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International Council for the
Exploration of the Sea

C.M.1982/Assess:8

REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

Copenhagen, 23 March - 1 April 1982

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REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

1. PARTICIPANTS

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T Jakobsen	Norway
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P Lewy	Denmark
C T Macer	United Kingdom (England and Wales)
A Souplet	France
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G Wagner	Federal Republic of Germany

K Hoydal, ICES Statistician, also attended the meeting.

2. TERMS OF REFERENCE

At the 1981 Statutory Meeting it was decided (C.Res.1981/2:27:6) that the North Sea Roundfish Working Group should meet at ICES headquarters from 23 March to 1 April 1982 to:

(i) assess catch options for 1983 for cod, haddock and whiting in Sub-areas IV, VI and VII (excluding Divisions VIIa, VIIf and VIIg),

(ii) advise on appropriate minimum mesh size for cod, haddock and whiting if fished in a single species fishery in Sub-area IV, and investigate other possibilities of improving the exploitation patterns on these stocks,

(iii) look at the information available on haddock and cod stocks in Division VIb, with the aim of carrying out an analytical assessment of these stocks, if this is possible,

(iv) estimate the species composition of by-catches in the Pandalus borealis fisheries and advise on an appropriate by-catch limit,

(v) specify deficiencies in data required for assessments.

3. INTRODUCTION

When the report of the 1980 meeting of the Working Group was considered by ACFM, criticisms were expressed concerning the method adopted by the Working Group to determine the values of F at each age for 1980. ACFM revised the calculations by an alternative method subsequently described by Saville (1981). However, it became apparent that there were errors in the revised assessments and, therefore, the assessments were recalculated by a Group consisting of the Chairman of ACFM, the Chairman of the North Sea Roundfish Working Group and the ICES Statistician meeting on 2 November 1981. The details of these revised assessments are given in Appendix 1 to this report (p.130).

4. DATA BASE

Revision of Age Frequencies of Discarded Haddock and Whiting 1960-74 North Sea

In last year's report, total international age frequencies for discarded haddock and whiting for the period 1960-74 were all based entirely on Dutch data. For the period 1975-80, Dutch and Scottish data are available. Comparison of these data sets indicates that the Dutch data and the Scottish data are not in good agreement as to discard practices by the respective fleets. Accordingly, estimates were made of discards of haddock and whiting by Scotland for the period 1960-74. These estimates were then used in conjunction with the Dutch data for those years to derive the total international discard data set. The effect of this procedure can be seen by comparing Tables 4.2 and 4.3 of this report with Tables 3.2 and 3.3 of last year's report.

The method employed to estimate Scottish discards for the period 1960-74 was as follows: the average number of fish of each age discarded per fish landed was estimated from annual data for the period 1975-80 for each Scottish gear type for which human consumption landings age frequencies exist (trawl, seine, light trawl, Nephrops trawl). These average values were then used to estimate discard numbers at age from the appropriate landings' age frequencies for the period 1960-74.

It should be noted that this revision is of a provisional nature. A comprehensive and final estimation of Scottish discards for the period 1960-75 will be carried out during 1982. The results, with associated revisions to the international data, will be made available to the Working Group in advance of next year's meeting.

5. DETERMINATION OF FISHING MORTALITY RATES IN THE LAST DATA YEAR

At last year's meeting the socalled "gamma method" was used to estimate F at age in the last data year. This method was found to have a number of deficiencies and, in an attempt to overcome these, a modified method (the "rho method") was employed.

Basically, the gamma method assumed the following relationship between catch per unit effort and mean number of fish in the sea:

$$\Gamma_{a,y} = \alpha \bar{N}^{\beta}_{a,y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Using Equation (1), correlation is forced between Γ and $\bar{N}$ since the Γ values contain at least some numbers which are also used to calculate $\bar{N}$. A version of the gamma method which would avoid this problem is

$$\Gamma_{a,y} = \alpha N^{\beta}_{a+1,y+1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The rho method makes the assumption that the value of β is exactly unity and that α varies with time, i.e.

$$\Gamma_{a,y} = \alpha_{a,y} N_{a+1,y+1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

or $$rho_{a,y} = \alpha_{a,y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

where $rho_{a,y} = \Gamma_{a,y} / N_{a+1,y+1}$

The theoretical implications of these changes in the assumptions are explained in Appendix 2 (p. 139).

The basic method is to plot $rho_{a,y}$ for each age (a) against year (y). The scatter diagram thus obtained is then used to predict rho in the last data year ($rho_{a,y}$).

In the last data year, therefore, we know $\Gamma_{a,y}$ and $rho_{a,y}$. Hence we can determine $N_{a+1,y+1} = rho_{a,y}/\Gamma_{a,y}$.

Having determined $N_{a+1,y+1}$ and knowing the catch number in the last data year ($C_{a,y}$), we can determine $F_{a,y}$, the fishing mortality rate at age a in the last data year by solving the following equation for $F_{a,y}$:

$$\frac{C_{a,y}}{N_{a+1,y+1}} = \frac{F_{a,y}}{Z_{a,y}} (e^{Z_{a,y}} - 1) \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

The full computational procedure is an iterative one and is fully described in Appendix 2.

For the North Sea stocks, the catch and effort data to which the method was applied were as follows:

Cod - Scotland trawl, seine, light trawl, Nephrops trawl,
England trawl, seine (Table 5.1)

Haddock - Scotland trawl, seine, light trawl, Nephrops trawl (Table 5.4)

Whiting - Scotland trawl, seine, light trawl, Nephrops trawl (Table 5.7)

The output solutions are shown in Tables 5.2-5.3 for cod, in Tables 5.5-5.6 for haddock, and in Tables 5.7-5.8 for whiting. The values of rho from the final iteration are shown plotted against year for cod in Figure 5.1, for haddock in Figure 5.2 and for whiting in Figure 5.3.

The method did not work well for some of the older age groups. This is because the VPA was initiated at age 10 and the values of N at age were not, therefore, well determined at those ages.

The data for Division VIa stocks will not be presented in this report, because the method failed to function well for any of these stocks. This is probably because there are still some internal inconsistencies in the human consumption catch at age set. More importantly, no data are yet available for Division VIa stocks or discards or industrial by-catch. The lack of these data may inhibit application of the rho method to Division VIa stocks.

6. ESTIMATION OF RECRUITMENT

In previous years the Working Group used the results of the International Young Fish Surveys (IYFS) to determine the abundance of the youngest age groups. If this practice had been followed this year, the 1980 and 1981 year classes for the North Sea stocks would have been derived from the IYFS indices and the use of an IYFS index/VPA year class strength relationship. The year class strengths for the West of Scotland stocks would then have been derived from a relationship VPA year class strength VIa/VPA year class strength IV. Input F values for 1981 in the VPA on the appropriate age group would then have to be scaled to give the predicted numbers in the stock.

This year, as mentioned in Section 4, the discard data base for the North Sea haddock and whiting stocks has been revised resulting in a change in VPA stock numbers. The revised data, together with updated IYFS indices, are given in Tables 6.1-6.3 and the relationships are plotted in Figure 6.1-6.3.

In considering the IYFS data this year, the Working Group also examined alternative plots of the data in which the IYFS:VPA ratio was plotted as a time series. For cod, there appeared to be no trend with time, but for haddock and whiting there appears to be evidence of a trend of increasing survey efficiency with time (Figures 6.4-6.5). It is worth noting that this plot is essentially the same plot of

$$\frac{\Gamma}{N}$$

against year, which was used to make the fishing efficiency correction in the rho method used for calculation of VPA input F values. In the case of the survey data, the survey indices are equivalent to cpue indices.

Having observed a probable efficiency trend with time, the Group had to consider possible options for obtaining estimates of recruitment. The options considered were:

1) To use average recruitment
2) To use recruitment determined by an input of an average F value in the VPA
3) To use recruitment estimates from the IYFS/VPA relationships
4) To use estimates of recruitment from IYFS/VPA relationships corrected for efficiency trend.

For cod, the scatter of points from Option 3 was too great to be used for prediction purposes. An alternative data set using selected survey rectangles appeared to give a better relationship but gave a very poor prediction of the 1979 year class, and the predicted value of the 1980 year class was such that the corresponding F value in VPA appeared anomalous.

Option 4 is not applicable for cod. Option 1 was considered unsatisfactory, as the available evidence indicated that the 1980 year class was a poor one.

For haddock and whiting with Option 4, there was some uncertainty about whether the time-series trend was a real one. For Option 3 there were problems with a large positive intercept in the IYFS/VPA plot for whiting and an apparently curved relationship. As with cod, there was evidence to suggest that the year classes concerned were not of average size, and Option 1 was rejected.

Consequently, Option 2, recruitment determined by using an F value in VPA for 0- and 1-groups in 1981 based on an average of recent years, was used for all three North Sea stocks.

Having decided on this approach for the North Sea stocks, it was agreed that it would be appropriate to use the same method for the West of Scotland stocks rather than the use of the VIa/IV relationship. In some cases atypical F values were omitted, if they occurred in the period for calculating the average.

The apparent trend in the efficiency of the IYFS in catching haddock and whiting, which has come to light at this meeting, is something which requires further investigation to determine how real the effect is and

what might account for it, and it is recommended that the IYFS data are re-examined with this objective.

7. NORTH SEA COD

7.1 Catch Trends (Table 7.1 and Figure 7.1.a)

Provisional nominal landings in 1981 were 272 856 tonnes, which represents a 10% increase over the 1980 figure, and a 24% increase over the 1981 TAC of 220 000 tonnes. The 1981 landings were exceeded only by those in 1972 over the past 10 years.

7.2 Age Composition (Table 7.2)

Details of countries supplying age composition data are given in the text table below. Landings by countries, which have an age-sampling programme, formed a high proportion of the total landings in both 1980 and in 1981. Discards were excluded from the VPA input data because they are not as reliably estimated as for haddock and whiting, at least in the Scottish data. Industrial fishery by-catches were also excluded, since they, too, are not estimated with sufficient reliability; the quantities are relatively small.

North Sea Cod

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1980	Industrial by-catch	Norway	595	Not known	?
	Human consumption landings	Belgium, Denmark, England, Federal Republic of Germany, France, Netherl., Scotland	245 726	250 766	98
	Discards	England, Netherl., Scotland	72 617	170 675	43
1981	Industrial by-catch	-	-	Not known	-
	Human consumption landings	Belgium, Denmark, England, Federal Republic of Germany, Netherl., Scotland	260 939	278 920	94
	Discards	Netherl., Scotland	10 919	47 132	23

7.3 Recruitment (Table 6.1 and Figure 7.1.b)

As noted in last year's report, the IYFS/VPA correlation is poor and gives particularly poor prediction of abundant year classes. IYFS estimates adjusted by salinity and by timing considerations give much better correlation (Burd, 1981), but the 1979 year class is still greatly underestimated.

Such adjusted IYFS estimates from the 1981 and 1982 surveys were not available to the Working Group. However, data referring only to rectangles in which salinity has remained within the range 34‰ to 35‰ were supplied from the Lowestoft Laboratory, these data correlating

closely with the full adjusted data set. The estimates correlated well with VPA, but the 1979 year class is still seriously underestimated. Predictions for the 1980 and 1981 year classes were 86 millions and 129 millions, respectively. Using the value indicated for the 1980 year class, together with the catch of this year class estimated for 1981, an F value of 0.35 is produced, a figure which is twice the recent average and well in excess of the highest value recorded previously. It was, therefore, decided not to accept this estimate but to use a recent average F figure (0.18, mean 1978-79), which produces a stock size of 152 millions at age 1 in 1981. Since there is doubt about the IYFS estimates of the 1979 and 1980 year classes, it was considered advisable to assume average recruitment (210 millions) for the 1981 year class recruiting at age 1 in 1982, for which the "standard salinity rectangles" estimate is 129 millions.

7.4 Weight at Age (Table 7.3)

The data on catch weight at age for 1981 were the mean of the data sets supplied (consumption landings) weighted by numbers landed. Before taking means, each set had been adjusted where necessary by sums of products of number x mean weight, to correspond to the total nominal weight. However, for Scottish data the adjustment was made to the numbers instead of the mean weight. For predictions in 1982 and 1983, the mean weights at age were arithmetic averages (unweighted) for the period 1976-81. Stock mean weights were assumed to be the same as catch mean weights.

7.5 Fishing Mortalities in 1981

Except for F at age 1 (which was a recent average), these were estimated by the rho method described in Section 5. F at age 2 was not adjusted to correspond to the number predicted by the IYFS, for the reasons described above (see Section 6 on recruitment), but the F value used does in fact result in a stock size at age 1 in 1980, which is close to that deduced by ACFM in 1981 (Burd, 1981). The F value of 1.23 at age 2 is the largest yet seen in the present cod VPA, but similar increases over preceding years have occurred when other strong year classes (1969, 1970, 1976) have recruited at age 2. It is smaller than the final value (1.30) adopted as input in 1980 for this age group by ACFM (November 1981 Report).

F values for some of the age groups >5 are rather high compared to the recent average and are also about double those finally adopted by ACFM last year for 1980 input. In support of the present values for 1981, it can be said that the values used last year appear to be low compared to recent levels of F, and, in addition, there is some evidence from the VPA that the increased Fs which strong year classes seem to attract at age 2 are also reflected to some extent in the older age groups. The abundance of the 1979 year class might, therefore, have had this effect.

7.6 VPA Results

The fishing mortality results (M = 0.2) are given in Table 7.4. Mean F values increased in 1972 and thereafter fluctuated about a higher level than previously. F in 1980 and 1981 appears to have increased substantially, but this does of course depend on the input method used. The spawning stock biomass (Figure 7.1.c) has shown a gradual decline from 1968 to 1978 but has had a more or less constant level since then.

7.7 Equilibrium Yield for Average Recruitment

This was calculated as described in Section 5.2 of the 1981 Working Group report. The results are given in Figure 7.2. Present F is well in excess of F_{max}. The section on optimum mesh size is also relevant in this context.

7.8 Catch Predictions

The input data are given in Table 7.6. For prediction purposes, mean weights and exploitation patterns averaged over the period 1976-81 were used.

Two options for 1982 were considered:

1) that the 1982 TAC of 235 000 tonnes would be taken, or

2) that F in 1982 would be the same as in 1981.

Both options result in similar catches in 1982, with Option 2 producing 226 000 tonnes at a slightly lower F than in Option 1. Results for Option 2 are shown in Table 7.7 and Figure 7.3. In 1983, the spawning stock biomass will start at the lowest level recorded in the past 17 years. Catch predictions and associated biomasses are tabulated for a range of F values for 1983,and for F_{max} and $F_{0.1}$. If F remains constant in 1983, the predicted catch is 195 000 tonnes.

8. COD IN DIVISION VIa

8.1 Catch Trends (Table 8.1, Figure 8.1.a)

Provisional nominal landings in 1981 were 22 681 tonnes, and were the largest recorded over the past 10 years. They were 16% greater than the TAC for Division VIa, which was 19 500 tonnes.

8.2 Age Composition (Table 8.2)

Details of data supplied for the past 2 years are given in the text table below. Discard estimates were not included in the VPA input, since they have not been collected for a sufficient period for estimates of past total international discards to be made. The revision of the data base, as completed for the North Sea cod at the 1981 ad hoc Working Group meeting, still remains to be done for the Division VIa stock, and it is hoped that this can be accomplished in 1982.

Cod in Division VIa

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1980	Human consumption landings	England, France, Ireland, Scotland	17 739	17 878	99
	Discards	Scotland	344	704	49
1981	Human sumption landings	England, Ireland, Scotland	15 809	23 256	68
	Discards	Scotland	217	837	26

8.3 Recruitment (Table 8.5, Figure 8.1.b)

In the absence of a recruitment survey and of a VPA correlation between the North Sea and Division VIa cod stocks, recruitment of the 1980 year class at age 1 in 1981 was determined by applying an average recent F (1977, 1978) to the catch number. This results in the smallest year class since that of 1971, which was about the same size. Although the rho method was not used to determine 1981 F values (see Section 6), it does also indicate a very poor 1980 year class. Year classes after that of 1980 were assumed as the average of the period 1967-78, at 7.233 millions. The 1978 and 1979 year classes are indicated by the current VPA to be the two largest on record for this stock.

8.4 Weight at Age (Table 8.3)

This was calculated as a mean weighted by the number landed by each fleet. A sum of products correction was applied to all data sets before taking means, except for the Scottish data, in which the numbers were adjusted.

8.5 Fishing Mortalities in 1981

The rho method as used for the North Sea stocks was not used in this stock, as explained in Section 6. Input F values were, therefore, calculated as the mean of the 1976-78 Fs, except that the unusually high values of ages 1 and 2 in 1976 were omitted. The Fs are broadly similar to those used as input F values last year.

8.6 VPA Results (Tables 8.4-8.5)

Some increase in F values is apparent in recent years, although these are dependent on the input values. It is possible that the recent strong year classes are attracting increased fishing effort. The spawning stock biomass (Figure 8.1.c) appears to be increasing after remaining constant for the previous 10 years.

8.7 Yield at Average Recruitment (Figure 8.1.d)

This was calculated using values for mean weights and fishing mortalities averaged over the period 1976-81. Mean recruitment of 7.2 millions was used to calculate the total yield. As with the North Sea stock, the present level of F is well in excess of F_{max}.

8.8 Catch Predictions

Input data are given in Table 8.6. Mean data for the period 1976-81 were used for weight at age and F at age in predictions for 1982 and 1983.

For 1982, Option 1 (Table 8.7) assumed that the TAC (17 000 tonnes) was adhered to, and this implies an approximate halving of F in 1981. Option 2 (Table 8.8) assumes no change in F in 1982, in which case a catch of 31 000 tonnes is predicted. This value is about 30% higher than the previous highest values since 1967. The result is attributable to the presence in the fishery of the 1979 year class. This year class has been estimated to be about 4 times the abundance estimated to it at the last Working Group meeting, based on an average historic abundance. A range of catch and biomass options is given for 1983, and this is graphed in Figure 8.2.

9. COD IN DIVISION VIb

No age compositions are available for this stock, but nominal landings are quite small (Table 9.1). If a TAC is set for the whole of Sub-area VI, an appropriate allowance will need to be made for Division VIb.

10. COD IN SUB-AREA VII

10.1 Cod in Divisions VIId and VIIe (Table 10.1)

As in 1980, the only data available for 1981 were from England, but were based on limited sampling. No further progress towards making an analytical assessment was, therefore, possible.

10.2 Cod in Divisions VIIb,c and VIIg-k (Table 10.2)

No age composition data are available for these Divisions.

11. NORTH SEA HADDOCK

11.1 Catch Trends

Total international landings and total international catches are given in Table 11.1 and shown in Figure 11.1.a for the period 1966-81. Because of the revision of the total international discard estimates referred to in Section 4, the catch values (landings and discards) are different from those presented last year.

The TAC for 1981 was 140 000 tonnes and provisional nominal landings for 1981 were 129 265 tonnes. The Working Group's estimate of total landings in 1981 was 147 227 tonnes.

11.2 Age Composition (Table 11.2)

The estimates of total international discard age compositions were revised for the period 1966-75 by the method stated in Section 4. The revised estimates resulted in a substantial increase in the estimated number of fish discarded and altered the age compositions from those previously used, especially for the younger age groups. Details of the data supplied to the Group by various nations for 1980 (final) and 1981 (provisional) are summarized in the following text table:

North Sea Haddock

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1980	Industrial by-catch	Denmark, Norway	23 346	25 154	93
	Human consumption landings	Belgium, Denmark, England, France, Netherlands, Scotland	93 980	98 812	95
	Discards	Scotland	61 461	94 910	65
1981	Industrial by-catch	Denmark, Norway	16 218	17 786	91
	Human consumption landings	Belgium, Denmark, England, France, Netherlands, Scotland	122 341	129 441	95
	Discards	Scotland	43 795	68 258	64

11.3 Weight at Age

Mean weight at age data for the total fishery are given in Table 11.3. The revision to the discard data has also affected these values.

11.4 Recruitment

For the reasons given in Section 6, it was deciced that it was not advisable to estimate the number of fish in the sea at age 1 in the years 1981 and 1982 from the IYFS survey data. Instead, average F values for the period 1976-78 were calculated for ages 0 and 1 and were used to estimate from the catch data the number of fish in the sea at these ages in 1981. The number of fish at age 0 in 1980 was then obtained from the VPA results. This procedure resulted in estimates of the 1980 and 1981 year classes at age 0 of 834 millions and 3 421 millions, respectively. These values may be compared with the average for the 0-group for the period 1966-78 (excluding the 1967 year class) of 2 415 millions. Historical values for recruitment from VPA are given in Figure 11.1.b.

11.5 Fishing Mortalities in 1981 for Age Groups 2 to 11+

These were calculated using the method described in Section 5.

11.6 VPA Results

Estimated fishing mortalities are shown in Table 11.4 and estimated stock numbers and stock biomass are shown in Table 11.5.

Historical spawning stock biomass values (age 2 and older) are shown in Figure 11.1.c.

Estimated spawning stock biomass in 1981 is somewhat higher than the corresponding values for 1978 and 1979, which were among the lowest on record.

11.7 Equilibrium Yield for Average Recruitment

Equilibrium yield and spawning stock biomass curves are shown in Figure 11.2. These were calculated by methods described in Section 5.2 of the 1981 Roundfish Working Group report. Exploitation pattern and mean weight at age used in the computations, were set at the 1976-81 average values as shown in the last six columns of Table 11.6.

11.8 Catch Predictions

Input data for catch predictions are shown in Table 11.6. The following primary assumptions were made when carrying out the catch predictions:

1) The exploitation pattern in the years 1982 and 1983 would be the same as the average for the period 1976-81.

2) Mean weight at age in the stock and in the various components of the catch (industrial by-catch, human consumption landings and discards) would be the same as the appropriate average values for the period 1976-81.

3) Discarding rates at age would be the same as the average rate for the period 1976-81.

Two catch predictions were then made, based on the following secondary assumptions:

1) The values of F in 1982 would be such that the combined landings of the human consumption fleet and the industrial fleet would exactly equal to the TAC of 180 000 tonnes.

2) The values of the human consumption Fs (landings and discards) in 1982 would be such that the average over the age range 2-6 in 1982 is equal to the corresponding average value for 1981 ($\bar{F}_{2-6,81}$ = 1.223, human consumption fishery).

The result of the second prediction is shown in Table 11.7. Figure 11.3 shows the results as graphs.

The results of prediction 1 have not been included, since the level of F in the human consumption fishery required to take the TAC is about 750% higher than that in evidence for 1981. Such F levels virtually exterminate the spawning stock by the end of 1982 so that predicted landings for 1983 are unbelievably low.

Prediction 2 implies F levels in 1982 unchanged from those in 1981. The resultant landings' figure is 126 000 tonnes (96 000 tonnes human consumption, 30 000 tonnes industrial by-catch). Estimated discards in 1982 under this prediction are 88 000 tonnes.

12. HADDOCK IN DIVISION VIa

12.1 Catch Trends

Nominal landings in 1981 were 17 745 tonnes (Table 12.1), and the Working Group estimated total landings did not differ appreciably from this value. The ACFM advised TAC for 1981 was 15 500 tonnes.

12.2 Age Composition (Table 12.2)

The historical data set was unchanged from that used last year. No estimate of discards or industrial age compositions for the total international fleet are yet available. Data for 1980 (final) and 1981 (provisional) were supplied by the nations indicated in the following text table:

Haddock in Division VIa

Year	Category	Nations supplying age composition data	Weight represented by age composition	Total weight caught	% represented by age composition
1980	Human consumption landings	England, Ireland, Scotland	9 931	12 763	78
1981	Human consumption landings	Ireland, Scotland	13 714	18 179	75

12.3 Weight at Age

Values of mean weight at age of the human consumption landings are shown in Table 12.3.

Stock mean weights are assumed to be equal to mean weights in the human consumption landings.

12.4 Recruitment

For the reasons given in Section 6 it was not thought advisable to estimate recruitment at age 1 in 1981 and 1982 in Division VIa from

the previously used plots of IV/VIa abundance values. Instead, F for age 1 in 1981 was estimated as the average F for age 1 over the period 1977-78 (the 1976 value was ignored since it appeared abnormally high on a historical basis). This procedure produced an estimate of the 1980 year class at age 1 of 4.8 millions. This value may be compared with the average at age 1 for the period 1966-78 (excluding the 1967 year class) of 40.5 millions.

Lacking a valid basis for estimating the abundance of the 1981 year class in 1982, it was decided to assume that its abundance would be set at the average mentioned above. Year classes after that of 1981 were also assumed to be of average abundance.

12.5 Fishing Mortality Rates in 1981, Ages 2-8+

These were assumed to be equal to the average values for the period 1976-78.

12.6 VPA Results

Estimates of fishing mortality rate are given in Table 12.4 and stock numbers and stock biomass values are given in Table 12.5. The estimated spawning stock size for 1981 is about double that for 1979.

12.7 Equilibrium Yield for Average Recruitment

The yield and spawning stock biomass curves are shown in Figure 12.1.d. The exploitation pattern and the mean weight at age values used as input were average for the period 1976-81.

12.8 Catch Prediction

The input data for the catch predictions are given in Table 12.6.

The primary assumptions about exploitation pattern and mean weight at age in 1982 and 1983 were the same as those described for North Sea haddock, except that no consideration needed to be given for industrial by-catch and discards, since no data on these components of the fishery are yet available.

The secondary assumptions on F levels in 1982 were identical to those given for North Sea haddock, i.e.

1) F_{82} to produce the TAC of 15 500 tonnes
2) $\bar{F}_{82} = \bar{F}_{81}$

The results of the prediction runs are shown in Tables 12.7 and 12.8. Only the results for Option 2 (Figure 12.2) are presented graphically for 1983, since the two sets of results are virtually identical for that year.

The level of F required to take the TAC in 1982 is 16% lower than F levels in 1981. The expected catch in 1982, assuming $\bar{F}_{82} = \bar{F}_{81}$ is 17 000 tonnes.

Under all options for 1983 (irrespective of assumptions for 1982) spawning stock levels at the start of 1984 are expected to fall below the 1981 level. This is principally due to the assumptions mentioned in Section 12.4, that the 1980 year class is of very low abundance.

13. HADDOCK IN DIVISION VIb

13.1 Catch Trends (Table 13.1)

Increased fishing activity on Rockall Bank resulted in a significant increase in landings in 1980 when 7 300 tonnes were landed. Provisional figures indicate that landings in 1981 exceeded 9 000 tonnes. Virtually all the catch was taken by English trawlers.

13.2 Stock Assessment

Sampling of landings from this stock have been poor, and there is no adequate historic data series of age compositions of landings. Although English landings have increased, the majority of vessels in 1981 landed in foreign ports and sampling was not possible. It is, therefore, not possible to make a VPA for this stock. Jones (1982) has described a trawl survey on Rockall Bank and an assessment based on the results of the survey. This assessment is summarized here:

The age composition of the stock was obtained from survey catches made with a trawl fished with a small-meshed liner. The total stock size was estimated to be 70 000 tonnes. This was based on a comparison of survey catch rates at Rockall with catch rates from a similar survey in the northern North Sea, and using the estimated North Sea haddock stock size and the total area occupied by the two stocks. The age composition shows that year class strengths have been very variable (Table 13.2). The year classes of 1975, 1978, and 1979 appear to have failed almost completely, and in recent years the fishery has been sustained by the abundant 1976 and 1977 year classes. Survey results indicated that the 1980 year class, which will recruit to the fishery in 1982, and especially the 1981 year class, are both very abundant. Estimates of fishing mortality at age were made, using an age composition of the catch derived from the age composition of the stock, and a selection ogive appropriate to an 80 mm cod-end mesh size, and scaled to a total catch estimate of 9 000 tonnes.

This gave a value on fully exploited age groups of F = 0.18 (Table 13.3). A yield per recruit curve (Figure 13.1) calculated from the exploitation pattern and weight at age data is given in Table 13.3 and gives a value of F_{max} = 0.35.

These results were used as a basis for a catch prediction, which gave a predicted catch of 17 000 tonnes for 1982 and 30 000 tonnes in 1983 for the same level of fishing mortality as in 1981.

These catch predictions are not greatly affected by error in the estimate of 1981 stock size, but they are very dependent on the estimates of the size of the 1980 and 1981 year classes. A further survey is planned for 1982.

14. HADDOCK IN SUB-AREA VII

Nominal catches of haddock in Divisions VIId,e and in VIIb,c,g-k are given in Tables 14.1 and 14.2. No other data were available, and no assessments could be attempted.

15. NORTH SEA WHITING

15.1 Catch Trends (Table 15.1, Figure 15.1.a)

Total official landings in the period 1972-80 fluctuated between 103 000 tonnes and 191 000 tonnes, averaging 138 000 tonnes (Table 15.1). Provisional nominal landing figures for 1981 amount

to 93 000 tonnes, and the Working Group estimate of total landings is 149 000 tonnes. This is close to the recommended TAC of 150 000 tonnes. Total catch in 1981 including discards is estimated to have been 194 000 tonnes.

15.2 Age Composition (Table 15.2)

Estimates of discards have been revised for the whole time series (see Section 5). For 1980, the age composition has been updated from the provisional figures. The major change was resulting from an increase in the estimate of discards of 30 000 tonnes, which produced higher catch in numbers, especially for age groups 1-3.

Details of the data supplied to the Working Group by various nations for 1980 and 1981 (provisional) are summarized in the following text table:

North Sea Whiting

Year	Category	Nations supplying age composition data	Weight represented by age comp.	Total weight caught	% represented by age compositions
1980	Industrial by-catch	Denmark, Norway	41 747	45 747	91
	Human consump. landings	England, France, Netherl., Scotland	87 003	92 534	94
	Discards	England, Netherl., Scotland	47 561	86 940	55
1981	Industrial by-catch	Denmark, Norway	63 132	70 167	90
	Human consump. landings	England, France, Netherl.,Scotland	74 233	79 024	94
	Discards	Netherlands, Scotland	17 117	44 994	38

15.3 Recruitment

In the absence of acceptable independent estimates of the strengths of year classes 1980 and 1981 (see Section 6), the values used were those resulting from assuming average F for the period 1977-79 for ages 0 and 1 in 1981. This gave for the 1980 year class a value of 1 066 x 10^6 and for the 1981 year class 2 566 x 10^6 at age 0, which are both below the long-term average of 3 131 x 10^6.

15.4 Weight at Age

Mean weight at age data for total catches are given in Table 15.3.

15.5 Fishing Mortalities in 1981 for Age Groups 2-11+

Fishing mortalities in 1981 for these age groups were based on the method described in Section 5.

15.6 VPA Results

Estimates of F as calculated by VPA are given in Table 15.4. The average F values over the age groups 2-6 indicate that the overall fishing mortality in 1981 was about 6% higher than in 1980 and there has been an increasing trend after 1978. Estimates of stock numbers and stock biomass are given in Table 15.5.

Knife-edged recruitment at age 2 to the spawning stock was assumed. Spawning stock biomass after 1965 has fluctuated between 160 000 tonnes and 500 000 tonnes (Table 15.5, Figure 15.1.c). From 1981 to 1982 the spawning stock biomass is estimated to have been reduced from 312 000 tonnes to 208 000 tonnes.

15.7 Equilibrium Yield for Average Recruitment

Long-term yield and discards assuming average recruitment are presented in Figure 15.2. Input data were those used for catch predictions (Table 15.6). The calculations were done as described in Section 5.2 of last year's report.

15.8 Catch Prediction

Input data for the catch predictions are given in Table 15.6. The following primary assumptions were made when carrying out the catch predictions:

1) The exploitation pattern in the years 1982 and 1983 would be the same as the average for the period 1976-81.

2) Mean weight at age in the stock and in the various categories of catch would be the same as the appropriate average for 1976-81.

3) Discarding rates at age would be the same as the average rates for 1976-81.

Two catch predictions were then made, based on the following secondary assumptions:

1) The values of F in 1982 would be such that the combined landings of the human consumption fleet and the industrial fleet would exactly equal the TAC of 170 000 tonnes.

2) The value in 1982 would be such that the average over the age range 2-6 in 1982 is equal to the corresponding average value for 1981 ($\bar{F}_{2-6,81}$ = .90, human consumption fishery).

The results of Prediction 1 show that the level of F in the human consumption fishery in 1982 required to take the TAC is about 350% higher than in 1981. This option for landings in 1982 is therefore disregarded.

The results of Prediction 2 are shown in Table 15.7 and Figure 15.3. The landings in 1982 with the same level of F levels as in 1981 is estimated to be 127 000 tonnes (70 000 tonnes human consumption, 57 000 tonnes industrial by-catch). Estimated discards in 1982 are 54 000 tonnes.

16. WHITING IN DIVISION VIa

16.1 Catch Trends (Table 16.1 and Figure 16.1)
Provisional landings in 1981 were 11 800 tonnes, which is the lowest after 1970. The TAC was 16 400 tonnes. Estimates of discards were not available.

16.2 Age Composition (Table 16.2)

There were no changes in the age composition data used last year. A provisional age composition for 1981 was assembled. Details of the data supplied to the Working Group are summarized in the text table below.

Whiting in Division VIa

Year	Category	Nations supplying age comp. data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1980	Human consumption landings	France, Ireland Scotland	12 534	12 782	98
1981	Human consumption landings	Ireland, Scotland	11 370	11 779	88

16.3 Recruitment (Figure 16.1.b)

There were no independent estimates available of the strength of the most recent year classes, which therefore had to be taken from the VPA. It was therefore decided to assume that F at age 1 in 1981 was equal to the average F for the period 1976-80. The estimate of the 1980 year class at age 1 obtained by these means is 18.6×10^6. This might be compared to the long-term average (1966-78) of 8.7×10^6. This average value was used as prediction input for year classes after that in 1980.

16.4 Weight at Age

Mean weights at age for total landings are given in Table 16.3.

16.5 Fishing Mortalities in 1981 for Age Groups 2-8+

The average F at age for 1976-78 was used as input in 1981 for age groups 2-4. F = 1.20 was used for older age groups.

16.6 VPA Results

Estimates of fishing mortality as calculated by VPA are given in Table 16.4, and stock numbers and biomass in Table 16.5. Spawning stock biomass (ages 2+) appears to have been stable at a relatively low level in recent years (Table 16.5, Figure 16.1.c).

16.7 Equilibrium Yield for Average Recruitment

Yield was calculated using an exploitation pattern and mean weights at age equal to the averages for 1976-81 (Figure 16.1.d).

16.8 Catch Prediction

The input data for the catch predictions are given in Table 16.6.

The primary assumption about exploitation pattern and mean weight at age in 1982 and 1983 were the same as described for North Sea whiting, except that no consideration was given to industrial by-catch and discards, for which no data are yet available.

The secondary assumptions were:

1) F_{82} to produce the TAC of 13 000 tonnes

2) $\bar{F}_{82} = \bar{F}_{81}$

The results of the prediction runs are shown in Tables 16.7 and 16.8, and are also given in Figure 16.2.

To take the TAC of 13 000 tonnes in 1982, an increase in fishing mortality of 30% from 1981 is needed.

17. WHITING IN SUB-AREA VII

17.1 Whiting in Divisions VIId,e

Landing figures for 1980 have been revised from 7 348 tonnes to 8 635 tonnes. The time series shows a decline since 1975 (Table 17.1). Provisional landings in 1981 are 8 348 tonnes, which is the lowest value since 1974.

Age composition for 1980 has been revised to the total catch of the year. For 1981, the age compositions have been submitted by England (13.6% of the provisional landings) and France (85.2%). The English age composition was raised to the total of English and Belgium catches and then the French was added.

A VPA was made to give some indication about the level of exploitation. The input and the results are given in Tables 17.2 - 17.5. The data-base time series is too short to allow to detect any trend in fishing mortality. The age groups seem to be fully exploited from the age of 3 or 4, but there are no data on discards, which means that the fishing mortalities on the younger age groups are poorly estimated. The VPA seems to indicate that the 1980 year class is the smallest of the time series.

17.2 Whiting in Divisions VIIb,c and VIIg-k (Table 17.6)

Landings in 1980 have increased from the low 1977-79 level to the level of 1976. Landings in 1981 are not known because the reported data are incomplete.

18. APPROPRIATE MINIMUM MESH SIZES FOR SINGLE SPECIES FISHERIES FOR COD, HADDOCK AND WHITING

A paper on this subject by Macer (1982) was considered by the Working Group, and it was agreed that the results could be adopted to provide the relevant advice.

The input data used in the analyses are given in Tables 18.1-18.5. The values for mean length at each age were derived from English groundfish surveys and from Working Group data. Standard deviations

were also obtained from the groundfish surveys and from English commercial data, while the weight-length constants come from unpublished English data (cubic exponent assumed). The Working Group expressed reservations about the constant values for standard deviation for the older ages. If standard deviation is a function of mean length, it is thought unlikely that the conclusions from this study would be affected significantly. Selectivity data (Table 18.2) were taken from the 1974 Working Group report, except for selection ranges at the larger mesh sizes, which were estimated by extrapolation.

Mean length per age group at different mesh sizes were obtained by applying a selection ogive to the length composition of each age group in the stock, assuming normal distributions for the latter. These mean lengths were converted to mean weights by application of appropriate length/weight relationships. The calculations also produced the numbers retained by each mesh size, which were expressed as a proportion of the number retained by the 75 mm mesh. By applying these proportions to the F at age array for the latter mesh size, exploitation patterns were obtained for the other mesh sizes.

The exploitation patterns for the 75 mm mesh are the mean values for the human consumption catch (landings and discards) in the period 1975-80, taken from the Working Group data. They were smoothed and normalised to unity at the age/ages of maximum F. Although there is some doubt about the reliability of the discard data in cod, it was felt to be preferable to include them in this particular analysis.

