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REPORT OF THE MACKEREL WORKING GROUP

Copenhagen, 28 February - 6 March 1984

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REPORT OF THE MACKEREL WORKING GROUP

1. INTRODUCTION

1.1 Terms of Reference

At the 71st Statutory Meeting in Gothenburg it was decided (C.Res.1983/2:8:11) that the Mackerel Working Group (Chairman: Dr E D Anderson) should meet at ICES headquarters from 28 February to 6 March 1984 to:

- (i) consider the report of the ad hoc Group on Mackerel Egg Surveys,
- (ii) assess catch options for the mackerel stocks in Sub-areas II, III, IV, VI, VII, VIII and IX inside safe biological limits in 1985,
- (iii) continue the examination of the relationship between Sub-area IX mackerel and the Western area stock (Sub-areas VI-VIII),
- (iv) review the data available to assess the state of the horse mackerel in Sub-areas VII, VIII and IX,
- (v) take into account the levels of predation mortality implied by the results of the stomach sampling project,
- (vi) analyse the effect of changes in the data sets of weight at age and age at first maturity on the time series of stock and spawning stock biomass.

In addition, relative to the ACFM recommendation that fishing for mackerel should be banned in Division VIa north of 58°N during the period 1 November to 30 April as a conservation measure for the North Sea stock, the Group was asked by the Chairman of ACFM to:

- 1) provide on a monthly basis estimates of the proportion of mackerel of North Sea stock origin in the area to which the ACFM recommendation applies,
- 2) assess quantitatively the effects of the recommendation on the evolution of the North Sea stock under the following conditions:
  - a) closure through the period recommended by ACFM,
  - b) closure from 1 December to 30 April,
  - c) closure from 1 to 31 December and from 1 March to 30 April.

1.2 Participation

The Working Group met in Copenhagen with the following participants:

E D Anderson (Chairman)	USA
E Bakken (part-time)	Norway
M F Borges	Portugal
H Dornheim	Federal Republic of Germany
A Eltink	Netherlands
L S Gordo	Portugal
J C Guéguen	France
E Kirkegaard	Denmark

ctd.

S J Lockwood	U.K. (England and Wales)
B Lundgren	Denmark
J Molloy	Ireland
A Saville	U.K. (Scotland)
T Westgård	Norway

Mr K Hoydal, ICES Statistician, also attended the meeting.

2. ALLOCATION OF MACKEREL CATCHES TO STOCKS

2.1 Allocation of Catches to Stocks in Divisions IIa, IVa and VIa

In the 1982 and 1983 reports of the Working Group (Anon., 1982, 1984a), the use of Norwegian tagging data to split catches into stocks was questioned. This was mainly because of the low number of tags returned in recent years, but also because of doubts whether the fish tagged in the western area mix into the entire Western stock. The objection was also raised that some of the fish tagged in the North Sea might belong to the Western stock, since the tagging in the North Sea takes place after the spawning season. Consequently, at the Working Group meeting in 1983 it was decided to use age composition data to split catches into stocks in Division IIa, and to use a combination of age composition data, tagging data and what was known about the general biology to split catches in Division VIa. In their 1983 report (Anon., 1984b), ACFM did not accept the use of age composition data to split catches between stocks and re-allocated the catches taken in Divisions IIa and VIa. They also asked the Working Group to evaluate what part of the inaccuracy in estimating mixing ratios between stocks from tagging data was caused by the low numbers of tags returned. A working document presented to the Working Group investigated this problem and concluded that, although the inaccuracy caused by low numbers of tags returned is appreciable, it does not affect the ratios so much that they are useless. Since the Norwegian tagging data were the only data on mixing ratios available to the Working Group on which to base a quantitative estimate, it was decided to use these data.

2.1.1 Division IIa

Taking into consideration the known distribution of spawning of the Western stock and the distribution of its juvenile stages, the Working Group considered that it was unlikely that the age 1 and 2 mackerel of the Western stock would migrate to Division IIa. Accordingly, all of the age 1 and 2 mackerel caught in Division IIa in 1981-83 were allocated to the North Sea stock.

For age 3 and older fish, the split between stocks was made on the basis of returns of tags in 1981-83 given in Table 2.1 and the method described in Anon. (1984a). These estimates were made, not including tags released in the year in question, using the stock sizes for both stocks from the VPA done by ACFM in November 1983 (Anon., 1984b). The estimates of the North Sea stock proportion calculated in this way were: 1981 - 0.01, 1982 - 0.01, 1983 - 0.06. Including tags returned in 1983 from the 1983 releases gave an estimate for that year of 0.03 for the North Sea proportion in Division IIa. Because of the reservations about the estimates from tagging data mentioned earlier, the Working Group decided that a value of 0.10, as used before, for the North Sea stock component in the Division IIa catches should be used in each of the years 1981-83.

2.1.2 Division IVa

As in the 1983 assessment (Anon., 1984a), it was assumed that all of the catch taken in Division IVa in 1981-83 belonged to the North Sea stock. The absence of Western stock fish from Division IVa catches in 1981 and 1982 was assumed because the fishery in those years was distributed in an area where mixing would not be expected. The fishery in 1983 took place in the same area as in the two preceding years.

2.1.3 Division VIa

As in previous years mixing of the two stocks in Division VIa was assumed to occur only in the area north of 58°N in the period January-April and November-December.

The mixing rates in this area during this time period were estimated as described for Division IIa, using the Norwegian tag returns from this area and time period (Table 2.1). These gave estimates of the North Sea stock proportion of the catch of age 3 and older fish as follows: 1981 - 0.12, 1982 - 0.11, 1983 - 0.14 in the first quarter of the year and 0.04 in the last quarter. In view of the reservations mentioned earlier about the assumptions which were made concerning these estimates, the Working Group decided to use a North Sea stock proportion of 0.10 in each of the years 1981-83 for the winter fishery north of 58°N. All age 1-2 fish were assumed to be from the Western stock.

This represents a much lower proportion of North Sea stock in this fishery than was assumed in earlier years but is supported by changes in the fishery in this area and time period in recent years. The fisheries in this area and time period have changed not only in national participation but also very markedly in age composition of the catches (Tables 4.3-4.5). The large proportion of fish of age 3 and younger in the catches in recent years suggests that the North Sea stock component must be small in light of the weakness of these year classes in the North Sea stock. Moreover, a Scottish acoustic survey of the mackerel stock in this area in November 1983 estimated the population biomass to be considerably more than the estimated total North Sea stock biomass, and age 2-3 mackerel constituted about 50% of this biomass.

2.2 Division IXa

The Working Group was asked to examine the relationship between Sub-area IX mackerel and the mackerel belonging to the Western stock. For reasons outlined in Section 5, the Working Group decided not to include mackerel from Sub-area IX in the Western stock assessment.

3. MACKEREL - NORTH SEA AND NORWEGIAN SEA AREAS

3.1 The Fishery in 1983

Total landings for the years 1974-83 by countries are shown in Table 3.1 for the North Sea, Skagerrak and Kattegat (Sub-area IV and Division IIIa) and in Table 3.2 for the Norwegian Sea (Division IIa). The catch in 1982 has been revised by some countries, and the reported catch was increased by 1 337 tonnes in Sub-area IV and Division IIIa and by 188 tonnes in Division IIa.

ACFM had recommended that there should be no fishing on the North Sea stock in 1983, but EEC and Norway agreed to a TAC of 30 000 tonnes for Sub-area IV and Division IIIa. The total landings from these areas were 35 600 tonnes, of which 66% was taken by Norway and 24% by Denmark.

The catch in Division IIa in 1983 was 48 900 tonnes, the highest catch on record. Norway took 79% and Denmark 21% of this catch.

The quarterly distribution of the fishery is shown in Table 3.3. The total catch of the North Sea stock in 1983 was estimated at 47 439 tonnes (Table 3.1).

### 3.2 Catch in Numbers

#### 3.2.1 1983 data

Since Danish vessels fishing in Division IIa occupied the same area and time period as the Norwegian fleet, Danish catches were allocated to age groups using Norwegian data. Age 1-2 fish were all allocated to the North Sea stock and 90% of all other age groups were allocated to the Western stock (see Section 2.1.1).

In Division IIIa, about 60% of the catch was taken by Norway in the third quarter of the year. The rest of the catch was taken in equal proportions by Sweden and Denmark. Since most of these catches were also taken in the third quarter, they were split into age groups using Norwegian data.

In Sub-area IV, Norway took 67% of the catch, while Denmark took 25%. The rest of the catch was taken by France, the Netherlands, Belgium, England and Scotland. In the absence of age composition data from countries other than Norway, all catches were split into age groups using Norwegian data. The estimation of the age composition of the Division VIa catch is given in Section 4.3.1, and the proportioning of the part of it taken north of 58°N during the winter fishery to the North Sea stock is explained in Section 2.1.3.

The catch in numbers at age for the North Sea stock in 1983 is summarised for Sub-area IV, Divisions IIa, IIIa and VIa in Table 3.7.

#### 3.2.2 Revision of the 1982 and 1981 data

##### 1982

The catches reported to ICES in 1982 for the North Sea (Sub-area IV) and Skagerrak (Division IIIa) have been revised by Denmark, the Faroes, France, Federal Republic of Germany, Sweden, England and Scotland. Since the difference amounted to only a 4% increase, the Working Group decided to add 4% to the numbers at age in these areas given in Table 3.2.B in Anon. (1984a).

There was a slight revision of catches reported in 1982 in the Norwegian Sea (Division IIa), but the Working Group did not consider that this minor change warranted revision of the numbers at age.

The revised catch in numbers at age for the North Sea stock in 1982 is shown in Table 3.8.

##### 1981

The new numbers at age for the 1981 catch for the North Sea stock are shown in Table 3.9.



3.2.3 Weight at age

Mean weight at age data were the same as in the previous report (Anon., 1984a). They are given in Table 3.13. In the present report, the calculated catch of the North Sea stock in tonnes is included in the catch tables referring to 1981 (Table 3.9), 1982 (Table 3.8) and 1983 (Table 3.7). A sum of products check on these data produced the following results:

Year	1981	1982	1983
Catch tonnes x 10 <sup>-3</sup>	65.9	47.0	47.4
SOP tonnes x 10 <sup>-3</sup>	62.7	44.5	48.4
% $\frac{\text{Catch}}{\text{SOP}}$	105.1	105.6	98.0

This indicates that the mean weights at age used for the catch data are satisfactory for recent years.

3.3 Assessment of the North Sea Stock

3.3.1 Spawning stock biomass estimates from egg surveys in 1982 and 1983

The total egg production estimate given in the previous Working Group report for 1982 based on an egg survey was 105 x 10<sup>12</sup> eggs (Anon., 1984a). The details of this survey are reported by Iversen and Eltink (1983). The survey estimate was later re-calculated by a newly developed computer program (Iversen and Westgård, in press), and the total egg production estimate increased by 20%. The new estimate is not necessarily more correct than the previous one, but by introducing an automatic procedure for the calculations, a consistent estimate is assured for each year and the results can be obtained much sooner following completion of the survey. It also simplifies recalculations for a series of years if new data become available.

The 1983 egg survey gave, using the computer program, an estimate of 160 x 10<sup>12</sup> eggs produced. To convert the estimates to spawning stock biomass, the fecundity of the stock must be known. The fecundity of the North Sea stock has been investigated by Iversen and Adoff (1983) and Walsh (1983). The first used a histological method, while the latter used Gilson's fluid to separate ova. In the report of the ad hoc Working Group on Mackerel Egg Surveys (Anon., 1984c), there is no direct advice as to which fecundity relationship should be used. However, it is recognised in the report that using histological techniques has advantages, and the present Working Group decided to use the fecundity/weight relationship given by Iversen and Adoff (1983). The final spawning stock estimates were 190 000 and 240 000 tonnes in 1982 and 1983, respectively.

3.3.2 Exploitation pattern

Separable virtual population analysis (SVPA) (Pope and Shepherd, 1982; Anon., 1983) was used to estimate the exploitation pattern of the fishery on the North Sea stock. Various runs were made to determine the most appropriate set of ages and years to serve as a basis for

estimating the exploitation pattern. Using the coefficient of variation (CV) and the log catch ratio residuals as a guide, a data set comprised of ages 2-13 during 1977-83 was found to be most suitable (terminal F reference age = 3 years, S = 1.0 at age 13, M = 0.15, CV = 24%). Only a few log catch ratio residuals in the final data set were in excess of the recommended level of  $2 \log_e (1 + CV/100)$  with these not exhibiting any specific pattern and indicating a fairly consistent set of catch in numbers at age for the North Sea stock.

The exploitation pattern at ages 1-14 in 1983 from the extended analysis of the SVPA (using terminal populations option) was used to factor the terminal F in 1983 for the standard VPA, as this pattern fits the 1983 catch data exactly.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
S	0.09	0.36	1.00	1.50	1.39	1.62	1.58	1.65	1.26	1.69	1.78	1.75	1.29	1.46

These results indicate full recruitment to the fishery at age 4 in 1983 with a relatively flat-topped pattern at ages 4-14. This represents a change from the previous assessment of this stock (Anon., 1984a) wherein 100% recruitment was assumed at ages 3 and older.

### 3.3.3 Fishing mortality and stock size

A VPA for the North Sea stock was done using the same maturity ogive and mean weight at age of the spawning stock at the time of spawning (Table 3.13) as used in the 1983 assessment (Anon., 1984a). The exploitation pattern for the terminal year (Section 3.3.2) and the input F values for the oldest true age group (14 years) in years prior to 1983 were obtained from the extended analysis of the final SVPA run. The final SVPA run was tuned to obtain a terminal F in 1983, which produced spawning stock biomass estimates as close as possible to the egg survey estimates of 190 000 and 240 000 tonnes in 1982 and 1983, respectively. This final SVPA run was based on using a terminal F of 0.20 at the reference age of 3 years. The closest estimates obtained were 209 000 and 213 000 tonnes in 1982 and 1983, respectively, using a mean F in 1983 of 0.28 at ages 4-14. The  $F_{4-14}$  in 1983 represented a 17% increase over the 1982 value.

Results of the VPA for the period 1969-83 are given in Tables 3.10 - 3.12 and in Figure 3.1.

### 3.3.4 Recruitment

The number of recruits at age 1 estimated from VPA is given in Table 3.12 and Figure 3.1. This shows that the North Sea stock continues to suffer from poor recruitment, and indicates that the 1982 year class may even be poorer than the 1978 year class, the previous lowest year class on record.

The 1983 catch of age 2 fish (1981 year class) was  $17 \times 10^6$  fish (Table 3.10). This is the highest catch of age 2 fish since 1977, supporting earlier indications that the 1981 year class is stronger than any others produced since 1975 and possibly of about the same strength as the 1980 year class.

### 3.4 Forecasts for the North Sea Stock

#### 3.4.1 Exploitation pattern

The average exploitation pattern determined by the SVPA for the 1977-83 period was adopted for the catch and stock forecasts and the yield per recruit analysis. This pattern indicated 100% recruitment to the fishery at ages 5 and older (Table 3.13), compared to 100% recruitment at ages 3 and older in the previous assessment (Anon., 1984a). There was no evidence to indicate that the pattern determined for 1983 (100% recruitment at ages 4 and older) was more likely to persist in 1984-85 than the constant pattern estimated for 1977-83.

#### 3.4.2 Recruitment

No information is available concerning the strength of the 1983 year class. Considering the pattern of generally poor recruitment in recent years, it was decided to carry out the prognosis assuming a strength of  $20 \times 10^6$  fish at age 1 for the 1983 year class. The same assumption was made as well for the 1984 and 1985 year classes. This level is equivalent to the strength of the 1978 year class, the poorest year class on record (not considering the 1982 year class whose size is not known with any degree of confidence).

#### 3.4.3 Catch and stock predictions

The input parameters for the catch forecasts of the North Sea stock are given in Table 3.13. The weights at age in the catch and stock as well as the proportions of mature fish by age were retained from the previous assessment (Anon., 1984a). Stock numbers by age on 1 January 1984 were obtained from the VPA (Table 3.12).

Table 3.14 shows a series of stock and catch predictions for 1985-86. All predictions were made on the assumption that landings from the North Sea stock in 1984 will amount to 45 000 tonnes. This was estimated by the Working Group on the basis of national catches in 1983, information relating to catches in 1984 at the time of the meeting, and information on fisheries management for 1984.

On this basis, the spawning stock biomass at the time of spawning in 1984 was estimated to be 210 000 tonnes. This is about the same as the VPA estimate for 1983, and only 12% less than the 1983 egg survey estimate. This apparent stability in spawning stock biomass is due to the relatively stronger 1981 year class recruiting to the spawning stock.

A continued fishery in 1985, giving a catch of 45 000 tonnes as estimated for 1984, would increase  $F$  from an estimated 0.27 in 1984 to 0.35 in 1985 and would result in a spawning stock biomass of about 110 000 tonnes at spawning time in 1986. Maintaining  $F$  at the 1984 level of 0.27 would give a catch of about 37 000 tonnes in 1985, and the spawning stock in 1986 would be about 120 000 tonnes.

Management by setting  $F$  in 1985 equal to  $F_{0.1}$  (i.e., 0.22) would result in a catch of 29 000 tonnes and a spawning stock in 1986 of 130 000 tonnes.

Setting  $F$  in 1985 equal to  $M$  (i.e., 0.15) gives a catch of 21 000 tonnes. No fishery on North Sea mackerel in 1985 would result in a spawning stock biomass of about 160 000 tonnes in 1986, a decrease of about 5% from 1985, showing that the stock will continue to decline even without fishing unless recruitment is considerably better than assumed.

Included in the management options provided is fishing at  $F_{0.1}$  which was adopted by ACFM in 1983 for its Western stock advice for 1984 (Anon., 1984b). It is implicit in adopting this option that it does not conflict with the principle of safe biological limits.

The choice of  $F_{0.1}$  as a management objective is wholly arbitrary, with only some economic justification (Gulland and Boerema, 1973). The computed value of  $F_{0.1}$  for any species may vary considerably with the mean weights at age and exploitation pattern. This point is illustrated by the comparison between the North Sea stock ( $F_{0.1} = 0.22$ ) and the Western stock ( $F_{0.1} = 0.17$ ). If these parameters vary year by year, the selection of  $F_{0.1}$  may lead to undesirable fluctuations in management advice. It is also worth noting that over the 12-year period 1971 to 1983, the value of  $F_{4-14}$  for the North Sea stock has only been appreciably higher than 0.22 in four years, yet the stock has declined continuously.

A more stable management option which has some biological basis (Shepherd, 1982) is to adopt a catch level where  $F = M$ . The difference between  $F_{0.1}$  and  $F = M$  is smaller for the Western stock than for the North Sea stock, but if the objective is to offer consistent advice, the more stable option should be preferred. In the case of the North Sea stock, this does not offer a realistic alternative to NO FISHING.

#### 4. MACKEREL - WESTERN AREA

##### 4.1 The Fishery in 1983 (Sub-areas VI, VII, VIII)

The landings by each country for the 10-year period 1974-83 are shown in Table 4.1. The 1982 figure has been revised and underwent a slight increase. Total estimated landings for 1983 are about 577 000 tonnes which is about 21 000 tonnes lower than the figure recorded for 1982. Table 4.1 also shows the approximate amounts of mackerel estimated to have been discarded in Sub-areas VI and VII in those years for which figures are available (1978-83). The figures for discards must be considered as a minimum estimate because information is only available from two countries.

