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

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1 INTRODUCTION

1.1 Terms of Reference

At the 82nd ICES Statutory Meeting in St John's, Canada in 1994, it was decided (C.Res.1994/2:6:13) that the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (Chairperson: Ms Carmela Porteiro) will meet at ICES Headquarters from 10-19 October 1995 to:

a) assess the status of and provide catch options for 1996 and 1997 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 1996 for the sardine stock in Divisions VIIIc and IXa, and the anchovy stocks in Sub-area VIII and Division IXa;

c) provide data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1994 by statistical rectangle of the North Sea for mackerel and horse mackerel);

d) for those stocks and/or fisheries where data permit, provide the information required to give advice or guidance on i) medium-term management objectives (in terms of spawning stock biomass and mortality rates) and options, ii) the appropriateness of controls on catch (or landings) and fishing effort; iii) the potential for multispecies and multi-annual catch options;

e) analyse the mackerel and hose mackerel data from the quarterly International Bottom Trawl Surveys of the North Sea and Division IIIa and evaluate the potential usefulness or the surveys in assessments.

1.2 Participants

The Working Group met in Copenhagen with the following participants:

Pablo Abaunza	Spain
Fátima Borges	Portugal
Pablo Carrera	Spain
Chris Darby	UK (England)
Guus Eltink	Netherlands
Svein Iversen	Norway
John Molloy	Ireland
Alberto Murta	Portugal
John Nichols	UK (England)
Kenneth Patterson	UK (Scotland)
Graça Pestana	Portugal
Carmela Porteiro (Chairperson)	Spain
Patrick Prouzet	France
Beatriz Roel	UK
Dankert Skagen	Norway
Karl-Johan Stæhr	Denmark
Andrés Uriarte	Spain
Begoña Villamor	Spain

1.3 Medium-Term Projections and Risk Analysis

1.3.1 Interpretation

The general understanding of the term medium term prediction is that it covers the range of years where the development of the stock is influenced both by the presumably known present state of the stock, and unknown future events. At most, this corresponds to the life span of the species in question. It is also a common understanding that, because of the influence by unknown future events, the prediction should be made with a stochastic model, and the results expressed as distributions rather than absolute values. To make these distributions more realistic, the uncertainty of the starting values representing the present state of the stock should also be accounted for.

Both the time range and the presentation of the results will to a large extent depend on the purpose of the analysis.

The main purpose for the present analysis is to estimate the likely development of the stock some years ahead, in order to evaluate the effect of the present, and alternative management regimes. For this purpose, the time horizon of interest is somewhat shorter than the life span of the species, and the results of interest will mainly be the distributions of stock biomasses, catches and fishing mortalities, and the probability (risk) of these variables passing certain levels. Therefore, the Working Group has used a range of 10 years for the mackerel and horse mackerel.

Risk analysis in a narrower sense is interpreted as demonstrating the uncertainty in short term predictions.

1.3.2 Theory and limitations

Medium term projections were made with a stock projection model used in a Monte-Carlo regime with random input data. A medium term prediction was attempted by this Working Group in 1994 using a somewhat different approach. The present method is described (Patterson, 1995) WD

The method is a pure projection model, without any modelled feedback on the management measures, and no simulations of future assessments. Basically, it is a translation of the assumed values and distributions of the input data to values and distributions of the output.

Initial stock numbers at age and fishing mortalities at age and estimates of their variances and covariances are taken from the preceding assessment, which can be ICA

or XSA. Recruitments in previous years are also taken from this assessment. Weights at age in the catch and in the stock, maturity ogive, fractions of F and M before spawning and natural mortality are all taken from the input data for the assessment.

By the Monte-Carlo approach, a large number of projections are made, each with a set of input data and parameters which are drawn randomly from their assumed distributions. In the present model, the following are treated as stochastic variables:

1. Initial numbers at age and fishing mortalities at age. Since these are interdependent, initial numbers and fishing mortalities for all ages are treated as having a multivariate distribution, characterized by the means and a common covariance matrix. These covariances are estimated by the ICA procedure, while the XSA can only provide variance estimates.

2. Recruitment. The approach taken here is to estimate parameters in a stock recruitment function (e.g. the Beverton-Holt equation) from spawning stock and recruitment estimates from the assessment. The residuals in this regression are used as a collection of random numbers, representing the unpredictable component of the yearly recruitments. For each year, the value of this function for the predicted SSB is computed. Then, a number drawn from the collection of residuals is added.

3. Weights at age in the stock are assumed to be lognormally distributed, and the parameters of these distributions are estimated from the historical data.

4. Maturity ogive is treated as a stochastic variable, assuming that the arc-sine of the square root of the maturity at age is normally distributed. Again, the distribution parameters are derived from historical data.

The parameters which are not treated as random variables are the natural mortality, the catch weights at age and the partial fishing mortalities as a fraction of the total fishing mortality. Variations in the natural mortality would be in conflict with the assumptions underlying the assessment methods used.

The management regime can be either a constraint on the fishing mortality (which has to be expressed as a multiplier of the reference level) or on the catch. The model can handle several fleets with separate management rules.

Thus, the model takes into consideration both uncertainty of the initial values in the prediction, and of parameters that influence the development of the stock state over time. There are some limitations to the sources of error that are included, however.

The variances and covariances estimated through the assessment essentially express the discrepancy between the model and the observed data. This may be due to inappropriateness of the model applied in the assessment, or to measurement noise in the input data for the assessment. It is not an independent measure of the noise in the data, but rather a measure of how well the model is fitted to the data, including the noise in the input data. External estimates of the uncertainty of the input data (e.g. in catches at age etc.) can be entered as weighting factors in the assessment, at least in the ICA, and will in turn be conveyed to the covariance matrix of the stock numbers and fishing mortalities. However, to take the effect of errors in age readings, weights at age etc. fully into account would require an extensive evaluation of their effect throughout the whole assessment process, which is not part of the routine assessment programs.

Several approaches have been suggested for the stochastic modelling of future recruitments. The simplest alternative is to assume some stochastic variation around a long term average, without taking possible stock-recruitment relations into account. The argument in favour of this is that a statistically significant effect of the SSB on the recruitment only has been found in a very few stocks. The second alternative, which is the one used here, is to assume variation around a parametric stock-recruitment function. With the present method, the distribution of this variation is represented by the residuals. By this, problems with finding an appropriate parametric distribution function are avoided. However, this distribution will be appropriate only if the assumed stock - recruitment function gives an unbiased estimate of the recruitment, which should be checked thoroughly. The third approach is the kernel method, by which recruitments are drawn from the historical ones, with a higher probability for those generated by an SSB close to the present SSB. This might be an alternative if there are problems with finding an appropriate parametric stock-recruitment function.

Whatever method is used, it is important to stress that very little is known about the expected recruitment outside the range of SSB's that have been experienced for the stock in question. Projections which lead outside this range should be treated with caution, because they reflect dynamics that are only assumed, and to a large extent dependent on the choice of stock-recruitment function. Unless collapse of the stock has been experienced, no model can predict the risk of a future collapse. Thus, if the risk of bringing the stock biomass below some level is to be evaluated, it would be preferable to express it as the probability of passing that level at least once, rather than on the fraction of the trajectories being below.

The uncertainty assumed for the initial data reflect how well the model fits the data. The uncertainty of the recruitment is only the year to year variation of the re-

cruitment estimates around a modelled value, without taking the uncertainty of the estimated recruitments and the corresponding biomasses into account. In particular if there are strong correlations between the initial numbers at age, the variance of the stock size, and consequently of the fishing mortality and/or the catches may be considerably larger in the first prediction years than in the subsequent years.

For the mackerel, attempting to include trawl survey data in the assessment led to very large variances in the estimates of the initial stock numbers. The reason for this is not entirely clear, but may be due to the problem of finding an appropriate model for the relation between these indices and the stock size. The most appropriate model available was the power model, where the two parameters turned out to be closely correlated ($r>0.999$). Thus, the population model in that case is overparameterized. Even though none of these parameters are used in the prediction, the covariances of those which are used may also be affected.

1.3.3 Implementation

A medium-term projection programme implementing the method described in the foregoing section was available to the Working Group. Detailed documentation is available in Patterson (WD, 1995). The projection calculations were tested by comparison with detailed output from the IFAP multifleet projection programme and found to agree closely. Some problems were encountered in interfacing the programme with XSA output, which should be corrected in due course.

1.4 Evaluation of the Quarterly IBTS Surveys

The Working Group was asked to evaluate the potential usefulness of the mackerel and horse mackerel data from the quarterly International Bottom Trawl Surveys of the North Sea and Division IIIa for assessment purposes.

This evaluation was not carried out, because at the time of the Working Group meeting the mackerel data for the full time series (1991-1995) were not complete and the horse mackerel data were not available.

This question of evaluating the usefulness of the quarterly IBTS surveys for assessment purposes will be considered at the next meeting of the IBTS Working Group in November 1995. Following a possible recommendation to be made by the IBTS Working Group an evaluation might be carried out in future when, for both mackerel and horse mackerel, all data will be available for the whole time series.

1.5 Quality and Adequacy of Fishery and Sampling Data

1.5.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. A short summary of the data, similar to that presented to the 1993 and 1994 Working Group is shown for each stock species. The overall sampling intensity is similar in recent years in all species. Intensive samplings carried out by Spain and Portugal on nearly all their fisheries. On the other hand, sampling is very low on some of the very large fisheries carried out by other countries, particularly in the Northern areas. In these areas some countries who have quite large fisheries do not carry out any sampling programmes whatsoever.

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

Mackerel

Year	Total catch	Total catch sampled	Samples	Measured	Aged
1994	822,000	657,000	807	72,541	13,360
1993	825,000	688,400	890	80,411	12,922
1992	760,000	645,000	792	77,000	11,800

In mackerel, although over 79% of the total mackerel catch appears to be covered by sampling there are a number of fisheries which are not covered by sampling programmes or where the sampling intensity is very low, e.g. the fisheries carried out by Denmark, Germany, France, the Faroes and Sweden. In addition, a large proportion of the Irish catch, taken in Division IVa, is very poorly sampled. The summarized details of the more important mackerel catching countries are shown in the following table:

Country	Catch	Catch sampled	Samples	Measured	Aged
Norway	259,000	255,400	181	15,983	1,727
UK (Scotland)	187,800	177,400	92	7,949	3,103
Ireland	90,000	75,000	36	4,949	2,938
Netherlands	53,600	50,300	86	6,806	2,124
UK (Engl. + Wales)	50,000	16,700	50	6,407	-
Denmark	50,000	28,600	20	825	888
Russia	28,000	23,200	12	10,112	535
Spain	27,000	27,000	153	9,531	1,380
Germany	26,500	1,200	9	1,264	131
Faroes	21,600	-	-	-	-
France	11,600	-	-	-	-
Sweden	7,100	-	-	-	-
Portugal	2,200	2,200	181	8,715	534
Others	8,000	-	-	-	-
Total	**822,400**	**657,000**	**807**	**72,541**	**13,360**

Horse Mackerel

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

Year	Total catch	Total catch sampled	Samples	Measured	Aged
1994	447,153	272,100	1,453	134,269	6,571
1993	504,190	379,000	1,178	158,954	7,476
1992	436,500	195,450	1,803	158,447	5,797

During 1994, detailed sampling of the horse mackerel was still at a very low level. The only countries that carry out comprehensive sampling programmes are the Netherlands, Portugal and Spain. Other countries that have substantial fisheries carry out little or no sampling programme and the overall sampling level of horse mackerel continues to be very unsatisfactory.

The following table shows the most important horse mackerel countries and summarized details of their sampling programmes in 1994:

Country	Catch	Catch sampled	Samples	Measured	Aged
Netherlands	119,400	119,400	118	13,901	2,940
Norway	94,700	94,000	9	948	316
Ireland	81,000	-	-	-	-
Spain	34,800	34,800	506	38,462	530
Germany	17,200	-	-	-	-
Portugal	19,000	19,000	809	80,000	2,785
Denmark	45,800	-	-	-	-
UK (Scotland	18,400	-	-	-	-
UK (England + Wales)	13,700	4,800	11	958	-
Others	3,000	-	-	-	-

Sardines

The sampling programmes carried out on Sardines in 1994 was very similar to that of 1992 and 1993 and is summarized as follows:

Year	Total catch	Catch sampled	Samples	Measured	Aged
1994	162,900	134,700	748	63,788	4,253
1993	149,600	143,200	813	68,225	4,821
1992	164,000	130,000	788	66,346	4,086

In general, the overall sampling intensity seems to be very satisfactory and good coverage appears to be maintained throughout the year. No sampling is carried out by France who in 1994 took over 7,000 tonnes of sardine from Sub-area VIII, nor by Denmark who took 20,700 t mainly from Division VIId.

The summarized details of individual sampling programmes are shown below:

Country	Catch	Catch sampled	Samples	Measured	Aged
Portugal	94,500	94,500	366	24,674	2,729
Spain	38,300	38,300	378	38,630	1,524
Denmark	20,700	-	-	-	-
France	7,500	-	-	-	-
UK (England)	1,900	1,900	4	404	-

Anchovy

The sampling programmes carried out on anchovy in 1994 are summarized below. The sampling levels are very similar to those of 1992 and 1993 although the number of fish aged has decreased considerably. However, sampling is stratified and appears to be satisfactory.

Year	Total catch	Catch sampled	Samples	Measured	Aged
1994	34,600	34,400	281	17,111	2,923
1993	39,700	39,700	323	21,113	6,563
1992	40,800	37,700	289	17,112	3,805

Small catches of anchovy are occasionally taken by Portugal but are not subject to a sampling programme.

The sampling data from France and Spain, who together take most of the catch are summarized below:

Country	Catch	Catch sampled	Samples	Measured	Aged
France	16,900	16,900	51	1,860	718
Spain	17,500	17,500	230	15,251	2,205
Portugal	200	-	-	-	-

1.5.2 Catch data for mackerel

Previous Working Groups have constantly expressed concern about the possibility of serious underestimation of catches of mackerel, particularly in those catches reported from the Northern fisheries in Divisions IIa, IVa, VIa, and Sub-area VII. These concerns are based on confidential information received from the industry. No attempts have, however, been made by the Working Groups to correct many of the reported catch data because of the lack of precise information. Therefore the effect that this underreporting may have on the accuracy of the stock assessment cannot be quantified. In the way the present assessment is done, i.e. by fitting the modelled biomass to the egg survey results, the likely effect of underreporting catches would be that the fishing mortalities in the most recent years would be underestimated and that the stock sizes and recruitments would be underestimated in earlier years. It is important that this problem should be further investigated, preferably in a working document to be submitted to the next meeting of the Working Group.

The Working Group therefore recommends that all countries should seriously examine the method by which the national catch statistics are collected. In particular the tolerance level of 20% permitted by EU

regulations should be examined. If discrepancies are found to exist then adjusted catch figures should be presented to the next meeting of the Working Group.

Large amounts of mackerel catches continue to be reported to wrong areas, particularly between Divisions IIa and IVa and between Divisions IVa and VIa. The Working Group is able to reallocate these catches at present on the basis of information from fishermen and the area misreporting does not affect the quality of the assessment at present. However, this may not always be the case, particularly if the North Sea stock recovers to the extent to where it is again subject to a separate assessment.

There is, however, concern about the possible misreporting of species in the northern areas because of quota restrictions. Reports from the fisheries suggest that mackerel may be reported as horse mackerel.

1.5.3 Fleet data

In 1993, the Working Group expressed concern that insufficient information was available about changes that may be taking place in the various national fleets. It was, therefore, decided that data should be collected about the different national fleets, particularly in relation to the introduction of new technical equipment and the improvement or increase in size of fishing nets. It was felt that important information from the fisheries was being lost without which it was difficult to determine changes in fish abundance. A certain amount of information on abundance was previously available from fluctuations in catches. However, this is not the case now because of the imposition of TACs and boat quotas. Decreases in stocks may therefore be difficult to detect because of rapid changes in efficiency. The Working Group therefore feels that data on fleet size and composition, e.g., size of vessels, type of vessel, overall horse power, size etc., should be updated each year. It is particularly important to note the introduction of new technical innovations which can revolutionize catching methods and may influence exploitation patterns, e.g., the use of extremely powerful and sensitive sonar systems, the ability of modern vessels within the last two years to use trawls whose mouth openings are >65 m, the introduction of dynaema as a netting material, the introduction of "graders" on board large vessels, the increased carrying capacity of vessels now compared with similar sized vessels some years ago. The collection of such data should enable the development of the fisheries to be more easily understood in future years. Some summary data for various fleets are shown in Table 1.5.1.

1.5.4 Discards

Discarding of small mackerel has historically been a major problem in the mackerel fishery and was largely responsible for the introduction of the "Cornwall Box". In the years prior to 1996 there was evidence of large-scale discarding and slipping of small mackerel in the fisheries in Division IIa and Sub-area IV, mainly because of the very high prices paid for larger mackerel (>600 g). This factor was put forward as a possible factor in the very low abundance of the 1991 year class in the 1993 catches in numbers at age. The Working Group is, therefore, concerned that a high level of discards may still exist, although reports from the 1994 fishery suggest that, because of very high prices paid for all mackerel, discarding in this year at any rate may be quite small. At present, only one country (the Netherlands) supply information on levels of discards based on observers. Some information is available about by-catch of mackerel from the Irish summer and autumn herring and horse mackerel fisheries. An EU programme carried out by Spain studied the rate of discards of all species taken by the Spanish fleets, fishing in Sub-areas VI, VII, VIIIc and IXa. This information, although available at the Working Group, was not included in the catch data. The quantities involved were quite small.

1.5.5 Age readings

The analysis of the age data for the various assessments depends on 1) the accuracy of the age readings of each species, and 2) the sampling intensity which enables the catches to be converted into numbers at age. The Working Group examined the various species in respect of the above factors.

Mackerel

In 1994, it became clear that there was a disappointing level of agreement between otolith readers, particularly among the older fish. A workshop was therefore held in Vigo, the results of which are discussed in Section 2.1. It is hoped that the level of accuracy will now improve with a consequent improvement in the accuracy of the assessment.

There are considerable catches that are not covered by age sampling. In some cases, there are no alternative suitable age compositions with which to convert them into numbers of age, e.g., the Danish industrial fisheries in Sub-area VII, the entire Irish trawl fishery in the North Sea. It is therefore important that working group members should ensure that catches are properly sampled for age if it is not possible to use some appropriate age composition.

Horse Mackerel

As in recent years, the only countries carrying out age readings on horse mackerel are the Netherlands, Spain, Portugal and to a lesser extent Norway. There still remains considerable difficulty in interpreting the growth zones in horse mackerel from the various areas. Because of this it is considered necessary to organize a further workshop on horse mackerel age readings.

The lack of age readings means that in the northern areas the Dutch and Norwegian age data are used to convert large catches into numbers at age. This may not present a big problem at present because the catches are still largely dominated by the 1982 year class. However, as this year class is eventually replaced by incoming ones the problem will be accentuated, particularly as it is becoming clear that catches from different areas have very different length distributions.

Anchovy

The age readings of anchovy appears to be satisfactory. In addition, there appears to be adequate age sampling of all the catches.

Sardine

The accuracy of the age readings of sardine appears to have improved as a result of the Workshop held in 1993, the report of which was discussed by the 1994 Working Group.

Catches made in the southern areas by Spain and Portugal are adequately sampled for age composition. However, catches by France for Division VIIIa are not sampled and these are not included in the assessments.

No age distribution is available for large catches of sardines taken by Denmark from Division VIIe. However, these catches are not included in any assessment at present.

1.5.6 Biological data

The main problems in respect to the biological data, identified by the Working Group, for the various species are:

Mackerel

The stock composition of the various catches, particularly the relationship between mackerel taken from the southern areas and the western areas needs to be further investigated.

Horse mackerel

The selection of an appropriate maturity ogive for the western horse mackerel stock still presents major difficulties. This affects the accuracy of the assessment and is further discussed in Section 6.6. The estimation of the correct spawning stock for 1982 is a cause of concern as it was this SSB which produced the strong 1982 year class and it has been suggested that this level of SSB may be an appropriate value of MBAL.

Anchovy

The main biological problems for anchovy lies in understanding the migration of 0-group fish and their prerecruit distribution. Information is also required about variations in natural mortality (M) as it has been suggested that M may increase dramatically immediately after spawning has been completed.

Table 1.5.1 Summary of fleet data from some nations

Country	Main fishing area	Directed fishery	Kind of gear	Secondary species	Number of boats	Mean Length (min - max)	Mean Horse power (min - max)	Mean Crew size (min - max)	Comments
DENMARK	IVa Northern North Sea	Herring (1st half) Mackerel (2nd half)	Purse seine		11	50.1 (35.7 - 65.9)	1355 (900 - 2480)	12	Human cons. 2 DKr/kg
NORWAY	Norwegian sea and North Sea	Mackerel	Purse seine	norway pout, herring, h, mackerel,capelin,sandeel	103	> 30			95% Human cons.
NORWAY	Norwegian sea and North Sea	Mackerel	Purse seine	Herring, horse mackerel, capelin, norway pout, sandeel	187	< 30			95% Human cons.
NORWAY	Norwegian sea and North Sea	Mackerel	Pelagic trawl	Norway pout, herring ,capelin sandeel	43	> 30			95% Human cons.
IRELAND	IVa and VIa	Mackerel	Single and paired pelagic trawl	Horse, mackerel, herring	17	45 (29.7-97)	1771 (634-5850)	12 (10-40)	Human cons, surplus to meal.
FRANCE	VIIIa and b	Anchovy, Tuna hake.	Pelagic and bottom trawl	Mackerel, sardine, horse mackerel, sole	230	17 (10-32)	305 (73 - 736)	(4 - 5)	Human cons. (3F/kg - 25F/kg)
FRANCE	VIIIb	Anchovy, Tuna	Purse seine, drift net, line and long-line	Hake, Horse mackerel	27	15 (11 -19)	134 (58 - 196)	(6 - 14)	Human cons. (3F/kg - 35F/kg)0
NETHERLANDS	VIA,VII.	Horse mackerel	stern trawler	Herring Mackerel	12	103 (71 - 120)	4963 (2699 - 7648)	35	Human cons. 0.75 fl/kg frozen fish
NETHERLANDS	Center and South of the North Sea	Herring in winter	Pelagic pair trawl or beam trawl in summer	flat fish and round fish in summer	14	38 (29 - 42)	1656 (1016 - 2286)	6	Human cons. 0.40 fl/kg
PORTUGAL	IXA	Horse mackerel,Hake	Bottom trawl	Blue whiting, mackerel, Anglerfish, Megrim, squids	125	27.4 (11.8 - 37.7)	637 (120 -1455)	11	Human cons. 231 esc./kg
PORTUGAL	IXA	Sardine	Purse seine	Horse mackerel, mackerel, anchovy	225	20.5 (10-29)	280 (35-751)	6	Human cons. and scam 74 esc./kg

Table 1.5.1 (continued)

SPAIN	VIIIc east	Anchovy, Tuna	Purse seine	Horse mackerel, sardine, mackerel	231	23 (16-33)	431 (106-950)	14	canned fish
SPAIN	VIIIc west	Sardine, Horse mackerel	Purse seine	Mackerel, anchovy	116	14.5	174		Human cons.
SPAIN	IXa north	Sardine, Horse mackerel	Purse seine	Mackerel	137	15	247		Human cons.
SPAIN	IXa south	Anchovy	Purse seine	Sardine, spanish mackerel	58	15 (7.9-20.2)	291 (49-624)	11	canned fish
SPAIN	VIIIc east	Demersal fish	Trawl	blue whiting, horse mackerel	25	25 (20-27)	499 (320-850)	11	fish meal and human cons.
SPAIN	VIIIc west	Demersal fish	Trawl	blue whiting, horse mackerel	49	28	490		human cons.
SPAIN	IXa north	Demersal fish	Trawl	blue whiting, horse mackerel	105	26	400		human cons.
SPAIN	IXa south	Shell fish and demersal fish	Trawl	Horse mackerel	286	14	207	6	human cons.
SPAIN	VIIIc east	Hake,	Gill net	Mackerel, horse mackerel	52	13	129	8	human cons.
SPAIN	VIIIc west	Hake, pollock	Gill net	red sea bream	86	26	201		human cons.
SPAIN	VIIIc east	Hake,mackerel, (Mar- Apr)	Long line and line	conger,red sea bream.	353	13	135	6	human cons.
SPAIN	IXa south	miscellaneous	hook and gill net	Sparidae, cephalopods, flat fish, h mac.	270	9	97	5	human cons.
SPAIN	IXa south	anchovy, Horse mackerel	trawl and purse seine	sardine, spanish mackerel	75	12	151	6	human cons.
SCOTLAND	IVA , VIA	Mackerel and herring	Purse seine		40	46 (32 - 74)	1888 (737 - 5804)	12	human cons. and fish meal # 120£/t
SCOTLAND	IVA , VIA	Mackerel	Pelagic trawl	herring, sprat	11	36 (23 - 57)	1092 (539 - 2332)	9	human cons. or fish meal # 120£/t
RUSSIA	IIA	Mackerel	Pelagic trawl		9	63.5 (53.7 - 82.2)	2271	47	human cons.
RUSSIA	IIA	Mackerel	Pelagic trawl		3	59.1	2200	39	human cons.
RUSSIA	IIA	Mackerel	Pelagic trawl		35	101.8	6149	93	human cons.

2 MACKEREL - GENERAL

2.1 Review of the Mackerel Otolith Reading Workshop

A Mackerel Otolith Reading Workshop (Chairman: A. Eltink) sponsored by the EU was held at the Instituto Español de Oceanografia (IEO) in Vigo, Spain from 8-14 February 1995 to:

a) evaluate the results of the mackerel otolith exchange carried out in 1994;
b) discuss and standardize age reading methods by preparing a manual and a standard collection;
c) advise on which age groups valid age readings can be achieved.

Results from this Workshop are reported in Anon. (1995). The 6 sets of otolith samples read by 10 otolith readers during the 1994 Mackerel Otolith Exchange and at this Workshop covered the area of the main distribution of the northeast Atlantic mackerel.

The first set of otoliths to be read at the Workshop was a validation set, which contained otoliths of known age. The ageing method was validated up to age 8. Results of the analysis of this validation set showed clearly the errors in the readings. Most readers had to try to correct for underestimation of the age of the older fish. One reader had to correct for overestimation and one for underestimation of most age groups. The assumption that modal age could be used as a best estimate of age was confirmed by a plot of modal age against actual age. This validation set contained one pair of otoliths with an actual age of 23 years. The modal age corresponded with actual age, while the average age was underestimated (20.7 years). After thorough discussions of the validation set, the results of the 1994 Mackerel Otolith Exchange were discussed to make the otolith readers aware of their errors in age reading. New samples from Divisions IXa and IVb,c were read to detect whether special problems occurred in these areas. Due to the relatively early opaque and hyaline ring formation in the otoliths from Division IXa, the rings were misinterpreted (mainly in young fish) by many of the readers, who were not familiar with this area. Information on the edge type of the otolith (e.g. hyaline or opaque) should be collected in future by area and by age group in order to achieve better interpretation of the hyaline and opaque edges. After thorough discussions on these sets the set from Divisions VIa and VIIb,c was read a second time to estimate the improvement in precision (first time readings were from the 1994 Mackerel Otolith Exchange). However, due to the bad quality of this otolith set (resin was not protected with a glass coverslip) a new set of otoliths from Division IVa was used to measure the precision in the age readings.

The results from this Division IVa set (see Table 2.1 and Figure 2.1 and 2.2) made the Workshop recommend that the Mackerel, Horse Mackerel, Sardine and Anchovy Assessment Working Group should use age groups up to and including age 11 with a 12+ age group. The otolith readers suggest that the results on precision achieved at the Workshop were an underestimate, because of the stress from a tight time schedule, unfamiliar microscopes, the many otoliths to read, etc.

Guide-lines on mackerel otolith reading were presented in the report. Of 148 otoliths from Division IVa 62 were accepted as a reference set (full agreement on all otoliths). The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy endorses all recommendations made by this Workshop.

The Working Group considered the age readings as appropriate for assessment purposes since the CVs were about 10-20% of most of the age group.

2.2 Egg Surveys

2.2.1 Western area

The 1995 ICES coordinated egg survey was the seventh consecutive triennial survey in the series. The survey strategy and methods for calculating total egg production are described in the report of the egg production workshop (Anon. 1994). They are broadly similar to those used in previous years. It was agreed at that workshop that provisional results of the egg survey would be prepared for this Working Group. The data will be fully analyzed at a meeting of the egg production working group scheduled for March 1996.

For the first time surveys of the southern area, south of 44°30'N, were more closely integrated into the western survey so that the results could be combined if required. Details of the surveys and provisional results are given by Walsh (WD, 1995) for the western area and by Sola *et al.* (WD, 1995) for the southern area.

The new survey strategy and an improvement in the deployment of vessels in 1995, compared to 1992, resulted in a much better coverage of the western area. Few occurrences of large numbers of eggs at the edges of the survey area were recorded and therefore the underestimate of production is likely to be less than in previous years.

Most of the mackerel egg production occurred north of 46°30'N on all surveys. The peak production occurred in period 5, well off the shelf edge, between 46°30'N and 53°N. Highest values, over $700 m^{-2} d^{-1}$, occurred on this survey to the west of Ireland, south of the Porcupine Bank. Details of survey coverage, the mean daily egg production for periods 3 to 7, and the interpolated values for unsampled periods, are given in text table below.

Period	Dates	Mean egg prod: $x10^{-13}$	Days	Total egg prod: $x10^{-15}$
*	16-25/3	(0.170)*	10	(0.017)*
3	26/3-14/4	0.62	20	0.124
*	15-21/4	(0.986)*	7	(0.069)*
4	22/4-16/5	1.42	25	0.354
5	17/5-8/6	2.62	23	0.603
6	9-29/6	0.51	21	0.107
7	30/6-16/7	0.19	17	0.032
		Total	123	**1.305**

Note: * interpolated periods and values.

The provisional seasonal stage I egg production curve is given in Figure 2.3. Although this has the second highest peak value recorded in the series, production in the other periods was low. The total seasonal production of **1.31×10^{15}** stage I eggs is the second lowest in the series, about 31% lower than in 1992.

Year	Total egg production x 10^{-15}
1977	1.98*
1980	1.84*
1983	1.53
1986	1.24
1989	1.52
1992	1.94
1995	1.31

* Values based on geometric mean for interpolated rectangles.

Only a provisional estimate of fecundity - 1566 eggs/g female is available for 1995. This is very close to the 1992 value of 1569 eggs/g female. Assuming a sex ratio of 1:1 and adjusting, by a factor of x1.08, for the weight difference between pre-spawning and spawning fish, gives a spawning stock biomass of 1.80 million tonnes. No atresia data are available yet for 1995. Correcting the spawning stock biomass for atresia, using the 1992 value of 8.8%, gives a provisional figure of **1.97 million tonnes**. This is the lowest SSB value since the egg surveys began.

Year	Spawning stock biomass ($x10^{-6}$ tonnes)
1977	3.22
1980#	2.99
1980~	2.41
1983	2.49
1986	2.01
1989	2.24
1992	2.93
1995*	1.97

excluding period 3.
~ including period 3.
* provisional.

2.2.2 Southern area

Data for mackerel egg production were only available from the surveys by Spain in periods 3,4 and 5 (Sola *et al.* WD, 1995) In period 3 the whole of the specified area from 39°N to 45°N was surveyed. In periods 4 and 5 coverage was limited to the Cantabrian coast east of 8°W. In period 4 the south-eastern corner east of 4°W was not sampled. The highest production of stage I eggs occurred on the first survey. Most of the production was confined to the Cantabrian shelf with few eggs occurring south of 42°N. Details of survey coverage, the mean daily egg production for periods 3 to 5, and the interpolated values for unsampled periods, are given in text table below.

Period	Dates	Mean egg prod: $x10^{-12}$	Days	Total egg prod: $x10^{-12}$
*	15/3-25/3	(1.194)*	11	(13.13)*
3	26/3-13/4	4.34	19	82.46
*	14/4-7/5	(2.11)*	24	(50.64)*#
4	8/5-12/5	0.55	5	2.75#
*	13/5-29/5	(0.354)*	17	(6.01)*#
5	30/5-5/6	0.14	7	0.98#
*	6/6-8/6	(0.03)*	3	(0.09)*#
		Total		**156.07**

Note: * interpolated periods and values.
see text below.

With peak egg production occurring on the first survey the Working Group was concerned at the probable extent of the unsampled egg production prior to that survey. It was agreed that an additional interpolated value, for the missing production, should be included. This value was derived from a 'mirror image' of the production curve in the sampled period. The values for the periods marked # in the table above were therefore doubled. This gave a total stage I egg production figure of **216.54×10^{12} eggs.** No data for fecundity or atresia are yet available for this area. In order to convert the stage I egg production into a spawning stock biomass the same values were used as for the western area in 1995 (section 2.2.1). This gave a provisional spawning stock biomass of **327,500 tonnes**, corrected for 8.8% atresia. This represents about 14% of the combined western area and southern area estimates.

Using the stage I egg production of 156.1×10^{12} eggs, that is without the interpolation for the estimated early production, a spawning stock biomass of 236,000 tonnes, corrected for atresia, is obtained. There was a single egg survey covering the Cantabrian coast in 1992 sampling over the 51 day period 23 April to 13 June (Anon. 1993). The mean daily egg production on this survey was 9.23×10^{12} stage I eggs. This was more than twice the peak value recorded in 1995 and it occurred some 5 weeks later than in 1995. The mean daily egg production value in 1992 integrated over the 51 day survey period gives a total production of 471×10^{12} stage I eggs. This gives a spawning stock biomass in 1992 of 712,000 tonnes after correction for atresia and conversion from pre-spawning biomass. This is probably an overestimate, bearing in mind the length of the survey period over which the production is integrated. It

represents 20% of the total when added to the western area estimate, which is a more realistic calculation of the proportion of those spawning in the southern area, than the workshop estimate of 43% (Anon. 1993a). That estimate was based on the comparison of the peak values recorded in each area and took no account of the likelihood of a much longer spawning period in the western area, in view of the greater latitudinal spread of the spawning grounds.

2.3 Stock Units

The mackerel caught in North East Atlantic waters has so far been treated as belonging to three stock units. However, there is no well established biological basis for this. Stock differentiation has been based on differences in spawning areas and time and to some extent on differences in year-class strength, individual growth and migration patterns. Based on this the mackerel has been divided into the North Sea and the Western stock. A Southern stock has been defined based on differences in spawning areas. However, overlapping in egg distributions between Southern and Western spawning areas have been observed (Anon. 1994). It also seems that the strength of the year classes in the Western stock are reflected in the Southern stock. Therefore the basis for a separate Southern stock unit is rather poor.

Tagging experiments have demonstrated that the North Sea and Western stocks are mixing in the North Sea and Norwegian Sea during the second half of the year (August-January). Since it is impossible to split the mackerel caught in these areas by stocks all the fish caught have been allocated to the Western stock and the catches of North Sea mackerel has therefore been included in the assessment of Western mackerel since 1988 (Anon. 1989). Due to big differences in stock size levels this has negligible impact on the assessment of the Western stock. The size of the North Sea stock is about 3% of the Western stock.

The Norwegian fleet fishing in The North Sea and Norwegian Sea have occasionally caught mackerel which had hooks on them demonstrating that they previously had been in areas fished by Portuguese and Spanish long-liners. Recent tagging experiments (Uriarte, 1995) demonstrate that mackerel tagged in the south-east corner of the Bay of Biscay are also mixing with mackerel of Western and North Sea origin in the North Sea and in the Norwegian Sea.

In 1994 about 10,000 mackerel were tagged at the south-east corner of the Bay of Biscay along the Basque Country coast . Uriarte (1995) describes this experiment and includes the tag recoveries from the tagging period March-April 1994 to the middle of August 1994. During this period 67 tags were recovered. The recoveries demonstrate that mackerel from the south-east corner of the Bay of Biscay migrate to the North Sea and Norwegian Sea and mix with Western and North Sea mackerel. Since it is impossible to split catches from these northern areas into Western, Southern and North Sea mackerel, the Working Group decided to do a combined assessment for a population unit called northeast Atlantic mackerel (ref. Section 3.4).

2.4 Allocation of Catches to Stock

Since 1987 all catches taken in the North Sea and Div. IIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in international waters. It has not been possible to calculate the total catch from the North Sea stock but it has been believed to be less than 10,000 t for a number of years. An international egg survey will be carried out in the North Sea in June-July 1996 and will provide information on the size of the stock.

Prior to 1995 catches from Div. VIIIc and IXa were all considered to belong to the Southern mackerel stock - although no assessment has been carried out on that stock. For the purpose of the combined assessment carried out by the present Working Group all catches from these divisions were included with the catches from the Western stock in the population unit Northeast Atlantic mackerel.

2.5 Distribution of Juvenile Mackerel

North Sea distribution charts based on data from the International Bottom Trawl Surveys (IBTS) are provided for 1-ringed mackerel (year class 1993) for the 2nd and 3rd quarters 1994 (Figures 2.4-2.5). Wider area charts based on IBTS and additional international surveys west of Ireland and the UK are provided for first and second winter mackerel (year classes 1994 and 1993 respectively) for the 4th quarter 1994 and the 1st quarter 1995 (Figures 2.6-2.9) The data were presented in a working document (Walsh WD, 1995).

Data in the second quarter (Figure 2.4) indicate an almost complete absence of 1-ringed fish from the North Sea as in 1993. This is a quarter in which immigration of this age group from the western stock is not expected and these data therefore suggest no evidence of a good 1993 North Sea year class.

Data in the 3 quarter (Figure 2.5) show a similar distribution of 1-ringed mackerel in the North Sea as in 1993. In both years high abundances were evident in the southern area and parts of the central North Sea indicating substantial immigration of western mackerel in both years.

Data in the 4 quarter give the first indications of the distribution and abundance (Figure 2.6) of the newest year class (1994). These indicate a continuing - almost complete absence of these first-winter fish from the North Sea and highest abundance in traditional loci in western areas. The distribution in western areas was

more northerly than usual with the highest concentrations northwest of Ireland.

The distribution of 2 winter fish (year class 1993) in the 4 quarter (Figure 2.7) indicated the continuing presence of relatively high numbers of this year class in the southern North Sea with some indications of a withdrawal away from the central North Sea towards the south-west, and to a lesser extent the north, compared to the 3 quarter. Distribution to the west was rather restricted with only one area of high abundance to the northwest of Ireland indicating that a relatively high proportion of this year class may be in the North Sea in this quarter.

In the 1 quarter of 1995 the distribution (Figure 2.8) of 1-winter mackerel (1994 year class) was fairly typical of recent years and not dissimilar from that of the previous quarter. The year class remained virtually absent from the North Sea indicating that like that of 1993 this year class is very weak in the North Sea stock. Greatest abundance was again northwest of Ireland as in the previous quarter.

The distribution of 2 winter fish (year class 1994) in this quarter is currently only available from the western area (Figure 2.9). Distribution was widespread and fairly typical of recent years. There are suggestions from the distributions of young mackerel, indicated by the young fish surveys, and from the age distributions of some of the commercial fisheries in the northern areas that there may be changes in the overall distribution of young fish. This matter needs to be investigated further at the next meeting of the Working Group.

2.6 The Fishery in 1994

The total catch, estimated by the Working Group, to have been taken from the various areas is shown in Table 2.2. This table shows the development of the various fisheries since 1969. The total estimated catch in 1994 was about 823,000 tonnes and was similar to that taken in 1993, which was the highest recorded since 1979. It is worth noting again that prior to 1979 catches of over 800,000 tonnes were taken on a number of occasions and also that prior to 1969 annual catches of over 1 million tonnes were taken mainly from the North Sea (Sub-area IV) area for a short time before the fishery collapsed.

During 1994 the largest catches were again taken from Sub-areas IV - mainly from the northern part of Division IVa. Catches from this Division have increased continuously in recent years. The significant decrease in catches that are shown for Divisions IIa and Vb and the corresponding increase in catches from Sub-area IV are due to more accurate information about the location of the 1994 catches rather than an actual change in the location of the fishery. A large amount of the catches taken in Division IVa (over 109,000 t), appears to have been reported as having been taken in Division IIa prior to 1994. In addition, to the misreporting of catches from Division IVa to Division IIa a large amount of catches (over 134,000 t) were also reported as taken in Division VII when in fact they were taken in Division IVa.

The catches from Sub-areas VI and VII (mainly from Divisions VIIj and h) and from Divisions VIIIa,b,d and e were very similar in 1994 to those in 1993 and did not suggest any major changes in the fisheries. Catches from Division VIIIc and IXa have remained stable now for a number of years.

Table 2.2 also shows estimates of discards. These estimates are available for only two fleets for 1994. There appears to have been a considerable decrease in the discards estimated in recent years.

The national catches recorded by the different countries for the different areas are shown in Tables 2.3-2.5b. As can be seen the main countries fishing mackerel are Norway, UK (Scotland), Ireland and the Netherlands. The tables contain large amounts of mackerel (over 244,000 t) which are believed to have been misreported in recent years or which cannot be allocated to a particular country. For these reasons these tables should not be used to detect trends in national catches. There does, however, appear to have been a substantial decrease in the Russian catch mainly taken in the international waters.

In recent years the Working Group has attempted to obtain more information about the development of the different national fleets and fisheries but because national catches are restricted by quotas they give little valuable information. Information about national fleets is available on Working Group files and it is intended that this will be updated each year. Further discussed in Section 1.5.3.

The catches per quarter and by Division and Sub-area for 1994 are shown in Table 2.6. The catches reflect the migrations of the main stocks which are further discussed in Section 2.7. Approximately 32% of the total catch was taken in Quarter 1 - over 89,000 tonnes (reported from Division IVa) are taken from Division IVa where fishing is prohibited. Only 6% of the catch was taken in Quarter 2 - mainly from the spawning areas in Sub-area VII. Over 27% of the catch was taken in Quarter 3 - mainly from the northern areas - Divisions IIa and IVa while a further 34% was taken in Quarter 4 - again mainly from Division IVa.

2.6.1 ACFM advice and management applicable to 1994 and 1995

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

Stock	1994			1995	
	TAC recommended by ACFM	Agreed T	Catch	Recommended TAC	Agreed TAC
North Sea Stock	Lowest possible level	95,700[1]	?	Lowest possible level	76,320[1]
Western Stock	831,000[2]	800,000	797,000	530,000	608,080
Southern Stock	No advice given	36,570[3]	25,000	No advice given	36,570

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

It is important to note that while the overall recommended TAC is meant to apply to the total catch of the Western stock the actual agreed TAC does not apply to the catches taken in international waters - mainly by Russian (>49000 t in 1993 and 26000 t in 1994).

In addition to the overall TAC and the national quota the following are some of the more important additional management measures which were in force in 1994 and are again in force in 1995:

1. Prohibition of fishing in Division IVa during Quarters 1 and 2, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year;

2. Prohibition of a directed mackerel fishery in the "Cornwall Box";

3. Restrictions on the quantities of mackerel which could be taken east of 2° in Quarters 3 and 4 by some countries;
4. Minimum landing size of 30 cm for Sub-area IV_1 Division IIIa and 25 cm for Divisions VIIIc and IXa;

5. Various national measures such as closed seasons and boat quotas.

2.7 Distribution of the Mackerel Fisheries

The total catches of mackerel during 1994 per quarter per Sub-area and Division are shown in Table 2.6. More detailed information on these catches, based on log book information and corrected where possible for misreporting, is shown in Figures 2.10a–d. This information is based on the fleets from Denmark, Ireland, Netherlands, Norway, Russia, Spain and UK (Scotland and England) and the catches cover about 90% of the total.

As mentioned in the previous Section 2.6, the area distribution of the fisheries in 1994 was very similar to that of 1993. The distribution of the catches by quarter again shows that the main catches during 1994 were taken in Quarters 3 and 4 while only a small amount was taken in Quarter 2.

First quarter 1994

Catches during this quarter (268,000 tonnes) were mainly taken from Divisions IVa and VIa during January and from Sub-area VII during February and March. At the end of this quarter catches of adult mackerel were taken in the southern area (Division VIIIc). The catches shown from Division IVa are probably underestimated as they are based on confidential information provided by Working Group members and may not cover the whole extent of misreported catches. Catches were mainly taken along the continental shelf and reflect the migrations of the shoal from the overwintering areas to the spawning grounds. The distribution of the catches is very similar to that of 1993 (Figure 2.10a).

Second quarter

Catches (47,000 tonnes) during this quarter were spread over large areas of Sub-areas VI, VII and VIII. The main catches were from the Bay of Biscay, Cantabrian Sea and along the Continental Shelf. Only very small catches were taken by the Russian fleet in 1994 from the more northerly areas compared to 1993. During this quarter the main shoals are either actively spawning or preparing for their post-spawning migrations to the Norwegian Sea and the North Sea (Figure 2.10b).

Third quarter

The main catches (228,000 tonnes) during this quarter were taken from Divisions IIa and from the eastern part of Division IVa. During this period the shoals are exploited during their summer feeding phase. It is believed that a large proportion of the catches taken in Division IIa were in fact taken from Division IVa. However it is not possible to allocate them to the precise statistical rectangles (Figure 2.10c). There are very few catches of adult fish taken from Division VIIIc as the stock has migrated away from this area. Catches of juvenile fish (<3 years old) are taken in Division IXa.

Fourth quarter

The main catches (280,000 tonnes) during this quarter were taken from Division IIa (Norwegian Sea) and the northern part of Division IVa. As in quarter 3 it is believed that considerable quantities were reported as having been taken in Division IIa but were in fact taken from Division IVa. Reports from fishermen suggested that the shoals during this quarter were distributed much further to the east than in 1993. Catches of young fish were again taken from inshore along the Irish coast in

Divisions VIIb and VIa South and the fishery for juveniles continued in Division IXa. Although attempts have been made to correct for misreporting between Division VIa North and Division IVa the catches presented in Figure 2.10d may not be entirely accurate. Small catches were also taken from the Channel area and from Divisions VIIIc and IXa.

2.8 Length Composition by Fleet and Country

Length distributions of the 1994 catches by the various fleets were provided by Denmark, Ireland, Netherlands, Norway, Portugal, Russia, Spain and United Kingdom (England and Scotland). Length distributions were available from most of the major fishing fleets in 1994, accounting for about 80% of all landings.

The length distributions by country and by fleet for 1994 are shown in Table 2.7.

2.9 Catch in Numbers at Age

The catch in numbers at age by quarter for Divisions IIa; IIIa; IVa; IVb,c; VIa; VIIf,c,j,k; VIIa,e,f,g,h; VIId; and VIIIa,b,d,e are shown in Table 2.8. The percentage catch by numbers at age from 1985 to 1994 are given in Figure 2.11. The catch in numbers at age for quarter for Divisions VIIIc and IXa for southern mackerel is given in Table 2.9 for 1994 and for the period 1984-1994 in Table 2.10. The overall age distribution of the catches of the western stock is now largely composed of fish in the younger age groups (3-5 year olds), except in the fisheries from the northern areas in the 3 and 4 quarters. Catches from the southern areas which have been revised since 1994 mainly composed of fish between 2 and 7 years of age during the 1st and 2nd quarters but are largely dominated by 0-group fish in quarters 3 and 4.

Age distributions of catches were provided by Denmark, Ireland, Netherlands, Norway, Russia, United Kingdom (England and Scotland), Portugal and Spain. There were some serious deficiencies in age sampling in some of the more important fisheries, e.g. the Irish trawl fishery in the North Sea (14,000 tonnes), all the fisheries in VIId (14,000 tonnes) and the entire German, French, Faroese and Swedish fisheries which together took over 67,000 tonnes. Catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleet working in the same area or in an adjacent area at the same time. It was however apparent that this procedure was not always desirable because of the differences in fishing gear between fleets. The sampling intensity is further discussed in Section 1.5.1.

2.10 Mean Lengths at Age and Mean Weights at Age

Mean lengths. The mean lengths at age for 1994 for the western area and for the southern area are shown in Tables 2.11 and 2.12 respectively.

Mean weights. The mean weights per quarter for 1994 for the western area and for the southern area are shown in Tables 2.13 and 2.14 respectively. The mean weights is the catch for the southern area from 1984-1994 shown in Table 2.15; the mean weights in the stock for the southern mackerel from 1984-1994 are shown in Table 2.16.

2.11 Species Mixing

As in previous years, a Spanish fishery for Spanish mackerel, *Scomber japonicus*, also occurred in 1994, in the south of Division VIIb and in Sub-division VIIIc east. The fishery took place mainly in the autumn. Table 2.17 shows the Spanish mackerel catches by sub-division in the period 1982-1994. In 1994 the catch in Sub-division VIIIc east was 1,903 t, which was about the same level as in 1993. In Division VIIIb the catch was 427 t, which was a large increase with respect to 1992 and 1993 and about the same level as in 1991. As in 1993, in 1994 there was also a Spanish fishery of Spanish mackerel in Sub-division IXa north, mainly in the 3 quarter. The Spanish catch in Division IXa north was 7,560 t, which represented a large increase on the 1993 catch (2,557 t). There is no error in the identification of the mackerel species in the Spanish fishery in Divisions VIIIb,c and Sub-division IXa north.

In Sub-division IXa south, the Bay of Cadiz, there is a small Spanish fishery for mixed mackerel species of about 1,000 t. In the surveys (acoustics and trawl) carried out in the Gulf of Cadiz in 1993 and 1994, catch of *S. scombrus* were very scarce or even non-existent and *S. japonicus* made up between 85% and 100% of the total catch in weight of both species (M. Millan, pers.comm). Due to the uncertainties in the proportion of *S. scombrus* in the landings, they have never been included in the mackerel catches reported to this Working Group by Spain.

In Portugal the landings of Spanish mackerel from Division IXa (CN, CS and S) were 4,440 t. This species is landed by all fleets but the purse seiners accounted for 65% of the total weight. The Portuguese landings are also shown in Table 2.17.

MACKEREL DIVISION IVa First readings

Table 2.1 **The mean age recorded, 2stdev, CV (%), the number of age readings and the agreement with modal age are presented by modal age for each reader and for all readers combined. The number of age readings and the agreement is given for age groups 0-15 combined.**

READER 1	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.17	4.00	4.94	5.85	6.81	7.82	9.46	9.73	10.60	11.25	13.00	11.50	15.67	
	2stdev	-	-	0.00	0.78	0.00	0.50	0.98	1.50	0.81	3.33	2.02	1.10	1.91	1.41	4.24	2.31	
	CV (%)	-	-	0%	12%	0%	5%	8%	11%	5%	18%	10%	5%	9%	5%	18%	7%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	83%	100%	94%	90%	63%	82%	92%	55%	60%	50%	60%	0%	0%	80%

READER 2	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	4.00	5.00	6.20	7.50	8.64	9.69	10.82	11.20	14.00	14.00	14.00	14.33	
	2stdev	-	-	0.00	0.58	0.00	0.73	1.67	2.63	4.13	2.87	3.07	3.58	3.65	3.16	0.00	4.16	
	CV (%)	-	-	0%	9%	0%	7%	13%	18%	24%	15%	14%	16%	13%	11%	0%	15%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	92%	100%	88%	85%	63%	55%	46%	36%	60%	25%	20%	100%	33%	71%

READER 3	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	4.00	5.00	5.95	7.00	7.55	8.92	9.45	11.00	11.00	12.00	13.00	13.33	
	2stdev	-	-	0.00	0.58	0.00	0.00	0.45	0.73	1.38	1.91	1.04	0.00	2.31	2.45	2.83	2.31	
	CV (%)	-	-	0%	9%	0%	0%	4%	5%	9%	11%	6%	0%	10%	10%	11%	9%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	92%	100%	100%	95%	88%	64%	62%	45%	100%	50%	40%	50%	0%	81%

READER 4	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	4.00	5.25	6.25	7.06	8.27	9.33	9.82	10.60	12.50	13.80	14.00	14.00	
	2stdev	-	-	0.00	0.58	0.00	1.15	1.43	0.89	1.57	0.98	1.75	1.10	2.00	2.61	0.00	3.46	
	CV (%)	-	-	0%	9%	0%	11%	11%	8%	10%	5%	9%	5%	8%	9%	0%	12%	
	Number of age readings	-	-	10	12	19	16	20	16	11	12	11	5	4	5	2	3	146
	Agreement with modal age	-	-	100%	92%	100%	81%	60%	81%	64%	67%	55%	60%	75%	60%	100%	67%	77%

READER 5	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.17	4.05	5.25	6.40	7.31	8.45	9.62	10.55	11.20	12.75	13.60	13.50	16.33	
	2stdev	-	-	0.00	0.78	0.46	1.15	1.20	0.96	1.38	1.92	1.64	1.67	2.52	3.63	1.41	6.43	
	CV (%)	-	-	0%	12%	6%	11%	9%	7%	8%	10%	8%	7%	10%	13%	5%	20%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	83%	95%	81%	65%	69%	64%	62%	36%	40%	0%	20%	50%	33%	67%

READER 6	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.00	4.00	4.94	6.00	6.94	8.00	9.38	10.09	10.00	12.25	12.40	13.00	14.33	
	2stdev	-	-	0.00	0.00	0.00	0.89	1.45	0.89	1.79	2.24	1.66	1.41	2.52	4.38	0.00	1.15	
	CV (%)	-	-	0%	0%	0%	9%	12%	6%	11%	12%	8%	7%	10%	18%	0%	4%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	100%	100%	81%	65%	81%	55%	54%	64%	20%	50%	0%	0%	0%	70%

READER 7	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	4.11	5.50	6.35	7.25	8.18	10.15	10.64	11.80	13.50	12.60	12.00	14.33	
	2stdev	-	-	0.00	0.58	0.63	2.53	1.63	1.55	1.96	3.64	3.38	1.67	4.16	1.10	0.00	1.15	
	CV (%)	-	-	0%	9%	8%	23%	13%	11%	12%	18%	16%	7%	15%	4%	0%	4%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	92%	89%	75%	80%	88%	82%	38%	45%	40%	0%	60%	0%	33%	71%

READER 8	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	3.95	5.00	5.70	7.13	8.64	9.54	10.73	10.80	12.50	13.00	12.00	14.00	
	2stdev	-	-	0.00	0.58	1.05	0.00	1.31	2.05	3.38	2.53	2.21	0.89	1.15	4.69	5.66	2.83	
	CV (%)	-	-	0%	9%	13%	0%	12%	14%	20%	13%	10%	4%	5%	18%	24%	10%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	2	146
	Agreement with modal age	-	-	100%	92%	89%	100%	65%	69%	73%	31%	36%	80%	50%	20%	50%	50%	71%

READER 9	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.17	4.00	5.13	6.00	6.56	8.00	8.46	9.45	10.00	11.25	12.80	13.50	14.00	
	2stdev	-	-	0.00	0.78	0.00	0.68	0.92	1.26	0.89	1.55	1.87	1.41	4.43	2.19	1.41	3.46	
	CV (%)	-	-	0%	12%	0%	7%	8%	10%	6%	9%	10%	7%	20%	9%	5%	12%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	83%	100%	88%	80%	63%	82%	62%	45%	20%	50%	60%	50%	67%	75%

READER 10	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.08	4.05	5.19	6.00	7.13	7.82	8.77	10.00	10.40	13.25	12.80	13.00	14.00	
	2stdev	-	-	0.00	0.58	0.46	1.09	0.92	1.00	0.81	1.85	1.55	2.68	1.91	0.89	2.83	3.46	
	CV (%)	-	-	0%	9%	6%	10%	8%	7%	5%	11%	8%	13%	7%	3%	11%	12%	
	Number of age readings	-	-	10	12	19	16	20	16	11	13	11	5	4	5	2	3	147
	Agreement with modal age	-	-	100%	92%	95%	88%	80%	75%	82%	62%	73%	80%	25%	80%	50%	0%	79%

ALL READERS	Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0-15
	Mean age recorded	-	-	2.00	3.10	4.02	5.12	6.07	7.07	8.14	9.33	10.13	10.76	12.43	13.00	12.95	14.45	
	2stdev	-	-	0.00	0.60	0.44	1.13	1.29	1.51	2.12	2.52	2.27	1.96	3.17	2.91	2.55	3.32	
	CV (%)	-	-	0%	10%	5%	11%	11%	11%	13%	13%	11%	9%	13%	11%	10%	11%	
	Number of age readings	-	-	100	120	190	160	200	160	110	129	110	50	40	50	20	29	1468
	Agreement with modal age	-	-	100%	90%	97%	88%	77%	74%	70%	57%	49%	56%	38%	42%	45%	28%	74%

Table 2.2 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	356,487	-	356,487
1973	52,200	-	52,200	167,300	-	167,300	326,519	-	326,519	21,600	available	567,619	-	567,619
1974	64,100	-	64,100	234,100	-	234,100	298,391	-	298,391	6,800		603,391	-	603,391
1975	64,800	-	64,800	416,500	-	416,500	263,062	-	263,062	34,700		779,062	-	779,062
1976	67,800	-	67,800	439,400	-	439,400	303,842	-	303,842	10,500		821,542	-	821,542
1977	74,800	-	74,800	259,100	-	259,100	258,131	-	258,131	1,400	27,417	620,848	-	620,848
1978	151,700	15,100	166,900	355,500	35,500	391,000	148,817	-	148,817	4,200	26,508	686,725	50,700	737,425
1979	203,300	20,300	223,600	398,000	39,800	437,800	152,323	500	152,823	7,000	22,475	783,098	60,600	843,698
1980	218,700	6,000	224,700	386,100	15,600	401,700	87,391	-	87,391	8,300	15,964	716,455	21,600	738,055
1981	335,100	2,500	337,600	274,300	39,800	314,100	64,172	3,216	67,388	18,700	18,053	710,325	45,516	755,841
1982	340,400	4,100	344,500	257,800	20,800	278,600	35,033	450	35,483	37,600	21,076	691,009	25,350	716,359
1983	315,100	22,300	337,400	245,400	9,000	254,400	40,889	96	40,985	49,000	14,853	665,242	31,396	696,638
1984	306,100	1,600	307,700	176,100	10,500	186,600	39,374	202	39,576	93,900	20,308	635,782	12,302	648,084
1985	308,140	2,735	390,875	75,043	1,800	76,843	46,790	3,656	50,446	78,000	18,111	606,084	8,191	614,275
1986	104,100	+	104,100	128,499	+	128,499	236,309	7,431	243,740	101,000	24,789	594,697	7,431	602,128
1987	183,700	+	183,700	100,300	+	100,300	290,829	10,789	301,618	47,000	22,187	644,016	10,789	654,805
1988	115,600	3,100	118,700	75,600	2,700	78,300	308,550	29,766	338,316	116,200	24,772	640,772	35,566	676,288
1989	121,300	2,600	123,900	72,900	2,300	75,200	279,410	2,190	281,600	86,900	18,321	578,831	7,090	585,921
1990	114,800	5,800	120,600	56,300	5,500	61,800	300,800	4,300	305,100	116,800	21,311	610,011	15,600	625,611
1991	109,500	10,700	120,200	50,500	12,800	63,300	358,700	7,200	365,900	97,800	20,683	637,183	30,700	667,883
1992	141,906	9,620	151,526	72,153	12,400	84,553	364,184	2,980	367,164	139,062	18,046	735,351	25,000	760,351
1993	133,497	2,670	136,167	99,828	12,790	112,618	387,838	2,720	390,558	165,973	19,720	806,856	18,180	825,036
1994	134,338	1,390	135,728	113,088	2,830	115,918	474,830	1,150	475,980	69,900	25,043	817,198	5,370	822,568

[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 2.3 Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb), 1982-1994. (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
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	1993[2]	1994[2]
Denmark	4,265	6,433	6,800	1,098	251	-	-
Estonia					216	-	3,302
Faroe Islands	22	1,247	3,100	5,793	3,347	1,167	6,258
France	-	11	-	23	6	6	5
Germany, Fed. Rep.	380	-	-	-	-	-	-
German Dem. Rep.	-	2,409	-	-	-	-	-
Latvia					100	4,700	1,508
Norway	86,400	68,300	77,200	76,760	91,900	110,500	140,708
Poland	-	-	-	-	-	-	-
Russia					42,440	49,600	26,038
UK (England & Wales)	-	-	+	-	1	-	20
UK (Scotland)	1,413	-	400	514	801	-	1,686
USSR	27,924	12,088	30,000	13,631[3]	-	-	-
Misreported[1]							109,625
Discards	-	-	2,300	-	-	-	-
Total	120,404	90,488	118,700	97,819	139,062	165,973	69,900

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

Table 2.4 Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and Division IIIa), 1982-1994. (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	1993[2]	1994[2]
Belgium	20	37	-	125	102	191	351
Denmark	32,588	26,831	29,000	38,834	41,719	42,502	47,852
Estonia					400	-	-
Faroe Islands	-	2,685	5,900	5,338	-	11,408	11,027
France	1,806	2,200	1,600	2,362	956	1,480	1,570
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940	1,479
Ireland	-	8,880	12,800	13,000	13,136	13,206	9,032
Latvia					211	-	-
Netherlands	2,564	7,343	13,700	4,591	6,547	7,770	3,637
Norway	59,750	81,400	74,500	102,350	115,700	112,700	115,741
Sweden	1,003	6,601	6,400	4,227	5,100	5,934	7,099
UK (Engl. & Wales)	160	5,618	1,300	2,671	2,258	2,262	2,272
UK (Scotland)	616	33,042	28,100	33,991	32,879	38,747	25,207
UK (N.Ireland)	100	-	1,400	255	-	1	-
Russia	-	-	-	-	-	-	2,003
Romania	-	-	-	-	-	-	2,903
Unallocated, discards, and misreported	233,532	100,651	126,900	153,958	143,546	149,417	245,807
Total	338,316	281,600	305,100	365,875	367,164	390,558	475,980
Misreported[3]	180,000	92,000	126,000	130,000	127,000	146,697	245,157

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

Table 2.5a 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	1993[2]	1994[2]
Belgium	-	-	-	-	-	-	-
Denmark	-	1,000?	-	1,573	194	-	2,239
Faroe Islands	2,600	1,100	1,000	4,095	-	2,350	4,283
France	8,900	12,700	17,400	10,364	9,109	8,296	9,998
Germany, Fed. Rep.	15,900	16,200	18,100	17,138	21,952	23,776	25,011
Ireland	85,800	61,100	61,500	64,827	76,313	81,773	79,996
Netherlands	26,100	24,000	24,500	29,156	32,365	44,600	40,698
Norway	17,300	700	-	-	-	600	2,552
Poland	-	-	-	-	-	-	-
Spain	1,500	1,400	400	4,020	2,764	3,162	4,126
UK (Engl. & Wales)	24,100	14,700	19,200	25,500	29,978	40,111	47,736
UK (N.Ireland)	8,900	11,000	12,800	2,995	2,238	1,476	754
UK (Scotland)	175,400	123,400	130,700	134,093	164,674	173,678	160,166
USSR	+	-	-	-	-	-	-
Unallocated + misreported	-175,300	-73,100	-114,500	-133,802	-125,528[1]	-146,697[1]	-130,133
Discard	5,800	4,900	11,300	23,550	22,020	15,660	4,220
Grand Total	377,000	288,900	302,900	183,509	236,079	248,785	251,646
Misreported[3]	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697	134,765

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

Table 2.5b Landings (tonnes) of Mackerel in Divisions VIIIc and IXa, 1977-1994. (Data submitted by Working Group members).

