.898E+03	-.100E+01	.445E+03	.588E+03	.125E+03	.744E+03

INDEX : 2 from 1984 to 1992

	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.296E+04	.206E+04	.249E+04	.372E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.464E+04
1	.573E+04	.274E+04	.161E+04	.238E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.594E+04
2	.115E+04	.455E+04	.167E+04	.134E+04	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.121E+04
3	.104E+04	.108E+04	.658E+03	.929E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.818E+03
4	.528E+03	.839E+03	.323E+03	.666E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.307E+03
5	.760E+02	.144E+03	.127E+03	.237E+03	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.380E+02
6	.400E+02	.610E+02	.500E+02	.490E+02	-.100E+01	-.100E+01	-.100E+01	-.100E+01	.100E+01

FISHING MORTALITY

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	.0468	.0886	.0722	.0484	.0711	.1067	.0085	.0525	.0136	.0407	.0676	.0710	.0636	.0632	.0672	.0389	.0414	.0412
1	.4750	.4781	.3929	.1983	.2395	.2647	.1255	.1155	.2628	.0963	.1444	.1516	.1358	.1350	.1436	.0831	.0883	.0879
2	.7391	.5624	.3891	.3456	.3804	.3899	.5179	.2258	.1562	.3525	.2656	.2788	.2498	.2484	.2641	.1529	.1624	.1617
3	.6423	.1271	.3723	.3664	.2601	.3265	.3158	.5186	.2297	.2589	.3430	.3601	.3227	.3208	.3411	.1974	.2098	.2089
4	1.8352	.1176	.2445	.5374	.2565	.2400	.3315	.2713	.4333	.2400	.3614	.3794	.3399	.3379	.3593	.2080	.2210	.2201
5	.8230	.3872	.3760	.3306	.2882	.3109	.2945	.2474	.2704	.6936	.2529	.3485	.3123	.3105	.3301	.1911	.2031	.2022
6	.8230	.3872	.3760	.3306	.2882	.3109	.2945	.2474	.2704	.6936	.2529	.3485	.3123	.3105	.3301	.1911	.2031	.2022

NUMBERS AT AGE (Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	10761.	11654.	14358.	15968.	14373.	11805.	8320.	24322.	9474.	7581.	7035.	12093.	7350.	8000.	8419.	20590.	13144.	2558.	6199.
1	5735.	7382.	7668.	9603.	10937.	9624.	7628.	5931.	16592.	6719.	5233.	4727.	8098.	4958.	5399.	5659.	14238.	9067.	1765.
2	3141.	2564.	3290.	3721.	5662.	6189.	5310.	4837.	3799.	9172.	4387.	3256.	2920.	5082.	3114.	3362.	3744.	9371.	5970.
3	614.	1078.	1051.	1603.	1894.	2782.	3013.	2274.	2774.	2336.	4635.	2418.	1771.	1635.	2850.	1719.	2075.	2288.	5731.
4	95.	232.	683.	520.	799.	1050.	1443.	1579.	973.	1585.	1296.	2365.	1213.	922.	853.	1457.	1015.	1209.	1335.
5	25.	11.	148.	384.	219.	444.	594.	745.	866.	454.	897.	649.	1163.	621.	473.	428.	851.	585.	698.
6	6.	4.	59.	149.	140.	331.	589.	739.	571.	233.	866.	672.	820.	798.	430.	175.	121.	421.	591.

Table 11.19 (continued)

STOCK SUMMARY

Year	Recruits	Total B	Spawn B	Landings	Yld/SSB
	x10^6	tonnes	tonnes	tonnes	
1976	10761.	244245.	161697.	141690.	.8763
1977	11654.	277953.	195088.	125750.	.6446
1978	14358.	350768.	255705.	139990.	.5475
1979	15968.	436111.	321203.	153441.	.4777
1980	14373.	550410.	411223.	191682.	.4661
1981	11805.	641084.	490883.	214133.	.4362
1982	8320.	644311.	500716.	204504.	.4084
1983	24322.	594410.	475125.	181139.	.3812
1984	9474.	696184.	520739.	202686.	.3892
1985	7581.	715898.	564265.	204107.	.3617
1986	7035.	686678.	557007.	180606.	.3242
1987	12093.	562128.	450684.	168825.	.3746
1988	7350.	539726.	422524.	158540.	.3752
1989	8000.	511347.	347240.	137126.	.3949
1990	8419.	462129.	325954.	139157.	.4269
1991	20590.	471441.	375231.	127756.	.3405
1992	13144.	753704.	581198.	126054.	.2169
1993	2558.	903631.	668807.	138795.	.2075