As in recent years, a disturbing aspect of the catch table is the amount of 'unallocated' catches, which amounts to about 16% of the recorded landed catch in 1983. Although the major catches were again recorded by the United Kingdom (Scotland and England), Ireland and the Netherlands, the catch of United Kingdom (Scotland and England) decreased by over 20% from the 1982 level. Catches made by the Federal Republic of Germany and United Kingdom (Northern Ireland) increased substantially compared to 1982. However, it should be noted, as in the previous report of the Working Group (Anon., 1984a) that this table should not be considered as a reliable indication of the total catches taken by some countries because of the problem of unallocated catches.

The distribution of the catches and discards by Sub-area and by quarters is shown in Tables 4.2 and 3.3. The quarterly catches in Division VIa have been divided into catches north and south of 58°N in order to give an indication of the quantities taken in the North Rona fishery. Approximately 52% of the total Division VIa catch appears to have been taken north of 58°N in 1983. About 87% of the total Division VIa catch was taken in quarters III and IV.

In Sub-area VII, the percentage of the total catch taken in quarter I decreased from 63% in 1982 to 48% in 1983, while the percentage taken in quarter IV increased from 13% in 1982 to 27% in 1983 indicating some change in the timing of the fishery in this area.

The percentage of the total catch taken in each Sub-area has remained constant in recent years - approximately 56% of the total catches in 1983 being taken in Division VIa.

#### 4.2 Discarding in the Western Area Fisheries

It has been recognised for some years that discarding of mackerel has probably reached very high levels in the western area fisheries, particularly in Sub-area VII (Anon., 1980). With the exception of the winter 1979/80 when considerable effort was put into estimating the scale of discarding by direct observation, estimates of discard rates in national fisheries have been based largely on the advice of individual members of the Working Group. This was still the only information available for 1983, but the people offering advice on discard rates reported significantly lower values than hitherto. The reasons for this decrease in discard rate is a matter largely for conjecture, but it is thought that discarding is now no more than about 5% in any fishery. In weight, the total discards in 1983 were estimated to be:

Division VIa	2 500 tonnes
Division VIIa-c	800 tonnes
Division VIId-k	8 000 tonnes.

#### 4.3 Catch in Number and Weight at Age

##### 4.3.1 Division VIa in 1983

The catches taken in this Division in 1983 by Ireland, Netherlands, Norway and Scotland were sampled for age and amounted to about 80% of the total international catch in Division VIa.

To estimate the total catch in numbers at age, the catches by Denmark and the Faroes were raised to Norwegian data, English catches using Scottish data, Northern Irish catches using Irish data and Federal Republic of Germany catches using Dutch data.

All age 1-2 fish were allocated to the Western stock and 10% of all older age groups were allocated to the North Sea stock (see Section 2.1.3). The Division VIa catches in 1983, as well as in 1982, were characterised by a much higher proportion of younger fish than in previous years. The catch in numbers at age is shown in Table 4.3. The catch in numbers at age allocated to the Western stock in 1983 is given in Table 4.7. Discards were estimated to account for about 0.7% of the total.

##### 4.3.2 Sub-areas VII and VIII in 1983

###### Divisions VIIa-c

Numbers at age data were supplied by the Federal Republic of Germany, Ireland and the Netherlands. These three nations accounted for over 99% of the total catch reported. The English catch was allocated to age groups using the Dutch age distribution data, and the French catch by the Irish data.

It was estimated that about 2.5% of the total catch ( $116 \times 10^6$  fish) was discarded.

###### Divisions VIId-k

Information on age distribution was available for catches reported by England, Federal Republic of Germany and the Netherlands. Their catches accounted for 84% of the total in these Divisions. Danish and Irish catches taken in the western English Channel during the first

quarter of the year were allocated to age groups using the first quarter age distribution from the English fishery. The age distribution of the English third quarter fishery was applied to the French catches in the summer fishery in the eastern English Channel.

Discards were estimated to account for about 4% of the total catch ( $1032 \times 10^6$  fish).

#### Sub-area VIII

No sampling of commercial fisheries in Sub-area VIII was undertaken. The total catch was allocated to age groups by the age distribution of the total catch in Divisions VIIId-k.

#### 4.3.3 Revision of 1982 and 1981 data

A revision had to be made for both 1982 and 1981 to the catch in numbers at age taken in Division VIa due to a change in the re-allocation of the catches. For the winter fishery north of  $58^\circ\text{N}$ , all of the age 1-2 fish were allocated to the Western stock and 10% of all older age groups were allocated to the North Sea stock (see Section 2.1.3).

The catch in numbers at age for the western area is shown in Table 4.4 for 1982 and in Table 4.5 for 1981.

The catch in numbers at age for the Western stock are given in Table 4.6 for 1982 and Table 4.8 for 1981.

#### 4.3.4 Weight at age

##### 4.3.4.1 Weight at age in the stock

The mean weights at age in the stock at spawning time, which were used in earlier Mackerel Working Group reports (e.g. Anon., 1984a) showed a very high mean weight at age 9. Mean weights at age in the stock were, therefore, re-estimated by using samples from Dutch commercial freezer trawlers in Division VIIj in 1982 (March, April, May and June) and in 1983 (March, April and May), which were smoothed by fitting a curve by eye and rounding them to the nearest 5 grammes (Table 4.14). These mean weights at age were used for 1978 and onwards, based on the assumption that no changes occurred during those years.

##### 4.3.4.2 Weight at age in the catch

Since there were differences in the sums of products (SOPs) and actual catch, the mean weights at age in the catch were updated for 1983 according to the weighted mean of the annual mean weight at age from English, Scottish, Irish, Norwegian and Dutch data (Table 4.14). The Working Group recommends that, in the future, the mean weights at age in the catch will be determined and updated every year.

#### 4.4 Assessment of the Western Stock

##### 4.4.1 Spawning stock biomass estimates from the egg survey in 1983

During 1983, a plankton survey of the main western area spawning grounds was undertaken jointly by the Federal Republic of Germany, France, the Netherlands and the United Kingdom. The preliminary results of this survey were provided in the previous report of this Working Group (Anon., 1984a). During February 1984, the results of this survey (and also those from recent surveys in the North Sea) were examined in greater detail by an ad hoc Working Group which has reported separately (Anon., 1984 c).

In addition to estimating the size of the Western spawning stock in number during 1983, the egg survey data for 1980 were re-assessed, and the 1980 spawning stock in number was revised. No revisions were made to the 1977 spawning stock estimate.

The new spawning stock size estimate are:

1980 ..... 7310 x 10<sup>6</sup> fish  
1983 ..... 6985 x 10<sup>6</sup> fish.

4.4.2 Cornish hand-line fishery cpue

Catch per unit effort (cpue) data from the English hand-line fishery for mackerel off Cornwall (Lockwood and Dawson, 1976; Dawson, 1979) were examined as a possible source of information to measure stock abundance and on which to base the estimate of terminal F for the VPA. This data set extended from 1972-83 and was available as quarterly mean values. Based on the assumption that there had not been any significant change in the distribution of Western mackerel during the third quarter of the year during the 1972-83 period, the third quarter cpue was thought to be a reliable index of stock abundance. Age compositions of the hand-line catches have exhibited a broad measure of correspondence with the age compositions of the stock (Figure 4.1). With this supporting evidence, it was assumed that the third quarter cpue data were a reasonably reliable index of the Western stock abundance.

Total international effort (f), expressed in terms of hand-line hook hours, was calculated for each year 1972-83 as the ratio between Western stock catch /SOP from the catch in numbers used in the VPA run by ACFM in November 1983 (Anon., 1984b) and cpue (Table 4.9). These effort values were plotted against the values of  $\bar{F}_{3-8}$  from the November 1983 VPA (Anon., 1984b) and two functional regressions fitted, one linear and the other a power curve (Figure 4.2). Over the range of these data, there is no significant difference between the two regressions.

The  $\bar{F}$  value predicted for 1983 from the regressions ( $r = 0.82$ ) was 0.22. This was used as the terminal  $\bar{F}$  for running a VPA, using the exploitation pattern derived by SVPA (see Section 4.4.4). The  $\bar{F}_{2-10}$  (ages exploited by all fisheries throughout the range of the stock as well as by the hand-line fishery) values from this VPA were used in a new regression of  $\bar{F}$  vs f which predicted an F of 0.21 for 1983. Use of this F as input to a second VPA resulted in minimal changes to  $\bar{F}_{2-10}$  in most years. A final regression of  $\bar{F}$  vs f again predicted an F of 0.21 in 1983.

Results from the VPA using a terminal  $\bar{F}$  of 0.21 estimated a spawning stock size in 1983 of 7612 x 10<sup>6</sup> fish (11% higher than the egg survey estimate) and 8207 x 10<sup>6</sup> fish in 1980 (8% higher than the revised egg survey estimate).

4.4.3 Distribution of juvenile fish in the western area (Division VIa)

During the past two or three years, higher numbers of small fish have occurred in the catches taken in Division VIa than previously. Initially it was thought that this was simply a consequence of the higher than average abundance of the 1979 year class. If this were the only reason, the prevalence of small fish in Division VIa catches should have fallen again, particularly in 1983, as successive year class strengths decreased relative to the 1979 year class. Since the catches of small fish remained very high, it was assumed that some change has taken place independent of year class strength, i.e., a shift in the overall distribution of juvenile fish in the western area.

To examine the possibility of a shift in distribution of juvenile fish into Division VIa, the abundance of juvenile fish was examined

relative to the total catch of Western stock fish in Division VIa. For this purpose, juvenile fish were defined as all those less than age 3. The numbers of age 1-2 fish are given as a percentage of the total catch each year, 1976-83, in the text table below. (Catches in Division VIa were not separated from the total western catch in the 1974 or 1975 Working Group reports.)

Year	1976	1977	1978	1979	1980	1981	1982	1983
$\Sigma N \times 10^{-6}$	158.9	166.3	309.3	433.6	436.3	560.2	846.1	879.6
Juveniles $\times 10^{-6}$	8.0	13.9	2.2	2.4	25.9	50.1	231.7	95.9
% juveniles	5.0	8.4	0.7	0.6	5.9	8.9	27.4	10.9
$\Sigma R \times 10^{-6}$	9 430	10 746	6 073	4 355	10 183	10 786	7 096	3 012

$\Sigma N$  = total catch in number

$\Sigma R$  = the sum of 0-group recruitment estimates for the preceding two years.

If there had been a simple shift in distribution of juvenile fish towards Division VIa, this should show as an increase in the relative abundance with time. In the text table above, it can be seen that there have been some changes, but they do not appear to follow a clear trend. However, it is apparent that the relative abundance fell when the weak 1977 year class entered the fishery (1978 and 1979) and then increased again as the stronger 1979 and 1980 year classes entered the fishery.

These fluctuations were examined, relative to year class strength, by plotting the percentage values given above against the corresponding 0-group recruitment estimates. These values, also given in the table above, are the sum of two year classes, as the juvenile fish are defined as ages 1-2. These data are shown in Figure 4.3.

A linear regression fitted to the 1976-81 data shows a good correlation ( $r = 0.95$ ). This suggests that, over this period, any fluctuation in relative abundance of juvenile fish in Division VIa was purely a function of year class strength. The values for 1982 and 1983 indicate a similar trend with respect to year class strength, but their position is significantly different from the data for 1976-81.

The conclusion drawn from these data is that there was a significant increase in the abundance of juvenile fish in Division VIa during 1982 and 1983, which was independent of year class strength. This increase is assumed to result from a shift in the distribution of juvenile fish, but it is not known whether this results from an extension of total distribution, or a translocation of the total juvenile stock towards Division VIa.

#### 4.4.4 Exploitation pattern

SVPA was used to estimate the exploitation pattern of the fishery on the Western mackerel stock. Using the coefficient of variation (CV) and the log catch ratio residuals as a guide, a data set comprised of ages 1-9 during 1978-83 was found to be most suitable for estimating the exploitation pattern (terminal F reference age = 3 years,  $S = 0.8$  at age 9,  $M = 0.15$ ,  $CV = 16\%$ ). The number of log catch ratio residuals in the above data set in excess of the recommended level of  $2 \log_e (1 + CV/100)$  was very small, followed no specific pattern and suggested a rather consistent set of catch in numbers at age for the Western stock.



The exploitation pattern at ages 1-9 in 1983 from the extended analysis of the SVPA (using terminal populations option) was used to factor the terminal F for 1983 for the standard VPA, as this pattern fits the 1983 catch data exactly.

Age	1	2	3	4	5	6	7	8	9
S	0.38	1.10	1.00	0.94	0.75	0.88	0.64	0.64	0.66

These results indicate a dome-shaped exploitation pattern in 1983 with a maximum (100% recruitment) at age 2 followed by a decline to a stable level at ages 7 and older at 60% of the maximum. The exploitation pattern in the previous assessment of the Western stock (Anon., 1984a) assumed a 100% recruitment at ages 2 and older.

#### 4.4.5 Fishing mortality and stock size

A traditional VPA was run using the output of the separable VPA (see Section 4.4.4) as input for the F values at the oldest true ages for the period 1977-82, and to obtain the terminal F pattern in 1983. The terminal F values for 1983 were adjusted by trial and error until they produced a spawning stock size at spawning time in 1983 corresponding to that calculated from the egg survey:  $6985 \times 10^6$  (see Section 4.4.1). The result was  $\bar{F} = 0.22$  on ages 3-10 which represents a 16% increase over the 1982 value (see Table 4.11). The  $\bar{F}$  of 0.22 in 1983 based on the egg survey estimate of spawning stock biomass is quite close to the  $\bar{F}$  of 0.21 for 1983 based on the Cornish hand-line fishery cpue (see Section 4.4.2). Based on this level of correspondence between estimates of  $\bar{F}$  in 1983 from two independent sources of information, the Working Group felt confident in the reliability of the results.

Results of the VPA for the period 1972-83 are given in Tables 4.10-4.12 and Figure 4.5. For the period 1978-83, the spawning stock biomass has shown a relatively constant declining trend and was at its lowest historical level in 1983 which corresponds to a decrease of 36% in 6 years.

The spawning stock size estimate calculated for 1980 is 8% higher than that estimated by the plankton survey in that year, but no adjustment of the fishing mortality in 1983 was made to match this figure because it was assumed to lie within the likely confidence limits of the survey results (see Table 4.12).

#### 4.4.6 Recruitment

The number of recruits at age 1 estimated from VPA is given in Table 4.12 and Figure 4.5. Aside from the relatively weak 1977 year class, recruitment was at a fairly constant level in all years until the 1982 year class. Based on the exploitation pattern applied to the terminal F in the VPA, the 1982 year class was estimated to be as weak as the 1977 year class (about  $500 \times 10^6$  at age 1) and only 13% of the level of the 1978-81 year classes.

#### Commercial fishery data

Hitherto there has been no information available on the strength of recruiting year classes in the Western stock which could be used in the assessment. The only indications have been the 1-group stock levels estimated by the VPA, and this has been determined by the 1-group catch

levels and the exploitation pattern assigned to that age group for determining the terminal F. Clearly this has not been satisfactory, particularly as the level of l-group recruitment in the most recent year of the VPA can have a significant effect on the spawning stock biomass in the last year of the stock forecast.

An analysis of some English commercial fishery data was carried out to derive an index of l-group recruitment. The data analysed refer to English landings by purse seiners fishing in Divisions VIIe and f during the fourth quarter of the year, 1976 to 1983, and similarly, landings made by pair trawlers. (This latter distinction was made to eliminate any bias which might result from freezer trawlers landing mixed Division catches.). A simple index of recruitment was calculated as the number of 0- and l-group fish per tonne of fish landed. Regressions were then fitted to these data (Table 4.13) against their corresponding year class strengths calculated by VPA.

With correlation coefficients of 0.14 for the purse-seine and 0.36 for the pair-trawl data, it is clear that very little can be deduced from commercial catch rates of 0-group fish. The catch rate in 1977 was very low, corresponding with a weak year class, but the 1982 year class is thought to be weak, yet the 0-group catch rates were higher than for the strong 1979 year class.

The correlation coefficients for the l-group data are appreciably better, but it can be seen (Figure 4.4) that the relationship is highly dependent on the 1977 year class. From these data it cannot be ascertained what shape the relationship may follow, but the correlation coefficient can be improved (0.73 to 0.87 for purse seine, and 0.55 to 0.76 for pair trawl) by means of a semi-log plot.

The two sets of data are shown to demonstrate that there is an inherent consistency in the data. The pair-trawl data include an additional observation (1974 year class) as the purse seiners did not commence fishing in Divisions VIIe and f before 1976. Due to the exclusion of purse seiners from the "box" around Cornwall, there is only an observation of the l-group catch rate by pair trawlers in 1983 (1982 year class). (This datum was not included in the regression.) The catch rate is very low, similar to the 1977 year class value, and the VPA also indicates that the strength of the two year classes is similar.

While these regressions are highly dependent on the 1977 data, it is significant that the low 1977 year class strength and catch rate coincide, and also that they are clearly separated from the other data. This supports the evidence that the 1982 year class is also very weak.

#### Research vessel data

As yet, there are no standardised young fish surveys in the western area, although the Fisheries Laboratory, Lowestoft, has fished for mackerel each winter for the past eight years. Initially this fishing was restricted to trace identification in support of mackerel acoustic surveys in Divisions VIIe and f (Lockwood and Johnson, 1976), but since 1979, the range has been extended to include the Celtic Sea and Bay of Biscay.

As the available data do not comprise a time series of standardised samples, there are no clear trends, and it is difficult to draw firm conclusions. However, the very strong 1979 year class was reflected in high 0- and l-group catches, while the weak 1982 year class resulted in low catch rates.

During December 1983, an extensive survey was made of the Celtic Sea and Bay of Biscay. In addition to using demersal and pelagic trawls, as during previous surveys, Isaac-Kidd, Boothbay and Neuston nets were also used. Despite this range of sampling gear and the area covered, only three 0-group mackerel were caught. This was interpreted as indicative of a weak 1983 year class. The catch rates of 1-group fish during this cruise (1982 year class) were also low.

The above information from both commercial fishery and research vessel data was not used in any quantitative sense in this assessment. There is the possibility, as well, that the reduced catch rates observed for the 1982 and 1983 year classes could be related to a shift in distribution (see Section 4.4.3).

#### 4.5 Forecasts for the Western Stock

##### 4.5.1 Exploitation pattern

The exploitation pattern determined by the SVPA for the 1978-83 period indicated a 100% recruitment at age 3 followed by a decline to a stable level of 80% at age 6 and older.