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

Table 2.6 Catches of mackerel by Division and Sub-area in 1994. (Data submitted by Working Group members.)

Division/ Sub-area	Quarter				Total
	1	2	3	4	
IIa + Vb	500	1,600	66,600	1,200	69,900
IVa	89,000	1,500	140,000	233,800	464,300
IVb	+	+	700	100	800
IVc	100	600	1,300	1,000	3,000
IIIa	100	400	6,500	900	7,900
VI	112,300	4,400	6,200	12,800	135,700
VII	54,500	22,700	4,700	28,000	109,900
VIIIa,b,d,e	2,900	2,400	400	300	6,000
Sub-total	259,400	33,600	226,400	278,100	797,500
VIIIc	7,700	12,500	600	300	21,100
IXa	600	1,000	1,100	1,300	4,000
Grand total	267,700	47,100	228,100	279,700	822,600

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

Table 2.7 Length distributions by fleet per country.

Country ▶	*SCOTLAND*				*NORWAY*	*Nether-*	Spain			*Ireland*	*UK (England & Wales)*		*Russia*	Portugal			Denmark
Gear ▶	Total	Total	Total	Total	Total	lands											
Length cm	P. Seine	0ther	Pair Trawl	All Gears	P.seine	Pelagic	P. seine	Artisanal	Trawl	P. Trawl	Trawl	Handline	Commercial	P.seine	Artisanal	Trawl	P Seine
10	0	0	0	0	ICES Div	trawl											
11	0	0	0	0	IV and VI		95	0	0								
12	0	0	0	0	combined		0	0	0								
13	0	0	0	0			1140	0	0								
14	0	0	0	0			2565	0	0								
15	0	0	0	0			4845	0	0								
16	0	0	0	0		10	1697	0	0								
17	0	0	0	0		10	652	0	0		212.9	0		0	0	1	
18	0	0	0	0		20	657	0	0	249	425.9	0	0	0	0	4	
19	0	0	0	0		280	1048	0	0	1426	1064.7	0	0	0	0	16	
20	0	0	0	0		260	4492	0	0	2538	3407	6.8	0	0	0	79	
21	358	6	0	487		1610	2789	6	25	1434	4045.8	0.2	0	0	0	55	
22	164	0	0	227		2250	2145	0	27	594	1137.1	0.6	0	0	0	106	
23	63	0	0	88		2890	2239	2	12	276	1924.7	1.5	0	0	0	49	
24	25	0	6	31		1460	220	7	26	779	10032.3	9.3	0	0	4	31	
25	175	11	39	228	0	1540	76	24	82	5731	24785.8	47.9	0	13	9	21	
26	400	43	247	754	3	1760	15	8	540	10244	33870.9	148.5	0	0	14	78	
27	525	189	712	1811	60	2590	56	63	639	9384	18740.4	249.6	0	13	18	242	
28	1041	792	3041	6351	1081	1460	238	205	1278	5822	11462.8	327.1	0	0	29	424	
29	1908	709	4142	8929	2326	2430	580	256	1099	9253	7963.4	697.1	1443	184	35	452	509
30	4859	606	3413	12099	5080	2900	702	759	911	12996	7375.1	674.8	4276	172	41	437	540
31	9551	2506	5319	22601	11075	4260	826	938	674	19563	3449.7	451.3	3761	90	51	263	509
32	14492	2961	7162	32052	20616	5980	674	1384	559	27229	2581.8	537.6	5307	158	28	233	5150
33	17936	4714	8044	39821	28944	8530	665	1357	638	26096	2016.7	541	2770	250	44	200	6870
34	22204	5288	7205	45172	145418	12280	560	2085	1118	21979	542.9	362.1	3801	396	45	178	12805
35	21053	5107	8597	45186	49666	13920	657	3287	1221	19438	338.4	119.6	6448	525	75	138	18657
36	17725	5063	6788	38572	57849	11080	834	4241	1623	17591	59.4	81	4787	385	110	85	33314
37	18689	4905	8912	42643	305118	11440	1270	5648	1227	17662	50	63.8	5635	230	99	55	37456
38	18219	4067	6628	42760	323923	12530	1825	5299	922	15980	42.6	50.7	5493	229	100	28	35390
39	16661	3666	6113	34266	307125	13340	2073	4148	549	16407	29.2	31.4	2733	108	92	16	35236
40	11033	2168	3864	22012	40169	10360	1946	3181	437	11984	22.4	6.3	3736	51	65	8	28713
41	9121	2177	3725	19459	22055	5270	1398	2165	280	7400	16.3	7.1	2037	1	33	3	16662
42	3911	887	941	12607	11971	4120	918	1345	125	3791	10.5	2.9	1578	0	18	2	10301
43	3268	390	680	5534	5793	2560	390	676	77	2838	5.3	0.1	1340	1	14	0	4387
44	1747	146	391	2909	2429	760	144	445	82	1279	3.6	1	456	0	5	0	2321
45	411	60	95	739	1198	430	21	259	13	505	0.7	0	257	0	5	0	509
46	133	29	52	269	91	0	0	84	0	275	0.7	0	0	0	8	0	
47	73	3	15	119	34	10	1	0	0	0	0.3	0	0	0	0	0	
48	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	
49	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	
50	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	
51						0	0	0	0	29	0	0	0	0	0	0	
52						0	0	0	0	29	0	0	0	0	0	0	
53						0	0	0	0	0	0	0	0	0	0	0	
54						0	0	0	0	29	0	0	0	0	0	0	
Total nos	195745	46493	86131	437726	1342052	138340	40453	37872	14184	270830	135619.3	4419.3	55858	2809	942	3203	249329
Tonnes	84012	19336	33508	177592	259001	50252	7463	15220	4330	90028	15291.5	1300.4	28041	947	390	819	42634

Table 2.8	Catch in numbers ('000) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1994.									
1994	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)
0	0	0	0	0	0	0	0	0	0	0
1	1	0	702	0	4,051	1,040	12,121	8,983	0	26,898
2	54	1	5,651	4	7,698	922	17,780	13,177	57	45,344
3	322	30	30,572	19	45,576	12,407	2,918	2,163	233	94,240
4	307	27	36,016	22	46,741	19,784	445	330	507	104,178
5	216	39	38,730	23	46,904	30,102	295	219	1,142	117,670
6	115	23	26,610	16	25,000	16,125	89	66	1,239	69,283
7	94	23	25,458	15	35,087	20,716	15	11	1,140	82,559
8	74	11	12,137	7	16,290	6,429	0	0	600	35,547
9	42	11	10,662	6	13,889	4,817	89	66	574	30,155
10	27	6	8,209	5	15,028	4,128	0	0	246	27,649
11	13	2	2,880	2	3,420	1,157	0	0	222	7,696
12	12	5	3,829	2	4,482	1,097	0	0	136	9,564
13	17	1	2,802	2	3,853	1,063	0	0	53	7,791
14	12	0	657	0	1,718	747	0	0	53	3,187
15+	8	1	1,827	1	2,048	634	0	0	11	4,530
Total	1,314	180	206,740	124	271,787	121,168	33,752	25,015	6,213	666,293
Tonnes	487	75	91,560	56	111,594	47,615	3,975	2,946	2,861	261,169

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	22,289	970	0	0	8	23,267
2	0	20	0	97	2,902	1,624	27	384	630	5,684
3	63	350	58	49	1,581	12,966	54	192	1,091	16,404
4	389	76	233	676	1,075	18,790	80	2,666	1,039	25,024
5	836	39	579	725	732	15,229	107	2,858	1,618	22,723
6	928	52	984	146	1,221	6,305	54	576	1,037	11,303
7	449	49	405	49	396	4,024	27	192	714	6,305
8	63	10	58	0	248	2,478	27	0	255	3,139
9	192	34	232	49	129	2,358	27	192	226	3,439
10	31	22	58	49	129	1,365	27	192	94	1,967
11	95	0	116	0	49	196	27	0	69	552
12	32	52	0	0	44	13	0	0	33	174
13	0	28	0	0	0	672	0	0	15	715
14	0	15	0	0	32	0	0	0	10	57
15+	0	53	0	0	65	5	0	0	10	133
Total	3,078	800	2,723	1,840	30,892	66,995	457	7,252	6,851	120,888
Tonnes	1,583	395	1,509	613	4,415	20,186	107	2,418	2,377	33,603

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	157	0	0	157
1	337	0	296	4,109	141	12	3,441	12,788	49	21,173
2	13,863	448	9,228	576	1,773	309	1,112	1,737	98	29,144
3	26,078	2,541	38,655	445	2,224	323	446	734	195	71,640
4	21,661	2,456	36,771	274	1,474	225	70	165	195	63,292
5	21,003	1,236	41,100	273	4,948	336	290	284	390	69,860
6	12,669	623	26,845	114	1,422	295	0	0	195	42,163
7	10,932	957	36,140	104	2,028	147	0	0	49	50,356
8	6,923	673	25,035	108	1,981	251	70	0	49	35,090
9	4,764	603	13,812	76	345	320	0	0	49	19,969
10	3,308	364	7,658	51	961	172	0	112	49	12,675
11	1,431	249	3,604	13	345	66	0	0	49	5,757
12	1,277	807	4,706	12	12	148	0	0	49	7,011
13	582	45	351	1	0	89	0	0	49	1,117
14	211	0	56	0	23	101	0	0	49	440
15+	1,996	334	804	2	5	23	0	0	49	3,213
Total	127,036	11,336	245,062	6,157	17,682	2,817	5,586	15,820	1,563	433,059
Tonnes	66,607	6,552	140,021	1,423	6,162	993	883	2,845	390	225,876

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	142	0	170	312
1	228	16	20,891	2,409	19,850	9,205	14,093	5,873	560	73,125
2	375	119	60,628	745	16,907	9,044	44,809	2,072	244	134,942
3	554	413	95,571	690	11,604	5,669	3,480	695	114	118,789
4	281	278	61,295	0	1,599	1,292	2,637	1,036	117	68,534
5	375	222	75,349	55	1,721	469	423	695	177	79,486
6	262	135	52,125	55	135	75	0	695	44	53,526
7	231	111	43,510	108	235	69	0	341	2	44,607
8	134	95	28,909	0	47	81	142	341	1	29,750
9	158	56	22,163	0	96	42	0	1,377	1	23,893
10	71	48	13,228	0	39	57	0	695	1	14,139
11	36	8	4,077	108	0	0	0	1,377	1	5,607
12	54	135	9,931	0	47	0	0	1,036	1	11,204
13	17	0	1,977	0	0	0	0	695	1	2,690
14	19	32	1,898	55	0	14	0	341	1	2,360
15+	20	71	2,044	57	0	0	0	0	1	2,193
Total	2,815	1,739	493,596	4,282	52,280	26,017	65,726	17,269	1,435	665,158
Tonnes	1,223	921	232,724	1,017	12,827	6,311	15,995	5,684	338	277,040

Table 2.9 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1994.

Sheet1

1994	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0		0		0
1	58	437	7		508		1,010
2	219	2,653	18		403		3,293
3	461	1,133	48		209		1,852
4	1,426	228	52		113		1,819
5	3,217	242	94		84		3,637
6	3,071	94	88		71		3,324
7	2,563	37	73		17		2,690
8	1,259	10	40		10		1,319
9	1,232	6	43		5		1,287
10	606	3	22		8		639
11	429	1	17		5		451
12	237	0	15		7		259
13	101	0	5		0		107
14	139	0	8		0		147
15+	30	0	3		0		33
Total	15,048	4,845	534		1,440		21,867
Tonnes	6,744	947	239		350		8,281

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0		0		0
1	47	37	21		1,074		1,180
2	847	624	45		705		2,221
3	2,597	1,180	53		370		4,200
4	3,862	1,295	61		196		5,414
5	6,607	1,858	113		141		8,719
6	4,569	930	139		121		5,758
7	3,124	437	122		27		3,710
8	1,328	111	74		10		1,523
9	1,265	69	87		3		1,424
10	631	30	44		11		716
11	454	11	36		2		502
12	322	2	31		6		361
13	154	2	11		0		167
14	169	2	17		0		188
15+	109	0	5		0		114
Total	26,083	6,588	858		2,667		36,197
Tonnes	10,311	2,199	400		602		13,511

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	13,381		91		13,472
1	6	2	9		242		258
2	203	636	8		622		1,469
3	182	748	18		287		1,235
4	44	242	7		142		436
5	60	239	6		190		494
6	37	86	1		109		234
7	24	27	0		73		124
8	10	5	0		23		38
9	9	4	0		7		20
10	4	1	0		25		31
11	3	1	0		0		4
12	2	0	0		0		2
13	1	0	0		0		1
14	1	0	0		0		1
15+	0	0	0		0		1
Total	588	1,991	13,431		1,811		17,821
Tonnes	157	488	377		675		1,698

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	329	2	10,959		137		11,427
1	51	31	1		345		428
2	87	131	0		469		667
3	112	335	1		215		662
4	47	102	0		104		252
5	53	76	0		147		276
6	21	11	0		77		109
7	11	3	0		68		83
8	3	0	0		14		18
9	2	0	0		1		4
10	1	0	0		6		7
11	1	0	0		0		1
12	0	0	0		0		0
13	0	0	0		0		0
14	0	0	0		0		0
15+	0	0	0		0		0
Total	699	690	10,961		1,583		13,934
Tonnes	131	167	725		531		1,554

Table 2.10 Catch numbers at age for the Southern Mackerel (Numbers * 10^-3).											
GE/YEA	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
0	287887	81221	30419	4927	54829	40961	18896	5118	41728	6234	24899
1	15285	30856	27323	16783	46960	21433	31935	11339	8634	13484	2876
2	3788	3046	13324	8040	4347	5880	7518	9842	5372	7549	7650
3	8599	1934	4862	10580	6652	4360	2662	11552	8889	2477	7949
4	4679	10506	5402	4660	9719	4159	2876	12671	5482	10810	7920
5	6475	3333	13251	9464	3220	6010	4683	6813	7813	4435	13126
6	1643	2050	3727	7019	5588	2767	6615	4136	3430	8242	9425
7	931	722	377	1707	12975	4106	1929	5609	2060	4352	6608
8	1583	524	1522	1818	5610	5532	4718	1337	2908	2106	2899
9	1540	1024	638	1082	1824	1581	5468	1405	868	2260	2735
10	608	941	525	1626	543	819	1532	2899	1053	1424	1393
11	732	775	198	917	291	334	697	523	1186	917	957
12	348	528	3224	483	764	291	596	56	428	542	623
13	500	364	1714	461	716	292	58	111	195	643	275
14	360	313	0	115	125	85	137	79	14	279	336
15+	4	558	3237	241	940	346	145	361	68	1183	148
TOTAL	334962	138694	109745	69921	155105	98956	90465	73851	90128	66937	89819
CATCH (t	20308	18111	24789	22187	24773	18321	21312	20781	18046	19719	25045
SOP	20045	17833	25378	23026	24931	18358	20852	20724	17993	19704	25107
%	99	98	102	104	101	100	98	100	100	100	100

Table 2.11 Length (cm) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1994.

1994	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	21.5	0.0	30.8	0.0	20.5	20.4	20.9	20.9	0.0	21.1
2	31.3	28.9	32.2	31.3	30.7	29.7	27.0	27.0	30.6	28.3
3	32.6	32.2	34.3	32.7	32.6	32.5	29.9	29.9	34.6	33.0
4	34.7	33.8	34.6	34.6	34.8	34.8	32.1	32.1	36.8	34.7
5	36.1	35.9	36.3	35.8	36.5	36.4	33.6	33.6	37.8	36.4
6	37.0	37.3	37.9	36.6	37.6	38.0	37.6	37.6	39.2	37.8
7	38.3	38.5	38.7	38.1	39.2	38.7	34.5	34.5	39.8	38.9
8	38.2	38.7	39.3	37.7	39.0	39.7	0.0	0.0	40.6	39.2
9	40.2	39.7	39.9	39.9	40.4	39.7	37.6	37.6	41.0	40.1
10	40.2	39.9	41.0	39.8	41.2	40.5	0.0	0.0	41.5	41.0
11	41.8	40.4	41.2	41.7	41.9	42.4	0.0	0.0	42.5	41.7
12	41.0	43.1	41.3	40.4	42.4	42.4	0.0	0.0	43.4	42.0
13	40.6	41.3	41.8	40.3	41.2	40.8	0.0	0.0	44.1	41.4
14	41.0	0.0	42.0	0.0	41.5	40.6	0.0	0.0	43.7	41.4
15+	42.2	43.4	44.5	41.9	43.4	42.9	0.0	0.0	45.7	43.7
0-15+	35.5	36.3	36.9	36.1	36.5	36.8	25.2	25.2	39.3	35.7

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	23.0	20.8	0.0	0.0	21.5	22.9
2	0.0	31.9	0.0	24.0	27.7	29.3	31.4	24.0	30.6	28.2
3	34.2	35.7	35.2	34.5	32.1	32.7	33.7	34.5	32.9	32.8
4	36.4	35.7	37.5	34.6	34.2	34.5	35.8	34.6	35.7	34.0
5	37.6	36.4	38.1	35.4	36.5	35.7	36.1	35.4	36.5	35.9
6	38.2	38.0	37.9	36.8	39.0	36.3	36.7	36.8	37.5	37.0
7	39.5	39.7	39.8	34.5	39.4	37.6	37.6	34.5	38.6	38.0
8	39.1	40.5	39.3	0.0	39.2	37.5	39.2	0.0	40.0	37.9
9	39.5	42.9	39.9	39.5	39.7	37.8	39.4	39.5	40.6	38.5
10	40.0	41.8	40.0	41.5	42.2	39.9	39.2	41.5	41.1	40.3
11	40.8	0.0	39.2	0.0	39.5	37.5	39.5	0.0	42.3	39.3
12	42.0	44.2	0.0	0.0	39.5	36.5	0.0	0.0	43.1	41.8
13	0.0	42.0	0.0	0.0	0.0	39.2	0.0	0.0	44.6	39.4
14	0.0	44.7	0.0	0.0	38.5	0.0	0.0	0.0	43.6	41.0
15+	0.0	43.5	0.0	0.0	45.8	41.5	0.0	0.0	45.8	44.7
0-15+	38.2	38.0	38.4	34.8	25.8	34.8	36.4	34.8	36.1	32.8

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0.0	0.0	20.6
1	30.4	0.0	24.1	27.0	26.6	27.5	26.0	27.0	21.5	26.8
2	31.1	32.9	32.2	31.5	29.8	30.3	29.4	31.3	31.1	31.3
3	33.5	34.9	34.6	32.9	33.0	32.0	31.1	32.6	33.5	34.1
4	35.4	35.7	36.1	34.1	34.7	34.0	33.5	33.2	35.8	35.8
5	36.6	37.2	37.8	35.7	36.5	35.0	32.4	35.1	36.2	37.3
6	38.4	38.6	38.8	36.2	37.4	35.9	0.0	0.0	36.9	38.6
7	39.2	38.6	38.9	38.7	37.2	37.3	0.0	0.0	37.9	38.9
8	40.1	40.6	40.1	39.1	38.7	37.3	33.5	0.0	39.6	40.0
9	40.1	41.7	40.5	37.6	37.6	38.0	0.0	0.0	40.1	40.3
10	40.5	42.5	41.7	37.6	39.5	39.8	0.0	35.0	40.5	41.1
11	43.0	42.5	42.3	40.5	43.2	38.5	0.0	0.0	42.0	42.4
12	43.0	45.0	43.5	43.4	42.7	39.6	0.0	0.0	43.2	43.5
13	42.1	43.5	43.6	43.5	0.0	40.7	0.0	0.0	44.6	42.6
14	43.1	0.0	36.7	0.0	39.9	38.4	0.0	0.0	43.6	41.1
15+	42.9	47.5	44.8	44.8	44.9	40.5	0.0	0.0	45.8	43.9
0-15+	36.3	38.0	37.8	29.4	35.9	35.7	27.5	28.0	36.7	36.6

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	0.0	17.3	19.7
1	29.0	28.3	29.0	28.1	27.7	28.1	28.0	28.6	26.9	28.3
2	32.7	33.9	32.8	31.4	32.0	32.1	32.0	32.2	31.3	32.4
3	34.5	35.2	34.7	32.4	33.6	33.5	33.0	33.0	33.8	34.5
4	36.1	36.0	36.3	0.0	34.5	35.4	32.7	34.8	35.3	36.0
5	37.2	37.3	37.6	35.5	35.8	36.6	33.8	33.5	36.5	37.5
6	38.8	38.1	38.7	34.5	38.4	37.4	0.0	39.0	36.5	38.7
7	39.4	39.6	39.3	34.5	38.3	38.7	0.0	40.5	37.8	39.3
8	39.9	40.8	40.1	0.0	38.5	36.0	32.5	41.5	39.5	40.0
9	40.0	41.0	40.2	0.0	36.5	39.5	0.0	36.8	39.8	40.0
10	40.9	41.3	40.5	0.0	43.5	36.5	0.0	38.5	40.1	40.4
11	41.6	41.5	41.8	37.5	0.0	0.0	0.0	39.0	41.8	41.0
12	41.8	43.8	42.2	0.0	38.5	0.0	0.0	39.5	43.1	42.0
13	42.7	0.0	42.4	0.0	0.0	0.0	0.0	41.0	44.7	42.0
14	42.6	44.5	43.0	37.5	0.0	42.5	0.0	38.5	43.6	42.3
15+	43.2	47.4	42.7	40.4	0.0	0.0	0.0	0.0	45.9	42.8
0-15+	36.3	38.0	36.7	30.2	31.0	31.3	31.2	33.9	29.3	35.4

Table 2.12 Length (cm) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1994.

1994	VIIIc East	VIIIc West	IXa North	Xa Centr-	Xa Centr-	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	22.4	26.6	25.9		29.8		28.0
2	29.6	28.7	30.4		29.7		28.9
3	33.6	30.7	32.8		33.8		31.8
4	37.2	34.4	36.1		35.8		36.7
5	37.8	35.1	37.3		37.1		37.6
6	39.0	36.3	39.0		37.7		38.9
7	39.6	37.7	39.8		39.5		39.6
8	40.4	39.1	40.8		41.5		40.4
9	41.0	39.8	41.4		41.8		41.0
10	41.2	39.6	41.8		40.9		41.2
11	42.1	40.9	42.4		42.7		42.1
12	43.1	42.2	43.7		43.0		43.1
13	42.8	41.8	43.4		0.0		42.8
14	43.0	42.1	43.5		0.0		43.1
15+	45.2	45.5	45.1		0.0		45.2
0-15+	38.9	29.8	38.3		32.0		36.4

	VIIIc East	VIIIc West	IXa North	Xa Centr-	Xa Centr-	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	25.6	25.4	25.0		28.8		28.5
2	30.3	30.0	29.8		29.7		30.0
3	33.2	32.8	32.3		33.6		33.1
4	36.1	35.5	36.3		35.7		35.9
5	36.9	36.1	37.6		36.9		36.7
6	38.0	36.8	39.4		37.4		37.9
7	39.0	37.8	40.1		39.2		38.9
8	40.2	39.1	41.1		40.2		40.2
9	41.0	39.7	41.5		41.9		41.0
10	41.3	39.4	41.8		40.7		41.2
11	42.5	40.7	42.4		42.2		42.4
12	43.6	42.1	43.7		39.7		43.5
13	43.8	41.2	43.3		0.0		43.8
14	43.5	41.2	43.4		0.0		43.5
15+	45.5	45.6	44.9		0.0		45.5
0-15+	37.4	35.1	38.7		31.3		36.6

	VIIIc East	VIIIc West	IXa North	Xa Centr-	Xa Centr-	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	ength (cm	length (cm	length (cm	length (cm	length (cm	length (cm	length(cm)
0	0.0	0.0	16.2		27.5		16.3
1	24.8	26.5	28.5		29.9		29.7
2	30.1	30.0	30.6		34.7		32.0
3	31.2	31.8	32.0		35.8		32.6
4	35.0	34.1	33.6		36.5		34.9
5	36.4	34.4	34.3		36.9		35.6
6	37.9	35.6	36.4		36.7		36.5
7	39.0	37.4	36.9		38.2		38.2
8	40.1	39.9	38.2		39.9		39.9
9	40.9	40.2	38.1		40.5		40.6
10	41.0	40.0	37.5		40.7		40.7
11	42.0	41.2	0.0		0.0		41.8
12	43.5	43.2	0.0		0.0		43.5
13	43.0	41.8	0.0		0.0		42.7
14	43.2	41.2	0.0		0.0		42.9
15+	45.7	46.9	0.0		0.0		46.1
0-15+	32.9	32.1	16.3		34.7		20.4

Table 2.12 (continued)

	VIIIc East	VIIIc West	IXa North	Xa Centr-	Xa Centr-	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	24.4	26.5	21.6		21.9		21.7
1	29.1	29.7	28.4		30.3		30.1
2	30.4	31.1	30.4		34.2		33.2
3	31.8	31.8	31.8		36.3		33.2
4	34.4	33.2	33.7		37.0		35.0
5	35.7	34.2	34.6		37.2		36.1
6	37.2	36.5	36.9		36.6		36.7
7	38.2	36.8	37.4		38.1		38.1
8	39.6	38.3	38.2		39.3		39.3
9	40.3	38.5	38.1		40.5		40.3
10	40.1	38.1	37.5		41.1		40.9
11	42.5	43.3	0.0		0.0		42.5
12	42.7	42.5	0.0		0.0		42.7
13	41.8	41.7	0.0		0.0		41.8
14	43.0	43.8	0.0		0.0		43.0
15+	46.7	46.9	0.0		0.0		46.7
0-15+	28.8	32.1	21.6		33.4		23.8

Table 2.13 Weight (g) at age by quarter and by Division(s) for MACKEREL in Sub-areas II-VIII except Div. VIIIc in 1994.

1994	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	70	0	241	0	46	46	55	55	0	58
2	245	184	275	231	229	169	133	133	200	168
3	279	254	339	265	276	239	190	190	302	287
4	343	305	347	319	340	308	242	242	367	336
5	388	390	407	358	393	367	295	295	396	390
6	422	454	468	385	444	425	428	428	444	449
7	474	507	503	436	498	465	312	312	465	491
8	470	515	531	426	509	497	0	0	498	514
9	554	565	560	512	559	279	428	428	515	513
10	556	571	608	508	593	547	0	0	532	590
11	630	608	625	590	652	646	0	0	577	639
12	597	713	623	539	659	648	0	0	614	643
13	579	656	652	531	604	565	0	0	644	616
14	597	0	663	0	628	550	0	0	625	617
15+	653	742	801	605	720	677	0	0	724	747
0-15+	377	416	440	374	414	384	114	114	453	390

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	86	60	0	0	64	85
2	0	305	0	84	156	172	217	84	200	160
3	388	399	427	358	233	227	275	358	256	237
4	438	410	527	313	286	278	333	313	330	291
5	495	445	542	347	354	324	343	347	354	343
6	520	465	531	393	471	345	360	393	386	396
7	549	534	573	320	429	391	390	320	424	418
8	603	573	700	0	457	375	445	0	476	402
9	589	703	633	480	480	411	450	480	498	452
10	587	626	587	570	570	482	442	570	518	506
11	605	0	612	0	499	412	453	0	569	517
12	579	774	0	0	484	333	0	0	603	599
13	0	620	0	0	0	461	0	0	671	471
14	0	782	0	0	441	0	0	0	622	562
15+	0	685	0	0	744	496	0	0	731	710
0-15+	514	492	554	333	143	301	355	333	349	278

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight(g)
0	0	0	0	0	0	0	54	0	0	54
1	251	0	124	155	146	170	128	153	64	150
2	307	354	329	260	208	227	194	248	210	299
3	393	428	416	318	265	278	231	289	270	399
4	477	467	489	360	316	317	340	291	333	477
5	529	539	569	421	355	320	251	355	345	536
6	631	608	615	474	392	344	0	0	366	609
7	657	607	621	598	388	379	0	0	401	618
8	688	709	678	585	430	397	295	0	458	664
9	700	765	701	511	398	397	0	0	476	892
10	726	812	767	558	444	456	0	447	493	724
11	908	811	798	647	561	426	0	0	557	805
12	899	951	861	850	772	453	0	0	604	868
13	799	861	865	861	0	504	0	0	671	793
14	858	0	696	0	512	414	0	0	623	891
15+	919	869	929	925	917	466	0	0	730	910
0-15+	524	578	571	229	349	354	158	177	379	522

	IIa	IIIa	4A	4BC	6A	7BCJK	7AEFGH	7D	8ABDE	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	75	0	36	54
1	196	189	198	181	160	162	166	169	153	174
2	296	350	308	266	265	259	261	265	259	283
3	359	401	377	287	315	301	288	317	323	364
4	426	437	447	0	348	329	235	316	382	432
5	466	499	506	424	391	414	357	272	431	500
6	542	537	562	334	510	447	0	551	442	561
7	563	613	587	319	503	506	0	614	396	586
8	595	672	628	0	508	388	303	556	453	625
9	585	678	620	0	426	547	0	394	468	606
10	642	698	649	0	789	407	0	445	480	639
11	677	703	695	439	0	0	0	497	546	641
12	690	832	736	0	508	0	0	503	602	714
13	759	0	761	0	0	0	0	545	675	705
14	755	864	780	503	0	704	0	490	622	732
15+	783	812	749	548	0	0	0	0	732	746
0-15+	442	530	475	237	246	243	241	328	235	419

Table 2.14 Weight (g) at age by quarter and by sub-division of SOUTHERN MACKEREL in 1994.

1994	VIIIc East	VIIIc West	IXa North	Xa Centr-	IXa Centr-	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0		0		0
1	74	130	119		178		150
2	184	168	205		176		170
3	282	210	261		281		237
4	385	305	361		336		371
5	406	328	401		382		400
6	447	364	461		406		445
7	469	412	493		474		469
8	498	463	537		564		499
9	521	492	562		573		523
10	531	484	578		532		533
11	569	536	606		644		571
12	612	595	668		676		617
13	599	579	655		0		602
14	614	590	661		0		616
15+	717	762	738		0		719
0-15+	449	196	449		241		379

	VIIIc East	VIIIc West	IXa North	Xa Centr-	IXa Centr-	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0		0		0
1	116	113	106		159		155
2	198	195	191		175		190
3	266	261	250		275		265
4	349	338	365		336		346
5	374	359	409		374		371
6	415	382	477		392		411
7	449	418	505		461		447
8	496	464	549		501		496
9	525	487	566		581		526
10	535	478	581		524		535
11	587	527	606		620		587
12	632	591	666		503		632
13	648	551	650		0		647
14	630	549	655		0		631
15+	722	770	731		0		722
0-15+	399	332	466		222		375

Table 2.14 (continued)

	VIIIc East	VIIIc West	IXa North	Xa Centr-	IXa Centr-	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight(g)
0	0	0	27		158		28
1	105	128	164		216		212
2	197	194	206		355		263
3	219	235	240		399		271
4	318	294	283		427		340
5	357	306	301		440		364
6	405	343	368		430		394
7	439	403	385		495		464
8	481	495	428		575		539
9	510	506	424		606		544
10	518	501	402		617		598
11	558	552	0		0		557
12	621	647	0		0		622
13	600	584	0		0		596
14	606	552	0		0		597
15+	737	842	0		0		770
0-15+	269	246	28		366		95

	VIIIc East	VIIIc West	IXa North	Xa Centr-	IXa Centr-	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	98	128	66		73		67
1	175	188	162		223		214
2	203	218	203		342		304
3	234	234	236		420		295
4	305	272	287		447		350
5	344	299	312		453		390
6	394	370	382		425		414
7	429	380	399		490		477
8	479	433	428		547		532
9	505	439	424		606		537
10	499	426	402		640		611
11	603	655	0		0		603
12	607	606	0		0		607
13	569	574	0		0		569
14	625	678	0		0		626
15+	830	840	0		0		830
0-15+	188	245	66		334		111

Table 2.15 Catch weights at age (kg) for the Southern Mackerel.

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

Table 2.16 Stock weights at age (kg) for the Southern Mackerel.

GE/YEA	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
2	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193
3	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291
4	0.361	0.361	0.361	0.361	0.361	0.361	0.361	0.361	0.361	0.361	0.361
5	0.397	0.397	0.397	0.397	0.397	0.397	0.397	0.397	0.397	0.397	0.397
6	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429
7	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463
8	0.505	0.505	0.505	0.505	0.505	0.505	0.505	0.505	0.505	0.505	0.505
9	0.526	0.526	0.526	0.526	0.526	0.526	0.526	0.526	0.526	0.526	0.526
10	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536
11	0.546	0.546	0.546	0.546	0.546	0.546	0.546	0.546	0.546	0.546	0.546
12	0.595	0.595	0.595	0.595	0.595	0.595	0.595	0.595	0.595	0.595	0.595
13	0.591	0.591	0.591	0.591	0.591	0.591	0.591	0.591	0.591	0.591	0.591
14	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592	0.592
15+	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651

Table 2.17 Catches in tonnes of *Scomber japonicus* in Divisions VIIIb, VIIIc and IXa in the period 1982–1994

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Spain	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903
	VIIIc west	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903
	IXa North	0	0	0	0	0	0	0	0	0	0	0	2557	7560
	IXa South	-	-	-	-	-	-	-	-	-	-	895	800	1013
	Total	0	0	0	0	0	0	0	0	0	0	895	3357	8573
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903
Portugal	IXa CN, CS & S	-	-	-	-	-	-	-	-	-	10000	9000	7333	4440

- not available

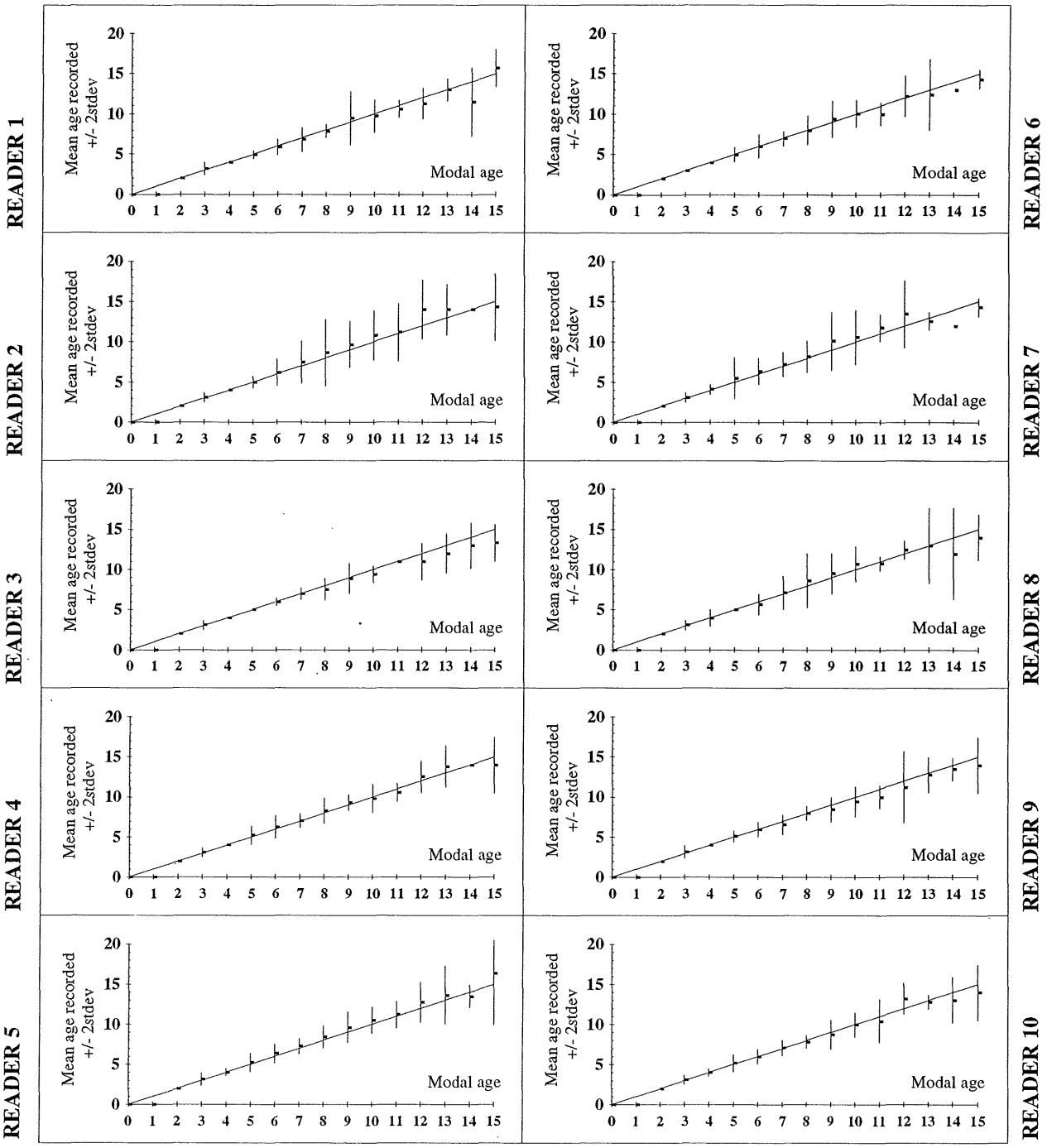


Figure 2.1 In above age bias plots the mean age recorded +/- 2stdev of each age reader is plotted against the modal age.

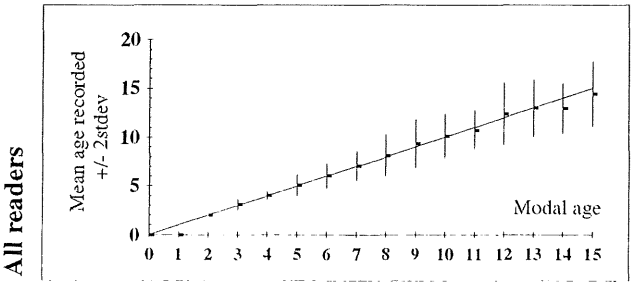


Figure 2.2 In above age bias plot the mean age recorded +/- 2stdev of all age readers is plotted against the modal age.

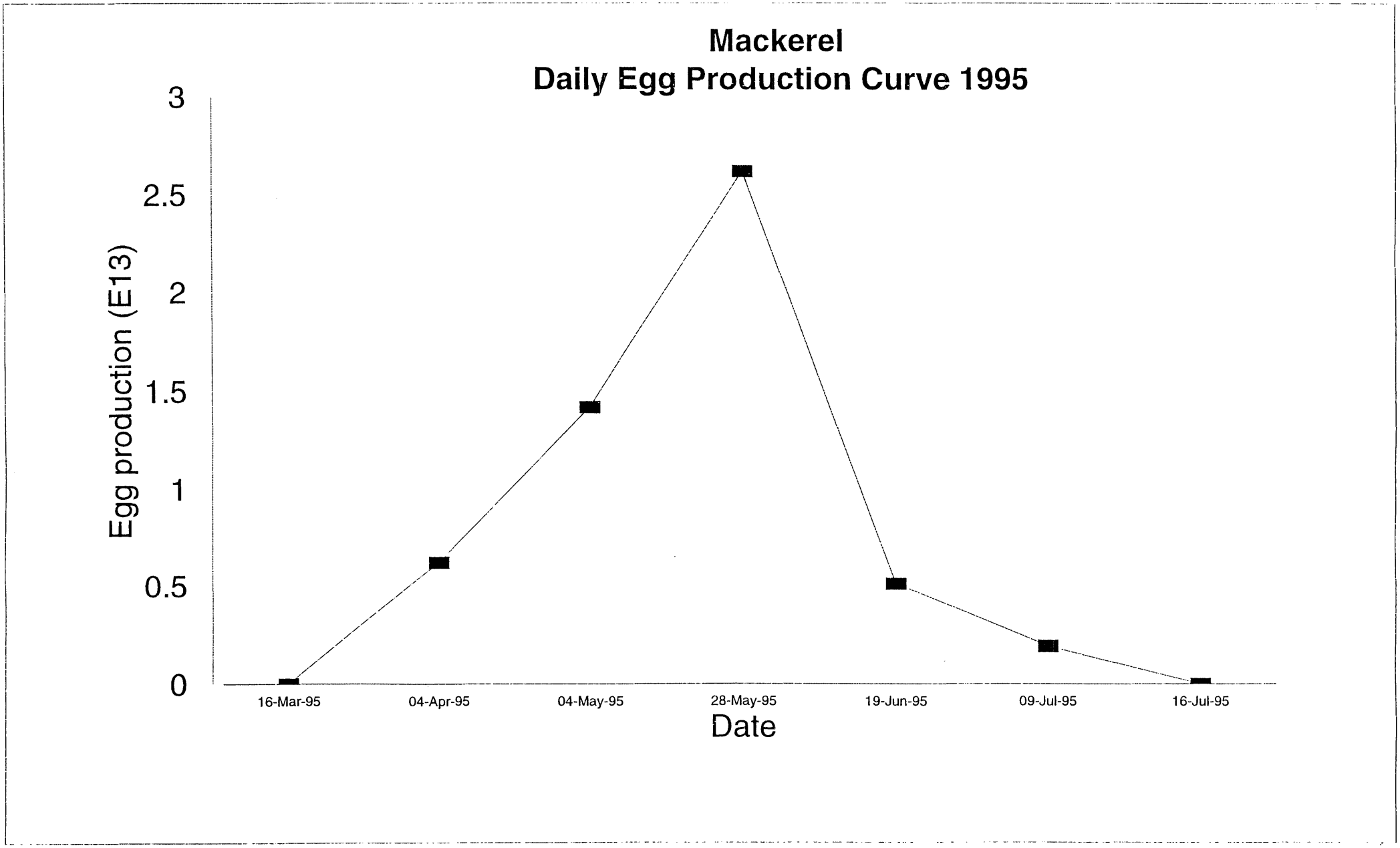


Figure 2.3 Western Mackerel. Daily Egg Production Curve 1995.

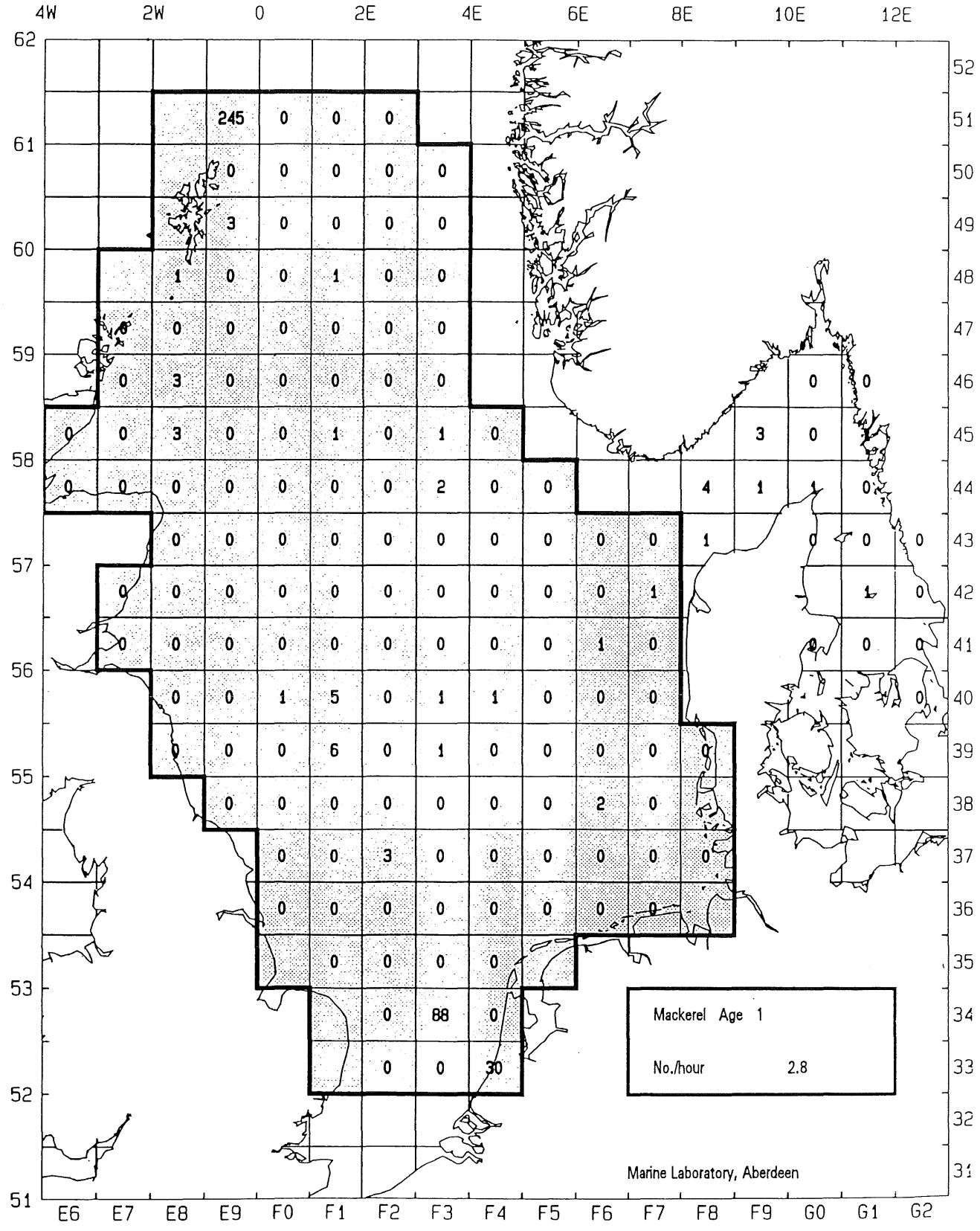


Figure 2.4 The distribution of age 1 group mackerel as numbers per hour from the International Bottom Trawl Surveys of the North Sea in the record quarter of 1994 (provisional).

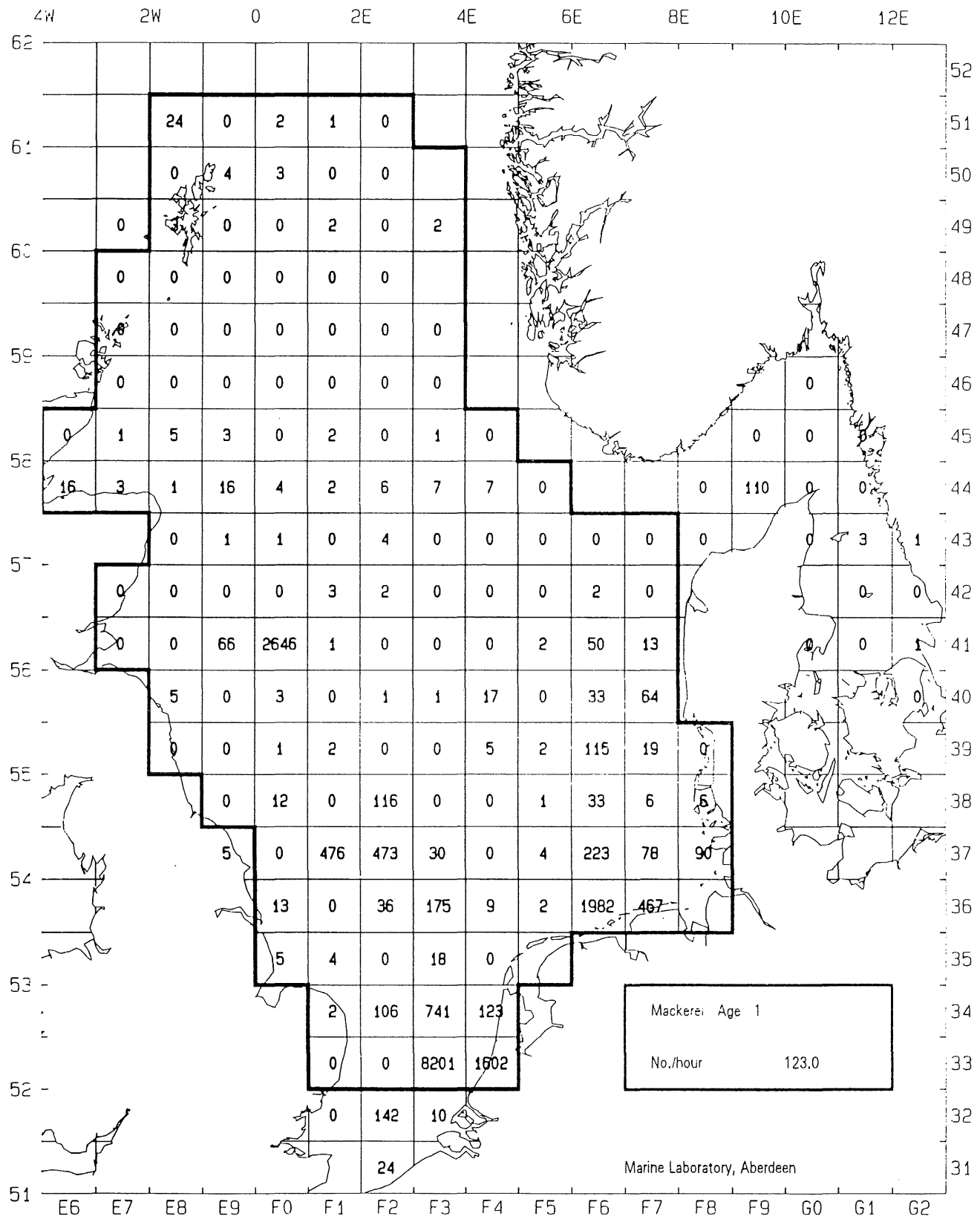


Figure 2.5 The distribution of age group 1 mackerel as numbers per hour from the International Bottom Trawl Surveys of the North Sea in the 3rd Quarter 1994 (provisional).

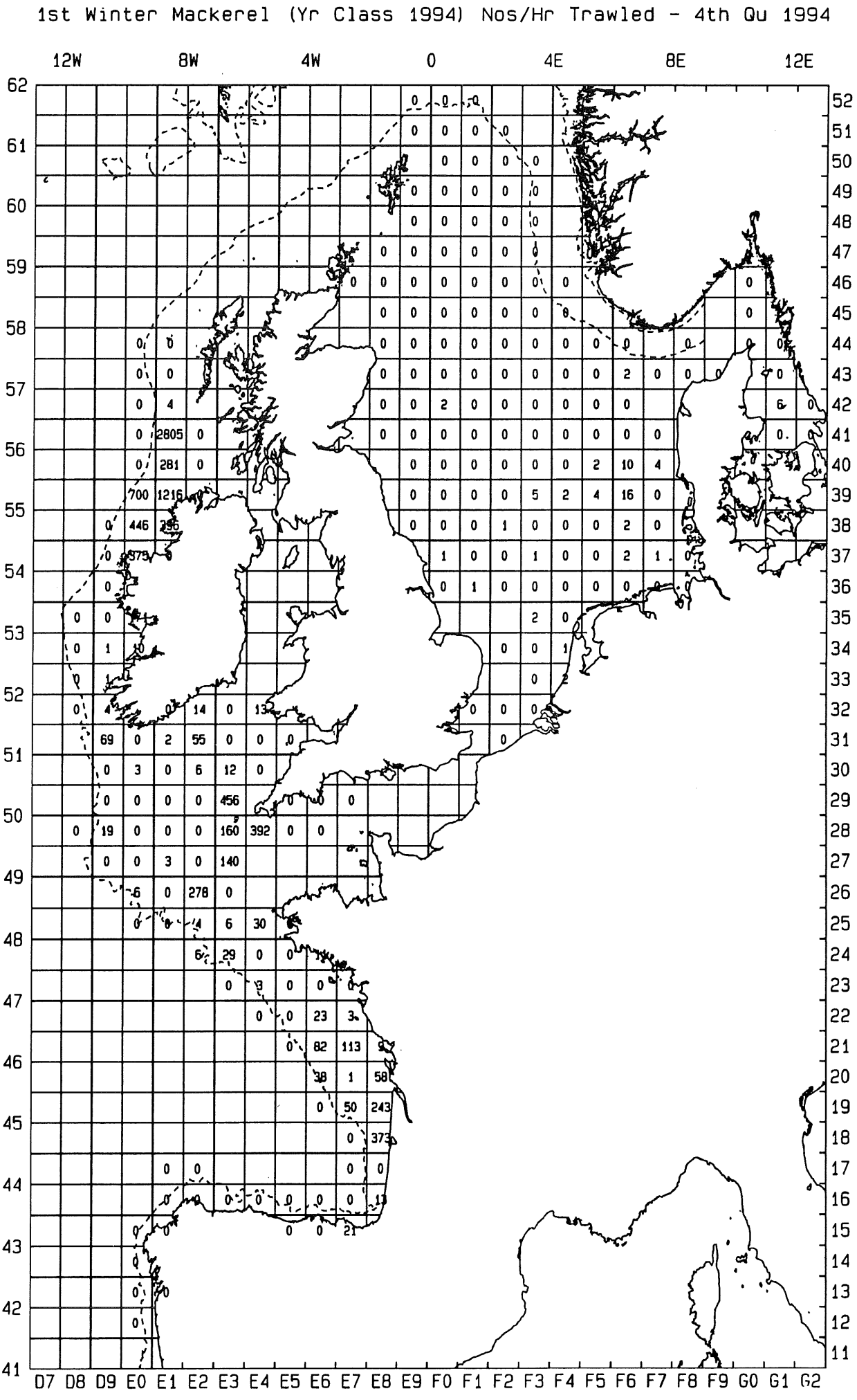


Figure 2.6 The distribution of the 1994 year class, number per hour, from the International Bottom Trawl Surveys in the 4th Quarter 1994 (provisional).

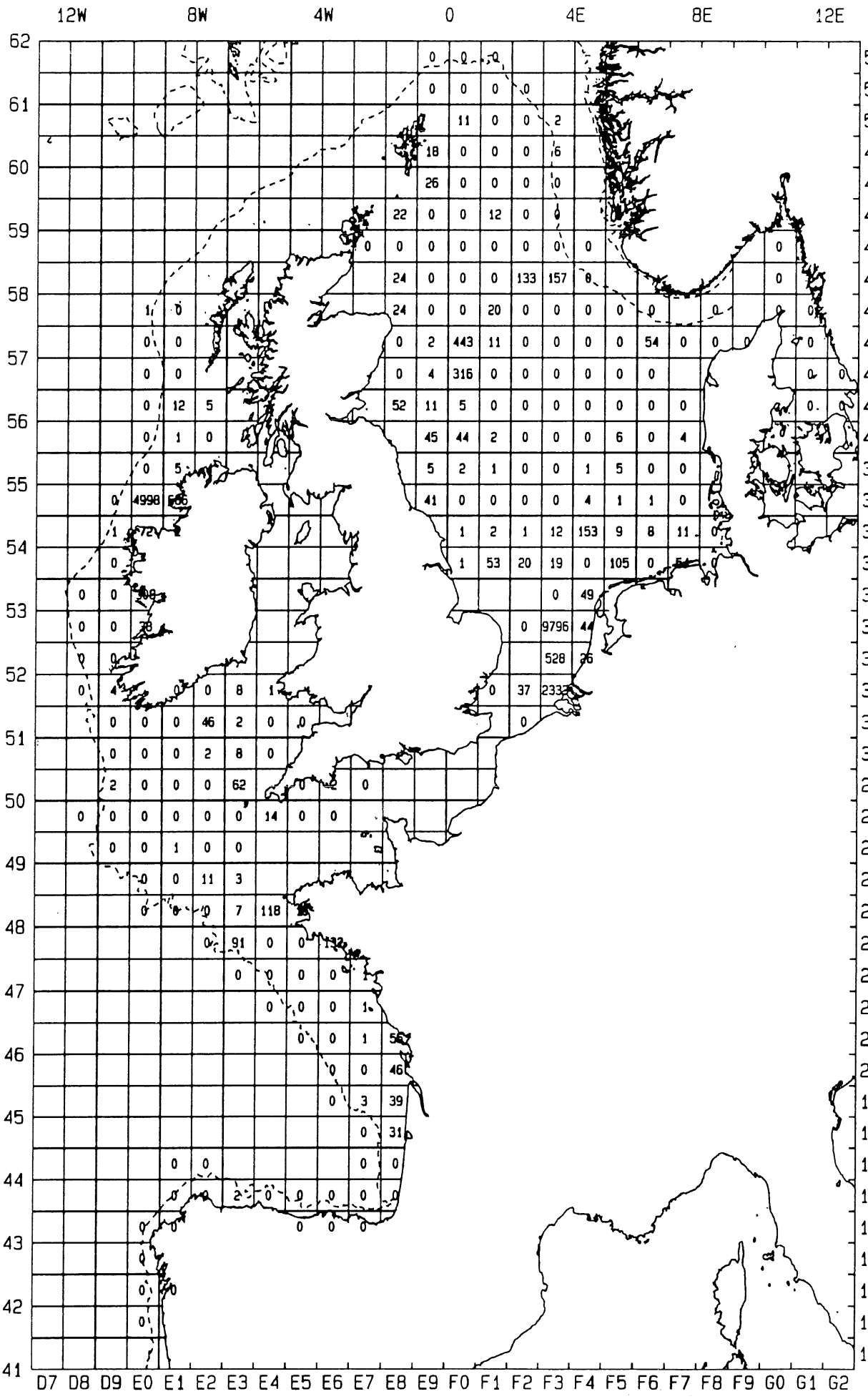


Figure 2.7 The distribution of the 1993 year class, number per hour, from the International Bottom Trawl Surveys in the 4th Quarter 1994 (provisional).

