International Council for the
Exploration of the Sea

C.M.1981/G:8
Demersal Fish Committee

# 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

## 1. PARTICIPANTS

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V Nikolaev, ICES Statistician, also attended the meeting.

## 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 $F_{\text{⌘}}$. The average value of F in the array $F_{\text{⌘}}$ over the appropriate range of ages for each species is referred to as $\overline{F}_{\text{⌘}}$. 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 | - | - |
| 0 | 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 x $10^6$ and for the 1980 year class 1 400 x $10^6$ compared to a mean of 2 200 x $10^6$ 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 | 5922 | 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 | 18232 | 17584 | 23082 | 14398 | 41450 | 29501 |
| 4 | 14869 | 4220 | 6608 | 4307 | 8469 | 3596 | 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 | 318 | 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 | 23 | 21 | 15 | 8 |
| TOTAL | 106955 | 145253 | 136737 | 239835 | 313501 | 406967 | 369324 |

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 | 4.130 | 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 | 1.60 | 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 | 65366 | 83344 | 70808 | 36033 | 32726 | 83663 | 96769 |
| 4 | 20601 | 17047 | 30469 | 25928 | 32475 | 30881 | 13948 | 11985 | 26418 |
| 5 | 7243 | 9039 | 7983 | 14901 | 10431 | 14938 | 14260 | 5583 | 4936 |
| 6 | 2788 | 3888 | 4338 | 3663 | 6900 | 4636 | 6738 | 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 | 5023 | 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 | 39 | 7 | 47 | 65 | 83 |
| 12+ | 69 | 23 | 32 | 167 | 48 | 34 | 22 | 35 | 47 |
| TOTAL | 310183 | 425573 | 335369 | 728017 | 681112 | 745258 | 999653 | | |
| Total Biomass | 470742 | 439201 | 433669 | 483166 | 551948 | 586367 | 662563 | | |
| Spawn.St.Biomass | 294011 | 257757 | 229384 | 230515 | 196931 | 287342 | 270623 | | |

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

| $F_{H.C.}/F_{H.C.\ast}$ | $F_{IND}/F_{IND\ast}$ | 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.

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

$F_{IND\ast}$ = the equivalent for the industrial fishery.

Average recruitment at age 1 = 235.6 x $10^6$ (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 | Nx$10^{-3}$ Industr. by-catch 1980 | Ind. $\bar{W}$ | Ind. F | Total F 1980 | Reference F : $\bar{F}$ 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

$\bar{F}$ = 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 $\geq 3$) 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 | 203 | 524 | 698 |
| 6 | 304 | 355 | 176 | 325 | 392 | 210 | 313 | 87 | 219 |
| 7 | 45 | 156 | 182 | 52 | 147 | 156 | 91 | 113 | 24 |
| 8+ | 26 | 39 | 115 | 84 | 78 | 102 | 102 | 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] $F_{\bar{x}}$ |
|---|---|---|---|---|
| 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

$\bar{F}_{\bar{x}}$ = 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 | $\bar{F}_{81}/\bar{F}_{\text{ж}}$ | : | 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 $\geq 3$) at the beginning of the year.

Table 7.8 Cod in Division VIa.
Results of catch predictions ('000 tonnes).
Option 2 ($\bar{F}$ 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 | 3253694 | 227927 | 45517 | 443587 | 393013 |
| 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 | 12388 |
| 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 | 0.30 | 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 | 0.53 | 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 | 1.36 | 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 | 1.16 | 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 | 55517 | 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 | 6872 | 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 | 6636409 |
| 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 | 370452 | 508133 | 900827 | 1493100 | 2798703 | 904539 | 2159436 |
| 2 | 246197 | 1148133 | 1772375 | 178954 | 239573 | 391405 | 915884 | 1714559 | 1065224 |
| 3 | 579284 | 108757 | 303623 | 652664 | 51025 | 72411 | 148993 | 478133 | 429826 |
| 4 | 89820 | 206426 | 19179 | 63522 | 186462 | 16596 | 22696 | 61185 | 124100 |
| 5 | 4340 | 27555 | 46523 | 7134 | 10943 | 55965 | 6103 | 7555 | 43021 |
| 6 | 2422 | 1919 | 7814 | 11059 | 2324 | 6221 | 22751 | 1009 | 12860 |
| 7 | 17156 | 811 | 721 | 2150 | 3713 | 850 | 1612 | 11877 | 4039 |
| 8 | 935 | 4656 | 137 | 423 | 748 | 1337 | 590 | 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 x $10^{-6}$ (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. W(kg) | Ind. F | Total F 1980 | Reference F : $F_{\bar{x}}$[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

$\bar{F}_{\bar{x}}$ = 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 |
|---|---|---|---|
| $\bar{F}_{81}/\bar{F}_{sq}$ | .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 |

| $\bar{F}_{82}/\bar{F}_{81}$ | 1982 H.C.L. | 1982 Disc. | 1982 Ind.B.C. | 1982 T.C. | SSB 1983 | $\bar{F}_{82}/\bar{F}_{81}$ | 1982 H.C.L. | 1982 Disc. | 1982 Ind.B.C. | 1982 T.C. | SSB 1983 | $\bar{F}_{82}/\bar{F}_{81}$ | 1982 H.C.L. | 1982 Disc. | 1982 Ind.B.C. | 1982 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 | 54 | 60 | 585 | 5664 | 2 | 169 | 1957 | 577 | 1514 |
| 2 | 464 | 174 | 6057 | 12437 | 48796 | 171 | 1250 | 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 | 33106 |
| 7 | 174 | 31 | 9 | 727 | 4373 | 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 | 1.431 | 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 | 0.34 | 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 | 63363 |

| | 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 | 3835 | 12758 | 53271 | 967 | 3255 | 11870 | 35610 |
| 5 | 301 | 4112 | 3216 | 1645 | 5399 | 22129 | 408 | 1841 | 17087 |
| 6 | 787 | 164 | 1712 | 1206 | 738 | 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 | 60030 | | |

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 $F_{\bar{x}}$ |
|---|---|---|---|---|
| 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

$\bar{F}_{\bar{x}}$ = 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 | $\bar{F}_{81}/\bar{F}_{\text{æ}}$ | : | 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 | $\bar{F}_{81}/\bar{F}_{ж}$ | : 1.0 ($\bar{F}_{ж}$ = 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 | 0.308 | 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

Fishing mortalities from VPA (M = 0.2).

| | 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 |

Stock size in numbers ('000) from VPA.

| | 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 | 300695 | 137405 | 125o217 | 1210201 | 12681o2 | 589482 | 188303 |
| 1 | 341721 | 439284 | 394218 | 630966 | 409867 | 605430 | 413717 | 983371 | 1151617 |
| 2 | 505414 | 700067 | 375750 | 536794 | 1471663 | 159901 | 233757 | 612502 | 854855 |
| 3 | 358857 | 175o70 | 241739 | 165127 | 186925 | 850168 | 28979 | o2987 | 2o6032 |
| 4 | 9o564 | 253074 | 38010 | 71569 | 33420 | 56608 | 151397 | 7257 | 17584 |
| 5 | 9038 | 5o465 | 67332 | 8797 | 17295 | 13095 | 17226 | 61085 | 3553 |
| 6 | 4484 | 12519 | 8400 | 29688 | 1755 | 4218 | 2254 | 9359 | 18767 |
| 7 | 767 | 2860 | 838 | 1884 | 6008 | 1301 | 715 | 3787 | 2393 |
| 8 | 127 | 690 | 122 | 92 | 623 | 1291 | 170 | 242 | 318 |
| 9 | 2 | 106 | 31 | 23 | 34 | 130 | 450 | 61 | 115 |
| 10+ | 9 | 0 | 3 | 5 | 1 | 17 | 29 | 137 | 44 |
| TOTAL | 1453514 | 1915892 | 1425142 | 1582350 | 3383808 | 2902360 | 2116856 | 2330270 | 2443581 |

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|
| 0 | 598983 | 239096 | 424143 | 6o3911 | 685096 | 477651 | 329901 |
| 1 | 677816 | 860064 | 430697 | 1004400 | 418165 | 607384 | 287945 |
| 2 | 1096806 | 390494 | 1071346 | 531675 | 334981 | 464226 | 323239 |
| 3 | 275041 | 297688 | 158567 | 2o8869 | 202957 | 211191 | 243289 |
| 4 | 40563 | 54230 | 75098 | 31689 | 69023 | 86122 | 80281 |
| 5 | 5753 | 9213 | 13315 | 18277 | 7o16 | 25051 | 31o41 |
| 6 | 1250 | 1987 | 2716 | 4657 | 5385 | 3115 | 7561 |
| 7 | 5889 | 116 | 545 | 406 | 1422 | 1179 | 922 |
| 8 | 352 | 1585 | 22 | 167 | 245 | 194 | 590 |
| 9 | 52 | 142 | 291 | 4 | 7 | 15 | 35 |
| 10+ | 19 | 2 | 25 | 138 | 7 | 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 | 0.636 | 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 | 0.286 | 0.239 | 0.259 | 0.255 |
| 4 | 0.377 | 0.373 | 0.361 | 0.375 | 0.337 | 0.313 | 0.330 |
| 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 | 1.13 | 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 | 868306 | 1244257 | 723408 | 989655 | 3163710 | 233290 | 398719 | 1028386 | 1420090 |
| 3 | 916295 | 261783 | 595985 | 259209 | 332393 | 1276230 | 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 | 3257 | 1116 | 3224 | 9393 | 1794 | 1415 | 4606 | 3438 |
| 8 | 371 | 803 | 183 | 176 | 965 | 2366 | 321 | 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 | 1982-1977 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 4382706 | 2625462 | 3115094 | 2881763 | 2793032 | 3449915 | 2076955 | ********** | 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 | 3911 | 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 | 695 |
| 9 | 95 | 260 | 533 | 7 | 13 | 27 | 60 | 232 | 197 |
| 10+ | 35 | 4 | 42 | 253 | 13 | 7 | 35 | 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 = $3139 \times 10^{-6}$ (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 W (kg) c) | N x $10^{-3}$ H.C. landings 1980 | H.C. landings W (kg) | H.C. landings F | N x $10^{-3}$ Discards 1980 | H.C. disc. W(kg) | H.C. disc. F | N x $10^{-3}$ Industr. by-catch 1980 | Ind. W (kg) | Ind. F | Total F 1980 | Reference F : $F_{\bar{x}}$ 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

$\bar{F}_{\bar{x}}$ = 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 | $\bar{F}_{81}/\bar{F}_{\text{ж}}$ | : 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 | 5343 | 7241 | 887 | 664 | 2335 | 16668 | 13715 |
| 2 | 6070 | 10477 | 26858 | 10452 | 25148 | 6773 | 8393 | 11973 | 30395 |
| 3 | 43493 | 2219 | 10949 | 9232 | 8628 | 28090 | 4032 | 4022 | 5583 |
| 4 | 4800 | 28202 | 719 | 3659 | 2564 | 3237 | 33860 | 1357 | 1471 |
| 5 | 389 | 1862 | 13598 | 325 | 1204 | 664 | 1300 | 14832 | 359 |
| 6 | 103 | 187 | 813 | 5037 | 118 | 211 | 234 | 797 | 4330 |
| 7 | 16 | 54 | 116 | 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 | 0.465 | 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 | 0.769 | 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 | 0.365 | 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 | 24753 | 26894 | 37557 | 114072 | 238773 | 85895 |
| 1 | 50661 | 60452 | 56092 | 210194 | 20266 | 22019 | 30749 | 93394 | 195491 |
| 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 | 366 | 169 | 87 |
| TOTAL | 276841 | 239828 | 413112 | 310821 | 243677 | 199106 | 240819 | 390935 | 361428 |
| Total Biomass | 59970 | 52319 | 43293 | 69768 | 53760 | 43298 | 36104 | 40406 | 61363 |
| Spawn.Stock Biomass | 48926 | 37931 | 31850 | 26468 | 50153 | 38763 | 29677 | 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 | 93680 | 156719 | 110068 | 120046 | 40025 | 86222 |
| 2 | 147681 | 49440 | 115320 | 41660 | 62262 | 112346 | 84411 | 89673 | 59501 |
| 3 | 17990 | 75397 | 25452 | 53058 | 22157 | 34660 | 61264 | 58892 | 37954 |
| 4 | 1792 | 5816 | 29386 | 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 | 344254 | | |
| 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 $F_{\overline{x}}$ 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

$\overline{F}_{\overline{x}}$ = 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 | 15847 | 19949 | 7333 | 5723 |
| 2 | 7513 | 13004 | 9201 | 7982 | 9895 |
| 3 | 5074 | 2855 | 4649 | 4542 | 4342 |
| 4 | 1410 | 843 | 1556 | 2482 | 1733 |
| 5 | 521 | 253 | 433 | 639 | 445 |
| 6 | 74 | 46 | 88 | 93 | 49 |
| 7+ | 0 | 8 | 0 | 10 | 7 |
| TOTAL | 27259 | 30836 | 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- 3),U | 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 | 6328 | 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 | $\bar{F}_{ages}$ | 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 | $\bar{F}_{3t}$ | 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 | $\bar{F}_{\text{æ}}$ | 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 | - | - | - | - |
| T[illegible]bot | 4 | 15 | 0.0 | - | - | - | - |
| [illegible]ting | - | 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.