Two methods were used to calculate "optimum" mesh sizes. In the first, rather simple, method, the annual biomass of a cohort of fish was calculated with a natural mortality of 0.2 and zero fishing mortality, and the mean weight at the age of maximum biomass was converted to length, and the mesh size corresponding to 50% retention was calculated. The results are given in Table 18.6, in which "optimum" mesh sizes of 261 mm, 134 mm, and 91 mm are indicated for cod, haddock and whiting, respectively. Although infinite fishing mortalities would be required to obtain the maximum yields, these mesh sizes are close to those calculated as "optimum" for recent Fs by the second method.

In the second method, yield per 1 year old recruit was calculated for each mesh size over a range of Fs, using the appropriate exploitation patterns and weight at age data. Total yield was obtained by multiplying by average recruitment (1981 Working Group data). Table 18.7 gives equilibrium yields at different mesh size per recruit levels of F (1975-80) and at F_{max}. With recent Fs, maximum yields are obtained at mesh sizes of 250 mm, 140 mm, and 90 mm for cod, haddock and whiting, respectively, these values being similar to those obtained from the first method. The last column gives the total yield from all three species combined, and this occurs at a mesh size of 120 mm.

These results indicate, therefore, that at the present level of fishing mortality (~ effort), on biological considerations the correct mesh size to secure a maximum yield in the long run would be

Cod	250 mm
Haddock	140 mm
Whiting	90 mm.

On the other hand, with the use of the present recommended mesh size of 90 mm, the results suggest that fishing mortality levels, in order to secure a maximum yield in the long run for each species separately, should be as follows:

Cod	0.3 (reduction 72%)
Haddock	0.45 (reduction 55%)
Whiting	1.5 (increase 107%)

Intermediate combinations can be read from Table 18.7.

It should be pointed out that the calculations take no account of possible density-dependent effects, nor of species interactions. In view of the large changes in biomass, which are predicted at large mesh sizes (Table 18.8), such effects are clearly possible.

Other Possibilities of Improving Exploitation Patterns for Cod, Haddock and Whiting

In the context of the fisheries in the North Sea for cod, haddock and whiting, improving exploitation patterns on these species means reducing the number of younger fish in the catches.

In the human consumption fisheries, large amounts of young haddock and whiting are known to be discarded. The only way to alleviate this problem is to enforce mesh sizes appropriate to each species. The mesh size appropriate to cod is, however, not the same as that for haddock, which is in turn different from that for whiting. Since these species are caught in a mixed fishery, there, therefore, to be little scope for eliminating discarding entirely.

Small-meshed fisheries often take a significant by-catch of young protected species. Obviously, any reduction in such fisheries will reduce the mortality rates on the by-catch species, provided that the mesh size in the human consumption fisheries can be appropriately set to ensure that discarding does not increase, as a result of there being more young fish in the sea.

With regard to cod, the IYFS data show that 1 and 2 year old fish are concentrated in the German Bight in spring. If the fisheries in this area were directed solely towards cod, or if certain areas within it could be so defined, a mesh increase could be effective in reducing Fs on these age groups, according to the data in Table 18.7. In this context, it should be noted that both in the Federal Republic of Germany and in the Netherlands is cod fishing being more and more commonly performed by vessels using, voluntarily, cod ends with mesh sizes of 100-120 mm compared to the present legal mesh size of 80 mm. Alternatively, a closed area regulation could achieve a similar result, though it would also preclude capture of older cod in these areas. Apart from the question of enforcement, the Working Group did not have the data necessary for an evaluation of the likely results of such measures. Appropriate data would be, for example, North Sea charts of catches by area (preferably by ICES rectangles) and by season (preferably monthly) for all demersal species by each country. This questions is obviously also relevant to the North Sea Flatfish Working Group.

19. BY-CATCHES IN THE Pandalus borealis FISHERIES

19.1 The Pandalus Fisheries

The main countries fishing for Pandalus in the North Sea are Denmark, Norway and Scotland. The Danish fishery has taken place on the Fladen Ground, and there is also a fishery in the Skagerrak, which extends into the North Sea in the Norwegian Deep. Landings consist of the Pandalus catches and by-catch fish suitable for human consumption. In addition, some of the vessels, which are equipped with industrial fish holds, also land by-catches of species not suitable for human consumption for industrial purposes. This category may possibly include undersized protected species.

The Norwegian fishery takes place mainly in the Norwegian Deeps and extends into the Skagerrak. All the by-catch is normally landed sorted into fish suitable for human consumption and the remainder, which is used for industrial purposes.

The Scottish fishery takes place on the Fladen Ground and in the Farne Deeps. Only by-catch suitable for human consumption is normally landed, and the rest of the by-catch is discarded at sea.

Nominal landings of Pandalus in the period 1970-80 from the North Sea and the Skagerrak are given in Table 19.1.

19.2 Species Composition of the By-Catches

A study of the by-catches in the Danish fishery was commissioned in 1981 by the Commission of the European Communities, but the only results to date relate to the Skagerrak fishery.

For the Norwegian fishery, sampling has been carried out in 1981, and the results are summarized in Table 19.2. The by-catch species landed for human consumption and for industrial species are shown separately. On average, Pandalus accounted for 42% of the total catch, and 4.5% consisted of fish landed for human consumption. The remaining 53% of the catch was landed for industrial purposes with blue whiting being the most abundant species. Undersized cod, haddock and whiting together amounted to less than 1% of the total catch.

Data of the by-catch landed in the Scottish Pandalus fishery in 1970-75 on the Fladen Ground have been analyzed by Howard (1976), and his results, with additional data for 1976-80, are summarized in Table 19.3. The by-catch data in this table do not include fish which are discarded at sea. Some information on discarding is available from Howard (1978), who found that the catches were made up of 46% Pandalus, 15% fish retained for landing, and 39% discarded fish. These data are given in Table 19.4. However, of the discarded fish about 87% (by number) were Norway pout,and cod, haddock and whiting accounted for 0.4%, 2.3% and 1.1% respectively of the discarded fish.

In addition to the above observations, data from research surveys carried out by commercial vessels chartered by the Federal Republic of Germany were given in the report of the 1981 meeting of this Working Group.

The available data indicate that in both the Scottish and Norwegian commercial Pandalus fisheries, the catch is made up of about 45% Pandalus and 55% by-catch. Surveys by the Federal Republic of Germany took a lower proportion (21-30%) of shrimp, but these results may not be typical of true commercial fisheries. On the

Fladen Ground (Scottish data), the observed by-catch landings of protected species constituted about 26% of the landings of shrimp. In the Norwegian Deep (Norwegian data), the equivalent percentage is about 11%. The quantity of undersized protected species taken in the Pandalus fishery appears to be small.

In considering advice on appropriate by-catch limits, the Working Group was given no indication what was to be considered as by-catch. Possibilities for this category could be

(i) Total fish (excluding Pandalus) retained on board

(ii) Total fish of protected species retained on board

(iii) Fish of protected species retained on board for sale for human consumption.

In this context it should be remembered that some vessels discard by-catch fish not suitable for human consumption, while other vessels retain on board all by-catch fish.

The other requirement of a by-catch regulation is to define to what the by-catch is to be related. In the case of the Pandalus fishery, it would probably be the most simple to define the level of by-catch in relation to the quantity of Pandalus on board a vessel, e.g., the quantity of by-catch retained on board a vessel should not exceed x % by-weight of the quantity of Pandalus. The actual percentage figure will depend on the definition of by-catch.

20. DEFICIENCIES IN DATA

20.1 Age Frequencies and Mean Weight at Age

The Working Group considers it highly desirable that age frequencies and/or mean weight at age data should be provided as indicated in the following text table:

Species	Area	Nation	Age frequency	Mean weight at age
Cod	IV	France	x	x
	VIa	France	x	x
	VIId,e	France	x	x
Whiting	VIIe	England	x	x

20.2 Sum of Products Discrepancies

SOP discrepancies are unacceptably high for the data sets in the following text table:

Species	Area	Nation
Haddock	VIa	France
Whiting	VIa	France
Cod	IV	Netherlands

20.3 Other Considerations

20.3.1 In the past, Faroese industrial by-catch of haddock and whiting have been estimated from the following relationship:

$$\frac{\text{(Norway pout catch by Faroes)}}{\text{(Norway pout catch by Denmark)}} \times \text{(Danish age composition)}.$$

Some doubt was thrown on this procedure at this meeting, and the Working Group would like advice on this topic. In this context, it should be remembered that the only other data on industrial by-catch age frequencies are provided by Norway.

20.3.2 Assuming that ACFM finds the "rho method" described in Section 5 acceptable, it would be very desirable to have access to data from as many nations as possible disaggregated by gear. An example of the type of data required is provided in Table 5.1 for North Sea cod, where Scotland provided data for four gears and England provided data for two gears over a 16 year period. In addition, effort data corresponding to the Danish industrial by-catch age frequencies already available to the Group are also required.

The Dutch representation intends to try to provide appropriate data for North Sea cod for the next meeting. More data for haddock and whiting in the North Sea and for cod, haddock and whiting in Division VIa are urgently required.

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Table 4.1 North Sea. COD. Numbers ('000) and weight (tonnes) in each category.

Year	Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight
1963	56 495	107 936	5 659	1 708	62 154	109 644
1964	51 729	115 435	6 571	1 857	58 300	117 292
1965	94 349	172 619	19 798	5 204	114 147	177 823
1966	115 024	211 937	22 578	6 010	137 602	217 947
1967	124 779	242 108	15 724	4 481	140 503	246 589
1968	146 039	277 062	6 372	2 150	152 411	279 212
1969	76 286	193 612	7 443	2 027	83 729	195 639
1970	124 517	218 763	63 759	11 002	188 276	229 765
1971	226 093	314 544	53 707	13 374	279 800	327 918
1972	243 478	341 051	21 573	8 831	265 051	349 882
1973	125 133	227 787	46 620	8 196	171 753	235 983
1974	102 367	202 269	4 588	950	106 955	203 219
1975	109 863	184 974	35 390	6 045	145 253	191 019
1976	128 536	209 914	8 201	2 050	136 737	211 964
1977	140 359	181 121	99 474	16 573	239 833	197 694
1978	212 729	260 890	100 786	27 874	313 515	288 764
1979	170 706	248 051	236 295	67 490	407 001	315 541
1980	192 691	250 766	660 066	170 675	852 757	421 441
1981*	226 016	278 920	164 776	47 132	390 792	326 052

*Preliminary

Table 4.2 North Sea. HADDOCK. Numbers ('000) and weight (tonnes) in each category.

Year	Industrial		Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1960	142 567	12 200	208 753	75 242	853 264	131 791	1 204 584	219 233
1961	982 786	11 100	189 763	74 862	888 867	132 991	2 061 416	218 953
1962	285 824	11 200	148 967	58 677	2 673 394	383 153	3 108 185	453 030
1963	255 844	13 700	180 624	68 364	1 245 890	188 969	1 682 358	271 033
1964	598 840	88 600	351 422	130 509	643 595	160 319	1 593 857	379 428
1965	1 092 756	74 600	369 998	161 613	253 860	62 236	1 716 614	298 449
1966	2 232 098	46 700	406 399	225 760	489 695	73 573	3 128 192	346 033
1967	699 516	20 700	272 201	147 391	448 264	78 059	1 419 981	246 150
1968	557 995	34 200	220 977	105 440	837 979	161 882	1 616 951	301 522
1969	1 889 659	338 353	909 208	330 897	1 203 447	260 231	4 002 314	929 481
1970	1 621 762	179 729	1 244 162	524 622	515 018	101 376	3 380 942	805 727
1971	913 516	31 546	473 069	235 358	1 282 184	177 485	2 668 769	444 389
1972	531 113	29 585	427 890	192 901	760 224	128 130	1 719 227	350 616
1973	170 412	11 267	449 107	178 610	659 515	114 719	1 279 034	304 596
1974	936 218	47 777	357 011	149 617	1 000 667	166 782	2 383 896	364 176
1975	734 412	41 380	362 239	146 616	1 862 031	260 427	2 958 681	448 423
1976	446 767	48 204	397 743	165 624	788 037	154 289	1 632 547	368 117
1977	350 521	34 993	319 991	137 372	225 974	44 369	896 486	216 734
1978	425 714	9 659	192 021	85 981	422 631	77 681	1 040 366	173 321
1979	1 099 865	17 414	190 414	83 249	286 968	41 834	1 577 247	142 497
1980	768 645	25 154	218 392	98 860	541 779	94 910	1 528 816	218 924
1981*	828 555	17 894	269 456	129 425	303 259	68 528	1 401 270	215 847

*Preliminary

Table 4.3 North S WHITING. Numbers ('000) and weight (tonnes) in each gory.

Year	Industrial		Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1960	141 183	11 639	190 513	47 566	763 229	121 600	1 094 925	180 805
1961	271 885	16 177	289 708	67 828	1 645 728	241 122	2 207 321	325 127
1962	112 954	8 347	222 274	55 952	1 185 487	156 713	1 520 715	221 012
1963	499 847	45 431	214 477	58 205	853 608	154 401	1 567 932	258 037
1964	393 794	28 124	220 682	60 064	341 223	58 784	955 699	146 972
1965	182 171	22 259	313 057	85 978	490 073	77 184	985 301	185 421
1966	431 635	51 176	351 953	105 229	545 116	83 356	1 328 704	239 761
1967	280 275	22 840	245 396	68 215	1 102 690	142 703	1 628 361	233 758
1968	592 395	57 506	298 807	88 281	596 827	90 898	1 488 029	236 685
1969	1 980 444	152 364	203 640	57 149	625 916	114 566	2 810 000	324 079
1970	1 855 953	114 504	271 813	79 274	347 540	67 814	2 475 306	261 592
1971	1 477 350	71 699	185 690	58 005	458 746	62 589	2 121 786	192 293
1972	1 351 090	61 166	178 908	59 868	398 294	66 598	1 928 292	187 632
1973	1 273 007	89 614	234 405	66 479	658 852	110 128	2 166 264	266 221
1974	1 841 153	130 293	254 114	74 561	477 271	84 753	2 572 538	289 607
1975	1 019 586	86 376	251 761	78 722	698 963	134 698	1 970 310	299 796
1976	1 395 318	149 759	243 201	74 231	633 359	134 176	2 271 878	358 166
1977	1 657 167	106 104	267 023	74 374	555 515	107 186	2 479 705	287 664
1978	1 163 125	55 274	322 834	88 475	241 670	35 442	1 727 629	179 191
1979	887 889	59 021	351 613	99 321	651 877	78 371	1 891 379	236 713
1980	644 159	45 747	313 565	92 534	547 726	86 940	1 505 450	225 221
1981*	982 344	70 167	257 746	79 024	290 065	44 994	1 530 155	194 185

*Preliminary

Table 5.1. North Sea COD.
Effort (hours fished) and catch at age (No. x 10^{-3}). Input for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1966	194.012	1453.	2836.	1034.	502.	235.	90.	18.	4.	2.	4.	
1967	215.319	714.	3668.	1693.	534.	232.	126.	33.	13.	7.	50.	
1968	218.141	333.	1830.	1598.	584.	75.	65.	41.	9.	3.	1.	
1969	123.010	23.	1258.	836.	562.	172.	29.	26.	7.	2.	10.	
1970	133.445	300.	303.	1025.	485.	270.	101.	15.	15.	7.	50.	
1971	174.559	735.	2150.	520.	579.	160.	64.	57.	9.	5.	60.	SCOTLAND
1972	201.493	200.	5089.	1633.	183.	317.	76.	43.	15.	4.	2.	TRAWL
1973	182.541	323.	1405.	2629.	471.	61.	67.	28.	14.	0.	0.	
1974	185.432	565.	1179.	926.	820.	144.	34.	49.	14.	8.	3.	
1975	152.977	351.	1597.	431.	265.	272.	38.	9.	16.	7.	1.	
1976	121.841	129.	1301.	677.	152.	85.	87.	11.	4.	3.	2.	
1977	144.548	420.	576.	840.	228.	70.	31.	31.	6.	3.	2.	
1978	135.220	304.	1425.	286.	182.	64.	16.	12.	7.	3.	1.	
1979	87.467	216.	916.	448.	74.	47.	23.	12.	4.	3.	1.	
1980	55.475	154.	850.	380.	127.	20.	20.	8.	7.	1.	2.	
1981	51.553	96.	928.	388.	114.	51.	14.	6.	2.	1.	1.	
1966	500.668	2603.	7065.	1301.	584.	430.	68.	32.	27.	5.	0.	
1967	514.854	1295.	8285.	5577.	511.	292.	123.	38.	24.	11.	3.	
1968	548.642	896.	8746.	4593.	969.	241.	142.	74.	25.	13.	9.	
1969	491.435	64.	5755.	2716.	1308.	467.	111.	75.	33.	17.	11.	
1970	426.563	1201.	2890.	5014.	1055.	470.	113.	22.	25.	12.	7.	SCOTLAND
1971	416.144	4542.	8553.	644.	705.	587.	205.	71.	16.	9.	9.	SEINE
1972	392.432	938.	19054.	3501.	396.	339.	120.	57.	27.	5.	8.	
1973	414.898	2657.	7445.	6165.	870.	137.	98.	42.	31.	12.	4.	
1974	349.604	3858.	6283.	1610.	1085.	252.	54.	38.	22.	15.	7.	
1975	329.432	1820.	8673.	1783.	556.	471.	79.	9.	5.	13.	4.	
1976	307.165	537.	14244.	2891.	370.	179.	113.	37.	10.	4.	9.	
1977	313.913	2742.	4316.	3069.	714.	177.	51.	35.	24.	6.	2.	
1978	325.246	1704.	14716.	1386.	851.	202.	48.	23.	21.	8.	3.	
1979	316.419	2523.	8024.	3258.	383.	345.	67.	44.	19.	12.	4.	
1980	297.227	1068.	5960.	2342.	829.	144.	90.	33.	15.	9.	4.	
1981	289.672	853.	13281.	2348.	692.	204.	26.	11.	12.	3.	0.	
1966	35.841	190.	269.	63.	31.	11.	2.	1.	1.	0.	0.	
1967	28.022	54.	263.	82.	12.	9.	4.	1.	1.	0.	0.	
1968	48.238	33.	301.	140.	35.	9.	4.	3.	1.	0.	0.	
1969	62.666	20.	494.	243.	87.	23.	6.	4.	2.	1.	2.	
1970	83.529	334.	302.	397.	93.	33.	10.	2.	2.	0.	0.	SCOTLAND
1971	104.901	992.	1768.	207.	150.	41.	14.	6.	2.	2.	1.	LIGHT
1972	121.031	204.	3927.	705.	111.	50.	6.	2.	0.	0.	0.	TRAWL
1973	152.422	760.	1255.	1898.	202.	20.	23.	12.	1.	4.	0.	
1974	116.982	459.	1185.	438.	376.	40.	5.	8.	3.	1.	2.	
1975	161.009	965.	1559.	776.	120.	113.	6.	1.	2.	1.	0.	
1976	152.419	263.	3274.	415.	101.	38.	39.	10.	1.	1.	0.	
1977	224.824	2068.	1807.	774.	118.	75.	24.	15.	8.	2.	1.	
1978	236.929	2256.	5380.	671.	270.	51.	28.	7.	8.	5.	0.	
1979	287.494	1973.	5845.	1808.	178.	61.	15.	3.	4.	2.	0.	
1980	333.197	1798.	5207.	2042.	534.	69.	58.	15.	4.	3.	1.	
1981	251.504	691.	5237.	1475.	294.	82.	11.	6.	0.	0.	0.	

/Continued ....

Table 5.1. (Continued).

Year	Effort	Age	1	2	3	4	5	6	7	8	9	10	
1966	96.261		180.	249.	40.	11.	4.	1.	1.	0.	0.	0.	
1967	99.959		108.	253.	87.	10.	4.	2.	1.	0.	0.	0.	
1968	114.054		26.	325.	111.	30.	5.	2.	1.	0.	0.	0.	
1969	111.707		7.	156.	122.	40.	14.	2.	1.	0.	0.	0.	
1970	62.579		50.	38.	54.	15.	3.	1.	0.	0.	0.	0.	
1971	72.909		132.	401.	34.	25.	7.	2.	1.	0.	0.	0.	SCOTLAND NEPHROPS TRAWL
1972	70.077		10.	209.	107.	5.	4.	1.	0.	0.	0.	0.	
1973	80.569		49.	58.	132.	12.	1.	1.	1.	0.	0.	0.	
1974	127.264		11.	133.	48.	43.	3.	0.	0.	0.	0.	0.	
1975	118.508		124.	84.	84.	5.	3.	0.	0.	0.	0.	0.	
1976	140.770		25.	367.	57.	15.	2.	1.	0.	0.	0.	0.	
1977	96.190		105.	124.	55.	3.	3.	1.	10.	0.	0.	0.	
1978	102.023		105.	253.	26.	8.	1.	1.	0.	0.	0.	0.	
1979	113.256		92.	177.	50.	5.	1.	0.	0.	0.	0.	0.	
1980	102.023		63.	205.	61.	10.	2.	1.	0.	0.	0.	0.	
1981	92.791		72.	110.	28.	7.	1.	0.	0.	0.	0.	0.	
1966	586.657		1278.	5871.	3888.	414.	168.	100.	32.	41.	8.	2.	
1967	566.950		951.	6099.	2919.	1128.	223.	145.	74.	32.	12.	3.	
1968	549.481		64.	7917.	4816.	1168.	608.	185.	71.	35.	11.	11.	
1969	486.211		74.	1612.	3389.	1099.	362.	171.	52.	26.	9.	1.	
1970	497.735		552.	1785.	1044.	1260.	686.	195.	125.	24.	28.	13.	ENGLISH TRAWL
1971	506.736		1379.	11218.	1277.	512.	794.	350.	153.	57.	22.	4.	
1972	504.859		78.	10957.	3689.	458.	216.	377.	183.	56.	42.	9.	
1973	465.836		870.	1593.	3699.	1097.	311.	128.	90.	40.	11.	7.	
1974	414.315		569.	2863.	549.	1335.	428.	109.	47.	45.	28.	5.	
1975	325.095		1193.	1677.	739.	194.	472.	171.	28.	27.	20.	6.	
1976	342.829		288.	3631.	904.	436.	98.	237.	60.	16.	0.	7.	
1977	341.870		1501.	1115.	1176.	360.	187.	57.	74.	28.	8.	5.	
1978	374.963		1112.	5795.	599.	541.	185.	64.	31.	33.	12.	2.	
1979	332.937		713.	4129.	1792.	211.	216.	53.	29.	8.	16.	4.	
1980	252.811		1021.	2123.	1210.	550.	80.	70.	23.	9.	4.	5.	
1981	424.468		652.	14203.	1727.	648.	198.	34.	33.	8.	6.	2.	
1966	187.928		191.	3099.	2477.	397.	223.	156.	61.	37.	21.	5.	
1967	185.676		115.	2311.	1364.	1029.	196.	154.	98.	27.	10.	1.	
1968	193.651		2.	3335.	2470.	934.	561.	182.	66.	27.	12.	12.	
1969	201.783		13.	740.	2192.	992.	438.	234.	62.	30.	14.	4.	
1970	162.456		214.	627.	628.	920.	531.	162.	90.	12.	14.	13.	ENGLISH SEINE
1971	170.979		534.	4436.	635.	257.	531.	230.	91.	33.	11.	1.	
1972	186.509		54.	6736.	2440.	329.	166.	365.	183.	53.	41.	6.	
1973	199.405		687.	1626.	5266.	1012.	144.	105.	84.	33.	4.	2.	
1974	173.854		468.	2167.	322.	851.	382.	91.	31.	25.	35.	5.	
1975	168.919		2008.	1893.	595.	99.	272.	113.	11.	10.	21.	6.	
1976	177.535		228.	6925.	727.	389.	94.	230.	68.	14.	5.	4.	
1977	150.554		1975.	1842.	1184.	184.	137.	45.	17.	25.	6.	2.	
1978	181.284		805.	11500.	669.	490.	117.	70.	19.	33.	8.	1.	
1979	171.916		1588.	6472.	2253.	150.	259.	70.	32.	15.	17.	4.	
1980	178.424		2553.	7283.	1259.	544.	127.	186.	45.	20.	8.	11.	
1981	185.423		352.	12234.	1052.	415.	370.	64.	66.	15.	9.	5.	

Table 5.2. North Sea COD.
Gamma (cpue-index).

AGE	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	2.231	1.125	0.584	0.079	0.979	5.072	0.681	1.835	2.902	3.334	0.595	3.838	2.448	2.936	4.062	1.000
2	0.394	0.452	0.403	0.239	0.129	0.625	0.974	0.330	0.331	0.469	0.827	0.277	0.908	0.651	0.584	1.000
3	1.512	1.077	1.650	1.391	0.830	0.491	1.582	2.121	0.553	0.673	0.923	1.063	0.502	1.460	1.078	1.000
4	0.763	1.486	1.397	1.646	1.689	0.977	0.585	1.519	1.991	0.631	0.750	0.776	1.033	0.465	1.300	1.000
5	1.002	0.840	1.635	1.434	2.126	2.325	1.169	0.877	1.432	2.111	0.655	0.837	0.769	1.180	0.573	1.000
6	1.966	2.641	3.040	3.554	3.547	5.964	6.461	2.434	2.105	3.914	5.419	1.594	1.657	1.694	3.044	1.000
7	1.017	1.585	2.024	2.202	2.324	2.908	5.538	1.990	1.891	0.764	1.944	2.118	1.078	1.882	1.561	1.000
8	2.666	2.052	2.167	2.079	1.960	3.915	4.093	2.888	3.406	2.873	1.480	2.501	2.763	1.177	1.837	1.000
9	1.721	1.587	1.609	2.099	3.079	2.211	4.817	1.722	4.126	3.337	1.009	1.299	1.580	2.766	1.564	1.000
10	0.625	10.564	2.259	1.617	7.275	14.268	1.689	1.749	0.861	1.867	1.608	0.800	0.407	1.095	2.168	1.000

Table 5.3. North Sea COD.
Regression analysis for the estimation of terminal Fs.

YEAR/AGE		1	2	3	4	5	6	7	8	9
1966	1	0.985	0.588	0.794	0.743	0.655	0.473	0.457	0.750	1.123
1967	2	0.498	0.523	0.642	0.806	0.707	0.668	0.597	0.970	0.336
1968	3	0.663	0.547	0.778	1.025	0.785	0.880	0.706	0.666	0.919
1969	4	0.079	0.640	0.690	0.827	0.929	0.665	0.822	0.696	0.452
1970	5	0.285	0.378	0.921	0.890	0.915	0.821	0.657	0.497	0.917
1971	6	0.756	0.721	0.625	1.342	1.146	0.923	0.995	0.956	0.459
1972	7	0.867	0.974	0.924	0.884	1.575	1.525	1.000	2.162	1.897
1973	8	1.356	1.386	1.012	1.213	1.141	1.502	0.835	0.739	0.580
1974	9	2.429	0.893	0.924	1.149	1.099	1.024	2.187	1.493	1.302
1975	10	1.642	1.397	0.795	1.267	1.255	1.232	0.511	3.870	1.720
1976	11	0.553	1.769	1.309	1.187	1.158	1.447	1.069	0.644	1.274
1977	12	1.184	1.077	1.001	1.166	1.260	1.051	1.010	1.560	1.025
1978	13	1.219	1.352	1.015	1.342	1.455	1.118	1.256	1.550	1.226
1979	14	1.475	1.237	1.263	1.166	1.701	1.241	2.103	1.230	1.586
1980	15	1.222	1.354	1.210	1.660	1.514	2.042	2.427	2.488	1.697
1981	16	1.553	1.585	1.229	1.469	1.642	1.655	1.903	2.129	1.624
PREDIC. N		85432.	255283.	41941.	13696.	5917.	1111.	742.	215.	103.
PREDIC. F		0.346	1.235	1.000	0.780	0.997	1.106	1.241	0.985	0.968
COR.COEF.		0.507	0.802	0.786	0.801	0.861	0.751	0.707	0.478	0.585
SLOPE		0.067	0.075	0.038	0.045	0.061	0.068	0.099	0.097	0.065
INTERCEPT		0.476	0.393	0.625	0.753	0.664	0.560	0.315	0.574	0.586

Table 5.4. North Sea HADDOCK.
Effort (hours fished) and catch at age (No. x 10^{-3}). Input for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1965	172.992	3118.	548.	55569.	2055.	158.	109.	32.	10.	3.	2.	
1966	194.012	32137.	1544.	1143.	55854.	752.	66.	31.	16.	2.	0.	
1967	215.319	112299.	13358.	838.	767.	43192.	512.	9.	21.	4.	1.	
1968	218.141	21758.	75527.	3650.	372.	518.	12809.	49.	10.	2.	10.	
1969	123.010	26.	56898.	14068.	519.	225.	323.	1486.	20.	1.	0.	SCOTLAND TRAWL
1970	133.445	883.	4771.	92679.	2917.	153.	83.	26.	431.	3.	0.	
1971	174.359	47647.	5343.	7806.	83059.	1808.	122.	34.	43.	432.	27.	
1972	201.493	4598.	76452.	4199.	4120.	31677.	735.	32.	7.	10.	44.	
1973	182.541	5014.	51520.	37305.	832.	851.	6405.	1409.	18.	2.	20.	
1974	185.432	24707.	12502.	34230.	7336.	166.	207.	1562.	33.	4.	7.	
1975	152.977	3964.	51399.	5715.	14221.	1923.	73.	57.	383.	15.	70.	
1976	121.841	520.	26812.	20097.	1311.	3065.	596.	16.	6.	90.	100.	
1977	144.348	4250.	3538.	36968.	7624.	451.	1006.	179.	20.	5.	0.	
1978	135.220	9364.	9910.	2194.	17291.	1781.	169.	332.	61.	16.	200.	
1979	87.467	6138.	13902.	4106.	760.	4608.	337.	58.	73.	29.	9.	
1980	55.475	5779.	20663.	5687.	1065.	193.	1159.	104.	11.	18.	4.	
1981	51.553	709.	23581.	12373.	1122.	100.	12.	320.	8.	2.	2.	
1965	582.364	69774.	3568.	173131.	5856.	481.	300.	70.	17.	8.	13.	
1966	500.668	149827.	6223.	1158.	85923.	1082.	87.	35.	25.	3.	0.	
1967	514.854	866273.	28196.	1180.	862.	45338.	360.	45.	32.	10.	13.	
1968	548.642	188256.	153075.	5926.	515.	409.	17787.	71.	13.	2.	1.	
1969	491.435	1111.	322894.	30588.	1069.	272.	215.	3495.	23.	3.	1.	
1970	426.563	20187.	20402.	205833.	6994.	85.	154.	36.	777.	4.	3.	SCOTLAND SEINE
1971	416.144	543516.	21374.	13554.	108820.	2462.	82.	36.	37.	249.	44.	
1972	392.432	178579.	167637.	9213.	4693.	39759.	911.	53.	7.	3.	110.	
1973	414.898	98804.	195251.	69360.	1972.	1043.	9872.	351.	42.	7.	39.	
1974	349.604	351880.	48342.	86495.	13184.	441.	234.	2390.	48.	3.	8.	
1975	329.432	480815.	161726.	15612.	25836.	3708.	151.	110.	530.	22.	11.	
1976	307.165	35831.	329380.	57468.	2529.	8069.	1026.	54.	13.	146.	10.	
1977	313.913	33809.	37092.	130090.	12895.	1684.	1480.	347.	24.	7.	64.	
1978	325.246	160841.	69033.	14340.	44152.	2366.	482.	673.	86.	29.	3.	
1979	316.419	83633.	78817.	17215.	3040.	8073.	648.	70.	113.	24.	4.	
1980	297.227	131314.	128308.	26206.	3393.	501.	2415.	123.	20.	56.	23.	
1981	289.672	10352.	132688.	54454.	5036.	683.	99.	563.	14.	22.	1.	

/Continued ...

Table 5.4. (Continued).

Year	Effort	Age 1	2	3	4	5	6	7	8	9	10	
1965	54.799	1759.	83.	3851.	58.	7.	4.	1.	0.	0.	0.	
1966	35.841	3112.	121.	36.	1248.	17.	1.	1.	1.	0.	0.	
1967	28.022	13286.	441.	20.	16.	469.	2.	0.	0.	0.	0.	
1968	48.238	216.	3150.	121.	21.	38.	235.	1.	0.	0.	0.	
1969	63.666	189.	20609.	1002.	34.	10.	8.	87.	1.	0.	0.	
1970	83.529	812.	934.	18154.	568.	4.	5.	1.	83.	0.	0.	
1971	104.901	67866.	3052.	1553.	16024.	347.	12.	18.	6.	45.	12.	
1972	121.031	28413.	20279.	2495.	1083.	7920.	137.	13.	1.	1.	28.	SCOTLAND
1973	152.422	20457.	34299.	9429.	242.	213.	1591.	48.	3.	1.	6.	LIGHT
1974	116.982	45001.	8695.	14943.	2336.	31.	21.	283.	6.	0.	1.	TRAWL
1975	161.009	128502.	26965.	2450.	5213.	520.	13.	14.	77.	3.	1.	
1976	152.419	3355.	59426.	11342.	637.	1757.	328.	7.	5.	45.	1.	
1977	224.824	10102.	6441.	41122.	3492.	390.	787.	99.	15.	2.	5.	
1978	236.929	45734.	11471.	2914.	12280.	774.	110.	167.	24.	4.	0.	
1979	287.494	44659.	23157.	4111.	714.	3644.	203.	20.	57.	20.	0.	
1980	333.197	92522.	46285.	8063.	755.	197.	1015.	61.	18.	8.	5.	
1981	251.504	8661.	58144.	13653.	1518.	161.	20.	320.	12.	6.	7.	
1965	60.036	12.	0.	296.	7.	0.	1.	0.	0.	0.	0.	
1966	96.261	330.	15.	4.	178.	3.	0.	0.	0.	0.	0.	
1967	99.959	1698.	62.	5.	3.	86.	1.	0.	0.	0.	0.	
1968	114.054	354.	533.	39.	5.	7.	62.	0.	0.	0.	0.	
1969	111.707	0.	5955.	503.	19.	4.	4.	17.	0.	0.	0.	
1970	62.579	24.	35.	2039.	76.	1.	1.	0.	3.	0.	0.	
1971	72.909	3101.	101.	102.	766.	12.	1.	0.	0.	2.	0.	SCOTLAND
1972	70.077	483.	756.	38.	27.	241.	5.	0.	0.	0.	0.	NEPHROPS
1973	80.369	472.	1073.	359.	4.	6.	39.	1.	0.	0.	0.	TRAWL
1974	127.264	578.	150.	441.	54.	0.	0.	58.	0.	0.	0.	
1975	118.308	5466.	354.	56.	108.	6.	0.	0.	1.	0.	0.	
1976	140.776	61.	1479.	451.	19.	47.	7.	0.	1.	1.	0.	
1977	96.190	230.	49.	863.	45.	9.	13.	2.	0.	0.	0.	
1978	100.636	570.	93.	104.	69.	4.	1.	1.	0.	0.	0.	
1979	113.256	912.	315.	21.	3.	18.	3.	0.	1.	0.	0.	
1980	102.023	3094.	773.	100.	7.	1.	14.	1.	0.	0.	0.	
1981	92.791	179.	1662.	137.	11.	1.	0.	4.	0.	0.	0.	

Table 5.5. North Sea HADDOCK.
Gamma (cpue index).

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	3.210	8.900	45.536	9.336	0.066	1.250	33.457	11.680	6.009	25.236	36.773	2.999	2.572	11.689	6.318	10.579	1.000
2	0.012	0.025	0.124	0.652	1.396	0.098	0.105	0.886	0.937	0.276	0.959	2.122	0.224	0.398	0.480	0.846	1.000
3	1.521	0.018	0.014	0.063	0.404	2.869	0.188	0.155	0.904	1.296	0.232	0.980	2.248	0.217	0.270	0.459	1.000
4	0.567	11.152	0.128	0.066	0.161	1.021	18.815	0.886	0.255	2.176	4.542	0.513	2.417	7.483	0.504	0.662	1.000
5	0.378	1.357	69.361	0.875	0.571	0.409	3.847	64.855	1.722	0.510	5.330	12.579	2.247	4.743	17.434	0.995	1.000
6	1.814	0.916	6.821	59.677	7.148	1.598	1.985	10.993	103.961	3.243	1.542	16.060	25.922	4.776	9.457	43.520	1.000
7	0.051	0.031	0.039	0.054	3.114	0.058	0.058	0.057	1.060	2.720	0.129	0.071	0.428	0.802	0.103	0.230	1.000
8	0.518	0.831	1.025	0.406	0.990	30.899	1.669	0.288	1.598	2.076	24.817	0.669	1.302	4.086	6.002	1.271	1.000
9	0.253	0.154	0.319	0.142	0.113	0.319	41.661	0.960	0.239	0.366	1.490	11.292	0.519	1.749	4.522	3.628	1.000
10	5.644	0.000	6.800	1.122	0.589	2.037	18.128	51.714	17.337	3.759	11.369	19.911	54.836	37.601	2.963	16.428	1.000

Table 5.6. North Sea HADDOCK.
Regression analysis for the estimation of terminal Fs.

