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REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

Copenhagen, 24 March - 2 April 1981

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REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

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2. TERMS OF REFERENCE

At the 1980 Statutory Meeting, it was decided (C.Res.1980/2:6/6) that the North Sea Roundfish Working Group should meet at ICES Headquarters from 24 March - 2 April 1981 to:

(i) assess TACs for 1982 for cod, haddock and whiting in Sub-areas IV, VI and VII (excluding Divisions VIIa, f and g),

(ii) advise on appropriate minimum mesh size for cod, haddock and whiting if fished in a single-species fishery in Sub-area IV,

(iii) reexamine the appropriate mesh sizes for NEAFC Recommendation 1 fisheries in Sub-area VI in the light of previous recommendations of ICES on this subject, and bearing in mind the enforcement problems of a differential in minimum mesh size between Sub-areas IV and VI,

(iv) assess the effects of an increase in mesh size to 80 mm in Divisions VIId,e,

(v) 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,

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

3. DATA BASE

In its 1980 report (C.M.1980/G:8) the Working Group drew attention to the deficiencies in the data bases and recommended that a special meeting of the Group be convened to revise the age composition data base. Subsequently the Council decided (C.Res.1980/2:6/17) that such a meeting should be held in Aberdeen from 11 to 17 February 1981. A report of that meeting is available as C.M.1981/G:3.

At the Aberdeen meeting it was possible to revise only the date bases for the North Sea stocks. For the West of Scotland stocks some progress has been made for haddock and whiting but further revisions are likely to be necessary. Any such changes will be made before the next meeting of the Group, but these changes are expected to be relatively minor ones. For West of Scotland cod the data base, apart from updating, is unchanged from last year and this too will be revised during the coming year. There is no significant amount of industrial fishing in the West of Scotland area but discarding in the human consumption fishery is known to occur. Collection of discard data has only just commenced but, because data were available for only one or two years, no discard data are included in the catch age compositions for the West of Scotland stocks used in the Virtual Population Analysis (VPA).

For the North Sea stocks the data bases include age compositions for human consumption landings, discards, and industrial by-catches. For cod industrial by-catches are very small and sampling is poor, and therefore this category has not been included in the cod analysis. For all three species sampling of discards is carried out by only a few countries. In estimating the quantities and age compositions of total (all countries) discards it has been assumed that countries not reporting discards do discard at the same rate, in proportion to human consumption landings, as countries reporting discards, and also that unsampled discards have the same age compositions as sampled discards. For industrial catches in some of the earlier years only weights of the by-catch were known. To have a consistent data series it is necessary to include by-catch age compositions for these earlier years. Age compositions were, therefore, estimated from the age compositions of human consumption landings. The procedure adopted for doing this is described in the report of the Aberdeen meeting.

Tables 3.1 to 3.3 give a summary of the numbers and weights taken in each category for the three species. According to the Working Group estimates, the quantities of cod discarded have been increasing in recent years. For haddock and whiting attention is drawn to the high proportions of the catch which are discarded, particularly in years when abundant year classes recruit to the fisheries.

4. DETERMINATION OF FISHING MORTALITY RATES IN LATEST YEAR

The Group decided to use one of the methods discussed by the recent ad hoc Working Group on Fishing Effort (C.M.1981/G:5). This method is fully described in Appendix 1. Also given in Appendix 1 are:

(1) The data input for cod, haddock and whiting, North Sea and Division VIa.

(2) Tabulations of the output values for each stock.

(3) Graphs of the final iterated values for each stock.

Some difficulties were encountered in applying this method. The most important of these were:

(a) It was decided that, especially for the younger age groups, inclusion of data on the catch at age of discards, where available, was essential to obtain valid values of catch per effort. Detailed data on the catch at age of discards for each appropriate fleet/stock combination were not available to the Group. No data exist currently (on discards) for any of the Division VIa stocks. For the North Sea

stocks, preliminary data on discards for each of the appropriate fleet/stock combinations were obtained by multiplying the array of total discard numbers at age in each year by the ratio

$$\frac{\text{(weight landed for human consumption by fleet)}}{\text{(total weight landed for human consumption)}}$$

(b) No effort data were available to the Group for the industrial fisheries, and for this reason age compositions of the industrial by-catch could not be included in the estimation of an index of catch per unit of effort.

(c) Application of the method to data for all years for which the VPA can be run led to lower estimates of F in 1980 than application of the method with data restricted to the period 1970-80.

The Group thought that this was probably because the effort data have not been appropriately corrected for changes in fishing power. The Group decided to use the outputs resulting from the data for the period 1970-80, since it was thought that fishing power changes in that period were not as great as fishing power changes over the whole period for which data exist.

Geometric mean regression lines were fitted to data for the period 1970-79 inclusive. These lines were used to predict 1980 stock sizes at age and from these, knowing catch numbers at age and M at age, the corresponding values of F at age were derived.

The results obtained were very encouraging. The estimated values of F in 1980 appeared to be very reasonable when compared to the historical values estimated from VPA. The fact that the estimated exploitation patterns for 1980 in some cases show considerable variations in the values of F at age is not an indication that the method is theoretically invalid. Examinations of historical data indicate that considerable variations in F at age values within a year are to be expected.

The theoretical basis of the method will be further studied by members of the Group before next year's meeting.

5. GENERAL COMMENTS TO ASSESSMENTS

5.1 Choice of an Index of Fishing Mortality

The Working Group considered what single figure index of fishing mortality could give a satisfactory indication of the overall level of fishing mortality. Fishing mortality in any one year is defined as an array of values of fishing mortality at each age and no single figure can represent an array. Thus, for any average value that may be quoted, it is assumed that it relates to a specific exploitation pattern. This obviously creates problems when trying to determine an index of fishing mortality when the exploitation pattern is changing instead of, or in addition to, changes in the overall level of fishing. For this year the Working Group decided to quote fishing mortalities in terms of an arithmetic average of a range of age groups. The age range was specified as from the average age at first maturity to an age of three years younger than the oldest true age group used in VPA. Thus, for North Sea haddock, the age range is 2 to 6, and the index of fishing mortality is indicated by the symbol $\bar{F}_{2-6}$.

At this meeting of the Working Group, catch per unit effort data were used for the first time to provide an objective measure of fishing mortality in the most recent year for input into VPA(see Sect.4). This method produces an array of predicted values of F at age for the latest year and these values, apart from any adjustment on values for the youngest age groups to make them consistent with year class strengths predicted from young fish surveys, have been input directly into the VPA without any form of smoothing. As is often the case in the VPA-calculated arrays of F, the values estimated from cpue can be rather variable from age to age within a year. Consequently, the Working Group considered it preferable for the purposes of prediction, yield per recruit, etc., to use smoothed exploitation patterns for each component of the fishery determined as the average for the years 1975-80. The array of values of F for human consumption fisheries (landings and discards) obtained by this process is referred to in this report as F_{*}. The average value of F in the array F_{*} over the appropriate range of ages for each species is referred to as $\overline{F}_{*}$. A consequence of this approach is that the exploitation patterns for the predictions are not identical with those used in 1980. In past years, a smoothed exploitation was nearly always adopted for the most recent year and this could be carried forward into the prediction period. The problem created by having exploitation patterns in the prediction period different from those in 1980 is that the index of fishing mortality for 1980 is not directly comparable with the index for 1981 and 1982. Thus, to avoid possible confusion, catch predictions for 1982 are presented for changes in F_{1982} relative to F_{1981} instead of the standard F_{82}/F_{80} ratio.

A note on a possible alternative method for determining the level of exploitation in each year is given in Appendix 2.

5.2 Yield per Recruit Calculations

Yield per recruit curves for West of Scotland stocks have been calculated in the usual way, using exploitation patterns based on an average for the years 1975-80 and weight at age data averaged for 1978-80.

For the North Sea stocks in previous years yield per recruit curves have been calculated in the same way using the array of total F at age as the exploitation pattern. In the past, these curves have probably been used mainly to determine long-term exploitation strategy in the human consumption fishery alone without taking account of discarding or the fact that in the yield per recruit curves reductions in F were assumed to apply in the same proportion in the industrial fishery although no proposals have so far been considered for reducing the industrial fisheries in the same way as has been proposed for human consumption fisheries.

This year the Working Group decided to evaluate the equilibrium yield for average recruitment for human consumption landings, discards, and industrial by-catch separately. To do this the catch prediction program was used with average recruitment for each year and run for fifteen years so that estimated yields were those that would result from the equilibrium stock. In making this calculation a number of assumptions are possible for changes in the industrial fishery. In the calculations presented here it was assumed that the fishing mortality generated by the industrial fishery would remain constant at the level of the 1975-80 reference period. For the human consumption fishery and discards, Fs were varied in the same proportions. The exploitation patterns used were those based on the average for 1975-80. The results are referred to in the relevant species' sections.

6. NORTH SEA COD

6.1 Catch Trends (Table 6.1 and Figure 6.1.A)

Provisional nominal landings in 1980 were 239 000 tonnes compared to the TAC of 200 000 tonnes. In addition, total international discards were estimated at 39 000 tonnes.

6.2 Age Composition (Table 6.3)

Provisional data for 1979 as used last year were revised and a provisional data set was assembled for 1980. Details of data sources are given below:

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1979	Industrial by-catch	Norway, Denmark, Fed.Rep.of Germany (shrimp trawl)	5 833	5 833	100
	Human consumption landings	Belgium, Denmark, England, France, Netherlands, Scotland	223 410	248 051	90
	Discards	Netherlands, Scotland	25 801	67 490	38
1980	Industrial by-catch	Norway	595	Not known	?
	Human consumption landings	Belgium, Denmark, Fed.Rep.of Germany, France, England, Netherlands, Scotland	242 891	255 904	95
	Discards	England, Netherlands, Scotland[1]	15 612	37 399	42

1) Scottish data not used - see text.

The data base used in the assessment was that resulting from the ad hoc Data Base Meeting (ICES, C.M.1981/G:3). The main difference from that used last year is the inclusion of estimates of total international discards, which results in increased estimates of 1 year old fish. Estimates from by-catches in small-meshed fisheries have not been included in the assessment data base, since they are not considered to be sufficiently reliable. The quantities involved are relatively small.

Provisional Scottish data on discards for 1980 were excluded since there was some doubt about the very high discarding rates indicated.

6.3 Recruitment (Table 6.2 and Figures 6.1.B and 6.2.A)

The recruitment of the 1979 year class predicted by the IYFS using the previous VPA data base was 208 million fish. Using the revised data base the prediction is similar at 231 millions, a figure which is almost equalled by the catch of this year class in 1980. Inspection of Figure 6.2.A shows that the IYFS' index of abundance fails to reliably predict recruitment of abundant year classes, and it was decided that the IYFS data should not be used for the estimation of the 1979 and 1980 year classes. Data from the commercial fisheries indicate that the 1979 year class is a large one. Discarding rates have been high and the number landed is the largest on record. Cpue data from nearly all fleets also point to a very abundant year class, and in the absence of any better information it was decided to use the value given for recruitment by the cpue analysis. This value of 752 million fish is 30% higher than the previous most abundant year class (1976), and it must be considered to be a provisional estimate at present. The only other data available to the Group were the results of an English groundfish survey, which has been carried out since 1977, too short a time period for its correlation with other sources of data to be assessed. This survey also indicates that the 1979 year class is abundant, but slightly less so than the 1976 year class.

In view of the uncertainties surrounding the abundance of the 1979 year class it is strongly suggested that the catch predictions for 1981 and 1982 should be treated as provisional estimates, subject to revision. Year classes after that of 1979 were set at 235.6 millions, the mean VPA number at age 1 for years 1963-77.

6.4 Weight at Age (Table 6.4)

The final weight at age for each of the consumption landings and discard categories was a weighted mean of the national data sets. The weight at age used for stock biomass calculations for each year was the weighted mean of the category weights at age for that year. For catch predictions in 1981 and 1982 mean values for the period 1978-80 were used.

6.5 Fishing Mortalities in 1980

A constant value of M = 0.2 was assumed throughout. F values for 1980 were predicted for all age groups using the method described in Section 4 and used as input for VPA.

6.6 VPA Results

Estimates of fishing mortality as calculated by VPA are given in Table 6.5, and stock numbers and stock biomass in Table 6.6. Spawning stock biomass (Figure 6.1.C) has shown a decline since 1968, but with the entry of the 1976 year class into the spawning stock in 1979, to be followed by the 1979 year class in 1982, this trend should be reversed.

6.7 Equilibrium Yield for Average Recruitment

This has been calculated as described in Section 5.2 and the results are given in Table 6.7 and illustrated in Figure 6.3.

6.8 Catch Predictions (Tables 6.8 - 6.10, Figure 6.4)

Input data for catch predictions are given in Table 6.8. Catch predictions have been made under two assumptions for the catch in 1981. In Option 1, it is assumed that the TAC of 190 000 tonnes is adhered to,

which implies a reduction in fishing mortality of 57% compared to the reference level $\bar{F}_*$ (average for the years 1975-80). In Option 2 it is assumed that fishing mortality remains unchanged compared to the reference level, in which case a prediction for landings of 350 000 tonnes is implied for 1981.

For both options a range of F values and associated catches is given for 1982. Attention is again drawn to the uncertainty of the size of the 1979 year class, which will form a major part of the catches in 1981 and 1982. The catch prediction results should, therefore, be treated with caution.

7. COD IN DIVISION VIa

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

Provisional nominal landings in 1980 were 17 800 tonnes, compared to the TAC of 11 600 tonnes (plus 500 tonnes in Division VIb).

7.2 Age Composition (Table 7.2)

Data for 1979 were revised and a provisional age composition for 1980 was assembled. Details of the data supplied are given in the text table below.

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1979	Human consumption landings	England, Scotland, Ireland, France (length only, Scottish ALK)	16 104	16 242	99
	Discards	Scotland	23	-	-
1980	Human consumption landings	England, Scotland, Ireland, France (length only, Scottish ALK)	16 007	17 791	90

No data on industrial fishery by-catches are available but quantities are probably small. Discard data were not included in the VPA input data. These quantities also appear to be small, but only limited data are so far available.

7.3 Recruitment (Table 6.2, Figure 7.1.B)

The relationship between recruitment in Division VIa and in Sub-area IV as indicated by VPA number at age 1 was re-examined but again found to be non-significant (Figure 6.2.B). It was therefore decided to accept the value of 7.7 millions at age 1 for year class 1979 as derived by using the method described in Section 4. Subsequent year classes were assumed as the average of the years 1967-77 (7.2 millions). Figure 7.1.B indicates an increasing trend in recruitment.

7.4 Weight at Age (Table 7.3)

For 1979 and 1980 the same procedure was used as for North Sea cod (see Section 6.4).

7.5 Fishing Mortalities in 1980 (Table 7.4)

A constant value of M = 0.2 was assumed throughout. F values for 1980 were fixed using cpue data from the commercial fishery as described in Section 4.

7.6 VPA Results

Estimates of fishing mortality as calculated by VPA are given in Table 7.4, and stock numbers and stock biomass in Table 7.5. Spawning stock biomass (Figure 7.1.C) has been maintained at a steady level in the past decade.

7.7 Yield per Recruit

This has been calculated as described in Section 5.2 using an exploitation pattern based on the reference period 1975-80. The results are shown in Figure 7.1.D.

7.8 Catch Predictions (Tables 7.6 - 7.8 and Figure 7.2)

For the catch predictions mean values of weight at age for the period 1978-80 were used (Table 7.6).

Predictions were made under two assumptions. In Option 1 it is assumed that the TAC of 9 500 tonnes is adhered to, which implies a reduction in fishing effort relative to the reference level of 66%. In Option 2 there is no change in fishing mortality in 1981, in which case a catch of 23 300 tonnes is predicted. The exploitation pattern used is that for the reference period 1975-80.

For both options a range of predicted catches associated with various F values in 1982 have been calculated.

8. COD IN DIVISION VIb

No age composition data were available for this stock, but nominal landings are quite small (Table 8.1). If a TAC is set for the whole of Sub-area VI, an appropriate allowance will need to be made for Division VIb.

9. COD IN SUB-AREA VII

9.1 Cod in Divisions VIId and VIIe (Table 9.1)

In last year's report a preliminary VPA for Division VIId was included, based on French data for the years 1974-79. For 1980 the only data available for age compositions related to English landings, based on

limited sampling. Since English landings form only a small proportion of the total, it was decided that it would be inappropriate to raise these data to a total international age composition. No further progress towards making an analytical assessment was therefore possible.

9.2 Cod in Divisions VIIb,c and VIIg-k (Table 9.2)

No age composition data are available from these areas. Nominal landings for 1980 are at present incomplete.

10. NORTH SEA HADDOCK

10.1 Catch Trends

Total international landings and total international catches are given in Table 10.1,and shown in Figure 10.1A for the period 1960-80.

TAC for 1980 was 90 000 tonnes, nominal catches in 1980 were 101 000 tonnes, the Working Group estimate of total landings in 1980 was 122 000 tonnes.

10.2 Age Composition (Table 10.3)

The catch at age data base for the period 1960-78 was extensively revised but the revision did not alter the data much in comparison with the preliminary revision presented by the Group last year (see Section 3).

Details of the data supplied to the Group by various nations for 1979 (final) and 1980 (provisional) are summarised in the following text table.

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1979	Industrial by-catch	Denmark, Norway	16 076	17 414	92
	Human consumption landings	Belgium, England, France, Netherlands, Scotland	73 848	83 249	84
	Discards	Scotland	26 003	39 972	65
1980	Industrial by-catch	Denmark, Norway	23 346	25 154	93
	Human consumption landings	Belgium, Denmark, England, France, Netherlands,Scotland	88 841	96 271	92
	Discards	England, Scotland	57 960	76 669	76

10.3 Weight at Age

Mean weight at age data for the total fishery are given in Table 10.4.

10.4 Recruitment

The numbers of fish in the sea at age 1 in 1980 and 1981 (the 1979 and 1980 year classes) were estimated using results from the IYFS given in Table 10.2.

No attempt was made to fit regression lines to the scatter diagram of IYFS indices vs VPA numbers at age 1 shown in Figure 10.2. Instead, values of numbers of fish in the sea in accordance with the IYFS indices were selected by eye from the scatter diagram. This procedure led to estimates of 1979 and 1980 year classes at age 1 of 2 800 and 800 millions respectively.

Average recruitment at age 0 for use in the predictions was assessed from the VPA results given in Table 10.6 as 2 036 million. This value excludes estimates for the very abundant 1962 and 1967 year classes.

The 1979 year class is of above average abundance (4 463 millions at age 0).

The historical series of recruitment levels at age 0 is also shown graphically in Figure 10.1.B.

10.5 Fishing Mortalities in 1980

The method referred to in Section 4 and described in Appendix 1 was used to estimate fishing mortality rates at ages 2-10. For ages 0 and 1, fishing mortality rates were adjusted to be in accordance with the estimates of the abundance of the 1979 and 1980 year classes referred to in the preceding section.

10.6 VPA Results

Estimates of fishing mortality, as calculated by VPA, are given in Table 10.5, and stock numbers and stock biomass in Table 10.6.

Historical spawning stock biomass levels (age 2 and older) are shown in Table 10.6 and Figure 10.1.C.

The estimated levels of spawning stock in 1978 and 1979 are only slightly in excess of the lowest on record. The estimated level for 1980 (357 000 tonnes) is about 80% greater than that for 1979.

10.7 Equilibrium Yield for Average Recruitment

The yield and spawning stock biomass curves per recruit are shown in Figure 10.3. This has been calculated as described in Section 5.2, and the results are given in Table 10.7.

10.8 Catch Predictions

Input data for the catch predictions are given in Table 10.8. Mean weights at age data for all nations except Scotland were adjusted where there were sums of products discrepancies within each national data set before summing up and raising to total international catch. For Scotland, the numbers at age were adjusted.

The TAC for 1980 (90 000 tonnes) was exceeded by about 30 000 tonnes and about 77 000 tonnes were discarded in 1980.

In carrying out the predictions, it was assumed that the exploitation pattern in 1981 and 1982 = the average exploitation pattern for the reference period 1975-80.

Three further assumptions were then made:

(1) TAC 1981 = 120 000 tonnes as recommended by ACFM.

(2) Landings in 1981 = 240 000 tonnes. This TAC would have been recommended, if there had been no uncertainty about the results of last year's prediction runs and would have been the best estimate of the TAC in 1981 to bring about a 10% reduction in levels of fishing mortality compared to 1979.

(3) Levels of fishing mortality in 1981 equal to the levels for the reference period.

The results of predictions are given in Table 10.9 and shown graphically in Figure 10.4.

11. HADDOCK IN DIVISION VIa

11.1 Catch Trends (Table 11.1, Figure 11.1.A)

Nominal landings in 1980 were 12 800 tonnes, compared to the Division VIa portion of the Sub-area VI TAC of 13 000 tonnes.

11.2 Age Composition (Table 11.2)

The historical data set used included only minor changes from that used last year. The data set does not include discards or industrial fishery by-catches, data for which are few. Data for 1979 were revised and a provisional age composition for 1980 was constructed.

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1979	Human consumption landings	England, Ireland*, Scotland	9 116	13 956	65
1980	Human consumption landings	England, Ireland, Scotland	9 386	12 783	73

* Provisional data - not included.
France provided length compositions for both years.

11.3 Weight at Age (Table 11.3)

Mean values for the period 1978-80 were used in the catch predictions for 1981 and 1982.

11.4 Recruitment (Table 10.2 and Figures 10.2.B and 11.1.B)

Recruitment of the 1979 and 1980 year classes at age 1 was predicted as 100 millions and 24 millions respectively from a plot of VPA numbers in Sub-area IV and Division VIa. Year classes after that of 1980 were calculated at 39.8 millions, the average from VPA for the period 1965-77, excluding the 1967 year class.

11.5 Fishing Mortalities in 1980

Natural mortality of M = 0.2 was assumed for all ages. For 1980, F values were calculated from cpue data from the commercial fisheries, as explained in Section 4. F at age 1 was corrected to correspond to the recruitment predicted from North Sea Division VIa recruitment correlation.

11.6 VPA Results

Estimates of fishing mortality as calculated by VPA are given in Table 11.4, and stock numbers and stock biomass in Table 11.5.

Spawning stock biomass (Figure 11.1.C) reached a high level in 1969 due to the recruitment of the 1967 year class and has fluctuated around 50 000 tonnes in the past 5 years.

11.7 Yield per Recruit (Figure 11.1.D)

The yield per recruit curve was calculated using the exploitation pattern for the reference period 1975-80, and $\bar{F}_{*}$ is close to F_{max}.

11.8 Catch Predictions

Input data for catch predictions are given in Table 11.6. The results of the catch predictions are shown in Tables 11.7 and 11.8 and in Figure 11.2.

It was assumed that the exploitation pattern in 1981 and 1982 = the average exploitation pattern for the period 1975-80. Two assumptions were then made:

Option 1: TAC (15 500 tonnes) taken exactly in 1981.

Option 2: Fishing mortality levels in 1981 = fishing mortality at the same level as that for the reference period 1975-80.

12. HADDOCK IN DIVISION VIb

12.1 Catch Trends (Table 12.1)

There was a substantial increase to 7 300 tonnes in nominal landings in 1980 compared to those in the preceding three years, largely due to increased English landings. However, landings are still well below those during the period 1974-76, which averaged 47 500 tonnes, largely due to catches reported by USSR.

12.2 Age Composition, VPA, Recruitment (Tables 12.2-12.5)

English age composition data are available for the period 1976-80. These were raised to a total international age composition as VPA input, a procedure which is probably valid for all years except 1976, when the English landings formed only a small proportion of the total. The resultant catch age composition is given in Table 12.2 together with the mean weight at age data.

Two VPA runs were made with guessed input F values of 0.5 and 0.8 (Table 12.3). The results show that two year classes (1973 and 1976) have dominated the landings. Comparison with relative year class strengths in Division VIa shows no correlation, indicating that the two stocks are probably separate. The absence of 1 year old fish from the landings is due to a comparatively slow growth rate at Rockall.

Since the actual values of F in 1980 are unknown, it is not possible to estimate stock size and hence to predict catches in 1981 and 1982. No 2 year old fish were landed in 1980, and the 1978 year class is obviously weak. A fishing survey at Rockall is planned by England in 1981 and this should provide further information.

13. HADDOCK IN SUB-AREA VII (excluding Divisions VIIa, VIIf and VIIg)

No age composition data are available. Nominal landing data are given in Tables 13.1 and 13.2

14. NORTH SEA WHITING

14.1 Catch Trends

Total official nominal catches in the period 1971-79 fluctuated between 103 000 tonnes and 191 000 tonnes, averaging 138 000 tonnes (Table 14.1). Provisional nominal landing figures for 1980 amount to 101 000 tonnes, whereas the Working Group estimate of total landings is 132 000 tonnes. This is 18 000 tonnes below the TAC of 150 000 tonnes and represents a decrease of 26 000 tonnes from 1979. Total catch in 1980 which includes discards is estimated to have been 189 000 tonnes (Table 14.1, Figure 14.1.A).

14.2 Age Composition

The revision of the data base is described in Section 3. Total catch in numbers at age used for VPA input is given in Table 14.3.

For the human consumption landings in 1980 age compositions were available from England, France, Netherlands and Scotland, accounting for 92% of the landings.

Age compositions for industrial trawl landings were submitted by Denmark and Norway, accounting for 91% of the landings.

Discard estimates including number per age group and weight at age were submitted by England, Netherlands and Scotland, representing 71% of the total discards estimated by the Working Group.

14.3 Recruitment (Table 14.2 and Figure 14.1.B)

The recruitment indices at age 1 from the IYFS in the period 1965-79 were plotted against VPA recruitment values and the diagram was used to estimate the size of the year classes 1979 and 1980 at age 1 (Figure 14.2.A). The estimated value for the 1979 year class was $2\ 400 \times 10^6$ and for the 1980 year class $1\ 400 \times 10^6$ compared to a mean of $2\ 200 \times 10^6$ for the year classes 1959 to 1976.

14.4 Weight at Age

The weight at age data for total landings are given in Table 14.4.

14.5 Fishing Mortalities in 1980 (Table 14.5)

A value of M = 0.2 was assumed for all age groups. For the age groups 2-9 input F values for 1980 for the VPA were based on the method using the correlation between stock number and catch in number per unit of effort for each age group as described in Section 4. For the age groups 0 and 1, F values were calculated on the basis of the recruitment estimates of the year classes 1979 and 1980 and the catches of these year classes in 1980.

14.6 VPA Results

Estimates of F calculated by VPA are given in Table 14.5

The average F values over the age groups 2-6 indicate that the overall fishing mortality in 1980 was about 14% lower than in 1979 and there seems to have been a steady decline from 1975 when the fishing mortality was about twice the 1980 level. Estimates of stock numbers and stock biomass are given in Table 14.6.

Knife-edge recruitment at age 2 to the spawning stock was assumed. There appears to have been a small increase in the spawning stock biomass from 1979 to 1980 followed by a marked increase to about 500 000 tonnes in 1981 (Figure 14.1.C). This is the highest level after 1969, but the increase is caused by the 1979 year class alone and is therefore totally dependent on the recruitment estimate of this year class.

14.7 Equilibrium Yield for Average Recruitment

Long-term yield and discards assuming average recruitment are presented in Table 14.7 and in Figure 14.3. The input data for catch predictions were used (Table 14.8) and the F values generated by the industrial trawl fishery were kept constant whereas the overall level of F values for the human consumption fishery was varied.

14.8 Catch Predictions

The input data for catch predictions are given in Table 14.8. The weights at age used are the average for the years 1978-80.

The predictions were carried out using two options. The results are presented in Tables 14.9 and 14.10 and Figure 14.4. In Option 1 it is assumed that the TAC of 150 000 tonnes for 1981 is taken. This means a reduction of the exploitation by the human consumption fishery of 70% compared to the 1975-80 level.

Option 2 assumes that the exploitation in 1981 is at the 1975-80 reference level, which would give total landings of 213 000 tonnes.

The relatively high levels of F values for North Sea whiting make predictions of both catches and biomass very much dependent on the recruiting year classes, especially when these are good, which also generally means that they are more difficult to estimate with desired accuracy. The only possible way to improve this situation would seem to be either to improve the recruitment estimates or to reduce the exploitation on the youngest age groups.

15. WHITING IN DIVISION VIa

15.1 Catch Trends

Landings of whiting from Division VIa are shown in Table 15.1.A and Figure 15.1.A. Landings have declined from 24 937 tonnes in 1976 (and 17 082 tonnes in 1979) to 12 767 tonnes in 1980, which was close to a TAC for 1980 of 13 000 tonnes. Estimates of discards were not available.

15.2 Age Composition (Table 15.2)

The 1979 age composition data were updated and the 1980 data compiled. For 1979 age composition data were submitted by Scotland and Ireland. For 1980 age composition data were submitted by Scotland and Ireland. Length composition data were submitted by France for 1979 and 1980. These were transformed into age compositions using Scottish ALKs. Reported age and length composition data accounted for 93% and 97% of total 1979 and 1980 landings respectively.

15.3 Recruitment (Table 14.2 and Figures 14.2.B and 15.1.B)

Year class strengths were estimated (by eye) from a plot of VPA numbers at age 1 in the North Sea against VPA numbers at age 1 in Division VIa. Estimates of numbers at age 1 were 120 million for 1980 and 40 million for 1981. For catch prediction the average recruitment at 1 year old for the year classes 1962-78 of 92 million was adopted.

15.4 Weight at Age (Table 15.3)

Weight at age for each component of the fishery was submitted by Scotland, Ireland and France for 1979 and 1980. Combined estimates of weight at age were obtained from a weighted mean, using numbers landed as the weighting factors.

15.5 Fishing Mortalities in 1980

Terminal fishing mortalities for 1980 were derived from the method described in Section 4. F on age group 1 in 1980 was adjusted to produce the estimate of year class strength in 1980 and for age 0 to produce the average recruitment of 1 groups in 1981.

15.6 VPA Results

Estimates of fishing mortality as calculated by VPA are given in Table 15.4, and stock numbers and stock biomass in Table 15.5.

Spawning stock biomass (ages 2+) derived from VPA are shown in Figure 15.1.C.

15.7 Yield per Recruit

Yield per recruit and spawning stock biomass curves were calculated as described in Section 5.2, using the exploitation pattern based on the average one for 1975-80. The results are illustrated in Figure 15.1.D.

15.8 Catch Predictions

Input data for catch predictions are given in Table 15.6. Results are shown in Table 15.7 and Figure 15.2. Two options were considered. In Option 1 the 1981 TAC is assumed for the landings. This required an effort reduction of 54% compared to that of the reference period 1975-80. In Option 2 effort in 1981 is assumed to be at the same level as that for the reference period.

16. WHITING IN SUB-AREA VII

16.1 Whiting in Divisions VIId and VIIe

Landing figures for 1979 have been revised from 10 700 tonnes to 8 960 tonnes and the time series now shows a decline since 1977 (Table 16.1). Provisional landings in 1980 are 7 348 tonnes which is the lowest since 1973.

Age compositions for 1976-80 have been submitted by England which, on average, accounts for only 12% of the nominal landings. It is therefore possible that the data base may not be very representative for the total fishery. The data base time series is also too short to give much information about the stock.

A trial VPA was made to give some indication about the level of exploitation. The input and the results are given in Tables 16.2-16.5. Trends in fishing mortalities over the period cannot be detected with the restricted data base. The age groups seem to be fully exploited from about the age of 4. However, some discarding is likely to take place which means that the F values on the younger age groups are underestimated. The VPA indicates that the year classes 1979 and 1980 are small compared to the year classes 1976-78. Unless the data base is totally misleading, this is probably a valid observation and means that the spawning stock biomass is likely to be reduced to a comparatively low level in 1982.

16.2 Whiting in Divisions VIIb,c and VIIg-k (Table 16.6)

Landings in 1977-79 have been low compared to the period 1972-76. The level of landings in 1980 is not known because statistical returns are incomplete.

17. APPROPRIATE MINIMUM MESH SIZE FOR COD, HADDOCK AND WHITING IF FISHED IN A SINGLE SPECIES FISHERY IN SUB-AREA IV

The optimum mesh size for exploiting a single species is dependent on the level of fishing mortality and therefore there is no single optimum mesh size. For the North Sea stocks there are further complications in that part of the catch in the directed human consumption fisheries will be discarded, at least for meshes in the lower part of the size range. Interpretation of what is considered an optimum mesh size will depend on whether discards are included or excluded from the yield. Furthermore, for haddock and whiting, substantial by-catches are taken in the industrial fisheries.

Any determination of an optimum mesh size in the directed fisheries will be very much dependent on whether it is assumed that industrial fishing will continue to take a substantial by-catch or whether it is assumed that there will be no industrial fishing. In the time available to the Working Group, it was not possible to undertake the calculations required to simulate a range of possible assumptions.

18. EFFECTS OF A MESH INCREASE TO 90 mm IN SUB-AREA VI

With effect from 1 December 1980, the minimum cod end mesh size in the West of Scotland area was increased from 70/75 mm to 80 mm in line with the increase adopted for the North Sea. A further increase to 90 mm has been agreed for the European Community zone of the North Sea to take effect from 1 October 1982.