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year				
1	1986	.2656	.2179	.3238
2	1987	.2788	.2280	.3410
3	1988	.2498	.2020	.3089
4	1989	.2484	.1984	.3108
5	1990	.2641	.2092	.3333
6	1991	.1529	.1191	.1962
7	1992	.1624	.1254	.2104
8	1993	.1617	.1212	.2159
Separable Model: Selection (S) by age				
9	0	.2546	.1753	.3698
10	1	.5436	.4642	.6366
	2	1.0000	Fixed : Reference age	
11	3	1.2916	1.1295	1.4769
12	4	1.3607	1.1953	1.5489
	5	1.2500	Fixed : last true age	

Separable Model: Populations in year			1993	
13	0	2557611.	893767.	7318880.
14	1	9066914.	6385829.	12873650.
15	2	9370529.	7021072.	12506185.
16	3	2287977.	1744842.	3000180.
17	4	1209186.	920068.	1589154.
18	5	584783.	438455.	779945.
Separable Model: Populations at age 5				
19	1986	896541.3128	657942.1706	1221667.1334
20	1987	649352.6597	502095.5318	839798.1062
21	1988	1163297.0433	906314.4477	1493146.2412
22	1989	620627.5015	478524.5897	804929.3679
23	1990	472879.1854	363528.4554	615123.0272
24	1991	428169.7872	322806.4685	567923.4606
25	1992	850731.0682	644694.5235	1122614.3918

Age-structured index catchabilities
Age-Structured Index 1

Linear model fitted. Slopes at age:

26	1 Q	.14119E-04	.10291E-04	.19371E-04
27	2 Q	.21335E-04	.15572E-04	.29232E-04
28	3 Q	.81861E-04	.57922E-04	.11569E-03
29	4 Q	.10533E-03	.75232E-04	.14746E-03
30	5 Q	.26369E-03	.18419E-03	.37751E-03
31	6 Q	.13273E-02	.10610E-02	.16605E-02

Age-Structured Index 2

Linear model fitted. Slopes at age:

32	0 Q	.44329E-03	.30678E-03	.64055E-03
33	1 Q	.59569E-03	.41293E-03	.85935E-03
34	2 Q	.62401E-03	.43196E-03	.90147E-03
35	3 Q	.55902E-03	.38576E-03	.81010E-03
36	4 Q	.64276E-03	.44087E-03	.93710E-03
37	5 Q	.26855E-03	.18256E-03	.39503E-03
38	6 Q	.11201E-03	.76862E-04	.16324E-03

Table 11.19 (continued)

RESIDUALS ABOUT THE MODEL FIT

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

Age	1986	1987	1988	1989	1990	1991	1992	1993	
1	-.50042E+00	.48825E+00	.37057E+00	-.78439E+00	-.15521E+00	-.36429E+00	.68343E+00	-.33202E+00	.10000E+0
2	-.10052E+00	-.19041E+00	-.20970E+00	-.11140E+00	.40273E-01	.10753E+00	-.53115E-01	.19457E-01	.10000E+01
3	.84494E-02	.82189E-01	-.17047E+00	-.44677E-01	-.68604E-01	-.12072E-01	-.55831E-01	.33043E+00	.10000E+01
4	-.21866E+00	-.94059E-01	-.23964E+00	-.40649E-01	.21635E+00	.21727E+00	.26998E+00	.16865E+00	.10000E+01
5	-.90140E-02	.36495E+00	.88294E-01	.12147E+00	.24007E-01	-.42255E-01	-.12696E+00	-.59296E-01	.10000E+01
6	.14831E-01	-.21499E+00	.37232E-12	-.14801E+00	-.13030E+00	.30640E+00	.17976E+00	.19118E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

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

Aged Index 1

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	-.15754E+00	-.27698E+00	.79411E+00	-.10000E+01	.37715E-01	-.10421E+01	-.11320E+00	.75798E+00
2	-.13217E+01	-.48082E+00	.17920E+00	-.10000E+01	.12257E-02	.87768E+00	.11904E+00	.62542E+00
3	.12034E+01	-.10000E+01	-.51078E+00	-.10000E+01	.35529E+00	.42256E-01	-.53559E+00	-.55462E+00
4	.65447E+00	.67444E+00	-.49681E+00	-.10000E+01	-.29094E+00	.87200E+00	-.11445E+01	-.26866E+00
5	.71720E+00	-.17554E+00	.12148E+01	-.10000E+01	-.15710E+00	-.64361E+00	-.51360E+00	-.46509E+00
6	-.52893E+00	-.10951E+01	-.63534E-02	-.10000E+01	-.58330E-01	.10823E+01	-.93669E-01	.44067E+00