Age	1	2	3	4	5	6	7	8	9
S	0.39	0.83	1.00	0.92	0.85	0.80	0.80	0.80	0.80

Concern was expressed as to the appropriate exploitation pattern to be used in forecasting the catch in 1984-85, particularly with respect to the exploitation pattern for ages 1-2. During the 1978-83 period, there were rather high catches of 1-2 fish resulting in S values of 0.39 and 0.83, respectively (see text table above). Implementation of the closed area in the Celtic Sea in November 1983 to reduce the catch of mackerel less than 30 cm total length (effectively ages 1-2) should in theory result in a significant reduction in the catch of age 1-2 fish in 1984-85. However, there is evidence that some age 1-2 fish will still be vulnerable in areas outside of the closed area in Sub-area VII. In addition, there were significant increases in the relative proportion of age 1-2 fish caught in Division VIa fisheries in 1982-83, compared to earlier years, indicating a possible northerly shift in the distribution of young fish in the Western stock toward Division VIa (see Section 4.4.3). Based on all of this evidence, the Working Group was doubtful whether the relative catch of age 1-2 fish would actually diminish in 1984-85. Being unable to make any reliable estimates as to possible future changes in the exploitation pattern, it was decided to adopt the constant pattern estimated by SVPA for 1978-83 for the catch and stock forecasts and the yield per recruit analysis (Table 4.14).

##### 4.5.2 Yield per recruit and $F_{0.1}$

Among the management options which the Working Group is asked to present each year is that related to  $F_{0.1}$ . The Working Group on Methods of Fish Stock Assessments (Anon., 1983) has drawn attention to the fact that where assessments are made on an age distribution which is truncated, relative to the true age distribution in the stock, the value for  $F_{0.1}$  may be overestimated. The Western mackerel stock assessment is based on just such a truncated age distribution; therefore, the effects on  $F_{0.1}$  of extending the age distribution were examined.

Two trial runs were made, one using calculated (von Bertalanffy) mean weights at age, and the other using observed weights at age from the English winter fishery 1982/83.

Mean weights at age were calculated for ages 1-20 by fitting a von Bertalanffy growth curve to the western area catch mean weights at age. Mean weights for age 10+ and 15+ groups were calculated by taking the arithmetic mean weight of ages 10-20 and 15-20 years, respectively. The mean weight at age 20 was so close to  $W_{\infty}$  that it could be taken as the mean weight of the 20+ age group. Three runs of the yield per recruit program were made using maximum age groups of 10+, 15+ and 20+. In each case,  $F_{0.1} = 0.17$  and  $F_{\max} = 0.42$ . This value for  $F_{0.1}$  was the value adopted by ACFM for managing the stock in 1984.

Mean weights at age in the English winter fishery 1982/83 were available for ages 1-17. Mean weights were calculated for three plus groups: 10+, 12+ and 15+, and the Y/R program was run over these age ranges. As before, extending the age range did not influence  $F_{0.1}$  or  $F_{\max}$  significantly; in each case, the values were:  $F_{0.1} = 0.14$  and  $F_{\max} = 0.28$ .

It is assumed that this stability in the computed values of  $F_{0.1}$  is a function of the flat-topped growth curve, where the mean weight of the 10+ age group is close to  $W_{\infty}$ . It was concluded that extending the age distribution of the data in the Western stock assessment will not influence the calculation of  $F_{0.1}$  significantly.

#### 4.5.3 Recruitment

There is no quantitative estimate available concerning the strength of the 1983 year class. However, based on English research vessel data (see Section 4.4.6) which indicated that the 1983 year class was weak, the prognosis was carried out assuming this year class to be of the same size as the weak 1977 and 1982 year classes ( $500 \times 10^6$  fish at age 1).

The 1984 and 1985 year classes were set at  $1000 \times 10^6$  fish at age 1 for the purposes of the prognosis. Although no evidence exists for a stock/recruitment relationship for Western mackerel, two weak year classes have occurred in succession (1982 and 1983), with the spawning stock biomass now at a record low level. The Working Group felt that setting the 1984 and 1985 year classes at the level of  $1000 \times 10^6$  fish was a conservative approach, which is in agreement with the levels set for the prognosis in the 1983 assessment (Anon., 1984a).

#### 4.5.4 Catch and stock projections

The Working Group assumed that there would be no effective enforcement of the agreed TAC of 430 000 tonnes for the western area in 1984 and that the total catch for the Western stock would be 650 000 tonnes. A series of forecasts was run assuming that level of catch in 1984 using the input parameters given in Table 4.14. Stock numbers by age on 1 January 1984 were obtained from the VPA (Table 4.13).

Although the closed area around Cornwall has been in force since November 1983, its full benefit on the spawning stock may not be achieved for 2-3 years. Therefore, no account was taken of this closure when running the forecasts for 1985 and 1986.

The results of the forecast are presented in Table 4.15.  $\bar{F}_{3-10}$  required to produce a 1984 catch of 650 000 tonnes would be 0.26, which represents an 18% increase over the 1983 level. The spawning stock biomass at spawning time would be about  $1900 \times 10^3$  tonnes in 1984. Maintaining this catch level in 1985 and 1986 would correspond to an  $\bar{F}_{3-10}$  of 0.36 and would reduce the spawning stock biomass to about  $1000 \times 10^3$  tonnes in 1986.

A reduction of the fishing mortality to the level of  $M$  (0.15) in 1985 and 1986 would result in a catch of about 300 000 tonnes in 1985 and a spawning stock biomass of  $1400 \times 10^3$  in 1986. It must be pointed out that this level of  $F$ , which represents a reduction of about 30% from the 1983 level, was considered as a management reference point by ACFM in years previous to 1983.

Due to the poor level of recruitment of both the 1982 and 1983 year classes, it must be noted that even a total ban on the fishery in 1985 and in 1986 would not prevent the spawning stock biomass from reaching a new historical minimum of  $1700 \times 10^3$  tonnes in 1986, which is 50% of the 1978 biomass level. In such circumstances, the Working Group again felt very concerned by the continuing absence of effective enforcement of TACs in the western area.

5. MACKEREL IN SUB-AREA IX

5.1 The Fishery in 1983

The total catches of mackerel from Sub-area IX are shown in Table 5.1. There was no information available on Spanish catches in 1983, so the Working Group assumed them to be at the same level as in 1982 (800 tonnes). The Portuguese catch amounted to 2 239 tonnes, which represents a 38% drop from the 1982 figure.

From biological sampling, it appears that about 40% of the catches were immature fish (Table 5.2).

5.2 Biological Information

Research on growth and on reproduction of mackerel on the western coast of the Iberian Peninsula has been conducted by Portugal since 1981. The results which were presented to the Working Group (Gordo and Martins, C.M.1984) suggest that there are significant differences in both growth rate and the maturity ogive between mackerel in Portuguese waters and mackerel usually attributed to the Western stock. No information is available on the northern boundary of the distribution of the mackerel found in Portuguese waters, but the Working Group felt that there was enough biological evidence to conclude that the mackerel in Division IXa belong to a different population.

Due to the scarcity of information on the fishery and the lack of information on Spanish catches, no analytical assessment of the stock was possible and no recommendation was proposed for management.

6. PREDATION MORTALITY ON MACKEREL

The only quantitative information available concerning predation on mackerel was that presented by Daan (1983) for North Sea cod. This indicated that only a very low percentage of mackerel occurs in the diet of cod in the North Sea area. Very few mackerel were found in the saithe and whiting stomachs analysed at the present time in the international stomach sampling project (Gislason, 1983; Hislop et al., 1983).

In such circumstances, no estimate could be made of predation mortality for either mackerel stock.

7. CHANGES IN WEIGHT AT AGE AND AGE AT FIRST MATURITY ON STOCK AND SPAWNING STOCK BIOMASS

There were no data available to the Working Group to indicate changes for mackerel in mean weights at age in the stock and in age at first maturity over the range of years which might suggest that they would have

an influence on the spawning stock biomass estimates. It is possible that data may become available in the future to examine the likelihood of such changes and their potential effect on stock biomass estimates.

8. EFFECTS OF A BAN ON FISHING IN DIVISION VIA

8.1 Terms of Reference

Several days before the meeting began, the Working Group received from the Chairman of ACFM, the following request from EEC:

"Eastern mackerel stock: ACFM recommendation that fishing for mackerel should be banned in ICES Division VIa north of 58°N during the period 1 November to 30 April.

The Working Group has been requested:

1. to provide on a monthly basis estimates of the proportion of mackerel of eastern stock origin in the area to which the ACFM recommendation applies;
2. to assess quantitatively the effects of the recommendation on the evolution of the eastern mackerel stock under the following conditions,
  - a) closure throughout the period recommended by ACFM,
  - b) closure from 1 December to 30 April,
  - c) closure from 1 to 31 December and from 1 March to 30 April.

Request 1 is considered self-explanatory in the context of the explanation for request 2.

The reports of ACFM do not evaluate quantitatively the effects of the ban on the evolution of the eastern mackerel stock. It would be useful for management to have estimates of the evolution of the size of the stock under the three conditions a) to c) listed above compared with what would happen if there were no ban. For the purpose of these comparisons it could be assumed either that no fishing took place in the North Sea, as recommended by ACFM, or that a catch equal to the TAC agreed between the EEC and Norway was taken.

The background to this request is that various countries have requested that the ban should be implemented during different periods. For example, it has been argued that during November the proportion of the eastern mackerel stock in the area to which the ban should apply may be very low and that, for this reason, the ban should not be applied. Furthermore, it is argued that the effect of a ban in November would be to divert the mackerel fleets to the fishery to the south and west of Ireland and the U.K. with possible deleterious effects on the western mackerel stock.

It is suggested that the results could be presented as a series of four graphs showing stock size against time for no ban on fishing and for the three alternatives listed above."

8.2 Proportion of North Sea Mackerel in Division VIa North of 58°N

In relation to request 1 in the above terms of reference, the Working Group was unable to provide such data on a monthly basis. It was only able to estimate proportions of North Sea stock from tagging data, and the returns on a monthly basis were much too small to allow

any confidence to be placed in the resulting estimates. As explained in Section 2, the best estimates which can be provided on an annual basis for the entire period which has been proposed for closure are that in each of the years 1981-83, the North Sea stock proportion of the catch of fish age 3 and older was 10%. As explained there, even this proportion is subject to considerable reservations. The age 1-2 fish caught in the area and period under consideration, which in 1982 and 1983 constituted a much larger proportion of the catch than in preceding years, are considered to be of the Western stock. The estimates of the catch in weight of North Sea stock fish and the total catch in weight of both stocks in the relevant area and period in 1981-83 are given in the text table below:

	<u>North Sea stock</u> (tonnes)	<u>Total catch</u> (tonnes)
1981	4 404	44 144
1982	7 547	99 546
1983	6 218	88 557

The reduced proportion of the total catch in weight in 1982-83 ascribable to the North Sea stock is due to the higher proportion of age 1-2 fish in the fishery in those years. The proportions of the North Sea stock in the fishery, based on these estimates, are therefore quite small. This appears to represent a major change from the proportions of North Sea stock in the catches estimated at the time when ACFM's recommendation of a prohibition of this fishery was first made. The changes which have taken place in recent years in the age composition of the catches taken in this fishery supports the changes in the estimated proportions of the two stocks from the tagging data.

### 8.3 Assessment of the Effects of a Fishing Ban on the North Sea Stock

In view of what is said above about estimating the monthly proportions of the two stocks in the catches, it is clear that any assessment of the effects of closures during different time periods of the fishery in Division VIa north of 58°N can be based only on the relative size of the catches taken during different time periods. Sufficiently detailed catch data for this purpose are available only for 1982 and 1983. For these years, the catches in weight of both stocks and the catches in numbers at age of the North Sea stock are:

1982	Total catch (tonnes)	Numbers at age ( $\times 10^{-3}$ )							
		3	4	5	6	7	8	9	10+
1 Jan - 30 Apr, 1 Nov - 31 Dec	99 546	7 098	3 678	343	2 434	1 841	1 204	1 144	2 407
1 Jan - 30 Apr, 1 Dec - 31 Dec	32 169	2 741	1 967	222	1 311	786	498	423	970
1 Mar - 30 Apr, 1 Dec - 31 Dec	17 098	1 620	827	85	604	378	243	233	455

1983	Total catch (tonnes)	Numbers at age (x 10 <sup>-3</sup> )							
		3	4	5	6	7	8	9	10+
1 Jan - 30 Apr, 1 Nov - 31 Dec	88 557	9 298	5 334	1 546	182	762	669	401	1 261
1 Jan - 30 Apr, 1 Dec - 31 Dec	29 505	3 282	1 893	778	85	521	339	130	566
1 Mar - 30 Apr, 1 Dec - 31 Dec	17 843	1 888	900	453	60	189	157	53	271

On the basis of these data and the total catches in numbers by age group taken from the North Sea stock (Tables 3.7 and 3.8), the fishing mortality rates generated on the North Sea stock by this fishery can be estimated in each of the time periods and years, as well as the stock size in each year up to January 1984 if this fishery had been closed in 1982 and 1983 during these time periods. These predictions should be reasonably accurate provided the estimates of mixing rates used are approximately correct.

To estimate the continued effects of these closures beyond January 1984 it is necessary to estimate the catch in weight and its age composition which will be taken in the relevant periods in 1984 and subsequent years, the mixing rates of the two stocks, and the catches which will be taken from the North Sea stock in other areas. The following assumptions were made: (a) the catches of the Western stock will be 650 000 tonnes in both 1984 and 1985; (b) the catches of the North Sea stock will be 45 000 tonnes in both 1984 and 1985 in the absence of any closure in the relevant area and time periods in Division VIa north of 58°N; and (c) the pattern of the fishery in the western area in time and space will be maintained at the average of 1982 and 1983.

As regards (c), the proportion of the total catch taken in the relevant area and during the maximum time period proposed for closure was 0.160 in 1982 and 0.152 in 1983. These are very similar, and accordingly the mean value of 0.156 was used to estimate the proportion of the Western stock catch which will be taken in this area and time period in 1984 and 1985. In both years, the Western stock catch would be 101 400 tonnes. In both 1982 and 1983, the proportion of the North Sea stock catch to the Western stock catch, in weight, was approximately 0.07 and this value was used to estimate, in both years, the catch in weight of the North Sea stock which would be taken in this area over the maximum period of closure. This would mean a North Sea stock catch of 7 120 tonnes in both years.

To do the predictions for the maximum period specified (1 November - 30 April), a prediction was run to generate a catch of 37 888 tonnes (45 000-7 120) in both years, given the North Sea stock at 1 January 1984 which would have been available if this closure had been in effect since 1982.

For shorter period closures, the mean proportions of the Fs generated in these periods in 1982 and 1983 relative to the Fs generated in the longest period in these years were used to make adjustments to the Fs used for the longest period in 1984 and 1985. These in turn were applied to the stocks which would have been available at 1 January 1984 if the closures during the appropriate periods had been in force since 1982.



To gauge the relative effects of the proposed closures in this area to those of fisheries in other areas where the North Sea stock is fished, estimates were also made of the size of the North Sea mackerel spawning stock if all fisheries on it had been closed at 1 January 1982 (Table 8.1). The results of all of these estimations are given in the text table below, expressed as percentage changes in spawning stock biomass relative to that which the current assessment gives as the actual value in 1982. The results are expressed as spawning stock biomass since this should be the major management consideration in a stock such as North Sea mackerel which is in a badly depleted state and in which recruitment has been at a very low level for many years.

Fishing Regime	Spawning stock biomass 1982	Spawning stock biomass 1983	Spawning stock biomass 1984	Spawning stock biomass 1985
No fishing in any area	+2.2%	+27.1%	+45.4%	+40.1%
Closure in Div. VIa N of 58°N 1 Nov - 30 Apr	+0.5%	+9.6%	+9.4%	-12.2%
Closure in Div. VIa N of 58°N 1 Dec - 30 Apr	+0.2%	+7.2%	+5.4%	-14.2%
Closure in Div. VIa N of 58°N 1 - 31 Dec + 1 Mar - 30 Apr	+0.1%	+6.2%	+4.1%	-18.8%
Fishing in all areas as at present	+0.0%	+3.3%	+1.6%	-21.1%

In the above text table, it is clear that under the present regime of continued fishing in all areas where the North Sea stock is exploited, the spawning stock biomass will increase slightly from the 1982 level up to 1984 because of the recruitment of the slightly stronger 1981 and 1982 year classes to the spawning stock in 1984 and 1985. But the spawning stock will decrease again markedly in 1986 due to the low recruitment levels by subsequent year classes. Closures of the mackerel fishery in Division VIa north of 58°N, even for the maximum period envisaged, and if they had been put into operation in 1982, would have had little effect in reducing this decline.

The relative effects of the different management regimes can be seen in the text table below, which expresses the percentage increase in each year measured as the percentage change from the spawning stock biomass in that year under the present regime of no closure in any area.

Fishing Regime	Spawning stock biomass 1982	Spawning stock biomass 1983	Spawning stock biomass 1984	Spawning stock biomass 1985
No fishing in any area	+2.2%	+23.1%	+43.1%	+77.5%
Closure in Div. VIa N of 58°N 1 Nov - 30 Apr	+0.5%	+6.1%	+7.6%	+11.3%
Closure in Div. VIa N of 58°N 1 Dec - 30 Apr	+0.2%	+3.7%	+3.7%	+8.8%
Closure in Div. VIa N of 58°N 1 - 31 Dec + 1 Mar - 30 Apr	+0.1%	+2.8%	+2.4%	+3.0%

From these values it is clear that any closure in Division VIa will have a negligible effect in increasing the spawning stock biomass of the North Sea stock relative to that which would be produced by prohibiting fishing on the stock in Sub-area IV and Division IIIa where the major catches of this stock are taken.

9. HORSE MACKEREL

9.1 The Horse Mackerel Fisheries

9.1.1 Total catches (Sub-areas IV, VI, VII, VIII and IX)

Total catch for the area has been between 103 000 and 140 000 tonnes since 1979, and in 1983 the estimated catch was 121 000 tonnes (Table 9.1). The catch in 1976 reached a peak of 372 500 tonnes due to the USSR fishery in the area, which stopped in 1978-79. It must be indicated, however, that there is a great deal of uncertainty associated with the amount and location of horse mackerel catches over the entire area and period.

Catches in Sub-areas VII, VIII and IX represent 85% of the total catch in the whole area (Table 9.1). The principal fisheries are conducted by the Netherlands (Sub-area VII), Spain (Sub-area VIII) and Portugal (Sub-area IX).

Catches from Sub-areas IV and VI are given in Tables 9.2 and 9.3.

9.1.2 Sub-area VII

Catches from Sub-area VII fluctuated between 33 000 tonnes and 46 000 tonnes during 1979-82. In 1983, the catch increased to 43 600 tonnes, of which about 80% was caught by the Netherlands (Table 9.4).

During the mackerel spawning season in 1983 in Division VIIj, the Netherlands caught 20 000 tonnes of horse mackerel as by-catch.

In Division VIIe, there is a directed fishery on young horse mackerel (7 000 tonnes in 1983) conducted also by the Netherlands.

A United Kingdom catch of 1 200 tonnes was taken in Sub-area VII in 1983, compared to a peak of 13 000 tonnes in 1980. The catches taken by France have ranged from 2 300 to 4 700 tonnes.

#### 9.1.3 Sub-area VIII

In Sub-area VIII, catches have dropped in the last seven years from 130 000 tonnes to about 21 000 tonnes. This drop reflects the changes in the Spanish catches in this Sub-area, which account for over 90% of the landings (Table 9.5). Catches by gear and catch rates (for Spain) were presented in 1981 (Anon., 1981) showing a decreasing trend for all the gears from 1978 to 1981. Similar data are not available for subsequent years.