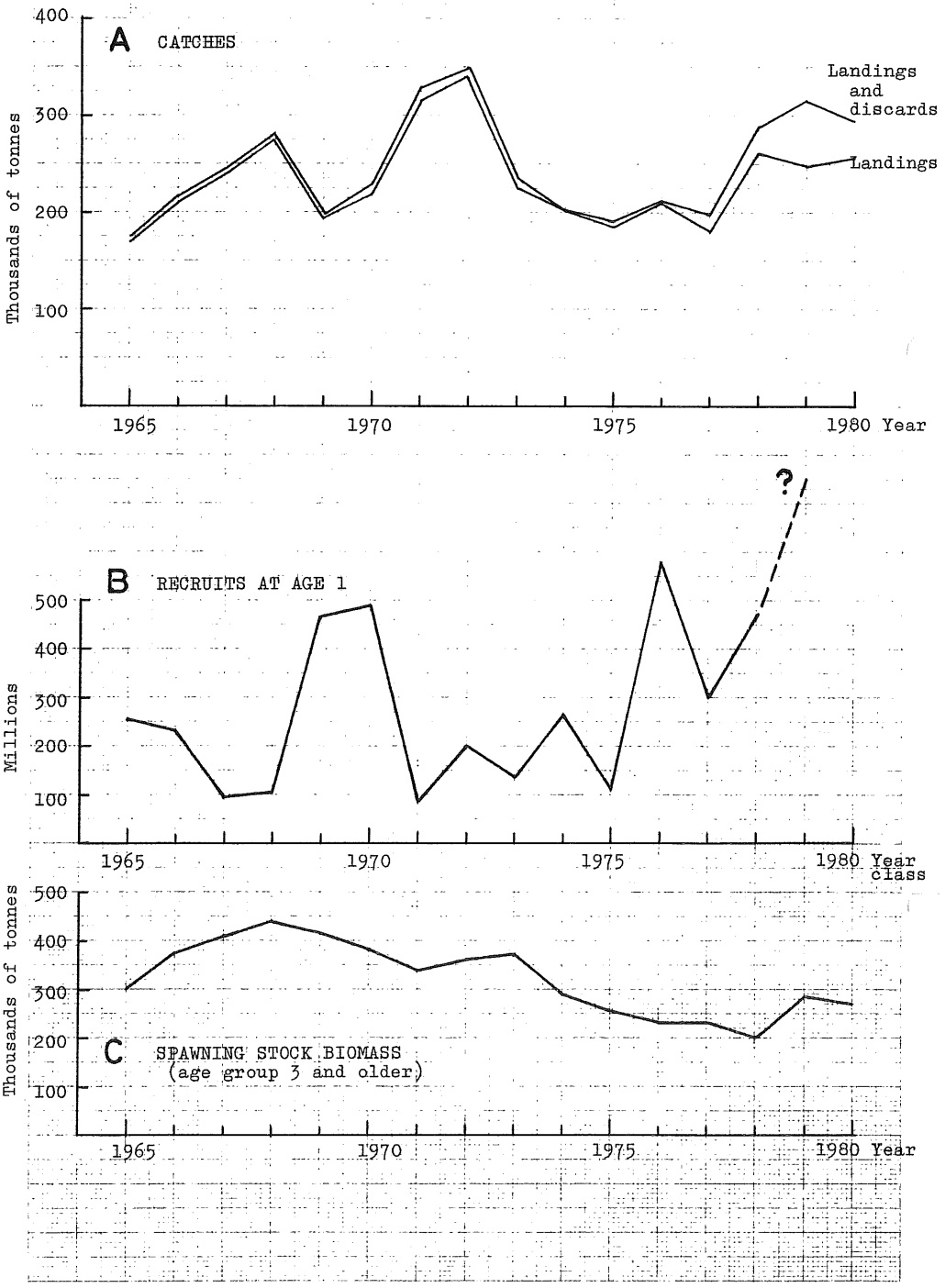


Figure 6.2 North Sea COD.

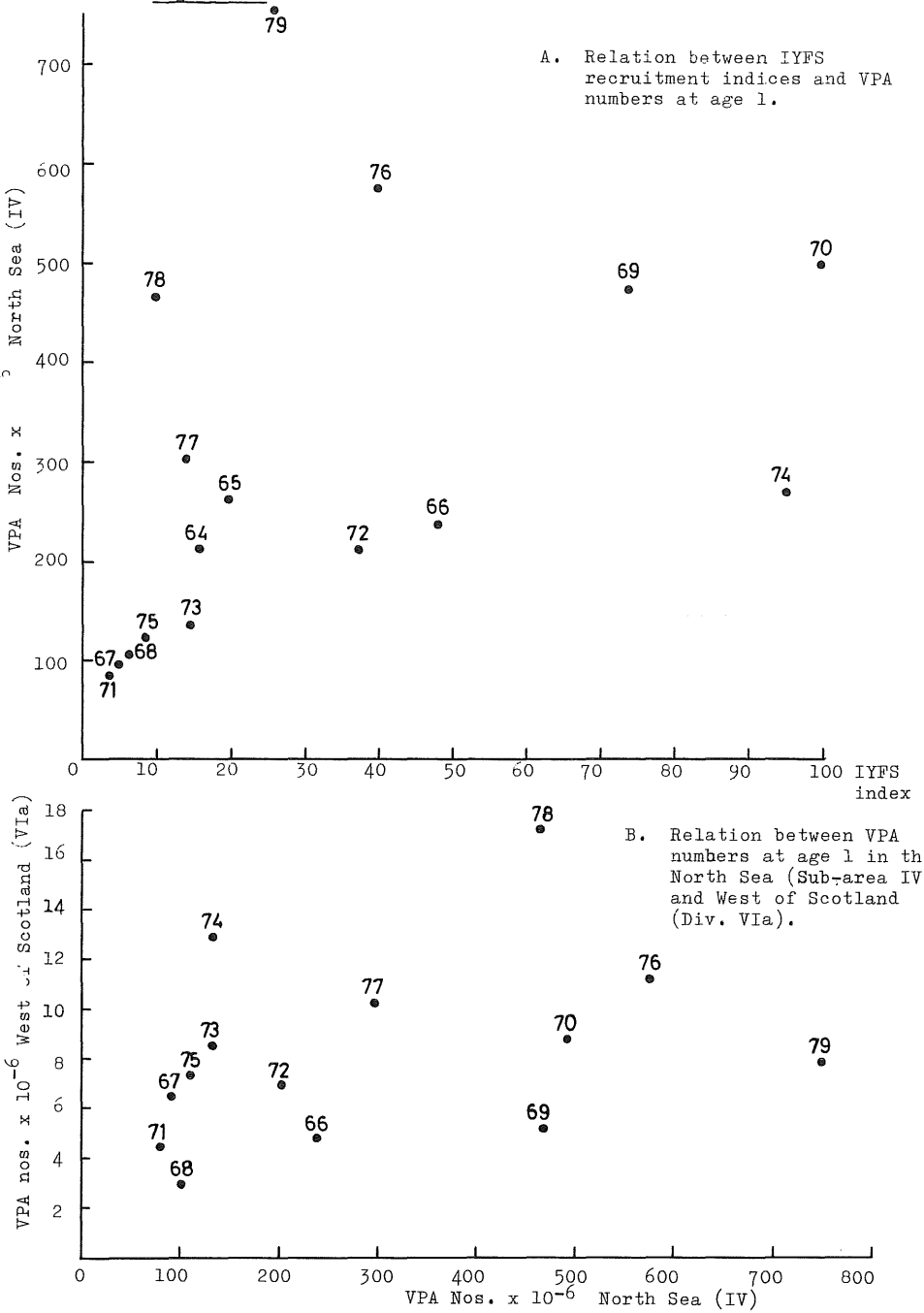


Figure 6.3 North Sea COD.
Equilibrium yield for average recruitment.

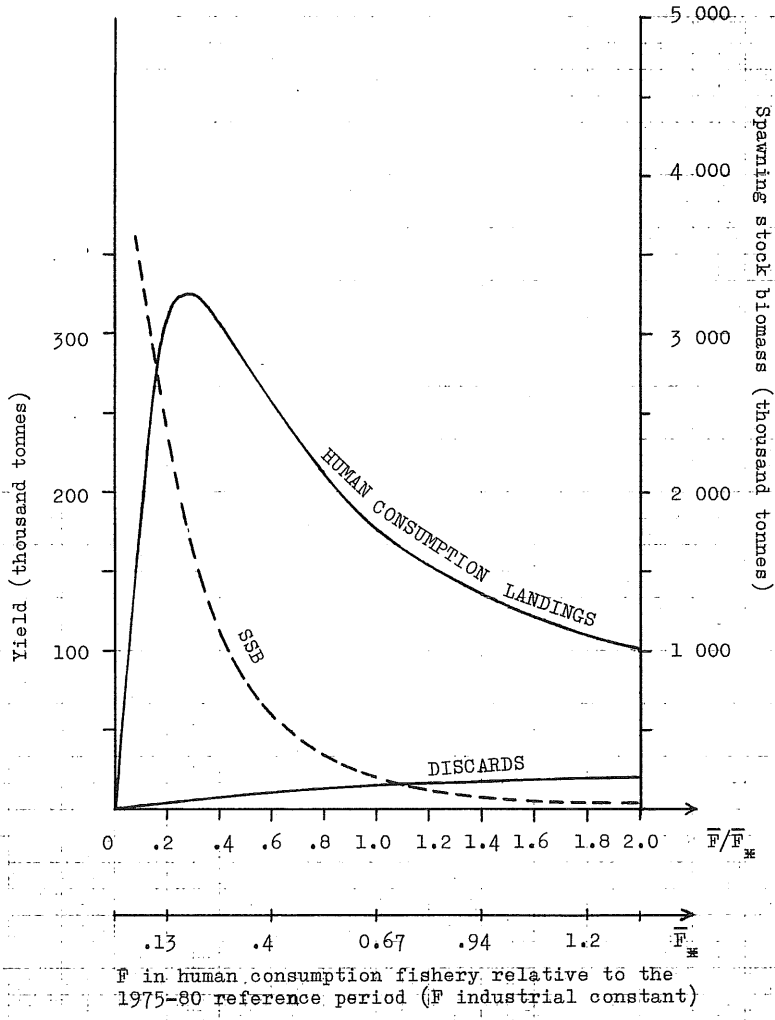


Figure 6.4 North Sea COD.
Predictions for catch in 1982 and spawning stock biomass in 1983.

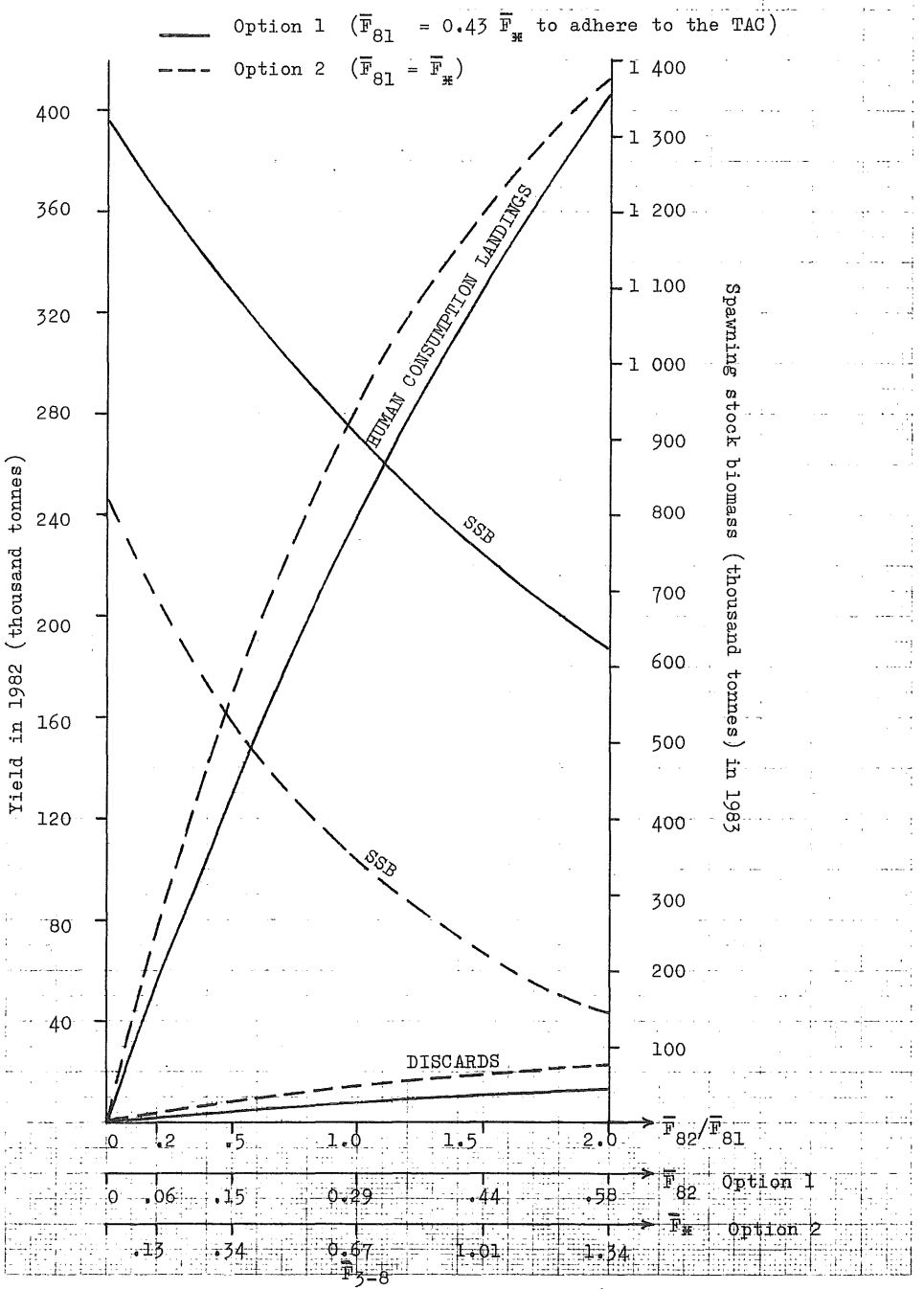


Figure 7.1 COD in Division VIa.