YEAR/AGE		1	2	3	4	5	6	7	8	9
1965	1	11.430	0.755	0.530	0.572	0.311	0.377	0.600	0.256	0.106
1966	2	10.515	2.309	0.404	0.593	0.418	0.517	0.357	0.971	0.045
1967	3	7.464	4.880	0.495	0.277	1.000	1.095	1.131	2.797	0.615
1968	4	0.205	2.106	1.538	0.221	0.297	1.000	0.222	0.689	0.195
1969	5	0.031	0.658	1.347	0.934	0.413	1.649	1.000	0.193	0.099
1970	6	1.396	1.498	1.117	0.853	0.435	0.798	0.238	1.000	0.019
1971	7	5.092	2.541	1.663	1.233	0.757	0.691	1.101	0.519	1.000
1972	8	1.474	3.366	3.725	1.821	1.345	0.997	0.567	0.235	0.086
1973	9	3.373	2.320	2.870	0.957	0.897	1.278	4.434	0.839	0.072
1974	10	3.956	4.500	2.167	1.332	0.353	0.773	2.006	0.447	0.058
1975	11	3.205	4.468	3.480	1.608	0.876	0.463	2.325	1.897	0.276
1976	12	2.832	4.780	4.483	1.183	1.609	1.497	0.568	0.706	0.667
1977	13	1.805	6.142	3.719	2.415	1.326	1.796	1.702	0.514	0.208
1978	14	5.554	8.349	3.792	2.721	1.114	1.322	3.467	1.181	0.410
1979	15	1.692	6.083	4.348	1.380	1.711	1.852	1.072	2.457	0.622
1980	16	2.522	5.341	4.640	3.115	2.103	2.277	3.331	1.163	1.397
1981	17	1.062	6.767	5.061	2.576	1.724	1.815	2.798	1.267	0.707
PREDIC. N		345171.	691369.	220696.	28160.	3409.	611.	3893.	214.	92.
PREDIC. F		0.599	1.012	1.167	1.308	1.315	1.495	1.060	0.966	1.107
COR.COEF.		-0.472	0.779	0.932	0.831	0.786	0.675	0.564	0.199	0.478
SLOPE		-0.335	0.354	0.299	0.147	0.093	0.078	0.152	0.032	0.040
INTERCEPT		6.757	0.745	-0.020	0.076	0.146	0.482	0.217	0.716	0.028

Table 5.7. North Sea WHITING.
Effort (hours fished) and catch at age (No. x 10^{-3}). Input for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1965	172.992	691.	276.	13399.	2904.	484.	155.	49.	18.	1.	1.	
1966	194.012	1777.	2793.	867.	13469.	1430.	138.	54.	15.	8.	0.	
1967	215.319	8255.	7704.	5071.	702.	10632.	817.	118.	23.	12.	0.	
1968	218.141	7211.	21140.	6637.	3078.	267.	4229.	287.	26.	10.	3.	
1969	123.010	74.	11622.	6575.	1453.	564.	45.	935.	63.	2.	0.	
1970	133.445	394.	274.	14338.	2377.	347.	114.	4.	212.	10.	10.	SCOTLAND
1971	174.559	4798.	2519.	453.	13095.	1484.	179.	52.	0.	81.	30.	TRAWL
1972	201.493	8830.	7643.	2421.	307.	7895.	868.	95.	38.	10.	22.	
1973	182.541	9833.	16099.	4608.	794.	82.	170.	216.	25.	10.	3.	
1974	185.432	1726.	17080.	7424.	987.	207.	35.	533.	37.	5.	2.	
1975	152.977	1677.	5988.	13289.	2160.	279.	42.	7.	121.	12.	1.	
1976	121.841	280.	8121.	2858.	3928.	691.	121.	14.	0.	29.	2.	
1977	144.348	885.	6342.	13056.	1521.	2332.	211.	26.	2.	2.	12.	
1978	135.220	2270.	12979.	15501.	8632.	550.	752.	71.	9.	0.	0.	
1979	87.467	2856.	14814.	11068.	7828.	2945.	166.	212.	25.	1.	0.	
1980	55.475	626.	10603.	10096.	3439.	2395.	875.	30.	21.	3.	3.	
1981	51.553	238.	6634.	8047.	3470.	546.	537.	104.	2.	4.	0.	
1965	582.364	108732.	10197.	110884.	17446.	2061.	844.	159.	46.	0.	4.	
1966	500.668	94342.	47443.	8605.	82293.	7236.	723.	293.	22.	15.	0.	
1967	514.854	453102.	56306.	21666.	2880.	24824.	2040.	233.	53.	9.	2.	
1968	548.642	168236.	112615.	17163.	6304.	698.	6853.	570.	31.	5.	0.	
1969	491.435	6952.	70980.	25683.	4178.	1599.	110.	1742.	128.	13.	1.	
1970	426.563	21905.	3377.	50805.	8738.	1086.	553.	38.	387.	44.	60.	
1971	416.144	161744.	22242.	3630.	37940.	3860.	520.	172.	13.	164.	11.	SCOTLAND
1972	392.432	46775.	27827.	4850.	846.	14887.	2587.	1780.	33.	10.	367.	SEINE
1973	414.898	72079.	49676.	12692.	2514.	245.	4100.	487.	77.	25.	19.	
1974	349.604	44934.	557205.	25559.	4326.	720.	102.	1175.	79.	13.	8.	
1975	329.432	54357.	31190.	39771.	10131.	835.	103.	19.	292.	34.	0.	
1976	307.165	22193.	67582.	12457.	10886.	1890.	264.	43.	0.	73.	1.	
1977	313.913	22193.	50659.	37035.	3336.	2528.	371.	31.	10.	1.	6.	
1978	325.246	14994.	29309.	43713.	15391.	1058.	1409.	201.	36.	0.	7.	
1979	316.419	90752.	41123.	28164.	14668.	6093.	678.	156.	3.	0.	0.	
1980	297.227	27033.	73706.	37658.	11915.	9368.	2556.	260.	229.	27.	7.	
1981	289.672	8753.	22761.	26215.	11223.	2555.	2228.	400.	44.	4.	1.	

/Continued ....

Table 5.7. (Continued).

Year	Effort	Age 1	2	3	4	5	6	7	8	9	10	
1965	54.799	481.	363.	3484.	454.	49.	22.	3.	1.	0.	0.	
1966	35.841	2678.	1254.	162.	1666.	125.	11.	5.	0.	0.	0.	
1967	28.022	7614.	1156.	410.	66.	409.	46.	4.	1.	0.	0.	
1968	48.238	4514.	3278.	542.	196.	35.	181.	14.	1.	0.	0.	
1969	63.666	794.	5074.	1678.	267.	88.	7.	102.	6.	1.	0.	
1970	83.529	2381.	1350.	4914.	1089.	127.	87.	4.	125.	8.	3.	
1971	104.901	25395.	3085.	610.	6129.	769.	124.	61.	4.	29.	4.	
1972	121.031	21378.	10224.	1786.	335.	4156.	508.	80.	18.	4.	13.	SCOTLAND
1973	152.422	34373.	15192.	3207.	710.	73.	1430.	183.	39.	6.	3.	LIGHT
1974	116.982	18997.	16613.	5208.	774.	148.	15.	423.	35.	7.	2.	TRAWL
1975	161.009	26423.	13340.	18384.	3497.	424.	34.	5.	186.	21.	0.	
1976	152.419	5575.	30123.	5298.	5248.	876.	195.	18.	1.	44.	5.	
1977	224.824	24596.	29945.	24841.	1664.	2419.	460.	34.	18.	0.	4.	
1978	236.944	8785.	19909.	30721.	14472.	956.	1612.	635.	72.	6.	0.	
1979	287.494	171149.	42911.	23155.	17996.	4058.	377.	284.	57.	5.	0.	
1980	333.197	20806.	58382.	38436.	9525.	9430.	1864.	144.	145.	3.	0.	
1981	251.504	6577.	19035.	21483.	9665.	1770.	1448.	309.	9.	1.	0.	
1965	60.036	1130.	78.	1347.	11.	12.	3.	1.	0.	0.	0.	
1966	96.261	3943.	1208.	245.	2128.	162.	19.	7.	0.	0.	0.	
1967	99.959	16371.	1295.	503.	60.	504.	49.	2.	1.	0.	0.	
1968	114.054	4520.	3435.	603.	255.	37.	238.	16.	1.	0.	0.	
1969	111.707	673.	3395.	1009.	157.	66.	4.	68.	4.	1.	0.	
1970	62.579	1274.	632.	1382.	204.	48.	20.	1.	13.	3.	0.	
1971	72.909	3077.	465.	94.	782.	60.	10.	5.	0.	1.	0.	SCOTLAND
1972	70.077	1587.	302.	60.	13.	153.	15.	1.	1.	0.	0.	NEPHROPS
1973	80.369	2404.	798.	176.	42.	4.	76.	8.	2.	0.	0.	TRAWL
1974	127.264	1563.	877.	447.	69.	19.	1.	39.	1.	0.	0.	
1975	118.308	2103.	574.	601.	199.	32.	2.	0.	11.	1.	0.	
1976	140.776	4221.	2378.	392.	359.	99.	17.	0.	0.	5.	1.	
1977	96.190	1798.	1540.	924.	103.	148.	56.	3.	4.	0.	1.	
1978	100.636	439.	984.	1196.	344.	17.	34.	27.	2.	1.	0.	
1979	113.256	6601.	1642.	582.	521.	62.	5.	2.	1.	1.	0.	
1980	102.023	1373.	3639.	1931.	383.	477.	38.	1.	3.	0.	0.	
1981	92.791	1570.	1805.	1003.	274.	28.	26.	6.	0.	0.	0.	

Table 5.8. North Sea WHITTING.
Gamma (cpue index).

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	6.069	5.928	27.821	9.679	0.457	1.603	12.060	5.280	6.991	4.667	5.544	2.122	3.193	1.650	17.691	2.682	1.000
2	0.212	1.117	1.234	2.266	1.643	0.171	0.592	0.844	1.310	19.173	1.060	2.534	1.810	1.043	1.725	2.667	1.000
3	1.900	0.175	0.403	0.304	0.528	1.161	0.086	0.127	0.283	0.658	1.184	0.394	1.171	1.363	0.934	1.359	1.000
4	0.688	3.827	0.126	0.277	0.211	0.471	2.002	0.053	0.133	0.261	0.662	0.825	0.228	1.297	1.416	0.913	1.000
5	0.372	1.543	5.349	0.169	0.423	0.341	1.007	4.231	0.063	0.207	0.303	0.741	1.389	0.449	2.350	4.086	1.000
6	0.170	0.179	0.490	1.816	0.033	0.182	0.159	0.744	1.362	0.032	0.037	0.154	0.334	0.825	0.249	1.133	1.000
7	0.183	0.390	0.307	0.737	3.080	0.062	0.322	3.023	0.819	2.327	0.035	0.092	0.108	1.719	0.825	0.514	1.000
8	1.119	0.823	1.285	1.559	5.308	22.009	0.408	3.087	3.225	3.950	16.681	0.183	1.267	5.488	5.816	7.864	1.000
9	0.075	1.600	0.953	0.614	1.722	8.770	26.114	2.421	4.282	5.684	14.046	30.066	0.196	5.459	3.145	5.652	1.000
10	1.592	0.000	1.125	0.000	0.589	33.489	1.872	47.314	10.082	4.419	0.000	0.105	1.444	6.234	0.000	4.775	1.000

Table 5.9. North Sea WHITTING.
Regression analysis for the estimation of terminal Fs.

YEAR/AGE		1	2	3	4	5	6	7	8	9
1965	1	0.779	0.064	1.000	0.337	0.205	0.266	0.176	0.353	0.002
1966	2	1.051	0.240	0.933	1.000	1.036	0.804	1.800	0.699	6.924
1967	3	2.035	0.329	1.178	0.329	1.000	0.781	1.224	1.807	2.475
1968	4	0.348	0.385	1.163	0.440	0.345	1.007	0.606	0.800	7.970
1969	5	0.289	0.086	1.259	0.319	0.622	0.095	1.000	0.983	1.315
1970	6	0.564	0.236	0.966	0.510	0.350	0.682	0.123	1.088	3.658
1971	7	1.613	0.306	1.501	0.649	0.623	0.174	0.524	0.096	2.475
1972	8	0.365	0.194	0.729	0.323	1.130	1.140	5.512	0.703	0.714
1973	9	0.343	0.175	1.158	0.253	0.330	0.750	0.983	2.026	2.926
1974	10	0.514	1.933	1.610	0.573	0.174	0.862	0.786	0.732	36.897
1975	11	0.255	0.212	2.142	0.915	0.616	0.223	0.555	1.037	7.929
1976	12	0.163	0.275	1.655	0.892	0.808	0.921	0.367	0.359	2.892
1977	13	0.305	0.202	2.010	0.526	1.340	0.867	0.258	4.906	0.363
1978	14	0.120	0.128	1.767	1.015	0.762	2.010	4.139	4.686	70.875
1979	15	1.430	0.168	1.582	0.771	1.619	1.111	0.999	2.564	3.141
1980	16	0.595	0.302	2.000	0.972	2.195	2.507	1.577	8.620	4.316
1981	17	0.265	0.388	2.003	0.872	1.375	1.526	1.709	4.659	20.146
PREDIC. N		591096.	542356.	418566.	146779.	30433.	14938.	2442.	246.	34.
PREDIC. F		0.473	1.289	1.157	1.173	1.451	1.323	1.510	3.224	3.226
COR.COEF.		-0.358	0.078	0.767	0.523	0.561	0.605	0.158	0.661	0.317
SLOPE		-0.051	0.007	0.069	0.030	0.065	0.077	0.049	0.317	1.231
INTERCEPT		1.131	0.267	0.830	0.356	0.269	0.224	0.870	-0.727	-0.787

Table 6.1 North Sea COD.
Estimates of recruitment at age 1.

Year class	IYFS index[1]	IYFS index[2]	VPA numbers x 10^{-6}	
			IV	VIa
1969	73.8		379	5.2
1970	99.7		429	8.8
1971	4.1	1.8	78	4.4
1972	37.7	3.0	154	6.9
1973	14.6	3.3	128	8.2
1974	95.7	5.6	224	12.8
1975	8.8	1.7	108	7.4
1976	40.3	7.6	370	9.6
1977	14.4	3.9	220	9.5
1978	9.8	2.3	227	16.3
1979	26.3	4.3	374	32.0
1980	13	1.4		
1981	11[3]	2.4[3]		

1) Unadjusted arithmetic mean number per hour trawling per statistical rectangle.

2) Unadjusted geometric mean number per hour trawling per "standard salinity rectangle" (34-35‰).

3) Preliminary figure.

Table 6.2 North Sea HADDOCK
Estimates of recruitment at age 1.

Year class	IYFS index[1)]	VPA numbers x 10^{-6}	
		IV	VIa
1969	28	469	7
1970	855	3 290	83
1971	740	2 335	37
1972	187	755	18
1973	1 072	2 608	61
1974	1 168	4 599	169
1975	177	396	5
1976	162	560	7
1977	385	924	30
1978	480	1 135	73
1979	896	1 638	108
1980	268		
1981	506[2)]		

1) Unadjusted arithmetic mean number per hour trawling per statistical rectangle.

2) Preliminary figure.

Table 6.3 North Sea WHITING
Estimates of recruitment at age 1.

Year class	IYFS index[1]	VPA numbers x 10^{-6}	
		IV	VIa
1969	69	926	22
1970	274	1 408	31
1971	332	2 438	93
1972	1 156	3 258	194
1973	322	1 710	67
1974	893	3 175	150
1975	679	1 800	49
1976	418	2 132	77
1977	513	1 807	104
1978	457	1 886	51
1979	692	1 403	84
1980	227		
1981	130[2]		

1) Unadjusted arithmetic mean number per hour trawling per statistical rectangle.

2) Preliminary figure.

Table 7.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1972-81 (data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980*)	1981*)
Belgium	21 133	11 741	10 253	7 566	7 483	10 346	17 473	12 576	9 630	8 714
Denmark	72 520	47 950	54 207	46 344	53 277	42 582	41 858	48 509	56 404	56 721
Faroe Islands	284	803	416	732	448	260	56	113	150	94
France	24 038	13 247	7 275	8 667	8 079	7 511	11 944	12 559	10 910	11 039
German Dem.Rep.[a]	122	343	132	223	69	21	75	84	63	-
Germany,Fed.Rep.	49 431	21 410	17 089	16 457	24 445	22 663	37 040	20 411	26 343	30 104
Iceland	-	-	+	-	-	-	-	-	-	-
Ireland	-	-	-	-	98	136	174	1	-	-
Netherlands	47 634	25 758	24 029	23 263	21 835	29 903	48 817	34 752	45 400	49 480
Norway[b]	4 377	454	324	1 528	1 877	1 449	2·747	3 575	4 506	6 519
Poland	189	1 551	4 750	2 991	2 961	381	115	142	28	7
Spain	91	90	80	63	14	-	-	-	-	-
Sweden	2 887	2 534	2 071	900	597	36	...[c]	298	293	322
UK(Engl.&Wales)	62 503	47 327	39 857	33 615	46 475	35 424	59 127	54 923	49 951	57 329
UK(Scotland)	55 190	48 844	39 887	37 308	39 597	34 406	41 984	42 811	45 044	52 527
USSR	774	2 497	2 667	6 796	6 187	-	17	17	-	-
Total IV	341 173	224 549	203 037	186 453	213 442	185 118	261 427	230 771	248 722	272 856
Total IVa	74 768	59 640	64 152	58 343	68 352	55 623	43 357	41 118	48 467	
Total IVb	215 160	134 953	114 087	107 227	126 218	100 191	164 388	147 313	161 767	
Total IVc	51 245	29 956	24 798	20 883	18 872	29 304	53 682	42 340	38 488	

*) Provisional figures.
a) 1971-1972 incl. IIIa.
b) Figures from Norway do not include cod caught in Rec. 2 fisheries.
c) Included in IIIa.

Table 7.2. North Sea COD (Sub-area IV).
VPA, catch in numbers ('000).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	17052	10363	5895	2835	52342	43107	36038	24408	14677
2	56011	66125	79679	21724	33017	148958	178956	29728	55431
3	29060	30478	39843	30305	17431	16612	47005	52475	10716
4	6674	11215	12093	13021	12319	6537	5460	13567	14869
5	3421	3211	5922	4365	6140	6473	2608	2058	4392
6	1134	1910	1266	2736	1739	2640	3104	1095	920
7	458	902	732	572	977	876	1628	1043	417
8	360	350	302	410	202	442	603	471	373
9	123	179	170	146	199	224	380	69	318
10	60	35	108	40	106	72	110	58	75
11+	71	11	28	82	45	86	16	161	179
TOTAL	115024	124779	146038	76236	124517	226093	243479	125133	102367

	1975	1976	1977	1978	1979	1980	1981
1	30305	6238	60267	28358	36314	55522	22804
2	48051	93083	48281	156890	86741	94284	167372
3	18232	17584	25082	14251	39700	29942	24188
4	4220	6608	4307	8469	3596	9702	6807
5	6484	1589	2190	2884	3061	1523	3440
6	1732	2439	675	961	660	1037	686
7	577	770	926	371	342	384	488
8	149	98	307	364	113	159	124
9	180	49	223	131	127	69	59
10	80	49	20	32	34	46	28
11+	53	29	81	38	18	23	20
TOTAL	109863	128536	140359	212729	170706	192691	226016

Table 7.3. North Sea COD (Sub-area IV).
VPA, mean weight (kg) at age of the stock.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.398	0.388	0.470	0.309	0.377	0.386	0.386	0.302	0.504
2	0.958	0.949	0.961	0.869	0.930	0.894	0.800	0.853	1.032
3	2.393	2.222	2.243	2.151	2.049	2.198	2.084	1.909	2.213
4	4.181	4.261	4.154	3.877	4.053	4.268	3.960	3.758	4.152
5	6.979	6.451	5.445	5.755	6.210	6.552	6.045	5.521	6.242
6	9.467	9.073	8.169	6.763	8.063	8.681	8.241	7.403	8.341
7	11.616	11.244	8.425	9.359	10.110	10.417	9.771	8.979	9.878
8	11.828	11.687	10.312	9.814	10.263	11.256	10.214	9.771	10.762
9	13.826	12.858	11.108	10.499	12.080	12.915	11.869	11.087	12.226
10	14.632	13.485	12.752	12.768	12.789	13.176	12.508	12.273	12.413
11+	15.025	15.818	12.125	11.534	14.663	15.743	14.284	12.846	13.629

	1975	1976	1977	1978	1979	1980	1981
1	0.373	0.373	0.306	0.369	0.302	0.534	0.585
2	0.871	1.000	0.905	0.744	0.836	0.974	0.889
3	2.310	2.372	2.091	1.919	2.369	1.972	2.081
4	4.162	4.328	4.412	4.130	4.475	4.512	4.226
5	6.282	6.372	6.639	6.425	6.678	6.295	6.961
6	8.454	8.560	8.750	8.615	8.657	9.084	8.801
7	9.801	10.078	9.980	9.578	10.672	9.683	9.791
8	10.320	11.017	10.897	10.787	11.460	11.736	11.063
9	11.933	12.690	12.018	12.153	13.017	12.666	12.855
10	12.671	13.912	12.830	12.560	13.849	13.866	14.118
11+	13.641	14.452	13.814	13.830	15.849	15.972	14.968

Table 7.4. North Sea COD (Sub-area IV).
VPA, fishing mortalities (M = 0.2).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.08	0.05	0.08	0.03	0.16	0.12	0.05	0.19	0.13
2	0.58	0.54	0.69	0.43	0.64	0.95	0.97	0.77	0.87
3	0.64	0.72	0.74	0.63	0.75	0.80	0.95	0.90	0.71
4	0.57	0.54	0.72	0.57	0.57	0.72	0.68	0.82	0.70
5	0.52	0.60	0.63	0.62	0.59	0.68	0.73	0.60	0.71
6	0.40	0.62	0.51	0.69	0.54	0.55	0.84	0.79	0.59
7	0.44	0.65	0.52	0.45	0.56	0.59	0.80	0.77	0.83
8	0.50	0.72	0.47	0.63	0.28	0.54	1.11	0.57	0.71
9	0.86	0.50	0.98	0.43	0.73	0.59	1.54	0.34	1.00
10	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.75	0.75
11+	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.75	0.75
F(3- 8),U	0.51	0.64	0.60	0.60	0.55	0.65	0.85	0.74	0.71

	1975	1976	1977	1978	1979	1980	1981	1976-1981
1	0.16	0.07	0.20	0.15	0.19	0.18	0.18	0.16
2	0.84	1.04	1.01	1.15	0.94	1.10	1.23	1.08
3	0.81	0.89	0.81	0.98	1.09	1.08	1.00	0.98
4	0.69	0.80	0.57	0.83	0.72	0.90	0.78	0.77
5	0.78	0.62	0.70	0.98	0.85	0.79	0.99	0.82
6	0.68	0.78	0.59	0.77	0.63	0.80	1.09	0.78
7	0.52	0.76	0.79	0.77	0.71	0.96	1.21	0.86
8	0.82	0.24	0.80	0.85	0.56	0.87	1.00	0.72
9	0.95	0.72	1.41	1.00	0.85	0.82	1.00	0.97
10	0.75	0.75	0.75	0.80	0.80	0.90	1.00	0.83
11+	0.75	0.75	0.75	0.80	0.80	0.90	1.00	0.83
F(3- 8),U	0.72	0.68	0.71	0.86	0.76	0.90	1.01	

Table 7.5. North Sea COD (Sub-area IV).
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

		1966	1967	1968	1969	1970	1971	1972	1973	1974
	1	231310	223589	89138	90112	379380	428655	77732	153818	128305
	2	140894	175998	173542	67661	70130	263455	312033	60385	105957
	3	67431	64700	83253	70924	35912	32818	83212	96363	22921
	4	16780	29231	25764	32604	30974	13850	12058	26321	32183
	5	9230	7766	15892	10298	15042	14335	5504	4995	9458
	6	3769	4493	3486	6079	4528	6823	5954	2178	2249
	7	1410	2068	1971	1720	2489	2151	3218	2109	807
	8	1001	743	887	958	896	1163	977	1183	797
	9	231	497	296	456	418	552	557	265	547
	10	137	80	247	91	242	164	251	120	155
	11+	102	25	64	137	103	196	57	333	370
	TOTAL	472356	506991	392539	287090	540114	764160	501532	348069	301748
	SPAWN. ST.	100152	109603	129859	123317	90603	72052	111767	133867	69485
Biomass:	Total	594513	650788	639510	501445	586874	733265	634824	463710	464283
	SSB	367475	398989	430842	412949	373047	332276	355193	365759	292334

		1975	1976	1977	1978	1979	1980	1981	1982	1966-1978
	1	223941	107816	570453	219686	226704	373516	152281	**********	209979
	2	91818	156046	82643	249039	154312	152911	255803	104139	150123
	3	35746	32562	45088	24758	64783	49183	41536	61216	53499
	4	9198	15015	10842	16341	7618	17807	13691	12510	20705
	5	13071	3762	4764	5022	5832	3027	5943	5138	9011
	6	3822	4919	1659	1945	1548	2048	1120	1808	3993
	7	1018	1582	1852	755	735	677	752	308	1781
	8	289	496	608	691	287	297	213	184	822
	9	319	104	318	224	241	134	101	64	368
	10	165	101	41	63	67	84	48	31	143
	11+	109	60	167	75	36	42	54	25	145
	TOTAL	379499	329262	518437	518599	462164	599726	471522		
	SPAWN. ST.	63739	56401	65341	49874	81147	73299	63459		
Biomass:	Total	419068	420430	408188	449611	453148	576963	524231		
	SSB	255564	224169	220038	183262	255678	228570	207738		

Table 7.6 North Sea COD (Sub-area IV). Input data for catch predictions.

Age	Stock $\bar{W}$ (kg)	H.C.landings 1981 N x 10^{-3}	H.C.landings 1981 $\bar{W}$ (kg)	H.C.landings 1981 F	Discards 1981 N x 10^{-3}	Discards 1981 $\bar{W}$ (kg)	Discards 1981 F	Ind. landings 1981 N x 10^{-3}	Ind. landings 1981 $\bar{W}$ (kg)	Ind. landings 1981 F	Total F 1981	Ref. $F=\bar{F}_{76-81}$ H.C.landings	$\bar{W}_{76-81}$ H.C.landings
1	412	22 804	585	.18							.18	.16	.412
2	891	167 372	889	1.23							1.23	1.08	.891
3	2 134	24 188	2 081	1.00							1.00	.98	2.134
4	4 347	6 807	4 226	.78							.78	.77	4.347
5	6 562	3 440	6 961	.99							.99	.82	6.562
6	8 745	686	8 801	1.09							1.09	.78	8.745
7	9 964	488	9 791	1.21							1.21	.86	9.964
8	11 160	124	11 063	1.00							1.00	.72	11.160
9	12 567	59	12 855	1.00							1.00	.97	12.567
10	13 523	28	14 118	1.00							1.00	.83	13.523
11	14 814	20	14 968	1.00							1.00	.83	14.814
Weight Tonnes	-	278 920									-	-	

Recruitment at age 1: (N x 10^{-3}) 1981 : 152 281
1982 : 209 979
1983 : 209 979

M = .2

Age at first maturity : 3

Table 7.7 Management Options: Species - COD.
Area - ICES Sub-area IV. North Sea

1982				1983					1984	
Stock biom.	Spawning stock	$\bar{F}$ (3-8) H.C.	Total landings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (3-8) H.C.	H.C. landings	Stock biom.	Spawning stock biomass
421	241	1.01 ($=\bar{F}_{81}$)	226	$\bar{F}_{0.1}$	372	160	.12	38	-	395
				$\bar{F}_{max}$	372	160	.20	57	-	357
				$\bar{F}_{83} = \bar{F}_{82}$	372	160	1.01	195	350	138
				$\bar{F}_{83} = 0$	372	160	0	0	694	454
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	372	160	0.20	57	591	357
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	372	160	0.51	123	474	249
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	372	160	1.52	239	277	77
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	372	160	2.03	267	232	43

Weights in thousands of tonnes

Recruitment 1982-83 R_1 = 210 millions

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 3 and older

Exploitation pattern 1982-83 based on 1976-81 average

Table 8.1 Nominal catch (in tonnes) of COD in Division VIa, 1972 - 1981.
(Data for 1972 - 1980 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	39	75	174	49	71	-	-	4	57	30[a]
Denmark	-	-	-	7	-	-	-	-	27[a]	-
Faroe Islands	-	7	13	3	39	43	-	40	3	-
France	2 360	3 445	3 678	3 546	5 611	3 583	4 499	4 590	5 495	6 770
German Dem. Rep.	-	-	-	2	-	-	-	-	-	
Germany, Fed. Rep.	3	15	6	12	1	3	31	40	1	---[b]
Iceland	-	-	-	-	-	-	-	-	-	
Ireland	686	583	883	1 141	1 341	984	1 214	2 237	2 331	2 719
Netherlands	21	4	5	5	11	5	3	20	1	
Norway	-	13	14	17	22	29	40	32	48	35
Poland	491	184	175	68	18	-	-	-	-	-
Spain	102	208	137	180	15	20[a]	108[a]	-	-	
U.K.(England+Wales)	3 371	2 074	2 467	2 217	2 742	2 434	2 082	2 348	2 302	3 150[c]
U.K. (Scotland)	7 018	5 645	6 084	5 806	7 475	5 513	5 539	6 929	7 603	9 970
U.K. (N. Ireland)	2	3	3	3	13	5	5	2	2	7
USSR	606	7	13	107	46	-	-	-	-	-
Total VIa	14 699	12 263	13 652	13 163	17 405	12 619	13 521	16 242	17 870	22 681

* Provisionsal

[a] Includes VIb

[b] Included in VIb

[c] December catch estimated

Table 8.2. COD in Division VIa.
VPA, catch in numbers ('000).

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	101	222	84	92	335	220	153	727	1260
2	1004	859	986	272	884	2264	504	1841	2043
3	1427	1862	970	944	525	1068	1271	752	1217
4	141	1296	1519	457	709	483	518	874	506
5	140	112	624	356	220	405	145	235	269
6	104	121	104	133	185	91	101	53	60
7	21	72	84	24	68	72	42	52	11
8+	12	18	53	39	36	47	47	22	19
TOTAL	2950	4562	4424	2317	2960	4650	2841	4556	5385

	1976	1977	1978	1979	1980	1981
1	1988	1179	680	846	1206	444
2	4753	1185	1792	1500	3250	6926
3	1362	1497	1035	2150	1997	3222
4	585	590	728	666	794	914
5	255	245	289	340	190	187
6	185	81	96	140	78	31
7	58	49	49	34	28	18
8+	18	13	30	38	9	3
TOTAL	9204	4837	4699	5714	7552	11745

Table 8.3. COD in Division VIa.
VPA, mean weight (kg) at age of the stock.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606
2	1.372	1.372	1.372	1.372	1.372	1.372	1.372	1.372	1.372
3	2.988	2.988	2.988	2.988	2.988	2.988	2.988	2.988	2.988
4	5.052	5.052	5.052	5.052	5.052	5.052	5.052	5.052	5.052
5	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573
6	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966
7	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807
8+	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664

	1976	1977	1978	1979	1980	1981
1	0.606	0.606	0.606	0.721	0.627	0.522
2	1.372	1.372	1.372	1.412	1.385	1.123
3	2.988	2.988	2.988	2.858	3.008	2.767
4	5.052	5.052	5.052	4.902	5.289	4.868
5	6.573	6.573	6.573	6.689	7.433	7.448
6	7.966	7.966	7.966	7.824	8.319	9.104
7	8.807	8.807	8.807	9.150	9.262	10.207
8+	9.664	9.664	9.664	10.039	9.595	10.612

Table 8.4. COD in Division VIa.
VPA, fishing mortalities (M = 0.2).

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.02	0.04	0.03	0.02	0.04	0.06	0.02	0.10	0.12
2	0.16	0.28	0.24	0.14	0.26	0.45	0.18	0.46	0.46
3	0.39	0.48	0.58	0.39	0.44	0.58	0.49	0.44	0.62
4	0.32	0.73	0.94	0.60	0.57	0.97	0.63	0.75	0.60
5	0.30	0.45	1.00	0.59	0.66	0.77	0.91	0.67	0.55
6	0.47	0.47	1.02	0.59	0.72	0.64	0.82	1.09	0.36
7	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
8+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
F(3- 4),U	0.35	0.61	0.76	0.49	0.51	0.78	0.56	0.60	0.61

	1976	1977	1978	1979	1980	1981	1976-1981
1	0.35	0.14	0.08	0.06	0.04	0.12	0.13
2	0.81	0.36	0.34	0.26	0.33	0.36	0.41
3	0.64	0.66	0.62	0.89	0.67	0.65	0.69
4	0.71	0.64	0.80	1.15	1.04	0.75	0.84
5	0.71	0.75	0.76	1.20	1.29	0.75	0.91
6	0.94	0.52	0.77	1.11	1.05	0.75	0.86
7	0.70	0.70	0.70	0.70	0.70	0.75	0.71
8+	0.70	0.70	0.70	0.70	0.70	0.75	0.71
F(3- 4),U	0.67	0.65	0.71	1.01	0.85	0.70	

Table 8.5. COD in Division VIa.
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	4861	6556	2855	5226	8762	4368	6899	8240	12762
2	7038	3889	5004	2261	4196	6871	3578	5511	6091
3	4893	5549	2412	3210	1606	2040	3596	2311	2861
4	568	2725	2711	1107	1781	846	1206	1805	1218
5	587	338	1075	868	497	823	203	524	698
6	304	355	176	325	392	210	313	87	219
7	45	156	182	52	147	156	91	113	24
8+	26	39	115	84	78	102	102	49	41
TOTAL	18924	19208	14529	13134	17460	16017	15848	18638	23915
SPAWN. ST.	6424	8962	6670	5646	4502	4778	5571	4888	5061
Biomass: Total	37850	45739	40677	31022	33306	33685	31660	34168	37735
Spawn. st.	24424	36551	32082	34752	22239	21610	22845	21614	21645

	1976	1977	1978	1979	1980	1981	1982	1967-1978
1	7597	9616	9455	16256	32019	4324	**********	7233
2	9313	4271	6810	7126	12554	25120	3140	5436
3	3155	3288	2434	3966	4485	7359	14552	3155
4	1254	1566	1436	1058	1333	1888	3145	1502
5	545	505	591	527	284	386	750	609
6	331	218	195	226	150	64	149	260
7	126	106	106	74	61	37	25	109
8+	39	28	65	82	19	6	17	64
TOTAL	22159	19497	21090	29334	50884	39189		
SPAWN. ST.	5449	5011	4827	5942	6312	9740		
Biomass: Total	40722	34972	36597	45149	61943	63929		
Spawn. st.	23462	23285	21525	23360	24480	33456		

Table 8.6 West of Scotland COD (Division VIa). Input data for catch prediction

Age	Stock $\bar{W}$ (kg)	H.C. landings 1981 N x 10^{-3}	$\bar{W}$ (kg)	F	Discards 1981 N x 10^{-3}	$\bar{W}$ (kg)	F	Ind. Landings 1981 N x 10^{-3}	$\bar{W}$ (kg)	F	Total F 1981	Ref.F = $\bar{F}_{76-81}$ H.C.Landings	$\bar{W}_{76-81}$ H.C.landings
1	.615	444	.522	.12							.12	.13	.615
2	1.339	6 926	1.123	.36							.36	.41	1.339
3	2.933	3 222	2.767	.65							.65	.69	2.933
4	5.036	914	4.868	.75							.75	.84	5.036
5	6.882	187	7.448	.75							.75	.91	6.882
6	8.191	31	9.104	.75							.75	.86	8.191
7	9.173	18	10.207	.75							.75	.71	9.173
8	9.873	3	10.612	.75							.75	.71	9.873
Weight tonnes	-	23 256									-	-	

Recruitment at age 1: (N x 10^{-3}) 1981 : 4 324
1982 : 7 233
1983 : 7 233

M = .2 Age at first maturity : 3

Table 8.7 Management Options: Species - COD
Area - ICES Division VIa. West of Scotland.
OPTION 1

1982				1983					1984	
Stock biom.	Spawning stock biomass	$\bar{F}$ (3-4) H.C.	Total landings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (3-4) H.C.	H.C. landings	Stock biom.	Spawning stock biomass
73	65	.330 (=F to take TAC)	17	$\bar{F}_{0.1}$	79	67	.18	10.8		
				$\bar{F}_{max}$	79	67	.31	18.0		
				$\bar{F}_{83} = \bar{F}_{82}$	79	67	.330	19.8	75	63
				$\bar{F}_{83} = 0$	79	67	0	0	100	88
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	79	67	.066	4.5	94	82
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	79	67	.165	10.7	86	74
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	79	67	.495	27.5	65	54
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	79	67	.659	34.0	57	46

Weights in thousands of tonnes

Recruitment 1982-83 R_1 = 7.2 millions

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 3 and older

Exploitation pattern 1982-83 based on 1976-81 average

Table 8.8 Management Options: Species - COD.
Area - ICES Division VIa. West of Scotland

OPTION 2

1982				1983					1984	
Stock biom.	Spawning stock biomass	$\bar{F}$ (3-4) H.C.	Total land-ings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (3-4) H.C.	H.C. land-ings	Stock biom.	Spawning stock biomass
73	65	.70 ($=\bar{F}_{81}$)	31	$\bar{F}_{0.1}$	59	48	.18	18.6		
				$\bar{F}_{max}$	59	48	.31	13.4		
				$\bar{F}_{83} = \bar{F}_{82}$	59	48	.695	25.7	45	34
				$\bar{F}_{83} = 0$	59	48	0	0	78	66
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	59	48	.139	6.7	70	57
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	59	48	.348	15.1	59	47
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	59	48	1.043	33.3	36	25
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	59	48	1.390	38.8	29	18