#### 9.1.4 Sub-area IX

Catches in Sub-area IX reached a peak of 67 000 tonnes in 1977 and decreased in subsequent years to a level of 38 000 tonnes in 1983 (Table 9.5).

Portuguese catches are about 75% of the total. They show a peak in 1977 and a decreasing trend since then to 1983 (30 000 tonnes). Portuguese catch rates (Table 9.9) indicate a concomitant decrease over time, but did not undergo an increase from 1982 to 1983.

### 9.2 Biological Sampling

#### 9.2.1 Length compositions

Length compositions of the catches in 1983 by gear for the fisheries in Sub-areas VII and IX are given in Table 9.6.

The pelagic trawl fishery conducted by the Netherlands in Sub-area VII shows a mode at 34 cm. Length distributions from English commercial catches in Division VIIe indicate a single mode at 31 cm. Length distributions from Portuguese commercial landings in Sub-area IX are bimodal at 13-15 cm (0-1 group) and 32 cm for all gears, and indicate that a very high proportion of the catch is very young fish.

From length compositions for Division IXa in 1983, it can be seen that there is a relative scarcity in the catch in numbers in the 22-29 cm group which has been a constant feature of the catch compositions in the previous years, both in Divisions VIIIc and IXa (Anon., 1982). This phenomenon may be due to a possible decrease in availability of that size group to the fishery for unknown reasons.

#### 9.2.2 Growth parameters, maturity and sex ratios

Estimates of growth parameters have been prepared by scientists from different countries, but because of uncertainties about the reliability of ageing techniques for horse mackerel, the reliability of these data is uncertain.

From Division IXa, data in 1983 on maturity stages by length group confirm the length at first maturity of 23 cm and a spawning season from January to June with a peak during February. The 1983 sex ratio appeared to be 1:1 as in the previous year.

#### 9.2.3 Otolith exchange

As a result of a recommendation by the 1983 Working Group (Anon., 1984a), a programme of otolith exchange was started among the countries involved in horse mackerel fisheries. Only the results of the readings

by the Netherlands and England were available at the time of the meeting. They show good agreement at ages 1-3 but increasing differences appear on older age group readings (Table 9.7).

The same otoliths will be read by France, Scotland, Portugal, Spain and the Federal Republic of Germany in preparation for a workshop on the interpretation of horse mackerel otolith readings already proposed by the Working Group (Anon., 1982).

### 9.3 Assessment of Horse Mackerel in Sub-areas VII, VIII and IX

In the absence of information about stock identity, the data from each area were considered separately.

#### 9.3.1 Sub-area VII

Horse mackerel eggs were sampled during the Western mackerel egg survey cruises in 1977, 1980 and 1983.

The 1980 and 1983 data have not been completely analysed (Anon, 1984c) and an assessment of the stock based on those data cannot be done until the egg analysis is completed.

#### 9.3.2 Sub-area VIII

Since the Western mackerel egg surveys also covered Divisions VIIIA,b, the problem identified above (see Section 9.3.1) also applies here.

Length compositions of the catch are available from the Spanish fishery in Division VIIIC (Anon., 1981, 1982) only for 1980-82. Catch at age data for 1982 were presented at the 1983 Working Group meeting (Anon., 1984a). Lacking any other data, an assessment was not possible for this Sub-area.

#### 9.3.3 Sub-area IX

Estimates of minimum stock biomass from stratified random trawl surveys in 1979-82 (Cardador, 1983) fluctuated from year to year and follow no specific trend. The 1983 estimate was the highest level in the time series (19 509 ± 12 000 tonnes).

Recruitment indices were estimated for 1981-83 (Table 9.8) using bottom-trawl survey data (Borges, 1983). They indicate weak recruitment (individuals ≤ 20 cm) in 1981, followed by an increase in 1982 and 1983. The Portuguese data available for Division IXa (Table 9.9) also indicate a high catch rate in 1983 and good recruitment of the 0-group.

A Schaefer surplus production model was applied to the total international catches and the Portuguese commercial trawl opue for the period 1969-83 (Table 9.9 and Figure 9.1). The MSY obtained is about 60 000 tonnes corresponding to a opue of 112 kg per hour trawling and an effort level equivalent to 500 000 hours trawling. The catch in 1983 was estimated to be 38 000 tonnes. The 1983 level of effort exceeded the effort corresponding to the maximum yield by about 25% but was closer to this level than was the 1982 effort which exceeded the level corresponding to maximum yield by 45%. The location of virtually all of the data points on the right hand side of the yield curve is indicative of a long period of excessive exploitation.

Given the unreliability of ageing data, it was impossible to specify a reasonably accurate exploitation pattern by age or mean weights at age in order to do a yield per recruit analysis. An analysis done at the 1982 meeting (Anon., 1982) indicated an  $F_{max}$  of 0.2, assuming first capture at age 0, and the potential for considerable increase in both yield and spawning stock biomass per recruit by increasing the age at first capture to age 3 or 4.

Catch curve analysis of 1983 age compositions (ages 1-4) indicated a  $Z$  of 1.3 ( $F = 1.1$  if  $M = 0.2$ ). This indicates that present levels of  $F$  on young ages is vastly in excess of the likely  $F_{\max}$  point.

As stated previously (Anon., 1982), the main feature of this fishery is the heavy exploitation of ages 0-1, which seriously reduces the number of fish available for recruitment to the spawning stock. The current fishing pattern of catching mainly age 0-1 fish must be drastically changed in order to increase potential yield.

#### 10. MACKEREL EGG SURVEYS

The terms of reference to the ad hoc Working Group on Mackerel Egg Surveys (Anon., 1984c) included the request for advice on the need for, and frequency of, further egg surveys. The ad hoc Working Group did not offer advice since it considered it more appropriate that it be discussed by the Mackerel Working Group.

Due to the low level of the North Sea stock, it is recommended that assessment by egg survey be carried out frequently. If the surveys are made annually, there would probably be less ship time available than if they were undertaken in alternate years. If sampling intensity is reduced, there is a concomitant increase (widening) in the confidence intervals about the egg production estimate. It was decided, therefore, that intensive surveys in the North Sea should be undertaken every two years to ensure the best possible assessment.

The Western spawning area is substantially larger than the spawning area in the North Sea. To achieve a comparable level of sampling intensity to the North Sea and comparable confidence intervals about the egg production estimate, a proportionately greater amount of ship time would be required. It was thought most unlikely that the level of sampling intensity achieved in 1983 could be repeated on a 2-year cycle, but it should be possible every third year.

A North Sea survey will be carried out in 1984 by Denmark, the Netherlands, Norway and Scotland. The Working Group recommends that this survey should be followed by another in 1986.

At present, no plans are in hand for a Western stock survey. The Working Group recommends that another be carried out in 1986.

This Working Group also wishes to support the recommendation of the ad hoc Working Group that fishing be done during the plankton surveys to sample the spawning population, and that further work should be carried out on mackerel fecundity. The specific problem with existing fecundity data from the North Sea is well known (see Section 3.3.1), but fecundity relationships should be ideally re-assessed with each new egg survey. Re-assessment may be particularly important if the stock size changes significantly, as fecundity may change as a function of stock density.

#### 11. DEFICIENCIES IN DATA

The Working Group again considered the deficiencies in data necessary to make accurate assessments. These deficiencies have previously been considered by the 1982 and 1983 Working Groups (Anon., 1982; Anon., 1984a).

11.1 Mackerel

Catch statistics

Information is lacking about the location of many of the catches made by Ireland, N. Ireland, Netherlands, Federal Republic of Germany, Denmark, Faroes and Spain. This information is particularly important for catches made in Division VIa. Detailed information is also required about these catches on a monthly basis. If possible, sampling data from the catches should be supplied on a monthly basis per statistical rectangle. As mentioned earlier in the report, the Working Group is still concerned about the amounts of catches in the 'unallocated' category and the resulting uncertainty associated with the estimates of total catch. Obviously the accuracy of the assessments is dependent on the accuracy of the total catch data.

Stock mixing

The lack of precise information about the rate of mixing between the two stocks in Divisions IIa, IVa and VIa is one of the major problems in assessing the mackerel stocks. During most Working Group meetings, there is insufficient time for proper presentation, analysis, and discussion of all data which might offer new insight concerning mixing rates. Consequently, the Working Group recommends that its meeting in 1985 be extended for 2 additional days, and that this extra time be devoted to the above-stated purpose. The Working Group, therefore, requests that its members collect, assemble, and analyse data and prepare working papers or documents pertaining to such topics as: tagging results (including data by age groups), parasite studies, electrophoretic studies, otolith  $l_1$  studies, geographical distribution of the fisheries and stocks, age and length distributions, and other biological parameters which may offer clues to mixing rates of the two stocks.

Age compositions

Age data are lacking from the catches taken by Spain, France, Faroes, N.Ireland and Denmark. In the absence of age materials, length frequencies of catches would be useful, since age/length keys from other countries could be used. It was also agreed by the Working Group to provide age compositions for the Western stock to age 15+. Since some countries routinely age mackerel to at least age 15+, those members with such data for previous years should summarize these in time for the 1985 meeting to facilitate necessary revisions to the catch in numbers by age group used in the VPA. Since some members expressed concern over their uncertainty in being able to age mackerel beyond age 10+, it was agreed that an otolith exchange among countries should be done as soon as possible. This exchange will be coordinated by Wendy Dawson of the Fisheries Laboratory, Lowestoft (United Kingdom).

Other data

There is still not sufficient information available to adequately forecast recruitment levels. Mean weights at age applicable to the catch in numbers at age need to be developed on an annual basis. As mentioned previously, fecundity data need to be collected each time a new egg survey is conducted.

11.2 Horse Mackerel

Catch statistics

Information is lacking concerning Spanish catches, which represent most of the catch in Sub-area VIII. Discard estimates by various countries are not available, and discard is considered to be quite high. Total catches are unreliable given the above-stated problems.

Ageing

Available age compositions are considered unreliable in view of observed differences in ageing between countries. As stressed previously, otolith exchanges and a workshop on the interpretation of otolith readings are considered necessary.

Stock identity

Data are not available to identify and separate the different stocks of horse mackerel in Sub-areas IV, VI, VII, VIII and IX.

Assessment

The overall data base required to assess the status of horse mackerel in the different areas are insufficient. Much of the difficulty relates to the above-mentioned problems. As mentioned previously, additional processing and analysis are required before material collected during the 1980 and 1983 mackerel egg surveys can be used. Information is very limited concerning mortality estimates, recruitment, biomass estimates, measures of relative abundance, and the like.

REFERENCES

- Anon. 1980. Report of the Mackerel Working Group. ICES, C.M.1980/H:7, 46 pp.
- Anon. 1981. Report of the Mackerel Working Group. ICES, Doc. C.M.1981/H:7, 73 pp.
- Anon. 1982. Report of the Mackerel Working Group. ICES, Doc. C.M.1982/Assess:11, 77 pp.
- Anon. 1983. Report of the Working Group on Methods of Fish Stock Assessments. ICES, Doc. C.M.1983/Assess:17, 73 pp.
- Anon. 1984a. Report of the Mackerel Working Group. ICES, Doc. C.M.1984/Assess:1, 61 pp.
- Anon. 1984b. Report of the ICES Advisory Committee on Fishery Management, 1983. ICES Coop.Res.Rep., No.128.
- Anon. 1984c. Report of the ad hoc Working Group on Mackerel Egg Surveys. ICES, Doc. C.M.1984/H:4.
- Borges, M F. 1983. Recruitment indices of horse mackerel (Trachurus trachurus L.) based on young fish survey in the Portuguese waters (Division IXa) in 1982. ICES, Doc. C.M.1983/H:40, 7 pp.
- Cardador, F. 1983. Indices of abundance from groundfish surveys in the Portuguese continental coast (Division IXa) during 1979/82. ICES, Doc. C.M.1983/G:45, 9 pp.
- Daan, N. 1983. Analysis of the cod data collected during the 1981 stomach sampling project. ICES, Doc. C.M.1983/G:61.
- Dawson, W A. 1979. The maximum sustainable yield of the Western mackerel stock as estimated from catch per unit of effort. ICES, Doc. C.M.1979/H:24.
- Gislason, H. 1983. A preliminary estimate of the yearly intake of fish by saithe in the North Sea. ICES, Doc. C.M.1983/G:53.

- Gordo, L S and Martins M B. 1984. On some biological characteristics of mackerel (*Scomber scombrus* L.) from the west continental coast of Portugal. ICES, Doc. C.M.1984 (in press).
- Gulland, J A and L K Boerema. 1973. Scientific advice on catch levels. U.S. Fish. Bull., 71(2):325-335.
- Hislop, J R G, Robb, A P, Brown, M A and Armstrong, D. 1983. A preliminary report on the analysis of the whiting stomachs collected during the 1981 North Sea stomach sampling project. ICES, Doc. C.M.1983/G:59.
- Iversen, S A and Adoff, G R. 1983. Fecundity observations on mackerel from the Norwegian coast. ICES, Doc. C.M.1983/H:45.
- Iversen, S A and Eltink, A. 1983. Spawning, egg production and stock size of North Sea mackerel in 1982. ICES, Doc. C.M.1983/H:46.
- Lockwood, S J and Dawson, W A. 1976. Recent changes in the catch per unit effort of the Cornish mackerel handline fishery. ICES, Doc. C.M.1976/H:18.
- Lockwood, S J and Johnson, P O. 1976. Mackerel research in the southwest. MAFF Dir.Fish.Res. Lab.Leaflet, No.32.
- Pope, J G and Shepherd, J G. 1982. A simple method for the consistent interpretation of catch at age data. ICES, J.Cons.int.Explor.Mer, 40:176-184.
- Shepherd, J G. 1982. A family of general production curves for exploited populations. Mathematical Biosciences, 59:77-93.
- Walsh, M. 1983. Investigations on the fecundity of North Sea mackerel. ICES, Doc. C.M.1983/H:48.
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Table 2.1 Results of the Norwegian Tagging Experiments  
(tag returns from Norwegian landings to selected factories, 1981 - 1983).

RELEASES			RECAPTURES								
			Norwegian Sea			North Sea	Via				
			1981	1982	1983	1982	Q4 1981	Q1 1982	Q4 1982	Q1 1983	Q4 1983
OFF SOUTHWEST - IRELAND	Year	No									
	1970	4 540									
	71	5 000					1				
	72	5 086		1							
	73	8 205		1							
	74	10 028		4			1	1			
	75	10 003									
	76	9 474		3			1				
	77	14 032	2	4	1		2				
	78	18 169	3	5	2	1	1				
	79	20 173	3	7	1		3			1	
	80	9 992	2	4			2		1		
	81	9 972		5	3				1		
	82	10 065		5	5	1				3	3
83	13 400			16						2	
Sum	148 139	10	39	28	2	11	3	0	4	8	
IN THE NORTH SEA	1970	3 505									
	71	9 350									
	72	11 818						1			
	73	7 277							1		
	74	4 493									
	75	9 995				1	2				
	76	1 763		1							
	77	7 094					2				
	78	12 173					7				
	79	11 991	2	2	2	1	4	1	1		1
	80	5 678		1	3	1	3				1
	81	4 199			2	1	2	3			
	82	13 164			7	2				11	1
	83	9 216									5
Sum	111 715	2	6	14	6	20	6	1	12	8	

Table 3.1 Nominal catch (tonnes) of MACKEREL in the North Sea, Skagerrak and Kattegat (IV and IIIa) 1974 - 1983 (Data for 1974-1976 as officially reported to ICES. Data from 1977 onwards were submitted by Working Group members).

Country \ Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Belgium	145	134	292	49	10	10	5	55	102	92
Denmark	3 890	9 836	27 986	21 833	18 068	19 171	13 234	9 982	2 034	8 410
Faroe Isl.	18 625	23 424	63 476	42 836	33 911	28 118	14 770	-	720	-
France	2 254	2 749	2 607	2 529	3 452	3 620	2 238	3 755	3 041	2 248
Germany, Dem. Rep.	234	141	259	41	233	-	-	-	-	-
Germany, Fed. Rep.	270	276	284	-	284	211	56	59	28	10
Iceland	4 689	198	302	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	738	733	-	-
Netherlands	3 259	2 390	2 163	2 673	1 065	1 009	853	1 706	390	96
Norway	248 314	206 871	197 351	180 800	82 959	90 720	44 781	28 341	27 612	23 469
Poland	4 520	2 313	2 020	298	-	-	-	-	-	-
Sweden	3 579	4 789	6 448	4 012	4 501	3 935	1 666	2 446	692	1 157
U.K. (Engl. & Wales)	61	33	89	105	142	95	76	6 520	28	16
U.K. (Scotland)	390	578	1 199	1 590	3 704	5 272	9 514	10 575	28	4
USSR	8 161	9 330	1 231	2 765	488	162	-	-	-	-
Unallocated	-	-	-	-	-	500	-	3 216	450	96
Total	298 391	263 062	305 709	259 531	148 817	152 823	87 931	67 388	35 125	35 598

\*) Preliminary

Note: In contrast to the corresponding tables in Working Group reports for year prior to 1982, the catches do not include catches taken in IIIa.

Table 3.2 Nominal catches (tonnes) of MACKEREL in the Norwegian Sea  
(Division IIa), 1974-1983.

Year Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Denmark <sup>2)</sup>							-	801	1 008	10 427 <sup>3)</sup>
Faroe Isl. <sup>1)</sup>	-	-	-	-	283	6	270	-	180	-
France <sup>2)</sup>	-	7	8	-	2	-	-	6	8	-
German Dem. Rep. <sup>2)</sup>	11	-	-	-	-	-	-	51	-	-
Germany, F.R. <sup>2)</sup>	-	-	-	-	53	174	2	-	-	4
Netherlands <sup>2)</sup>	-	-	2	-	-	-	-	-	-	-
Norway <sup>1)</sup>	6 818	34 662	10 516	1 400	3 867	6 887	6 618	12 941	34 540	38 405
Poland	-	-	-	-	-	-	-	-	231	-
U.K. (England and Wales) <sup>1)</sup>	+	+	+	+	1	-	-	255	-	-
U.K. (Scotland) <sup>2)</sup>	-	-	-	-	-	-	296	968	-	-
USSR*	-	-	-	-	-	5	1 450	3 640	1 641	40
Total	6 829	34 669	10 526	1 400	4 206	7 072	8 340	18 662	37 608	48 876

1) Data provided by W.G. members

2) Data reported to ICES

3) Includes 1 497 tonnes caught in Division Vb

\*) Preliminary

Table 3.3 Quarterly catches of MACKEREL in 1983  
(including estimates of discards and unallocated catches)

Area	I	II	III	IV	Unknown	TOTAL
IIa	-	-	48 500	300	+	48 800
IIIa	+	300	4 800	400	-	5 500
IVa,c	100	1 900	26 500	1 400	200	30 100
Via (N of 58°)	14 700	-	39 500	118 200	-	172 400
Via (S of 58°)	10 500	16 500	15 900	113 000	-	155 900
VII	115 300	51 300	9 700	65 000	-	241 300
VIII	600	900	500	600	15 000	17 600
IX	-	-	-	-	3 000	3 000

Table 3.4 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group for the North Sea (Divisions IVa,b,c), the Norwegian Sea (Division IIa) and Skagerrak (Division IIIa) area in 1983.

