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REPORT OF THE NORTH SEA ROUND FISH WORKING GROUP

Copenhagen, 7 - 16 June 1983

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x) General Secretary,
ICES,
Palægade 2-4,
1261 Copenhagen K,
Denmark.

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REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

1. PARTICIPANTS

D W Armstrong	United Kingdom (Scotland)
E D Anderson	USA
N Daan	Netherlands
J P Hillis (part-time)	Ireland
B W Jones (Chairman)	United Kingdom (England)
J Lahn-Johannessen	Norway
F Lamp	Federal Republic of Germany
P Lewy	Denmark
C T Macer	United Kingdom (England)
O M Smedstad	Norway
T Smith	USA
A Souplet	France
G Wagner	Federal Republic of Germany

K Hoydal, ICES Statistician, also attended the meeting.

2. TERMS OF REFERENCE

At the 1982 Statutory Meeting of ICES it was decided (C.Res.1982/2:5:10) that the North Sea Roundfish Working Group should meet at ICES headquarters from 7-16 June 1983 to:

- (i) assess catch options for 1984 inside safe biological limits for cod, haddock and whiting in Sub-areas IV, VI and Divisions VII d, e,
- (ii) advise on possibilities other than by mesh regulations to improve the exploitation pattern on these stocks,
- (iii) review which data are available in the Working Group files for evaluating density dependence in the parameters of the models used in fish stock assessment,
- (iv) specify deficiencies in data required for assessments.

3. INTRODUCTION

At the 1981 meeting of the Working Group a new method was introduced, the Gamma method, for determining on an objective basis the levels of fishing mortality in the most recent year. The resultant values of F were then used to initiate the Virtual Population Analysis (VPA). There were subsequently some criticisms of the Gamma method mainly on the grounds that it did not allow for catchability varying with time. At the 1982 meeting the Working Group used a new method, the Rho method, which made allowance for changing catchability, and this method was considered by ACFM to be generally acceptable. Shortly before the 1983 North Sea Roundfish Working Group meeting there was a meeting of the Working Group on Methods of Fish Stock Assessment which, *inter alia*, examined the currently available methods which use catch and effort data to determine F values in the most recent year. As there was only one week between the meetings, members of the Roundfish Working Group did not have adequate time to assimilate and implement fully the recommendations of the Methods Working Group. Thus, the Roundfish Working Group had to adopt a pragmatic approach to the problem of tuning the VPAs by using the best of the methods for which computational software was available.

Three methods were attempted this year:

- (a) The Armstrong-Cook method as the method preferred by the Methods Working Group;
- (b) The Rho method for continuity and comparison with the 1982 assessments;
- (c) The Lewy method, which is a development of the Rho method, has the advantage that it calculates catchability at a fleet-disaggregated level.

These methods are described in greater detail in Section 5.

ACFM was critical of the Report of the 1982 meeting of the Working Group "because of the way the Working Group appeared to have discarded the IYFS data, although the difficulties in obtaining reliable estimates of recruiting year classes were appreciated". It was not the intention of the Working Group to discard the IYFS data, but during the 1982 meeting it became apparent that the difficulties in interpreting these data were greater than the Group was able to resolve in the available time. An International Gadoid Survey Working Group has been convened to meet in 1983 to examine the problems associated with the prediction of recruiting year class strength from survey data. Unfortunately, the Gadoid Group is not due to meet until July and consequently the Roundfish Working Group had to make its estimates of recruitment (see Section 6) in the absence of any advice, which might be given.

4. REVISIONS TO DATABASE

Estimation of the Age Frequency Distributions of Haddock Discarded in Division VIa, 1965-77

Estimates of the numbers of haddock discarded at each age by Scottish vessels exist for the period 1978-82. These data were used to estimate the average number of haddock discarded per fish landed for ages 1 to 11 for each Scottish gear. Estimates of numbers discarded at each of these ages were then obtained for the period 1965-77 using the relationship

$$D(a,y,g) = L(a,y,g) \cdot X(a,g)$$

where a refers to age, y refers to year, g refers to gear, L refers to number landed, X is average number discarded per fish landed and D refers to discards.

In many cases no fish are landed at age 0, and it is therefore not possible to estimate the number discarded per fish landed. For this age group discards were estimated using the following relationship

$$\frac{D(0,y,g) / E(y,g)}{D(1,y+1,g) / E(y+1,g)} = K(g)$$

where E refers to fishing effort and K is the average ratio of discards per unit effort determined from data for the period 1978-82.

The values obtained by these methods are of course rather crude and it is hoped to improve on the estimation technique in the near future.

Mean weight at age for discards for the period 1965-77 was assumed to be equal to the mean value over all gears for the period 1978-82.

This was the only major revision to the database other than updating for the last two years. Updated total weights and total numbers for North Sea cod, haddock and whiting stocks can be found in Tables 4.1 - 4.3.

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

As mentioned in Section 3, the Working Group attempted to use three methods for determining F in the last data year:

- (a) The Rho method
- (b) The Lewy method (see Appendix)
- (c) The Armstrong-Cook method.

The program for the Rho method was available on the ICES computer, for the Lewy method on the Charlottenlund computer, and for the Armstrong-Cook method on the Aberdeen computer.

Individual fleet catch and effort data were available as indicated in the text table below, which also shows which fleet data were excluded from the final analysis.

+ indicates data available
 X indicates fleets excluded from final analysis

Fleet	North Sea			West of Scotland		
	Cod	Haddock	Whiting	Cod	Haddock	Whiting
Scottish Trawl	+ X	+	+	+	+	+
Seine	+	+	+	+	+	+
Light Trawl	+	+	+	+	+	+
<u>Nephrops</u> Trawl	+ X	+ X	+ X	+ X	+ X	+ X
English Trawl	+	+ X	+ X	+ X	+ X	
Seine	+ X	+ X	+ X			
Netherlands Beam Trawl	+					

An initial decision was made to exclude the Scottish Nephrops trawl fleet data from all stocks because it was felt that these data are inappropriate for this purpose. English trawl and English seine data had to be excluded from the haddock and whiting analyses as there were no fleet discard data available.

Preliminary runs were made with both the Rho and the Lewy methods for the North Sea stocks and with the Rho method for West of Scotland stocks. In general, the results for the methods were in good agreement. The Lewy method has the advantage that q values for each age in each year are calculated for each fleet separately. Plots were therefore made of q against year for each age/fleet combination. On the basis of these plots it was decided to exclude some additional fleet data before proceeding to the final analysis. For both haddock stocks both methods calculated F values for a number of age groups which were unrealistically high. The data for the North Sea haddock stock were transmitted to Aberdeen for use in the Armstrong-Cook program. The results from this method also gave unacceptable values for a number of age groups and none of these methods could be used this year for haddock. Logistical problems did not permit the Armstrong-Cook analysis to be extended to other stocks.

Although the results from the Rho and Lewy methods were generally in good agreement (see below) a decision had to be made as to which sets of F values were to be used in the assessments. The Working Group considered that the Lewy method was in principle preferable to the Rho method because it enabled the q values to be calculated on disaggregated fleet data. In addition, the program for the Lewy method incorporated a calculation of the coefficient of variation for the estimated F values. However, because of the convenience of access to the Rho method on the ICES computer, because the Rho method used the ICES VPA program, and in order to allow some comparison with the previous year's assessment, the Working Group decided to use the output from the Rho method. Input data, Gamma values, Rho values and regression analyses are given in Tables 5.1 - 5.12, and plots of the Rho values against time are given in Figures 5.1 - 5.6.

The text table below give the F values in 1982 for North Sea cod and whiting estimated by the two methods and also shows the 95% confidence limits associated with these estimates as calculated by the Lewy method. It should be noted that this confidence interval represents a minimum figure, as it relates only to the estimate of F from the regression line and does not include any error associated with the catch numbers and effort data.

North Sea Cod

Age	1	2	3	4	5	6	7	8
Rho F	.20	1.22	.96	.65	.67	.60	.77	.75
Lewy F	.21	1.46	1.04	.65	.75	.61	.76	.59
Lewy 95% Confidence Interval \pm	.06	.20	.14	.09	.09	.08	.11	.10

North Sea Whiting

Rho F	.78	1.14	.98	1.00	1.22	2.01	1.70	1.50
Lewy F	.76	.68	1.14	1.11	1.19	2.03	1.29	1.15
Lewy 95% Confidence Interval \pm	1.38	.22	.14	.18	.30	.72	.43	

6. ESTIMATION OF RECRUITMENT

Preliminary indices of abundance for the North Sea stocks for the 1982 and 1981 year classes were available from the 1983 IYFS. Indices were calculated as:

- (a) IYFS standard survey arithmetic mean index,
- (b) Burd-Parnell arithmetic mean index based on rectangles fished in all years;
- (c) Burd-Parnell geometric mean index based on rectangles fished in all years.

These indices are tabulated together with VPA year class strength estimates in Tables 6.1-6.3.

Plots were made of the various indices against VPA year class strength estimates, and for North Sea/West of Scotland relationship for VPA year class strength estimates. These plots for the IYFS standard arithmetic mean indices are reproduced in Figures 6.1-6.6 and Tables 6.4-6.6 and give the calculated coefficients for straight line geometric mean regressions.

The North Sea Roundfish Working Group did not wish to anticipate discussions expected to take place in the International Gadoid Survey Working Group (IGSWG). However, the Working Group suggests that the following points relating to the interpretation of IYFS data might be considered by the IGSWG:

- (1) What is the best computational method for deriving a survey index and, in particular, should the index be based on arithmetic or geometric average?
- (2) For estimation of absolute year class strength:
 - (2a) Is a straight line relationship appropriate?
 - (2b) If a line is fitted should a predictive or a GM regression be used?
 - (2c) Should a fitted line be forced through the origin?
 - (2d) Are there other means than the available linear regression techniques to reduce the coefficient of variation of the estimates?
- (3) Is the variance of the data sufficiently small for a useful prediction to be obtained?

The indications from the 1983 IYFS are that the 1982 year classes for all three species in the North Sea are of relatively low abundance.

Interpretation of the recruitment data is discussed for each stock in the appropriate section.

7. NORTH SEA COD

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

Provisional nominal landings in 1982 were 251 361 tonnes, compared to 290 296 tonnes in 1981. Unreported landings of 20 303 tonnes in 1981 and 4 573 tonnes in 1982 were also included in the Working Group estimates of landings. The TACs agreed between EEC and Norway for 1981 and 1982 (220 000 tonnes and 235 000 tonnes respectively) were thus exceeded by 90 649 tonnes and 20 182 tonnes in these two years.

7.2 Age Composition (Table 7.2)

There were no revisions to the data base other than updating of the 1981 data and addition of 1982 data. As shown in the text table on p.6, only a very small proportion of the landings was not covered by sampling. As in previous years, discards and industrial fishery by-catches were not included in the VPA input data, since they are not considered to be reliably estimated.

NORTH SEA COD

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	Percentage represented by age compositions
1981	Industrial by-catch	-	-	Not known	-
	Human consumption landings	Belgium, Denmark, England, Federal Republic of Germany, Netherlands, Scotland, France	303 467	310 599	98
	Discards	Netherlands, Scotland	10 919	Not known	-
1982	Industrial by-catch	Norway	368	Not known	-
	Human consumption landings	Belgium, Denmark, England, Federal Republic of Germany, Netherlands, Scotland, France	248 397	255 934	97
	Discards	Scotland	4 212	Not known	-

7.3 Recruitment (Table 7.5 and Figure 7.1.B)

The numbers of fish of the 1981 and 1982 year classes were estimated from IYFS-VPA plots.

1981 year class

This was estimated at 180 million fish at age 2 from the 1983 IYFS, using the correlation with VPA, which is highly significant. The catch at age 1 in 1982 implies an F value of 0.27 (the highest recorded value for this age group) and a stock number at age 1 of 290 millions. This value is supported by the English groundfish survey estimate of 260 millions at age 1. Last year there were uncertainties about the size of this year class as estimated by the IYFS at age 1. The Working Group used a value of 210 millions and ACFM finally adopted a value of 138 millions. The Rho estimate of F at age 1 in 1982 is 0.20 which implies a stock size of 388 millions. However, the Rho plot for this age group has a high variance probably due to the effects of discarding. The IYFS estimate is, therefore, preferred.

1982 year class

The IYFS in 1983 indicates a very low abundance for this year class. Inspection of various IYFS indices plotted against VPA showed that all gave a similar value for year class strength, since the scatter of points is reduced near the origin. The 1982 year class is indicated to be similar in size to the poor year classes of 1971, 1973, 1975 and 1980. The mean of these year classes is 110 millions and this value was adopted as the estimated size of the 1982 year class at age 1.

1983 year class

This was assumed as 202 millions at age 1, the average recruitment for the years 1963-79.

7.4 Weight at Age (Table 7.3)

Stock mean weights were assumed to be the same as catch mean weights. For predictions of catch in 1983 and 1984, mean weights were calculated as arithmetic means for the period 1977-82.

7.5 Fishing Mortalities in 1982 (Table 7.4)

F at age 1

Two estimates were available for this age group: that from the Rho method which gave 0.20 and that implied by the IYFS recruitment estimate which indicates an F of 0.27. The latter value is the highest yet seen in the VPA for this age group but is the preferred value, for the reasons described in Section 5.

F at other ages

These were estimated using the Rho method as described in Section 5. Catch and effort data were available for 6 fleets and these were examined separately using the Lewy method. This showed that in 2 fleets the variance about the regression line was rather higher than in the other 4 fleets. Exclusion of these 2 fleets in the Rho method gave slightly higher values for the correlation coefficient for older age groups and therefore the F values estimated are based on 4 fleet data sets. The F values obtained from using the data from all 6 fleets are in fact similar to the 4 fleet data.

The estimate at age 2 is higher than those previously estimated for this age by VPA, but the other values are similar to recent average levels.

The F values on the older age groups are lower than those indicated by the Rho method in last year's assessment. Although both sets of F values were estimated using the Rho method, this year's catch and effort data were updated by including Dutch data and by excluding fleet data showing relatively high variances. In addition, there were some revisions to English catch/effort data.

7.6 VPA Results (Tables 7.4 and 7.5, Figures 7.1.A-B)

Mean F on ages 3-8 increased between 1963 and 1972 but has remained relatively stable in subsequent years. Recruitment has fluctuated between 78 and 444 millions at age 1. Spawning stock biomass declined steadily from 1968 to 1978 but this trend has subsequently reversed.

7.7 Equilibrium Yield for Average Recruitment (Figure 7.1.C)

This was calculated using mean weights and mean Fs averaged over the period 1977-82. Yield was calculated for an average recruitment of 202 millions at age 1 (1963-79). The maximum yield is estimated at 315 000 tonnes at an F of 0.18 compared to recent average F (1977-82) of 0.74.

7.8 Catch Predictions

Input data are given in Table 7.6. The mean weights and exploitation pattern are the average for the period 1977-82. Results are given in Tables 7.7 and 7.8 and graphed in Figure 7.1.D.

1983

Two assumptions were considered:

Assumption 1: $F_{83} = F_{82}$

In this case a catch in 1983 of 223 000 tonnes at a mean F of 0.73 is produced. Last year's prediction was 200 000 tonnes at a mean F of 1.01.

Assumption 2: $Catch_{83} = TAC = 240\ 000$ tonnes

Following this assumption F will increase by 12% to 0.82.

1984

Catches and spawning biomasses were calculated for a range of Fs for both options in 1983. At constant F, catches in 1984 are predicted at 183 000 tonnes under Assumption 1, and 169 000 tonnes under Assumption 2 ($F_{84} = F_{82}$). The decreased catches in 1984 are primarily the result of the low abundance of the 1982 year class.

8. COD IN DIVISION VIa

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

Provisional nominal landings in 1982 were 21 544 tonnes compared to 23 950 tonnes in 1981. Despite the decrease in landings in 1982, the quantity was nevertheless high compared to recent levels. The TAC recommended by ACFM for 1982 was 17 000 tonnes.

8.2 Age Composition (Table 8.2)

Details of data supplied for the past 2 years are given in the text table below. There were no changes in the VPA input data for years prior to 1981. The data base does not include estimates of discards.

<u>Year</u>	<u>Nations supplying age composition data</u>	<u>Weight represented by age composition</u>	<u>Total weight caught</u>	<u>% represented by age composition</u>
1981	England, Ireland, Scotland	16 222	23 921	68
1982	England, Ireland, France, Scotland	21 485	21 740	99

8.3 Recruitment (Table 8.5, Figure 8.1.B)

1981 year class

The VPA correlation with the North Sea is non-significant (1 year old) or only just significant (2 years old) and so it was decided to use an average value of F to determine the strength of this year class. The mean for the period 1977-79 (0.10) was selected, and this results in an estimate of 21.3 millions at age 1. This is the largest year class yet seen in the VPA but this estimate is supported by Scottish opue data (Table 5.3). Although the Rho method is potentially less reliable for this age group, the estimate of 20.7 millions, which it indicates, is very close to the adopted value of 21.3 millions, as calculated from mean F.

1982 and 1983 year classes

There is a clear upward trend in recruitment since 1965. However, the Group decided that it would be inadvisable to extrapolate this trend, since to do so would estimate the 1982 and 1983 year classes as being of high abundance and hence we would obtain a very optimistic forecast. For this reason it was assumed that the abundance of the 1982 and 1983 year classes is 7.7 millions at age 1, the mean for the period 1967-79.

8.4 Weight at Age (Table 8.3)

The mean weight data for the period 1967-78 are a nominal constant series, set at the 1978 level. For this period, biomass estimates should be treated with caution.

8.5 Fishing Mortalities in 1982

F at age 1

This was assumed to be the same as the average for the years 1977-79 (0.10). The Rho method gives an almost identical value.

F at other ages

These were estimated using the Rho method. Data from 4 fleets were examined initially. In one of them (English trawl), fishing effort has declined drastically in the last few years and this resulted in some anomalous gamma values which biased the corresponding Rho estimate. This fleet was therefore excluded from the Rho analyses. Except at age 5, the estimated Fs are in good agreement with recent values.

8.6 VPA Results (Tables 8.4-8.5, Figure 8.1.B)

Mean F has shown an increasing trend over the whole period (1967-82). Recruitment has also tended to increase and fluctuations have also become more marked in recent years. After remaining at a constant level during the period 1971-80, spawning stock biomass has increased over the past two years.

8.7 Yield at Average Recruitment (Figure 8.1.C)

This was calculated using mean weights and mean fishing mortalities for the period 1977-82. A mean recruitment of 7.7 millions (1967-79) was assumed. The maximum yield is calculated as 15 500 tonnes at an F of 0.31. Recent average F has been 0.83.

8.8 Catch Predictions

The input data are given in Table 8.6. The mean weights and exploitation pattern are averages for the period 1977-82.

1983

In the absence of an agreed TAC for 1983, only a single option ($F_{83} = F_{82}$) was assumed. The predicted catch is 22 600 tonnes at a mean F value of 0.84. In last year's assessment a catch of 25 700 tonnes was predicted at an F of 0.71.

1984

Table 8.7 and Figure 8.1.D give the predicted catches and spawning biomass for a range of Fs. If F remains constant in 1984, a catch of 23 200 tonnes is predicted.

9. COD IN DIVISION VIb

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

10. COD IN SUB-AREA VII

10.1 Cod in Divisions VII d and e (Table 10.1)

As in previous years the only data available were from England, but based on limited sampling. Since English landings form only a small proportion of the total, no analytical assessment was attempted.

10.2 Cod in Divisions VII b,c and VII g-k (Table 10.2)

No age compositions are available for these areas.

11. NORTH SEA HADDOCK

11.1 Catch Trends

Total international landings and total international catches are given in Table 11.1 and shown in Figure 11.1.A for the period 1960-82.

The TAC for 1982 was 180 000 tonnes and provisional nominal landings for that year are 181 049 tonnes. The Working Group's estimate of total landings for 1982 is 186 463 tonnes. Discards for 1982 were estimated at 41 308 tonnes.

11.2 Age Composition

Details of the data supplied to the Working Group by various nations for 1981 (final) and for 1982 (provisional) are summarized in the text table below:

Year	Category	Nations supplying age composition data	Weight represented by age composition	Total weight caught	% represented by age composition
1981	Industr.	Denmark, Norway	16 216	17 615	92
	Human consump.	Belgium, Denmark, England, France, Netherlands, Scotland	122 961	130 009	95
	Discards	Scotland	38 527	60 290	64
1982	Industr.	Denmark, Norway	19 969	20 980	95
	Human consump.	Belgium, Denmark, England, France, Fed.Rep. of Germany, Netherlands, Scotland	161 505	165 475	98
	Discards	Scotland	26 252	41 308	64

11.3 Weight at Age

Mean weight at age data for the total catch (used as stock weights) are given in Table 11.3.

11.4 Recruitment (Table 11.5, Figure 11.1.B)

1982 year class

Recruitment indices for the 1982 year class at age 1 in 1983 were available from the IYFS. These indices indicated that the 1982 year class is of very low abundance. The scatter diagram of IYFS index versus VPA number indicates a curvilinear relationship whereas the basic assumption made in the past was that the relationship should be rectilinear. Pending the deliberations of the forthcoming Young Gadoid Survey Working Group it was decided to estimate the absolute abundance of this year class by inspection of the scatter diagram of IYFS index versus VPA rather than by regression methods. This resulted in an estimate of 760 million fish at age 1 in 1983.

1981 year class

For the first time in this Working Group an index of abundance for 2-year old haddock was also available from the IYFS. This allowed estimation of the absolute abundance of the 1981 year class in 1983 from Figure 6.4.A. The abundance estimated by use of regression methods was 760 million fish at age 2. Given the catch of this year class at age 1 in 1982, this implies that the abundance of the 1981 year class at age 1 was about 1250 million fish. Inspection of the IYFS index for age 1 fish gives a very similar result.

Recruitment at age 0 in 1983, 1984 and 1985 was assumed to be 2695.318 millions, this value being the average for the period 1961-79 excluding the 1967 year class.

11.5 Fishing Mortalities in 1982 for Age Groups 0 to 11+

As noted in Section 5, none of the methods available for the estimation of these values produced acceptable results. It was therefore decided to use mean values of fishing mortality rates for the period 1978 through 1980.

Fishing mortalities at age 0 and 1 in 1982 were evaluated to produce the abundance levels estimated from the IYFS.

11.6 VPA Results

Estimated fishing mortalities for the period 1960-82 are shown in Table 11.4 and the corresponding stock number and stock biomasses are shown in Table 11.5.

Historical spawning stock biomasses are shown in Figure 11.1.B.

Current spawning stock size is higher than that for the period 1978-79 when the stock size was at almost the lowest recorded level.

11.7 Equilibrium Yield for Average Recruitment

Equilibrium yield and spawning stock size are shown in Figure 11.1.C.

11.8 Catch Predictions

Input data for catch predictions are shown in Table 11.6.

Only one set of options was calculated, since assuming $F_{83} = F_{82}$ produces a predicted catch (human consumption landings + industrial by-catch) of 182 000 tonnes. This is almost identical to the agreed TAC for 1983 of 181 000 tonnes.

Predicted catches for 1984 are presented in Table 11.7 and are also shown graphically in Figure 11.1.D.

12. HADDOCK IN DIVISION VIa

12.1 Catch Trends (Table 12.1)

Nominal landings in 1982 were 28 883 tonnes and the Working Group-estimated total (29 228 tonnes) did not differ appreciably from this value.

The weight of haddock discarded in the period 1965 to 1977 was estimated by the methods explained in Section 4. Scottish discard data were raised to total international level for the period 1978-82.

Figure 12.1.A shows estimated weight landed and discarded since 1965.

12.2 Age Composition (Table 12.2)

Details of the data supplied to the Working Group by various nations for 1981 (final) and for 1982 (provisional) are summarized in the text table below.

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1981	Human consump.	England, Ireland, France, Scotland	14 775	18 218	81
	Discards	Scotland	9 980	15 060	66
1982	Human consump.	England, Ireland, France, Scotland	29 112	29 228	100
	Discards	Scotland	6 554	9 910	66

12.3 Weight at Age

Mean weight at age data for the total catch (used as stock weights) are given in Table 12.3. The values shown now include data on discards and are therefore different from corresponding values presented in previous reports.

12.4 Recruitment (Table 12.5)

The abundance of the 1982 year class in 1983 was estimated by inspection of the scatter diagram of VPA in Division VIa versus VPA in Sub-area IV (Figure 12.1.B) as 48 millions at age 1. A similar procedure was adopted to estimate the abundance of the 1981 year class in 1982 as 102 millions at age 1.

Average recruitment of 173.286 millions at age 0 (mean value for 1965-79 excluding the 1967 year class) is assumed for the years 1983, 1984 and 1985.

12.5 Fishing Mortalities in 1982 for Age Groups 0 to 11+

As noted in Section 5 none of the methods available for the estimation of these values produced acceptable results. It was therefore decided to use mean values of fishing mortality rates for the period 1978 through 1980.

Fishing mortalities at ages 0 and 1 were chosen to produce the stock abundances at those ages indicated in the preceding section.

12.6 Fishing Mortalities at Age 11 for 1965 to 1981

These values were adjusted by inspection of trial VPAs to be more or less in accordance with F at ages 7-9.

12.7 VPA Results

Estimated fishing mortalities for the period 1965-82 are shown in Table 12.4 and the corresponding stock numbers and stock biomasses are shown in Table 12.5.

Historical spawning stock biomasses are shown in Figure 12.1.B.

Current spawning stock size is about three times as great as that in 1979 when the stock size was at the lowest recorded level.

12.8 Equilibrium Yield for Average Recruitment

Equilibrium yield and spawning stock size are shown in Figure 12.1.C for an average recruitment at age 0 of 173.286 million.

12.9 Catch Predictions

Input data for catch predictions are shown in Table 12.6.

Since no TAC has been agreed for Division VIa only one set of catch predictions, assuming $F_{83} = F_{82}$, was made. The landings predicted for 1983 on this basis are 38 000 tonnes, which is considerably higher than the catch of 29 200 tonnes in 1982.

Predicted catches for 1984 are presented in Table 12.7 and are also shown graphically in Figure 12.1.D.

It should be noted that the predictions presented in this report are not comparable to those previously presented since discards are now included in the data base. In particular, the inclusion of the discards has considerably increased our estimate of the abundance of the 1979 year class, which results especially from the estimate of the numbers of fish of this year class discarded at age 2 in 1981. It is estimated that the landings from this year class alone in 1983 will be about 25 000 tonnes.