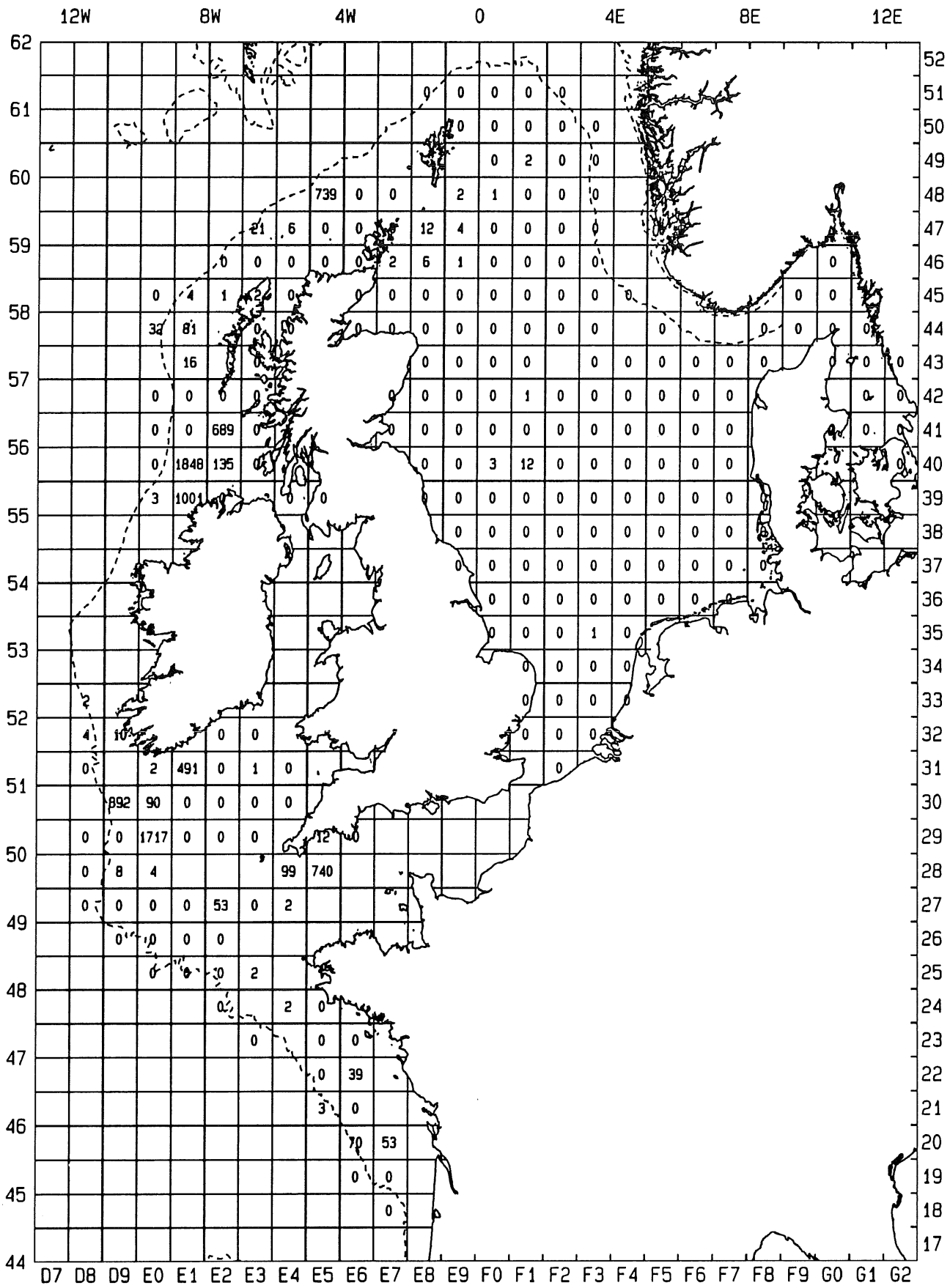


Figure 2.8 The distribution of the 1994 year class, numbers per hour, from the International Bottom Trawl Surveys in the 1st Quarter 1995 (provisional).

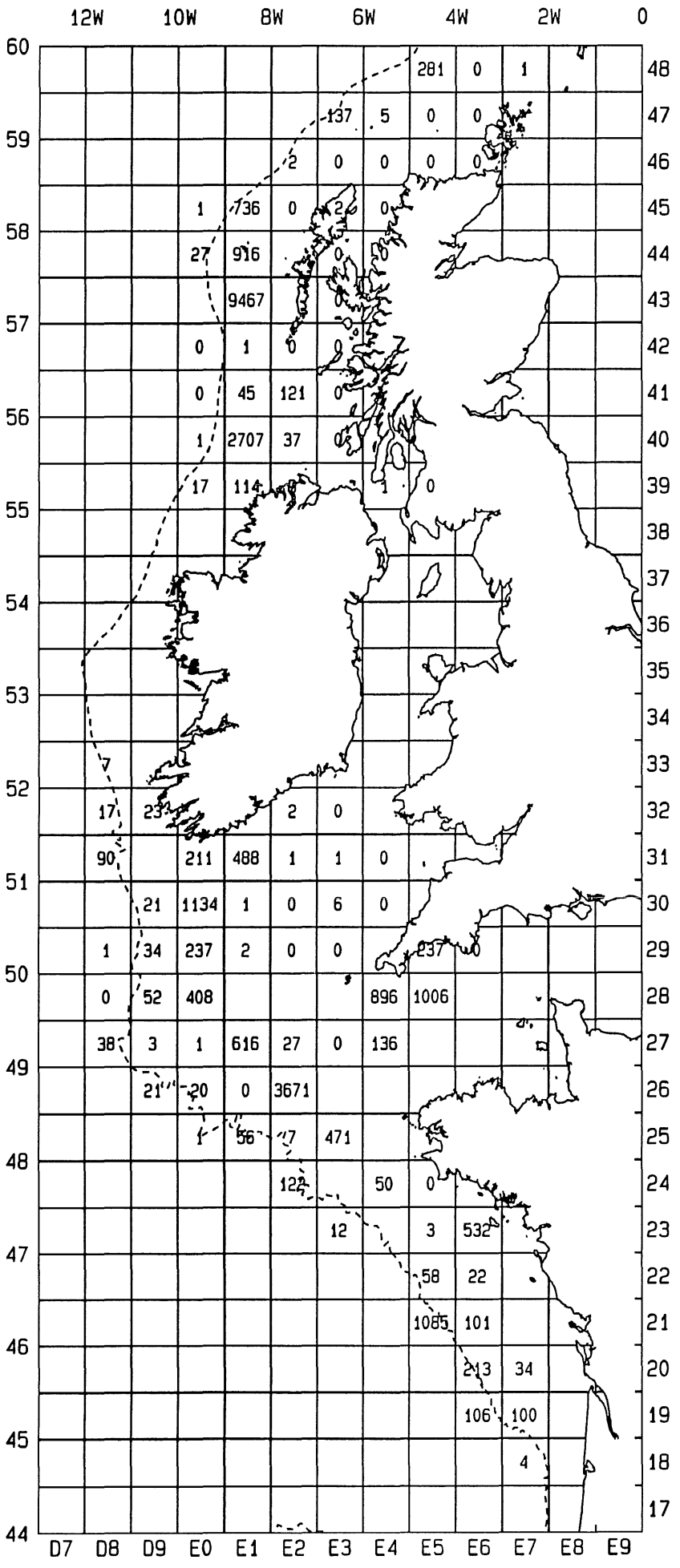
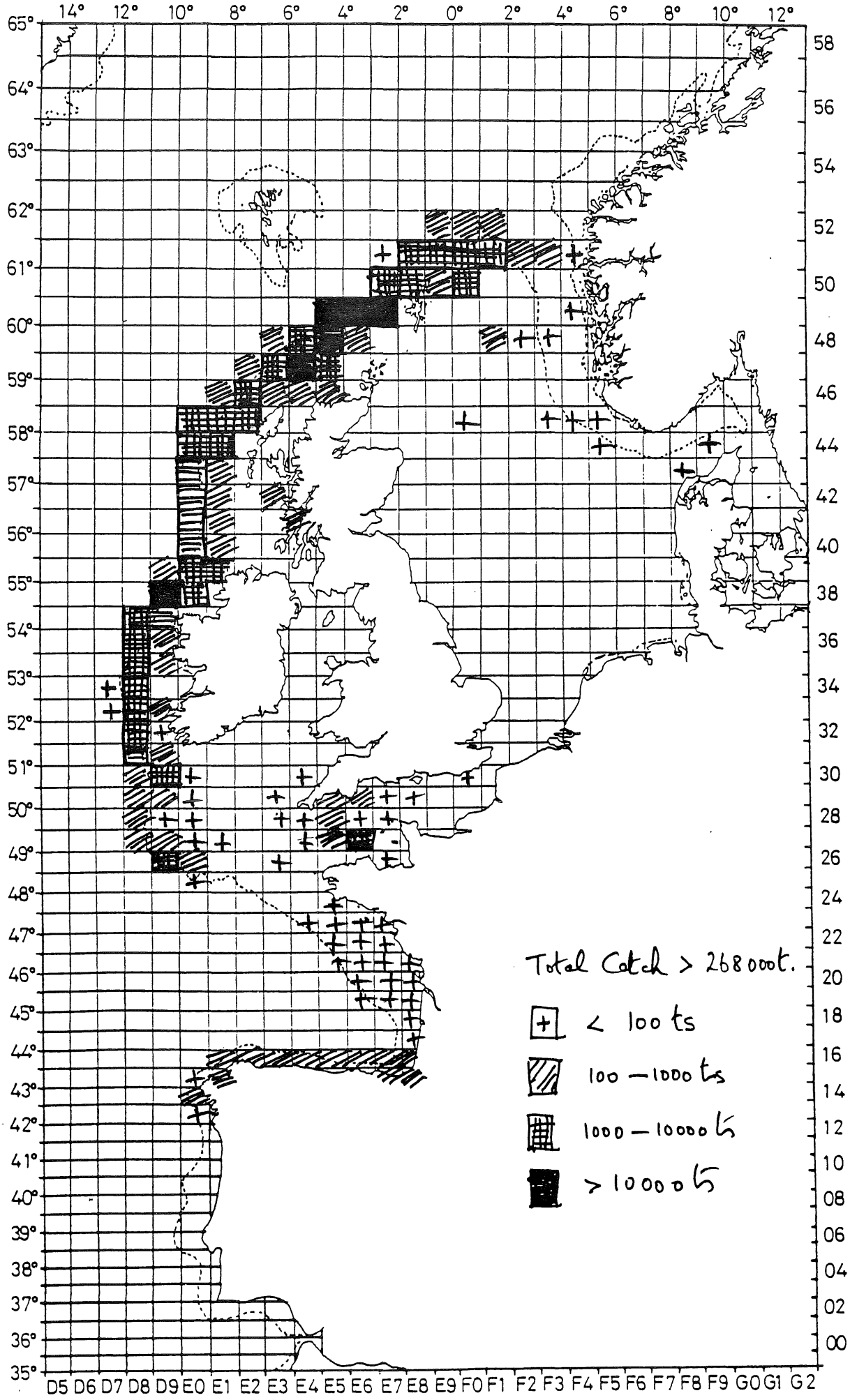


Figure 2.9 The distribution of the 1993 year class, numbers per hour, from the International Bottom Trawl Surveys in the 1st Quarter 1995 (provisional).



44 **Figure 2.10a** Distribution of mackerel fishery. 1st Quarter 1994.

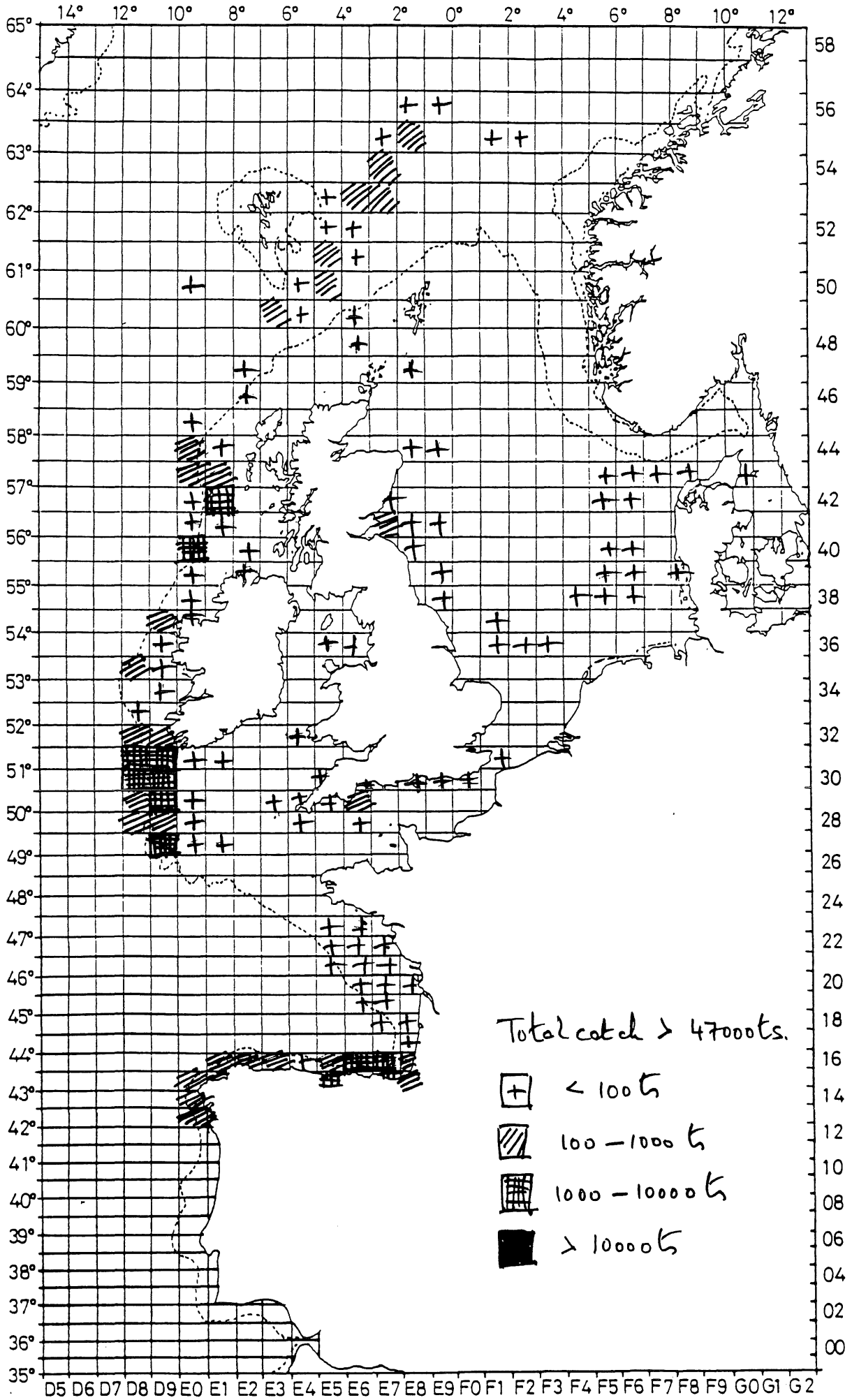


Figure 2.10b Distribution of mackerel fishery. 2nd Quarter 1994.

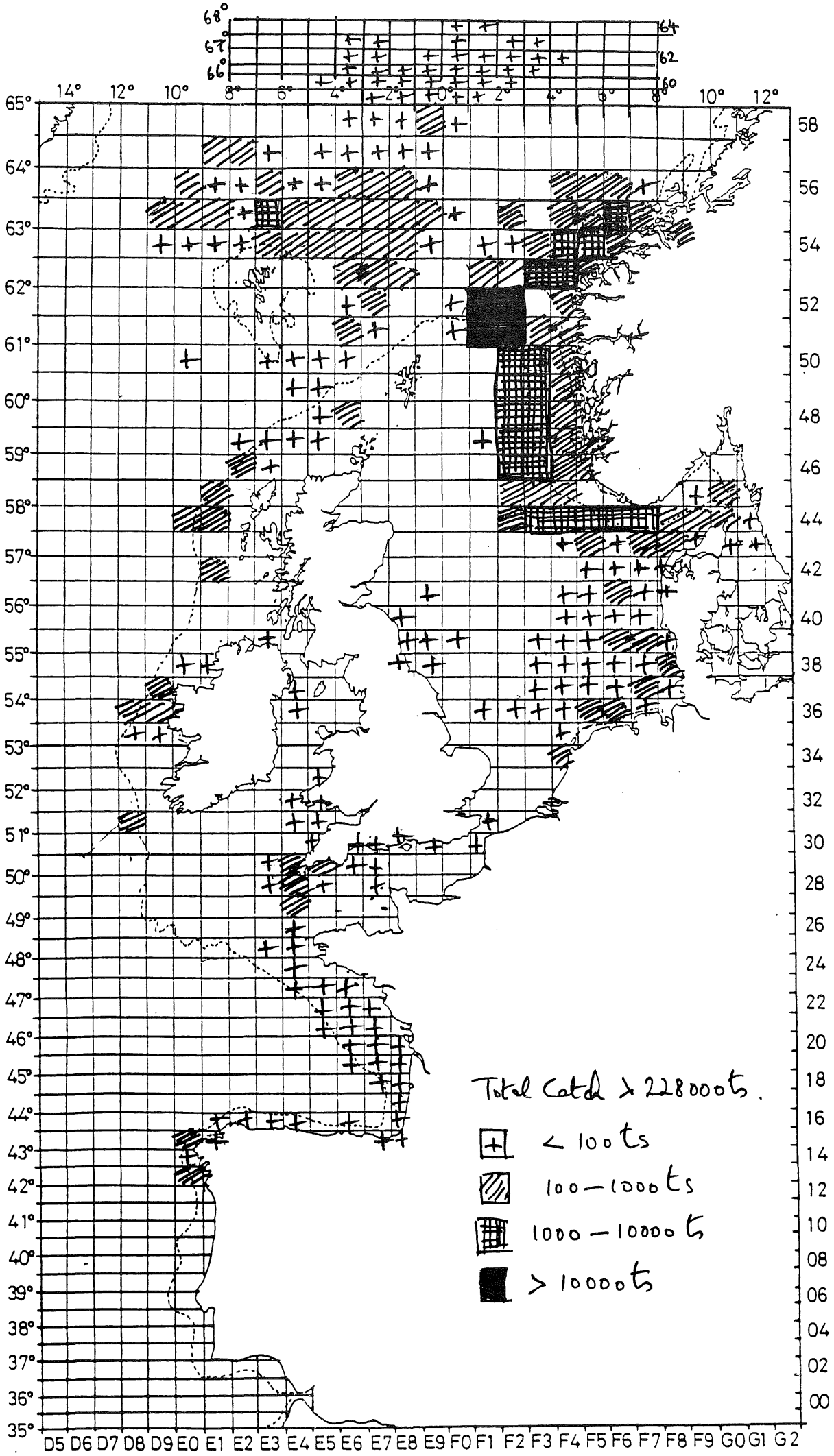


Figure 2.10c Distribution of mackerel fishery. 3rd Quarter 1994.

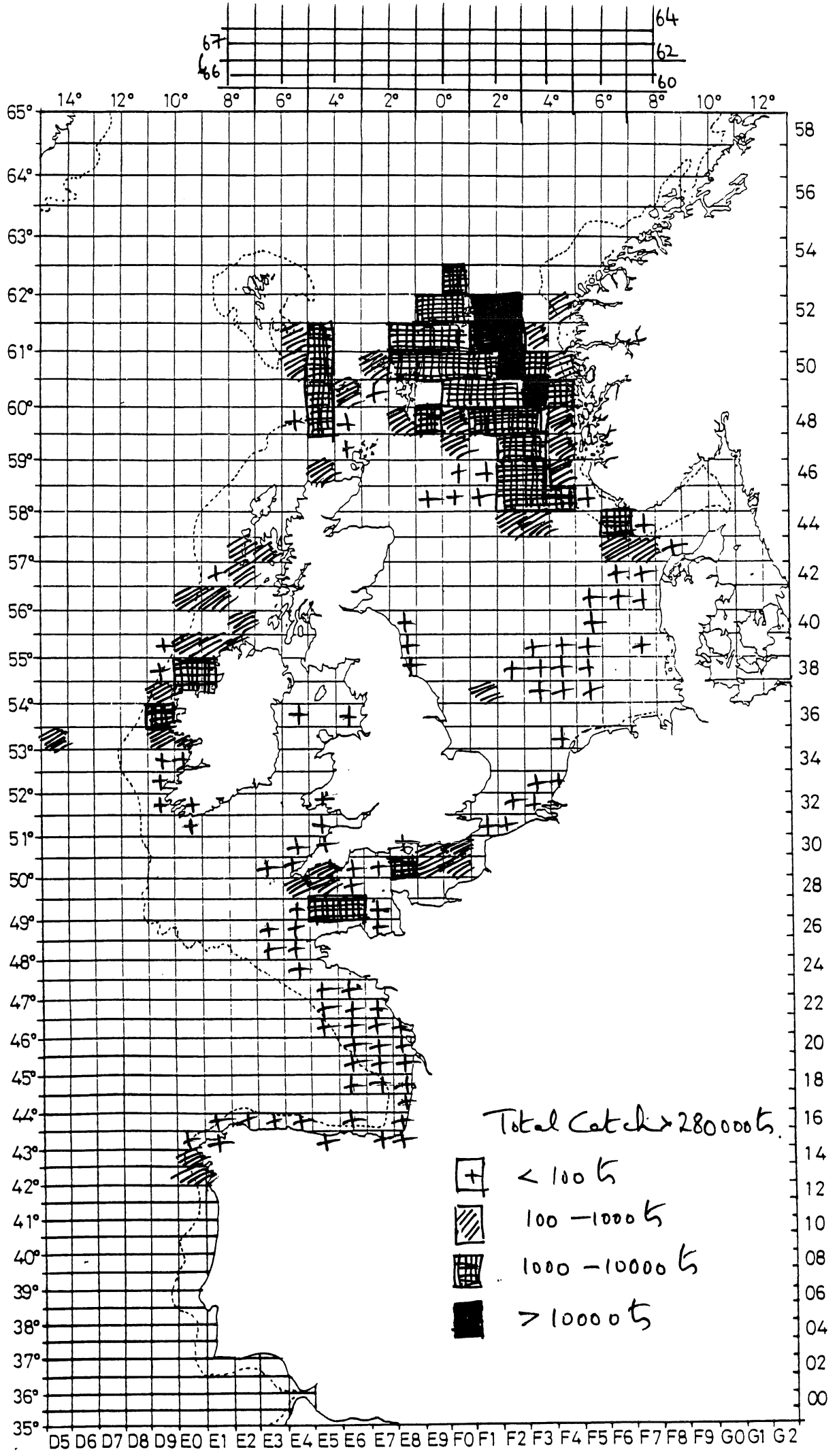


Figure 2.10d Distribution of mackerel fishery. 4th Quarter 1994.

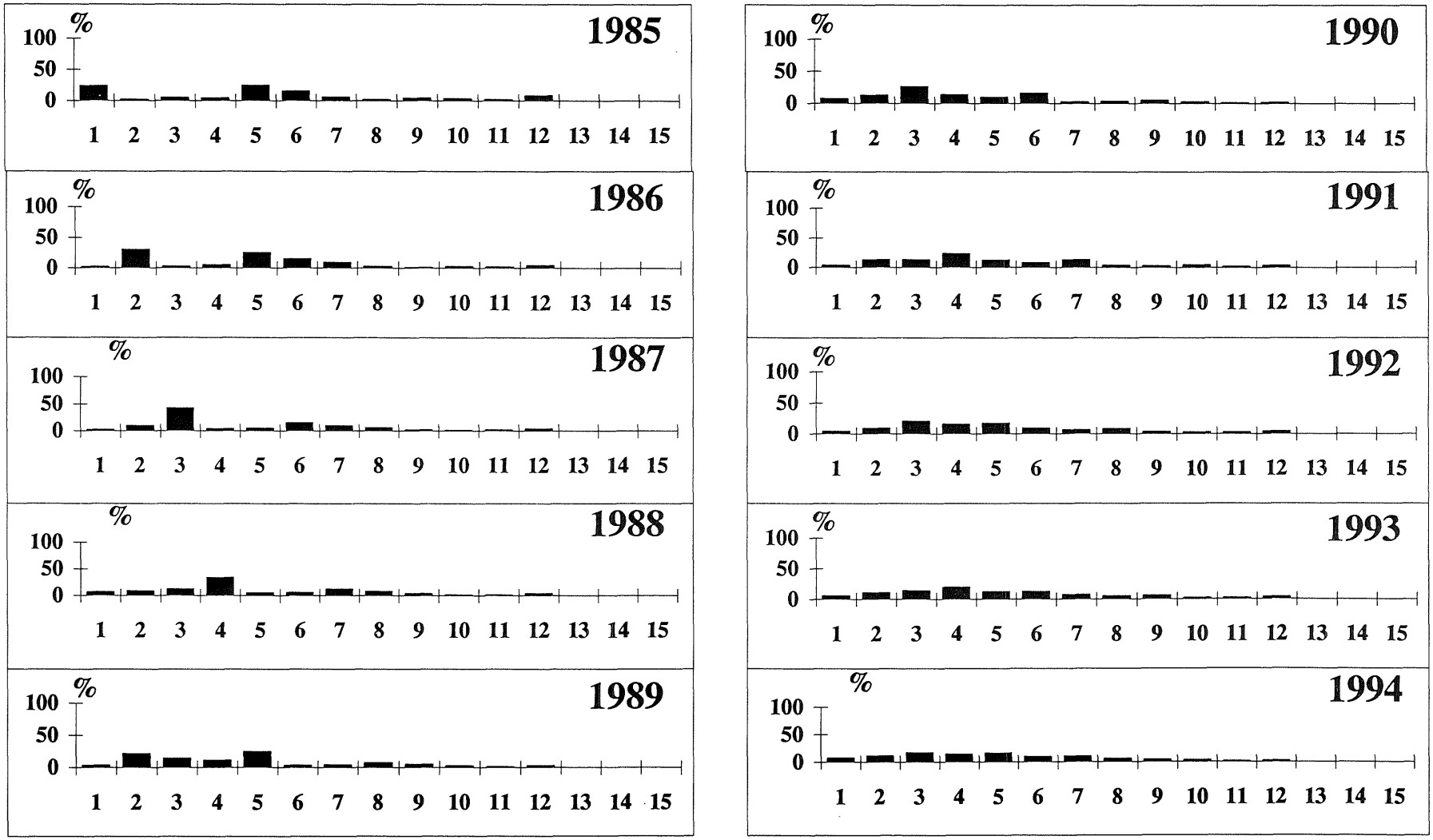


Figure2.11 The age composition of the western mackerel in the international catches from 1982-1994. Age 15 is a plus group.

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3 NORTH SEA, WESTERN AND SOUTHERN MACKEREL (DIVISIONS IIa, IIIa, IVa-c, Vb, VIa-b, VIIa-k, VIII a,b,c,e and IXa)

3.1 North Sea Mackerel

3.1.1 Fishery independent information from egg surveys

No new estimate of total egg production has been made in 1994 as no mackerel egg survey has been conducted.

The areas in the central North Sea known as the main spawning area was last surveyed in 1991 and 1992, with a single coverage of the spawning area in June both years (Anon. 1993). The daily egg production 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) with an estimated total egg production of $53*10^{12}$, corresponding to a SSB of 78,000 tons. It is difficult to evaluate the state of the SSB based on one coverage of the spawning area. However, since the surveys in both years (1991 and 1992) were carried out in mid June, which is close to the peak spawning in the previous years and only small amounts of eggs were observed the Working Group 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 from 1990 to 1992.

Mackerel egg surveys in the North Sea will take place in June-July 1996 (Anon. 1994).

3.1.2 Recruitment

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

3.1.3 Assessment

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

The spawning stock biomass and the catches for the North Sea mackerel Stock have been reviewed by the Working Group for the period 1966 to 1994 and are given in Table 3.2. There is no evidence of stock recovery.

3.1.4 Management measures and considerations

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

The Working Group recommends that the North Sea should be closed to mackerel fishery until the Western stock enters the area late July/early August. The Working Group thereby support the recommendations made by ACFM in 1994:

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

The closure of the mackerel fishery in Divisions IVb,c and IIIa the whole year will protect the North Sea stock in this area and the juvenile Western fish which are numerous particularly in Division IVb,c during the second half of the year. This closure has unfortunately resulted in increased discards of mackerel in the non-directed fisheries in the these area. At present vessels are permitted to take only 10% of their catch as mackerel by-catch. Two trawlers pairtrawling for horse mackerel in Division IVb,c in the period August to October 1994 have been reported to contain 16 to 52 percent of mackerel with an average of 29 percent. The total catch of all species for these to trawlers were 2508 tonnes during this period.

For 1994 the reported landings of mackerel in Division IIIa and IVb,c have been 7943 and 3109 tonnes respectively and with the above mentioned percentage of mackerel in the catches in Division IVb,c the catches could have been 2 to 3 times as large in this area. In addition it is unknown to the Working Group whether all by catches are reported to the log books.

3.2 Western Mackerel

3.2.1 Fishery independent information

Table 3.3 presents the catches of mackerel by the MAFF Western Approaches March ground fish survey, carried out in each year since 1984.

In 1994 the survey was unfinished due to gear failure, only a limited area within VIIj was covered. The catches at length were raised to provide a survey index value for the whole of VIIj. Screening of the raised 1994 values, within an XSA fit, revealed large negative log catchability residuals at all ages. The 1994 survey data was therefore excluded from the following analysis. The remaining data, including the 1995 survey results, were used for further model fits.

A preliminary spawning stock biomass estimate of 1.97 million tonnes of Western mackerel is available from the egg surveys carried out in 1995. This estimate together with the estimates of earlier years is listed in section 4.2.

3.2.2 Recruitment

Last year the recruitment indices for the Western stock were examined in an ICA analysis which incorporated all available tuning data (Anon. 1995b). 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. Attempts to improve the analysis by fitting a Generalised Linear Model were presented in Walsh and Patterson (1995 WD). The new analysis has reduced but not removed the increasing trend, which is still in contradiction with both the Western mackerel and combined assessments performed this year. The Working Group decided not to use the index series for predicting recruitment to the stock until the discrepancy has been resolved.

3.2.3 Maturity at age

Assumptions about maturity made by the Working Group in 1994 were retained for the present assessment, but the basis for these assumptions should be examined in detail at the next meeting of the egg production workshop, as they are critical to the fitting of the populations to the egg surveys.

3.2.4 Stock assessment

Tables 3.4 to 3.6 show the catches in number, mean weights at age in the catch and mean weights at age in the stock.

Following the rejection of the 1994 ground fish survey data (section 3.2.1) an XSA analysis was not possible this year. Two procedures were available for an assessment of this stock, the traditional 'hand tuned' separable VPA and ICA using two selection patterns described in Anon. 1995 and Patterson (1994 WD).

Preliminary investigations were carried out using separable VPA "tuned" to the estimates of SSB derived from the egg production surveys. These revealed that, due to the convergence properties of the VPA, the estimate of reference fishing mortality is heavily influenced by the 1995 egg production SSB estimate. Figure 3.1 shows the sum of squares relationship ([egg production SSB - VPA SSB]^2) for a range of values of reference age fishing mortality. If the 1995 egg production estimate is included in the minimisation, the minimum is well defined at a reference F of 0.3. The time series of SSB estimates derived from a separable VPA using this reference F is presented in Figure 3.2 (complete output in ICES files).

If the 1995 egg production estimate is excluded, the minimum is less well defined and lies within the range 0.28 - 0.32 (Figure 3.1). The 1995 egg production estimate of SSB is provisional (Section 4.2) and should be considered as having an associated error, equivalent to that of the previous estimates (10% c.v.). This is possible within the ICA methodology and the Working Group decided to use ICA for this years assessment, as recommended last year (Anon. 1995).

ICA fits using both the egg production estimates and the Western Approaches survey were used to examine the relationship between the indices and the catch at age data as estimated by a separable VPA. As in last years ICA analysis two selection patterns were used: a terminal selection of 1.0 for the period 1975–1988, and a terminal selection of 1.2 for the years after 1988. Both were calculated relative to the reference fishing mortality at age 5.

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

$$\sum_{a=0}^{a=11}\sum_{y=1985}^{y=1988}\lambda_a\left(\ln(C_{a,y}) - \ln(F_y.S1_a.\overline{N}_{a,y})\right)^2 +$$

$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=1995}\lambda_a\left(\ln(C_{a,y} - \ln(F_y.S2_a.\overline{N}_{a,y})\right)^2 +$$

$$\sum_{y=1984}^{y=1995}\sum\left(\ln(EPB_y) - \ln(\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a - PM.M)\right)^2$$

subject to the constraints:

$$S1_5 = S2_5 = 1.0;$$
$$S1_{11} = 1.0;$$
$$S2_{11} = 1.2;$$
$$F_{1995} = F_{1994};$$

where:

N bar: mean exploited population abundance over the year;
N: population abundance on 1 January;
O: proportion of fish assumed to spawn;
M: Natural mortality;
F: fishing mortality at age 5;
S1, S2: selection at age over the time periods 1985-1989; and 1990–1995, referenced to age 5;
λ: weighting factor set to 0.1 for age 0, 1.0 for all other ages;
a,y: age and year subscripts;
PF, PM: proportion of fishing and natural mortality occurring before spawning;
EPB: Egg production estimates of mackerel spawning biomass;
C: Catches in number at age and year.

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

Tables 3.7 presents the ICA diagnostic output. Tables 3.8, 3.9 and 3.10 present the estimated fishing mortalities and population numbers-at-age and stock summary.

Mean F on ages 4-8 is estimated to have been 0.32 in 1994 and 0.31 in 1993 (3% higher than estimated in last year's assessment (F_{93} = 0.30). Mean F over the period 1990 to 1993 is now estimated to have been 9% lower than estimated last year.

Figure 3.4 shows that whilst the yield remained relatively stable between 1980 and 1990, the spawning stock biomass increased slowly. This resulted from a sustained level of good recruitment. Since 1990 the yield and reference F have increased rapidly, they have stabilised in 1994 but are well above the long term mean. After 1992 the SSB has declined sharply and in 1994 is estimated to be at a historical low (2.03 million tonnes). Recruitment in 1994 is estimated to be extremely low, however this is based on one years catch-at-age data at a low level of fishing mortality.

3.2.5 Catch predictions

The ICA estimated recruitment for 1993 (3909 million) is close to the geometric mean for the series (3467) and was left unchanged. The recruitment for 1994 is estimated to be 136 million. This is well below the historical mean. The estimate is derived from one years 0 group catch at low F and is considered unreliable. However, all information available at the Working Group points to a low 1994 abundance. These are : a) the separable VPA of the catch at age data of both the western and southern areas; b) the 1995 Western Approaches survey which gives a low estimate for the 1994 year class at age 1; c) the previously used recruitment index, for which the last estimate is low if the trend is ignored. In order to provide a conservative estimate of the strength of the 1994 year class within the catch forecast, the Working Group agreed to use an average of the three lowest catches in the historical series (1977, 1982, 1983). This gives a 1994 year class strength of 1375 million. Catch in 1996 and SSB in 1997 are only weakly dependent on the 1994 year class strength.

Table 3.11 presents the input values for the catch forecasts. Apart from the recruitment and 1 group populations, the ICA estimated abundances of all other ages, for 1995, were used as the starting populations in the prediction. The exploitation pattern used in the prediction was the separable ICA F's of the final year. 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 1992–1994.

The anticipated catch from the Western mackerel in 1995 is 650,000 tonnes, 608,080 tonnes by agreed TAC and 41,920 tonnes outside the agreed TAC, which is well below the value of 793,000 tonnes recorded in 1994 (F95 = F94 x 0.915). In 1994 and 1995 discarding is not considered to have been at the same magnitude as in previous years because high prices were being paid for small fish.

The single option catch forecasts show three scenarios:

i) F95 at the anticipated value of 0.915 x F94, with similar values for F96 and F97 (Table 3.12a).
ii) Constant catch at F95 (650,000 tonnes, Tables 3.12b).
iii) F returning to the 1994 level in 1996 and 1997 (Tables 3.12c).

The detailed outputs for each option are given in Tables 3.13 - 3.15.

All three forecasts show SSB continuing the rapid decline estimated for recent years, well below its previous

historic low (2.2 million tonnes). Table 3.16 presents the management option table for a catch of 650,000 tonnes in 1995.

3.2.6 Long-term yield

Figure 3.7 shows the results of the yield per recruit and short term yield calculations. Table 3.17 presents the detailed output. F_{max} was estimated to be at a reference F of 0.57 and $F_{0.1}$ at 0.18. Figure 3.8 illustrates the scatter plot of recruitment at age 0 against spawning stock biomass, together with the estimates of F_{high} (reference F 0.457) F_{med} (0.196) and F_{low} (0.05). The reference F for 1994 is estimated as 0.32, which lies between F_{med} and F_{high}.

3.2.7 Comments on the assessment

The 1995 egg production estimate of SSB is provisional and will be re-calculated in March 1996. The estimate of the 1994 year class is low but uncertain.

Anon. (1991) performed a sensitivity analysis for status quo forecasts made using data from this stock. The results revealed that the forecasts were sensitive to the estimates of the strength of the year class that recruited two years before the year of the assessment. The forecast made this year will be sensitive to the estimate of recruitment in 1993 which now appears to be an average year class (taken as GM in last years assessment).

3.2.8 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 seven months of the year (see Section 3.1). The Working Group supports the continuation of this policy. However, 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 and 1994 the highest on record. Fishing mortality has shown a strong upward trend. The Working Group points out that the current fishing mortality is above F_{med} and that, even with the anticipated reduction in catch in 1995, the spawning stock biomass is predicted to decrease to a historic low. In 1991 ACFM recommended that fishing mortality should be reduced from the levels then prevailing whereas the present assessment indicates that it has only stabilised. 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 and that the TAC should be applied to all areas including international waters.

It is a cause for concern that the recruitment index and the catch at age data are in conflict. 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.

3.3 Southern Mackerel (Divisions VIIIc and IXa)

3.3.1 Effort and catch per unit effort

Table 3.18A shows the data of fishing effort corresponding to different Spanish and Portuguese commercial fleets. For Spain we have the effort of hand-line fleets of Santander and Santona (Sub-division VIIIc East) from 1989 to 1994, for which mackerel is the target species from March to May, the trawl fleets of Aviles and La Coruña (Sub-division VIIIc East and VIIIc West) from 1983 to 1994 and the purse-seine fleet of Vigo (Sub-division IXa North) from 1983 to 1994 . For Portugal we have the fishing effort of the trawl fleet (Sub-division IXa Central-North, Central-South and South) from 1988 to 1994. For the trawler fleet and the purse seiner fleet, the mackerel is a by catch. The trawl fleet effort of the two countries correspond to total annual effort of whole fleet and these fleet have demersal species as their main target.

Table 3.18B shows CPUE corresponding to the fleets referred to in Table 3.18A. The trawl and purse-seine fleets show fluctuations in the periods considered, while the hand-line fleets are relatively stable, and increase being observed for the fleet of Santander in 1994.

Catches per unit effort at age from the Aviles bottom trawl fleet, from the La Coruña bottom trawl and from Portuguese bottom trawl fleet are available from 1988 to 1994, and from the Santona hand-line fleet are available in the period from March to May from 1989 to 1994 (Table 3.19).

3.3.2 Surveys

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

Table 3.20 shows the numbers at age per hour from the Spanish bottom trawl surveys from 1984 to 1994 covering IXa and VIIIc. These surveys are carried out every year in September-October, which is the period when mackerel abundance is very low in this area and these surveys has as its main aim the indices of hake recruitment.

3.3.3 Stock assessment

An assessment of the southern stock was not attempted this year. However, XSA was fitted to the southern area data set in order to examine the potential use of the fleet data as an index of recruitment strength. The log catchability values fitted by XSA have c.v.'s greater than 70%, at all ages, for the majority of fleets. There are strong year effects in all fleets, indicating the fleet effort measures may be inappropriate for this species, or that the catches by the fleets used are not consistent with the total catches at age. When CPUE is plotted against the populations fitted by a separable model there is an apparent contradiction in that CPUE does not follow the changes in abundance determined from the catch at age data.

If the population abundances fitted by a separable VPA of the southern data are plotted against those of a fit to the western mackerel, the population estimates are coincident at the all ages (Figure 3.9a, b, c). The abundant 1980 and weak 1983 and 1982 year classes can be followed through each of the ages. This indicates that the bulk of the southern area catches, which are taken in the eastern part of VIIIc, have an age structure similar to that of the western area.

3.3.4 Comments on the assessment

The fleets in the southern area land a substantial catch of 0 and 1 group mackerel. Given the current problems in the estimation of recruitment to all areas, further analysis of the reasons for the lack of correlation between the fleet CPUE and populations fitted the VPA should be undertaken in order to assess whether a useful recruitment index can be derived from these fleets.

3.4 North East Atlantic (NEA) Mackerel

3.4.1 Fishery independent information

Preliminary spawning stock biomass estimates of 1.97 million tonnes for the western area and 0.327 million tonnes for the southern area are presented in section 2.2. The ratio of the two values (0.14) is similar to that calculated for the 1992 egg surveys (0.19). Taking into account that the 1992 value is the more uncertain of the two, all of the western area egg survey estimates of spawning stock biomass since 1984 were raised by 15% to provide an index of abundance for the combined stock.

Each of the fleet catch per unit effort (CPUE) series provided for the southern area were examined for coincidence with the populations fitted to the catch at age data using the XSA and ICA methods. As described in section 3.3.2 there is no agreement between the fleet data series and the VPA or Separable VPA fitted populations. The CPUE series were excluded from the population models. For reasons described in section 3.2.4 the Western Approaches survey was also excluded from the analysis.

3.4.2 Recruitment

The western mackerel recruitment index was also rejected for reasons given in section 3.2.2.

3.4.3 Data preparation

The analysis was restricted to the years 1984–1994. The data series for the southern area is only available for this period and the stock spawning in the North Sea had been reduced to near the present low level by 1984, so its contribution to the catch at age data was negligible. For the North Sea stock, only data for 1984–1987 were included, since data for the North Sea have been included in the data for the Western stock from 1988 onwards.

Catches from the three areas were summed together. Figure 3.10 shows the relative catches at age for the western and southern areas.

Mean weight in the catch was obtained as a catch number weighted average of the weights used for the three stocks. Catch weights for the 0 and 1 groups are determined primarily from the southern area and those for all other ages primarily from the western area.
Weights in the stock and maturity ogives were obtained as averages weighted by the relative proportion of the egg production spawning stock biomass within the respective areas. For the North Sea spawners, the biomass estimates by egg surveys since 1984 range from 37 to 133 thousand tonnes (Anon. 1989), which corresponds to approximately 1.5% to 4.5% of the combined North Sea and Western spawners. Thus, for combining the North Sea and Western stock data, weighting factors of 0.03 and 0.97 respectively were applied. Weighting factors of 0.15 and 0.85 were used for the Southern and Western data.

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

3.4.4 Stock assessment

Tables 3.21 to 3.23 show the catches in number, mean weights at age in the catch and mean weights at age in the stock.

A similar procedure to that used for the assessment of the Western mackerel was used for the combined assessment. A terminal selection of 1.0 was used for the period 1975–1988, a terminal selection of 1.2 for the years after 1988. Both were calculated relative to the reference fishing mortality at age 5.

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

$$\sum_{a=0}^{a=11}\sum_{y=1985}^{y=1988}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S1_a.\overline{N}_{a,y}))^2 +$$
$$\sum_{a=0}^{a=11}\sum_{y=1989}^{y=1995}\lambda_a(\ln(C_{a,y} - \ln(F_y.S2_a.\overline{N}_{a,y}))^2 +$$
$$\sum_{y=1984}^{y=1995}\Sigma(\ln(EPB_y) - \ln(\Sigma_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S2_a - PM.M))^2$$

subject to the constraints

$S1_5 = S2_5 = 1.0$
$S1_{11} = 1.0$
$S2_{11} = 1.2$
$F_{1995} = F_{1994}$

where

N bar	mean exploited population abundance over the year
N	population abundance on 1 January
O	proportion of fish assumed to spawn
M	Natural mortality
F	fishing mortality at age 5
S1, S2	selection at age over the time periods 1985–1989 and 1990–1995, referenced to age 5.
λ	weighting factor set to 0.1 for age 0, 1.0 for all other ages.
a,y	age and year subscripts.
PF, PM	proportion of fishing and natural mortality occurring before spawning.
EPB	Egg production estimates of mackerel spawning biomass.
C	Catches in number at age and year.

Parameter estimates and their standard deviations are listed in Table 3.24. Tables 3.25, 3.26 and 3.27 present the estimated fishing mortalities, population numbers-at-age and stock summary.

Mean F on ages 4–8 is estimated to have been 0.29 in 1994 and 0.28 in 1993, a reduction in the values estimated for the western area. This is consistent with the addition of 15% to the spawning stock biomass and the fact that catches from the ages over which F bar is calculated are derived almost exclusively from the western area. Figure 3.11 compares the F bar calculated for the western assessment with that for the combined.

Figure 3.13 shows that the population parameter estimates are consistent with the those estimated for the western area. SSB estimates decline in recent years and recruitment estimates also decrease. The only major difference between the assessments, apart from the relative level of the parameters, is the estimate for recruitment in 1994. Although low in the combined assessment, it is not as low as the value estimated in the model fit for the western area.

3.4.5 Catch predictions

The recruitment for 1994 is estimated to be 2983 million. This is below the historical mean, but similar to the values assumed in the forecast of the western stock catches. The estimate was retained for the forecasts. Table 3.28 presents the input values for the catch forecasts. Apart from the recruitment in 1995, the ICA-estimated abundances at all ages were used as the starting populations in the prediction. Recruitments in 1995, 1996 and 1997 were taken to be the geometric mean (1975–1993) calculated for western mackerel, raised by the average ratio of the estimated western and southern area recruitments for the period 1984–1992.

Catch forecasts have been calculated for the provision of area based TACs. Two "fleets" have been defined, corresponding to the exploitation of the western area (including the North Sea and international waters - WNS fleet) and that of the southern area (SA fleet).

The exploitation pattern used in the prediction was the separable ICA F's for the final year. This was subdivided into partial Fs for each fleet using the ratio of the fleet catch at each age and the total catch at each age, averaged over the last three years. Weight at age in the catch was taken as an average of the values for the period 1992–1994 for each area. Weight at age in the stock from an average (1992–1994) of the combined data.

The anticipated catch by the WNS fleet in 1995 is 650,000 tonnes, 608,080 tonnes by agreed TAC and 41,920 tonnes outside the agreed TAC, well below the value of 793,000 tonnes recorded in 1994. F95 for the WNS in the combined assessment is 0.914 x F94. The TAC for the SA fleet is 36,570 tonnes but this has never been fully taken. The fishery is a by-catch fishery which has averaged 21,000 tonnes since 1984 (max. 25,000 in 1994, min. 18,000 in 1985).

Three sets of catch forecasts are given:

i) F95 for the WNS fleet, the expected F of 0.914 x F94, with similar Fs for F96 and F97 (Tables 3.29a,b,c,d). SA fleet status quo F in all years.

ii) Constant catch at F95 (650,000 tonnes) for the WNS fleet, SA fleet status quo F in all years (Tables 3.30a,b,c,d).

iii) WNS fleet F returning to the 1994 level in 1996 and 1997, SA fleet status quo F in all years (Tables 3.31a,b,c,d).

As for the western assessment, all three forecasts show SSB decreasing in 1996 (1.9 million tonnes) and 1997 (1.8 million tonnes). This continues the rapid decline estimated for recent years, to well below the previous historic low. Catches by the WNS fleet decrease from 650,000 for scenarios (i) (600,000 tonnes in 1996 and 570,000 in 1997) and (iii) (650,000 tonnes in 1996 and 600,000 in 1997).

Table 3.32 presents the management option table for a catch of 650,000 tonnes in 1995.

3.4.6 Short-term risk analysis

A short-term risk analysis was calculated using the methodology given in section 1.3.1. The following assumptions are made in the calculations:

- Catches by the WNS fleet were constrained to 650 000t in 1995.
- Fishing mortality by the SA fleet was constrained equal to the fishing mortality estimated in 1994.
- 'MBAL' was taken as 2.3 million t, being the value of 2.0 million t for the 'western stock', raised by 15%.
- The estimated risk is the probability that the stock size will fall below the MBAL level at spawning time in 1996 and 1997.
- The response of the estimated risk to different levels of catch by the WNS fleet was calculated over a range spanning complete closure of the fishery for two years, to maintaining catches at 1994 levels.

Parameters were estimated as follows:

- Stock population parameters (Fishing mortality, selection, population abundance at age) were taken directly from the ICA fit (Section 3.4.4).
- The estimate of the variance-covariance matrix provided by the ICA programme was used as the estimate of uncertainty in the stock population parameters.
- Estimates of recruitments in 1995 and later were modelled by fitting a Beverton-Holt function with autocorrelated errors. Stock and recruit parameter estimates over the period from 1974 to 1995 were used (estimates from 1974 to 1984 were 'western stock' values raised by 15%). Virtually no dependence of recruitment on stock size could be detected over the range of stock sizes observed historically, and the fitted function is virtually flat over these values.
- Mean weights at age in the catches and the fleet partial-F ratio at age were calculated as arithmetic means over the years 1993–1995 and were assumed to be known precisely thereafter.
- The mean and variance of maturity ogive and weights in the stock were estimated from observations from 1993 to 1995.

The results are shown in Figure 3.16a and b. Stock size in 1995 is estimated as being close to MBAL, hence in order to allow the stock size to have a 50% chance of recovering to the MBAL by 1996 it would be necessary to reduce the catches from the 1995 level of 650,000 t to approximately 240,000 t in 1996. Over a two-year period however, this analysis indicates that it would be sufficient to reduce catches to about 410,000 t for a two-period in order to achieve a 50% chance of recovery to MBAL. Uncertainties due to model specification preclude calculations over longer periods, particularly when the stock is at its lowest historical level.

This analysis is dependent on available information about stock size and recruitment, and should be updated when further years of catch observations become available and when the egg survey estimate for 1995 is revised from its preliminary value. The analysis does however describe current perceptions of risk due to stochastic errors in observed data.

3.4.7 Medium term predictions

Medium term predictions were made using the ICPROJ programme (Patterson, 1995 WD) as outlined in section 1.3. The input parameters were the same as used for the short term predictions. The projections were made for ten years.

Three sets of scenarios were made, one with three levels of catch by the WNS, one with three levels of fishing mortality for the WNS fishery, and one with three levels of fishing mortality for the SA fleet, keeping the catches in the WNS fishery constant.
The scenarios and the corresponding figures are outlined in the text table below:

WNS fleet	SA fleet	Figure
Catch=550 000t	F-multipl=1.0	3.17a
Catch=650 000t	F-multipl=1.0	3.17b
Catch=750 000t	F-multipl=1.0	3.17c
F-multipl=0.75	F-multipl=1.0	3.18a
F-multipl=1.0	F-multipl=1.0	3.18b
F-multipl=1.25	F-multipl=1.0	3.18c
Catch=650 000t	F-multipl=0.5	3.19a
Catch=650 000t	F-multipl=1.0	3.19b
Catch=650 000t	F-multipl=1.5	3.19b

Since the stock at the start of the projection is estimated to be close to the adopted MBAL of 2.3 million tonnes, the probability that the SSB is below MBAL is close to 50% already at the beginning of the prediction period. As pointed out in section 1.3.2, the prediction of the recruitment below this level is highly speculative, being largely dependent on the choice of stock-recruitment function.

When a constant fishing mortality is assumed, the average SSB and recruitment will tend to stabilize at a level

where the SSB/recruitment ratio given by the weights at age, the maturity ogive and the mortality equals the SSB/recruitment ratio given by the stock recruitment function. Since this equilibrium point is dependent on the stock-recruit curve, its level and stability should not be trusted unless it is well within the range of historical SSBs, which is not the case for the present examples.

Amongst the simulations of different levels of the WNS fishery, only those with the lowest options for catch or fishing mortality show a fairly stable distribution of predicted SSBs over time. (i.e. Figure 3.17a and Figure 3.18a). Thus, with constant catches at 550 000 tonnes, the risk of being below MBAL does not increase over the 10 years. This is also the case for an F-factor of 0.75, corresponding to an average F(4-8) of 0.20 and an average catch of 605,000 tonnes in 1995 and 615,000 tonnes in 2004. All the other of these examples show a decline in median SSB and an increasing risk of being below the MBAL as time passes, indicating that they are likely to cause a further deterioration of the stock. If constant catch is assumed, also the risk of reaching very low levels of SSB increases with time (Figures 3.17b-c).

The runs shown in Figures 3.19a-b were made to illustrate the effect of moderate changes in the fishing mortality in the Southen area. Even though this fishery mainly exploits young mackerel, the level of the fishing mortality is so low that these changes have little effect on the overall development of the stock.

Due to the problems noted above, only limited conclusions can be drawn from these simulations. It appears, however, that with a constant fishing mortality of around 0.2, the stock can be expected to remain near the present level, and the catches to be just over 600,000 tonnes on average. It also appears that constant catches of about 550,000 tonnes will keep the stock at the present level.

3.4.8 Long-term yield

Table 3.33 and 3.34 present two options for the yield per recruit calculations and short term yield calculations.

Table 3.33 presents the effect on total yield and yield from the western area, of changes in the fishing mortality in the southern area. Doubling the fishing mortality in the southern area, a 94% increase in yield per recruit, reduces yield per recruit in the western area by 10%. The SSB is reduced by 4%.

Table 3.34 presents the yield per recruit and short term forecasts for the whole area. F_{max} is estimated to be at a combined reference F of 0.53, 7% lower than the value for the western assessment (0.57). However, for pelagic species F_{max} is generally estimated to be at levels of reference F well beyond sustainable levels and should not be used as a fishing mortality target. $F_{0.1}$, which for the western area is 0.19, is a appropriate objective for this stock.

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

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

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

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

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

$ Hamre, J. 1980 Rapp.P.-v. Reun.Cons.int.Explor.Mer. 177:212-242

* Report of the Mackerel Working Group 1975,ICES CM1975/H:3.

" Report of the Mackerel Working Group 1981, ICES CM 1981/H:7

+ Report of the Mackerel Working Group 1989, ICES CM 1989/H:7

Estimations based on Mackerel Egg Surveys

** Asumed by the Working Group to be 10 000 t as in 1990.

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

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

		Age								
	Effort	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	5.962	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
1994	1.200	1.054	0.274	1.121	0.906	1.634	0.878	0.342	0.071	0.136	0.056
1995	2.039	0.063	1.083	2.622	2.008	0.696	0.493	0.212	0.188	0.061	0.156

ICES area VIIh

Data standardised to total numbers per hour.

		Age									
	Effort	1	2	3	4	5	6	7	8	9	10
1984	1.000	41.118	440.713	760.175	451.060	584.927	5.162	0.000	0.189	0.234	0.145
1985	1.000	212.420	22.920	120.900	275.240	148.870	36.510	12.770	3.130	7.300	5.902
1986	1.000	1.964	43.059	11.860	9.580	18.220	15.770	10.930	0.260	0.043	0.185
1987	1.000	13.360	20.010	73.200	4.330	9.320	40.670	27.380	13.220	2.492	0.227
1988	1.000	3.040	48.460	165.455	268.911	17.650	50.990	41.417	30.290	4.560	6.810
1989	1.000	223.000	209.308	130.923	41.692	36.923	6.846	0.000	3.154	0.000	0.154
1990	1.000	3.620	63.982	117.466	33.213	3.801	8.869	1.357	3.801	2.534	2.353
1991	1.000	16.230	1251.920	437.470	216.320	18.170	0.000	9.250	6.670	0.000	0.000
1992	1.000	0.000	138.000	459.000	50.000	20.000	23.000	7.000	1.000	0.000	0.500
1993	1.000	104.000	171.000	149.000	141.000	22.000	7.000	3.000	1.000	2.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	1.000	156.300	1528.000	614.900	432.300	134.100	57.300	8.700	7.200	0.000	0.000

Table 3. 4

Run title : Mackerel in the Western Area(Fishing Areas VI, VIIandVIII)

At 14/10/1995 5:13

Table 1 Catch numbers at age Numbers*10**-6

YEAR	1972	1973	1974
AGE			
0	2	0	1
1	12	34	87
2	12	49	24
3	29	64	124
4	508	116	109
5	0	582	192
6	0	0	567
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
+gp	0	0	0
TOTALNUM	563	845	1103
TONSLAND	171	219	298
SOPCOF %	77	69	72

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
0	1	34	2	10	80	20	38	2	0	1
1	53	279	154	31	351	485	266	203	44	15
2	104	185	290	564	62	469	506	436	713	80
3	95	322	154	425	603	75	225	484	445	662
4	306	171	166	244	366	381	32	184	392	375
5	192	289	51	258	217	282	175	25	130	238
6	144	119	140	72	233	145	159	137	20	92
7	1246	280	64	152	87	158	100	109	91	16
8	0	439	89	57	154	52	117	85	71	51
9	0	0	159	83	71	140	35	87	47	39
10	0	0	0	211	75	44	139	24	49	25
11	0	0	0	0	189	48	29	90	19	21
+gp	0	0	0	0	0	115	176	148	126	44
TOTALNUM	2141	2117	1268	2107	2486	2414	1997	2012	2147	1659
TONSLAND	491	507	326	504	606	605	662	624	614	551
SOPCOF %	57	74	85	80	79	75	95	89	91	98

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
0	0	18	2	0	24	5	5	2	13	0
1	234	26	23	99	43	109	47	75	115	144
2	16	398	148	127	307	202	203	151	203	215
3	49	30	654	175	203	408	195	347	264	301
4	420	64	52	505	163	205	363	261	387	261
5	243	332	79	67	356	152	182	298	240	290
6	158	194	237	78	46	247	125	153	247	176
7	59	120	149	179	54	41	192	112	146	184
8	16	38	84	112	106	45	50	136	96	104
9	42	11	33	52	67	80	42	50	119	77
10	33	29	18	19	31	32	68	36	37	56
11	20	20	25	12	14	16	29	40	28	20
+gp	80	60	61	52	35	27	52	68	66	56
TOTALNUM	1372	1339	1565	1478	1449	1569	1553	1728	1961	1885
TONSLAND	561	538	615	628	567	606	646	742	805	798
SOPCOF %	101	101	98	100	100	100	99	100	100	100

Table 3.5

Run title : Mackerel in the Western Area(Fishing Areas VI, VIIandVIII)

At 14/10/1995 5:13

Table 2 Catch weights at age (kg)

YEAR	1972	1973	1974
AGE			
0	0.066	0.066	0.066
1	0.137	0.137	0.137
2	0.158	0.158	0.158
3	0.241	0.241	0.241
4	0.416	0.314	0.314
5	0	0.437	0.334
6	0	0	0.472
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
+gp	0	0	0
SOPCOFAC	0.7692	0.6888	0.7246

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
0	0.066	0.066	0.066	0	0	0.066	0.066	0.066	0.066	0.069
1	0.137	0.137	0.137	0.137	0.137	0.131	0.131	0.131	0.178	0.137
2	0.158	0.158	0.158	0.158	0.158	0.248	0.248	0.248	0.216	0.176
3	0.241	0.241	0.241	0.241	0.241	0.283	0.283	0.283	0.27	0.294
4	0.314	0.314	0.314	0.314	0.314	0.343	0.343	0.343	0.306	0.324
5	0.334	0.334	0.334	0.334	0.334	0.373	0.373	0.373	0.383	0.341
6	0.398	0.398	0.398	0.398	0.398	0.455	0.455	0.455	0.425	0.429
7	0.48	0.41	0.41	0.41	0.41	0.497	0.497	0.497	0.43	0.538
8	0	0.508	0.503	0.503	0.503	0.508	0.508	0.508	0.491	0.468
9	0	0	0.511	0.511	0.511	0.539	0.539	0.539	0.542	0.561
10	0	0	0.511	0.511	0.511	0.573	0.573	0.573	0.608	0.619
11	0	0	0	0	0.511	0.573	0.573	0.573	0.608	0.636
+gp	0	0	0	0	0	0.573	0.573	0.573	0.608	0.636
SOPCOFAC	0.5699	0.7434	0.855	0.8021	0.7897	0.7527	0.9456	0.8908	0.9063	0.9759

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
0	0	0	0.049	0.071	0.061	0.061	0.06	0.055	0.053	0.054
1	0.151	0.166	0.176	0.157	0.154	0.167	0.155	0.164	0.136	0.135
2	0.273	0.245	0.222	0.26	0.238	0.234	0.255	0.238	0.241	0.257
3	0.349	0.339	0.318	0.326	0.321	0.337	0.332	0.334	0.317	0.341
4	0.418	0.421	0.399	0.39	0.377	0.38	0.397	0.398	0.377	0.391
5	0.416	0.473	0.478	0.462	0.434	0.425	0.426	0.462	0.437	0.451
6	0.434	0.444	0.513	0.537	0.455	0.469	0.471	0.497	0.486	0.517
7	0.52	0.456	0.492	0.567	0.546	0.53	0.508	0.534	0.53	0.546
8	0.544	0.541	0.496	0.563	0.596	0.558	0.556	0.557	0.55	0.593
9	0.562	0.593	0.577	0.568	0.579	0.612	0.612	0.599	0.585	0.585
10	0.627	0.546	0.635	0.617	0.582	0.611	0.635	0.654	0.599	0.629
11	0.666	0.692	0.634	0.627	0.649	0.592	0.651	0.667	0.651	0.683
+gp	0.7039	0.692	0.7213	0.7049	0.7422	0.7173	0.7076	0.6702	0.6795	0.7143
SOPCOFAC	1.0094	1.0055	0.9766	1.0037	0.9996	1.0006	0.9871	1	1.0005	1.0001

Table 3.6

Run title : Mackerel in the Western Area(Fishing Areas VI, VIIandVIII)

At 14/10/1995 5:13

Table 3 Stock weights at age (kg)

YEAR AGE	1972	1973	1974
0	0	0	0
1	0.113	0.113	0.113
2	0.131	0.131	0.131
3	0.201	0.201	0.201
4	0.38	0.251	0.251
5	0	0.41	0.264
6	0	0	0.44
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
+gp	0	0	0

YEAR AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0	0	0	0	0	0	0	0	0	0	0
1	0.113	0.113	0.113	0.095	0.095	0.095	0.07	0.07	0.07	0.07
2	0.131	0.131	0.131	0.15	0.15	0.15	0.172	0.108	0.156	0.187
3	0.201	0.201	0.201	0.215	0.215	0.215	0.241	0.202	0.22	0.246
4	0.251	0.251	0.251	0.275	0.275	0.275	0.3	0.26	0.261	0.283
5	0.264	0.264	0.264	0.32	0.32	0.32	0.3	0.379	0.322	0.305
6	0.316	0.316	0.316	0.355	0.355	0.355	0.359	0.329	0.36	0.379
7	0.47	0.38	0.38	0.38	0.38	0.38	0.401	0.388	0.384	0.429
8	0	0.49	0.412	0.4	0.4	0.4	0.412	0.417	0.42	0.421
9	0	0	0.511	0.42	0.42	0.42	0.427	0.425	0.497	0.465
10	0	0	0.511	0.485	0.485	0.485	0.413	0.46	0.453	0.515
11	0	0	0	0	0.485	0.485	0.509	0.513	0.55	0.497
+gp	0	0	0	0	0	0.485	0.509	0.513	0.55	0.5493

YEAR AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
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	0.15	0.164	0.139	0.146	0.176	0.128	0.149	0.216	0.193	0.175
3	0.292	0.261	0.233	0.233	0.238	0.213	0.227	0.257	0.264	0.23
4	0.3	0.29	0.268	0.302	0.299	0.28	0.307	0.309	0.311	0.289
5	0.328	0.345	0.363	0.327	0.342	0.331	0.356	0.359	0.357	0.353
6	0.366	0.337	0.371	0.434	0.363	0.365	0.408	0.4	0 416	0.407
7	0.421	0.395	0.392	0.455	0.419	0.405	0.431	0.424	0.458	0.468
8	0.44	0.467	0.402	0.436	0.468	0.393	0.506	0.464	0 464	0.464
9	0.448	0.441	0.459	0.46	0.441	0.42	0.547	0.489	0 48	0.472
10	0.554	0.451	0.483	0.528	0.451	0.514	0.574	0.523	0 512	0.55
11	0.579	0.472	0.442	0.606	0.496	0.514	0.574	0.556	0.597	0.612
+gp	0.5991	0.5675	0.5469	0.6445	0.585	0.514	0.574	0.582	0.561	0.568

Table 3.7 Western mackerel ICA diagnostic output

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1984	.1928	.1519	.2447
2	1985	.1636	.1298	.2063
3	1986	.1636	.1305	.2050
4	1987	.1953	.1563	.2440
5	1988	.2048	.1639	.2559
6	1989	.1474	.1158	.1876
7	1990	.1537	.1204	.1963
8	1991	.1730	.1350	.2218
9	1992	.2127	.1641	.2756
10	1993	.2952	.2211	.3941
11	1994	.3010	.2144	.4227

Separable Model: Selection (S) by age

12	0	.0005	.0003	.0010	.0124	.0064	.0239
13	1	.0900	.0685	.1183	.1595	.1175	.2165
14	2	.2901	.2216	.3798	.4801	.3629	.6352
15	3	.5257	.4031	.6855	.7911	.6082	1.0290
16	4	.7454	.5734	.9689	.9888	.7712	1.2677
	5	1.0000	Fixed : Reference age				
17	6	1.0932	.8474	1.4102	1.0297	.8155	1.3002
18	7	1.0259	.8005	1.3148	1.0736	.8536	1.3501
19	8	1.0242	.8029	1.3066	1.2035	.9617	1.5062
20	9	.9584	.7517	1.2218	1.3931	1.1173	1.7370
21	10	1.0562	.8249	1.3522	1.1527	.9203	1.4437
	11	1.0000	Fixed : last true age		1.2000	Also fixed	

Separable Model: Populations in year 1994

32	0	136042.	29629.	624631.
33	1	3352186.	1955538.	5746322.
34	2	1832807.	1202346.	2793856.
35	3	1414984.	980102.	2042828.
36	4	933849.	663841.	1313679.
37	5	1197299.	869529.	1648622.
38	6	627118.	460420.	854169.
39	7	825878.	611115.	1116115.
40	8	346266.	254443.	471226.
41	9	216271.	156691.	298505.
42	10	390899.	275788.	554057.
43	11	47067.	32797.	67548.