YEAR CLASS	AGE	D I V I S I O N S					TOTAL
		IIa	IIIa	IVa	IVb	IVc	
1982	1	-	57	-	-	55	112
1981	2	2 498	6 081	5 956	2 214	219	16 968
1980	3	18 966	4 242	9 057	3 370	158	35 793
1979	4	23 480	1 008	5 437	2 027	207	32 159
1978	5	8 525	315	2 701	1 013	268	12 822
1977	6	1 229	52	444	192	55	1 972
1976	7	8 053	527	2 223	826	292	11 921
1975	8	8 446	212	3 265	1 240	261	13 424
1974	9	6 979	477	2 337	905	158	10 856
1973	10	6 924	317	2 025	763	225	10 254
1972	11	1 403	159	923	348	103	2 936
1971	12	5 338	263	1 459	550	164	7 774
1970	13	863	264	538	203	61	1 929
1969	14	5 809	477	4 313	1 627	486	12 712
≤1968	≥15+	2 141	52	935	353	103	3 584
Total		100 684	14 503	41 613	15 631	2 815	1 075 246
Tomes		48 877	5 459	20 967	7 872	1 295	84 470

Table 3.5 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group for the North Sea (Divisions IVa, b, c), the Norwegian Sea (Division IIa) and Skagerrak (Division IIIa) area in 1982.

Year Class	Age	Divisions					Total
		IIa	IIIa	IVa	IVb	IVc	
1981	1	-	2 151	416	2	450	3 020
1980	2	2 057	6 158	5 497	62	543	14 316
1979	3	7 667	900	5 662	446	588	15 264
1978	4	7 651	273	3 936	430	663	12 954
1977	5	1 694	51	1 064	205	142	3 156
1976	6	5 073	396	2 686	697	976	9 828
1975	7	5 129	459	3 360	921	475	10 344
1974	8	5 922	485	4 846	899	246	12 398
1973	9	5 143	197	2 239	888	338	8 805
1972	10	2 078	138	1 637	442	180	4 474
1971	11	4 696	168	1 690	445	181	7 179
1970	12	2 040	340	995	356	145	3 877
1969	13	5 824	558	5 130	399	365	12 776
1968	14	2 310	26	780	374	152	3 642
≤1967	≥15	924	36	735	240	97	2 032
Total		58 207	12 337	40 675	7 307	5 539	124 065
Tonnes		37 608	4 776	6 580	14 655	9 114	72 733

Table 3.6 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group for the North Sea (Divisions IVa,b,c), the Norwegian Sea (Division IIa) and Skagerrak (Division IIIa) area in 1981.

Year class	Age	D I V I S I O N S				Total
		IIa	IIIa	IVa	IVb+IVc	
1980	1		1 680	600	1 587	3 867
1979	2		422	785	4 826	6 033
1978	3	256	429	2 947	7 892	11 524
1977	4	163	181	238	664	1 246
1976	5	838	481	3 174	8 571	13 064
1975	6	2 911	809	4 371	11 385	19 476
1974	7	3 260	2 268	5 603	8 963	20 094
1973	8	3 912	610	2 876	5 912	13 310
1972	9	1 537	436	1 480	2 845	6 298
1971	10	2 701	362	2 356	3 973	9 392
1970	11	792	250	602	979	2 623
1969	12	4 401	2 590	5 744	9 685	22 420
1968	13	1 125	204	903	218	2 450
1967	14	1 025	160	1 368	543	3 096
≤1966	≥15	373	146	957	218	1 694
Total		23 294	11 028	3 995	68 261	136 587
Tonnes		18 662	6 401	20 642	32 576	78 281

Table 3.7 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group of the North Sea stock in 1983.

Year class	Age	D I V I S I O N S						TOTAL
		IIa	IIIa	IVa	IVb	IVc	VIa	
1982	1	-	57	-	-	55	-	112
1981	2	2 498	6 081	5 956	2 214	219	-	16 968
1980	3	1 897	4 242	9 057	3 370	158	9 298	28 022
1979	4	2 348	1 008	5 437	2 027	207	5 334	16 361
1978	5	853	315	2 701	1 013	268	1 546	6 696
1977	6	123	52	444	192	55	182	1 048
1976	7	805	527	2 223	826	292	762	5 435
1975	8	845	212	3 265	1 240	261	669	6 492
1974	9	698	477	2 337	905	158	401	4 976
1973	10	692	317	2 025	763	225	269	4 291
1972	11	140	159	923	348	103	112	1 785
1971	12	534	263	1 459	550	164	199	3 169
1970	13	86	264	538	203	61	77	1 229
1969	14	581	477	4 313	1 627	486	501	7 985
≤1968	≥15+	214	52	935	353	103	104	1 761
Total		12 314	14 503	41 613	15 631	2 815	19 454	106 330
Tonnes		5 628	5 459	20 967	7 872	1 295	6 218	47 439



Table 3.8 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group of the North Sea stock in 1982.

Year class	Age	Division						TOTAL
		IIa	IIIa	IVa	IVb	IVc	VIa	
1981	1	-	2 151	416	2	450	-	3 019
1980	2	2 057	6 158	5 497	62	543	-	14 317
1979	3	767	900	5 662	448	588	7 098	15 463
1978	4	766	273	3 936	430	663	3 678	9 746
1977	5	169	51	1 064	205	142	343	1 974
1976	6	507	396	2 686	697	976	2 434	7 696
1975	7	513	459	3 360	921	475	1 841	7 569
1974	8	592	485	4 846	899	246	1 204	8 272
1973	9	514	197	2 239	888	338	1 144	5 320
1972	10	208	138	1 637	442	180	385	2 990
1971	11	470	168	1 690	445	181	602	3 556
1970	12	240	340	995	356	145	144	2 184
1969	13	582	558	5 130	899	365	1 083	8 617
1968	14	231	26	780	374	152	96	1 659
1967	15	92	36	735	240	97	96	1 296
TOTAL		7 672	12 336	40 673	7 308	5 541	20 148	93 678
Tonnes		4 300	4 776	6 580	14 655	9 114	7 547	46 972

Table 3.9 MACKEREL. Catch in number ( $10^{-3}$ ) by age group of the North Sea stock in 1981.

Year class	Age	Divisions					Total
		IIa	IIIa	IVa	IVb,c	VIa	
1980	1		1 680	600	1 587	-	3 867
1979	2		422	776	4 826	-	6 024
1978	3	26	429	2 947	7 892	192	11 486
1977	4	16	181	238	664	43	1 142
1976	5	84	481	3 174	8 571	230	12 540
1975	6	291	809	4 371	11 385	511	17 367
1974	7	326	2 268	5 603	8 963	663	17 823
1973	8	391	610	2 876	5 912	745	10 534
1972	9	154	436	1 480	2 845	520	5 435
1971	10	270	362	2 356	3 974	580	7 542
1970	11	79	250	602	979	311	2 221
1969	12	440	2 590	5 744	9 685	1 905	20 364
1968	13	112	204	903	218	326	1 763
1967	14	102	160	1 368	543	278	2 451
≤ 1966	≥ 15	37	146	957	218	185	1 543
Total		2 328	11 028	33 995	68 262	6 489	122 102
Tonnes		1 866	6 401	20 642	32 576	4 401	65 886

Table 3.10. VIRTUAL POPULATION ANALYSIS

MACKEREL IN THE NORTH SEA (FISHING AREAS IV, VIA AND IIA)

CATCH IN NUMBERS	UNIT: MILLIONS											
-----	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	64.4	110.3	0.8	2.6	4.5	2.9	11.9	2.7	1.1	0.0	2.3	2.7
2	110.2	191.1	83.0	35.6	12.1	18.7	10.1	73.6	19.3	8.2	0.5	5.6
3	473.1	75.8	50.3	162.6	37.6	23.6	16.2	69.7	58.9	34.7	11.3	2.4
4	308.6	185.1	18.0	33.2	280.2	39.9	42.4	13.9	54.3	40.8	21.2	14.3
5	79.7	64.5	29.7	21.3	74.3	240.8	27.8	33.8	9.8	27.9	33.3	23.5
6	35.6	19.0	13.8	23.5	36.0	45.8	193.2	19.5	26.6	6.0	14.3	25.9
7	624.0	5.3	2.1	10.7	19.7	7.5	25.6	118.6	31.6	14.2	4.2	15.3
8	0.0	98.6	0.9	1.4	34.8	16.1	20.4	31.3	125.9	16.1	9.2	12.3
9	0.0	0.0	17.7	0.6	0.5	3.2	15.8	8.0	31.2	45.7	2.0	14.0
10	0.0	0.0	0.0	11.7	0.0	0.5	5.0	9.0	8.3	14.6	27.0	3.5
11	0.0	0.0	0.0	0.0	4.0	0.3	0.5	4.0	8.8	5.5	5.2	19.3
12	0.0	0.0	0.0	0.0	0.0	24.6	0.2	0.5	4.5	5.5	2.0	3.8
13	0.0	0.0	0.0	0.0	0.0	0.0	22.2	0.1	0.8	2.9	2.0	1.3
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.1	0.6	1.2	1.6
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	3.2	2.3	2.2
TOTAL	1695.6	749.7	216.3	303.2	503.7	423.8	391.3	388.1	383.7	225.9	138.0	147.7
	1981	1982	1983									
1	3.9	3.0	0.1									
2	6.0	14.3	17.0									
3	11.5	15.5	28.0									
4	1.1	9.7	16.4									
5	12.5	2.0	6.7									
6	17.4	7.7	1.0									
7	17.8	7.6	5.4									
8	10.5	8.3	6.5									
9	5.4	5.3	5.0									
10	7.5	3.0	4.3									
11	2.2	3.6	1.8									
12	20.4	2.2	3.2									
13	1.8	8.6	1.2									
14	2.5	1.7	8.0									
15+	1.5	1.3	1.8									
TOTAL	122.0	93.8	106.4									

Table 3.11.

## VIRTUAL POPULATION ANALYSIS

MACKEREL IN THE NORTH SEA (FISHING AREAS IV, VIA AND IIA)

	FISHING MORTALITY COEFFICIENT					NATURAL MORTALITY COEFFICIENT = 0.15							
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	
1	0.06	0.04	0.00	0.01	0.02	0.01	0.02	0.01	0.01	0.00	0.02	0.02	
2	0.24	0.25	0.03	0.10	0.03	0.12	0.03	0.19	0.09	0.07	0.03	0.07	
3	0.02	0.24	0.09	0.08	0.13	0.08	0.13	0.26	0.22	0.21	0.13	0.21	
4	0.75	0.49	0.08	0.07	0.18	0.19	0.18	0.15	0.32	0.22	0.18	0.22	
5	1.01	0.32	0.13	0.12	0.22	0.22	0.19	0.21	0.14	0.25	0.26	0.29	
6	1.42	0.67	0.10	0.13	0.29	0.20	0.26	0.19	0.23	0.12	0.19	0.32	
7	1.04	0.78	0.13	0.10	0.15	0.08	0.15	0.24	0.49	0.18	0.11	0.30	
8	0.00	0.41	0.27	0.11	0.49	0.16	0.33	0.27	0.40	0.47	0.16	0.47	
9	0.00	0.00	0.11	0.27	0.05	0.07	0.23	0.19	0.44	0.23	0.09	0.36	
10	0.00	0.00	0.00	0.10	0.00	0.06	0.14	0.19	0.30	0.36	0.20	0.22	
11	0.00	0.00	0.00	0.00	0.04	0.19	0.08	0.15	0.26	0.31	0.19	0.20	
12	0.00	0.00	0.00	0.00	0.00	0.36	0.22	0.10	0.24	0.25	0.17	0.20	
13	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.16	0.22	0.23	0.13	0.15	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.22	0.24	0.13	0.13	
15+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.22	0.24	0.13	0.13	
( 4-14)w	0.95	0.44	0.11	0.10	0.19	0.21	0.24	0.22	0.34	0.24	0.19	0.27	
	1981	1982	1983										
1	0.02	0.01	0.02										
2	0.05	0.07	0.07										
3	0.20	0.18	0.18										
4	0.14	0.25	0.27										
5	0.29	0.37	0.25										
6	0.34	0.27	0.30										
7	0.35	0.23	0.29										
8	0.32	0.26	0.30										
9	0.37	0.25	0.23										
10	0.32	0.34	0.31										
11	0.20	0.24	0.33										
12	0.31	0.29	0.32										
13	0.13	0.20	0.24										
14	0.43	0.17	0.27										
15+	0.43	0.17	0.27										
( 4-14)w	0.31	0.2	0.28										

Table 3.12. VIRTUAL POPULATION ANALYSIS

HACKEREL IN THE NORTH SEA (FISHING AREAS IV, VIA AND IIA)

STOCK SIZE IN NUMBERS UNIT: MILLIONS

BIOMASS TOTALS UNIT: THOUSAND TONNES

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: 0.100  
PROPORTION OF ANNUAL M BEFORE SPAWNING: 0.400

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	1162.8	3334.1	479.7	479.2	219.3	453.2	541.6	294.8	150.5	18.7	100.7	147.7
2	556.1	941.1	2767.5	412.1	410.0	184.6	387.4	435.1	251.2	128.5	16.1	84.5
3	1094.3	376.8	633.5	2305.1	321.8	341.7	141.6	324.1	323.6	198.4	103.0	13.4
4	623.9	510.1	254.3	496.7	1433.5	242.1	272.2	106.9	214.5	224.1	134.7	78.2
5	133.2	253.6	264.5	202.2	398.5	1319.0	171.5	195.1	79.1	134.5	155.2	99.7
6	49.8	41.7	158.7	203.7	154.3	274.3	912.6	121.9	136.7	59.0	90.0	102.8
7	1025.4	10.4	18.4	123.8	155.5	99.6	193.7	607.0	86.9	93.1	45.3	64.2
8	0.0	311.5	4.1	13.9	96.7	113.9	78.8	143.1	412.9	45.7	67.0	35.1
9	0.0	0.0	177.2	2.7	10.7	51.1	83.2	49.0	94.2	239.2	26.5	49.1
10	0.0	0.0	0.0	136.2	1.8	8.7	41.1	57.0	34.7	52.3	163.7	19.2
11	0.0	0.0	0.0	0.0	106.4	1.5	7.0	30.7	40.7	22.2	31.6	115.9
12	0.0	0.0	0.0	0.0	0.0	87.8	7.1	5.6	22.7	26.9	14.1	22.4
13	0.0	0.0	0.0	0.0	0.0	0.0	53.0	0.7	4.4	15.4	18.1	10.2
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.2	0.5	3.0	10.0	13.7
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	16.0	20.3	18.9
TOTAL (H)	4649.4	5779.4	4761.9	4377.5	3706.3	3177.6	2664.7	2416.1	1866.4	1277.1	995.6	875.1
SPS (H)	2731.0	1682.3	2373.7	3397.5	2986.2	2410.9	1934.7	1689.8	1423.6	1084.1	821.1	616.7
SPS BIOM	1128.3	676.3	650.5	1267.6	1270.3	1089.9	916.9	778.8	661.1	511.4	407.4	318.8

	1981	1982	1983	1984
1	703.7	331.2	6.8*****	
2	124.6	223.4	282.3	5.7
3	67.6	101.7	179.0	227.2
4	9.3	47.5	73.7	124.2
5	54.1	7.0	32.0	47.9
6	64.1	35.0	4.2	21.5
7	64.6	39.2	23.0	2.6
8	41.2	39.2	26.7	14.8
9	18.8	25.7	26.0	17.0
10	29.4	11.2	17.3	17.6
11	13.3	18.3	6.9	10.9
12	81.9	9.4	12.5	4.5
13	15.7	51.7	6.1	7.8
14	7.6	11.9	36.5	4.1
15+	4.6	9.1	3.2	29.5
TOTAL (H)	860.5	961.4	740.5	
SPS (H)	474.9	451.9	512.8	
SPS BIOM	236.0	206.6	213.4	



Table 3.14 Forecasts of stock biomasses and catches for the North Sea MACKEREL stock. Basic parameters are given in Table 3.13. Stock biomass and catch in tonnes  $\times 10^{-3}$ . Spawning stock biomass at the time of spawning.

1983		1984				Management option for 1985	1985				1986	
Total landings	$\bar{F}_{4-14}$	Stock biomass	Spawn. stock biom.	$\bar{F}_{4-14}$	Total landings		Stock biomass	Spawn. stock biom.	$\bar{F}_{4-14}$	Total landings	Stock biomass	Spawn. stock biom.
47.4	.28	233	210	0.27	45	Maintain catch level	185	163	0.35	45	131	111
						$F_{85} = F_{84}$		164	0.27	37	139	122
						$F_{85} = F_{0.1}$		165	0.22	29	146	129
						$F_{85} = M$		166	0.15	21	155	138
						No fishing		168	0	0	176	160

Table 4.1. Nominal catch (tonnes) of MACKEREL in the western area (VI, VII and VIII)  
(Data for 1974-77 as officially reported to ICES)

Country \ Year	1974	1975	1976	1977	1978 <sup>***</sup>	1979 <sup>***</sup>	1980 <sup>***</sup>	1981 <sup>***</sup>	1982 <sup>***</sup>	1983 <sup>*)</sup> <sup>***</sup>
Belgium	7	17	10	1	1	3	3	-	-	++
Denmark	-	-	3	698	8 677	8 535	14 932	13 464	15 100	15 000
Faroe Islands	8 659	1 760	5 539	3 978	15 076	10 609	15 234	9 070	10 500	9 400
France	37 824	25 818	33 556	35 702	34 860	31 510	23 907	14 829	12 300	11 000
Germany, Dem.Rep.	2 885	9 693	4 509	431	-	-	-	-	-	-
Germany, Fed.Rep.	993	1 941	391	446	28 873	21 493	21 088	29 221	11 200	23 000
Iceland	-	21	10	-	-	-	-	-	-	-
Ireland	8 526	11 567	14 395	23 022	27 508	24 217	40 791	92 271	109 700	110 000
Netherlands	7 315	13 263	15 007	35 766	50 815	62 396	91 081	88 117	67 200	83 100
Norway	32 597	1 907	4 252	362	1 900	25 414	25 500	21 610	19 000	19 000
Poland	22 405	21 573	21 375	2 240	-	92	-	1	-	-
Spain <sup>†</sup>	30 177	23 408	18 480	21 853	19 142	15 556	15 000	11 469	15 600	15 000
Sweden	-	-	38	-	-	-	-	-	-	-
U.K. (England & Wales)	21 132	31 546	57 311	132 320	213 344	244 293	150 598	75 722	82 900	62 000
U.K. (N.Ireland)	75	30	95	97	46	25	-	4 153	9 600	18 400
U.K. (Scotland)	8 466	16 174	28 399	52 662	103 671	103 160	108 372	109 153	147 400	120 100
USSR	103 435	309 666	262 384	16 396	-	-	-	-	-	-
Unallocated						54 000	98 258	140 322	97 300	90 600
Total ICES members	284 496	468 384	465 754	325 974	503 913	601 303	604 761	609 402	597 800	576 600
Bulgaria	13 558	20 830	28 195	-	-	-	-	-	-	-
Rumania	-	2 166	13 222	-	-	-	-	-	-	-
Discard	-	-	-	-	50 700	60 600	21 600	42 300	24 900	11 300
GRAND TOTAL	298 054	491 380	507 178	325 974	554 613	661 903	626 361	651 702	622 700	587 900

\*) Preliminary  
 \*\*\*) Working Group estimate  
 †) Includes S. japonicus



Table 4.2 Catches of MACKEREL (tonnes) by Sub-areas in the western area. Discards not estimated prior to 1978.