13. HADDOCK IN DIVISION VIb

13.1 Catch Trends (Table 13.1)

The English fishery on Rockall Bank continued in 1982 taking a catch of 7 700 tonnes compared with 9 000 tonnes in 1981. Landings by other countries were insignificant and amounted to only 68 tonnes in 1982.

13.2 Stock Assessment

Again in 1982 sampling of commercial landings was not possible because they were not landed in the United Kingdom. The English research vessel trawl survey made in 1981 was repeated in 1982, and some additional stations were worked. Also in 1982 a trawl survey was undertaken by the Scottish research ship "Scotia".

For the English surveys, the data for the two years can be compared for the 45 stations which were common to both surveys. The catch age compositions and weights caught were as follows:

Age	Number per 45 hauls	
	1981	1982
0	353 962	
1	95 650	96 767
2	323	69 808
3	164	1 844
4	5 496	1 555
5	25 692	6 577
6	0	22 804
7	417	0
8	551	1 999
9	59	1 148
10+	3	16
Total N	482 317	202 520
Total weight	36 148	48 490
Total N ages 1-10+	128 355	202 520
Total weight ages 1-10+	30 596	48 490

In the 1982 survey, which was made in July, no 0-group fish of the 1982 year class were caught, whereas in 1981 when the survey was conducted in August large numbers of 0-group fish were caught. It was not clear whether the 1982 year class is a failure or whether the survey was too early for the 0-group fish to be available on the bottom. For the remaining year classes the results of the two surveys are consistent in showing the 1976, 1977, 1980 and 1981 year classes to be abundant. Other year classes are poor or virtual failures and contribute very little to the catch. Catch rates (in weight) of fish at age 1 and older were 58% higher in 1982 than in 1981. This increase is less than the doubling that was predicted on the basis of the 1981 survey alone.

Estimates of mortality rates between years for the various year classes are highly variable. For the poor year classes this is probably due to sampling error. For the abundant year classes the indication is that mortality rates are low, but it is possible that survey results may be affected by changes in seasonal availability.

The general indications are that current catch levels could be maintained in 1983, but the prospects for 1984 are less certain because of the absence of information on the abundance of the 1982 year class.

Information from the 1982 fishery indicated that catch rates were high and that large individual hauls were being taken. In these circumstances selectivity of trawl cod ends tends to be reduced. In the 1982 situation with high abundance of 1- and 2-year old fish in the selection range, it is thought that a high proportion of fish in the catches would have been below legal minimum landing size and to conform with conservation regulations would have required a high rate of discarding.

14. HADDOCK IN SUB-AREA VII

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

15. NORTH SEA WHITING

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

The provisional nominal landings for 1982 amount to 102 000 tonnes, which is close to the catch reported for 1981 and below the TAC agreed for 1982 of 170 000 tonnes. The Working Group estimates of total catches, however, differed considerably between 1981 (192 000 tonnes) and 1982 (134 000 tonnes).

15.2 Age Composition (Table 15.2)

The age composition data for 1981 were updated and provisional estimates for 1982 were prepared.

Details of the data supplied to the Working Group by various nations for 1981 and 1982 are summarized in the following text table:

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1981	Industrial by-catch	Denmark, Norway	63 132	66 595	95
	Human consump.	England, France, Netherlands and Scotland	76 746	80 018	96
	Discards	Netherlands and Scotland	17 117	45 560	38
1982	Industrial by-catch	Denmark, Norway	31 970	32 990	97
	Human consump.	Belgium, England, France, Netherlands, Scotland	72 118	72 381	100
	Discards	Scotland	9 945	29 004	34

15.3 Recruitment

The abundance of the 1982 year class at 1 year old and the 1981 year class at 2 years old were both estimated at 500×10^6 million fish at age 1 and 2, respectively on the basis of the preliminary indices of these year classes in the 1983 IYFS. These estimates were obtained by inspection of the appropriate VPA/IYFS scatter diagram (Figures 6.5 and 6.6).

The F values implied by these recruitment figures on 0- and 1-year old whiting in 1982 were on the low side, but they were not considered to be unrealistically low.

The recruitment at age 0 entering the fishery in 1983 and subsequently was assumed to correspond to the average recruitment at age 0 of $2\,700 \times 10^6$ fish during the time period 1961-80.

15.4 Weight at Age

Mean weight at age data for total catches (used as stock weights) are given in Table 15.3.

15.5 Fishing Mortalities in 1982 for Age Groups 2-9

Fishing mortalities in 1982 for these age groups were obtained by the Rho method (see Section 5).

15.6 VPA Results

Estimates of F calculated by VPA are given in Table 15.4. The average F values over the age groups 2-6, although variable from one year to another, were considered to justify a constant terminal F value on the oldest age groups in the catch of 1.0. The average value obtained in 1982 was slightly above the values obtained for the preceding period.

Estimates of stock numbers and spawning stock biomass are given in Table 15.5. Due to a steady decline in recruitment from year class 1978 onwards, the spawning stock biomass shows a pronounced downward trend since 1980, although in 1982 (210 000 tonnes) it was still higher than the lowest value on record (Table 15.5, Figure 15.1.B).

15.7 Equilibrium Yields for Average Recruitment

Long-term equilibrium yields in terms of total landings and human consumption landings are presented in Figure 15.1.C. Input data were those used for catch predictions (Table 15.6). In calculating these yields F for the industrial fisheries has been kept constant. Also the proportion discarded, the average for the last 6 years, has been kept constant, irrespective of F resulting from the human consumption fishery.

The actual yield curve presented strongly depends on these assumptions and so do the biological reference points, which therefore have not been calculated. The F level in the human consumption landings is indicated.

15.8 Catch Prediction (Table 15.7 and Figure 15.3)

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

- 1) The partial exploitation pattern in the human consumption fishery (landings and discards) in 1983 would be the same as the average partial human consumption exploitation pattern over the period 1977-82, the level being scaled to the average value of fishing mortality over the age groups 2-6 in 1982. The exploitation pattern and the level of fishing mortality in the industrial fishery were assumed to correspond to the average pattern and level in this fishery over the period 1977-82. The overall exploitation pattern was obtained by adding the two patterns in the human consumption and the industrial fishery.
- 2) Mean weight at age in the stock and in the various categories of catch would remain the same as the average for 1977-82.
- 3) Discarding rates at age would be the same as the average rates for 1977-82.

No catch prediction was made for the assumption that the catch in 1983 would equal the agreed TAC of 170 000 tonnes, because this would result in unrealistically high fishing mortalities. Therefore only the assumption with $\bar{F}_{83}^{hc} = \bar{F}_{82}^{hc}$ was pursued, which gives landings in 1983 of 93 000 tonnes.

Attention is drawn to the development in the spawning stock biomass (SSB). The estimated SSB in 1984 is 127 000 tonnes, which represents the lowest value on record. This recent decrease is due to a sequence of bad year classes. Although in the prediction for 1985 the SSB is back at a much higher level, this calculated increase is entirely due to the assumption that the 1983 year class, which enters the SSB in 1985, is of average size. In view of the downward trend in recruitment in recent years and without any information on recruitment in 1983, the estimated SSB in 1985 cannot be relied upon.

16. WHITING IN DIVISION VIa

16.1 Catch Trends (Table 16.1 and Figure 16.1.A)

The revised reported landings of 18 477 tonnes taken in 1981 are well above the provisional figure of 11 800 tonnes reported in 1982.

However, the Working Group estimate of 12 664 tonnes was used in the assessment. The provisional landings in 1982 were 13 540 tonnes. There was no agreed TAC in effect. The estimated total catch including discards was 18 770 tonnes.

16.2 Age Composition (Table 16.2)

The age composition data for 1981 were revised. Provisional age compositions for 1982 were compiled. In addition to data on the human consumption landings, discard data were provided by Scotland. However, since these are available for one year only, they have not been used in the assessment. Details of the data supplied to the Working Group are summarized in the text table below.

Year	Category	Nations supplying age composition data	Weight represented by age compositions	Total weight caught	% represented by age compositions
1981	Human consumption landings	France, Ireland, Scotland	12 491	12 664	98
1982	Human consumption landings	France, Ireland, Scotland	13 265	13 540	98
	Discards	Scotland	3 253	5 230	62

16.3 Recruitment

With reference to Section 6, abundance figures of the 1982 year class at 1 year old and the abundance of the 1981 year class at 2 years old were estimated from the regression lines of VPA recruitment indices for Division VIa on the VPA recruitment indices for Sub-area IV for the two age groups, respectively. According to the lines connecting \bar{x} , \bar{y} and the origin, the number of the 1982 year class at 1 year old was estimated at 20×10^6 fish and the number of the 1981 year class at 2 years old were estimated at 14×10^6 fish.

The F value implied by the recruitment figure for the 1981 year class of 0.18 in 1982 was not considered to be anomalous.

The number of recruits at age 1 entering the fishery in 1984 and subsequently was assumed to be 88×10^6 , which is the average number of 1-group whiting during the period 1963-80.

16.4 Weight at Age

Mean weight at age data for total catches (used as stock weights) are given in Table 16.3.

16.5 Fishing Mortalities in 1982 for Age Groups 2-6

Fishing mortalities in 1982 for these age groups were obtained by the Rho method (see Section 5).

16.6 VPA Results

Estimates of F from the VPA are given in Table 16.4. The average F values over the age groups 2-4 are consistently lower than the terminal

F values for the oldest age group during the whole time period. However, since discard data are not included in this assessment, the average fishing mortalities are underestimated and the terminal F values used generally appear to correspond with the estimated mortalities in 5- and 6-year old whiting.

The F level estimated in 1982 from the Rho method is somewhat higher than in the results from the VPA indicated for the preceding years.

Estimates of stock numbers and spawning stock biomasses are given in Table 16.5. Spawning stock biomass (ages 2+) has dropped in 1982, due to the poor 1980 year class reaching maturity (Figure 16.1.C).

16.7 Equilibrium Yield for Average Recruitment

Yield was calculated using an exploitation pattern and mean weights at age equal to the averages 1977-82. The flat curve (Figure 16.1.C) has no clear maximum. The $F_{0.1}$ is indicated in the figure, although it must be observed that due to lack of information on discards both the real exploitation pattern, and thus the yield curve, remain unknown.

16.8 Catch Prediction

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

The primary assumption about exploitation pattern and mean weight at age in 1982 and 1983 were the same as described for North Sea whiting, except that no consideration was given to discards, for which no adequate data are yet available. There has not been an agreed TAC for whiting in 1983 in Division VIa and, therefore, only the assumption that $F_{83} = F_{82}$ has been considered.

The results of the prediction runs are shown in Tables 16.7 and are also given in Figure 16.1.D.

The estimated spawning stock biomass (2+ whiting) in 1985 should be treated with care, because a major proportion of this biomass consists of the 1983 year class, which has been assumed to be of average size. Despite the recent series of bad year classes, the low spawning stock biomass of 8 000 tonnes estimated at the beginning of 1984 is therefore bound to increase in any prediction runs based on average recruitment of the 1983 year class.

The landings estimated for 1983 of 8 200 tonnes in the present assessment are considerably smaller than the value of 12 100 tonnes predicted in the 1982 Working Group report. This discrepancy is due to the fact that in the former assessment the recruitment of the 1982 year class at 1 year old was assumed to be of average size ($87\ 046 \times 10^3$), whereas now it has been estimated as a poor year class ($20\ 486 \times 10^3$).

17. WHITING IN SUB-AREA VII

17.1 Whiting in Divisions VII d, e

Landing figures for 1981 have been revised from 8 271 tonnes to 10 804 tonnes, which brings the catch back to the level observed in the mid-1970s (Table 17.1). Provisional landings in 1982 are 8 640 tonnes.

The age composition of the total catch in 1981 has been revised. For 1982, age composition data have been submitted by England and France covering 99% of the provisional landings.

A VPA was made to give some indication about the level of exploitation. The input catch data are given in Tables 17.2-17.3. Both catch at age and weight at age data reveal an apparent discontinuity in 1981: the numbers landed of the older age groups are rather larger during the last

two years than during the earlier period, whereas the weights at age are consistently lower over the age range. The fishing mortalities are given in Table 17.4. In the absence of catch per unit of effort data the input values for the last data year were adjusted in an iterative procedure to correspond with the resultant averages over the period 1976-79. The terminal F values on the oldest age group were arbitrarily set at 1.0. The stock estimates (Table 17.5) show a sudden increase in abundance of older age groups in 1981. However, these results cannot be relied upon, because the discontinuity in the input data in 1980/81 is likely to indicate a major sampling problem in this fishery.

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

Landings in 1980-82 fluctuated around 9 000 tonnes as they did in the earlier period of 1973-76.

18. POSSIBILITIES FOR IMPROVING THE EXPLOITATION PATTERNS OTHER THAN BY MESH REGULATION

For North Sea cod there have been suggestions that some fleets have been concentrating in areas where young fish predominate and are consequently taking a high proportion of young cod in their catches. One area that has been mentioned in this context is the Helgoland Bight. Figure 18.1 shows the main areas of distribution of 0-, 1- and 2-groups cod in the southern North Sea in each quarter of the year based on research vessel survey data for the period 1980-82. This shows that young cod are concentrated in the German Bight at certain times of the year.

No data were available at the Working Group meeting giving an area breakdown of quantities caught together with the associated age compositions. Consequently, it was not possible to estimate what proportions of young fish were taken in any particular area. Detailed data of this kind would be required for any quantitative assessment of cod. In addition, it would also be essential to have estimates on discards by area. Furthermore, any local conservation measures, which might be contemplated, would also have implications for fisheries for other species, which take place in the same area.

For haddock and whiting in the North Sea the two major factors influencing the exploitation pattern are the catches of undersized fish taken with current human consumption fishery mesh sizes and subsequently discarded and the by-catches in the industrial fisheries. The first of these problems is probably best resolved by mesh regulation. The second problem is more a question of policy and economics relating to the co-existence of industrial and human consumption fisheries.

19. DATA AND WORKING GROUP FILES FOR EVALUATING DENSITY DEPENDENCE IN THE PARAMETERS USED FOR STOCK ASSESSMENT

Data are available in the Working Group computer files which enable stock biomass to be calculated. These data include weight at age estimates, which could be used for density-dependent growth analyses. However, because sums of products corrections have been applied in many cases the interpretation of these data requires some care. Year class strength estimates are available from VPA for stock recruitment analyses. No detailed maturity ogive data are available to examine possible density-dependent maturity relationships.

In addition to the aggregated data in the Working Group files, more detailed national data are available at various institutes.

20. DEFICIENCIES IN THE DATA

Some countries were still unable to present properly prepared data at the beginning of the Working Group meeting, even though this year the Group did not meet until June. Work on assembling the basic age composition data was therefore delayed while telephone calls and telexes were sent to obtain national data.

Some uncertainties remain unresolved for Irish data for Division VIa.

The Working Group used IYFS indices to help determine the abundance of recruiting year classes. The indices prepared from the 1983 IYFS were incomplete, because some countries had not met deadlines for submitting survey data to the IYFS Coordinator.

For Item 2 of the terms of reference, data are required giving catches (landings and discards separately) together with associated age composition data split on an area basis. It would also be helpful to the Working Group, if the problems requiring analysis could be specified more explicitly with a definition of any areas which might be subject of any special concern.

Knife-edge age at maturity has been used for all stocks for spawning stock biomass estimates. It is hoped that at the next meeting, maturity ogives will be available for three years for the North Sea stocks from IYFS data.

Discard estimates have not yet been worked up for the Division VIa whiting stock. Discard data for Division VIa haddock were included in the assessment for the first time this year.

For West of Scotland cod mean weight data for the period 1967-77 need to be revised.

For Divisions VIIId,e whiting there appear to be some sampling problems.

21. RECOMMENDATIONS AND SUGGESTIONS

It is recommended that the ICES VPA programme be enhanced to enable the partial F values to be calculated for each category of catch.

It is suggested that if alternative F indices to those used in this report are recommended either by ACFM or by the Working Group on Fish Stock Assessment, then consideration should be given to whether the proposed indices can be used for expressing the average partial F in the different categories separately.

The Working Group recommends that the suitability of industrial by-catch data for recruitment predictions is examined.

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

Year	Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight
1963	56 495	107 936	5 659	1 708	62 154	109 644
1964	51 729	115 435	6 571	1 857	58 300	117 292
1965	94 349	172 619	19 798	5 204	114 147	177 823
1966	115 024	211 937	22 578	6 010	137 602	217 947
1967	124 779	242 108	15 724	4 481	140 503	246 589
1968	146 039	277 062	6 372	2 150	152 411	279 212
1969	76 286	193 612	7 443	2 027	83 729	195 639
1970	124 517	218 763	63 759	11 002	188 276	229 765
1971	226 093	314 544	53 707	13 374	279 800	327 917
1972	243 478	341 051	21 573	8 831	265 051	349 882
1973	125 133	227 787	46 620	8 196	171 753	235 983
1974	102 367	202 269	4 588	950	106 955	203 219
1975	109 863	184 974	35 390	6 045	145 253	191 019
1976	128 536	209 914	8 201	2 050	136 737	211 964
1977	140 359	181 121	99 474	16 573	239 833	197 694
1978	212 729	260 890	100 786	27 874	313 515	288 764
1979	170 706	248 051	236 295	67 490	407 001	315 541
1980	192 691	250 766	660 066	170 675	852 757	421 441
1981	249 276	310 599	164 776	47 132	414 052	357 731
1982#)	183 263	255 934	**)	**)		

#)preliminary

**)insufficient data

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

Year	Industrial		Human consumption		Discards		Total	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1960	142 567	12 200	208 753	75 242	853 264	131 791	1 204 584	219 233
1961	982 786	11 100	189 763	74 862	888 867	132 991	2 061 416	218 953
1962	285 824	11 200	148 967	58 677	2 673 394	383 153	3 108 185	453 030
1963	255 844	13 700	180 624	68 364	1 245 890	188 969	1 682 358	271 033
1964	598 840	88 600	351 422	130 509	643 595	160 319	1 593 857	379 428
1965	1 092 756	74 600	369 998	161 613	253 860	62 236	1 716 614	298 449
1966	2 232 098	46 700	406 399	225 760	489 695	73 573	3 128 192	346 033
1967	699 516	20 700	272 201	147 391	448 264	78 059	1 419 981	246 150
1968	557 995	34 200	220 977	105 440	837 979	161 882	1 616 951	301 522
1969	1 889 659	338 353	909 208	330 897	1 203 447	260 231	4 002 314	929 481
1970	1 621 762	179 729	1 244 162	524 622	515 018	101 376	3 380 942	805 727
1971	913 516	31 546	473 069	235 358	1 282 184	177 485	2 668 769	444 389
1972	531 113	29 585	427 890	192 901	760 224	128 130	1 719 227	350 616
1973	170 412	11 267	449 107	178 610	659 515	114 719	1 279 034	304 596
1974	936 218	47 777	357 011	149 617	1 000 667	166 782	2 383 896	364 176
1975	734 412	41 380	362 239	146 616	1 862 031	260 427	2 958 681	448 423
1976	446 767	48 204	397 743	165 624	788 037	154 289	1 632 547	368 117
1977	350 521	34 993	319 991	137 372	225 974	44 369	896 486	216 734
1978	425 714	9 659	192 021	85 981	422 631	77 681	1 040 366	173 321
1979	1 099 865	17 414	190 414	83 249	286 968	41 834	1 577 247	142 497
1980	768 645	25 154	218 392	98 860	541 779	94 910	1 528 816	218 924
1981	815 192	17 615	244 100	130 009	299 417	60 290	1 388 709	207 914
1982*	577 653	20 988	309 824	165 475	191 907	41 308	1 079 384	227 771

*Preliminary

Table 4.3 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	141 183	11 639	190 513	47 566	763 229	121 600	1 094 925	180 805
1961	271 885	16 177	289 708	67 828	1 645 728	241 122	2 207 321	325 127
1962	112 954	8 347	222 274	55 952	1 185 487	156 713	1 520 715	221 012
1963	499 847	45 431	214 477	58 205	853 608	154 401	1 567 932	258 037
1964	393 794	28 124	220 682	60 064	341 223	58 784	955 699	146 972
1965	182 171	22 259	313 057	85 978	490 073	77 184	985 301	185 421
1966	431 635	51 176	351 953	105 229	545 116	83 356	1 328 704	239 761
1967	280 275	22 840	245 396	68 215	1 102 690	142 703	1 628 361	233 758
1968	592 395	57 506	298 807	88 281	596 827	90 898	1 488 029	236 685
1969	1 980 444	152 364	203 640	57 149	625 916	114 566	2 810 000	324 079
1970	1 855 953	114 504	271 813	79 274	347 540	67 814	2 475 306	261 592
1971	1 477 350	71 699	185 690	58 005	458 746	62 589	2 121 786	192 293
1972	1 351 090	61 166	178 908	59 868	398 294	66 598	1 928 292	187 632
1973	1 273 007	89 614	234 405	66 479	658 852	110 128	2 166 264	266 221
1974	1 841 153	130 293	254 114	74 561	477 271	84 753	2 572 538	289 607
1975	1 019 586	86 376	251 761	78 722	698 963	134 698	1 970 310	299 796
1976	1 395 318	149 759	243 201	74 231	633 359	134 176	2 271 878	358 166
1977	1 657 167	106 104	267 023	74 374	555 515	107 186	2 479 705	287 664
1978	1 163 125	55 274	322 834	88 475	241 670	35 442	1 727 629	179 191
1979	887 889	59 021	351 613	99 321	651 877	78 371	1 891 379	236 713
1980	644 159	45 747	313 565	92 534	547 726	86 940	1 505 450	225 221
1981	932 530	66 595	258 430	80 018	293 714	45 560	1 484 674	192 173
1982*	333 574	32 990	240 768	72 881	189 004	29 004	763 346	134 375

*Preliminary

Table 5.1 North Sea COD. Effort (hours fished) and catch at age ($N \times 10^{-3}$)
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10		
1968	548.642	896.	8746.	4593.	969.	241.	142.	74.	25.	13.	9.	S o o t t i s h S e t n e	
1969	491.435	64.	5755.	2716.	1508.	467.	111.	75.	35.	17.	11.		
1970	426.563	1201.	2890.	3014.	1055.	470.	113.	22.	25.	12.	7.		
1971	416.144	4542.	8553.	644.	705.	587.	205.	71.	16.	9.	9.		
1972	392.432	938.	19054.	3501.	396.	339.	120.	57.	27.	5.	8.		
1973	414.698	2657.	7445.	6165.	870.	157.	98.	42.	51.	12.	4.		
1974	349.604	3858.	6283.	1610.	1085.	252.	54.	38.	22.	15.	7.		
1975	329.432	1820.	8673.	1783.	556.	471.	79.	9.	5.	13.	4.		
1976	307.165	537.	14244.	2891.	570.	179.	113.	37.	10.	4.	9.		
1977	313.913	2742.	4316.	3009.	714.	177.	51.	35.	24.	6.	2.		
1978	325.246	1704.	14716.	1386.	851.	202.	48.	23.	21.	8.	3.		
1979	316.419	2523.	8024.	3258.	583.	345.	67.	44.	19.	12.	4.		
1980	297.227	1068.	5960.	2342.	829.	144.	90.	33.	15.	9.	4.		
1981	289.672	853.	13281.	2348.	692.	204.	26.	11.	12.	3.	0.		
1982	297.730	4070.	4794.	6024.	822.	291.	151.	25.	21.	12.	1.		
1968	48.238	33.	301.	140.	35.	9.	4.	3.	1.	0.	0.		S o o t t i s h L i g h t T r a w l
1969	67.666	20.	494.	243.	87.	23.	6.	4.	2.	1.	0.		
1970	83.529	334.	302.	597.	93.	33.	10.	2.	2.	0.	2.		
1971	104.901	992.	1768.	207.	150.	41.	14.	6.	2.	2.	1.		
1972	121.031	204.	5927.	705.	111.	50.	6.	2.	0.	0.	0.		
1973	152.422	760.	1255.	1898.	202.	20.	23.	12.	1.	4.	0.		
1974	116.982	450.	1185.	438.	376.	40.	5.	3.	3.	1.	2.		
1975	161.009	965.	1559.	776.	120.	113.	6.	1.	2.	1.	0.		
1976	152.419	263.	3274.	415.	101.	38.	59.	10.	1.	1.	0.		
1977	224.324	2068.	1807.	774.	118.	75.	24.	13.	8.	2.	1.		
1978	236.929	2256.	5380.	671.	270.	51.	28.	7.	8.	3.	0.		
1979	287.494	1973.	5845.	1808.	178.	61.	75.	2.	4.	2.	0.		
1980	333.197	1798.	5207.	2042.	534.	69.	38.	15.	4.	3.	1.		
1981	251.504	691.	5237.	1475.	294.	82.	11.	6.	0.	0.	0.		
1982	250.370	4704.	2946.	2302.	377.	110.	39.	6.	6.	4.	3.		

...Ctd.

Table 5.1 Ctd.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8	9	10	
1968	549.481	64.	7917.	4816.	1168.	608.	185.	71.	55.	11.	11.		English Trawl
1969	486.211	74.	1612.	5389.	1079.	562.	171.	52.	20.	9.	1.		
1970	497.735	552.	1785.	1044.	1266.	686.	195.	125.	24.	28.	13.		
1971	506.736	1379.	11213.	1277.	512.	794.	556.	153.	57.	22.	4.		
1972	504.859	78.	10957.	3689.	458.	216.	377.	183.	56.	42.	9.		
1973	465.836	870.	1593.	5699.	1097.	371.	126.	90.	40.	11.	7.		
1974	414.315	569.	2863.	549.	1335.	428.	109.	47.	45.	28.	5.		
1975	525.771	1192.	1673.	734.	192.	468.	171.	26.	27.	20.	6.		
1976	347.067	288.	3628.	904.	436.	98.	238.	60.	16.	6.	7.		
1977	341.370	1501.	1113.	1176.	500.	182.	57.	74.	25.	8.	5.		
1978	390.263	1024.	6014.	650.	569.	193.	66.	37.	33.	11.	2.		
1979	391.414	879.	4437.	1896.	229.	247.	57.	52.	3.	16.	5.		
1980	281.121	1191.	2398.	1334.	548.	77.	72.	24.	10.	4.	5.		
1981	244.283	308.	6358.	944.	263.	125.	19.	24.	4.	3.	2.		
1982	213.590	1846.	1388.	1723.	266.	135.	81.	16.	11.	5.	1.		
1968	526.713	637.	3040.	568.	107.	47.	1.	7.	2.	0.	0.		Dutch Beam-Trawl
1969	514.675	179.	317.	484.	224.	56.	65.	6.	3.	0.	0.		
1970	771.045	4108.	592.	94.	269.	93.	27.	45.	6.	2.	0.		
1971	524.939	7227.	7759.	169.	73.	289.	101.	19.	21.	1.	19.		
1972	678.995	627.	8468.	1037.	152.	31.	64.	52.	14.	6.	4.		
1973	941.423	6468.	464.	1527.	451.	32.	13.	25.	11.	1.	1.		
1974	894.920	949.	2595.	535.	663.	216.	42.	21.	25.	3.	5.		
1975	880.061	4118.	2677.	790.	133.	227.	78.	14.	3.	4.	2.		
1976	769.105	467.	3209.	466.	212.	34.	57.	29.	4.	4.	5.		
1977	698.530	11511.	1579.	779.	153.	57.	14.	22.	4.	3.	4.		
1978	595.259	3513.	8750.	567.	219.	29.	15.	5.	5.	5.	2.		
1979	639.183	3308.	3716.	1508.	65.	71.	12.	10.	5.	6.	2.		
1980	638.866	5354.	5358.	649.	564.	13.	20.	4.	3.	1.	1.		
1981	606.136	1240.	7301.	747.	263.	135.	9.	11.	1.	2.	2.		
1982	586.555	4767.	1203.	1199.	176.	73.	75.	7.	7.	1.	1.		