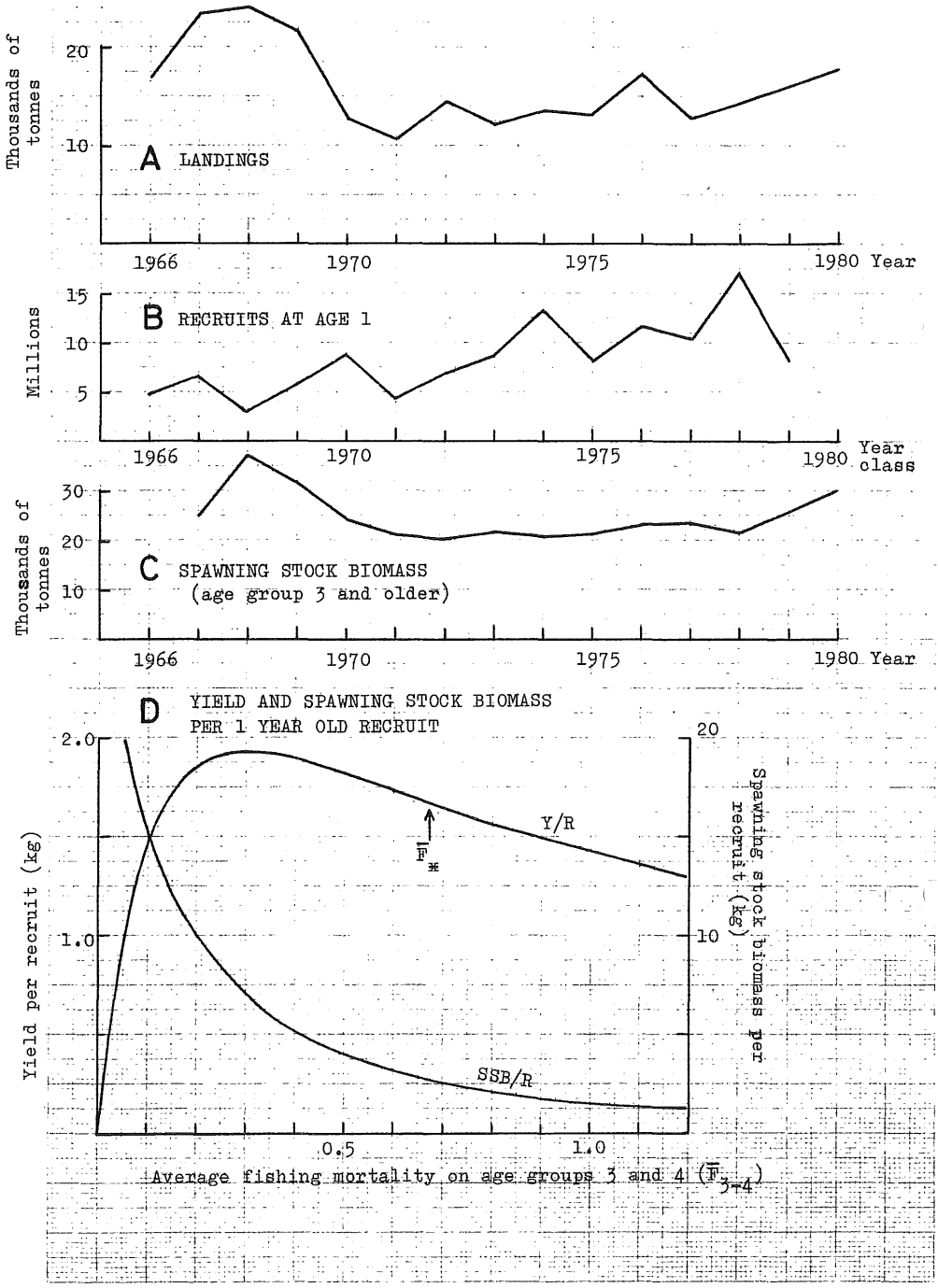


Figure 7.2 COD in Division VIa.
Predictions for catch in 1982 and spawning stock biomass in 1983.

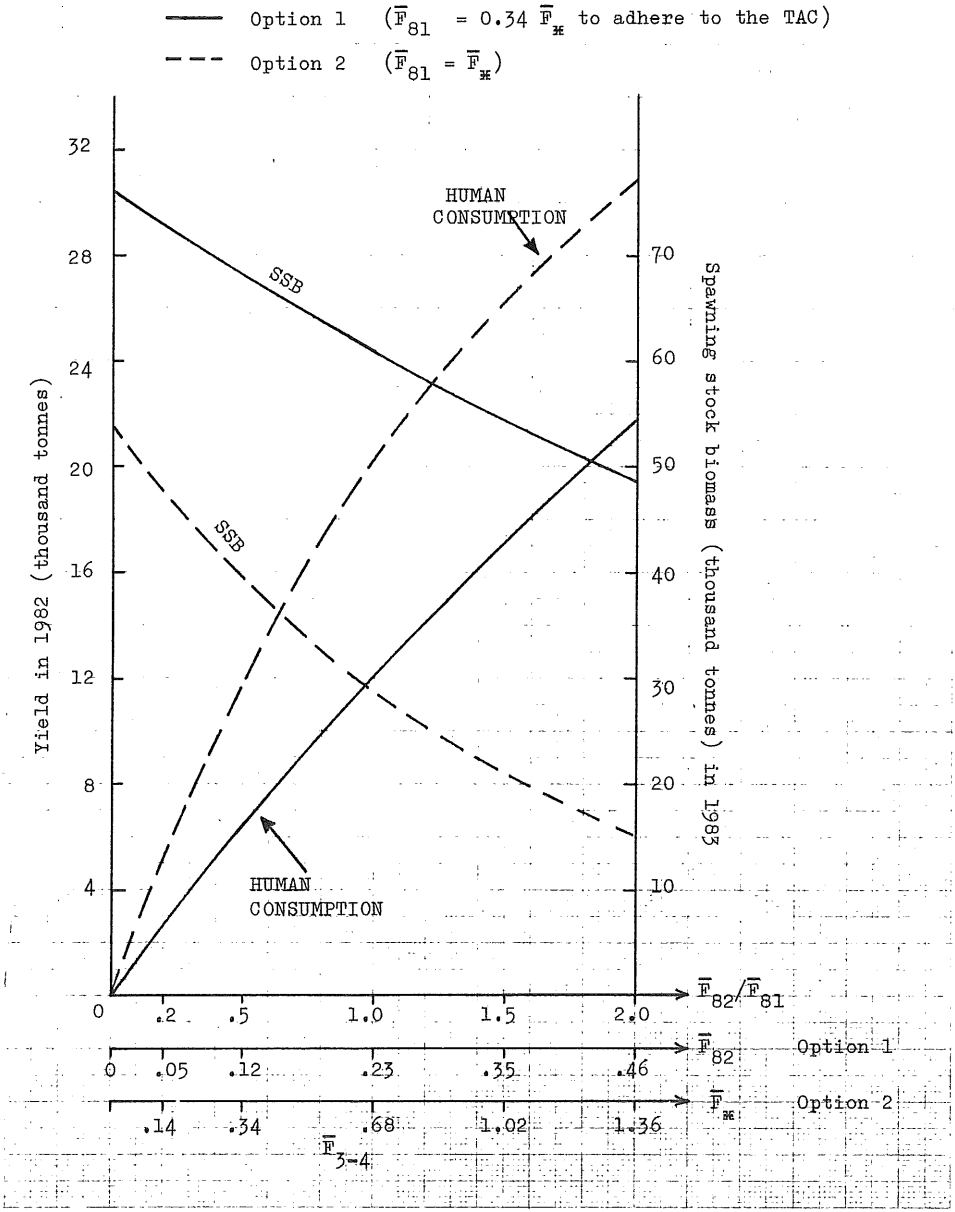


Figure 10.1 North Sea HADDOCK.

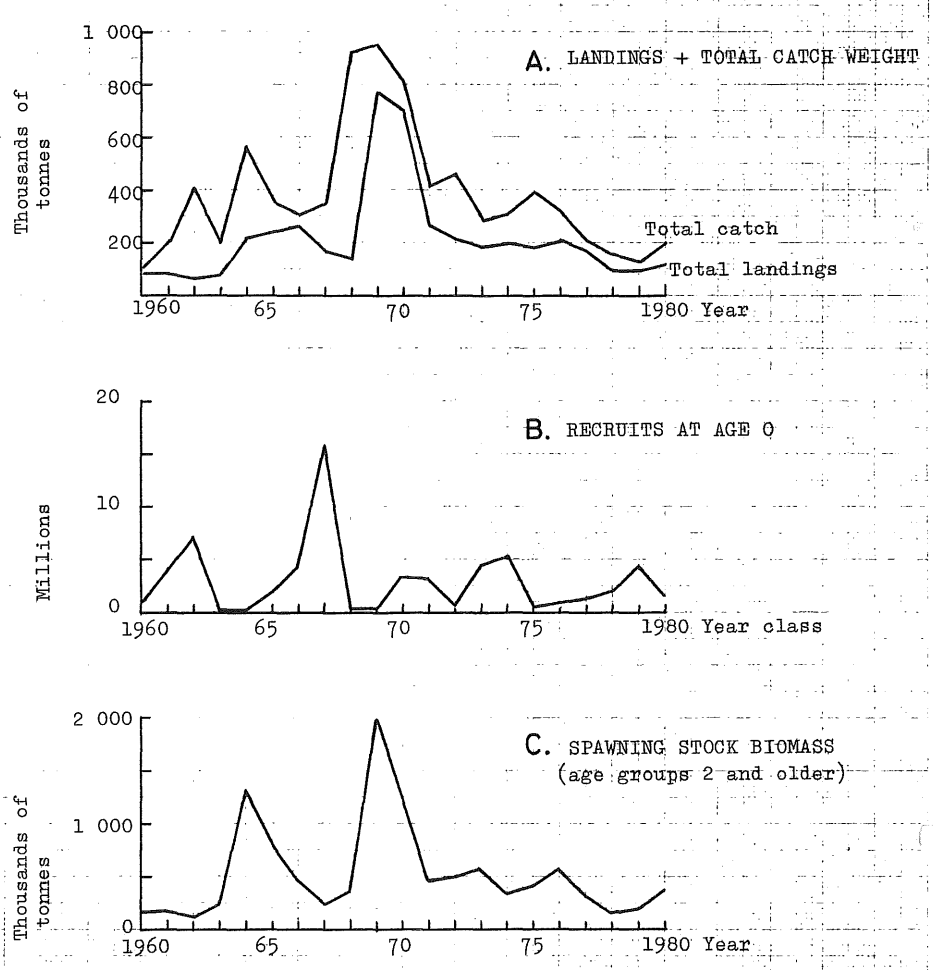
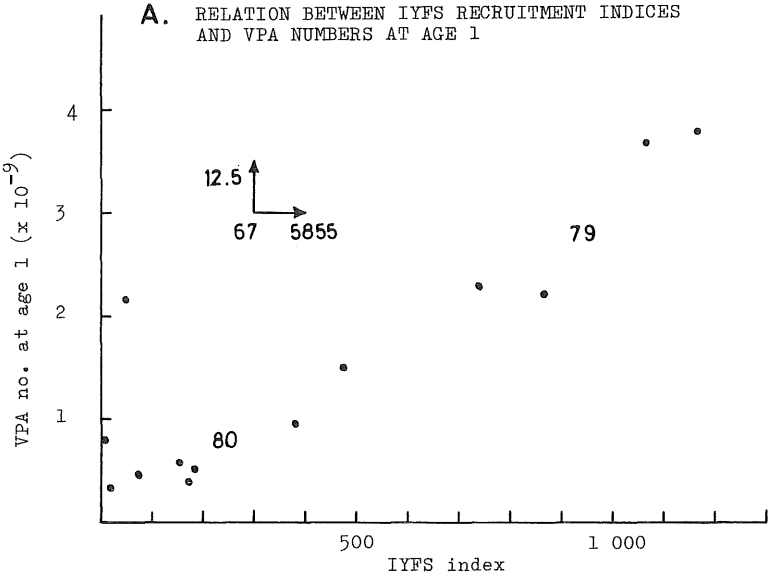


Figure 10.2 North Sea HADDOCK.