Weights in thousands of tonnes

Recruitment 1982-83 R_1 = 7.2 millions

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 3 and older

Exploitation pattern 1982-83 based on 1976-81 average

F values relate to the Human Consumption Fishery (landings + discards) only

Table 10.1 Nominal catch (in tonnes) of COD in Divisions VIId and VIIe, 1972-1981
(Data for 1972-1980 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	124	93	67	59	65	53	435	699	163	363
Denmark	-	-	-	2 718	1 506	1 120	2 160	2 052	660[a]	
France	2 658	1 425	3 099	2 143	1 646	5 185	8 044	4 848	4 001	4 229
Netherlands	30	2	4	+	2	1	+	-	-	
Poland	7	13	6	-	-	-	-	-	-	
U.K. (England & Wales)	717	499	260	159	142	581	654	485	365	444[b]
U.K. (Scotland)	-	-	-	-	-	-	-	+	-	-
U.S.S.R.	8	45	-	3	4	-	-	-	-	-
Total VIId,e	3 544	2 077	3 436	5 082	3 365	6 940	11 293	8 084	5 189	

*)Provisional

a)Includes VIIb,c

b)December catch estimated

Table 10.2 Nominal catch (in tonnes) of COD in Divisions VIIb,c and Viig,k, 1972-1981
(Data for 1972-1980 as officially reported to ICES

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	77	323	167	116	159	85	52	51	110	200
Denmark	-	-	-	-	-	-	-	18	...[b]	-
Faroe Islands	-	256	-	-	-	-	-	-	-	
France	4 168	2 791	2 302	2 877	3 196	1 972	2 192	2 918	4 475	
Germany,Fed. Rep.	-	1	-	-	-	-	3[a]	-	7	-
Ireland	352	568	283	474	506	315	323	552	1 028	1 257
Netherlands	22	14	9	54	46	291	279	-	5	
Norway	-	-	-	1	-	+	-	-	-	-
Poland	130	75	39	19	40	6	-	2	-	-
Spain	137	301	232	588	1 140	51	11	-	17	
UK(England+Wales)	56	60	26	73	44	33	28	33	83	213[c]
UK(Scotland)	-	-	-	-	-	-	2	1	12	+
USSR	139	10	72	134	203	-	-	-	-	-
Total VIIb,c, g-k	5 081	4 399	3 130	4 336	5 234	2 753	2 890	3 575	5 737	

*) Provisional
a) Catch in VIIg only
b) Included in VIIe
c) December catch estimated

Table 11.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1972-1981
(Data for 1972-1980 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	1 601	2 385	1 137	2 209	2 166	2 293	1 295	732	1 414	1 179
Denmark	34 858	13 118	44 342	32 930	46 899	20 069	8 093	8 248	12 928	13 048
Faroe Islands	5	1 198	435	267	183	385	12	7	27	29
France	7 814	4 695	4 020	4 646	5 500	6 914	5 122	7 208	1 407	11 557
German Dem.Rep.[a]	90	22	8	44	20	8	37	12	36	-
Germany,Fed.Rep.	4 020	4 587	3 478	2 396	3 433	3 744	2 589	2 549	2 354	3 718
Iceland	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	31	53	101	-	-	-
Netherlands	5 188	3 185	3 035	1 901	1 728	1 598	857	955	1 569	2 758
Norway[b]	1 146	454	324	331	367	374	609	968	1 191	2 022
Poland	38	2 553	3 001	1 485	1 155	485	62	106	59	31
Spain	-	101	210	-	-	-	-	-	-	-
Sweden[c]	5 305	4 550	3 098	2 083	2 455	113	-	907	1 165	1 300
UK(England+Wales)	20 827	16 586	10 798	11 499	17 238	17 167	12 200	10 774	12 195	13 587
UK(Scotland)	96 197	88 132	71 679	64 686	80 576	89 465	58 406	54 119	64 058	80 036
USSR	36 467	49 356	42 234	49 686	42 852	8 010	54	18	-	-
Total IV	213 556	190 922	187 799	174 163	204 603	150 678	89 599	86 603	104 430	129 265
Total IVa	135 095	126 662	122 977	110 848	138 591	116 577	57 886	51 741	64 886	
Total IVb	75 325	62 288	63 695	62 761	65 594	34 030	31 457	34 361	39 084	
Total IVc	3 136	1 972	1 127	554	418	71	94	501	433	
WG total catch[d]	462 694	287 099	307 689	401 053	334 888	219 953	170 804	140 635	218 924	215 577

*) Provisionsal a) 1972 includes IIIa
b) Figures from Norway do not include haddock caught in Rec. 2 fisheries. For 1973-1974 Rec. 2 fisheries were officially reported but have been deducted in the figures given here to make a consistent data series.
c) 1972-1974 includes IIIa d) Includes discards

Table 11.2. North Sea HADDOCK (Sub-area IV).
VPA, catch in numbers ('000).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	1066954	305250	11106	72556	924600	330669	259683	59629	601454
1	1005867	837000	1096950	20474	266146	1809927	674560	364092	1215968
2	25637	88972	438693	3574209	218271	70729	584054	566823	174438
3	6411	4851	19540	303195	1905921	47248	40054	257619	326841
4	411444	3575	1938	7586	57333	397367	20915	6106	55159
5	9956	177371	2518	2411	1177	10289	155786	4398	1834
6	1045	2436	45822	2520	1192	458	3516	58835	1320
7	601	214	324	19134	258	192	187	1237	10583
8	163	210	41	199	5943	146	53	105	237
9	89	57	14	23	71	1577	27	29	22
10	23	33	5	7	11	159	401	108	32
11+	2	0	0	0	19	8	11	53	8
TOTAL	3128192	1419981	1616951	4002314	3380942	2068769	1719227	1279034	2385896

	1975	1976	1977	1978	1979	1980	1981
0	44913	167010	115080	289807	950761	388199	688781
1	2097418	167563	250410	458727	350378	726641	142598
2	632852	1045329	105734	141915	195699	317956	405374
3	57028	206721	376518	28439	41293	69810	140563
4	106044	9624	39548	109212	8397	12535	19022
5	15515	30523	5949	8583	25838	4787	2509
6	953	4786	6000	1186	3927	7752	440
7	599	187	1136	1911	342	722	2546
8	2625	67	115	386	427	170	122
9	255	682	24	112	124	139	57
10	61	52	163	24	41	70	25
11+	18	3	5	64	20	35	53
TOTAL	2958081	1652547	896486	1040366	1577247	1528816	1401270

Table 11.3. North Sea HADDOCK (Sub-area IV).
VPA, mean weight (kg) at age of the stock.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	0.010	0.011	0.010	0.011	0.013	0.011	0.024	0.044	0.024
1	0.088	0.115	0.126	0.031	0.073	0.107	0.116	0.126	0.128
2	0.247	0.281	0.253	0.216	0.222	0.247	0.242	0.240	0.226
3	0.367	0.461	0.509	0.407	0.353	0.362	0.388	0.372	0.343
4	0.534	0.594	0.731	0.799	0.735	0.506	0.506	0.585	0.548
5	0.949	0.639	0.858	0.891	0.872	0.886	0.606	0.649	0.890
6	1.265	1.057	0.837	1.030	1.191	1.267	0.999	0.725	0.895
7	1.524	1.501	1.606	1.094	1.360	1.535	1.361	1.044	0.953
8	1.943	1.933	2.258	2.047	1.437	1.330	2.246	1.302	1.512
9	1.729	2.071	2.689	3.037	2.535	1.274	2.006	2.784	2.301
10	2.963	2.348	2.067	3.284	3.961	1.967	1.654	1.726	2.507
11+	2.042	0.000	0.000	0.000	3.870	4.308	2.901	2.020	4.148

	1975	1976	1977	1978	1979	1980	1981
0	0.020	0.013	0.019	0.010	0.009	0.012	0.010
1	0.101	0.125	0.108	0.143	0.094	0.097	0.072
2	0.241	0.224	0.240	0.250	0.289	0.279	0.256
3	0.356	0.400	0.346	0.415	0.438	0.469	0.466
4	0.450	0.509	0.599	0.444	0.625	0.719	0.834
5	0.680	0.580	0.609	0.695	0.659	0.862	1.133
6	1.245	0.893	0.753	0.709	0.712	0.947	1.564
7	1.124	1.876	1.096	0.924	1.072	1.391	1.211
8	1.093	1.746	1.708	1.301	1.165	1.761	1.703
9	1.724	1.235	1.973	1.814	1.359	1.708	1.842
10	2.219	2.330	1.604	1.913	2.130	2.029	1.608
11+	2.856	2.527	3.190	1.800	1.390	3.291	1.493

Table 11.4. North Sea HADDOCK (Sub-area IV).
VPA, fishing mortalities (M = 0.2).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	0.53	0.03	0.02	0.13	0.23	0.12	0.25	0.02	0.11
1	1.99	0.56	0.12	0.05	0.96	0.91	0.38	0.74	0.71
2	0.92	1.17	0.65	0.73	1.14	0.74	0.88	0.64	1.03
3	0.57	0.43	0.92	1.42	1.20	0.84	1.38	1.21	1.00
4	0.80	0.36	0.31	1.23	1.29	0.89	1.22	0.82	1.03
5	1.13	1.01	0.47	0.79	0.62	0.87	1.17	0.95	0.63
6	1.27	1.00	0.81	1.26	1.28	0.53	0.87	1.12	0.87
7	1.09	1.03	0.33	1.02	0.39	0.72	0.43	0.91	1.17
8	1.10	1.96	0.55	0.54	1.11	0.39	0.25	0.46	0.43
9	0.84	1.87	0.68	0.70	0.20	1.07	0.12	0.37	0.16
10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
11+	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
F(2- 6),U	0.90	0.80	0.63	1.09	1.11	0.77	1.10	0.95	0.91

	1975	1976	1977	1978	1979	1980	1981	1976-1981
0	0.10	0.24	0.11	0.21	0.42	0.71	0.25	0.32
1	0.09	0.62	0.67	0.78	0.41	0.66	0.62	0.63
2	1.06	0.92	1.03	1.06	0.95	0.83	1.01	0.97
3	1.30	1.37	1.08	0.94	1.12	1.16	1.17	1.14
4	1.12	0.80	1.15	1.16	0.82	1.44	1.30	1.11
5	1.01	1.30	0.95	0.87	1.00	2.06	1.30	1.25
6	0.81	1.08	1.04	0.88	1.47	1.00	1.50	1.16
7	1.41	0.36	0.83	1.22	0.70	1.40	1.00	0.92
8	1.13	0.56	0.39	0.78	1.06	0.93	1.00	0.79
9	1.22	1.11	0.40	0.85	0.62	1.35	1.00	0.89
10	0.90	0.90	0.90	0.90	0.90	0.90	1.00	0.92
11+	0.90	0.90	0.90	0.90	0.90	0.90	1.00	0.92
F(2- 6),U	1.06	1.09	1.05	0.98	1.07	1.30	1.26	

Table 11.5. North Sea HADDOCK (Sub-area IV).
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	4441184	13009579	557761	653197	5035142	3215845	1186086	3251566	6279447
1	1246351	2145418	10575714	446628	469391	3290300	2334809	755474	2608312
2	46288	139549	1005724	1506050	347189	147609	1083027	1506077	293640
3	22602	15085	55392	451338	2955384	90704	57750	506670	562700
4	816870	12962	8100	11548	85421	131033	32103	11876	89704
5	15908	301940	7402	4808	2770	19214	244779	7807	4281
6	1571	4195	89607	3803	1787	1215	6569	62319	2480
7	980	561	1269	32520	883	408	585	2247	10576
8	265	269	106	748	9625	492	103	311	739
9	171	72	31	50	434	2607	271	103	161
10	42	60	9	13	20	291	735	198	59
11+	4	0	0	0	35	15	20	97	15
TOTAL	6592675	15627491	12081016	9090744	8908081	7499733	4946958	5764746	9858113
SPAWN. ST.	904959	474494	1142541	7990918	3405548	993588	1428042	1757706	970354
Biomass: Total	629658	642192	1674960	1872654	1303723	850434	757948	748891	816619
Spawn. St.	475551	252594	362042	1851623	1204001	462998	458644	510632	332048

	1975	1976	1977	1978	1979	1980	1981	1982	1966-1978
0	533473	867796	1254872	1705410	3042705	834435	3421363	**********	5230104
1	4599874	396264	560222	923629	1135379	1638237	336568	2181558	2319197
2	1051633	1891930	174603	234943	347078	615220	691998	148235	1171405
3	85469	299096	618779	50810	60361	110097	220349	206352	430155
4	170220	19100	62209	172407	10300	17703	28252	35992	171035
5	26221	45307	6976	16048	44335	5861	3429	6304	54112
6	1865	7958	10094	2199	5496	13336	610	765	15043
7	855	678	2186	2935	745	1035	4029	111	4806
8	4192	171	387	777	710	304	210	1213	1403
9	592	1104	80	214	292	203	98	65	438
10	112	95	299	44	75	128	43	29	152
11+	33	5	5	117	37	64	57	30	27
TOTAL	6473339	3529504	2690711	3109554	4659510	3236623	4707006		
SPAWN. ST.	1340992	2265244	875618	480495	481428	763951	949074		
Biomass: Total	862339	650380	393172	322622	309031	425407	372252		
Spawn. St.	387183	589566	308826	173489	174921	256484	313806		

Table 11.6 Input data for catch predictions for North Sea HADDOCK

Age	Stock	H.C. landings 1981			Discards 1981			Ind. landings 1981			Total F 1981	Reference Period: 1976 - 1981					
	$\bar{w}$ (kg)	$Nx10^{-3}$	$\bar{w}$ (kg)	F	$Nx10^{-3}$	$\bar{w}$ (kg)	F	$Nx10^{-3}$	$\bar{w}$ (kg)	F		H.C. catch E		Discards		Ind. catch F	
												F	$\bar{w}$	Prop. ret.	$\bar{w}$	F	$\bar{w}$
0	.012	0	-		1 534	.073	.001	687 247	.009	.249	0.25	.0034	-	0.000	.061	.32	.011
1	.107	1 707	.336	.007	33 969	.160	1.48	106 722	.040	.165	0.62	.33	.281	0.043	.137	.30	.040
2	.256	134 572	.376	.335	241 323	.198	.601	29 479	.177	.073	1.01	.84	.359	.398	.207	.13	.174
3	.422	109 376	.513	.912	26 343	.290	.330	4 644	.370	.039	1.17	1.03	.466	.846	.247	.10	.292
4	.622	18 491	.844	1.264	87	.650	.006	444	.472	.030	1.30	1.07	.633	.973	.343	.05	.470
5	.756	2 291	1.135	1.290	3	.727	.002	15	.854	.008	1.30	1.21	.765	.997	.400	.04	.534
6	.930	463	1.562	1.487	0	-	0	4	1.270	.013	1.50	1.15	.941	.985	.450	.01	.600
7	1.262	2 346	1.211	1.00	0	-	0	0	-	0	1.00	.92	1.261	1.000	-	0	.644
8	1.564	122	1.703	1.00	0	-	0	0	-	0	1.00	.79	1.562	1.000	-	0	-
9	1.655	57	1.842	1.00	0	-	0	0	-	0	1.00	.89	1.654	1.000	-	0	-
10	1.936	25	1.608	1.00	0	-	0	0	-	0	1.00	.92	1.939	1.000	-	0	-
11+	2.282	33	1.793	1.00	0	-	0	0	-	0	1.00	.90	2.247	1.000	-	0	-
Weight Tonnes	-	129 441			68 258			17 787			-	-					

Recruitment at age 0: ($N \times 10^{-3}$) 1981 = 3 421 363; 1982 = 2 415 147; 1983 = 2 415 147 M = .2 Age at first maturity: 2

Table 11.7 Management Options : Species - HADDOCK
Area - ICES Sub-area IV, North Sea

1982				1983								1984	
Stock Biom.	Spawning Stock Biom.	$\bar{F}$ (2-6) H.C.	Total landings	Management Option for 1983	Stock Biom.	Spawning Stock Biom.	$\bar{F}$ (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock Biom.	Spawning Stock Biom.
430	168	1.22 ($=\bar{F}_{81}$)	125	$\bar{F}_{0.1}$	471	289							
				$\bar{F}_{83}=\bar{F}_{82}$			1.22	141.6	110.8	30.8	110.2	455	273
				$\bar{F}_{83}=0$			0	39.8	0	39.8	0	737	554
				$\bar{F}_{83}=0.2\ \bar{F}_{82}$			0.24	69.1	31.5	37.6	28.3	659	477
				$\bar{F}_{83}=0.5\ \bar{F}_{82}$			0.61	103.2	68.5	34.7	64.1	566	384
				$\bar{F}_{83}=1.5\ \bar{F}_{82}$			1.83	165.0	137.3	27.7	144.3	380	199
				$\bar{F}_{83}=2.0\ \bar{F}_{82}$			2.44	179.6	154.3	25.3	170.0	330	148

Weights in thousands of tonnes
Recruitment 1982-83 R_0 = 2 415 147 x 10^3
Stock Biomass = fish at age 0 and older
Spawning Stock Biomass = fish at age 2 and older
Exploitation pattern 1982-83 based on 1976-81 average
F values relate to the Human Consumption Fishery (Landings + Discards) only

Table 12.1 Nominal catch (in tonnes) of HADDOCK in Division VIa, 1972-1981
(Data for 1972-1980 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	44	45	98	23	45	-	-	2	3	
Denmark	-	-	-	-	13	-	-	37	-	
Faroe Islands	-	2	1	-	-	-	-	2	-	
France	5 014	5 141	3 979	2 328	3 026	3 401	4 255	4 786	2 808	3 312
German Dem.Rep.	87	-	-	9	-	-	-	-	-	
Germany.Fed.Rep.	7	15	18	3	30	+	20	2	3	72[a,b]
Ireland	3 982	2 631	1 715	599	1 115	616	441	877	726	1 664
Netherlands	205	169	63	19	30	28	13	2	2	
Norway	-	-	-	-	3	7	13	9	16	20
Poland	-	402	97	20	-	-	-	-	-	
Spain	101	497	540	-	-	-	-	-	-	
UK(Engl.&Wales)	2 393	2 187	1 512	1 214	1 971	3 827	2 [illegible]05	1 654	1 279	990[c]
UK(Scotland)	27 730	17 631	9 583	8 973	11 992	11 422	9 629	7 459	8 198	11 687
UK(N.Ireland)	1	-	-	-	-	-	-	-	+	
USSR	1 480	110	364	495	533	-	-	-	-	-
Total VIa	41 044	28 830	17 970	13 683	18 758	19 301	17 176	14 830	13 035	17 745

*) Provisional

a) Includes VIb

b) August-December catch estimated based on information from fishing vessels

c) December catch estimated

Table 12.2. HADDOCK in Division VIa.
VPA, catch in numbers ('000).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	60	585	3664	2	169	1937	577	1314	1867
2	174	6057	12437	48790	171	1230	26859	5535	3566
3	1082	771	2570	7995	78450	2925	2254	15952	9032
4	46916	1227	354	1253	2749	91769	2516	255	3270
5	1926	24356	680	250	174	659	53933	1098	92
6	64	596	14064	357	87	131	505	33106	484
7	31	9	727	4373	143	7	51	223	11788
8+	57	17	51	186	598	226	88	164	199
TOTAL	50310	33598	34547	63092	82541	98884	86543	57647	32298

	1975	1976	1977	1978	1979	1980	1981
1	4908	617	450	983	2142	2502	215
2	11081	22015	1316	1036	10381	10291	21550
3	2807	13207	29467	822	1820	5335	16053
4	3485	1671	5647	24053	430	916	1585
5	1852	1600	680	3008	9573	143	170
6	100	828	496	353	848	3117	27
7	99	21	506	251	112	229	734
8+	3367	908	304	441	145	51	50
TOTAL	27759	41467	38866	30947	25457	22584	40384

Table 12.3. HADDOCK in Division VIa.
VPA, mean weight (kg) at age of the stock.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.313	0.284	0.259	0.199	0.348	0.296	0.286	0.260	0.269
2	0.524	0.373	0.368	0.314	0.261	0.333	0.324	0.330	0.331
3	0.563	0.636	0.627	0.576	0.389	0.363	0.346	0.409	0.397
4	0.575	0.481	0.827	0.919	0.817	0.469	0.552	0.600	0.572
5	1.041	0.669	0.731	1.028	1.284	1.052	0.546	0.498	0.776
6	1.125	1.177	0.811	1.024	1.261	1.320	0.984	0.572	0.686
7	1.522	1.849	1.431	0.997	1.043	1.595	1.502	1.210	0.767
8+	1.523	1.612	1.901	1.572	1.343	1.452	1.565	1.637	1.144

	1975	1976	1977	1978	1979	1980	1981
1	0.277	0.294	0.306	0.245	0.268	0.251	0.263
2	0.363	0.338	0.369	0.352	0.366	0.373	0.340
3	0.462	0.502	0.437	0.415	0.465	0.587	0.493
4	0.583	0.593	0.689	0.521	0.696	0.722	0.862
5	0.786	0.829	0.799	0.831	0.753	0.998	0.953
6	1.010	1.054	1.127	1.054	1.021	0.976	1.405
7	0.962	1.536	1.337	1.142	1.435	1.143	1.260
8+	0.947	1.097	1.117	1.206	1.383	1.565	1.124

Table 12.4. HADDOCK in Division VIa.
VPA, fishing mortalities (M = 0.2).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.00	0.02	0.01	0.00	0.03	0.03	0.02	0.09	0.03
2	0.08	0.71	0.55	0.10	0.02	0.50	0.58	0.23	0.35
3	0.26	0.58	0.77	0.82	0.23	0.41	1.41	0.85	0.72
4	0.54	0.51	0.58	1.14	0.79	0.47	0.68	0.57	0.77
5	0.58	0.61	0.60	1.10	0.46	0.43	0.56	0.83	0.42
6	1.43	0.22	0.90	0.75	1.87	0.77	0.70	0.82	1.16
7	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
8+	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
F(2- 4),U	0.29	0.60	0.63	0.69	0.55	0.59	0.89	0.55	0.61

	1975	1976	1977	1978	1979	1980	1981	1976-1981
1	0.03	0.14	0.07	0.04	0.03	0.03	0.05	0.06
2	0.29	0.21	0.50	0.22	0.67	0.22	0.32	0.36
3	0.53	0.67	0.45	0.69	0.77	0.90	0.61	0.68
4	0.69	0.68	0.69	0.83	1.01	1.23	0.75	0.86
5	0.70	0.81	0.66	1.03	0.98	1.22	0.80	0.91
6	1.14	0.80	0.64	0.88	0.98	1.07	0.80	0.86
7	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
8+	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
F(2- 4),U	0.50	0.52	0.55	0.58	0.81	0.78	0.56	

Table 12.5. HADDOCK in Division VIa.
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	15891	40100	687967	14355	6595	83270	36683	17657	60913
2	2537	12956	32505	559950	11749	5247	66426	29512	15271
3	5275	1920	5200	15313	414443	9465	3190	30373	19182
4	122358	3345	882	1965	5501	268724	5125	639	10656
5	4781	58159	1640	405	515	2052	137754	2127	295
6	91	2191	25854	734	110	206	1089	64511	763
7	61	18	1438	8647	283	14	101	441	23310
8+	113	34	101	368	1183	447	174	324	394
TOTAL	151086	118723	755585	601736	440379	369484	250542	145585	128784
SPAWN. ST.	135195	78623	67416	587383	433784	286215	213860	127928	67871
Biomass: Total	84442	60626	218476	199675	173758	159043	112553	66160	53570
Spawn. St.	79468	49238	40292	196819	171463	134396	102062	61569	37185

	1975	1976	1977	1978	1979	1980	1981	1982	1966-1978
1	168774	5115	7408	29539	75464	108244	4860	**********	90328
2	48186	133750	3632	5659	23297	58213	86304	3735	71168
3	7662	29489	89146	1795	5701	9799	38398	51345	48650
4	7642	3706	12345	40565	735	1401	5214	17082	37649
5	4024	5144	1541	5064	10689	220	536	1266	17039
6	159	1641	1148	654	1474	5153	53	124	7632
7	196	42	605	496	221	455	1451	20	2742
8+	6658	1796	601	972	287	101	99	570	1005
TOTAL	245501	178682	116426	90645	119868	183584	136855		
SPAWN. ST.	74527	173567	109618	61105	46405	75340	129475		
Biomass: Total	82054	70082	55075	40751	45234	61571	54686		
Spawn. St.	35304	68578	52808	33513	25546	34401	53408		

Table 12.6 HADDOCK in Division VIa
Input data for catch predictions

Age	No. x 10^{-3} landings 1981	Landings $\bar{w}$ (kg)	F_{1981}	Reference F
1	215	.271	.05	.05
2	21 550	.356	.32	.32
3	16 053	.483	.61	.60
4	1 585	.681	.75	.76
5	170	.861	.80	.81
6	27	1.106	.80	.76
7	734	1.304	.80	.71
8	50	1.249	.80	.71
Weight landed	18 179	-	-	-

Recruitment at age 1. No. x 10^{-3} : 1981 - 4 860
1982 - 40 525
1983 - 40 525

Age at first maturity : 2

Table 12.7 Management Options: Species - HADDOCK
Area - ICES Division VIa, West of Scotland

Option 1

1982				1983					1984	
Stock Biom.	Spawning Stock Biom.	$\bar{F}$ (2-4) H.C.	Total land-ings	Management Option for 1983	Stock Biom.	Spawning Stock Biomass	$\bar{F}$ (2-4) H.C.	H.C. land-ings	Stock Biom.	Spawning Stock Biomass
50.7	39.7	0.47 (=F to take TAC)	15.5	$\bar{F}_{0.1}$	48.1	37.2	.17			
				$\bar{F}_{max}$	48.1	37.2	.37			
				$\bar{F}_{83}=\bar{F}_{82}$	48.1	37.2	.467	14.0	46.1	35.2
				$\bar{F}_{83}=0$	48.1	37.2	0	0	62.2	51.2
				$\bar{F}_{83}=0.2\ \bar{F}_{82}$	48.1	37,2	.093	3.4	58.3	47.3
				$\bar{F}_{83}=0.5\ \bar{F}_{82}$	48.1	37,2	.233	7.9	53.1	42.1
				$\bar{F}_{83}=1.5\ \bar{F}_{82}$	48.1	37.2	.700	18.7	40.8	29.8
				$\bar{F}_{83}=2.0\ \bar{F}_{82}$	48.1	37.2	.934	22.3	36.7	25.7

Weights in thousands of tonnes

Recruitment 1982-1983 R_1 = 40.5 millions

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1982-1983 based on 1976-1981 average

Table 12.8 Management Options: Species - HADDOCK
Area - ICES Division VIa, West of Scotland

Option 2

1982				1983					1984	
Stock Biom.	Spawning Stock Biom.	$\bar{F}$ (2-4) H.C.	Total landings	Management Option for 1983	Stock Biom.	Spawning Stock Biomass	$\bar{F}$ (2-4) H.C.	H.C. landings	Stock Biom.	Spawning Stock Biomass
50.7	39.7	.56 ($=F_{81}$)	17.7	$\bar{F}_{0.1}$	45.5	34.5	.17	5.2		42
				$\bar{F}_{max}$	45.5	34.5	.39	11.3		35.5
				$\bar{F}_{83}=\bar{F}_{82}$	45.5	34.5	.560	14.7	42.6	31.6
				$\bar{F}_{83}=0$	45.5	34.5	0	0	59.5	48.5
				$\bar{F}_{83}=0.2\ \bar{F}_{82}$	45.5	34.5	.112	3.7	55.2	44.2
				$\bar{F}_{83}=0.5\ \bar{F}_{82}$	45.5	34.5	.280	8.5	49.7	38.7
				$\bar{F}_{83}=1.5\ \bar{F}_{82}$	45.5	34.5	.840	19.3	37.4	26.4
				$\bar{F}_{83}=2.0\ \bar{F}_{82}$	45.5	34.5	1.120	22.7	33.5	22.6

Weights in thousands of tonnes

Recruitment 1982-1983 R_1 = 40.5 millions

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1982-1983 based on 1976-1981 average

Table 13.1 Nominal catch (in tonnes) of HADDOCK in Division VIb, 1972 - 1981
(Data for 1982-1980 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	-	-	-	-	33	-	-	-	-	-
Faroe Islands	-	-	2	1	8	3	11	20	5	-
France	1 527	600	353	21	4	4	3	4	1	
Germany, Fed. Rep.	-	-	-	-	-	-	-	-	17	...a)
Ireland	-	-	-	-	-	-	61	-	-	
Norway	-	-	-	-	-	+	4	16	2	7
Poland	-	54	-	-	-	-	-	-	-	
Spain	-	-	-	-	-	-	-	-	6	
U.K. (Engl.&Wales)	27	1	-	5	2 111	2 694	2 365	1 654	6 261	9 000
U.K. (Scotland)	616	72	22	71	640	297	2 060	548	1 051	27
U.S.S.R.	7 304	3 291	48 911	49 830	40 474	-	-	-	-	-
Total VIb	9 474	4 018	49 288	49 928	43 243	2 998	4 504	2 242	7 343	

*) Provisional

a) Included in VIa

Table 13.2 Length and age composition of haddock caught by G.A. REAY together with mean lengths of each age group

Length	Age 0	1	2	3	4	5	6	7	8	9	13	Total (45 hauls)
<12	156 318											156 318
12-14	194 248											194 248
15-17	3 396	425										3 821
18-20		9112										9 112
21-23		30716										30 716
24-26		30692										30 692
27-29		24060										24 060
30-32		645	323		3227	2259						6 453
33-35				164	1147	1967		164				3 442
36-38					370	6293						6 663
39-41					340	9508						9 848
42-44					368	4913						5 281
45-47					44	705		176	132	44		1 101
48-50						37		61	233	12		344
51-53						8		12	98			118
54+						3		3	88	3	3	100
Total	353 962	95650	323	164	5496	25692	-	417	551	59	3	482 317
Total kg												36 148
Mean length cm	11.70	24.22	31.00	34.00	33.51	38.77	-	41.96	49.77	47.08	55.00	15.97

Table 13.3 Data used in stock assessment and 1982 catch prediction

Age-group	No. in stock$\times 10^{-3}$ Sept. 81	No. caught $\times 10^{-3}$ 1981	Fishing mortality	Exploitation pattern	Average weight kg	No. in stock$\times 10^{-3}$ 1.1.82	$F_{82}=F_{81}$	No. in catch 1982
0	685 441	0	0	0	0.016	-	0	0
1	185 225	10 322	0.05	0.28	0.14	641 235	0.05	28 214
2	625	115	0.16	0.88	0.27	173 279	0.16	23 219
3	318	66)		1	0.41	585	0.18	88
4	10 643	2 085)		1	0.56	297	0.18	45
5	49 752	10 552)		1	0.71	9 957	0.18	1 493
6	0	0)		1	0.87	46 543	0.18	6 982
7	808	172 }	0.18	1	1.02	0	0.18	0
8	1 076	230)		1	1.19	756	0.18	113
9	114	25)		1	1.27	1 007	0.18	151
10	0	0)		1)		107	0.18	16
11	0	0)		1 }	1.34	0	0.18	0
12	0	0)		1)		0	0.18	0
13	6	1)		1		0	0.18	0
Total	933 999	23 568						60 321
Tonnes	70 000	9 000						17 762

Table 14.1 Nominal catch (in tonnes) of HADDOCK in Divisions VIId and VIIe, 1972-81.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	2	1	+	+	+	1	-	1	+	-
Denmark	-	-	-	-	-	2	22	21	15	-
France	224	208	487	868	405	438	356	333	298	243
Germany, Fed.Rep.	-	-	-	+	-	-	-	-	-	
Ireland	-	-	-	-	-	4	-	-	+	
Netherlands	9	1	-	1	-	-	-	-	-	
Poland	-	12	-	-	-	-	-	-	-	-
UK(England & Wales)	166	135	113	99	45	29	22	51	59	115[a]
USSR	10	2	33	3	-	-	-	-	-	-
Total VIId,e	411	359	633	971	450	474	400	406	372	

* Provisional

a) December catch estimated

Table 14.2 Nominal catch (in tonnes) of HADDOCK in Divisions VIIb,c and VIIg-k, 1972-81.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	45	65	35	33	19	13	5	2	2	1
Denmark	-	-	-	-	-	-	-	1	-	-
Faroe Isl.	-	3	-	-	-	-	-	-	-	-
France	6 456	5 524	6 057	4 583	3 726	2 244	1 479	1 931	2 219	
Germany, Fed.Rep.	-	1	-	+	3	-	-	-	-	-
Ireland	1 103	1 348	829	507	287	153	111	155	274	662
Netherlands	56	12	2	4	14	1	-	16	-	
Poland	-	62	143	-	-	-	-	-	-	-
Spain	733	890	1 100	-	-	294	-	-	5	
UK(England & Wales)	107	24	39	46	24	18	13	19	50	78[a]
UK(Scotland)	-	-	-	-	-	-	8	22	56	4
USSR	253	24	456	1 290	183	-	-	-	-	-
Total VIIb,c and VIIg-k	8 753	7 953	8 661	6 463	4 256	2 273	1 616	2 146	2 606	

*) Provisional

a) December catch estimated

Table 15.1 Nominal catch (in tonnes) of WHITING in Sub-area IV, 1972-81.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	2 745	3 387	3 156	3 279	2 640	3 275	3 304	3 941	3 153	2 611
Denmark	50 109	73 928	109 654	61 941	116 973	46 479	15 741	41 965	17 916	16 862
Faroe Islands	-	1 453	1 126	764	1 262	472	42	581	21	21
France	19 822	20 353	19 825	20 079	19 557	17 592	22 525	27 590	23 626	21 939
German Dem.Rep.	-	5	-	3	18	-	22	5	-	-
Germany,Fed.Rep.	264	403	454	446	302	461	348	1 280	1 267	634
Iceland	-	-	-	-	4	9	38	-	-	-
Netherlands	7 613	8 811	12 057	14 078	12 274	9 406	11 030	13 417	14 389	15 009
Norway[a]	28	39	58	55	71	33	64	49	27	27
Poland	-	7	1 002	888	509	445	8	3	1	-
Spain	107	119	110	65	18	-	-	-	-	-
Sweden[b]	596	2 328	2 440	255	153	341	...	31	16	8
UK(Engl.&Wales)	3 789	4 592	5 519	5 246	5 112	6 185	7 542	7 581	6 778	5 780
UK (Scotland)	23 846	20 756	25 274	27 969	26 167	33 017	42 779	44 841	42 218	30 455
USSR	613	3 522	2 978	5 098	5 612	2 413	-	-	-	-
Total Sub-Area IV	109 532	139 703	183 653	140 166	190 672	120 128	103 443	141 284	109 412	93 346
Total Div. IVa	32 932	29 616	76 761	75 444	100 001	61 499	42 837	48 554	42 529	
Total Div. IVb	66 789	96 678	87 842	41 930	69 908	42 911	40 943	68 775	41 156	
Total Div. IVc	9 811	13 409	19 050	22 792	20 763	15 718	19 663	23 955	25 727	
WG total catch[c]	291 394	364 740	351 266	290 589	345 951	294 635	178 773	234 947	225 221	194 185

*) Provisional figures.

a) Figures from Norway do not include whiting caught in Rec. 2 fisheries. For 1973 and 1974 Rec. 2 fisheries were officially reported, but have been deducted from the figures given here to make a consistent time series.

b) 1972-1974 include Div. IIIa, 1978 included in Div. IIIa.

c) Includes discards.