Table 5.2 North Sea COD. Rho values and regression analysis for estimation of Terminal Fs

YEAR/AGE	1	2	3	4	5	6	7	8	9	
1963	1	0.583	0.642	0.739	0.837	0.697	0.893	0.511	0.650	0.548
1969	2	0.080	0.357	0.616	0.651	0.735	0.668	0.545	0.716	0.245
1970	3	0.415	0.561	0.795	0.743	0.783	0.795	0.869	0.492	0.305
1971	4	0.579	0.934	0.599	0.928	1.146	0.937	0.875	1.000	0.402
1972	5	0.448	0.939	0.828	0.830	1.154	1.525	1.000	1.986	1.897
1973	6	1.314	1.069	0.911	1.064	1.100	1.637	0.814	0.742	0.437
1974	7	1.319	0.852	0.892	1.149	1.184	1.085	1.616	1.779	1.142
1975	8	0.638	1.140	0.878	1.065	1.213	1.337	0.617	3.696	1.396
1976	9	0.247	1.367	1.202	1.154	0.996	1.563	1.093	0.644	2.065
1977	10	1.225	0.833	0.895	1.092	1.164	1.130	1.009	1.798	1.095
1976	11	0.717	1.388	0.954	1.158	1.269	1.211	1.031	1.804	1.734
1979	12	0.673	0.929	1.032	0.869	1.288	1.034	1.286	1.423	1.574
1980	13	0.485	0.846	1.067	1.069	0.912	1.211	1.264	1.691	0.809
1981	14	0.439	1.038	1.131	1.064	0.810	0.650	0.824	1.292	1.328
1982	15	0.794	1.229	1.157	1.170	1.174	1.201	1.229	1.965	1.673
PREDIC. F		387533.	47902.	90212.	14567.	6435.	3967.	640.	401.	118.
PREDIC. F		0.197	1.221	0.964	0.652	0.672	0.603	0.772	0.745	0.829
COR. COEF.		0.217	0.580	0.825	0.660	0.381	0.142	0.505	0.369	0.529
SLOPE		0.020	0.043	0.035	0.026	0.019	0.011	0.037	0.074	0.075
INTERCEPT		0.493	0.535	0.634	0.781	0.891	1.038	0.678	0.852	0.548

Table 5.3 West of Scotland COD. Effort (hours fished) and catch at age ($N \times 10^{-3}$).
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8	

1968	50.001	23.	257.	554.	355.	24.	31.	19.	2.		Scottish Trawl
1969	42.058	6.	153.	217.	413.	154.	18.	17.	7.		
1970	40.572	38.	38.	205.	133.	128.	45.	8.	6.		
1971	41.234	71.	204.	26.	160.	57.	37.	16.	7.		
1972	55.536	49.	527.	168.	34.	94.	12.	10.	1.		
1973	51.153	14.	58.	202.	79.	15.	52.	13.	5.		
1974	45.899	73.	199.	103.	236.	30.	10.	12.	5.		
1975	37.080	22.	171.	80.	39.	58.	13.	3.	4.		
1976	35.307	43.	216.	158.	52.	41.	43.	7.	1.		
1977	33.948	99.	69.	75.	27.	12.	9.	6.	2.		
1978	51.582	37.	267.	79.	112.	55.	21.	9.	5.		
1979	33.573	16.	109.	103.	34.	29.	15.	4.	2.		
1980	19.660	167.	147.	78.	38.	7.	6.	2.	3.		
1981	13.753	1.	175.	85.	16.	2.	0.	0.	0.		
1982	14.194	159.	34.	121.	27.	3.	0.	1.	0.		

1968	150.094	163.	212.	798.	401.	37.	26.	19.	4.		Scottish Seine
1969	140.718	13.	788.	358.	482.	131.	30.	14.	4.		
1970	95.629	131.	471.	454.	62.	51.	10.	5.	5.		
1971	98.743	66.	287.	123.	110.	28.	21.	2.	1.		
1972	70.741	59.	256.	187.	52.	32.	3.	2.	1.		
1973	59.596	224.	247.	153.	35.	10.	12.	16.	1.		
1974	56.448	90.	204.	69.	49.	17.	6.	2.	0.		
1975	56.420	145.	231.	99.	34.	12.	5.	0.	0.		
1976	57.090	48.	224.	89.	61.	10.	10.	0.	0.		
1977	41.920	121.	122.	112.	22.	11.	5.	2.	0.		
1978	33.617	81.	145.	69.	45.	14.	4.	2.	2.		
1979	38.465	120.	114.	196.	25.	19.	5.	0.	1.		
1980	38.640	245.	216.	73.	36.	13.	4.	0.	0.		
1981	37.208	16.	464.	147.	48.	9.	1.	1.	0.		
1982	36.689	217.	147.	146.	34.	15.	4.	0.	0.		

...Ctd.

Table 5.3 Ctd.

YEAR	EFFORT AGE	1	2	3	4	5	6	7	8
1968	65.348	39.	45.	175.	97.	9.	7.	4.	1.
1969	106.856	9.	150.	134.	229.	70.	12.	4.	2.
1970	118.881	14.	242.	298.	87.	62.	9.	2.	2.
1971	129.187	41.	296.	140.	174.	39.	7.	6.	1.
1972	142.244	302.	406.	346.	97.	62.	20.	6.	3.
1973	91.151	270.	167.	252.	139.	33.	25.	1.	3.
1974	88.651	159.	365.	137.	123.	37.	6.	7.	1.
1975	132.353	453.	296.	203.	90.	37.	9.	1.	1.
1976	139.225	202.	446.	305.	101.	43.	30.	11.	0.
1977	143.574	363.	190.	398.	161.	61.	9.	3.	1.
1978	127.387	139.	405.	187.	135.	53.	8.	3.	1.
1979	99.803	161.	187.	484.	57.	51.	0.	0.	1.
1980	121.211	177.	735.	345.	136.	36.	11.	5.	1.
1981	165.002	34.	1160.	540.	189.	32.	4.	3.	0.
1982	135.280	401.	375.	628.	167.	47.	6.	2.	1.

Scottish Light Trawl

Table 5.4 West of Scotland COD. Rho values and regression analysis for estimation of terminal Fs.

YEAR/AGE	1	2	3	4	5	6	7	
1968	1	0.524	0.940	1.018	0.794	0.715	0.410	0.636
1969	2	0.076	0.747	1.140	1.251	1.108	1.129	0.938
1970	3	0.425	1.130	1.127	0.700	0.954	0.185	0.720
1971	4	0.173	0.801	0.844	0.554	0.782	0.379	1.295
1972	5	1.560	1.172	1.050	0.568	0.791	1.791	0.770
1973	6	1.392	0.674	0.710	0.660	0.419	2.526	1.102
1974	7	0.629	0.927	0.587	0.857	0.517	1.241	3.433
1975	8	0.947	0.663	0.649	0.333	0.643	0.726	0.919
1976	9	0.821	0.734	0.820	0.511	0.725	1.633	6.054
1977	10	0.916	0.471	0.895	0.439	0.365	0.654	1.855
1978	11	0.467	0.669	0.694	0.590	0.782	0.878	1.939
1979	12	0.434	0.388	1.673	0.559	0.751	1.253	3.838
1980	13	0.431	0.653	0.804	0.662	0.682	2.461	7.237
1981	14	0.110	0.818	0.832	0.586	0.156	1.578	1.173
1962	15	0.612	0.551	0.883	0.453	0.495	1.796	4.243
PREDIC. M		20672.	5916.	6670.	2112.	521.	139.	31.
PREDIC. F		0.102	0.367	0.738	0.933	1.409	1.012	1.126
COR. COEF.		-0.016	-0.573	-0.039	-0.496	-0.290	0.446	0.530
SLOPE		-0.002	-0.030	-0.003	-0.026	-0.019	0.077	0.269
INTERCEPT		0.638	1.001	0.923	0.842	0.780	0.640	0.201

Table 5.5 North Sea HADDOCK. Effort (hours fished) and catch at age ($N \times 10^{-3}$) discards included.
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10	
1963	188.572	48725.	45161.	3273.	2476.	1700.	113.	58.	161.	18.	2.	
1964	197.623	U.	94916.	11013.	854.	642.	572.	22.	22.	44.	1.	
1965	172.992	3118.	548.	55569.	2055.	158.	109.	32.	10.	3.	2.	
1966	194.012	32137.	1544.	1143.	55654.	752.	66.	31.	10.	2.	2.	
1967	215.319	112299.	13358.	838.	707.	43192.	512.	9.	21.	4.	1.	
1968	218.141	21758.	75527.	3656.	372.	518.	12809.	49.	10.	2.	1.	
1969	123.010	26.	56898.	14068.	519.	225.	323.	1486.	20.	1.	0.	
1970	133.445	883.	4771.	92679.	2917.	153.	63.	26.	431.	3.	0.	
1971	174.559	47647.	5343.	7806.	83059.	1808.	122.	34.	45.	432.	27.	
1972	201.493	4598.	76452.	4199.	4120.	31677.	755.	32.	7.	10.	44.	
1973	182.541	5014.	51520.	37305.	832.	851.	6405.	1409.	18.	2.	20.	
1974	185.432	24707.	12502.	54230.	7356.	166.	207.	1562.	33.	4.	7.	
1975	152.977	3964.	51399.	5715.	14221.	1923.	73.	57.	383.	15.	7.	
1976	121.841	520.	26812.	20097.	1311.	3065.	596.	16.	6.	90.	10.	
1977	144.348	4250.	3538.	36968.	7624.	451.	1006.	179.	20.	5.	35.	
1978	135.220	9364.	9910.	2194.	17291.	1781.	169.	352.	61.	16.	2.	
1979	87.467	6138.	13902.	4106.	760.	4608.	337.	58.	75.	29.	9.	
1980	55.475	5779.	20663.	5687.	1065.	193.	1159.	104.	11.	16.	4.	
1981	51.553	709.	23581.	12373.	1122.	100.	12.	320.	8.	2.	2.	
1982	47.889	1101.	2865.	20239.	3249.	147.	56.	49.	106.	1.	1.	

1963	618.798	603428.	135520.	4341.	2785.	1302.	117.	73.	126.	15.	1.	
1964	639.177	1621.	315369.	17856.	1213.	761.	417.	23.	39.	55.	1.	
1965	582.364	69774.	3568.	173131.	5856.	481.	300.	70.	17.	8.	13.	
1966	500.663	149827.	6223.	1158.	65923.	1082.	87.	35.	25.	3.	0.	
1967	514.854	866273.	28196.	1180.	862.	45338.	360.	45.	32.	10.	13.	
1968	543.642	188256.	153075.	5926.	515.	409.	17787.	71.	13.	2.	1.	
1969	491.435	1111.	322894.	30588.	1069.	272.	3495.	215.	23.	3.	1.	
1970	426.563	20187.	20402.	205833.	6994.	85.	154.	36.	777.	4.	3.	
1971	416.144	543516.	21374.	13554.	108820.	2462.	82.	36.	37.	249.	44.	
1972	592.432	178579.	167037.	9213.	4693.	39759.	911.	53.	7.	5.	110.	
1973	414.893	98804.	193251.	69360.	1972.	1043.	9872.	351.	42.	7.	39.	
1974	349.604	351880.	48342.	86495.	13184.	441.	234.	2390.	46.	3.	8.	
1975	529.432	480815.	161726.	15612.	25336.	3708.	151.	110.	530.	22.	11.	
1976	307.165	35831.	329586.	57466.	2529.	8069.	1026.	54.	13.	146.	10.	
1977	313.913	33809.	37092.	130090.	12895.	1884.	1480.	347.	24.	7.	64.	
1978	325.246	166841.	69033.	14346.	44152.	2366.	462.	673.	86.	29.	5.	
1979	316.419	83633.	78817.	17215.	3040.	8073.	648.	70.	113.	24.	4.	
1980	297.227	131314.	128508.	26206.	3593.	501.	2415.	123.	20.	56.	23.	
1981	289.672	10357.	134264.	55728.	5181.	702.	102.	579.	15.	22.	1.	
1982	297.730	31144.	30969.	118899.	14297.	682.	145.	39.	230.	1.	9.	

S O O T F I S H T R A W L

S O O T F I S H S E I N E

...Otd.

Table 5.5 contd.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8	9	10
1963	5.316	1569.	250.	0.	5.	3.	0.	0.	0.	0.	0.	0.
1964	24.653	0.	3150.	117.	10.	5.	2.	0.	0.	0.	0.	0.
1965	54.799	1759.	83.	5851.	58.	7.	4.	1.	0.	0.	0.	0.
1966	35.641	3112.	171.	36.	1246.	17.	1.	1.	1.	0.	0.	0.
1967	28.022	13286.	441.	20.	16.	469.	2.	0.	0.	0.	0.	0.
1968	48.233	216.	3150.	121.	21.	38.	235.	1.	0.	0.	0.	0.
1969	63.666	189.	20609.	1002.	34.	10.	8.	87.	1.	0.	0.	0.
1970	83.529	812.	934.	16154.	568.	4.	5.	1.	85.	0.	0.	0.
1971	104.901	67866.	3052.	1553.	16024.	347.	12.	18.	0.	45.	12.	12.
1972	121.031	28413.	20279.	2495.	1085.	7920.	157.	13.	1.	1.	28.	28.
1973	152.422	20457.	34299.	9429.	242.	203.	1591.	48.	3.	1.	6.	6.
1974	116.982	45001.	8695.	14943.	2536.	31.	21.	283.	6.	0.	1.	1.
1975	161.009	128502.	26965.	2450.	5213.	520.	15.	14.	77.	3.	1.	1.
1976	152.419	5355.	59426.	11342.	657.	1757.	328.	7.	5.	45.	1.	1.
1977	224.824	10102.	6441.	41122.	3492.	390.	787.	99.	15.	2.	5.	5.
1978	236.929	45734.	11471.	2914.	12280.	774.	110.	167.	24.	4.	0.	0.
1979	287.494	44659.	23157.	4111.	714.	3644.	203.	20.	57.	20.	0.	0.
1980	333.197	92522.	46285.	8063.	755.	197.	1015.	61.	18.	8.	5.	5.
1981	251.504	7979.	58145.	13653.	1518.	161.	20.	320.	12.	6.	7.	7.
1982	250.870	25257.	10170.	55467.	3927.	133.	67.	7.	56.	0.	0.	0.

I W E I I + H G I I H S I I 4 0 0 S

Table 5.6 North Sea HADDOCK. Rho values and regression analysis for estimation of terminal Fs

YEAR/AGE	1	2	3	4	5	6	7	8	9	
1963	1	1.22	3.73	0.91	0.67	0.94	0.34	0.34	1.18	0.70
1964	2	3.25	0.97	1.09	0.34	0.38	1.53	0.14	0.55	0.97
1965	3	10.80	0.76	0.55	0.59	0.36	0.51	0.60	0.23	0.42
1966	4	11.55	2.44	0.45	0.80	0.42	0.50	0.31	0.92	0.12
1967	5	7.46	5.87	0.54	0.27	0.94	0.76	1.23	2.55	2.67
1968	6	0.20	2.58	1.64	0.22	0.26	1.00	0.21	0.65	0.33
1969	7	0.03	0.62	1.34	0.86	0.37	1.03	1.00	0.18	0.40
1970	8	1.32	1.59	1.12	0.82	0.36	0.89	0.21	1.00	0.04
1971	9	4.91	2.72	1.72	1.23	0.79	0.48	2.27	0.54	1.00
1972	10	1.38	3.92	3.61	1.85	1.44	0.99	0.83	0.24	0.06
1973	11	3.18	2.50	2.97	1.00	0.92	1.37	2.32	0.77	0.34
1974	12	3.76	4.80	2.16	1.39	0.42	0.74	2.11	0.44	0.08
1975	13	3.00	4.90	3.51	1.67	0.99	0.60	2.57	1.85	0.74
1976	14	2.03	4.77	4.47	1.23	1.96	1.57	0.67	0.97	1.59
1977	15	1.76	5.98	3.57	2.51	1.68	1.77	2.23	0.75	0.50
1978	16	5.20	8.12	3.51	2.83	1.21	1.82	4.47	1.25	1.30
1979	17	1.54	6.25	3.93	1.33	1.86	2.02	1.08	3.41	0.60
1980	18	1.04	5.12	4.21	2.28	1.39	1.99	4.35	1.86	7.94
1981	19	1.00	3.40	3.79	2.16	0.92	0.72	3.31	3.91	3.92
1982	20	1.55	6.04	4.64	2.41	1.55	1.67	3.42	2.20	2.79
PREDIC. N		679627.	152432.	456264.	76508.	8014.	1344.	474.	1449.	35.
PREDIC. F		0.65	0.91	1.06	1.16	1.83	1.51	1.75	0.73	2.67
COR. COEF.		-0.29	0.63	0.96	0.83	0.65	0.61	0.75	0.52	0.46
SLOPE		-0.18	0.23	0.23	0.12	0.06	0.06	0.18	0.19	0.15
INTERCEPT		5.07	1.45	0.11	0.10	0.30	0.48	-0.23	0.24	-0.29

Table 5.7 West of Scotland HADDOCK. Effort (hours fished) and catch at age ($N \times 10^{-3}$) discards included.
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8	9	10	
1966	71.525	789.	249.	146.	20569.	921.	36.	17.	24.	0.	0.		Scottish Trawl
1967	54.231	5922.	2987.	182.	102.	12814.	85.	1.	3.	2.	0.		
1968	50.001	6886.	13331.	644.	138.	398.	8402.	310.	15.	2.	0.		
1969	42.058	0.	30459.	3585.	252.	117.	174.	2264.	81.	2.	0.		
1970	40.572	0.	113.	26460.	1376.	43.	34.	72.	242.	3.	2.		
1971	41.234	842.	475.	449.	16253.	142.	8.	1.	0.	10.	2.		
1972	55.536	3284.	18408.	903.	1041.	23671.	196.	5.	5.	0.	6.		
1973	51.153	1711.	5191.	0261.	96.	641.	17059.	61.	0.	1.	01.		
1974	45.899	6484.	3795.	5154.	1909.	28.	215.	4366.	8.	1.	13.		
1975	37.080	5986.	11545.	1404.	1095.	666.	20.	51.	1523.	40.	2.		
1976	35.507	66.	13426.	5902.	718.	595.	183.	4.	1.	217.	1.		
1977	33.948	2534.	237.	12304.	2059.	129.	171.	52.	7.	1.	27.		
1978	51.582	1376.	688.	192.	10859.	1542.	156.	122.	99.	1.	10.		
1979	33.575	8618.	2235.	611.	74.	3186.	309.	31.	24.	3.	2.		
1980	19.660	465.	3664.	1346.	274.	27.	873.	47.	2.	1.	1.		
1981	13.753	3.	14272.	3733.	169.	23.	2.	131.	2.	3.	0.		
1982	14.194	86.	479.	7212.	1405.	37.	2.	12.	39.	0.	0.		
1966	156.511	491.	165.	2.	18628.	538.	4.	2.	6.	0.	0.			Scottish Seine
1967	158.208	8256.	10693.	516.	103.	6640.	170.	4.	3.	2.	0.		
1968	150.094	88598.	16469.	1653.	117.	143.	2124.	259.	3.	0.	0.		
1969	140.718	67.	90695.	3738.	701.	63.	81.	754.	41.	5.	0.		
1970	95.629	4332.	183.	45402.	444.	65.	16.	19.	114.	7.	0.		
1971	98.748	35005.	1870.	1554.	32278.	139.	50.	2.	2.	79.	7.		
1972	70.741	8052.	17913.	585.	344.	8341.	74.	10.	1.	0.	20.		
1973	59.596	25035.	3433.	3691.	29.	31.	1630.	8.	14.	2.	5.		
1974	56.448	23940.	1637.	885.	681.	8.	31.	652.	10.	5.	4.		
1975	56.420	90247.	7636.	467.	324.	183.	3.	4.	130.	1.	1.		
1976	57.090	11826.	20806.	5050.	212.	223.	155.	3.	2.	109.	1.		
1977	41.920	3812.	1159.	6791.	803.	161.	69.	48.	4.	2.	23.		
1978	33.617	3470.	296.	137.	1946.	130.	16.	6.	5.	0.	1.		
1979	38.465	12198.	3181.	207.	84.	780.	50.	7.	4.	2.	0.		
1980	38.660	7436.	6520.	765.	94.	25.	538.	21.	2.	1.	2.		
1981	37.208	35.	17244.	4960.	316.	49.	4.	126.	4.	1.	0.		
1982	36.689	2883.	1213.	15227.	1523.	27.	5.	1.	14.	1.	0.	...Ctd.	

Table 5.7 Ctd.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	9	10
1966	40.533	0.	5.	0.	703.	21.	0.	0.	0.	0.	0.
1967	80.916	429.	1526.	73.	7.	189.	7.	0.	0.	0.	0.
1968	65.348	2444.	514.	132.	9.	13.	82.	9.	0.	0.	0.
1969	106.650	0.	0105.	274.	82.	5.	8.	55.	0.	1.	0.
1970	118.881	558.	61.	7190.	94.	18.	4.	4.	24.	2.	0.
1971	129.167	12856.	427.	524.	7717.	30.	21.	1.	0.	51.	3.
1972	142.244	1479.	20885.	447.	197.	4635.	45.	15.	1.	0.	20.
1973	91.151	559.	1171.	1396.	9.	19.	720.	7.	5.	1.	3.
1974	88.651	5161.	950.	706.	425.	4.	73.	421.	9.	2.	4.
1975	132.553	20271.	4525.	598.	560.	320.	8.	8.	253.	2.	2.
1976	139.225	2067.	11485.	2004.	172.	209.	119.	3.	3.	93.	1.
1977	143.574	1151.	363.	5582.	661.	95.	68.	49.	9.	1.	50.
1978	127.387	2563.	206.	157.	1412.	205.	33.	19.	13.	1.	1.
1979	99.803	10349.	2420.	163.	35.	803.	59.	17.	5.	4.	0.
1980	121.211	4939.	3870.	1035.	184.	38.	500.	52.	7.	1.	2.
1981	165.002	28.	14863.	4408.	423.	40.	8.	176.	12.	5.	1.
1982	135.280	4962.	960.	12389.	1722.	71.	10.	15.	14.	1.	1.

Scottish Light Trawl

Table 5.8 West of Scotland HADDOCK. Rho values and regression analysis for estimation of terminal Fs

YEAR/AGE	$G(Y, A)/V(Y+1, A+1)$, $G=SCALED$ GAMMA, $V=SCALED$ H									
	1	2	3	4	5	6	7	8	9	
1966	1	1.496	0.615	0.281	1.013	0.999	0.293	0.195	0.095	0.000
1967	2	4.067	6.652	1.351	0.147	1.302	0.063	0.442	0.103	0.038
1968	3	0.471	4.685	2.333	0.660	0.779	1.257	4.001	0.827	0.848
1969	4	0.016	1.000	2.401	3.270	1.109	0.252	2.342	1.223	2.519
1970	5	2.211	0.137	1.000	0.694	0.665	0.200	0.261	0.676	0.360
1971	6	1.100	2.334	1.174	1.000	0.136	0.136	0.116	0.018	2.892
1972	7	2.952	7.464	3.229	1.112	1.000	0.049	0.807	0.043	0.000
1973	8	3.773	2.437	3.414	0.914	1.460	1.000	0.029	1.048	0.249
1974	9	3.974	4.925	5.357	1.596	0.391	0.415	1.000	0.544	2.625
1975	10	3.409	4.464	3.274	2.367	1.099	0.270	0.164	1.000	0.223
1976	11	12.238	2.436	4.196	2.036	1.367	0.219	0.352	0.221	1.309
1977	12	26.380	5.104	2.500	2.106	1.777	0.425	1.303	2.098	0.346
1978	13	2.015	1.865	1.455	2.169	2.968	0.672	0.682	1.025	1.567
1979	14	7.182	5.369	4.030	1.636	2.397	1.137	0.999	3.061	1.354
1980	15	0.296	2.496	5.915	6.043	0.566	1.137	2.510	0.790	3.290
1981	16	0.031	2.979	4.831	3.169	3.194	0.120	4.355	1.050	0.952
1982	17	7.814	3.758	5.120	3.374	2.083	0.651	1.807	1.606	1.750
FREDC. F		22314.	12143.	139579.	15419.	1155.	129.	311.	388.	49.
FREDC. F		1.339	0.563	0.926	0.641	1.737	2.126	2.472	1.550	1.295
COR. COEFF.		0.253	0.076	0.496	0.593	0.585	0.235	0.193	0.517	0.217
SLOPE		0.356	0.034	0.221	0.179	0.169	0.621	0.060	0.087	0.055
INTERCEPT		1.764	3.179	1.360	0.330	0.438	0.292	0.790	0.122	0.811

Table 5.9 North Sea WHITING. Effort (hours fished) and catch at age ($N \times 10^{-3}$) discards included.
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8	9	10	
1963	188.572	2960.	20149.	6765.	4090.	1156.	284.	3.	43.	1.			1.
1964	197.623	204.	12553.	11005.	2101.	1056.	246.	77.	1.	11.			4.
1965	172.992	691.	276.	13399.	2904.	484.	155.	49.	18.	1.			1.
1966	194.012	1777.	2793.	867.	13469.	1430.	138.	54.	13.	8.			u.
1967	215.319	8255.	7704.	5071.	702.	10632.	817.	118.	23.	12.			u.
1968	218.141	7211.	21140.	6637.	3078.	267.	4229.	287.	26.	10.			3.
1969	123.010	74.	11022.	6575.	1453.	564.	45.	935.	63.	2.			0.
1970	133.445	394.	274.	14358.	2377.	347.	114.	4.	212.	10.			0.
1971	174.559	4798.	2519.	453.	13095.	1484.	179.	52.	0.	81.			1.
1972	201.493	3830.	7643.	2421.	307.	7895.	868.	95.	38.	10.			22.
1973	182.541	9833.	16099.	4608.	794.	82.	170.	216.	25.	10.			3.
1974	185.432	1726.	17080.	7424.	987.	207.	55.	533.	37.	5.			2.
1975	152.977	1677.	5988.	13289.	2166.	279.	42.	7.	121.	12.			1.
1976	171.641	280.	8121.	2358.	3928.	691.	121.	14.	0.	29.			2.
1977	144.343	885.	6342.	13056.	1521.	2332.	211.	26.	2.	2.			12.
1978	135.220	2270.	12979.	13501.	8632.	550.	752.	71.	9.	0.			u.
1979	87.467	2856.	14814.	11068.	7823.	2945.	166.	212.	25.	1.			0.
1980	55.475	626.	10603.	10096.	3439.	2395.	875.	30.	21.	3.			3.
1981	51.553	238.	6634.	8047.	3470.	546.	537.	104.	2.	4.			3.
1982	47.389	271.	677.	6532.	2666.	916.	69.	14.	2.	0.			u.