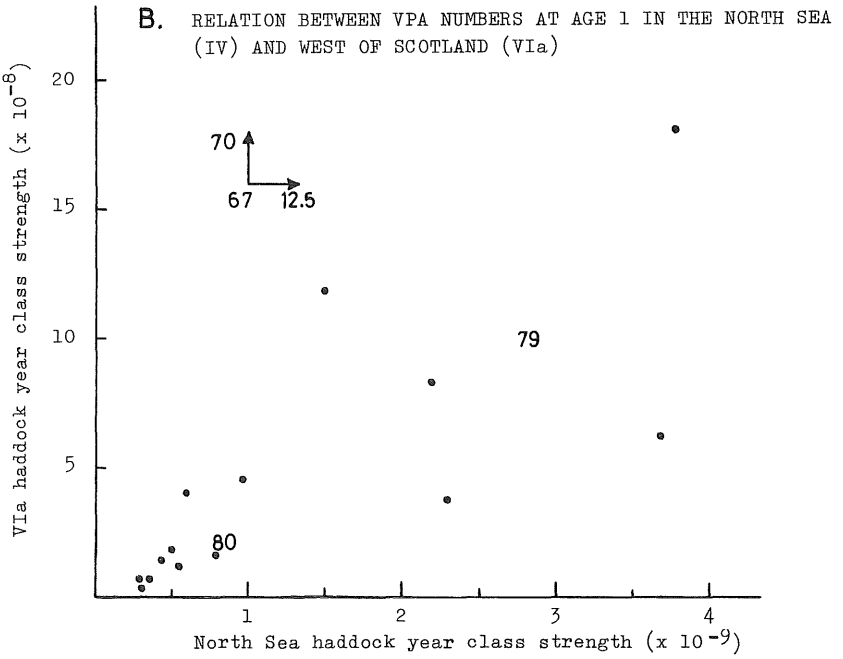
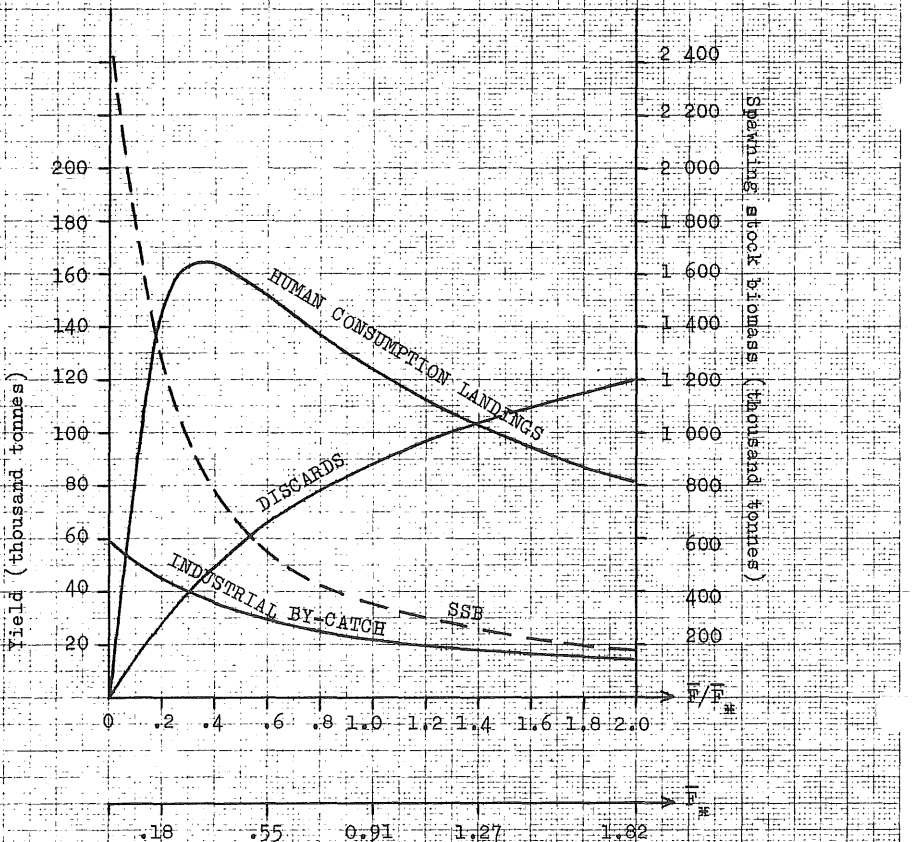
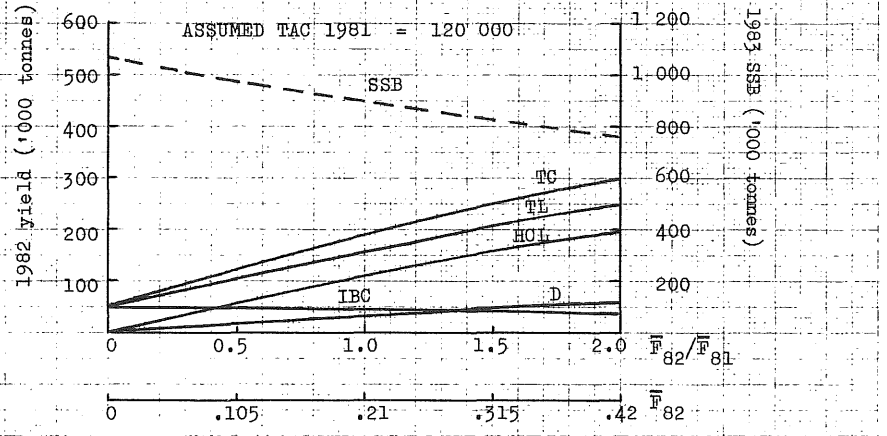



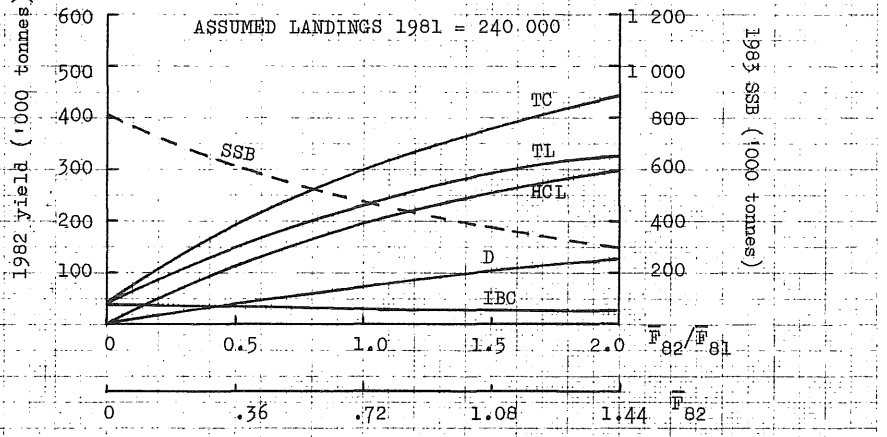
Figure 10.3 North Sea HADDOCK.
Equilibrium yield for average recruitment.




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

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



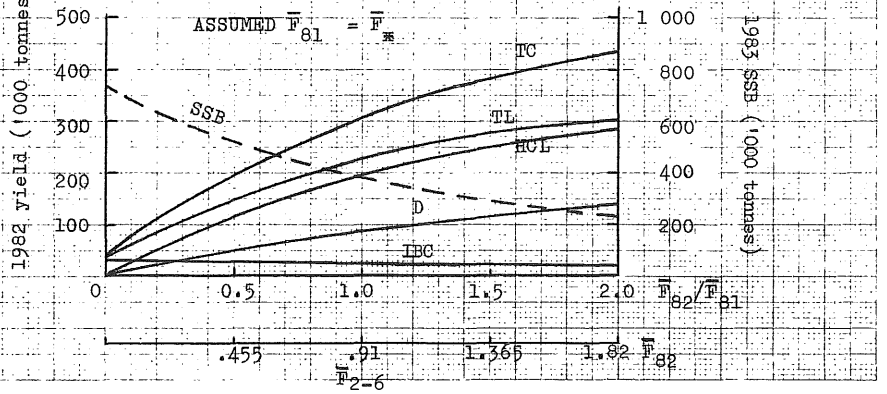



Figure 11.1 HADDOCK in Division VIa.

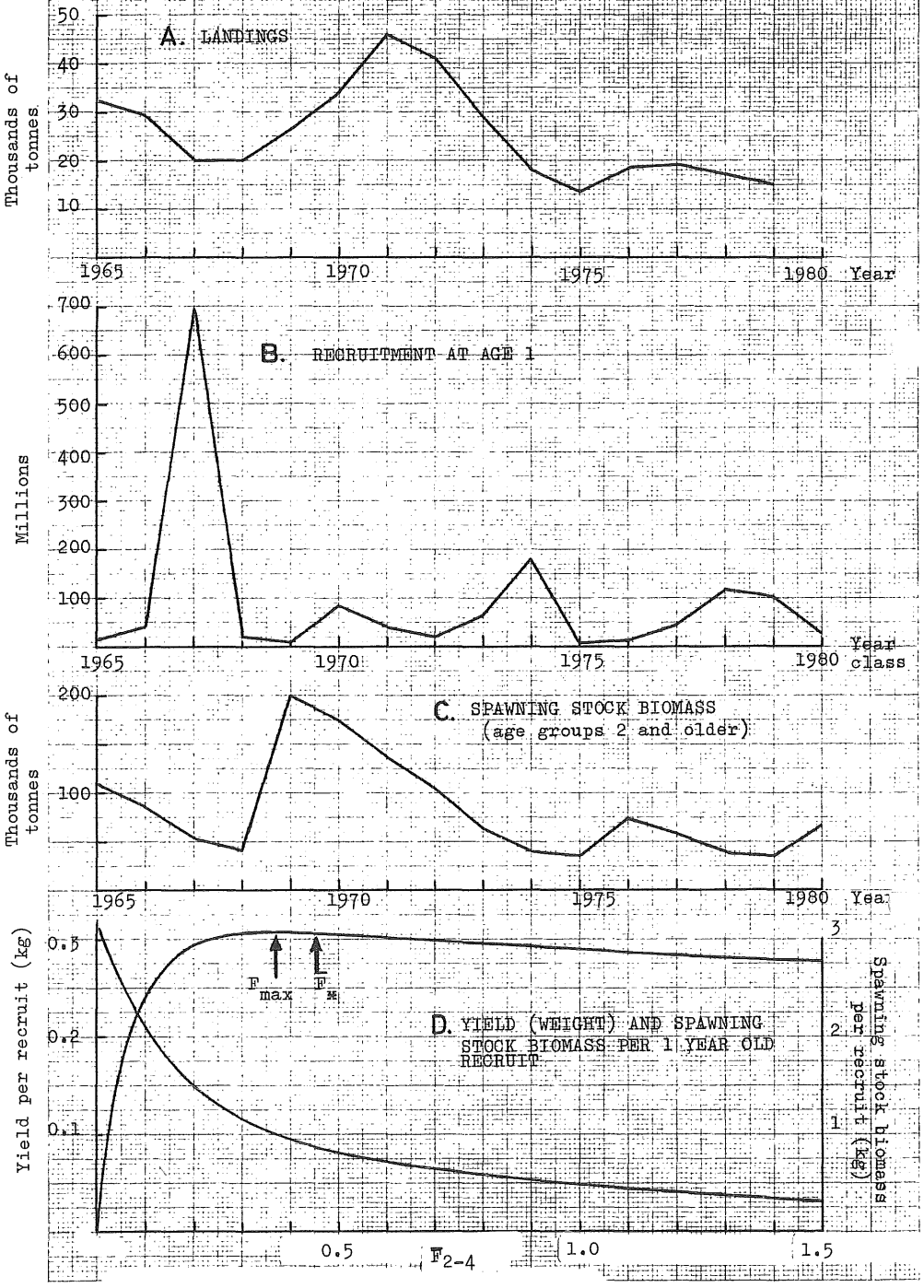


Figure 11.2 HADDOCK in Division VIa.
Predictions for catch in 1982 and spawning stock biomass in 1983. Average 1975-80 exploitation pattern.

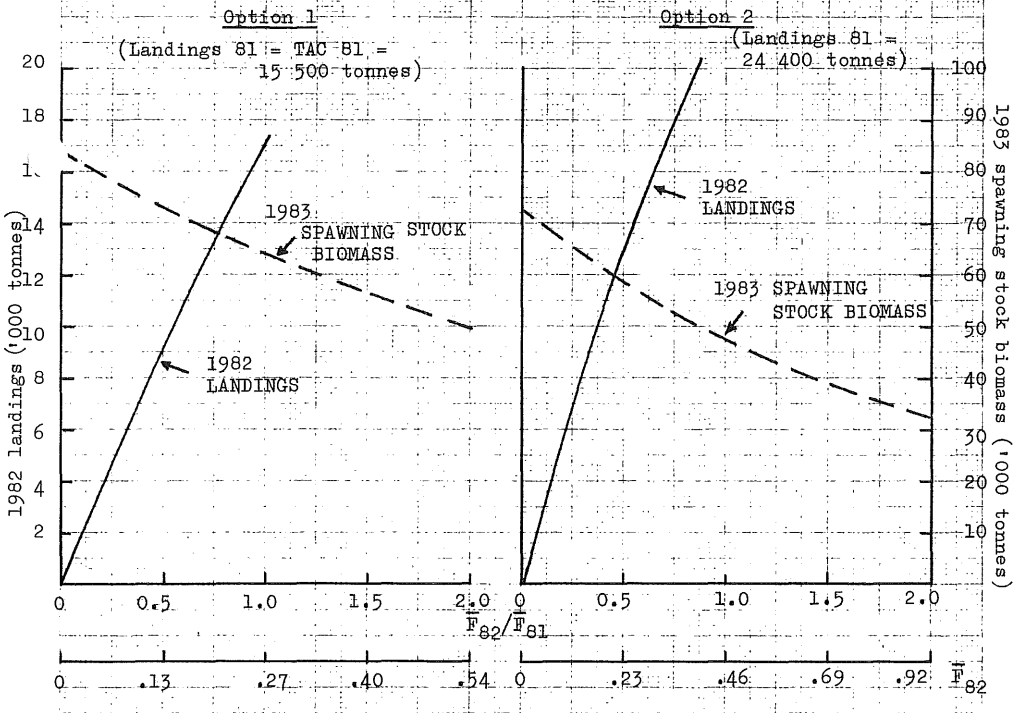


Figure 14.1 North Sea WHITING.