Table 15.2. North Sea WHITING (Sub-area IV).
VPA, catch in numbers ('000).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	90463	214852	101597	1210116	1185666	1234652	553426	175648	570112
1	512766	981122	739468	375230	599086	621466	938807	1156006	754672
2	324435	214449	463192	1021170	77938	105634	317317	664580	974691
3	98769	120368	100029	154952	545947	17709	42449	131494	228625
4	238544	23263	45148	27826	49610	126045	5390	15099	52094
5	47932	65829	7006	12715	10920	12891	58548	3136	4876
6	12379	7511	29626	1674	5544	2059	8328	17527	1223
7	2820	811	1843	5659	1157	701	3787	2297	5822
8	690	122	92	623	1291	170	242	318	352
9	166	31	23	54	130	430	61	115	52
10	0	3	5	1	17	29	137	44	19
11+	0	0	0	0	0	0	0	0	0
TOTAL	1528704	1628561	1488029	2810006	2475306	2121786	1928292	2166264	2572538

	1975	1976	1977	1978	1979	1980	1981
0	239142	424539	664985	686282	477685	332373	570623
1	956417	478651	1017151	418282	619543	521704	203376
2	401312	1114173	480400	355745	466684	437785	363716
3	299652	161154	261985	203499	211648	282591	265016
4	54982	76447	31540	69135	80230	83419	95615
5	9173	13317	18292	7618	25082	38185	21022
6	7987	2716	4637	5387	5115	8027	10148
7	116	545	406	1422	1179	755	1706
8	1385	22	167	245	194	548	224
9	142	291	4	7	15	45	51
10	2	23	135	7	1	13	17
11+	0	0	5	0	5	5	1
TOTAL	1970510	2271878	2479705	1727629	1891379	1505450	1530155

Table 15.3. North Sea WHITING (Sub-area IV).
VPA, mean weight (kg) at age of the stock.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	0.068	0.052	0.036	0.043	0.020	0.036	0.022	0.027	0.026
1	0.107	0.117	0.111	0.097	0.109	0.116	0.071	0.084	0.071
2	0.183	0.197	0.188	0.173	0.204	0.217	0.200	0.166	0.149
3	0.253	0.267	0.296	0.261	0.240	0.280	0.280	0.278	0.253
4	0.294	0.329	0.360	0.362	0.349	0.316	0.375	0.387	0.376
5	0.363	0.341	0.486	0.414	0.457	0.428	0.417	0.459	0.463
6	0.394	0.426	0.447	0.416	0.453	0.521	0.519	0.458	0.521
7	0.406	0.493	0.620	0.535	0.512	0.636	0.573	0.548	0.543
8	0.639	0.623	0.731	0.670	0.630	0.559	0.742	0.736	0.787
9	0.724	0.621	0.776	0.737	0.785	0.742	0.809	0.904	1.033
10	0.000	0.486	0.842	1.238	0.798	0.731	0.868	0.862	0.958
11+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	1975	1976	1977	1978	1979	1980	1981
0	0.030	0.019	0.019	0.010	0.009	0.013	0.014
1	0.100	0.107	0.090	0.074	0.098	0.082	0.090
2	0.214	0.194	0.176	0.185	0.165	0.178	0.164
3	0.275	0.294	0.288	0.239	0.259	0.255	0.241
4	0.369	0.359	0.375	0.337	0.313	0.337	0.334
5	0.465	0.440	0.449	0.460	0.434	0.346	0.422
6	0.553	0.512	0.483	0.462	0.492	0.486	0.455
7	0.818	0.440	0.532	0.514	0.541	0.472	0.591
8	0.596	0.457	0.532	0.689	0.617	0.620	0.693
9	0.716	0.692	0.932	0.741	0.669	0.580	0.904
10	1.022	0.917	0.440	1.828	0.738	0.795	0.734
11+	0.000	0.000	0.941	0.000	0.521	0.717	0.703

Table 15.4. North Sea WHITING (Sub-area IV).
VPA, fishing mortalities (M = 0.2).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	0.04	0.05	0.15	0.77	0.56	0.37	0.14	0.09	0.15
1	0.70	0.71	0.26	1.29	1.20	0.66	0.55	0.49	0.66
2	0.84	0.73	0.91	0.69	1.10	0.71	0.86	0.98	1.04
3	1.15	0.90	0.95	0.93	1.05	0.82	0.70	1.17	1.19
4	1.00	0.98	1.09	0.77	0.91	0.75	0.65	0.59	1.08
5	1.51	0.86	0.95	1.12	0.81	0.64	1.00	1.04	0.38
6	2.58	1.14	1.37	0.65	1.21	0.34	1.19	1.00	1.92
7	2.77	1.56	1.02	1.15	1.31	0.85	2.20	1.44	1.20
8	2.68	1.62	0.76	1.52	0.95	0.67	0.84	1.74	0.94
9	2.93	1.43	2.54	0.71	1.20	0.97	0.54	1.41	2.65
10	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11+	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
F(2- 6),U	1.57	0.92	1.05	0.83	1.02	0.65	0.88	0.95	1.12

	1975	1976	1977	1978	1979	1980	1981	1976-1981
0	0.11	0.16	0.29	0.28	0.27	0.42	0.28	0.28
1	0.40	0.34	0.73	0.29	0.45	0.29	0.49	0.43
2	0.92	1.18	0.70	0.58	0.62	0.66	0.62	0.73
3	1.17	1.33	1.05	0.74	0.91	1.00	1.16	1.03
4	1.12	1.18	1.09	0.91	0.83	1.23	1.17	1.07
5	1.12	0.96	1.08	0.87	1.06	1.18	1.45	1.10
6	2.25	1.36	1.15	1.20	1.18	1.31	1.32	1.25
7	1.16	1.27	0.76	1.61	0.97	1.10	1.50	1.17
8	1.11	0.71	2.77	1.78	1.11	2.43	1.50	1.68
9	1.43	0.75	0.26	1.52	0.47	0.86	1.50	0.86
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
F(2- 6),U	1.32	1.20	1.01	0.86	0.92	1.08	1.14	

Table 15.5. North Sea WHITING (Sub-area IV).
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
0	2065901	4547268	795063	2449122	3616359	4331133	4588545	2282185	4505401
1	1109867	2100988	3529079	559887	925834	1408476	2457673	3258022	1710060
2	623181	450793	844184	2224275	126400	227279	597852	1155395	1631649
3	156511	221140	177672	278906	909120	34333	91703	206870	355158
4	41024.3	40405	73908	56496	90479	259545	12327	37225	52816
5	66218	124049	12400	20441	21430	29923	100039	5275	16969
6	14524	11949	42930	3921	5457	7811	12976	30052	1534
7	5187	1104	5122	8967	1714	1329	4546	3244	9029
8	785	164	189	919	2524	580	464	414	628
9	118	44	27	75	202	754	159	164	59
10	0	5	9	2	29	50	235	76	33
11+	0	0	0	0	0	0	0	0	0
TOTAL	5050336	7497908	5479183	5603003	5099548	6301014	7846558	6978921	8285336
SPAWN. ST.	1274568	849652	1154441	2595994	1157155	561405	820560	1458715	2067875
Biomass: Total	606070	691484	685594	653231	451584	478784	475641	617485	605530
Spawn. St.	306033	209211	265223	493610	290340	159480	201619	282192	366975

	1975	1976	1977	1978	1979	1980	1981	1982	1966-1978
0	2461478	3071580	2937522	3056834	2238642	1065985	2566024	**********	3131460
1	3174999	1799668	2152552	1807181	1885687	1403243	574584	1587815	1990468
2	725699	1741231	1045534	858030	1105583	988332	859669	288198	940731
3	470263	257041	458187	425369	385704	486260	417990	378626	307856
4	88209	119423	51571	126095	166652	127420	146962	107282	109134
5	14755	23451	30026	14231	41706	59599	30453	37344	36862
6	9516	3944	7358	8347	4867	11875	14957	5848	12332
7	183	820	829	1912	2061	1225	2623	5271	5076
8	2234	47	189	316	514	639	333	585	696
9	201	600	19	10	44	85	46	74	187
10	3	39	232	12	2	22	29	10	56
11+	0	0	5	0	5	9	2	9	0
TOTAL	6947541	6997851	6641822	6278337	5829267	4144693	4613071		
SPAWN. ST.	1311064	2126597	1571947	1414322	1704937	1675466	1473163		
Biomass: Total	720365	714458	594587	475125	560933	499224	399646		
Spawn. St.	329020	463533	346862	310825	355987	370300	312009		

Table 15.6 Input data for catch predictions - North Sea WHITING.

Age	Stock $\bar{W}$ (kg)	H.C.landings 1981			Discards 1981			Ind.landings 1981			Total F 1981	Reference Period 1976-1981					
												H.C. catch		Discards		Ind.catch F	
		N x 10^{-3}	$\bar{W}$ (kg)	F	N x 10^{-3}	$\bar{W}$ (kg)	F	N x 10^{-3}	$\bar{W}$ (kg)	F				Prop. retained	$\bar{W}$	F	$\bar{W}$
0	.014	9	.180	-	25 161	.071	.01	545 453	.011	.27	.28	.01	.158	.0004	.069	.27	.012
1	.090	3 121	.224	.01	85 769	.131	.21	114 486	.056	.28	.49	.19	.205	.07	.139	.25	.062
2	.177	57 971	.237	.10	114 710	.164	.20	191 035	.142	.33	.62	.43	.237	.34	.177	.31	.151
3	.263	100 288	.289	.44	53 976	.197	.24	110 752	.218	.48	1.16	.75	.287	.67	.223	.32	.258
4	.343	67 304	.352	.84	8 693	.230	.11	17 618	.319	.22	1.17	.97	.353	.86	.256	.15	.370
5	.425	17 106	.432	1.15	1 622	.289	.11	2 894	.435	.19	1.45	1.07	.434	.91	.299	.09	.456
6	.478	9 916	.436	1.29	126	.252	.02	106	.597	.01	1.32	1.27	.485	.97	.367	.05	.481
7	.515	1 758	.592	1.30	8	.268	-				1.30	1.22	.514	1	.282	.02	.547
8	.568	224	.693	1.30							1.30	1.76	.570	1	0	.01	.482
9	.753	31	.904	1.30							1.30	.91	.750	1	0	.01	1.076
10	.909	17	.734	1.00							1.00	1.01	.913	1	0	.01	.842
11^{+}	.721	1	.703	1.00							1.00	1.06	.721	1	0	0	0
Weight tonnes	-	79 024			44 994			70 167			-	-					

Recruitment at age 0 ($N \times 10^{-6}$) 1981 : 2 566
1982 : 3 131
1983 : 3 131

M = .2

Age at first maturity : 2

Table 15.7 Management Options: Species - WHITING. Area - ICES Sub-area IV North Sea
OPTION 2

1982				1983							1984	
Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock biom.	Spawning stock biomass
395	208	.90 ($=\bar{F}_{81}$)	127	$\bar{F}_{0.1}$	450	322							
				$\bar{F}_{max}$	450	322							
				$\bar{F}_{83} = \bar{F}_{82}$	450	322	.90	125	60	65	70	513	295
				$\bar{F}_{83} = 0$	450	322	0	76	0	76	0	641	421
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	450	322	.18	90	16	74	16	610	390
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	450	322	.45	105	35	70	38	569	350
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	450	322	1.35	138	78	60	98	469	251
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	450	322	1.80	149	92	57	122	433	217

Weights in thousands of tonnes
Recruitment 1981 R_o = 2 566 x 10^6 1982, 1983 R_o = 3 131 x 10^6
Stock biomass = fish at age 0 and older
Spawning stock biomass = fish at age 2 and older
Exploitation pattern 1982-83 based on 1976-81 average
F values relate to the human consumption fishery (landings + discards) only

Table 16.1 Nominal catch (in tonnes) of WHITING in Division VIa, 1972-81.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	7	5	10	1	14	-	-	-	+	-
Denmark	-	121	-	-	-	-	119	92	32[a]	-
Faroe Isl.	-	5	1	30	2	-	-	770	-	
France	1 662	2 777	2 983	2 763	3 655	3 395	3 610	2 779	2 609	1 227
German Dem.Rep.	-	-	-	-	31	-	-	-	-	
Germany Fed.Rep.	148	127	80	62	1	1	2	4	1	63[a,b]
Ireland	1 122	2 117	2 431	2 429	3 255	2 752	2 080	2 791	4 407	2 330
Netherlands	40	57	23	85	255	78	23	17	2	
Norway	-	-	-	-	1	-	-	-	-	-
Poland	-	10	9	-	-	-	-	-	-	-
Spain	1 397	1 540	1 479	1 871	821	763[a]	-	-	-	
UK(Engl. & Wales)	102	91	112	132	244	520	669	320	227	112
UK(Scotland)	10 707	9 796	9 929	12 668	16 658	9 873	8 174	10 613	7 386	8 069
USSR	128	-	-	-	-	-	-	-	-	-
Total VIa	15 313	16 646	17 057	20 041	24 937	17 382	14 677	17 386	14 664	11 801

*) Provisional.

a) Includes Division VIb.

b) Aug.-Dec. catch estimates based on information from fishing vessels.

Table 16.2 WHITING in Division VIa.
VPA, catch in numbers ('000).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	1688	5543	7241	887	664	2335	16008	13715	9031
2	10477	26858	10452	25148	6773	8393	11973	36395	50779
3	2219	10949	9232	8628	28090	4032	4022	5583	10018
4	28202	779	5059	2564	5237	33800	1357	1471	1165
5	1862	13598	525	1214	604	1300	14832	359	182
6	187	813	5037	118	211	234	797	4330	42
7	34	116	528	2106	17	67	79	278	830
8+	18	33	39	219	519	151	70	36	31
TOTAL	44687	58429	42313	40874	40175	50372	49798	62167	72078

	1975	1976	1977	1978	1979	1980	1981
1	14931	8526	16037	17712	6522	11631	3478
2	16762	46222	13525	18177	34233	11479	23011
3	35244	15711	25070	6670	15272	15216	10943
4	2811	17433	3125	9389	3392	4307	4465
5	279	1513	4711	931	3492	1205	1471
6	57	65	292	1429	264	1120	437
7	9	14	13	64	374	85	187
8+	237	45	10	5	9	84	5
TOTAL	71350	89529	62583	54377	64358	45127	44597

Table 16.3. WHITING in Division VIa.
VPA, mean weight (kg) at age of the stock.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.258	0.204	0.206	0.178	0.206	0.209	0.211	0.197	0.194
2	0.244	0.240	0.263	0.223	0.200	0.247	0.258	0.234	0.216
3	0.325	0.319	0.366	0.335	0.273	0.277	0.346	0.362	0.318
4	0.374	0.424	0.444	0.500	0.381	0.316	0.369	0.479	0.445
5	0.609	0.412	0.554	0.571	0.517	0.426	0.426	0.485	0.592
6	0.720	0.639	0.539	0.649	0.619	0.551	0.495	0.535	0.640
7	0.816	0.824	0.701	0.618	0.670	0.696	0.604	0.654	0.574
8+	0.871	0.878	0.854	0.725	0.667	1.006	0.713	0.750	0.843

	1975	1976	1977	1978	1979	1980	1981
1	0.209	0.201	0.200	0.199	0.218	0.172	0.190
2	0.245	0.243	0.240	0.245	0.232	0.238	0.217
3	0.306	0.311	0.295	0.285	0.306	0.324	0.287
4	0.472	0.363	0.388	0.388	0.405	0.419	0.381
5	0.652	0.500	0.429	0.515	0.536	0.486	0.407
6	0.612	0.691	0.623	0.549	0.691	0.499	0.527
7	0.853	1.045	0.853	0.601	0.695	0.652	0.552
8+	0.713	1.169	1.065	0.973	0.651	0.786	0.605

Table 16.4. WHITING in Division VIa.
VPA, fishing mortalities (M = 0.2).

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.03	0.11	0.04	0.05	0.03	0.09	0.22	0.08	0.16
2	0.40	0.94	0.59	0.18	0.63	0.75	0.83	1.03	0.48
3	0.86	0.95	1.07	0.71	0.32	1.02	1.04	1.33	0.94
4	0.66	0.77	1.05	1.05	0.65	0.82	1.28	1.65	1.24
5	0.72	0.80	1.02	1.36	0.88	0.59	1.12	1.78	1.02
6	0.61	0.83	0.81	1.52	0.97	0.95	0.91	1.30	1.23
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
F(2- 4),U	0.64	0.89	0.90	0.65	0.53	0.86	1.05	1.34	0.88

	1975	1976	1977	1978	1979	1980	1981	1976-1981
1	0.12	0.21	0.20	0.21	0.15	0.16	0.23	0.20
2	0.49	0.62	0.59	0.53	0.78	0.42	0.58	0.59
3	0.76	1.28	0.85	0.67	0.95	1.02	0.94	0.95
4	0.76	1.08	1.01	0.90	0.88	0.99	1.00	0.98
5	1.26	1.38	1.05	1.02	1.09	0.95	1.20	1.11
6	1.13	1.27	1.21	1.09	0.96	1.48	1.20	1.20
7	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.03
8+	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.03
F(2- 4),U	0.67	0.99	0.81	0.70	0.87	0.81	0.84	

Table 16.5. WHITING in Division VIa.
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	60253	55419	208136	20242	21982	30714	93225	194078	67364
2	35123	47807	40556	103871	15772	17398	23041	61325	146525
3	4193	19354	15250	18485	111519	6859	6755	8196	17881
4	63637	1457	6108	4290	7431	66086	2033	1958	1774
5	3951	26901	551	1751	1235	3191	23911	464	309
6	448	1573	9961	163	370	420	1449	6419	64
7	58	199	563	3616	29	115	136	477	1425
8+	51	57	67	376	891	259	120	67	53
TOTAL	167694	152767	281133	212795	159230	125022	150670	272978	235395
SPAWN. ST.	107441	97347	72997	192552	137248	94307	57445	78901	168032
Biomass: Total	50876	41873	67930	52097	42440	35425	39773	60493	52280
Spawn. St.	36536	30567	25054	48494	37912	29006	20103	22260	39212

	1975	1976	1977	1978	1979	1980	1981	1982	1966-1978
1	150065	49493	77001	103626	51427	84407	18605	**********	87046
2	47016	109401	32846	48619	68897	36408	58628	12103	60715
3	74456	23476	48241	14971	23528	25877	19511	26875	28434
4	5728	28023	5319	17158	6297	7458	7667	6240	10275
5	421	2183	7961	1578	5691	2136	2278	2309	5724
6	91	98	450	2333	465	1560	677	569	1829
7	15	24	22	110	642	146	290	167	522
8+	407	77	17	9	15	144	8	73	187
TOTAL	278200	213375	171858	188404	159963	158137	107004		
SPAWN. ST.	128135	163882	94857	84777	105536	73730	89059		
Biomass: Total	69003	55498	43215	45139	40773	36718	26227		
Spawn. St.	37640	45550	27815	24518	29562	22200	22692		

Table 16.6 Input data for catch predictions.WHITING in Division VIa

Age	Stock $\bar{W}$ (kg)	H. C. landings 1981			Discards 1981			Ind.landings 1981			Total F	Reference F = $\bar{F}_{7(}$-81		
		N x 10^{-3}	$\bar{W}$ (kg)	F	N x 10^{-3}	$\bar{W}$ (kg)	F	N x 10^{-3}	$\bar{W}$ (kg)	F	1981	H.C. catch F	Prop.not disc.	Ind.catch F
1	.197	3 478	.190	.23								.20 .197		
2	.234	23 611	.217	.58								.59 .234		
3	.301	10 943	.287	.94								.95 .301		
4	.391	4 465	.381	1.00								.98 .301		
5	.479	1 471	.407	1.20								1.11 .479		
6	.597	437	.527	1.20								1.20 .597		
7	.733	187	.552	1.20								1.03 .733		
8	.885	5	.665	1.20								1.03 .885		
Weight tonnes -		11 779									-	-		

Recruitment at age 1 : (N x 10^{-3}) 1981 : 18 605
1982 : 87 046
1983 : 82 046

M = .2

Age at first maturity : 2

Table 16.7 Management Options: Species - WHITTING. Area - ICES Division VIa West of Scotland

OPTION 1

1982				1983					1984	
Stock biom.	Spawning stock biomass	$\bar{F}$ (2-4) H.C.	Total landings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (2-4) H.C.	H.C. landings	Stock biom.	Spawning stock biomass
32	15	1.09 (= F to take TAC)	13.0	$\bar{F}_{0.1}$	35	18	0.16	2.7		32
				$\bar{F}_{max}$	35	18	0.46	6.6		28
				$\bar{F}_{83} = \bar{F}_{82}$	35	18	1.09	13.2	38	21
				$\bar{F}_{83} = 0$	35	18	0	0	52	35
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	35	18	0.22	3.5	49	31
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	35	18	0.54	7.8	44	27
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	35	18	1.63	17.1	34	16
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	35	18	2.18	20.0	30	13

Weights in thousands of tonnes

Recruitment 1982-83 $R_1 = 87\ 046 \times 10^3$

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1982-83 based on 1976-81 average

Table 16.8 Management Options: Species - WHITTING
Area - ICES Division VIa west of Scotland

OPTION 2

1982				1983					1984	
Stock biom.	Spawning stock biomass	$\bar{F}$ (2-4 H.C.	Total land-ings	Management option for 1983	Stock biom.	Spawning stock biomass	$\bar{F}$ (2-4) H.C.	H.C. land-ings	Stock biom.	Spawning stock biomass
32	15	0.84 ($=\bar{F}_{81}$)	11.0	$\bar{F}_{0.1}$	37	20	0.16	3.0		35
				$\bar{F}_{max}$	37	20	0.46	7.8		29
				$\bar{F}_{83} = \bar{F}_{82}$	37	20	0.84	12.1	41	24
				$\bar{F}_{83} = 0$	37	20	0	0	55	38
				$\bar{F}_{83} = 0.2\ \bar{F}_{82}$	37	20	0.17	3.1	51	34
				$\bar{F}_{83} = 0.5\ \bar{F}_{82}$	37	20	0.42	7.0	47	30
				$\bar{F}_{83} = 1.5\ \bar{F}_{82}$	37	20	1.26	16.1	37	20
				$\bar{F}_{83} = 2.0\ \bar{F}_{82}$	37	20	1.68	19.1	34	16

Weights in thousands of tonnes

Recruitment 1982-83 $R_1 = 87\ 046 \times 10^3$

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1982-83 based on 1976-81 average

Table 16.9 Nominal catch (in tonnes) of WHITING in Division VIb, 1972-81.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Denmark	-	-	-	-	-	-	-	-	...a)	-
Faroe Isl.	-	-	1	-	-	+	-	-	-	
France	69	62	-	-	-	-	-	-	3	
Germany, Fed.Rep.	-	-	-	-	-	-	-	-	-	...a)
Ireland	-	-	-	-	-	-	1	-	-	
Spain	-	-	-	-	-	...a)	-	-	-	
U.K.(Engl. & Wales)	+	+	-	-	3	2	5	1	+	-
UK(Scotl.)	12	1	+	12	15	5	24	2	59	+
Total VIb	81	63	1	12	18	7	30	3	62	

*) Provisional

a) Included in Div. VIa.

Table 17.1 Nominal catch (in tonnes) of WHITING in Divisions VIId and VIIe in 1972-81.
(Data for 1971-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981⁎
Belgium	19	38	39	70	103	36	85	92	85	103
Denmark	-	-	-	-	18	-	1	2 585	6	-
France	3 121	5 050	7 917	10 060	8 390	8 886	8 010	5 352	7 690	7 109
Germany, Fed.Rep.	-	-	25	1	-	-	-	-		
Ireland	-	-	-	-	-	11	12	-	13	
Netherlands	21	42	12	14	5	1	2	1	2	
UK (Engl. & Wales)	515	498	579	1 255	1 504	1 342	1 038	930	839	1 059
USSR	-	19	-	-	-	-	-	-	-	
Total VIId,e	3 676	5 647	8 572	11 400	10 020	10 276	9 148	8 960	8 635	

⁎) Provisional

Table 17.2. WHITING in the English Channel (Divisions VIIe and VIId). VPA, catch in numbers ('000).

	1976	1977	1978	1979	1980	1981
0	140	0	150	0	33	0
1	12727	13847	19949	7333	4375	2233
2	7513	13004	9201	7982	11628	8788
3	5074	2835	4649	4542	5103	8900
4	1410	843	1556	2482	2037	6807
5	521	253	433	639	523	2869
6	74	46	88	93	58	950
7+	0	8	0	10	8	562
TOTAL	27259	30836	36026	23081	23765	31109

Table 17.3. WHITING in the English Channel (Divisions VIIe and VIId). VPA, mean weight (kg) at the age of the stock.

	1976	1977	1978	1979	1980	1981
0	0.218	0.200	0.130	0.170	0.195	0.000
1	0.280	0.258	0.207	0.299	0.282	0.160
2	0.374	0.347	0.260	0.379	0.336	0.236
3	0.479	0.496	0.346	0.435	0.436	0.261
4	0.594	0.642	0.412	0.518	0.461	0.291
5	0.696	0.749	0.668	0.594	0.538	0.349
6	0.742	0.850	0.711	1.052	0.633	0.418
7+	0.740	0.955	0.711	0.479	0.700	0.382

Table 17.4. WHITING in the English Channel (Divisions VIIe and VIId). Fishing mortalities (M = 0.2).

	1976	1977	1978	1979	1980	1981	1976-1978
0	0.003	0.000	0.003	0.000	0.004	0.000	0.002
1	0.361	0.416	0.477	0.203	0.206	0.420	0.418
2	0.750	0.721	0.508	0.335	0.533	0.754	0.659
3	1.339	0.700	0.579	0.477	0.350	0.976	0.873
4	1.364	0.792	1.034	0.664	0.384	1.035	1.063
5	1.960	0.942	1.260	1.936	0.264	1.413	1.387
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7+	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F(2- 4),U	1.151	0.738	0.707	0.492	0.423	0.922	

Table 17.5. WHITING in the English Channel (Divisions VIIe and VIId).
VPA, stock size in numbers ('000) at 1 January.
Biomass unit: tonnes.

	1976	1977	1978	1979	1980	1981	1982	1976-1978
0	50779	65402	49937	29361	8139	0**********		55373
1	45044	43576	36292	42842	25271	6975	0	48304
2	14785	27027	24738	30070	30095	17706	3945	22183
3	7286	6010	11316	12818	18514	15196	7170	8204
4	2006	1644	2568	5461	6848	11226	4929	2073
5	638	441	641	786	2419	4015	3432	574
6	125	77	148	157	98	1599	841	117
7+	0	13	0	17	13	946	806	4
TOTAL	120664	144191	145640	121512	91397	57663		
SPAWN. ST.	24841	35213	39411	49309	57986	50688		
Biomass: Total	34431	38147	30083	38242	31427	14958		
Spawn. St.	10748	13824	11939	20441	22713	13842		

Table 17.6 Nominal catch (in tonnes) of WHITING in Divisions VIIb,c and VIIg-k.
(Data for 1972-80 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981⁎
Belgium	20	124	75	83	97	60	37	26	31	61
France	5 695	4 035	4 331	3 637	4 731	3 962	3 868	4 127	5 603	
Germany, Fed.Rep.	-	+	-	2	-	1	45	-	+	-
Ireland	1 141	1 894	1 641	2 562	1 980	1 201	1 172	2 674	3 710	3 579
Netherlands	377	2 080	915	66	112	86	63	3	4	
Poland	-	14	-	-	-	-	-	-	-	
Spain	1 491	1 121	1 367	2 974	2 772	-	-	-	-	
UK(Engl. & Wales)	34	21	15	61	21	26	38	23	60	189[a]
UK(Scotland)	-	-	-	-	-	2	1	1	80	1
USSR	3	16	-	64	2	-	-	-	-	-
Total VIIb,c and g-k	8 761	9 305	8 344	9 449	9 715	5 338	5 224	6 854	9 488	

⁎) Provisional

a) December catch estimate

Table 18.1 Mean length ($\bar{l}$ cm), standard deviation (s), and mean weight ($\bar{w}$,g) of North Sea ROUNDFISH populations. Von Bertalanffy parameters are: COD: L_∞ 123 cm, K .234, to - .155 years; HADDOCK: L_∞ 60 cm, K .236, to - 1.08; WHITING: L_∞ 42 cm, K .324, to - 1.185

		Age											
		1	2	3	4	5	6	7	8	9	10	11	12
Cod	$\bar{l}$	29.1	48.7	64.2	76.5	86.2	93.9	99.9	104.8	108.6	111.6	114.0	115.8
	s	5.40	8.46	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41	8.41
	$\bar{w}$	282	1304	2900	4823	6849	8812	10604	12187	13548	14693	15646	16425
Haddock	$\bar{l}$	23.2	31.0	37.0	41.9	45.7	48.7	51.1	52.9	54.4	55.6		
	s	2.76	3.86	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21		
	$\bar{w}$	125	299	515	739	952	1147	1321	1462	1588	1695		
Whiting	$\bar{l}$	21.5	27.3	31.5	34.5	36.7	38.3	39.4	40.2	40.8	41.3		
	s	2.68	2.76	2.82	3.28	4.06	4.06	4.06	4.06	4.06	4.06		
	$\bar{w}$	84	170	259	342	415	470	511	542	566	587		

Weight-length constants: COD: .0104; HADDOCK: .0096; WHITING: .0081

Table 18.2 Selectivity data used. SF = selection factor; L_{50} = 50% selection length; range = ± 25% length, reference 50% selection length.

	SF		Mesh Size (mm)									
			75	80	90	100	120	140	160	200	250	300
Cod	3.6	L50 cm	27.0	28.8	32.4	36.0	43.2	50.4	57.6	72.0	90.0	108.0
		Range cm	2.4	2.6	2.9	3.1	3.5	4.0	4.5	5.5	6.75	8.0
Haddock	3.4	L50 cm	25.5	27.2	30.6	34.0	40.8	47.6	54.4	68.0	85.0	-
		Range cm	2.1	2.3	2.5	2.6	2.8	3.0	3.2	3.6	4.1	-
Whiting	3.8	L50 cm	28.5	30.4	34.2	38.0	45.6	53.2	60.8	-	-	-
		Range cm	2.6	2.9	3.3	3.5	3.9	4.3	4.7	-	-	-

Table 18.3 COD. Exploitation patterns (A) and mean weights in grammes (B) at different mesh sizes.

	Age	Mesh size (mm)									
		75	80	90	100	120	140	160	200	250	300
A.	1	.36	.30	.18	.10	.02	.004	0	0	0	0
	2	1.00	.99	.96	.91	.71	.44	.21	.03	0	0
	3	.82	.82	.82	.82	.81	.74	.59	.21	.03	0
	4	.65	.65	.65	.65	.65	.65	.62	.42	.10	.01
	5	.65	.65	.65	.65	.65	.65	.64	.57	.25	.05
	6	.65	.65	.65	.65	.65	.65	.65	.62	.40	.11
	7	.65	.65	.65	.65	.65	.65	.65	.64	.50	.19
	8	.65	.65	.65	.65	.65	.65	.65	.65	.56	.27
	9	.65	.65	.65	.65	.65	.65	.65	.65	.59	.33
	10	.65	.65	.65	.65	.65	.65	.65	.65	.61	.38
	11	.65	.65	.65	.65	.65	.65	.65	.65	.62	.42
	12	.65	.65	.65	.65	.65	.65	.65	.65	.63	.45
B.	1	351	372	415	460	532	535	-	-	-	-
	2	1314	1321	1348	1391	1545	1775	2050	2464	-	-
	3	2900	2900	2900	2900	2930	3041	3262	3922	4324	-
	4	4823	4823	4823	4823	4823	4823	4920	5437	6415	6947
	5	6849	6849	6849	6849	6849	6849	6767	7131	8123	8943
	6	8812	8812	8812	8812	8812	8812	10647	8922	9702	10781
	7	10604	10604	10604	10604	10604	10604	10604	10647	11215	12395
	8	12187	12187	12187	12187	12187	12187	12187	12187	12597	13759
	9	13548	13548	13548	13548	13548	13548	13548	13548	13850	14930
	10	14693	14693	14693	14693	14693	14693	14693	14693	14913	15900
	11	15646	15646	15646	15646	15646	15646	15646	15646	15774	16707
	12	16425	16425	16425	16425	16425	16425	16425	16425	16545	17386

Table 18.4 HADDOCK. Exploitation patterns (A) and mean weights in grammes (B) at different mesh sizes.

	Age	Mesh size (mm)								
		75	80	90	100	120	140	160	200	250
A.	1	.30	.19	.06	.02	0	0	0	0	0
	2	.77	.69	.48	.27	.04	0	0	0	0
	3	1.00	.97	.86	.70	.30	.07	.01	0	0
	4	1.00	.99	.96	.88	.56	.21	.04	0	0
	5	1.00	1.00	.99	.96	.76	.39	.12	0	0
	6	1.00	1.00	1.00	.99	.88	.56	.22	.01	0
	7	1.00	1.00	1.00	1.00	.93	.69	.32	.02	0
	8	1.00	1.00	1.00	1.00	.96	.77	.42	.03	0
	9	1.00	1.00	1.00	1.00	.97	.83	.50	.04	0
	10	1.00	1.00	1.00	1.00	.98	.87	.57	.06	0
B.	1	159	165	174	182	-	-	-	-	-
	2	318	329	357	391	456	-	-	-	-
	3	525	532	557	596	712	842	971	-	-
	4	739	743	755	779	879	1029	1172	-	-
	5	952	952	959	972	1044	1190	1365	-	-
	6	1147	1147	1147	1157	1205	1333	1522	1901	-
	7	1321	1321	1321	1325	1357	1465	1649	2003	-
	8	1462	1462	1462	1462	1486	1576	1753	2133	-
	9	1588	1588	1588	1588	1604	1679	1847	2250	-
	10	1695	1695	1695	1695	1707	1770	1930	2366	-

Table 18.5 WHITING. Exploitation patterns (A) and mean weights in grammes (B) at different mesh sizes.

	Age	Mesh size (mm)							
		75	80	90	100	120	140	160	200
A.	1	.13	.08	.03	.01	0	0	0	0
	2	.37	.26	.11	.04	.01	0	0	0
	3	.65	.52	.28	.13	.02	0	0	0
	4	.77	.68	.46	.25	.05	.01	0	0
	5	.78	.72	.55	.36	.10	.02	0	0
	6	1.00	.95	.77	.54	.17	.04	.01	0
	7	1.00	.96	.81	.60	.20	.05	.01	0
	8	1.00	.97	.84	.64	.23	.05	.01	0
	9	1.00	.97	.86	.67	.26	.06	.01	0
	10	1.00	.98	.87	.70	.28	.07	.01	0
B.	1	116	116	117	118	-	-	-	-
	2	198	203	205	214	219	-	-	-
	3	276	284	298	309	319	-	-	-
	4	354	363	382	402	427	440	-	-
	5	428	437	461	491	542	571	-	-
	6	479	487	509	539	599	631	671	-
	7	517	523	544	572	636	670	702	-
	8	547	552	571	599	664	704	728	-
	9	571	576	593	620	686	727	739	-
	10	591	596	612	638	707	753	740	-

Table 18.6 Mean weight (g) and biomass (kg) of a cohort of 1000 fish, with zero fishing mortality and natural mortality of 0.2.

Age	Cod		Haddock		Whiting	
	Mean weight	Biomass	Mean weight	Biomass	Mean weight	Biomass
1	282	282	125	125	84	84
2	1304	1068	299	245	170	139
3	2900	1935	515	345	259	174
4	4823	2647	739	406	342	188
5	6849	3077	952	428	415	187
6	8812	3242	1147	422	470	173
7	10604	3194	1321	398	511	154
8	12187	3005	1462	361	542	134
9	13548	2735	1588	321	566	114
10	14693	2429	1695	280	587	97
T_{max} (years)	6		5		4	
Mean weight (g)	8812		952		342	
Mean length (cm)	93.9		45.7		34.5	
Selection factor	3.6		3.4		3.8	
Mesh Size (mm) at 50% retention	261		134		91	

Table 18.7 Equilibrium yield at recent Fs, maximum sustainable yield (MSY), and F-value giving MSY (F_{max}), at various mesh sizes. Y and MSY are in thousands of tonnes. Data calculated for average recruitment at age 1 (millions): COD 236; HADDOCK 1 032; WHITING 2 216.

Mesh size (mm)	Cod			Haddock			Whiting			Total
	$Y^{\ddagger}$	MSY	F_{max}	$Y^{\ddagger}$	MSY	F_{max}	$Y^{\ddagger}$	MSY	F_{max}	$Y^{\ddagger}$
75	248	399	.30	328	387	.35	350	350	.75	926
80	262	406	.30	357	401	.35	361	363	.95	980
90	293	422	.30	411	434	.45	372	390	1.5	1076
100	328	435	.30	464	469	.65	363	419	2.8	1155
120	379	466	.35	549	560	2.2	259	459	11.0	1187
140	444	503	.45	582	672	12.6	102	494	74.0	1128
160	516	546	.55	535	-	∞	22	-	∞	1073
200	641	641	1.0	152	-	∞	0	0	-	793
250	713	759	3.6	0	0	-	0	0	-	713
300	644	866	36.0	0	0	-	0	0	-	644
Recent F	1.06			.98			.70			

‡ Eq. yield at recent Fs.

Table 18.8 Equilibrium stock biomass ('000 tonnes, ages > 1) with average recruitment. Recent Fs values are as in Table 18.7.

Mesh size (mm)	Recent F			
	Cod	Haddock	Whiting	Total
75	482	674	1135	2291
80	512	762	1292	2566
90	582	950	1649	3181
100	682	1164	2050	3896
120	791	1693	2952	5436
140	992	2401	3736	7129
160	1280	3319	4075	8674
200	2014	5419	4168	11601
250	3210	5983	4168	13361
300	4747	5983	4168	14898

Table 19.1 *Pandalus borealis* landings (tonnes) from ICES Sub-area IV (North Sea) and Division IIIa (Skagerrak and Kattegat)

Year	Denmark	Germany Fed.Rep.	Norway	U.K.	Sweden	Total North Sea	Total IIIa
1970	3 460	-	1 107	118	915	5 600	3 566
1971	3 572	33	1 265	435	1 358	6 664	3 774
1972	2 448	-	1 216	187	1 150	5 001	3 270
1973	196	-	913	1 184	936	3 247	3 325
1974	337	-	767	482	520	2 106	3 144
1975	1 392	2	604	525	252	2 775	3 957
1976	1 861	-	1 051	2 213	177	5 302	5 758
1977	782	1	960	2 011	113	3 867	4 836
1978	1 592	-	692	2 163	79	4 526	4 127
1979	654	-	894	547	-	2 095	5 228
1980	1 273	-	1 140	609	38	3 060	7 298

Table 19.2 Species composition in the Norwegian deep sea prawn (Pandalus borealis) fishery in the southern part of the Norwegian Deeps (Trench) from March to December 1981.