Previous advice from ICES (ICES Coop.Res.Rep., No.73) was that there would be long-term benefits for both roundfish and flatfish by increasing the minimum mesh size to at least 90 mm in both the North Sea and West of Scotland. Apparently, doubts were expressed concerning the applicability of this recommendation to the West of Scotland as some of the parameters used in the mesh assessments for that area had been derived from experiments in the North Sea. There are still very few results of selectivity experiments reported for the West of Scotland area, and the Group had no alternative but to continue to use selection factors derived from North Sea experiments. Indeed, because of the variable nature of selectivity results, it would take a very large number of experiments in the West of Scotland area to demonstrate that selection factors in that area were significantly different from those determined for the North Sea. A comparison of

mean weight at age in human consumption landings in recent years indicates, if anything, that growth rates for West of Scotland haddock and whiting (the most critical roundfish species) were slightly faster than those in the North Sea. This would imply that the benefit likely to result from a mesh increase in West of Scotland would be greater than for the North Sea.

New assessments have been made for cod, haddock and whiting for the West of Scotland area using yield per recruit calculations. F at age arrays were averaged for the years 1975-80 to represent the exploitation patterns for the mesh size prior to 1981 and amended exploitation patterns were calculated to represent the exploitation pattern corresponding to a 90 mm mesh size. These and other data used are given in Table 18.1 to 18.4. Selection factors are those determined for the North Sea as used in earlier assessments made by the Working Group (ICES, C.M.1974/F:36).

Results of the assessments are given in Tables 18.2-18.4. The differences in the yields per recruit for the two exploitation patterns indicate the long-term change to be expected from the introduction of a 90 mm mesh size. For cod, the effects are insignificant over the range of fishing mortalities studied. For haddock, there will be small long-term gains except at low levels of fishing mortality. At present levels of F, a gain of 1% would be expected. For whiting, long-term gains are produced at levels of fishing mortality greater than 60% of the present F. At present levels of F, a gain of about 2% would be expected.

These assessments are based on data for Division VIa only as no adequate data were available for Division VIb stocks. No account was taken of discards. Discarding is known to occur but no adequate data are yet available. As a consequence of omitting discards, long-term gains will tend to be underestimated.

19. EFFECTS OF AN INCREASE OF MINIMUM MESH SIZE TO 80 mm IN THE ENGLISH CHANNEL (DIVISIONS VIId,e)

The present minimum mesh size in Divisions VIId,e is 75 mm. The most recent mesh assessments for cod and whiting were made at the 1978 meeting of the Working Group (ICES, C.M.1978/G:7), and since then independent assessments have been made for whiting by French scientists (unpubl.). For both cod and whiting in Divisions VIId,e, the available data for mesh assessments are very poor. There is still some uncertainty about the levels of fishing mortality. It is not known with any certainty what are the actual mesh sizes in use. Nor is it known to what extent discarding takes place and no allowance can be made for this. Very few selection experiments have been carried out in the area.

The recent French whiting assessments used the Gulland method but were based on length compositions of French landings only, but the results were not inconsistent with the results obtained at the 1978 Working Group meeting. In both cases it was assumed that the mesh size in use by the French fleet was in the range 50-60 mm. For the change from this mesh size to 80 mm for whiting, immediate losses of about 45% were predicted for the French fleet and approximately 20% for the England and Wales fleet, for which a current mesh size of 70 mm was assumed. The long-term changes were estimated by the 1978 Working Group to be gains in the range 8-12%, but to be losses of 3-8% by the French scientists.

For cod, the only previous assessment is that made by the 1978 Working Group which indicated immediate losses of 0-3% and long-term gains of 0-4%.

In view of the quality of the data available, the present Working Group is unable to improve on the earlier assessments. However, as the present legal minimum mesh size is now 75 mm for any fleet using gear with that mesh size, a further change from that size to 80 mm to bring the English Channel into line with the North Sea would be expected to have a minimal effect in the long term.

20. SPECIES COMPOSITION OF BY-CATCHES IN THE NORTH SEA FISHERIES FOR *Pandalus borealis*

The only data on the subject available at the Working Group meeting were the results of research surveys by the Federal Republic of Germany carried out in 1965 using a chartered commercial fishing cutter of 22.1 m length with a 200 HP engine. Fishing took place on the Fladen Ground (416 hours) and in the Farne Deeps (431 hours). Trawls designed for *Pandalus* fishing were used. The results of these surveys were reported in ICES C.M.1966/M:2 and are summarised here. It is not known whether the research survey catch compositions are the same as those which would be taken in the commercial fisheries.

Tables 20.1 and 20.2 give the weights of the main species in the catches on the two grounds. Of the by-catch species, haddock was the most abundant on the Fladen Ground. In 1965 the extremely abundant 1962 year class of haddock was present in the stock as three year old fish and consequently haddock by-catches may have been greater than in an average year. In the Farne Deeps, whiting accounted for over 60% of the catch (by weight). It was noted that the whiting by-catch was reduced during dark nights when the fish migrated vertically away from the bottom. Age or length compositions of the by-catch species were not reported, but Table 20.3 shows the numbers for each species which were undersized in catches from the Fladen Ground (using the minimum landing sizes which were applicable in 1966).

In view of the limited amount of data, and in the absence of any data from actual commercial fisheries, the Working Group considers that it would be premature to make any recommendation on appropriate by-catch limits.

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Table 3.1 North Sea. COD. Numbers ('000) and weight (tonnes) in each category.

Year	Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight
1963	56 494	107 936	5 659	1 708	62 153	109 644
1964	51 729	115 435	6 571	1 857	58 300	117 292
1965	94 350	172 619	19 798	5 204	114 148	177 822
1966	115 025	211 937	22 578	6 010	137 602	217 947
1967	124 780	242 108	15 724	4 481	140 504	244 887
1968	146 040	277 062	6 371	2 150	152 411	279 212
1969	76 285	193 612	7 442	2 027	83 727	195 639
1970	124 516	218 763	63 759	11 002	188 274	229 765
1971	226 092	314 544	53 707	13 374	279 800	327 918
1972	243 479	341 051	21 573	8 831	265 052	349 882
1973	125 132	227 787	46 620	8 196	171 752	235 983
1974	102 365	202 269	4 588	950	106 953	203 219
1975	109 864	184 974	35 390	6 045	145 253	191 019
1976	128 537	209 914	8 201	2 050	136 737	211 964
1977	140 359	181 121	99 474	16 573	239 833	197 694
1978	212 731	260 890	100 787	27 874	313 517	288 764
1979	164 997	235 083	223 936	64 014	388 933	299 097
1980*	204 950	258 041	164 373	38 714	369 323	296 755

* Preliminary

Table 3.2 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	142 566	12 200	208 754	75 242	95 831	28 214	447 151	115 656
1961	982 785	11 100	189 764	74 862	375 598	113 652	1 548 147	199 614
1962	285 825	11 200	148 967	58 677	1 277 053	344 164	1 711 845	414 041
1963	255 844	13 700	180 624	68 364	427 549	124 189	864 017	206 253
1964	598 839	88 600	351 423	130 509	952 964	340 889	1 903 226	559 998
1965	1 092 757	74 600	369 998	161 613	256 110	121 256	1 718 865	357 469
1966	2 232 097	46 700	406 398	225 760	97 394	40 490	2 735 889	312 950
1967	699 516	20 700	272 201	147 391	624 196	190 103	1 595 913	348 194
1968	557 995	34 200	220 977	105 440	3 219 382	189 477	3 998 354	929 117
1969	1 889 660	338 353	909 208	330 897	843 594	294 769	3 642 462	964 019
1970	1 621 762	179 729	1 244 162	524 622	268 520	109 671	3 134 443	814 022
1971	913 516	31 546	473 067	235 358	448 626	152 521	1 835 209	419 425
1972	531 114	29 585	427 890	192 901	758 476	240 208	1 717 479	462 694
1973	170 411	11 267	449 107	178 610	280 278	97 222	899 796	287 099
1974	936 217	47 777	357 013	149 617	1 859 138	110 295	3 152 368	307 689
1975	734 411	41 380	362 239	146 616	1 392 274	213 057	2 488 924	401 053
1976	446 768	48 204	397 744	165 624	610 964	121 060	1 455 476	334 888
1977	350 522	34 993	319 992	137 372	239 493	47 588	910 007	219 953
1978	425 715	9 659	192 022	85 981	408 642	75 164	1 026 378	170 804
1979	1 099 865	17 414	190 414	83 249	273 872	39 972	1 564 151	140 635
1980*	768 668	25 154	213 217	96 271	444 474	76 669	1 426 359	190 094

* Preliminary

Table 3.3 North Sea. WHITING. Numbers ('000) and weight (tonnes) in each category.

Year	Industrial		Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1960	141 182	11 639	190 514	47 566	1 279 858	284 337	1 611 554	343 542
1961	271 886	16 177	289 707	67 828	2 440 874	511 407	3 002 467	595 412
1962	112 954	8 347	222 274	55 952	887 061	181 316	1 222 289	245 615
1963	499 846	45 431	214 478	58 205	2 100 144	424 640	2 814 469	528 276
1964	393 795	28 124	220 684	60 064	675 890	142 978	1 290 369	231 166
1965	182 172	22 259	313 057	85 978	958 285	195 272	1 453 514	303 509
1966	431 634	51 176	351 954	105 229	1 132 303	218 402	1 915 891	374 807
1967	280 276	22 840	245 395	68 215	899 471	179 479	1 425 141	270 534
1968	592 394	57 506	298 807	88 281	691 148	154 799	1 582 350	300 586
1969	1 980 444	152 364	203 642	57 149	1 199 725	228 616	3 383 810	438 129
1970	1 855 954	114 504	271 812	79 274	774 593	177 784	2 902 359	371 562
1971	1 477 350	71 699	185 689	58 005	453 796	103 703	2 116 835	233 407
1972	1 351 090	61 166	178 908	59 868	800 272	170 360	2 330 271	291 394
1973	1 273 006	89 614	234 405	66 479	936 169	208 647	2 443 580	364 740
1974	1 841 153	130 293	254 115	74 561	607 256	146 412	2 702 524	351 266
1975	1 019 586	86 376	251 759	78 722	589 072	125 491	1 860 416	290 589
1976	1 395 319	149 759	243 202	74 231	538 245	121 961	2 176 765	345 951
1977	1 657 166	106 104	267 023	74 374	599 989	114 157	2 524 178	294 635
1978	1 163 125	55 274	322 832	88 475	238 946	35 024	1 724 903	178 773
1979	887 889	59 021	351 613	99 321	636 630	76 605	1 876 132	239 947
1980*	644 159	45 747	291 432	86 422	369 834	56 537	1 305 425	188 706

* Preliminary

Table 6.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1971-80 (data for 1971-79 as officially reported to ICES).

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x]
Belgium	19 334	21 133	11 741	10 253	7 566	7 483	10 346	17 473	12 576	6 224
Denmark	68 179	72 520	47 950	54 207	46 344	53 277	42 582	41 858	48 509	53 848
Faroe Islands	123	284	803	416	732	448	260	56	113	-
France	24 769	24 038	13 247	7 275	8 667	8 079	7 511	11 944	12 559	10 713
German Dem.Rep.[a]	18	122	343	132	223	69	21	75	84	63
Germany,Fed.Rep.	46 647	49 431	21 410	17 089	16 457	24 445	22 663	37 040	20 411	26 173
Iceland	1	-	-	+	-	-	-	-	-	-
Ireland	-	-	-	-	-	98	136	174	1	-
Netherlands	46 614	47 634	25 758	24 029	23 263	21 835	29 903	48 817	34 752	42 662
Norway[b]	7 732	4 377	3 692	1 360	1 528	1 877	1 449	2 747	3 575	4 279
Poland	178	189	1 551	4 750	2 991	2 961	381	115	142	28
Spain	-	91	90	80	63	14	-	-	-	-
Sweden	3 060	2 887	2 534	2 071	900	597	36	...[d]	298	293
UK(Engl.&Wales)	55 525	62 503	47 327	39 857	33 615	46 475	35 424	59 127	54 923	49 948
UK(Scotland)	37 229	55 190	48 844	39 887	37 308	39 597	34 406	41 984	42 811	44 713
USSR	5 153	774	2 497	2 667	6 796	6 187	-	17	17	-
Total IV	314 562	341 173	227 787	204 073	186 453	213 442	185 118	261 427	230 771	238 944
Total IVa	61 368	74 768	62 878	65 188	58 343	68 352	55 623	43 357	41 118	
Total IVb	184 957	215 160	134 953	114 087	107 227	126 218	100 191	164 388	147 313	
Total IVc	68 237	51 245	29 956	24 798	20 883	18 872	29 304	53 682	42 340	
WG Total catch[c]	327 918	349 882	235 983	203 219	191 019	211 964	197 694	288 764	299 097	296 755

x) Provisional figures.
a) 1971-72 incl. IIIa.
b) Figures from Norway do not include cod caught in Rec. 2 fisheries.
c) Include discards.
d) Included in IIIa.

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

Year class	IYFS index[1]	VPA number x 10^{-6}	
		North Sea (IV)	West of Scotland (VIa)
1964	16.0	212	-
1965	20.2	257	-
1966	28.5	240	4.9
1967	5.4	97	6.4
1968	6.5	104	2.9
1969	73.8	469	5.2
1970	99.7	493	8.8
1971	4.1	84	4.4
1972	37.7	205	6.9
1973	14.6	135	8.3
1974	95.7	267	12.9
1975	8.8	117	7.3
1976	40.3	575	11.2
1977	14.4	300	10.2
1978	9.8	466	17.1
1979	26.3	752[2]	7.7[2]
1980	17.2	-	-

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

2) Estimated from commercial fishery cpue data.

Table 6.3 North Sea COD (Sub-area IV).
Input catch in numbers ('000) for VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	31792	35971	21861	9035	7400	113949	80551	7331	69507
2	52316	59860	69921	82680	24602	35169	165281	196498	31054
3	17061	29470	30908	40074	30305	17431	16012	47313	52670
4	8755	6674	11215	12093	13021	12319	6537	5460	13567
5	2277	3421	3211	3922	4365	6140	6473	2608	2058
6	910	1134	1910	1266	2786	1739	2046	3104	1095
7	625	458	902	732	572	977	876	1628	1043
8	283	360	350	302	410	202	442	603	471
9	48	123	179	170	146	199	224	380	69
10	72	60	35	108	40	106	72	110	58
11	2	60	3	20	69	28	64	7	75
12+	6	11	8	8	13	17	22	9	86
TOTAL	114147	137602	140503	152410	83729	188276	279800	265051	171753

	1974	1975	1976	1977	1978	1979	1980
1	18549	64717	11920	158475	62378	245198	226098
2	56147	49029	95602	49547	223475	112368	100881
3	10716	18252	17584	23082	14398	41450	29501
4	14869	4220	6608	4307	8469	3590	9648
5	4392	6484	1589	2190	2884	3061	1481
6	920	1732	2439	675	961	660	1033
7	417	377	770	926	371	342	584
8	373	149	98	307	364	113	160
9	518	180	49	223	131	127	68
10	75	80	49	20	32	34	45
11	149	43	15	8	17	3	17
12+	30	10	14	73	21	15	8
TOTAL	106955	145253	136737	239833	313501	406967	369524

Table 6.4 North Sea COD (Sub-area IV).
Mean weight (kg) at age in the catch.

	1965	1966	1967	1968	1969	1970	1971
1	0.400	0.398	0.388	0.470	0.309	0.377	0.386
2	0.933	0.958	0.949	0.961	0.869	0.930	0.894
3	2.283	2.393	2.222	2.243	2.151	2.049	2.198
4	4.512	4.181	4.261	4.154	3.877	4.053	4.268
5	7.274	6.979	6.451	5.445	5.755	6.210	6.552
6	9.496	9.467	9.073	8.169	6.763	8.063	8.681
7	11.904	11.616	11.244	8.425	9.359	10.110	10.417
8	12.040	11.828	11.687	10.312	9.814	10.263	11.256
9	12.989	13.826	12.858	11.108	10.499	12.080	12.915
10	14.428	14.632	13.485	12.752	12.768	12.789	13.176
11	12.640	15.025	15.818	12.125	11.534	14.663	15.743
12+	17.424	17.129	16.260	8.937	11.671	14.600	15.254

	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.386	0.302	0.504	0.373	0.373	0.306	0.369	0.302	0.316
2	0.800	0.853	1.032	0.871	1.000	0.905	0.744	0.836	0.947
3	2.084	1.909	2.213	2.310	2.372	2.091	1.919	2.369	1.930
4	3.960	3.758	4.152	4.162	4.328	4.412	4.150	4.475	4.477
5	6.045	5.521	6.242	6.282	6.372	6.639	6.425	6.678	6.223
6	8.241	7.403	8.341	8.434	8.560	8.750	8.615	8.657	9.082
7	9.771	8.979	9.878	9.801	10.078	9.980	9.578	10.672	9.609
8	10.214	9.771	10.762	10.320	11.017	10.897	10.787	11.460	11.715
9	11.869	11.087	12.226	11.933	12.690	12.018	12.153	13.017	12.567
10	12.508	12.273	12.413	12.671	13.912	12.830	12.560	13.849	14.051
11	14.284	12.846	13.629	13.641	14.452	13.814	13.830	15.849	16.152
12+	13.918	12.868	14.065	15.072	14.646	14.251	13.394	8.732	11.986

Table 6.5 North Sea COD (Sub-area IV).
Fishing mortalities from VPA (M = 0.2).

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.18	0.17	0.11	0.11	0.08	0.31	0.20	0.10	0.46
2	0.52	0.60	0.56	0.71	0.48	0.67	1.01	1.03	0.79
3	0.64	0.62	0.72	0.74	0.63	0.75	0.80	0.95	0.90
4	0.62	0.56	0.52	0.71	0.58	0.57	0.72	0.69	0.82
5	0.42	0.53	0.58	0.57	0.61	0.60	0.68	0.71	0.61
6	0.44	0.39	0.66	0.48	0.58	0.53	0.56	0.85	0.76
7	0.41	0.42	0.61	0.57	0.41	0.41	0.56	0.83	0.80
8	0.70	0.45	0.66	0.42	0.74	0.25	0.33	0.98	0.61
9	0.47	0.77	0.42	0.81	0.37	1.04	0.48	0.54	0.27
10	0.39	2.16	0.52	0.48	0.45	0.50	1.00	0.45	0.14
11	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
12+	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
F(3- 8),U	0.54	0.49	0.62	0.58	0.59	0.52	0.61	0.83	0.75

	1974	1975	1976	1977	1978	1979	1980	1975-1980
1	0.16	0.31	0.12	0.36	0.26	0.85	0.40	0.38
2	0.87	0.84	1.04	1.00	1.33	1.03	1.11	1.06
3	0.71	0.79	0.86	0.77	0.95	1.00	0.87	0.87
4	0.70	0.68	0.77	0.53	0.74	0.66	0.67	0.68
5	0.70	0.77	0.60	0.64	0.83	0.67	0.64	0.69
6	0.61	0.67	0.75	0.56	0.65	0.46	0.50	0.60
7	0.75	0.55	0.72	0.74	0.70	0.51	0.53	0.62
8	0.77	0.67	0.26	0.72	0.74	0.47	0.48	0.56
9	1.16	1.14	0.49	1.72	0.80	0.63	0.59	0.90
10	0.52	1.12	1.22	0.38	1.63	0.50	0.48	0.89
11	0.65	0.65	0.65	0.65	0.65	0.65	0.50	0.63
12+	0.65	0.65	0.65	0.65	0.65	0.65	0.50	0.63
F(3- 8),U	0.71	0.69	0.66	0.66	0.77	0.63	0.61	

Table 6.6 North Sea COD (Sub-area IV).
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	212367	257275	239829	96601	103846	468973	493545	83750	204717
2	141997	145237	178234	176642	70943	78346	281558	331390	61957
3	39448	69398	65566	83344	70808	36055	52726	83663	96769
4	20601	17047	30469	25928	32475	30881	13948	11985	26418
5	7243	9039	7985	14901	10431	14938	14260	5585	4936
6	2788	3888	4338	3663	6900	4636	6758	5893	2243
7	2025	1467	2165	1845	1864	3157	2239	3148	2060
8	613	1097	790	966	855	1013	1708	1049	1127
9	141	249	576	334	520	334	648	1001	323
10	246	72	94	311	122	295	97	330	479
11	5	137	7	46	158	64	146	16	171
12+	14	25	18	18	30	39	50	21	196
TOTAL	427488	504931	529868	404598	298952	638709	847463	527829	401396
Total Biomass	516771	615771	670775	654747	513666	630424	780782	659566	486233
Spawn.St.Biomass	299341	374238	408577	439592	419928	380759	338638	362127	371559

	1974	1975	1976	1977	1978	1979	1980	1981	1963-1977
1	135041	267290	116910	575004	299816	465949	751675	**********	235603
2	105301	93851	160677	84972	328475	189363	163053	412528	138956
3	23034	36208	33155	46637	25538	71330	55226	43995	52363
4	32341	9291	13389	11483	17596	8102	21561	18943	19968
5	9537	13200	3837	5068	5544	6849	3420	9033	8959
6	2200	3886	5025	1720	2191	1970	2873	1477	4074
7	859	979	1634	1936	804	935	1021	1427	1811
8	757	332	464	651	759	327	459	492	846
9	501	287	138	292	259	296	167	233	385
10	202	129	75	69	43	95	129	76	170
11	340	98	34	18	59	7	47	65	83
12+	69	23	32	167	48	34	22	35	47
TOTAL	510183	425573	335369	728017	681112	745258	999653		
Total Biomass	470742	439201	433669	483166	551948	586367	662563		
Spawn.St.Biomass	294011	257757	229384	230515	196951	287342	270623		

Table 6.7 North Sea COD.
Equilibrium yield ('000 tonnes) for average recruitment.

$F_{H.C.}/F_{H.C.*}$	F_{IND}/F_{IND*}	Human consumption landings	Discards	Industrial by-catch	SSB[a)]
0	1	0	0	-	5 704
.2	1	316	3.9	-	2 424
.3	1	325	5.5	-	1 653
.4	1	307	7.1	-	1 156
.5	1	282	8.5	-	828
.6	1	256	9.9	-	606
.7	1	232	11.0	-	452
.8	1	211	12.2	-	342
.9	1	192	13.2	-	263
1.0	1	177	14.3	-	205
1.5	1	127	18.4	-	68
2.0	1	102	21.4	-	26

a) Spawning stock biomass ('000 tonnes), age groups 3 and older.

$F_{H.C.*}$ = F for human consumption catch relative to that in the reference period 1975-80.

F_{IND*} = the equivalent for the industrial fishery.

Average recruitment at age 1 = 235.6×10^6 (year classes 1962-76).

Table 6.8 North Sea COD. Input data for catch predictions.

Age	Stock $\bar{W}$ (kg)	N x 10^{-3} H.C. landings 1980	Human consump. landings $\bar{W}$ (kg)	Human consump. landings F	N x 10^{-3} Discards 1980	H.C. disc. $\bar{W}$ (kg)	H.C. disc. F	Nx10^{-3} Industr. by-catch 1980	Ind. $\bar{W}$	Ind. F	Total F 1980	Reference F : $F_{\bar{x}}$ a)		
												H.C. catch F	Propor. not discarded	Industr. catch F
0														
1	.329	66 854	.549	.118	159 244	.231	.282				.40	.38	.32	
2	.619	95 752	.953	1.054	5 129	.376	.056				1.11	1.06	.88	
3	2.08	29 501	2.10	.87							.87	.88	.99	
4	4.36	9 648	4.36	.67							.67	.68	1	
5	6.44	1 481	6.44	.64							.64	.69	1	
6	8.79	1 033	8.79	.50							.50	.60	1	
7	9.95	384	9.95	.53							.53	.63	1	
8	11.30	160	11.30	.48							.48	.56	1	
9	12.60	68	12.60	.59							.59	.90	1	
10	13.50	45	13.50	.48							.48	.89	1	
11	14.50	17	14.50	.50							.50	.65	1	
12	16.0	7	16.0	.50							.50	.65	1	
Weight (tonnes)	-	258 041	-		38 714	-			-		-	-	-	-

Recruitment at age 1 (N x 10^{-3}): 1980: 751 675
1981: 235 600 b)
1982: 235 600 b)

Age at first maturity = 3

$\bar{F}_{\bar{x}}$ = 0.67

M = 0.2

a) Average 1975-80

b) Average for year classes 1962-76

Table 6.9 North Sea COD.
Results of catch predictions ('000 tonnes).
Option 1 (TAC of 190 000 tonnes in 1981 adhered to).

1980	Total biomass	: 625	
	SSB	: 276	
	Human consumption landings	: 258	(TAC_{80} = 200)
	Discards	: 39	
	Industrial by-catch	: 0	
	Total catch	: 297	
1981	$\bar{F}_{81}/\bar{F}_{*}$	: 0.43	($\bar{F}_{3-8}$ = 0.29)
	Total biomass	: 603	
	SSB	: 270	
	Human consumption landings	: 190	
	Discards	: 11	
	Industrial by-catch	: 0	
	Total catch	: 201	
1982	Total biomass	: 878	
	SSB	: 699	

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	Discards	Industrial by-catch	Total catch	SSB 1983
0	0	0	-	0	1 320
.2	54.8	1.7	-	56.5	1 224
.5	130.0	4.0	-	134.0	1 093
1.0	238.8	7.6	-	246.4	905
1.5	330.0	10.8	-	340.8	750
2.0	406.6	13.6	-	420.2	623

SSB = spawning stock biomass (age groups ≥ 3) at the beginning of the year.

Table 6.10 North Sea COD.
Results of catch predictions ('000 tonnes).
Option 2 (F in 1981 equal to that in the reference period 1975-80).

1980	Total biomass	: 625	
	SSB	: 276	
	Human consumption landings	: 258	(TAC_{80} = 200)
	Discards	: 39	
	Industrial by-catch	: -	
	Total catch	: 297	
1981	$\bar{F}_{81}/\bar{F}_{*}$	: 1.00	($\bar{F}_{*}$ = 0.67)
	Total biomass	: 603	
	SSB	: 270	
	Human consumption landings	: 350	
	Discards	: 22	
	Industrial by-catch	: -	
	Total catch	: 372	
1982	Total biomass	: 569	
	SSB	: 410	

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	Discards	Industrial by-catch	Total catch	SSB 1983
0	0	0	-	0	824
.2	76.5	3.5	-	80.0	691
.5	170.2	8.1	-	178.2	532
1.0	283.6	14.3	-	297.9	344
1.5	360.2	19.1	-	379.3	224
2.0	412.4	23.0	-	435.4	147

SSB = spawning stock biomass at the beginning of the year.

Table 7.1 Nominal catch (in tonnes) of COD in Division VIa, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x)]
Belgium	41	39	75	174	49	71	-	-	4	22
Denmark	-	-	-	-	7	-	-	-	-	27
Faroe Islands	-	-	7	13	3	39	43	-	40	-
France	1 054	2 360	3 445	3 678	3 546	5 611	3 583	4 499	4 590	5 523
German Dem.Rep.	-	-	-	-	2	-	-	-	-	-
Germany,Fed.Rep.of	46	3	15	6	12	1	3	31	40	4
Iceland	+	-	-	-	-	-	-	-	-	-
Ireland	888	686	583	883	1 141	1 341	984	1 214	2 237	2 315
Netherlands	10	21	4	5	5	11	5	3	20	-
Norway	-	-	13	14	17	22	29	40	32	30
Poland	154	491	184	175	68	18	-	-	-	-
Spain	-	102	208	137	180	15	20[a)]	108[a)]	-	-
UK(England+Wales)	2 414	3 371	2 074	2 467	2 217	2 742	2 434	2 082	2 348	2 302
UK(Scotland)	5 732	7 018	5 645	6 084	5 806	7 475	5 513	5 539	6 929	7 569
UK (N.Ireland)	2	2	3	3	3	13	5	5	2	2
USSR	325	606	7	13	107	46	-	-	-	-
Total VIa	10 666	14 699	12 263	13 652	13 163	17 405	12 619	13 521	16 078	17 794
WG total catch[b)]								14 247	16 242	17 791

x) Provisional

a) Includes VIb

b) Includes discards

Table 7.2 COD in Division VIa.
Input catch in numbers ('000) for VPA.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	101	222	84	92	335	220	153	727	1260
2	1004	859	980	272	884	2264	504	1841	2043
3	1427	1862	970	944	523	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	161	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
1	1988	1179	680	846	1094
2	4753	1183	1792	1500	3127
3	1362	1497	1035	2150	2003
4	585	590	728	666	797
5	255	245	289	340	190
6	185	81	96	140	78
7	58	49	49	34	29
8+	18	13	30	38	10
TOTAL	9204	4837	4699	5714	7328

Table 7.3 COD in Division VIa.
Mean weight (kg) at age in the catch.

	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
1	0.606	0.606	0.606	0.721	0.661
2	1.372	1.372	1.372	1.412	1.427
3	2.988	2.988	2.988	2.858	2.887
4	5.052	5.052	5.052	4.902	5.397
5	6.573	6.573	6.573	6.689	7.647
6	7.966	7.966	7.966	7.824	8.872
7	8.807	8.807	8.807	9.150	9.723
8+	9.664	9.664	9.664	10.039	10.364

Table 7.4 COD in Division VIa.
Fishing mortalities from VPA (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	0.11
2	0.16	0.28	0.24	0.14	0.26	0.45	0.18	0.46	0.45
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	1975-1980
1	0.35	0.12	0.08	0.06	0.17	0.15
2	0.79	0.37	0.28	0.24	0.30	0.41
3	0.62	0.63	0.64	0.62	0.58	0.62
4	0.71	0.61	0.73	1.21	0.50	0.73
5	0.71	0.75	0.70	0.96	1.70	0.89
6	0.94	0.52	0.77	0.90	0.60	0.68
7	0.70	0.70	0.70	0.70	0.47	0.66
8+	0.70	0.70	0.70	0.70	0.47	0.66
F(3- 4),U	0.67	0.62	0.69	0.92	0.54	

Table 7.5 COD in Division VIa.
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	4861	6356	2855	5226	8762	4368	6899	8323	12930
2	7638	3889	5004	2261	4196	6871	3378	5511	6159
3	4893	5349	2412	3210	1606	2640	3596	2311	2861
4	568	2725	2711	1107	1781	846	1206	1805	1218
5	587	338	1075	868	497	823	263	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	48	41
TOTAL	18924	19208	14529	13134	17460	16017	15848	18721	24150
Total Biomass	37850	45739	40677	31022	33306	33685	31660	34218	37930
Sp.Stock Biomass	24424	36551	32082	24752	22239	21610	22845	21614	21645

	1976	1977	1978	1979	1980	1981	1967-1977
1	7319	11243	10182	17111	7699	**********	7195
2	9450	4207	8142	7723	13245	5318	5324
3	3211	3499	2383	5055	4974	8034	3235
4	1254	1411	1526	1026	2216	2280	1512
5	545	505	627	600	250	1101	611
6	331	218	195	256	189	37	266
7	126	106	106	74	85	85	109
8+	39	28	65	82	29	58	64
TOTAL	22274	21218	23227	31926	28687		
Total Biomass	41029	36431	39409	50230	55022		
Spawn.St. Biomass	23628	23845	22067	26988	31032		

Table 7.6 COD in Division VIa.
Input data for catch predictions.

Age	N x 10^{-3} landings 1980	Landings[c] $\bar{W}$ (kg)	F 1980	Reference[a] F_*
1	1 094	.663	.17	.15
2	3 127	1.40	.30	.41
3	2 003	2.91	.58	.62
4	797	5.12	.50	.73
5	190	6.97	1.70	.90
6	78	8.22	.60	.68
7	29	9.23	.47	.70
8+	10	10.00	.47	.70
Weight landed (tonnes)	17 791	-	-	-

Year class strengths (N x 10^{-3}) at age 1: 1980: 7 700
1981: 7 200[b]
1982: 7 200[b]

Age at first maturity = 3

$\bar{F}_*$ = 0.68

M = 0.2

a) Average 1975-80.

b) Average recruitment for year classes 1966-76.

c) Average values for the period 1978-80.

Table 7.7 COD in Division VIa.
Results of catch predictions ('000 tonnes).
Option 1 (TAC of 9 500 tonnes in 1981 adhered to.
Exploitation pattern as in the reference period 1975-80).

1980	Total biomass	:	53.8
	SSB	:	30.2
	Human consumption landings	:	17.8
1981	$\bar{F}_{81}/\bar{F}_{*}$	:	0.34 ($\bar{F}_{3-4}$= 0.23)(TAC_{81}= 9.5)
	Total biomass	:	56.8
	SSB	:	44.2
	Human consumption landings	:	9.5
1982	Total biomass	:	68.3
	SSB	:	54.8

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	SSB 1983
0	0	75.7
.2	2.6	72.4
.5	6.4	67.8
1.0	12.1	60.7
1.5	17.2	54.3
2.0	21.7	48.7

SSB = spawning stock biomass (age group ≥ 3) at the beginning of the year.

Table 7.8 Cod in Division VIa.
Results of catch predictions ('000 tonnes).
Option 2 (F in 1981 equal to that in the reference period 1975-80. Exploitation pattern as in the reference period 1975-80).

1980	Total Biomass	:	53.8
	SSB	:	30.2
	Human consumption landings	:	17.8
1981	$\bar{F}_{81}/\bar{F}_{*}$	:	1.0 ($\bar{F}_{*}$ = 0.68)
	Total biomass	:	56.8
	SSB	:	44.2
	Human consumption landings	:	23.3
1982	Total biomass	:	49.0
	SSB	:	36.3

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	SSB 1983
0	0	54.2
.2	5.2	47.6
.5	11.7	39.4
1.0	20.2	28.8
1.5	26.3	21.1
2.0	30.8	15.6

SSB = spawning stock biomass at the beginning of the year.