Separable Model: Populations at age 11

44	1984	131040.1813	81527.7971	210621.7725
45	1985	122203.7101	83578.3451	178679.6180
46	1986	144310.2840	103282.4627	201635.9557
47	1987	141570.0172	104296.6848	192164.0156
48	1988	46955.5748	35147.7507	62730.2165
49	1989	93347.9985	70298.3287	123955.2772
50	1990	168128.9963	126642.7229	223205.5561
51	1991	207874.4357	155951.4412	277084.8458
52	1992	276422.8846	206589.8061	369861.4784
53	1993	77854.8165	57011.5688	106318.2892

SSB Index catchabilities

SSB Index 1 was used as absolute estimator.

No fitted catchability for this index.

Table 3.7 Western mackerel ICA diagnostic output (cont)

RESIDUALS ABOUT THE MODEL FIT

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

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	
0	-.31506E+00	-.48592E+00	.45295E+00	.21621E+01	.10856E+01	.49097E+00	.56120E-01	-.20393E+01	-.62617E+00	-.34097E+00	-.54592E+00	.10000E+00
1	-.37950E-09	-.17101E+01	.96152E+00	-.92985E+00	-.54878E+00	.30571E+00	.82155E-01	.15842E+00	.13982E+00	-.10410E+00	.15735E+00	.10000E+01
2	.11419E+00	.17264E+00	.13476E+01	-.27037E+00	.50110E+00	-.68252E+00	-.38556E+00	.67916E-01	.90263E-01	.26419E+00	.29253E-01	.10000E+01
3	-.10282E+00	-.92504E-02	-.30812E-02	.48617E+00	-.69562E+00	.32025E+00	.44998E+00	-.39245E+00	-.32918E+00	-.19628E+00	.50552E-01	.10000E+01
4	.68066E-01	.95720E-01	.43470E+00	.54157E-01	-.24090E-01	.15718E+00	-.11953E-01	.76435E-01	.71984E-01	-.16301E+00	-.12493E+00	.10000E+01
5	-.99587E-01	.71205E-01	-.50276E-01	-.23602E+00	.41905E+00	.37056E+00	-.33762E+00	.13651E+00	.19270E-01	-.21326E-01	.58690E-01	.10000E+01
6	.96308E-01	.19863E+00	-.11358E+00	-.64363E-01	-.69278E-01	-.37197E-01	.67515E-01	.22643E+00	.26858E+00	.12513E+00	.47080E-01	.10000E+01
7	.15267E+00	-.75363E-01	.19765E+00	.18015E+00	-.23626E+00	-.32431E+00	-.50632E+00	-.22974E-01	-.12223E+00	-.16713E+00	-.13263E+00	.10000E+01
8	-.38600E-01	.10823E+00	.12466E+00	-.16602E+00	.50317E+00	.20878E+00	.29089E-01	-.21663E+00	-.41245E+00	.60676E-01	-.53131E-01	.10000E+01
9	-.60608E-01	.52251E-01	-.11112E+00	.42443E-01	.11705E+00	-.46756E+00	.56191E+00	.41815E+00	-.37743E+00	-.23981E-02	.18412E+00	.10000E+01
10	-.13844E+00	-.62059E-02	-.12607E+00	.28035E-01	-.25094E+00	.40015E-01	-.44478E-01	-.59337E+00	.59206E+00	.26195E+00	-.83989E-04	.10000E+01
11	-.10536E-01	-.64342E-01	.75123E-01	.15263E+00	-.12409E-02	.12338E+00	-.14561E+00	.53123E-01	.11342E+00	-.63874E+00	.38756E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

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

Idx	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	.18089E+00	-.10000E+01	-.10000E+01	.11080E+00	-.10000E+01	-.10000E+01	.26405E-01	-.10000E+01	-.10000E+01	-.12466E+00	-.10000E+01	-.10000E+01

1989	1990	1991	1992	1993	1994	1995
-.24653E+00	-.10000E+01	-.10000E+01	.10396E-02	-.10000E+01	-.10000E+01	.80024E-01

Table 3.7 Western mackerel ICA diagnostic output (cont)

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE ----

Separable model fitted from 1984 to 1994

Variance	:	.7066
Skewness test statistic	:	-8.5203
Kurtosis test statistic	:	87.8441
Partial chi-square	:	10.3273
Probability of chi-square	:	1.0000
Degrees of freedom	:	43

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Index used as absolute measure of abundance.

Variance	:	.0183
Skewness test statistic	:	-.5658
Kurtosis test statistic	:	-.4285
Partial chi-square	:	.0087
Probability of chi-square	:	1.0000
Number of observations	:	7
Degrees of freedom	:	7
Weight in the analysis	:	1.0000

Table 3.8 Western mackerel fishing mortality at age

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.0002	.0073	.0023	.0032	.0153	.0037	.0058	.0011	.0000	.0001	.0001	.0001	.0001	.0001	.0018	.0019	.0021	.0026	.0036	.0037
1	.0188	.0736	.0387	.0428	.1376	.1151	.0612	.0362	.0292	.0173	.0147	.0147	.0176	.0184	.0235	.0245	.0276	.0339	.0471	.0480
2	.0349	.0807	.0964	.1840	.1053	.2595	.1603	.1279	.1629	.0559	.0475	.0475	.0567	.0594	.0708	.0738	.0831	.1021	.1417	.1445
3	.0850	.1368	.0848	.1893	.2884	.1713	.1809	.2141	.1762	.1014	.0860	.0860	.1027	.1077	.1166	.1216	.1369	.1683	.2336	.2382
4	.1071	.2057	.0919	.1773	.2334	.2821	.0961	.2087	.2543	.1437	.1220	.1219	.1456	.1527	.1457	.1520	.1711	.2103	.2919	.2977
5	.2140	.1321	.0828	.1908	.2242	.2686	.1909	.0957	.2119	.1928	.1636	.1636	.1953	.2048	.1474	.1537	.1730	.2127	.2952	.3010
6	.1345	.1877	.0829	.1522	.2488	.2171	.2248	.2119	.1003	.2108	.1789	.1788	.2135	.2239	.1518	.1583	.1782	.2190	.3040	.3100
7	.4759	.3918	.1397	.1154	.2618	.2524	.2145	.2240	.2025	.1978	.1679	.1678	.2003	.2101	.1582	.1651	.1858	.2283	.3169	.3232
8	.2192	.2875	.1967	.1664	.1557	.2356	.2816	.2691	.2113	.1975	.1676	.1675	.2000	.2098	.1774	.1850	.2083	.2560	.3553	.3623
9	.2051	.1266	.1509	.2677	.3025	.1949	.2332	.3309	.2232	.1848	.1568	.1568	.1872	.1963	.2053	.2142	.2410	.2963	.4113	.4194
10	.2261	.1395	.0874	.2893	.3846	.2929	.2851	.2368	.2961	.2036	.1728	.1728	.2063	.2163	.1699	.1772	.1994	.2452	.3403	.3470
11	.2140	.1321	.0828	.1908	.4293	.4302	.3100	.2871	.2783	.1928	.1636	.1636	.1953	.2048	.1769	.1845	.2076	.2552	.3543	.3612
12	.2140	.1321	.0828	.1908	.4293	.4302	.3100	.2871	.2783	.1928	.1636	.1636	.1953	.2048	.1769	.1845	.2076	.2552	.3543	.3612

Table 3.9 Western mackerel population numbers at age (Millions)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
																				**	***
0	4922.	5093.	936.	3421.	5651.	5624.	7175.	1896.	1293.	7668.	2884.	3301.	5797.	3232.	4480.	2452.	2651.	2600.	3909.	(136.)	(3399.)
1	3038.	4235.	4352.	804.	2935.	4790.	4823.	6140.	1630.	1113.	6599.	2482.	2841.	4989.	2782.	3849.	2106.	2277.	2232.	3352.	117.
2	3261.	2566.	3387.	3604.	663.	2201.	3675.	3904.	5097.	1363.	941.	5597.	2105.	2402.	4216.	2339.	3233.	1763.	1894.	1833.	2750.
3	1247.	2710.	2038.	2647.	2580.	513.	1462.	2694.	2957.	3727.	1109.	772.	4594.	1712.	1948.	3381.	1870.	2561.	1370.	1415.	1365.
4	3245.	986.	2034.	1611.	1885.	1665.	372.	1050.	1872.	2134.	2899.	876.	610.	3568.	1323.	1492.	2577.	1403.	1863.	934.	960.
5	1071.	2509.	691.	1597.	1162.	1285.	1080.	291.	734.	1249.	1591.	2209.	667.	454.	2636.	984.	1103.	1869.	979.	1197.	597.
6	1229.	744.	1892.	547.	1136.	799.	845.	768.	228.	511.	887.	1163.	1614.	473.	318.	1958.	727.	799.	1300.	627.	763.
7	3523.	925.	531.	1499.	405.	762.	553.	581.	535.	177.	356.	638.	837.	1122.	325.	235.	1439.	523.	552.	826.	396.
8	0.	1884.	538.	398.	1150.	268.	510.	384.	400.	376.	125.	259.	464.	589.	783.	239.	172.	1028.	358.	346.	515.
9	0.	0.	1216.	380.	290.	847.	182.	331.	253.	279.	266.	91.	189.	327.	411.	564.	171.	120.	685.	216.	207.
10	0.	0.	0.	900.	250.	184.	600.	124.	205.	174.	199.	195.	67.	135.	232.	288.	392.	116.	77.	391.	122.
11	0.	0.	0.	0.	580.	147.	118.	388.	84.	131.	122.	144.	142.	47.	93.	168.	208.	276.	78.	47.	238.
12	0.	0.	0.	0.	0.	354.	709.	635.	557.	271.	572.	428.	368.	304.	231.	172.	300.	322.	236.	199.	148.

** Replaced by average of the year class strengths in 1977, 1982 and 1983 (1375)
*** Replaced by GM recruitment 1975 - 1993 (3467)

Table 3.10 The Western mackerel stock summary (without SOP)

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Fbar(4-8)
1975	4922	4162566	3051219	491380	0.161	0.230
1976	5093	3779221	2699611	507178	0.188	0.241
1977	936	3681041	2687185	325974	0.121	0.119
1978	3421	3659642	2870618	503913	0.176	0.160
1979	5651	3364636	2535102	605744	0.239	0.225
1980	5624	3132816	2157230	604761	0.280	0.251
1981	7175	3239783	2262430	661762	0.293	0.202
1982	1896	3140193	2159994	623819	0.289	0.202
1983	1293	3311275	2425112	614287	0.253	0.196
1984	7668	3095837	2483671	550929	0.222	0.189
1985	2884	3490779	2610336	561292	0.215	0.160
1986	3301	3513579	2276862	537615	0.236	0.160
1987	5797	3464055	2686526	615380	0.229	0.191
1988	3232	3743829	2821349	628000	0.223	0.200
1989	4480	3783021	2866246	567400	0.198	0.156
1990	2452	3496660	2684349	605937	0.226	0.163
1991	2651	3850870	3027643	646169	0.213	0.183
1992	2600	3781588	2926955	742305	0.254	0.225
1993	3909	3319562	2474106	805039	0.325	0.313
1994	**(136)	2834900	2034615	793264	0.390	0.319

** Replaced by arithmetic average of YC strength in 1977, 1982, 1983

Table 3.11

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

Single option prediction: Input data

Year: 1995								
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	3467.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0037	0.054
1	1183.000	0.1500	0.0800	0.4000	0.4000	0.070	0.0480	0.145
2	2750.000	0.1500	0.6000	0.4000	0.4000	0.195	0.1445	0.245
3	1365.000	0.1500	0.9000	0.4000	0.4000	0.250	0.2382	0.331
4	960.000	0.1500	0.9700	0.4000	0.4000	0.303	0.2977	0.389
5	597.000	0.1500	0.9700	0.4000	0.4000	0.356	0.3010	0.450
6	763.000	0.1500	0.9900	0.4000	0.4000	0.408	0.3100	0.500
7	396.000	0.1500	1.0000	0.4000	0.4000	0.450	0.3232	0.537
8	515.000	0.1500	1.0000	0.4000	0.4000	0.464	0.3623	0.567
9	207.000	0.1500	1.0000	0.4000	0.4000	0.480	0.4194	0.590
10	122.000	0.1500	1.0000	0.4000	0.4000	0.528	0.3470	0.627
11	238.000	0.1500	1.0000	0.4000	0.4000	0.588	0.3612	0.667
12+	148.000	0.1500	1.0000	0.4000	0.4000	0.570	0.3612	0.688
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	3467.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0037	0.054
1	.	0.1500	0.0800	0.4000	0.4000	0.070	0.0480	0.145
2	.	0.1500	0.6000	0.4000	0.4000	0.195	0.1445	0.245
3	.	0.1500	0.9000	0.4000	0.4000	0.250	0.2382	0.331
4	.	0.1500	0.9700	0.4000	0.4000	0.303	0.2977	0.389
5	.	0.1500	0.9700	0.4000	0.4000	0.356	0.3010	0.450
6	.	0.1500	0.9900	0.4000	0.4000	0.408	0.3100	0.500
7	.	0.1500	1.0000	0.4000	0.4000	0.450	0.3232	0.537
8	.	0.1500	1.0000	0.4000	0.4000	0.464	0.3623	0.567
9	.	0.1500	1.0000	0.4000	0.4000	0.480	0.4194	0.590
10	.	0.1500	1.0000	0.4000	0.4000	0.528	0.3470	0.627
11	.	0.1500	1.0000	0.4000	0.4000	0.588	0.3612	0.667
12+	.	0.1500	1.0000	0.4000	0.4000	0.570	0.3612	0.688
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1997								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	3467.000	0.1500	0.0000	0.4000	0.4000	0.000	0.0037	0.054
1	.	0.1500	0.0800	0.4000	0.4000	0.070	0.0480	0.145
2	.	0.1500	0.6000	0.4000	0.4000	0.195	0.1445	0.245
3	.	0.1500	0.9000	0.4000	0.4000	0.250	0.2382	0.331
4	.	0.1500	0.9700	0.4000	0.4000	0.303	0.2977	0.389
5	.	0.1500	0.9700	0.4000	0.4000	0.356	0.3010	0.450
6	.	0.1500	0.9900	0.4000	0.4000	0.408	0.3100	0.500
7	.	0.1500	1.0000	0.4000	0.4000	0.450	0.3232	0.537
8	.	0.1500	1.0000	0.4000	0.4000	0.464	0.3623	0.567
9	.	0.1500	1.0000	0.4000	0.4000	0.480	0.4194	0.590
10	.	0.1500	1.0000	0.4000	0.4000	0.528	0.3470	0.627
11	.	0.1500	1.0000	0.4000	0.4000	0.588	0.3612	0.667
12+	.	0.1500	1.0000	0.4000	0.4000	0.570	0.3612	0.688
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRED
Date and time: 17OCT95:17:54

Table 3.12a

Mackerel in the Western Area (Fishing Areas VI, VII and VIII) 17:47 Wednesday, October 18, 1995

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	0.9150	0.2917	1570415	650008	12711000	2579987	6864800	2237279	5874812	1894902
1996	0.9150	0.2917	1453725	593115	12956298	2324859	6104939	1988636	5207674	1680075
1997	0.9150	0.2917	1406976	550394	13275257	2282736	5953052	1860718	5106504	1577897
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRED
Date and time : 18OCT95:17:48
Computation of ref. F: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.12b

Mackerel in the Western Area (Fishing Areas VI, VII and VIII) 17:47 Wednesday, October 18, 1995

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	0.9150	0.2917	1570395	650000	12711000	2579987	6864800	2237279	5874820	1894904
1996	1.0169	0.3242	1595439	650000	12956316	2324865	6104956	1988642	5150881	1659945
1997	1.1421	0.3642	1675448	650000	13144809	2234836	5831202	1814650	4890519	1500040
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRED
Date and time : 18OCT95:17:48
Computation of ref. F: Simple mean, age 4 - 8
Prediction basis : TAC constraints

Table 3.12c

Mackerel in the Western Area (Fishing Areas VI, VII and VIII) 17:47 Wednesday, October 18, 1995

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	0.9150	0.2917	1570415	650008	12711000	2579987	6864800	2237279	5874812	1894902
1996	1.0000	0.3188	1572182	640676	12956298	2324859	6104939	1988636	5160243	1663262
1997	1.0000	0.3188	1496400	582317	13166198	2242680	5851171	1822193	4977771	1530729
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRED
Date and time : 18OCT95:17:48
Computation of ref. F: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.13

17:47 Wednesday, October 18, 1995

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

Single option prediction: Detailed tables

Year: 1995 F-factor: 0.9150 Reference F: 0.2917

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0034	10882	588	3467000	0	0	0	0	0
1	0.0439	47230	6848	1183000	82810	94640	6625	87576	6130
2	0.1322	316796	77721	2750000	535333	1650000	321200	1473865	286912
3	0.2180	248910	82306	1365000	341705	1228500	307535	1060364	265445
4	0.2724	213291	82899	960000	290880	931200	282154	786440	238291
5	0.2754	133923	60265	597000	212731	579090	206349	488477	174061
6	0.2837	175606	87803	763000	311050	755370	307939	635078	258900
7	0.2957	94491	50710	396000	178200	396000	178200	331333	149100
8	0.3315	135496	76781	515000	238960	515000	238960	424777	197097
9	0.3838	61555	36297	207000	99429	207000	99429	167205	80314
10	0.3175	30941	19411	122000	64457	122000	64457	101192	53463
11	0.3305	62456	41658	238000	140023	238000	140023	196384	115539
12+	0.3305	38838	26721	148000	84409	148000	84409	122121	69650
Total		1570415	650008	12711000	2579987	6864800	2237279	5874812	1894902
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 0.9150 Reference F: 0.2917

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0034	10882	588	3467000	0	0	0	0	0
1	0.0439	118733	17216	2973989	208179	237919	16654	220162	15411
2	0.1322	112257	27540	974465	189696	584679	113818	522266	101668
3	0.2180	378161	125045	2073802	519142	1866421	467227	1610978	403282
4	0.2724	209911	81585	944784	286270	916441	277682	773975	234514
5	0.2754	141159	63521	629256	224225	610378	217498	514869	183465
6	0.2837	89791	44896	390139	159047	386237	157456	324729	132381
7	0.2957	118001	63327	494530	222539	494530	222539	413773	186198
8	0.3315	66717	37806	253582	117662	253582	117662	209157	97049
9	0.3838	94620	55794	318194	152839	318194	152839	257022	123456
10	0.3175	30785	19313	121385	64132	121385	64132	100682	53194
11	0.3305	20060	13380	76441	44973	76441	44973	63075	37109
12+	0.3305	62648	43103	238731	136157	238731	136157	196987	112349
Total		1453725	593115	12956298	2324859	6104939	1988636	5207674	1680075
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1997 F-factor: 0.9150 Reference F: 0.2917

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0034	10882	588	3467000	0	0	0	0	0
1	0.0439	118733	17216	2973989	208179	237919	16654	220162	15411
2	0.1322	282207	69235	2449746	476884	1469847	286130	1312943	255586
3	0.2180	134002	44310	734854	183958	661368	165563	570852	142903
4	0.2724	318911	123950	1435381	434920	1392320	421873	1175876	356290
5	0.2754	138921	62515	619282	220671	600704	214051	506709	180557
6	0.2837	94643	47321	411218	167640	407106	165963	342274	139534
7	0.2957	60337	32381	252864	113789	252864	113789	211571	95207
8	0.3315	83317	47213	316676	146938	316676	146938	261198	121196
9	0.3838	46590	27473	156676	75257	156676	75257	126556	60789
10	0.3175	47323	29687	186590	98581	186590	98581	154765	81768
11	0.3305	19959	13312	76055	44746	76055	44746	62757	36922
12+	0.3305	51153	35194	194926	111173	194926	111173	160842	91734
Total		1406976	550394	13275257	2282736	5953052	1860718	5106504	1577897
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.14

17:47 Wednesday, October 18, 1995

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

Single option prediction: Detailed tables

Year: 1995 F-factor: 0.9150 Reference F: 0.2917

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0034	10882	588	3467000	0	0	0	0	0
1	0.0439	47229	6848	1183000	82810	94640	6625	87576	6130
2	0.1322	316792	77720	2750000	535333	1650000	321200	1473866	286913
3	0.2179	248907	82305	1365000	341705	1228500	307535	1060366	265445
4	0.2724	213289	82898	960000	290880	931200	282154	786441	238292
5	0.2754	133921	60264	597000	212731	579090	206349	488478	174061
6	0.2836	175604	87802	763000	311050	755370	307939	635079	258901
7	0.2957	94489	50709	396000	178200	396000	178200	331333	149100
8	0.3315	135494	76780	515000	238960	515000	238960	424778	197097
9	0.3837	61554	36296	207000	99429	207000	99429	167205	80314
10	0.3175	30941	19410	122000	64457	122000	64457	101192	53463
11	0.3305	62456	41658	238000	140023	238000	140023	196384	115539
12+	0.3305	38838	26721	148000	84409	148000	84409	122121	69650
Total		1570395	650000	12711000	2579987	6864800	2237279	5874820	1894904
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 1.0169 Reference F: 0.3242

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0038	12091	653	3467000	0	0	0	0	0
1	0.0488	131645	19088	2973989	208179	237919	16654	219731	15381
2	0.1469	123888	30394	974466	189696	584680	113818	519199	101071
3	0.2422	415526	137401	2073805	519143	1866425	467228	1595416	399386
4	0.3027	230031	89405	944787	286271	916444	277682	764642	231687
5	0.3061	154666	69600	629258	224226	610380	217499	508593	181228
6	0.3152	98344	49172	390140	159047	386239	157457	320653	130720
7	0.3287	129164	69318	494532	222539	494532	222539	408359	183762
8	0.3684	72903	41312	253583	117662	253583	117662	206092	95627
9	0.4265	103138	60817	318196	152840	318196	152840	252667	121364
10	0.3529	33663	21118	121386	64132	121386	64132	99268	52447
11	0.3673	21921	14621	76441	44973	76441	44973	62153	36567
12+	0.3673	68460	47101	238733	136157	238733	136157	194109	110707
Total		1595439	650000	12956316	2324865	6104956	1988642	5150881	1659945
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1997 F-factor: 1.1421 Reference F: 0.3642

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0042	13577	733	3467000	0	0	0	0	0
1	0.0548	147373	21369	2972868	208101	237829	16648	219121	15338
2	0.1650	345118	84669	2437792	474557	1462675	284734	1289496	251022
3	0.2721	160707	53141	724113	181270	651701	163143	550465	137800
4	0.3400	376577	146363	1400962	424491	1358933	411757	1117053	338467
5	0.3438	162997	73349	600779	214078	582756	207655	478308	170437
6	0.3541	110908	55454	398798	162576	394810	160951	322718	131561
7	0.3691	70550	37862	245002	110251	245002	110251	199061	89577
8	0.4138	96919	54921	306418	142178	306418	142178	244553	113472
9	0.4790	53687	31657	150998	72529	150998	72529	117409	56395
10	0.3963	54592	34248	178784	94458	178784	94458	143689	75916
11	0.4125	23163	15450	73413	43192	73413	43192	58621	34489
12+	0.4125	59280	40785	187883	107156	187883	107156	150025	85564
Total		1675448	650000	13144809	2234836	5831202	1814650	4890519	1500040
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.15

17:47 Wednesday, October 18, 19

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

Single option prediction: Detailed tables

Year: 1995 F-factor: 0.9150 Reference F: 0.2917

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0034	10882	588	3467000	0	0	0	0	0
1	0.0439	47230	6848	1183000	82810	94640	6625	87576	6130
2	0.1322	316796	77721	2750000	535333	1650000	321200	1473865	286912
3	0.2180	248910	82306	1365000	341705	1228500	307535	1060364	265445
4	0.2724	213291	82899	960000	290880	931200	282154	786440	238291
5	0.2754	133923	60265	597000	212731	579090	206349	488477	174061
6	0.2837	175606	87803	763000	311050	755370	307939	635078	258900
7	0.2957	94491	50710	396000	178200	396000	178200	331333	149100
8	0.3315	135496	76781	515000	238960	515000	238960	424777	197097
9	0.3838	61555	36297	207000	99429	207000	99429	167205	80314
10	0.3175	30941	19411	122000	64457	122000	64457	101192	53463
11	0.3305	62456	41658	238000	140023	238000	140023	196384	115539
12+	0.3305	38838	26721	148000	84409	148000	84409	122121	69650
Total		1570415	650008	12711000	2579987	6864800	2237279	5874812	1894902
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 1.0000 Reference F: 0.3188

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0037	11891	642	3467000	0	0	0	0	0
1	0.0480	129507	18779	2973989	208179	237919	16654	219803	15386
2	0.1445	121970	29923	974465	189696	584679	113818	519706	101169
3	0.2382	409389	135371	2073802	519142	1866421	467227	1597984	400029
4	0.2977	226733	88124	944784	286270	916441	277682	766180	232153
5	0.3010	152453	68604	629256	224225	610378	217498	509627	181597
6	0.3100	96943	48471	390139	159047	386237	157456	321325	130993
7	0.3232	127337	68337	494530	222539	494530	222539	409251	184163
8	0.3623	71892	40739	253582	117662	253582	117662	206596	95861
9	0.4194	101749	59998	318194	152839	318194	152839	253383	121708
10	0.3470	33192	20822	121385	64132	121385	64132	99501	52570
11	0.3612	21617	14418	76441	44973	76441	44973	62305	36656
12+	0.3612	67510	46448	238731	136157	238731	136157	194583	110977
Total		1572182	640676	12956298	2324859	6104939	1988636	5160243	1663262
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1997 F-factor: 1.0000 Reference F: 0.3188

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	0.0037	11891	642	3467000	0	0	0	0	0
1	0.0480	129467	18773	2973054	208114	237844	16649	219734	15381
2	0.1445	305376	74919	2439771	474942	1463863	284965	1301189	253298
3	0.2382	143296	47383	725883	181713	653295	163541	559335	140020
4	0.2977	337565	131200	1406611	426203	1364413	413417	1140702	345633
5	0.3010	146287	65829	603808	215157	585694	208702	489017	174253
6	0.3100	99599	49800	400830	163405	396822	161771	330130	134583
7	0.3232	63417	34034	246288	110830	246288	110830	203817	91718
8	0.3623	87347	49497	308095	142956	308095	142956	251009	116468
9	0.4194	48581	28646	151925	72975	151925	72975	120980	58111
10	0.3470	49235	30887	180055	95129	180055	95129	147594	77979
11	0.3612	20882	13929	73845	43445	73845	43445	60189	35411
12+	0.3612	53456	36778	189033	107812	189033	107812	154075	87874
Total		1496400	582317	13166198	2242680	5851171	1822193	4977771	1530729
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.16

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

17:47 Wednesday, October 18, 1995

Prediction with management option table

Year: 1995					Year: 1996					Year: 1997	
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
0.9150	0.2917	2579987	1894902	650008	0.0000	0.0000	2324859	1872827	0	2782861	2206786
.	.	.	.	.	0.1000	0.0319	.	1850672	72755	2721457	2125747
.	.	.	.	.	0.2000	0.0638	.	1828792	143416	2661835	2048052
.	.	.	.	.	0.3000	0.0957	.	1807185	212048	2603938	1973556
.	.	.	.	.	0.4000	0.1275	.	1785846	278713	2547713	1902119
.	.	.	.	.	0.5000	0.1594	.	1764772	343473	2493108	1833610
.	.	.	.	.	0.6000	0.1913	.	1743960	406385	2440073	1767901
.	.	.	.	.	0.7000	0.2232	.	1723406	467508	2388559	1704871
.	.	.	.	.	0.8000	0.2551	.	1703108	526895	2338519	1644406
.	.	.	.	.	0.9000	0.2870	.	1683061	584601	2289908	1586394
.	.	.	.	.	1.0000	0.3188	.	1663262	640676	2242680	1530729
.	.	.	.	.	1.1000	0.3507	.	1643708	695172	2196794	1477311
.	.	.	.	.	1.2000	0.3826	.	1624397	748135	2152209	1426044
.	.	.	.	.	1.3000	0.4145	.	1605325	799614	2108883	1376836
.	.	.	.	.	1.4000	0.4464	.	1586488	849652	2066779	1329597
.	.	.	.	.	1.5000	0.4783	.	1567885	898295	2025859	1284245
.	.	.	.	.	1.6000	0.5101	.	1549511	945584	1986086	1240699
.	.	.	.	.	1.7000	0.5420	.	1531365	991561	1947426	1198882
.	.	.	.	.	1.8000	0.5739	.	1513442	1036265	1909845	1158721
.	.	.	.	.	1.9000	0.6058	.	1495740	1079736	1873309	1120145
.	.	.	.	.	2.0000	0.6377	.	1478257	1122009	1837787	1083087
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPRED5
Date and time : 18OCT95:17:56
Computation of ref. F: Simple mean, age 4 - 8
Basis for 1995 : F factors

Table 3.17

17:32 Tuesday, October 17, 1995

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

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	0.000	0.000	7.179	2193.880	4.993	2053.107	4.702	1933.544
0.1000	0.0319	0.124	60.859	6.356	1765.596	4.175	1626.183	3.885	1511.916
0.2000	0.0638	0.209	98.050	5.792	1481.084	3.616	1342.973	3.327	1233.335
0.3000	0.0957	0.271	122.201	5.379	1279.177	3.207	1142.313	2.920	1036.752
0.4000	0.1275	0.319	138.577	5.062	1128.884	2.895	993.218	2.608	891.270
0.5000	0.1594	0.357	150.039	4.809	1012.874	2.646	878.358	2.361	779.635
0.6000	0.1913	0.388	158.256	4.602	920.725	2.444	787.316	2.160	691.489
0.7000	0.2232	0.414	164.252	4.429	845.812	2.275	713.468	1.993	620.257
0.8000	0.2551	0.437	168.682	4.282	783.731	2.132	652.413	1.851	561.580
0.9000	0.2870	0.456	171.981	4.155	731.447	2.009	601.120	1.729	512.459
1.0000	0.3188	0.473	174.446	4.043	686.807	1.902	557.436	1.623	470.769
1.1000	0.3507	0.488	176.285	3.945	648.240	1.807	519.793	1.529	434.965
1.2000	0.3826	0.501	177.647	3.857	614.576	1.723	487.024	1.446	403.898
1.3000	0.4145	0.513	178.641	3.778	584.926	1.648	458.240	1.372	376.699
1.4000	0.4464	0.524	179.345	3.707	558.604	1.580	432.758	1.306	352.695
1.5000	0.4783	0.534	179.822	3.642	535.071	1.518	410.039	1.245	331.362
1.6000	0.5101	0.543	180.118	3.582	513.900	1.462	389.658	1.190	312.283
1.7000	0.5420	0.551	180.268	3.527	494.744	1.411	371.271	1.140	295.122
1.8000	0.5739	0.559	180.301	3.477	477.324	1.363	354.598	1.094	279.608
1.9000	0.6058	0.566	180.239	3.430	461.408	1.320	339.410	1.051	265.518
2.0000	0.6377	0.573	180.099	3.386	446.806	1.279	325.515	1.012	252.666
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YPR95
Date and time : 17OCT95:17:33
Computation of ref. F: Simple mean, age 4 - 8
F-0.1 factor : 0.5611
F-max factor : 1.7812
F-0.1 reference F : 0.1789
F-max reference F : 0.5679
Recruitment : Single recruit

Table 3.18A SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOK		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (N°·fishing trips)	SANTOÑA (Subdiv.VIIIc East) (N° fishing trips)	VIGO (Subdiv.IXa North) (Fishing days)	(Subdiv.IXa CN,CS &S) (Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	12568	33999	-	-	20	-
1984	10815	32427	-	-	700	-
1985	9856	30255	-	-	215	-
1986	10845	26540	-	-	157	-
1987	8309	23122	-	-	92	-
1988	9047	28119	-	-	374	66402
1989	8063	29628	-	605	153	37122
1990	8492	29578	322	509	161	77535
1991	7677	26959	209	724	66	67893
1992	12693	26199	70	698	286	32155
1993	7635	29670	151	1216	-	13454
1994	9620	39590	130	1926	-	16790

- Not available

Table 3.18B SOUTHERN MACKEREL. CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOK		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg/HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Kg/ HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (Kg/N° fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Kg/N° fishing trips)	VIGO (Subdiv.IXa North) (t/Fishing days)	(Subdiv.IXa CN,CS &S) (Kg/Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	14.2	34.2	-	-	1.3	-
1984	24.1	40.1	-	-	5.6	-
1985	17.6	38.1	-	-	4.2	-
1986	41.1	34.2	-	-	5.0	-
1987	13.0	36.5	-	-	2.1	-
1988	15.9	48.0	-	-	3.7	30.2
1989	19.0	43.0	-	1427.5	2.1	37.9
1990	82.7	59.0	739.6	1924.4	2.7	25.3
1991	68.2	54.6	632.9	1394.4	2.0	25.9
1992	35.1	19.7	905.6	856.4	3.9	49.3
1993	12.8	19.2	613.7	1790.9	-	60.1
1994	57.2	41.4	2388.6	1590.6	-	48.2

- Not available

Table 3.19 SOUTHERN MACKEREL. CPUE at age from fleets.

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	2	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1

IXa trawl fleet (Portugal) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	66402	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	37122	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	77535	2840	5729	1967	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	67893	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	32155	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	13454	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	16790	650	1128	1447	342	125	94	65	21	4	1	2	0	1	0	0	0

VIIIc East hand-line fleet (Spain:Santona) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9

Table 3. 20 SOUTHERN MACKEREL. CPUE at age from surveys.

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

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

Run title : Mackerel in the North East Atlantic

At 15/10/1995 5:02

Table 3.21 North East Atlantic mackerel catch numbers at age Numbers*10-3**

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE											
0	288397	81220	48519	7417	55119	65400	24246	10007	43447	19354	25369
1	32024	267056	56423	40203	145969	64263	140534	58459	83583	128144	147336
2	86397	20745	412124	156970	131606	312739	209848	212521	156292	210319	222760
3	685128	57933	37262	664649	182062	207689	410751	206421	356209	266677	309019
4	389079	442205	74302	56789	514809	167588	208146	375451	266591	398240	268950
5	252475	250432	353451	89173	69720	362469	156742	188623	306143	244285	302866
6	98442	164050	201927	245038	83498	48696	254015	129145	156070	255472	185705
7	22171	61922	122477	150876	192215	58116	42549	197888	113899	149932	190436
8	62052	19424	41322	86027	117130	111251	49698	51077	138458	97746	106425
9	48110	47223	13137	34862	53464	68240	85447	43415	51208	121400	80195
10	37627	37341	31825	19696	19803	32228	33041	70839	36612	38794	57823
11	30221	26774	22298	25796	12601	13904	16587	29743	40956	29067	20567
+gp	69450	96961	78775	63267	54975	35814	27905	52986	68205	68217	57762
TOTALNUM	2101573	1573286	1493842	1640763	1632971	1548397	1659509	1626575	1817673	2027647	1975213
TONSLAND	648084	614275	602128	654805	676288	585921	625611	667883	760351	825036	827712
SOPCOF %	101	101	103	100	104	100	100	99	100	100	101

Table 3.22 North East Atlantic mackerel catch weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE											
0	0.031	0.055	0.039	0.076	0.055	0.049	0.085	0.068	0.051	0.061	0.046
1	0.102	0.144	0.146	0.179	0.133	0.136	0.156	0.156	0.167	0.134	0.136
2	0.184	0.262	0.245	0.223	0.259	0.237	0.233	0.253	0.239	0.24	0.255
3	0.295	0.357	0.335	0.318	0.323	0.32	0.336	0.327	0.333	0.317	0.339
4	0.326	0.418	0.423	0.399	0.388	0.377	0.379	0.394	0.397	0.376	0.39
5	0.344	0.417	0.471	0.474	0.456	0.433	0.423	0.423	0.46	0.436	0.448
6	0.431	0.436	0.444	0.512	0.524	0.456	0.467	0.469	0.495	0.483	0.512
7	0.542	0.521	0.457	0.493	0.555	0.543	0.528	0.506	0.532	0.527	0.543
8	0.48	0.555	0.543	0.498	0.555	0.592	0.552	0.554	0.555	0.548	0.59
9	0.569	0.564	0.591	0.58	0.562	0.578	0.606	0.609	0.597	0.583	0.583
10	0.628	0.629	0.552	0.634	0.613	0.581	0.606	0.63	0.651	0.595	0.627
11	0.636	0.679	0.694	0.635	0.624	0.648	0.591	0.649	0.663	0.647	0.678
+gp	0.6632	0.7095	0.6884	0.7178	0.6973	0.7393	0.7126	0.7077	0.6691	0.6789	0.7127
SOPCOFAC	1.0057	1.0071	1.03	0.9978	1.0393	1	0.9992	0.9885	0.9995	1.0006	1.0106

Table 3.23 North East Atlantic mackerel stock weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE											
0	0	0	0	0	0	0	0	0	0	0	0
1	0.085	0.085	0.085	0.084	0.082	0.082	0.082	0.082	0.082	0.082	0.082
2	0.19	0.16	0.172	0.15	0.153	0.179	0.138	0.156	0.213	0.193	0.178
3	0.255	0.293	0.267	0.244	0.242	0.246	0.225	0.237	0.262	0.268	0.239
4	0.298	0.312	0.303	0.285	0.311	0.308	0.292	0.315	0.317	0.319	0.3
5	0.323	0.342	0.355	0.37	0.338	0.35	0.341	0.362	0.365	0.363	0.36
6	0.389	0.379	0.354	0.382	0.433	0.373	0.375	0.411	0.404	0.418	0.41
7	0.437	0.43	0.408	0.405	0.456	0.426	0.414	0.436	0.43	0.459	0.467
8	0.437	0.452	0.474	0.421	0.446	0.474	0.41	0.506	0.47	0.47	0.47
9	0.477	0.463	0.457	0.472	0.47	0.454	0.436	0.544	0.495	0.487	0.48
10	0.52	0.552	0.468	0.493	0.529	0.464	0.517	0.568	0.525	0.516	0.548
11	0.507	0.575	0.488	0.462	0.597	0.503	0.519	0.57	0.554	0.589	0.602
+gp	0.5663	0.6033	0.5797	0.5613	0.6403	0.5901	0.5298	0.5801	0.586	0.5678	0.5732

Table 3.24 Mackerel in the North East Atlantic ICA diagnostic output

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1984	.2067	.1727	.2474
2	1985	.1712	.1436	.2040
3	1986	.1633	.1375	.1939
4	1987	.1853	.1563	.2197
5	1988	.1978	.1668	.2345
6	1989	.1451	.1206	.1745
7	1990	.1498	.1242	.1808
8	1991	.1644	.1358	.1990
9	1992	.2007	.1644	.2450
10	1993	.2659	.2132	.3316
11	1994	.2745	.2125	.3545

Separable Model: Selection (S) by age

12	0	.0694	.0433	.1113	.0484	.0294	.0796
13	1	.1414	.1151	.1738	.1927	.1528	.2431
14	2	.2941	.2400	.3603	.4837	.3912	.5981
15	3	.5334	.4367	.6515	.7981	.6542	.9737
16	4	.7491	.6148	.9128	.9844	.8159	1.1877
	5	1.0000	Fixed : Reference age				
17	6	1.0784	.8901	1.3065	1.0362	.8694	1.2350
18	7	1.0547	.8750	1.2713	1.0864	.9145	1.2906
19	8	1.0547	.8782	1.2666	1.2085	1.0209	1.4306
20	9	.9970	.8307	1.1967	1.3678	1.1580	1.6155
21	10	1.0940	.9085	1.3173	1.1588	.9777	1.3734
	11	1.0000	Fixed : last true age		1.2000	Also fixed	

Separable Model: Populations in year 1994

32	0	2082872.	665948.	6514555.
33	1	2884220.	1910365.	4354522.
34	2	2144632.	1557655.	2952803.
35	3	1494711.	1130212.	1976761.
36	4	1045606.	806961.	1354827.
37	5	1353339.	1062674.	1723507.
38	6	733594.	580711.	926726.
39	7	863524.	687146.	1085174.
40	8	372702.	294933.	470978.
41	9	270111.	211631.	344752.
42	10	430802.	331626.	559639.
43	11	56646.	43171.	74328.

Separable Model: Populations at age 11

44	1984	173795.2485	121578.5917	248438.3803
45	1985	158296.8661	118780.5343	210959.6320
46	1986	154483.9478	119834.7450	199151.6744
47	1987	150295.3873	119105.8521	189652.3390
48	1988	53220.2017	42697.2315	66336.6164
49	1989	95611.8499	77015.2560	118698.8956
50	1990	172242.5293	138666.9478	213947.8036
51	1991	217633.4178	174598.6137	271275.3757
52	1992	299527.1679	239573.6634	374484.0857
53	1993	89392.1691	70431.1903	113457.6864

SSB Index catchabilities

SSB Index 1 was used as absolute estimator.

No fitted catchability for this index.

Table 3.24 Mackerel in the North East Atlantic
ICA diagnostic output (cont)

RESIDUALS ABOUT THE MODEL FIT

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

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	
0	.10052E+01	-.15065E+00	.15965E+00	.18292E+01	.84261E+00	.33967E+00	-.51415E-01	-.17026E+01	-.63421E+00	-.34151E+00	-.45624E+00	.10000E+00
1	-.48551E-10	.24155E+00	.57413E+00	-.83555E+00	-.53036E+00	.25864E+00	.38331E-01	.13585E+00	.84135E-01	-.13151E+00	.11701E+00	.10000E+01
2	.81837E-01	.14428E+00	.95131E-01	-.97938E-01	.50909E+00	-.57996E+00	-.31767E+00	.87899E-01	.11834E+00	.24187E+00	.53560E-01	.10000E+01
3	-.96973E-01	.13341E-02	.29264E-01	-.70898E+00	-.55743E+00	.25491E+00	.48740E+00	-.36305E+00	-.24859E+00	-.15006E+00	.57670E-01	.10000E+01
4	.95119E-01	.14120E+00	.42021E+00	.86208E-01	.54347E-01	.13055E+00	.23009E-01	-.28360E-01	.99570E-01	-.19521E+00	-.10650E+00	.10000E+01
5	-.81805E-01	.91003E-01	-.43226E-01	-.23264E+00	.34863E+00	.22734E+00	-.21518E+00	.17152E+00	.26875E-01	-.14045E+00	.66729E-01	.10000E+01
6	.45859E-01	.17099E+00	-.11164E+00	-.45191E-01	-.56061E-01	-.22142E-01	.92199E-01	.23785E+00	.21509E+00	.15496E+00	.67907E-01	.10000E+01
7	.40776E-01	-.56791E-01	.13760E+00	.19439E+00	-.19236E+00	-.30024E+00	-.46388E+00	-.22782E+00	-.13358E+00	-.15854E+00	-.14452E+00	.10000E+01
8	.52027E-01	.16622E+00	.28090E-01	-.13042E+00	.45048E+00	.19410E+00	.41111E-01	-.19854E+00	.14312E+00	-.57012E-02	-.56662E-01	.10000E+01
9	-.74145E-01	.14798E-01	-.36939E-01	.76783E-01	-.13238E-02	-.43480E+00	.51401E+00	.36859E+00	-.37697E+00	-.23212E+00	.51395E-01	.10000E+01
10	-.52659E-01	-.26937E-02	-.95780E-01	.99396E-02	-.14909E+00	.10382E+00	-.12604E+00	-.52287E+00	.56096E+00	.24432E+00	-.21159E-02	.10000E+01
11	.64844E-01	-.10749E+00	.12091E+00	.15348E+00	.54216E-03	.92814E-01	-.85970E-01	.81324E-01	.16505E-01	-.63788E+00	.32749E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

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

Idx	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-.10000E+01	-.10000E+01	-.12200E+00	-.10000E+01	-.10000E+01	-.19954E+00	-.10000E+01	-.10000E+01	.40723E-01	-.10000E+01	-.10000E+01	.75095E-01

Table 3.24 Mackerel in the North East Atlantic
ICA diagnostic output (cont)

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1984 to 1994

Variance	:	.1808
Skewness test statistic	:	-9.0459
Kurtosis test statistic	:	28.5130
Partial chi-square	:	1.4573
Probability of chi-square	:	1.0000
Degrees of freedom	:	43

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Index used as absolute measure of abundance.

Variance	:	.0129
Skewness test statistic	:	-.9806
Kurtosis test statistic	:	-.4424
Partial chi-square	:	.0042
Probability of chi-square	:	1.0000
Number of observations	:	4
Degrees of freedom	:	4
Weight in the analysis	:	1.0000

Table 3.25 Mackerel in the North East Atlantic fishing mortality at age

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.0143	.0119	.0113	.0129	.0137	.0070	.0073	.0080	.0097	.0129	.0133
1	.0292	.0242	.0231	.0262	.0280	.0280	.0289	.0317	.0387	.0512	.0529
2	.0608	.0503	.0480	.0545	.0582	.0702	.0725	.0795	.0971	.1286	.1328
3	.1103	.0913	.0871	.0989	.1055	.1158	.1196	.1312	.1602	.2122	.2191
4	.1549	.1282	.1223	.1388	.1482	.1428	.1475	.1618	.1976	.2617	.2702
5	.2067	.1712	.1633	.1853	.1978	.1451	.1498	.1644	.2007	.2659	.2745
6	.2230	.1846	.1761	.1999	.2133	.1503	.1552	.1704	.2080	.2755	.2844
7	.2181	.1805	.1722	.1955	.2086	.1576	.1628	.1786	.2180	.2888	.2982
8	.2180	.1805	.1722	.1955	.2086	.1753	.1810	.1987	.2425	.3213	.3317
9	.2061	.1707	.1628	.1848	.1972	.1984	.2049	.2249	.2745	.3637	.3754
10	.2262	.1873	.1786	.2027	.2164	.1681	.1736	.1905	.2326	.3081	.3181
11	.2067	.1712	.1633	.1853	.1978	.1741	.1798	.1973	.2408	.3191	.3294
12	.2067	.1712	.1633	.1853	.1978	.1741	.1798	.1973	.2408	.3191	.3294

Table 3.26 Mackerel in the North East Atlantic population numbers at age (Millions)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	7977.	3450.	3432.	5882.	3666.	4903.	2699.	2793.	3077.	3394.	2083.	(3633.)
1	1255.	6768.	2934.	2921.	4998.	3112.	4191.	2306.	2385.	2623.	2884.	1769.
2	1498.	1049.	5686.	2468.	2449.	4183.	2605.	3504.	1923.	1975.	2145.	2355.
3	3957.	1214.	858.	4665.	2012.	1989.	3356.	2085.	2786.	1502.	1495.	1616.
4	2233.	3050.	953.	677.	3637.	1558.	1525.	2563.	1574.	2043.	1046.	1033.
5	1304.	1646.	2309.	726.	507.	2699.	1163.	1132.	1877.	1112.	1353.	687.
6	538.	913.	1194.	1688.	519.	358.	2010.	861.	827.	1322.	734.	885.
7	208.	370.	653.	862.	1190.	361.	265.	1481.	625.	578.	864.	475.
8	416.	144.	266.	473.	610.	831.	265.	194.	1066.	433.	373.	552.
9	309.	288.	104.	193.	335.	426.	600.	191.	137.	720.	270.	230.
10	231.	216.	209.	76.	138.	237.	301.	421.	131.	90.	431.	160.
11	174.	158.	154.	150.	53.	96.	172.	218.	300.	89.	57.	270.
12	261.	560.	487.	394.	329.	241.	182.	318.	342.	268.	221.	172.

** Replaced by the GM recruitment to the Western Mackerel raised by the arithmetic mean (1984-1992) of the ratio of the combined and western mackerel recruitment estimates (3798)

Table 3.27

Mackerel in the North East Atlantic stock summary (without SOP)

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Fbar(4-8)
1984	7977.	3473021.	2793330.	648084.	.2320	0.204
1985	3450.	3865811.	2882781.	614275.	.2131	0.169
1986	3432.	3883704.	2611436.	602128.	.2306	0.161
1987	5882.	3828174.	2985475.	654805.	.2193	0.183
1988	3666.	4086632.	3113379.	676288.	.2172	0.195
1989	4903.	4093338.	3144896.	585921.	.1863	0.154
1990	2699.	3875703.	2983481.	625611.	.2097	0.159
1991	2793.	4196873.	3324753.	667883.	.2009	0.175
1992	3077.	4126292.	3235040.	760351.	.2350	0.213
1993	3394.	3677106.	2785535.	825036.	.2962	0.283
1994	2083.	3182154.	2357191.	827712.	.3511	0.292

Table 3.28

North East Atlantic mackerel.

17:32 Tuesday, October 17, 1995

Multi fleet prediction with mangement option table: Input data

1995	Southern Area		Western + North Sea							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0100	0.058	0.0033	0.054	3798.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0040	0.158	0.0489	0.145	1769.000	0.1500	0.1400	0.4000	0.4000	0.082
2	0.0046	0.224	0.1282	0.245	2355.000	0.1500	0.6400	0.4000	0.4000	0.178
3	0.0044	0.283	0.2147	0.331	1616.000	0.1500	0.9100	0.4000	0.4000	0.239
4	0.0070	0.334	0.2632	0.389	1033.000	0.1500	0.9800	0.4000	0.4000	0.300
5	0.0080	0.369	0.2665	0.450	687.000	0.1500	0.9800	0.4000	0.4000	0.360
6	0.0100	0.409	0.2744	0.500	885.000	0.1500	0.9900	0.4000	0.4000	0.410
7	0.0081	0.445	0.2901	0.537	475.000	0.1500	1.0000	0.4000	0.4000	0.467
8	0.0076	0.477	0.3241	0.567	552.000	0.1500	1.0000	0.4000	0.4000	0.470
9	0.0086	0.501	0.3668	0.590	230.000	0.1500	1.0000	0.4000	0.4000	0.480
10	0.0095	0.521	0.3086	0.627	160.000	0.1500	1.0000	0.4000	0.4000	0.548
11	0.0119	0.547	0.3175	0.667	270.000	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.0079	0.628	0.3215	0.688	172.000	0.1500	1.0000	0.4000	0.4000	0.573
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

1996	Southern Area		Western + North Sea							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0100	0.058	0.0033	0.054	3798.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0040	0.158	0.0489	0.145	.	0.1500	0.1400	0.4000	0.4000	0.082
2	0.0046	0.224	0.1282	0.245	.	0.1500	0.6400	0.4000	0.4000	0.178
3	0.0044	0.283	0.2147	0.331	.	0.1500	0.9100	0.4000	0.4000	0.239
4	0.0070	0.334	0.2632	0.389	.	0.1500	0.9800	0.4000	0.4000	0.300
5	0.0080	0.369	0.2665	0.450	.	0.1500	0.9800	0.4000	0.4000	0.360
6	0.0100	0.409	0.2744	0.500	.	0.1500	0.9900	0.4000	0.4000	0.410
7	0.0081	0.445	0.2901	0.537	.	0.1500	1.0000	0.4000	0.4000	0.467
8	0.0076	0.477	0.3241	0.567	.	0.1500	1.0000	0.4000	0.4000	0.470
9	0.0086	0.501	0.3668	0.590	.	0.1500	1.0000	0.4000	0.4000	0.480
10	0.0095	0.521	0.3086	0.627	.	0.1500	1.0000	0.4000	0.4000	0.548
11	0.0119	0.547	0.3175	0.667	.	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.0079	0.628	0.3215	0.688	.	0.1500	1.0000	0.4000	0.4000	0.573
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

1997	Southern Area		Western + North Sea							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0100	0.058	0.0033	0.054	3798.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0040	0.158	0.0489	0.145	.	0.1500	0.1400	0.4000	0.4000	0.082
2	0.0046	0.224	0.1282	0.245	.	0.1500	0.6400	0.4000	0.4000	0.178
3	0.0044	0.283	0.2147	0.331	.	0.1500	0.9100	0.4000	0.4000	0.239
4	0.0070	0.334	0.2632	0.389	.	0.1500	0.9800	0.4000	0.4000	0.300
5	0.0080	0.369	0.2665	0.450	.	0.1500	0.9800	0.4000	0.4000	0.360
6	0.0100	0.409	0.2744	0.500	.	0.1500	0.9900	0.4000	0.4000	0.410
7	0.0081	0.445	0.2901	0.537	.	0.1500	1.0000	0.4000	0.4000	0.467
8	0.0076	0.477	0.3241	0.567	.	0.1500	1.0000	0.4000	0.4000	0.470
9	0.0086	0.501	0.3668	0.590	.	0.1500	1.0000	0.4000	0.4000	0.480
10	0.0095	0.521	0.3086	0.627	.	0.1500	1.0000	0.4000	0.4000	0.548
11	0.0119	0.547	0.3175	0.667	.	0.1500	1.0000	0.4000	0.4000	0.602
12+	0.0079	0.628	0.3215	0.688	.	0.1500	1.0000	0.4000	0.4000	0.573
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

Notes: Run name : COMBMAN
Date and time: 17OCT95:19:12

Table 3.29a

North East Atlantic mackerel.

08:46 Wednesday, October 18, 1995

Multi fleet prediction: Summary table

	Southern Area				Western + North Sea			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1995	1.0000	0.0081	87674	20027	0.9141	0.2593	1551598	650033
1996	1.0000	0.0081	88981	18709	0.9141	0.2593	1464123	598929
1997	1.0000	0.0081	91160	18588	0.9141	0.2593	1444309	565119
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
1996	1553103	617638	14638413	2619994	7036627	2247206	6066728	1915988
1997	1535469	583707	15265746	2595129	7069720	2141099	6126729	1832006
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:09:59
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.29b

North East Atlantic mackerel.

08:46 Wednesday, October 18, 1995

Multi fleet prediction: Detailed tables

Year 1995.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 0.9141 and reference F	0.2593

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	35046	2033	0.0030	10572	571
1	0.0040	6417	1014	0.0447	71713	10398
2	0.0046	9486	2125	0.1172	241652	59205
3	0.0044	5998	1697	0.1963	267513	88547
4	0.0070	5966	1993	0.2406	205069	79772
5	0.0080	4526	1670	0.2436	137833	62025
6	0.0100	7257	2968	0.2508	182037	91019
7	0.0081	3137	1396	0.2652	102697	55148
8	0.0076	3372	1609	0.2963	131455	74535
9	0.0086	1561	782	0.3353	60857	35905
10	0.0095	1229	640	0.2821	36487	22878
11	0.0119	2585	1414	0.2902	63040	42048
12+	0.0079	1093	687	0.2939	40671	27982
Total		87674	20027		1551598	650033
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	45618	2604	3798000	0	0	0	0	0
1	78130	11412	1769000	145058	247660	20308	228738	18757
2	251138	61330	2355000	419190	1507200	268282	1351937	240645
3	273511	90244	1616000	386224	1470560	351464	1278107	305468
4	211036	81765	1033000	309900	1012340	303702	863491	259047
5	142360	63695	687000	247320	673260	242374	573346	206404
6	189295	93987	885000	362850	876150	359222	743379	304785
7	105834	56544	475000	221825	475000	221825	401017	187275
8	134828	76144	552000	259440	552000	259440	460358	216368
9	62418	36688	230000	110400	230000	110400	188769	90609
10	37716	23518	160000	87680	160000	87680	134093	73483
11	65625	43462	270000	162540	270000	162540	225331	135649
12+	41764	28668	172000	98556	172000	98556	143564	82262
Total	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.29c
North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

(cont.)

Year 1996.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 0.9141 and reference F	0.2593

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37851	2195	0.0030	11418	617
1	0.0040	11705	1849	0.0447	130806	18967
2	0.0046	5841	1308	0.1172	148810	36459
3	0.0044	6660	1885	0.1963	297070	98330
4	0.0070	6573	2195	0.2406	225919	87883
5	0.0080	4573	1688	0.2436	139260	62667
6	0.0100	3770	1542	0.2508	94571	47286
7	0.0081	3876	1725	0.2652	126878	68134
8	0.0076	1900	906	0.2963	74081	42004
9	0.0086	2380	1192	0.3353	92771	54735
10	0.0095	1078	562	0.2821	32008	20069
11	0.0119	985	539	0.2902	24021	16022
12+	0.0079	1788	1123	0.2939	66509	45758
Total		88981	18709		1464123	598929
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	49269	2812	4102000	0	0	0	0	0
1	142511	20816	3226694	264589	451737	37042	417223	34212
2	154652	37767	1450220	258139	928140	165209	832529	148190
3	303731	100215	1794548	428897	1633039	390296	1419322	339218
4	232492	90078	1138028	341408	1115267	334580	951284	285385
5	143833	64355	694111	249880	680228	244882	579280	208541
6	98341	48828	459770	188506	455172	186621	386196	158340
7	130754	69858	586844	274056	586844	274056	495440	231371
8	75981	42910	311075	146205	311075	146205	259431	121933
9	95150	55927	350615	168295	350615	168295	287761	138125
10	33086	20630	140357	76916	140357	76916	117631	64462
11	25006	16561	102882	61935	102882	61935	85861	51688
12+	68297	46881	281271	161168	281271	161168	234769	134523
Total	1553103	617638	14638413	2619994	7036627	2247206	6066728	1915988
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.29d
North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

(cont.)