Month	No.of samples	Av.total catch kg	Av.prawn catch kg	Human consumption average catch kg							Industrial average by-catch kg								
				Total	Cod	Haddock	Whiting	Saithe	Hake	Other species[1]	Total	Norway pout	Blue whiting	Prawn	Cod	Haddock	Whiting	Hake	Other species[2]
Mar	2	2 514	1 401	163.0	69.0	7.0	15.0	11.0	3.0	58.0	950	575.5	92.6	4.8	51.1	27.3	46.3	30.6	121.8
Apr	5	1 930	937	73.0	17.0	.4	.2	.6	4.8	50.0	920	10.6	295.8	6.0	-	7.5	5.4	85.8	508.9
May	3	3 638	1 206	232.0	8.3	1.7	-	-	51.3	170.7	2 200	-	1193.6	12.7	-	-	-	-	993.7
Jun	5	1 650	913	58.0	9.2	.4	-	-	19.8	28.6	680	2.4	318.3	4.3	-	-	-	2.3	352.7
Aug	4	3 298	1 237	74.0	33.0	.8	-	2.3	-	38.0	1 988	63.0	895.1	4.5	.8	.8	-	-	1023.8
Sep	3	3 221	1 495	93.0	17.7	-	-	2.7	.3	72.3	1 633	-	680.1	2.0	-	-	-	-	950.9
Oct	4	1 450	786	37.0	12.0	-	-	.8	.3	24.0	627	12.7	268.8	.6	-	.2	.2	-	357.2
Nov	1	1 039	521	18.0	-	-	-	-	-	18.0	500	58.9	317.2	5.2	-	-	-	-	118.2
Dec	3	3 371	829	309.0	96.2	-	-	-	5.2	207.6	2 233	156.8	934.9	7.1	-	12.3	-	-	1121.9
Overall average		2 455	1 042	111.5	20.0	.9	1.0	1.5	9.7	78.4	1 302	68.3	555.1	5.1	.1	4.4	4.0	16.7	648.3
Percent		100.00	42.44	4.54	.81	.04	.04	.06	.40	3.19	53.03	2.78	22.61	.21	+	.18	.16	.68	26.41

1) Mainly piked dogfish, ling, skates and monk (angler)

2) Mainly argentines and blackmouth shark (Etmopterus spinax)

Table 19.3 Landings of shrimp (P. borealis) and landed by-catch (metric tonnes) in the Scottish shrimp fishery on the Fladen Ground for the years 1970-1980.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Average % 1970-1980
Total all species	252.1	725.0	297.9	238.7	537.4	670.8	2460.6	2485.9	2651.2	386.2	634.2	100
Shrimp	102.5	438.7	186.9	162.7	433.6	524.7	1939.7	1698.1	2027.3	253.7	372.8	72
Nephrops	0.1	15.9	3.6	1.4	13.6	1.1	51.8	8.4	7.5	3.4	5.0	1
Cod	50.8	87.6	67.7	42.6	57.7	69.8	-	-	not available	-	-	⁂14
Haddock	41.8	35.1	14.1	3.5	3.0	5.5	-	-	not available	-	-	⁂4
Whiting	6.1	12.0	7.3	1.1	1.9	4.2	-	-	not available	-	-	⁂1
Total protected fish	102.8	140.2	95.7	50.6	68.4	90.0	274.9	564.9	434.8	97.6	186.5	19
Total fish	149.5	270.4	107.4	74.6	90.2	145.0	469.1	779.4	616.4	129.1	256.4	27

⁂ Average 1970-75

Fish discarded at sea not included

Table 19.4 Weight of discarded fish as a percentage of the total catch in the Scottish Pandalus fishery on the Fladen Ground, 1972-77.

Month	Discarded fish	Retained fish	Shrimp
March	7.1	12.4	80.5
April	14.5	16.8	68.7
May	19.6	25.2	55.2
June	29.2	16.7	54.1
July	60.3	11.4	28.2
August	73.3	4.6	22.1
October	68.4	15.3	16.3
Average	38.9	14.6	46.4

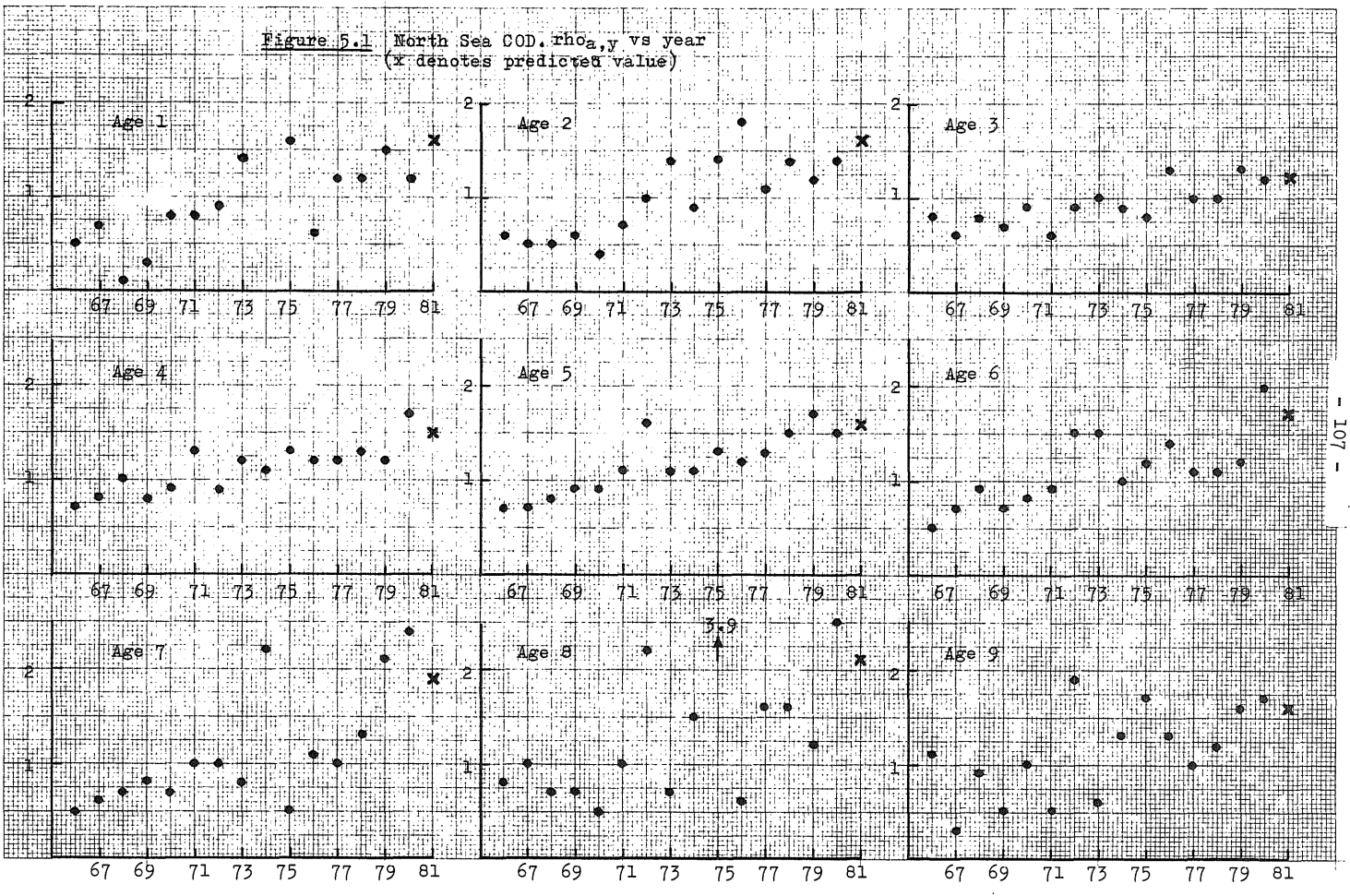


Figure 5.1 North Sea COD. $rho_{a,y}$ vs year
(x denotes predicted value)

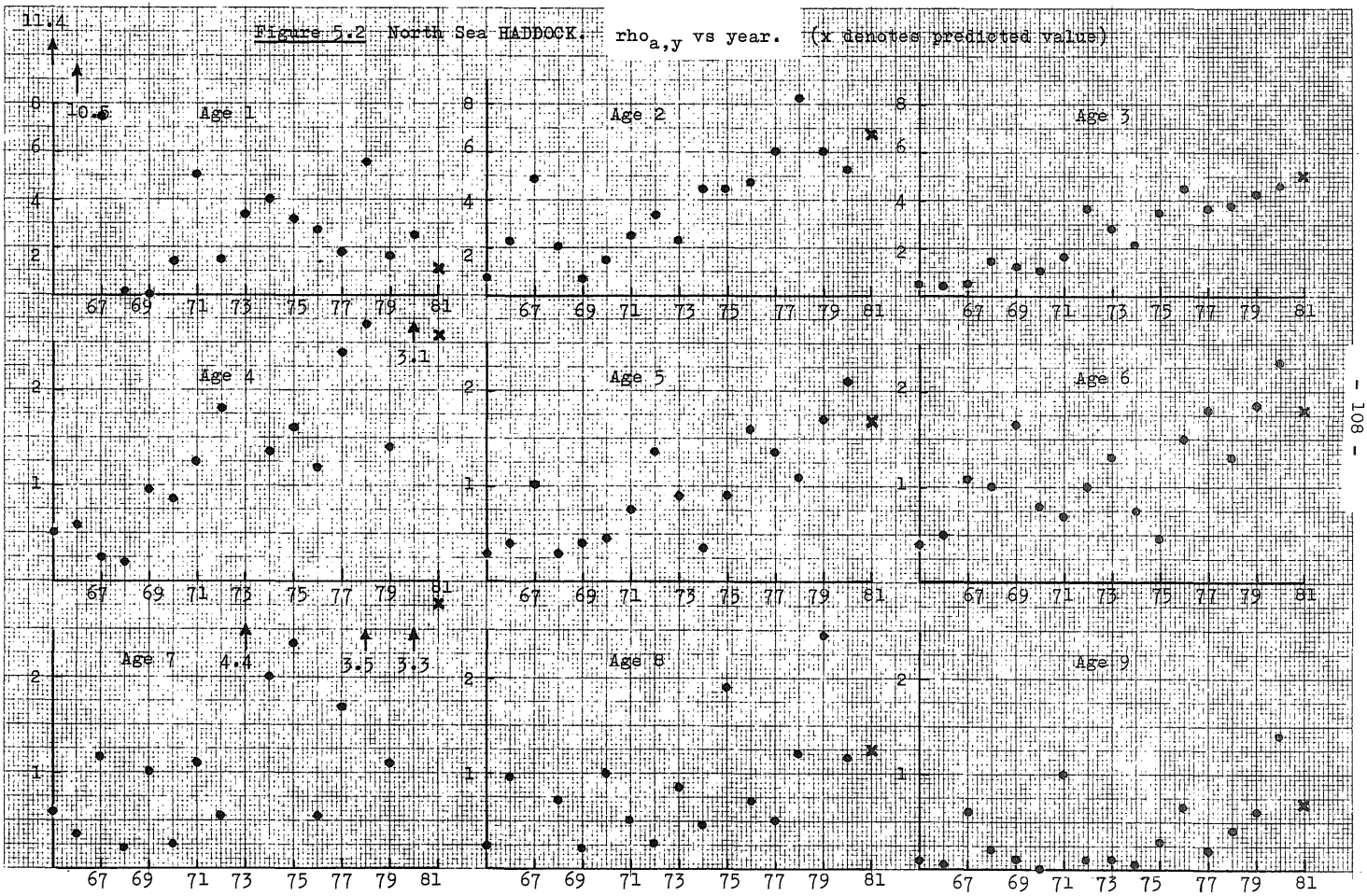


Figure 5.2 North Sea HADDOCK. rho a,y vs year. (x denotes predicted value)
Age 1
Age 2
Age 3
Age 4
Age 5
Age 6
Age 7
Age 8
Age 9
10.6
3.1
4.4
3.5
3.3
67 69 71 73 75 77 79 81

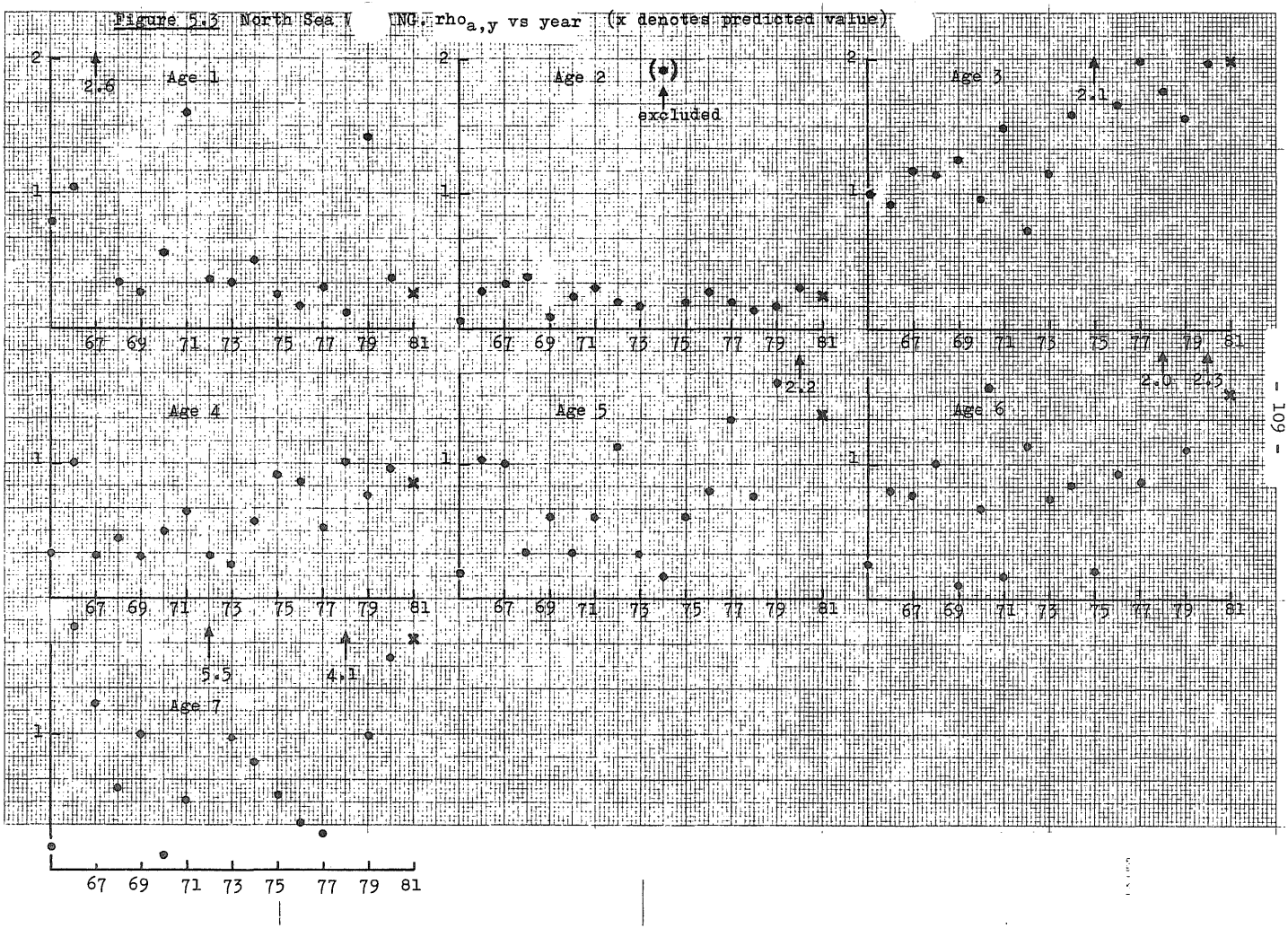
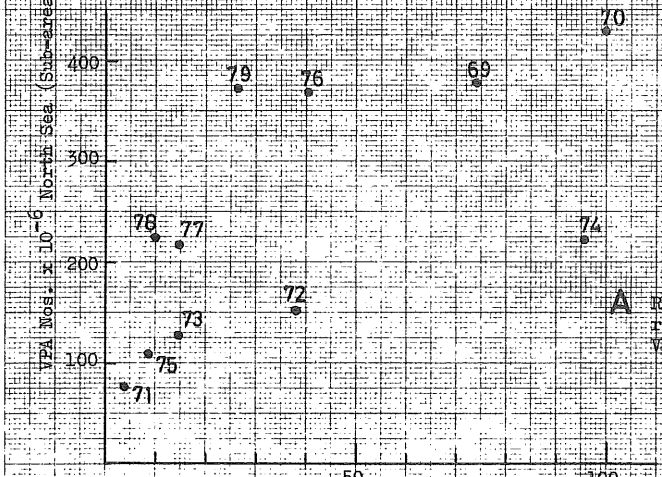
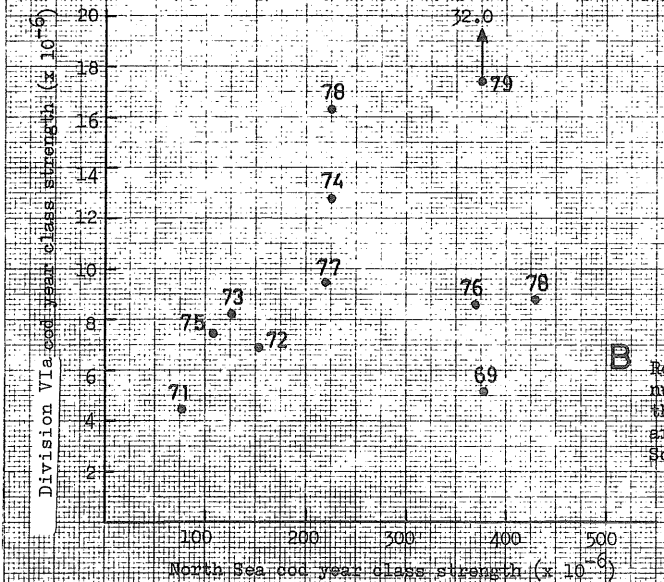


Figure 5.3 North Sea I NG.rho$_{a,y}$ vs year (x denotes predicted value)
Age 1
2.6
Age 2
(•)
excluded
Age 3
2.1
2.2
2.0
2.3
Age 4
5.5
4.1
Age 5
Age 6
Age 7
1
2
67 69 71 73 75 77 79 81

Figure 6.1. North Sea COD.



A Relation between IYFS recruitment indices and VPA numbers at age 1



B Relation between VPA numbers at age 1 in the North Sea (Sub-area IV) and West of Scotland (Division VIa)

Figure 6.2 North Sea HADDOCK.

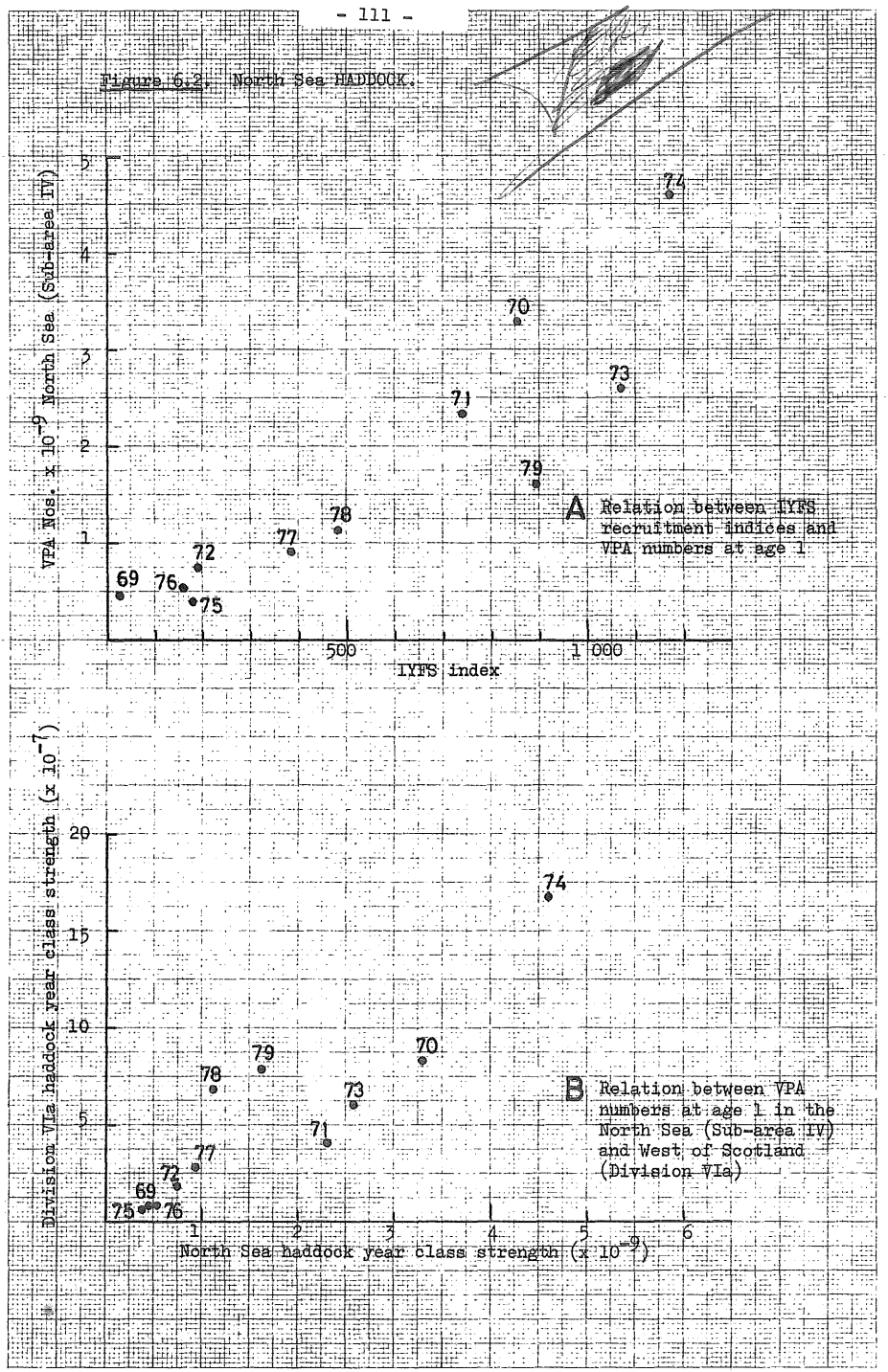
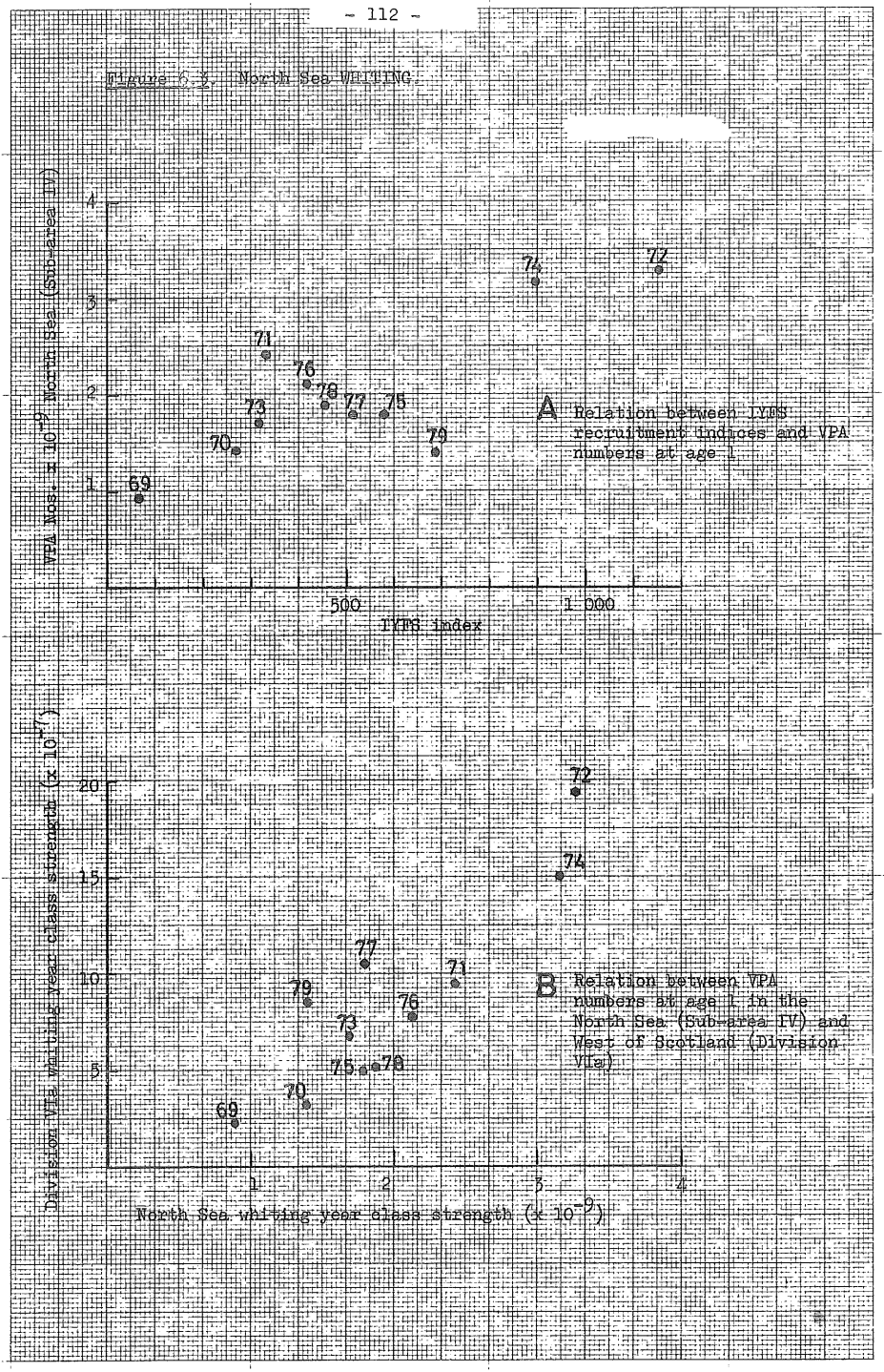


Figure 6.3 North Sea WHITING



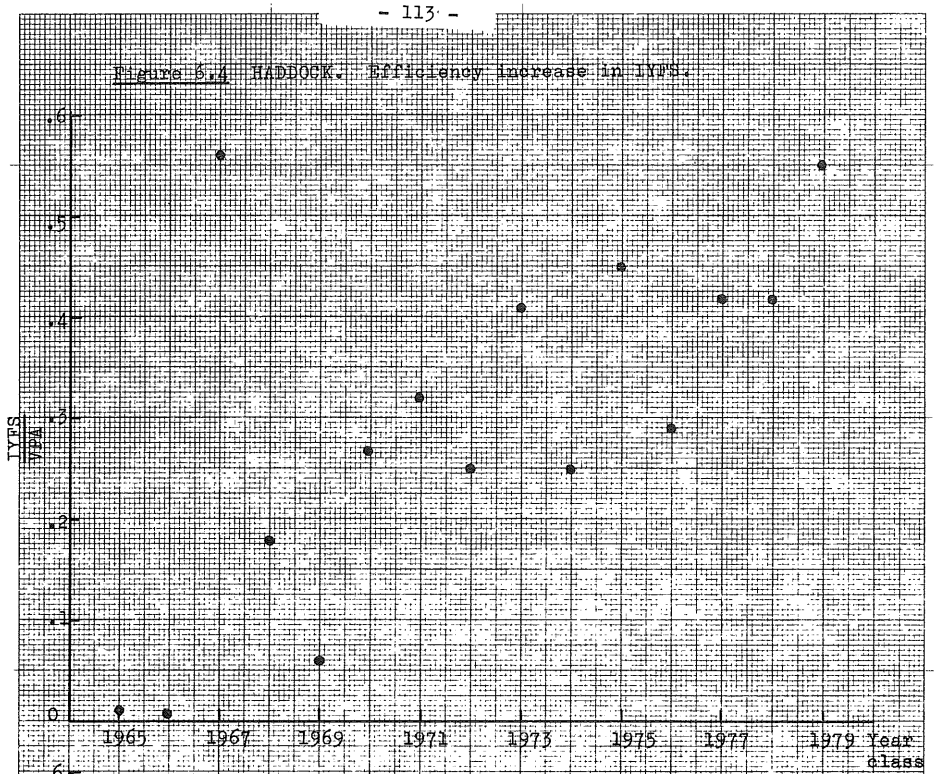


Figure 6.4 HADDOCK. Efficiency increase in IYFS.

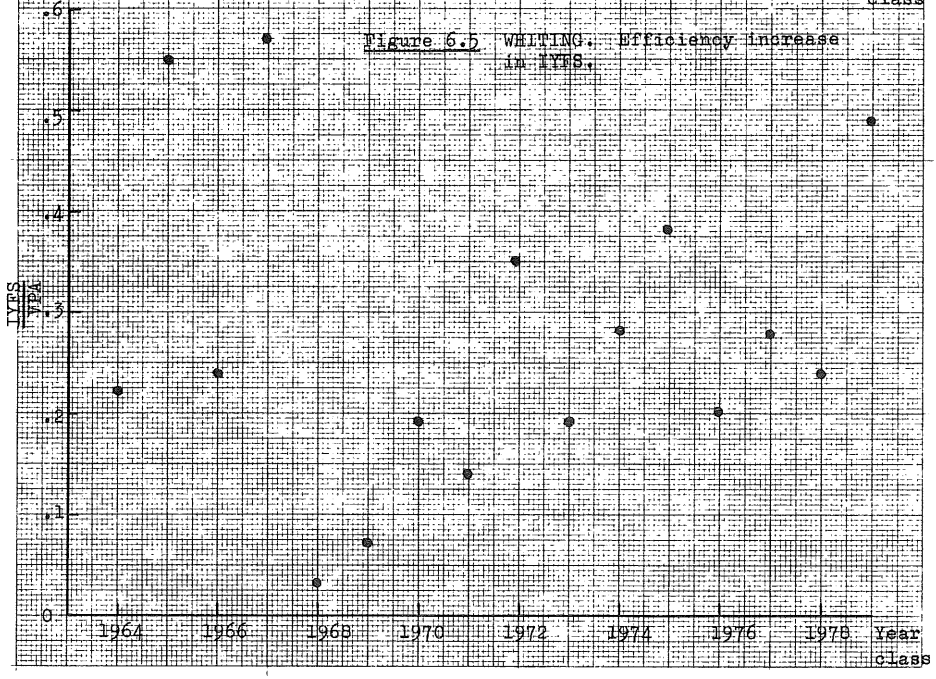


Figure 6.5 WHITING. Efficiency increase in IYFS.

Figure 7.1 North Sea COD.

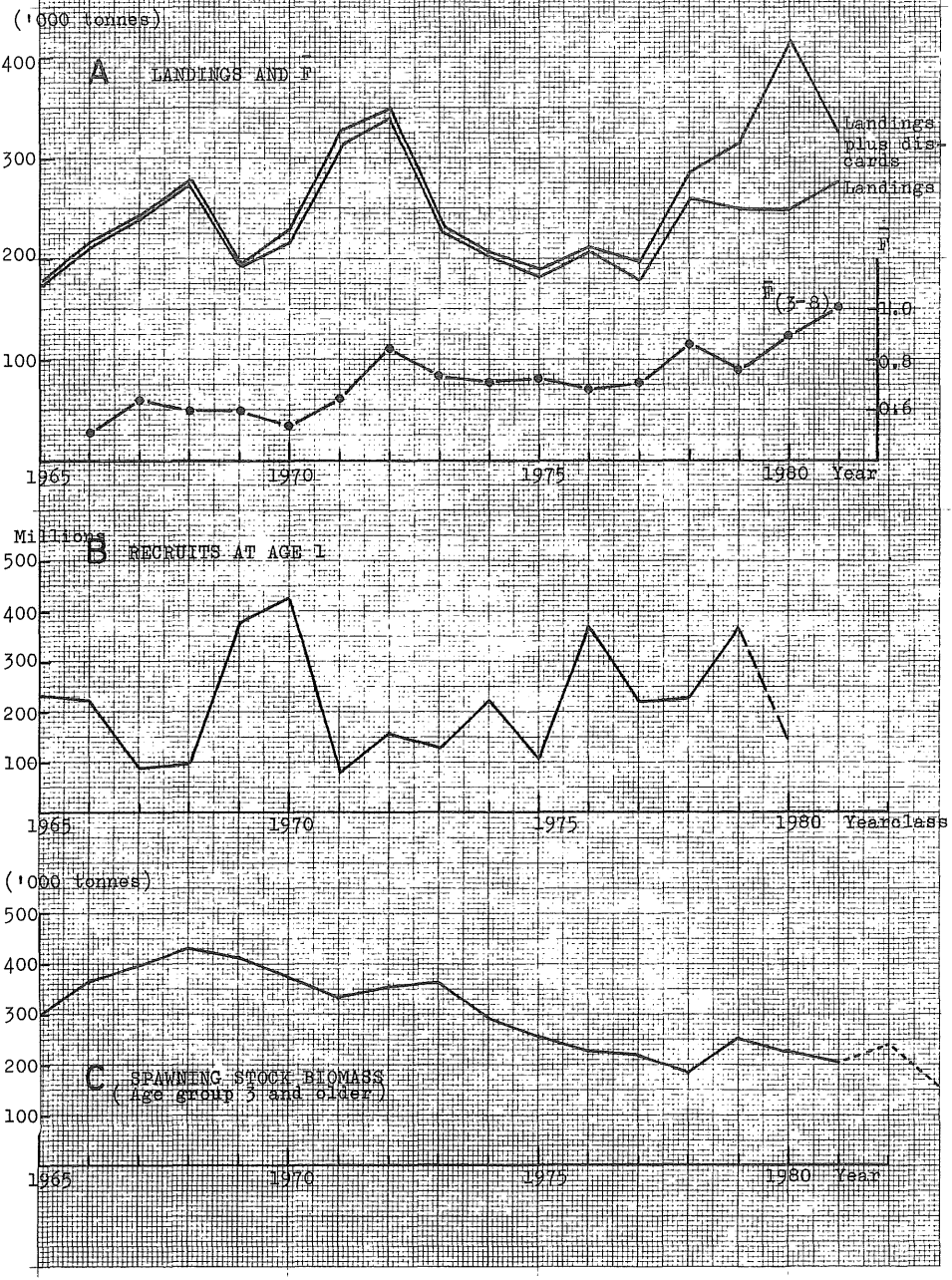


Figure 7.2 North Sea COD.
Equilibrium yield for average recruitment

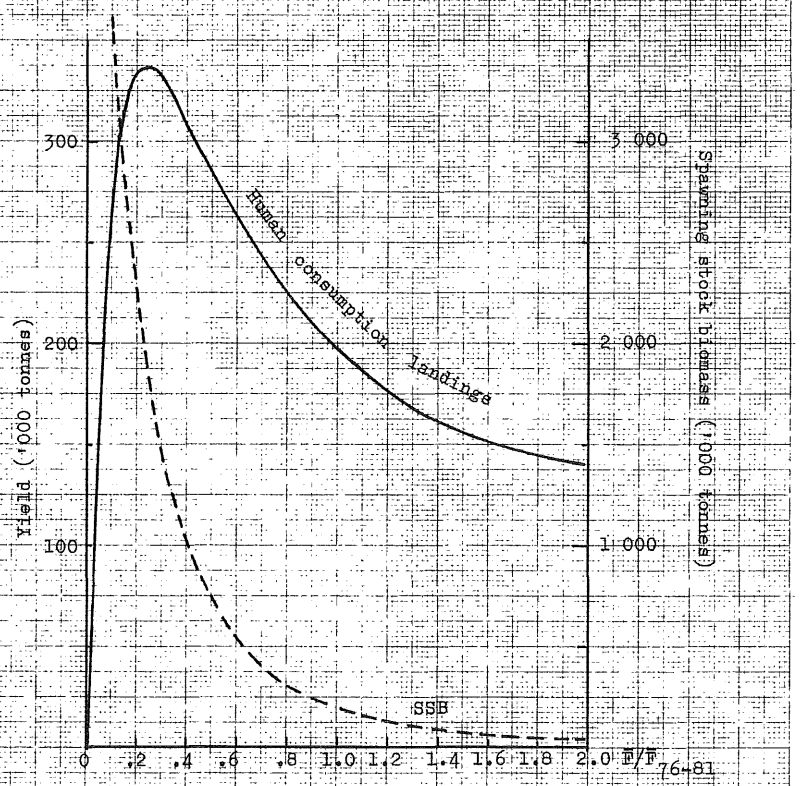


Figure 7.3 North Sea COD.
Predictions for catch in 1983 and spawning stock biomass in 1984.
——— Option 1 ($\bar{F}_{82} = \bar{F}_{83}$)
– – – – Option 2 ($\bar{F}_{82} = \bar{F}_{81}$)

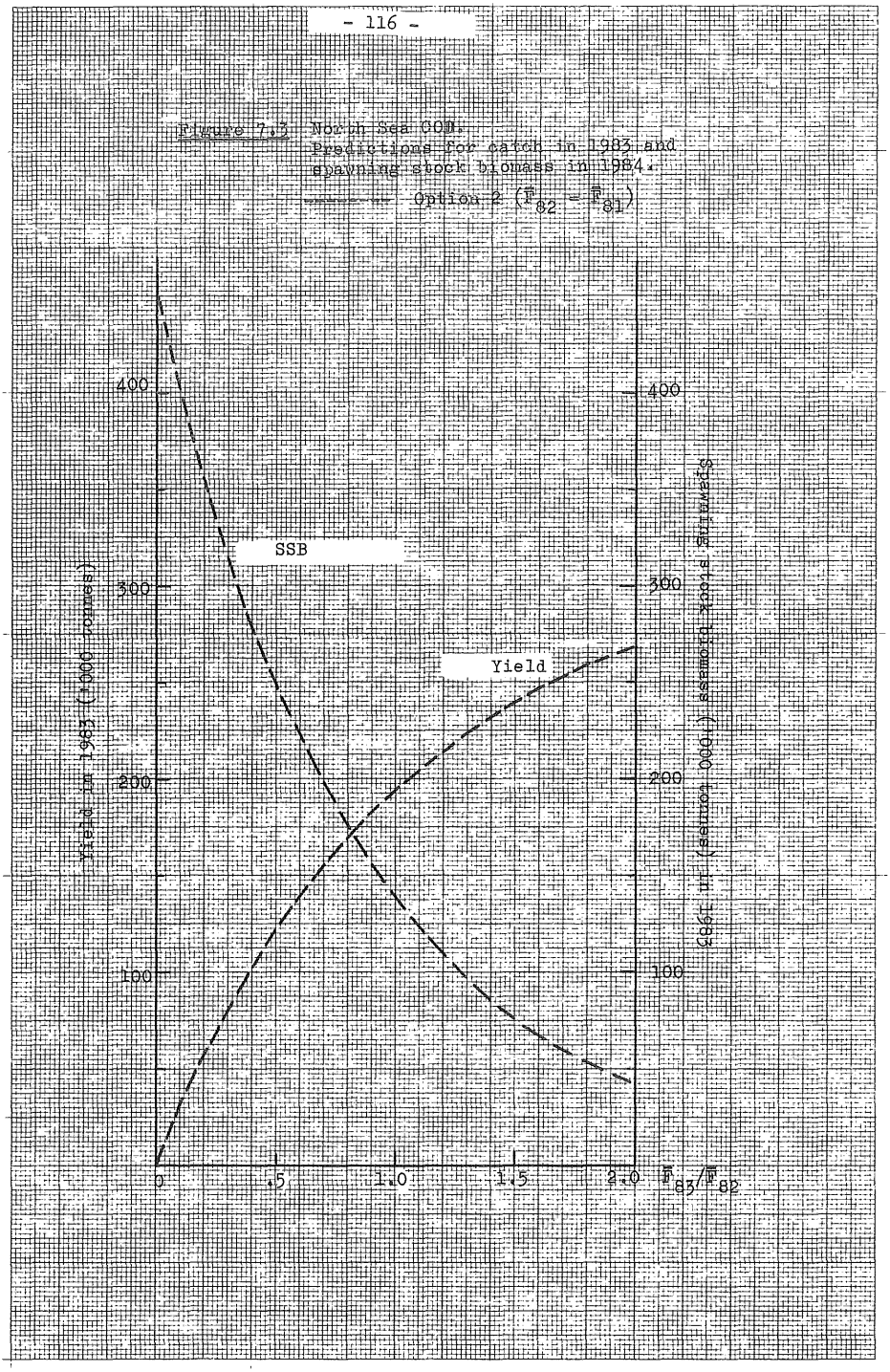


Figure 8.2. Cod in Division VIa.