YEAR	S u b - a r e a s					
	VI			VII and VIII		
	Landings	Discard	Catch	Landings	Discard	Catch
1969	4 800	-	4 800	66 300	-	66 300
1970	3 900	-	3 900	100 300	-	100 300
1971	10 200	-	10 200	122 600	-	122 600
1972	10 000	-	10 000	157 800	-	157 800
1973	52 200	-	52 200	167 300	-	167 300
1974	64 100	-	64 100	234 100	-	234 100
1975	64 800	-	64 800	416 500	-	416 500
1976	67 800	-	67 800	439 400	-	439 400
1977	74 800	-	74 800	259 100	-	259 100
1978	151 700	15 200	166 900	355 500	35 500	391 000
1979	203 300	20 300	223 600	398 000	39 800	437 800
1980	218 700	6 000	224 700	386 100	15 600	401 700
1981	335 100	2 500	337 600	274 300	39 800	314 100
1982	340 400	4 100	344 500	257 800	20 800	278 600
1983*	327 100	2 300	329 400	250 000	9 000	259 000

\* Preliminary

Table 4.3 MACKEREL. Catch in numbers ( $\times 10^{-3}$ ) by age group for the western area (Sub-areas VI, VII and VIII) in 1983.

YEAR CLASS	AGE	D I V I S I O N S					TOTAL
		VIA North 58°N winter	VIA rest	VIIa-c	VIIId-k	VIIIa-c <sup>⊛</sup>	
1983	0						
1982	1	2 963	2 731	140	34 922	3 013	43 769
1981	2	88 513	115 171	17 716	459 760	39 593	720 753
1980	3	92 981	107 623	17 721	207 958	17 948	444 231
1979	4	53 345	111 417	24 217	177 615	15 312	381 906
1978	5	15 462	44 147	16 005	47 974	3 452	127 040
1977	6	1 822	8 617	2 225	6 640	577	19 881
1976	7	7 617	36 128	7 691	32 380	2 780	86 596
1975	8	6 686	33 415	8 166	16 289	1 402	65 958
1974	9	4 013	27 102	2 591	8 446	728	42 880
≤1973	≥10	12 613	107 255	19 404	39 911	3 403	182 586
TOTAL		170 891	708 729	115 878	1 031 897	88 208	2 115 603
TONNES		88 557	240 023	36 354	205 080	17 632 <sup>⊛⊛</sup>	587 646
		328 580					

<sup>⊛</sup> No sample data available. Age distribution of catch assumed to be the same as in Division VIIId-k.

<sup>⊛⊛</sup> Working Group estimate

Table 4.4 MACKERREL. Catch in numbers ( $\times 10^{-3}$ ) by age group for the western area (Sub-areas VI, VII and VIII) in 1982.

YEAR CLASS	AGE	D I V I S I O N S					TOTAL
		Via North 58° winter	Via rest	VIIa-c	VIIId-k	VIIIa-c	
1982	0	-	-	-	1 674	291	1 965
1981	1	20 987	47 301	232	129 718	4 717	202 955
1980	2	84 855	59 494	1 680	284 854	5 055	435 938
1979	3	70 980	91 117	4 434	310 515	6 711	483 757
1978	4	36 782	44 273	6 120	90 917	2 816	180 908
1977	5	3 432	6 376	966	11 428	1 351	23 553
1976	6	24 342	41 185	4 931	61 469	2 553	134 480
1975	7	18 406	38 048	4 787	38 982	5 639	105 862
1974	8	12 043	33 677	4 707	25 588	4 461	80 476
1973	9	11 443	36 397	5 768	26 923	2 987	83 518
1972	≥ 10	24 068	119 903	17 408	75 188	12 030	248 597
TOTAL		307 338	517 771	51 033	1 057 256	48 611	1 982 009
TONNES		99 546	244 554				622 700
		344 100		278 600			

Table 4.5. MACKEREL.  
Catch in numbers ( $\times 10^{-3}$ ) by age group for the Western area  
(Sub-areas VI, VII and VIII) in 1981.

Year Class	Age	Divisions					Total
		Div. VIa North 58°N Winter	Div. VIa Rest	Div. VIIa-c	Div. VIIId-k	Div. VIIIA-c	
1981	0	-	-	-	5 052	33 295	38 347
1980	1	113	7 584	647	210 921	46 847	266 112
1979	2	270	40 534	20 047	424 561	21 033	506 445
1978	3	1 918	25 318	14 603	176 262	6 662	224 763
1977	4	432	8 156	2 012	18 493	2 521	31 614
1976	5	2 300	55 533	21 976	91 159	3 270	174 229
1975	6	5 113	72 388	14 129	62 514	2 232	156 376
1974	7	6 633	51 842	8 041	29 639	1 090	97 245
1973	8	7 429	60 390	16 237	28 163	1 567	113 776
1972	9	5 201	17 485	3 115	7 609	1 002	34 412
≤1971	≥10	35 844	205 283	29 296	61 664	6 378	338 465
Total		65 233	544 503	130 103	1 116 037	125 897	1 981 784
Tonnes		44 144	293 456	314 100			651 700
		337 600					

Table 4.6. MACKEREL.  
Catch in numbers ( $\times 10^{-3}$ ) by age group of the Western stock  
in 1982.

Year Class	Age	Divisions					Total
		IIa	VIa	VIIa-c	VIIId-k	VIIIA-c	
1982	0	-	-	-	1 674	291	1 965
1981	1	-	68 288	232	129 718	4 717	202 955
1980	2	-	144 349	1 680	284 854	5 055	435 938
1979	3	6 900	154 999	4 434	310 515	6 711	483 559
1978	4	6 886	77 377	6 120	90 917	2 816	184 116
1977	5	1 476	9 435	966	11 428	1 351	24 686
1976	6	4 563	63 093	4 931	61 469	2 553	136 609
1975	7	4 614	54 613	4 787	38 982	5 639	108 635
1974	8	5 237	44 516	4 707	25 588	4 461	84 509
1973	9	4 627	46 696	5 768	26 923	2 987	87 001
≤1972	≥10	16 080	141 564	17 408	75 188	12 030	262 270
Total		50 383	804 960	51 033	1 057 256	48 611	2 012 243
Tonnes		33 308	336 553	278 600			648 461

Table 4.7. MACKEREL.

Catch in numbers ( $\times 10^{-3}$ ) by age group of the Western stock in 1983.

Year Class	Age	Divisions					Total
		IIa	VIa	VIIa-c	VIIId-k	VIIIa-c <sup>*)</sup>	
1983	0	-	-	-	-	-	-
1982	1	-	5 694	140	34 922	3 013	43 769
1981	2	-	203 684	17 716	459 760	39 593	720 753
1980	3	17 069	191 306	17 721	207 958	17 948	452 002
1979	4	21 132	159 428	24 217	177 615	15 312	397 704
1978	5	7 672	58 063	16 005	47 974	3 452	133 166
1977	6	1 106	10 257	2 225	6 640	577	20 805
1976	7	7 248	42 982	7 691	32 380	2 780	93 081
1975	8	7 601	39 432	8 166	16 289	1 402	72 890
1974	9	6 281	30 714	2 591	8 446	728	48 760
≤1973	≥10	20 230	118 607	19 404	39 911	3 403	201 555
Total		88 339	860 167	115 878	1 031 897	88 208	2 184 485
Tonnes		43 249	322 362	36 354	205 080	17 632 <sup>*)</sup>	624 677

\*) No sample data available. Age distribution of catch assumed to be the same as in Division VIIId-k.

\*\*) 85% Working Group estimate.

Table 4.8. MACKEREL.

Catch in numbers ( $\times 10^{-3}$ ) by age group of the Western stock in 1981.

Year Class	Age	Divisions					Total
		IIa	VIa	VIIa-c	VIIId-k	VIIIa-c	
1981	0	-	-	-	5 052	33 295	38 347
1980	1	-	7 697	647	210 921	46 847	266 112
1979	2	-	40 804	20 047	424 561	21 033	506 445
1978	3	231	27 318	14 603	176 262	6 662	225 076
1977	4	147	8 545	2 012	18 493	2 521	31 718
1976	5	755	57 603	21 976	91 159	3 270	174 763
1975	6	2 620	76 989	14 129	62 514	2 232	158 484
1974	7	2 934	57 812	8 041	29 639	1 090	99 516
1973	8	3 521	67 066	16 237	28 163	1 567	116 554
1972	9	1 383	22 166	3 115	7 609	1 002	35 275
≤ 1971	≥10	9 368	237 540	29 296	61 664	6 378	344 246
Total		20 959	603 540	130 103	1 116 037	125 897	1 996 536
Tonnes		16 796	333 199	296 795		17 305	664 095

Table 4.2. The relationship between total international effort, measured in terms of Cornish handline effort (3Q cpue), and  $\bar{F}_{3-8}$  calculated by VPA (ACFM, November 1983).

Year	VPA SOP* Catch (tonnes $\times 10^{-3}$ )	Cornish Handline Cpue (t/10 <sup>-5</sup> Hook Hours)	Total International Effort (f) (Hook Hours $\times 10^{-8}$ )	$\bar{F}_{3-8}$ $\sqrt{\text{ACFM,}}$ Nov. 1983	$\bar{F}_{2-10}$ VPA		
					Run 1	Run 2	Run 3
1973	319	94	3.39	0.07	0.056	0.056	0.056
1974	411	272	1.51	0.08	0.078	0.078	0.078
1975	862	157	5.49	0.21	0.163	0.163	0.163
1976	682	196	3.48	0.16	0.146	0.146	0.146
1977	381	170	2.24	0.08	0.087	0.086	0.086
1978	628	82	7.66	0.15	0.153	0.152	0.152
1979	767	105	7.30	0.21	0.209	0.208	0.207
1980	803	107	7.50	0.21	0.222	0.219	0.218
1981	687	95	7.23	0.17	0.163	0.160	0.159
1982	682	93	7.33	0.18	0.181	0.178	0.176
1983	687	83	8.28	$\sqrt{0.22}$	$\sqrt{0.214}$	$\sqrt{0.212}$	

Functional Regressions

	$y = ax + b$	$y = ax^b$
r	0.80	0.82
a	0.023	0.0446
b	0.029	0.7464

\*) SOP data 1973-80 from Working Group file

SOP data 1981-83 revised by this Working Group.

Table 4.10. VIRTUAL POPULATION ANALYSIS

## MACKEREL, WESTERN STOCK

CATCH IN NUMBERS	UNIT: MILLIONS											
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	1.6	0.0	1.3	1.0	34.2	2.0	10.3	79.5	19.5	38.3	2.0	0.0
1	12.4	33.8	87.0	52.5	279.4	153.5	31.3	351.1	484.5	266.1	203.0	43.8
2	12.1	49.4	24.3	104.0	184.9	239.5	563.6	61.0	463.7	506.4	455.9	720.8
3	29.4	64.0	123.5	94.5	322.3	154.0	425.0	602.5	75.2	225.1	483.6	452.0
4	507.7	115.5	106.5	306.3	170.0	166.0	245.7	365.5	381.3	31.7	184.1	397.7
5	0.0	582.3	191.8	192.2	286.8	51.0	258.3	217.2	282.0	174.8	24.7	133.2
6	0.0	0.0	567.0	143.8	118.6	140.0	71.9	233.1	145.2	156.5	156.6	20.8
7	0.0	0.0	0.0	1240.2	279.7	64.4	151.9	80.3	158.4	99.5	108.6	93.1
8	0.0	0.0	0.0	0.0	436.8	89.4	56.7	154.2	52.4	110.6	84.5	72.9
9	0.0	0.0	0.0	0.0	0.0	158.5	83.2	70.5	139.6	35.3	67.0	48.8
10+	0.0	0.0	0.0	0.0	0.0	0.0	210.6	263.7	200.9	344.2	262.3	201.6
TOTAL	563.2	845.0	1103.4	2140.5	2117.3	1268.3	2106.9	2485.7	2413.7	1996.5	2012.3	2184.7
<u>SUM OF PRODUCTS</u> ( $10^{-3}$ tonnes)												
SOP	222.0	318.6	411.4	862.2	682.2	381.3	628.2	767.0	803.5	699.8	700.3	608.5
Nominal	170.8	219.4	298.1	491.4	507.2	326.0	554.6	666.3	626.4	664.1	648.5	624.7

Table 4.11. VIRTUAL POPULATION ANALYSIS

MACKEREL, WESTERN STOCK

	FISHING MORTALITY COEFFICIENT				UNIT: Year <sup>-1</sup>	NATURAL MORTALITY COEFFICIENT = 0.15						
	1972	1973	1974	1975		1976	1977	1978	1979	1980	1981	1982
0	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00
1	0.00	0.02	0.02	0.02	0.07	0.04	0.06	0.13	0.11	0.08	0.06	0.10
2	0.01	0.01	0.02	0.03	0.07	0.09	0.17	0.16	0.25	0.16	0.18	0.29
3	0.01	0.04	0.04	0.06	0.11	0.08	0.17	0.20	0.28	0.17	0.21	0.26
4	0.06	0.05	0.08	0.12	0.18	0.07	0.16	0.21	0.25	0.18	0.19	0.25
5	0.00	0.09	0.10	0.18	0.14	0.07	0.15	0.20	0.23	0.17	0.19	0.20
6	0.00	0.00	0.12	0.09	0.15	0.09	0.13	0.18	0.19	0.19	0.18	0.23
7	0.00	0.00	0.00	0.38	0.25	0.11	0.15	0.21	0.17	0.18	0.18	0.17
8	0.00	0.00	0.00	0.00	0.21	0.11	0.12	0.18	0.18	0.18	0.21	0.17
9	0.00	0.00	0.00	0.00	0.00	0.10	0.14	0.21	0.23	0.17	0.19	0.17
10+	0.00	0.00	0.00	0.00	0.00	0.10	0.14	0.21	0.23	0.17	0.19	0.17
( 2-10)W	0.04	0.06	0.08	0.17	0.15	0.09	0.16	0.21	0.23	0.17	0.19	0.24
( 3-10)W	0.05	0.07	0.09	0.21	0.17	0.09	0.15	0.22	0.22	0.17	0.19	0.22



Table 4.12. VIRTUAL POPULATION ANALYSIS

MACKEREL, WESTERN STOCK

STOCK SIZE IN NUMBERS UNIT: MILLIONS

BIOMASS TOTALS UNIT: THOUSAND TONNES

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: 0.400  
 PROPORTION OF ANNUAL M BEFORE SPAWNING: 0.400

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	2268.4	5369.9	3823.7	5268.3	5404.0	641.8	3570.5	5794.9	4287.0	4479.7	571.9	0.0
1	4981.6	1950.9	4621.9	3289.9	4533.5	4619.6	550.5	3063.6	4914.1	3671.8	3820.3	490.4
2	2250.7	4276.2	1647.9	3897.5	2783.0	3643.3	3833.9	444.9	2312.0	3781.1	2914.0	3100.1
3	3142.9	1926.0	5634.6	1395.6	3258.2	2274.1	2867.6	2778.4	325.9	1556.9	2786.0	2104.9
4	8703.9	2677.9	1598.4	3014.1	1113.9	2506.1	1771.7	2775.2	1234.8	211.1	1131.8	1950.8
5	0.0	7021.3	2197.9	1275.3	2310.7	890.9	2003.3	1299.5	1448.3	1226.9	152.3	803.9
6	0.0	0.0	5504.2	1714.2	919.9	1721.7	642.1	1485.3	917.7	985.9	894.3	108.3
7	0.0	0.0	0.0	4212.8	1342.3	682.0	1352.2	486.2	1062.8	655.6	702.0	643.4
8	0.0	0.0	0.0	0.0	2476.4	896.9	527.4	1023.3	338.2	768.3	472.2	503.8
9	0.0	0.0	0.0	0.0	0.0	1725.8	689.2	401.5	738.2	242.6	555.4	328.3
10+	0.0	0.0	0.0	0.0	0.0	0.0	1746.2	1501.7	1094.0	2365.9	1668.6	1356.4
TOTAL NO	21347.5	23222.2	23028.8	24067.5	24141.9	19462.1	19555.0	20354.5	19272.9	19945.8	15666.8	11390.4
SPS NO	11290.0	11493.3	11718.8	11200.3	10561.0	10656.3	10532.4	9136.1	7882.5	8367.3	7975.9	6980.0
SPS BIOM	3511.5	3589.5	3609.7	3367.2	3070.8	3074.4	3340.8	2941.7	2460.4	2705.3	2421.4	2153.4

1984

0	++++++
1	0.0
2	331.5
3	2002.6
4	1394.1
5	1311.6
6	508.8
7	74.0
8	467.7
9	306.2
10+	1218.5

Table 4.13. VPA estimates of 0- and 1-group stock abundance each year, 1975-83, and recruitment indices from English landings by purse seiners and pair trawlers from Divisions VIIe and f. [The 1983 data are omitted from the regressions.]

Year	0-Gr. Recruitment Index			1-Gr. Recruitment Index		
	VPA	Purse Seine	Pair Trawl	VPA	Purse Seine	Pair Trawl
	(No. x 10 <sup>-6</sup> )	(No./t landed)		(No. x 10 <sup>-6</sup> )	(No./t landed)	
1975	5 271	-	29.67	3 295	-	2 655
1976	5 413	9.12	430.92	4 535	1 232	1 988
1977	644	2.02	0	4 627	2 016	1 480
1978	3 536	26.43	14.17	552	198	175
1979	5 802	1.25	9.87	3 034	1 757	1 803
1980	4 294	72.68	16.92	4 920	3 019	1 825
1981	4 473	14.16	38.63	3 677	2 146	2 083
1982	566	13.44	19.64	3 814	923	673
1983	[0]	-	[0]	[485]	-	[462]

			<u>Semi-log</u>	<u>Linear</u>	<u>Linear</u>	<u>Semi-log</u>
r	0.14	0.36	0.87	0.73	0.55	0.76
Intercept	14.30	-24.42	5.244	-14.69	451.01	5.400
Slope	0.002	0.025	0.00053	0.45	0.32	0.00049

Table 4.14. Input data for catch forecasts, Western MACKEREL stock (M = 0.15).

Age	Stock Number in 1984 (x 10 <sup>-6</sup> )	Fishing Pattern	Weight at Age in the Catch in 1983	Weight at Age at Spawning	Maturity Ogive
1	500.0	0.39	0.178	0.095	0.18
2	381.5	0.83	0.216	0.150	0.38
3	2 002.6	1.00	0.270	0.215	0.67
4	1 394.1	0.92	0.306	0.275	0.89
5	1 311.6	0.84	0.383	0.320	0.93
6	568.8	0.80	0.425	0.355	1.00
7	74.0	0.80	0.430	0.380	1.00
8	467.7	0.80	0.491	0.400	1.00
9	366.2	0.80	0.542	0.420	1.00
10+	1 218.5	0.80	0.608	0.485	1.00

Recruitment at age 1: 1984 500 x 10<sup>-6</sup>  
 1985 1 000 x 10<sup>-6</sup>  
 1986 1 000 x 10<sup>-6</sup>

Table 4.15. Forecasts of stock biomasses and catches for the Western MACKEREL stock. Basic parameters are given in Table 4.14. Stock biomass and catch in tonnes  $\times 10^{-3}$ . Spawning stock biomass at the time of spawning.