Year 1997.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 0.9141 and reference F	0.2593

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37851	2195	0.0030	11418	617
1	0.0040	12642	1997	0.0447	141276	20485
2	0.0046	10655	2387	0.1172	271433	66501
3	0.0044	4101	1161	0.1963	182937	60552
4	0.0070	7299	2438	0.2406	250881	97593
5	0.0080	5038	1859	0.2436	153419	69039
6	0.0100	3809	1558	0.2508	95550	47775
7	0.0081	2013	896	0.2652	65915	35396
8	0.0076	2348	1120	0.2963	91524	51894
9	0.0086	1341	672	0.3353	52280	30845
10	0.0095	1643	856	0.2821	48793	30593
11	0.0119	864	473	0.2902	21072	14055
12+	0.0079	1554	976	0.2939	57812	39774
Total		91160	18588		1444309	565119
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	49269	2812	4102000	0	0	0	0	0
1	153918	22482	3484965	285767	487895	40007	450618	36951
2	282088	68888	2645232	470851	1692948	301345	1518551	270302
3	187039	61713	1105091	264117	1005632	240346	874025	208892
4	258180	100031	1263766	379130	1238490	371547	1056389	316917
5	158457	70898	764683	275286	749389	269780	638177	229744
6	99359	49333	464529	190457	459884	188552	390193	159979
7	67928	36292	304874	142376	304874	142376	257388	120200
8	93872	53014	384321	180631	384321	180631	320517	150643
9	53621	31517	197586	94841	197586	94841	162166	77839
10	50436	31449	213962	117251	213962	117251	179318	98266
11	21936	14528	90251	54331	90251	54331	75320	45343
12+	59366	40750	244488	140091	244488	140091	204068	116931
Total	1535469	583707	15265746	2595129	7069720	2141099	6126729	1832006
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:09:59
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.30a
North East Atlantic mackerel.

20:46 Wednesday, October 18, 1995

Multi fleet prediction: Summary table

	Southern Area				Western + North Sea			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1995	1.0000	0.0081	87674	20027	0.9141	0.2593	1551598	650033
1996	1.0000	0.0081	88541	18543	1.0027	0.2844	1590482	649848
1997	1.0000	0.0081	89602	17991	1.0950	0.3106	1671163	649668
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
1996	1679023	668391	14638413	2619994	7036627	2247206	6016811	1898197
1997	1760765	667659	15149744	2552270	6960772	2099627	5939585	1764355
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:20:54
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.30b

North East Atlantic mackerel.

20:46 Wednesday, October 18, 1995

Multi fleet prediction: Detailed tables

Year 1995.	Southern Area	F-factor 1.0000	and reference F 0.0081
	Western + North Sea	F-factor 0.9141	and reference F 0.2593

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	35046	2033	0.0030	10572	571
1	0.0040	6417	1014	0.0447	71713	10398
2	0.0046	9486	2125	0.1172	241652	59205
3	0.0044	5998	1697	0.1963	267513	88547
4	0.0070	5966	1993	0.2406	205069	79772
5	0.0080	4526	1670	0.2436	137833	62025
6	0.0100	7257	2968	0.2508	182037	91019
7	0.0081	3137	1396	0.2652	102697	55148
8	0.0076	3372	1609	0.2963	131455	74535
9	0.0086	1561	782	0.3353	60857	35905
10	0.0095	1229	640	0.2821	36487	22878
11	0.0119	2585	1414	0.2902	63040	42048
12+	0.0079	1093	687	0.2939	40671	27982
Total		87674	20027		1551598	650033
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	45618	2604	3798000	0	0	0	0	0
1	78130	11412	1769000	145058	247660	20308	228738	18757
2	251138	61330	2355000	419190	1507200	268282	1351937	240645
3	273511	90244	1616000	386224	1470560	351464	1278107	305468
4	211036	81765	1033000	309900	1012340	303702	863491	259047
5	142360	63695	687000	247320	673260	242374	573346	206404
6	189295	93987	885000	362850	876150	359222	743379	304785
7	105834	56544	475000	221825	475000	221825	401017	187275
8	134828	76144	552000	259440	552000	259440	460358	216368
9	62418	36688	230000	110400	230000	110400	188769	90609
10	37716	23518	160000	87680	160000	87680	134093	73483
11	65625	43462	270000	162540	270000	162540	225331	135649
12+	41764	28668	172000	98556	172000	98556	143564	82262
Total	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.30c
North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

(cont.)

Year 1996.	Southern Area	F-factor 1.0000	and reference F 0.0081
	Western + North Sea	F-factor 1.0027	and reference F 0.2844

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37846	2195	0.0033	12523	676
1	0.0040	11681	1846	0.0490	143184	20762
2	0.0046	5810	1301	0.1285	162352	39776
3	0.0044	6601	1868	0.2153	322963	106901
4	0.0070	6502	2172	0.2639	245138	95359
5	0.0080	4523	1669	0.2672	151088	67989
6	0.0100	3728	1525	0.2751	102572	51286
7	0.0081	3830	1704	0.2909	137527	73852
8	0.0076	1875	895	0.3250	80192	45469
9	0.0086	2344	1175	0.3678	100260	59154
10	0.0095	1064	555	0.3094	34669	21738
11	0.0119	972	532	0.3184	26010	17348
12+	0.0079	1765	1108	0.3224	72003	49538
Total		88541	18543		1590482	649848
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	50368	2871	4102000	0	0	0	0	0
1	154865	22607	3226694	264589	451737	37042	416501	34153
2	168162	41078	1450220	258139	928140	165209	828755	147518
3	329564	108769	1794548	428897	1633039	390296	1408564	336647
4	251640	97531	1138028	341408	1115267	334580	942452	282736
5	155611	69658	694111	249880	680228	244882	573834	206580
6	106300	52811	459770	188506	455172	186621	382458	156808
7	141356	75556	586844	274056	586844	274056	490372	229004
8	82067	46363	311075	146205	311075	146205	256468	120540
9	102605	60328	350615	168295	350615	168295	284045	136342
10	35734	22292	140357	76916	140357	76916	116351	63761
11	26982	17880	102882	61935	102882	61935	84900	51110
12+	73768	50646	281271	161168	281271	161168	232110	132999
Total	1679023	668391	14638413	2619994	7036627	2247206	6016811	1898197
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.30d
North East Atlantic mackerel.

20:46 Wednesday, October 18, 1995

Multi fleet prediction: Detailed tables

(cont.)

Year 1997.	Southern Area	F-factor	1.0000	and reference F	0.0081
	Western + North Sea	F-factor	1.0950	and reference F	0.3106

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37840	2195	0.0036	13674	738
1	0.0040	12585	1988	0.0535	168463	24427
2	0.0046	10492	2350	0.1404	320187	78446
3	0.0044	3982	1127	0.2351	212753	70421
4	0.0070	7005	2340	0.2882	288411	112192
5	0.0080	4813	1776	0.2918	175567	79005
6	0.0100	3636	1487	0.3005	109244	54622
7	0.0081	1918	853	0.3177	75215	40390
8	0.0076	2227	1062	0.3549	104012	58975
9	0.0086	1264	633	0.4016	59039	34833
10	0.0095	1550	808	0.3379	55143	34574
11	0.0119	819	448	0.3477	23921	15955
12+	0.0079	1471	924	0.3520	65537	45089
Total		89602	17991		1671163	649668
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	51514	2933	4102000	0	0	0	0	0
1	181048	26416	3483947	285684	487753	39996	448895	36809
2	330679	80796	2633796	468816	1685629	300042	1498025	266648
3	216734	71548	1092609	261134	994275	237632	850832	203349
4	295416	114531	1239953	371986	1215154	364546	1016931	305079
5	180380	80781	747057	268940	732116	263562	611559	220161
6	112880	56109	453689	186012	449152	184152	373596	153174
7	77132	41244	297551	138956	297551	138956	245988	114876
8	106239	60037	374569	176047	374569	176047	305143	143417
9	60303	35466	191993	92157	191993	92157	153448	73655
10	56693	35382	207120	113502	207120	113502	169751	93023
11	24740	16403	87817	52866	87817	52866	71624	43118
12+	67007	46013	237644	136170	237644	136170	193794	111044
Total	1760765	667659	15149744	2552270	6960772	2099627	5939585	1764355
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:20:54
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.31a
North East Atlantic mackerel.

08:46 Wednesday, October 18, 1995

Multi fleet prediction: Summary table

	Southern Area				Western + North Sea			
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight
1995	1.0000	0.0081	87674	20027	0.9141	0.2593	1551598	650033
1996	1.0000	0.0081	88554	18548	1.0000	0.2837	1586668	648313
1997	1.0000	0.0081	90068	18162	1.0000	0.2837	1541940	600361
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Year	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1995	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
1996	1675223	666862	14638413	2619994	7036627	2247206	6018325	1898737
1997	1632008	618523	15153244	2553561	6964058	2100877	5991753	1782422
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:09:59
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.31b

North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

Year 1995.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 0.9141 and reference F	0.2593

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	35046	2033	0.0030	10572	571
1	0.0040	6417	1014	0.0447	71713	10398
2	0.0046	9486	2125	0.1172	241652	59205
3	0.0044	5998	1697	0.1963	267513	88547
4	0.0070	5966	1993	0.2406	205069	79772
5	0.0080	4526	1670	0.2436	137833	62025
6	0.0100	7257	2968	0.2508	182037	91019
7	0.0081	3137	1396	0.2652	102697	55148
8	0.0076	3372	1609	0.2963	131455	74535
9	0.0086	1561	782	0.3353	60857	35905
10	0.0095	1229	640	0.2821	36487	22878
11	0.0119	2585	1414	0.2902	63040	42048
12+	0.0079	1093	687	0.2939	40671	27982
Total		87674	20027		1551598	650033
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	45618	2604	3798000	0	0	0	0	0
1	78130	11412	1769000	145058	247660	20308	228738	18757
2	251138	61330	2355000	419190	1507200	268282	1351937	240645
3	273511	90244	1616000	386224	1470560	351464	1278107	305468
4	211036	81765	1033000	309900	1012340	303702	863491	259047
5	142360	63695	687000	247320	673260	242374	573346	206404
6	189295	93987	885000	362850	876150	359222	743379	304785
7	105834	56544	475000	221825	475000	221825	401017	187275
8	134828	76144	552000	259440	552000	259440	460358	216368
9	62418	36688	230000	110400	230000	110400	188769	90609
10	37716	23518	160000	87680	160000	87680	134093	73483
11	65625	43462	270000	162540	270000	162540	225331	135649
12+	41764	28668	172000	98556	172000	98556	143564	82262
Total	1639272	670060	14002000	2810983	7646170	2485792	6592130	2120753
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.31c

North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

(cont.)

Year 1996.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 1.0000 and reference F	0.2837

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37846	2195	0.0033	12489	674
1	0.0040	11682	1846	0.0489	142808	20707
2	0.0046	5811	1302	0.1282	161942	39676
3	0.0044	6603	1869	0.2147	322181	106642
4	0.0070	6504	2172	0.2632	244559	95133
5	0.0080	4525	1670	0.2665	150731	67829
6	0.0100	3729	1525	0.2744	102331	51165
7	0.0081	3831	1705	0.2901	137206	73680
8	0.0076	1876	895	0.3241	80008	45365
9	0.0086	2345	1175	0.3668	100036	59021
10	0.0095	1065	555	0.3086	34589	21687
11	0.0119	973	532	0.3175	25950	17308
12+	0.0079	1765	1109	0.3215	71838	49425
Total		88554	18548		1586668	648313
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size,	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	50335	2869	4102000	0	0	0	0	0
1	154490	22553	3226694	264589	451737	37042	416523	34155
2	167752	40977	1450220	258139	928140	165209	828870	147539
3	328784	108511	1794548	428897	1633039	390296	1408890	336725
4	251063	97306	1138028	341408	1115267	334580	942720	282816
5	155256	69499	694111	249880	680228	244882	574000	206640
6	106060	52691	459770	188506	455172	186621	382572	156854
7	141037	75385	586844	274056	586844	274056	490526	229076
8	81884	46260	311075	146205	311075	146205	256558	120582
9	102381	60196	350615	168295	350615	168295	284157	136396
10	35654	22242	140357	76916	140357	76916	116390	63782
11	26922	17841	102882	61935	102882	61935	84930	51128
12+	73603	50533	281271	161168	281271	161168	232190	133045
Total	1675223	666862	14638413	2619994	7036627	2247206	6018325	1898737
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 3.31d

North East Atlantic mackerel.

Multi fleet prediction: Detailed tables

(cont.)

Year 1997.	Southern Area	F-factor 1.0000 and reference F	0.0081
	Western + North Sea	F-factor 1.0000 and reference F	0.2837

	Southern Area			Western + North Sea		
Age	Absolute F	Catch in numbers	Catch in weight	Absolute F	Catch in numbers	Catch in weight
0	0.0100	37846	2195	0.0033	12489	674
1	0.0040	12613	1993	0.0489	154195	22358
2	0.0046	10554	2364	0.1282	294147	72066
3	0.0044	4021	1138	0.2147	196228	64951
4	0.0070	7091	2368	0.2632	266617	103714
5	0.0080	4873	1798	0.2665	162344	73055
6	0.0100	3683	1506	0.2744	101050	50525
7	0.0081	1944	865	0.2901	69620	37386
8	0.0076	2261	1078	0.3241	96414	54667
9	0.0086	1285	644	0.3668	54826	32348
10	0.0095	1573	819	0.3086	51093	32035
11	0.0119	831	454	0.3175	22168	14786
12+	0.0079	1493	937	0.3215	60748	41795
Total		90068	18162		1541940	600361
Unit	-	Thousands	Tonnes	-	Thousands	Tonnes

	Total				1 January		Spawning time	
Age	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0	50335	2869	4102000	0	0	0	0	0
1	166808	24351	3483978	285686	487757	39996	449734	36878
2	304701	74430	2634144	468878	1685852	300082	1505539	267986
3	200249	66089	1092988	261224	994619	237714	858099	205086
4	273708	106082	1240672	372202	1215858	364758	1027748	308325
5	167217	74853	747588	269132	732636	263749	618223	222560
6	104732	52031	454016	186146	449475	184285	377783	154891
7	71564	38251	297772	139059	297772	139059	248899	116236
8	98675	55745	374862	176185	374862	176185	309166	145308
9	56112	32992	192161	92237	192161	92237	155738	74754
10	52666	32855	207325	113614	207325	113614	171923	94214
11	22999	15241	87890	52910	87890	52910	72554	43677
12+	62241	42732	237850	136288	237850	136288	196346	112506
Total	1632008	618523	15153244	2553561	6964058	2100877	5991753	1782422
Unit	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : COMBINE
Date and time : 18OCT95:09:59
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Prediction basis : F factors

Table 3.32

North East Atlantic mackerel.

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Multi fleet prediction with mangement option table

Year: 1995								
Southern Area			Western + North Sea			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.0081	20027	0.9141	0.2593	650033	670060	2810983	2120753
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1996									Year: 1997	
Southern Area			Western + North Sea			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
1.0000	0.0081	20424	0.0000	0.0000	0	20424	2619994	2110203	3078970	2467762
1.0000	0.0081	20203	0.1000	0.0284	72622	92826	.	2087976	3017644	2386802
1.0000	0.0081	19987	0.2000	0.0567	143381	163368	.	2065997	2957912	2308832
1.0000	0.0081	19774	0.3000	0.0851	212329	232102	.	2044262	2899731	2233736
1.0000	0.0081	19564	0.4000	0.1135	279515	299079	.	2022769	2843056	2161402
1.0000	0.0081	19359	0.5000	0.1418	344988	364347	.	2001515	2787847	2091723
1.0000	0.0081	19157	0.6000	0.1702	408795	427952	.	1980498	2734062	2024596
1.0000	0.0081	18959	0.7000	0.1986	470982	489941	.	1959714	2681661	1959922
1.0000	0.0081	18765	0.8000	0.2269	531594	550359	.	1939161	2630607	1897606
1.0000	0.0081	18573	0.9000	0.2553	590674	609247	.	1918836	2580862	1837557
1.0000	0.0081	18386	1.0000	0.2837	648263	666649	.	1898737	2532389	1779688
1.0000	0.0081	18201	1.1000	0.3120	704403	722604	.	1878860	2485154	1723915
1.0000	0.0081	18020	1.2000	0.3404	759134	777154	.	1859205	2439122	1670157
1.0000	0.0081	17842	1.3000	0.3688	812493	830335	.	1839767	2394261	1618337
1.0000	0.0081	17667	1.4000	0.3971	864518	882185	.	1820544	2350537	1568379
1.0000	0.0081	17495	1.5000	0.4255	915246	932741	.	1801535	2307920	1520214
1.0000	0.0081	17326	1.6000	0.4539	964711	982037	.	1782736	2266379	1473773
1.0000	0.0081	17160	1.7000	0.4822	1012949	1030109	.	1764145	2225884	1428989
1.0000	0.0081	16997	1.8000	0.5106	1059992	1076989	.	1745759	2186408	1385799
1.0000	0.0081	16836	1.9000	0.5390	1105873	1122709	.	1727578	2147922	1344143
1.0000	0.0081	16678	2.0000	0.5673	1150623	1167302	.	1709597	2110398	1303963
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : COMBMAN
Date and time : 18OCT95:09:24
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Basis for 1995 : F factors

Table 3.33

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North East Atlantic mackerel.

Multi fleet yield per recruit: Summary table

Southern Area			Western + North Sea			Total			1 January		Spawning time	
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	1.0000	0.2837	171.359	171.359	4.152	727.926	2.100	606.280	1.812	517.530
0.1000	0.0008	0.497	1.0000	0.2837	170.737	171.234	4.146	725.792	2.094	604.304	1.807	515.721
0.2000	0.0016	0.991	1.0000	0.2837	170.117	171.108	4.139	723.667	2.089	602.337	1.802	513.920
0.3000	0.0024	1.482	1.0000	0.2837	169.500	170.983	4.132	721.552	2.083	600.378	1.797	512.128
0.4000	0.0033	1.970	1.0000	0.2837	168.887	170.857	4.125	719.445	2.078	598.428	1.792	510.343
0.5000	0.0041	2.455	1.0000	0.2837	168.276	170.731	4.119	717.347	2.072	596.487	1.787	508.568
0.6000	0.0049	2.937	1.0000	0.2837	167.668	170.605	4.112	715.258	2.067	594.555	1.781	506.800
0.7000	0.0057	3.416	1.0000	0.2837	167.064	170.480	4.105	713.179	2.061	592.632	1.776	505.041
0.8000	0.0065	3.892	1.0000	0.2837	166.462	170.354	4.099	711.107	2.056	590.717	1.771	503.290
0.9000	0.0073	4.365	1.0000	0.2837	165.863	170.228	4.092	709.045	2.050	588.810	1.766	501.547
1.0000	0.0081	4.836	1.0000	0.2837	165.267	170.102	4.086	706.991	2.045	586.912	1.761	499.813
1.1000	0.0090	5.303	1.0000	0.2837	164.674	169.977	4.079	704.946	2.040	585.023	1.756	498.086
1.2000	0.0098	5.767	1.0000	0.2837	164.084	169.851	4.072	702.910	2.034	583.141	1.751	496.368
1.3000	0.0106	6.229	1.0000	0.2837	163.496	169.725	4.066	700.882	2.029	581.269	1.746	494.657
1.4000	0.0114	6.687	1.0000	0.2837	162.912	169.599	4.059	698.863	2.024	579.404	1.742	492.954
1.5000	0.0122	7.143	1.0000	0.2837	162.330	169.473	4.053	696.852	2.018	577.548	1.737	491.259
1.6000	0.0130	7.596	1.0000	0.2837	161.751	169.347	4.047	694.850	2.013	575.700	1.732	489.572
1.7000	0.0138	8.047	1.0000	0.2837	161.175	169.222	4.040	692.856	2.008	573.860	1.727	487.893
1.8000	0.0147	8.494	1.0000	0.2837	160.601	169.096	4.034	690.870	2.003	572.028	1.722	486.221
1.9000	0.0155	8.939	1.0000	0.2837	160.031	168.970	4.027	688.893	1.998	570.204	1.717	484.557
2.0000	0.0163	9.381	1.0000	0.2837	159.463	168.844	4.021	686.923	1.992	568.388	1.712	482.901
2.1000	0.0171	9.821	1.0000	0.2837	158.897	168.718	4.015	684.962	1.987	566.580	1.708	481.252
2.2000	0.0179	10.257	1.0000	0.2837	158.335	168.592	4.008	683.009	1.982	564.781	1.703	479.611
2.3000	0.0187	10.691	1.0000	0.2837	157.775	168.466	4.002	681.064	1.977	562.988	1.698	477.978
2.4000	0.0195	11.123	1.0000	0.2837	157.218	168.341	3.996	679.128	1.972	561.204	1.693	476.351
2.5000	0.0204	11.552	1.0000	0.2837	156.663	168.215	3.989	677.199	1.967	559.428	1.689	474.733
2.6000	0.0212	11.978	1.0000	0.2837	156.111	168.089	3.983	675.278	1.962	557.659	1.684	473.121
2.7000	0.0220	12.401	1.0000	0.2837	155.562	167.963	3.977	673.365	1.957	555.898	1.679	471.517
2.8000	0.0228	12.822	1.0000	0.2837	155.015	167.837	3.971	671.460	1.952	554.144	1.675	469.920
2.9000	0.0236	13.241	1.0000	0.2837	154.471	167.712	3.965	669.562	1.947	552.398	1.670	468.330
3.0000	0.0244	13.657	1.0000	0.2837	153.929	167.586	3.958	667.672	1.942	550.660	1.665	466.748
-	-	Grams	-	-	Grams	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : COMBYPR
Date and time : 18OCT95:08:48
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Recruitment : Single recruit

Table 3.34

North East Atlantic mackerel.

Multi fleet yield per recruit: Summary table

Southern Area			Western + North Sea			Total			1 January		Spawning time	
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.0000	0.0000	0.000	0.000	7.179	2203.516	5.090	2073.271	4.794	1952.533
0.1000	0.0008	1.392	0.1000	0.0284	55.178	56.570	6.405	1798.542	4.322	1669.475	4.027	1553.880
0.2000	0.0016	2.311	0.2000	0.0567	90.045	92.356	5.860	1521.027	3.781	1393.096	3.487	1282.077
0.3000	0.0024	2.956	0.3000	0.0851	113.249	116.205	5.452	1319.698	3.378	1192.864	3.086	1085.940
0.4000	0.0033	3.431	0.4000	0.1135	129.274	132.704	5.134	1167.371	3.065	1041.596	2.774	938.356
0.5000	0.0041	3.794	0.5000	0.1418	140.647	144.442	4.877	1048.321	2.814	923.571	2.524	823.660
0.6000	0.0049	4.083	0.6000	0.1702	148.884	152.967	4.666	952.843	2.607	829.086	2.318	732.200
0.7000	0.0057	4.318	0.7000	0.1986	154.936	159.255	4.488	874.637	2.434	751.841	2.146	657.717
0.8000	0.0065	4.516	0.8000	0.2269	159.426	163.942	4.335	809.440	2.285	687.576	1.999	595.986
0.9000	0.0073	4.686	0.9000	0.2553	162.773	167.459	4.202	754.272	2.157	633.314	1.872	544.057
1.0000	0.0081	4.836	1.0000	0.2837	165.267	170.102	4.086	706.991	2.045	586.912	1.761	499.813
1.1000	0.0090	4.969	1.1000	0.3120	167.115	172.084	3.982	666.019	1.946	546.795	1.663	461.699
1.2000	0.0098	5.090	1.2000	0.3404	168.466	173.556	3.889	630.169	1.857	511.777	1.576	428.547
1.3000	0.0106	5.202	1.3000	0.3688	169.430	174.632	3.806	598.532	1.778	480.950	1.498	399.465
1.4000	0.0114	5.306	1.4000	0.3971	170.089	175.395	3.730	570.402	1.706	453.610	1.427	373.761
1.5000	0.0122	5.404	1.5000	0.4255	170.506	175.910	3.660	545.221	1.640	429.199	1.363	350.888
1.6000	0.0130	5.497	1.6000	0.4539	170.728	176.225	3.596	522.542	1.580	407.273	1.305	330.413
1.7000	0.0138	5.586	1.7000	0.4822	170.794	176.380	3.537	502.007	1.525	387.472	1.251	311.984
1.8000	0.0147	5.672	1.8000	0.5106	170.732	176.404	3.483	483.320	1.475	369.502	1.202	295.314
1.9000	0.0155	5.755	1.9000	0.5390	170.567	176.322	3.432	466.238	1.428	353.122	1.156	280.169
2.0000	0.0163	5.836	2.0000	0.5673	170.316	176.152	3.385	450.558	1.384	338.129	1.114	266.352
-	-	Grams	-	-	Grams	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : COMBYPR
Date and time : 18OCT95:08:48
Computation of ref. F: Southern Area: Simple mean, age 4 - 8
Western + North Sea: Simple mean, age 4 - 8
Recruitment : Single recruit

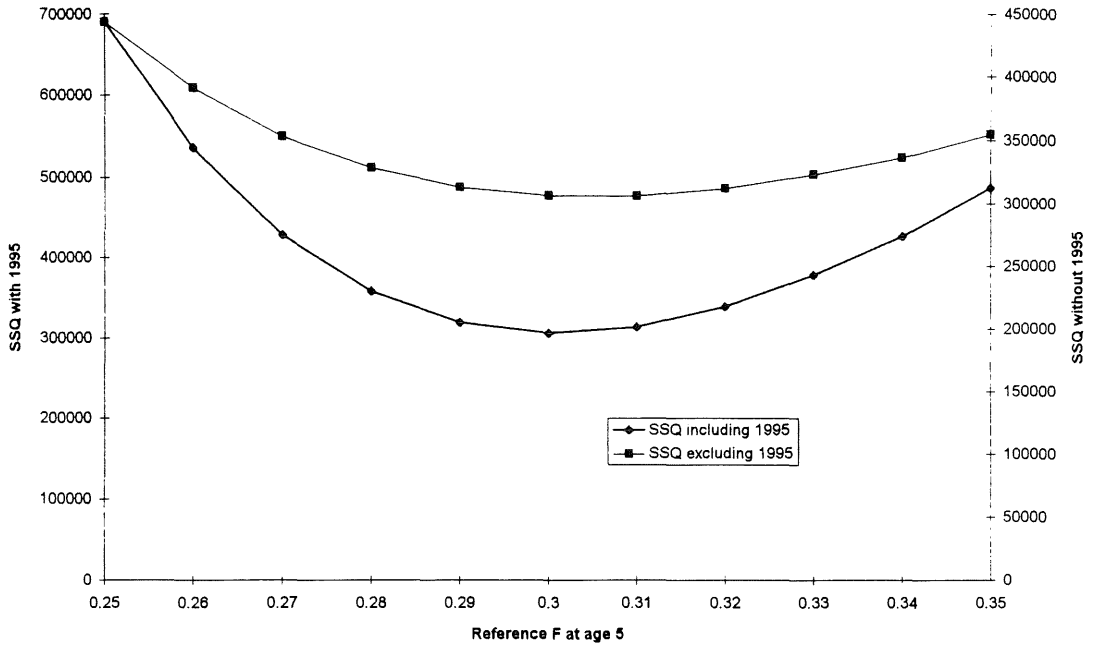


Figure 3.1 The SSQ relationship resulting from the Western mackerel Separable VPA tuning.

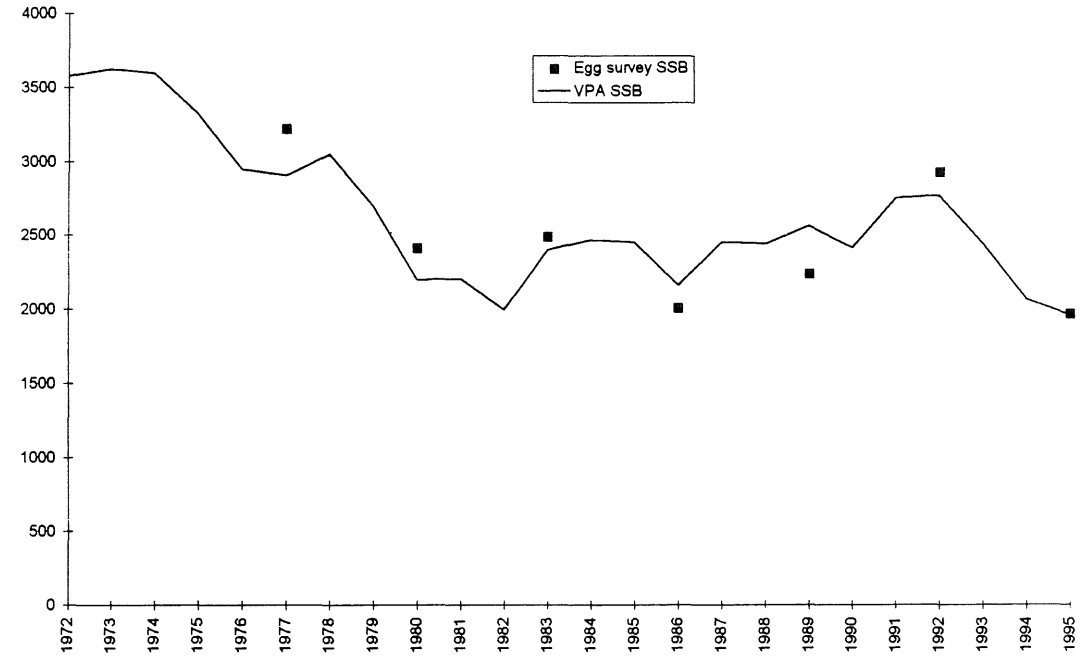


Figure 3.2 The Western mackerel spawning stock biomass estimates from the egg production survey and estimated by a 'tuned' Separable VPA.

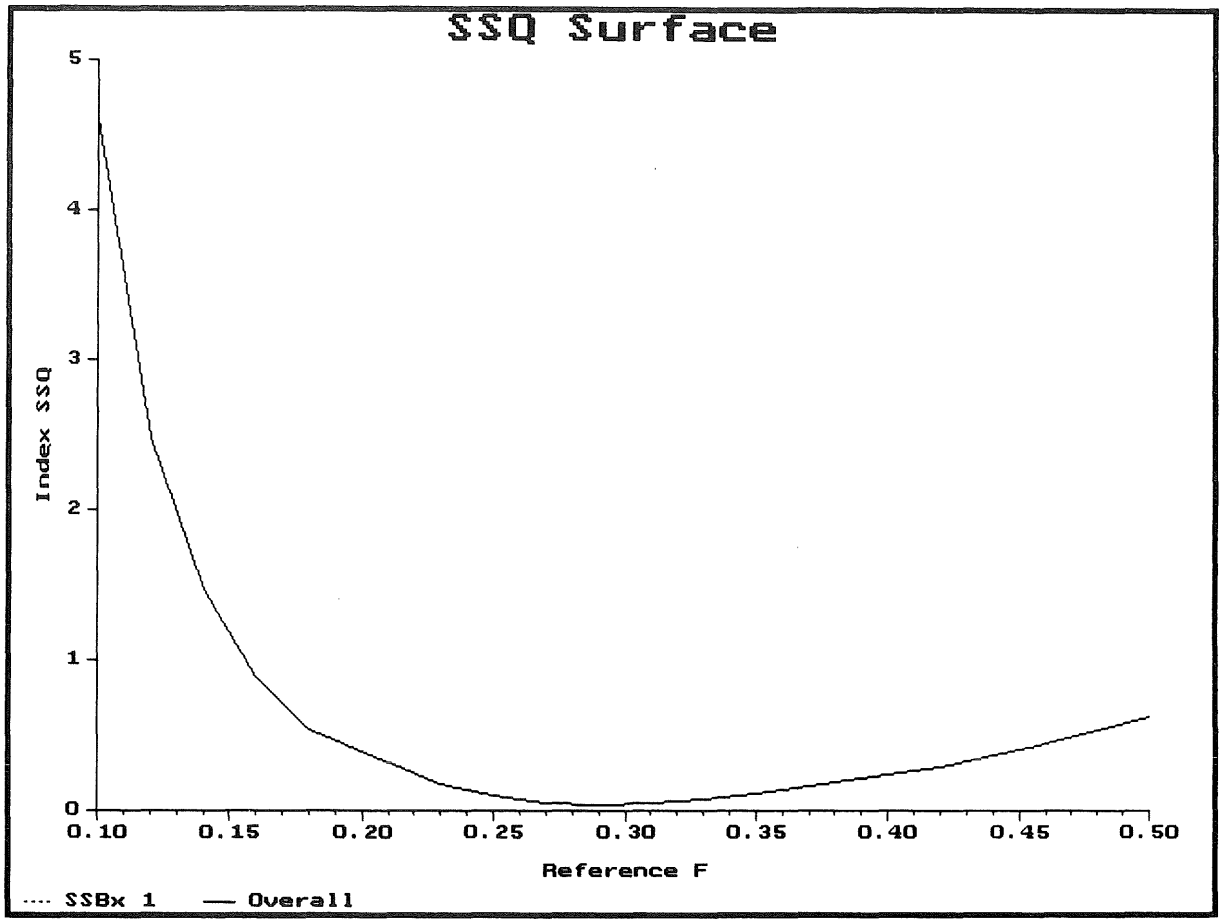


Figure 3.3 The ICA sum of squares relationship for the Western mackerel assessment.

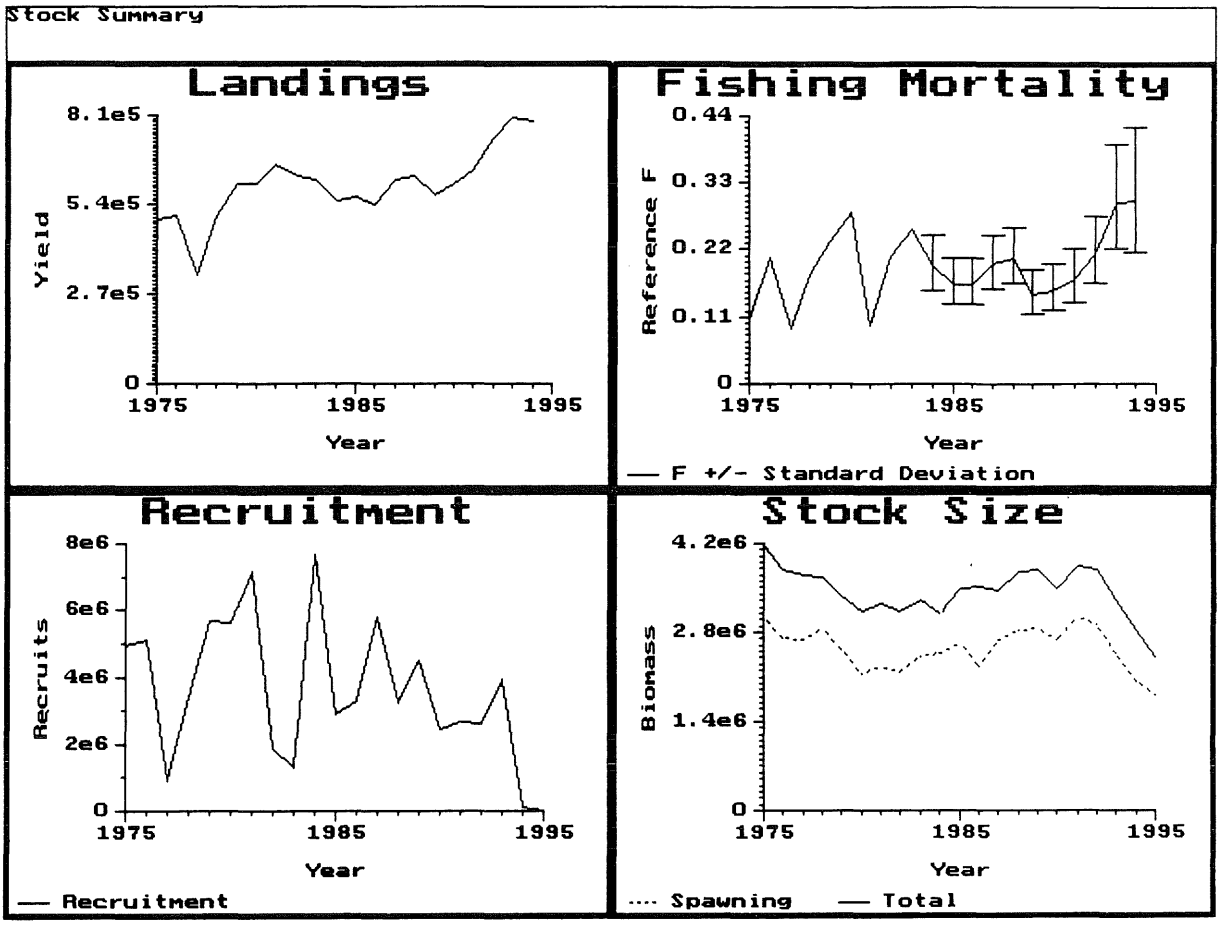


Figure 3.4 The long term trends in stock parameters for the Western mackerel.

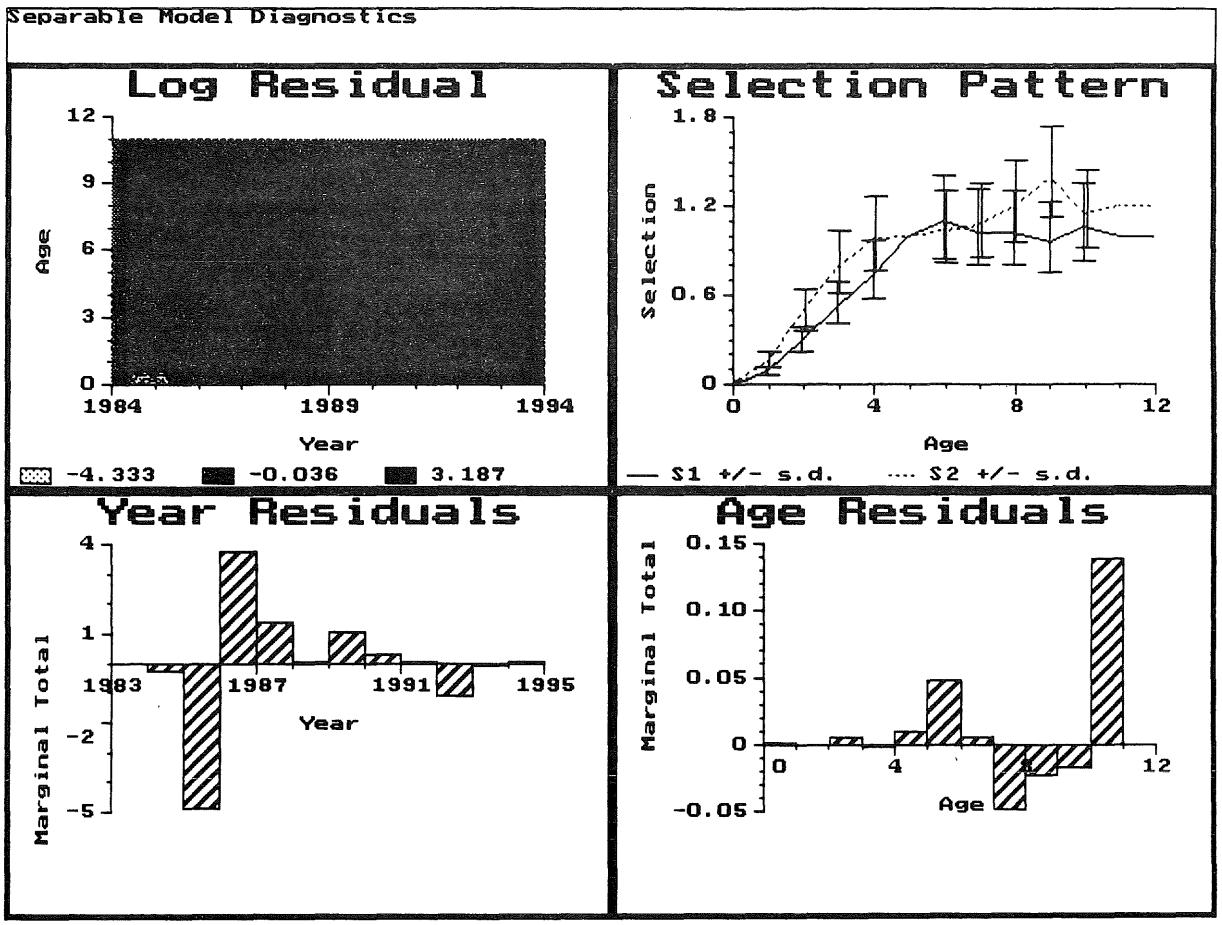


Figure 3.5 The catch at age residuals and selection-at-age as fitted by ICA to the Western mackerel data.

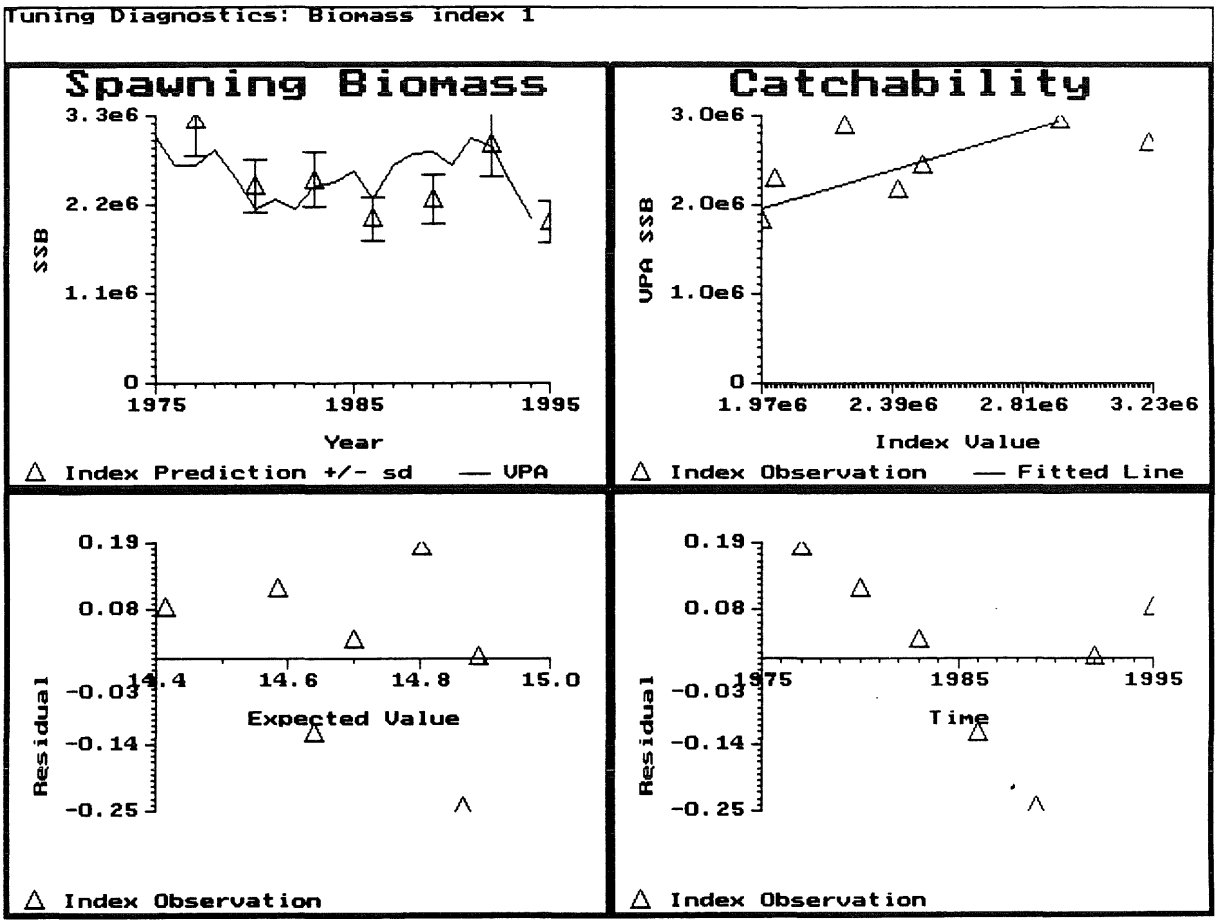
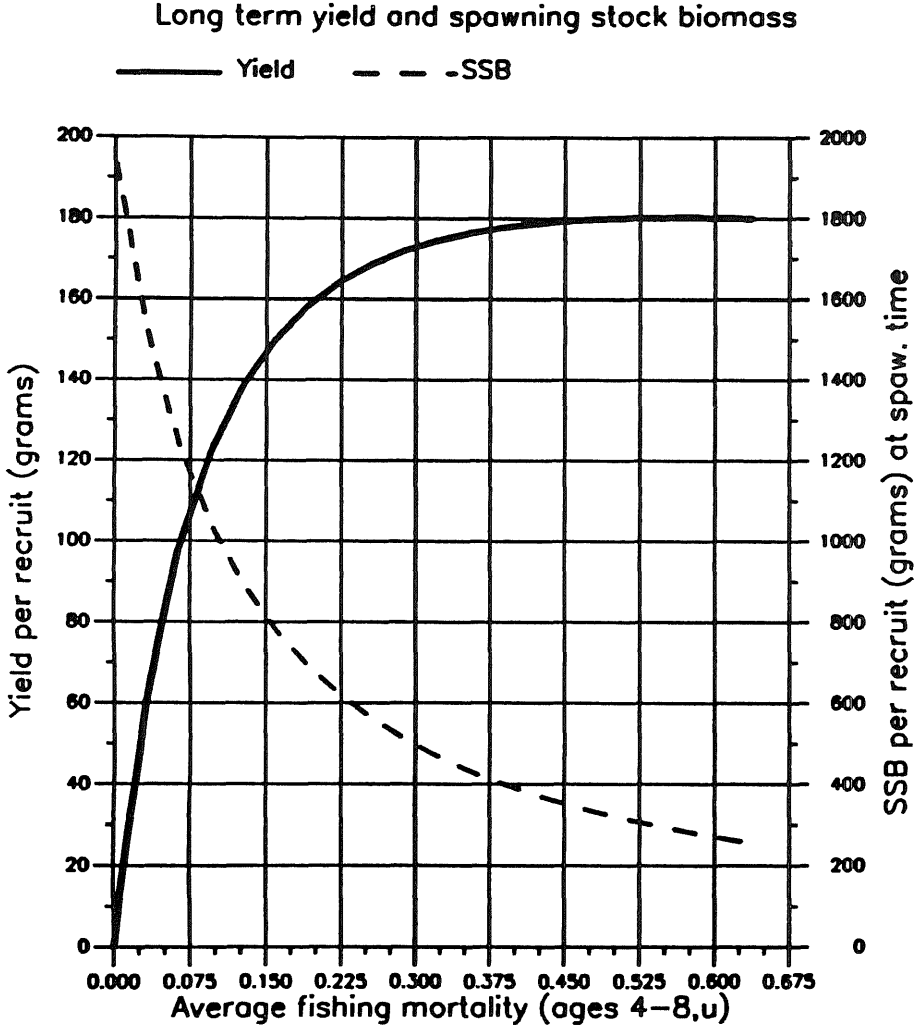


Figure 3.6 The diagnostics for the egg production index as fitted by ICA to the Western mackerel data.

Figure 3.7

FISH STOCK SUMMARY
STOCK: Mackerel in the Western Area (Fishing Areas VI, VII and VIII)
17–10–1995



(run: YPR95) **C**

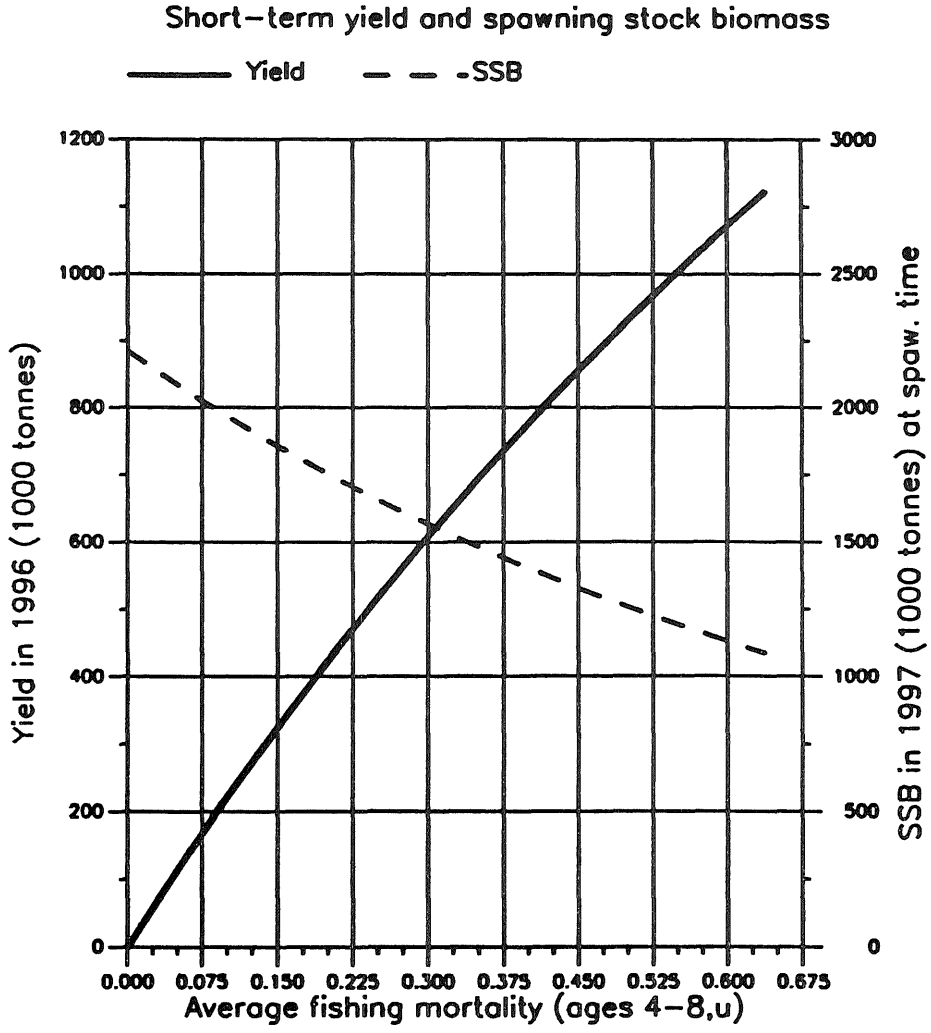


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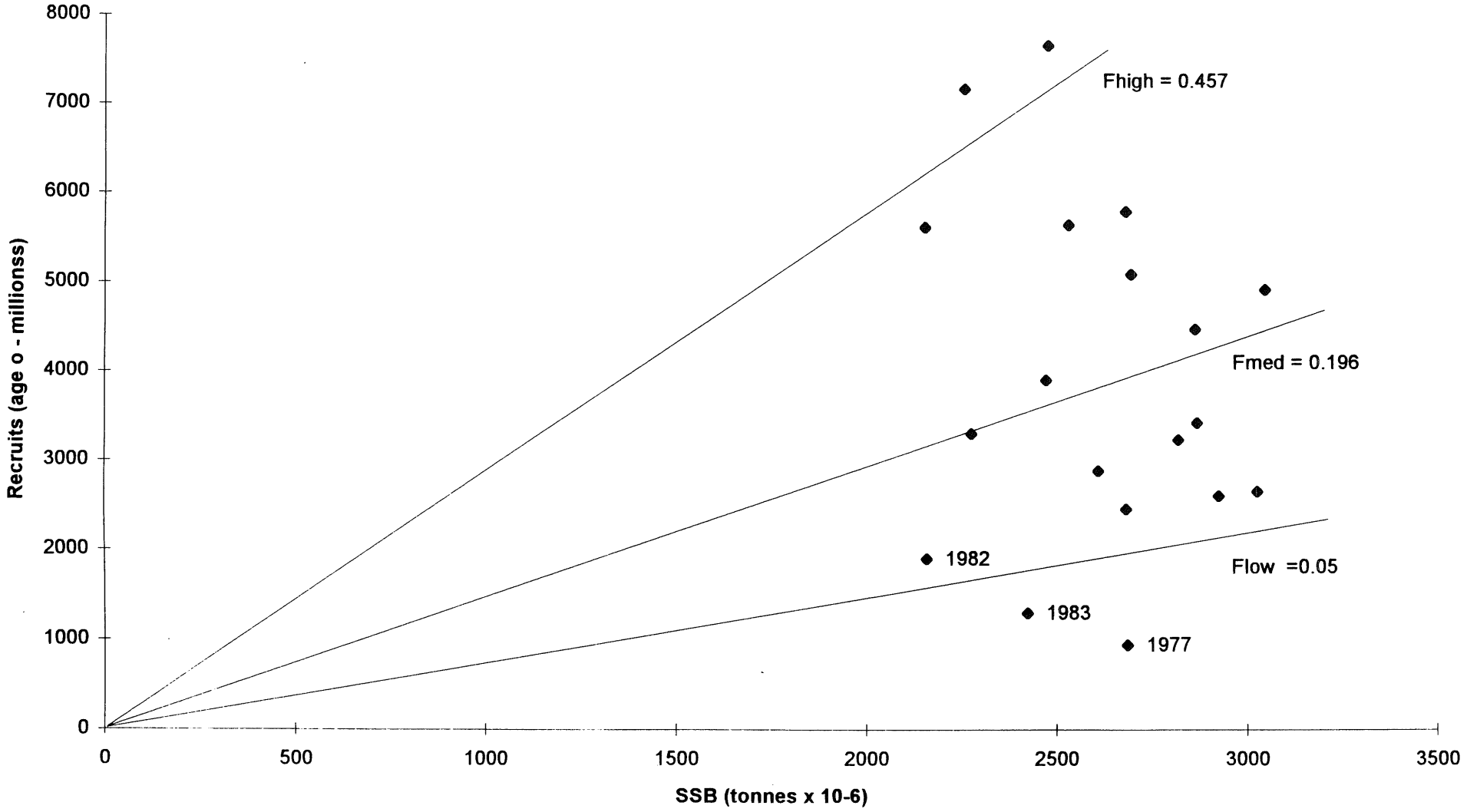
Figure 3.8 The Western mackerel stock-recruitment



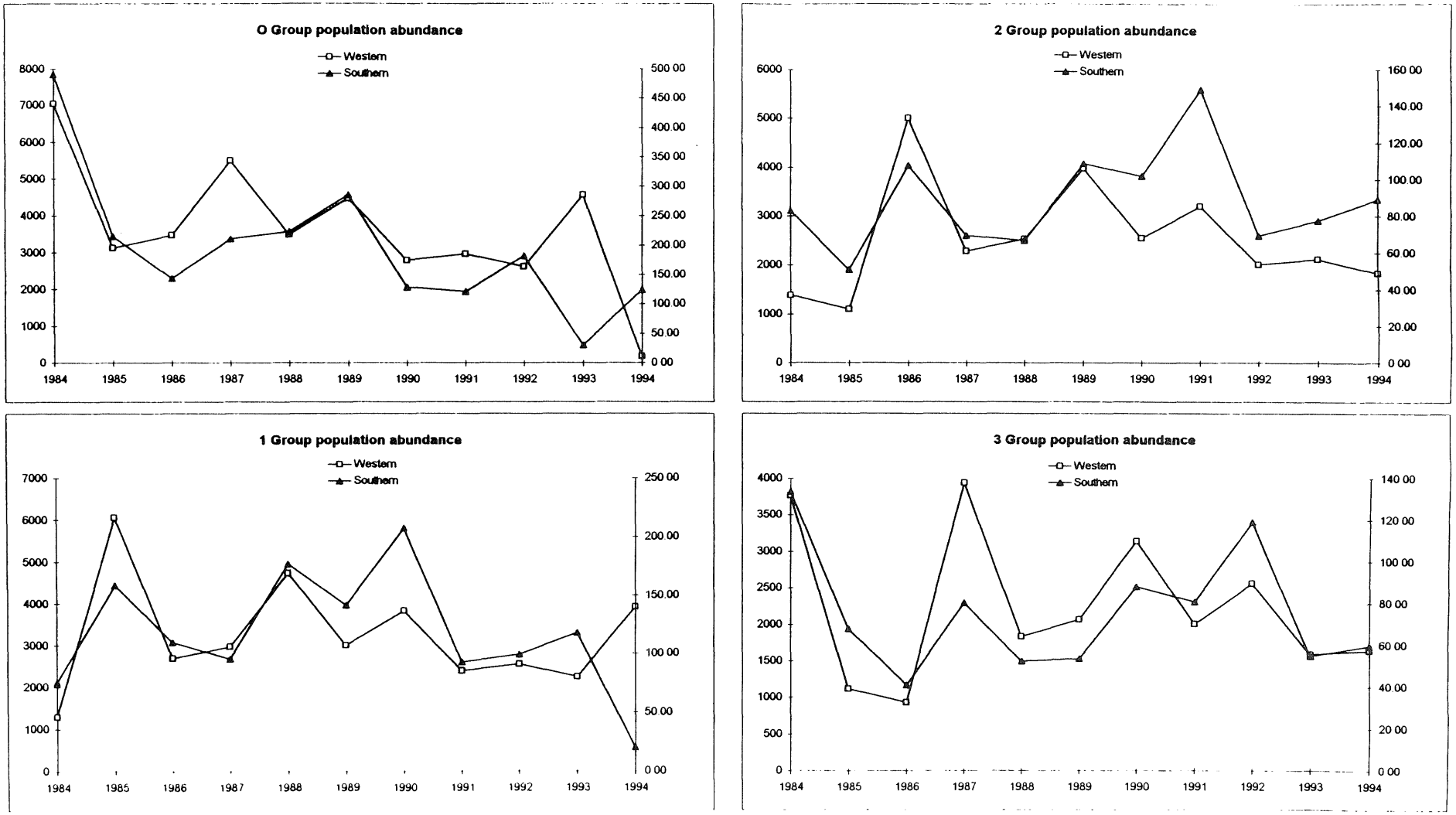


Figure 3.9a Comparison of the populations at age fitted by applying a separable VPA model to the western and southern area catch at age data sets.

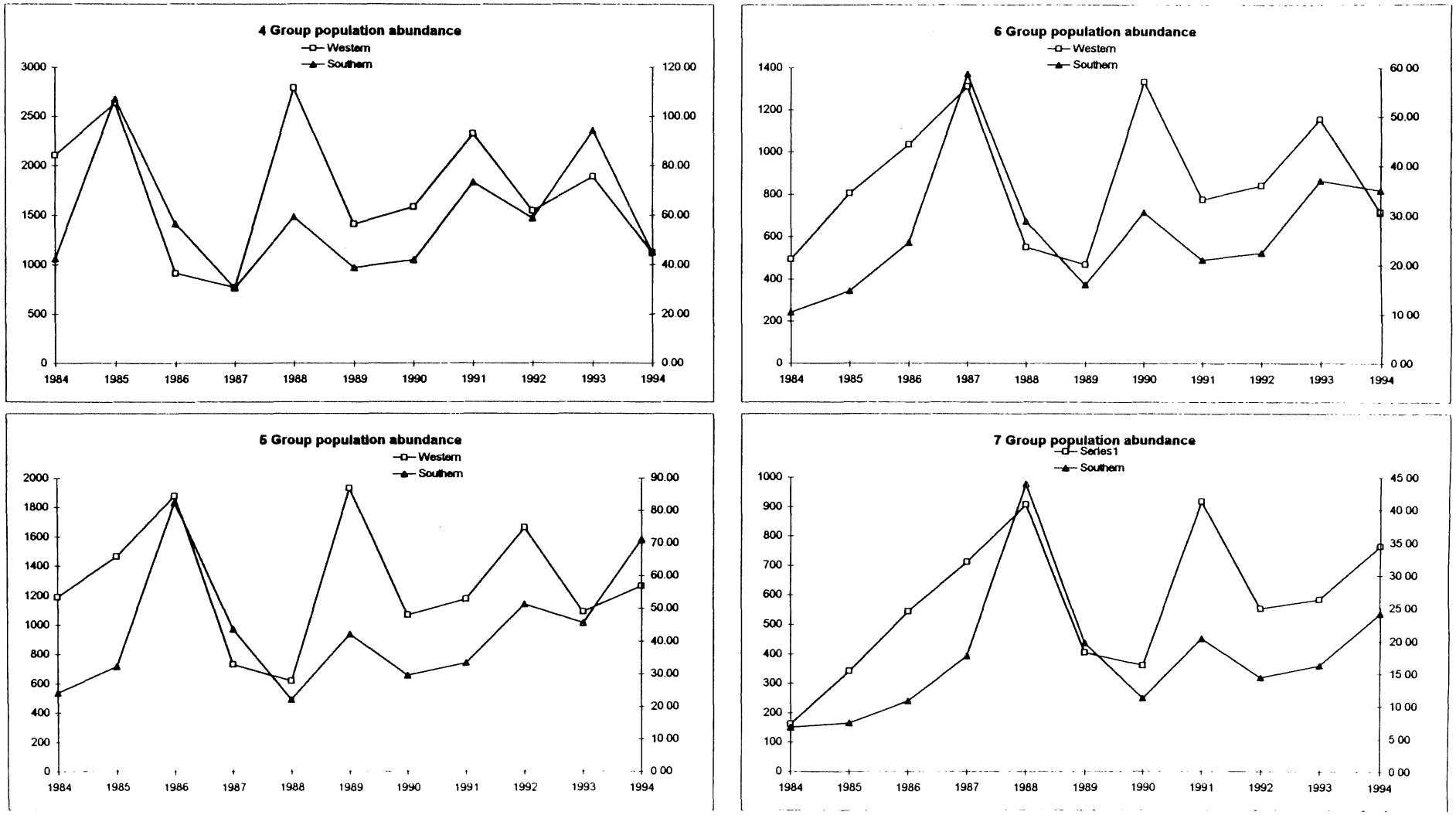


Figure 3.9b Comparison of the populations at age fitted by applying a separable VPA model to the western and southern area catch at age data sets.