Table 8.1 Nominal catch (in tonnes) of COD in Division VIb, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 x)
Belgium	-	-	-	-	1	-	-	-	-	-
Faroe Islands	-	-	-	5	3	22	40	10	92	75
France	-	1 659	320	1 128	4	4	3	1	2	-
Germany,Fed.Rep.of	-	-	-	-	-	-	-	-	111	135
Ireland	-	-	-	-	-	-	-	3	-	-
Norway	-	-	-	3	-	8	3	69	138	75
Poland	-	-	8	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	... a)	... a)	-	-
UK(England+Wales)	37	32	1	-	28	77	89	285	129	1
UK(Scotland)	57	175	128	39	98	61	33	384	198	370
USSR	-	701	26	-	110	1 398	-	-	-	-
Total VIb	94	2 567	483	1 175	243	1 571	168	752	528	656

x) Provisional

a) Included in VIa

Table 9.1 Nominal catch (in tonnes) of COD in Divisions VIId and VIIe, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x]
Belgium	213	124	93	67	59	65	53	435	699	-
Denmark	-	-	-	-	2 718	1 506	1 120	2 160	2 052	655[a]
France	4 544	2 658	1 425	3 099	2 143	1 646	5 185	8 044	4 848	3 798
Germany,Fed. Rep.of	+	-	-	-	-	-	-	-	-	-
Netherlands	13	30	2	4	+	2	1	+	-	-
Poland	-	7	13	6	-	-	-	-	-	-
UK(England+Wales)	662	717	499	260	159	142	581	654	485	363
UK(Scotland)	-	-	-	-	-	-	-	-	+	-
USSR	-	8	45	-	3	4	-	-	-	-
Total VIId,e	5 432	3 544	2 077	3 436	5 082	3 365	6 940	11 293	8 084	4 816

x) Provisional

a) Includes VIIb,c

Table 9.2 Nominal catch (in tonnes) of COD in Divisions VIIb,c and VIIg-k, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x]
Belgium	295	77	323	167	116	159	85	52	51	-
Denmark	-	-	-	-	-	-	-	-	18	...[b]
Faroe Islands	-	-	256	-	-	-	-	-	-	-
France	5 570	4 168	2 791	2 302	2 877	3 196	1 972	2 192	2 918	-
Germany,Fed. Rep.of	2	-	1	-	-	-	-	3[a]	-	7
Ireland	347	352	568	283	474	506	315	323	552	-
Netherlands	81	22	14	9	54	46	291	279	-	-
Norway	-	-	-	-	1	-	+	-	-	-
Poland	33	130	75	39	19	40	6	-	2	-
Spain	-	137	301	232	588	1 140	51	11	-	-
UK(England+Wales)	13	56	60	26	73	44	33	28	33	82
UK(Scotland)	-	-	-	-	-	-	-	2	1	12
USSR	24	139	10	72	134	203	-	-	-	-
Total VIIb,c, g-k	6 365	5 081	4 399	3 130	4 336	5 234	2 753	2 890	3 575	101

x) Provisional

a) Catch in VIIg only

b) Included in VIIe

Table 10.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1981-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x]
Belgium	971	1 601	2 385	1 137	2 209	2 166	2 293	1 295	732	70
Denmark	31 043	34 858	13 118	44 342	32 930	46 899	20 069	8 093	8 248	12 250
Faroe Islands	-	5	1 198	435	267	183	385	12	7	-
France	8 738	7 814	4 695	4 020	4 646	5 500	6 914	5 122	7 208	6 758
German Dem.Rep.[a]	3	90	22	8	44	20	8	37	12	36
Germany,Fed.Rep.of	3 045	4 020	4 587	3 478	2 396	3 433	3 744	2 589	2 549	2 387
Iceland	1	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	31	53	101	-	-
Netherlands	6 914	5 188	3 185	3 035	1 901	1 728	1 598	857	955	1 508
Norway[b]	1 063	1 146	454	324	331	367	374	609	968	1 103
Poland	-	38	2 553	3 001	1 485	1 155	485	62	106	59
Spain	-	-	101	210	-	-	-	-	-	-
Sweden[c]	5 857	5 305	4 550	3 098	2 083	2 455	113	-	907	1 165
UK(England+Wales)	16 648	20 827	16 586	10 798	11 499	17 238	17 167	12 200	10 774	12 195
UK(Scotland)	121 539	96 197	88 132	71 679	64 686	80 576	89 465	58 406	54 119	63 727
USSR	62 398	36 467	49 356	42 234	49 686	42 852	8 010	54	18	-
Total IV	258 220	213 556	190 922	187 799	174 163	204 603	150 678	89 599	86 603	101 258
Total IVa	197 306	135 095	126 662	122 977	110 848	138 591	116 577	57 886	51 741	
Total IVb	58 270	75 325	62 288	63 695	62 761	65 594	34 030	31 457	34 361	
Total IVc	2 644	3 136	1 972	1 127	554	418	71	94	501	
WG total catch[d]	419 425	462 694	287 099	307 689	401 053	334 888	219 953	170 804	140 635	198 094

x) Provisional
a) 1971-72 includes IIIa
b) Figures from Norway do not include haddock caught in Rec.2 fisheries
c) 1971-74 includes IIIa
d) Includes discards

Table 10.2 North Sea HADDOCK.
Estimates of recruitment at age 1.

Year class	IYFS index[1)]	VPA numbers x 10^{-6}	
		IV	VIa
1964		325	3
1965	12	801	16
1966	62	2 153	40
1967	5 855	12 517	696
1968	81	453	14
1969	27	333	7
1970	873	2 211	83
1971	740	2 278	37
1972	187	517	18
1973	1 072	3 689	62
1974	1 168	3 791	181
1975	177	370	6
1976	162	568	11
1977	385	967	45
1978	480	1 493	118
1979	896 →	2 800 →	100
1980	260 →	800 →	24

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

Table 10.3 North Sea HADDOCK (Sub-area IV).
Input catch in numbers ('000) for VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	644464	1659073	299005	11066	70826	872881	323084	235453	41089
1	263857	639524	1059053	3612334	15319	173168	1013783	820721	197424
2	11118	15557	50650	306478	3255694	227927	45517	443587	395013
3	754764	5478	4903	17979	270963	1796108	47513	38610	217572
4	37376	404418	3559	1974	7393	55706	392553	20372	6090
5	4638	9920	175795	2503	2395	1164	10223	154573	4365
6	1960	1043	2427	45635	2508	1188	456	3503	38711
7	450	601	214	324	19134	258	192	187	1237
8	107	163	216	41	199	5943	146	33	105
9	90	89	57	14	23	71	1577	27	29
10+	40	25	33	5	7	30	167	412	161
TOTAL	1718864	2735891	1595912	3998353	3642461	3134444	1835211	1717478	899796

	1974	1975	1976	1977	1978	1979	1980
0	576696	44728	165770	107312	289636	950679	388025
1	2105535	1487848	138859	252457	448155	341001	641636
2	103793	717537	895525	107539	139219	192215	303058
3	300590	79252	209408	391774	28299	41146	68076
4	51726	138440	9609	39531	108810	8395	12588
5	1828	16608	30527	3952	8581	25834	4528
6	1316	953	4786	6000	1181	3927	7528
7	10583	599	187	1136	1911	342	690
8	237	2625	67	115	386	427	161
9	22	255	682	24	112	124	133
10+	40	79	55	166	88	61	104
TOTAL	3152366	2488924	1455475	910006	1026378	1564151	1426327

Table 10.4 North Sea HADDOCK (Sub-area IV).
Mean weight (kg) at age in the catch.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.023	0.035
1	0.047	0.084	0.192	0.214	0.041	0.043	0.164	0.221	0.143
2	0.235	0.303	0.401	0.341	0.250	0.267	0.305	0.338	0.332
3	0.403	0.396	0.516	0.570	0.433	0.381	0.401	0.423	0.416
4	0.669	0.552	0.621	0.751	0.829	0.759	0.522	0.524	0.610
5	0.845	0.951	0.642	0.861	0.895	0.879	0.890	0.608	0.651
6	1.194	1.267	1.060	0.839	1.034	1.194	1.271	1.002	0.726
7	1.173	1.524	1.501	1.606	1.094	1.360	1.535	1.361	1.044
8	1.482	1.943	1.935	2.258	2.047	1.437	1.350	2.246	1.302
9	1.706	1.729	2.071	2.689	3.037	2.535	1.274	2.006	2.784
10+	2.244	2.963	2.348	2.067	3.284	3.961	1.967	1.654	1.726

	1974	1975	1976	1977	1978	1979	1980
0	0.022	0.020	0.012	0.015	0.009	0.009	0.012
1	0.290	0.092	0.121	0.108	0.142	0.093	0.085
2	0.278	0.233	0.228	0.238	0.251	0.290	0.281
3	0.377	0.318	0.399	0.340	0.416	0.439	0.467
4	0.570	0.403	0.509	0.597	0.445	0.625	0.719
5	0.892	0.651	0.580	0.609	0.695	0.659	0.871
6	0.896	1.245	0.893	0.753	0.710	0.712	0.947
7	0.953	1.124	1.876	1.096	0.924	1.072	1.398
8	1.512	1.093	1.746	1.708	1.301	1.163	1.759
9	2.301	1.724	1.235	1.973	1.814	1.359	1.724
10+	2.507	2.219	2.330	1.604	1.913	2.130	2.054

Table 10.5 North Sea HADDOCK (Sub-area IV).
Fishing mortalities from VPA (M = 0.2).

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.54	0.52	0.02	0.02	0.18	0.50	0.12	0.34	0.01
1	2.02	1.93	0.77	0.38	0.04	0.83	0.69	0.50	0.54
2	0.39	0.66	0.86	0.55	0.71	1.18	0.54	0.76	0.48
3	0.61	0.34	0.44	0.90	1.35	1.16	0.85	1.35	1.15
4	1.16	0.79	0.38	0.32	1.29	1.26	0.89	1.21	0.81
5	1.29	1.22	1.00	0.51	0.81	0.71	0.85	1.16	0.96
6	1.02	1.27	1.26	0.79	1.60	1.39	0.68	0.81	1.10
7	0.80	1.09	1.03	0.54	0.96	0.70	0.92	0.68	0.78
8	0.40	0.78	1.98	0.55	0.77	0.94	1.17	0.39	1.08
9	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
10+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
F(2- 6),U	0.89	0.85	0.79	0.61	1.15	1.14	0.76	1.06	0.90

	1974	1975	1976	1977	1978	1979	1980	1975-1980
0	0.13	0.10	0.23	0.10	0.16	0.27	0.33	0.20
1	0.97	0.56	0.53	0.66	0.70	0.29	0.29	0.51
2	0.62	1.13	0.80	1.05	1.00	0.77	0.45	0.87
3	0.83	1.54	1.30	1.05	0.92	0.96	0.69	1.09
4	0.98	1.29	0.79	1.12	1.00	0.80	0.90	0.98
5	0.62	1.06	1.24	0.92	0.80	0.70	1.60	1.05
6	0.89	0.78	1.09	0.89	0.81	1.15	0.45	0.86
7	1.10	1.58	0.33	0.86	0.82	0.58	0.63	0.80
8	0.33	0.95	0.77	0.35	0.82	0.43	0.60	0.65
9	0.70	0.70	0.70	0.70	0.70	0.70	0.23	0.62
10+	0.70	0.70	0.70	0.70	0.70	0.70	0.23	0.62
F(2- 6),U	0.79	1.10	1.06	1.01	0.91	0.88	0.82	

Table 10.6 North Sea HADDOCK (Sub-area IV).
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	1683484	4444127	15617932	505084	484879	3659227	3150038	889287	4551094
1	325286	801332	2152813	12516882	452659	533190	2211378	2287762	516596
2	37872	35317	95444	817900	7005399	356777	118487	905127	1137763
3	1812912	21028	15013	55029	395193	2830379	90102	56260	345342
4	59038	809256	12295	7895	11037	84036	725154	31446	11932
5	6928	15201	301912	0872	4690	2495	19496	244212	7699
6	3323	1569	3660	90948	3384	1705	1003	6854	62909
7	891	979	361	849	33769	562	347	414	2489
8	353	328	268	106	405	10631	230	113	172
9	195	193	123	30	50	154	3417	58	63
10+	87	54	71	11	15	65	362	893	349
TOTAL	3930368	6129384	18199893	14039604	8391479	7279221	6319992	4422426	0630409
Total Biomass	823040	596559	822366	3071850	2000695	1309253	869484	1030017	816124
Spawn.St.Biomass	790917	484805	252846	387587	1977287	1258334	475318	503968	582962

	1974	1975	1976	1977	1978	1979	1980	1981	1960-1977
0	5265615	501736	876114	1299099	2142386	4462622	1530617	**********	3050165
1	3689010	3791276	570452	508133	900827	1493100	2798703	904539	2159436
2	246197	1148133	1772375	178954	239573	391405	915884	1714559	1065224
3	579284	108757	503623	652664	51025	72411	148993	478133	429826
4	89820	206426	19179	63522	186462	16596	22696	61185	124100
5	4340	27555	46523	7134	10943	55965	0103	7555	43021
6	2422	1919	7814	11059	2324	6221	22751	1009	12860
7	17156	811	721	2150	3713	850	1012	11877	4039
8	955	4656	137	425	748	1337	390	703	1246
9	48	552	1478	52	243	269	711	175	422
10+	87	171	119	360	191	132	556	825	160
TOTAL	9894914	5791993	3398535	2785550	3610434	6500907	5449015		
Total Biomass	1547819	771782	628002	399694	339540	379113	630134		
Spawn.St. Biomass	362162	412950	572664	318849	182969	200091	375430		

Table 10.7 North Sea HADDOCK.
Equilibrium yield ('000 tonnes) for average recruitment. (Exploitation pattern as in the reference period 1975-80.)

$F_{H.C.}/F_{H.C.*}$	F_{IND}/F_{IND*}	Human consumption landings	Discards	Industrial by-catch	SSB[a)]
0	1	0	0	59	2 442
.2	1	149	28	45	1 265
.3	1	163	40	40	975
.4	1	164	49	36	782
.5	1	159	58	32	648
.6	1	152	66	30	553
.7	1	144	72	27	482
.8	1	137	78	25	427
.9	1	130	84	24	384
1.0	1	123	88	22	349
1.5	1	98	107	17	240
2.0	1	81	119	14	183

a) Spawning stock biomass ('000 tonnes), age groups 2 and older.

$F_{H.C.*}$ = F for human consumption catch relative to that in the reference period 1975-80.

F_{IND*} = the equivalent for the industrial fishery.

Average recruitment at age 0 = 2036×10^{-6} (year classes 1960-77, excluding 1962 and 1967).

Table 10.8 North Sea HADDOCK. Input data for catch predictions.

Age	Stock $\bar{W}$ (kg)[c]	N x 10^{-3} H.C.landings 1980	H.C. landings $\bar{W}$ (kg)	H.C. landings F	N x 10^{-3} Discards 1980	H.C. disc. $\bar{W}$ (kg)	H.C. disc. F	N x 10^{-3} Industr. by-catch 1980	Ind. $\bar{W}$(kg)	Ind. F	Total F 1980	Reference F : $F_{\bar{m}}$[a]		
												H.C. catch F	Propor. not discarded	Industr. catch F
0	.010	0	0	0	475	.046	.000	387 550	.01	.362	.362	.002	0	.20
1	.107	7 064	.273	0	285 292	.146	.129	349 280	.024	.158	.290	.280	.036	.22
2	.274	124 370	.358	.18	156 576	.217	.232	22 112	.17	.033	.450	.740	.392	.13
3	.441	57 708	.473	.59	2 099	.249	.021	8 269	.272	.084	.690	.990	.748	.10
4	.596	11 012	.610	.80	32	.269	.002	1 344	.47	.098	.900	.940	.904	.04
5	.742	4 469	.745	1.58		.280		59	.567	.021	1.600	1.020	.980	.04
6	.790	7 504	.804	.45		.290		24	.643	.001	.450	.850	.988	.01
7	1.130	690	1.130	.63					.7		.630	.800	1	0
8	1.410	161	1.410	.60							.600	.650	1	0
9	1.630	133	1.630	.23							.230	.620	1	0
10	2.00	104	2.00	.23							.230	.620	1	0
11														
12														
Weight (tonnes)	-	96 271	-			-			-		-	-	-	-

Recruitment at age 0 (N x 10^{-3}): 1980: 1 403 342[b]
1981: 2 036 000[b]
1982: 2 036 000[b]

Age at first maturity = 2

$\bar{F}_{\bar{m}}$ = 0.91 (human consumption fishery only)

M = 0.2

a) Average 1975-80.

b) Average for year classes 1960-77, excluding 1962 and 1967.

c) Average for 1978-80.

Table 10.9 North Sea HADDOCK. Results of catch predictions ('000 tonnes) (assumes exploitation pattern in 1981 and 1982 = average exploitation pattern for the reference period 1975-80).

1980 Total biomass: 671 SSB: 357 H.C. landings: 96 Discards: 77 Industrial by-catch: 25 Total catch: 198

1981	TAC = 120 000	TAC = 240 000	$\bar{F}_{81} = \bar{F}_{75-80}$ = > landings = 273 000
$\bar{F}_{81}/\bar{F}_{\infty}$	.23	.79	1.0
$\bar{F}_{81}$ H.C. fishery only	.21	.72	.91
Total biomass	847	847	847
SSB	741	741	741
H.C. landings	72	200	235
Discards	42	120	143
Industrial by-catch	48	40	38
Total catch	162	360	416
1982			
Total biomass	973	709	635
SSB	806	542	469

	1982															
$\bar{F}_{82}/\bar{F}_{81}$	H.C.L.	Disc.	Ind.B.C.	T.C.	SSB 1983	$\bar{F}_{82}/\bar{F}_{81}$	H.C.L.	Disc.	Ind.B.C.	T.C.	SSB 1983	$\bar{F}_{82}/\bar{F}_{81}$	H.C.L.	Disc.	Ind.B.C.	T.C.	SSB 1983
0.0	0	0	48	48	1065	0.0	0	0	36	36	801	0.0	0	0	33	33	728
0.2	24	7	48	78	1028	0.2	51	18	35	103	716	0.2	54	21	31	106	634
0.5	58	16	46	121	974	0.5	114	42	32	189	607	0.5	119	48	28	195	520
1.0	110	32	45	186	891	1.0	195	75	28	299	467	1.0	196	85	25	305	380
1.5	157	46	43	246	817	1.5	253	102	26	381	365	1.5	246	113	22	381	286
2.0	200	59	41	300	750	2.0	294	124	23	441	290	2.0	279	136	19	434	220

SSB = spawning stock biomass (age groups 2 and older) at the beginning of the year.

Table 11.1 Nominal catch (in tonnes) of HADDOCK in Division VIa, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x]
Belgium	9	44	45	98	23	45	-	-	2	-
Denmark	-	-	-	-	-	13	-	-	37	-
Faroe Islands	-	-	2	1	-	-	-	-	2	-
France	2 354	5 014	5 141	3 979	2 328	3 026	3 401	4 255	4 786	2 861
German Dem.Rep.	10	87	-	-	9	-	-	-	-	-
Germany.Fed.Rep.	15	7	15	18	3	30	+	20	2	3
Iceland	+	-	-	-	-	-	-	-	-	-
Ireland	4 316	3 982	2 631	1 715	599	1 115	616	441	877	490
Netherlands	78	205	169	63	19	30	28	13	2	-
Norway	-	-	-	-	-	3	7	13	9	-
Poland	10	-	402	97	20	-	-	-	-	-
Spain	-	101	497	540	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK(Engl.&Wales)	1 491	2 393	2 187	1 512	1 214	1 971	3 827	2 805	1 654	1 279
UK(Scotland)	33 087	27 730	17 631	9 583	8 973	11 992	11 422	9 629	7 459	8 185
UK(N.Ireland)	2	1	-	-	-	-	-	-	-	+
USSR	4 927	1 480	110	364	495	533	-	-	-	-
Total VIa	46 299	41 044	28 830	17 970	13 683	18 758	19 301	17 176	14 830	12 818
WG total catch									13 965	12 783

x) Provisional

Table 11.2 HADDOCK in Division VIa.
Input catch in numbers('000) for VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	34	60	585	5664	2	169	1957	577	1314
2	464	174	6057	12437	48796	171	1230	26839	5535
3	60970	1082	771	2570	7895	78450	2925	2234	15952
4	6754	40916	1227	354	1233	2749	91769	2316	255
5	295	1926	24336	680	250	174	659	53933	1098
6	275	64	396	14064	357	87	131	505	35106
7	174	31	9	727	4375	143	7	51	223
8+	23	57	17	51	186	598	226	88	164
TOTAL	68989	50310	33398	34547	63092	82541	98884	86543	57647

	1974	1975	1976	1977	1978	1979	1980
1	1867	4908	617	450	983	2142	2513
2	3566	11081	22615	1316	1036	10381	12748
3	9032	2867	13207	29467	822	1826	5351
4	5270	3485	1671	5647	24053	430	918
5	92	1852	1600	680	3008	9573	142
6	484	100	828	496	353	848	3107
7	11788	99	21	306	251	112	230
8+	199	3367	908	304	441	145	56
TOTAL	32298	27759	41467	38666	30947	25457	25065

Table 11.3 HADDOCK in Division VIa.
Mean weight (kg) at age in the catch.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.273	0.313	0.284	0.259	0.199	0.348	0.296	0.286	0.260
2	0.295	0.324	0.373	0.368	0.314	0.261	0.333	0.324	0.330
3	0.440	0.563	0.636	0.627	0.576	0.389	0.363	0.346	0.409
4	0.695	0.575	0.481	0.827	0.919	0.817	0.469	0.532	0.600
5	0.916	1.041	0.669	0.731	1.028	1.284	1.052	0.546	0.498
6	1.041	1.125	1.177	0.811	1.024	1.261	1.320	0.984	0.572
7	1.249	1.322	1.849	1.451	0.997	1.043	1.595	1.502	1.210
8+	1.517	1.523	1.612	1.901	1.572	1.343	1.452	1.565	1.637

	1974	1975	1976	1977	1978	1979	1980
1	0.269	0.277	0.294	0.306	0.245	0.268	0.251
2	0.331	0.363	0.338	0.369	0.352	0.366	0.373
3	0.397	0.462	0.502	0.437	0.415	0.465	0.589
4	0.572	0.583	0.593	0.689	0.521	0.696	0.723
5	0.776	0.786	0.829	0.799	0.831	0.753	1.000
6	0.686	1.010	1.054	1.127	1.054	1.021	0.989
7	0.767	0.962	1.536	1.337	1.142	1.435	1.146
8+	1.144	0.947	1.097	1.117	1.206	1.383	1.584

Table 11.4 HADDOCK in Division VIa.
Fishing mortalities from VPA (M = 0.2).

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.01	0.00	0.02	0.01	0.00	0.03	0.03	0.02	0.08
2	0.08	0.08	0.71	0.54	0.10	0.02	0.30	0.58	0.23
3	0.37	0.25	0.58	0.77	0.82	0.23	0.41	1.40	0.84
4	0.79	0.53	0.50	0.58	1.12	0.77	0.46	0.67	0.56
5	1.34	0.55	0.59	0.58	1.09	0.45	0.42	0.54	0.81
6	1.53	1.36	0.20	0.84	0.71	1.80	0.72	0.66	0.77
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(2- 4),U	0.41	0.29	0.60	0.63	0.68	0.54	0.39	0.88	0.55

	1974	1975	1976	1977	1978	1979	1980	1975-1980
1	0.03	0.03	0.13	0.05	0.02	0.02	0.028	0.05
2	0.34	0.29	0.19	0.45	0.15	0.38	0.16	0.27
3	0.71	0.51	0.65	0.40	0.57	0.41	0.34	0.48
4	0.76	0.68	0.65	0.66	0.68	0.66	0.37	0.62
5	0.41	0.68	0.78	0.60	0.93	0.64	0.48	0.68
6	1.10	1.08	0.75	0.60	0.74	0.75	0.44	0.73
7	0.70	0.70	0.70	0.70	0.70	0.55	0.47	0.64
8+	0.70	0.70	0.70	0.70	0.70	0.55	0.47	0.64
F(2- 4),U	0.61	0.49	0.50	0.50	0.46	0.48	0.29	

Table 11.5 HADDOCK in Division VIa.
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3141	15924	40245	695517	14418	6609	83473	36846	17889
2	7029	2541	12984	32421	566132	11803	5259	66592	29646
3	218170	5336	1923	5222	15410	419503	9509	3200	30507
4	13447	123879	3396	885	1983	5580	272864	5161	647
5	432	4987	59416	1681	408	530	2116	141132	2156
6	378	93	2359	26876	768	112	278	1141	67263
7	377	67	19	1575	9474	310	15	110	483
8+	50	123	37	110	403	1296	490	191	355
TOTAL	243024	152951	120378	764288	608995	445742	374002	254373	148947
Total Biomass	109607	85616	61750	221565	202618	176010	161212	114612	68014
Spawn.St.Biomass	108750	80631	50321	41426	199749	173710	136504	104074	65363

	1974	1975	1976	1977	1978	1979	1980	1981	1965-1977
1	61672	181039	5543	10805	45372	118243	100370	**********	90240
2	13461	48808	143791	3982	8440	36260	94875	79907	72650
3	19291	7818	29998	97361	2080	5977	20308	66192	66404
4	10765	7731	3833	12758	53271	967	3255	11870	35610
5	301	4112	3216	1645	5399	22129	408	1841	17087
6	787	164	1712	1206	758	1744	9560	207	7934
7	25540	214	45	663	544	289	671	5041	2992
8+	431	7295	1967	659	955	375	163	427	1031
TOTAL	132248	257181	190105	129078	116801	185985	229671		
Total Biomass	55717	86496	74261	60408	49743	67790	85823		
Spawn.St.Biomass	39127	36348	72632	57102	38627	36101	60630		

Table 11.6 HADDOCK in Division VIa.
Input data for catch predictions.

Age	N x 10^{-3} landings 1980	Landings[a] $\bar{W}$ (kg)	F 1980	Reference F_{*}
1	2 513	.255	.03	.05
2	12 748	.364	.16	.27
3	5 351	.490	.34	.48
4	918	.647	.37	.62
5	142	.861	.48	.68
6	3 107	1.02	.44	.73
7	230	1.24	.47	.64
8	56	1.40	.47	.64
Weight landed (tonnes)	12 783	-	-	-

Year class strengths (N x 10^{3}) at age 1: 1980: 100 000
1981: 24 000[b]
1982: 39 800[b]

Age at first maturity = 2

$\bar{F}_{*}$ = 0.46

M = 0.2

a) Average 1975-80.

b) Average for year classes 1964-77, excluding the 1967 year class.

Table 11.7 HADDOCK in Division VIa.
Catch predictions ('000 tonnes).
Option 1: (TAC of 15 500 tonnes for 1981 is adhered to. Exploitation pattern as in the reference period 1975-80.)

1980	Total biomass	:	81.7
	SSB	:	57.8
	Human consumption landings	:	12.8
1981	$\bar{F}_{81}/\bar{F}_{*}$	:	0.58 ($\bar{F}_{2-4}$= 0.27)(TAC_{81}=15.5)
	Total biomass	:	81.9
	SSB	:	77.8
	Human consumption landings	:	15.5
1982	Total biomass	:	80.2
	SSB	:	70.1

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	SSB 1983
0	0	82.9
.2	3.9	78.5
.5	9.4	72.5
1.0	17.4	63.7
1.5	24.3	56.2
2.0	30.2	49.7

SSB = spawning stock biomass (age groups 2 and older) at the beginning of the year.

Table 11.8 HADDOCK in Division VIa.
Catch predictions ('000 tonnes).
Option 2: (F in 1981 equal to that in the reference period 1975-80. Exploitation pattern as in the reference period 1975-80.)

1980	Total biomass	: 81.7
	SSB	: 57.8
	Human consumption landings	: 12.8
1981	$\bar{F}_{81}/\bar{F}_{ref}$	: 1.0 ($\bar{F}_{ref}$ = 0.46)
	Total biomass	: 81.9
	SSB	: 77.8
	Human consumption landings	: 24.4
1982	Total biomass	: 69.9
	SSB	: 61.7

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	SSB 1983
0	0	72.9
.2	5.6	66.7
.5	12.9	58.6
1.0	22.8	47.6
1.5	30.5	39.2
2.0	36.4	32.7

SSB = spawning stock biomass at the beginning of the year

Table 12.1 Nominal catch (in tonnes) of HADDOCK in Division VIb, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x)]
Belgium	-	-	-	-	-	33	-	-	-	-
Faroe Islands	-	-	-	2	1	8	3	11	20	-
France	182	1 527	600	353	21	4	4	3	4	-
Germany,Fed.Rep.	-	-	-	-	-	-	-	-	-	17
Ireland	-	-	-	-	-	-	-	61	-	-
Norway	-	-	-	-	-	-	+	4	16	-
Poland	-	-	54	-	-	-	-	-	-	-
UK(Engl.&Wales)	117	27	1	-	5	2 111	2 694	2 365	1 654	6 261
UK(Scotland)	313	616	72	22	71	640	297	2 060	548	1 051
USSR	9	7 304	3 291	48 911	49 830	40 447	-	-	-	-
Total VIb	621	9 474	4 018	49 288	49 928	43 243	2 998	4 504	2 242	7 329

x) Provisional

Table 12.2 HADDOCK in Division VIb.

A. Input catch in numbers ('000) for VPA.

	1976	1977	1978	1979	1980
1	0	0	0	0	0
2	3134	0	2723	0	0
3	69319	682	227	1038	233
4	13406	3713	1722	11	16218
5	4	467	3710	393	0
6	41	50	411	1539	499
7	8	10	0	119	474
8	2356	0	0	1	0
9	0	21	0	0	0
10+	0	7	21	1	0
TOTAL	88268	4950	8814	3102	17424

B. Mean weight (kg) at age in the catch.

	1976	1977	1978	1979	1980
1	0.000	0.000	0.000	0.000	0.000
2	0.508	0.000	0.276	0.000	0.000
3	0.472	0.408	0.336	0.393	0.228
4	0.585	0.595	0.516	0.635	0.414
5	1.756	0.869	0.659	0.589	0.000
6	1.289	0.977	0.789	0.967	0.521
7	1.862	1.276	0.000	0.872	0.632
8	0.706	0.000	0.000	1.914	0.000
9	0.000	1.528	0.000	0.000	0.000
10+	0.000	1.162	0.891	1.994	0.000

Table 12.3 HADDOCK in Division VIb.

A. F = 0.8

Fishing mortalities from VPA (M = 0.2).

	1976	1977	1978	1979	1980
2	0.41	0.00	0.06	0.00	0.00
3	1.72	0.15	2.31	0.03	0.80
4	2.23	0.37	0.66	0.80	0.80
5	0.04	0.45	0.78	0.31	0.00
6	1.04	0.80	0.94	0.90	0.80
7	0.80	0.80	0.00	0.80	0.80
8+	0.80	0.80	0.00	0.80	0.80

Stock size in numbers ('000) from VPA.