Aged Index 2

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.48492E-01	-.16172E+00	.12599E+00	-.13831E-01	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.98611E-01
1	-.23009E-01	-.23385E-02	-.24196E+00	.25520E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.12643E-01
2	-.29371E+00	.37069E+00	.29893E-01	.12247E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.22870E+00
3	.89961E-01	.33105E+00	-.77841E+00	.23221E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	.12595E+00
4	.50186E+00	.30725E+00	-.33930E+00	-.20087E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.26853E+00
5	-.58964E+00	.10676E+01	-.12665E+00	.90394E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.13247E+01
6	.59805E-01	.17512E+01	-.14982E+00	.16813E+00	-.10000E+01	-.10000E+01	-.10000E+01	-.10000E+01	-.21352E+01

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1986 to 1993

Variance	:	.1400
Skewness test statistic	:	1.4621
Kurtosis test statistic	:	3.7184
Partial chi-square	:	.2473
Probability of chi-square	:	1.0000
Degrees of freedom	:	25

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6
Variance	:	.4011	.5310	.4863	.5595	.4900	.4745
Skewness test stat.	:	-.1698	-.7498	.8594	-.1931	.9352	-.0645
Kurtosis test stat.	:	-.3713	-.1851	-.3034	-.6952	-.4253	-.2647
Partial chi-square	:	.5409	.7307	.4493	.7108	.5601	.4775
Prob. of chi-square	:	.9973	.9938	.9939	.9943	.9970	.9981
Number of data	:	7	7	6	7	7	7
Degrees of freedom	:	6	6	5	6	6	6
Weight in analysis	:	1.0000	1.0000	1.0000	1.0000	1.0000	5.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

Age	:	0	1	2	3	4	5	6
Variance	:	.0136	.0311	.0730	.1983	.1435	1.0186	1.9153
Skewness test stat.	:	-.2238	.1138	.2007	-1.2135	.4173	-.1429	-.4184
Kurtosis test stat.	:	-.5672	-.2377	-.5848	.0170	-.7287	-.6593	-.2012
Partial chi-square	:	.0069	.0164	.0382	.1116	.0952	.8987	3.4489
Prob. of chi-square	:	1.0000	1.0000	.9998	.9985	.9989	.9248	.4857
Number of data	:	5	5	5	5	5	5	5
Degrees of freedom	:	4	4	4	4	4	4	4
Weight in analysis	:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Sardine in Fishing Areas VIIIc and IXa

Yield per recruit: Summary table (dome shaped, S = 1.25 and F1991-1993)

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0	0	34794827	1220990	21994759	1135593	20253025	1045667
0.1000	0.0159	300579	18195	33892604	1159069	21112606	1074415	19374136	985406
0.2000	0.0318	571726	34125	33079469	1103799	20319299	1019876	18584088	931758
0.3000	0.0477	817919	48156	32341853	1054153	19601274	970950	17869319	883695
0.4000	0.0636	1042766	60581	31668825	1009302	18947606	926807	17218906	840392
0.5000	0.0795	1249205	71638	31051479	968574	18349394	886776	16623950	801178
0.6000	0.0954	1439656	81522	30482486	931414	17799313	850303	16077129	765499
0.7000	0.1113	1616127	90394	29955760	897363	17291283	816928	15572364	732898
0.8000	0.1272	1780300	98388	29466207	866037	16820212	786268	15104565	702991
0.9000	0.1431	1933594	105615	29009527	837111	16381808	757998	14669441	675455
1.0000	0.1590	2077213	112170	28582070	810312	15972423	731845	14263346	650018
1.1000	0.1749	2212189	118134	28180714	785404	15588939	707574	13883162	626446
1.2000	0.1908	2339407	123575	27802773	762185	15228675	684982	13526211	604537
1.3000	0.2067	2459635	128551	27445927	740483	14889315	663898	13190175	584119
1.4000	0.2226	2573539	133115	27108157	720145	14568842	644169	12873041	565042
1.5000	0.2385	2681699	137309	26787701	701039	14265499	625665	12573051	547175
1.6000	0.2544	2784629	141171	26483013	683052	13977744	608269	12288663	530403
1.7000	0.2703	2882776	144736	26192731	666080	13704218	591882	12018519	514626
1.8000	0.2862	2976539	148033	25915650	650035	13443719	576413	11761419	499755
1.9000	0.3021	3066271	151086	25650702	634837	13195183	561783	11516297	485712
2.0000	0.3180	3152286	153919	25396935	620416	12957659	547922	11282204	472426
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YRDOMED
Date and time : 30JUN94:15:24
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : Not found
F-max factor : Not found
F-0.1 reference F : Not found
F-max reference F : Not found
Recruitment : 9780 (Millions)