1983		1984			Total landings <sup>*)</sup>	Management option for 1985	1985			1986		
Total landings <sup>*)</sup>	$\bar{F}(3-10)$	Stock biomass	Spawn. stock biom.	$\bar{F}(3-10)$			Stock biom.	Spawn. stock biom.	$\bar{F}(3-10)$	Total landings <sup>*)</sup>	Stock biomass	Spawn. stock biom.
625	0.22	2 500	1 879	0.26	650	Maintain catch level	1 976	1 463	0.36	650	1 452	980
						$F_{85} = F_{84}$		1 517	0.26	501	1 577	1 181
						$F_{85} = F_{0.1}$		1 573	0.17	338	1 714	1 338
						$F_{85} = M$		1 584	0.15	306	1 741	1 369
						No fishing		1 681	0	0	1 998	1 682

\*) Includes landings taken from outside the Western area and excludes landings of North Sea stock from within the Western area. Spawning stock biomass is estimated at 1 June.

Table 5.1 Nominal catch (tonnes) of MACKEREL in Sub-area IX, 1974-1983.

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983 <sup>¶</sup>
Portugal	2 329	2 224	2 595 <sup>¶¶</sup>	1 743 <sup>¶¶</sup>	1 555 <sup>¶¶</sup>	1 071 <sup>¶¶</sup>	1 921 <sup>¶¶</sup>	3 108 <sup>¶¶</sup>	3 600 <sup>¶¶</sup>	2 239
Spain	3 264	3 345	2 520	2 935	6 221	6 280	2 719	2 111	796	800 <sup>¶¶</sup>
France	-	1	-	-	-	-	-	-	-	-
Poland	-	-	-	8	-	-	-	-	-	-
USSR	-	44	466	2 879	189	111	-	-	-	-
TOTAL	5 593	5 614	5 581	7 565	7 965	7 462	4 460	5 219	4 396	3 039

¶ Preliminary

¶¶ Working Group estimate

Table 5.2 MACKEREL in Sub-area IX.  
Catch in numbers ( $\times 10^{-3}$ ) by age group  
in 1981-83.\*

Age	1981	1982	1983
0	12 888	17 460	6 108
1	11 034	9 787	7 263
2	3 224	3 222	3 927
3	986	1 571	1 213
4	169	386	215
5	69	218	59
6	56	182	16
7	25	99	16
8	14	59	11
9	8	36	8
$\geq 10$	52	265	20
Total	28 525	33 285	18 856
Tonnes	5 219	4 396	3 039

\* Based on Portuguese sampling and ageing

Table 8.1 Effects on North Sea spawning stock biomass in 1983-85 if the fisheries in all areas continue at their current level through 1985, and if closures had been introduced in Division VIa for differing time periods in 1982. Biomass is given in tonnes.

Fishing Regime	1982	1983	1984	1985
No fishing in any area	211 070	262 666	300 460	289 360
Fishing in all areas at past and predicted levels	206 600	213 400	210 000	163 000
Closure in Div. VIa north of 58°N 1 Nov - 30 Apr in each year up to 1985	207 565	226 370	225 980	181 393
Closure in Div. VIa as above from 1 Dec - 30 Apr	207 100	221 380	217 787	177 355
Closure in Div. VIa as above from 1-31 Dec and 1 Mar - 30 Apr	206 780	219 440	215 068	167 846

Table 9.1 Landings of HORSE MACKEREL by Sub-area (tonnes).

Sub-area	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983 <sup>*)</sup>
IV	30 548	9 933	8 668	1 326	4 920	1 412	2 151	6 825	5 115	7 524
VI	3 480	3 272	4 194	670	408	7 791	8 724	11 134	5 036	10 340
VII	116 901	117 599	177 010	28 855	26 060	43 525	45 697	34 749	33 478	43 571
VIII	66 238	86 738	129 558	124 906	83 804	47 155	37 495	40 073	22 684	21 200
IX	51 025	45 795	53 024	67 388	47 211	40 107	36 811	38 152	37 174	37 986
Total	217 167	312 797	372 454	223 145	162 403	139 990	130 878	130 933	103 487	120 621

<sup>\*)</sup> Preliminary

Table 9.2 Landings of HORSE MACKEREL in Sub-area IV by country (tonnes)

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Belgium	34	23	15	14	15	9	8	34	7	55
Denmark	-	-	-	63	1 543	496	199	3 576	1 612	1 894
Faroe Islands	772	156	116	130	3	0	260	0	2 327	5 189
France	582	140	147	325	182	221	292	2	567	258
German Dem. Rep.	-	-	4	-	-	-	-	-	-	-
Germany, Fed. Rep.	686	696	162	2	1 993	376	+	139	30	52
Ireland	-	-	-	-	-	-	1 161	412	-	-
Netherlands	576	173	82	223	106	88	101	355	559	1
Norway	20 713	2 174	4 842	450	1 037	199	119	2 292	7	73
Poland	62	-	11	6	-	-	-	-	-	2
Sweden	2 <sup>a)</sup>	+	-	-	-	+	-	-	-	-
U.K. (England & Wales)	5	3	11	22	36	23	11	15	6	-
U.K. (Scotland)	1 222	2	+	4	5	+	-	-	-	-
U.S.R.R.	5 894	6 566	3 278	87	-	-	-	-	-	-
TOTAL	30 548	9 933	8 668	1 326	4 920	1 412	2 151	6 825	5 115	7 524

\* Preliminary

a) Includes IIIa



Table 9.3 Landings of HORSE MACKEREL in Sub-area VI by country (tonnes)

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Belgium	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	443	734	341	2 785	7
Faroe Islands	342	2	2	-	-	-	-	-	1 248	-
France	-	-	293	113	91	151	45	454	4	10
Ireland	-	-	-	-	59	-	-	-	-	-
Germany, Fed. Rep.	209	263	5	-	-	155	5 550	10 212	2 113	4 823
Netherlands	-	106	69	19	114	6 910	2 385	100 <sup>a)</sup>	50 <sup>a)</sup>	5 500 <sup>a)</sup>
Norway	627	869	90	-	-	-	-	5	-	-
Poland	1 067	479	48	-	-	-	-	-	-	-
Spain	400	150	175	147	91	20	-	-	-	-
U.K. (England & Wales)	14	6	37	40	44	73	9	5	+	-
U.K. (Scotland)	41	187	85	105	9	39	1	17	83	-
U.S.R.R.	780	1 210	3 390	246	-	-	-	-	-	-
TOTAL	3 480	3 272	4 194	670	408	7 791	8 724	11 134	5 036	10 340

\* Provisional

a) Estimated from biological sampling

Table 9.4 Landings of HORSE MACKEREL in Sub-area VII, by country (tonnes)

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983 <sup>*)</sup>
Belgium	3	4	2	1	1	3	+	1	1	-
Denmark	-	-	-	-	2 104	4 287	5 045	3 099	877	994
France	2 466	2 443	3 800	2 448	3 564	4 407	1 983	2 800	2 314	4 717
G.D.R.	8	-	92	45	-	-	-	-	-	-
Germany, Fed.Rep.	825	521	3	308	2 923	5 333	2 289	1 079	12	2 195
Ireland	-	-	-	1 133	3 388	-	-	16	-	-
Netherlands	-	41	280	2 088	10 556	25 174	23 002	25 000 <sup>a)</sup>	27 500 <sup>a)</sup>	34 350 <sup>a)</sup>
Norway	16	-	-	-	29	959	394	-	-	-
Poland	4 643	1 869	2 967	640	61	-	-	-	-	-
Spain	12 315	10 890	17 124	483	516	676	50	234	104	(100)
UK (Engl. and Wales)	675	438	2 014	1 343	2 918	2 686	12 933	2 520	2 670	1 215
UK (Scotl.)	-	-	-	-	-	-	1	-	-	-
USSR	95 650	101 393	150 728	20 366	-	-	-	-	-	-
Total	116 901	117 599	177 010	28 855	26 060	43 525	45 697	34 749	33 478	43 571

\*) Provisional

a) Estimated from biological sampling

( ) Estimated from 1982 catch level

Table 9.5 Landings of HORSE MACKEREL in Sub-areas VIII and IX, by country (tonnes)

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983 <sup>*)</sup>
<u>Sub-area VIII</u>										
Denmark	-	-	-	-	-	127	-	-	-	-
France	2 477	2 386	3 380	4 881	3 643	4 240	3 361	3 711	3 073	2 200
German Dem.Rep.	-	-	14	-	-	-	-	-	-	-
Netherlands	-	-	-	-	19	-	-	-	-	-
Spain	62 836	72 916	95 401	104 812	80 139	42 766	34 134	36 362	19 610	(19 000)
UK (Engl.& Wales)	-	-	-	-	-	22	-	+	1	-
USSR	925	11 436	30 763	15 213	3	-	-	-	-	-
Total	66 238	86 738	129 558	124 906	83 804	47 155	37 495	40 073	22 683	(21 200)
<u>Sub-area IX</u>										
Poland	-	-	-	168	-	-	-	-	-	-
Portugal	48 071	43 491	49 041	51 341	32 043	26 977	25 132	26 032	28 334	29 986
Spain	2 954	1 882	3 339	981	14 787	12 880	11 679	12 120	8 840	(8 000)
USSR	-	422	644	14 898	381	250	-	-	-	-
Total	51 025	45 795	53 024	67 388	47 211	40 107	36 811	38 152	37 174	(37 986)

<sup>\*)</sup> Preliminary

( ) Estimated from 1982 catch level

- 3 -

Table 9.6 HORSE MACKEREL. Length composition of the catch in 1983 by countries, Sub-areas and gears.

Length (cm)	Portugal IXa Commercial landings			Netherlands VII Commercial landings	England VIIe Commercial landings
	Trawl	Artisanal	Purse seine	Pelagic trawl	All gears
4		19			
5		234			
6		1115			
7		1624	14		
8	5	2980	36		
9	129	6670	50		
10	1781	865	469		
11	9141	631	370		
12	43888	889	641		
13	<u>104374</u>	3714	3365	283	
14	88453	15234	8273	848	
15	88130	<u>16322</u>	<u>15743</u>	848	
16	59397	13711	10861	283	1
17	30379	4182	7030	565	6
18	18305	2525	6521	1696	9
19	9615	2709	3898	848	10
20	4859	2301	2629	283	6
21	3766	1004	1379	334	2
22	3507	352	1296	601	17
23	2709	624	887	5566	50
24	2169	535	554	8628	49
25	1220	365	523	8855	135
26	715	323	458	8613	111
27	377	224	232	8103	114
28	499	409	594	9361	253
29	609	709	925	8336	485
30	1174	1122	1526	9066	365
31	2491	1727	2549	13490	586
32	<u>3296</u>	<u>2679</u>	<u>2742</u>	12516	367
33	2690	2137	1573	14397	508
34	1414	2408	916	<u>15440</u>	381
35	596	1561	397	11242	399
36	342	1049	194	5654	174
37	144	558	139	2867	149
38	94	384	71	1513	-
39	26	204	8	283	74
40	3	82	4		
41	1	65			
42		19			
43		12			
Total	486299	94364	76884	150519	4251
Tonnes	16449	7097	6440	34350	1215

Table 9.7 Comparison of age readings of HORSE MACKEREL between England and the Netherlands  
 (3 otoliths =  $\pm$  2% were not comparable).

		NETHERLANDS																				
Age	Year class	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	Total
1	1981	5	1																			6
2	1980		14	1																		15
3	1979			3	1	1																5
4	1978				1		12	4	1													18
5	1977					1		9	6	1	1											21
6	1976								2	2												26
7	1975											2	6	7	6						1	20
8	1974										1	1	4	7	4	2					1	10
9	1973											2	1	5	1						1	1
Total		5	15	5	1	14	13	9	3	1	1	5	12	21	11	2	2	-	-	1	1	122

ENGLAND

Table 9.8 Total number per area (Y) of HORSE MACKEREL  $\leq 20$  cm in length and standard error (s.e.) in October/ November 1981, 1982, 1983 in continental Portuguese waters (Division IXa).

Year	1981					1982				1983			
Depth meters	20-500					20-500				20-500			
Sector	$N_h$	$n_h$	$Y (10^{-6})$	s.e.( $10^{-6}$ )	C.V.	$n_h$	$Y(10^{-6})$	s.e.( $10^{-6}$ )	C.V.	$n_h$	$Y(10^{-6})$	s.e.( $10^{-6}$ )	C.V.
CAM	27	26	1.42	0.93	0.65	15	85.2	59.3	0.70	27	90.2	40.0	0.44
MAT	25	-	-	-		25	108.1	83.8	0.78	-	-	-	-
AVE	27	13	0.15	0.15	1.00	16	46.2	30.8	0.67	28	70.1	25.9	0.37
FIG	34	33	1.74	0.68	0.39	15	41.0	32.0	0.78	32	48.5	12.8	0.28
BER	14	-	-	-		14	6.0	4.4	0.74	-	-	-	-
LIS	30	-	-	-		30	46.8	40.6	0.87	-	-	-	-
SIN	26	-	-	-		25	9.8	5.8	0.59	-	-	-	-
MIL	17	17	6.93	5.32	0.77	8	0.1	(1.6)	-	17	23.3	14.0	0.60
ARR	16	16	0.91	0.52	0.57	6	41.2	(101.1)	-	14	14.5	4.8	0.33
SAG	9	-	-	-	0.40	8	0	0	0	-	-	-	-
POR	9	-	-	-	1.00	17	3.4	1.5	0.44	-	-	-	-
VSA	10	-	-	-	0.51	9	0.6	0.3	0.53	-	-	-	-
TOTAL	254	105	11.15	5.47	0.53	188	388.5	156.3	0.40	118	246.60	51.5	0.21
TOTAL COMMON AREA	118	105	11.15	5.47	0.53	60	213.70	74.1	0.57	118	246.60	51.5	0.21

Table 9.9 HORSE MACKEREL. Sub-area IX. Total catch, cpue (Kg per hour trawling) and estimated total effort (and average of 3 years).

YEARS	C A T C H				TOTAL	CPUE (kg/hr)	Estimated effort (10 <sup>-3</sup> )	Mean effort (3 years)
	PORTUGAL	SPAIN	USSR	POLAND				
1969	58 983	6 512	-	-	65 495	85.5	766.0	-
1970	68 943	4 657	-	-	73 600	126.4	582.3	-
1971	57 467	1 496	-	-	58 963	111.4	529.2	625.8
1972	81 033	2 088	-	-	83 121	157.8	526.7	546.1
1973	45 497	* 1 622	-	-	47 119	76.8	613.53	556.5
1974	48 071	* 2 954	-	-	51 025	88.0	579.83	573.4
1975	43 491	* 1 882	422	-	45 795	76.5	598.63	597.3
1976	49 041	* 3 339	644	-	53 024	78.9	672.04	616.8
1977	51 341	* 981	14 898	168	67 388	70.7	953.5	741.3
1978	32 043	* 14 787	381	-	47 211	85.1	554.77	726.7
1979	26 977	* 12 880	250	-	40 107	65.8	609.53	705.8
1980	25 132	* 11 679	-	-	36 811	48.5	758.99	64.1
1981	26 032	* 12 120	-	-	38 152	49.9	764.57	711.0
1982	28 334	* 8 840	-	-	37 174	40.6	915.62	813.1
1983	29 986	(8 000)	-	-	37 986	53.3	712.68	797.6

\* Working Group data

() Estimated

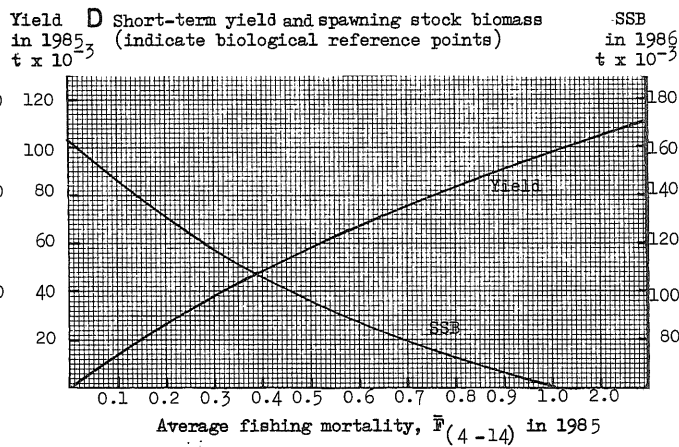
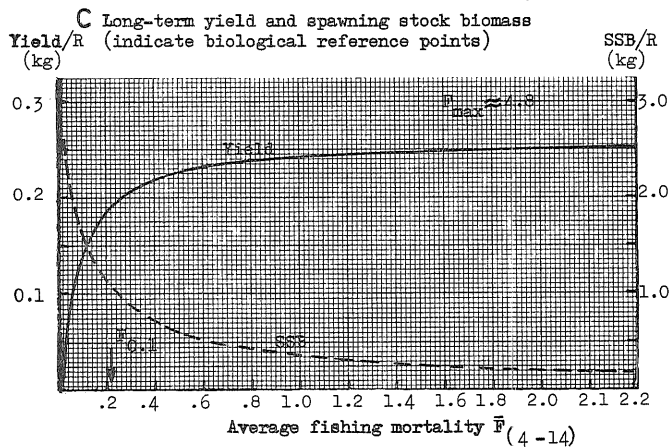
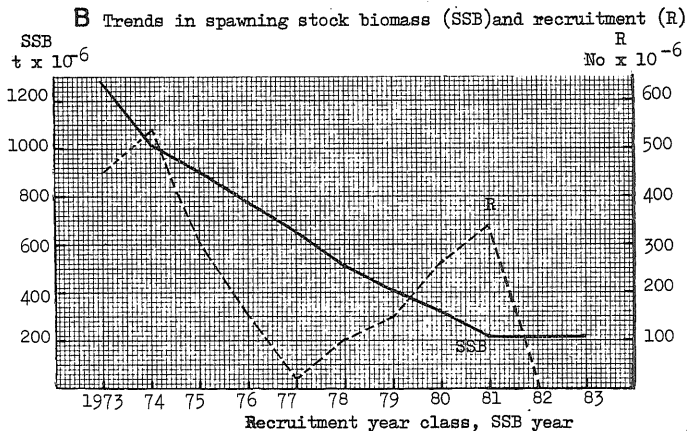
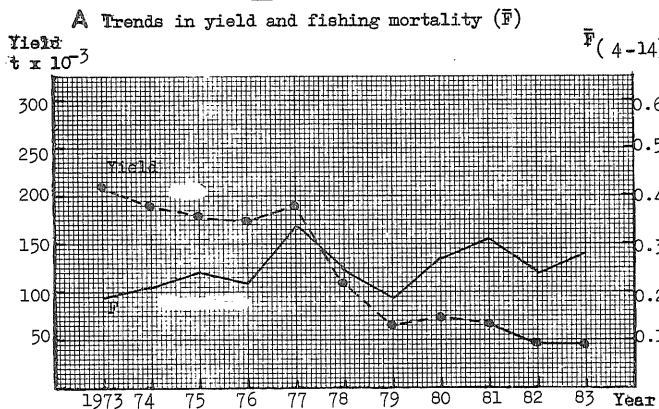
Table 9.10 Age composition (Portuguese ageing), mean length and mean weight at age for HORSE MACKEREL in Division IXa (Portuguese coast), for the years 1981-1983.