	1976	1977	1978	1979	1980
2	10137	328	52243	563	0
3	90566	5488	268	40316	461
4	16016	13212	3878	22	32071
5	125	1408	7483	1637	0
6	69	99	734	2818	987
7	16	20	0	235	937
8+	4659	55	0	4	0
TOTAL	121988	84419	65295	45594	34455
SPAWN. ST.	121588	20609	64607	45594	34455

B. F = 0.5

	1976	1977	1978	1979	1980
2	0.37	0.00	0.04	0.00	0.00
3	1.68	0.13	2.01	0.02	0.50
4	2.15	0.35	0.55	0.50	0.50
5	0.03	0.40	0.70	0.23	0.00
6	0.84	0.50	0.75	0.71	0.50
7	0.50	0.50	0.00	0.50	0.50
8+	0.50	0.50	0.00	0.50	0.50

	1976	1977	1978	1979	1980
2	11038	342	71685	791	0
3	91478	6224	280	56233	648
4	16208	13921	4481	31	45102
5	174	1553	8063	2127	0
6	79	139	852	3288	1388
7	22	28	0	331	1318
8+	6552	78	0	6	0
TOTAL	125552	22285	85361	62807	48456
SPAWN. ST.	125552	22285	85361	62807	48456

Table 13.1 Nominal catch (in tonnes) of HADDOCK in Divisions VIId and VIIe, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 x)
Belgium	1	2	1	+	+	+	1	-	1	-
Denmark	-	-	-	-	-	-	2	22	21	-
France	97	224	208	487	868	405	438	356	333	297
Germany,Fed.Rep.	1	-	-	-	+	-	-	-	-	-
Ireland	-	-	-	-	-	-	4	-	-	-
Netherlands	-	9	1	-	1	-	-	-	-	-
Poland	-	-	12	-	-	-	-	-	-	-
UK(Engl.&Wales)	71	166	135	113	99	45	29	22	51	59
USSR	-	10	2	33	3	-	-	-	-	-
Total VIId,e	170	411	359	633	971	450	474	400	406	356

x) Provisional

Table 13.2 Nominal catch (in tonnes) of HADDOCK in Divisions VIIb,c and VIIg-k, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x)]
Belgium	23	45	65	35	33	19	13	5	2	-
Denmark	-	-	-	-	-	-	-	-	1	-
Faroe Islands	-	-	3	-	-	-	-	-	-	-
France	3 652	6 456	5 524	6 057	4 583	3 726	2 244	1 479	1 931	-
Germany,Fed.Rep.	1	-	1	-	+	3	-	-	-	-
Ireland	947	1 103	1 348	829	507	287	153	111	155	-
Netherlands	66	56	12	2	4	14	1	-	16	-
Poland	3	-	62	143	-	-	-	-	-	-
Spain	-	733	890	1 100	-	-	294	-	-	-
UK(Engl.&Wales)	25	107	24	39	46	24	18	13	20	51
UK(Scotland)	-	-	-	-	-	-	-	8	22	56
USSR	136	253	24	456	1 290	183	-	-	-	-
Total VIIb,c and VIIg-k	4 853	8 753	7 953	8 661	6 643	4 256	2 723	1 616	2 147	107

x) Provisional

Table 14.1 Nominal catch (in tonnes) of WHITING in Sub-area IV, 1971-80.
(Data for 1971-79 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[x)]
Belgium	2 108	2 745	3 387	3 156	3 279	2 640	3 275	3 304	3 941	3 062
Denmark	55 618	50 109	73 928	109 654	61 941	116 973	46 479	15 741	41 965	17 457
Faroe Islands	-	-	1 453	1 126	764	1 262	472	42	581	-
France	16 668	19 822	20 353	19 825	20 079	19 557	17 592	22 525	27 590	17 753
German Dem.Rep.	-	-	5	-	3	18	-	22	5	-
Germany Fed.Rep.	233	264	403	454	446	302	461	348	1 280	1 266
Iceland	-	-	-	-	-	4	9	38	-	-
Netherlands	6 322	7 613	8 811	12 057	14 078	12 274	9 406	11 030	13 417	12 182
Norway[a)]	25	28	39	58	55	71	33	64	49	32
Poland	-	-	7	1 002	888	509	445	8	3	1
Spain	-	107	119	110	65	18	-	-	-	-
Sweden[b)]	616	596	2 328	2 440	255	153	341	...	31	16
UK(Engl.& Wales)	4 158	3 789	4 592	5 519	5 246	5 112	6 185	7 542	7 581	6 778
UK(Scotland)	26 755	23 846	20 756	25 274	27 969	26 167	33 017	42 779	44 841	42 029
USSR	541	613	3 522	2 978	5 098	5 612	2 413	-	-	-
Total Sub-area IV	113 044	109 532	139 703	183 653	140 166	190 672	120 128	103 443	141 284	100 576
Total Div. IVa	23 451	32 932	29 616	76 761	75 444	100 001	61 499	42 837	48 554	
Total Div. IVb	70 728	66 789	96 678	87 842	41 930	69 908	42 911	40 943	68 775	
Total Div. IVc	18 865	9 811	13 409	19 050	22 792	20 763	15 718	19 663	23 955	
WG total catch[c)]	233 407	291 394	364 740	351 266	290 589	345 951	294 635	178 773	234 947	188 706

x) Provisional figures.
a) Figures from Norway do not include whiting caught in Rec. 2 fisheries.
b) 1971-74 includes Div. IIIa, 1978 included in Div. IIIa.
c) Includes discards.

Table 14.2 WHITING.
Estimates of recruitment of 1 year olds.

Year class	IYFS index 1)	VPA number x 10^{-6}	
		North Sea (IV)	West of Scotland (VIa)
1962		2 747	248
1963		1 345	17
1964	418	1 895	51
1965	600	1 365	60
1966	501	1 642	56
1967	2 019	4 558	210
1968	19	730	20
1969	69	1 146	22
1970	274	1 710	31
1971	332	2 811	93
1972	1 156	3 409	195
1973	322	1 611	70
1974	893	3 049	157
1975	679	1 934	60
1976	418	2 168	94
1977	513	1 763	157
1978	457	1 671	110
1979	692 →	2 400 →	120
1980	200 →	1 400 →	40

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

Table 14.3 North Sea WHITING (Sub-area IV)
Input catch in numbers ('000) for VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	136536	275157	500695	157405	1250217	1210201	1268162	589482	188303
1	541721	439284	594218	630966	409867	605430	413717	983371	1151617
2	505414	700067	373750	536794	1471663	159901	233757	612502	854855
3	358857	175070	241739	165127	186925	850168	28779	62987	206032
4	96564	253074	38010	71569	53420	56608	151397	7257	17584
5	9038	56465	67332	8797	17295	13095	17226	61085	5553
6	4484	12519	8406	29688	1755	4218	2254	9359	18767
7	767	2860	838	1884	6008	1301	715	3787	2393
8	122	690	122	92	623	1291	170	242	318
9	2	106	31	23	34	130	430	61	115
10+	9	0	3	5	1	17	29	137	44
TOTAL	1453514	1915892	1425142	1582350	3383808	2902360	2116836	2330270	2445581

	1974	1975	1976	1977	1978	1979	1980
0	598983	239096	424143	663911	685096	477651	329901
1	677816	860064	450697	1004406	418165	607384	287945
2	1096806	590494	1071346	551675	334981	464226	323259
3	275041	297688	158567	208869	202957	211191	243289
4	40563	54230	75098	31689	69023	86122	80281
5	5753	9213	13315	18277	7010	25051	31041
6	1250	1987	2716	4657	5385	3115	7561
7	5889	116	545	406	1422	1179	922
8	552	1385	22	167	245	194	590
9	52	142	291	4	7	15	55
10+	19	2	23	138	1	4	20
TOTAL	2702524	1860417	2176763	2524179	1724904	1876132	1305424

Table 14.4 North Sea WHITING (Sub-area IV).
Mean weight (kg) at age in the catch.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.073	0.091	0.068	0.053	0.045	0.023	0.038	0.027	0.043
1	0.160	0.126	0.162	0.135	0.098	0.120	0.150	0.088	0.103
2	0.211	0.204	0.213	0.213	0.182	0.204	0.241	0.220	0.190
3	0.259	0.265	0.275	0.301	0.271	0.247	0.289	0.292	0.283
4	0.340	0.306	0.337	0.353	0.363	0.356	0.323	0.379	0.389
5	0.420	0.370	0.347	0.477	0.404	0.447	0.429	0.422	0.459
6	0.500	0.395	0.435	0.449	0.417	0.448	0.518	0.516	0.464
7	0.546	0.470	0.501	0.621	0.540	0.513	0.656	0.573	0.554
8	0.634	0.639	0.623	0.731	0.670	0.630	0.559	0.742	0.736
9	1.256	0.724	0.621	0.776	0.787	0.785	0.742	0.809	0.904
10+	0.612	0.000	0.486	0.842	1.238	0.798	0.731	0.868	0.862

	1974	1975	1976	1977	1978	1979	1980
0	0.033	0.030	0.019	0.019	0.010	0.009	0.013
1	0.077	0.101	0.109	0.090	0.074	0.098	0.087
2	0.168	0.219	0.195	0.172	0.185	0.165	0.171
3	0.265	0.279	0.296	0.280	0.239	0.259	0.255
4	0.377	0.373	0.361	0.375	0.337	0.313	0.350
5	0.459	0.464	0.440	0.449	0.460	0.434	0.357
6	0.525	0.353	0.512	0.483	0.462	0.492	0.461
7	0.544	0.818	0.440	0.532	0.514	0.541	0.479
8	0.787	0.596	0.457	0.332	0.689	0.617	0.626
9	1.033	0.716	0.692	0.932	0.741	0.669	0.575
10+	0.958	1.022	0.917	0.440	1.828	0.738	0.789

Table 14.5 North Sea WHITING (Sub-area IV).
Fishing mortalities from VPA (M = 0.2).

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.09	0.14	0.06	0.16	0.68	0.49	0.34	0.14	0.10
1	0.22	0.43	0.31	0.17	0.94	0.86	0.51	0.48	0.46
2	1.00	0.94	0.83	0.89	0.71	1.35	1.01	1.04	1.06
3	0.56	1.29	1.08	1.17	0.94	1.27	1.60	0.86	1.37
4	0.75	1.02	1.20	1.22	0.80	0.87	0.83	0.76	0.63
5	0.44	1.57	0.87	1.07	1.23	0.89	0.73	1.01	1.11
6	0.80	2.38	1.20	1.33	0.63	1.29	0.36	1.23	1.05
7	0.62	2.68	1.65	1.01	1.18	1.52	0.80	2.10	1.39
8	0.45	2.45	1.27	0.84	1.20	0.90	0.86	0.71	1.37
9	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
10+	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
F(2- 6),0	0.71	1.44	1.03	1.14	0.86	1.15	0.79	0.98	1.04

	1974	1975	1976	1977	1978	1979	1980	1975-1980
0	0.16	0.11	0.16	0.29	0.31	0.17	0.19	0.21
1	0.62	0.37	0.28	0.70	0.30	0.51	0.14	0.38
2	1.13	0.91	1.12	0.66	0.54	0.64	0.56	0.74
3	1.33	1.17	1.30	1.00	0.58	0.80	0.86	0.95
4	1.23	1.12	1.16	1.05	0.78	0.52	0.83	0.91
5	0.43	1.13	0.96	1.05	0.79	0.75	0.57	0.84
6	2.03	2.25	1.38	1.16	1.09	0.92	0.53	1.22
7	1.23	1.42	1.25	0.80	1.69	0.76	0.80	1.12
8	0.79	1.19	1.30	2.51	2.17	1.34	1.18	1.62
9	0.90	0.90	0.90	0.90	0.90	0.90	0.99	0.92
10+	0.90	0.90	0.90	0.90	0.90	0.90	0.99	0.92
F(2- 6),0	1.23	1.31	1.18	0.98	0.76	0.73	0.63	

Table 14.6 North Sea WHITING (Sub-area IV)
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	1817356	2307807	5899099	1043124	2769918	3413278	4824370	4812742	2174794
1	1895404	1364766	1641503	4558412	730242	1145702	1710205	2810791	3409134
2	868366	1244257	723408	989655	3163710	233290	398719	1028386	1420090
3	916295	261783	395985	259209	332393	1276250	49657	118730	297967
4	198885	429012	58912	109645	65862	105874	292525	14904	41106
5	27840	76680	126413	14556	26384	24130	36273	104584	5728
6	8801	14688	13034	43533	4107	6287	8098	14323	31343
7	1819	5257	1116	3224	9393	1794	1415	4606	5438
8	371	803	183	176	965	2366	521	521	460
9	4	194	57	42	62	238	788	112	211
10+	16	0	5	9	2	31	53	251	81
TOTAL	5735217	5703249	8859716	7021585	7103039	6209220	7322425	8909950	7384352
Total Biomass	941464	872808	1000144	1026855	904134	632726	666244	699716	834464
Spawn.St.Biomass	505533	490837	333082	356184	707924	416736	226387	321422	389807

	1974	1975	1976	1977	1978	1979	1980	1981	1982-1987
0	4382706	2625462	3115094	2881763	2793032	3449915	2076935	**********	3138617
1	1610754	3048641	1933939	2168307	1762555	1671082	2394259	1403407	2217491
2	1758809	712665	1723858	1196110	878376	1067204	824073	1700757	1313811
3	403678	467174	235919	461022	504231	419239	458853	385391	448227
4	61895	87323	118632	52875	138517	231234	154941	158965	111515
5	17934	14757	23389	30550	15149	51853	112191	55315	54521
6	1538	9523	5911	7309	8781	5612	20101	63447	10342
7	8996	165	825	802	1874	2411	1823	9687	2456
8	701	2150	33	193	295	283	922	671	675
9	95	260	533	7	13	27	60	232	197
10+	55	4	42	255	13	7	55	29	47
TOTAL	8247141	6968126	7156175	6799194	6102835	6898868	6044193		
Total Biomass	709063	717479	731876	625169	500275	578632	595182		
Spawn.St.Biomass	440405	330802	461890	375268	341916	383816	359881		

Table 14.7 North Sea WHITING.
Equilibrium yield ('000 tonnes) for average recruitment.

$F_{H.C.}/F_{H.C.*}$	F_{IND}/F_{IND*}	Human consumption landings	Discards	Industrial by-catch	SSB[a)]
0	1	0	0	166	1 216
.2	1	84	22	139	835
.3	1	96	32	128	722
.4	1	101	40	120	638
.5	1	102	48	112	574
.6	1	102	55	106	523
.7	1	100	62	100	481
.8	1	98	68	95	446
.9	1	96	73	90	417
1.0	1	94	78	86	392
1.5	1	85	99	71	304
2.0	1	77	115	60	251

Average recruitment at age 0 = 3139×10^{-6} (year classes 1960-77).

$F_{H.C.*}$ = F for human consumption catch relative to that in the reference period 1975-80.

F_{IND*} = the equivalent for the industrial fishery.

a) Spawning stock biomass ('000 tonnes), age groups 2 and older.

Table 14.8 North Sea WHITING. Input data for catch predictions.

Age	Stock $\bar{W}$ (kg)[c]	N x 10^{-3} H.C. landings 1980	H.C. landings $\bar{W}$ (kg)	H.C. landings F	N x 10^{-3} Discards 1980	H.C. disc. $\bar{W}$(kg)	H.C. disc. F	N x 10^{-3} Industr. by-catch 1980	Ind. $\bar{W}$ (kg)	Ind. F	Total F 1980	Reference F : $\bar{F}_R$ [a]		
												H.C. catch F	Propor. not discarded	Industr. catch F
0	.011	0	.113	0	1 401	.072	.001	328 500	.010	.19	.19	.01	0	.20
1	.086	5 919	.203	.003	123 388	.124	.06	158 638	.060	.08	.14	.14	.07	.24
2	.174	61 498	.232	.11	158 694	.155	.28	103 047	.154	.18	.56	.43	.31	.31
3	.254	131 760	.273	.47	66 438	.190	.24	45 091	.251	.16	.86	.69	.64	.26
4	.327	56 769	.342	.59	15 395	.204	.16	8 117	.380	.08	.83	.79	.85	.12
5	.417	26 986	.426	.32	3 955	.234	.05	700	.465	.008	.37	.77	.94	.07
6	.472	6 949	.481	.49	562	.263	.04	50	.500	.004	.53	1.16	.98	.06
7	.511	906	.511	.79	0	.300	0	16	.543	.014	.80	1.10	1.0	.02
8	.664	590	.647	1.18	0	-	0	0	.600	0	1.18	1.59	1.0	.03
9	.662	35	.662	.99	0	-	0	0	-	0	.99	.91	1.0	.01
Weight (tonnes)	-	86 422	-		56 836	-		45 747	-		-	-	-	-

Year class strengths: 1980: 2 071 913[b]
1981: 3 138 617[b]
1982: 3 138 617[b]
} numbers at age 0 x 10^{-3}

Age at first maturity = 2

$\bar{F}_R$ = 0.77 (human consumption fishery only)

M = 0.2

a) Average 1975-80.

b) Average recruitment for year classes 1960-77.

c) Average for 1978-80.

Table 14.9 North Sea WHITING.
Results of catch predictions ('000 tonnes).
Option 1: (TAC for 1981 adhered to. Exploitation pattern as in the reference period 1975-80.)

1980	Total biomass	: 595
	SSB	: 360
	Human consumption landings	: 86
	Discards	: 57
	Industrial by-catch	: 46
	Total catch	: 189
1981	$\bar{F}_{81}/\bar{F}_{*}$	: 30 ($\bar{F}_{2-6}$ = 0.23; human consumption fishery only)
	Total biomass	: 660 TAC_{81} = 150
	SSB	: 504
	Human consumption landings	: 44
	Discards	: 28
	Industrial by-catch	: 108
	Total catch	: 180
1982	Total biomass	: 734
	SSB	: 519

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	Discards	Industrial by-catch	Total catch	SSB 1983
0	0	0	121	121	680
.2	12	6	119	137	661
.5	30	14	117	161	633
1.0	57	28	113	198	596
1.5	82	41	109	232	551
2.0	104	53	106	263	516

SSB = spawning stock biomass (age groups 2 and older) at the beginning of the year.

Table 14.10 North Sea WHITING.
Results of catch predictions ('000 tonnes).
Option 2: (F in 1981 equal to that in the reference period 1975-80. Exploitation pattern as in the reference period.)

1980	Total biomass	:	595
	SSB	:	360
	Human consumption landings	:	86
	Discards	:	57
	Industrial by-catch	:	46
	Total catch	:	189
1981	$\bar{F}_{81}/\bar{F}_{hc}$	:	1.0 ($\bar{F}_{hc}$ = 0.77, human consumption fishery only)
	Total biomass	:	660
	SSB	:	504
	Human consumption landings	:	118
	Discards	:	83
	Industrial by-catch	:	95
	Total catch	:	296
1982	Total biomass	:	600
	SSB	:	386

$\bar{F}_{82}/\bar{F}_{81}$	Human consumption landings	Discards	Industrial by-catch	Total catch	SSB 1983
0	0	0	101	101	563
.2	27	16	96	139	518
.5	61	39	91	191	459
1.0	105	72	83	260	381
1.5	137	99	76	312	321
2.0	161	123	70	354	275

SSB = spawning stock biomass at the beginning of the year.

Table 15.1.A. Nominal catch (in tonnes) of WHITING in Divisions VIa, 1971-1980
(Data for 1971-1979 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*)
Belgium	9	7	5	10	1	14	-	-	-	-
Denmark	-	-	121	-	-	-	-	119	92	-
Faroe Islands	-	-	5	1	30	2	-	-	770	-
France	2 507	1 662	2 777	2 983	2 763	3 655	3 395	3 610	2 779	2 611
German Dem. Rep.	-	-	-	-	-	31	-	-	-	-
Germany, Fed. Rep. of	+	148	127	80	62	1	1	2	4	1
Iceland	-	-	-	-	-	-	-	-	-	-
Ireland	1 178	1 122	2 117	2 431	2 429	3 255	2 752	2 080	2 791	2 862
Netherlands	28	40	57	23	85	255	78	23	17	-
Norway	-	-	-	-	-	1	-	-	-	-
Poland	2	-	10	9	-	-	-	-	-	-
Spain	-	1 397	1 540	1 479	1 871	821	763[a)]	-	-	-
U.K. (Engl.+ Wales)	66	102	91	112	132	244	520	669	320	227
U.K. (Scotland)	11 435	10 707	9 796	9 929	12 668	16 658	9 873	8 174	10 613	7 371
USSR	-	128	-	-	-	-	-	-	-	-
Total VIa	15 225	15 313	16 646	17 057	20 041	24 937	17 382	14 677	17 386	13 072
Working Group total catch									17 082	12 767

*) Provisional

a) Includes VIb.

Table 15.1. B. Nominal catch (in tonnes) of WHITING in Division VIb, 1971-1980
(Data for 1971-1979 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*)
Faroe Islands	-	-	-	1	-	-	+	-	-	-
France	800	69	62	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	1	-	-
Spain	-	-	-	-	-	-	.. a)	-	-	-
U.K. (Engl.+ Wales)	+	+	+	-	-	3	2	5	1	+
U.K. (Scotland)	7	12	1	+	12	15	5	24	2	59
Total VIb	807	81	63	1	12	18	7	30	3	59

*) Provisional

a) Included in VIa

Table 15.2 WHITING in Division VIa.
Input catch in numbers ('000) for VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0	0	0	0	0	0	0	0	0
1	6900	1688	5543	7241	887	664	2335	16668	15715
2	6070	10477	26858	10432	25148	6773	8393	11973	30395
3	43493	2219	10949	9232	8628	28090	4032	4022	5583
4	4800	28202	719	5659	2564	3237	33860	1357	1471
5	589	1862	13598	325	1204	664	1300	14832	359
6	103	187	813	5037	118	211	234	797	4330
7	16	54	110	328	2106	17	67	79	278
8+	5	18	33	39	219	519	151	70	36
TOTAL	61776	44687	58429	42313	40874	40175	50372	49798	62167

	1974	1975	1976	1977	1978	1979	1980
0	0	37	13	19	1	10	43
1	9031	14931	8526	16037	17712	6322	9548
2	50779	16762	46222	13325	18177	34233	11342
3	10018	36244	15711	25070	6670	13272	16095
4	1165	2811	17433	3125	9389	3392	4547
5	182	279	1513	4711	931	3492	1341
6	42	57	65	292	1429	264	1137
7	830	9	14	13	64	374	94
8+	31	237	45	10	5	9	102
TOTAL	72078	71367	89542	62602	54378	61368	44249

Table 15.3 WHITING in Division VIa.
Mean weight (kg) at age in the catch.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.218	0.238	0.204	0.206	0.178	0.206	0.209	0.211	0.197
2	0.255	0.244	0.240	0.263	0.223	0.200	0.247	0.258	0.234
3	0.312	0.325	0.319	0.366	0.335	0.273	0.277	0.346	0.362
4	0.405	0.374	0.424	0.444	0.500	0.381	0.316	0.369	0.479
5	0.620	0.609	0.412	0.554	0.571	0.517	0.426	0.426	0.485
6	0.709	0.720	0.639	0.539	0.649	0.619	0.551	0.495	0.533
7	0.842	0.816	0.824	0.701	0.618	0.670	0.696	0.604	0.654
8+	0.753	0.871	0.878	0.854	0.725	0.667	1.006	0.713	0.750

	1974	1975	1976	1977	1978	1979	1980
0	0.000	0.107	0.136	0.117	0.112	0.136	0.098
1	0.194	0.209	0.201	0.200	0.199	0.218	0.164
2	0.216	0.245	0.243	0.240	0.235	0.232	0.235
3	0.318	0.306	0.311	0.293	0.285	0.306	0.323
4	0.445	0.472	0.563	0.388	0.388	0.405	0.414
5	0.592	0.652	0.500	0.429	0.515	0.536	0.477
6	0.640	0.612	0.691	0.623	0.549	0.691	0.602
7	0.574	0.853	1.045	0.853	0.601	0.695	0.634
8+	0.843	0.713	1.169	1.065	0.973	0.651	0.782

Table 15.4 WHITING in Division VIa.
Fishing mortalities from VPA (M = 0.2).

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.16	0.03	0.11	0.04	0.05	0.03	0.09	0.22	0.08
2	0.82	0.39	0.94	0.58	0.18	0.63	0.74	0.83	1.03
3	0.46	0.85	0.94	1.05	0.69	0.32	1.01	1.03	1.32
4	0.69	0.62	0.75	1.02	1.00	0.60	0.80	1.26	1.61
5	0.49	0.64	0.71	0.97	1.25	0.79	0.52	1.04	1.68
6	0.75	0.47	0.65	0.63	1.26	0.77	0.74	0.72	1.07
7	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
8+	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
F(2- 4),U	0.66	0.62	0.88	0.88	0.62	0.52	0.85	1.04	1.32

	1974	1975	1976	1977	1978	1979	1980	1975-1980
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00097	0.00
1	0.15	0.11	0.17	0.21	0.13	0.07	0.0917	0.13
2	0.47	0.46	0.58	0.43	0.39	0.41	0.16	0.40
3	0.93	0.74	1.11	0.72	0.40	0.54	0.34	0.64
4	1.22	0.75	1.03	0.68	0.67	0.37	0.36	0.64
5	0.94	1.18	1.29	0.91	0.44	0.56	0.24	0.77
6	1.00	0.91	1.04	0.98	0.80	0.21	0.36	0.72
7	0.60	0.60	0.60	0.60	0.60	0.50	0.11	0.50
8+	0.60	0.60	0.60	0.60	0.60	0.50	0.11	0.50
F(2- 4),U	0.87	0.65	0.90	0.61	0.48	0.44	0.29	

Table 15.5 WHITING in Division VIa.
Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	73837	68511	256731	24755	26894	37557	114072	238773	85895
1	50661	60452	56092	210194	20266	22019	30749	93394	193491
2	11764	35261	47970	41107	165555	15792	17428	23069	61462
3	128731	4222	19467	15381	18934	112897	6875	6779	8219
4	10490	66406	1480	6199	4395	7796	67191	2046	1978
5	1095	4302	29153	570	1825	1320	3488	24821	474
6	213	548	1857	11728	178	428	489	1691	7150
7	39	82	281	794	5099	41	162	191	673
8+	12	44	80	94	530	1257	566	169	87
TOTAL	276841	239828	413112	310821	245677	199106	240819	390935	361428
Total Biomass	59970	52319	43293	69768	55760	43298	36104	40406	61363
Spawn.Stock Biomass	48926	37931	31850	26468	50155	38765	29077	20700	22851

	1974	1975	1976	1977	1978	1979	1980	1981	1965-1977
0	192121	73648	114436	191438	134438	146635	48933	**********	115282
1	70325	157296	60265	95680	156719	110068	120046	40025	86222
2	147681	49440	115320	41660	62262	112346	84411	89673	59501
3	17990	75597	25452	55058	22157	34660	61264	53892	57954
4	1792	5816	29586	6899	21062	12156	16495	35702	16298
5	324	435	2253	8573	2857	8855	6907	9422	6049
6	72	103	109	506	2826	1504	4125	4448	1929
7	2010	22	34	31	155	1040	994	2356	728
8+	75	574	109	24	12	25	1078	1520	263
TOTAL	432390	362730	347363	395870	402489	427289	544254		
Total Biomass	53515	79459	75647	73401	78490	92055	78188		
Spawn.Stock Biomass	39872	38704	47970	32267	32246	48118	53705		

Table 15.6 WHITING in Division VIa.
Input data for catch predictions.

Age	No. x 10^{-3} landings 1980	Landings a) $\overline{W}$ (kg)	F 1980	Reference F_{*} b)
1	9 548	.194	.09	.13
2	11 342	.234	.16	.40
3	16 095	.305	.34	.64
4	4 547	.402	.36	.64
5	1 341	.509	.24	.77
6	1 137	.614	.36	.72
7	94	.643	.11	.50
8	97	.802	.11	.50
Weight landed	12 767	-	-	-

Recruitment at age 1, No. x 10^{-3} : 1980: 120 000
1981: 40 000
1982 92 000c)

Age at first maturity: 2

$\overline{F}_{*}$ = 0.56

M = 0.2

a) Average 1978-80 (from Table 15.3).

b) Average 1975-80 (from Table 15.4).

c) Average for year classes 1962-78.

Table 15.7 WHITING in Division VIa. Results of catch predictions ('000 tonnes).

OPTION 1 (TAC for 1981 of 14 000 tonnes adhered to. Exploitation pattern as in the reference period 1975-80.)

1980	Total biomass:	76.3
	SSB :	52.6
	Landings :	12.8
1981	Total biomass:	71.1
	SSB :	63.3
	Landings :	14.0
	$\bar{F}_{81}/\bar{F}_{*}$:	.46 ($\bar{F}_{2-4}$ = 0.26)
1982	Total biomass:	75.4
	SSB :	57.5

$\bar{F}_{82}/\bar{F}_{81}$	Landings	SSB 1983
0	0	75.8
.2	3.2	72.2
.5	7.8	67.2
1.0	14.5	59.7
1.5	20.4	53.2
2.0	25.5	47.6

OPTION 2 (F in 1981 equal to that in the reference period 1975-80. Exploitation pattern as in the reference period.)

1980	Total biomass:	76.3
	SSB :	52.6
	Landings :	12.8
1981	Total biomass:	71.1
	SSB :	63.3
	Landings :	25.7
	$\bar{F}_{81}/\bar{F}_{*}$:	1.0 ($\bar{F}_{*}$ = 0.56)
1982	Total biomass:	62.2
	SSB :	44.3

$\bar{F}_{82}/\bar{F}_{81}$	Landings	SSB 1983
0	0	62.7
.2	5.1	57.0
.5	11.8	49.6
1.0	20.7	39.8
1.5	27.5	32.5
2.0	32.7	26.9

SSB = spawning stock biomass (age groups 2 and older) at the beginning of the year.

Table 16.1. Nominal catch (in tonnes) of WHITING in Division VIId and VIIe in 1971-1980
(Data for 1971-1979 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*
Belgium	25	19	38	39	70	103	36	85	92	-
Denmark	-	-	-	-	-	18	-	1	2 585	-
France	2 999	3 121	5 050	7 917	10 060	8 390	8 886	8 010	5 352	6 509
Netherlands	1	21	42	12	14	5	1	2	1	-
Ireland	-	-	-	-	-	-	11	12	-	-
U.K. (Engl. + Wales)	567	515	498	579	1 255	1 504	1 342	1 038	930	839
Germany, Fed. Rep. of	+	-	-	25	1	-	-	-	-	-
USSR	-	-	19	-	-	-	-	-	-	-
Total VIId,e	3 592	3 676	5 647	8 572	11 400	10 020	10 276	9 148	8 960	7 348

*) Provisional

Table 16.2 WHITING in Division VIIe and VIId.
Input catch in numbers ('000) for VPA.

	1976	1977	1978	1979	1980
0	140	0	150	0	28
1	12727	13847	19949	7333	5723
2	7313	13004	9201	7982	9895
3	5074	2855	4649	4542	4342
4	1410	843	1556	2482	1755
5	521	253	433	639	445
6	74	46	88	93	49
7+	0	8	0	10	7
TOTAL	27259	30856	36026	23081	20222

Table 16.3 WHITING in Divisions VIIe and VIId.
Mean weight (kg) at age of the stock.

	1976	1977	1978	1979	1980
0	0.218	0.200	0.130	0.170	0.195
1	0.280	0.258	0.207	0.299	0.282
2	0.374	0.347	0.260	0.379	0.356
3	0.479	0.496	0.346	0.435	0.436
4	0.594	0.642	0.412	0.518	0.461
5	0.696	0.749	0.668	0.594	0.538
6	0.742	0.850	0.711	1.052	0.633
7+	0.740	0.955	0.711	0.479	0.700

Table 16.4 WHITING in Divisions VIIe and VIId.
Fishing mortalities from VPA (M = 0.2).

	1976	1977	1978	1979	1980	1976-1977
0	0.003	0.000	0.004	0.000	0.003	0.002
1	0.367	0.473	0.676	0.268	0.400	0.420
2	0.709	0.799	0.672	0.640	0.700	0.754
3	1.280	0.671	0.764	0.858	0.900	0.976
4	1.312	0.758	1.015	1.353	1.000	1.035
5	1.914	0.912	1.224	2.034	1.000	1.413
6	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
F(2- 5),0	0.994	0.735	0.718	0.749	0.800	

Table 16.5 WHITING in Divisions VIIe and VIId. Stock size in numbers ('000) and biomasses (tonnes) from VPA.

	1976	1977	1978	1979	1980	1981
0	49274	54081	41986	15118	10313	**********
1	45393	40216	44278	34240	12377	8418
2	15704	25738	20515	18430	21438	6793
3	7596	6528	9478	8576	7955	8716
4	2085	1729	2649	3613	2976	2648
5	654	460	663	786	764	896
6	127	79	151	160	84	230
7+	0	14	0	18	12	29
TOTAL	120833	128644	119720	80940	55919	
Total Biomass	34752	34796	24879	26038	18018	
Spawn.St.Biomass	11300	13604	10255	13231	12516	

Table 16.6. Nominal catch (in tonnes) of WHITING in Divisions VIIb,c and VIIg-k
(Data for 1971-1979 as officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*
Belgium	54	20	124	75	83	97	60	37	26	-
France	4 893	5 695	4 035	4 331	3 637	4 731	3 962	3 848	4 127	-
Germany, Fed. Rep. of	-	-	+	-	2	-	1	45	-	6
Ireland	482	1 141	1 894	1 641	2 562	1 980	1 201	1 172	2 674	-
Netherlands	100	377	2 080	915	66	112	86	63	3	-
Poland	-	-	14	-	-	-	-	-	-	-
Spain	-	1 491	1 121	1 367	2 974	2 772	-	-	-	-
U.K. (Eng.+ Wales)	17	34	21	15	61	21	26	38	22	60
U.K. (Scotland)	-	-	-	-	-	-	2	1	1	80
USSR	-	3	16	-	64	2	-	-	-	-
Total VIIb,c and g-k	5 546	8 761	9 305	8 344	9 449	9 715	5 338	5 204	6 853	146

*) Provisional

Table 18.1 Data used for assessment of mesh increase from 75 mm to 90 mm in Sub-area VI.
(Ref. ICES C.M.1974/F:36)

	COD	HADDOCK	WHITING
Selection factor	3.6	3.4	3.8
75 mm (50% retention	27.0	25.5	28.5
75 mm (range	±2.4	±2.1	±2.6
90 mm (50% retention	32.4	30.6	34.2
90 mm (range	±2.9	±2.5	±3.3

Table 18.2 COD - West of Scotland.
Long-term effect of a mesh increase from 75 mm to 90 mm (S.F. = 3.6).

Age	$\bar{F}_{ae}$	Fishing pattern 90 mm	Average weight (kg)
1	.15	.14	0.663
2	.41	.41	1.40
3	.62	.62	2.91
4	.73	.73	5.12
5	.90	.90	6.97
6	.68	.68	8.22
7	.66	.66	9.23
8+	.66	.66	10.00

Fishing mortality relative to average 1975-80	Y_w/R 75 mm	Y_w/R 90 mm
.2	1.6252	1.6263
.4	1.9169	1.9198
.6	1.8907	1.8949
.8	1.7870	1.7921
1.0	1.6725	1.6783
1.1	1.6182	1.6243

Table 18.3 HADDOCK - West of Scotland.
Long-term effect of an increase in mesh size from 75 mm to 90 mm (S.F.= 3.4).