Table 11.20b

Yield per recruit: Summary table (flat, S = 1.0; F1991-1993)

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0	0	24263877	851447	15336387	791862	14121921	729156
0.1000	0.0381	458498	27258	22888245	757706	13991397	699327	12779678	638149
0.2000	0.0761	830681	48064	21773670	683289	12906454	626063	11697633	566306
0.3000	0.1142	1140064	64304	20848920	622820	12010386	566697	10804616	508266
0.4000	0.1522	1402287	77217	20066629	572734	11255885	517668	10053314	460478
0.5000	0.1903	1628156	87645	19394073	530574	10610279	476522	9411056	420497
0.6000	0.2283	1825379	96177	18807918	494597	10050280	441519	8854549	386591
0.7000	0.2664	1999602	103237	18291072	463530	9558844	411387	8366745	357494
0.8000	0.3044	2155060	109136	17830731	436423	9123204	385180	7934873	332267
0.9000	0.3425	2294986	114107	17417110	412555	8733615	362179	7549182	310195
1.0000	0.3806	2421899	118326	17042600	391368	8382503	341827	7202093	290727
1.1000	0.4186	2537784	121930	16701196	372423	8063896	323688	6887628	273430
1.2000	0.4567	2644234	125026	16388094	355372	7773019	307416	6601006	257963
1.3000	0.4947	2742538	127698	16099402	339935	7506009	292731	6338359	244050
1.4000	0.5328	2833751	130013	15831935	325885	7259708	279409	6096521	231467
1.5000	0.5708	2918748	132026	15583059	313034	7031505	267262	5872877	220031
1.6000	0.6089	2998259	133782	15350576	301227	6819226	256138	5665246	209591
1.7000	0.6469	3072897	135316	15132638	290335	6621043	245909	5471794	200021
1.8000	0.6850	3143183	136660	14927677	280250	6435409	236466	5290968	191216
1.9000	0.7230	3209563	137837	14734356	270879	6261004	227718	5121444	183085
2.0000	0.7611	3272420	138870	14551525	262144	6096698	219590	4962084	175553
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YPR
Date and time : 30JUN94:19:07
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.1406
F-max factor : Not found
F-0.1 reference F : 0.4341
F-max reference F : Not found
Recruitment : 6820 (Millions)

Table 11. 21. SARDINE IN DIV. VIIIc AND IXa

PREDICTIONS

Recruitm.=GM Age 0, 1984-1992
FBAR(Ages 2-5)

OPTION A (S=1.25 dome shaped) F(1993)=.1982 F(1991-93)=.159

Fsq\YIELD('000t)	**19 95**	
	F(1993)	F(91-93)
F(1993)	154	121
F(1991-1993)	160	127

Fsq\SSB ('000 t)	**19 95**		**19 96**	
	F(1993)	F(91-93)	F(1993)	F(91-93)
F(1993)	688	694	667	689
F(1991-1993)	714	720	686	708

OPTION B (S=1.0 flat) F(1993)=.4313 F(1991-1993)= .3806

Fsq\YIELD('000t)	**19 95**	
	F(1993)	F(91-93)
F(1993)	142	128
F(1991-1993)	147	132

Fsq\SSB ('000 t)	**19 95**		**19 96**	
	F(1993)	F(91-93)	F(1993)	F(91-93)
F(1993)	309	312	289	299
F(1991-1993)	319	323	299	309

Table 11.22a

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table: Input data (Option A; dome sloped, S = 1.25)

Year: 1994 $F_{1994} = F_{1991-1993}$								
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	9780.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0405	0.018
1	7327.000	0.3300	0.6670	0.2500	0.2500	0.023	0.0864	0.038
2	5970.000	0.3300	0.9167	0.2500	0.2500	0.041	0.0156	0.055
3	5731.000	0.3300	0.9500	0.2500	0.2500	0.052	0.2054	0.062
4	1335.000	0.3300	0.9733	0.2500	0.2500	0.063	0.2164	0.070
5	698.000	0.3300	0.9967	0.2500	0.2500	0.071	0.1988	0.075
6+	591.000	0.3300	1.0000	0.2500	0.2500	0.076	0.1988	0.084
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