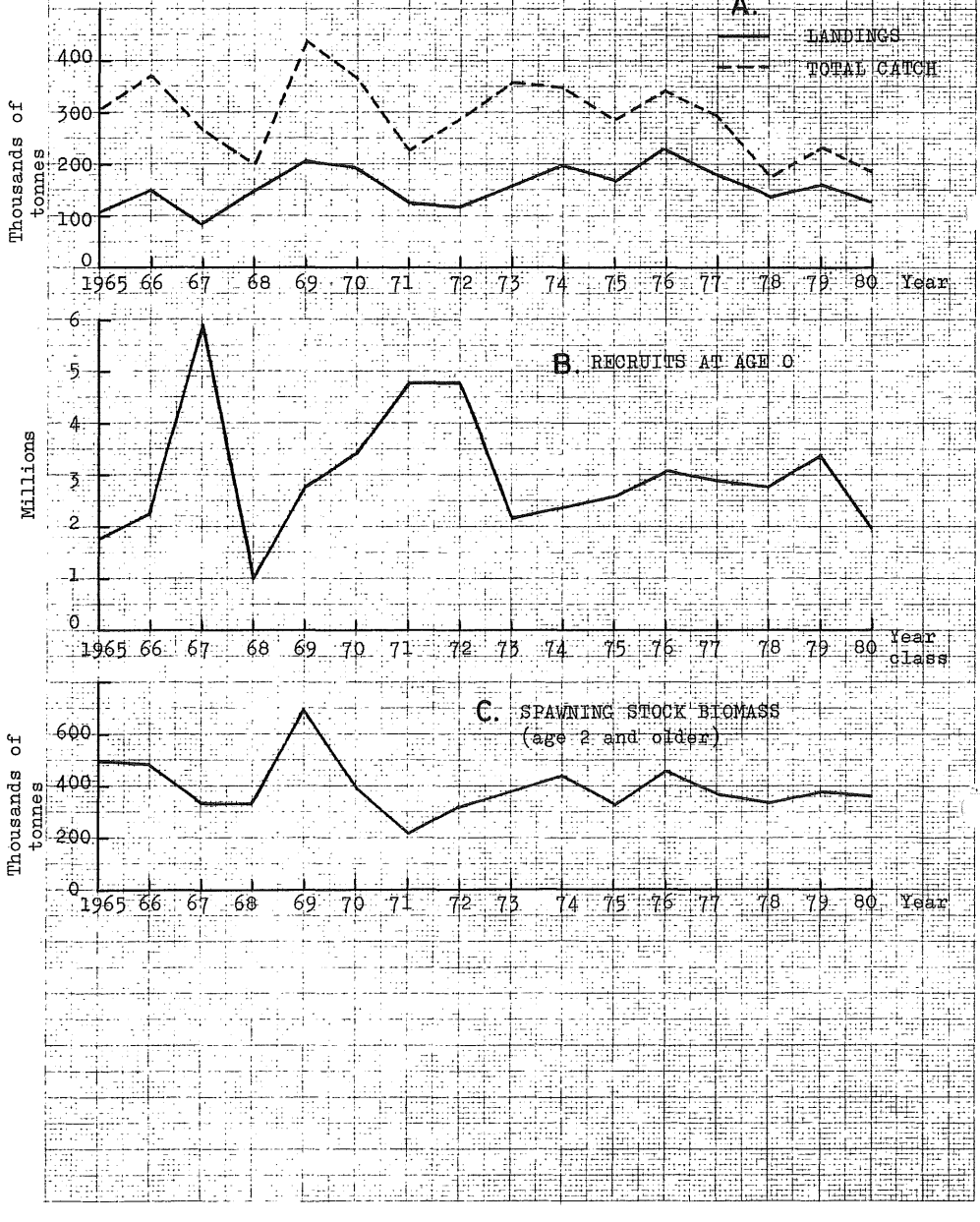


Figure 14.2 North Sea WHITING.

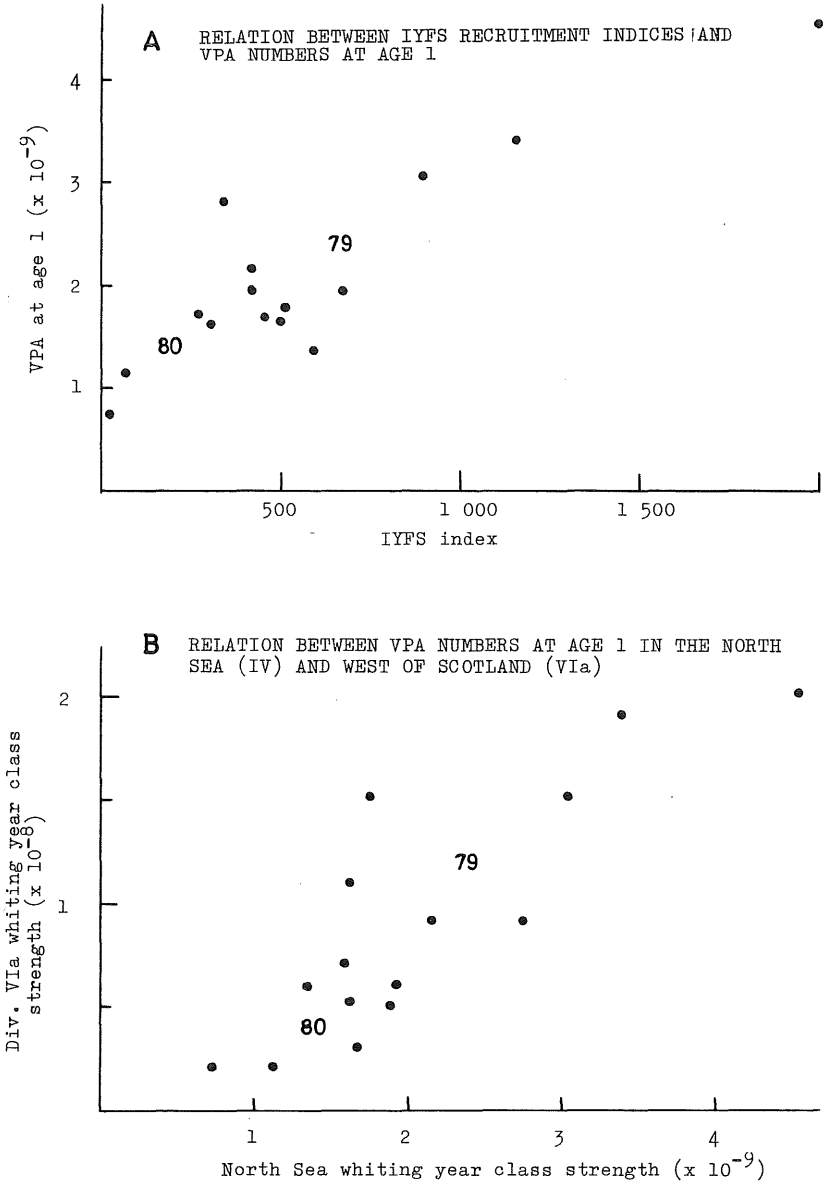
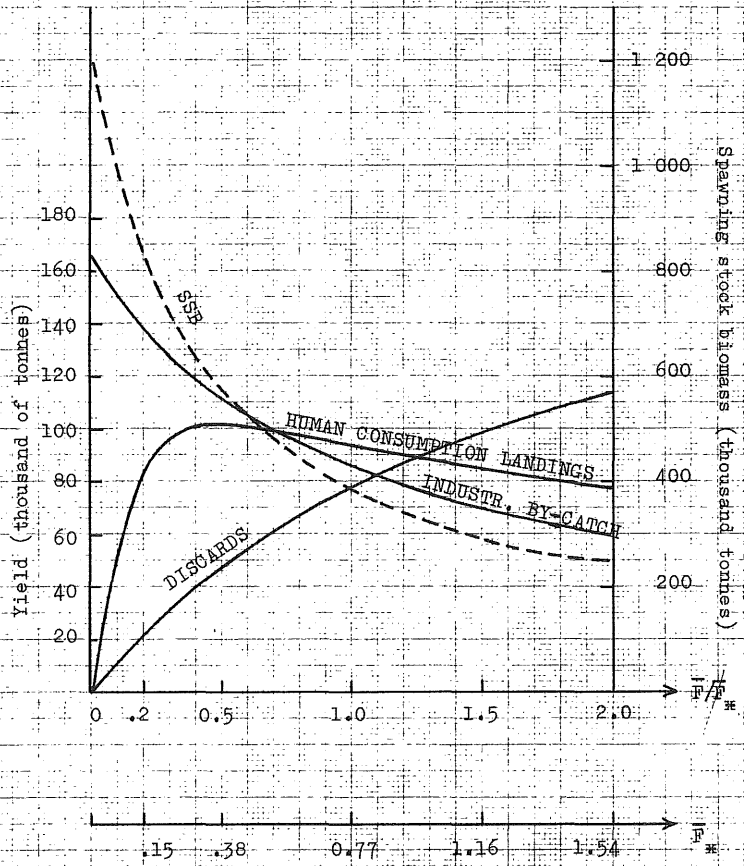


Figure 14.3 North Sea WHITING.
Equilibrium yield for average recruitment.




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

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

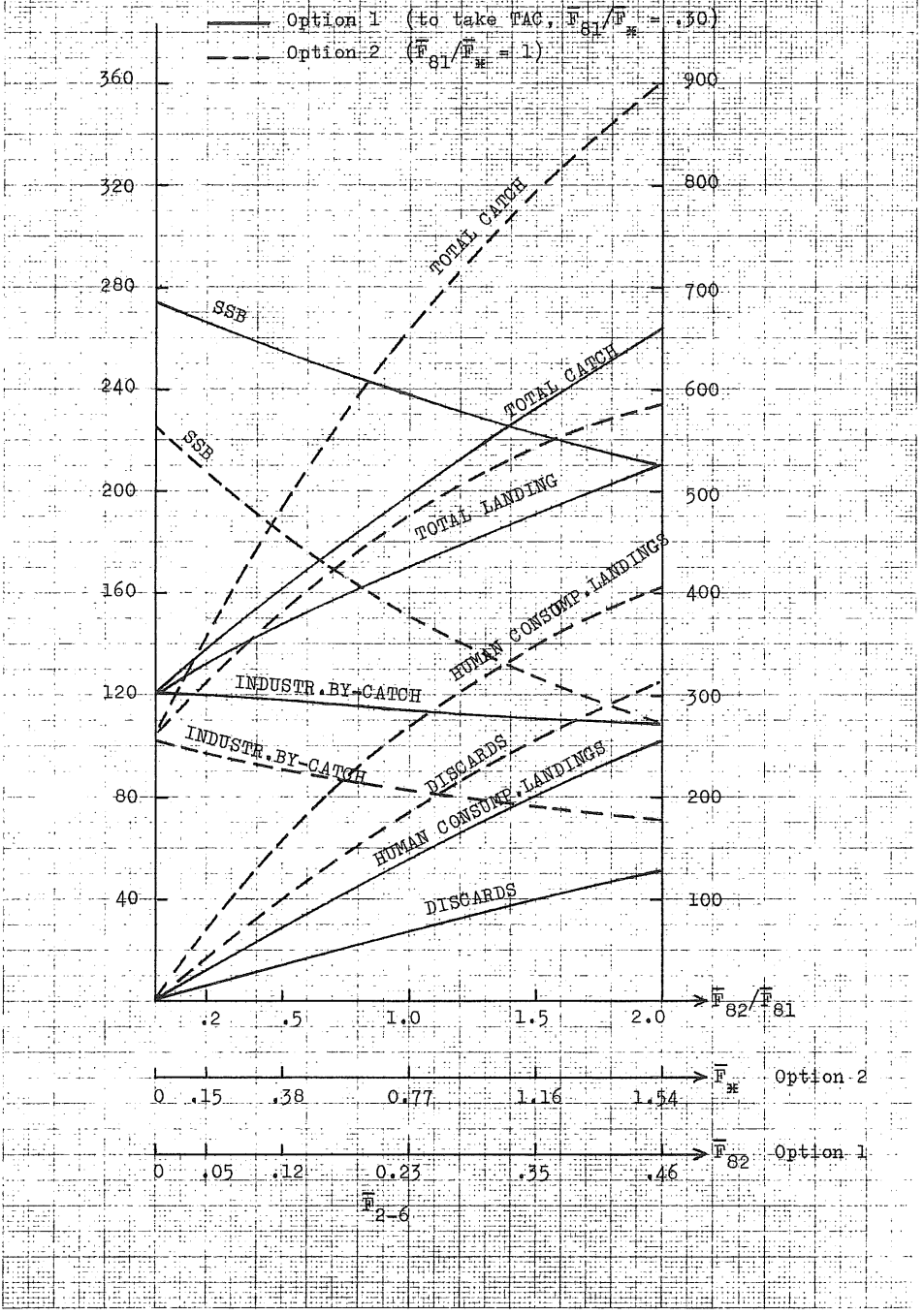


Figure 15.1 WHITING in Division VIa.