Age	$\bar{F}_{*}$	Fishing pattern 90 mm	Average weight (kg)
1	.05	.026	.255
2	.27	.23	.364
3	.48	.47	.490
4	.62	.62	.647
5	.68	.68	.861
6	.73	.73	1.020
7	.64	.64	1.240
8+	.64	.64	1.400

Fishing mortality relative to average 1975-80	Y_w/R 75 mm	Y_w/R 90 mm
.2	.260	.260
.4	.272	.272
.6	.303	.305
.8	.306	.309
1.0	.304	.308
1.2	.302	.306
1.4	.299	.303
1.6	.296	.300

Table 18.4 WHITING - West of Scotland.
Long-term effect of an increase in mesh size from 75 mm to 90 mm (S.F. = 3.8)

Age	$\bar{F}_{ae}$	Fishing pattern 90 mm	Average weight (kg)
1	.13	.04	.206
2	.40	.14	.236
3	.64	.30	.295
4	.64	.46	.394
5	.77	.66	.493
6	.72	.69	.621
7	.50	.49	.716
8+	.50	.50	.900

Fishing mortality relative to average 1975-80	Y_w/R 75 mm	Y_w/R 90 mm
.2	.137	.126
.4	.173	.168
.6	.183	.183
.8	.186	.189
1.0	.186	.190
1.2	.185	.191
1.4	.185	.190
1.6	.184	.190
1.8	.184	.189
2.0	.184	.188

Table 20.1 Species composition of catches made in the Fladen Ground area during April to July 1965.

Species	kg	%
Total all species	36 577	100.0
Pandalus	10 968	30.0
Haddock	11 521	31.9
Whiting	3 649	10.0
Norway pout	2 811	7.7
Cod	2 339	6.2
Monk	2 258	6.2
Herring	512	1.4
Spiny dogfish	474	1.3
Rockling	460	1.2
Long-rough dab	444	1.2
Ling	266	0.7
Witch	223	0.6
Hake	137	0.4
Catfish	120	0.4
Nephrops	112	0.3
Halibut	76	0.2
Megrim	59	0.2

Table 20.2 Species composition of catches made in the Farn Deep area area during July to September 1965.

Species	kg	%
Total all species	100 334	100.0
Pandalus	21 152	21.1
Whiting	63 371	63.2
Cod	5 516	5.5
Norway pout	3 652	3.6
Haddock	2 481	2.5
Herring	1 518	1.5
Rockling	735	0.7
Long-rough dab	732	0.7
Monk	118	0.1
Nephrops	372	0.4

Table 20.3 By-catch of protected fish species during April to July 1965 in the Fladen Ground survey in kg and numbers.

Fish species	Number of fish	kg	% of total weight	From these undersized:			% of total catch weight
				Number	%	kg	
Cod	1 106	2 339	6.2	81	7.3	11.5	0.03
Haddock	36 851	11 521	31.9	46	0.1	6.2	0.02
Hake	789	137	0.4	615	77.9	15.5	0.04
Witch	1 966	223	0.6	1 322	67.2	55.3	0.16
Dab	518	20	0.1	155	29.9	3.5	0.01
Megrim	266	59	0.2	67	25.2	8.5	0.02
Plaice	5	2	0.0	-	-	-	-
Turbot	4	15	0.0	-	-	-	-
Whiting	-	3 649	10.0	-	-	16.3	0.04
Protected fish total:		17 965	40.0			116.8	0.32
Other fish:		7 640	29.6				
Crustacean catch:		10 968	30.0				
Total catch		36 573	100.0				

Figure 6.1 North Sea COD.

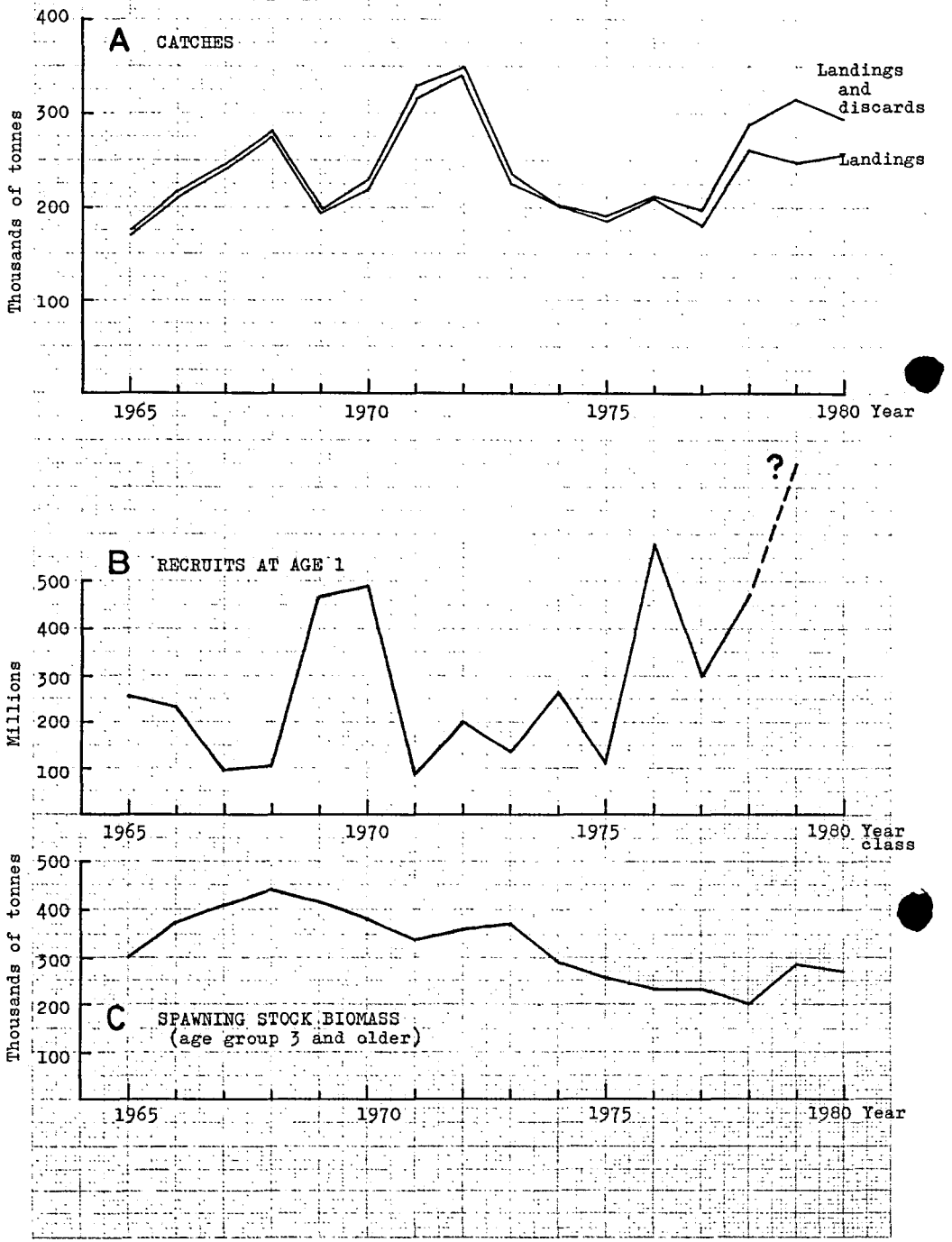


Figure 6.2 North Sea COD.

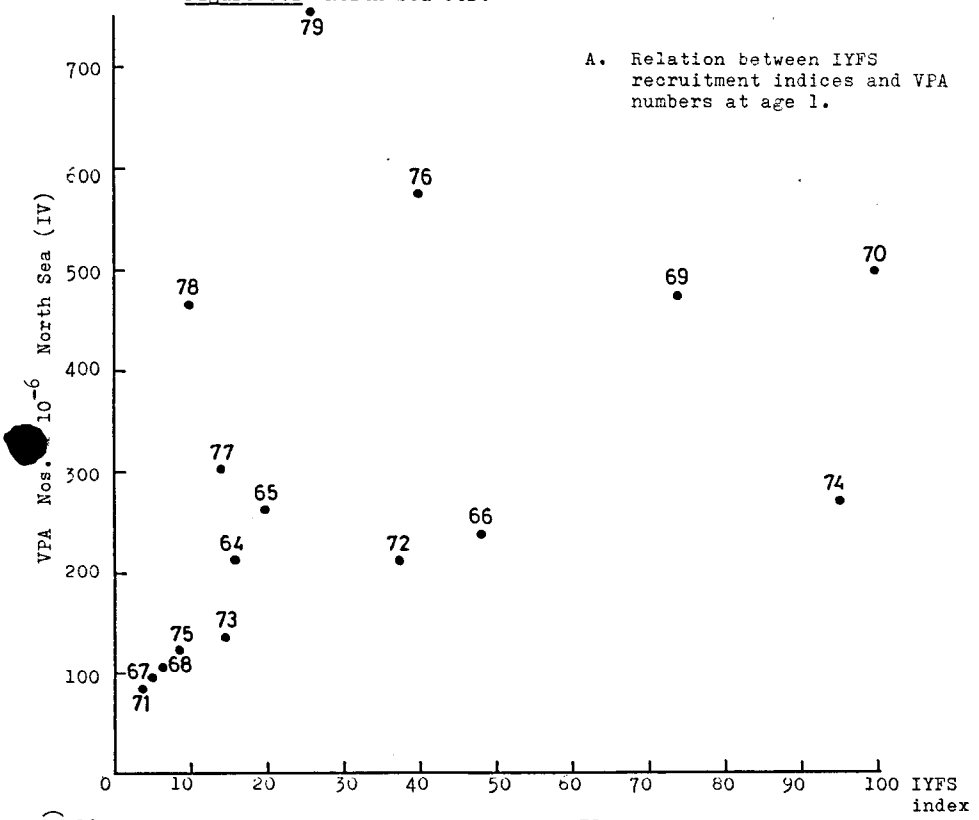


Figure 6.3 North Sea COD.
Equilibrium yield for average recruitment.

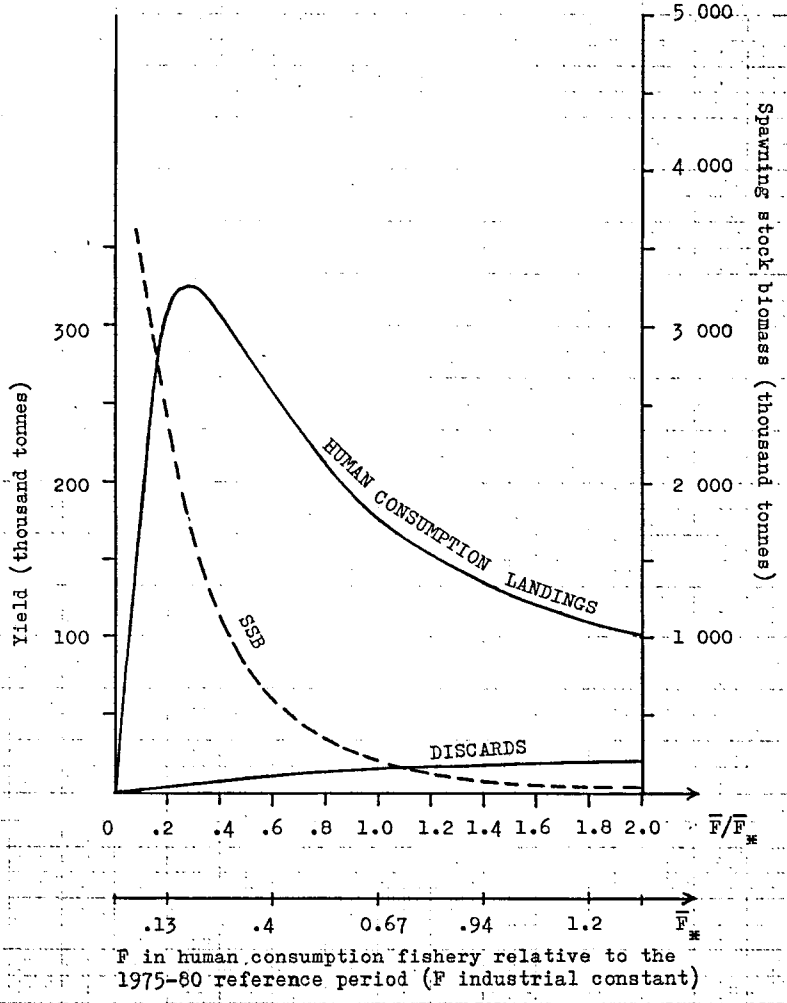


Figure 6.4 North Sea COD.
Predictions for catch in 1982 and spawning stock biomass in 1983.

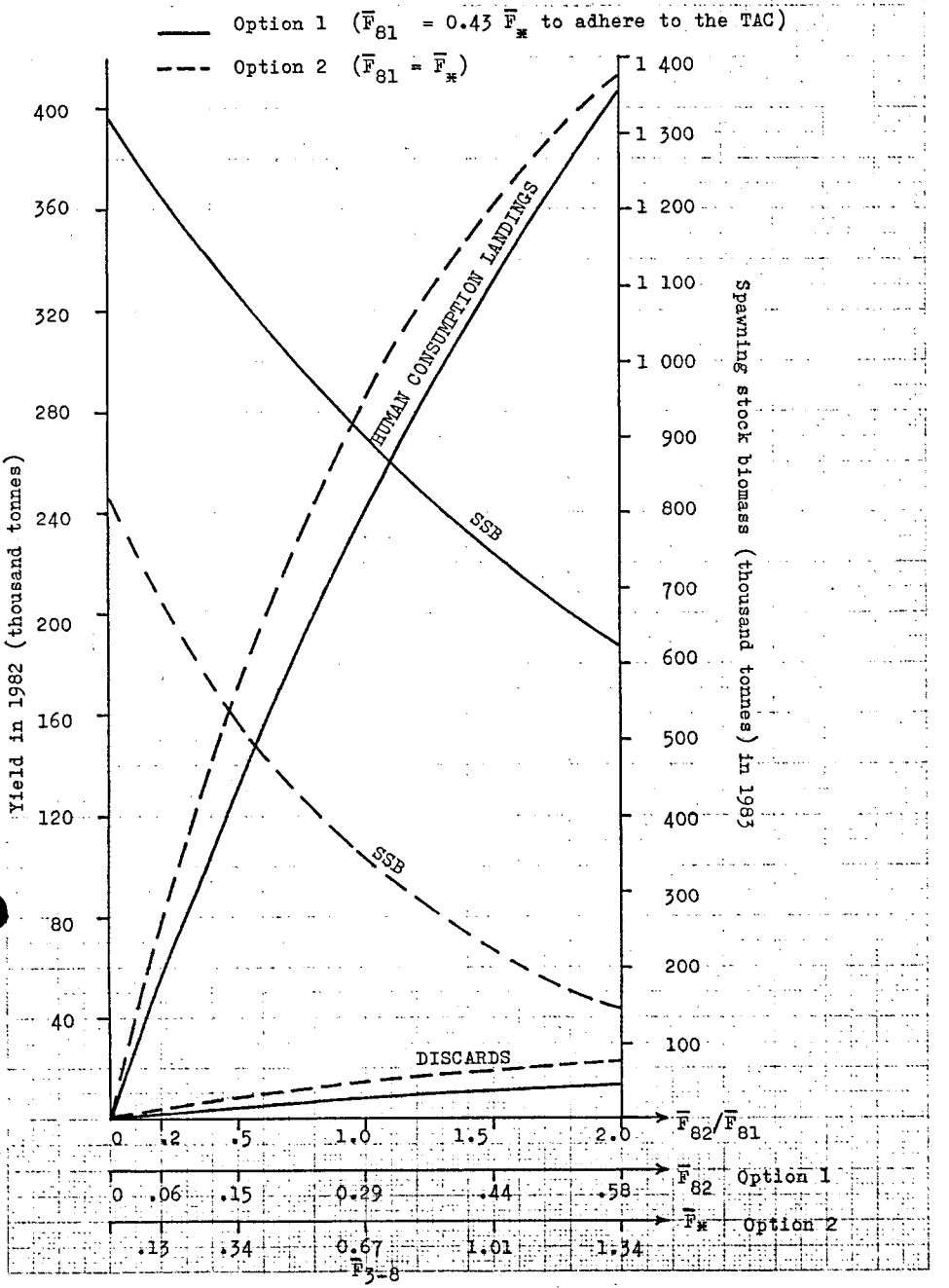


Figure 7.1 COD in Division VIa.

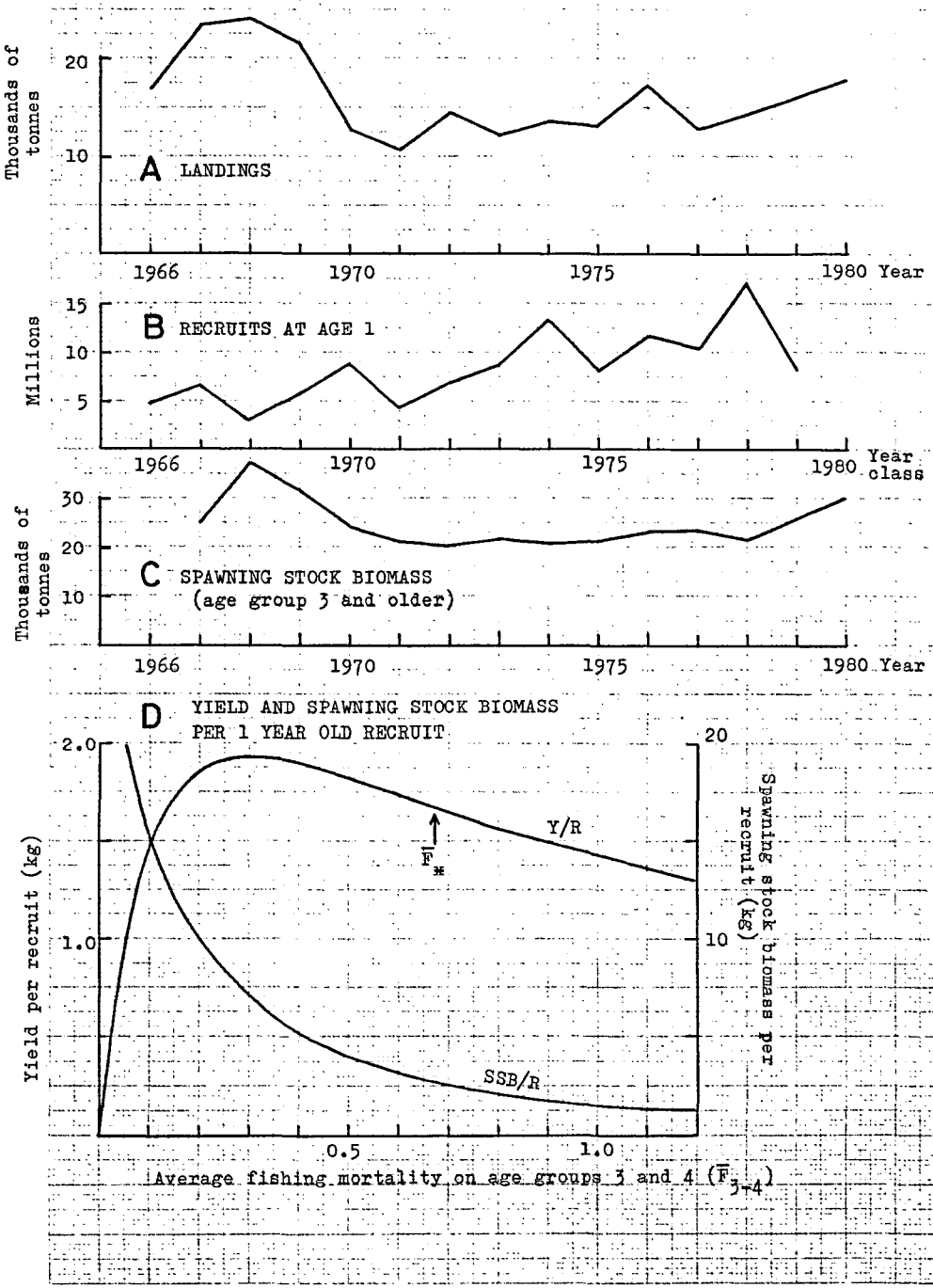


Figure 7.2 COD in Division VIa.
Predictions for catch in 1982 and spawning stock biomass in 1983.

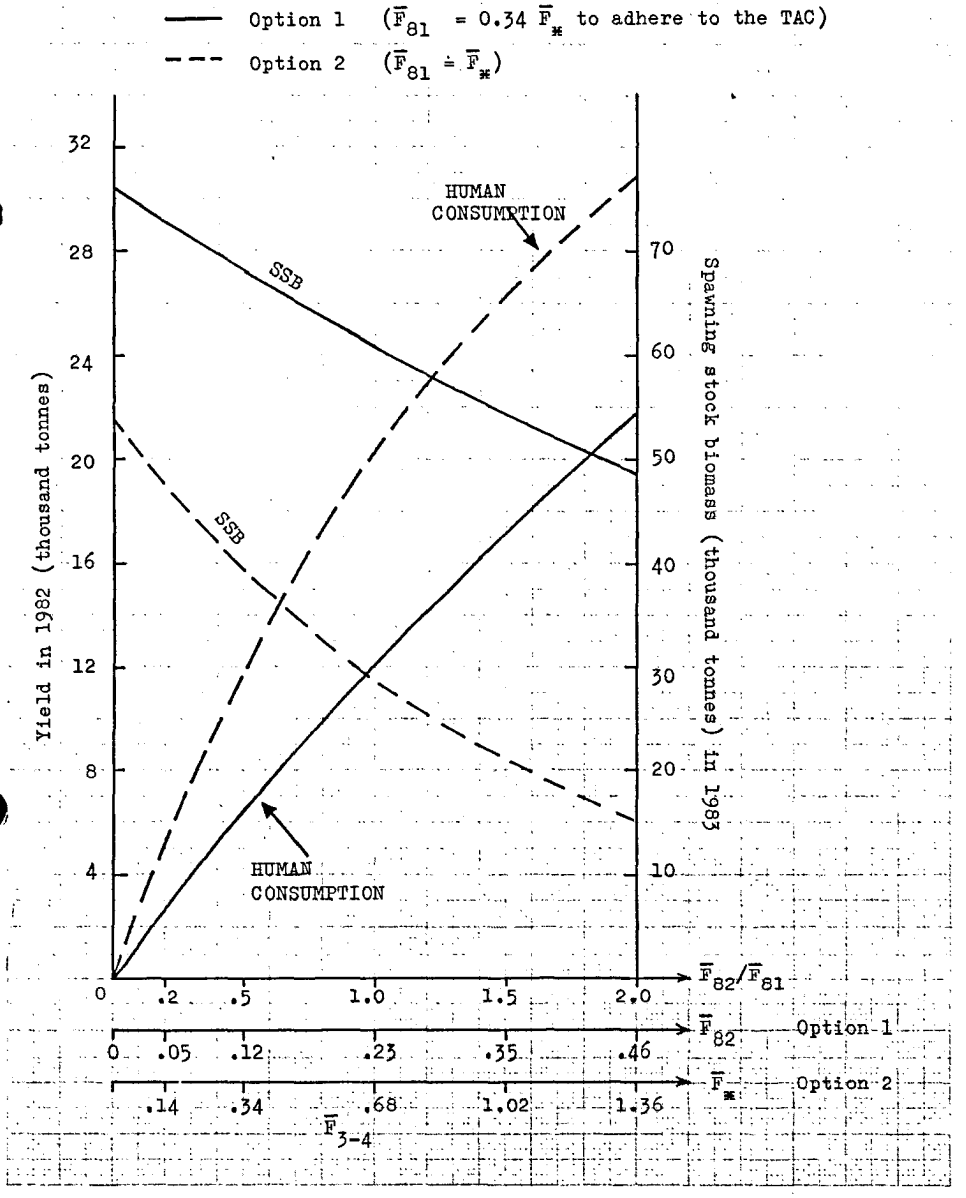


Figure 10.1 North Sea HADDOCK.

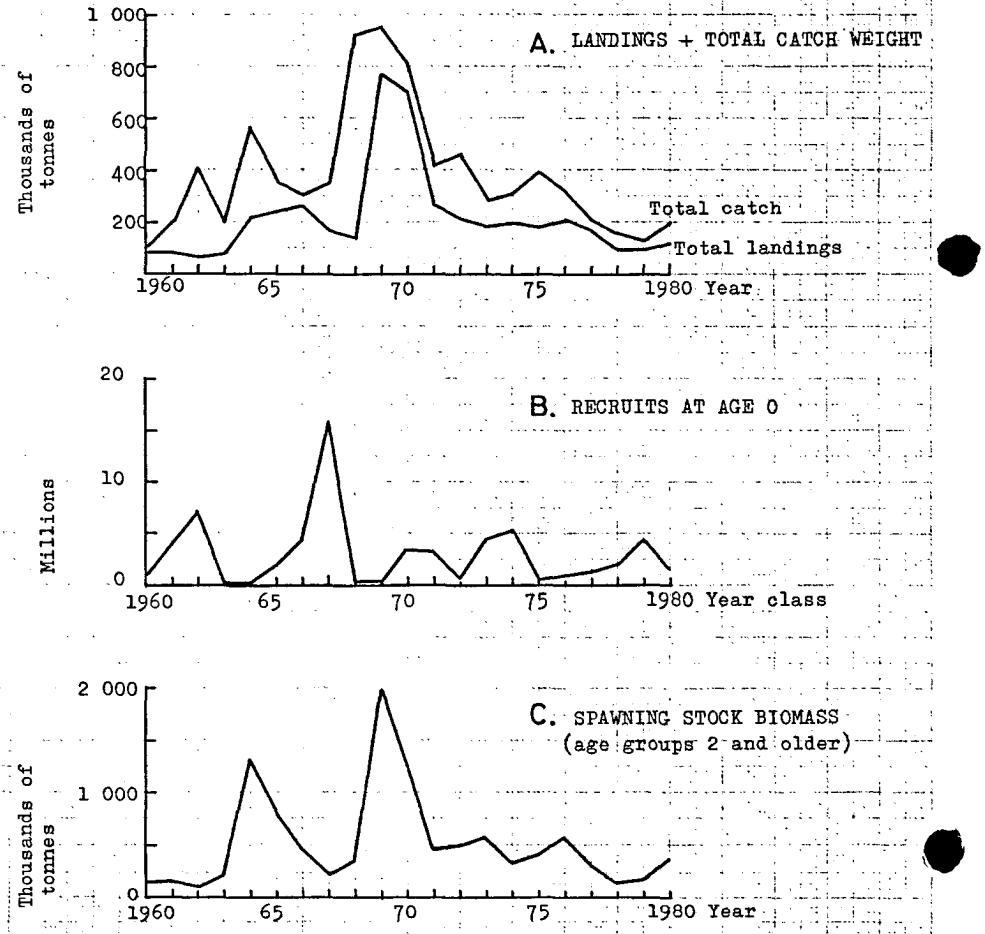
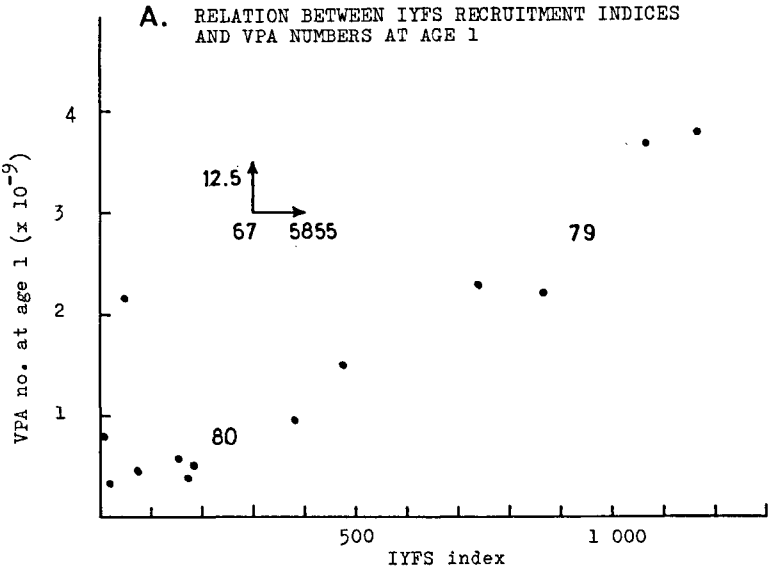


Figure 10.2 North Sea HADDOCK.



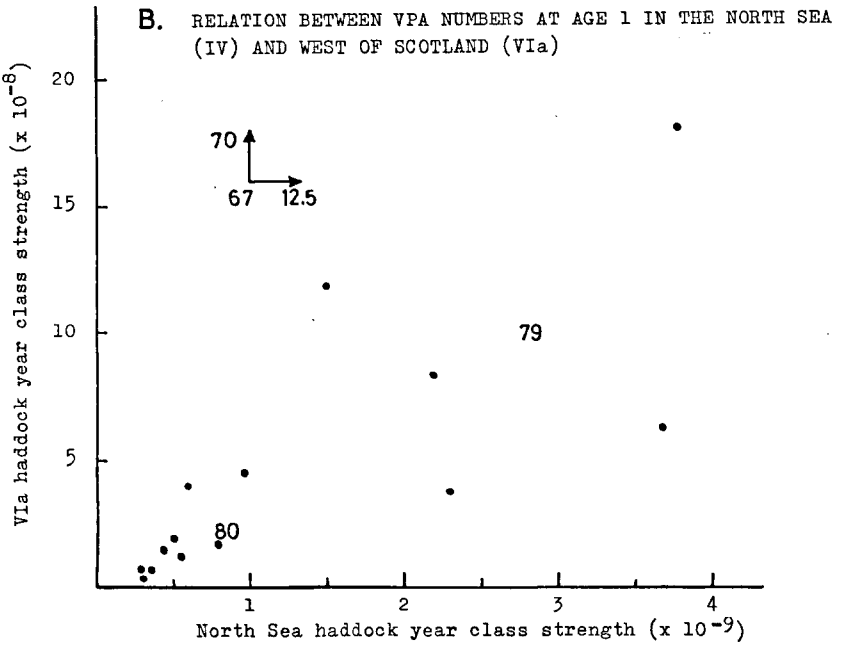


Figure 10.3 North Sea HADDOCK.
Equilibrium yield for average recruitment.

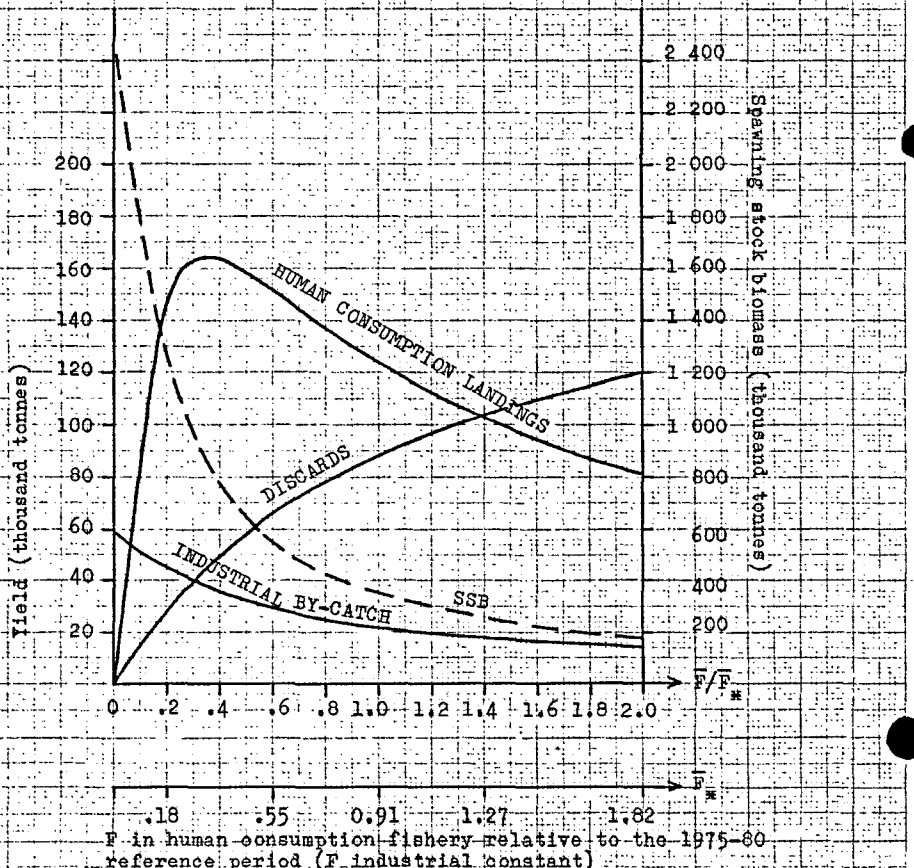


Figure 10.4 North Sea HADDOCK.
Predictions for catch in 1982 and spawning stock biomass in 1983.