~~Sardine in fishing Areas VIIIc and IXa~~

Prediction with management option table: Input data

Year: 1994 $F_{1994} = F_{1993}$								
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	9780.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0412	0.018
1	7327.000	0.3300	0.6670	0.2500	0.2500	0.023	0.0879	0.038
2	5970.000	0.3300	0.9167	0.2500	0.2500	0.041	0.1617	0.055
3	5731.000	0.3300	0.9500	0.2500	0.2500	0.052	0.2089	0.062
4	1335.000	0.3300	0.9733	0.2500	0.2500	0.063	0.2201	0.070
5	698.000	0.3300	0.9967	0.2500	0.2500	0.071	0.2022	0.075
6+	591.000	0.3300	1.0000	0.2500	0.2500	0.076	0.2022	0.084
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Table 11.22b

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table (Option A, dome shaped, S = 1.25)

Year: 1994 $F_{94} = F_{1991-93}$					Year: 1995 $F_{1995} = F_{1993}$					Year: 1996	
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	0.1591	889882	708781	117804	1.0000	0.1982	897105	714048	159599	852254	686026
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{93}$					Year: 1995 $F_{95} = F_{1991-93}$					Year: 1996	
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	0.1982	889882	701009	157199	1.0000	0.1590	865695	694360	121324	855800	688578
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{1991-93}$					Year: 1995 $F_{95} = F_{1991-93}$					Year: 1996	
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	0.1591	889882	708781	117804	1.0000	0.1591	897105	720466	127221	878095	707519
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{93}$					Year: 1995 $F_{95} = F_{93}$					Year: 1996	
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	0.1982	889882	701009	157199	1.0000	0.1982	865695	687969	153578	830063	667172
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : DOMED3
Date and time : 29JUN94:15:21
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1994 : F factors

Table 11.22c

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table (Option A)

Year: 1994 $F_{94} = F_{1991-93}$					Year: 1995					Year: 1996	
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	0.1590	889882	708787	117785	0.0000	0.0000	897120	747786	0	987752	831140
.	.	.	.	.	0.2000	0.0318	.	742218	27180	964257	804248
.	.	.	.	.	0.4000	0.0636	.	736705	53457	941577	778496
.	.	.	.	.	0.6000	0.0954	.	731245	78866	919680	753828
.	.	.	.	.	0.8000	0.1272	.	725838	103439	898536	730193
.	.	.	.	.	1.0000	0.1590	.	720483	127208	878117	707542
.	.	.	.	.	1.2000	0.1908	.	715181	150203	858394	685827
.	.	.	.	.	1.4000	0.2226	.	709929	172453	839340	665006
.	.	.	.	.	1.6000	0.2544	.	704728	193986	820930	645035
.	.	.	.	.	1.8000	0.2862	.	699578	214829	803139	625875
.	.	.	.	.	2.0000	0.3180	.	694477	235007	785944	607487
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table

Year: 1994 $F_{94} = F_{93}$					Year: 1995					Year: 1996	
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	0.1982	889882	701009	157199	0.0000	0.0000	865695	720299	0	960421	806637
.	.	.	.	.	0.2000	0.0396	.	713707	32831	932465	774868
.	.	.	.	.	0.4000	0.0793	.	707179	64565	905488	744512
.	.	.	.	.	0.6000	0.1189	.	700714	95242	879452	715503
.	.	.	.	.	0.8000	0.1586	.	694311	124900	854322	687778
.	.	.	.	.	1.0000	0.1982	.	687969	153578	830063	661275
.	.	.	.	.	1.2000	0.2379	.	681689	181311	806643	635938
.	.	.	.	.	1.4000	0.2775	.	675470	208134	784029	611711
.	.	.	.	.	1.6000	0.3172	.	669310	234080	762192	588543
.	.	.	.	.	1.8000	0.3568	.	663210	259182	741103	566383
.	.	.	.	.	2.0000	0.3965	.	657169	283469	720733	545186
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : DOMED6
Date and time : 29JUN94:16:33
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1994 : F factors

Table 11.23a

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table: Input data (Option B; flat, S = 1.0)