AGE	1981			1982			1983		
	Age composition (x 10 <sup>2</sup> )	Mean length (cm)	Mean weight (g)	Age composition (x 10 <sup>2</sup> )	Mean length (cm)	Mean weight (g)	Age composition (x 10 <sup>2</sup> )	Mean length (cm)	Mean weight (g)
0	28 919	13.50	19.11	73 213	13.20	17.87	305 056	13.48	19.02
1	83 504	15.66	29.77	117 301	15.18	27.13	254 989	16.52	34.93
2	14 184	19.71	59.21	65 423	20.92	70.75	44 652	19.47	57.08
3	8 763	24.00	106.66	10 157	25.65	130.10	7 925	23.72	102.98
4	7 023	29.61	199.82	7 132	29.66	200.83	6 538	27.18	154.70
5	9 416	31.76	246.38	12 164	31.32	236.32	10 992	31.17	232.95
6	9 102	33.01	276.51	18 116	32.19	256.49	12 449	32.35	260.32
7	6 491	34.94	327.69	15 514	32.98	275.76	7 384	33.20	281.30
8	3 672	36.76	381.32	7 516	34.36	312.14	2 631	34.57	317.43
9+	3 209	37.17	394.25	8 807	36.25	366.32	4 902	36.29	367.00
TOTAL	174 285			334 623			657 519		
TONNES	26 032			28 334			29 986		



Figure 3.1. FISH STOCK SUMMARY

(Stock) MACKEREL - NORTH SEA



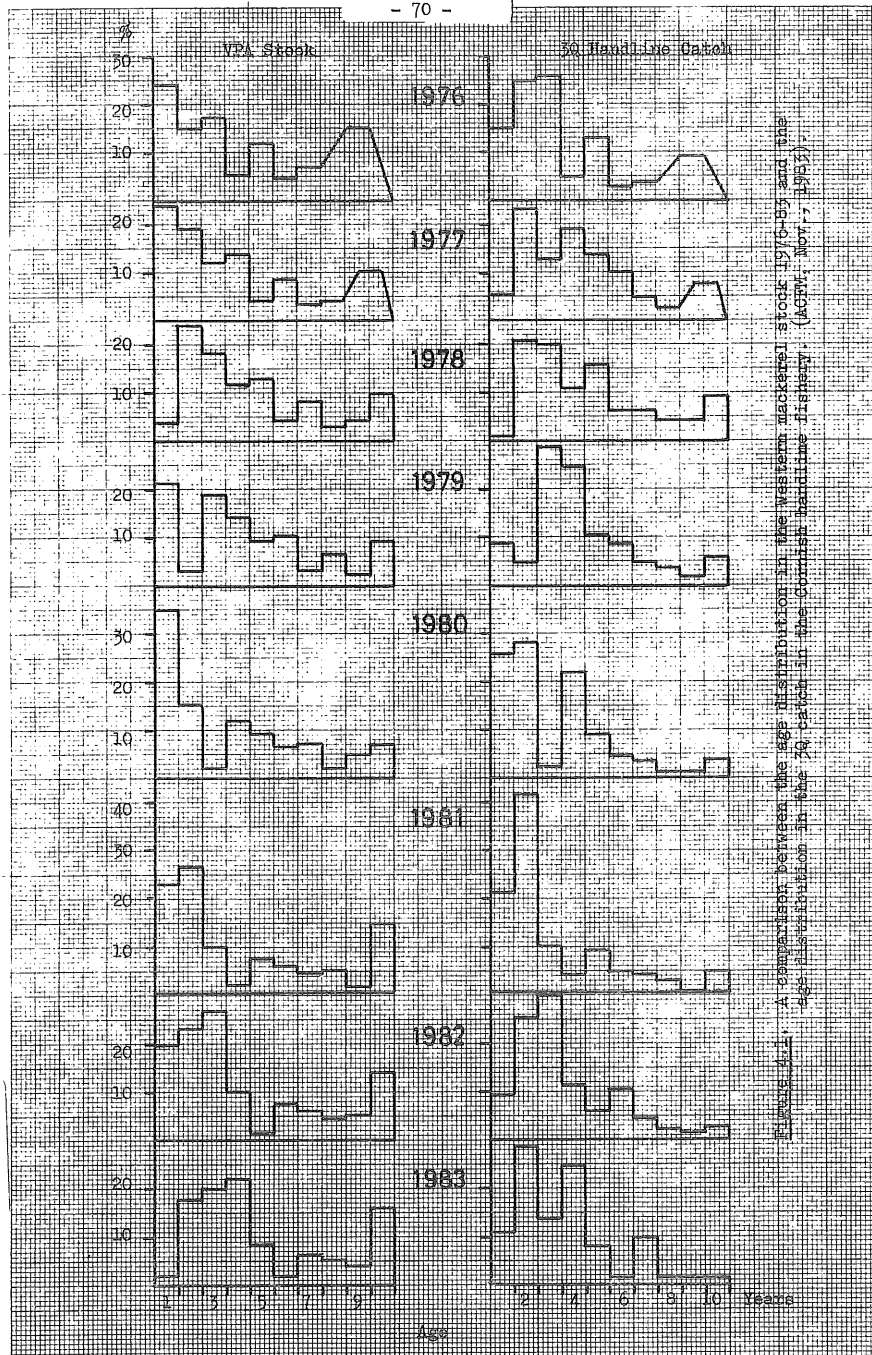


FIGURE 4.1. A comparison between the age distribution in the Western mackerel stock (1976-83) and the age distribution in the 30 catch in the Current headline fishery. (AGFR, Nov., 1983).

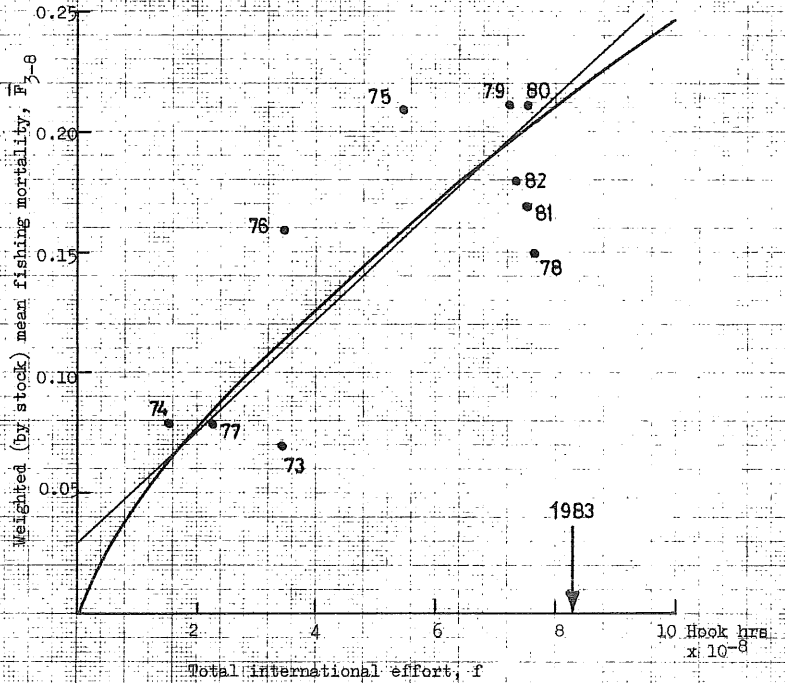


Figure 4.2. Relationship between total international effort, measured in terms of Cornish handline effort (30 opue), and  $F_{3-8}$  calculated by VPA (ACFM, Nov. 1985).

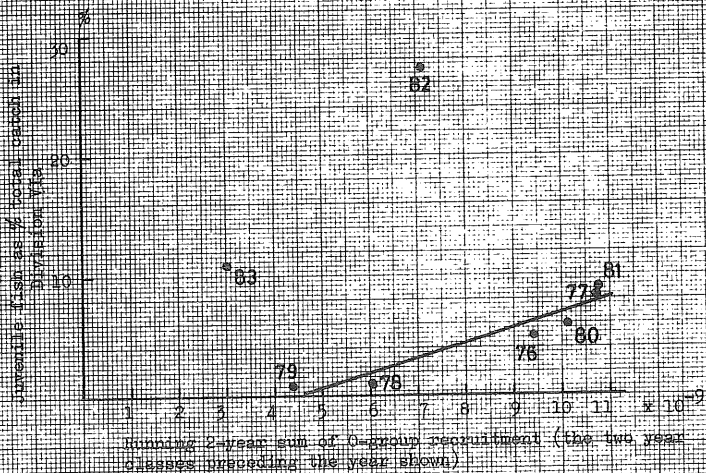


Figure 4.5. Relationship between the relative abundance of juvenile fish (1 & 2 year olds) in Division VIa, as a percentage of total catch of Western MACKEREL stock in Division VIa, and the corresponding year class strength.

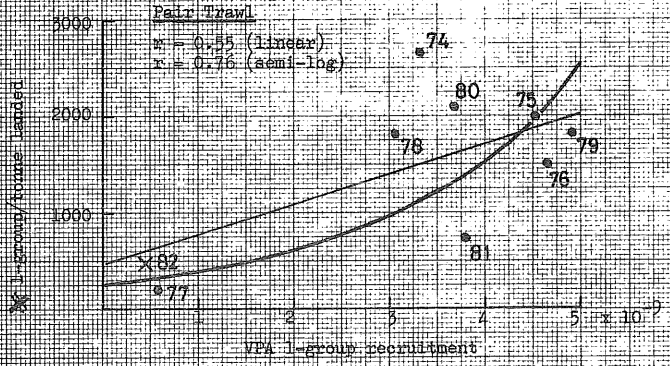
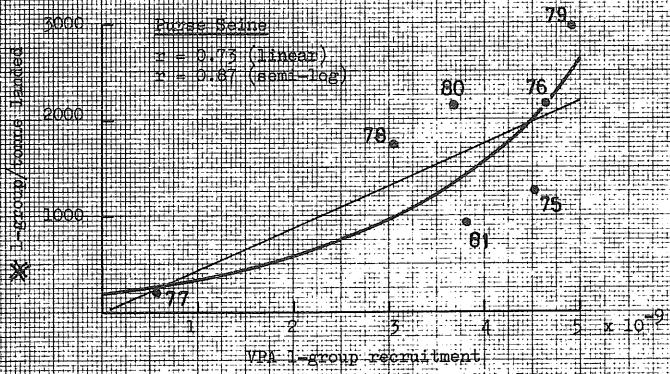
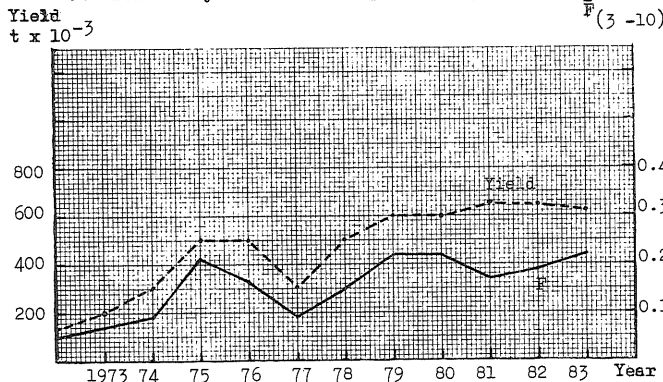


Figure 4.4 Relationship between the number of 1-group MACKEREL/t landed from Divisions VIIc and f), and the VPA estimate of 1-group recruitment. Dates refer to year classes. The 1982 datum is not included in the fitted regression.

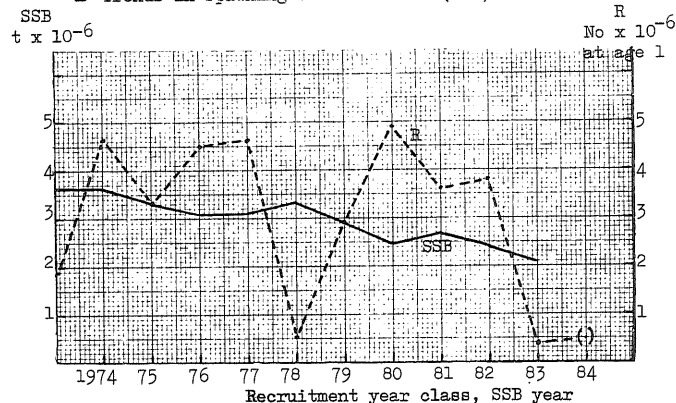
Figure 4.5. FISH STOCK SUMMARY

(Stock) MACKEREL - Western

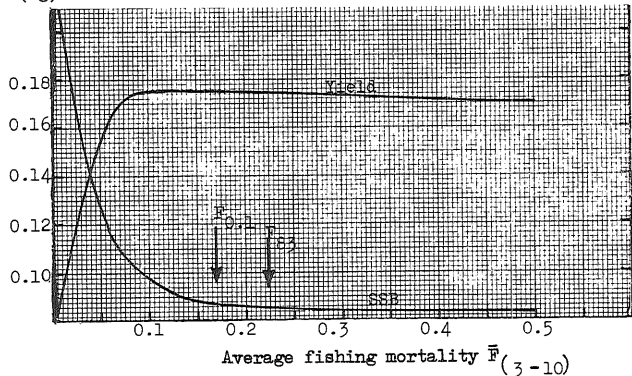
A Trends in yield and fishing mortality ( $\bar{F}$ )



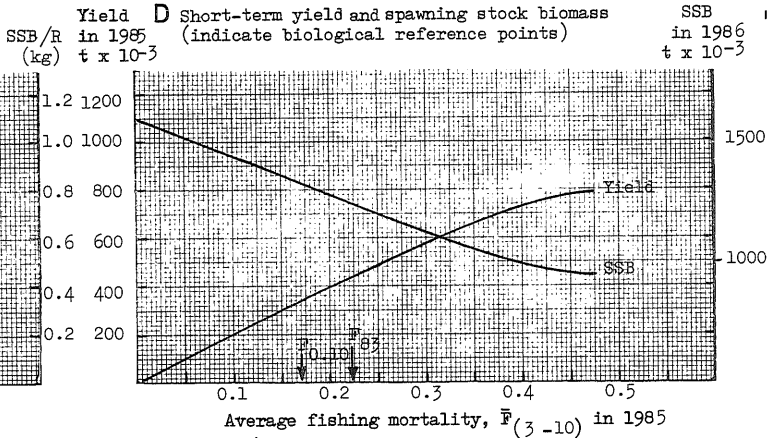
B Trends in spawning stock biomass (SSB) and recruitment (R)



C Long-term yield and spawning stock biomass  
Yield/R (indicate biological reference points)  
(kg)



D Short-term yield and spawning stock biomass  
in 1985 (indicate biological reference points)



$\bar{v}$  (kg/h)

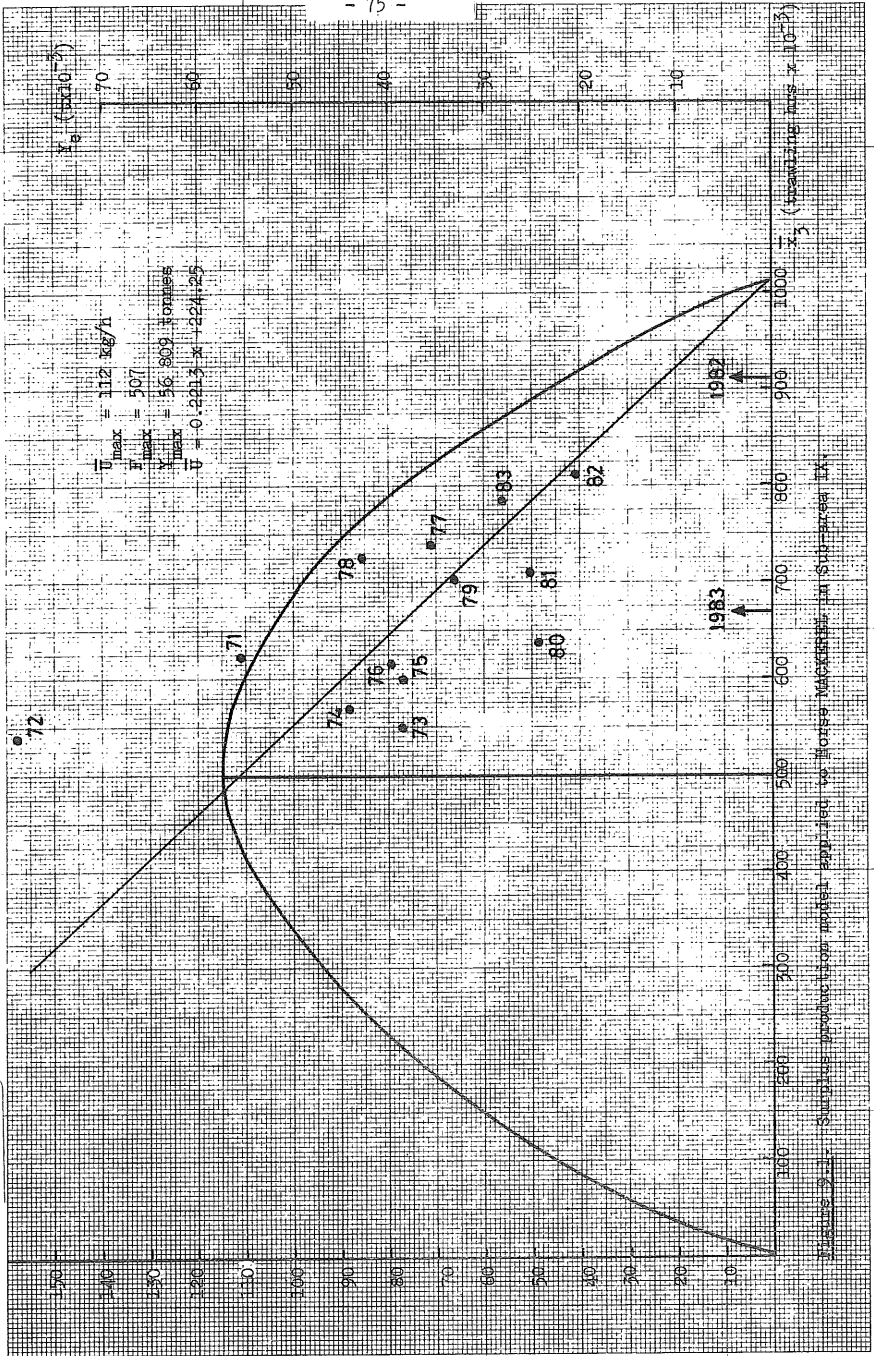


Figure 9.3. Summary of available data, period 1970-1980 for Forest MANGROVE in Subarosa, IX.