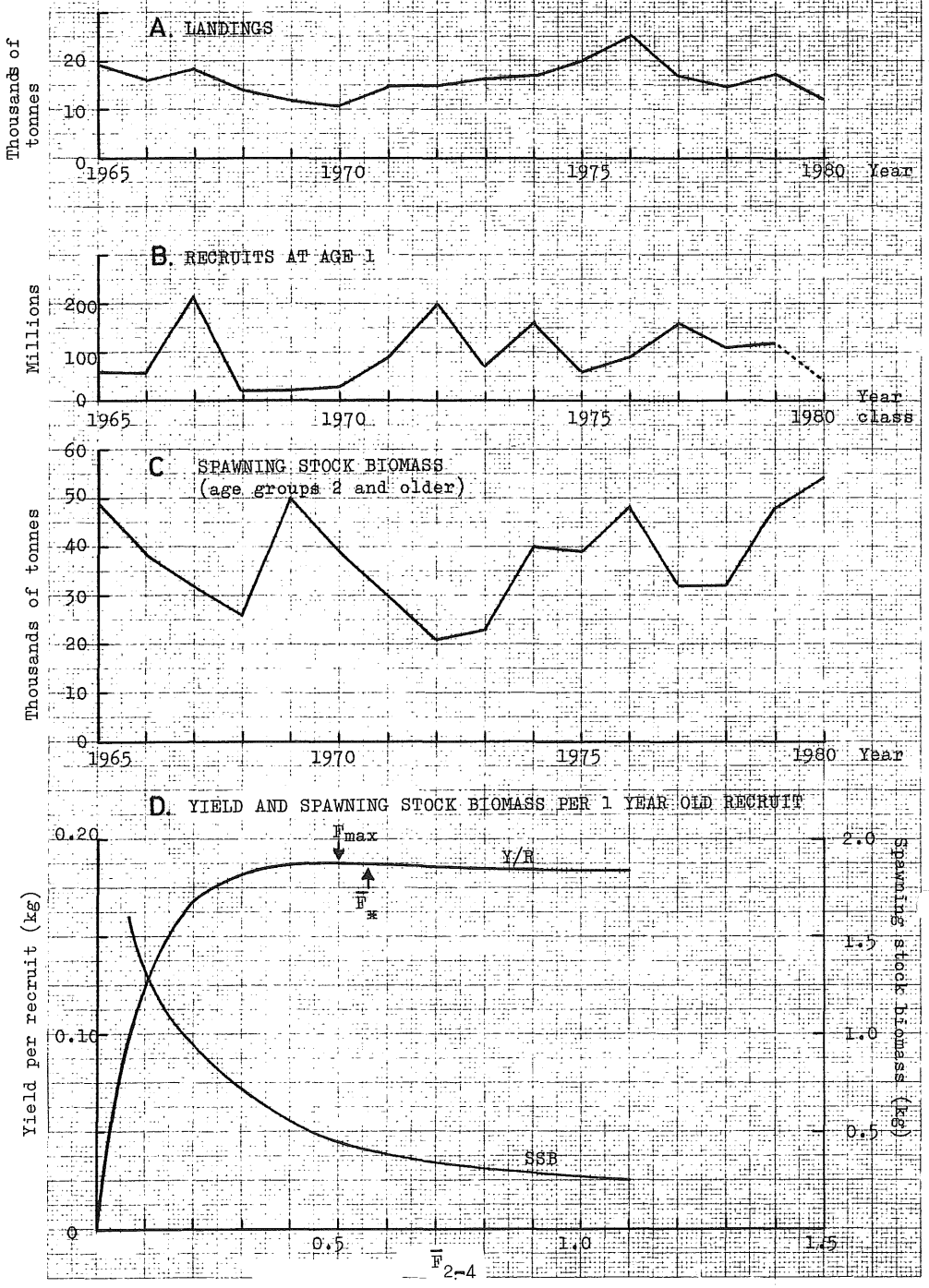
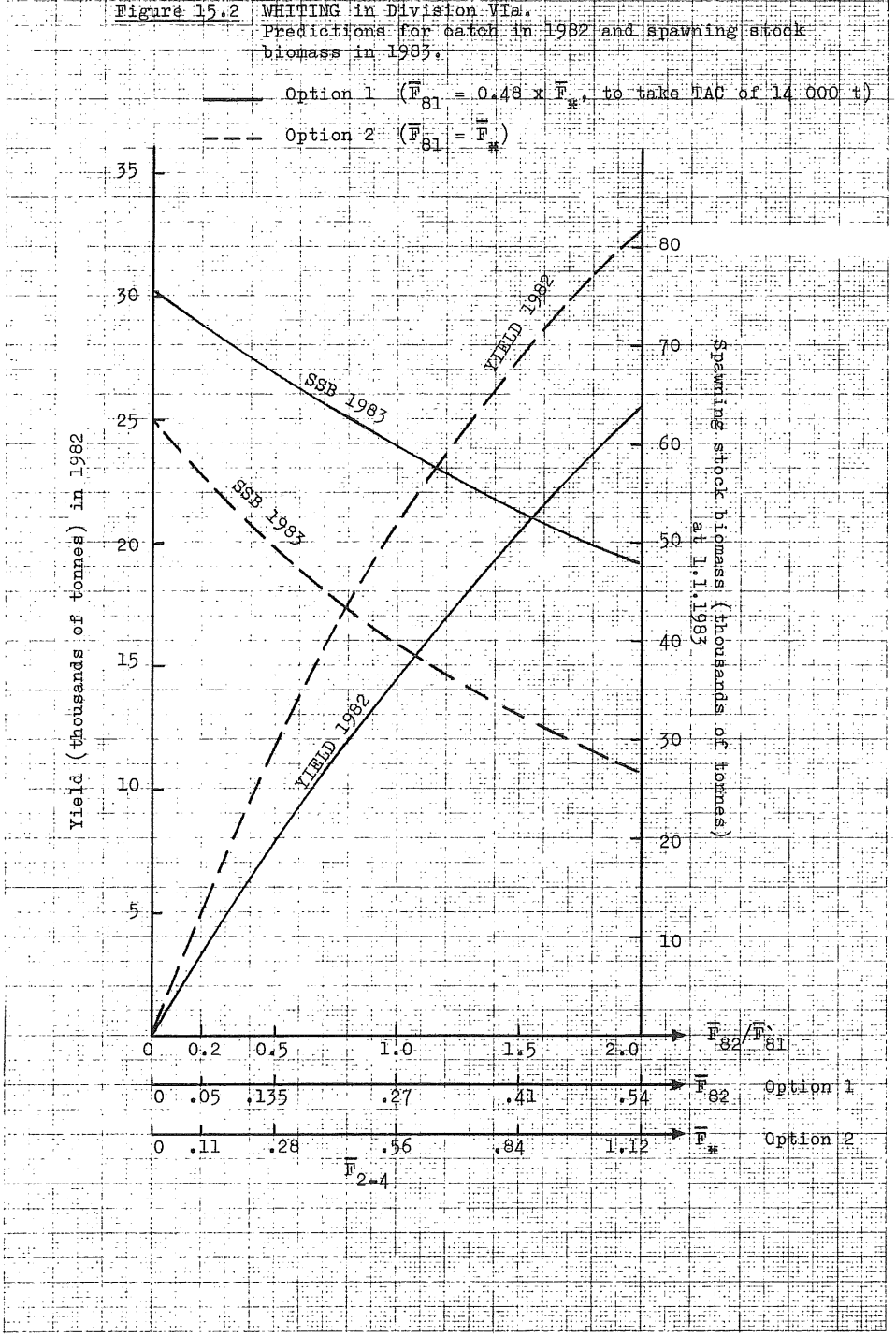


Figure 15.2 WHITING in Division VIa.
Predictions for catch in 1982 and spawning stock biomass in 1983.



## 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

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

$\varkappa$ 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 $\Gamma$s

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

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 $y_o \ldots\ldots y_1$

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 $y_o, \ldots\ldots y_r$.

$\alpha_a$ and $\beta_a$ 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. | 15. | 7. | 3. | |
| 1971 | 174.559 | 1763. | 2599. | 320. | 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. | 54. | 49. | 14. | 8. | 3. | SCOTLAND |
| 1975 | 152.977 | 1791. | 1638. | 431. | 265. | 272. | 58. | 9. | 16. | 7. | 1. | TRAWL |
| 1976 | 121.841 | 301. | 1377. | 677. | 152. | 85. | 87. | 11. | 4. | 3. | 2. | |
| 1977 | 144.548 | 3556. | 616. | 840. | 228. | 70. | 31. | 51. | 6. | 3. | 2. | |
| 1978 | 135.220 | 874. | 2540. | 289. | 182. | 64. | 16. | 12. | 7. | 3. | 1. | |
| 1979 | 87.467 | 280. | 926. | 448. | 74. | 47. | 23. | 12. | 4. | 3. | 1. | |
| 1980 | 55.477 | 2194. | 916. | 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. | 203. | 71. | 16. | 9. | 9. | |
| 1972 | 392.432 | 1282. | 20673. | 3529. | 396. | 339. | 120. | 57. | 27. | 5. | 8. | |
| 1973 | 414.898 | 7931. | 7600. | 6188. | 870. | 137. | 98. | 42. | 31. | 12. | 4. | SCOTLAND |
| 1974 | 349.604 | 4263. | 6313. | 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. | 57. | 10. | 4. | 9. | |
| 77 | 313.913 | 3347. | 4356. | 3069. | 714. | 177. | 51. | 35. | 24. | 6. | 2. | |
| 3 | 325.246 | 4844. | 20861. | 1401. | 851. | 202. | 48. | 23. | 21. | 8. | 3. | |
| 79 | 316.419 | 39370. | 8360. | 5228. | 380. | 342. | 66. | 44. | 18. | 11. | 4. | |
| 1980 | 297.225 | 12626. | 6332. | 2342. | 829. | 144. | 90. | 55. | 15. | 9. | 4. | |
| 1970 | 83.529 | 1033. | 326. | 397. | 95. | 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. | 23. | 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. | 3355. | 415. | 101. | 38. | 39. | 10. | 1. | 1. | 0. | TRAWL |
| 1977 | 224.824 | 5660. | 1853. | 774. | 118. | 75. | 24. | 13. | 8. | 2. | 1. | |
| 1978 | 236.929 | 3574. | 7960. | 677. | 270. | 51. | 28. | 7. | 8. | 3. | 0. | |
| 1979 | 287.494 | 21877. | 6066. | 1808. | 178. | 61. | 15. | 3. | 4. | 2. | 0. | |
| 1980 | 333.197 | 10601. | 5515. | 2052. | 536. | 70. | 38. | 15. | 4. | 3. | 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. | 3. | |
| 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. | 4331. | 741. | 1875. | 708. | 177. | 69. | 61. | 56. | 7. | MOTOR |
| 1975 | 2.629 | 6250. | 5759. | 1768. | 285. | 563. | 211. | 26. | 24. | 26. | 8. | TRAWL |
| 1976 | 3.107 | 1379. | 9464. | 1740. | 638. | 131. | 276. | 80. | 17. | 6. | 7. | |
| 1977 | 3.110 | 12274. | 3728. | 2327. | 534. | 235. | 66. | 100. | 58. | 8. | 4. | |
| 1978 | 3.192 | 5534. | 19687. | 1367. | 903. | 279. | 105. | 40. | 51. | 14. | 2. | |
| 1979 | 2.986 | 21179. | 11370. | 3648. | 337. | 366. | 87. | 41. | 12. | 21. | 5. | |
| 1980 | 1.989 | 13299. | 6049. | 2204. | 772. | 117. | 116. | 35. | 12. | 6. | 7. | |
| 1970 | 656.000 | 4244. | 1395. | 761. | 997. | 628. | 188. | 118. | 18. | 25. | 16. | |
| 1971 | 695.000 | 2786. | 7536. | 852. | 334. | 572. | 265. | 102. | 40. | 16. | 2. | |
| 1972 | 792.000 | 299. | 9964. | 3110. | 401. | 195. | 382. | 188. | 60. | 43. | 8. | |
| 1973 | 833.000 | 5998. | 1664. | 3881. | 1200. | 243. | 139. | 105. | 41. | 7. | 5. | ENGLAND |
| 1974 | 758.000 | 743. | 2530. | 433. | 1096. | 414. | 103. | 40. | 36. | 33. | 4. | SEINE |
| 1975 | 771.000 | 3361. | 3096. | 951. | 153. | 305. | 113. | 14. | 13. | 14. | 4. | |
| 1976 | 824.000 | 1079. | 7401. | 1361. | 499. | 102. | 216. | 62. | 13. | 5. | 5. | |
| 77 | 804.000 | 6240. | 708. | 409. | 94. | 41. | 12. | 18. | 7. | 1. | 1. | |
| 3 | 854.000 | 4186. | 14891. | 1034. | 685. | 211. | 79. | 50. | 38. | 11. | 2. | |
| 9 | 767.000 | 15500. | 8521. | 2669. | 246. | 268. | 63. | 50. | 9. | 16. | 4. | |
| 1980 | 865.000 | 13809. | 6281. | 2289. | 802. | 122. | 121. | 50. | 13. | 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 | 7.633 | 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 | 10.301 | 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 | -0.613 | -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 | -1.495 | -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. | 3. | 0. | |
| 1971 | 174.559 | 85632. | 4467. | 8090. | 80228. | 1774. | 121. | 34. | 43. | 432. | 27. | |
| 1972 | 201.493 | 105655. | 69149. | 4264. | 3906. | 31086. | 728. | 32. | 7. | 10. | 44. | |
| 1973 | 182.541 | 10435. | 47958. | 33432. | 809. | 835. | 6342. | 149. | 18. | 2. | 20. | |
| 1974 | 185.432 | 222660. | 8291. | 31135. | 6905. | 163. | 205. | 1562. | 33. | 4. | 7. | |
| 1975 | 152.977 | 94929. | 66943. | 7785. | 16311. | 2015. | 73. | 57. | 583. | 15. | 7. | SCOTLAND |
| 1976 | 121.841 | 7161. | 66577. | 22005. | 1260. | 3030. | 596. | 16. | 6. | 90. | 10. | TRAWL |
| 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 | 426.563 | 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. | 4648. | 39723. | 911. | 53. | 7. | 3. | 110. | |
| 1973 | 414.898 | 24752. | 120189. | 63564. | 1982. | 1042. | 9872. | 351. | 42. | 7. | 39. | |
| 1974 | 349.604 | 540844. | 22404. | 78275. | 12975. | 441. | 234. | 2390. | 48. | 5. | 8. | SCOTLAND |
| 1975 | 329.432 | 231344. | 164946. | 20700. | 35067. | 4081. | 151. | 110. | 530. | 22. | 11. | SEINE |
| 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. | 14372. | 44653. | 2396. | 479. | 673. | 86. | 29. | 5. | |
| 1979 | 316.419 | 92774. | 77521. | 17080. | 3106. | 8213. | 659. | 71. | 115. | 24. | 4. | |
| 1980 | 297.225 | 105612. | 133024. | 26178. | 3394. | 501. | 2416. | 123. | 20. | 55. | 23. | |
| 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. | 137. | 13. | 1. | 1. | 28. | |
| 1973 | 152.422 | 4620. | 22521. | 8923. | 246. | 203. | 1591. | 48. | 3. | 1. | 6. | SCOTLAND |
| 1974 | 116.982 | 90927. | 4371. | 13474. | 2278. | 31. | 21. | 283. | 6. | 0. | 1. | LIGHT |
| 1975 | 161.309 | 53768. | 41292. | 4389. | 7623. | 605. | 13. | 14. | 77. | 3. | 1. | TRAWL |
| 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 |
| 1973 | 80.369 | 193. | 1096. | 340. | 73. | 6. | 39. | 1. | 0. | 0. | 0. | NEPHROPS |
| 1974 | 127.264 | 2959. | 135. | 400. | 52. | 0. | 0. | 58. | 0. | 0. | 0. | TRAWL |
| 1975 | 118.308 | 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. | 13. | 2. | 0. | 0. | 0. | |
| 1978 | 100.630 | 385. | 150. | 108. | 76. | 4. | 1. | 1. | 0. | 0. | 0. | |
| 1979 | 113.256 | 581. | 440. | 28. | 3. | 21. | 3. | 0. | 1. | 0. | 0. | |
| 1980 | 102.023 | 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) | -2.588 | -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.