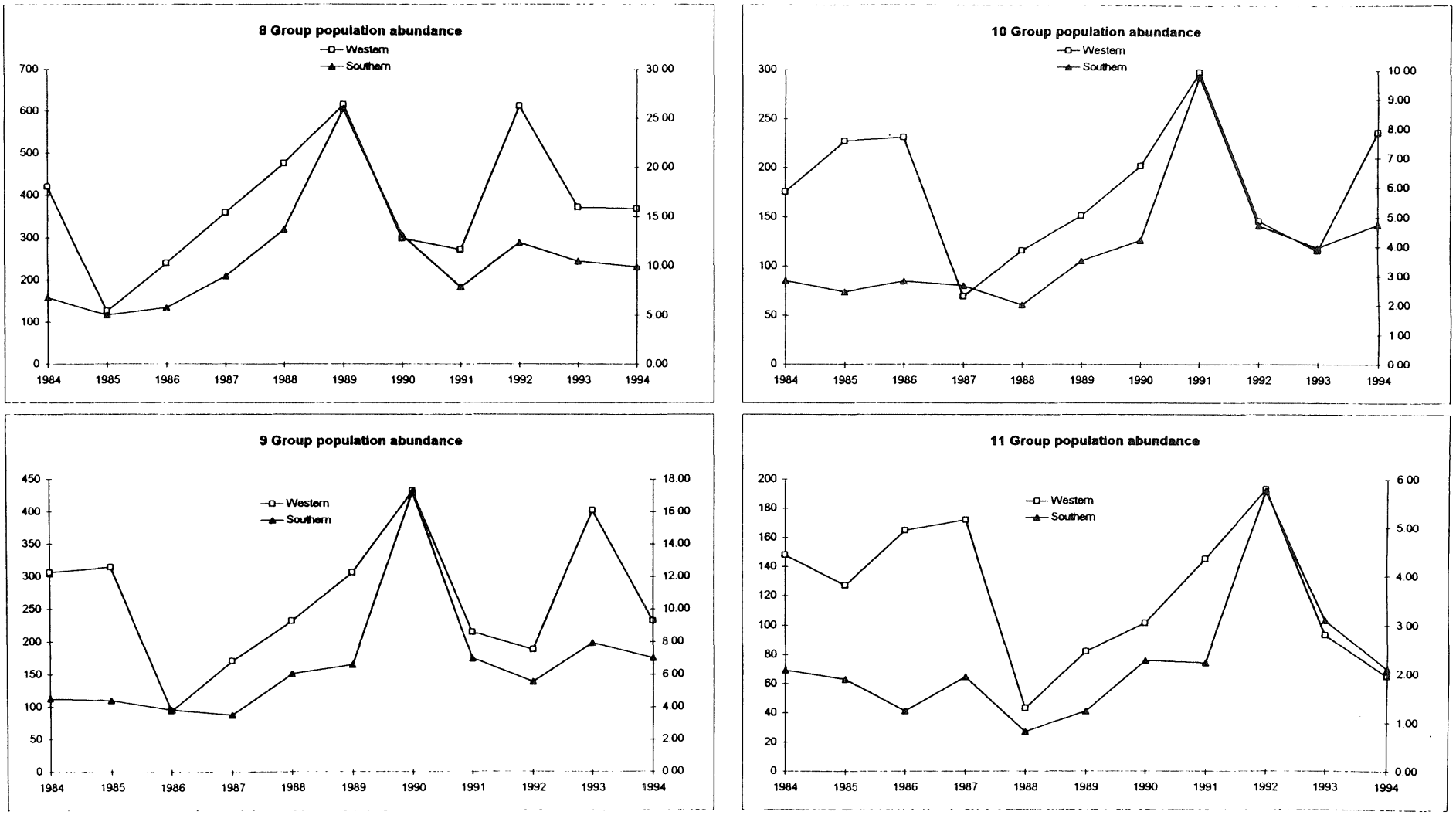


Figure 3.9c Comparison of the populations at age fitted by applying a separable VPA model to the western and southern area catch at age data sets.

Figure 3.10 The average (1984 - 1993) catch of mackerel taken in the two fisheries

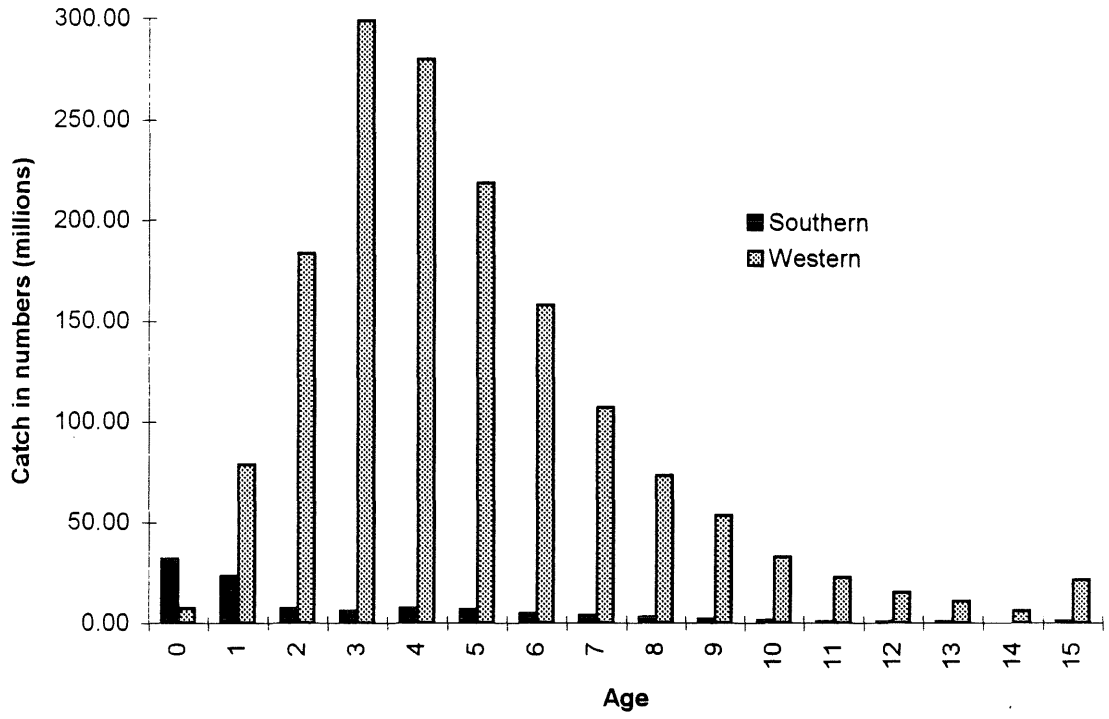
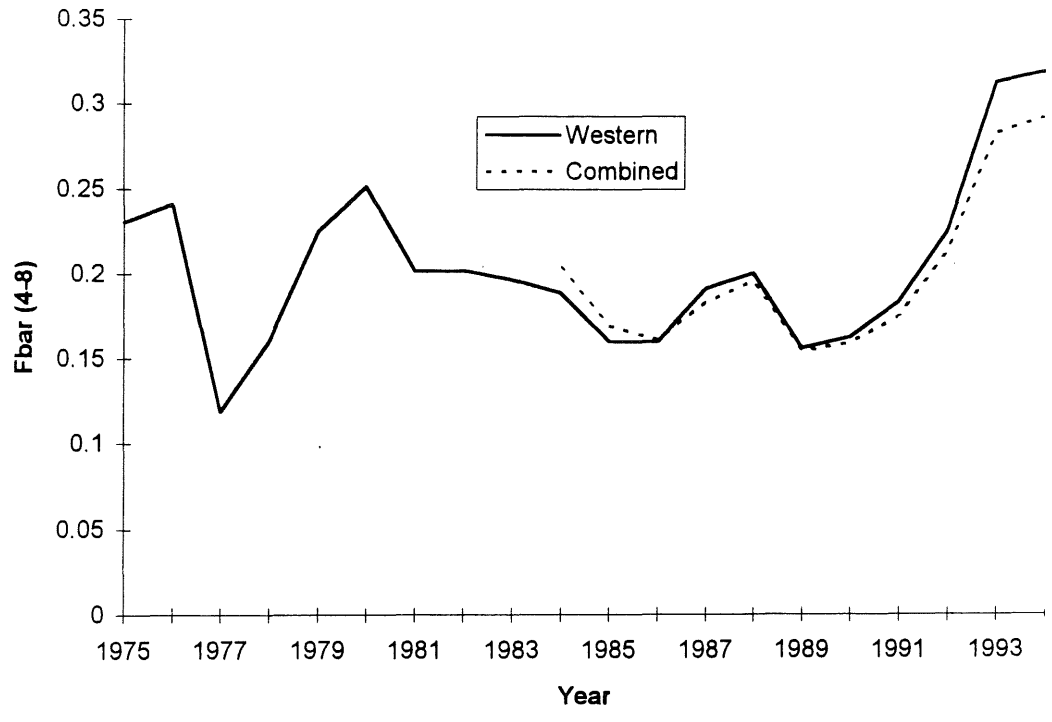


Figure 3.11 Fbar(4-8) as estimated by the western and combined assessments



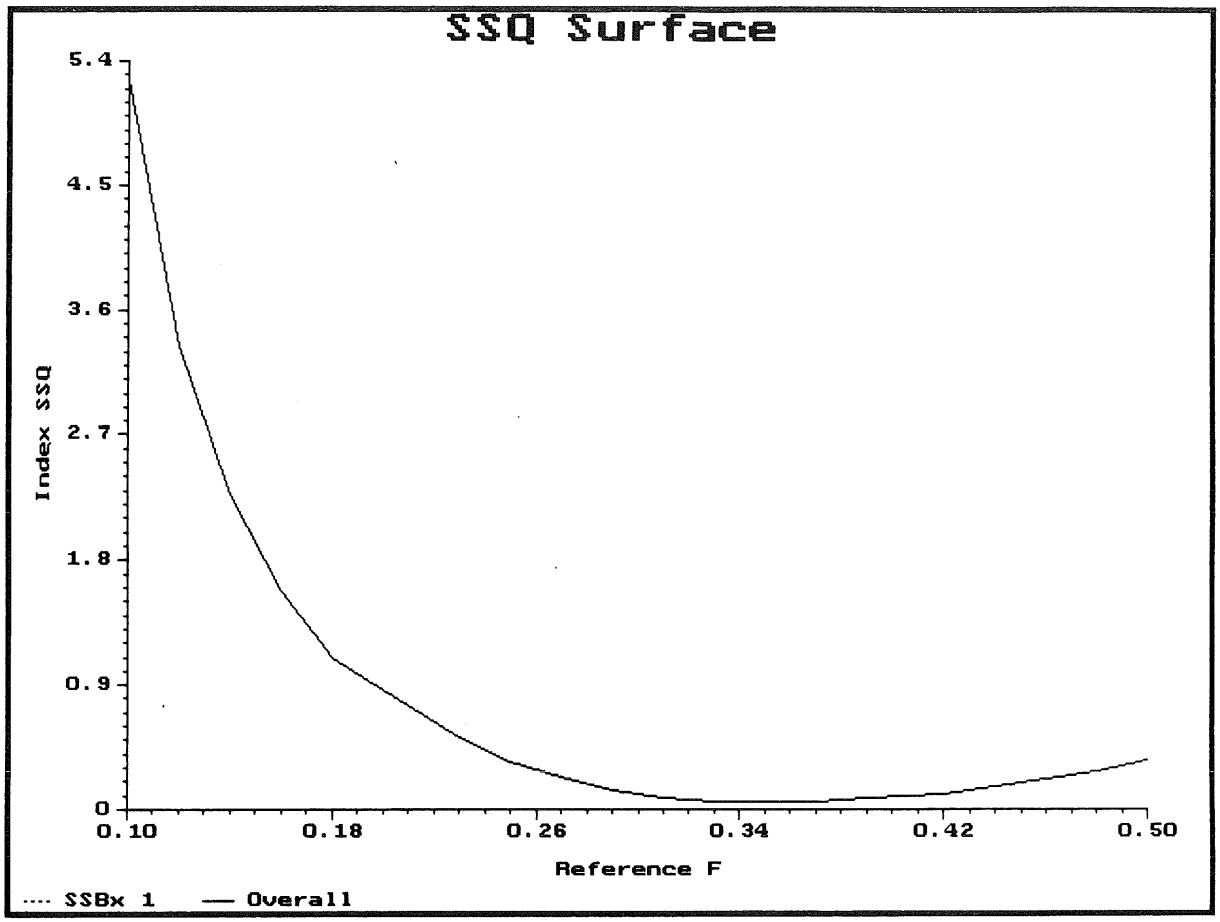


Figure 3.12 The ICA sum of squares relationship for the North East Atlantic mackerel.

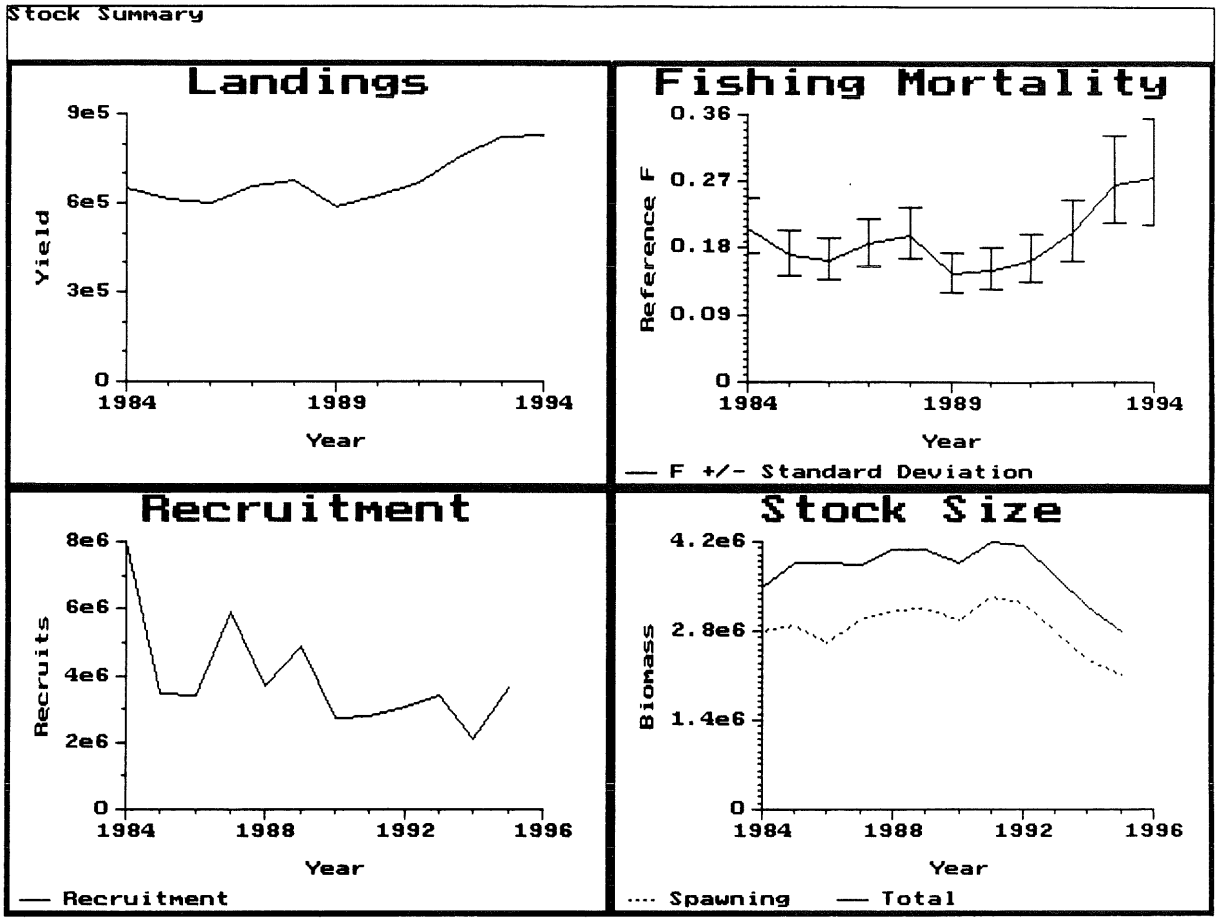


Figure 3.13 The long term trends in stock parameters for the North East Atlantic mackerel.

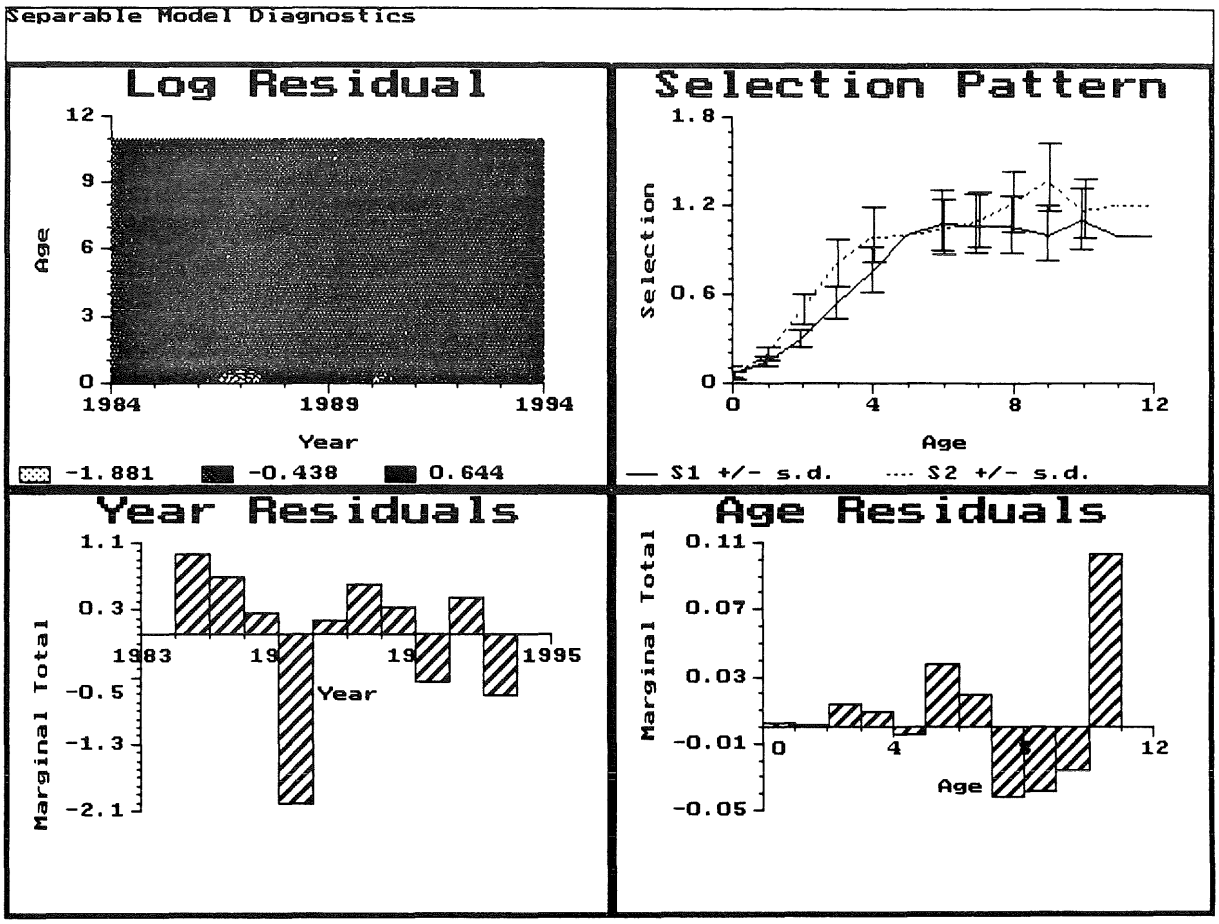


Figure 3.14 The catch at age residuals and selection-at-age as fitted by ICA to the North East Atlantic mackerel data.

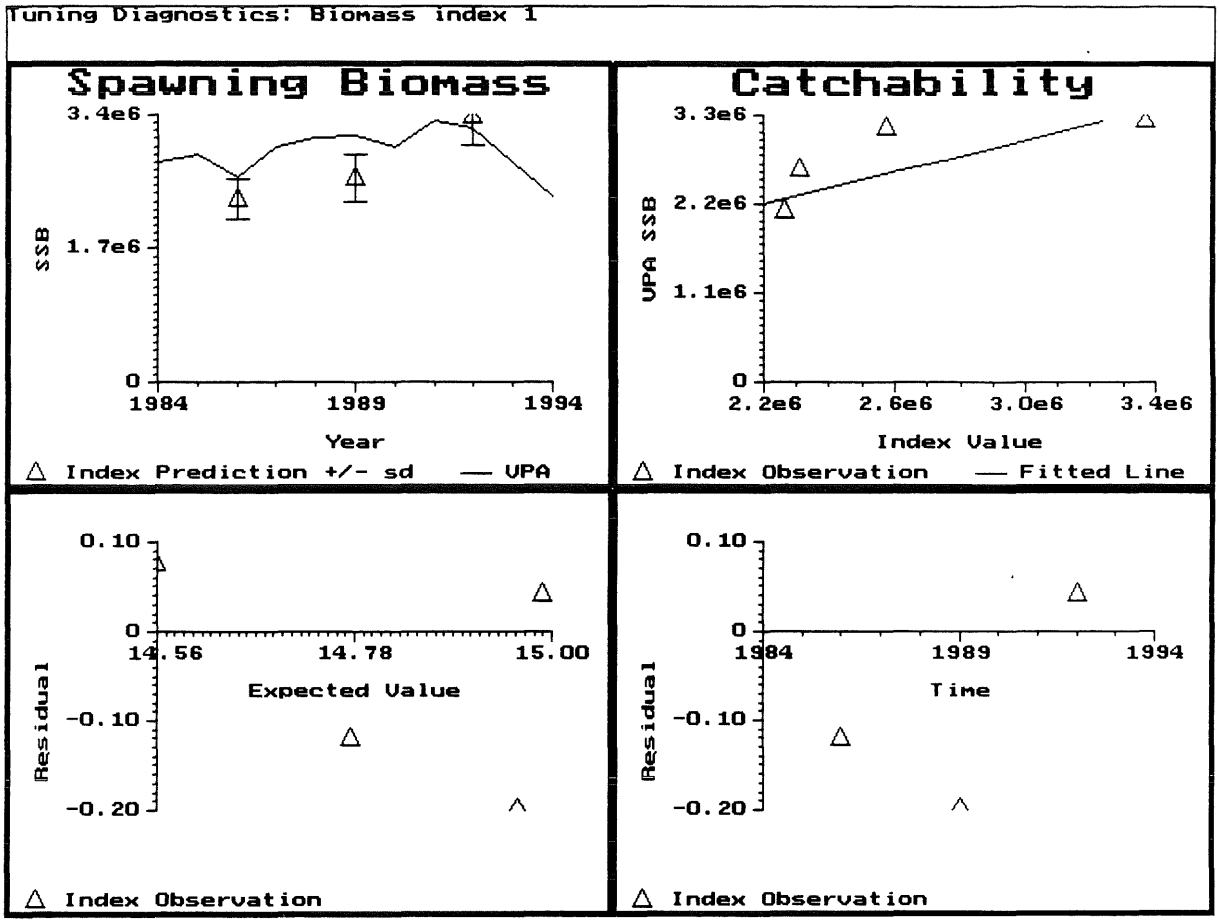


Figure 3.15 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic mackerel data.

Figure 3.16a NEA Mackerel :Risk in 1996

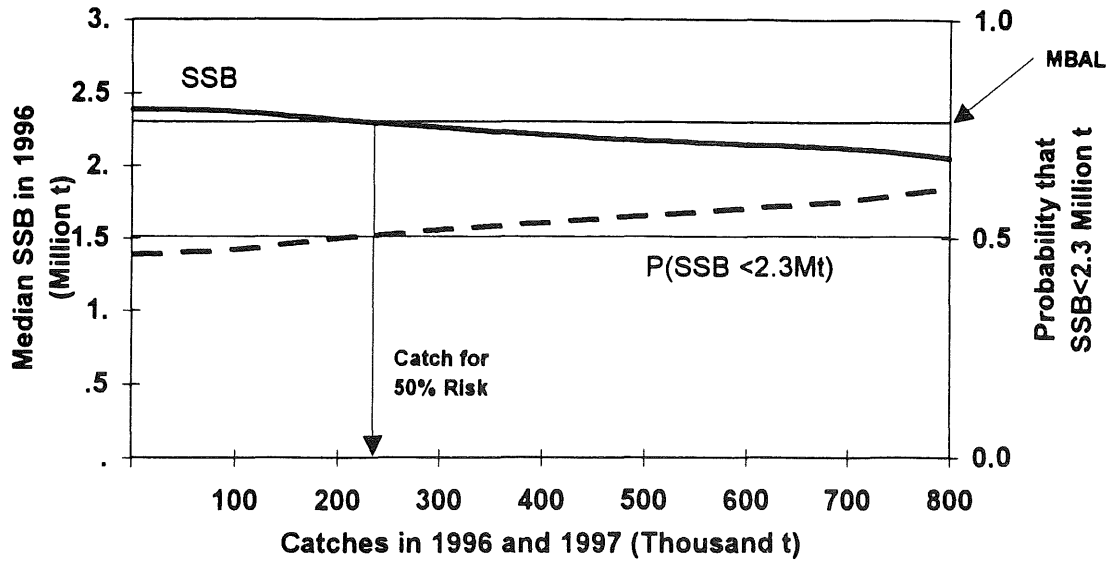


Figure 3.16b NEA Mackerel :Risk in 1997

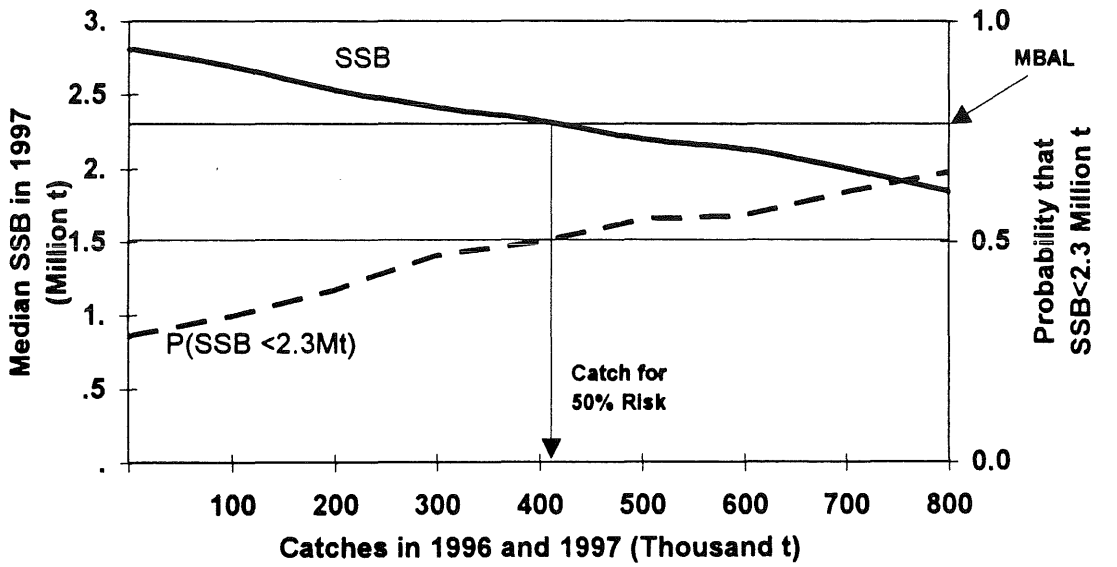
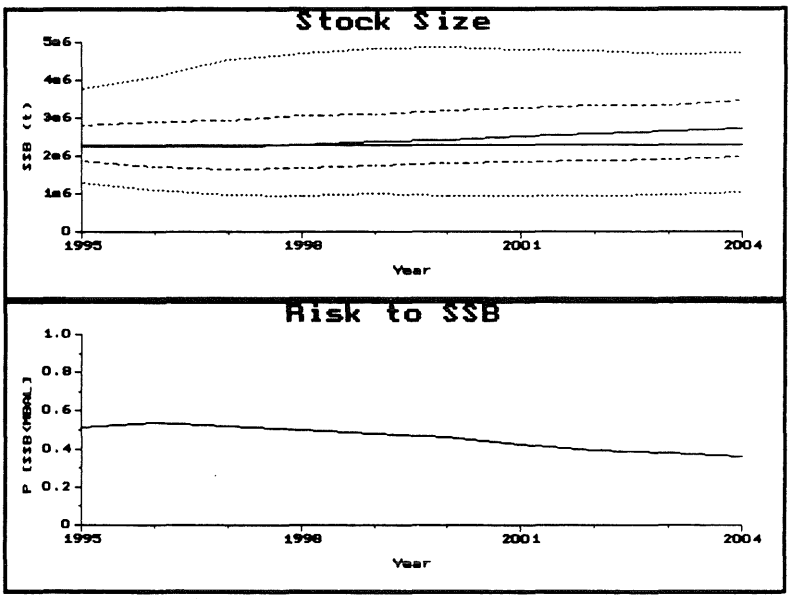


Figure 3.17

Stock size = SSB

a



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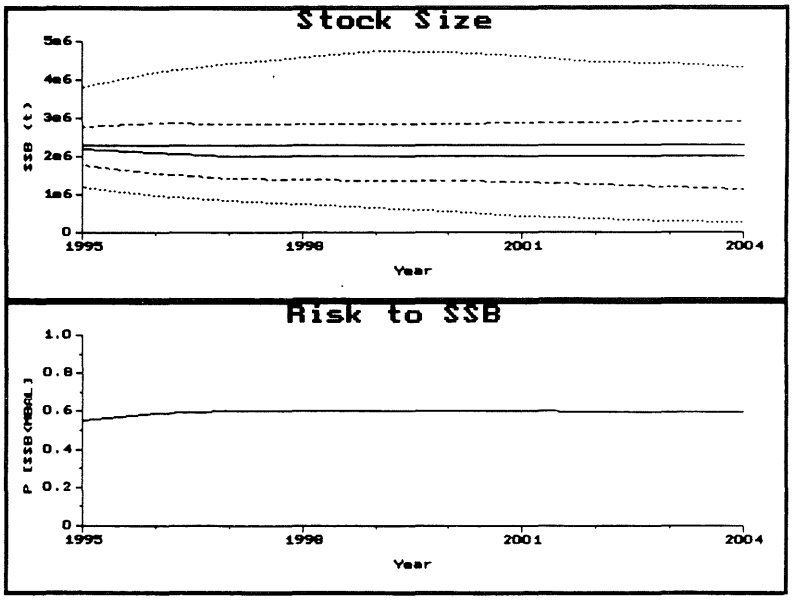


c

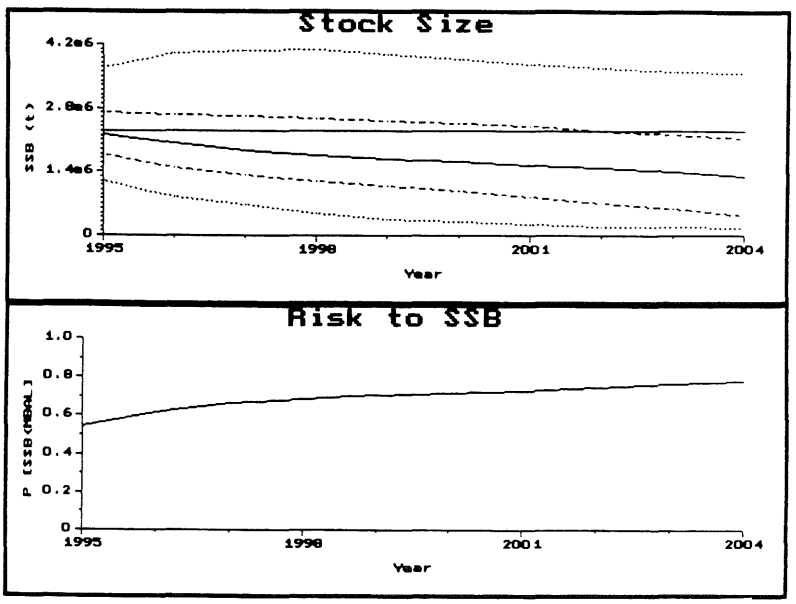
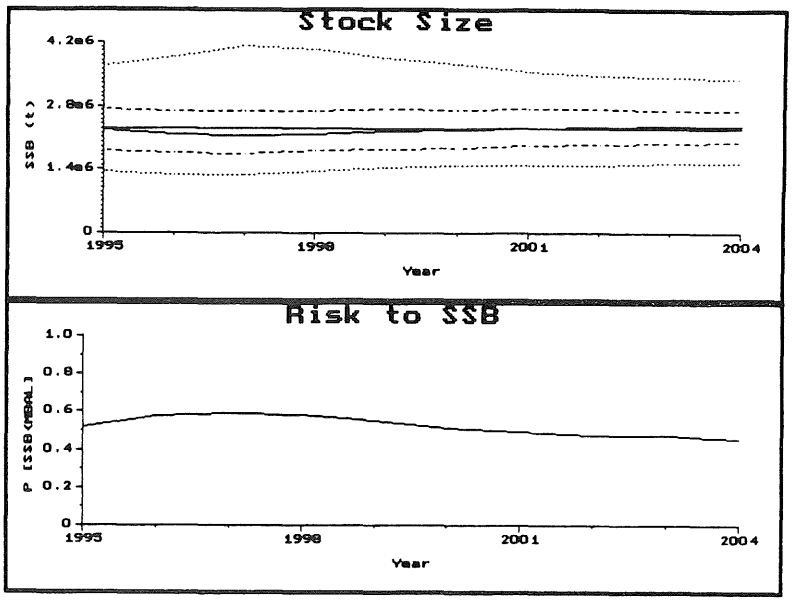


Figure 3.18

Stock size = SSB

a



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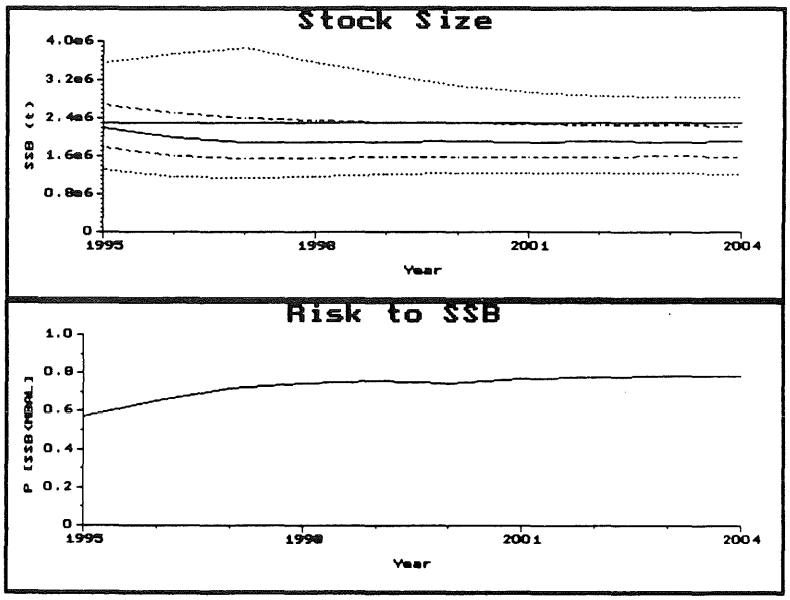


c

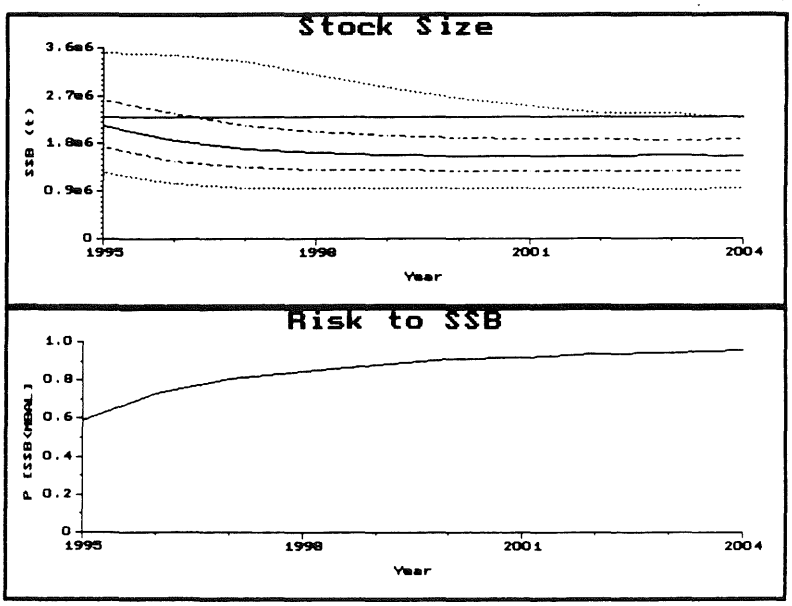
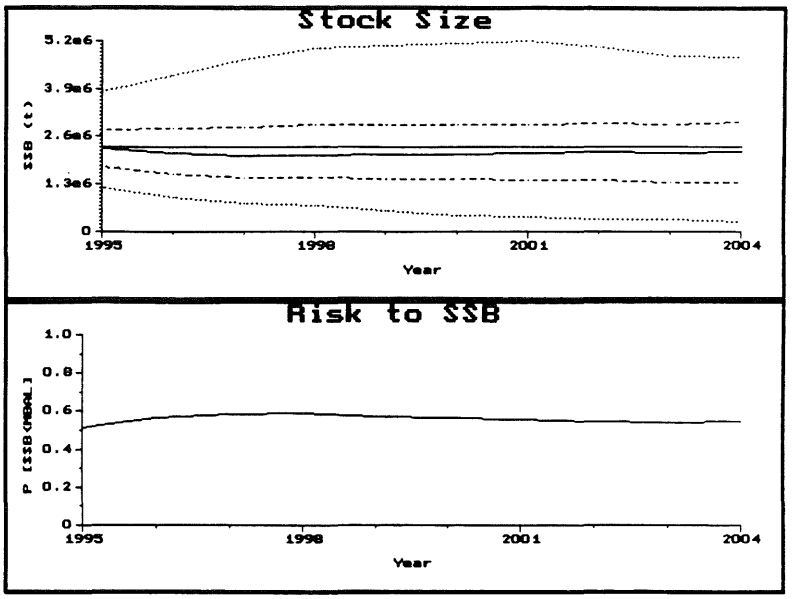


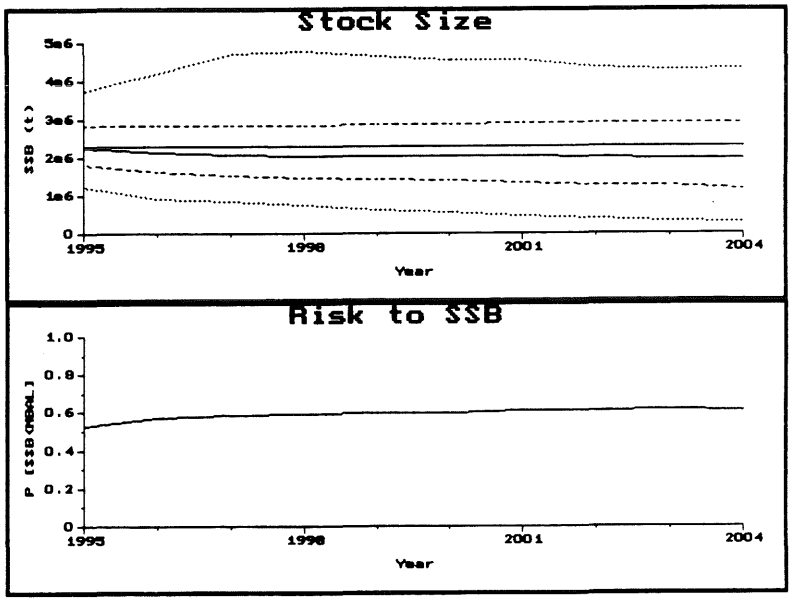
Figure 3.19

Stock size = SSB

a



b



4 HORSE MACKEREL - GENERAL

4.1 Stock Units

In later years the Working Group has considered the horse mackerel in the north east Atlantic as separated in three stocks, the North Sea-, the Southern- and the Western stock (Anon. 1990,1991). However, there is no well established biological basis for this. This separation is mainly based on the known distribution of eggs combined with the location and time of the different fisheries in recent years. Particularly data from the western egg survey in 1992 (Anon., 1993a) indicates that it might be difficult to determine a realistic border between a western and southern spawning area. In 1994 a tagging program of horse mackerel in Portuguese and Spanish waters was started. However, so far no tags has been recovered (Borges and Porteiro pers. comm.).

The 1982 year class is the strongest in all three stock units, while other year classes seem to be represented differently in the catches (Figures 5.1, 6.1, 7.2). The proportion of the 1982 year class in the western catches is high compared with the North Sea area and also with the southern area where the proportion is lowest. The 1987 year class is the second strongest year class in the western area, while in the North Sea area and the southern area the 1986 year class seems to be more abundant than the 1987 year class. There is no new information to base a change in the stock-separation used previously, therefore the Working Group considers the horse mackerel in the northeast Atlantic to consist of three units, Southern-, Western- and North Sea horse mackerel.

4.2 Egg Surveys

4.2.1 Western area

A brief general description of the 1995 series of surveys is given in section 2.2.1 and in more detail by Walsh (WD 1995).

Some horse mackerel egg production occurred on the first survey, period 3, west of the shelf between 47°30'N and 48°30'N. This had declined by the following survey in early May. Spawning then reached a peak in period 5 with most of the production occurring south of 48°N. On the final two surveys spawning spread northwards and declined. Details of survey coverage and the mean daily egg production, periods 3 to 7, are given in the table below.

Period	Dates	Mean egg prod: $x10^{-13}$	Days	Total egg prod: $x10^{-15}$
*	16-25/3	(0.095)*	10	(0.010)*
3	26/3-14/4	0.38	20	0.077
*	15-21/4	(0.295)*	7	(0.021)*
4	22/4-16/5	0.19	25	0.047
5	17/5-8/6	2.32	23	0.533
6	9-29/6	1.33	21	0.277
7	30/6-16/7	0.87	17	0.148
		Total	123	**1.114**

Note: * interpolated periods and values.

The provisional seasonal stage I egg production curve is given in Figure 4.2. The peak of production, at the end of May, coincides with the time of peak mackerel egg production. In 1989 and 1992 the peak of horse mackerel egg production occurred some 3 to 4 weeks later. The total seasonal production of **1.11×10^{15}** stage I eggs is the lowest since 1989, and about 30% lower than in 1992.

Year	Total egg production $\times 10^{-15}$
1980	0.635*
1983	0.381*
1986	0.508*
1989	1.63
1992	1.58
1995	1.11

* Values based on geometric mean for interpolated rectangles.

No estimates of fecundity or atresia are yet available from this area for 1995. The same value for fecundity as 1992, 1589 eggs/g female, has been assumed. Correcting for atresia, using the 1992 estimate of 10%, gives an effective fecundity of 1430 eggs/g female. Using this fecundity value and a conversion factor of 1.05 to correct from pre-spawning weight, a provisional spawning stock biomass estimate of **1.64 million tonnes** is obtained.

Year	Spawning stock biomass ($\times 10^{-6}$ tonnes)
1980	0.93
1983	0.56
1986	0.75
1989	2.39
1992	2.32
1995*	1.64

* provisional estimate

4.2.2 Southern area

Data for horse mackerel egg production were available for sampling period 2 (Portugal) and periods 3, 4 and 5 (Spain) (Sola *et al.*, WD 1995). Sampling in period 2 was from 14 to 23 March and extended from 36°N to 43°N. The Cantabrian coast was not covered in this period. In period 3 the whole of the specified area from 39°N to 45°N was surveyed. In periods 4 and 5 coverage was limited to the Cantabrian coast east of 8°W. In period 4 the south-eastern corner, east of 4°W, was not sampled. Few egg were found south of 43°N in the two periods, 2 and 3, when this area was surveyed. More production occurred along the Cantabrian coast in period 3 but this declined in period 4. Peak egg production, 0.8 x 10^{12} stage I eggs per day, occurred on the last survey. The highest values on this survey, > 400 $m^{-2}d^{-1}$, occurred at the extreme western edge of the surveyed area.

Details of survey coverage, the mean daily egg production for periods 2 to 5, and the interpolated values for unsampled periods, are given in text table below.

Period	Dates	Mean egg prod: x10^{-12}	Days	Total egg prod: x10^{-12}
*	4/3-13/3	(0.023)*	10	(0.23)*
2	14/3-23/3	0.068	10	0.68
*	24/3-25/3	(0.186)*	2	(0.372)*
3	26/3-13/4	0.580	19	11.02
*	14/4-7/5	(0.290)*	24	(6.96)*
4	8/5-12/5	0.090	5	0.455
*	13/5-29/5	(0.340)*	17	(5.78)*
5	30/5-5/6	0.800	7	5.6
*	6/6-8/6	(0.180)*	3	(0.54)*
		Total		**31.63**

* Interpolated periods and values.

The total production of **31.63 x10^{12}** stage I eggs in this area is lower than expected, but could increase when the results of period 1 will become available. Production was very low south of 43°N but it seems unlikely that any major spawning in that area was missed. With the peak production occurring on the last survey off the Cantabrian coast it is possible that spawning continued in that area well after the sampled period. To calculate the spawning stock biomass from this estimate of egg production it was necessary to use the fecundity data, corrected for atresia, from the western area in 1992 (1430 eggs/g female). This gave a provisional estimate of spawning stock biomass of **46,450 tonnes** after correcting for the weight difference of pre-spawning fish.

4.3 Allocation of Catches to Stock

The spatial and temporal distribution in the fishery in 1994 (Figure 4.3a-d) remains unchanged from previous years. Therefore the Working Group allocated the catches in 1994 to the different stocks as in recent years:

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

Since 1990 the Danish, Norwegian and Swedish catches in the western part of Division IIIa have been allocated to the western stock. The catches in this area since 1990 have been distributed both spatially and temporally closer to the catches in Division IVa than the catches in Divisions IVb,c. Also in 1994 the catches from Division IIIa were allocated to the western stock.

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

Southern stock (Division VIIIc and IXa):

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

4.4 Species Mixing

According to the Working Group recommendation regarding species mixing (Anon, 1994), special care was again taken 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 on *T. mediterraneus* and Portugal on *T. picturatus*.

In Divisions VIIIa,b and Sub-division VIIIc East, the total catch of *T. mediterraneus* was 4,917 t in 1994, a fall with respect to 1993 (6,226 t). In Division VIIIa,b the figure has increased with respect to 1993, remaining at the mean level for the period 1991-1994, while in Subdivision VIIIc East it has decreased with respect to 1993, remaining at the mean level for the period 1989-1994 (Table 4.2A).

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, mainly in autumn (Table 4.2B), when the *T. trachurus* catches were lowest. *T. mediterraneus* catches were lowest in spring.

A fishery for *T. picturatus* only occurred in the southern part of Division IXa, as in previous years. Data on *T. picturatus* in the Portuguese fishery for the period 1986-1994 are given in Table 4.3.

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

then be appropriate to set TACs for the other species as well.

4.5 The Fishery in 1994

The total international catches of horse mackerel in the North East Atlantic are shown in Table 4.4 and Figure 4.1. The total catch taken from all areas in 1994 is back to the level of 1992 after the maximum catch in 1993. Ireland, Denmark and the Netherlands have a directed trawl fishery for horse mackerel while Norway has a directed purse seine fishery. Spain and Portugal have a directed trawl and purse seine fishery.

Only two countries provide data for discards. Therefore the amount of discards given in the tables are not representative for the whole fishery in the respective areas. Nothing is known about the level of discards of the other fleets.

4.6 Distribution of the Horse Mackerel Fisheries

The distribution of the fisheries are given in Figure 4.2 a-d. These figures are based on data provided by Netherlands, Norway, Ireland, Denmark, UK (England and Wales) Portugal and Spain covering about 65%, 75%, 100% and 90% of the quarterly catches in the quarters 1-4 respectively. The total catch was allocated to quarters as for the data given by the above countries and given in Table 4.5. As in previous years most of the catches were taken in Sub-area VII (44%). Since 1990 this area has provided 43-51% of the catches.
As usual the main catches were taken in the fourth quarter and the smallest catches in the second quarter.

First quarter, 105,000 t. The main catches were taken along the continental shelf west of Ireland and the British Isles, in the Bay of Biscay and around the Iberian peninsula (Figure 4.2a).

Second quarter, 40,000 t. The main catches were as usual taken south west of Ireland, in the Bay of Biscay and around the Iberian peninsula (Figure 4.2b).

Third quarter, 87,000 t. The main catches were taken to the west of Ireland, in the Channel and around the Iberian peninsula. Some few catches were also taken in the northern part of the North Sea and in Skagerrak (Figure 4.2c).

Fourth quarter, 215,000 t. Almost 50% of the catches were taken in this quarter. As in previous years the fishery was conducted in two different areas. Almost 100,000 tons were taken in Division IVa, while the rest were taken west of Ireland, in the Channel, Bay of Biscay and around the Iberian peninsula (Figure 4.2d).

4.7 Length Compositions by Fleet and by Country

The 1994 annual length compositions by fleet were provided by Ireland, England, The Netherlands, Norway, Portugal and Spain. These length distributions were available for all major fishing fleets accounting for about 60% of the total landings in 1994.

The length distribution by country for each fleet (in millions) of fish per cm-length group are shown in Table 4.6.

4.8 Otolith Exchange in 1996

In the northeast Atlantic area only Netherlands, Spain, Portugal and Norway have provided catch in numbers at age based on own age readings. All catches of other countries were converted to numbers at age using the age compositions of one of the above mentioned countries. Dutch age compositions were used for the majority of the catches. The Dutch otolith reader recently went with early retirement and therefore the majority of catches in 1995 will be converted to numbers at age based on age readings by a much less experienced otolith reader. The Working Group regarded it to be very useful to carry out a new horse mackerel otolith exchange in 1996 to estimate the precision of the age readings of all otolith readers in the northeast Atlantic area. This exchange will be organised by A. Eltink of the Netherlands Institute of Fisheries Research in the Netherlands. An otolith reader of South-Africa will also participate in this otolith exchange.

Table 4.1 Landings and discards of HORSE MACKEREL (t) by year and division, for the North Sea, Western and Southern horse mackerel.(Data submitted by Working Group members.)

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

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

Table 4.2a Catches (t) of *Trachurus trachurus* and *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and IXa. in the period 1989-1994.

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

Table 4.2b Catches (t) and percentages (%) of *Trachurus mediterraneus* in relation to total landings of *Trachurus trachurus* in Divisions VIIIb and VIIIc in 1994.

		Trachurus mediterraneus						*T. trachurus*
		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total		Total
Divisions	Sub-Divisions	(t)	(t)	(t)	(t)	(t)	%	(t)
VIIIb		416	422	326	409	1573	55.5	1262
VIIIc	VIIIc East	884	172	759	1529	3344	25.6	9697
	East of 3°W	606	118	353	871	1949	44.1	2468
	West of 3°W	278	53	406	658	1395	16.2	7229

Table 4.3 Catches (t) of *Trachurus trachurus* and *Trachurus picturatus* in ICES Division IXa, Sub-area X, and in CECAF Division 34.1, in the period 1986-1994.

		1986	1987	1988	1989	1990	1991	1992	1993	1994
Trachurus trachurus (*)	Div. IXa	28,526	19,554	25,125	25,226	19,959	17,497	22,653	25,747	19,061
Trachurus picturatus	Div. IXa	367	181	2,370	2,394	2,012	1,700	1,035	1,028	1,045
	Div. X Azorean area	3,331	3,020	3,079	2,866	2,510	1,274	1,255	1,732	1,778
	34.1.1 Madeira's area	2,006	1,533	1,687	1,564	1,863	1,161	792	530	297

(*) As estimated by the Working Group.

Table 4.4 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	1994[1]
II + Vb	4,487	13,457	3,168	759
IV + IIIa	77,994	113,141	140,383	112,580
VI	34,455	40,921	53,822	69,616
VII	201,326	188,135	221,120	200,256
VIII	49,426	54,186	53,753	35,500
IX	21,778	26,713	31,944	28,442
Total	389,466	436,553	504,190	447,153

[1]Preliminary.

Table 4.5 Quarterly catches of HORSE MACKEREL ('000 t) by division and sub-area in 1994. (Data submitted by the Working Group members)

Quarterly catches of horse mack, 1994						
		QUARTER				
Division		1	2	3	4	TOTAL
IIa+Vb		0	0	0.2	0.6	0.8
IIIa		0	0	1.7	0.8	2.5
IVa		0.5	0.1	4.2	102.1	106.9
IVbc,VIId		0	0.5	1.3	3.9	5.7
VIa		2.4	1.9	39.1	26.1	69.5
VIIa-c,e-k		90.7	22.4	24.3	60.2	197.6
VIIIabde		0.3	0.6	0.4	10.1	11.4
VIIIc		5.5	7.5	7.1	4.3	24.4
IXa		5.6	6.6	9.1	7.2	28.5
sum		105	39.6	87.4	215.3	447.3

Table 4.6 Annual length distributions (millions) of HORSE MACKEREL catches by fleet and country in 1994.

Table 4.6	Annual length distributions (millions) of HORSE MACKEREL catches by fleet and country in 1994									
	Netherlands	Eng.&Wales	Norway	Spain				Portugal		
	Pelagic	Pelagic	Purse	Purse	Demersal	gill	hook	Artisan.	trawl	Purse
cm	trawl	trawl	seine	seine	trawl	net				seine
5										
6										
7										
8										
9	0.05			0.25	0.01					
10	0.05			2.18	0.04					
11	0.15			5.91	0.24				0.00	0.13
12	0.05			8.83	0.27			0.21	0.00	0.89
13	1.03			10.12	0.26			0.21	0.13	1.96
14	2.03			13.06	0.59			0.21	1.58	3.12
15	2.96			19.30	1.58			0.55	7.93	3.32
16	5.06			21.95	2.61			1.52	11.65	12.92
17	10.61			25.99	4.60			1.22	17.81	19.98
18	18.40			25.64	4.93			0.45	23.45	28.35
19	24.91			27.43	3.94			0.83	21.45	26.64
20	28.54	0.01		26.09	2.47			1.02	17.46	10.08
21	17.53	0.19		16.37	1.42			0.95	11.86	6.25
22	19.94	0.82		12.93	0.70			0.82	6.61	1.89
23	21.62	0.22		6.89	0.25			1.02	3.41	0.59
24	22.54	1.48		7.15	0.45			0.77	3.31	0.08
25	48.53	2.25		5.93	0.64	0.02		0.92	3.12	0.04
26	96.66	3.46		4.74	1.90	0.05		1.21	2.82	0.00
27	102.86	2.91		5.44	3.23	0.09	0.03	1.46	1.97	0.00
28	83.45	3.64	2.01	6.43	6.75	0.11	0.09	1.12	2.16	0.00
29	59.85	2.80	13.17	5.69	7.34	0.09	0.12	1.32	1.67	0.01
30	29.99	1.99	17.23	4.95	6.34	0.10	0.10	1.02	1.20	0.04
31	26.94	1.82	53.69	4.06	4.63	0.09	0.07	0.83	0.82	0.10
32	27.66	0.79	53.69	3.55	4.11	0.05	0.06	0.76	0.71	0.07
33	26.47	0.79	43.55	2.31	3.01	0.02	0.04	0.51	0.47	0.01
34	19.75	0.35	26.33	1.43	2.16	0.01	0.03	0.43	0.29	0.01
35	12.75	0.31	7.09	1.24	1.80	0.01	0.04	0.36	0.20	0.00
36	6.21	0.18	2.02	0.72	1.16	0.01	0.03	0.27	0.27	0.00
37	2.85	0.11	2.02	0.51	0.80	0.01	0.02	0.29	0.24	0.00
38	1.73	0.00		0.22	0.53	0.01	0.02	0.20	0.07	
39	0.45	0.00		0.15	0.28	0.01	0.02	0.14	0.02	
40	0.42	0.01		0.02	0.15		0.01	0.06	0.01	
41				0.02	0.02		0.01	0.01	0.00	
42					0.05			0.00	0.00	
43								0.00		
44								0.00		
45+								0.00		
sum	722.04	24.14	220.81	277.50	69.26	0.68	0.69	20.65	142.65	116.48
1000 t	119.40	4.77	94.70	22.50	12.00	0.15	0.20	3.20	10.49	5.37

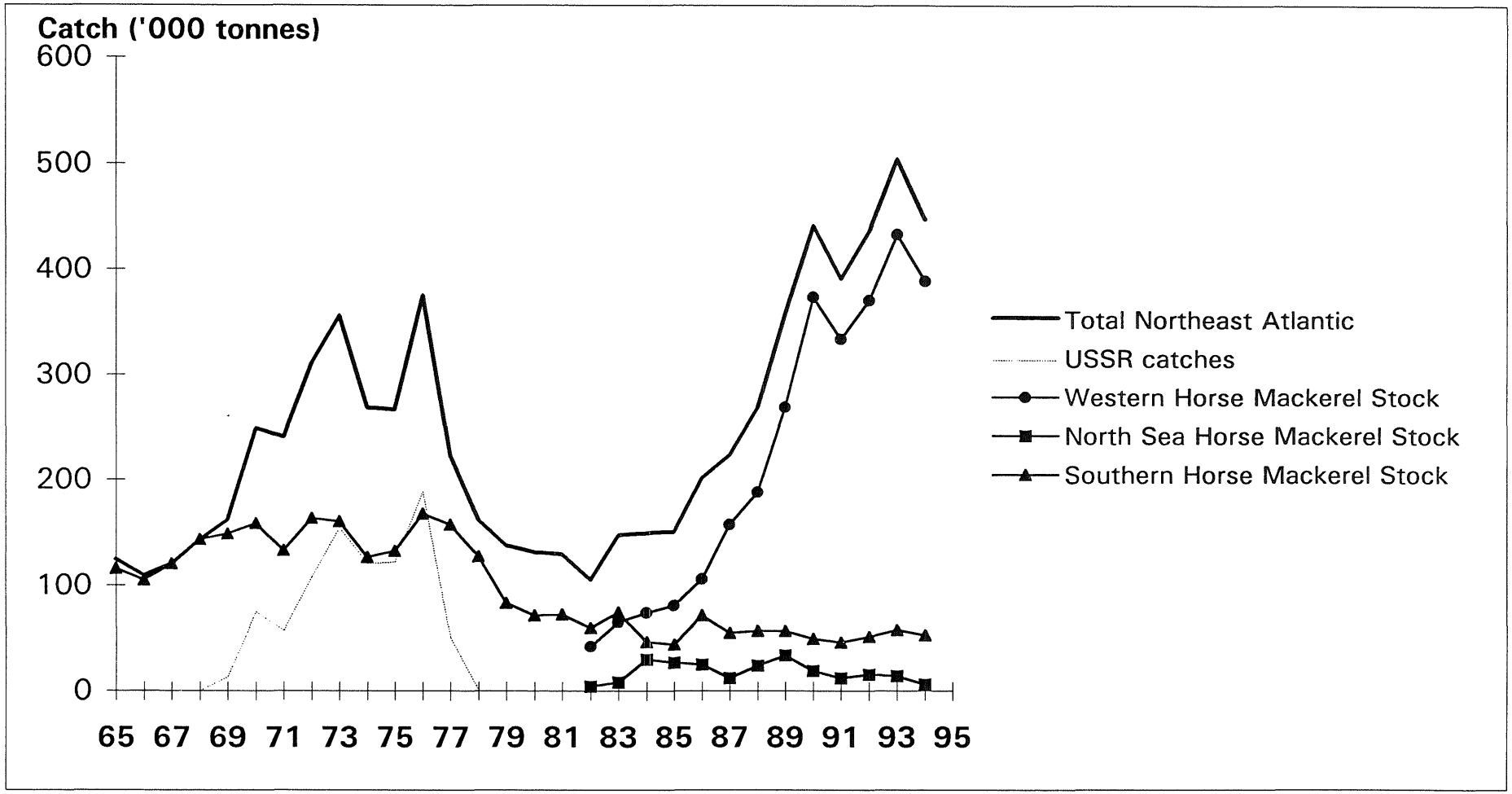


Figure 4.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 1994. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic.