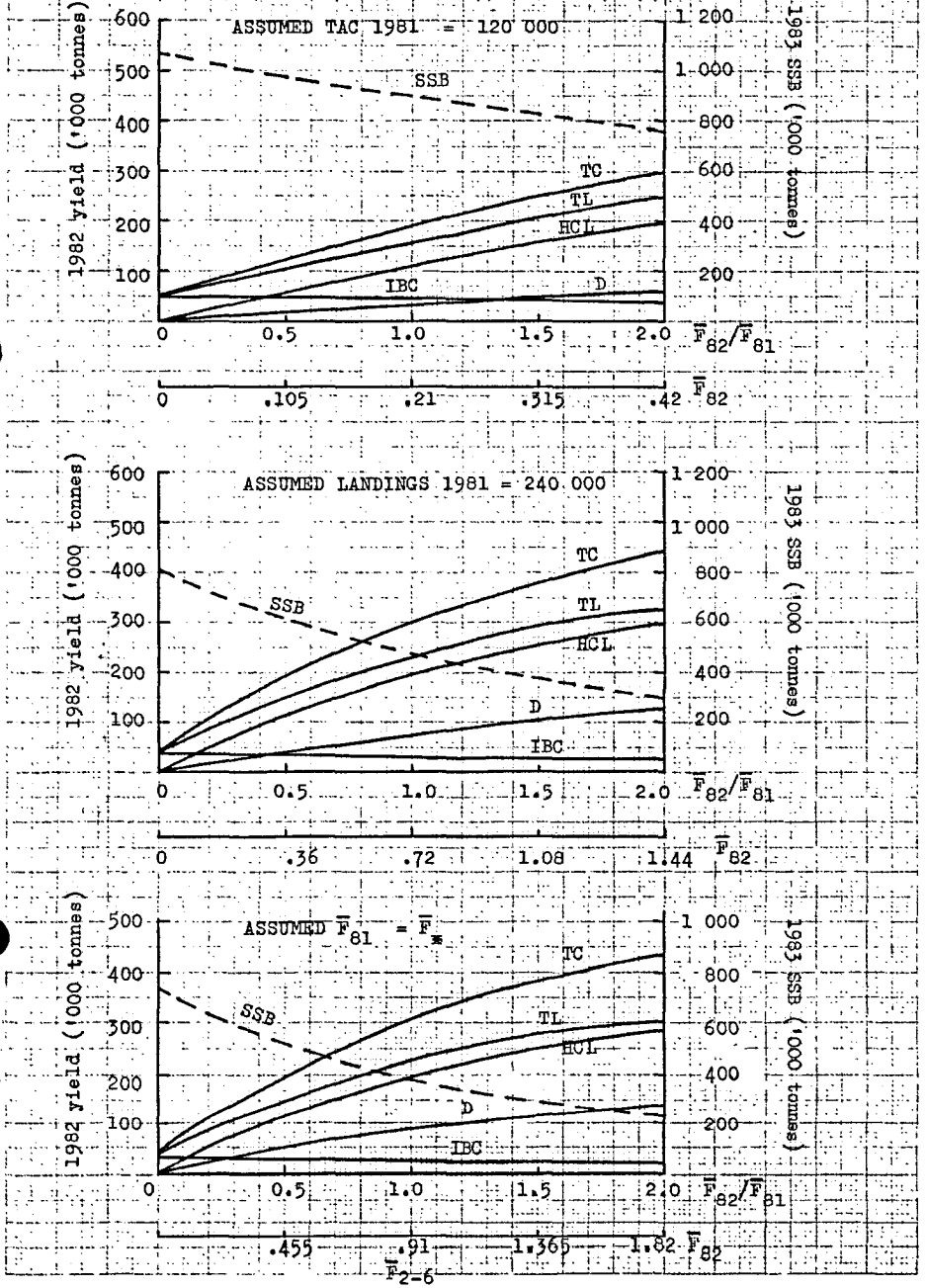


Figure 11.1 HADDOCK in Division VIa.

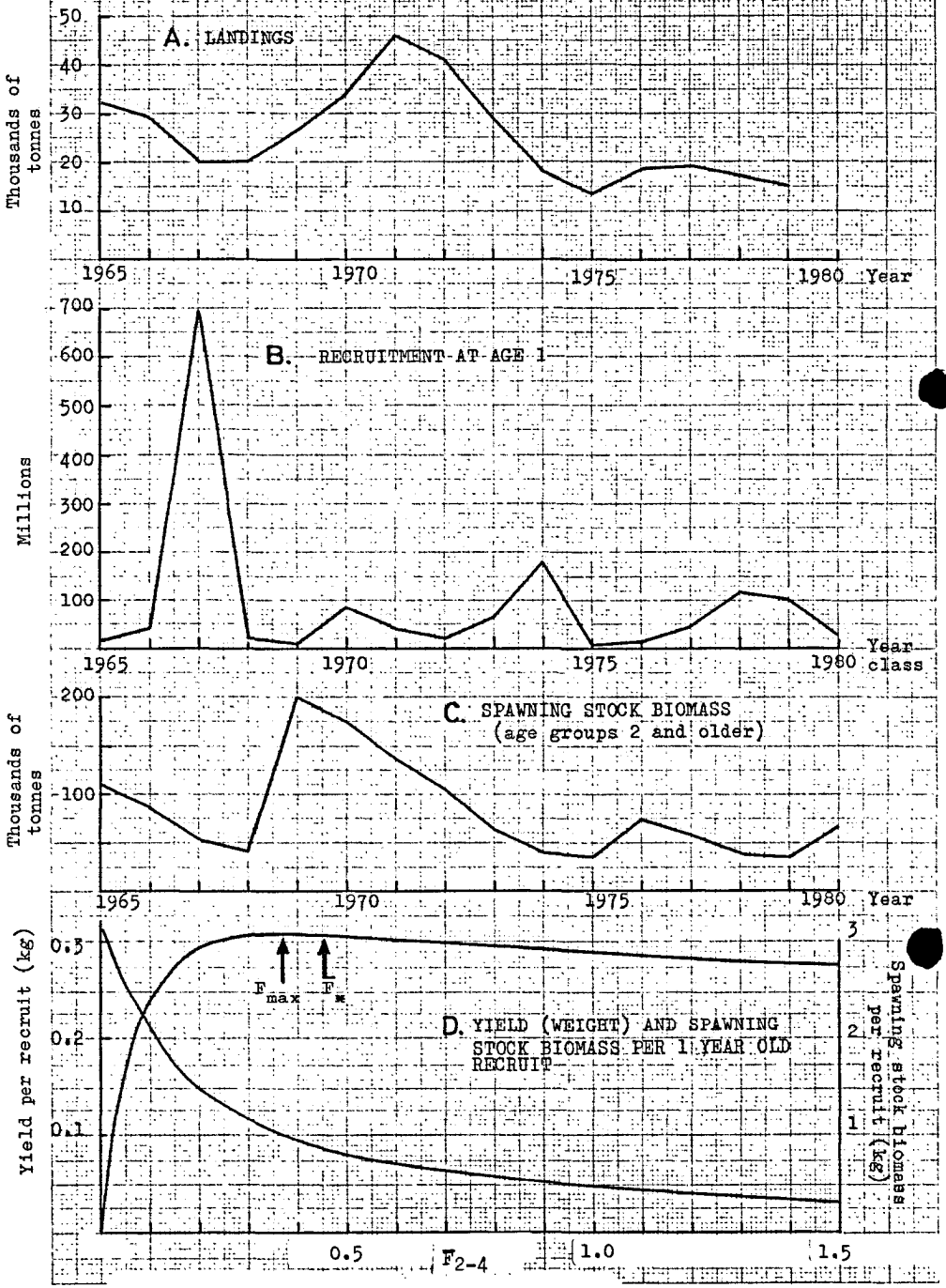


Figure 11.2 HADDOCK in Division VIa. Predictions for catch in 1982 and spawning stock biomass in 1983. Average 1975-80 exploitation pattern.

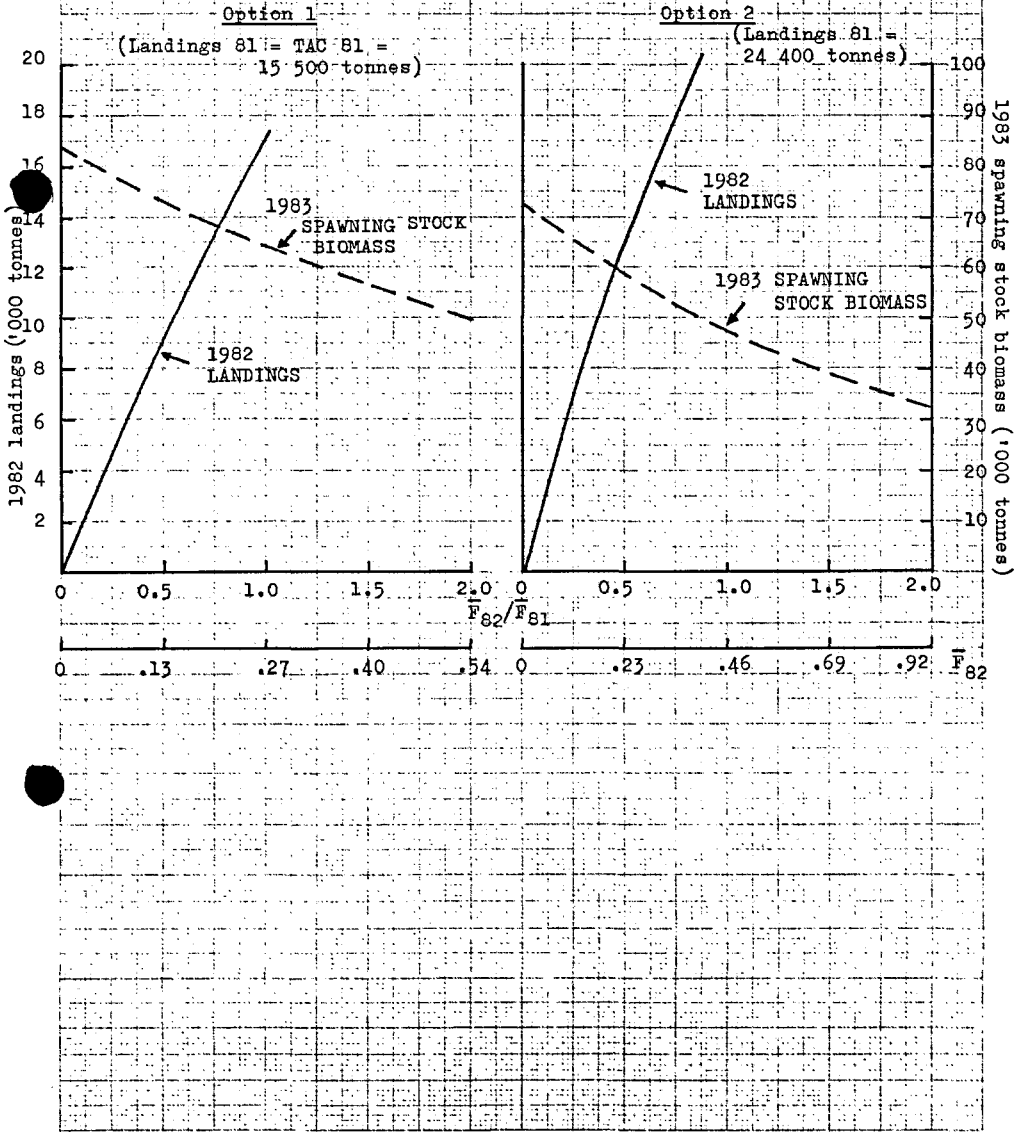


Figure 14.1 North Sea WHITING.

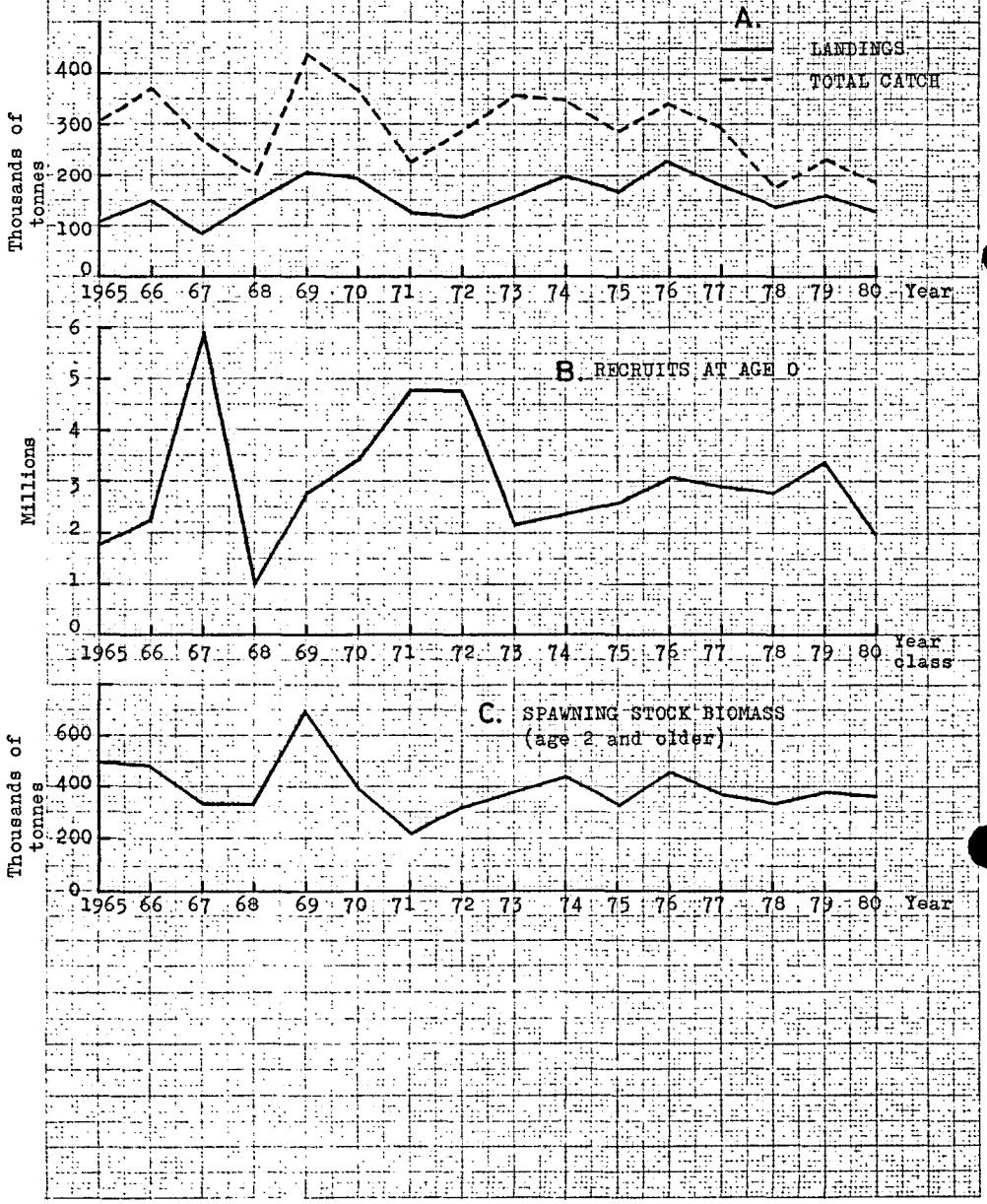
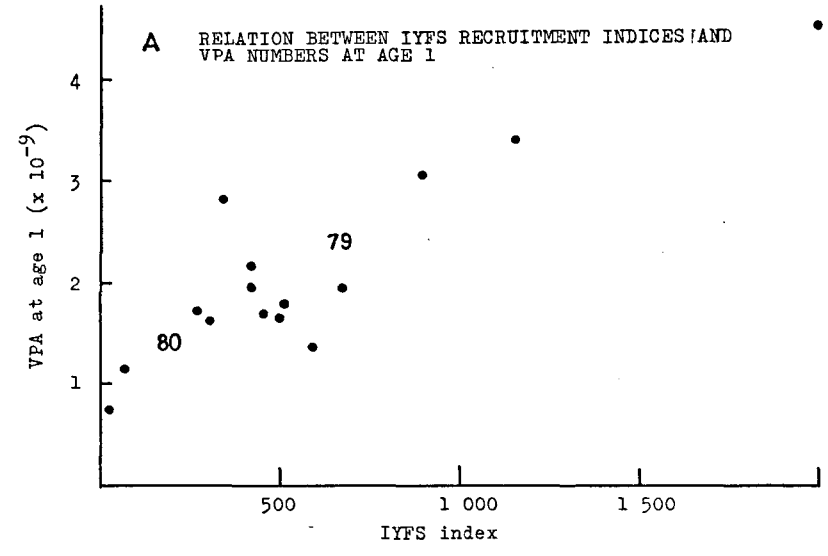


Figure 14.2 North Sea WHITING.



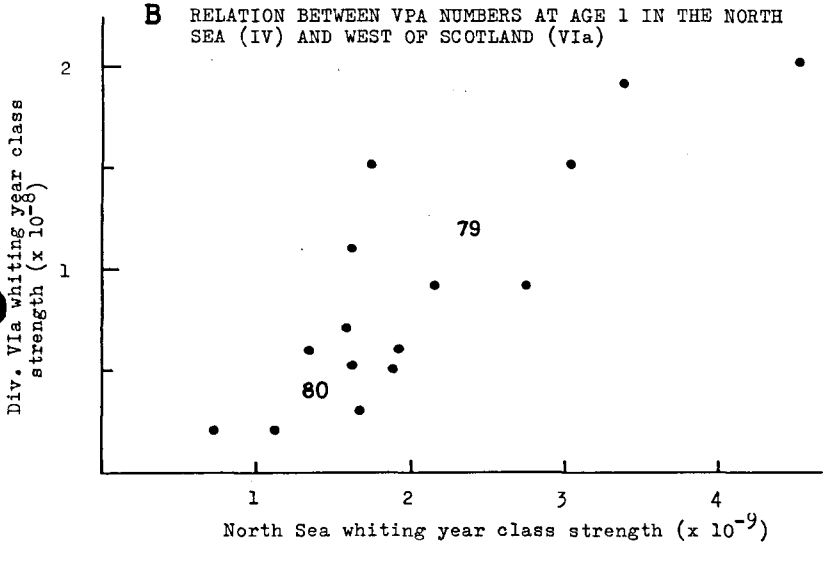
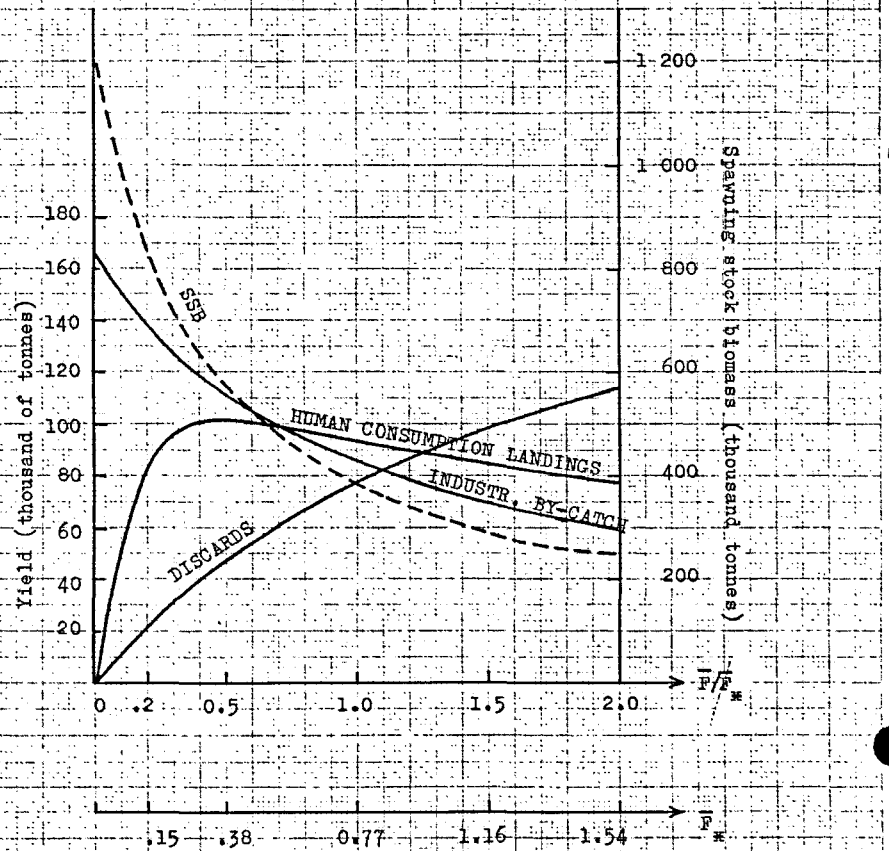


Figure 14.3 North Sea WHITING.
Equilibrium yield for average recruitment.



F in human consumption fishery relative to the 1975-80 reference period (F industrial constant)

AGF
Nr 247

Figure 14.4 North Sea WHITING.
Predictions for catch in 1982 and spawning stock biomass in 1983.

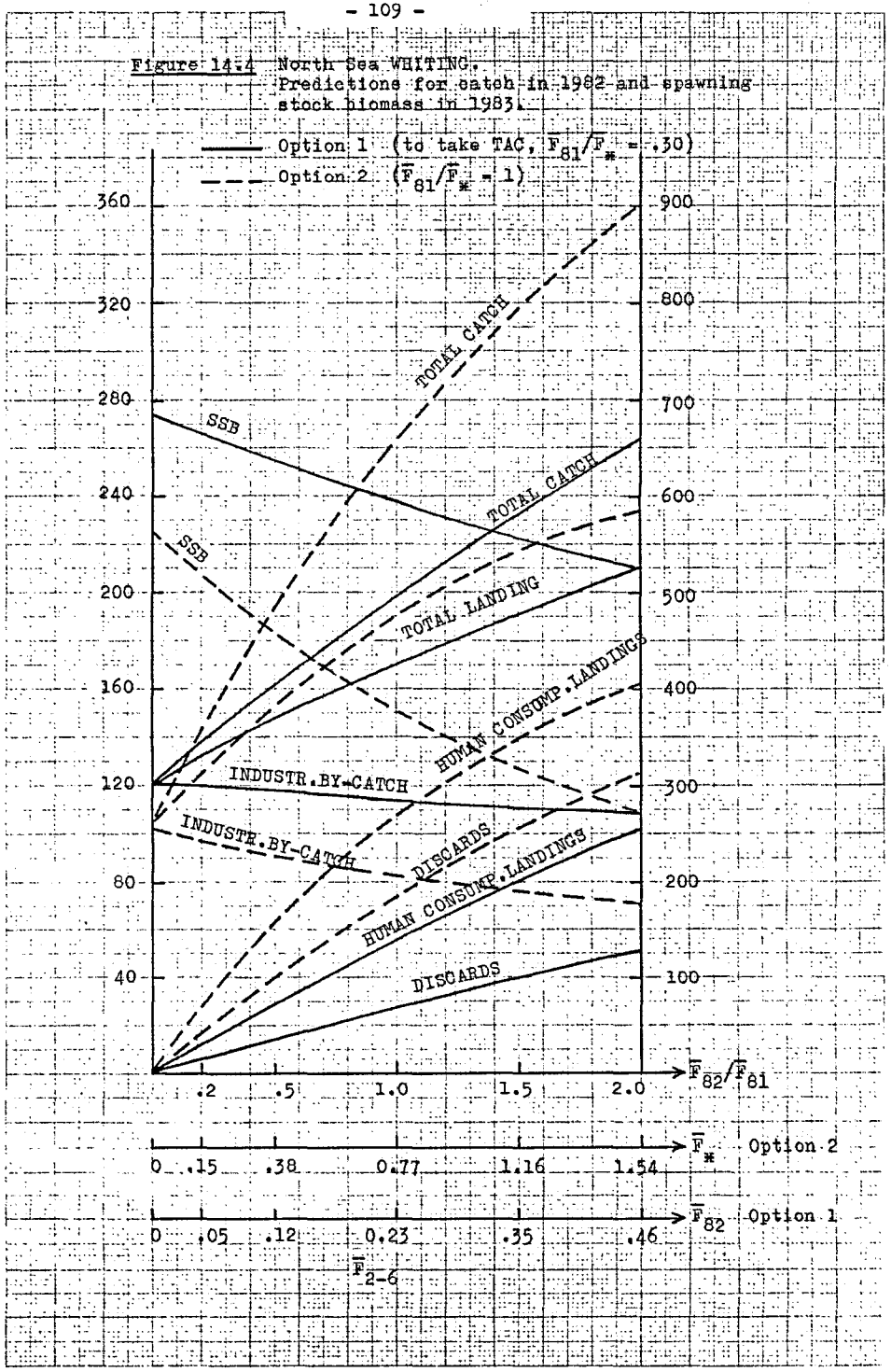


Figure 15.1 WHITING in Division VIa.

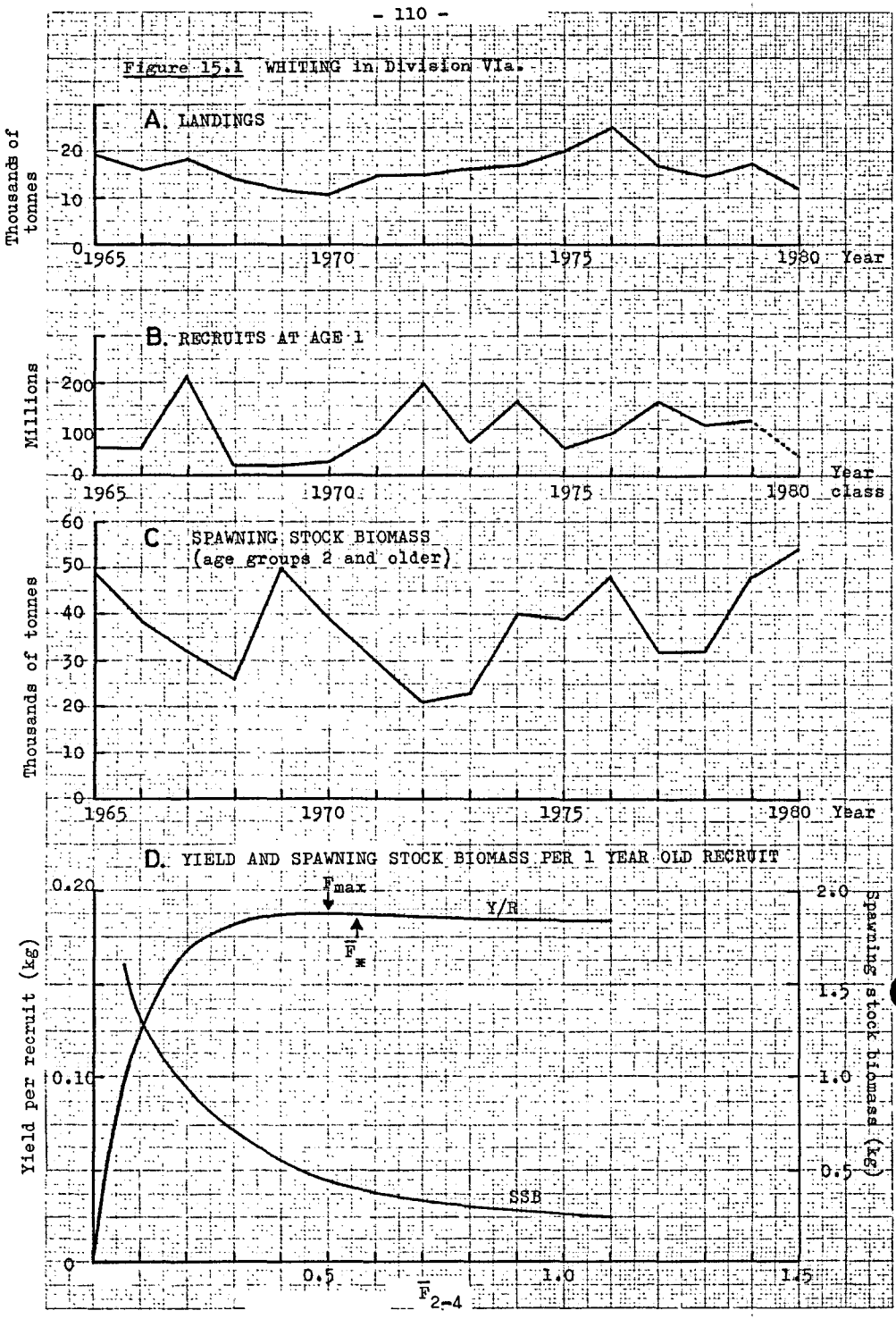
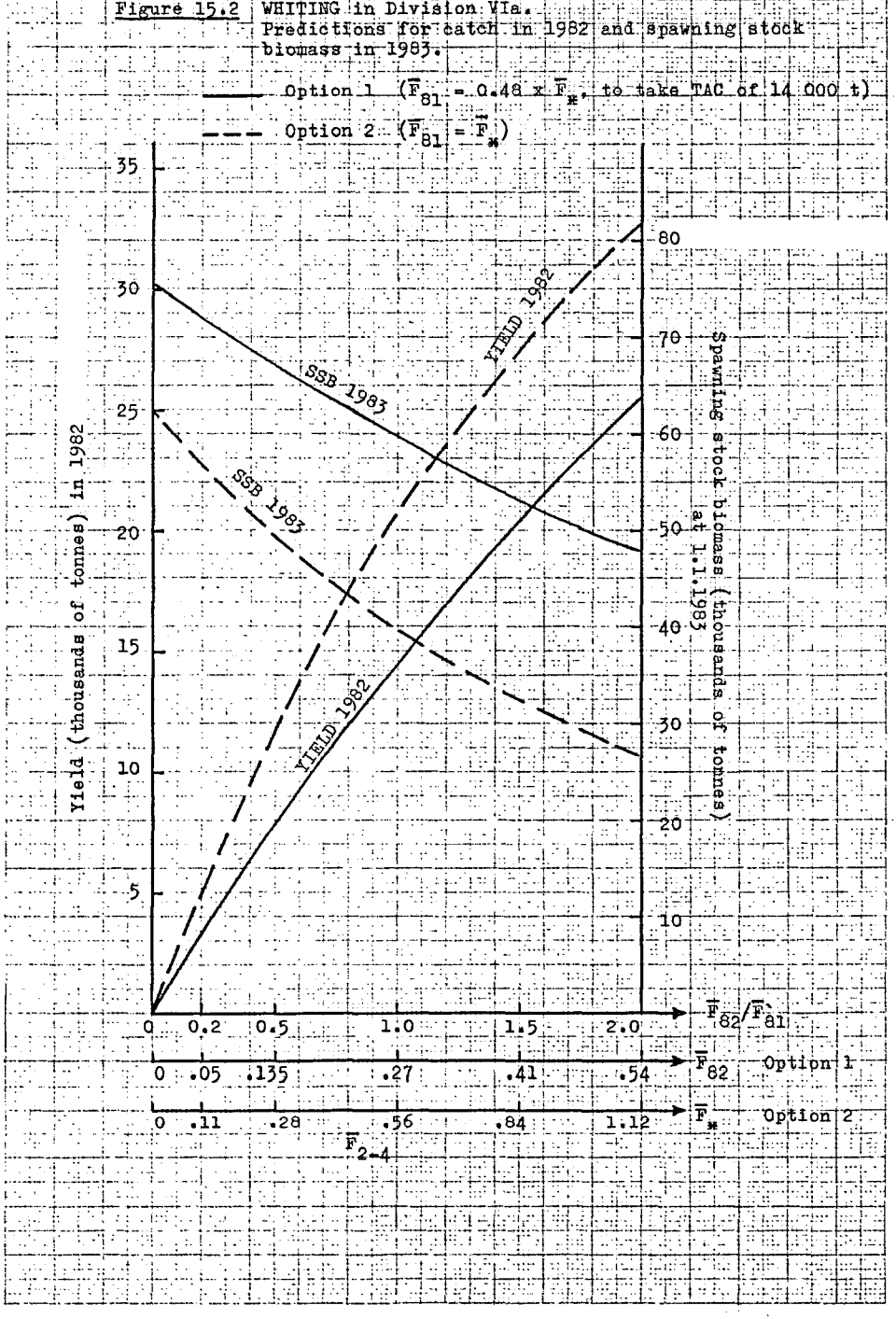


Figure 15.2 WHITING in Division VIa.
Predictions for catch in 1982 and spawning stock biomass in 1983.



APPENDIX 1

ESTIMATION OF TERMINAL Fs

This procedure is an extension to that described by the Effort Data Working Group (Anon., 1980).
The following description is made in "pseudo"-computer language:

A: read for each fleet effort data:

$$E_{yf} \qquad (y = \text{year};\ f = \text{fleet})$$

and number caught by this fleet:

$$C_{yfa} \qquad (a = \text{age})$$

for the years y_o, y_o+1, ... y_1

B: calculate cpue for each age group:

$$CPUE_{yfa} = C_{yfa}/E_{yf}$$

C: calculate relative CPUE for each age group

$$\gamma_{yfa} = CPUE_{yfa}/CPUE_{*fa}$$

* is index for the reference year.

D: calculate combined relative CPUE for all fleets

$$\Gamma_{ya} = \left(\sum_f \gamma_{yfa} C_{yfa}\right)/\sum_f C_{yfa}$$

E: calculate logarithms of scaled Γs

$$\Gamma'_{ya} = \log\left(\Gamma_{ya}/\max_y \left\{\Gamma_{ya}\right\}\right)$$

This scaling is made for representation purposes only.

F: read VPA-input, i.e.
Total numbers caught, C^{VPA}_{ya}, terminal Fs, F_{ya}, and Natural mortalities for the years

$$y = y_o, y_{o+1}, \ldots\ldots y_1$$

G: perform the VPA for the years y_o..... y_1

H: calculate mean stock numbers from VPA-output

$$\bar{N}_{ya} = N^{VPA}_{ya} (1-e^{-Z})/Z$$

N_{ya} = numbers at the begining of year y.