| YEAR | FORT 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 | 201.493 | 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. | 8032. | 550. | 752. | 71. | 9. | 0. | |
| 1979 | 87.467 | 2856. | 14814. | 11068. | 7828. | 2945. | 166. | 212. | 25. | 1. | |
| 1980 | 55.477 | 531. | 10354. | 10239. | 3653. | 2485. | 930. | 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. | 43493. | 28504. | 14808. | 6030. | 678. | 157. | 3. | 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. | 8153. | 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.

| ,R | EFFORT | AGE 1 | 2 | 3 | 4 | 5 | 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 | 51.153 | 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 |
| 1976 | 35.307 | 41. | 204. | 149. | 49. | 39. | 41. | 7. | 1. | TRAWL |
| 1977 | 33.948 | 98. | 69. | 75. | 27. | 12. | 9. | 6. | 2. | |
| 1978 | 51.582 | 36. | 256. | 76. | 107. | 53. | 20. | 9. | 5. | |
| 1979 | 33.373 | 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 | 5.864 | 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 | 8.542 | 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 | -1.336 | -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 | 8.348 | 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. | 1564. | 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 ($\times 10^{-3}$).

| 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 | 10.083 | 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 | 9.069 | 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.

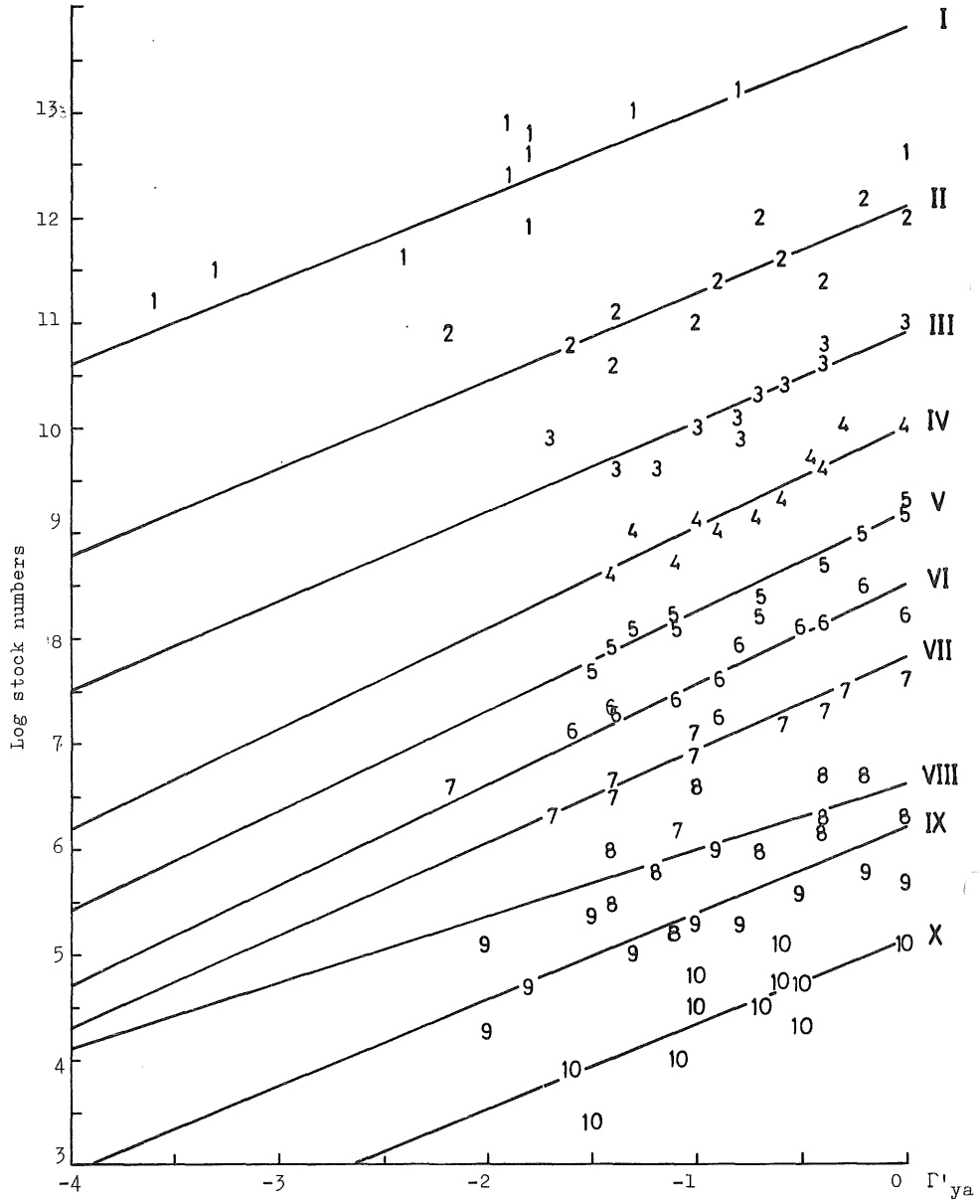
| YEAR | EFFORT | AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 40.572 | 3. | 13. | 2018. | 462. | 64. | 28. | 1. | 29. | |
| 1971 | 41.236 | 13. | 132. | 98. | 3024. | 166. | 36. | 3. | 0. | |
| 1972 | 55.536 | 329. | 473. | 235. | 56. | 1273. | 85. | 5. | 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 | 35.307 | 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. | 613. | 344. | 217. | 37. | 17. | |

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

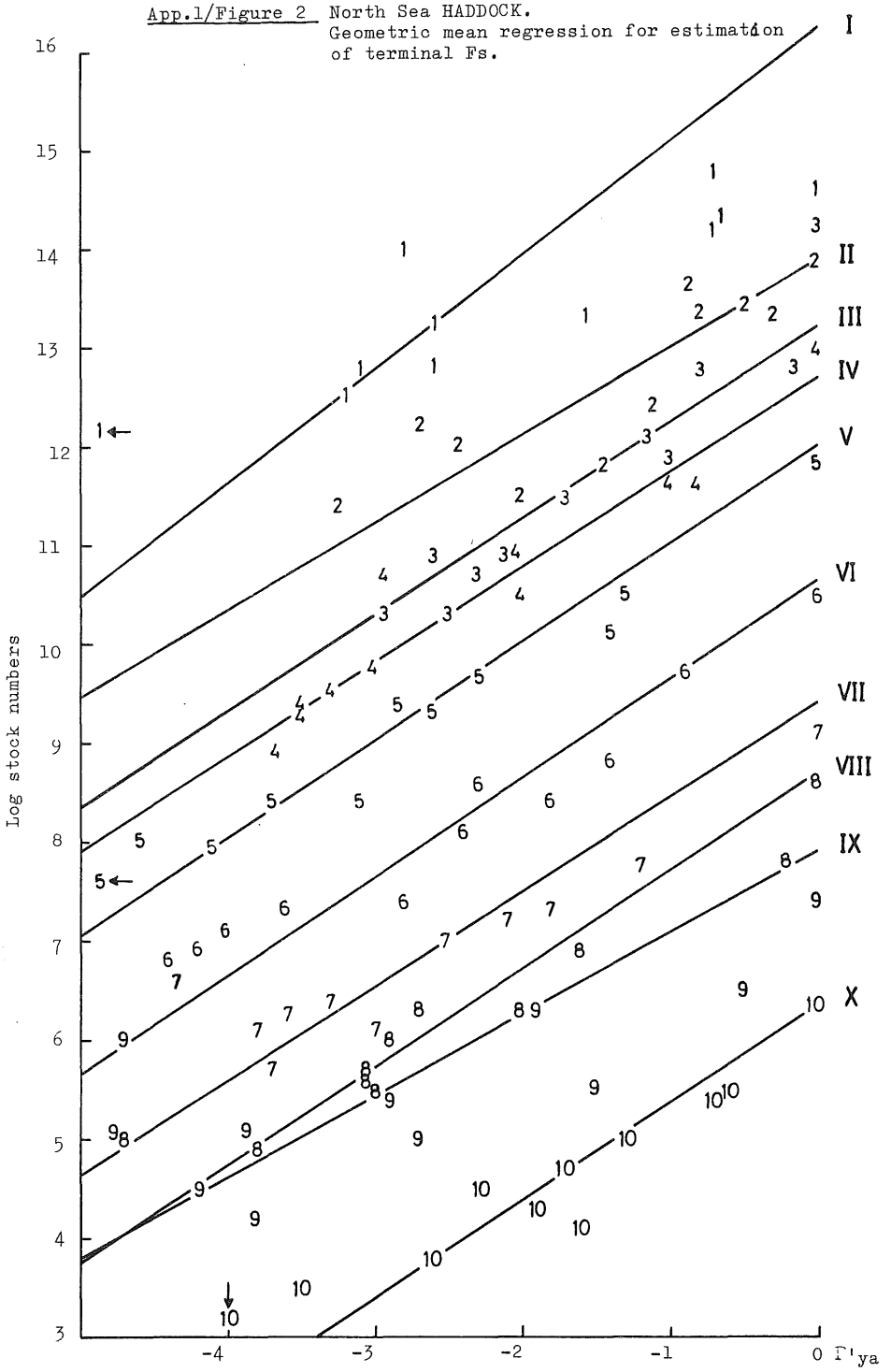
| YEAR | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 1970 | LOG(GAMMA) | -4.813 | -5.284 | -0.348 | -1.863 | -2.676 | -3.102 | -4.797 | -0.190 |
| | LOG(MEAN-N) | 9.883 | 9.278 | 11.376 | 8.490 | 6.679 | 5.586 | 2.157 | 6.642 |
| 1971 | LOG(GAMMA) | -3.363 | -2.982 | -5.389 | 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 | -2.405 |
| | LOG(MEAN-N) | 12.046 | 10.470 | 8.539 | 6.795 | 5.283 | 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 | -3.362 |
| | LOG(MEAN-N) | 11.502 | 11.344 | 10.103 | 9.136 | 8.726 | 7.101 | 6.595 | 2.890 |
| 1980 | LOG(GAMMA) | -1.963 | -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.

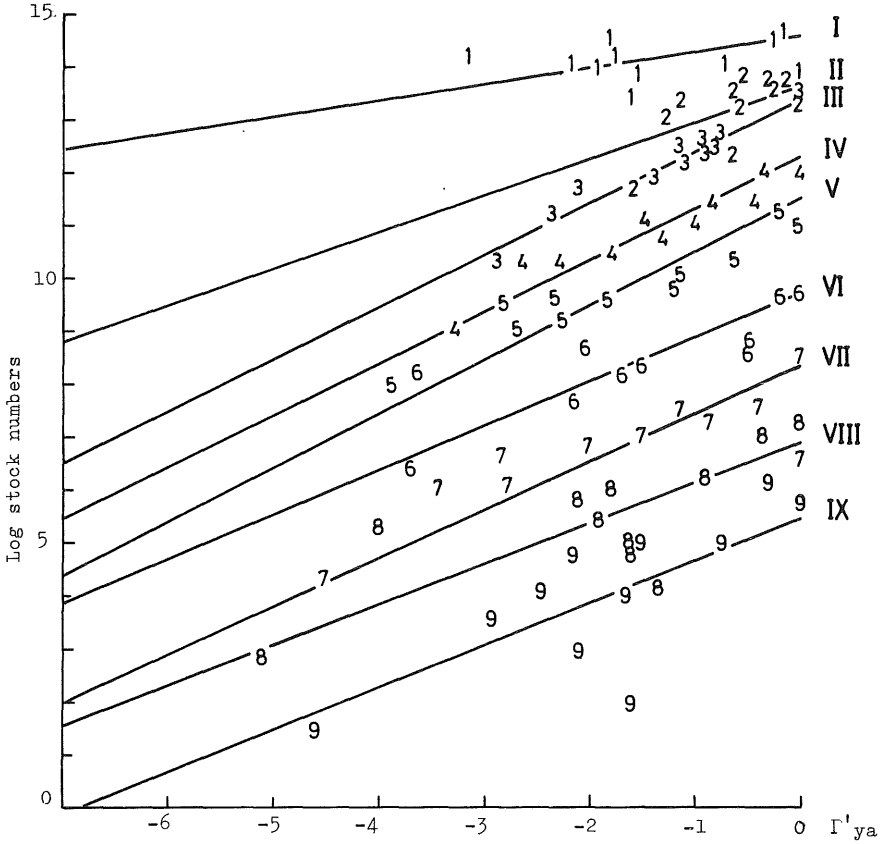
App.1/Figure 1 North Sea COD.
Geometric mean regression for estimation of terminal Fs.