1963	518.798	92451.	135622.	29035.	11459.	2795.	735.	4.	55.	10.			0.
1964	639.177	18627.	112650.	40095.	5487.	2358.	647.	142.	0.	14.			3.
1965	582.364	108732.	10197.	110384.	17446.	2061.	344.	159.	46.	0.			4.
1966	500.668	94342.	47443.	8605.	62293.	7236.	723.	293.	22.	15.			u.
1967	514.354	453102.	56306.	21666.	2380.	24674.	2040.	233.	53.	9.			2.
1968	548.642	166236.	112615.	17165.	6304.	698.	6653.	570.	31.	5.			u.
1969	491.435	6952.	70987.	25883.	4178.	1599.	110.	1742.	128.	13.			1.
1970	476.563	21905.	3377.	50805.	3738.	1686.	553.	38.	387.	44.			0.
1971	416.144	161744.	22242.	3630.	37940.	3860.	520.	172.	13.	164.			11.
1972	392.432	46775.	27827.	4850.	646.	14837.	2587.	1780.	33.	10.			367.
1973	414.398	72079.	49676.	12692.	2514.	245.	4100.	487.	77.	25.			19.
1974	349.604	44934.	557205.	25559.	4326.	720.	102.	1175.	79.	13.			8.
1975	329.432	54357.	31190.	39771.	10131.	835.	103.	19.	292.	34.			0.
1976	307.165	22193.	67582.	12457.	10886.	1800.	204.	43.	0.	13.			1.
1977	313.913	22193.	50659.	37035.	3336.	2529.	371.	31.	10.	1.			6.
1978	325.246	14994.	29309.	43713.	15391.	1058.	1409.	207.	30.	0.			7.
1979	316.419	90752.	41123.	28164.	14668.	6093.	678.	156.	3.	0.			0.
1980	297.227	27033.	73706.	37656.	11915.	9368.	2556.	760.	229.	27.			7.
1981	289.672	8753.	22761.	26215.	11225.	2555.	2228.	400.	44.	4.			1.
1982	297.730	5761.	7160.	26980.	13593.	2827.	561.	290.	85.	5.			u.

Sootfish Trawl

Sootfish Seine

...Ctd.

Table 5.10 North Sea WHITING. Rho values and regression analysis for estimation of Terminal Fs.

YEAR/AGE	1	2	3	4	5	6	7	8	9	
1963	1	0.261	0.342	1.843	0.742	0.451	0.937	1.041	2.316	0.826
1964	2	0.210	0.115	0.886	0.274	0.456	0.347	0.462	1.864	0.767
1965	3	0.772	0.064	1.000	0.346	0.224	0.228	0.117	0.412	0.000
1966	4	1.048	0.247	0.925	1.000	1.104	0.642	0.651	0.869	3.663
1967	5	2.635	0.341	1.184	0.337	1.000	0.708	1.032	2.104	0.843
1968	6	0.341	0.409	1.172	0.467	0.267	1.007	0.499	1.049	1.709
1969	7	0.275	0.091	1.252	0.337	0.563	0.038	1.000	1.236	0.720
1970	8	0.542	0.157	0.959	0.521	0.769	0.477	0.043	1.000	1.463
1971	9	1.517	0.307	1.400	0.674	0.611	0.140	0.241	0.039	1.000
1972	10	0.255	0.190	0.717	0.523	1.065	0.961	2.200	0.718	0.154
1973	11	0.253	0.187	1.149	0.259	0.322	0.515	0.611	1.088	1.133
1974	12	0.420	1.933	1.596	0.564	0.178	0.751	0.459	0.497	6.678
1975	13	0.211	0.205	2.047	0.912	0.548	0.186	0.334	0.600	1.544
1976	14	0.154	0.259	1.579	0.902	0.701	0.016	0.196	0.063	0.590
1977	15	0.208	0.188	1.886	0.537	0.986	0.388	0.167	1.257	0.085
1978	16	0.038	0.137	1.674	1.027	0.609	1.279	0.948	1.093	3.750
1979	17	0.822	0.167	1.463	0.801	1.418	0.766	0.958	1.085	0.165
1980	18	0.197	0.258	1.821	0.910	1.937	1.676	0.459	1.753	1.165
1981	19	0.368	0.119	1.370	0.856	0.939	1.683	0.803	0.347	0.153
1982	20	0.222	0.329	1.711	0.861	1.076	1.148	0.619	0.624	1.453
PREDIC. F	395193.	168789.	412437.	148245.	38373.	7673.	2257.	502.	76.	
PREDIC. F	0.761	1.143	0.983	1.000	1.218	2.070	1.696	1.539	1.717	
COR. COEFF.	-0.304	0.040	0.502	0.505	0.417	0.492	-0.033	-0.346	0.021	
SLOPE	-0.034	0.003	0.034	0.024	0.033	0.043	-0.003	-0.000	0.006	
INTERCEPT	0.892	0.272	1.023	0.382	0.407	0.284	0.687	1.417	1.329	

Table 5.11 West of Scotland WHITTING. Effort (hours fished) and catch at age ($N \times 10^{-3}$)
Input data for estimation of terminal Fs.

YEAR	EFFORT	AGE 1	2	3	4	5	6	7	8	

1965	72.614	1.	53.	5189.	655.	86.	23.	5.	2.	
1966	71.525	32.	385.	93.	4741.	306.	27.	7.	1.	
1967	54.231	104.	868.	1164.	53.	2142.	75.	8.	2.	
1968	50.001	472.	1206.	749.	578.	38.	841.	38.	2.	
1969	42.058	1.	1915.	1043.	295.	157.	10.	201.	7.	
1970	40.572	3.	12.	1886.	432.	60.	26.	1.	27.	
1971	41.234	15.	154.	114.	3515.	193.	42.	4.	0.	
1972	55.536	317.	456.	226.	54.	1226.	82.	5.	2.	
1973	51.153	292.	940.	595.	212.	45.	748.	37.	4.	
1974	45.899	68.	1740.	807.	184.	54.	5.	131.	7.	
1975	37.080	125.	521.	1508.	214.	31.	6.	0.	27.	
1976	35.307	51.	1703.	794.	1152.	165.	13.	3.	0.	
1977	33.948	302.	367.	1964.	223.	439.	17.	0.	0.	
1978	51.582	45.	028.	704.	2400.	241.	405.	25.	1.	
1979	33.373	143.	2080.	1799.	886.	705.	58.	75.	1.	
1980	19.060	22.	446.	1389.	580.	554.	257.	53.	25.	
1981	13.753	10.	973.	1124.	493.	151.	102.	22.	0.	
1982	14.194	36.	130.	1400.	834.	112.	131.	23.	3.	

1965	153.103	2971.	2772.	17100.	1388.	67.	17.	1.	1.	
1966	156.511	993.	7710.	1302.	12702.	734.	75.	13.	3.	
1967	158.208	2392.	13869.	4822.	555.	5543.	315.	55.	5.	
1968	150.094	3984.	8227.	4017.	1282.	133.	1679.	125.	8.	
1969	140.718	450.	11467.	5430.	986.	435.	48.	824.	86.	
1970	95.029	340.	1266.	8101.	805.	191.	57.	6.	174.	
1971	98.740	1117.	3820.	2073.	13834.	492.	77.	25.	0.	
1972	70.741	6861.	4168.	915.	521.	3008.	111.	13.	7.	
1973	59.596	5346.	9255.	1565.	523.	91.	853.	58.	0.	
1974	56.448	3007.	10864.	3065.	276.	23.	10.	251.	8.	
1975	56.420	5502.	5564.	11402.	569.	40.	10.	0.	16.	
1976	57.090	2576.	18225.	5244.	4578.	289.	19.	1.	0.	
1977	41.920	4895.	2857.	5562.	531.	1022.	44.	2.	1.	
1978	33.599	5427.	3320.	809.	1187.	73.	168.	7.	0.	
1979	38.465	2760.	10731.	3416.	526.	392.	17.	32.	0.	
1980	38.640	1837.	2579.	3843.	994.	258.	124.	4.	14.	
1981	37.208	653.	3818.	2488.	1015.	405.	92.	57.	1.	
1982	36.689	333.	881.	5771.	1072.	247.	74.	58.	13.	.....Ctd.

S o o t h I s h T r a w I

S o o t h I s h S e i n e

Table 5.11 Ctd.

YEAR	EFFORT	AGE	1	2	3	4	5	6	7	8
1965	37.387		519.	282.	3245.	400.	16.	6.	1.	0.
1966	40.538		269.	365.	154.	5741.	367.	37.	7.	4.
1967	80.918		647.	2899.	1440.	98.	2501.	140.	13.	1.
1968	65.343		489.	1960.	1617.	641.	51.	861.	60.	4.
1969	106.856		12.	5702.	1934.	569.	289.	30.	549.	63.
1970	118.381		26.	3663.	9914.	933.	202.	52.	5.	135.
1971	129.187		394.	2555.	608.	9059.	327.	63.	25.	1.
1972	142.244		3392.	2655.	1473.	314.	5353.	313.	30.	7.
1973	91.151		1177.	7482.	604.	145.	44.	503.	41.	5.
1974	88.651		1914.	9464.	1612.	159.	12.	7.	85.	3.
1975	132.553		2715.	5952.	9597.	826.	83.	13.	3.	87.
1976	139.225		2784.	9170.	3208.	5440.	731.	14.	5.	0.
1977	143.574		4643.	2497.	5289.	749.	1148.	78.	2.	1.
1978	127.527		3559.	3791.	1542.	1913.	136.	259.	4.	0.
1979	99.603		1239.	7603.	2304.	317.	297.	53.	59.	0.
1980	121.211		1525.	3193.	3952.	974.	151.	188.	12.	19.
1981	165.062		570.	6986.	4045.	1306.	498.	161.	66.	1.
1982	135.220		783.	1537.	8587.	1765.	328.	78.	65.	10.

Scottish Light-Drawl

Table 5.12 West of Scotland WHITING. Rho values and regression analysis for estimation of terminal Fs.

YEAR/AGE	1	2	3	4	5	6	7	
1965	1	0.804	2.021	0.694	0.473	0.248	0.413	0.269
1966	2	0.212	1.158	2.031	0.974	0.671	1.183	0.785
1967	3	0.510	2.600	1.996	0.761	0.637	0.632	0.819
1968	4	0.225	1.492	2.971	1.263	0.960	1.000	0.324
1969	5	0.263	0.590	1.664	1.269	1.488	4.642	1.000
1970	6	0.272	3.533	0.795	0.772	0.931	1.174	4.382
1971	7	0.593	2.757	3.451	1.104	0.531	1.233	0.720
1972	8	1.766	2.877	3.634	2.641	1.481	2.528	0.912
1973	9	0.732	4.195	4.627	2.592	2.749	1.466	1.635
1974	10	1.330	1.676	3.054	1.859	1.125	2.632	0.770
1975	11	0.979	1.666	2.517	1.025	1.802	1.849	3.590
1976	12	1.620	2.466	5.202	1.944	3.253	2.977	1.528
1977	13	2.380	1.600	2.294	1.414	1.201	2.866	2.251
1978	14	2.331	1.465	1.460	1.000	1.053	1.263	2.034
1979	15	1.704	3.952	3.419	0.913	1.045	1.104	1.108
1980	16	0.543	1.068	3.961	1.347	1.467	1.753	11.466
1981	17	1.262	0.935	2.266	1.552	1.136	1.501	0.887
1982	18	1.645	2.042	3.572	1.649	1.861	2.142	4.059
PREDIC. A		11980.	13207.	51715.	11785.	2731.	1064.	315.
PREDIC. F		0.331	0.659	0.974	1.007	1.565	1.647	2.081
COR. COEFF.		0.629	-0.035	0.341	0.231	0.384	0.193	0.426
SLOPE		0.099	-0.008	0.097	0.034	0.058	0.040	0.226
INTERCEPT		0.228	2.130	1.616	1.046	0.761	1.415	-0.002

Table 6.1 North Sea COD. Estimates of recruitment at age 1 and 2.

Year Class	A G E 1					A G E 2				
	IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶		IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶	
				IV	VIa				IV	VIa
1968						4.8			76	2.3
1969	73.8			379	5.2	29.1			263	4.2
1970	99.7			429	8.7	37.5	37.4	6.4	312	6.8
1971	4.1	4.5	1.4	78	4.3	10.5	10.5	2.7	60	3.3
1972	37.7	41.4	5.3	154	6.9	9.5	9.0	3.3	104	5.5
1973	14.6	10.5	3.1	129	8.2	6.1	3.8	1.8	92	6.1
1974	95.7	52.4	9.1	225	12.7	20.2	18.7	6.3	157	9.3
1975	8.8	9.4	2.2	109	7.4	3.1	3.4	1.3	84	4.3
1976	40.3	53.0	11.4	378	9.7	42.3	36.1	5.9	255	6.9
1977	14.4	18.3	5.3	224	9.0	9.2	11.4	3.6	158	6.7
1978	9.8	14.5	3.8	236	14.4	17.6	11.9	2.9	160	11.0
1979	26.3	21.6	6.6	444	20.5	29.7	28.5	11.6	313	15.7
1980	13.5	3.7	2.0	131	7.7	6.4	8.3	2.8	(88)	(5.9)
1981	12.8	11.6	3.4	(290)	(21.3)	20.2 ⁴⁾	15.4 ⁴⁾	4.3 ⁴⁾	(181)	(15.8)
1982	5.0 ⁴⁾	5.4 ⁴⁾	2.2 ⁴⁾							

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

2) Estimates obtained as for 1) but restricted to rectangles that have been fished every year (Burd and Parnell 1982)

3) Unadjusted geometric mean values of rectangles fished every year

4) Preliminary figure

Table 6.2 North Sea HADDOCK. Estimates of recruitment at age 1 and 2.

Year Class	A G E 1					A G E 2				
	IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶		IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶	
				IV	VIa				IV	VIa
1968						45			347	14
1969	28			469	18	32			148	9
1970	855			3 290	245	299	313	59	1 083	137
1971	740	788	62	2 335	76	971	987	103	1 306	44
1972	187	187	9	755	79	110	94	13	294	22
1973	1 072	803	116	2 608	169	385	284	60	1 052	76
1974	1 168	1 018	397	4 599	436	670	578	113	1 892	196
1975	172	103	20	398	35	84	91	17	176	8
1976	162	111	27	565	23	108	113	17	238	7
1977	385	421	56	933	56	240	107	16	355	31
1978	480	482	53	1 188	165	402	310	28	658	76
1979	896	614	83	2 039	388	675	718	119	1 018	297
1980	268	133	23	341	16	252	179	18	(154)	(13)
1981	533	242	38	(1 257)	(102)	348 ⁴⁾	263 ⁴⁾	41 ⁴⁾		
1982	305 ⁴⁾	199 ⁴⁾	35 ⁴⁾							

- 1) Unadjusted arithmetic mean number per hour trawling per statistical rectangle
- 2) Estimates obtained as for 1) but restricted to rectangles that have been fished every year (Burd and Parnell 1982)
- 3) Unadjusted geometric mean values of rectangles fished every year
- 4) Preliminary figure

Table 6.3 North Sea WHITING. Estimates of recruitment at age 1 and 2.

Year Class	A G E 1					A G E 2				
	IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶		IYFS index ¹⁾	IYFS index ²⁾	IYFS index ³⁾	VPA number x 10 ⁶	
				IV	VIa				IV	VIa
1968						77			126	16
1969	69			926	22	31			227	17
1970	274			1 408	31	190	222	20	598	23
1971	332	279	44	2 438	93	763	943	67	1 156	61
1972	1 136	1 011	273	3 258	194	496	250	55	1 632	147
1973	322	341	91	1 710	67	153	117	28	726	47
1974	833	793	257	3 175	150	535	440	61	1 741	110
1975	679	948	129	1 796	50	219	319	23	1 041	34
1976	418	621	211	2 139	79	293	386	36	843	50
1977	513	552	176	1 808	105	183	186	16	1 105	70
1978	457	451	143	1 956	63	391	450	27	1 146	45
1979	692	566	197	1 444	125	485	440	45	893	92
1980	227	178	74	498	20	232	181	11	(230)	(13)
1981	161	182	57	(826)	(20)	155 ⁴⁾	101 ⁴⁾	21 ⁴⁾		
1982	130 ⁴⁾	100 ⁴⁾	45 ⁴⁾							

- 1) Unadjusted arithmetic mean number per hour trawling per statistical rectangle
- 2) Estimates obtained as for 1) but restricted to rectangles that have been fished every year (Burd and Parnell 1982)
- 3) Unadjusted geometric mean values of rectangles fished every year
- 4) Preliminary figure

Table 6.4

Geometric mean regressions of different indices of abundance for COD and the estimated recruitment figures for I-group and II-group

r: correlation coefficient

u: slope

v: intercept

N: number of data points

range: range of year classes included

R_j^i : Recruitment of year class j at age i ($\times 10^{-6}$)

Age group	Relationship	r	u	v	N	range	R_j^i
I	VPA-IYFS standard	.58	3.80	103	12	1969-80	$R_{1982}^1 = 122$
	VPA-BP geometric	.75	36.11	28.3	10	1971-80	108
	VPA-BP arithmetic	.90	6.18	67.9	10	1971-80	101
	VPA _{VIA} - VPA _{IV}	.48*	.034	1.26	12	1969-80	-
	Final estimate Sub-area IV " " Division VIA						$R_{1982}^1 = 110 \begin{matrix} 1 \\ 3 \end{matrix}$ 7.7)
II	VPA-IYFS standard	.91	6.91	42.4	12	1968-79	$R_{1981}^2 = 182$
	VPA-BP geometric	.84	30.15	30.7	10	1970-79	160
	VPA-BP arithmetic	.92	7.32	43.9	10	1970-79	157
	VPA _{VIA} - VPA _{IV}	.55	0.040	.068	12	1968-79	-
	Final estimate Sub-area IV " " Division VIA						$R_{1981}^2 = 180 \begin{matrix} 2 \\ 3 \end{matrix}$ $R_{1981}^2 = 21.3 \begin{matrix} 2 \\ 4 \end{matrix}$

* Not significant

- 1) Based on the mean value of the poor year classes 1971, 1973, 1975 and 1980
- 2) Based on the regression of VPA-IYFS standard: see also Section 7.4
- 3) Because the correlation coefficient is not significant average recruitment has been assumed
- 4) See Section 8.3

Table 6.5

Geometric mean regressions of different indices of abundance for HADDOCK and the estimated recruitment figures for I-group and II-group.

r: correlation coefficient

u: slope

v: intercept

N: number of data points

range: range of year classes included

R_j^i : Recruitment of year class j at age i ($\times 10^{-6}$)

Age group	Relationship	r	u	v	N	range	R_j^i
I	VPA-IYFS standard	0.92	3.45	-218	12	1969-80	$R_{1982}^1 = 1\ 620$
	VPA-BP geometric	.91	11.71	586	10	1971-80	1\ 034
	VPA-BP arithmetic	.94	4.04	-305	10	1971-80	672
	VPA _{VIA} - VPA _{IV}	.83	0.106	-31.3	12	1969-80	50
	Final estimate Sub-area IV " " Division VIA							760^{1)} 48^{1)}
II	VPA-IYFS standard	.84	1.84	97	12	1968-79	$R_{1981}^2 = 561$
	VPA BP-geometric	.88	13.00	100	10	1970-79	332
	VPA-BP arithmetic	.75	1.82	152	10	1970-79	478
	VPA _{VIA} - VPA _{IV}	.69	0.163	-40.5	12	1968-79	84
	Final estimate Sub-area IV " " Division VIA							760^{1)} 70^{1)}

- 1) Because of the apparent curved nature of the relationships, the final recruitment figures chosen were based on the actual observations in the range of the index obtained.

Table 6.6

Geometric mean regressions of different indices of abundance for WHITING and the estimated recruitment figures for I-group and II-group.

r: correlation coefficient

u: slope

v: intercept

N: number of data points

range: range of year classes included

R_j^i : Recruitment of year class j at age i ($\times 10^{-6}$)

Age group	Relationship	r	u	v	N	range	R_j^i
I	VPA-IYFS standard	.77	2.65	549	12	1969-80	$R_{1982}^1 = 893$
	VPA-BP geometric	.62	10.56	338	10	1971-80	935
	VPA-BP arithmetic	.63	2.92	347	10	1971-80	878
	VPA _{VIA} - VPA _{IV}	.84	0.006	-40.2	12	1969-80	-7
	Final estimate Sub-area IV " " Division VIa							$500 \left. \begin{matrix} 1 \\ 20 \end{matrix} \right\}$
II	VPA-IYFS standard	.73	2.23	227	12	1968-79	$R_{1981}^2 = 573$
	VPA-BP geometric	.68	18.43	455	10	1970-79	839
	VPA-BP arithmetic	.22*	1.58	494	10	1970-79	653
	VPA _{VIA} - VPA _{IV}	.84	.03	-5.91	12	1968-79	9
	Final estimate Sub-area IV " " Division VIa							$500 \left. \begin{matrix} 1 \\ 14 \end{matrix} \right\}$

*) Not significant

1) Based on inspection of the graphs, taking into account the level of recruitment observed at corresponding indices of abundance.