Year: 1994 $F_{94} = F_{1991-93}$								
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	6820.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0781	0.018
1	4487.000	0.3300	0.6667	0.2500	0.2500	0.023	0.1592	0.038
2	3047.000	0.3300	0.9167	0.2500	0.2500	0.041	0.2665	0.055
3	3014.000	0.3300	0.9500	0.2500	0.2500	0.052	0.4158	0.062
4	580.000	0.3300	0.9733	0.2500	0.2500	0.063	0.4241	0.070
5	283.000	0.3300	0.9967	0.2500	0.2500	0.071	0.4158	0.075
6+	221.000	0.3300	1.0000	0.2500	0.2500	0.076	0.4158	0.084
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

$F_{94} = F_{93}$								
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	6820.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0888	0.018
1	.	0.3300	0.6667	0.2500	0.2500	0.023	0.1805	0.038
2	.	0.3300	0.9167	0.2500	0.2500	0.041	0.3020	0.055
3	.	0.3300	0.9500	0.2500	0.2500	0.052	0.4712	0.062
4	.	0.3300	0.9733	0.2500	0.2500	0.063	0.4807	0.070
5	.	0.3300	0.9967	0.2500	0.2500	0.071	0.4712	0.075
6+	.	0.3300	1.0000	0.2500	0.2500	0.076	0.4712	0.084
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Table 11.23b

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table (Option B, flat, S = 1.0)

Year: 1994 $F_{94} = F_{1991-93}$					Year: 1995 $F_{95} = F_{1991-93}$					Year: 1996	
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	0.3806	457914	343115	141431	1.0000	0.3806	431413	322971	131860	412616	308554
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{1991-93}$					Year: 1995 $F_{95} = F_{93}$					Year: 1996	
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	0.3806	457914	343115	141431	1.0000	0.4313	431413	319458	146686	400018	298646
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{93}$					Year: 1995 $F_{95} = F_{1991-93}$					Year: 1996	
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	0.4313	457914	339379	157307	1.0000	0.3806	417956	312408	127682	404395	298686
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 $F_{94} = F_{93}$					Year: 1995 $F_{95} = F_{93}$					Year: 1996	
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	0.4313	457914	339379	157307	1.0000	0.4313	417956	309027	142055	392171	289199
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : FLAT
Date and time : 29JUN94:09:50
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1994 : F factors

Table 11.23c

Sardine in Fishing Areas VIIIc and IXa

Sardine in Fishing Areas VIIIc and IXa

Prediction with management option table (Option B, flat, S = 1.0)

Year: 1994 F94 = F1991-93					Year: 1995					Year: 1996	
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	0.3806	457914	343115	141431	0.0000	0.0000	431413	350719	0	525541	432690
.	.	.	.	.	0.2000	0.0761	.	344966	29664	500003	403621
.	.	.	.	.	0.4000	0.1522	.	339317	57566	476049	376866
.	.	.	.	.	0.6000	0.2283	.	333770	83826	453568	352223
.	.	.	.	.	0.8000	0.3044	.	328322	108556	432455	329508
.	.	.	.	.	1.0000	0.3806	.	322971	131860	412616	308554
.	.	.	.	.	1.2000	0.4567	.	317717	153833	393963	289210
.	.	.	.	.	1.4000	0.5328	.	312556	174566	376414	271338
.	.	.	.	.	1.6000	0.6089	.	307488	194141	359893	254813
.	.	.	.	.	1.8000	0.6850	.	302510	212634	344331	239520
.	.	.	.	.	2.0000	0.7611	.	297621	230117	329663	225356
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Prediction with management option table

Year: 1994 F94 = F93					Year: 1995					Year: 1996	
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	0.4313	457914	339379	157307	0.0000	0.0000	417956	339110	0	513818	422182
.	.	.	.	.	0.2000	0.0863	.	332845	32408	485905	390455
.	.	.	.	.	0.4000	0.1725	.	326706	62658	459930	361556
.	.	.	.	.	0.6000	0.2588	.	320692	90917	435741	335209
.	.	.	.	.	0.8000	0.3450	.	314800	117336	413198	311164
.	.	.	.	.	1.0000	0.4313	.	309027	142055	392171	289199
.	.	.	.	.	1.2000	0.5175	.	303370	165204	372544	269113
.	.	.	.	.	1.4000	0.6038	.	297827	186898	354209	250727
.	.	.	.	.	1.6000	0.6900	.	292396	207248	337066	233878
.	.	.	.	.	1.8000	0.7763	.	287074	226351	321025	218421
.	.	.	.	.	2.0000	0.8626	.	281859	244300	306004	204227
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : FLAT
Date and time : 29JUN94:09:50
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1994 : F factors