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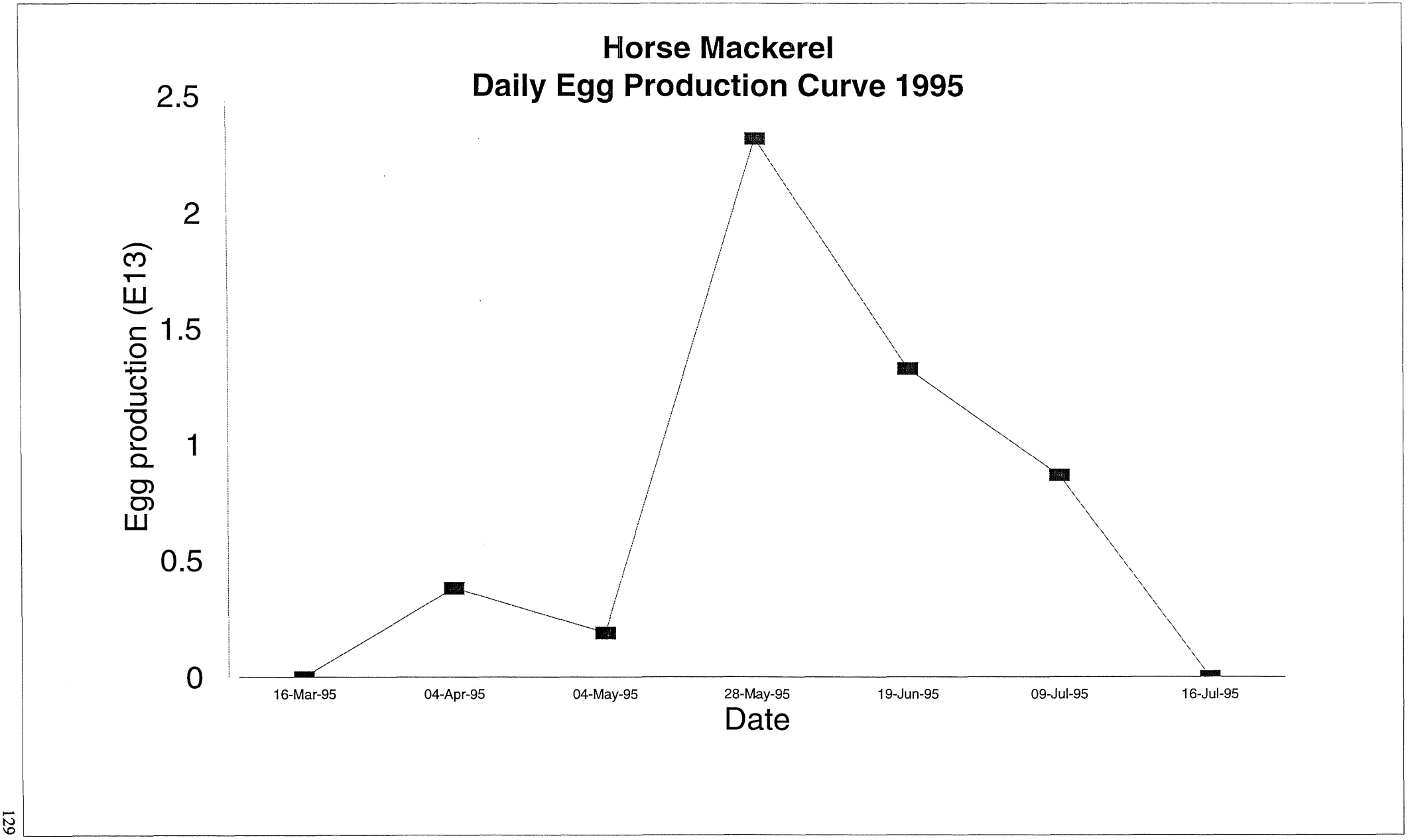
Horse Mackerel
Daily Egg Production Curve 1995
Egg production (E13)
2.5
2
1.5
1
0.5
0
16-Mar-95
04-Apr-95
04-May-95
28-May-95
19-Jun-95
09-Jul-95
16-Jul-95
Date

Figure 4.2

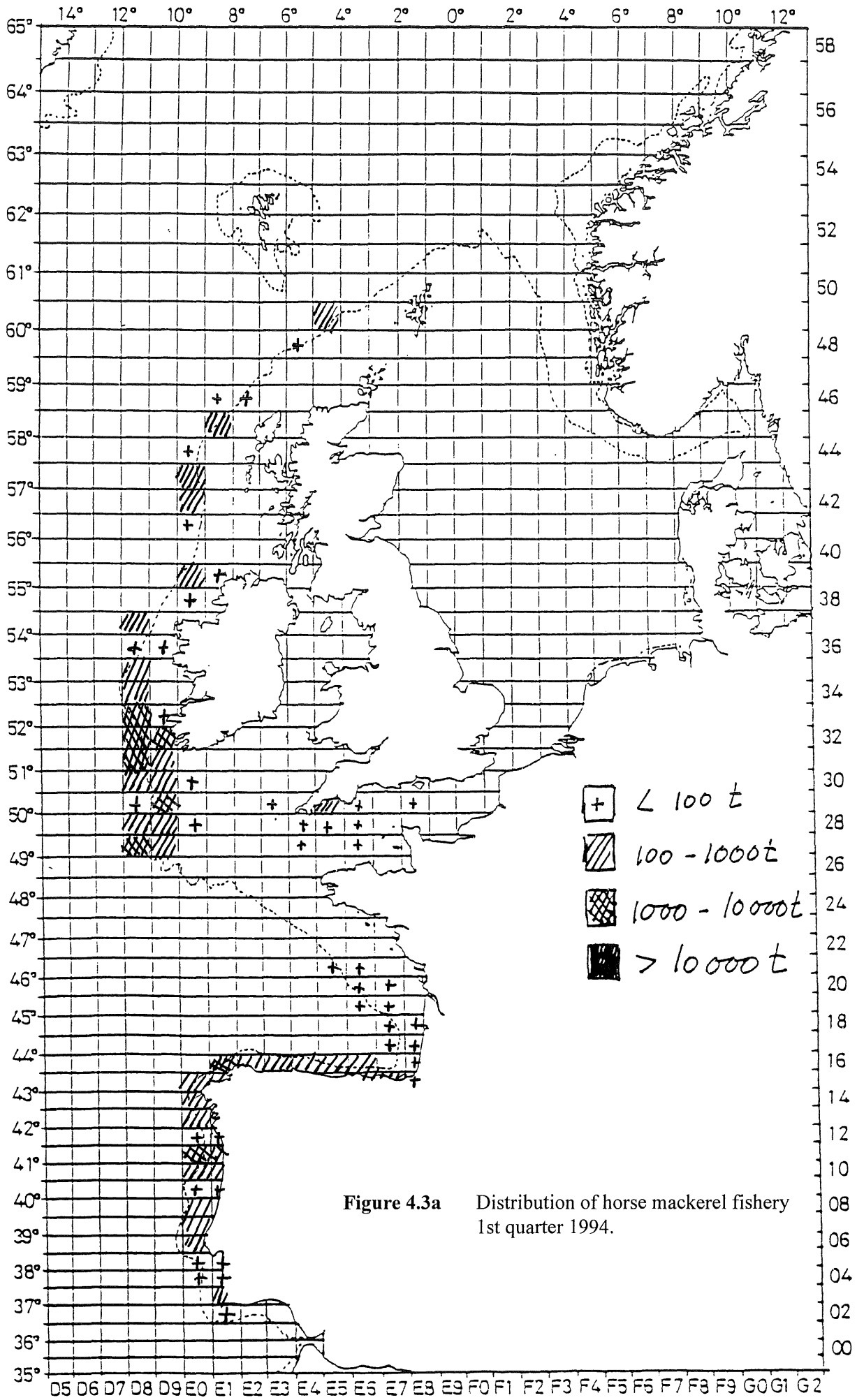

Figure 4.3a Distribution of horse mackerel fishery 1st quarter 1994.

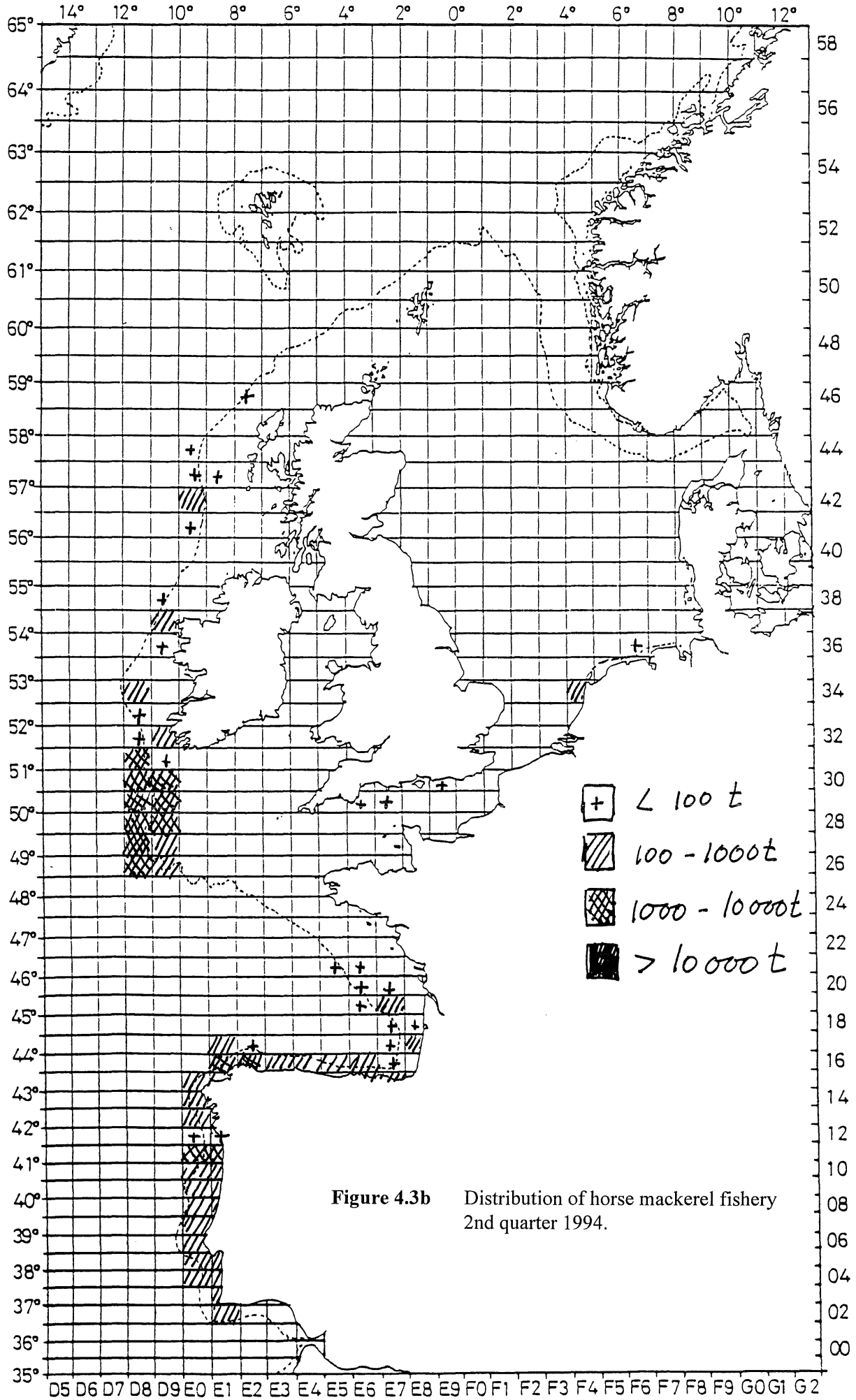

Figure 4.3b Distribution of horse mackerel fishery 2nd quarter 1994.

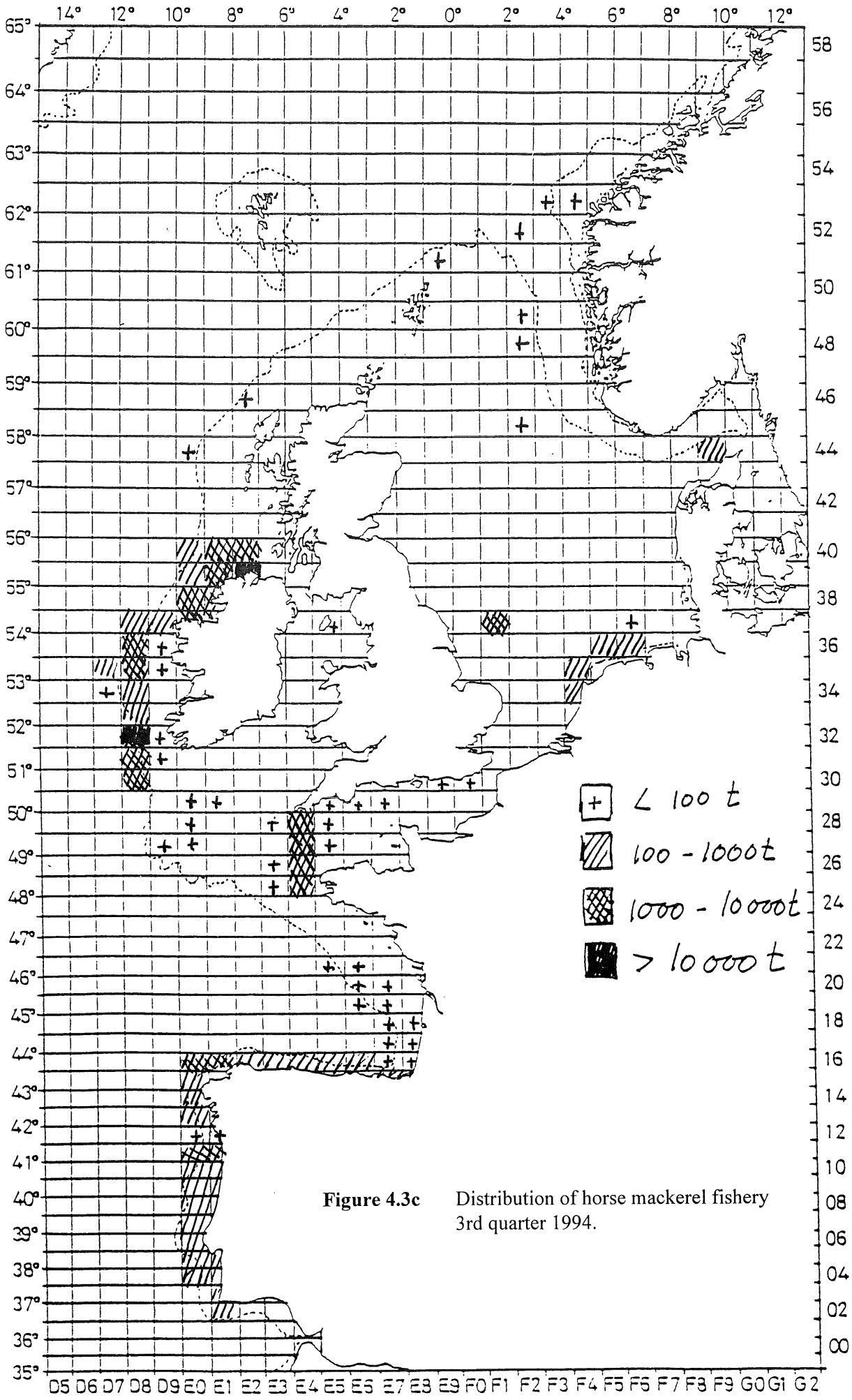

Figure 4.3c Distribution of horse mackerel fishery 3rd quarter 1994.

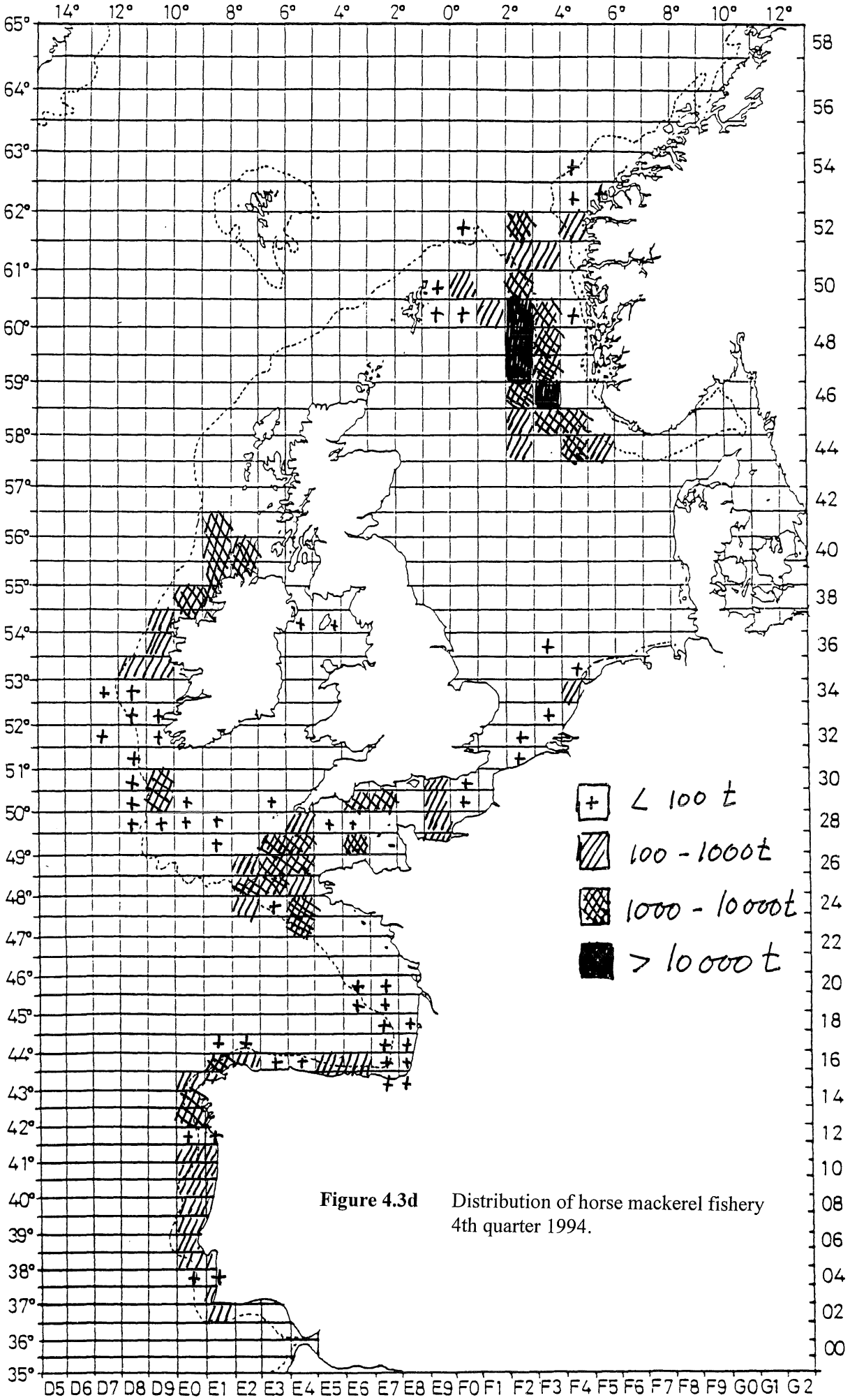

Figure 4.3d Distribution of horse mackerel fishery 4th quarter 1994.

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

5.1 The Fishery in 1994

The horse mackerel catches estimated to have been taken during 1994 from the North Sea and Division IIIa are given in Table 5.1. Further details of these catches per quarter and per area are given in Tables 4.1, 4.4 and 4.5. All catches taken from Divisions IVb, IVc, VIId and from Division IIIa (except for 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 1994 was about 113,000 t compared to 140,000 t in 1993. Most of this decrease was caused by a reduction in the Norwegian catches (28%). In 1994 the Norwegian catches still accounted for 83% of the total catches in Sub-area IV. Unallocated catches of 1,511 t are included in these total catches of 1994. Approximately 107,000 t were taken from the Division IVa area in the fourth quarter mainly by directed Norwegian industrial fisheries and this catch is assumed to belong to the western horse mackerel stock (see section 4.3). The total catch taken from Divisions IVb,c and VIId was about 6,000 t and this is the total catch believed to be taken from the North Sea stock (see Table 4.1). The comparable figure in 1993 was about 14,000 t. As in recent years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId.

5.2 Fishery Independent Information

5.2.1 Egg surveys

Horse mackerel egg surveys in the North Sea have been carried out from 1988 to 1991 (Eltink, 1992), but no egg surveys were carried out in the years 1992–1995.

5.2.2 Acoustic surveys

No acoustic estimates of the North Sea horse mackerel stock have been available from 1991–1995. The Working Group requests the Herring Survey Planning Group to include in their terms of reference the provision of estimates of the abundance, distribution and age-structure of horse mackerel in the North Sea during the ICES coordinated international acoustic surveys.

5.3 Age Composition

Samples taken from the Dutch commercial catches and research vessel catches were available for the period 1987–1994. The Dutch samples cover only a small proportion of the total, but give a rough indication of the age composition of the stock (Figure 5.1).

The strength of the 1982 year class in the central and southern North Sea does not seem as strong as in the western area (compare Figure 5.1 with 6.1) and the 1987 year class can not be recognized as a strong year class as is the case in the western area. In this area the 1986 year class even seems to be stronger than in the western area.

5.4 Assessment

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

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

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

5.5 Management Measures and Considerations

No forecast is available for 1996. The Working Group advises, that if a TAC is set for this stock, it should apply only to those areas where North Sea horse mackerel are fished, i.e. Divisions IVb,c, VIId, and Division IIIa.

Table 5.1 Landings (t) of HORSE MACKEREL in Sub-area IV by country. (Data submitted by Working Group members).

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

Country	1985	1986	1987	1988	1989	1990	1991	1992[7]	1993	1994[1]
Belgium	13	13	9	10	10	13	-	+	74	57
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	3,921
Estonia	-	-	-	-	-	-	-	293	-	
Faroe Islands	-	-	-	-	-	942	340	-	360	275
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	1,014
Ireland	-	-	-	-	-	687	2,657	2,600	4,086	415
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172	1,970	3,852	3,000	2,470	1,329
Norway[2]	203	776	11,728[5]	34,425[5]	84,161	117,903[2]	50,000[2]	96,000	126,800	94,000
Poland	-	-	-	-	-	-	-	-	-	
Sweden	-	2[2]	-	-	-	102	953[2]	800	697	2,087
UK (Engl. + Wales)	71	3	339	373	10	10	132	4	115	389
UK (N. Ireland)	-	-	-	-	-	-	350	-	-	
UK (Scotland)	998	531	487	5,749	2,093	458	7,309	996	1,059	7,582
USSR	-	-	-	-	-	-	-	-	-	
Unallocated + discards	-	-	-	-	-12,482[5]	-317[5]	-750[5]	-278	-3,270	1,511
Total	24,238	20,746	20,895	62,892	112,047	145,062	77,994	113,141	140,383	112,580

[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.

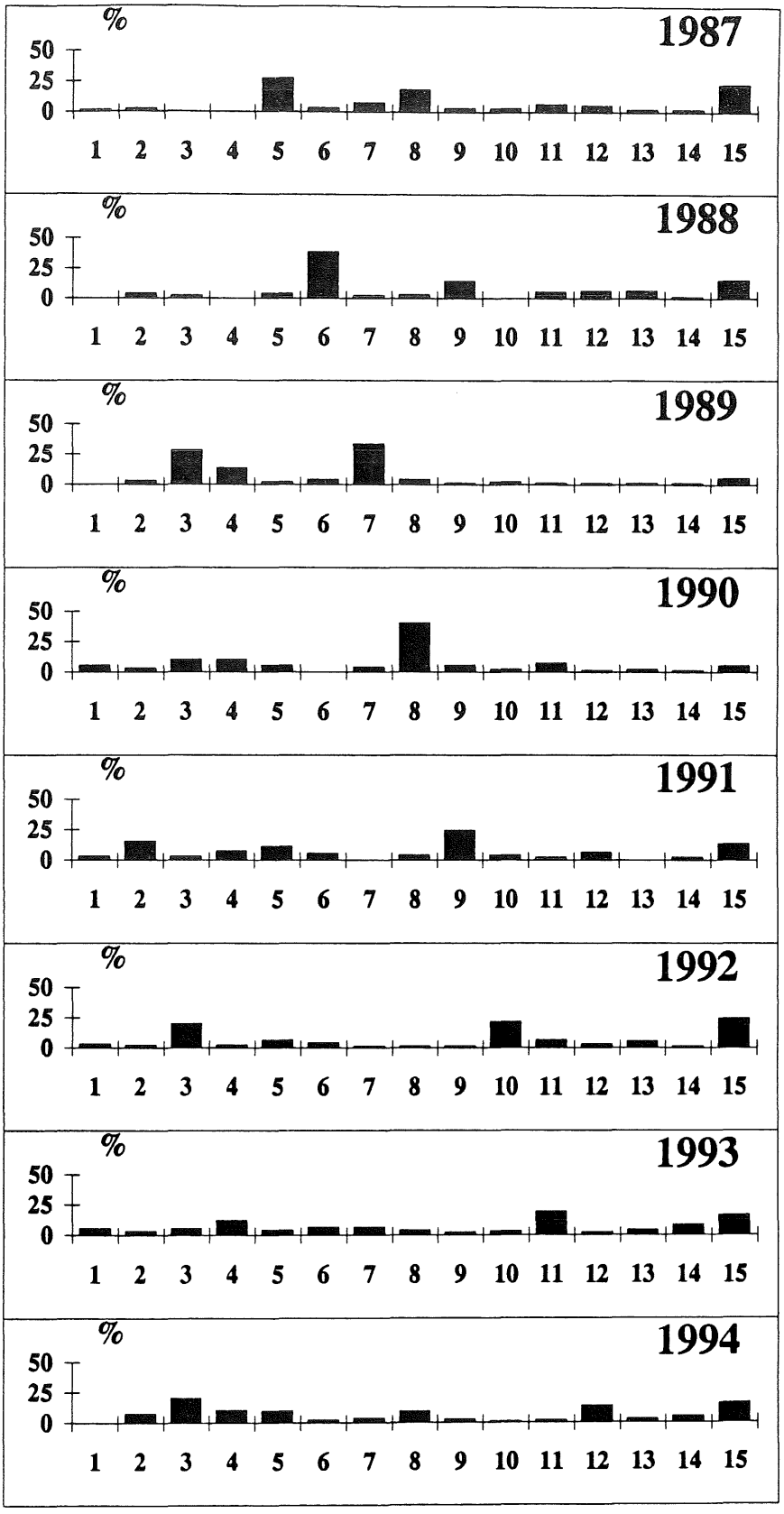

Figure 5.1 The age composition of the North Sea horse mackerel based on commercial and research vessel samples from 1987-1994.

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6 WESTERN HORSE MACKEREL (DIVISIONS IIa, IIIa (western part), IVa, Vb, VIa, VIIa-c, VIIe-k and VIIIa,b,d,e)

6.1 The Fishery in 1994

The fishery for the western horse mackerel stock is mainly carried out in Divisions IIa, IIIa (western part), IVa, VIa, VIIe,g,h,j and VIIIa. The national catches taken by the countries fishing these areas are shown in Tables 6.1-6.4, while additional information on the development of the fisheries by quarter and division is shown in Tables 4.1, 4.4, 4.5 and 5.1 and in Figures 4.3a-d.

Sub-areas II and Division Vb

The national catches taken in this area are shown in Table 6.1. The catch level has decreased from more than 13,000 tons in 1992 to 759 tons in 1994. This decrease is mainly caused by the Faroe Islands which had no fishery for horse mackerel in these areas in 1994. Also Norway has decreased the catches from 4,500 tons in 1992 to only 4 tons in 1994.

Sub-area IV and Division IIIa (western part)

The catches of Western horse mackerel from this area are dealt with in section 5.1. The total catch of Western mackerel is estimated to be about 107,000 tons (Table 4.1), mainly taken by a directed horse mackerel fishery by Norwegian purse seiners in the fourth quarter.

Sub-area VI

The catches taken in Division VI are shown in Table 6.2 and increased from about 54,000 tons in 1993 to about 70,000 tons in 1994. About 95% of the catches in this area are taken in a directed Irish trawl fishery for horse mackerel.

Sub-area VII

The catches taken from this area are mainly from Divisions VIIb,e,h,j and are shown in Table 6.3. The catches in 1994 were about 200,000 tons which was a reduction of 10% since 1993 with the highest catch level since 1979. The directed Dutch trawl fishery accounted for about 45% of the total catches.

Sub-area VIII

The catches from this area are mainly taken in Divisions VIIIa,b,d,e and given in Table 6.4. The catches in these areas increased until 1993 but is now reduced to the level of 1988. Spain is the major fishing nation for horse mackerel in this area and caught about 25,000 tons, about 70% of the total catch in 1994, mainly as by catches in other fisheries.

6.2 Fishery Independent Information from Egg Surveys

A preliminary spawning stock biomass estimate of 1.64 million tonnes of western horse mackerel is available from the egg surveys carried out in 1995. This estimate together with the estimates of earlier years are listed in a text table of section 4.2.

6.3 Catch in Numbers at Age

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

The catch in numbers at age by quarter and Divisions for western horse mackerel are shown in Table 6.5. The total annual catch in numbers for 1994 is shown in Table 6.8. The sampling intensity is discussed in Section 1.5.

The strong 1982 year class has made up the major part of the international catches since 1984 (Figure 6.1). In 1994 this year class contributed 38% by numbers and 56% by weight of the total catches. There is indications in the catches that the 1992 year class might be of significant strength, contributing 33% by numbers of the total catches.

6.4 Mean Length at Age and Mean Weight at Age

Mean weight and mean length at age in the catches in 1994

Mean weights and mean lengths at age in the catches by quarters in 1994 were provided only by the Netherlands and Norway. These data were applied to the catches from the other countries. The mean weight and mean length at age in the catches in 1994 are shown in Tables 6.6-6.8.

Mean weight at age in the stock

The mean weights at age in the stock at spawning time for 1994 are shown in Table 6.8. Usually the mean weight at age have been based on fish in all maturity stages sampled from the Dutch freezer trawlers the first and second quarter in Divisions VIIj and VIIk. This year the weight in stock is based on Dutch data from Division VIIj only since no data were available from Division VIIk.

Data for two and three years old horse mackerel were not obtained, but average weights were assumed to be the same as in previous years (Table 6.8).

6.5 Maturity at Age

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

The large disagreement between the spawning stock biomass estimate of 2.39 million tonnes from the egg survey in 1989 (section 4.2) and the spawning stock biomass of 3.87 million tonnes from the 'ADAPT'-assessment (Table 6.11) can be explained by changing the assumed value for the proportion of the 1982 year class that were mature in 1989 from 1.0 to 0.57. However, the assumed value of 1.0 was retained unchanged for the assessment calculation.

6.6 Stock Assessment

Fitting a population model for this stock presents particular problems, some of which were documented in last years Working Group report (Anon., 1995b). In summary, the stock is dominated by two cohorts. The 1982 cohort is estimated to have had an abundance at age 0 of around 65×10^9 individuals compared with more typical recruitments between 1×10^9 and 5×10^9. The 1987 cohort is the next most abundant cohort and is estimated to have numbered around 6 billion. Furthermore, there are indications from the recent catches at age that the 1992 cohort is also rather strong, but the strength of the estimate of this cohort depends on assumptions about recent exploitation pattern.

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

The method chosen to assess this stock is 'ADAPT'-type method (Gavaris, 1988) in which an arbitrary choice of selection pattern is made. The method is similar to that used by Anon. (1995b), except that the fitting of the estimated population abundance to the egg survey is done by computer algorithm rather than by hand. The use of this method also allows estimation of some of the uncertainty in the assessment, and of the sensitivity of the assessment to the assumed selection pattern. As fishing mortality is rather low in this stock, VPA 'convergence' does not help stabilise the analysis rapidly and hence the population model is likely to be strongly dependent on starting assumptions.

The model is a conventional VPA which is fitted by a non-linear minimisation. Given population abundance N, fishing mortality F, natural mortality M, weights at age W, and maturity at age O, egg survey estimates of abundance U, and the proportion of fishing and natural mortality exerted before spawning PF and PM respectively, the VPA is fitted by minimising:

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

where subscripts a and y denote age and year respectively.

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

- Selection pattern in 1994 and later years is equal to 1 on ages 5 and older;
- Selection on ages 0 to 5 in 1994 and later years set to mean from 1989 to 1993;
- Catch in 1995 constrained to 300 000 t;
- Natural mortality, weights at age in the stock and in the catch are assumed known precisely;
- Maturity ogive is assumed to be known precisely;
- Fishing mortality on the oldest age taken as an arithmetic mean from age 6 to the penultimate true age in the catch at age matrix.

The choices made about constraints listed above were made after a number of exploratory model fits and were chosen so as to achieve model fits conforming to a

regular and consistent selection pattern and a conservative estimate of the strength of the 1992 year-class. The model was found to be relatively stable to changes in the assumptions made about selection. The VPA-fitted stock sizes coincided well with the egg survey information in 1992 and 1995, but in 1983 the VPA stock size is almost two-fold higher than the egg survey estimates. However, given the very low fishing mortalities in the earlier years of the time series, which are all lower than the assumed natural mortality, these stock size estimates are not considered reliable. Egg survey information prior to 1992 was excluded on account of uncertainty introduced by the unknown maturity of the 1982 cohort.

Catches of fish in the 1992 cohort appear to be rather high, which may indicate that this year class is of above-average abundance. As there is no recruitment survey, the abundance of the year class can only be inferred from an assumed selection pattern on the younger fish. In order to investigate the dependence of the strength of this year-class on assumptions made about exploitation pattern, a range of model fits were calculated making the assumption that selection in 1994 on the five youngest ages was equal to mean selection over the previous four, five, six.. up to the ten previous years. Results of this simple test are given in Table 6.9. This shows that including more historical data from earlier years in the analysis, higher values for the estimated 1992 year class abundance are generated. In order to take a cautious view of stock dynamics and to avoid including possibly unrepresentative information from earlier years, it was decided to base the assessment and projections on a mean selection pattern calculated over the previous five years (1989-1993). This cautious view was also taken, because of the rather low abundance of the 1992 year class in the Dutch catches in the first half of 1995 as is shown in Figure 6.1. However, it should be noted that catches from this fleet, in the first half of the year, are taken from the spawning area and may be unrepresentative of juvenile abundance.

Input data for the assessment and projections is given in Table 6.10. and the fitted populations, fishing mortalities and stock sizes are given in Table 6.11. Figure 6.2A and 6.2B show the changes in the estimates of spawning stock biomass, recruitment, catch and fishing mortality over the period 1982 - 1995.

The minimum biologically acceptable stock size (MBAL) for this stock has historically been taken as the spawning stock size estimate from VPA in 1982, which was estimated by the Working Group in 1991 to be approximately 500 000t (Anon., 1991). However, the updated VPA calculation made here indicates a stock size of 1.2 million t in 1982 with the chosen constraints. Exploratory changes made to the constraints indicate a possible range for this value from 1.1 to 2 million t by conventional VPA methods and assumptions, which conflicts with the previous estimate and also with the egg survey estimate of spawning biomass in 1983 (560 000t), which had a quite good coverage of egg sampling. The discrepancies between the VPA and egg survey biomass estimates in 1983, 1986 and 1989 might be due to uncertainties in what maturity ogive to apply (see section 6.5). Although the Working Group considered it desirable to maintain the stock size above the level which produced the 1982 year-class, there are practical difficulties in estimating this level, which could lie in a range from 500 000t to over 1.2 million t. In consequence, the Working Group questioned the usefulness of MBAL concept for this stock, and indicated a preference for a fishing-mortality based reference point to be used for management purposes in the future. Maintaining fishing mortality below or equal to natural mortality may be an appropriate and cautious approach for managing a stock whose recruitment dynamics are so variable and poorly known.

6.7 Catch Predictions

A similar catch forecast has been carried out as last year by using a spread sheet. Except that now the flat topped exploitation pattern of 1994 and the stock size in numbers at age in 1996 have been taken from the 'ADAPT'-analysis (see section 6.5). In this catch prediction (Table 6.12) the starting year was 1996 and the predictions have been carried forward to 2001. A constant weak recruitment at age 1 of 1067 million fish has been assumed for the period 1996–2001, which was estimated from the weak year classes 1981, 1983–1986, 1988–1991 at age 1. The mean weights at age in the stock and in the catch for the whole period are the smoothed 1994 values except for the 1982 and 1987 year classes. For these two year classes growth curves have been drawn, which were based on available information on mean weights at age in the catch and in the stock. These curves have been extended to obtain the extrapolated values of mean weight at age in the catch and in the stock for the period 1996–2001. Figure 6.3 shows the predicted decrease in spawning stock biomass of western horse mackerel for five different options: constant annual catches of 100, 200, 300 and 400 thousand tonnes and an option where F = M = 0.15 for the whole period 1996–2001. This last option was also taken because of the uncertainty of the MBAL level as described in the previous section 6.7. In all 5 options the spawning stock decreases. In the case of a constant F = 0.15 (=M) the annual catches will gradually decrease during the period 1996 - 2001 (from 261 thousand tonnes in 1996 to 137 thousand tonnes in 2001).

6.8 Short-Term Risk Analysis

A very simple approach to the assessment of the consequences of management action under uncertainty is used here. Only uncertainty in the egg survey information is considered, and all other parameters and observations are assumed to be known precisely and the model is assumed to be correctly formulated. This approach considerably underestimates the uncertainty in the stock

projections, but is considered preferable to presenting a purely deterministic view of stock dynamics.

The ADAPT assessment model described above was used to fit 1000 VPA populations to the catch at age data for each of 1000 Monte-Carlo simulations of pseudo-egg surveys, assuming a lognormal error distribution and a coefficient of variation of 20%. The population vectors were then projected forwards through 1996 to 1998 under a range of constant-catch options from 100,000 t to 450 000t annually. Given the uncertainty in the appropriate level for MBAL it was decided to assess risk for two levels of minimum spawning stock, being the previously-used value of 500,000t and the VPA-estimate of 1.2 million t. The probability of the stock being below these levels in future years has been estimated by the proportion of Monte-Carlo iterations in which the spawning stock fell below those levels.
'Risk' is here termed to be estimated probability that the stock size will fall below the specified level at spawning time in 1996, 1997 and 1998, depending on the level of catches taken in these years, which here are assumed equal. Risk is assessed for levels of catch from 50,000t to 400,000t, and the median stock biomasses are also plotted (Figure 6.4).

These figures show that the stock is unlikely to fall below even the 1.2 million t level in 1996 over the range of catch options considered. However, in 1997 the risk of falling below the level exceeds 50% if catches exceed about 300,000t annually. By 1998, the risk of falling below the specified level exceeds 50% for catches above 240,000t annually. The risk of the stock falling below MBAL level of 500 000t was very low for most scenarios (less than 1%) and could not be measured with the techniques used. If catches were as high as 450,000t annually, then the estimated probability of the stock falling below the 500,000t level in 1998 was 17%.

6.9 Medium Term Projection

The method described in section 6.7. was used to calculate stock trajectories under four constant-catch scenarios from 100 000 t to 400 000 t. Probability distributions for catches and for stock size were calculated from the distribution of the estimates of catches and stock size from the Monte-Carlo iterations. Future recruitment was assumed to be 1067 million at age 1 in all years, which is a conservative estimate (see section 6.7). Estimates of trajectories of catch, spawning stock, fishing mortality and recruitment are given in Figure 6.5.

6.10 Long-Term Yield

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

6.11 Comments on Assessment

The assessment of this stock depends on the correct specification of natural mortality and maturity ogive. The former is assigned an assumed value and the latter could not be measured accurately, hence the assessment model used may be subject to substantial bias.

6.12 Management Considerations

Recent advice for this stock has been that catches should be limited such that the spawning stock biomass should not fall below the stock size in 1982. This value cannot be estimated accurately but is believed to be in the range 500 000t to 1.2 Million t. At recent historical levels of catches the stock is estimated as likely to fall below the lower level in the year 2000, but it is likely to fall below the higher level in about 1997. In either event, it appears likely that the recent levels of catches from this stock will not be sustainable in the short term.

Given the problems associated with the estimation of the reference stock size in 1982 used for the MBAL level, consideration should be given to managing this stock on the basis of a constant fishing mortality. As the long-term stock dynamics are unknown, it is suggested that a suitably cautious reference level would be that fishing mortality should be below or equal to natural mortality. In recent years, fishing mortality is estimated to have been at about the same level as natural mortality. By this criterion, exploitation of the stock should continue at recent levels of fishing mortality.

The strength of the 1992 year-class is not at present estimated reliably, as the estimate depends on assumptions made about selection pattern in 1994. The future development of the stock will depend on the abundance of this year-class, and present perceptions of the medium-term development of the stock should be kept under review as estimates of the strength of this year-class improve.

The TAC set by the EU for western horse mackerel is not divided by national quota. This stock is considered by the EU to be purely an EU stock. The fishery managed by the EU will only be closed if the catches of all EU member states overshoot the agreed TAC. The catches of western horse mackerel in Divisions IIa, IIIa and IVa by non-EU countries are not counted against the TAC, despite all recommendations made by ACFM that the TACs should apply to all areas where the stock is fished. Figure 6.6 shows that the total catches of western horse mackerel taken by EU and non-EU countries overshoot the agreed TAC in most years considerably. The agreed TACs have been increasing over the period 1987 to 1994 despite a rapid decrease in spawning stock size during this period.

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

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

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

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

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

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

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

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994[1]
Denmark	-	769	1,655	973	615	-	42	-	294
Faroe Islands	1,992	4,450[3]	4,000[3]	3,059	628	255	-	820	80
France	12	20	10	2	17	4	3	+	-
Germany, Fed. Rep.	354	174	615	1,162	2,474	2,500	6,281	10,023	1,430
Ireland	28,125	29,743	27,872	19,493	15,911	24,766	32,994	44,802	65,564
Netherlands	3,450	5,750	3,340	1,907	660	3,369	2,150	590	341
Norway	83	75	41	-	-	-	-	-	-
Spain	-[2]	-[2]	-[2]	-[2]	-[2]	1	3	-	-
UK (Engl. + Wales)	198	404	475	44	145	1,229	577	144	109
UK (N.Ireland	-	-	-	-	-	1,970	723	-	-
UK (Scotland)	138	1,027	7,834	1,737	267	1,640	86	4,523	1,760
USSR	-	-	-	-	44	-	-	-	-
Unallocated + discards	-13,897	-7,255	-	6,493	143	-1,278	-1,940	-6,960[4]	-51
Total	20,455	35,157	45,842	34,870	20,904	34,455	40,919	53,942	69,616

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

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

Country	1980	1981	1982	1983	1984	1985
Belgium	-	1	1	-	-	-
Denmark	5,045	3,099	877	993	732	+
France	1,983	2,800	2,314	1,834	2,387	1,477[2]
Germany, Fed.Rep.	2,289	1,079	12	1,977	228	1,881
Ireland	-	16	-	-	65	-
Netherlands	23,002	25,000	27,500[2]	34,350	38,700	100
Norway	394	-	-	-	-	33,550
Spain	50	234	104	142	560	-
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279	275
UK (Scotland)	1	-	-	-	1	1,630
USSR	-	-	-	-	-	-
						1
						120
						-
Total	45,697	34,749	33,478	40,526	42,952	39,034

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994[1]
Faroe Islands	-	-	-	-	28	-	-	-	-
Belgium	+	2	-	-	+	-	-	-	1
Denmark	30,408[2]	27,368	33,202	34,474	30,594	28,888	18,984	16,978	41,605
France	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	14,828
Ireland	703	15	481	12,645	17,887	19,074	15,568	16,363	15,281
Netherlands	40,750	69,400	43,560	43,582	111,900	104,107	109,197	157,110	92,903
Norway	-	-	-	-	-	-	-	-	-
Spain	137	148	150	14	16	113	106	54	29
UK (Engl. + Wales)	1,824	1,228	3,759	4,488	13,371	6,436	7,870	6,090	12,418
UK (N.Ireland)	-	-	-	-	-	2,026	1,690	587	119
UK (Scotland)	+	2	2,873	+	139	1,992	5,008	3,123	9,015
USSR	-	-	-	-	-	-	-	-	-
Unallocated + discards	-	-	-	28,368	7,614	24,541	15,563	4,010[3]	14,057
Total	77,628	100,734	90,253	138,890	192,196	201,326	188,135	221,000	200,256

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

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

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

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[1]
Denmark	-	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	28
Germany	-	-	-	-	-	-	80	62	-	
Netherlands	-[2]	-[2]	-[2]	-	-	6,000	12,437	9,339	19,000	7,272
Spain	23,292	40,334	30,098	26,629	27,170	25,182	23,733	27,688	27,921	25,409
UK (Engl. + Wales)	143	392	339	253	68	6	70	88	123	753
USSR	-	656	-	-	-	-	-	-	-	
Unallocated + discards	-	-	-	-	-	1,500	2,563	5,011	700	2,038
Total	27,740	45,362	37,703	34,177	38,686	43,496	46,396	54,186	53,709	35,500

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

Table 6.5 Catch in numbers ('000) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1994.

1994	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000	catch('000)	catch('000	atch('000	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	550,818	4,716	555,534
3	0	0	0	0	24,481	210	24,690
4	0	58	0	224	24,481	210	24,972
5	0	128	0	611	0	0	738
6	0	0	0	1,340	0	0	1,340
7	0	0	0	14,278	0	0	14,278
8	0	244	0	11,211	0	0	11,455
9	0	0	0	6,236	0	0	6,236
10	0	0	33	1,564	0	0	1,597
11	0	128	250	670	0	0	1,048
12	0	244	5,242	206,985	0	0	212,472
13	0	0	250	446	0	0	696
14	0	58	692	3,006	0	0	3,756
15+	0	686	1,909	11,374	0	0	13,969
Total	0	1,546	8,376	257,946	599,780	5,135	872,783
Tonnes	0	465	2,417	60,129	30,601	262	93,874

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000	catch('000)	catch('000	atch('000	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	64,476	11,340	75,816
3	0	0	0	0	2,866	504	3,370
4	0	18	0	0	2,866	504	3,388
5	0	40	0	383	0	0	424
6	0	0	0	0	0	0	0
7	0	0	0	3,444	0	0	3,444
8	0	77	0	3,064	0	0	3,141
9	0	0	0	1,150	0	0	1,150
10	0	0	27	0	0	0	27
11	0	40	199	767	0	0	1,007
12	0	77	4,182	59,722	0	0	63,981
13	0	0	199	383	0	0	583
14	0	18	552	1,914	0	0	2,484
15+	0	217	1,522	5,742	0	0	7,481
Total	0	489	6,682	76,569	70,207	12,348	166,294
Tonnes	0	147	1,928	18,885	3,582	630	25,172

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000	catch('000)	catch('000	atch('000	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	83	83
1	0	0	0	0	979	248	1,227
2	0	0	1,211	5,910	15,971	536	23,629
3	0	0	0	377	9,483	124	9,984
4	0	0	0	377	542	83	1,001
5	0	0	4,843	1,382	3,196	165	9,586
6	0	0	1,211	1,383	1,083	248	3,925
7	0	0	33,880	14,579	13,606	660	62,725
8	20	601	13,311	5,404	2,112	165	21,615
9	16	458	4,843	3,269	2,654	165	11,405
10	63	1,854	3,632	1,131	0	0	6,680
11	27	808	2,421	1,258	0	0	4,515
12	399	11,790	144,003	55,172	15,437	619	227,420
13	11	336	1,211	251	0	0	1,810
14	15	451	0	0	0	0	466
15+	26	764	1,211	628	0	0	2,629
Total	578	17,062	211,777	91,123	65,063	3,095	388,699
Tonnes	200	5,904	39,147	16,227	8,080	373	69,931

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000	catch('000)	catch('000	atch('000	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	2,232	2,232
1	0	0	0	0	7,401	6,696	14,097
2	0	0	0	880	126,239	14,508	141,627
3	0	0	0	440	62,798	3,349	66,587
4	0	0	0	440	17,430	2,232	20,102
5	0	0	0	440	24,813	4,465	29,717
6	0	0	0	0	15,000	6,696	21,696
7	0	0	32,590	15,984	58,964	17,857	125,395
8	57	10,481	16,328	7,124	13,365	4,465	51,809
9	43	7,984	0	0	5,955	4,465	18,447
10	176	32,316	0	440	0	0	32,931
11	77	14,081	0	440	1,022	0	15,619
12	1,116	205,452	86,928	44,098	56,095	16,741	410,429
13	32	5,861	0	0	1,022	0	6,914
14	43	7,853	0	0	0	0	7,895
15+	72	13,309	0	0	0	0	13,382
Total	1,615	297,336	135,845	70,285	390,094	83,705	978,880
Tonnes	559	102,887	26,124	13,008	47,231	10,089	199,898

Table 6.6 Length (cm) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1994.

1994	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,	VIIIa,b,d,e	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	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	18.5	18.5	18.5
3	0.0	0.0	0.0	0.0	22.5	22.5	22.5
4	0.0	24.5	0.0	23.5	23.5	23.5	23.5
5	0.0	27.0	0.0	29.3	0.0	0.0	28.9
6	0.0	0.0	0.0	29.0	0.0	0.0	29.0
7	0.0	0.0	0.0	28.8	0.0	0.0	28.8
8	0.0	30.3	0.0	29.2	0.0	0.0	29.3
9	0.0	0.0	0.0	29.6	0.0	0.0	29.6
10	0.0	0.0	31.5	29.9	0.0	0.0	29.9
11	0.0	30.5	33.5	30.5	0.0	0.0	31.2
12	0.0	32.5	33.0	31.4	0.0	0.0	31.4
13	0.0	0.0	34.5	31.5	0.0	0.0	32.6
14	0.0	31.5	35.1	31.9	0.0	0.0	32.4
15+	0.0	34.4	36.0	35.7	0.0	0.0	35.7
0-15+	0.0	32.0	33.9	31.3	18.9	18.9	22.7

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,	VIIIa,b,d,e	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	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	18.5	18.5	18.5
3	0.0	0.0	0.0	0.0	22.5	22.5	22.5
4	0.0	24.5	0.0	0.0	23.5	23.5	23.5
5	0.0	27.0	0.0	28.9	0.0	0.0	28.7
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	28.9	0.0	0.0	28.9
8	0.0	30.3	0.0	30.6	0.0	0.0	30.6
9	0.0	0.0	0.0	29.2	0.0	0.0	29.2
10	0.0	0.0	31.5	0.0	0.0	0.0	31.5
11	0.0	30.5	33.5	25.5	0.0	0.0	27.3
12	0.0	32.5	33.0	32.2	0.0	0.0	32.3
13	0.0	0.0	34.5	31.2	0.0	0.0	32.3
14	0.0	31.5	35.1	34.7	0.0	0.0	34.8
15+	0.0	34.4	36.0	36.4	0.0	0.0	36.2
0-15+	0.0	32.0	33.9	32.2	18.9	18.9	25.7

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,	VIIIa,b,d,e	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm	length (cm	length (cm)	length (cm	length (cm	length (cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	14.0	14.0
1	0.0	0.0	0.0	0.0	15.0	17.3	15.5
2	0.0	0.0	22.5	19.3	19.4	19.0	19.6
3	0.0	0.0	0.0	23.5	23.3	24.2	23.3
4	0.0	0.0	0.0	26.5	26.5	25.5	26.4
5	0.0	0.0	27.8	28.0	26.5	27.0	27.1
6	0.0	0.0	26.5	27.6	26.5	27.2	26.9
7	0.0	0.0	27.6	27.8	27.1	26.7	27.5
8	31.6	31.6	28.0	28.6	28.3	26.3	28.3
9	30.9	30.9	28.0	28.9	28.6	27.3	28.5
10	30.9	30.9	28.2	28.6	0.0	0.0	29.0
11	31.1	31.1	27.0	28.5	0.0	0.0	28.2
12	33.3	33.3	28.6	28.7	27.8	27.2	28.8
13	34.0	34.0	29.5	29.5	0.0	0.0	30.4
14	34.6	34.6	0.0	0.0	0.0	0.0	34.6
15+	36.3	36.3	34.5	33.9	0.0	0.0	34.9
0-15+	33.0	33.0	28.3	27.9	24.7	24.3	27.8

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,	VIIIa,b,d,e	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	14.0	14.0
1	0.0	0.0	0.0	0.0	16.4	17.3	16.8
2	0.0	0.0	0.0	21.0	21.0	19.0	20.8
3	0.0	0.0	0.0	22.5	24.3	24.2	24.2
4	0.0	0.0	0.0	26.5	25.5	25.5	25.5
5	0.0	0.0	0.0	29.5	26.6	27.0	26.7
6	0.0	0.0	0.0	0.0	26.4	27.2	26.7
7	0.0	0.0	28.2	28.0	26.9	26.7	27.4
8	31.6	31.6	28.5	28.3	26.8	26.3	28.5
9	30.9	30.9	0.0	0.0	26.7	27.3	28.7
10	30.9	30.9	0.0	26.5	0.0	0.0	30.8
11	31.1	31.1	0.0	28.5	30.5	0.0	31.0
12	33.3	33.3	28.8	28.6	27.4	27.2	30.8
13	34.0	34.0	0.0	0.0	34.5	0.0	34.1
14	34.6	34.6	0.0	0.0	0.0	0.0	34.6
15+	36.3	36.3	0.0	0.0	0.0	0.0	36.3
0-15+	33.0	33.0	28.6	28.3	24.3	24.3	27.9

Table 6.7 Weight (g) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1994.

1994 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)	IIa,e,f,g, 1'st Q weight(g)	VIIIa,b,d,e 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	47	47	47
3	0	0	0	0	79	79	79
4	0	128	0	99	113	113	113
5	0	179	0	187	0	0	186
6	0	0	0	186	0	0	186
7	0	0	0	172	0	0	172
8	0	237	0	187	0	0	188
9	0	0	0	196	0	0	196
10	0	0	243	190	0	0	191
11	0	263	269	217	0	0	236
12	0	322	267	236	0	0	236
13	0	0	268	244	0	0	253
14	0	284	307	251	0	0	262
15+	0	361	348	346	0	0	347
0-15+	0	300	289	232	51	51	107

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)	IIa,e,f,g, 2'nd Q weight(g)	VIIIa,b,d,e 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	47	47	47
3	0	0	0	0	79	79	79
4	0	128	0	0	113	113	113
5	0	179	0	175	0	0	175
6	0	0	0	0	0	0	0
7	0	0	0	176	0	0	176
8	0	237	0	212	0	0	213
9	0	0	0	176	0	0	176
10	0	0	243	0	0	0	243
11	0	263	269	147	0	0	176
12	0	322	267	247	0	0	248
13	0	0	268	284	0	0	278
14	0	284	307	307	0	0	307
15+	0	361	348	355	0	0	354
0-15+	0	300	289	250	51	51	153

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)	IIa,e,f,g, 3'rd Q weight (g)	VIIIa,b,d,e 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	0	0	0	21	21
1	0	0	0	0	28	43	31
2	0	0	102	68	57	56	62
3	0	0	0	105	100	110	101
4	0	0	0	162	155	140	156
5	0	0	171	181	132	144	159
6	0	0	156	175	143	153	159
7	0	0	174	172	154	148	169
8	301	301	179	192	177	147	185
9	292	292	173	190	174	157	183
10	299	299	187	196	0	0	221
11	319	316	162	180	0	0	196
12	351	351	190	189	169	155	197
13	371	371	181	181	0	0	218
14	389	389	0	0	0	0	389
15+	445	445	312	299	0	0	349
0-15+	346	346	186	179	124	121	180

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)	IIa,e,f,g, 4'th Q weight(g)	VIIIa,b,d,e 4'th Q weight(g)	All areas 4'th Q weight(g)
0	0	0	0	0	0	21	21
1	0	0	0	0	33	43	38
2	0	0	0	82	77	56	76
3	0	0	0	88	119	110	118
4	0	0	0	148	137	140	138
5	0	0	0	206	158	144	157
6	0	0	0	0	149	153	150
7	0	0	190	184	150	148	165
8	301	301	188	186	154	147	199
9	292	292	0	0	145	157	212
10	299	299	0	140	0	0	297
11	319	316	0	180	254	0	308
12	351	351	195	190	159	155	266
13	371	371	0	0	340	0	366
14	389	389	0	0	0	0	389
15+	445	445	0	0	0	0	445
0-15+	346	346	193	186	121	121	204

Table 6.8 Catch in numbers, mean length and mean weight in catch and mean weight in stock of Western horse mackerel in 1994.

Age	Catch in numbers (Millions) *	Mean length (cm)	Mean weight (kg) in catch	in stock
0	2.32	14.0	0.021	
1	15.32	16.7	0.037	
2	796.61	18.9	0.052	0.050
3	104.63	23.7	0.106	0.080
4	49.46	24.4	0.124	0.099
5	40.47	26.9	0.158	0.145
6	26.96	26.8	0.153	0.185
7	205.84	27.5	0.167	0.169
8	88.02	28.6	0.194	0.190
9	37.23	28.8	0.199	0.192
10	41.24	30.5	0.280	0.190
11	22.19	30.3	0.276	0.200
12	914.30	30.5	0.241	0.231
13	10.00	33.2	0.326	0.267
14	14.60	34.1	0.342	0.267
15+	37.46	36.0	0.383	0.338

* includes 0.76 mill from Div. IIIa

Table 6.9 Dependence of the estimated strength of the 1992 year class (at age 0) upon the year range over which a mean selection pattern in calculated.