Table 7.2 VIRTUAL POPULATION ANALYSIS

NORTH SEA COD (FISHING AREA IV)

CATCH IN NUMBERS	UNIT: THOUSANDS									
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	24408	14677	30305	6238	60207	28356	36314	55522	21629	65031
2	29723	55431	48051	93083	48281	156899	86741	94284	187109	57292
3	52475	10716	18232	17584	23082	14731	39700	29942	27518	51379
4	13567	14869	4220	6608	4307	3469	3596	9792	7627	6394
5	2058	4392	6434	1589	2190	2384	3001	1523	3777	2907
6	1095	920	1732	2439	675	961	660	1037	757	1644
7	1043	417	377	770	926	571	342	384	546	316
8	471	373	149	93	307	364	113	159	136	193
9	69	316	180	49	223	131	127	59	62	61
10	58	75	80	49	20	32	54	46	33	24
11+	161	179	53	29	81	36	16	25	22	23
TOTAL	125133	102367	109365	128536	140359	212777	170706	192691	249276	183264

Table 7.3 VIRTUAL POPULATION ANALYSIS

NORTH SEA COD (FISHING AREA IV)

MEAN WEIGHT AT AGE OF THE STOCK	UNIT: KILOGRAM									
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.302	0.504	0.373	0.373	0.306	0.365	0.302	0.534	0.642	0.590
2	0.853	1.032	0.871	1.000	0.905	0.744	0.836	0.974	0.891	0.940
3	1.909	2.213	2.310	2.372	2.091	1.919	2.369	1.972	2.052	1.839
4	3.758	4.152	4.162	4.328	4.412	4.130	4.475	4.512	4.275	4.503
5	5.521	6.242	6.282	6.372	6.639	6.425	6.678	6.295	6.867	6.796
6	7.403	8.341	8.434	8.560	8.750	8.615	8.657	9.084	8.767	8.903
7	8.979	9.878	9.801	10.078	9.930	9.578	10.672	9.683	9.843	10.629
8	9.771	10.762	10.320	11.017	10.897	10.767	11.460	11.736	11.367	12.430
9	11.037	12.326	11.933	12.690	12.018	12.153	13.017	12.666	13.097	13.229
10	12.273	12.413	12.671	13.912	12.830	12.566	13.849	13.866	14.131	12.843
11+	12.846	13.629	13.641	14.452	13.314	13.830	15.849	15.972	15.630	14.229

Table 7.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1973-1982 (data for 1973 - 1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	11 741	10 253	7 566	7 483	10 346	17 473	12 576	9 630	8 744	6 604
Denmark	47 950	54 207	46 344	53 277	42 582	41 858	48 509	56 404	68 252	63 975
Faroe Islands ^b	803	416	732	448	260	56	113	150	38	45
France	13 247	7 275	8 667	8 079	7 511	11 944	12 559	10 910	11 369	8 846
German Dem.Rep.	343	132	223	69	21	75	84	63	-	-
Germany, Fed. Rep.	21 410	17 089	16 457	24 445	22 663	37 040	20 411	26 343	29 741	19 045
Ireland	-	-	-	98	136	174	1	-	-	-
Netherlands	25 758	24 029	23 263	21 835	29 903	48 817	34 752	45 400	51 281	36 179
Norway ^{a)}	454	324	1 528	1 877	1 449	2 747	3 575	4 506	6 766	6 992
Poland	1 551	4 750	2 991	2 961	381	115	142	28	7	62
Spain	90	80	63	14	-	-	-	-	-	-
Sweden	2 534	2 071	900	597	36	... ^{b)}	298	293	321	438
UK(Engl.&Wales)	47 327	39 857	33 615	46 475	35 424	59 127	54 923	49 951	59 856	53 556
UK(Scotland)	48 844	39 887	37 308	39 597	34 406	41 984	42 811	45 044	53 921	55 619
USSR	2 497	2 667	6 796	6 187	-	17	17	-	-	-
Total IV	224 549	203 037	186 453	213 442	185 118	261 427	230 771	248 722	290 296	251 361
Total IVa	59 640	64 152	58 343	68 352	55 623	43 357	41 118	48 467	55 109	53 267
Total IVb	134 953	114 087	107 227	126 218	100 191	164 388	147 313	161 767	197 567	187 834
Total IVc	29 956	24 798	20 883	18 872	29 304	53 682	42 340	38 488	37 620	10 260

*) provisional figures

a) Figures from Norway do not include cod caught in Rec. 2 fisheries

b) Included in IIIa

Table 7.5 VIRTUAL POPULATION ANALYSIS

NORTH SEA COD (FISHING AREA IV)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1975	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1963-79
1	153957	128641	225120	109207	377570	224510	235776	444002	131415	292590	+++++++	201754
2	60475	104069	92094	157009	83742	254862	153260	160334	313486	87941	182869	142559
3	96394	22994	35833	32588	45863	25575	69452	57367	47499	90432	21256	51435
4	26321	32207	9258	13084	11025	16968	8358	21563	16251	14003	28349	18958
5	5005	9455	15091	3811	4821	5171	6340	3628	8987	6496	6241	8470
6	2178	2255	3822	4935	1699	1990	1668	2459	1608	3981	2722	3729
7	2109	887	1023	1582	1665	787	772	775	1066	641	1789	1632
8	1183	797	289	500	608	701	373	327	292	402	243	756
9	265	547	319	104	321	224	249	155	126	118	157	328
10	126	155	165	101	41	66	67	91	65	47	42	125
11+	349	370	109	60	167	78	36	45	44	45	34	116
TOTAL NO	348338	302299	381124	322981	527761	531032	481290	685747	520860	497297		
SFS NO	135927	69589	65910	56764	66409	51661	87254	81410	75958	116766		
TOT. BIOM	464211	464835	420370	425238	414707	461918	478736	654289	623737	581572		
SFS BIOM	366132	292651	256187	225494	223348	189457	275276	261026	260052	326280		

Table 7.4 VIRTUAL POPULATION ANALYSIS

NORTH SEA COD (FISHING AREA IV)

	FISHING MORTALITY COEFFICIENT					UNIT: Year ⁻¹	NATURAL MORTALITY COEFFICIENT = 0.20				
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1977-82
1	0.19	0.13	0.16	0.07	0.19	0.15	0.19	0.15	0.20	0.27	0.19
2	0.77	0.87	0.84	1.03	0.98	1.10	0.97	1.02	1.04	1.22	1.04
3	0.90	0.71	0.81	0.88	0.79	0.92	0.97	0.97	0.98	0.96	0.93
4	0.82	0.70	0.69	0.80	0.56	0.78	0.63	0.68	0.72	0.65	0.67
5	0.60	0.71	0.78	0.61	0.68	0.93	0.75	0.61	0.61	0.67	0.71
6	0.79	0.59	0.68	0.77	0.57	0.75	0.57	0.62	0.72	0.60	0.64
7	0.77	0.83	0.52	0.76	0.78	0.72	0.66	0.78	0.79	0.77	0.75
8	0.57	0.71	0.82	0.24	0.80	0.83	0.50	0.76	0.71	0.74	0.72
9	0.36	1.00	0.95	0.72	1.38	1.00	0.81	0.67	0.77	0.83	0.91
10	0.70	0.75	0.75	0.75	0.75	0.75	0.80	0.80	0.80	0.80	0.78
11+	0.70	0.75	0.75	0.75	0.75	0.75	0.80	0.80	0.80	0.80	0.78
(3-8)U	0.74	0.71	0.72	0.68	0.70	0.82	0.68	0.73	0.76	0.73	

Table 7.6

LIST OF INPUT VARIABLES FOR THE ICES PREDICTION PROGRAM

NORTH SEA COD

FIRST YEAR: 1983

LAST YEAR: 1985

YEAR	RECRUITMENT thousands
1983	110000.
1984	202000.
1985	202000.

AGE	STOCK SIZE thousands	F AT AGE %	M	MATURITY OGIVE	WEIGHT IN THE CATCH kilogram	WEIGHT IN THE STOCK kilogram
1	110000.0	0.190	0.20	0.000	0.457	0.457
2	180568.0	1.040	0.20	0.000	0.882	0.882
3	21226.0	0.920	0.20	1.000	2.040	2.040
4	28165.0	0.670	0.20	1.000	4.385	4.385
5	6215.0	0.710	0.20	1.000	6.617	6.617
6	2711.0	0.640	0.20	1.000	8.800	8.800
7	1777.0	0.740	0.20	1.000	10.064	10.064
8	242.0	0.720	0.20	1.000	11.450	11.450
9	156.0	0.900	0.20	1.000	12.700	12.700
10	42.0	0.770	0.20	1.000	13.347	13.347
11+	34.0	0.770	0.20	1.000	14.363	14.363

* Average F 1977-82 rescaled to $\bar{F}_{av} = \frac{1}{11} \sum_{t=1977}^{1982} F_t$

Table 7.7 North Sea (IV) COD. Management Options assuming that the fishing mortality remains unchanged from 1982-1983.

1983				1984					1985				
Stock Biomass	Spawning Stock Biomass	\bar{F}_{3-8} H.C.	Total Landings	Management Option for 1984	Stock Biomass	Spawning Stock Biomass	\bar{F}_{3-8} H.C.	H.C. Landings	Stock Biomass	Spawning Stock Biomass			
465	255	0.73 (= \bar{F}_{82})	223	$\bar{F}_{0.1}$	417	259	.12	41	645	412			
				\bar{F}_{max}				60			613	382	
				$\bar{F}_{84} = \bar{F}_{83}$				.73			183	413	200
				$\bar{F}_{84} = 0$				-			-	714	475
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$				.15			49	632	399
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$				.37			109	533	308
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$				1.1			234	333	131
$\bar{F}_{84} = 2.0 \bar{F}_{83}$	1.47	270	278	86									

Weights in thousands of tonnes

Recruitment 1983-84 $R_0 = 202\ 000 \times 10^3$

Stock Biomass = fish at age 1 and older

Spawning Stock Biomass = fish at age 3 and older

Exploitation pattern 1983-84 based on 1977-1982 average

Table 7.8 North Sea COD. Management Options assuming the TAC agreed for 1983 will be taken.

1983				1984					1985		
Stock Biomass	Spawning Stock Biomass	\bar{F}_{3-8} H.C.	Total Landings	Management Option for 1984	Stock Biomass	Spawning Stock Biomass	\bar{F}_{3-8} H.C.	H.C. Landings	Stock Biomass	Spawning Stock Biomass	
465	255	.82	240 (=TAC)	$\bar{F}_{0.1}$	390	233	.12	37	611	378	
				\bar{F}_{max}				55	581	350	
				$\bar{F}_{84} = \bar{F}_{83}$				.82	182	376	165
				$\bar{F}_{84} = 0$				-	-	674	436
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$				.16	49	592	360
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$				.41	110	491	268
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$				1.23	230	301	103
				$\bar{F}_{84} = 2.0 \bar{F}_{83}$				1.64	263	252	64

Weights in thousands of tonnes

Recruitment 1983-84 $R_0 = 202\ 000 \times 10^3$

Stock Biomass = fish at age 1 and older

Spawning Stock Biomass = fish at age 3 and older

Exploitation pattern 1983-84 based on 1977-1982 average

Table 8.1 Nominal catch (in tonnes) of COD in Division VIa, 1973-1982.
(Data for 1973 - 1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	75	174	49	71	-	-	4	57	30	35
Denmark	-	-	7	-	-	-	-	27 ^{a)}	-	3
Faroe Islands	7	13	3	39	43	-	40	3	-	-
France	3 445	3 678	3 546	5 611	3 583	4 499	4 590	5 495	7 601	7 237
German Dem. Rep.	-	-	2	-	-	-	-	-	-	-
Germany, Fed. Rep.	15	6	12	1	3	31	40	1	21	... ^{b)}
Ireland	583	883	1 141	1 341	984	1 214	2 237	2 331	2 725	3 527
Netherlands	4	5	5	11	5	3	20	1	-	-
Norway	13	14	17	22	29	40	32	48	40	183
Poland	184	175	68	18	-	-	-	-	-	-
Spain	208	137	180	15	20 ^{a)}	108 ^{a)}	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	1
U.K. (England+Wales)	2 074	2 467	2 217	2 742	2 434	2 082	2 348	2 302	3 187	2 784
U.K. (Scotland)	5 645	6 084	5 806	7 475	5 513	5 539	6 929	7 603	10 339	7 741
U.K. (N. Ireland)	3	3	3	13	5	5	2	2	7	33
USSR	7	13	107	46	-	-	-	-	-	-
Total VIa	12 263	13 652	13 163	17 405	12 619	13 521	16 242	17 870	23 950	21 544

*)provisional

a) includes VIb

b) included in VIb

Table 8.2 VIRTUAL POPULATION ANALYSIS

COD IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

	CATCH IN NUMBERS		UNIT: THOUSANDS									
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	101	222	84	92	355	270	153	727	1260	1988	1179	680
2	1004	859	986	272	884	2264	504	1841	2043	4753	1183	1792
3	1427	1862	970	944	523	1068	1271	752	1217	1362	1497	1035
4	141	1290	1519	457	709	483	518	874	506	535	590	728
5	140	112	624	356	220	405	145	235	269	255	245	289
6	104	121	104	133	185	91	161	55	60	135	81	90
7	21	72	84	24	63	72	42	52	11	58	49	49
8+	12	18	53	39	36	47	47	22	19	18	13	30
TOTAL	2950	4562	4424	2317	2960	4650	2841	4556	5335	9204	4837	4699
	1979	1980	1981	1982								
1	846	1206	447	1824								
2	1500	3250	6947	1059								
3	2150	1997	3232	3193								
4	606	794	917	1183								
5	340	190	189	365								
6	140	78	31	111								
7	34	28	18	20								
8+	38	9	6	12								
TOTAL	5714	7552	11787	8367								

Table 8.3 VIRTUAL POPULATION ANALYSIS

COD IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

MEAN WEIGHT AT AGE OF THE STOCK

UNIT: KILOGRAM

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.606	0.606	0.606	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	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	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	5.052	5.052	5.052
5	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573	6.573
6	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966	7.966
7	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807	8.807
3+	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664	9.664
	1979	1980	1981	1982								
1	0.721	0.627	0.544	0.708								
2	1.412	1.385	1.163	1.508								
3	2.858	3.008	2.830	2.777								
4	4.902	5.289	4.930	4.808								
5	6.689	7.433	7.481	6.177								
6	7.824	8.319	9.507	7.277								
7	9.150	9.262	10.235	9.655								
3+	10.039	9.595	11.055	10.502								

Table 8.4 VIRTUAL POPULATION ANALYSIS

COD IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

FISHING MORTALITY COEFFICIENT		UNIT: Year ⁻¹					NATURAL MORTALITY COEFFICIENT = 0.20					
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.02	0.04	0.03	0.02	0.04	0.06	0.02	0.10	0.12	0.35	0.14	0.09
2	0.16	0.23	0.24	0.14	0.27	0.45	0.78	0.46	0.46	0.31	0.36	0.34
3	0.38	0.47	0.58	0.39	0.44	0.59	0.50	0.45	0.63	0.64	0.66	0.62
4	0.50	0.72	0.92	0.60	0.57	0.97	0.65	0.77	0.63	0.73	0.65	0.81
5	0.26	0.42	0.96	0.57	0.66	0.77	0.93	0.70	0.57	0.76	0.79	0.79
6	0.33	0.38	0.87	0.54	0.67	0.64	0.82	1.15	0.38	1.04	0.59	0.86
7	0.50	0.50	0.50	0.50	0.60	0.60	0.70	0.70	0.80	0.80	0.90	0.90
8+	0.50	0.50	0.50	0.50	0.60	0.60	0.70	0.70	0.80	0.80	0.90	0.90
(3- 4)0	0.34	0.60	0.75	0.49	0.51	0.73	0.57	0.61	0.63	0.69	0.66	0.71
	1979	1980	1981	1982	1977-82							
1	0.07	0.07	0.07	0.10	0.09							
2	0.23	0.39	0.66	0.37	0.40							
3	0.36	0.74	0.36	0.74	0.75							
4	1.10	0.96	0.94	0.94	0.90							
5	1.23	1.21	0.64	1.41	1.01							
6	1.23	1.13	0.64	1.01	0.91							
7	0.90	0.90	0.90	1.19	0.95							
8+	0.90	0.90	0.90	1.19	0.95							
(3- 4)0	0.98	0.85	0.90	0.84								

Table 8.5 VIRTUAL POPULATION ANALYSIS

COD IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	4861	6356	2847	5189	8706	4312	6860	8207	12747	7420	9734	8984
2	7690	3889	5004	2255	4165	6825	3532	5478	6064	9300	4289	6907
3	4933	5391	2412	3210	1601	2615	3558	2274	2835	3133	3578	2450
4	595	2758	2745	1107	1781	842	1166	1774	1188	1233	1348	1428
5	664	360	1101	896	497	823	260	508	673	520	487	576
6	359	418	195	347	415	210	313	84	206	310	198	181
7	58	200	234	67	165	174	91	113	22	115	90	90
8+	33	50	147	106	87	114	102	48	38	36	24	55
TOTAL NO	19194	19423	14685	13178	17417	15916	15701	18486	23772	22067	19548	20669
SPS NO	6643	9178	6633	5734	4346	4779	5509	4800	4961	5347	5525	4779
TOT. BIOM	39303	47176	41934	31704	36636	33770	31337	33707	37132	40091	34488	36001
SPS BIOM	25807	37988	33343	25465	22646	21793	22609	21217	21088	22834	22705	21081
	1979	1980	1981	1982	1983	1967-79						
1	14378	20538	7726	21316	+++++++	7739						
2	6742	11008	15727	5922	15807	5534						
3	4045	4171	6096	6668	3359	3218						
4	1080	1397	1633	2112	2610	1466						
5	520	293	438	521	677	607						
6	214	125	72	189	104	265						
7	62	51	33	31	56	114						
8+	70	16	11	19	12	70						
TOTAL NO	27111	37600	31735	36779								
SPS NO	5991	6054	8282	9541								
TOT. BIOM	43164	51910	52195	57789								
SPS BIOM	23279	23786	29702	33766								

Table 8.6

LIST OF INPUT VARIABLES FOR THE ICES PREDICTION PROGRAM

VIA CUD

FIRST YEAR: 1983
LAST YEAR: 1985

YEAR	RECRUITMENT thousands
1983	7739.
1984	7739.
1985	7739.

AGE	STOCK SIZE thousands	F AT AGE %	M	MATURITY OGIVE	WEIGHT IN THE CATCH kilogram	WEIGHT IN THE STOCK kilogram
1	7739.0	0.090	0.20	0.000	0.635	0.635
2	15807.0	0.410	0.20	0.000	1.369	1.369
3	3359.0	0.760	0.20	1.000	2.908	2.908
4	2610.0	0.920	0.20	1.000	5.006	5.006
5	677.0	1.030	0.20	1.000	6.821	6.821
6	104.0	0.930	0.20	1.000	8.110	8.110
7	56.0	0.970	0.20	1.000	9.319	9.319
8+	12.0	0.970	0.20	1.000	10.087	10.087

* Average F 1977-82 rescaled to $\bar{F}_{av} = \bar{F}_{82}$

Table 8.7 West of Scotland COD. Management Options.

1983				1984					1985	
Stock Biomass	Spawning Stock Biomass	$\bar{F}(3-4)$ H.C.	Total Landings	Management Option for 1984	Stock Biomass	Spawning Stock Biomass	$\bar{F}(3-4)$ H.C.	H.C. Landings	Stock Biomass	Spawning Stock Biomass
55.5	28.9	.84 (= F_{82})	22.6	$\bar{F}_{0.1}$	52.2	39.3	.17	6.2	68.4	55.0
				\bar{F}_{max}	↓	↓	.31	10.7	62.0	48.7
				$\bar{F}_{84} = \bar{F}_{83}$			.84	23.2	44.1	31.1
				$\bar{F}_{84} = 0$			-	-	77.4	63.8
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$			.17	6.1	68.6	55.1
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$			.42	13.8	57.6	44.4
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$			1.26	29.8	34.7	22.2
				$\bar{F}_{84} = 2.0 \bar{F}_{83}$	↓	↓	1.68	34.4	28.1	15.9

Weights in thousands of tonnes

Recruitment 1983-84 $R_0 = 7\,739 \times 10^3$

Stock Biomass = fish at age 1 and older

Spawning Stock Biomass = fish at age 3 and older

Exploitation pattern 1983-84 based on 1977-82 average

Table 9.1 Nominal catch (in tonnes) of COD in Division VIb, 1973-1982.
(Data for 1973-1981 as officially reported to ICES).

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	-	-	-	1	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	... a)	-	-
Faroe Islands	-	5	3	22	40	10	92	75	2	77
France	320	1 128	4	4	3	1	2	1	4	27
Germany, Fed.Rep.	-	-	-	-	-	-	111	136	443	13 ^{a)}
Ireland	-	-	-	-	-	3	-	-	-	-
Norway	-	3	-	8	3	69	138	80	134	40
Poland	8	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	... a)	... a)	-	33	-	-
U.K. (Engl.&Wales)	1	-	28	77	89	285	129	1	67	3
U.K. (Scotland)	128	39	98	61	33	384	198	370	143	157
USSR	26	-	110	1 398	-	-	-	-	-	-
Total	483	1 175	243	1 571	168	752	670	696	793	317

*) Provisional

a) Included in Division VIa

Table 10.1 Nominal catch (in tonnes) of COD in Divisions VIIId and VIIe, 1973-1982
(Data for 1973 - 1981 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	124	93	67	59	65	53	435	699	163	363	293
Denmark	-	-	-	2 718	1 506	1 120	2 160	2 052	660 ^{a)}	-	-
France	2 658	1 425	3 099	2 143	1 646	5 185	8 044	4 848	4 001	4 480	3 234
Netherlands	30	2	4	+	2	1	+	-	-	4	-
Poland	7	13	6	-	-	-	-	-	-	-	-
U.K. (England & Wales)	717	499	260	159	142	581	654	485	365	422	564
U.K. (Scotland)	-	-	-	-	-	-	-	+	-	-	-
U.S.S.R.	8	45	-	3	4	-	-	-	-	-	-
Total VIIId,e	3 544	2 077	3 436	5 082	3 365	6 940	11 293	8 084	5 189	5 270	4 091

*)provisional

a) includes VIIb, c

Table 10.2 Nominal catch (in tonnes) of COD in Division VIIb, c and VIIg, k, 1973-1982
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	323	167	116	159	85	52	51	110	198	97
Denmark	-	-	-	-	-	-	18	... ^{b)}	-	-
Faroe Islands	256	-	-	-	-	-	-	-	-	-
France	2 791	2 302	2 877	3 196	1 972	2 192	2 918	4 475	5 947	5 782
Germany, Fed. Rep.	1	-	-	-	-	3 ^{a)}	-	7	-	-
Ireland	568	283	474	506	315	323	552	1 028	1 542	1 780
Netherlands	14	9	54	46	291	279	-	5	-	-
Norway	-	-	1	-	+	-	-	-	-	-
Poland	75	39	19	40	6	-	2	-	-	-
Spain	301	232	588	1 140	51	11	-	17	-	-
UK(England+Wales)	60	26	73	44	33	28	33	83	230	306
UK(Scotland)	-	-	-	-	-	2	1	12	+	-
USSR	10	72	134	203	-	-	-	-	-	-
Total VIIb,c, g-k	4 399	3 130	4 336	5 234	2 753	2 890	3 575	5 737	7 917	7 965

*)provisional

a) catch in VIIg only

b) included in VIIe

Table 11.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1973-1982.
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982#
Belgium	2 385	1 137	2 209	2 166	2 293	1 295	732	1 414	1 217	966
Denmark	13 118	44 342	32 930	46 899	20 069	8 093	8 248	12 928	13 198	32 159
Faroe Islands	1 198	435	267	183	385	12	7	27	46	15
France	4 695	4 020	4 646	5 500	6 914	5 122	7 208	7 407	12 344	15 989
German Dem.Rép.	22	8	44	20	8	37	12	36	-	-
Germany,Fed.Rep.	4 587	3 478	2 396	3 433	3 744	2 589	2 549	2 354	3 387	4 861
Ireland	-	-	-	31	53	101	-	-	-	-
Netherlands	3 185	3 035	1 901	1 728	1 598	857	955	1 557	2 279	1 121
Norway ^{a)}	454	324	331	367	374	609	968	1 191	2 283	1 782
Poland	2 553	3 001	1 485	1 155	485	62	106	59	31	317
Spain	101	210	-	-	-	-	-	-	-	-
Sweden ^{b)}	4 550	3 098	2 083	2 455	113	- ^{d)}	907	1 165	1 301	1 856
UK(England+Wales)	16 586	10 798	11 499	17 238	17 167	12 200	10 774	12 195	14 570	16 108
UK(Scotland)	88 132	71 679	64 686	80 576	89 465	58 406	54 119	64 058	82 798	105 875
USSR	49 356	42 234	49 686	42 852	8 010	54	18	-	-	-
Total IV	190 922	187 799	174 163	204 603	150 678	89 437	86 603	104 391	133 454	181 049
Total IVa	126 662	122 977	110 848	138 591	116 577	57 886	51 741	64 886	83 374	106 154
Total IVb	62 288	63 695	62 761	65 594	34 030	31 457	34 361	39 072	49 197	74 738
Total IVc	1 972	1 127	554	418	71	94	501	433	833	157
WG total catch ^{c)}	287 099	307 689	401 053	334 888	219 953	170 804	140 635	218 924	207 914	227 771

*)provisional

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

b) 1972-1974 includes IIIa

c) includes discards

d) included in IIIc

Table 11.2 VIRTUAL POPULATION ANALYSIS

NORTH SEA HADDOCK (FISHING AREA IV)

CATCH IN NUMBERS UNIT: THOUSANDS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	59629	601454	44913	107010	115080	289807	950761	583199	677031	560305
1	364092	1213968	2097418	167563	250416	458727	350378	726641	139893	290821
2	560823	174436	632057	1045529	103734	141915	195699	517956	40033	83994
3	237619	376841	57628	206721	376518	28439	41293	69819	142255	274874
4	6106	53159	106044	9624	39348	109212	6397	12335	19417	40010
5	4398	1834	15315	30523	3949	8583	25830	4737	2371	6279
6	30635	1320	953	4736	6000	1186	3927	772	446	1336
7	1237	10583	599	177	1136	1911	342	722	2382	305
8	105	237	2025	67	115	366	427	176	170	722
9	29	22	255	672	24	112	124	139	57	31
10	103	32	61	52	163	24	41	70	16	13
11+	53	3	13	3	3	64	20	35	35	14

TOTAL 1279034 2583896 2958661 1632347 896486 1040366 1577247 1526616 1368709 1079364

Table 11.3 VIRTUAL POPULATION ANALYSIS

NORTH SEA HADDOCK (FISHING AREA IV)

MEAN WEIGHT AT AGE OF THE STOCK UNIT: KILOGRAM

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.044	0.024	0.020	0.013	0.019	0.010	0.009	0.012	0.010	0.014
1	0.126	0.123	0.101	0.125	0.108	0.143	0.094	0.097	0.072	0.095
2	0.240	0.226	0.241	0.224	0.240	0.250	0.239	0.279	0.256	0.290
3	0.372	0.343	0.356	0.400	0.346	0.415	0.438	0.469	0.466	0.446
4	0.585	0.548	0.450	0.509	0.599	0.444	0.625	0.719	0.834	0.761
5	0.649	0.890	0.680	0.580	0.609	0.695	0.659	0.862	1.133	1.097
6	0.725	0.895	1.245	0.893	0.753	0.709	0.712	0.947	1.504	1.449
7	1.044	0.953	1.124	1.876	1.096	0.924	1.072	1.391	1.211	1.829
8	1.302	1.512	1.093	1.746	1.703	1.301	1.765	1.761	1.703	1.519
9	2.734	2.301	1.724	1.235	1.973	1.814	1.359	1.708	1.842	2.544
10	1.726	2.507	2.219	2.330	1.604	1.913	2.130	2.029	1.608	2.173
11+	2.020	4.148	2.856	2.527	3.190	1.800	1.390	3.291	1.493	2.541

Table 11.4 VIRTUAL POPULATION ANALYSIS

NORTH SEA HADDOCK (FISHING AREA IV)

	FISHING MORTALITY COEFFICIENT					NATURAL MORTALITY COEFFICIENT = 0.20					
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1977-82
0	0.02	0.11	0.10	0.24	0.11	0.20	0.35	0.70	0.39	0.36	0.35
1	0.75	0.71	0.69	0.62	0.66	0.77	0.39	0.49	0.60	0.30	0.53
2	0.64	1.03	1.06	0.92	1.02	1.04	0.91	0.75	0.57	0.90	0.86
3	1.27	1.00	1.30	1.37	1.08	0.90	1.04	1.05	0.93	1.00	1.00
4	0.82	1.03	1.12	0.80	1.16	1.16	0.70	1.14	1.00	1.02	1.04
5	0.95	0.65	1.01	1.30	0.96	0.67	0.99	1.50	0.69	1.12	1.02
6	1.12	0.87	0.81	1.02	1.04	0.89	1.43	0.98	0.52	1.12	1.00
7	0.91	1.17	1.41	0.30	0.63	1.24	0.71	1.42	0.93	1.12	1.05
8	0.46	0.43	1.13	0.50	0.59	0.73	1.11	0.98	1.16	0.96	0.90
9	0.57	0.16	1.22	1.11	0.40	0.65	0.62	1.04	1.14	1.04	0.95
10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
11+	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
(2-6)U	0.95	0.91	1.06	1.09	1.05	0.97	1.04	1.08	0.74	1.03	

Table 11.5 VIRTUAL POPULATION ANALYSIS

NORTH SEA HADDOCK (FISHING AREA IV)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1961-79
0	3251482	6279968	535643	673637	1266866	1770060	3535237	339636	2778424	1378071	++++++	2695318*
1	755441	2678244	4599293	298041	564505	933432	1188273	2938281	340792	1257281	759063	2235408
2	1306000	293610	1051584	1692276	176655	238419	556655	658411	1018240	153882	762580	1061472
3	366670	562647	85444	299067	619149	51981	69149	116527	255349	472052	51223	412301
4	11876	89704	170769	18980	62190	172619	17246	19941	33406	82497	142179	125324
5	7807	4281	26227	45264	6959	15924	44504	6628	5211	10098	24356	41238
6	62319	2436	1365	7853	1061	2166	5464	13472	1265	2144	2697	12185
7	2247	16576	355	673	2136	2963	734	1026	4139	587	574	3839
3	311	739	4192	171	367	777	639	246	262	1271	157	1146
9	103	161	392	1194	80	214	292	185	91	52	398	364
10	198	54	112	95	299	44	75	128	29	24	15	119
11+	97	15	32	5	5	117	37	64	64	26	16	20
TOTAL NO	5764555	9658476	6475806	5356579	2708027	3188789	5214755	3695789	3937150	3308789		
SPS NO	1757629	970264	1347867	2265507	872771	485298	493245	816671	1317935	722637		
TOT. BIOM	748865	816595	802382	650702	394257	326075	222597	481735	468298	473431		
SPS BIOM	510614	332021	387140	584593	309221	174895	179100	273688	420977	335385		

* 1967 excluded

Table 11.6 Input data for catch predictions for HADDOCK North Sea.