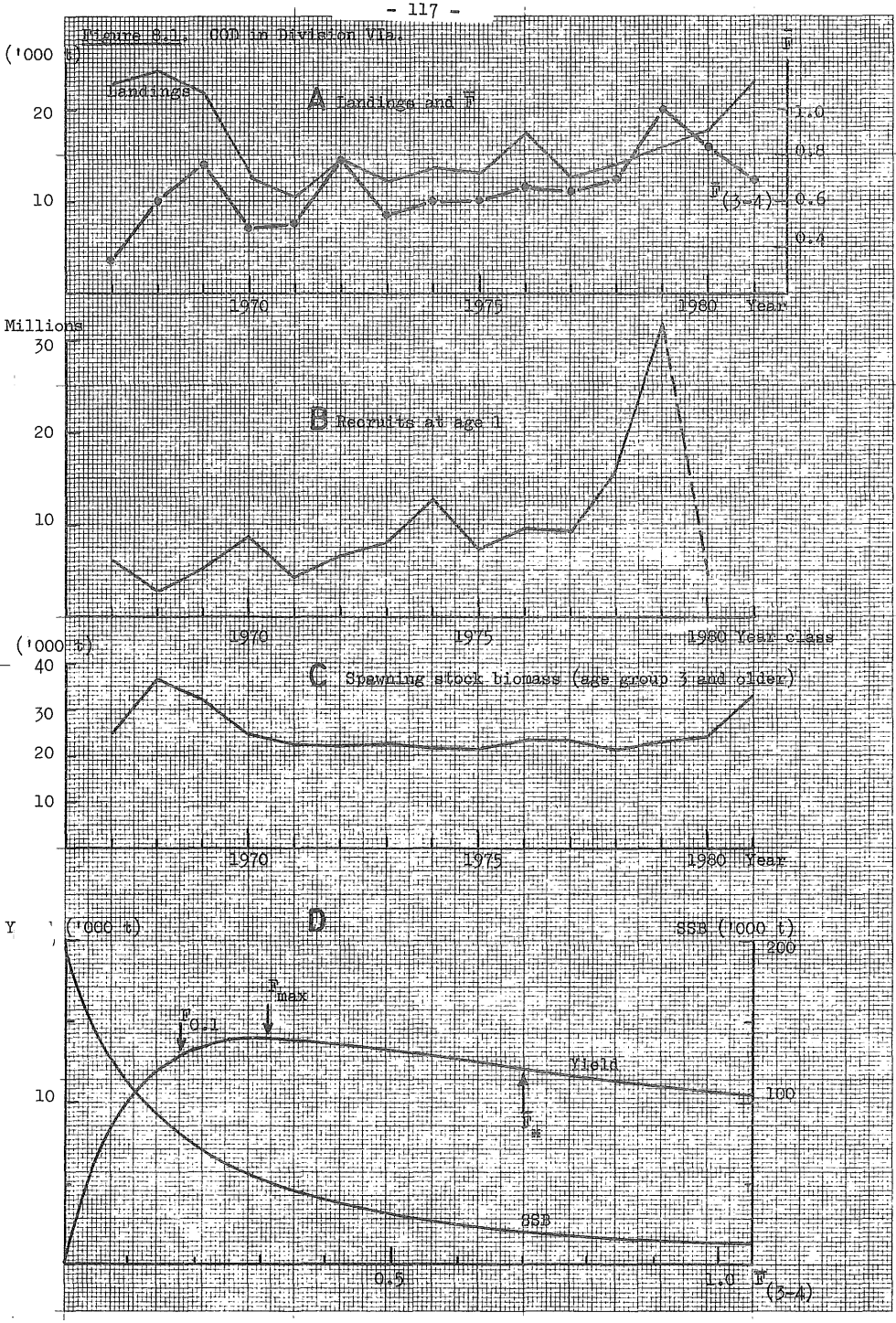


Figure 6.2. COD in Division VIa.
Predictions for catch in 1983 and spawning stock biomass in 1984.

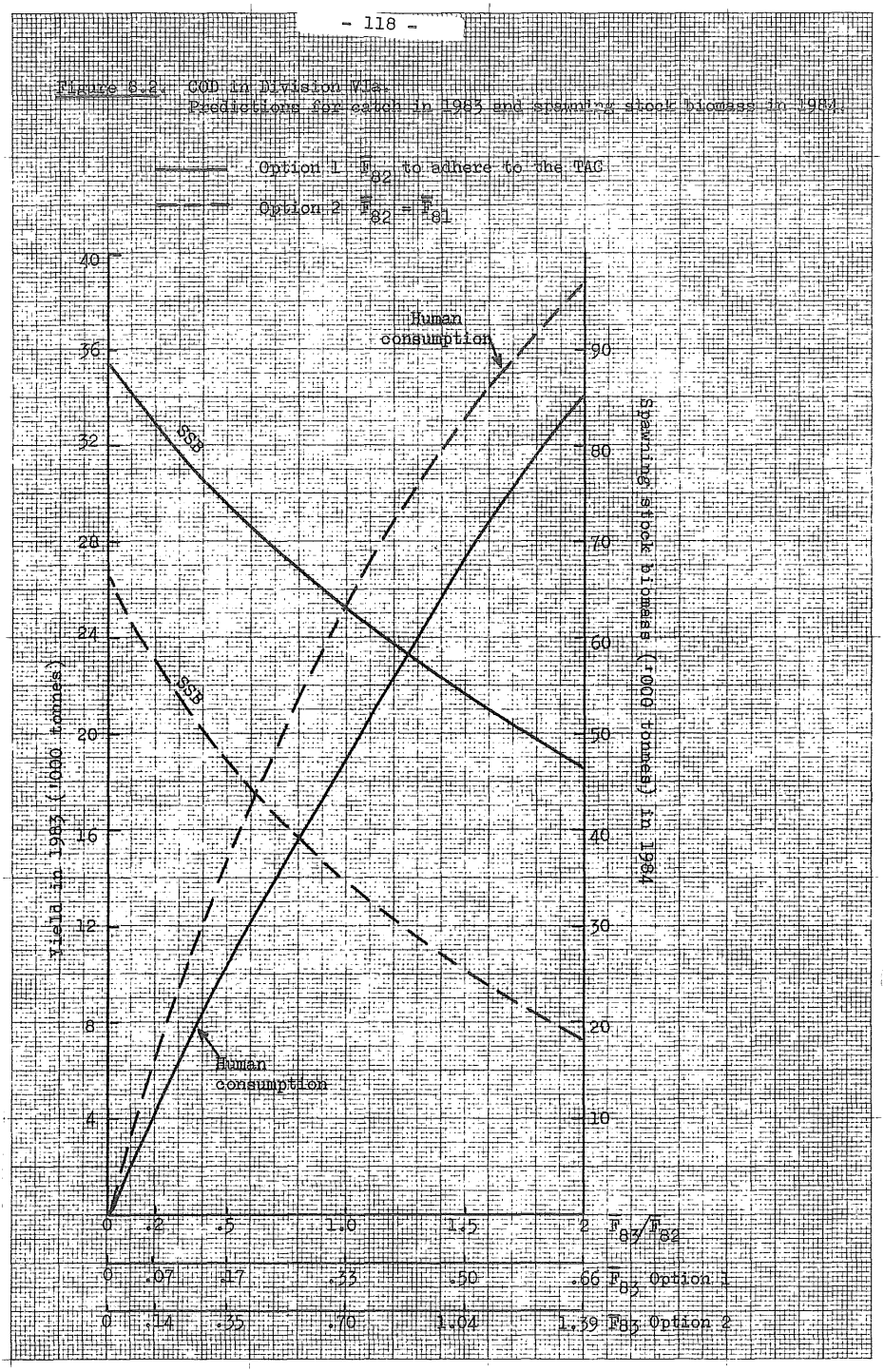


Figure 12.1. North Sea HADDOCK.

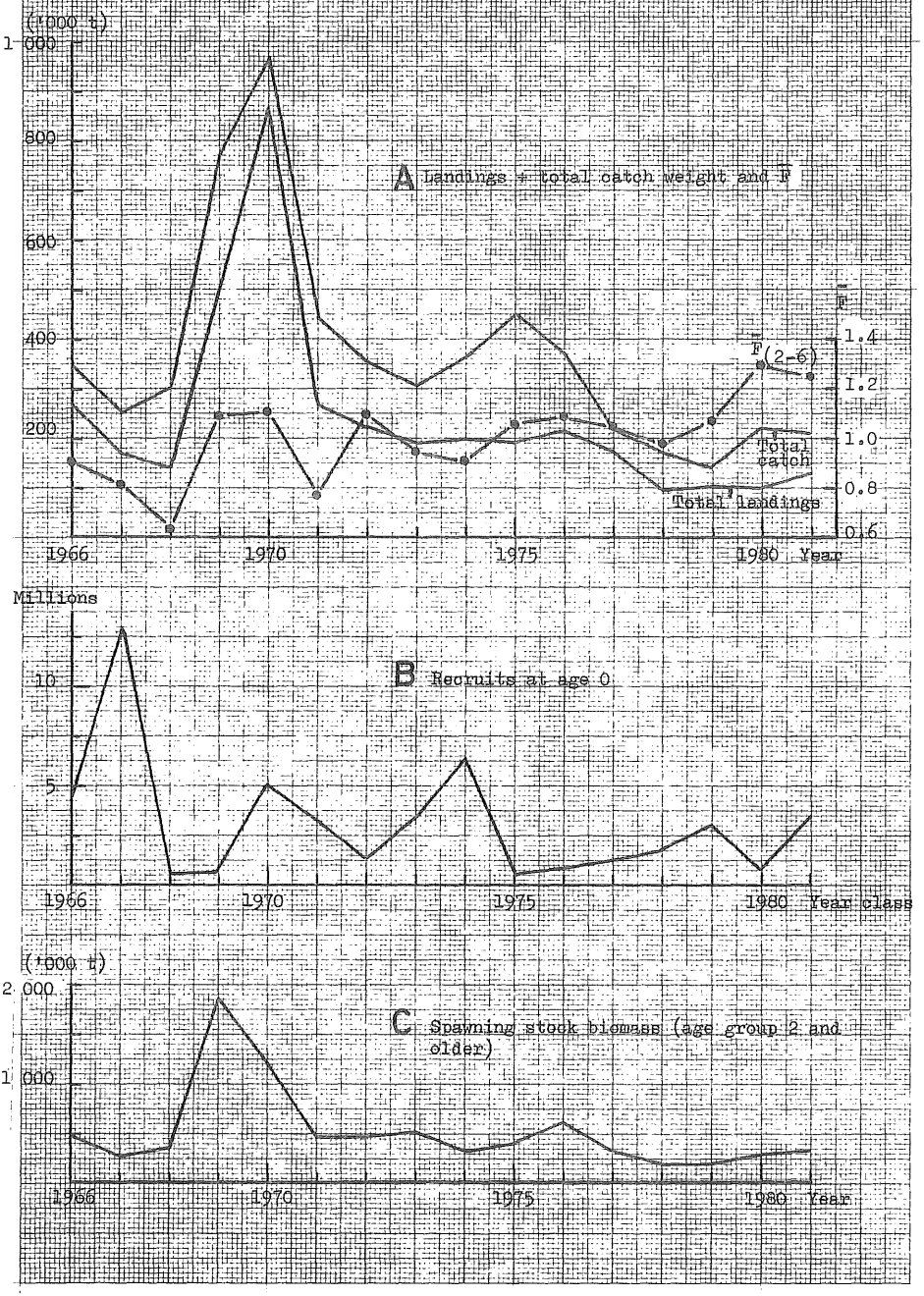


Figure 11.2. North Sea HADDOCK.
Long-term equilibrium yield (F-3rd. is kept constant).

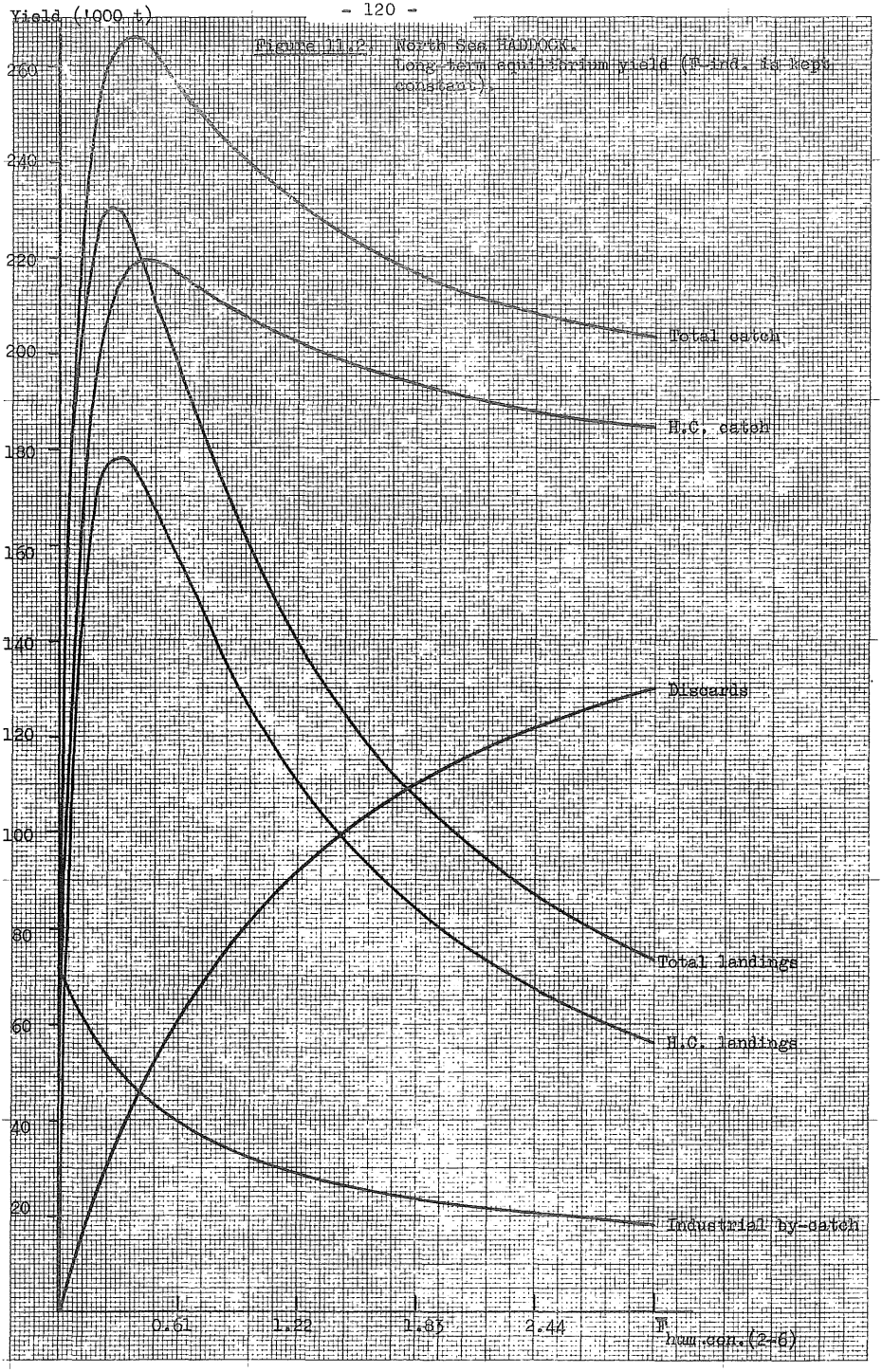


Figure 11.3. North Sea HADDOCK.
Prediction for catch in 1983 and spawning biomass in 1984.

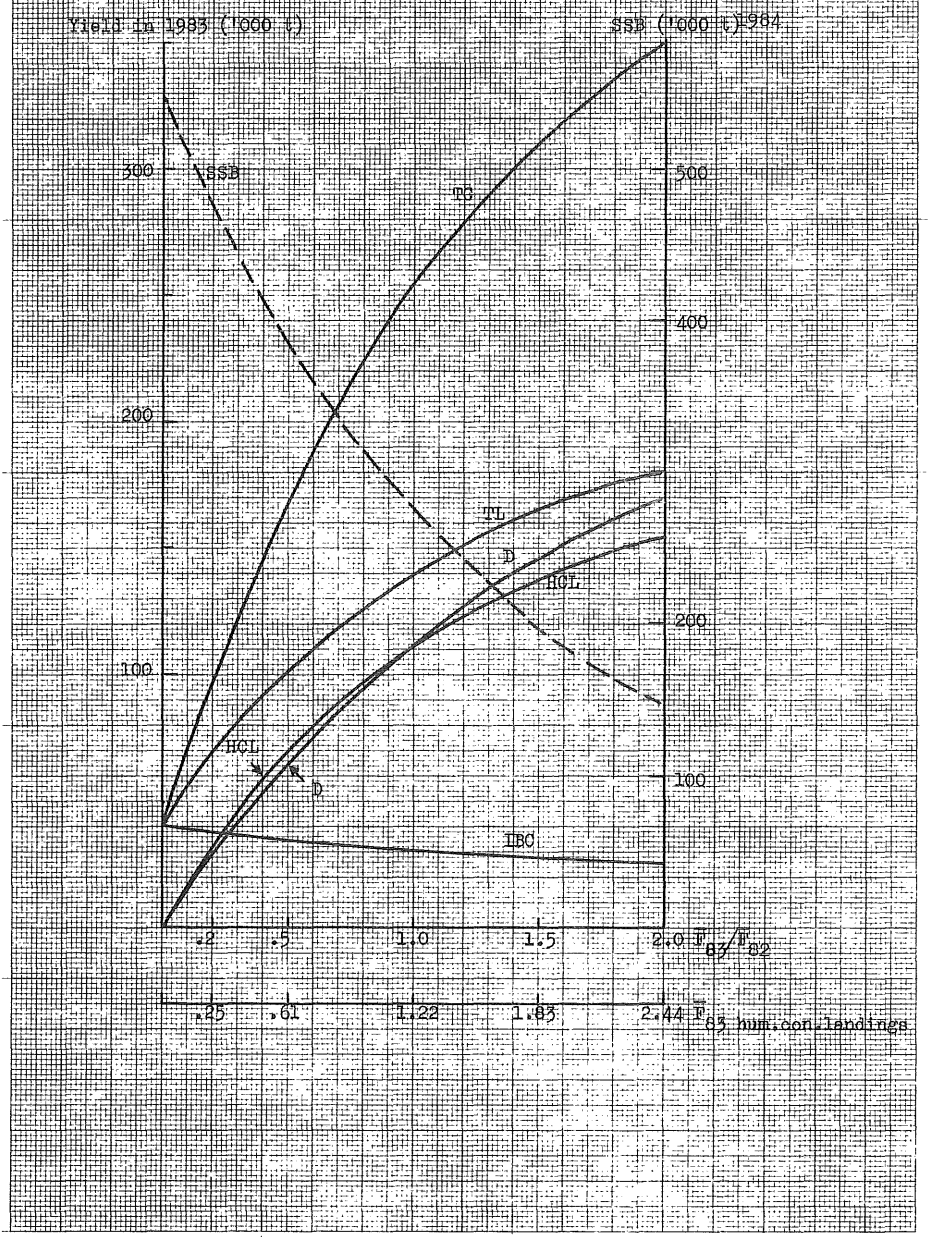


Figure 12.1. HADDOCK in Division VIa.

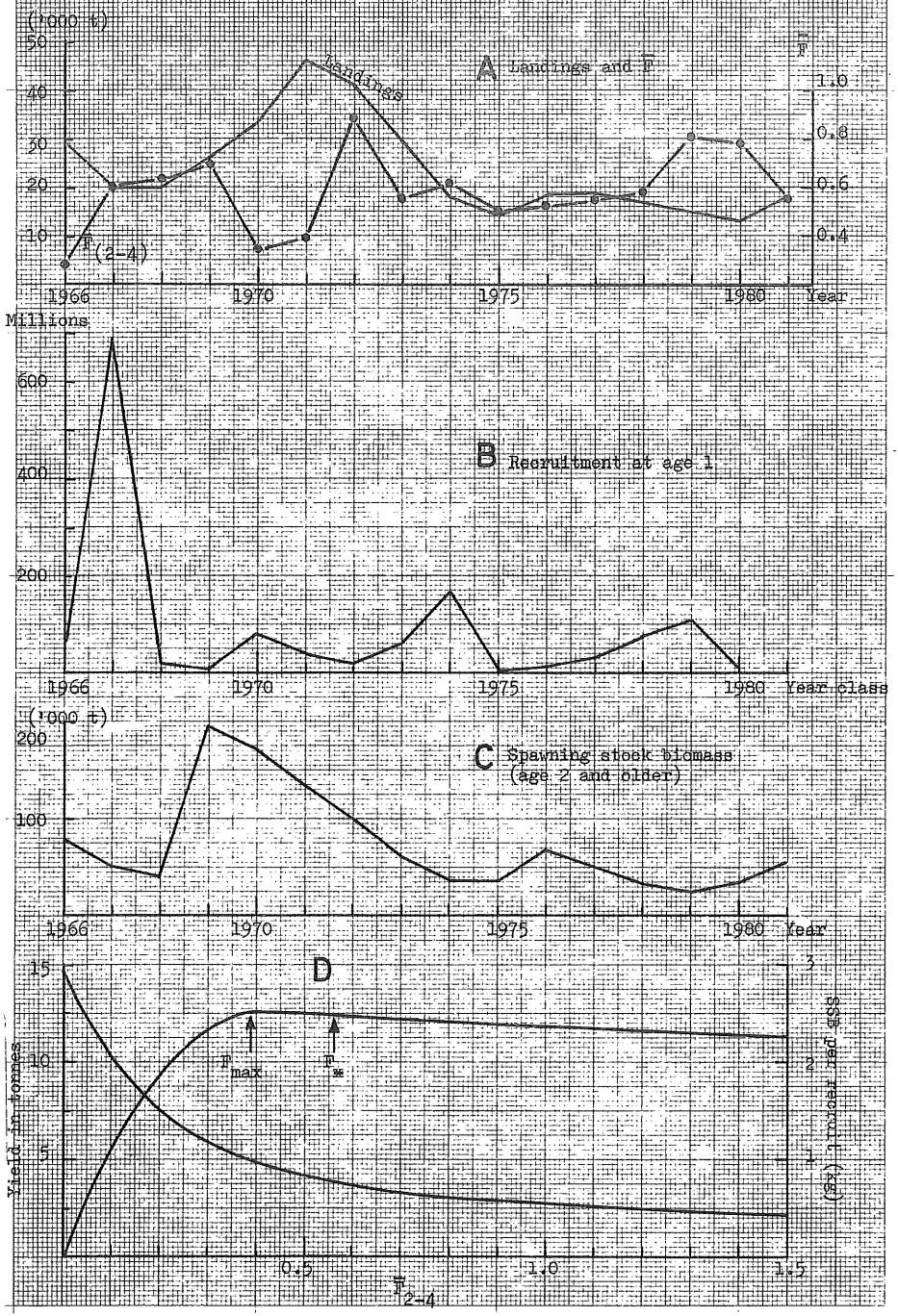


Figure 12.2 HADDOCK in Division VIa.
Predictions for catch in 1983 and spawning biomass in 1984.
Option $\bar{F}_{82} = \bar{F}_{81}$.

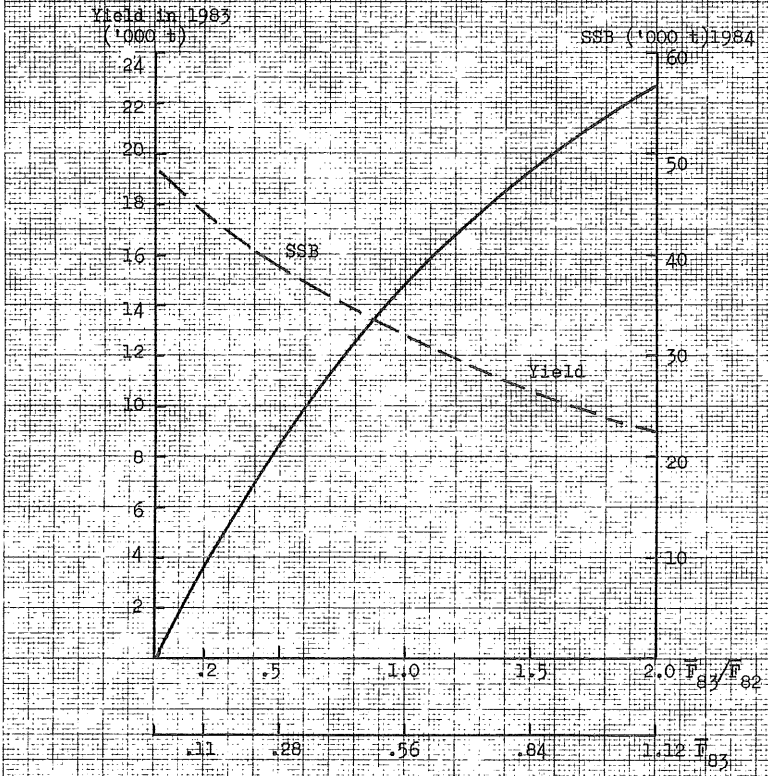


Figure 13.1 Yield per recruit curve for Rockall HADDOCK.

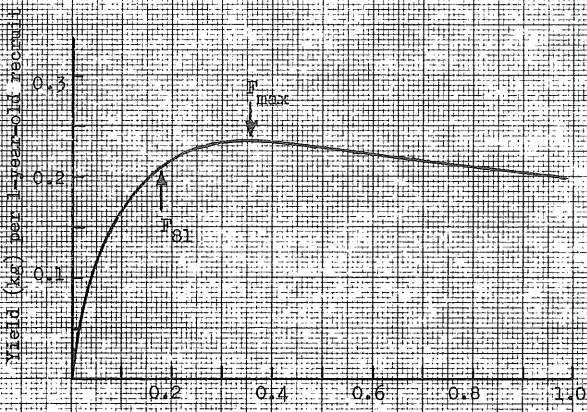
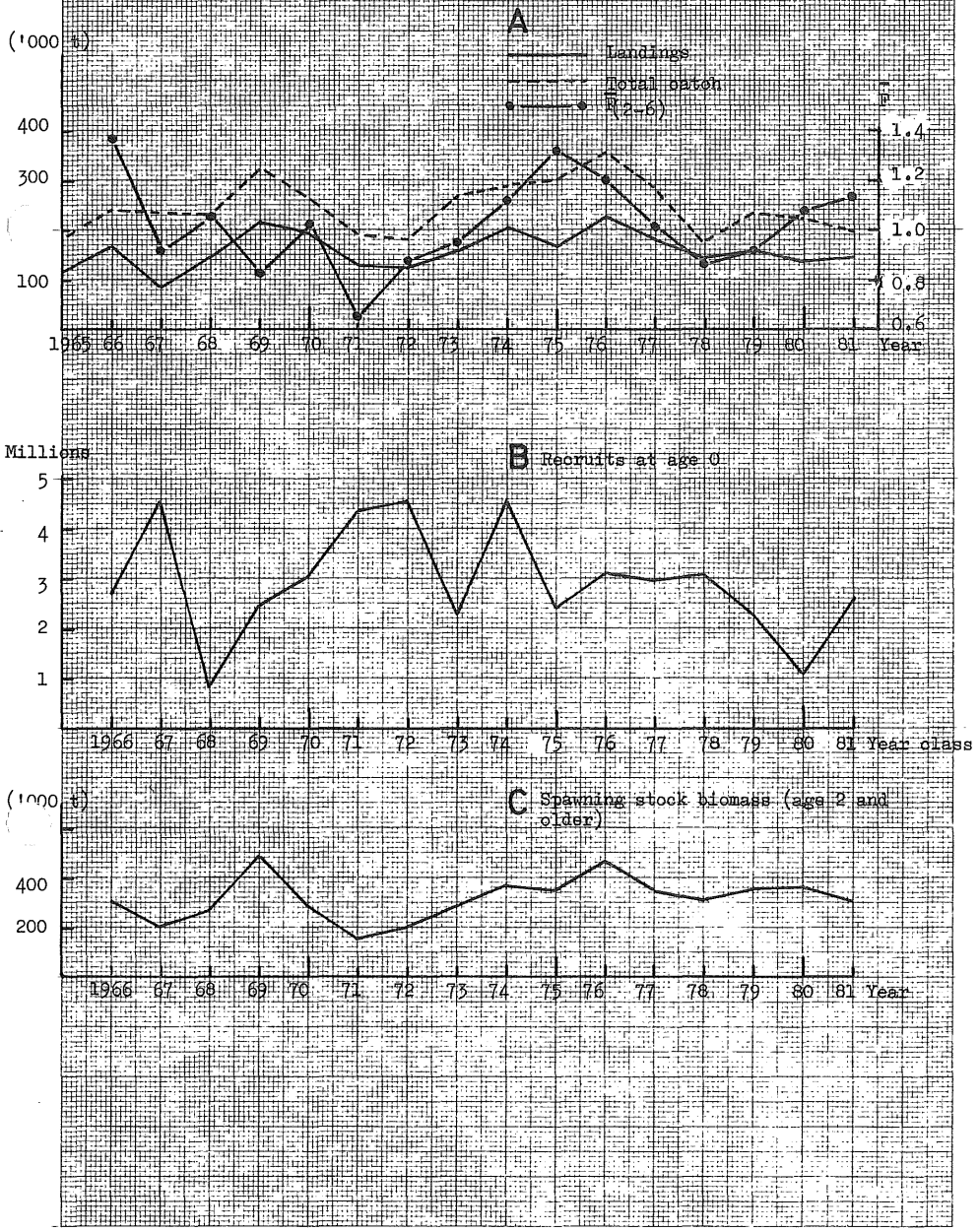


Figure 25.1. North Sea WHITING.



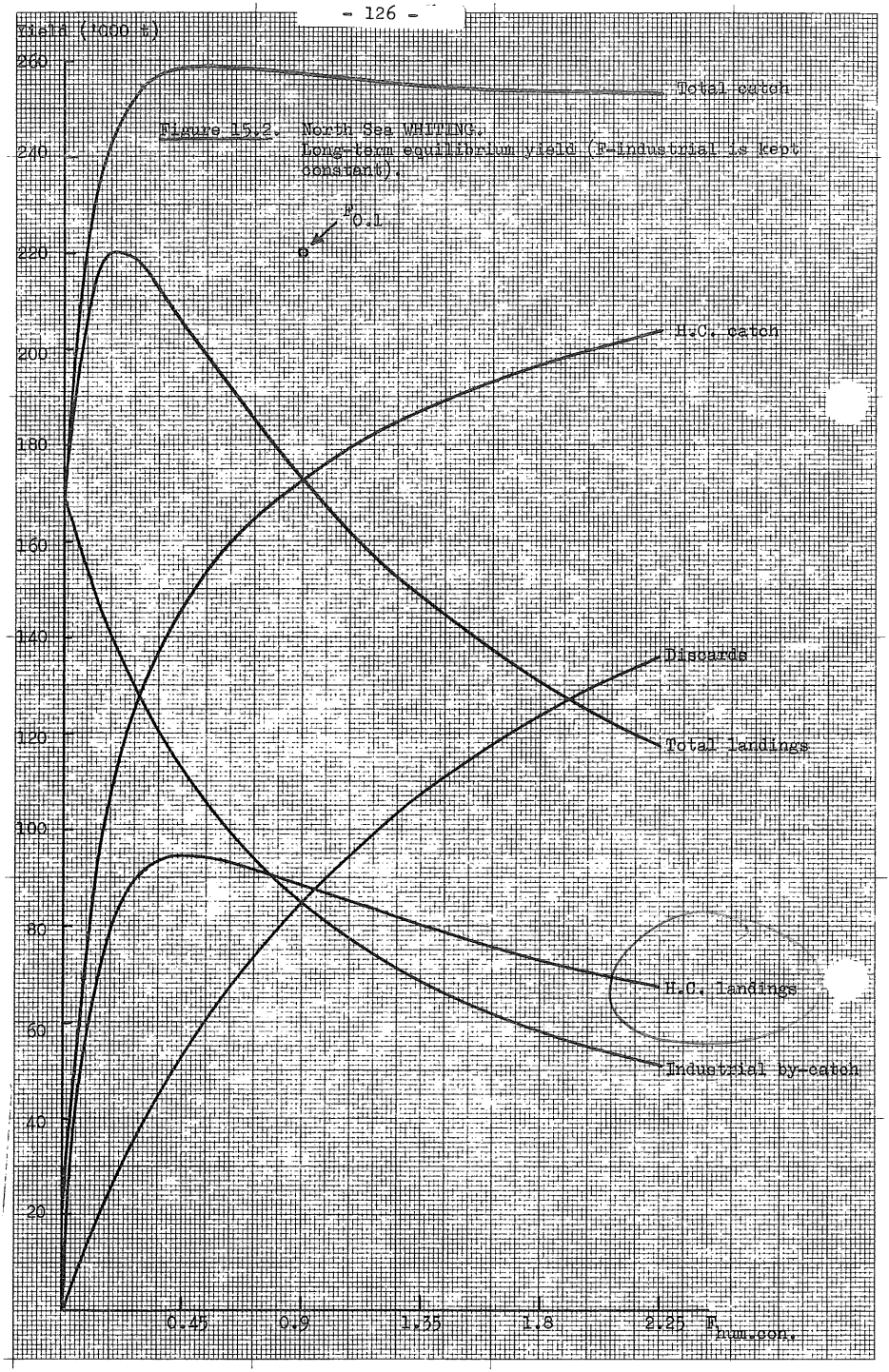


Figure 15.2. North Sea WHITING.
Long-term equilibrium yield (F-industrial is kept constant).