I: calculate log mean Ns for the years

$y = y_o, y_{o+1}, \ldots y_r$ where $y_r < y_1$, i.e.

$$\log (\bar{N}_{ya})$$

J: perform geometric mean regression analysis of

$$\Gamma'_{ya} \quad \text{vs} \quad \log (\bar{N}_{ya})$$

for each age group for the years $y_o, \ldots\ldots y_r$.

α_a and β_a are the intercept and regression coefficient resp.

K: predict $\log (\bar{N}_{y_1,a})$ i.e.

$$\log (\bar{N}_{y_1,a}) = \alpha_a + \beta_a \Gamma'_{y_1,a}$$

L: calculate terminal F in last year

$$\bar{N}_{y_1,a} = \exp (\log(\bar{N}_{y_1,a}))$$
$$F_{y_1,a} = C^{VPA}_{y_1,a} / \bar{N}_{y_1,a}$$

for all age groups.

M: calculate the sum of squares of deviations between the terminal Fs of the current iteration and the previous iteration:

$$\xi = \sum_a (F^{current}_{y_1,a} - F^{previous}_{y_1,a})^2$$

N: if $\xi > .0001$ go to G;

O: print output tables

STOP

The procedure was implemented in FORTRAN on the ICES computer during the Working Group meeting. Thus, the program described above should be considered as a first attempt to implement the method. The Working Group had some doubt about the validity of some aspects of the statistical procedure applied, e.g. the transformation from log $\bar{N}$ to $\bar{N}$ should perhaps have been

$$\bar{N} = \exp (\log \bar{N} + \tfrac{1}{2} s^2)$$

where s^2 is the variance around the regression line. This back transformation would result in higher estimates of $\bar{N}$ and, thus, lower values of $F = C/\bar{N}$. Another point is that effort data were not corrected for fishing power. Assuming fishing power increasing by time, this would produce lower estimates of $\bar{N}$ and thus higher values of $F = C/\bar{N}$ for the most recent years for which predictions are made.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1970	133.445	2710.	587.	1025.	485.	270.	101.	15.	13.	7.	5.	
1971	174.559	1763.	2599.	520.	579.	160.	64.	37.	9.	5.	6.	
1972	201.493	357.	5828.	1646.	183.	317.	76.	43.	15.	4.	2.	
1973	182.541	2809.	1478.	2640.	471.	61.	67.	28.	14.	6.	6.	
1974	185.432	770.	1217.	926.	820.	144.	34.	49.	14.	8.	3.	SCOTLAND
1975	152.977	1791.	1638.	431.	265.	272.	38.	9.	10.	7.	1.	TRAWL
1976	121.841	301.	1377.	677.	152.	85.	87.	11.	4.	3.	2.	
1977	144.348	3556.	616.	840.	228.	70.	31.	31.	6.	5.	2.	
1978	135.220	874.	2540.	289.	182.	64.	16.	12.	7.	5.	1.	
1979	87.467	280.	926.	448.	74.	47.	23.	12.	4.	5.	1.	
1980	55.477	2194.	910.	380.	127.	20.	20.	8.	7.	1.	2.	
1970	426.563	6217.	3065.	3014.	1055.	470.	113.	22.	25.	12.	7.	
1971	416.144	7139.	9687.	644.	705.	587.	205.	71.	16.	9.	9.	
1972	592.432	1282.	20673.	3529.	596.	339.	120.	57.	27.	5.	8.	
1973	414.898	7931.	7600.	6188.	870.	137.	98.	42.	31.	12.	4.	SCOTLAND
1974	549.604	4263.	6513.	1610.	1085.	252.	54.	38.	22.	15.	7.	SEINE
1975	329.432	5869.	8788.	1783.	556.	471.	79.	9.	5.	13.	4.	
1976	307.165	1180.	14529.	2891.	570.	179.	113.	37.	10.	4.	9.	
1977	513.913	3347.	4356.	3069.	714.	177.	51.	35.	24.	6.	2.	
1978	525.246	4844.	20861.	1401.	851.	202.	48.	23.	21.	8.	5.	
1979	516.419	39370.	8360.	5228.	580.	342.	66.	44.	18.	11.	4.	
1980	297.225	12626.	6552.	2342.	829.	144.	90.	53.	15.	9.	4.	
1970	83.529	1033.	326.	397.	93.	33.	10.	2.	2.	0.	0.	
1971	104.901	1485.	1983.	207.	150.	41.	14.	6.	2.	2.	1.	
1972	121.031	277.	4270.	711.	111.	50.	6.	2.	0.	0.	0.	
1973	152.422	2191.	1297.	1904.	202.	20.	25.	12.	1.	4.	0.	
1974	116.982	556.	1203.	438.	376.	40.	5.	8.	3.	1.	2.	SCOTLAND
1975	161.009	2031.	1589.	776.	120.	113.	0.	1.	2.	1.	0.	LIGHT
1976	152.419	401.	3335.	415.	101.	38.	39.	10.	1.	1.	0.	TRAWL
1977	224.824	5660.	1853.	774.	118.	75.	24.	13.	5.	2.	1.	
1978	236.929	3574.	7960.	677.	270.	51.	28.	7.	8.	5.	0.	
1979	287.494	21877.	6066.	1808.	178.	61.	15.	5.	4.	2.	0.	
1980	333.197	10601.	5515.	2052.	536.	70.	58.	15.	4.	5.	1.	
1970	4.069	5964.	1961.	1069.	1401.	883.	265.	166.	25.	35.	22.	
1971	3.946	5143.	13913.	1234.	618.	1056.	488.	188.	74.	29.	5.	
1972	4.372	467.	15552.	4853.	650.	305.	597.	294.	93.	67.	12.	
1973	3.789	5877.	2446.	5707.	1764.	358.	205.	154.	60.	10.	8.	ENGLAND
1974	3.500	1272.	4551.	741.	1865.	709.	177.	69.	61.	56.	7.	MOTOR
1975	2.629	6250.	5759.	1768.	285.	565.	211.	26.	24.	26.	8.	TRAWL
1976	3.107	1379.	9464.	1740.	638.	131.	246.	80.	17.	6.	7.	
1977	3.110	12274.	5728.	2527.	534.	235.	66.	100.	58.	8.	4.	
1978	3.192	5534.	19687.	1567.	903.	279.	105.	40.	51.	14.	2.	
1979	2.986	21179.	11370.	5648.	537.	366.	87.	41.	12.	21.	5.	
1980	1.989	15299.	6049.	2204.	772.	117.	116.	35.	12.	6.	7.	
1970	656.000	4244.	1395.	761.	997.	628.	188.	118.	18.	25.	10.	
1971	695.000	2786.	7536.	852.	534.	572.	265.	102.	40.	16.	2.	
1972	792.000	299.	9964.	3110.	401.	195.	382.	188.	60.	45.	8.	
1973	833.000	5998.	1664.	5881.	1200.	243.	139.	105.	41.	7.	5.	ENGLAND
1974	758.000	743.	2530.	433.	1096.	414.	105.	40.	36.	33.	4.	SEINE
1975	771.000	5361.	3096.	951.	155.	305.	115.	14.	15.	14.	4.	
1976	824.000	1079.	7401.	1361.	499.	102.	210.	62.	13.	5.	5.	
1977	804.000	6240.	708.	409.	94.	41.	12.	18.	7.	1.	1.	
1978	854.000	4186.	14891.	1034.	685.	211.	79.	30.	38.	11.	2.	
1979	767.000	15500.	8321.	2669.	246.	268.	65.	30.	9.	16.	4.	
1980	805.000	15809.	6281.	2289.	802.	122.	121.	36.	15.	6.	0.	

App.1/Table 1. North Sea COD.
Input data for estimation of terminal Fs.
Catch numbers (x 10^{-3}).

YEAR	Age group	1	2	3	4	5	6	7	8	9	10
1970	LOG(GAMMA)	-1.824	-2.195	-0.845	-0.258	0.000	-0.512	-0.341	-1.035	-0.524	0.000
	LOG(MEAN-N)	12.814	10.867	10.051	9.982	9.254	8.080	7.476	6.565	5.605	5.094
1971	LOG(GAMMA)	-1.927	-0.695	-1.724	-0.670	-0.040	-0.165	-0.440	-0.195	-0.901	-0.571
	LOG(MEAN-N)	12.916	12.001	9.941	9.111	9.166	8.483	7.524	6.735	5.945	4.707
1972	LOG(GAMMA)	-3.649	-0.239	-0.411	-1.255	-0.655	0.000	0.000	0.000	0.000	-0.623
	LOG(MEAN-N)	11.189	12.158	10.812	8.993	8.189	8.224	7.653	6.346	5.706	5.131
1973	LOG(GAMMA)	-1.780	-1.358	0.000	-0.233	-1.078	-0.906	-0.581	-0.385	-1.474	-1.014
	LOG(MEAN-N)	11.915	10.580	10.982	9.712	8.151	7.237	7.220	6.744	5.409	4.491
1974	LOG(GAMMA)	-2.380	-1.366	-1.237	0.000	-0.370	-1.122	-1.116	-0.350	-0.174	-0.467
	LOG(MEAN-N)	11.637	11.078	9.625	9.969	8.740	7.361	6.239	6.287	5.829	4.748
1975	LOG(GAMMA)	-1.782	-0.971	-1.047	-1.072	-0.244	-0.794	-2.177	-1.122	-0.801	-0.954
	LOG(MEAN-N)	12.252	10.974	10.041	8.727	9.043	7.849	6.611	5.233	5.311	4.813
1976	LOG(GAMMA)	-3.309	-0.428	-0.745	-1.020	-1.365	-0.391	-1.012	-1.436	-2.000	-0.494
	LOG(MEAN-N)	11.514	11.431	9.925	9.056	7.878	8.082	6.944	6.026	4.289	4.323
1977	LOG(GAMMA)	-1.315	-1.592	-0.681	-0.898	-1.286	-1.581	-0.998	-0.699	-1.957	-1.465
	LOG(MEAN-N)	12.995	10.808	10.501	9.006	8.141	7.095	7.136	5.991	5.139	3.427
1978	LOG(GAMMA)	-1.870	0.000	-1.351	-0.610	-1.114	-1.394	-1.717	-0.368	-1.323	-1.626
	LOG(MEAN-N)	12.391	12.034	9.628	9.339	8.147	7.297	6.275	6.197	4.962	3.897
1979	LOG(GAMMA)	0.000	-0.615	-0.401	-1.410	-0.732	-1.434	-1.406	-1.370	-0.956	-1.131
	LOG(MEAN-N)	12.572	11.599	10.635	8.598	8.426	7.274	6.507	5.474	5.303	3.957
1980	LOG(GAMMA)	-0.759	-0.871	-0.565	-0.401	-1.493	-0.905	-1.386	-1.243	-1.748	-0.739
	LOG(MEAN-N)	13.216	11.416	10.435	9.573	7.744	7.628	6.584	5.810	4.749	4.536
COR.COEFF (R)		0.731	0.828	0.859	0.946	0.955	0.934	0.832	0.638	0.768	0.803
SLOPE		0.814	0.840	0.862	0.946	0.956	0.939	0.866	0.639	0.814	0.808
INTERCEPT		13.833	12.148	10.921	9.952	9.171	8.477	7.784	6.604	6.173	5.133
PREDIC. MEAN-N		548937.	90741.	34019.	14371.	2308.	2055.	723.	334.	116.	93.
PREDICTED F		0.412	1.112	0.867	0.671	0.642	0.503	0.531	0.479	0.589	0.482

App.1/Table 2 North Sea COD.
Geometric mean regression analysis for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1970	133.445	68.	8113.	86237.	2747.	150.	82.	26.	431.	5.	0.	
1971	174.559	85632.	4467.	8090.	80228.	1774.	121.	34.	45.	432.	27.	
1972	201.495	105655.	69149.	4264.	3906.	31036.	728.	32.	7.	10.	44.	
1973	182.541	10435.	47958.	33452.	809.	855.	6342.	149.	18.	2.	20.	
1974	185.432	222660.	8291.	31135.	6905.	163.	205.	1562.	35.	4.	7.	
1975	152.977	94929.	66943.	7785.	16511.	2015.	73.	57.	585.	15.	7.	SCOTLAND TRAWL
1976	121.841	7161.	66577.	22005.	1263.	3030.	596.	16.	0.	90.	10.	
1977	144.348	14510.	8643.	45156.	7611.	447.	1006.	179.	20.	5.	55.	
1978	135.220	41045.	14543.	2283.	16936.	1742.	174.	332.	61.	16.	2.	
1979	87.467	6126.	13667.	4001.	757.	4471.	327.	56.	71.	28.	9.	
1980	55.477	1686.	21487.	5704.	1064.	192.	1159.	104.	11.	18.	4.	
1970	426.565	436.	18710.	188723.	6803.	85.	154.	36.	777.	4.	3.	
1971	416.144	122057.	9987.	13326.	109062.	2460.	82.	36.	37.	249.	44.	
1972	392.432	152582.	104850.	8649.	4048.	39723.	911.	53.	7.	3.	110.	
1973	414.898	24752.	120189.	63564.	1982.	1042.	9872.	351.	42.	7.	39.	SCOTLAND SEINE
1974	349.604	540844.	22404.	78275.	12975.	441.	234.	2390.	48.	3.	8.	
1975	329.432	231344.	164946.	20706.	35067.	4081.	151.	110.	530.	22.	11.	
1976	307.165	22331.	225408.	57334.	2564.	8098.	1026.	54.	13.	146.	10.	
1977	313.913	40479.	33521.	131182.	13099.	1689.	1480.	347.	24.	7.	64.	
1978	325.246	136516.	61528.	14572.	44653.	2396.	479.	673.	86.	29.	5.	
1979	316.419	92774.	77521.	17680.	3100.	8213.	659.	71.	115.	24.	4.	
1980	297.225	105612.	133024.	26178.	3394.	501.	2416.	123.	20.	55.	25.	
1970	83.529	30.	1399.	16652.	360.	4.	5.	1.	83.	0.	0.	
1971	104.901	20258.	1612.	1642.	16017.	347.	12.	18.	6.	45.	12.	
1972	121.031	29215.	16844.	2239.	1058.	7914.	157.	13.	1.	1.	28.	
1973	152.422	4620.	22521.	8923.	246.	203.	1591.	48.	3.	1.	6.	SCOTLAND LIGHT TRAWL
1974	116.982	90927.	4371.	13474.	2278.	31.	21.	283.	6.	0.	1.	
1975	161.309	53768.	41292.	4389.	7623.	605.	13.	14.	77.	3.	1.	
1976	152.419	4410.	46760.	10711.	647.	1764.	328.	7.	5.	45.	1.	
1977	224.824	11729.	7086.	41283.	3436.	391.	787.	99.	15.	2.	5.	
1978	236.929	34300.	12941.	2720.	11927.	781.	105.	167.	24.	4.	0.	
1979	287.494	29616.	24014.	4114.	750.	3913.	218.	21.	61.	22.	0.	
1980	333.197	94526.	46573.	8036.	754.	197.	1014.	60.	18.	8.	5.	
1970	62.579	2.	138.	1852.	71.	1.	1.	0.	3.	0.	0.	
1971	72.909	1114.	89.	100.	744.	12.	1.	0.	0.	2.	0.	
1972	70.077	1038.	832.	39.	26.	240.	5.	0.	0.	0.	0.	SCOTLAND NEPHROPS TRAWL
1973	80.369	193.	1096.	340.	73.	6.	39.	1.	0.	0.	0.	
1974	127.264	2959.	135.	400.	52.	0.	0.	58.	0.	0.	0.	
1975	118.303	993.	770.	93.	135.	8.	0.	0.	1.	0.	0.	
1976	140.776	202.	2590.	399.	19.	46.	7.	0.	1.	1.	0.	
1977	96.190	193.	111.	708.	44.	9.	15.	2.	0.	0.	0.	
1978	100.650	385.	150.	108.	76.	4.	1.	1.	0.	0.	0.	
1979	113.256	581.	440.	28.	3.	21.	3.	0.	1.	0.	0.	
1980	102.025	2045.	730.	97.	7.	1.	14.	1.	0.	0.	0.	

App.1/Table 3. North Sea HADDOCK.
Input data for estimation of terminal Fs.
Catch number ($\times 10^{-3}$).

YEAR		1	2	3	4	5	6	7	8	9	10
1970	LOG(GAMMA)	-7.982	-2.664	0.000	-2.945	-5.467	-4.167	-4.343	0.000	-4.744	-4.065
	LOG(MEAN-N)	12.243	12.175	14.251	10.687	7.566	6.864	6.592	8.627	6.033	2.755
1971	LOG(GAMMA)	-0.710	-3.277	-2.618	0.000	-2.846	-4.421	-3.651	-2.895	0.000	-0.740
	LOG(MEAN-N)	14.196	11.333	10.931	12.997	9.375	6.807	5.653	6.041	7.403	5.426
1972	LOG(GAMMA)	-0.644	-0.818	-2.904	-3.006	0.000	-2.325	-3.775	-4.663	-3.855	0.000
	LOG(MEAN-N)	14.314	13.273	10.259	9.740	11.798	8.310	6.149	4.979	5.609	6.351
1973	LOG(GAMMA)	-3.086	-0.860	-1.150	-3.671	-3.678	0.000	-2.056	-2.979	-4.231	-1.303
	LOG(MEAN-N)	12.807	13.626	12.155	8.919	8.445	10.452	7.235	5.545	4.510	5.039
1974	LOG(GAMMA)	0.000	-2.401	-0.808	-2.082	-4.592	-3.612	0.000	-2.703	-4.757	-2.552
	LOG(MEAN-N)	14.593	12.033	12.797	10.876	7.987	7.341	9.118	6.349	5.059	3.822
1975	LOG(GAMMA)	-0.723	-0.312	-2.080	-1.023	-2.269	-4.040	-3.040	-0.219	-2.902	-2.349
	LOG(MEAN-N)	14.792	13.361	10.852	11.583	9.669	7.092	6.088	7.782	5.445	4.468
1976	LOG(GAMMA)	-3.179	0.000	-0.992	-3.471	-1.435	-1.826	-3.605	-3.806	-0.517	-1.937
	LOG(MEAN-N)	12.481	13.929	11.941	9.407	10.113	8.415	6.295	4.875	6.526	4.308
1977	LOG(GAMMA)	-2.619	-2.024	-0.150	-1.966	-3.074	-1.368	-1.791	-3.116	-3.796	-0.628
	LOG(MEAN-N)	12.849	11.532	12.826	10.471	8.363	8.811	7.262	5.739	4.237	5.450
1978	LOG(GAMMA)	-1.568	-1.449	-2.520	-0.787	-2.627	-2.832	-1.179	-2.014	-2.680	-3.540
	LOG(MEAN-N)	13.365	11.848	10.330	11.591	9.279	7.289	7.745	6.304	5.001	3.535
1979	LOG(GAMMA)	-2.828	-1.132	-2.262	-3.480	-1.258	-2.379	-3.319	-1.594	-1.533	-1.629
	LOG(MEAN-N)	13.978	12.436	10.666	9.258	10.510	8.139	6.379	6.886	5.480	4.070
1980	LOG(GAMMA)	-2.583	-0.518	-1.748	-3.305	-4.093	-0.926	-2.513	-3.129	-1.908	-1.666
	LOG(MEAN-N)	13.267	13.414	11.506	9.532	7.947	9.715	7.006	5.590	6.342	4.725
COR.COEFF (R)		0.805	0.871	0.953	0.961	0.971	0.971	0.912	0.966	0.690	0.959
SLOPE		1.161	0.881	0.976	0.961	0.997	0.996	0.952	0.989	0.817	0.978
INTERCEPT		16.272	13.870	13.212	12.708	12.026	10.637	9.399	8.686	7.901	6.355
PREDIC. MEAN-N		577631.	669212.	99304.	13799.	2827.	16569.	1104.	268.	568.	113.
PREDICTED F		1.111	0.453	0.686	0.898	1.602	0.454	0.625	0.601	0.234	0.603

App.1/Table 4 North Sea HADDOCK.
Geometric mean regression analysis for the estimation of terminal Fs.

YE	EFFORT	AGE 1	2	3	4	5	6	7	8	9	
1970	133.445	5123.	7214.	38002.	2909.	503.	165.	15.	212.	10.	
1971	174.559	15789.	20849.	1971.	16116.	1956.	201.	54.	0.	81.	
1972	201.495	25478.	48248.	4986.	548.	7925.	987.	95.	38.	10.	
1973	182.541	28429.	40248.	12647.	1066.	124.	2271.	226.	25.	10.	SCOTLAND
1974	185.432	6685.	33168.	12361.	1866.	288.	37.	540.	37.	5.	TRAWL
1975	152.977	2192.	5168.	12588.	2150.	299.	42.	7.	121.	12.	
1976	121.841	277.	8199.	2858.	3940.	690.	121.	14.	0.	29.	
1977	144.348	882.	6380.	13329.	1528.	2352.	211.	26.	2.	2.	
1978	135.220	2270.	12979.	15501.	8632.	550.	752.	71.	9.	0.	
1979	87.467	2856.	14814.	11068.	7828.	2945.	106.	212.	25.	1.	
1980	55.477	531.	10554.	10239.	3655.	2485.	950.	47.	25.	5.	
1970	426.563	17135.	27069.	125957.	10411.	1647.	726.	75.	387.	44.	
1971	416.144	49957.	65792.	7581.	47095.	5484.	593.	177.	13.	164.	
1972	392.432	58032.	115502.	11142.	1414.	15954.	2909.	1780.	33.	10.	
1973	414.898	65213.	93510.	31285.	3121.	351.	4434.	511.	77.	25.	SCOTLAND
1974	349.604	19080.	86473.	37786.	6628.	968.	110.	1194.	79.	13.	SEINE
1975	329.432	22981.	27294.	38967.	9845.	837.	105.	19.	292.	34.	
1976	307.165	5583.	51258.	11497.	10543.	1890.	264.	43.	0.	73.	
1977	313.913	23106.	59814.	37308.	3390.	2539.	371.	31.	10.	1.	
1978	325.246	14435.	28532.	43515.	15313.	1058.	1409.	201.	36.	0.	
1979	316.419	140285.	45493.	28504.	14808.	6030.	678.	157.	5.	0.	
1980	297.225	18227.	47919.	33811.	13290.	9645.	2540.	411.	295.	18.	
1970	83.529	2266.	3596.	15452.	1322.	202.	110.	9.	125.	8.	
1971	104.901	9958.	13076.	1461.	8155.	1102.	139.	62.	4.	29.	
1972	121.031	17803.	35938.	3640.	501.	4483.	605.	80.	18.	4.	
1973	152.422	21800.	30820.	9567.	920.	108.	1539.	191.	39.	6.	
1974	116.982	5614.	25513.	9174.	1454.	218.	17.	428.	35.	7.	SCOTLAND
1975	161.009	10689.	12413.	18594.	3410.	425.	34.	5.	186.	21.	LIGHT
1976	152.419	2999.	25609.	4963.	4929.	876.	195.	18.	1.	44.	TRAWL
1977	224.824	17145.	47732.	27690.	1675.	2379.	460.	34.	18.	0.	
1978	236.944	9249.	20232.	30633.	14478.	956.	1612.	635.	72.	6.	
1979	287.494	116228.	39212.	22582.	17820.	4104.	377.	285.	57.	5.	
1980	333.197	21621.	46713.	33139.	9192.	7755.	1958.	171.	147.	3.	
1970	62.579	723.	1250.	4777.	290.	72.	27.	3.	13.	3.	
1971	72.909	1102.	1516.	189.	1012.	98.	12.	5.	0.	1.	
1972	70.077	642.	1228.	128.	18.	166.	18.	1.	1.	0.	
1973	80.369	1298.	1836.	566.	55.	6.	82.	8.	2.	0.	SCOTLAND
1974	127.264	390.	1674.	729.	115.	24.	1.	39.	1.	0.	NEPHROPS
1975	118.308	547.	576.	729.	199.	32.	2.	0.	11.	1.	TRAWL
1976	140.776	292.	2050.	423.	365.	99.	17.	0.	0.	5.	
1977	96.190	1056.	2717.	1302.	113.	150.	56.	3.	4.	0.	
1978	100.636	423.	1036.	1225.	355.	17.	34.	27.	2.	1.	
1979	113.256	3778.	1553.	598.	527.	67.	5.	2.	1.	1.	
1980	102.023	1681.	2819.	1657.	398.	399.	53.	1.	1.	0.	

App.1/Table 5 North Sea WHITING.
Input data for estimation of terminal Fs.
Catch numbers (x 10^{-3}).

YEAR	Age	1	2	3	4	5	6	7	8	9
1970	LOG(GAMMA)	-1.623	-1.530	0.000	-1.500	-2.338	-1.805	-2.790	0.000	-1.512
	LOG(MEAN-N)	13.470	11.684	13.412	11.082	9.594	8.092	6.753	7.269	4.973
1971	LOG(GAMMA)	-0.669	-0.665	-2.829	0.000	-1.159	-2.042	-2.002	-4.005	-0.308
	LOG(MEAN-N)	14.109	12.351	10.271	12.116	10.070	8.730	6.797	5.291	6.169
1972	LOG(GAMMA)	-0.274	0.000	-2.336	-3.300	0.000	-0.491	-0.380	-2.127	-2.447
	LOG(MEAN-N)	14.527	13.287	11.201	9.169	11.015	8.940	7.495	5.837	4.216
1973	LOG(GAMMA)	-0.137	-0.257	-1.395	-2.671	-3.890	0.000	-1.147	-1.950	-2.131
	LOG(MEAN-N)	14.729	13.602	11.920	10.238	8.067	9.793	7.451	5.445	4.850
1974	LOG(GAMMA)	-1.519	-0.222	-1.090	-1.824	-2.781	-3.698	-0.084	-1.841	-1.657
	LOG(MEAN-N)	13.912	13.789	12.239	10.401	9.494	6.422	8.473	6.098	4.057
1975	LOG(GAMMA)	-1.791	-1.285	-0.905	-1.315	-2.694	-3.637	-4.547	-0.336	-0.763
	LOG(MEAN-N)	14.659	12.974	12.446	10.790	9.009	8.176	4.404	7.056	5.061
1976	LOG(GAMMA)	-3.131	-0.546	-2.080	-1.053	-1.835	-2.195	-3.477	-5.103	0.000
	LOG(MEAN-N)	14.243	13.772	11.715	11.081	9.534	7.587	6.076	2.831	5.779
1977	LOG(GAMMA)	-1.745	-0.321	-0.846	-2.309	-1.218	-1.509	-2.737	-1.395	-4.584
	LOG(MEAN-N)	14.172	13.591	12.500	10.316	9.768	8.292	6.244	4.197	1.492
1978	LOG(GAMMA)	-2.170	-1.141	-0.752	-0.461	-2.261	-0.476	0.000	-1.596	-1.584
	LOG(MEAN-N)	14.143	13.339	12.761	11.389	9.171	8.503	6.736	4.794	2.051
1979	LOG(GAMMA)	0.000	-0.656	-1.128	-0.356	-0.643	-1.688	-0.883	-1.602	-2.129
	LOG(MEAN-N)	13.995	13.490	12.491	12.003	10.423	8.125	7.346	4.973	3.065
1980	LOG(GAMMA)	-1.898	-0.554	-0.863	-0.844	-0.181	-0.187	-1.501	-0.895	-2.464
	LOG(MEAN-N)	14.014	13.264	12.557	11.482	11.344	9.572	7.056	6.215	3.569
COR.COEFF (R)		0.200	0.670	0.976	0.966	0.955	0.786	0.860	0.751	0.789
SLOPE		0.307	0.700	0.977	0.983	1.016	0.834	0.916	0.760	0.801
INTERCEPT		14.596	13.652	13.400	12.312	11.527	9.728	8.430	6.895	5.542
PREDIC. MEAN-N		1220138.	575967.	284082.	96987.	84435.	14363.	1160.	500.	35.
PREDICTED F		0.236	0.561	0.856	0.828	0.375	0.526	0.795	1.179	0.987

App.1/Table 6 North Sea WHITING.
Geometric mean regression analysis for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	
1970	40.572	35.	35.	190.	123.	119.	42.	7.	6.	
1971	41.234	62.	179.	23.	141.	50.	32.	14.	6.	
1972	55.536	46.	498.	159.	32.	89.	11.	9.	1.	
1973	51.155	6.	26.	90.	35.	7.	14.	6.	2.	
1974	45.899	71.	192.	100.	228.	29.	10.	12.	3.	
1975	37.080	22.	175.	82.	40.	59.	13.	3.	4.	SCOTLAND TRAWL
1976	35.307	41.	204.	149.	49.	39.	41.	7.	1.	
1977	33.948	98.	69.	75.	27.	12.	9.	6.	2.	
1978	51.582	36.	256.	76.	107.	53.	20.	9.	5.	
1979	33.375	16.	109.	103.	54.	29.	15.	4.	2.	
1980	19.660	160.	141.	75.	36.	7.	6.	2.	3.	

App.1/Table 7 COD in Division VIa.
Input data for estimation of terminal Fs.
Catch numbers (x 10^{-3}).

YEAR		1	2	3	4	5	6	7	8
1970	LOG(GAMMA)	-2.244	-2.341	0.000	-0.494	0.000	-0.115	-0.677	-0.031
	LOG(MEAN-N)	8.435	7.605	7.789	6.665	6.500	5.646	4.587	4.020
1971	LOG(GAMMA)	-1.689	-0.725	-2.128	-0.373	-0.883	-0.403	0.000	-0.048
	LOG(MEAN-N)	8.970	8.098	7.141	7.116	5.804	5.738	4.976	3.940
1972	LOG(GAMMA)	-2.285	0.000	-0.492	-2.154	-0.604	-1.769	-0.740	-2.137
	LOG(MEAN-N)	8.254	8.342	7.479	6.336	6.253	5.059	4.988	4.207
1973	LOG(GAMMA)	-4.240	-2.870	-0.979	-1.982	-3.065	-1.445	-1.063	-1.362
	LOG(MEAN-N)	8.737	7.939	7.884	6.645	5.351	5.243	4.280	4.207
1974	LOG(GAMMA)	-1.660	-0.763	-0.765	0.000	-1.535	-1.673	-0.261	-0.848
	LOG(MEAN-N)	8.880	8.315	7.439	7.100	5.736	4.507	4.233	3.448
1975	LOG(GAMMA)	-2.619	-0.642	-0.750	-1.527	-0.612	-1.198	-1.434	-0.347
	LOG(MEAN-N)	9.315	8.417	7.594	6.724	6.272	4.915	3.884	3.301
1976	LOG(GAMMA)	-1.947	-0.440	-0.104	-1.275	-0.977	0.000	-0.538	-1.684
	LOG(MEAN-N)	8.634	8.698	7.691	6.749	5.867	5.435	4.021	3.247
1977	LOG(GAMMA)	-1.036	-1.484	-0.751	-1.832	-2.116	-1.477	-0.653	-0.952
	LOG(MEAN-N)	9.066	8.073	7.774	6.874	5.858	5.028	4.554	2.922
1978	LOG(GAMMA)	-2.456	-0.592	-1.156	-0.873	-1.049	-1.097	-0.666	-0.454
	LOG(MEAN-N)	9.093	8.647	7.384	6.899	6.025	4.973	4.214	3.758
1979	LOG(GAMMA)	-2.832	-1.010	-0.417	-1.584	-1.216	-0.949	-1.041	-0.935
	LOG(MEAN-N)	9.617	8.740	7.932	6.308	5.873	5.040	4.169	3.321
1980	LOG(GAMMA)	0.000	-0.223	-0.205	-0.998	-2.109	-1.536	-1.205	0.000
	LOG(MEAN-N)	8.789	9.246	8.147	6.970	4.712	4.865	4.120	3.580
COR.COEFF (R)		-0.037	0.772	0.691	0.705	0.904	0.784	0.543	-0.059
SLOPE		-0.048	1.087	0.977	1.079	1.381	0.906	0.544	-0.064
INTERCEPT		8.789	9.489	8.548	8.047	7.625	6.076	4.776	3.580
PREDIC. MEAN-N		6559.	10362.	3454.	1064.	111.	130.	62.	36.
PREDICTED F		0.167	0.302	0.580	0.749	1.707	0.601	0.471	0.223

App.1/Table 8 COD in Division VIa.
Geometric mean regression analysis for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	
1970	40.572	1.	39.	22261.	1364.	43.	34.	72.	242.	
1971	41.234	21.	154.	514.	25358.	226.	12.	2.	1.	
1972	55.536	95.	5921.	746.	1028.	23635.	196.	5.	5.	
1973	51.153	53.	1754.	5239.	95.	641.	17059.	61.	1.	SCOTLAND
1974	45.899	184.	1165.	3897.	1706.	25.	194.	4874.	7.	TRAWL
1975	37.080	184.	3867.	1172.	1678.	666.	20.	51.	1523.	
1976	35.307	2.	4588.	4953.	711.	595.	183.	4.	1.	
1977	33.948	79.	80.	10293.	2039.	129.	171.	52.	7.	
1978	51.582	122.	331.	151.	10517.	1527.	153.	122.	99.	
1979	33.373	302.	1661.	582.	75.	3261.	318.	32.	25.	
1980	19.960	1.	2087.	1296.	274.	27.	873.	47.	2.	