Age	Stock \bar{w} (kg)	H.C. landings 1982			Discards 1982			Ind. landings 1982			Total F 1982	Reference Period: 1977 - 1982					
		$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F		H:C. catch		Discards		Ind. catch	
												F ¹⁾	\bar{w} ²⁾	Prop. ret.	\bar{w}	F	\bar{w}
0	.012	-	-	-	15 185	.072	.015	351 120	.011	.345	0.36	.010	-	.000	.060	.340	.011
1	.102	7 226	.299	.007	93 671	.197	.095	195 924	.039	.198	0.30	.263	.286	.050	.167	.277	.039
2	.267	37 859	.355	.406	31 850	.248	.341	14 285	.211	.153	0.90	.779	.361	.448	.215	.110	.180
3	.430	211 332	.492	.768	49 360	.271	.180	14 202	.361	.052	1.00	.962	.471	.852	.253	.074	.309
4	.664	45 109	.766	.947	1 841	.264	.039	1 660	.640	.034	1.02	1.036	.666	.970	.338	.043	.502
5	.843	5 817	1.126	1.038	-	-	-	462	.735	.082	1.12	1.030	.852	.997	.420	.029	.606
6	1.022	1 336	1.449	1.12	-	-	-	-	-	-	1.12	1.029	1.031	.984	.284	.010	.829
7	1.254	365	1.829	1.12	-	-	-	-	-	-	1.12	1.091	1.254	1.000	-	-	-
8	1.526	722	1.519	0.96	-	-	-	-	-	-	0.96	.935	1.520	1.000	-	-	-
9	1.873	31	2.544	1.04	-	-	-	-	-	-	1.04	.987	1.873	1.000	-	-	-
10	1.910	13	2.173	0.90	-	-	-	-	-	-	0.90	.935	1.891	1.000	-	-	-
11+	2.284	14	2.416	0.90	-	-	-	-	-	-	0.90	.935	2.595	1.000	-	-	-
Weight tonnes		165 475			41 308			20 988			-	-					

Recruitment at age 0:
 1983 = $2\ 695\ 318 \times 10^{-3}$
 1984 = $2\ 695\ 318 \times 10^{-3}$
 1985 = $2\ 695\ 318 \times 10^{-3}$

1) Rescaled to $\bar{F}_{AV} = \bar{F}_{82}$
 2) Human consumption landings

Table 11.7 Management Options: HADDOCK in the North Sea

1983				1984								1985								
Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	Management Option for 1984	Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock Biom.	Spawning stock biom.							
455	345	.968	182	$\bar{F}_{84} = 0$	450	259	0	35.5	0	35.5	0	745	552							
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$										.194	70.0	36.0	34.0	20.0	683	490
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$										.484	111.5	79.4	32.1	46.8	605	414
				$\bar{F}_{84} = 1.0 \bar{F}_{83}$										.968	160.2	130.8	29.4	84.9	509	318
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$										1.452	191.7	164.5	27.2	116.3	441	251
				$\bar{F}_{84} = 2.0 \bar{F}_{83}$										1.936	212.3	186.9	25.4	142.7	391	202

Weight in '000 tonnes

Recruitment 1983-84 $R_0 = 2\ 695\ 318 \times 10^3$

Stock Biomass = fish at age 0 and older

Spawning Stock Biomass = fish at age 2 and older

Exploitation pattern 1983-84 based on 1977-82 average

F values relate to the Human Consumption Fishery (Landings - Discards) only

Table 12.1 Nominal catch (in tonnes) of HADDOCK in Division VIa, 1973-1982
(Data for 1973 - 1981 as officially reported to ICES).

COUNTRY	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	45	98	23	45	-	-	2	3	1	2
Denmark	-	-	-	13	-	-	37	-	-	-
Faroe Islands	2	1	-	-	-	-	2	-	-	-
France	5 141	3 979	2 328	3 026	3 401	4 255	4 786	2 808	3 403	3 789
German Dem.Rep.	-	-	9	-	-	-	-	-	-	-
Germany, Fed. Rep.	15	18	3	30	+	20	2	3	7	75 ^{a)}
Ireland	2 631	1 715	599	1 115	616	441	877	726	1 891	4 402
Netherlands	169	63	19	30	28	13	2	2	3	-
Norway	-	-	-	3	7	13	9	16	29	38
Poland	402	97	20	-	-	-	-	-	-	-
Spain	497	540	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	2 187	1 512	1 214	1 971	3 827	2 805	1 654	1 279	1 052	2 035
UK (Scotland)	17 631	9 583	8 973	11 992	11 422	9 629	7 459	8 198	12 051	18 541
UK (N. Ireland)	-	-	-	-	-	-	-	+	-	1
USSR	110	364	495	533	-	-	-	-	-	-
Total VIa	28 830	17 970	13 683	18 758	19 301	17 176	14 830	13 035	18 437	28 883
WG Total incl. discards	40 198	33 342	46 635	34 071	23 657	19 510	27 147	17 470	33 278	39 318

*) Provisional

a) Includes VIb

Table 12.2

VIRTUAL POPULATION ANALYSIS

HADDOCK IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

CATCH IN NUMBERS

UNIT: THOUSANDS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	19589	63689	6349	4226	4549	50	5302	15	703	133
1	47391	63831	179367	24212	13197	15948	65945	22728	251	15249
2	10908	11565	34956	72333	3407	2096	10262	21918	83792	4944
3	19479	10770	3341	15273	35946	969	1753	5031	20086	72046
4	258	6323	3552	1587	5704	24359	441	922	1708	6060
5	1221	83	1834	1490	681	2939	9282	142	194	887
6	33195	449	90	867	496	352	784	3081	39	106
7	149	9496	93	21	307	247	107	228	322	268
8	53	2086	3457	280	28	358	157	22	39	284
9	6	34	73	831	11	7	26	5	14	30
10	124	32	3	4	259	18	3	20	2	12
11+	0	5	0	5	5	214	41	6	3	1
TOTAL	130353	173363	233484	121024	64500	47543	100143	54716	108373	102020

Table 12.3 VIRTUAL POPULATION ANALYSIS

HADDOCK IN FISHING AREA VIA COA. COAST OF SCOTLAND, W. IRELAND)

MEAN WEIGHT AT AGE OF THE STOCK UNIT: KILOGRAM

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.040	0.040	0.040	0.040	0.040	0.066	0.052	0.077	0.067	0.053
1	0.159	0.159	0.159	0.160	0.161	0.152	0.152	0.134	0.052	0.157
2	0.251	0.246	0.260	0.256	0.274	0.276	0.224	0.219	0.245	0.273
3	0.333	0.363	0.423	0.459	0.436	0.389	0.457	0.571	0.463	0.376
4	0.596	0.526	0.561	0.593	0.665	0.516	0.750	0.719	0.386	0.746
5	0.512	0.779	0.822	0.830	0.300	0.227	0.771	0.992	0.975	1.126
6	0.571	0.679	1.023	1.095	1.128	1.045	1.040	0.985	1.365	1.539
7	1.134	0.775	1.000	1.548	1.537	1.122	1.490	1.143	1.293	1.543
8	1.705	1.905	1.037	1.467	1.115	1.660	1.743	1.570	1.363	1.514
9	2.232	1.323	1.136	1.760	1.592	2.125	1.753	1.622	1.367	1.738
10	1.520	1.279	2.316	1.627	1.540	1.572	1.569	1.674	1.215	2.068
11+	0.000	0.000	0.000	0.000	1.592	1.208	1.781	2.959	1.783	1.543

Table 12.4 VIRTUAL POPULATION ANALYSIS

HADDOCK IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

FISHING MORTALITY COEFFICIENT	UNIT: Year-1										NATURAL MORTALITY COEFFICIENT = 0.20
-----	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1977-82
0	0.10	0.12	0.16	0.16	0.07	0.00	0.01	0.00	0.01	0.0025	0.02
1	1.06	0.59	0.60	1.35	0.99	0.38	0.57	0.07	0.02	0.18	0.37
2	0.55	0.83	0.69	0.52	0.70	0.40	0.83	0.38	0.37	0.54	0.54
3	0.87	0.84	0.61	0.75	0.53	0.43	0.71	0.79	0.75	0.64	0.64
4	0.52	0.81	0.70	0.66	0.72	0.85	0.35	1.06	0.62	0.75	0.73
5	0.66	0.31	0.60	0.79	0.67	1.08	0.97	0.18	0.67	0.74	0.72
6	1.00	0.54	0.71	0.63	0.67	0.92	1.01	1.10	0.07	1.01	0.80
7	0.06	0.92	0.21	0.33	0.47	0.87	0.82	0.97	1.05	0.89	0.85
8	0.41	3.06	1.10	1.69	0.98	1.62	2.57	0.38	0.42	1.52	1.25
9	0.08	1.01	2.12	0.89	0.25	0.72	0.49	0.80	0.45	0.67	0.56
10	0.70	0.70	0.70	0.70	0.80	0.80	0.80	0.90	0.90	0.90	0.85
11+	0.70	0.70	0.70	0.70	0.80	0.80	0.80	0.90	0.90	0.90	0.85
(2-6)U	0.72	0.67	0.66	0.67	0.66	0.74	0.77	0.70	0.50	0.74	

Table 12.5 VIRTUAL POPULATION ANALYSIS

HADDOCK IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1985-79
0	227527	602178	50691	52344	73277	202077	479302	19682	125217	58758	++++++	173286 [#]
1	73763	168617	435607	35332	22873	55389	165390	387577	16173	101830	47995	161660
2	43671	22404	76477	196212	7524	6972	31441	76405	296313	12957	69637	88165
3	36371	20620	8736	51385	95859	3064	5779	11250	42879	167730	6182	58601
4	700	12431	7286	5591	12109	46253	1640	1528	4189	16648	72435	32204
5	2765	342	4541	2972	1527	4122	16202	946	433	1349	6438	15400
6	57015	1173	205	2035	1104	638	1339	5072	647	181	722	6328
7	2987	17179	558	82	89	467	279	400	1570	494	54	2084
8	107	2311	5674	369	49	453	158	76	125	391	166	749
9	91	58	89	1529	56	75	75	10	42	67	70	184
10	269	69	17	9	312	36	6	57	4	22	28	76
11+	7	11	0	11	10	423	81	11	5	2	8	36
TOTAL NO	450266	647392	589722	505666	215583	521063	699625	502933	487326	360990		
SFS NO	143976	76597	102323	233192	119634	63117	54927	95674	346506	200397		
TOT. BIOM	85253	87215	109194	80670	60347	54122	73499	91921	114162	107146		
SFS BIOM	65608	36376	57905	75925	53761	33472	27695	33476	99320	82925		

[#] 1967 excluded

Table 12.6 Input data for catch predictions for HADDOCK in Division VIa.

Age	Stock \bar{w} (kg)	H.C. landings 1982			Discards 1982			Ind. landings 1982			Total F 1982	Reference Period: 1977 - 1982					
		$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F		H.C. catch		Discards		Ind. catch	
												$F^{1)}$	$\bar{w}^{2)}$	Prop. ret.	\bar{w}	F	\bar{w}
0	.056	-	-		133	.038	.0025				.0025	.021	(.443)	.000	.055		
1	.170	247	.285	.003	15 002	.155	.177				.18	.397	.276	.175	.140		
2	.286	1 324	.369	.145	3 620	.238	.395				.54	.579	.368	.427	.224		
3	.445	45 684	.452	.402	26 962	.247	.238				.64	.687	.478	.823	.277		
4	.714	7 900	.754	.735	160	.363	.015				.75	.783	.718	.988	.300		
5	.916	887	1.126	.74							.74	.772	.918	.998	.284		
6	1.185	106	1.539	1.01							1.01	.858	1.188	.997	.308		
7	1.327	268	1.548	.89							.89	.912	1.327	1.000	-		
8	1.481	284	1.514	1.52							1.52	1.341	1.481	1.000	-		
9	1.665	30	1.738	.67							.67	.601	1.665	1.000	-		
10	1.573	12	2.068	.90							.90	.912	1.573	1.000	-		
11+	1.670	1	1.543	.90							.90	.912	1.670	1.000	-		
Weight tonnes		29 228			9 910												

Recruitment at age 0:

$$1983 = 173\ 286 \times 10^{-3}$$

$$1984 = 173\ 286 \times 10^{-3}$$

$$1985 = 173\ 286 \times 10^{-3}$$

1) Rescaled to $\bar{F}_{AV} = \bar{F}_{82}$

2) Human consumption landings

Table 12.7 Management Options: HADDOCK in the West of Scotland

1983				1984								1985	
Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	Management Option for 1984	Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock Biom.	Spawning stock biom.
99	82	.736 ($\bar{F}_{83} = \bar{F}_{82}$)	38	$\bar{F}_{84} = 0$	85	52	0	0	0	0	0	126	92
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$			.147	7.1	7.1	0	1.8	115	82
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$			.368	16.1	16.1	0	4.2	102	68
				$\bar{F}_{84} = 1.0 \bar{F}_{83}$			.736	27.4	27.4	0	7.5	84	51
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$			1.104	35.5	35.5	0	10.2	71	38
				$\bar{F}_{84} = 2.0 \bar{F}_{83}$			1.472	41.3	41.3	0	12.5	62	29

Weights in '000 tonnes

Recruitment 1983-84 $R_0 = 173\ 286 \times 10^3$

Stock Biomass = fish at age 1 and older

Exploitation pattern 1983-84 based on 1977-82 average

Table 13.1 Nominal catch (in tonnes) of HADDOCK in Division VIb, 1973 - 1982.

(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	-	-	-	33	-	-	-	-	-	-
Faroe Islands	-	2	1	8	3	11	20	5	1	21
France	600	353	21	4	4	3	4	1	10	39
Germany, Fed. Rep.	-	-	-	-	-	-	-	17	-	... a)
Ireland	-	-	-	-	-	61	-	-	-	-
Norway	-	-	-	-	+	4	16	2	10	3
Poland	54	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	6	-	-
U.K. (Engl.&Wales)	1	-	5	2 111	2 694	2 365	1 654	6 261	9 005	7 692
U.K. (Scotland)	72	22	71	640	297	2 060	548	1 051	27	5
U.S.S.R.	3 291	48 911	49 830	40 474	-	-	-	-	-	-
Total VIb	4 018	49 288	49 928	43 243	2 998	4 504	2 242	7 343	9 053	7 760

*)provisional

a) included in VIa

Table 14.1 Nominal catch (in tonnes) of HADDOCK in Divisions VIId and VIIe, 1973-1982.
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982#
Belgium	1	+	+	+	1	-	1	+	2	1
Denmark	-	-	-	-	2	22	21	15	-	-
France	208	487	868	405	438	356	333	298	420	365
Germany, Fed.Rep.	-	-	+	-	-	-	-	-	-	-
Ireland	-	-	-	-	4	-	-	+	-	-
Netherlands	1	-	1	-	-	-	-	-	-	-
Poland	12	-	-	-	-	-	-	-	-	-
UK(England & Wales)	135	113	99	45	29	22	51	59	119	60
USSR	2	33	3	-	-	-	-	-	-	-
Total VIId,e	359	633	971	450	474	400	406	372	541	426

*)provisional

Table 14.2 Nominal catch (in tonnes) of HADDOCK in Divisions VIIb,c and VIIg-k, 1973-1982.

(Data for 1973 to 1981 as officially reported to ICES)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	45	65	35	33	19	13	5	2	2	3	3
Denmark	-	-	-	-	-	-	-	1	-	-	-
Faroe Isl.	-	3	-	-	-	-	-	-	-	-	-
France	6 456	5 524	6 057	4 583	3 726	2 244	1 479	1 931	2 219	2 070	1 271
Germany, Fed.Rep.	-	1	-	+	3	-	-	-	-	-	-
Ireland	1 103	1 348	829	507	287	153	111	155	274	679	853
Netherlands	56	12	2	4	14	1	-	16	-	-	-
Poland	-	62	143	-	-	-	-	-	-	-	-
Spain	733	890	1 100	-	-	294	-	-	5	-	-
UK(England & Wales)	107	24	39	46	24	18	13	19	50	92	122
UK(Scotland)	-	-	-	-	-	-	8	22	56	4	-
USSR	253	24	456	1 290	183	-	-	-	-	-	-
Total VIIb,c and VIIg-k	8 753	7 953	8 661	6 463	4 256	2 273	1 616	2 146	2 606	2 848	2 249

*) provisional

Table 15.1 Nominal catch (in tonnes) of WHITING in Sub-area IV, 1973-82.
(Data for 1973-81 as officially reported to ICES.)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982 ^{x)}
Belgium	3 387	3 156	3 270	2 640	3 275	3 304	3 941	3 153	2 623	2 277
Denmark	73 928	109 654	61 941	116 973	46 479	15 741	41 965	17 916	16 430	31 103
Faroe Islands	1 453	1 126	764	1 262	472	42	581	21	12	9
France	20 353	19 825	20 079	19 557	17 592	22 525	27 590	23 626	24 744	24 261
German Dem. Rep.	5	-	3	18	-	22	5	-	-	-
Germany, Fed. Rep.	403	454	446	302	461	348	1 280	1 267	601	228
Ireland	-	-	-	4	9	38	-	-	-	-
Netherlands	8 811	12 057	14 078	12 274	9 406	11 030	13 417	14 389	14 600	11 220
Norway ^{a)}	39	58	55	71	33	64	49	27	27	15
Poland	7	1 002	888	509	445	8	3	1	-	-
Spain	119	110	65	18	-	-	-	-	-	-
Sweden ^{b)}	2 328	2 440	255	153	341	...	31	16	9	11
UK(England & Wales)	4 592	5 519	5 246	5 112	6 185	7 542	7 581	6 778	5 964	4 723
UK (Scotland)	20 756	25 274	27 969	26 167	33 017	42 779	44 841	42 218	31 399	28 796
USSR	3 522	2 978	5 098	5 612	2 413	-	-	-	-	-
Total Sub-Area IV	139 703	183 653	140 166	190 672	120 128	103 443	141 284	109 412	96 409	102 638
Total Div. IVa	29 616	76 761	75 444	100 001	61 499	42 837	48 554	42 529	33 799	35 015
Total Div. IVb	96 678	87 842	41 930	69 908	42 911	40 943	68 775	41 156	40 145	55 791
Total Div. IVc	13 409	19 050	22 792	20 763	15 718	19 663	23 955	25 727	22 465	11 832
WG total catch ^{c)}	364 740	351 266	290 589	345 951	294 635	178 773	234 947	225 221	192 173	134 375

x) Provisional figures.

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

b) 1973-74 include Div. IIIa, 1978 included in Div. IIIa.

c) Include discards.

Table 15.2 VIRTUAL POPULATION ANALYSIS

NORTH SEA WHITING (FISHING AREA IV)

CATCH IN NUMBERS	UNIT: THOUSANDS										
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	553426	175648	570112	239142	424539	664985	686282	477685	332373	543293	102892
1	938807	1156006	754672	956417	478651	1017151	418282	619543	321704	198342	196694
2	317317	664580	974691	401312	1114173	480400	335745	466684	457785	354910	106175
3	42449	131494	228625	299652	161154	261985	203499	211648	282591	261111	237755
4	5390	15099	32094	54982	76447	31540	69155	86230	83419	93063	86306
5	58348	3136	4876	9173	13317	18292	7618	25082	38185	21701	24979
6	8328	17527	1223	7937	2716	4637	5587	3115	8027	10186	6575
7	3787	2297	5822	116	545	406	1422	1179	755	1761	1716
8	242	318	352	1385	22	167	245	194	548	240	566
9	61	115	52	142	291	4	7	15	45	30	58
10	137	44	19	2	23	135	7	1	13	36	23
11+	0	0	0	0	0	3	0	3	5	1	7
TOTAL	1928292	2166264	2572538	1970310	2271876	2479705	1727629	1891579	1505450	1484674	765346

Table 15.3 VIRTUAL POPULATION ANALYSIS

NORTH SEA WHITING (FISHING AREA IV)

	MEAN WEIGHT AT AGE OF THE STOCK										
	UNIT: KILOGRAM										
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.022	0.027	0.026	0.030	0.019	0.019	0.010	0.009	0.013	0.014	0.029
1	0.071	0.084	0.071	0.100	0.107	0.090	0.074	0.098	0.082	0.091	0.061
2	0.200	0.166	0.149	0.214	0.194	0.176	0.185	0.165	0.178	0.165	0.180
3	0.280	0.278	0.253	0.275	0.294	0.288	0.239	0.259	0.255	0.241	0.252
4	0.375	0.387	0.376	0.369	0.359	0.375	0.337	0.313	0.337	0.330	0.308
5	0.417	0.459	0.463	0.465	0.440	0.449	0.460	0.434	0.346	0.411	0.381
6	0.519	0.458	0.521	0.353	0.512	0.483	0.462	0.492	0.486	0.433	0.489
7	0.573	0.548	0.543	0.818	0.440	0.532	0.514	0.541	0.472	0.574	0.526
8	0.742	0.736	0.787	0.596	0.457	0.332	0.689	0.617	0.620	0.662	0.710
9	0.809	0.904	1.033	0.716	0.692	0.932	0.741	0.669	0.580	0.914	0.727
10	0.868	0.862	0.958	1.022	0.917	0.440	1.828	0.738	0.795	1.051	1.141
11+	0.000	0.000	0.000	0.000	0.000	0.941	0.000	0.521	0.717	0.695	0.778

Table 15.4 VIRTUAL POPULATION ANALYSIS

NORTH SEA WHITING (FISHING AREA IV)

	FISHING MORTALITY COEFFICIENT					NATURAL MORTALITY COEFFICIENT = 0.20						
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1977-82
0	0.14	0.09	0.15	0.11	0.16	0.29	0.27	0.26	0.47	0.46	0.17	0.32
1	0.55	0.49	0.66	0.40	0.35	0.73	0.29	0.43	0.28	0.57	0.30	0.43
2	0.86	0.98	1.04	0.92	1.18	0.70	0.57	0.62	0.61	0.57	0.70	0.63
3	0.70	1.17	1.19	1.17	1.32	1.05	0.74	0.89	0.99	0.94	0.98	0.93
4	0.65	0.59	1.08	1.12	1.18	1.09	0.91	0.84	1.17	1.15	1.00	1.03
5	1.00	1.04	0.38	1.12	0.95	1.07	0.87	1.06	1.24	1.24	1.22	1.12
6	1.19	1.00	1.92	2.25	1.36	1.13	1.18	1.17	1.34	1.60	2.01	1.40
7	2.20	1.44	1.20	1.16	1.27	0.76	1.49	0.93	1.07	1.41	1.70	1.23
8	0.84	1.74	0.94	1.11	0.71	2.77	1.78	0.87	1.94	1.33	1.54	1.71
9	0.54	1.41	2.65	1.43	0.75	0.26	1.52	0.47	0.50	0.52	1.72	0.83
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(2-6)0	0.88	0.95	1.12	1.32	1.20	1.01	0.85	0.92	1.07	1.10	1.18	

Table 15.5 VIRTUAL POPULATION ANALYSIS

NORTH SEA WHITING (FISHING AREA IV)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	4588703	2282263	4504824	2457057	3079136	2939046	3142488	2288004	971841	1603786	724107	*****
1	2438037	3258182	1710126	3174531	1796056	2138530	1808426	1956057	1443613	497750	826047	500166
2	597852	1155639	1631805	725762	1740877	1040589	845042	1104599	1045770	892674	230037	499522
3	91763	206870	555324	470398	237099	437918	422985	389785	487077	464707	415264	93526
4	12327	37225	52816	88333	119534	51617	125880	164721	130716	147615	148206	126987
5	100039	5275	16969	14755	23550	30116	14268	41532	58058	33086	38342	44639
6	12976	30052	1534	9516	3944	7437	8419	4897	11736	13710	7873	9268
7	4546	3244	9029	183	320	829	1976	2119	1248	2512	2255	864
8	464	414	628	2234	47	189	316	363	686	352	502	337
9	159	164	59	201	600	19	10	44	125	81	76	88
10	235	76	33	3	59	232	12	2	22	62	39	11
11+	0	0	0	0	0	5	0	5	9	2	12	16
TOTAL NO	7347099	6979404	8283146	6942975	7001697	6646527	6368222	5952127	4150880	3656336	2390759	
SPS NO	820360	1438959	2068197	1311387	2126505	1568956	1416908	1708067	1735426	1554801	840605	
TOT. BIOM	475671	617541	605585	720282	714245	594672	476446	568894	512508	397097	282694	
SPS BIOM	201619	282233	367040	329117	463564	346363	311193	356609	381298	329349	211306	

1961-79

0	2819656
1	1915119
2	938086
3	333750
4	103719
5	31340
6	9807
7	2423
8	537
9	156
10	42
11+	1