Year Range for Calculating Mean Selection Pattern	Estimate of the 1992 Year Class Abundance at Age 0. (Billions)
1990 - 1993	13.9
1989 - 1993	13.7
1988 - 1993	16.6
1987 - 1993	19.2
1986 - 1993	21.7
1985 - 1993	24.0
1984 - 1993	25.6
1983 - 1993	26.6
1982 - 1993	28.3

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

Year	Age-Group 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
82	0	2523	14320	91566	7825	8968	7979	6013	1122	281	1122	4473	12560	19489	13205	5579
83	0	5668	1627	23595	38374	11005	31942	37775	12854	2360	3948	2428	12204	17142	27505	33335
84	0	0000	183682	3378	27621	114001	17009	29105	25890	11230	3121	0000	486	1337	3866	38732
85	0	1267	3802	467741	3462	32441	77862	9808	12545	4809	7155	0263	659	2888	0970	27005
86	0	0000	0000	1120	489397	6316	47149	79428	18609	15328	11052	2255	746	619	0211	37295
87	0	0083	0414	0000	2476	748405	1730	34886	76224	9854	8015	16252	7484	1173	0168	27613
88	767	23975	5354	1839	3856	16616	824940	10613	34963	59452	8531	14301	15158	4537	4285	28378
89	0	0000	0000	18860	16604	4821	13169	1159554	10940	53909	75496	12629	21975	12471	8162	16468
90	0	19117	42191	130153	57561	31195	9883	19305	1297370	34673	66058	95505	14040	32496	16935	53023
91	3230	19570	47240	13980	187410	126310	68330	19000	21090	1173940	21140	13060	51200	9710	9000	49400
92	12420	83830	24040	66180	50210	243720	110620	42840	14202	17930	1063910	12000	22750	69970	12110	32200
93	0	94250	49520	7700	52870	83770	307370	124050	65790	25250	3250	1177060	6420	16110	52610	33490
94	2315	15324	796606	104631	49463	40466	26961	205842	87767	37045	40453	21847	909325	9861	14411	37138

Table 6.10. Western Horse Mackerel. (b) Weight at age in the stock . (Kg)

Year	Age-Group 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
82	0.000	0.000	0.050	0.080	0.207	0.232	0.269	0.280	0.292	0.305	0.369	0.344	0.348	0.348	0.361	0.364
83	0.000	0.000	0.050	0.080	0.171	0.227	0.257	0.276	0.270	0.243	0.390	0.305	0.309	0.311	0.312	0.310
84	0.000	0.000	0.050	0.077	0.122	0.155	0.201	0.223	0.253	0.246	0.338	0.300	0.300	0.300	0.305	0.285
85	0.000	0.000	0.050	0.081	0.148	0.140	0.193	0.236	0.242	0.289	0.247	0.300	0.300	0.325	0.325	0.303
86	0.000	0.000	0.050	0.080	0.105	0.134	0.169	0.195	0.242	0.292	0.262	0.300	0.300	0.300	0.300	0.346
87	0.000	0.000	0.050	0.080	0.105	0.126	0.150	0.171	0.218	0.254	0.281	0.291	0.297	0.303	0.303	0.339
88	0.000	0.000	0.050	0.080	0.105	0.126	0.141	0.143	0.217	0.274	0.305	0.337	0.352	0.361	0.352	0.390
89	0.000	0.000	0.050	0.080	0.105	0.103	0.131	0.159	0.127	0.210	0.252	0.263	0.302	0.411	0.383	0.358
90	0.000	0.000	0.050	0.080	0.105	0.127	0.135	0.124	0.154	0.174	0.282	0.272	0.404	0.404	0.404	0.404
91	0.000	0.000	0.050	0.080	0.121	0.137	0.143	0.144	0.150	0.182	0.189	0.266	0.295	0.349	0.361	0.381
92	0.000	0.000	0.050	0.080	0.105	0.133	0.151	0.150	0.158	0.160	0.182	0.292	0.211	0.245	0.361	0.403
93	0.000	0.000	0.050	0.080	0.105	0.153	0.166	0.173	0.172	0.170	0.206	0.211	0.258	0.288	0.338	0.405
94	0.000	0.000	0.050	0.080	0.105	0.147	0.185	0.169	0.191	0.191	0.190	0.197	0.231	0.270	0.270	0.338
Values used in projections																
95	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.191	0.200	0.215	0.225	0.235	0.242	0.255	0.322
96	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.185	0.200	0.215	0.225	0.235	0.245	0.256	0.322
97	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.185	0.200	0.215	0.225	0.235	0.245	0.255	0.268
98	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.185	0.200	0.215	0.232	0.235	0.245	0.255	0.278
99	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.185	0.200	0.215	0.225	0.247	0.245	0.255	0.287
00	0.000	0.000	0.050	0.080	0.105	0.125	0.145	0.165	0.185	0.200	0.215	0.225	0.235	0.261	0.255	0.295

Table 6.10. Western Horse Mackerel. (c) Weight at age in the catches . (Kg)

	Age-Group															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year																
82	0.015	0.054	0.090	0.142	0.178	0.227	0.273	0.276	0.292	0.305	0.369	0.348	0.348	0.348	0.356	0.366
83	0.015	0.039	0.113	0.124	0.168	0.229	0.247	0.282	0.281	0.254	0.260	0.300	0.310	0.315	0.311	0.332
84	0.015	0.034	0.073	0.089	0.130	0.176	0.216	0.245	0.278	0.262	0.259	0.255	0.344	0.232	0.306	0.308
85	0.015	0.029	0.045	0.087	0.150	0.156	0.199	0.243	0.256	0.294	0.257	0.241	0.251	0.314	0.346	0.321
86	0.015	0.029	0.045	0.110	0.107	0.171	0.196	0.223	0.251	0.296	0.280	0.319	0.287	0.345	0.260	0.360
87	0.015	0.068	0.067	0.110	0.155	0.143	0.174	0.198	0.249	0.264	0.321	0.336	0.244	0.328	0.245	0.373
88	0.015	0.031	0.075	0.114	0.132	0.147	0.157	0.240	0.304	0.335	0.386	0.434	0.404	0.331	0.392	0.424
89	0.012	0.050	0.075	0.149	0.142	0.142	0.220	0.166	0.258	0.327	0.330	0.381	0.400	0.421	0.448	0.516
90	0.015	0.032	0.031	0.090	0.124	0.126	0.129	0.202	0.183	0.227	0.320	0.328	0.355	0.399	0.388	0.379
91	0.012	0.031	0.046	0.113	0.125	0.148	0.141	0.144	0.187	0.185	0.215	0.303	0.323	0.354	0.365	0.330
92	0.008	0.014	0.092	0.117	0.139	0.143	0.157	0.163	0.172	0.235	0.222	0.288	0.306	0.359	0.393	0.401
93	0.010	0.033	0.083	0.120	0.126	0.142	0.154	0.163	0.183	0.199	0.177	0.238	0.308	0.327	0.376	0.421
Values used in projections																
94	0.021	0.037	0.052	0.106	0.124	0.158	0.153	0.167	0.194	0.199	0.280	0.275	0.240	0.326	0.342	0.383
95	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.192	0.225	0.240	0.255	0.265	0.261	0.285	0.383
96	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.210	0.205	0.240	0.255	0.265	0.275	0.273	0.383
97	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.210	0.225	0.222	0.255	0.265	0.275	0.285	0.284
98	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.210	0.225	0.240	0.238	0.265	0.275	0.285	0.295
99	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.210	0.225	0.240	0.255	0.253	0.275	0.285	0.306
00	0.015	0.040	0.070	0.100	0.125	0.145	0.170	0.190	0.210	0.225	0.240	0.255	0.265	0.268	0.285	0.317

Table 6.10. Western Horse Mackerel. (d) Proportion of fish assumed to spawn.

	Age-Group															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year																
82	0.00	0.00	0.40	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
83	0.00	0.00	0.30	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
84	0.00	0.00	0.10	0.60	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
85	0.00	0.00	0.10	0.40	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
86	0.00	0.00	0.10	0.40	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
87	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
88	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
89	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
90	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
91	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
92	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
93	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
94	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Values used in projections																
95	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
96	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
97	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
98	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
99	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
00	0.00	0.00	0.10	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 6.10. Western Horse Mackerel. (e) Assumed Scalars used in Analysis.

Natural Mortality :	0.15 at all years and ages
Proportion of fishing mortality before spawning :	0.45 at all years and ages
Proportion of natural mortality before spawning :	0.45 at all years and ages

Table 6.11. Western Horse Mackerel. Results of ADAPT analysis. (a) Estimated historical fishing mortality

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.0000	.0000	.0000	.0000	.0000	.0000	.0010	.0000	.0000	.0015	.0010	.0000	.0010	.0009
1	.0035	.0001	.0000	.0011	.0000	.0000	.0053	.0000	.0288	.0307	.0478	.0086	.0419	.0367
2	.0097	.0027	.0041	.0054	.0000	.0004	.0027	.0000	.0811	.0876	.0455	.0342	.0888	.0780
3	.0235	.0188	.0064	.0123	.0019	.0000	.0020	.0110	.0399	.0331	.1612	.0175	.0893	.0784
4	.0105	.0117	.0261	.0077	.0151	.0048	.0055	.0214	.0398	.0704	.1510	.1772	.1411	.1238
5	.0123	.0174	.0413	.0368	.0165	.0275	.0383	.0080	.0483	.1093	.1168	.3783	.1892	.1661
6	.0121	.0524	.0320	.0340	.0653	.0053	.0363	.0367	.0193	.1343	.1250	.2001	.1892	.1661
7	.0156	.0691	.0587	.0220	.0419	.0597	.0388	.0623	.0657	.0444	.1106	.1903	.1892	.1661
8	.0049	.0399	.0586	.0307	.0503	.0489	.0744	.0485	.0872	.0901	.0403	.2337	.1892	.1661
9	.0170	.0122	.0422	.0131	.0453	.0322	.0464	.1487	.2017	.1006	.0977	.0887	.1892	.1661
10	.0656	.3261	.0190	.0325	.0359	.0286	.0335	.0727	.2587	.1724	.1182	.0219	.1892	.1661
11	.1187	.1865	.0000	.0019	.0122	.0645	.0619	.0604	.1174	.0704	.1326	.1757	.1892	.1661
12	.0844	.5070	.0489	.0912	.0062	.0483	.0749	.1210	.0838	.0808	.1595	.0923	.1892	.1661
13	.0902	.1502	.0883	.4225	.1100	.0115	.0355	.0772	.2493	.0728	.1433	.1535	.1892	.1661
14	.0511	.1679	.0435	.0810	.0459	.0374	.0502	.0784	.1354	.0957	.1159	.1445	.1892	.1661
15	.0511	.1679	.0435	.0810	.0459	.0374	.0502	.0784	.1354	.0957	.1159	.1445	.1892	.1661
Mean F on ages 4-14														
	.0439	.1400	.0417	.0703	.0404	.0335	.0451	.0668	.1188	.0947	.1192	.1687	.1848	.1623

Table 6.11. Western Horse Mackerel. Results of ADAPT analysis. (b) Estimated population abundance.
Millions of fish / SSB in millions of tonnes

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	64988	1019	1390	1545	2930	5651	787	842	809	2247	13741	468	2467	(1241)	(1241)
1	771	55936	877	1197	1330	2522	4864	677	724	696	1931	11816	402	2121	(1067)
2	1603	661	48139	755	1029	1145	2171	4164	583	606	581	1584	10082	332	1760
3	4242	1366	567	41264	646	886	985	1863	3584	463	478	478	1318	7940	264
4	808	3566	1154	485	35082	555	762	846	1586	2964	385	350	404	1037	6319
5	792	688	3034	968	414	29742	475	652	713	1312	2378	285	252	302	789
6	716	673	582	2505	803	351	24906	394	557	585	1012	1821	168	180	220
7	417	609	550	485	2084	647	300	20672	327	470	440	769	1283	120	131
8	245	353	489	446	408	1720	525	249	16719	263	387	339	547	914	87
9	18	210	292	397	372	334	1410	419	204	13189	207	320	231	390	666
10	19	15	178	241	337	306	279	1159	311	143	10265	162	252	165	284
11	43	15	9	151	201	280	256	232	927	207	104	7851	136	180	120
12	167	33	11	8	129	171	226	207	188	710	166	78	5669	97	131
13	243	132	17	9	6	111	140	180	158	149	564	122	61	4038	71
14	285	191	98	13	5	5	94	116	144	106	119	420	90	44	2944
15+	121	232	980	373	895	810	624	235	450	582	316	268	232	128	125
SSB	1.248	1.403	1.538	2.383	3.268	3.888	4.381	3.873	3.346	3.196	2.526	2.268	1.762	1.552	1.428
Egg survey		0.56			0.75			2.39			2.32			1.64	

Table 6.12 Inputs and outputs of a prediction for Western HORSE MACKEREL assuming F = M = 0.15.
The input values are printed in italics and the calculated values are in plain characters.
Constant weak recruitment of 1067 million fish at age 1 from 1996 onwards (=GM weak year classes).
Smoothed mean weights at age in stock and catch of 1994 are used for the years 1996 - 2001 except the bold values, which are extrapolated values from available growth curves of the 1987 and 1982 year classes

WESTERN HORSE MACKEREL

Stock-size-factor = *1.000*

YEAR = **1996** F-factor = *0.150*

								1st of January		Spawning time					
Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
1995	1	*0.222*	0.0332	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1994	2	*0.470*	0.0704	111.26	7.79	*1760*	88	176	9	159	8	*0.15*	*0.10*	*0.070*	*0.050*
1993	3	*0.472*	0.0708	16.77	1.68	*264*	21	106	8	96	8	*0.15*	*0.40*	*0.100*	*0.080*
1992	4	*0.746*	0.1119	621.84	77.73	*6319*	663	3791	398	3370	354	*0.15*	*0.60*	*0.125*	*0.105*
1991	5	*1.000*	0.1500	102.25	14.83	*789*	99	631	79	551	69	*0.15*	*0.80*	*0.145*	*0.125*
1990	6	*1.000*	0.1500	28.51	4.85	*220*	32	220	32	192	28	*0.15*	*1.00*	*0.170*	*0.145*
1989	7	*1.000*	0.1500	16.98	3.23	*131*	22	131	22	114	19	*0.15*	*1.00*	*0.190*	*0.165*
1988	8	*1.000*	0.1500	11.27	2.37	*87*	16	87	16	76	14	*0.15*	*1.00*	*0.210*	*0.185*
1987	9	***1.000***	**0.1500**	**86.31**	**17.69**	***666***	**133**	**666**	**133**	**582**	**116**	***0.15***	***1.00***	***0.205***	***0.200***
1986	10	*1.000*	0.1500	36.80	8.83	*284*	61	284	61	248	53	*0.15*	*1.00*	*0.240*	*0.215*
1985	11	*1.000*	0.1500	15.55	3.97	*120*	27	120	27	105	24	*0.15*	*1.00*	*0.255*	*0.225*
1984	12	*1.000*	0.1500	16.98	4.50	*131*	31	131	31	114	27	*0.15*	*1.00*	*0.265*	*0.235*
1983	13	*1.000*	0.1500	9.20	2.53	*71*	17	71	17	62	15	*0.15*	*1.00*	*0.275*	*0.245*
1982	14	***1.000***	**0.1500**	**381.52**	**104.15**	***2944***	**754**	**2944**	**754**	**2572**	**658**	***0.15***	***1.00***	***0.273***	***0.256***
+	15+	*1.000*	0.1500	16.20	5.90	*125*	40	125	40	109	35	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-14)W =	0.150	1504	**261**	14978	2004	9483	1627	8352	**1428**				

YEAR = **1997** F-factor = *0.150*

								1st of January		Spawning time					
Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
1996	1	0.222	0.033	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1995	2	0.470	0.070	56.16	3.93	888	44	89	4	80	4	*0.15*	*0.10*	*0.070*	*0.050*
1994	3	0.472	0.071	89.67	8.97	1412	113	565	45	511	41	*0.15*	*0.40*	*0.100*	*0.080*
1993	4	0.746	0.112	20.83	2.60	212	22	127	13	113	12	*0.15*	*0.60*	*0.125*	*0.105*
1992	5	1.000	0.150	630.23	91.38	4863	608	3891	486	3399	425	*0.15*	*0.80*	*0.145*	*0.125*
1991	6	1.000	0.150	75.75	12.88	585	85	585	85	511	74	*0.15*	*1.00*	*0.170*	*0.145*
1990	7	1.000	0.150	21.12	4.01	163	27	163	27	142	23	*0.15*	*1.00*	*0.190*	*0.165*
1989	8	1.000	0.150	12.58	2.64	97	18	97	18	85	16	*0.15*	*1.00*	*0.210*	*0.185*
1988	9	1.000	0.150	8.35	1.88	64	13	64	13	56	11	*0.15*	*1.00*	*0.225*	*0.200*
1987	10	**1.000**	**0.150**	**63.94**	**14.19**	**493**	**106**	**493**	**106**	**431**	**93**	***0.15***	***1.00***	***0.222***	***0.215***
1986	11	1.000	0.150	27.26	6.95	210	47	210	47	184	41	*0.15*	*1.00*	*0.255*	*0.225*
1985	12	1.000	0.150	11.52	3.05	89	21	89	21	78	18	*0.15*	*1.00*	*0.265*	*0.235*
1984	13	1.000	0.150	12.58	3.46	97	24	97	24	85	21	*0.15*	*1.00*	*0.275*	*0.245*
1983	14	1.000	0.150	6.82	1.94	53	13	53	13	46	12	*0.15*	*1.00*	*0.285*	*0.255*
1982	15	**1.000**	**0.150**	**282.63**	**80.27**	**2181**	**584**	**2181**	**584**	**1906**	**511**	***0.15***	***1.00***	***0.284***	***0.268***
+	16+	1.000	0.150	12.00	4.37	93	30	93	30	81	26	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-15)W =	0.150	1364	**244**	12567	1756	8796	1518	7708	**1328**				

Table 6.12 (continued)

YEAR = 1998 F-factor = *0.150*

Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1st of January SP. ST. size	1st of January SP. ST. biomass	Spawning time SP. ST. size	Spawning time SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
1997	1	0.222	0.033	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1996	2	0.470	0.070	56.16	3.93	888	44	89	4	80	4	*0.15*	*0.10*	*0.070*	*0.050*
1995	3	0.472	0.071	45.26	4.53	713	57	285	23	258	21	*0.15*	*0.40*	*0.100*	*0.080*
1994	4	0.746	0.112	111.41	13.93	1132	119	679	71	604	63	*0.15*	*0.60*	*0.125*	*0.105*
1993	5	1.000	0.150	21.11	3.06	163	20	130	16	114	14	*0.15*	*0.80*	*0.145*	*0.125*
1992	6	1.000	0.150	466.89	79.37	3603	522	3603	522	3148	456	*0.15*	*1.00*	*0.170*	*0.145*
1991	7	1.000	0.150	56.11	10.66	433	71	433	71	378	62	*0.15*	*1.00*	*0.190*	*0.165*
1990	8	1.000	0.150	15.65	3.29	121	22	121	22	105	20	*0.15*	*1.00*	*0.210*	*0.185*
1989	9	1.000	0.150	9.32	2.10	72	14	72	14	63	13	*0.15*	*1.00*	*0.225*	*0.200*
1988	10	1.000	0.150	6.19	1.49	48	10	48	10	42	9	*0.15*	*1.00*	*0.240*	*0.215*
1987	**11**	**1.000**	**0.150**	**47.37**	**11.27**	**366**	**85**	**366**	**85**	**319**	**74**	***0.15***	***1.00***	***0.238***	***0.232***
1986	12	1.000	0.150	20.20	5.35	156	37	156	37	136	32	*0.15*	*1.00*	*0.265*	*0.235*
1985	13	1.000	0.150	8.53	2.35	66	16	66	16	58	14	*0.15*	*1.00*	*0.275*	*0.245*
1984	14	1.000	0.150	9.32	2.66	72	18	72	18	63	16	*0.15*	*1.00*	*0.285*	*0.255*
1983	15	1.000	0.150	5.05	1.49	39	10	39	10	34	9	*0.15*	*1.00*	*0.295*	*0.265*
1982	16	**1.000**	**0.150**	**209.38**	**61.77**	**1616**	**449**	**1616**	**449**	**1412**	**392**	***0.15***	***1.00***	***0.295***	***0.278***
+	17+	1.000	0.150	8.89	3.24	69	22	69	22	60	19	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-16)W =	0.150	1129	**212**	10622	1519	7842	1393	6874	**1219**				

YEAR = 1999 F-factor = *0.150*

Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1st of January SP. ST. size	1st of January SP. ST. biomass	Spawning time SP. ST. size	Spawning time SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
1998	1	0.222	0.033	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1997	2	0.470	0.070	56.16	3.93	888	44	89	4	80	4	*0.15*	*0.10*	*0.070*	*0.050*
1996	3	0.472	0.071	45.26	4.53	713	57	285	23	258	21	*0.15*	*0.40*	*0.100*	*0.080*
1995	4	0.746	0.112	56.23	7.03	571	60	343	36	305	32	*0.15*	*0.60*	*0.125*	*0.105*
1994	5	1.000	0.150	112.91	16.37	871	109	697	87	609	76	*0.15*	*0.80*	*0.145*	*0.125*
1993	6	1.000	0.150	15.64	2.66	121	18	121	18	105	15	*0.15*	*1.00*	*0.170*	*0.145*
1992	7	1.000	0.150	345.88	65.72	2669	440	2669	440	2332	385	*0.15*	*1.00*	*0.190*	*0.165*
1991	8	1.000	0.150	41.57	8.73	321	59	321	59	280	52	*0.15*	*1.00*	*0.210*	*0.185*
1990	9	1.000	0.150	11.59	2.61	89	18	89	18	78	16	*0.15*	*1.00*	*0.225*	*0.200*
1989	10	1.000	0.150	6.90	1.66	53	11	53	11	47	10	*0.15*	*1.00*	*0.240*	*0.215*
1988	11	1.000	0.150	4.58	1.17	35	8	35	8	31	7	*0.15*	*1.00*	*0.255*	*0.225*
1987	**12**	**1.000**	**0.150**	**35.09**	**8.88**	**271**	**67**	**271**	**67**	**237**	**58**	***0.15***	***1.00***	***0.253***	***0.247***
1986	13	1.000	0.150	14.96	4.11	115	28	115	28	101	25	*0.15*	*1.00*	*0.275*	*0.245*
1985	14	1.000	0.150	6.32	1.80	49	12	49	12	43	11	*0.15*	*1.00*	*0.285*	*0.255*
1984	15	1.000	0.150	6.90	2.04	53	14	53	14	47	12	*0.15*	*1.00*	*0.295*	*0.265*
1983	16	1.000	0.150	3.74	1.14	29	8	29	8	25	7	*0.15*	*1.00*	*0.305*	*0.275*
1982	17	**1.000**	**0.150**	**155.11**	**47.46**	**1197**	**344**	**1197**	**344**	**1046**	**300**	***0.15***	***1.00***	***0.306***	***0.287***
+	18+	1.000	0.150	6.59	2.40	51	16	51	16	44	14	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-17)W =	0.150	958	**184**	9164	1314	6467	1194	5668	**1045**				

Table 6.12 (continued)

YEAR = 2000 F-factor = *0.150*

Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1st of January SP. ST. size	1st of January SP. ST. biomass	Spawning time SP. ST. size	Spawning time SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
1999	1	0.222	0.033	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1998	2	0.470	0.070	56.16	3.93	888	44	89	4	80	4	*0.15*	*0.10*	*0.070*	*0.050*
1997	3	0.472	0.071	45.26	4.53	713	57	285	23	258	21	*0.15*	*0.40*	*0.100*	*0.080*
1996	4	0.746	0.112	56.23	7.03	571	60	343	36	305	32	*0.15*	*0.60*	*0.125*	*0.105*
1995	5	1.000	0.150	56.99	8.26	440	55	352	44	307	38	*0.15*	*0.80*	*0.145*	*0.125*
1994	6	1.000	0.150	83.65	14.22	645	94	645	94	564	82	*0.15*	*1.00*	*0.170*	*0.145*
1993	7	1.000	0.150	11.59	2.20	89	15	89	15	78	13	*0.15*	*1.00*	*0.190*	*0.165*
1992	8	1.000	0.150	256.23	53.81	1977	366	1977	366	1728	320	*0.15*	*1.00*	*0.210*	*0.185*
1991	9	1.000	0.150	30.80	6.93	238	48	238	48	208	42	*0.15*	*1.00*	*0.225*	*0.200*
1990	10	1.000	0.150	8.59	2.06	66	14	66	14	58	12	*0.15*	*1.00*	*0.240*	*0.215*
1989	11	1.000	0.150	5.11	1.30	39	9	39	9	34	8	*0.15*	*1.00*	*0.255*	*0.225*
1988	12	1.000	0.150	3.40	0.90	26	6	26	6	23	5	*0.15*	*1.00*	*0.265*	*0.235*
1987	13	**1.000**	**0.150**	**26.00**	**6.97**	201	52	**201**	**52**	**175**	**46**	***0.15***	***1.00***	***0.268***	***0.261***
1986	14	1.000	0.150	11.09	3.16	86	22	86	22	75	19	*0.15*	*1.00*	*0.285*	*0.255*
1985	15	1.000	0.150	4.68	1.38	36	10	36	10	32	8	*0.15*	*1.00*	*0.295*	*0.265*
1984	16	1.000	0.150	5.11	1.56	39	11	39	11	34	9	*0.15*	*1.00*	*0.305*	*0.275*
1983	17	1.000	0.150	2.77	0.87	21	6	21	6	19	5	*0.15*	*1.00*	*0.315*	*0.285*
1982	18	**1.000**	**0.150**	**114.91**	**36.43**	**887**	**262**	**887**	**262**	**775**	**229**	***0.15***	***1.00***	***0.317***	***0.295***
+	19+	1.000	0.150	4.88	1.78	38	12	38	12	33	11	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-18)W =	0.150	816	**159**	8068	1142	5458	1033	4786	**904**				

YEAR = 2001 F-factor = *0.150*

Year class	Age	Exploit. pattern	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1st of January SP. ST. size	1st of January SP. ST. biomass	Spawning time SP. ST. size	Spawning time SP. ST. biomass	Natural mortality	Maturity ogive	Weight in the catch	Weight in the stock
(years)	(years)			(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)	(millions)	('000 tonnes)			(kg)	(kg)
2000	1	0.222	0.033	32.40	1.30	*1067*	0	0	0	0	0	*0.15*	*0.00*	*0.040*	*0.000*
1999	2	0.470	0.070	56.16	3.93	888	44	89	4	80	4	*0.15*	*0.10*	*0.070*	*0.050*
1998	3	0.472	0.071	45.26	4.53	713	57	285	23	258	21	*0.15*	*0.40*	*0.100*	*0.080*
1997	4	0.746	0.112	56.23	7.03	571	60	343	36	305	32	*0.15*	*0.60*	*0.125*	*0.105*
1996	5	1.000	0.150	56.99	8.26	440	55	352	44	307	38	*0.15*	*0.80*	*0.145*	*0.125*
1995	6	1.000	0.150	42.22	7.18	326	47	326	47	285	41	*0.15*	*1.00*	*0.170*	*0.145*
1994	7	1.000	0.150	61.97	11.77	478	79	478	79	418	69	*0.15*	*1.00*	*0.190*	*0.165*
1993	8	1.000	0.150	8.58	1.80	66	12	66	12	58	11	*0.15*	*1.00*	*0.210*	*0.185*
1992	9	1.000	0.150	189.82	42.71	1465	293	1465	293	1280	256	*0.15*	*1.00*	*0.225*	*0.200*
1991	10	1.000	0.150	22.81	5.48	176	38	176	38	154	33	*0.15*	*1.00*	*0.240*	*0.215*
1990	11	1.000	0.150	6.36	1.62	49	11	49	11	43	10	*0.15*	*1.00*	*0.255*	*0.225*
1989	12	1.000	0.150	3.79	1.00	29	7	29	7	26	6	*0.15*	*1.00*	*0.265*	*0.235*
1988	13	1.000	0.150	2.52	0.69	19	5	19	5	17	4	*0.15*	*1.00*	*0.275*	*0.245*
1987	14	**1.000**	**0.150**	**19.26**	**5.39**	**149**	**41**	**149**	**41**	**130**	**35**	***0.15***	***1.00***	***0.280***	***0.273***
1986	15	1.000	0.150	8.21	2.42	63	17	63	17	55	15	*0.15*	*1.00*	*0.295*	*0.265*
1985	16	1.000	0.150	3.47	1.06	27	7	27	7	23	6	*0.15*	*1.00*	*0.305*	*0.275*
1984	17	1.000	0.150	3.79	1.19	29	8	29	8	26	7	*0.15*	*1.00*	*0.315*	*0.285*
1983	18	1.000	0.150	2.05	0.67	16	5	16	5	14	4	*0.15*	*1.00*	*0.325*	*0.295*
1982	19	**1.000**	**0.150**	**85.13**	**27.92**	**657**	**198**	**657**	**198**	**574**	**173**	***0.15***	***1.00***	***0.328***	***0.302***
+	20+	1.000	0.150	3.61	1.32	28	9	28	9	24	8	*0.15*	*1.00*	*0.364*	*0.322*
		F(5-18)W =	0.150	711	**137**	7257	993	4646	884	4076	**774**				

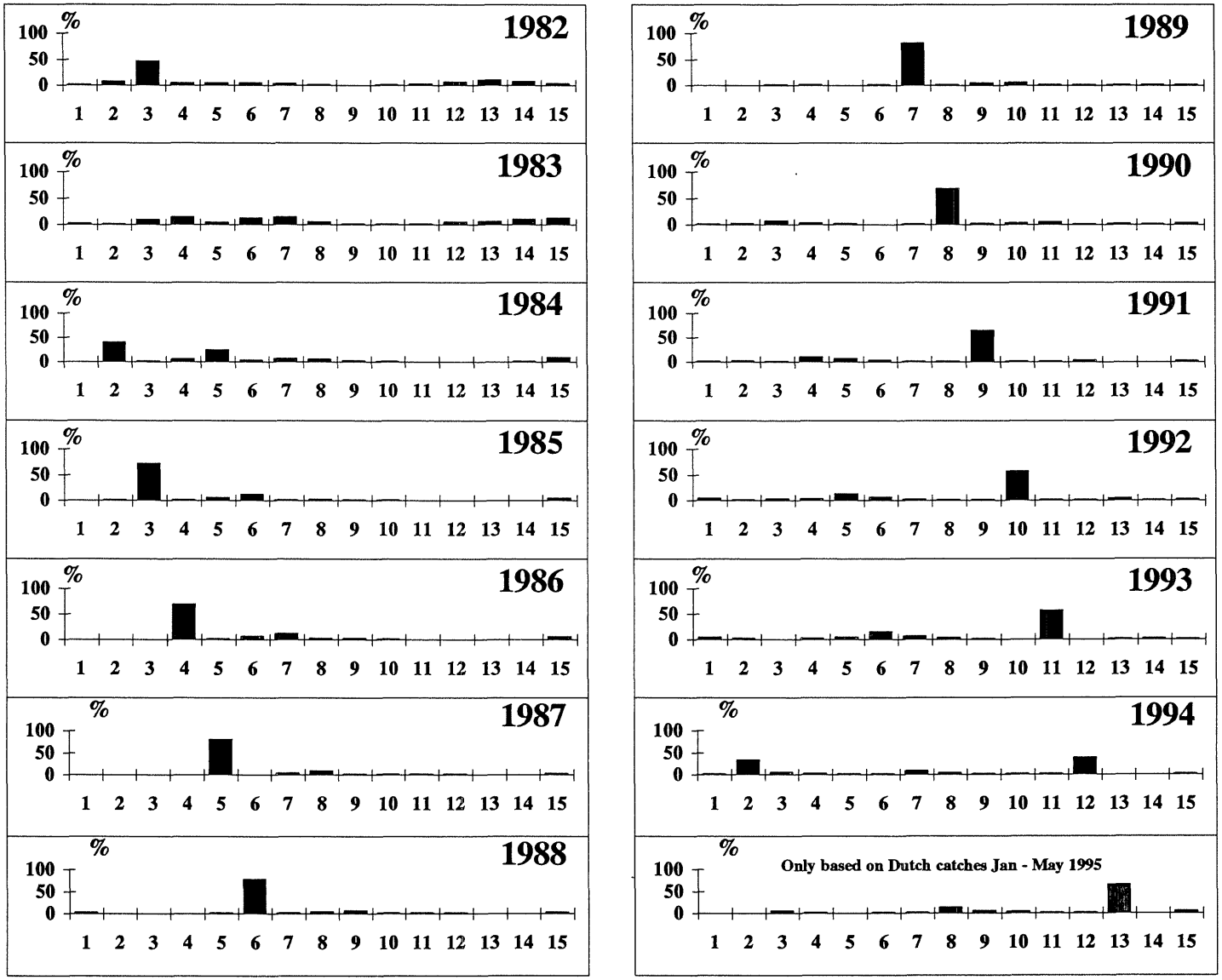

Figure 6.1 **The age composition of the western horse mackerel in the international catches from 1982-1994. For 1995 only based on Dutch catches from January - May 1995.**

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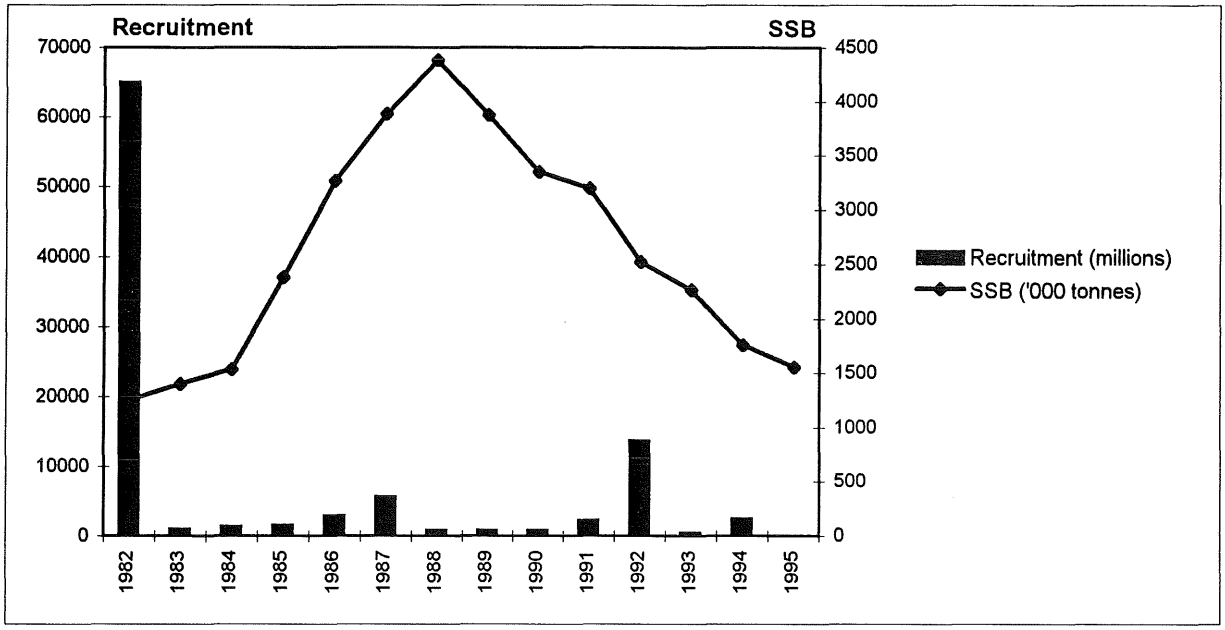

Figure 6.2A **The spawning stock biomass (SSB) and the recruitment of western horse mackerel as obtained from the 'ADAPT' - analysis over the period 1982 - 1995.**

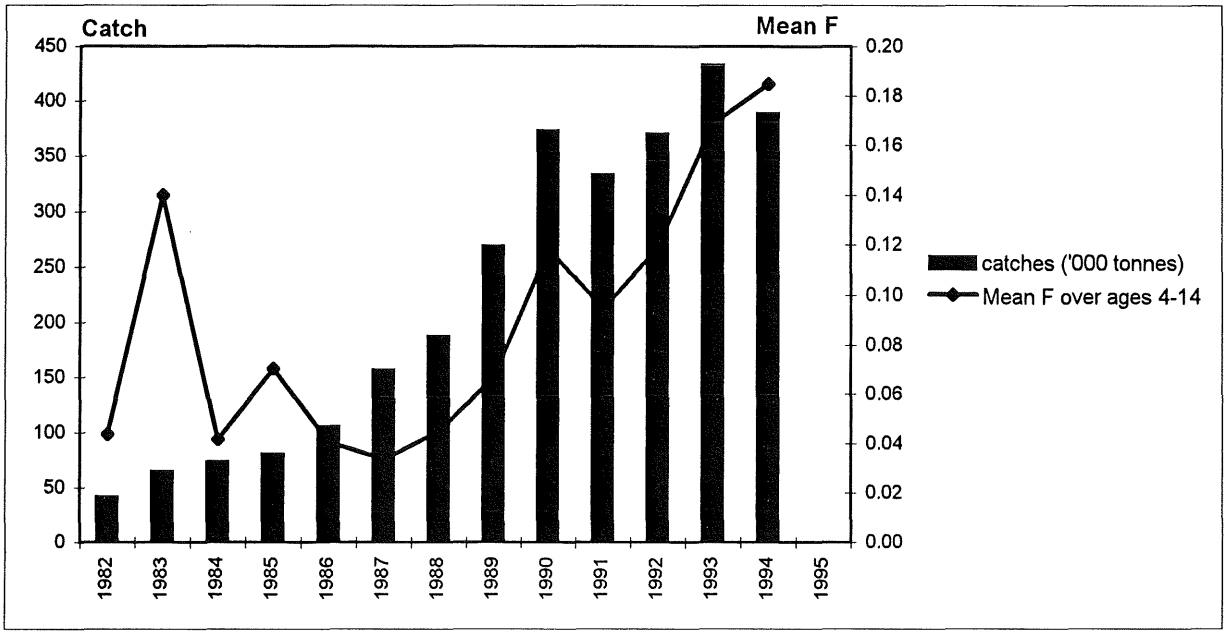

Figure 6.2B **The catch and the fishing mortality of western horse mackerel as obtained from the 'ADAPT' - analysis over the period 1982 - 1994.**

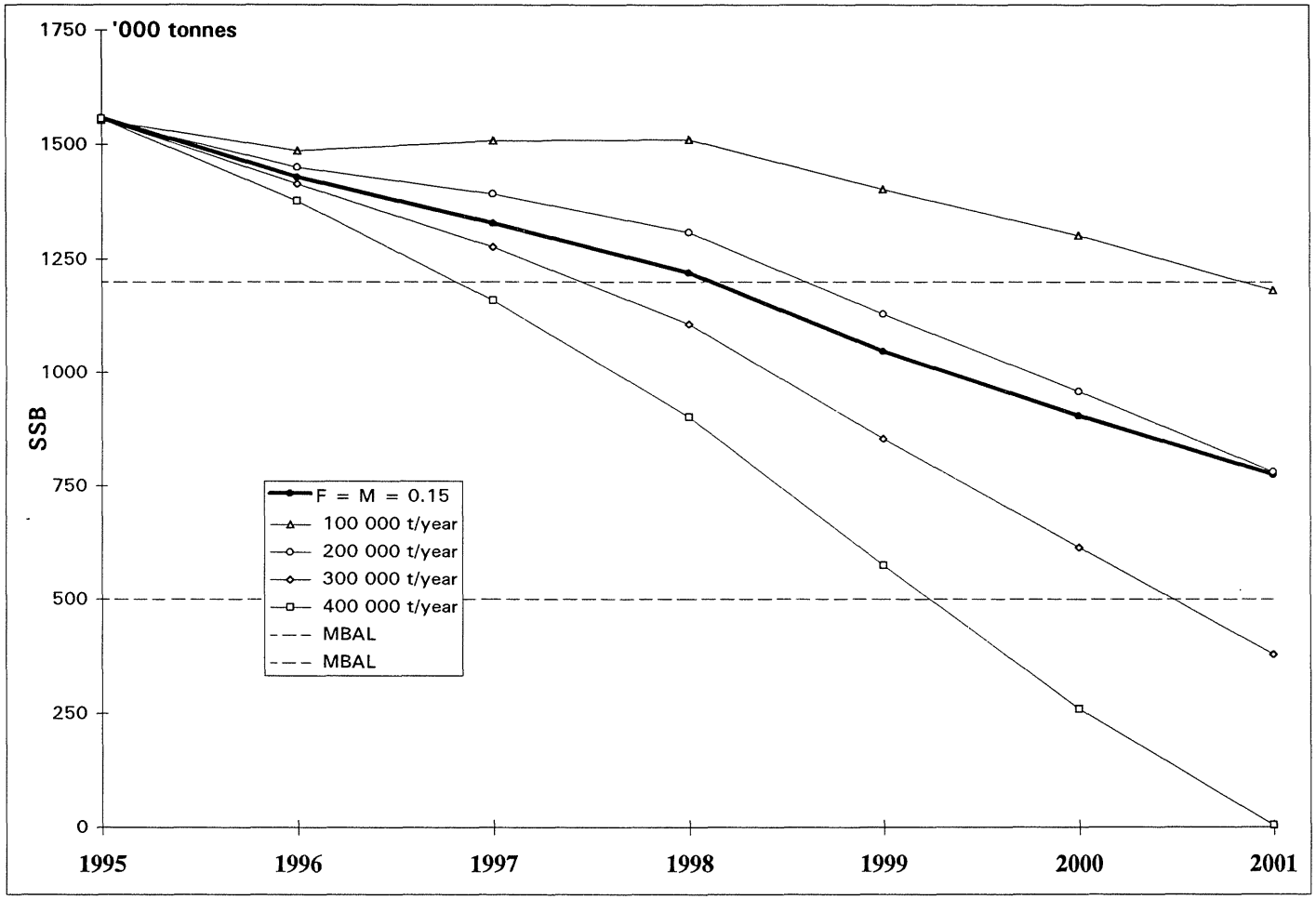

Figure 6.3 The predicted decrease in spawning stock biomass of western horse mackerel for different annual catch levels from 1996 onwards and for constant F = 0.15 (F=M).

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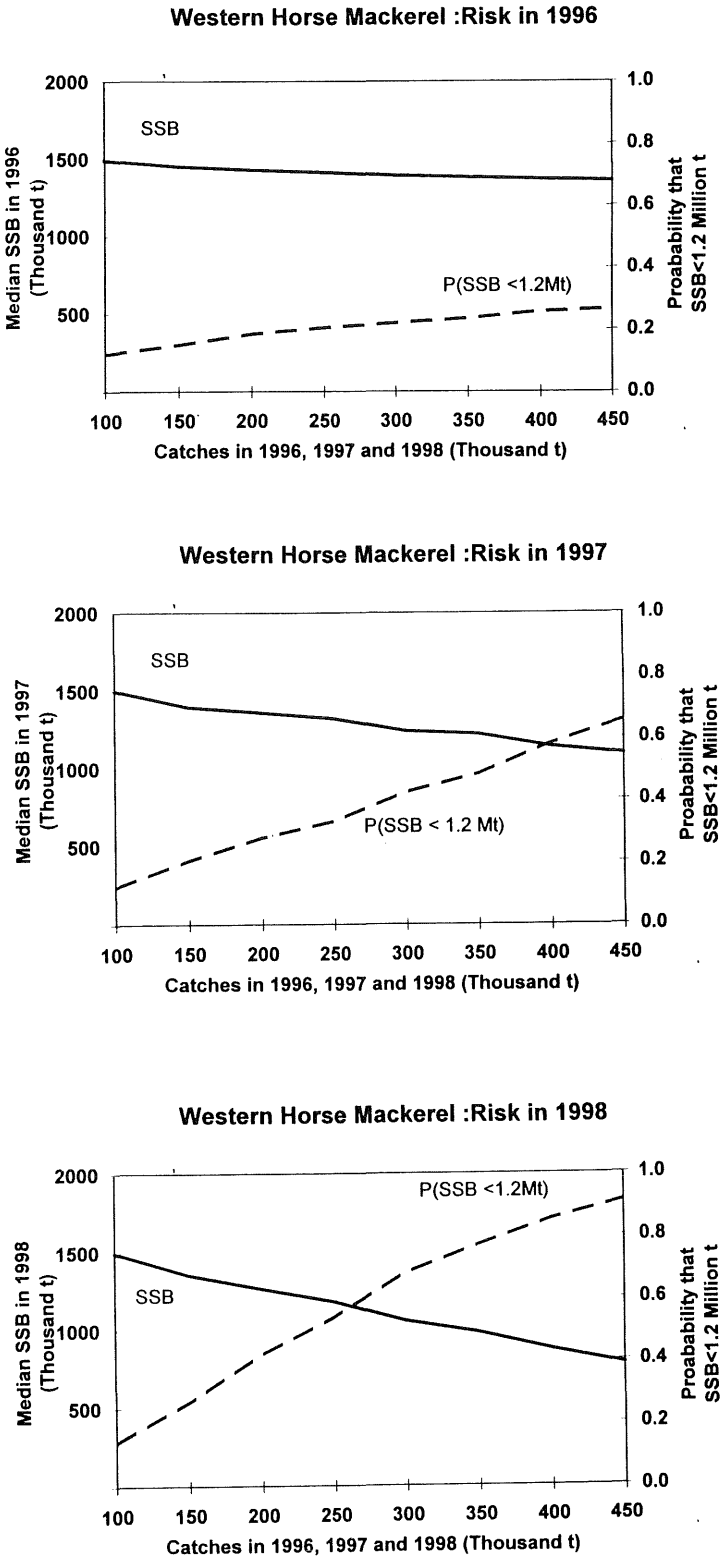


Figure 6.4 Western Horse Mackerel. Short term risk analysis. Estimated median stock size and the probability that the spawning stock size will fall below 1.2 million tonnes in 1996, 1997 and 1998, for a range of catch levels in which the annual catches are constrained to values from 100 to 450 000t.

Figure 6.4 (continued)

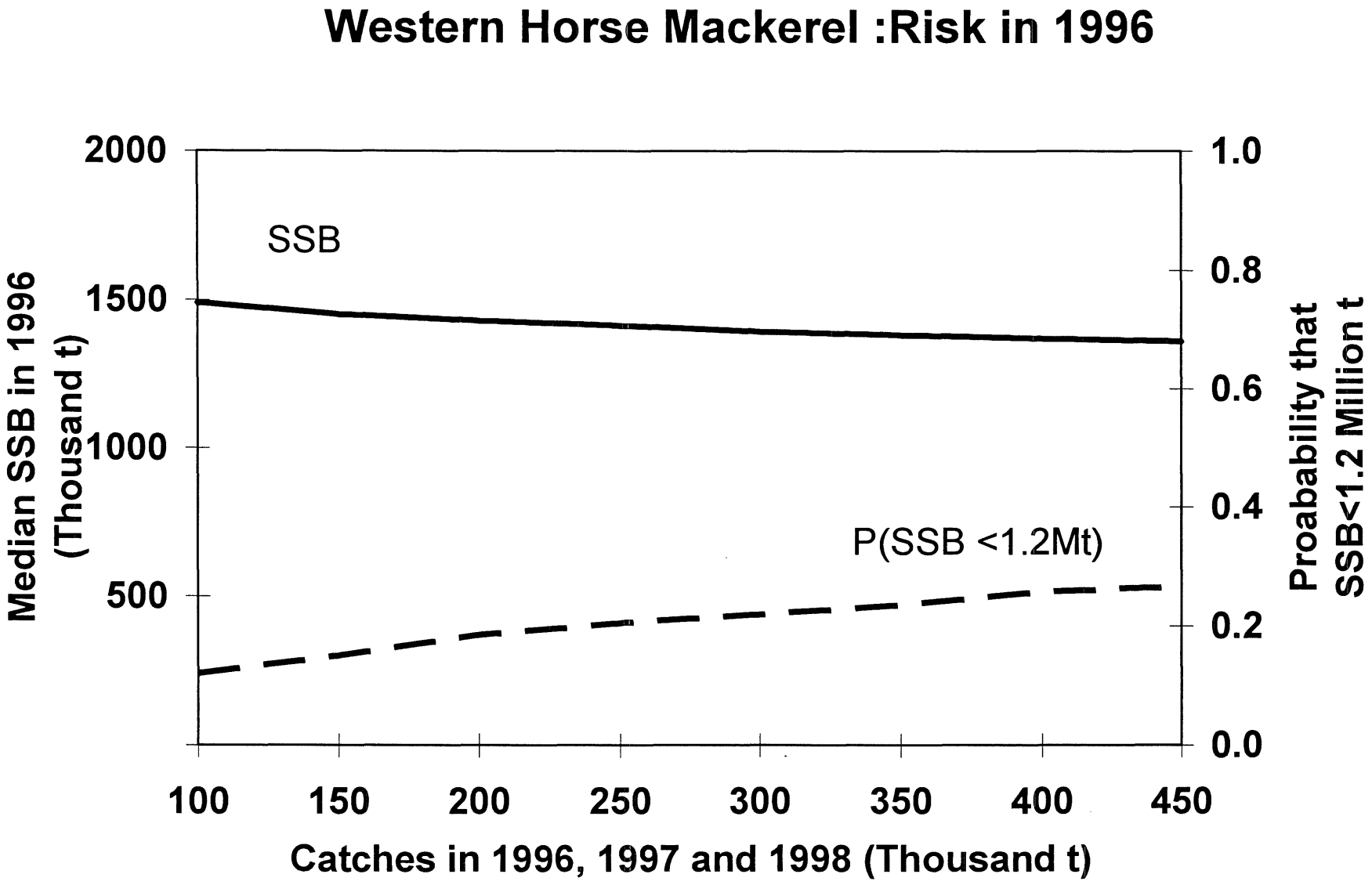


Figure 6.4 (continued)

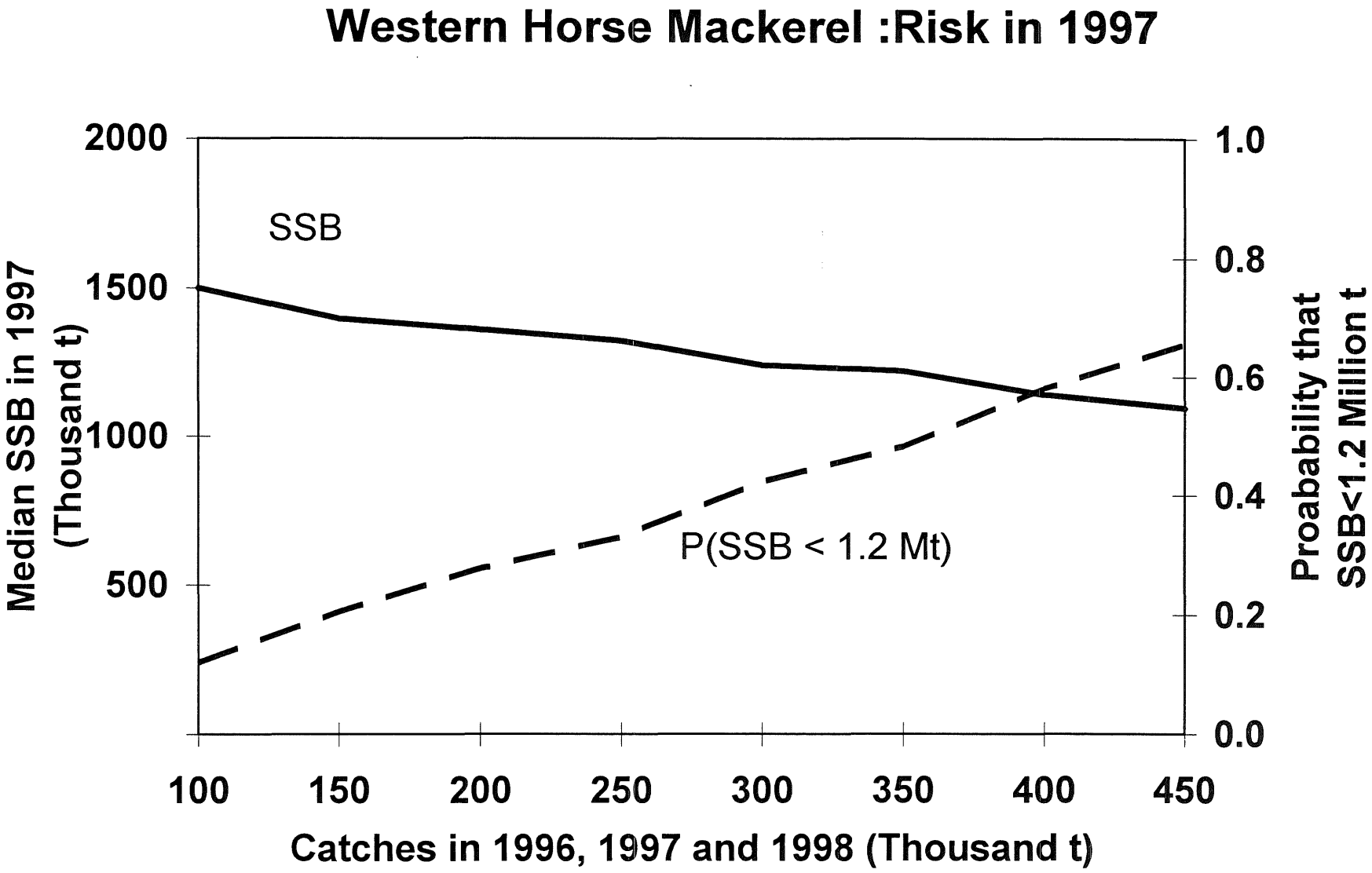
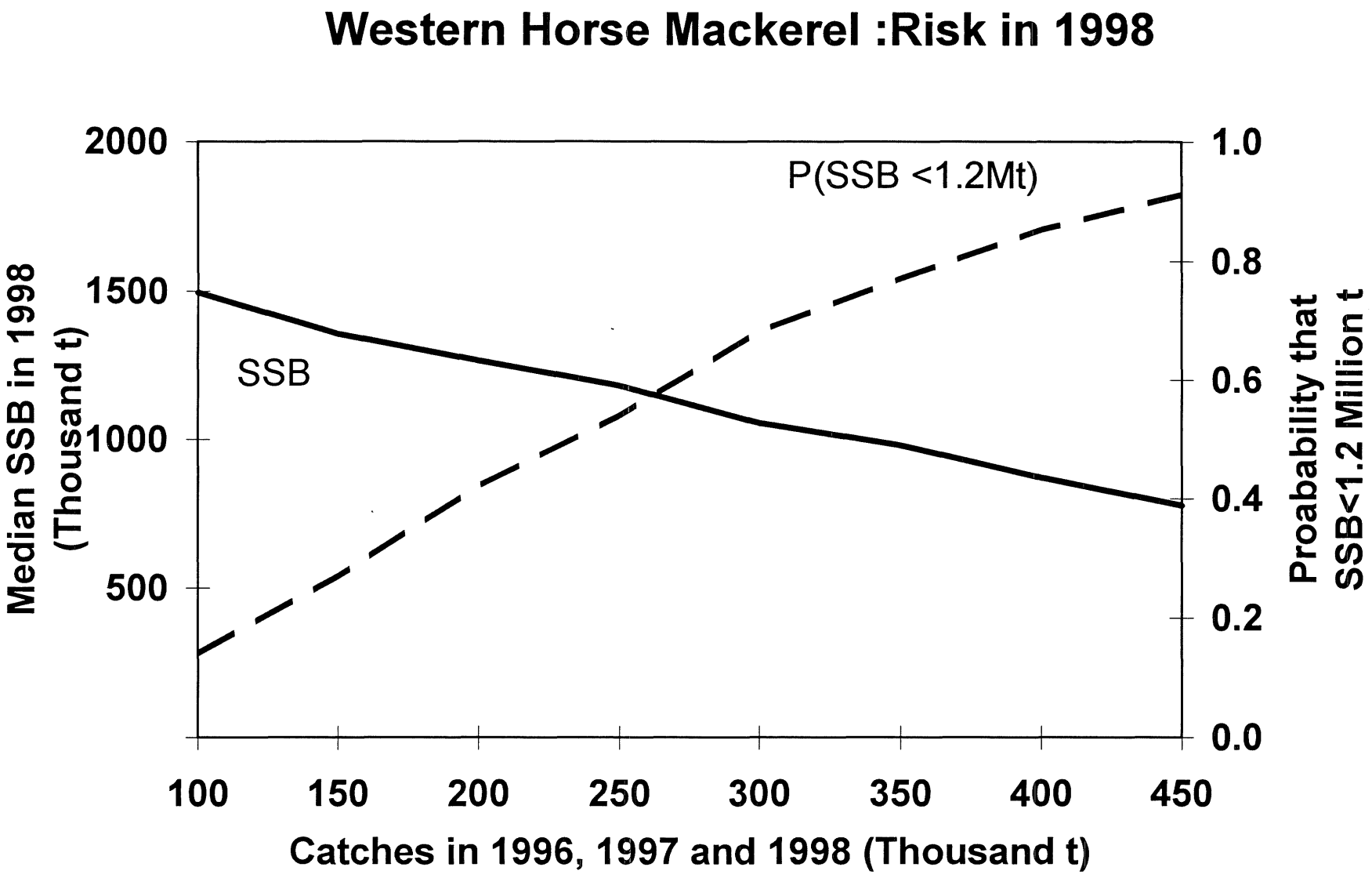


Figure 6.4 (continued)



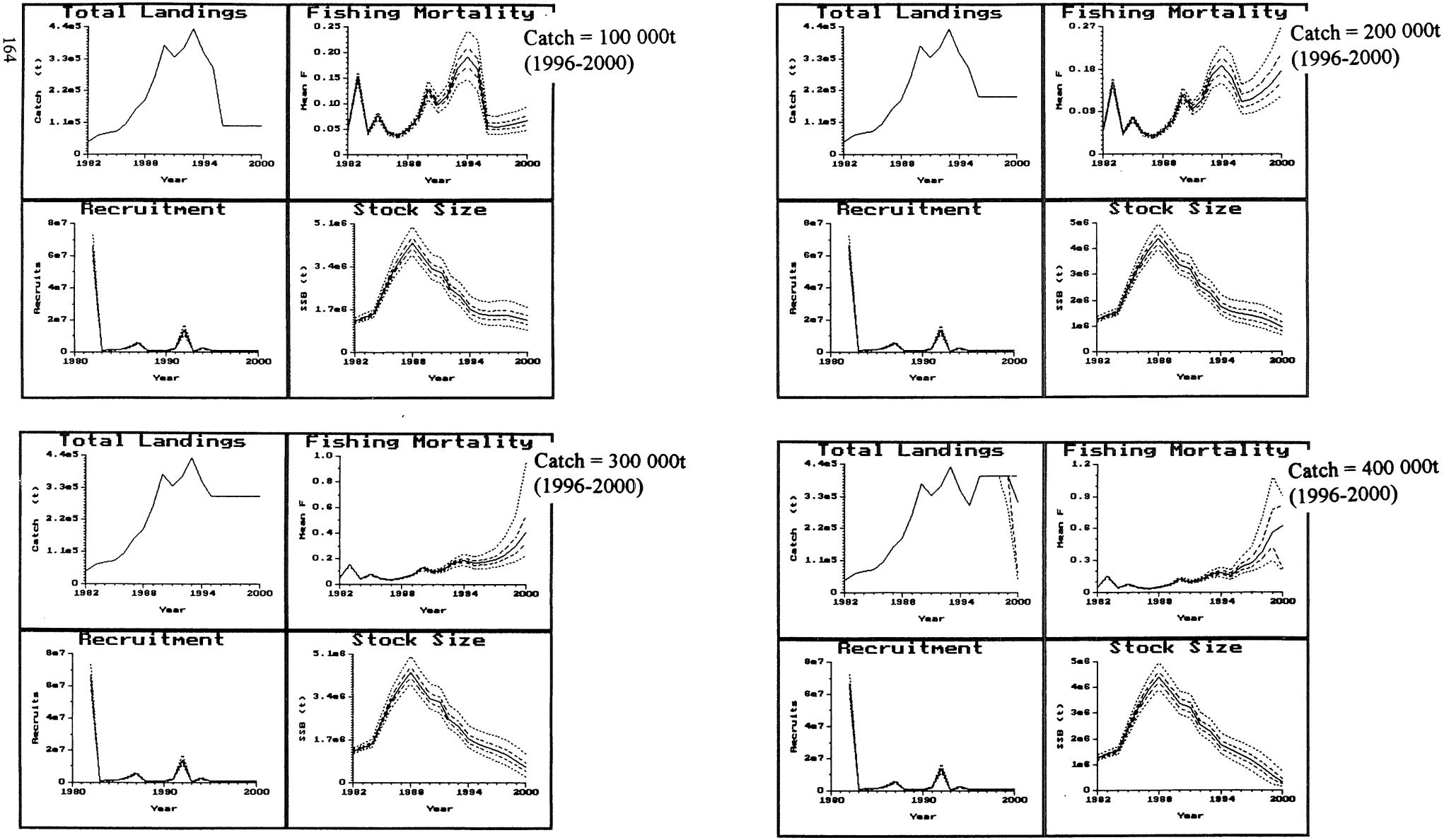


Figure 6.5 Western Horse Mackerel. Uncertainty in assessment and medium-term projections. Landings, fishing mortality, recruitment and spawning stock size estimates for four levels of annual catch catch constraint over the period 1996-2000. Full lines, medians. Dashed lines, 75 percentiles. Dotted lines, 95 percentiles. Fishing mortality constrained to be less than 1.0 in the projections.

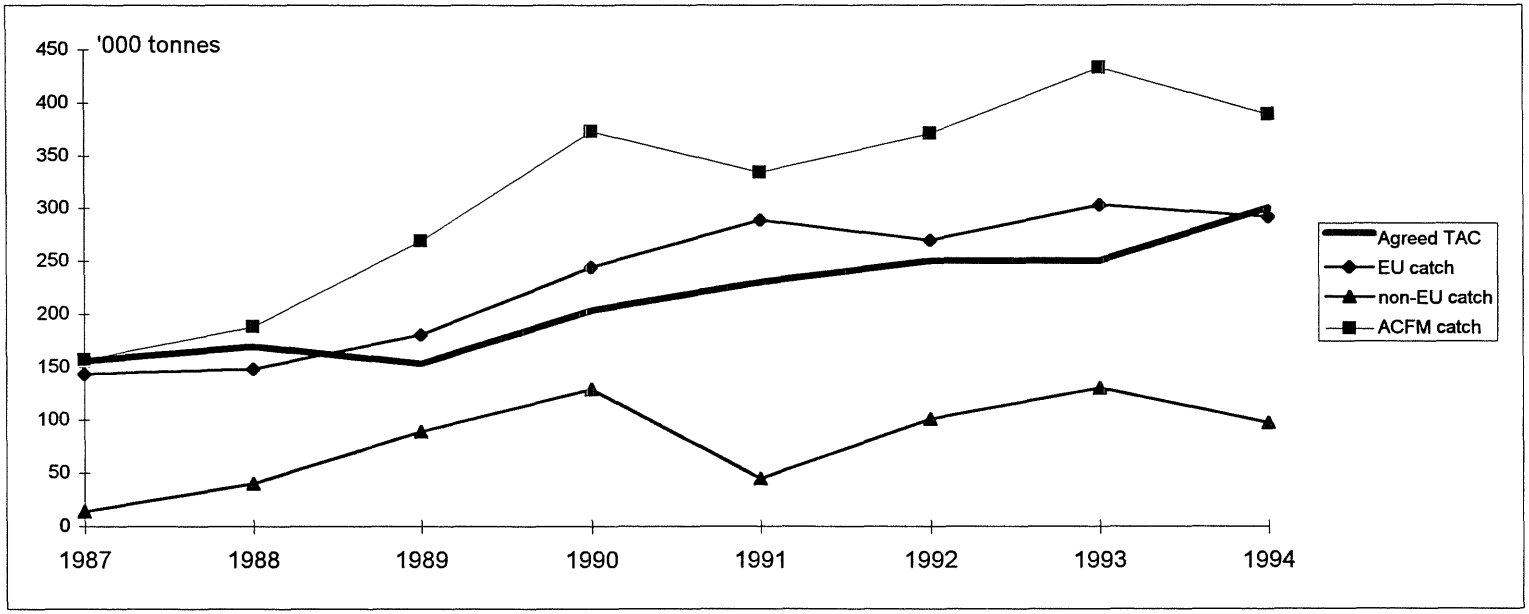


Figure 6.6 **Catches taken by EU countries and non-EU countries compared to the agreed TAC's over the period 1987 - 1994. The total catches (ACFM catches) overshoot in all year the agreed TAC's.**