App.1/Table 9 HADDOCK in Division VIa.
Input data for estimation of terminal Fs.
Catch numbers (x 10^{-3}).

YEAR		1	2	3	4	5	6	7	8
1970	LOG(GAMMA)	-5.906	-4.907	0.000	-2.906	-5.995	-5.986	-4.092	-1.930
	LOG(MEAN-N)	8.713	9.248	12.715	8.216	6.134	4.660	4.651	6.727
1971	LOG(GAMMA)	-2.877	-3.549	-3.785	0.000	-4.352	-7.044	-7.691	-7.435
	LOG(MEAN-N)	11.229	8.363	8.843	12.170	7.426	5.482	3.942	3.352
1972	LOG(GAMMA)	-1.666	-0.198	-3.710	-3.503	0.000	-4.549	-7.073	-6.123
	LOG(MEAN-N)	10.402	10.752	7.454	8.097	11.451	6.744	4.790	3.352
1973	LOG(GAMMA)	-2.167	-1.332	-1.678	-5.803	-3.525	0.000	-4.489	-7.650
	LOG(MEAN-N)	9.632	10.085	9.871	6.301	7.114	10.555	5.957	4.046
1974	LOG(GAMMA)	-0.814	-1.633	-1.866	-2.806	-6.661	-4.368	0.000	-5.596
	LOG(MEAN-N)	10.915	9.222	9.434	8.887	5.706	5.796	9.474	5.127
1975	LOG(GAMMA)	-0.601	-0.220	-2.854	-2.609	-3.165	-6.427	-4.346	0.000
	LOG(MEAN-N)	11.992	10.562	8.589	8.525	8.006	5.052	4.010	8.455
1976	LOG(GAMMA)	-5.074	0.000	-1.364	-3.419	-3.229	-4.164	-6.843	-7.279
	LOG(MEAN-N)	8.458	11.686	9.912	7.786	7.580	7.183	4.581	2.436
1977	LOG(GAMMA)	-1.358	-4.010	-0.593	-2.326	-4.718	-4.193	-4.239	-5.294
	LOG(MEAN-N)	9.171	7.980	11.198	9.055	6.893	6.633	6.408	3.724
1978	LOG(GAMMA)	-1.342	-3.008	-5.233	-1.104	-2.666	-4.722	-3.804	-3.063
	LOG(MEAN-N)	10.616	8.878	7.278	10.473	8.082	5.880	5.703	5.619
1979	LOG(GAMMA)	0.000	-0.960	-3.449	-5.612	-1.471	-3.555	-4.707	-4.004
	LOG(MEAN-N)	11.625	10.228	8.413	6.468	9.609	7.026	4.667	4.787
1980	LOG(GAMMA)	-5.196	-0.217	-2.134	-3.802	-5.751	-2.031	-3.809	-6.016
	LOG(MEAN-N)	7.722	11.343	9.669	7.825	5.680	8.853	6.195	3.604
COR.COEFF (R)		0.767	0.854	0.936	0.974	0.962	0.941	0.834	0.927
SLOPE		0.847	0.931	0.936	0.974	0.976	0.952	0.866	0.983
INTERCEPT		12.121	11.545	11.667	11.528	11.292	10.788	9.494	9.519
PREDIC. MEAN-N		2257.	84344.	15824.	2503.	293.	6995.	490.	37.
PREDICTED F		1.113	0.151	0.338	0.367	0.485	0.444	0.469	0.599

App.1/Table 10 HADDOCK in Division VIa.
Geometric mean regression analysis for estimation of terminal Fs.

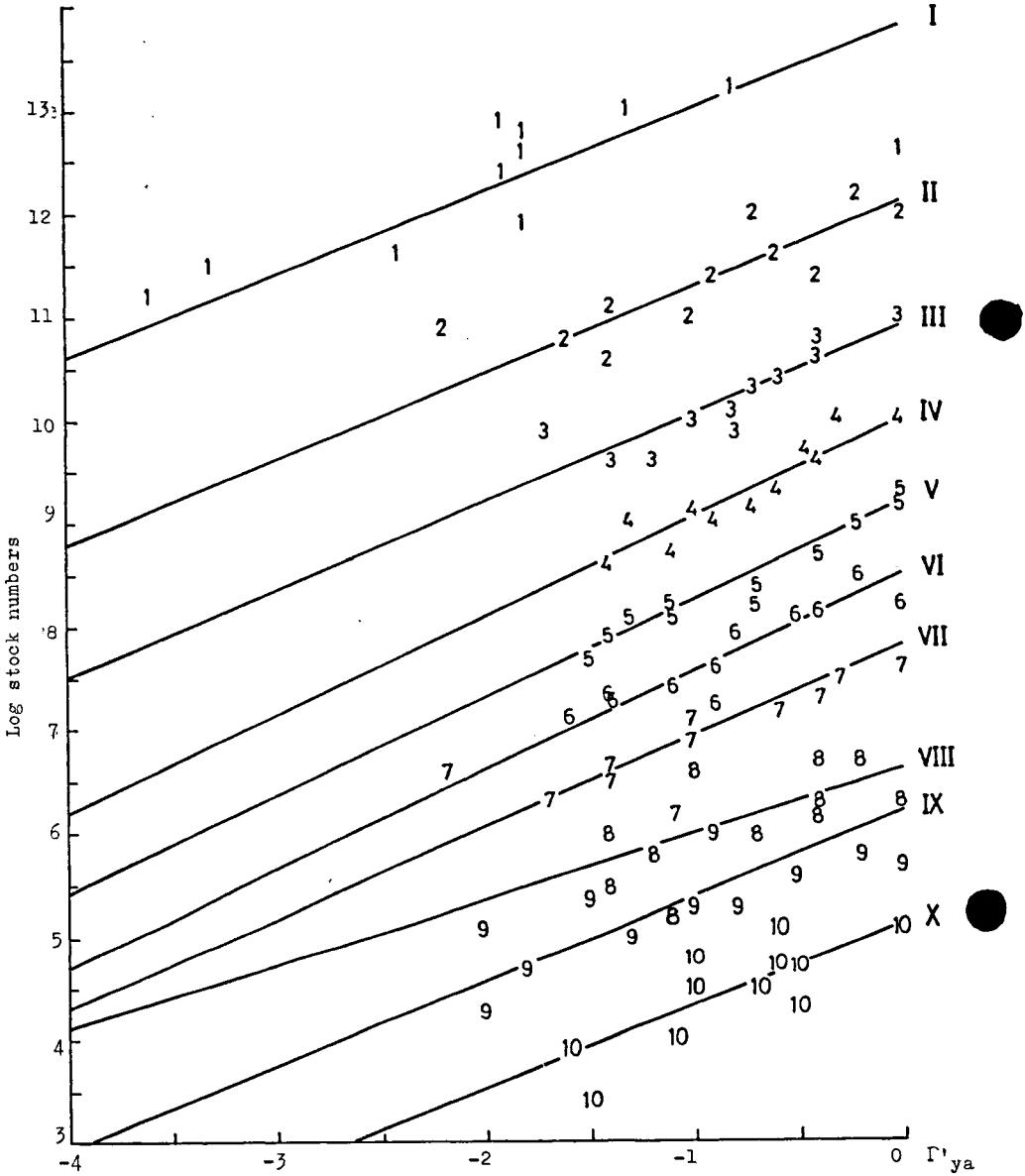
YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	
1970	40.572	3.	13.	2018.	462.	64.	28.	1.	29.	
1971	41.236	13.	132.	98.	3024.	166.	36.	3.	0.	
1972	55.536	329.	473.	235.	56.	1273.	85.	5.	2.	
1973	51.153	306.	993.	624.	222.	47.	785.	39.	4.	SCOTLAND
1974	45.899	71.	1816.	905.	192.	56.	5.	137.	7.	TRAWL
1975	37.080	127.	325.	1528.	217.	31.	6.	0.	27.	
1976	35.507	52.	1730.	807.	1170.	168.	13.	3.	0.	
1977	33.948	309.	376.	2032.	228.	450.	17.	0.	0.	
1978	51.582	46.	641.	719.	2451.	246.	414.	26.	1.	
1979	33.373	145.	2108.	1824.	898.	713.	39.	70.	1.	
1980	19.660	25.	445.	1385.	013.	344.	217.	37.	17.	

App.1/Table 11 WHITING in Division VIa.
Input data for estimation of terminal Fs.
Catch numbers (x 10^{-3}).

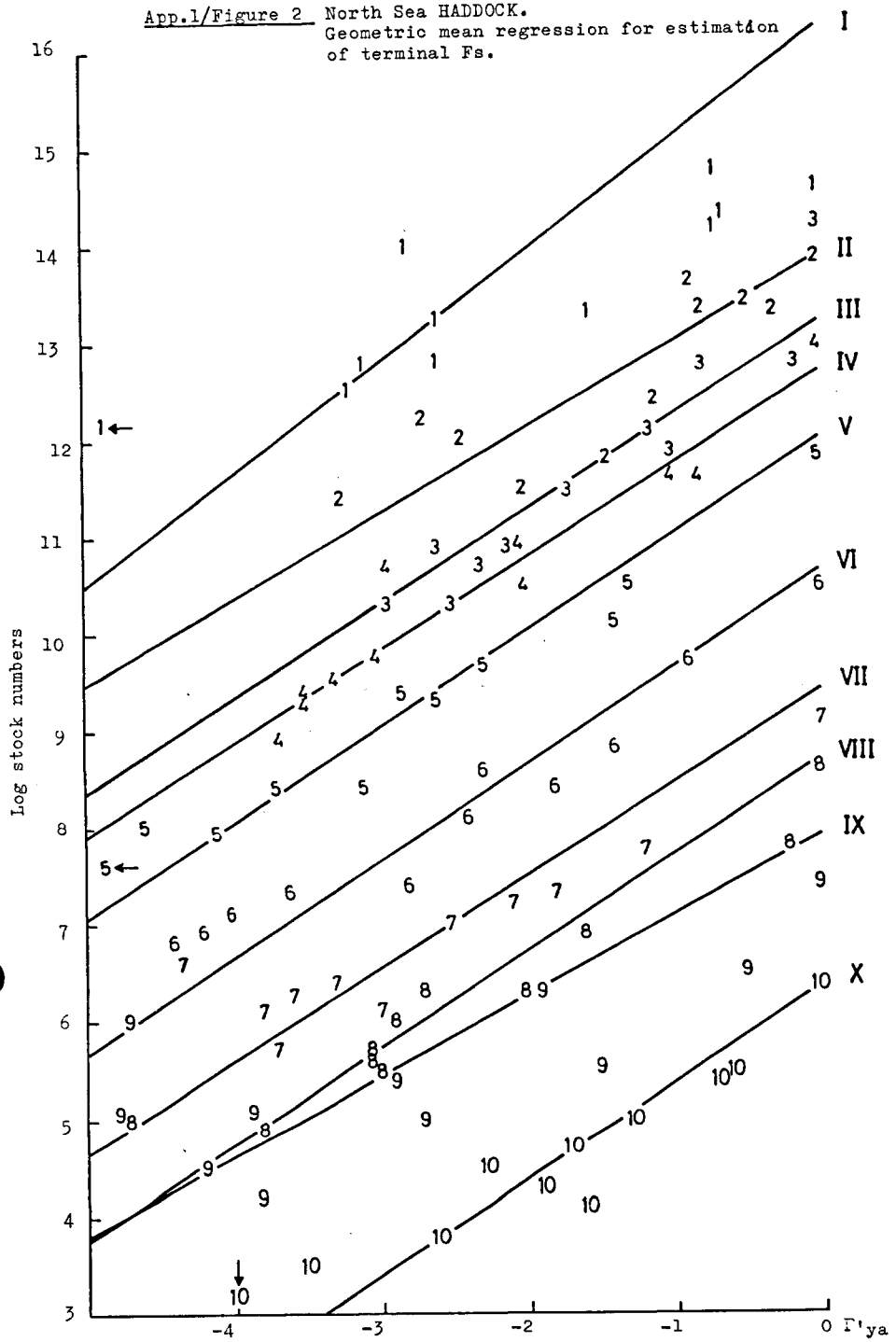
YEAR		1	2	3	4	5	6	7	8
1970	LOG(GAMMA)	-4.813	-5.284	-0.348	-1.863	-2.676	-3.102	-4.797	-0.190
	LOG(MEAN-N)	9.883	9.278	11.376	8.490	6.679	5.586	2.157	6.642
1971	LOG(GAMMA)	-3.363	-2.982	-5.589	0.000	-1.739	-2.867	-3.714	-5.877
	LOG(MEAN-N)	10.192	9.328	8.284	10.640	7.643	5.649	4.662	0.511
1972	LOG(GAMMA)	-0.429	-2.004	-2.812	-4.287	0.000	-2.505	-3.501	-3.179
	LOG(MEAN-N)	11.240	9.571	8.262	6.962	9.515	6.649	4.655	3.843
1973	LOG(GAMMA)	-0.420	-1.180	-1.754	-2.827	-3.217	0.000	-1.365	-2.403
	LOG(MEAN-N)	12.046	10.470	8.539	6.795	5.285	8.170	5.255	3.769
1974	LOG(GAMMA)	-1.772	-0.468	-1.273	-2.864	-2.933	-4.948	0.000	-1.735
	LOG(MEAN-N)	10.989	11.585	9.274	6.835	5.184	3.424	6.902	3.945
1975	LOG(GAMMA)	-0.977	-1.975	-0.536	-2.528	-3.311	-4.552	-7.009	-0.172
	LOG(MEAN-N)	11.814	10.494	10.795	8.204	5.358	3.920	1.823	5.966
1976	LOG(GAMMA)	-1.821	-0.254	-1.126	-0.794	-1.572	-3.730	-3.559	-5.721
	LOG(MEAN-N)	10.828	11.292	9.559	9.733	6.986	3.783	2.641	0.511
1977	LOG(GAMMA)	0.000	-1.741	-0.163	-2.391	-0.548	-3.422	-6.921	-5.682
	LOG(MEAN-N)	11.250	10.338	10.451	8.424	8.547	5.432	2.009	1.609
1978	LOG(GAMMA)	-2.323	-1.626	-1.620	-0.434	-1.570	-0.648	-1.779	-3.798
	LOG(MEAN-N)	11.802	10.759	9.721	9.550	7.643	7.477	3.990	0.511
1979	LOG(GAMMA)	-0.740	0.000	-0.254	-1.003	-0.070	-2.575	-0.271	-5.362
	LOG(MEAN-N)	11.502	11.344	10.103	9.136	8.726	7.101	6.595	2.890
1980	LOG(GAMMA)	-1.968	-1.026	0.000	-0.855	-0.270	-0.330	-0.461	0.000
	LOG(MEAN-N)	10.848	11.194	10.768	9.441	8.629	8.050	6.733	6.007
COR.COEFF (R)		0.778	0.866	0.867	0.924	0.966	0.937	0.905	0.929
SLOPE		1.014	1.033	0.868	0.924	0.986	0.938	0.941	0.930
INTERCEPT		12.844	12.254	10.768	10.231	8.895	8.359	7.167	6.007
PREDIC. MEAN-N		51431.	72727.	47480.	12597.	5589.	3134.	840.	406.
PREDICTED F		0.186	0.156	0.339	0.361	0.240	0.363	0.112	0.239

App.1/Table 12 WHITING in Division VIa.
Geometric mean regression analysis for estimation of terminal Fs.

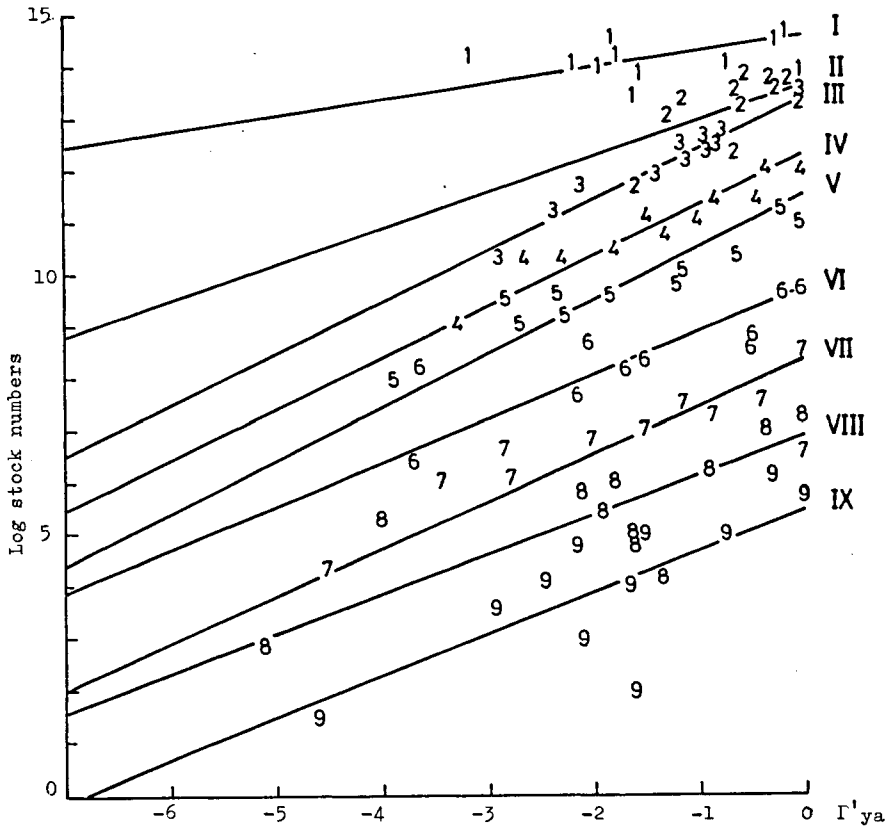
App.1/Figure 1 North Sea COD.
Geometric mean regression for estimation of terminal Fs.



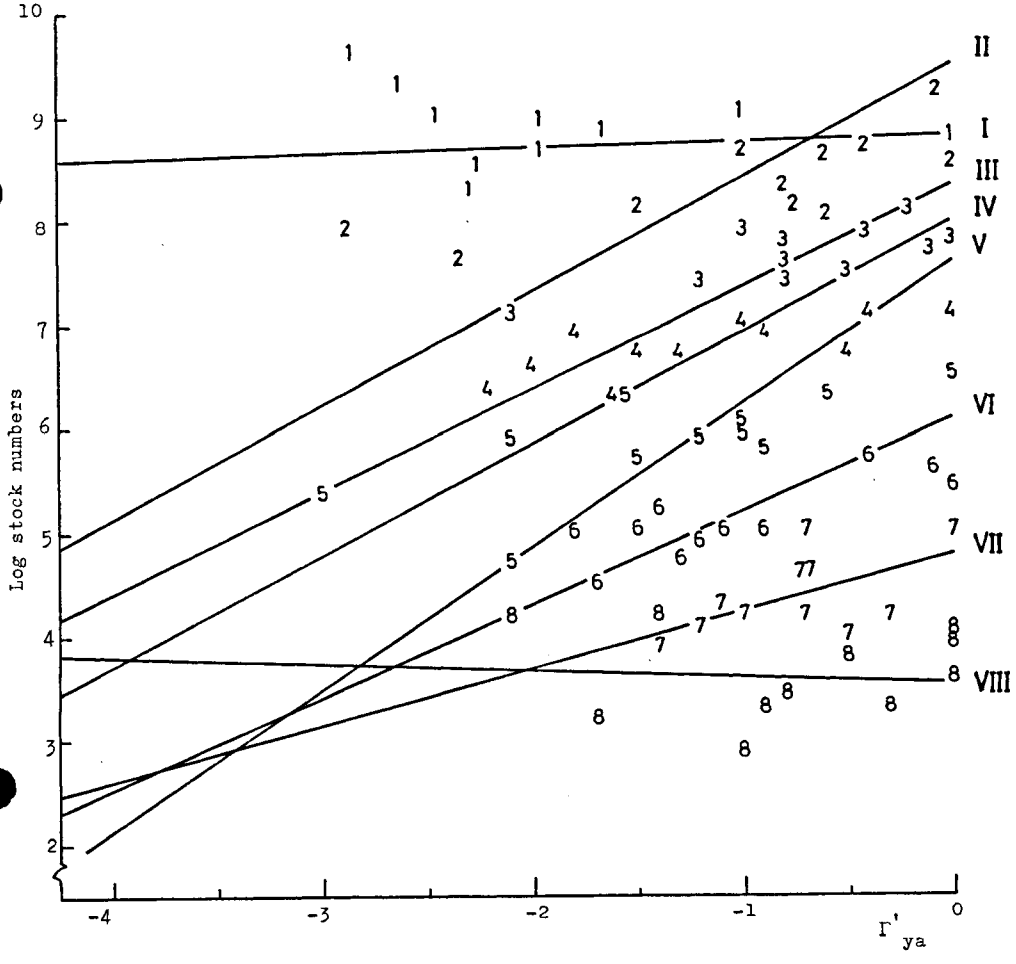
App.1/Figure 2 North Sea HADDOCK.
Geometric mean regression for estimation of terminal Fs.



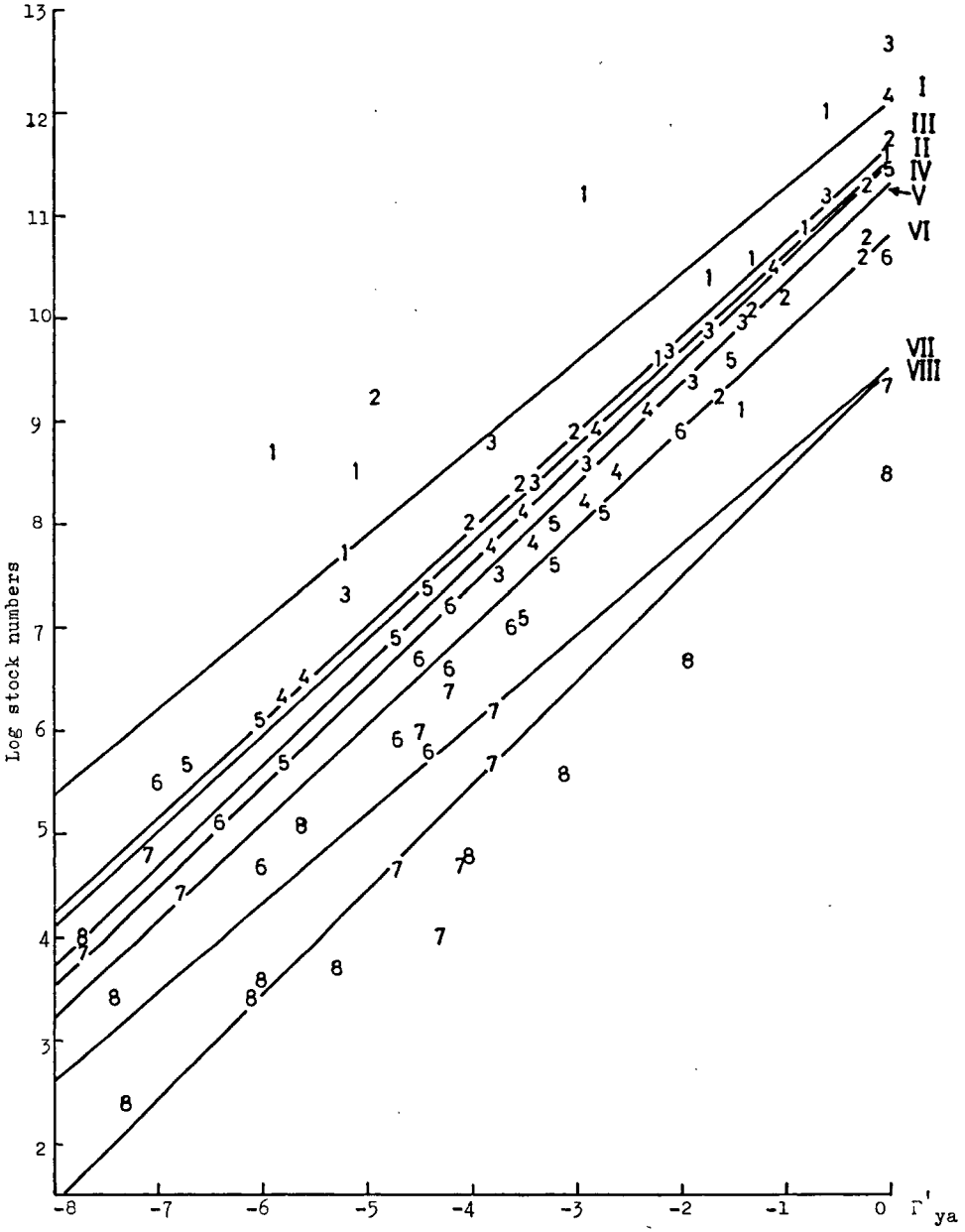
App.1/Figure 3 North Sea WHITING.
Geometric mean regression for estimation of terminal Fs.



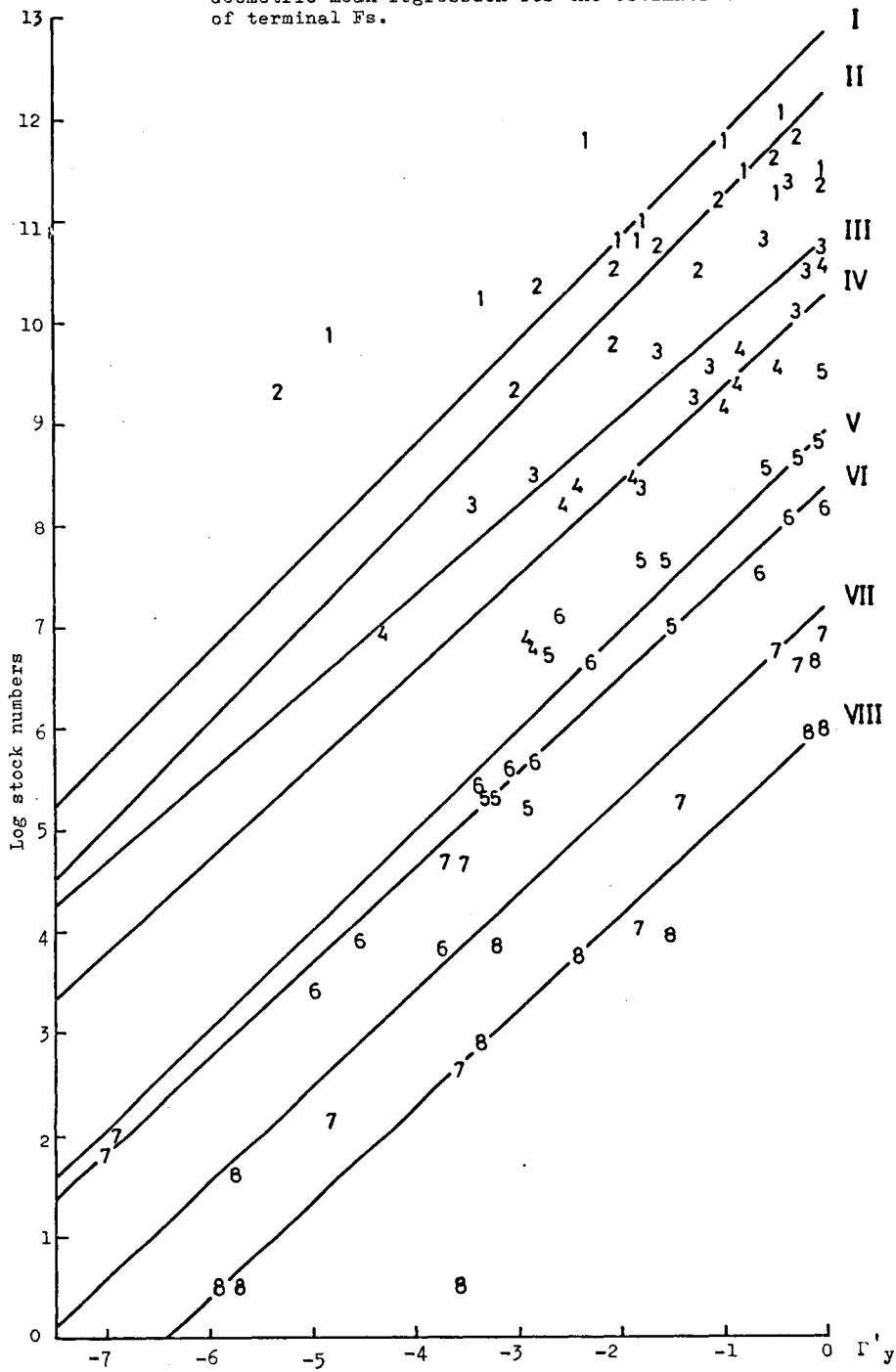
App.1/Figure 4 COD - West of Scotland - Div.VIa.
Geometric mean regressions for estimation of terminal Fs.



App.1/Figure 5 HADDOCK in Division VIa.
Geometric mean regression for estimation of terminal Fs.



App.1/Figure 6 WHITING in Division VIa.
Geometric mean regression for the estimation of terminal Fs.

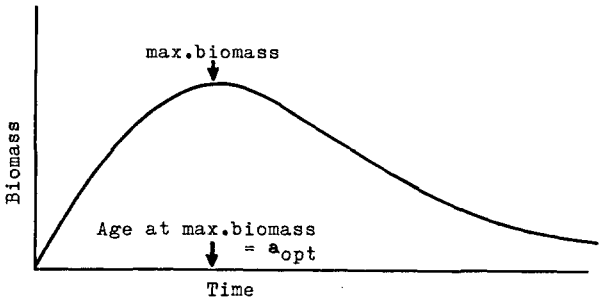


APPENDIX 2

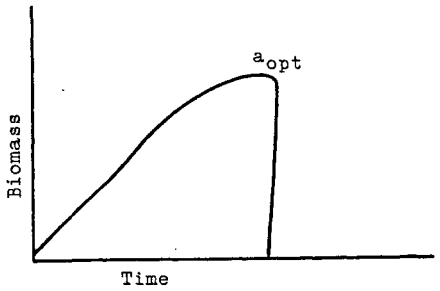
SUGGESTION FOR AN INDEX OF EXPLOITATION

ACFM has requested that the level of exploitation in each year be typified by some single number. The basic problem in doing this is that such a request means that an attempt should be made to completely describe a vector of numbers (e.g. values of F at age in a given year) by means of a single number and this is not possible.

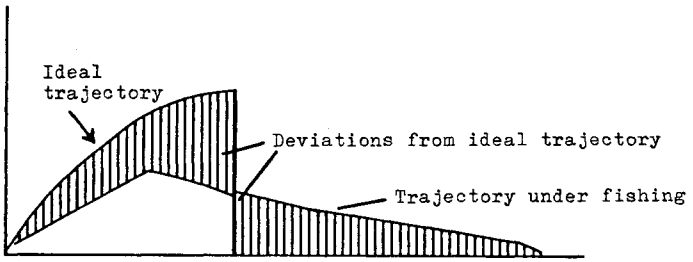
The following is a suggestion for a way out of this problem.
Consider a trajectory in time of the biomass of a cohort of fish not subject to exploitation. Under these conditions the cohort attains a max.biomass at some well defined age, i.e.



The ideal way to fish such a cohort is to catch all the fish at age a_{opt}.
The trajectory of the cohort biomass would then be as shown below.



In fact it is impossible to fish a cohort in the ideal manner so that under fishing the biomass trajectory of the cohort differs from the ideal trajectory by the amounts indicated by the hatched area in the following graph.



The value of a_{opt} can be computed by finding the value of a, for which the expression

$$\bar{w}_a \, N_a e^{-(a+0.5)M_a} = \text{max value}$$

N_a = number of age group a at the beginning of the year (from VPA output)
$\bar{w}_a$ = weight at age a.

Given that a_{opt} is known, the index to be calculated is:

$$G = \sum_{a<a_{opt}} N_a \bar{w}_a \left(\frac{1-e^{-Ma}}{M_a} - \frac{1-e^{-(F_a+M_a)}}{F_a + M_a}\right)$$

$$+ \sum_{a>a_{opt}} N_a \bar{w}_a \frac{1-e^{-(F_a+M_a)}}{F_a+M_a}$$

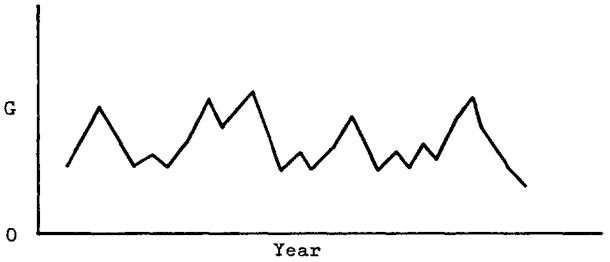
This is equivalent to the following expression

$$G = \sum_{a<a_{opt}} (\bar{N}_a^{unexp} - N^{exp}) \bar{w}_a$$

$$+ \sum_{a>a_{opt}} \bar{N}^{exp} \bar{w}_a$$

where $\bar{N}^{exp}$ and $\bar{N}^{unexp}$ are the mean number of fish in the sea between ages a and a+1, in the exploited stock and the unexploited stock respectively. The closer G is to zero, the better the stock has been fished to produce yield.

Given that a VPA exists for the stock in question, all of the quantities required to estimate G are known. The output of the procedure suggested would be as follows:



G could also be calculated for any long- or short-term simulated stock condition and in this way proposals for long- or short-term simulated situations could be compared with the historical series of G on an objective basis.

G was not calculated during this Working Group meeting because of lack of time.