Table 15.6 Input data for catch predictions for North Sea WHITING

Age	Stock \bar{w} (kg)	H.C. landings 1982			Discards 1982			Ind. landings 1982			Total F 1982	Reference Period: 1977 - 1982					
		$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F	$N \times 10^{-3}$	\bar{w} (kg)	F		H.C. catch		Discards		Ind. catch	
												$F^{1)}$	$\bar{w}^{2)}$	Prop. ret.	\bar{w}	F	\bar{w}
0	.029	-	-	-	20 337	.047	.03	82 555	.025	.14	.17	.021	.146	.000	.060	.301	.014
1	.061	9 906	.188	.02	58 647	.091	.09	128 141	.038	.19	.30	.205	.200	.092	.127	.248	.054
2	.180	36 004	.231	.24	29 375	.182	.19	40 796	.133	.27	.70	.430	.233	.393	.170	.248	.147
3	.252	112 393	.284	.46	57 116	.211	.24	68 246	.232	.28	.98	.774	.282	.683	.209	.242	.250
4	.308	55 927	.336	.65	19 890	.225	.23	10 489	.319	.12	1.00	1.006	.347	.847	.240	.136	.362
5	.381	19 292	.407	.94	3 243	.241	.16	2 444	.366	.12	1.22	1.155	.424	.889	.268	.093	.463
6	.489	5 101	.474	1.61	373	.244	.12	901	.676	.28	2.01	1.475	.480	.964	.317	.089	.482
7	.526	1 691	.530	1.68	23	.261	.02	2	.247	.00	1.70	1.362	.527	.996	.275	.019	.479
8	.710	366	.710	1.54	-	-	-	-	-	-	1.54	1.900	.607	1.000	-	.021	.503
9	.727	58	.727	1.72	-	-	-	-	-	-	1.72	.934	.761	1.000	-	-	-
10	1.141	23	1.141	1.00	-	-	-	-	-	-	1.00	1.125	.999	1.000	-	-	-
11+	.778	7	.778	1.00	-	-	-	-	-	-	1.00	1.125	.730	1.000	-	-	-
Weight tonnes		72 381			29 004			32 990									

Recruitment R_0 1982 : $724\ 107 \times 10^3$
 1983 : $2\ 700 \times 10^6$
 1984 : $2\ 700 \times 10^6$

1) Rescaled to $\bar{F}_{AV} = \bar{F}_{82}$

2) Human consumption landings

Table 15.7 Management Options: WHITING in the North Sea

1983				1984								1985	
Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	Management Option for 1984	Stock Biom.	Spawning stock biomass	\bar{F} (2-6) H.C.	Total landings	H.C. landings	Indust. landings	Discards	Stock Biom.	Spawning stock biom.
285	176	.968	93	$\bar{F}_{0.1}$	303	127	.197	58	12	46	9	448	270
				\bar{F}_{max}	303	127	.419	68	24	44	18	425	248
				$\bar{F}_{84} = \bar{F}_{83}$	303	127	.968	86	45	41	38	380	204
				$\bar{F}_{84} = 0$	303	127	0	47	0	47	0	471	293
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$	303	127	.194	58	12	46	9	448	271
				$\bar{F}_{84} = 0.5 \bar{F}_{83}$	303	127	.484	71	27	44	20	419	242
				$\bar{F}_{84} = 1.5 \bar{F}_{83}$	303	127	1.452	97	58	39	52	350	175
				$\bar{F}_{84} = 2.0 \bar{F}_{83}$	303	127	1.936	104	67	37	65	325	151

Weights in '000 tonnes

Recruitment 1983-84 R_0 2 700 000 x 10³

Stock Biomass = fish at age 0 and older

Spawning Stock Biomass = fish at age 2 and older

Exploitation pattern 1983-84 based on 1977-82 average

F values relate to the Human Consumption Fishery (Landings - Discards) only

Table 16.1 Nominal catch (in tonnes) of WHITING in Division VIa, 1973-1982.
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	5	10	1	14	-	-	-	+	-	2
Denmark	121	-	-	-	-	119	92	32 ^{a)}	-	-
Faroe Isl.	5	1	30	2	-	-	770	-	-	-
France	2 777	2 983	2 763	3 655	3 395	3 610	2 779	2 609	1 637	1 803
German Dem.Rep.	-	-	-	31	-	-	-	-	-	-
Germany Fed.Rep.	127	80	62	1	1	2	4	1	49	100 ^{a)}
Ireland	2 117	2 431	2 429	3 255	2 752	2 080	2 791	4 407	8 148	3 040
Netherlands	57	23	85	255	78	23	17	2	6	-
Norway	-	-	-	1	-	-	-	-	-	-
Poland	10	9	-	-	-	-	-	-	-	-
Spain	1 540	1 479	1 871	821	763 ^{a)}	-	-	-	-	-
UK(Engl. & Wales)	91	112	132	244	520	669	320	227	118	166
UK(Scotland)	9 796	9 929	12 668	16 658	9 873	8 174	10 613	7 386	8 519	8 422
UK(N.Ireland)	-	-	-	-	-	-	-	-	-	7
Total VIa	6 646	17 057	20 041	24 937	17 382	14 677	17 386	14 664	18 477	13 540

*)provisional

a) includes Division VIb

Table 16.2 VIRTUAL POPULATION ANALYSIS

WHITING IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

CATCH IN NUMBERS	UNIT: THOUSANDS											
-----	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	11263	2214	6900	1688	5343	7241	887	664	2335	16668	13715	9031
2	23890	32114	6070	10477	26858	16452	25148	6773	8593	11973	36395	50779
3	3126	11047	43493	2219	10949	9232	8628	28090	4032	4022	5583	10018
4	753	1421	4800	28202	719	3659	2564	3237	33860	1357	1471	1165
5	252	481	389	1862	13598	325	1204	664	1300	14832	359	182
6	36	149	103	187	813	5037	118	211	234	797	4330	42
7	0	56	16	34	116	328	2106	17	67	79	278	830
8+	4	4	5	18	33	39	219	519	151	70	36	31
TOTAL	39324	47486	61776	44687	58429	42313	40874	40175	50372	49798	62167	72078
	1975	1976	1977	1978	1979	1980	1981	1982				
1	14931	8526	16037	17712	6322	11631	3791	3074				
2	16762	46222	13325	18177	34233	11479	25862	5842				
3	36244	15711	25070	6670	13272	15216	11501	29636				
4	2811	17433	3125	9389	3392	4307	4753	6889				
5	279	1513	4711	931	3492	1205	1546	2044				
6	57	65	292	1429	264	1120	450	799				
7	9	14	13	64	374	85	197	258				
8+	237	45	10	5	9	84	5	95				
TOTAL	71330	89529	62583	54377	61358	45127	48105	48637				

Table 16.3 VIRTUAL POPULATION ANALYSIS

WHITING IN FISHING ARFA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

MEAN WEIGHT AT AGE OF THE STOCK

UNIT: KILOGRAM

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.196	0.192	0.218	0.238	0.204	0.206	0.178	0.206	0.209	0.211	0.197	0.194
2	0.276	0.213	0.255	0.244	0.240	0.263	0.223	0.200	0.247	0.258	0.234	0.216
3	0.380	0.382	0.312	0.325	0.319	0.366	0.335	0.273	0.277	0.346	0.362	0.318
4	0.412	0.551	0.465	0.374	0.424	0.444	0.500	0.381	0.316	0.369	0.479	0.445
5	0.440	0.629	0.620	0.609	0.412	0.554	0.571	0.517	0.426	0.426	0.485	0.592
6	0.675	0.740	0.769	0.720	0.639	0.539	0.649	0.619	0.551	0.495	0.533	0.640
7	0.000	0.672	0.842	0.816	0.624	0.701	0.618	0.670	0.696	0.604	0.654	0.574
8+	0.710	0.468	0.753	0.871	0.878	0.854	0.725	0.667	1.006	0.713	0.750	0.843
	1975	1976	1977	1978	1979	1980	1981	1982				
1	0.209	0.201	0.200	0.199	0.218	0.172	0.190	0.175				
2	0.245	0.243	0.240	0.235	0.232	0.238	0.226	0.213				
3	0.306	0.311	0.293	0.285	0.306	0.324	0.288	0.264				
4	0.472	0.363	0.388	0.388	0.405	0.419	0.382	0.341				
5	0.652	0.500	0.429	0.515	0.536	0.486	0.407	0.493				
6	0.612	0.691	0.623	0.549	0.691	0.499	0.531	0.502				
7	0.853	1.045	0.853	0.601	0.695	0.652	0.540	0.483				
8+	0.713	1.169	1.065	0.973	0.651	0.786	0.665	0.584				

Table 16.4 VIRTUAL POPULATION ANALYSIS

WHITING IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

FISHING MORTALITY COEFFICIENT	UNIT: Year-1					NATURAL MORTALITY COEFFICIENT = 0.20						
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.05	0.16	0.16	0.03	0.11	0.04	0.05	0.03	0.09	0.22	0.08	0.16
2	0.63	0.21	0.83	0.40	0.94	0.59	0.18	0.63	0.75	0.83	1.03	0.48
3	0.70	0.68	0.48	0.86	0.95	1.07	0.71	0.32	1.02	1.04	1.33	0.94
4	0.64	0.83	0.73	0.60	0.77	1.05	1.05	0.65	0.82	1.28	1.65	1.24
5	0.77	1.20	0.58	0.72	0.80	1.02	1.36	0.88	0.59	1.12	1.78	1.02
6	0.29	1.75	0.94	0.61	0.83	0.81	1.52	0.97	0.93	0.91	1.30	1.23
7	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8+	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(2- 4)U	0.66	0.58	0.68	0.64	0.89	0.90	0.65	0.53	0.86	1.05	1.34	0.88
	1975	1976	1977	1978	1979	1980	1981	1982	1977-82			
1	0.12	0.21	0.25	0.20	0.12	0.11	0.23	0.18	0.18			
2	0.49	0.62	0.57	0.51	0.76	0.32	0.37	0.65	0.53			
3	0.76	1.28	0.83	0.63	0.88	0.95	0.63	0.97	0.81			
4	0.76	1.08	1.01	0.90	0.78	0.83	0.92	1.01	0.91			
5	1.26	1.38	1.03	1.02	1.07	0.71	0.83	1.56	1.04			
6	1.13	1.27	1.21	1.09	0.96	1.37	0.65	1.65	1.15			
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
8+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
(2- 4)U	0.67	0.99	0.80	0.68	0.81	0.70	0.64	0.88				

Table 16.5 VIRTUAL POPULATION ANALYSIS

WHITING IN FISHING AREA VIA (NW. COAST OF SCOTLAND, N. IRELAND)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1- JANUARY

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	242523	16762	50491	60253	55419	208136	20242	21982	30714	93225	194078	67364
2	55813	188396	11729	35123	47807	40556	163871	15772	17398	23041	61325	146525
3	6748	24338	125335	4193	19354	15250	18485	111519	6859	6755	8196	17881
4	1731	2733	10059	65637	1457	6108	4290	7431	66066	2033	1958	1774
5	511	744	972	3951	26901	551	1751	1235	3191	23911	464	309
6	157	193	183	448	1573	9901	163	370	420	1449	6419	64
7	0	96	27	58	199	563	3616	29	115	136	477	1425
8+	0	7	9	31	57	67	376	891	259	120	62	53
TOTAL NO	307483	233269	198805	167694	152767	281133	212795	159230	125022	150670	272978	235395
SPS NO	64960	216508	148314	107441	97347	72997	192552	137248	94307	57445	78901	168032
TOT. BIOM	66547	54829	53553	50876	41873	67930	52097	42440	35425	39773	60493	52280
SPS BIOM	19013	51611	47546	36536	30567	25054	48494	37912	29006	20103	22260	39212
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1963-79		
1	150246	50495	78620	105310	62511	124776	20463	20486	*****	88728		
2	47016	109549	35666	49942	70275	45480	91670	13342	14004	65753		
3	74456	23476	48360	15638	24606	26995	26922	51834	5703	32438		
4	5728	28623	5319	17253	6840	8329	8567	11760	16088	13708		
5	421	2183	7961	1573	5768	2575	2981	2785	3507	4847		
6	91	93	450	2333	465	1622	1052	1063	479	1458		
7	15	24	22	110	642	146	338	443	167	445		
8+	407	77	17	9	15	144	9	163	163	145		
TOTAL NO	278380	214524	174415	192174	171123	210067	151983	101877				
SPS NO	128135	164029	95796	86864	108612	85291	131520	81391				
TOT. BIOM	69041	55735	43770	46012	44100	46791	37582	26337				
SPS BIOM	37640	45586	28046	25056	30473	25330	33694	22752				

Table 16.6

LIST OF INPUT VARIABLES FOR THE ICES PREDICTION PROGRAM

WHITING WST OF SCOTLAND ICES VIA

FIRST YEAR: 1983

LAST YEAR: 1985

YEAR RECRUITMENT
----- thousands

1983 20000.
1984 88728.
1985 88728.

AGE	STOCK SIZE thousands	F AT AGE [≠]	M	MATURITY OGIVE	WEIGHT IN THE CATCH kilogram	WEIGHT IN THE STOCK kilogram
1	20000.0	0.210	0.20	0.000	0.192	0.192
2	14000.0	0.620	0.20	1.000	0.231	0.231
3	5703.0	0.950	0.20	1.000	0.293	0.293
4	16088.0	1.060	0.20	1.000	0.387	0.387
5	3507.0	1.220	0.20	1.000	0.478	0.478
6	479.0	1.340	0.20	1.000	0.566	0.566
7	167.0	1.170	0.20	1.000	0.637	0.637
8+	183.0	1.170	0.20	1.000	0.787	0.787

[≠] \bar{F}_{AV} scaled to \bar{F}_{82}

Table 16.7 Management Options: WHITING in Division VIa

1983				1984								1985	
Stock Biom.	Spawning stock biomass	\bar{F} (2-4) H.C.	Total land-ings	Management Option for 1984	Stock Biom.	Spawning stock biomass	\bar{F} (2-4) H.C.	Total land-ings	H.C. land-ings	Indust. land-ings	Discards	Stock Biom.	Spawning stock biom.
17	13	0.88	8.2	$\bar{F}_{0.1}$	25	8	0.22		2.4			40	23
				$\bar{F}_{84} = \bar{F}_{83}$	25	8	0.88		7.5			34	17
				$\bar{F}_{84} = 0$	25	8	0.00		0			42	25
				$\bar{F}_{84} = 0.2 \bar{F}_{83}$	25	8	0.18		1.9			40	23
				$\bar{F}_{84} = 0.4 \bar{F}_{83}$	25	8	0.35		3.6			38	21
				$\bar{F}_{84} = 0.6 \bar{F}_{83}$	25	8	0.53		5.1			37	20
				$\bar{F}_{84} = 0.8 \bar{F}_{83}$	25	8	0.70		6.4			35	18
				$\bar{F}_{84} = 1.2 \bar{F}_{83}$	25	8	1.05		8.5			33	16

Weights in '000 tonnes

Recruitment 1983-84 $R_0 = 88\ 728 \times 10^3$

Stock Biomass = fish at age 1 and older

Spawning Stock Biomass = fish at age 2 and older

Exploitation pattern 1983-84 based on 1977-82 average

Table 12.8 Nominal catch (in tonnes) of WHITING in Division VIb, 1973-1982.
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Denmark	-	-	-	-	-	-	-	... a)	-	-
Faroe Isl.	-	1	-	-	+	-	-	-	-	-
France	62	-	-	-	-	-	-	3	-	-
Germany, Fed.Rep.	-	-	-	-	-	-	-	-	-	... a)
Ireland	-	-	-	-	-	1	-	-	-	-
Spain	-	-	-	-	... a)	-	-	-	-	-
U.K.(Engl. & Wales)	+	-	-	3	2	5	1	+	-	-
UK(Scotl.)	1	+	12	15	5	24	2	59	+	-
Total VIb	63	1	12	18	7	30	3	62	+	

*)provisional

a) included in Division VIa

Table 17.1 Nominal catch (in tonnes) of WHITING in Division VIId and VIe in 1973-1982
(Data for 1973-1981 as officially reported to ICES)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	38	39	70	103	36	85	92	85	102	101
Denmark	-	-	-	18	-	1	2 585	6	2	-
France	5 050	7 917	10 060	8 390	8 886	8 010	5 352	7 690	8 842	7 317
Germany, Fed.Rep.	-	25	1	-	-	-	-	-	-	-
Ireland	-	-	-	-	11	12	-	13	-	-
Netherlands	42	12	14	5	1	2	1	2	2	-
UK (Engl. & Wales)	498	579	1 255	1 504	1 342	1 038	930	839	1 136	1 222
USSR	19	-	-	-	-	-	-	-	-	-
Total VIId,e	5 647	8 572	11 400	10 020	10 276	9 148	8 960	8 635	10 084	8 640

*)provisional

Table 17.2 VIRTUAL POPULATION ANALYSIS

WHITING IN THE ENGLISH CHANNEL (FISHING AREAS VIIE AND VIID)

CATCH IN NUMBERS	UNIT: THOUSANDS						
-----	1976	1977	1978	1979	1980	1981	1982
0	140	0	150	0	33	0	0
1	12727	13847	19949	7333	4375	2764	5810
2	7313	13004	9201	7982	11628	10670	11060
3	5074	2835	4649	4542	5103	10831	12396
4	1410	843	1556	2482	2037	8200	2786
5	521	253	433	639	523	3217	1507
6	74	46	88	93	58	1044	585
7+	0	8	0	10	8	688	191
TOTAL	27259	30836	36026	23081	23765	37414	34337

Table 17.3 VIRTUAL POPULATION ANALYSIS

WHITING IN THE ENGLISH CHANNEL (FISHING AREAS VIIE AND VIID)

MEAN WEIGHT AT AGE OF THE STOCK

UNIT: KILOGRAM

	1976	1977	1978	1979	1980	1981	1982
0	0.218	0.200	0.130	0.170	0.195	0.000	0.000
1	0.280	0.258	0.207	0.299	0.282	0.157	0.150
2	0.374	0.347	0.260	0.379	0.336	0.233	0.201
3	0.479	0.496	0.346	0.435	0.436	0.259	0.279
4	0.594	0.642	0.412	0.518	0.461	0.297	0.339
5	0.696	0.749	0.668	0.594	0.538	0.370	0.402
6	0.742	0.850	0.711	1.052	0.633	0.455	0.431
7+	0.740	0.955	0.711	0.479	0.700	0.382	0.445

Table 17.4 VIRTUAL POPULATION ANALYSIS

WHITING IN THE ENGLISH CHANNEL (FISHING AREAS VIIE AND VIID)

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = 0.15

	1976	1977	1978	1979	1980	1981	1982	1977-82
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.36	0.40	0.47	0.19	0.09	0.09	0.32	0.26
2	0.75	0.71	0.49	0.33	0.48	0.32	0.53	0.48
3	1.34	0.70	0.56	0.44	0.34	1.10	0.72	0.64
4	1.36	0.79	1.03	0.63	0.35	1.37	0.91	0.85
5	1.96	0.94	1.26	1.94	0.24	1.38	1.00	1.13
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(2-4)U	1.15	0.73	0.69	0.47	0.39	0.93	0.72	

Table 17.5 VIRTUAL POPULATION ANALYSIS

WHITING IN THE ENGLISH CHANNEL (FISHING AREAS VIIE AND VIID)

STOCK SIZE IN NUMBERS UNIT: THOUSANDS

BIOMASS TOTALS UNIT: TONNES

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1976	1977	1978	1979	1980	1981	1982	1983	1976-79
0	51926	66145	53181	61351	42426	26160	U*****	58151	
1	45386	44563	56932	45635	52805	36486	22516	0	48129
2	14785	27320	25586	30619	32497	41399	28844	14017	24577
3	7286	6010	11566	13545	18986	17258	25783	14642	9602
4	2006	1644	2568	5676	7472	11632	4949	10802	2974
5	638	441	641	786	2603	4551	2536	1706	627
6	125	77	148	157	98	1757	984	803	127
7+	0	13	0	17	13	1158	321	413	8
TOTAL NO	122152	146214	150622	157785	156900	140400	85934		
SPS NO	24841	35506	40509	50800	61669	77754	63418		
TOT BIOM	34776	38652	30944	45151	47277	26224	19633		
SPS BIOM	10748	13925	12246	21077	24113	20496	16255		

Table 17.6 Nominal catch (in tonnes) of WHITING in Divisions VIIb,c and VIIg-k in 1973-1982.
(Data for 1973-1981 as officially reported to ICES).

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	20	124	75	83	97	60	37	26	31	61	28
France	5 695	4 035	4 331	3 637	4 731	3 962	3 868	4 127	5 603	5 442	4 673
Germany, Fed.Rep.	-	+	-	2	-	1	45	-	+	-	-
Ireland	1 141	1 894	1 641	2 562	1 980	1 201	1 172	2 674	3 710	3 612	4 076
Netherlands	377	2 080	915	66	112	86	63	3	4	21	-
Poland	-	14	-	-	-	-	-	-	-	-	-
Spain	1 491	1 121	1 367	2 974	2 772	-	-	-	-	-	-
UK(Engl. & Wales)	34	21	15	61	21	26	38	23	60	217	146
UK(Scotland)	-	-	-	-	-	2	1	1	80	1	-
USSR	3	16	-	64	2	-	-	-	-	-	-
Total VIIb,c and g-k	8 761	9 305	8 344	9 449	9 715	5 338	5 224	6 854	9 488	9 354	8 923

*)provisional

Figure 5.1 North Sea COD. Rho versus year (x denotes predicted values)

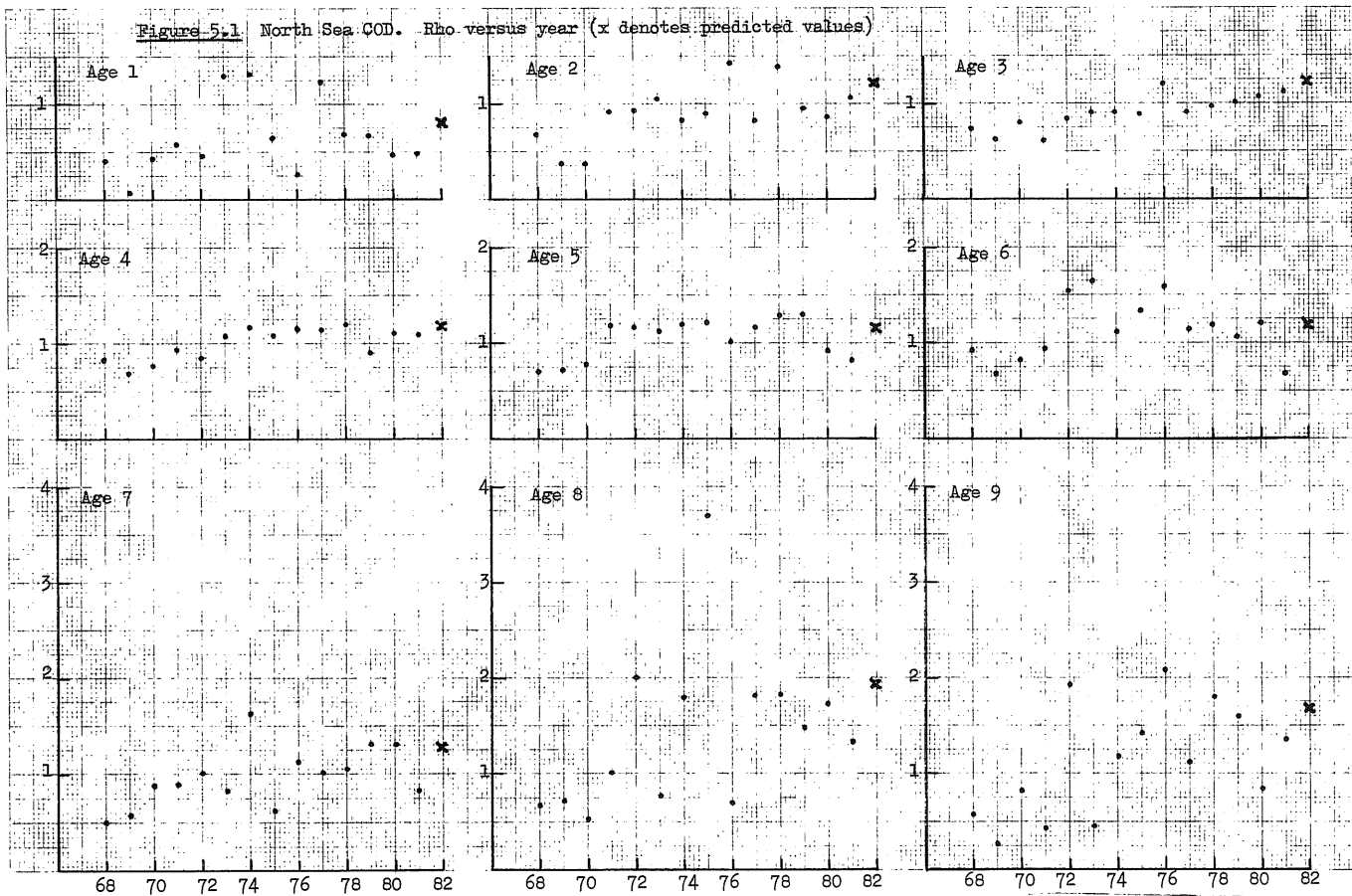


Figure 5.2.00D Division Via. RMOA, Y, versus Year (x denotes predicted value)