Figure 15.3. North Sea WHITING.
Predictions for catch in 1985 and spawning stock biomass in 1984.
Option $\bar{F}_{82} = \bar{F}_{81}$

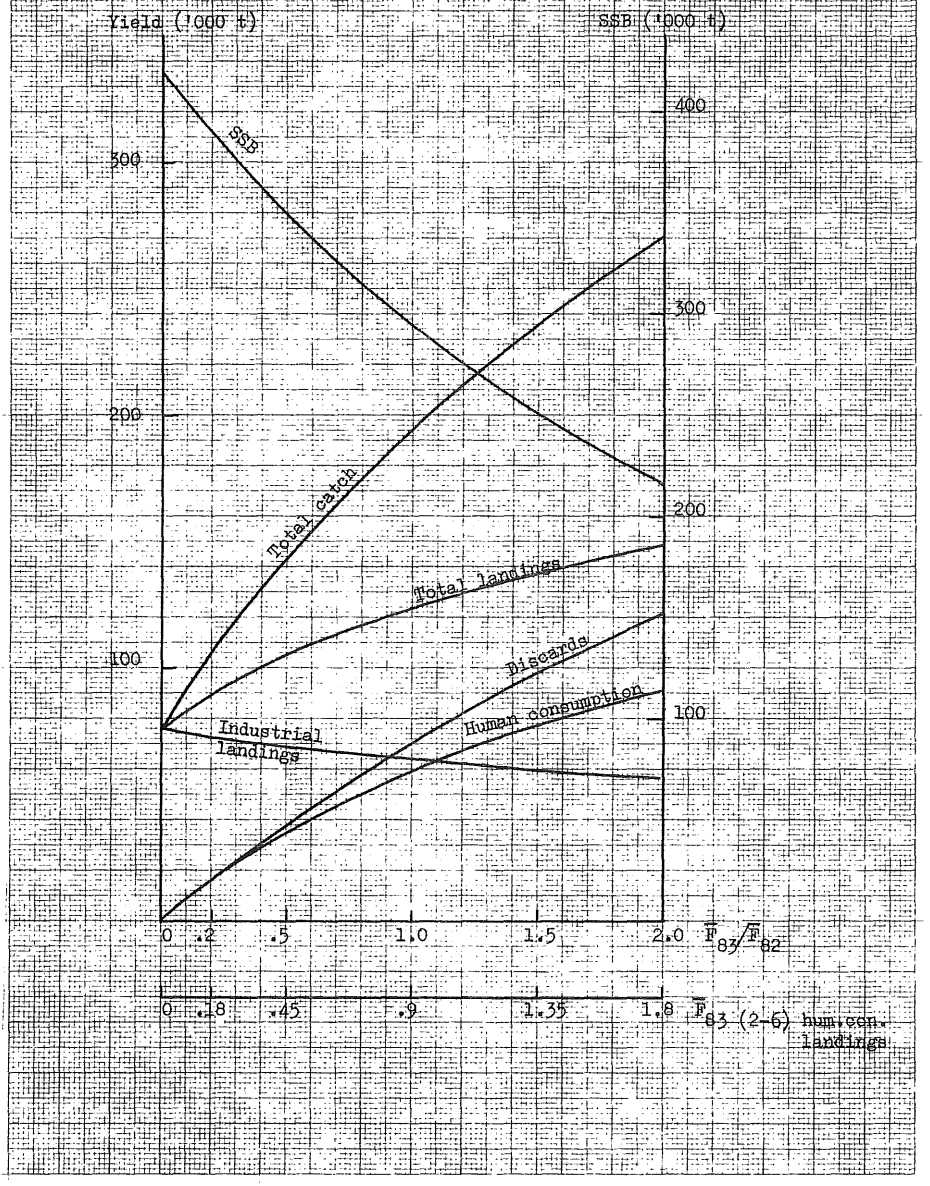


Figure 16.7. WHITING in Division VIa.

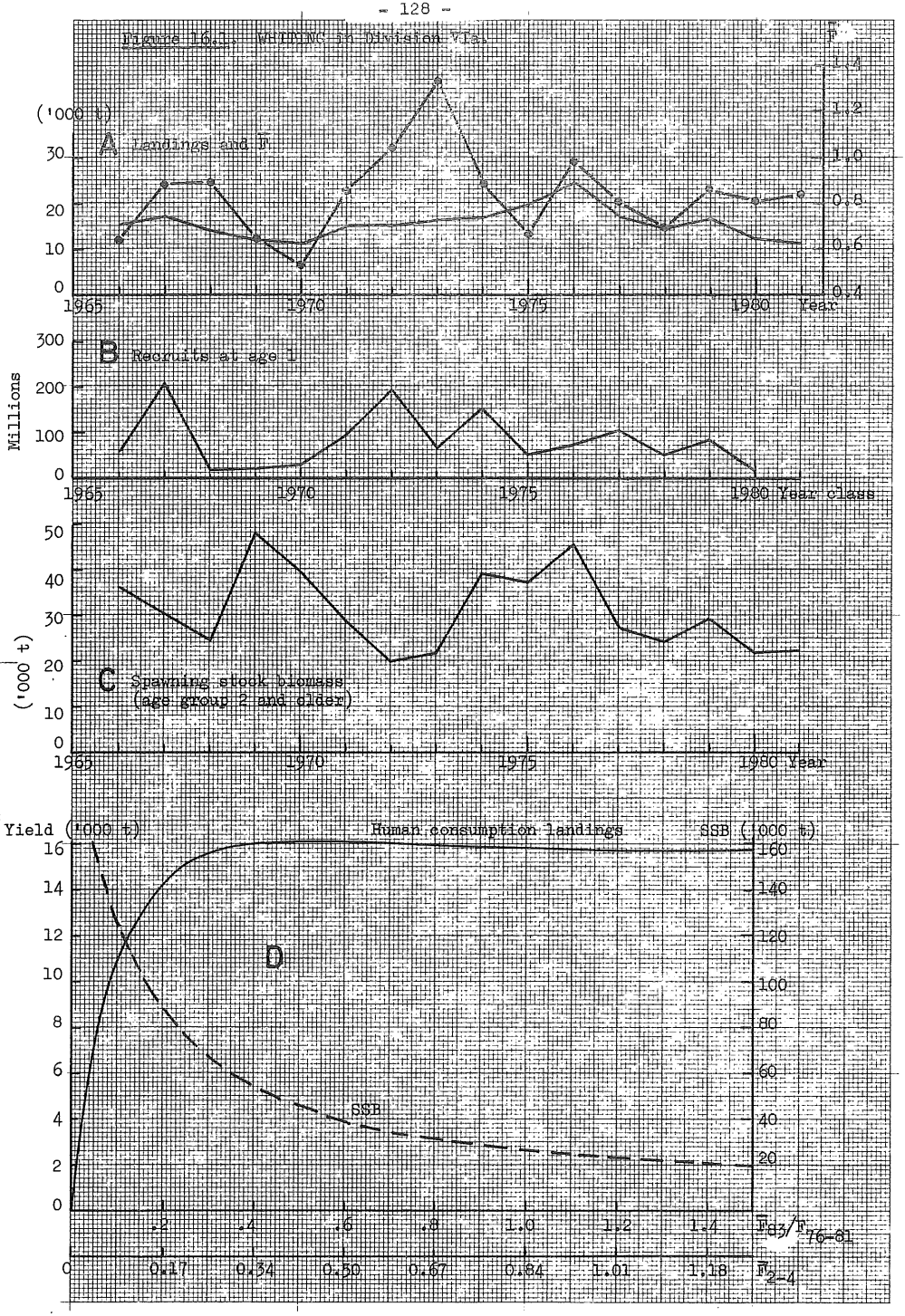
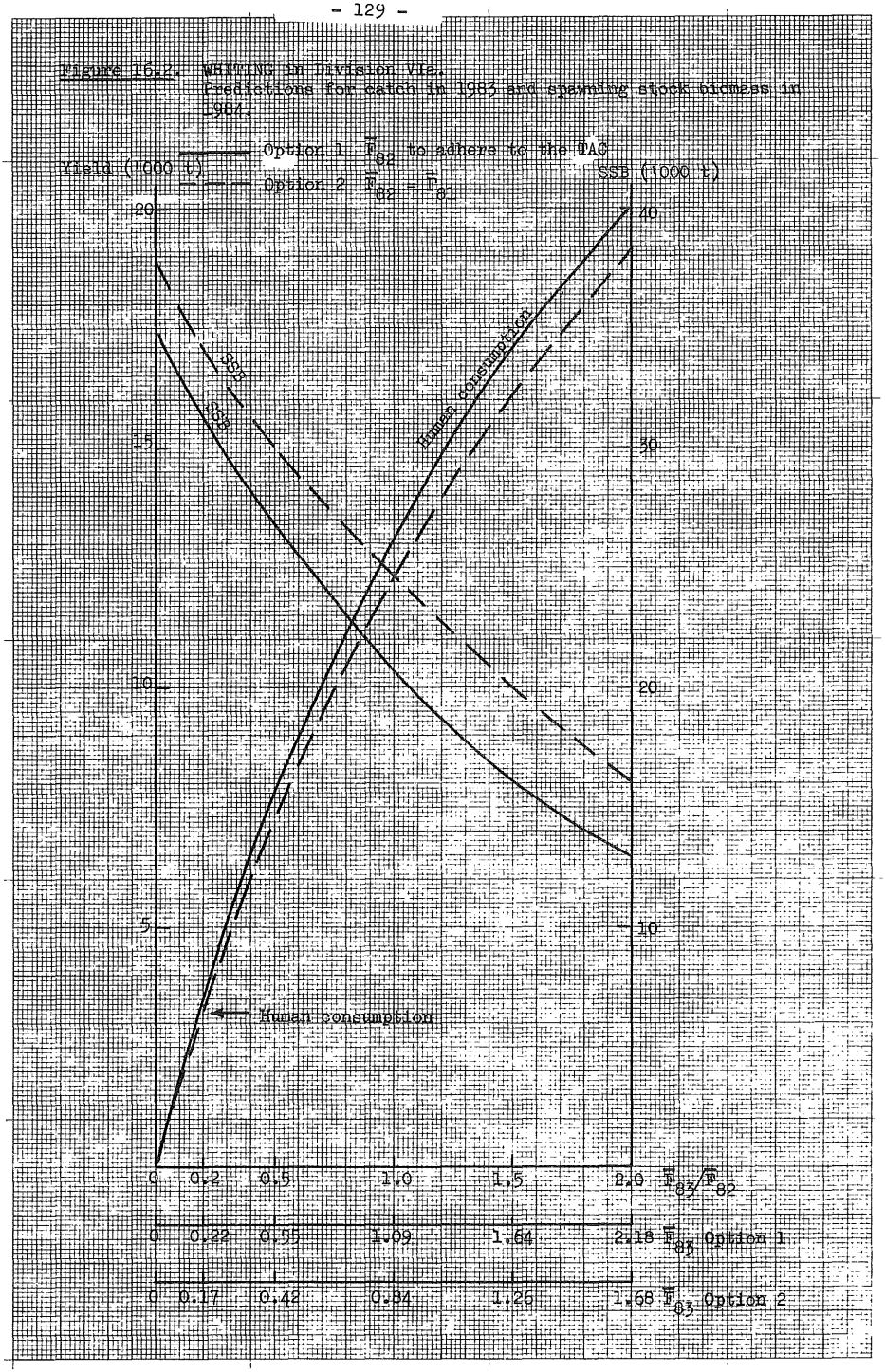


Figure 16.2. WHITING in Division VIa.
Predictions for catch in 1983 and spawning stock biomass in 1984.



APPENDIX 1

Revision of North Sea Cod, Haddock and Whiting Assessments by ACFM

At the July 1981 ACFM meeting, the approach used by the North Sea Roundfish Working Group in estimating the terminal Fs going into the VPAs was rejected. ACFM had also certain reservations concerning some of the other input parameters.

It was agreed to use the effort data in another way and re-assess the North Sea and Division VIa cod, haddock and whiting.

It was a very difficult job to do this during the restricted time available at the ACFM meeting, so the preliminary status of the assessments at that stage was clearly indicated in the Report from the July meeting of ACFM.

During the Statutory Meeting it was decided to have the final re-assessment done by the Chairman of the Roundfish Working Group, Mr Brian Jones, and he met together with the Chairman of ACFM and the Council's Statistician on 2 November at ICES headquarters. Only the North Sea stocks were considered at this meeting.

Data and Methods

Data available for the re-assessment were essentially the same as described in the Roundfish Working Group Report (C.M. 1981/G:8) from its March 1981 meeting.

The effort data were used to estimate the terminal Fs in the following way:

The percentage change in effort between the reference period 1975-77 and the last year 1980 was calculated for each age-group according to the following formula:

$$\frac{F_{80}}{\bar{F}_{75-77}} = \frac{\sum_i \left[\frac{E_{80,i}}{\bar{E}_{75-77,i}} \times \bar{C}_{75-77,i} \right]}{\sum_i \bar{C}_{75-77,i}} \times \frac{\sum_i \bar{C}_{75-77,i}}{\bar{C}_{75-77}} \times \frac{C_{80}}{\sum_i C_{80,i}}$$

where for each age $E_{80,i}$ = Effort by fleet i in 1980

$C_{80,i}$ = Catch number by fleet i in 1980

C_{80} = Catch number in total human consumption fishery (landings and discards)

$\bar{E}_{75-77,i}$ = Average effort by fleet i in period 1975-77.

Etc...

The first term represents a weighted average relative effort in the sampled fleets. Average catch numbers in 1975-77 were used for the weighting. The second and third terms adjust for differences in the proportion of the catch taken by the sampled fleets in 1980 compared with the proportion taken in the reference period.

This is basically the same procedure as that used by Saville (ICES C.M. 1981/G:80) except that Saville used 1975-79 as his reference period and he used catch numbers in 1980 as weighting factors to calculate weighted average relative effort.

Using the above equation the following results were obtained for effort (≡F) in 1980 relative to the reference period 1975-77 for North Sea stocks. (Note that the calculations relate to the human consumption fishery, i.e. landings and discards):

F_{80}/F_{75-77}

Age-group	Cod*	Haddock	Whiting
2		.617	.591
3	1.004	.856	.924
4	.876	.933	.883
5	.755	2.134	.554
6	.642	.633	.202
7	.556	1.003	.297
8	.889	1.026	.615
9	.492	.516	.756
10	.636	.873	

* Discards not included

VPAs were then run, which simulated for the three North Sea stocks comparable changes in F in the Human Consumption fisheries. For the youngest age groups estimates of F were derived from recruitment data. For the older age groups, for which the estimates of number by age are subject to larger variability than for the younger age groups, the changes in effort on average for selected ranges of age groups were simulated. The final VPA results are given in Tables 1-3.

Catch predictions were calculated based on the VPA results. Weight-at-age data used were the same as those used by the Working Group. For haddock and whiting the partition of F into the three components - H.C. landings, Industrial landings, and Discards - was according to the data given in Table 4. The results of catch predictions are given in Tables 5-7.

Appendix 1, Table 1

North Sea Cod - Results of VPA (Discards not included)

Fishing Mortality

	1975	1976	1977	1978	1979	1980	1975-77	1975-80
1	0.16	0.06	0.19	0.14	0.21	0.24[1])	0.14	0.17
2	0.83	1.02	0.97	1.05	0.85	1.30[1])	0.94	1.00
3	0.80	0.86	0.78	0.89	0.86	0.81	0.81	0.83
4	0.68	0.78	0.53	0.75	0.59	0.52	0.66	0.64
5	0.77	0.59	0.65	0.83	0.68	0.52	0.67	0.67
6	0.67	0.76	0.55	0.67	0.45	0.52	0.66	0.60
7	0.55	0.72	0.74	0.67	0.54	0.52	0.67	0.62
8	0.67	0.26	0.73	0.76	0.44	0.52	0.55	0.56
9	1.14	0.49	1.72	0.81	0.66	0.52	1.12	0.89
10	1.12	1.22	0.38	1.63	0.51	0.52	0.91	0.90
11	0.65	0.65	0.65	0.65	0.65	0.52	0.65	
12+	0.65	0.65	0.65	0.65	0.65	0.52	0.65	
$F_{(3-8)}^{u}$	0.69	0.66	0.66	0.76	0.59	0.57		

1) Based on recruitment

Stock Numbers

	1975	1976	1977	1978	1979	1980	1981
1	226052	110054	385989	232809	213632	345601	******
2	92838	157772	84475	261751	165052	142216	222802
3	36130	33189	46476	26233	74981	57858	31733
4	9338	13325	11511	17466	8809	26028	21073
5	13177	3875	5016	5567	6743	3995	12669
6	3882	5005	1751	2149	1988	2787	1945
7	979	1631	1922	830	901	1036	1356
8	332	464	648	747	348	432	504
9	287	138	292	256	287	183	210
10	129	75	69	43	93	121	89
11	98	34	18	39	7	46	59
12+	23	32	167	48	34	22	33
Total	383264	325595	538335	547939	472876	580325	
Spawn. Stock	64374	57769	67870	53379	94192	92508	

Appendix 1, Table 2

North Sea Haddock - Results of VPA

Fishing Mortality

	1975	1976	1977	1978	1979	1980	1975-77	1975-80
0	0.103	0.234	0.102	0.179	0.267	0.326[1])	0.146	0.20
1	0.567	0.523	0.669	0.779	0.330	0.290[1])	0.586	0.53
2	1.133	0.817	1.035	1.016	0.958	0.550	0.995	0.92
3	1.548	1.376	1.114	0.878	1.011	1.180	1.346	1.18
4	1.309	0.809	1.154	1.183	0.715	1.030	1.091	1.03
5	1.069	1.300	0.978	0.864	1.072	1.150	1.116	1.07
6	0.839	1.117	1.032	0.931	1.428	1.150	0.996	1.08
7	1.664	0.382	0.912	1.209	0.786	1.150	0.986	1.02
8	1.095	0.895	0.429	0.960	1.029	1.150	0.806	0.93
9	1.000	1.000	1.000	1.000	1.000	1.150	1.000	
10+	1.000	1.000	1.000	1.000	1.000	1.150	1.000	

[1]) Based on recruitment

Stock Numbers

	1975	1976	1977	1978	1979	1980	1981
0	504788	871938	1219757	1944089	4462622	1530617	*******
1	3759617	372950	564722	901878	1330826	2798703	904539
2	1146540	1746651	180990	236806	338713	783235	1714559
3	108357	302357	631871	52663	70186	106376	369974
4	204925	18865	62519	169784	17919	20903	26762
5	27421	45331	6880	16138	42582	7176	6110
6	1826	7707	10110	2119	5570	11930	1860
7	794	646	2065	2948	684	1093	3093
8	4276	123	361	679	721	255	283
9	438	1171	41	192	213	211	66
10+	136	94	285	151	105	165	97
Total	5759117	3367834	2679599	3327449	6270140	5260864	
Spawn. Stock	1494712	2122946	895121	481481	476692	931344	

Appendix 1, Table 3

North Sea Whiting - Results of VPA

Fishing Mortality

	1975	1976	1977	1978	1979	1980	1975-77	1975-80
0	0.110	0.158	0.269	0.279	0.163	0.190[1])	0.179	0.195
1	0.371	0.295	0.675	0.271	0.427	0.140[1])	0.447	0.363
2	0.903	1.125	0.723	0.500	0.544	0.425	0.917	0.703
3	1.164	1.286	1.018	0.682	0.690	0.620	1.156	0.910
4	1.116	1.137	1.027	0.812	0.707	0.620	1.093	0.903
5	1.128	0.959	0.997	0.753	0.811	0.620	1.028	0.878
6	2.246	1.384	1.148	0.956	0.822	0.620	1.593	1.196
7	1.418	1.252	0.801	1.614	0.563	0.620	1.157	1.045
8	1.194	1.296	2.512	2.174	1.125	0.620	1.667	1.487
9	0.900	0.900	0.900	0.900	0.900	0.620	0.900	0.853
10+	0.900	0.900	0.900	0.900	0.900	0.620	0.900	0.853

[1]) Based on recruitment

Stock Numbers

	1975	1976	1977	1978	1979	1980	1981
0	2521492	3194248	3095299	3091042	3488918	2096856	*******
1	3042242	1848830	2233090	1937153	1914716	2426173	1419691
2	713720	1718613	1126529	931008	1209956	1022836	1726878
3	468581	236771	456807	447712	462141	575031	547485
4	87393	119757	53550	135120	185265	189750	253262
5	14757	23444	31449	15692	49102	74786	83572
6	9523	3911	7354	9504	6053	17871	32938
7	165	825	802	1909	2992	2179	7871
8	2150	33	193	295	311	1395	960
9	260	533	7	13	27	83	614
10+	4	42	253	13	7	47	57
Total	6860287	7147007	7005334	6569462	7319488	6407007	
Spawn. Stock	1296553	2103929	1676945	1541267	1915854	1883978	

Appendix 1, Table 4

Partition of fishing mortality into human consumpltion landings, industrial landings, and discard components. Based on average exploitation pattern 1975-80.

Age group	Haddock			Whiting		
	H.C. catch F	Proportion not discarded	Industrial catch F	H.C. catch F	Proportion not discarded	Industrial catch F
0	.002	0	.2	.006	0	.186
1	.290	.034	.225	.089	.064	.230
2	.760	.36	.136	.263	.307	.310
3	.990	.75	.160	.460	.650	.220
4	.960	.81	.034	.540	.860	.096
5	.996	.98	.045	.550	.918	.056
6	1.040	.99	.014	.769	.970	.048
7	.986	1	.001	.687	.999	.020
8	.896	1	.002	.950	1	.065
9	.994	1	0	.558	1	.020
10+	.994	1	0	.553	1	.028
$\bar{F}_{2-6}$	.95			.516		

Appendix 1, Table 5

Management options: Species - Cod (Discards not included);
Area - ICES IV

1981			1982			1983	
Spawning stock biomass	F (3-8)	Catch H.C. landings	Management option for 1982	Spawning stock biomass	F (3-8)	Catch H.C. landings	Spawning stock biomass
280	0.57 ($=\bar{F}_{80}$)	230	$\bar{F}_{0\cdot1}$	370	0.125	65	655
			$\bar{F}_{max}$		0.19	95	605
			$\bar{F}_{82}=\bar{F}_{81}$		0.57	235	390
			$\bar{F}_{82}=0$		0	0	675
			$\bar{F}_{82}=0.2\ \bar{F}_{81}$		0.114	60	664
			$\bar{F}_{82}=0.5\ \bar{F}_{81}$		0.285	137	543
			$\bar{F}_{82}=1.5\ \bar{F}_{81}$		0.86	313	277
			$\bar{F}_{82}=2.0\ \bar{F}_{81}$				

Weights in thousands of tonnes

Recruitment 1981-83 R_1 = 208 000

Stock biomass = fish at age 1 and older

Spawning stock biomass = fish at age 3 and older

Exploitation pattern 1981-83 based on 1975-80 average

Appendix 1, Table 6

Management Options: Species - Haddock

Area - ICES IV

1981				1982								1983	
Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	Management option for 1982	Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock biom.	Spawnir stock biomass
776	659	0.95 ($=\bar{F}_{80}$)	228	$\bar{F}_{0\cdot1}$	607	441	0						
				$\bar{F}_{max}$			0.21	90					585
				$\bar{F}_{82}=\bar{F}_{81}$			0.95	201	171	30	90		361
				$\bar{F}_{82}=0$			0	41	0	41	0		687
				$\bar{F}_{82}=0.2\ \bar{F}_{81}$			0.19	85	47	38	22		599
				$\bar{F}_{82}=0.5\ \bar{F}_{81}$			0.48	138	104	34	52		492
				$\bar{F}_{82}=1.5\ \bar{F}_{81}$			1.43	241	215	26	121		272
				$\bar{F}_{82}=2.0\ \bar{F}_{81}$			1.90	267	244	23	144		209

Weights in thousands of tonnes

Recruitment 1981-83 R_0 = 2 036 000

Stock biomass = fish at age 0 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1981-83 based on 1975-80 average.

F values relate to the Human Consumption Fishery (landings + discards) only.

NOTE: To take 1981 TAC (= 140 000 tonnes) $\bar{F}_{81}$ = 0.37.

Appendix 1, Table 7

Management Options: Species - Whiting

Area - ICES IV

1981				1982								1983	
Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	Management option for 1982	Stock biom.	Spawning stock biomass	$\bar{F}$ (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock biom.	Spawning stock biomass
734	578	0.516	209	$\bar{F}_{0.1}$	713	496	0						
				$\bar{F}_{max}$			0.17	140					605
				$\bar{F}_{82} = \bar{F}_{81}$			0.516	202	109	93	54		502
				$\bar{F}_{82}=0$			0	107	0	107	0		674
				$\bar{F}_{82}=0.2\ \bar{F}_{81}$			0.1	130	26	104	12		633
				$\bar{F}_{82}=0.5\ \bar{F}_{81}$			0.26	161	61	100	29		579
				$\bar{F}_{82}=1.5\ \bar{F}_{81}$			0.77	236	148	88	77		439
				$\bar{F}_{82}=2.0\ \bar{F}_{81}$			1.03	261	178	83	97		388

Weights in thousands of tonnes

Recruitment 1981-83 R_0 = 3 138 617

Stock biomass = fish at age 0 and older

Spawning stock biomass = fish at age 2 and older

Exploitation pattern 1981-83 based on 1975-80 average.

F values relate to the Human Consumption Fishery (landings + discards) only.

NOTE: To take 1981 TAC (= 150 000 tonnes) $\bar{F}_{81}$ = 0.16

APPENDIX 2

Calculation of Terminal Fs by the gamma Method and the rho Method

1. The gamma Method

The name "gamma method" refers to the method described in the 1980 Roundfish Working Group Report. The essential gamma-method equation reads:

$$\log \bar{N}(y,a) = \alpha(a) + \beta(a) \log \Gamma(y,a) \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where

$\bar{N}(y,a)$ = average stock number in year of age group a, derived from VPA

$$\text{i.e., } \bar{N}(y,a) = N(y,a) \frac{1}{Z(y,a)} (1-\exp(-Z(y,a)) \quad \ldots\ldots\ldots \quad (2)$$

$\alpha(a)$ and $\beta(a)$ are the regression coefficient derived from the analysis described in the Appendix of last year's report.

$\Gamma(y,a)$ is the index of catch per unit effort (cf. the App. of last year's report).

Applying algebraic manipulations, Eq.(1) can be rewritten:

$$\exp(-\frac{\alpha(a)}{\beta(a)} \bar{N}(y,a)^{1/\beta(a)-1} \bar{N}(y,a) = \Gamma(y,a)$$

or

$$q(y,a) \cdot \bar{N}(y,a) = \Gamma(y,a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where

$$q(y,a) = \exp(-\frac{\alpha(a)}{\beta(a)} \bar{N}(y,a)^{1/\beta(a)-1} \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

$q(y,a)$ is thus the catchability coefficient which is seen by inserting

$$C(y,a) = \bar{F}(y,a) \bar{N}(y,a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

($C(y,a)$ = number caught) into Eq.(3), which gives

$$\bar{F}(y,a) = q(y,a) \frac{C(y,a)}{\Gamma(y,a)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

or

$$F(y,a) = q(y,a) \cdot E(y,a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

where E is the effort.

(In the present context we have ignored the various types of scaling applied in the calculations of Γ)

In the gamma method the catchability coefficient is thus assumed to be a function of abundance(see Equation 4).

If $\beta > 1$ the exponent to $\bar{N}$ in Eq.(4) becomes negative and q becomes a decreasing function of $\bar{N}$.

This would be a reasonable assumption, if the fish spread over a larger sea area when becoming more numerous and thus being relatively more difficult to catch. If $\beta < 1$ the exponent to $\bar{N}$ in Eq.(4) becomes positive, q becomes an increasing function of abundance. This would be a reasonable assumption if it is relatively easier to catch the fish when abundance is high, e.g., if the fish occupied the same area independent of abundance and if this e.g. could reduce the searching time for the fishermen.

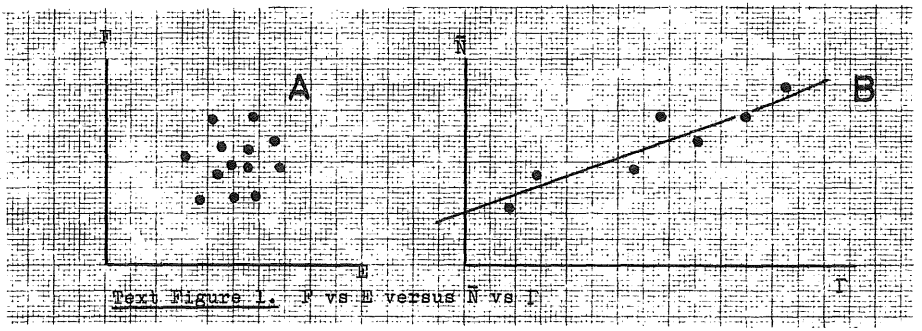
If $\beta = 1$ the catchability coefficient will be independent of the abundance.

2. Why use CPUE vs N rather than F vs Effort

In years prior to 1980 the Roundfish Working Group attempted to apply Eq.(7) to predict the input Fs for the last data year. That is, a regression of F from VPA on effort was made for the Fs and Es up to the last data year minus 2, say, using average Fs. In most cases, these plots all failed to demonstrate a functional relationship, and the Working Group then decided to use average Fs from some reference period as the estimate of terminal Fs. This was considered an unsatisfactory approach.

Based on the advice from the ad hoc Working Group on the Use of Effort Data in Assessments (Anon., 1981), it was decided to use Eq.(3) for the estimation of terminal $\bar{N}$s and from these and the catches in the last year to derive the terminal Fs.

The gamma cpue vs stock method turned out to give much higher correlation coefficients in the regression analysis than the method based on Eq.(7). This fact is not surprising, when one considers the variations of the observations in the two models. The effort data do not show large variations from year to year and nor do the Fs. Therefore, the points on the plot of F on E are not able to demonstrate a linear relationship even if such a relationship does exist (see text Figure 1.A). The Fs and $\bar{N}$s, however, show a large variation from year to year, and because of this feature, the demonstration of linear relationships turned out to be far more convincing for the cpue vs stock method (see text Figure 1.B)



Text Figure 1. F vs E versus $\bar{N}$ vs I

This is the simple reason, why the gamma method in the case of stock with variable recruitment is preferable to the F vs E method.

3. Weak Points in the gamma-Method

A. The catchability coefficients

First of all, the catchability coefficient in the gamma method is assumed to be independent of time, i.e. the development of fishing techniques has been ignored. This year the Working Group decided to modify the gamma method to take into consideration improvement of fishing efficiency. This new method will be described in Sections 4 and 5.

B. Estimation of F for the oldest age

Another problem to be faced when applying the gamma method is the choice of input Fs for the oldest age group.

Only the $\bar{N}$s of the most recent years are influenced by the terminal Fs determined from the gamma method (see text Table 1). But as all $\bar{N}$s are used in the regression analysis, some $\bar{N}$s, which were affected by the choice of input Fs for the oldest age group, are also used. Thus, the choice of input F values for the oldest age group does have an impact on the results of the gamma method. This impact, however, would diminish at successively younger ages.

Table 1. Ns in brackets are those Ns influenced by the terminal Fs determined by the gamma method. The remaining Ns are not affected by the gamma method but determined only from the catches and the (arbitrary) choice of input F for the oldest age group.

1974	1975	1976	1977	1978	1979	1980	Predicted 1981
N	N	(N)	(N)	(N)	(N)	(N)	(N)
N	N	N	(N)	(N)	(N)	(N)	(N)
N	N	N	N	(N)	(N)	(N)	(N)
N	N	N	N	N	(N)	(N)	(N)
N	N	N	N	N	N	(N)	(N)
N	N	N	N	N	N	N	(N)

C. Forced correlation

Eq.(1) can be rewritten (by inserting Eq.(5) and $\Gamma(y,a) = C(y,a)/E(y,a)$).

$$\log\left\{\frac{C(y,a)}{F(y,a)}\right\} = \alpha(a) + \beta(a) \log\left\{\frac{C(y,a)}{E(y,a)}\right\} \quad \ldots\ldots\ldots \quad (8)$$

Eq.(8) is not strictly correct, as the C on the left hand side refers to the total international catch, whereas C on the right hand side refers to only those catches for which effort data are available. However, we do have a regression analysis with (more or less) the same observations on both sides. If, e.g., the Es remained constant from year to year we are bound to end up with high correlation coefficients. To avoid these dubious aspects, it was decided to replace $\bar{N}(y,a)$ in Eq.(1) with $N(y+1,a+1)$.

In that case the observations used in the regression analysis will be independent, as $N(y+1,a+1)$ is calculated from the catches

$$C(y+1,a+1), \quad C(y+2,a+2) \ldots\ldots$$

Thus,

$$\bar{N}(y,a) = N(y+1,a+1)(\exp(Z(y,a)) - 1)/Z(y,a) \quad \ldots\ldots\ldots \quad (9)$$

is replaced by $N(y+1,a+1)$.

However, from a theoretical point of view this is less satisfactory, as cpue ought to be associated with the average abundance during the year.

Inserting Eq.(9) into Eq.(1) we get:

$$\log N(y+1,a+1) = \log \frac{Z(y,a)}{\exp(Z(y,a))-1} + \alpha(a) + \beta(a) \log \Gamma(y,a) \quad (10)$$

and using $N(y+1,a+1)$ as the dependent variable, we ignore the first term on the right hand side of the equality sign. If the Zs

change drastically from year to year in a systematic manner, the replacement of $\bar{N}(y,a)$ by $N(y+1,a+1)$ may introduce a bias. This effect needs to be further investigated. The analogs to Eq.(3) and (4) become:

$$\exp\left\{-\frac{\alpha(b)}{\beta(a)}\right\}\left\{\frac{\exp(Z(y,a))-1}{Z(y,a)}\right\}^{1/\beta(a)} N(y+1,a+1)^{1/\beta(a)-1} N(y+1,a+1)$$
$$= \Gamma(y,a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

and

$$q(y,a) = \exp\left(-\frac{\alpha(a)}{\beta(a)}\right)\left(\frac{\exp(Z(y,a))-1}{Z(y,a)}\right)^{1/\beta(a)} N(y+1,a+1)^{1/\beta(a)-1} \ldots (12)$$

4. The rho Method

The rho method takes its starting point in Eq.(11). To facilitate notation, let

$$A(a) = \exp\left(-\frac{\alpha(b)}{\beta(a)}\right)$$

In Eq.(11) A is considered a constant.

In the rho method A is assumed to be a function of y, the year, in order to take into account that the catchability coefficient should be considered a function of fishing efficiency. Based on an idea by D Armstrong and R Cook it was decided to apply the linear model.

$$A(y,a) = h'(a) + g'(a) \cdot y \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

was applied, where h' and g' are constants.

In order to reduce the complexity of the model, the factors

$$B = \left(\frac{\exp(Z(y,a))-1}{Z(y,a)}\right)^{1/\beta(a)} N(y+1,a+1)^{1/\beta(a)-1} \ldots\ldots \quad (14)$$

were assumed to remain constant from year to year. That is, the possible dependence of catchability abundance was ignored and the possibility of a bias being introduced by using $N(y+1,a+1)$ instead of $\bar{N}(y,a)$ was ignored as well.

Inserting Eqs.(13) and (14) into Eq.(11) we get

$$\left(h'(a)B(a) + g'(a)B(a)y\right) N(y+1,a+1) = \Gamma(y,a)$$

or by setting $h'(a)B(a) = h(a)$ and $g'(a)B(a) = g(a)$

$$h(a) + g(a)y = \frac{\Gamma(y,a)}{N(y+1,a+1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

The rho method is then to plot $\Gamma(y,a)/N(y+1,a+1)$ on year and estimate the constants h and g by ordinary regression analysis for each age group. The actual iterative procedure applied is described in the next section.

5. Computational procedure of the rho method

The iterative procedure to derive the terminal Fs from the rho method works along the same lines as the gamma method described in last year's report.

The following description is given in "pseudo-computer language":

A: Read for each fleet effort data

$E(y,f)$ (y=year, f=fleet)

and number caught by this fleet

$C(y,f,a)$ (a=age)

B: Calculate for each age group:

$$\text{cpue}(y,f,a) = \frac{C(y,f,a)}{E(y,f)}$$

C: Calculate relative cpue for each age group:

$$\gamma(y,f,a) = \frac{\text{cpue}(y,f,a)}{\text{cpue}(\varkappa,f,a)}$$

where $\varkappa$ is index for the reference year.

D: Calculate combined relative cpue for all fleets:

$$\Gamma(y,a) = \left(\sum_f \gamma(y,f,a)\, C(y,f,a)\right) \Big/ \sum_f C(y,f,a)$$

E: Make an initial guess on the terminal Fs for the last year $F(81,a)$.

Make a guess on the input Fs for the oldest age group for all years.

F: Perform VPA, the terminal Fs for last year being those derived from the previous iteration (in first iteration the terminal Fs come from point E above).

G: Scale stock numbers from VPA:

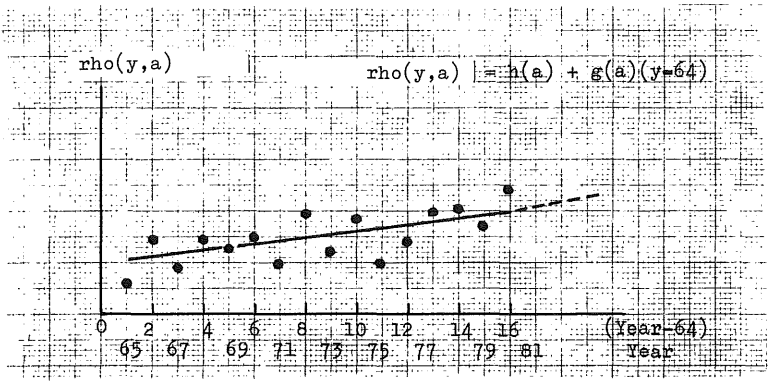
$$V(y,a) = \frac{N(y,a)}{\max\limits_{y \le 1978} \left\{N(y,a)\right\}}$$

(This is done only for presentation purposes.)

H: Calculate the rho's:

$$\text{rho}(y,a) = \frac{\Gamma(y,a)}{V(y+1,a+1)} \quad ; \quad y = 1965, \ldots\ldots, 1980$$

I: Perform regression analysis for each age group:



J: Predict N(82, a+1):

$$\text{rho}(81,a) = h(a) + g(a) \cdot 17 \quad \text{or}$$

$$\left(\frac{\Gamma(81,a)}{\frac{N(82,a+1)}{\max\limits_{y \le 1978} \{N(y,a+1)\}}} \right) = h(a) + g(a) \cdot 17$$

from which we get

$$N(82,a+1) = \frac{\Gamma(81,a) \max\limits_{y \le 1978} \{N(y,a+1)\}}{h(a) + g(a) \cdot 17}$$

K: Calculate F(81,a):
solve the equation

$$\frac{C(81,a)}{N(82,a+1)} = \frac{F(81,a)}{Z(81,a)} \left(\exp\left(Z(81,a)\right) - 1 \right)$$

with respect to F(81,a).

L: Compare terminal Fs of current iteration with those of previous iteration:

$$\text{if } \sum_a \left(F_{\text{current}}(81,a) - F_{\text{previous}}(81,a)\right)^2 > 0.0001$$

then go to F.

FINIS:

The procedure described above was programmed for the ICES computer during the Working Group meeting.

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