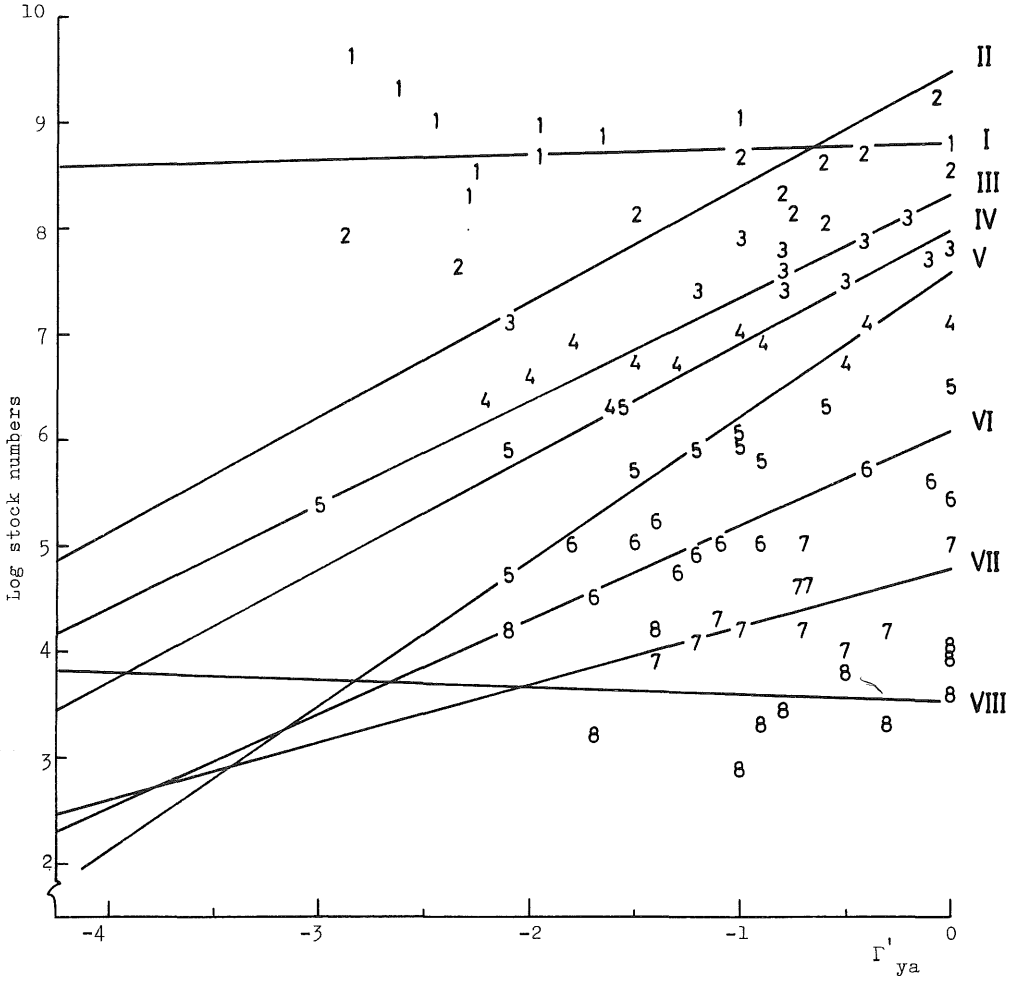
App.1/Figure 2 North Sea HADDOCK.
Geometric mean regression for estimation of terminal Fs.



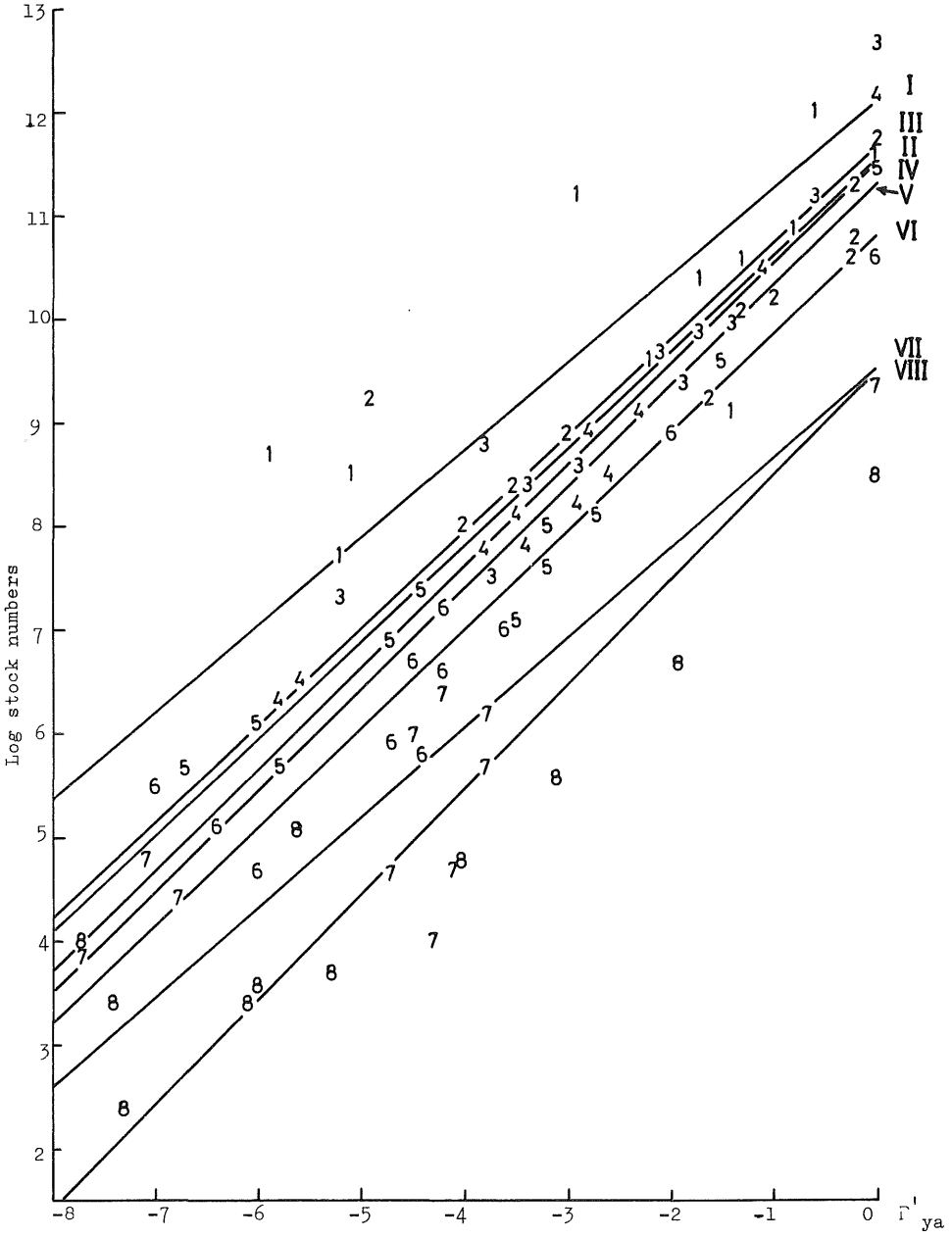
App.1/Figure 3 North Sea WHITING.
Geometric mean regression for estimation of terminal Fs.



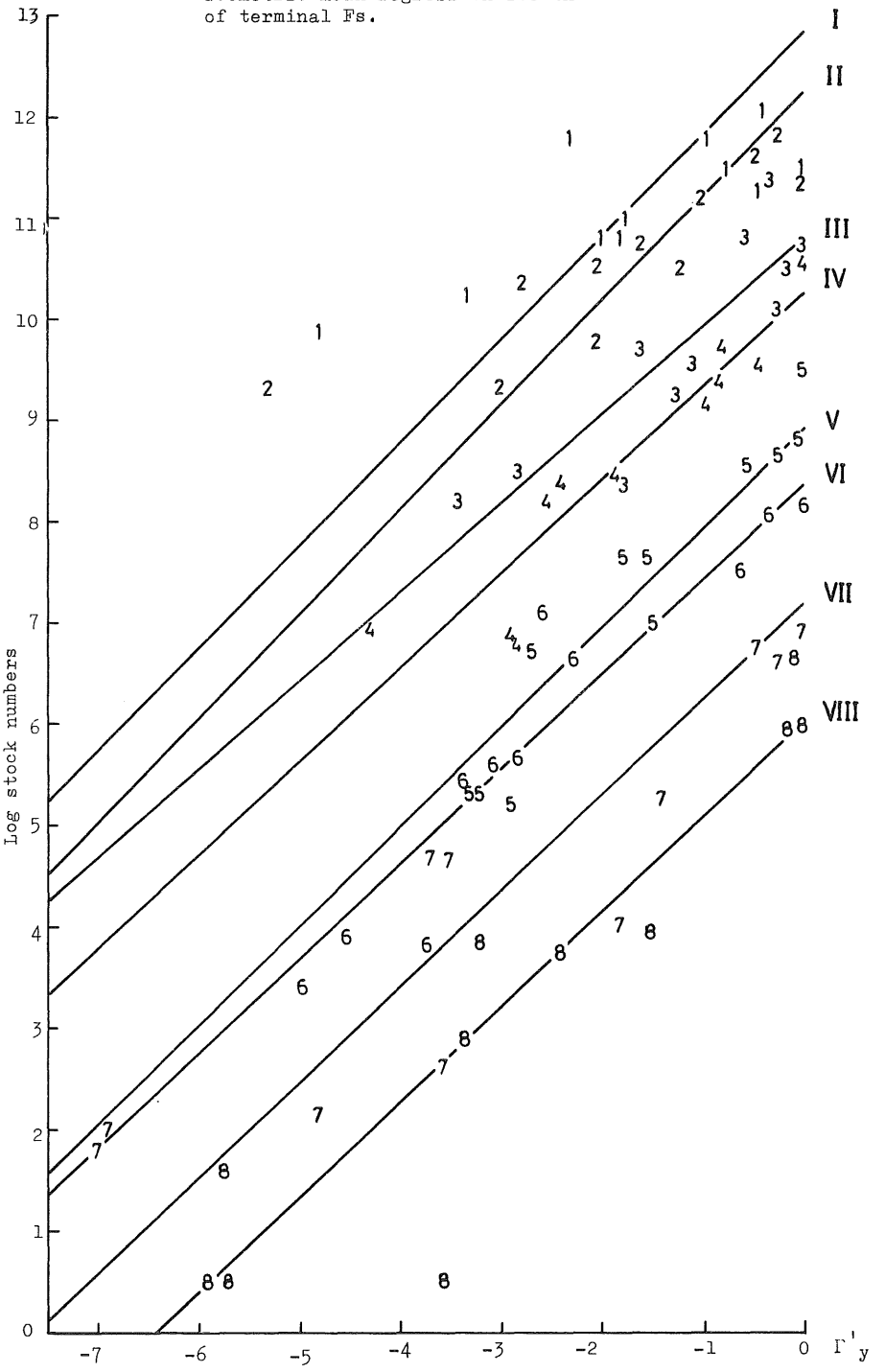
App.1/Figure 4 COD - West of Scotland - Div.VIa.
Geometric mean regressions for estimation of terminal Fs.



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.

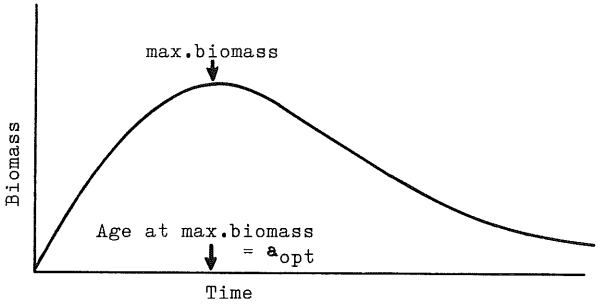


## APPENDIX 2

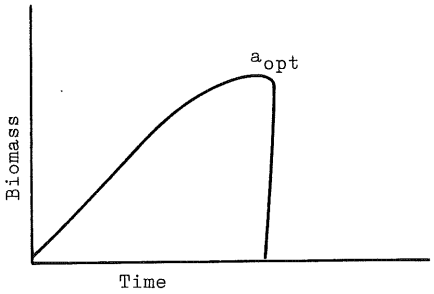
## SUGGESTION FOR AN INDEX OF EXPLOITATION

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.

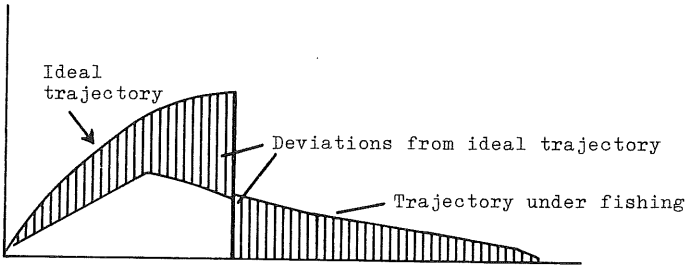
The following is a suggestion for a way out of this problem.
Consider a trajectory in time of the biomass of a cohort of fish not subject to exploitation. Under these conditions the cohort attains a max.biomass at some well defined age, i.e.




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:

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

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

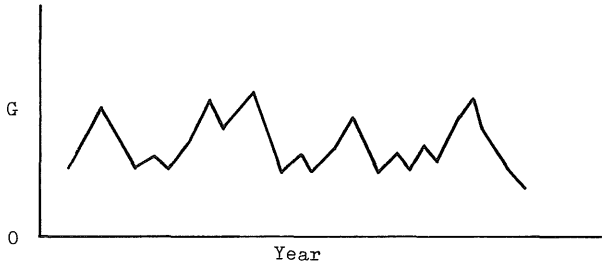
This is equivalent to the following expression

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

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

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.