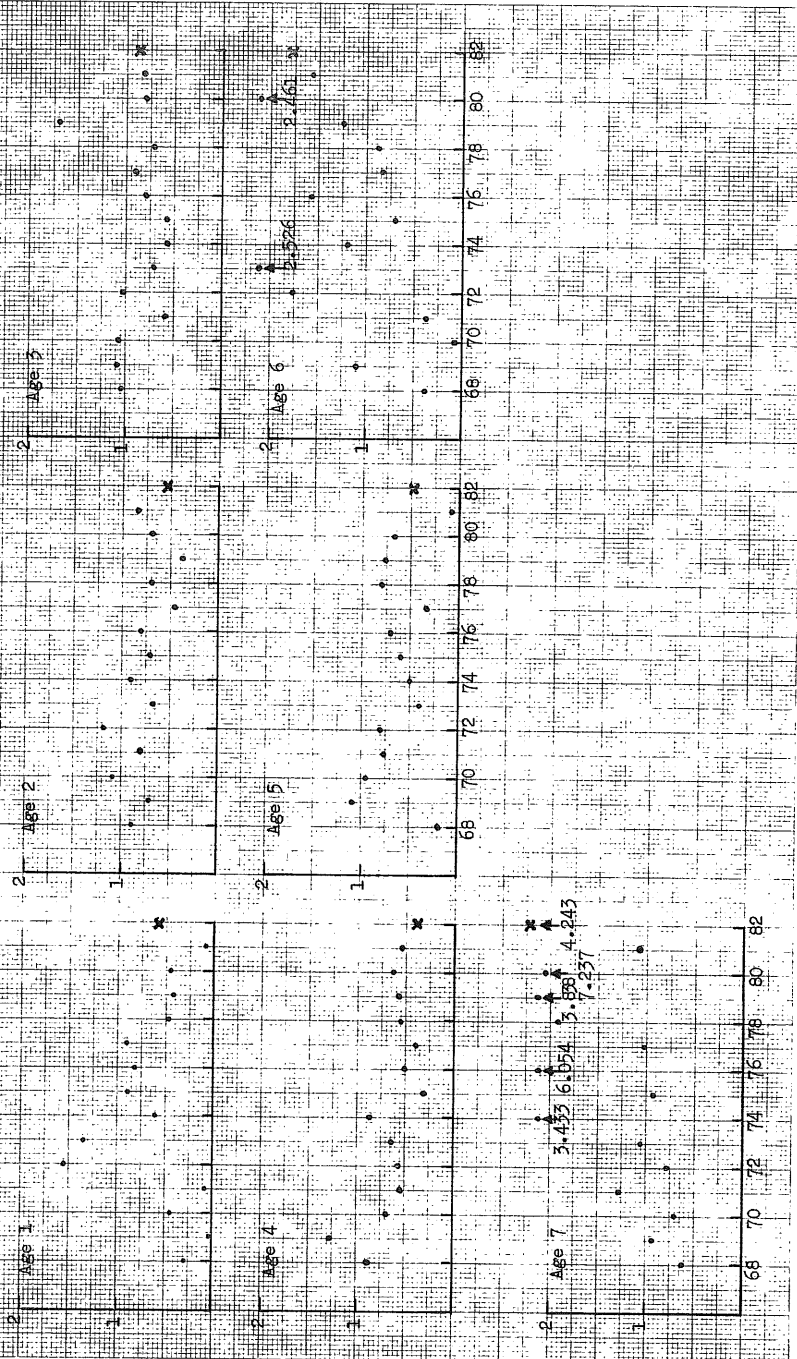


Figure 5.2 HADDOCK North Sea. Ibc versus Year

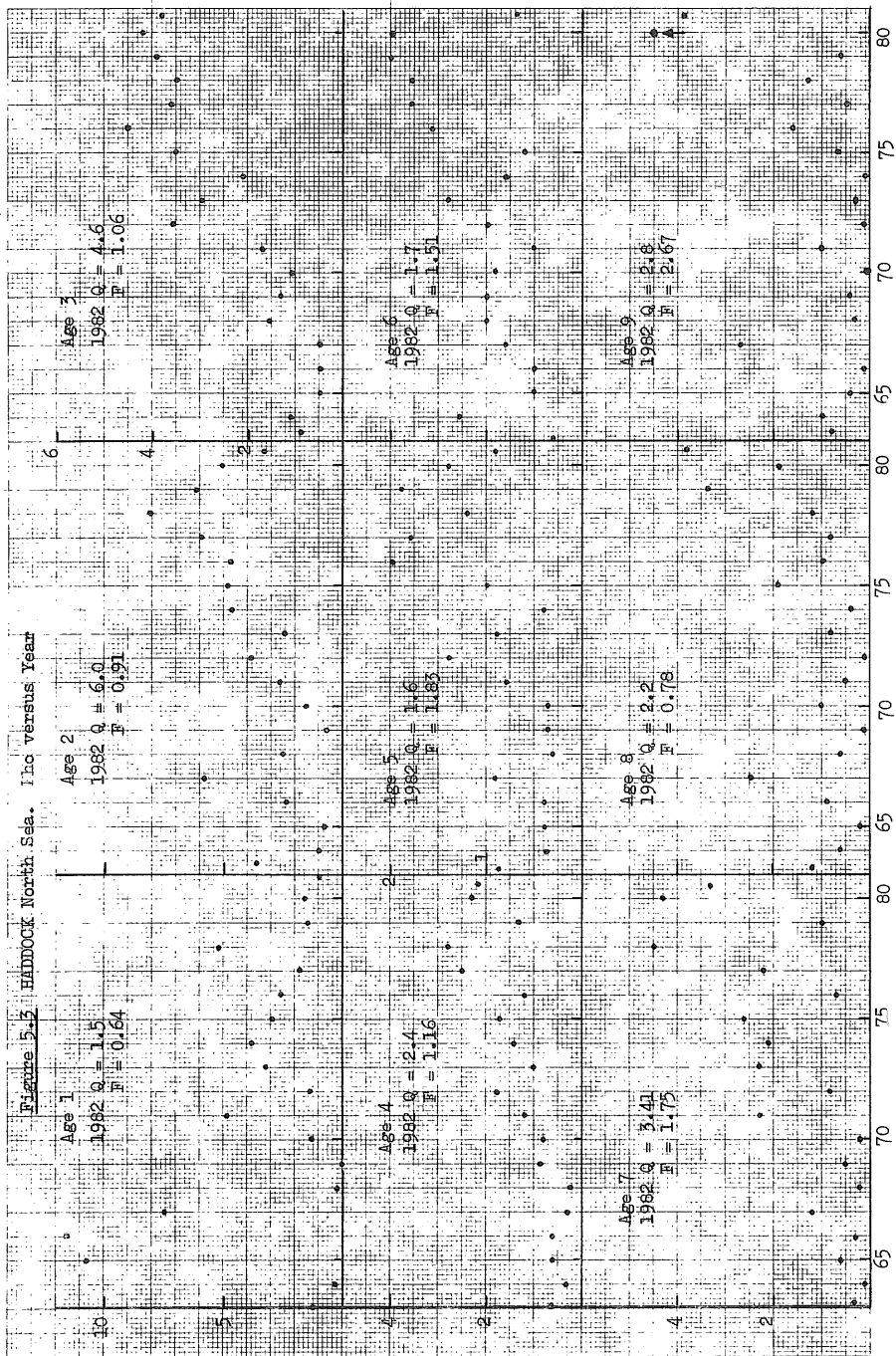
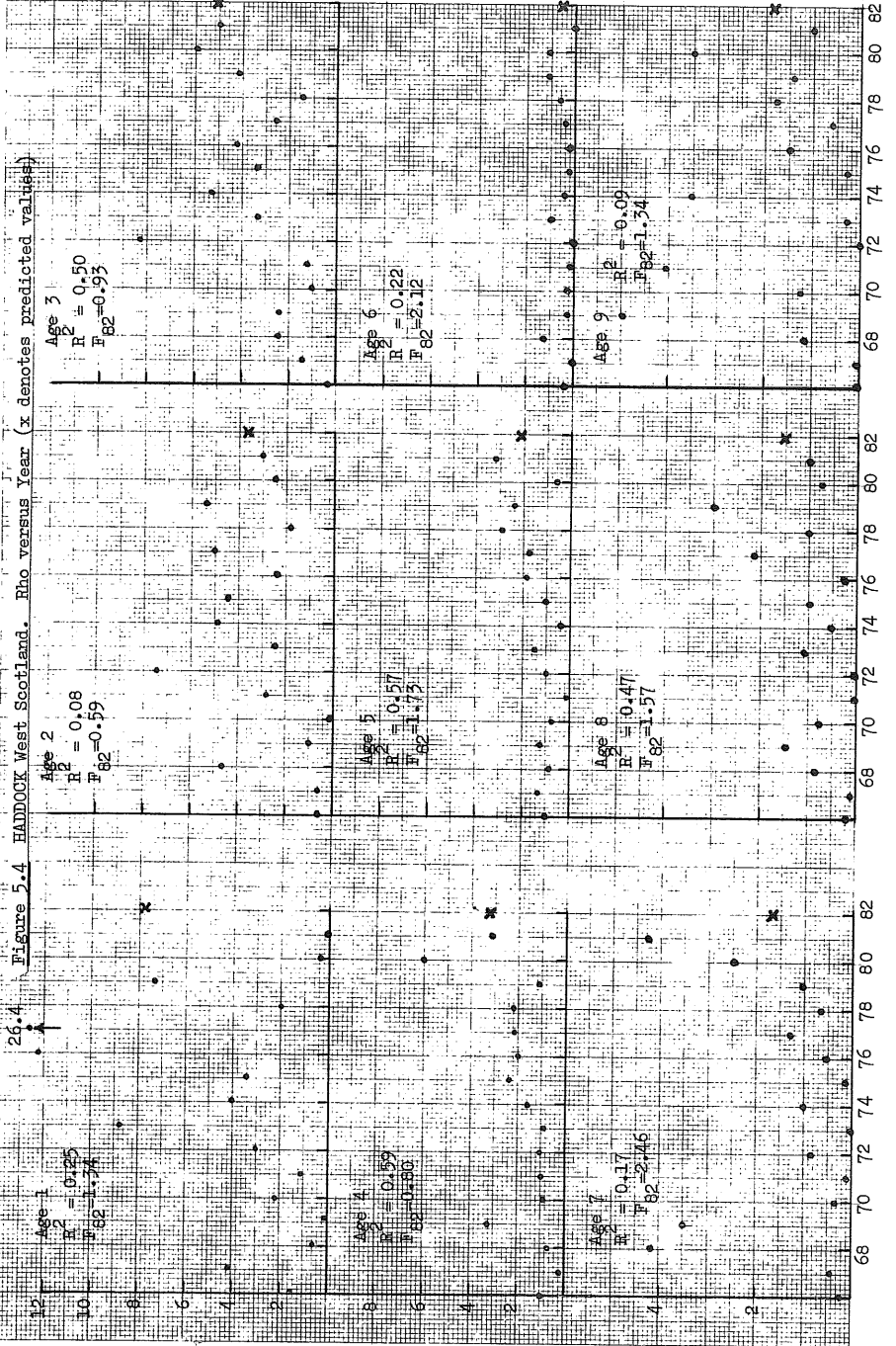


Figure 5.4 HADDOK West Scotland. Rho versus Year (x denotes predicted values)



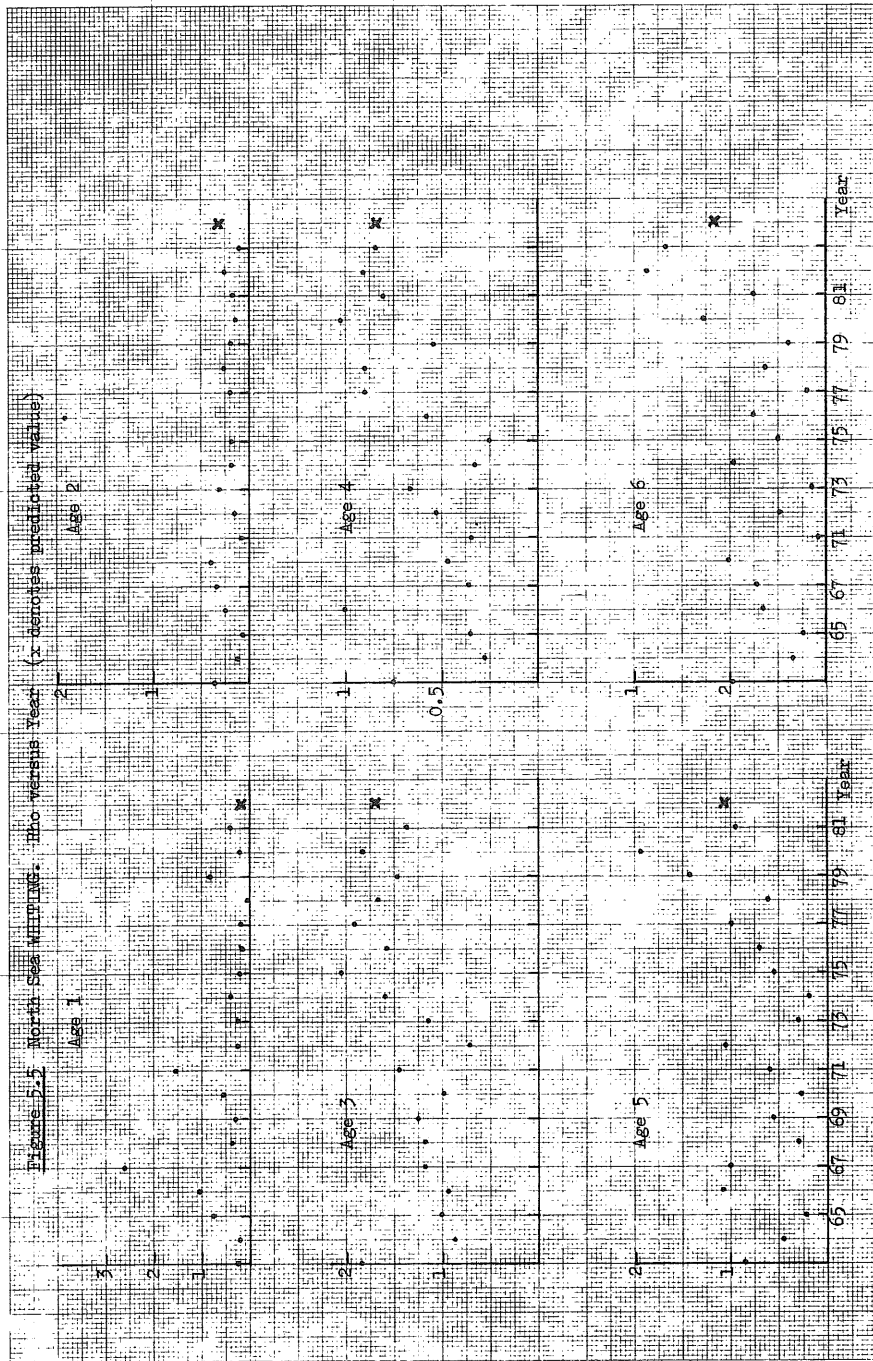
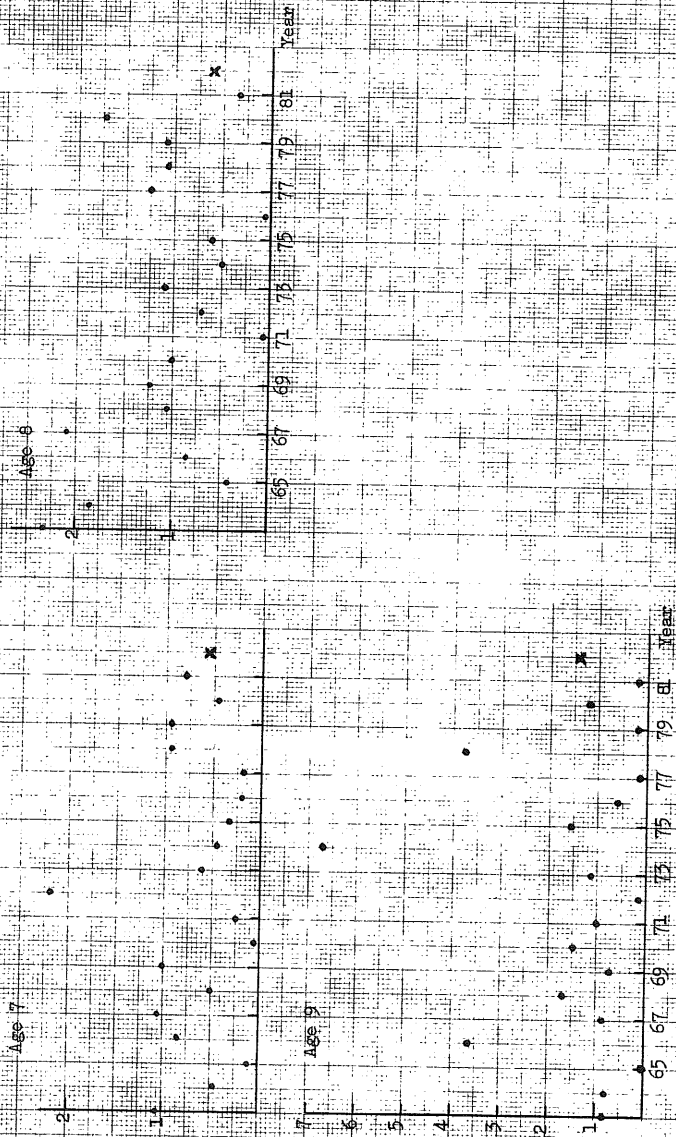


Figure 5.5 contd.



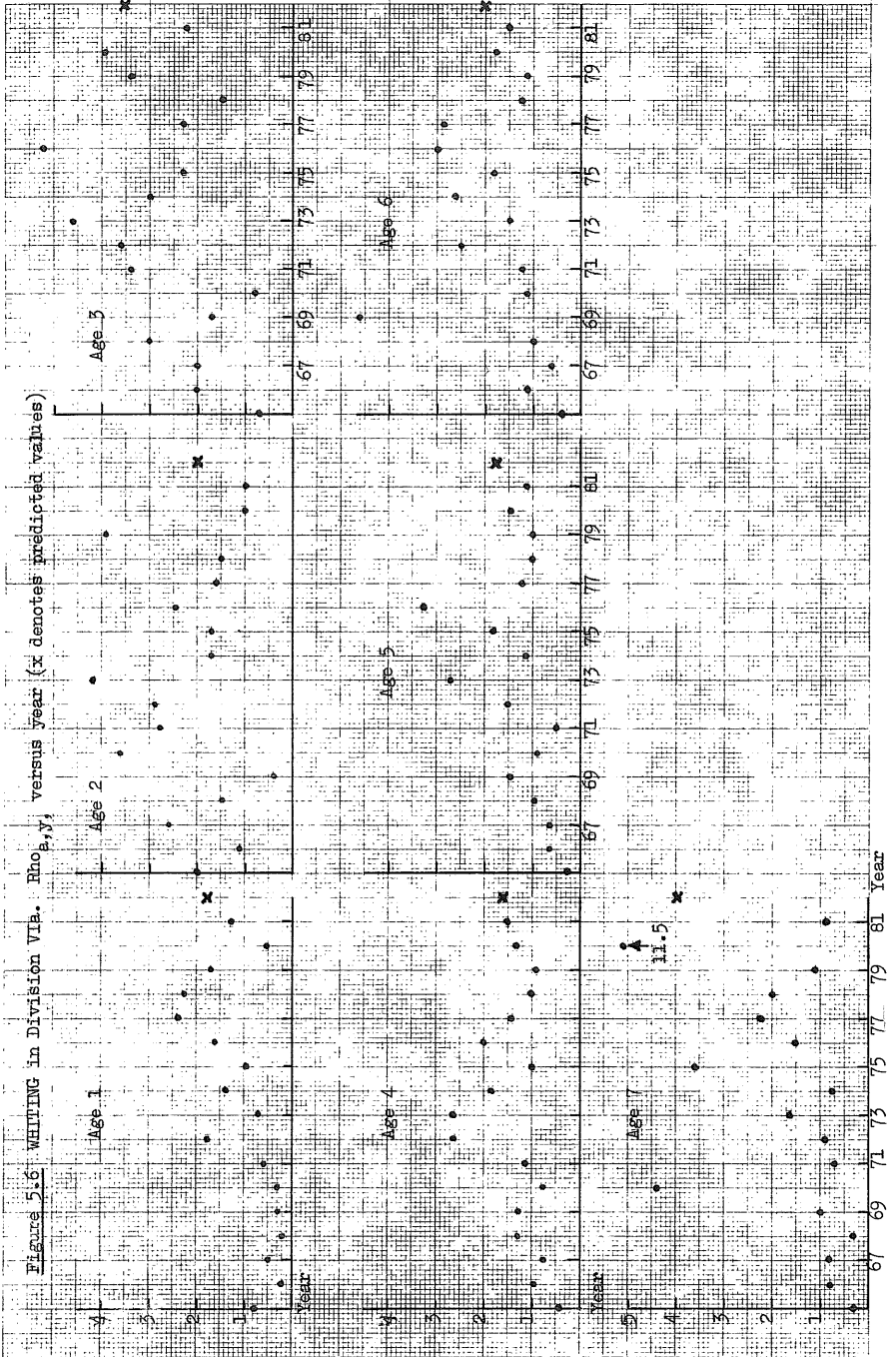


Figure 6.1 North Sea I-group (GD)
 x Estimated recruitment of the year class 1982

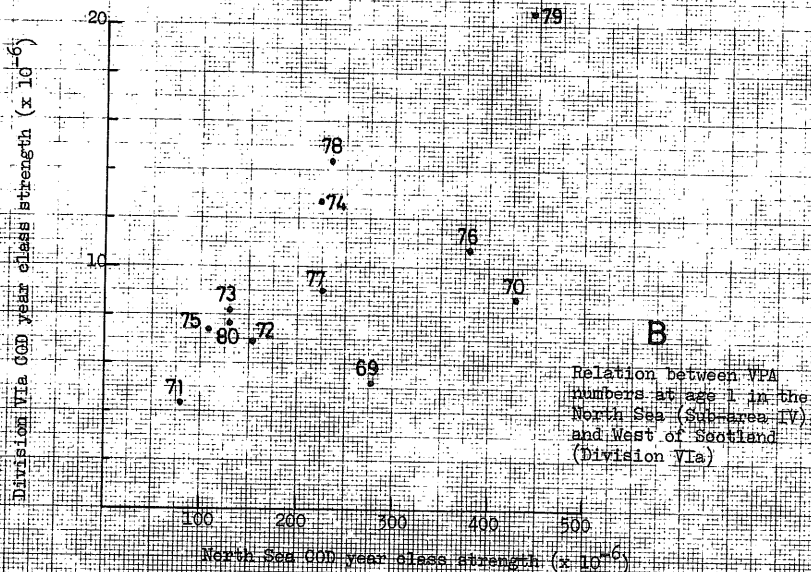
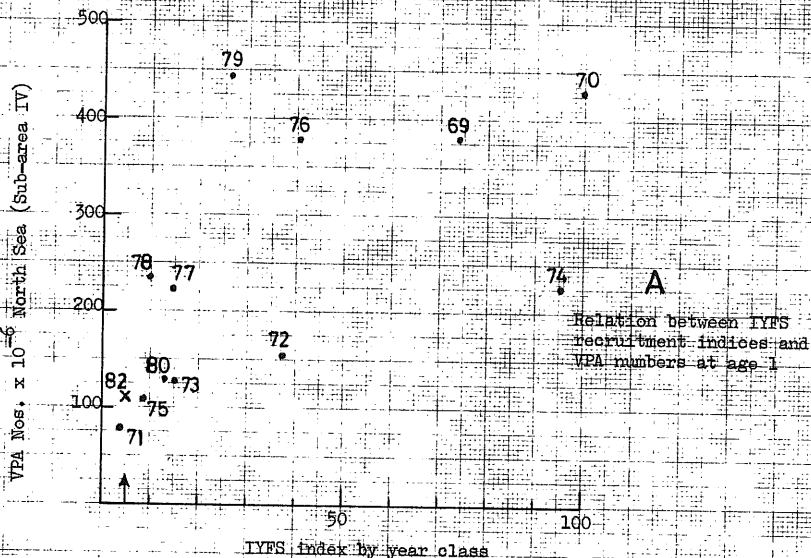


Figure 6.2 North Sea II-group COD
x Estimated recruitment of the year class 1981

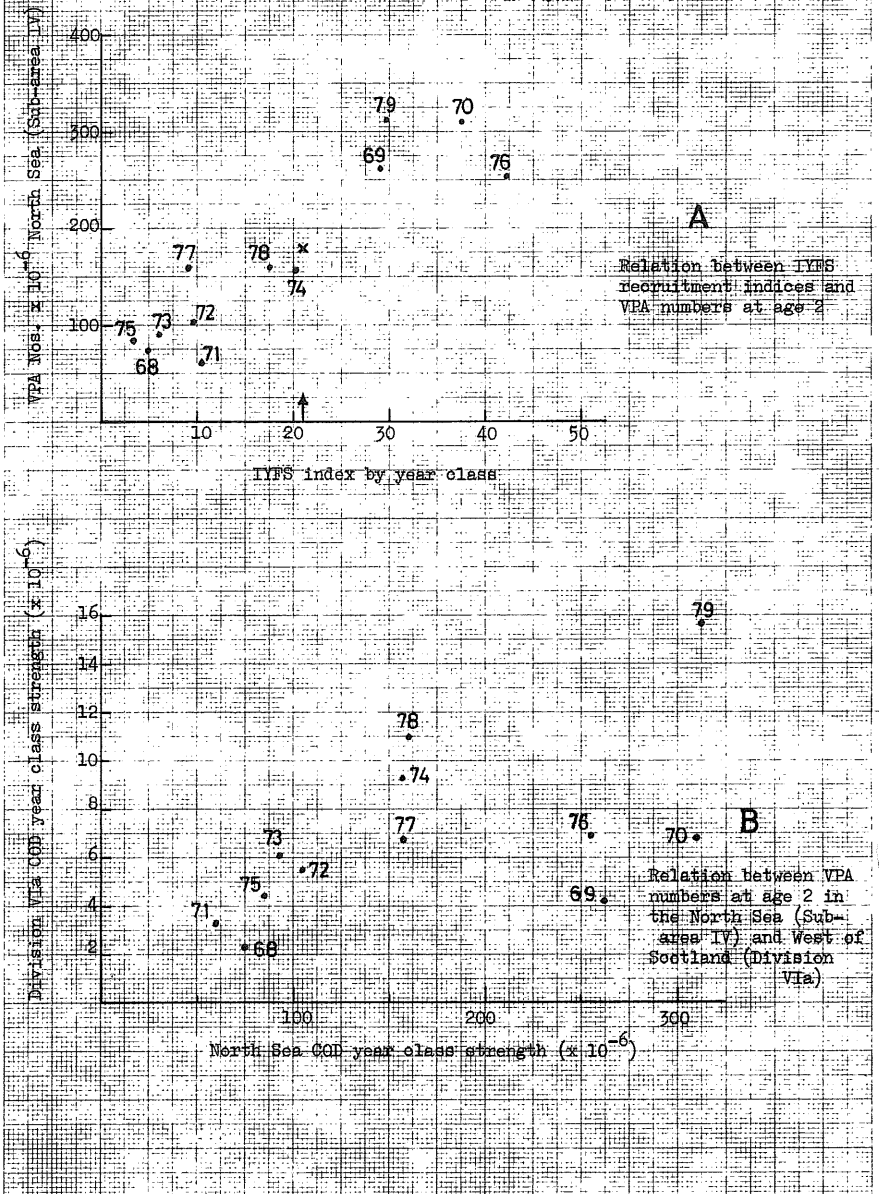


Figure 6.3 North Sea 1-group HADDOCK
x Estimated recruitment of the year class 1982

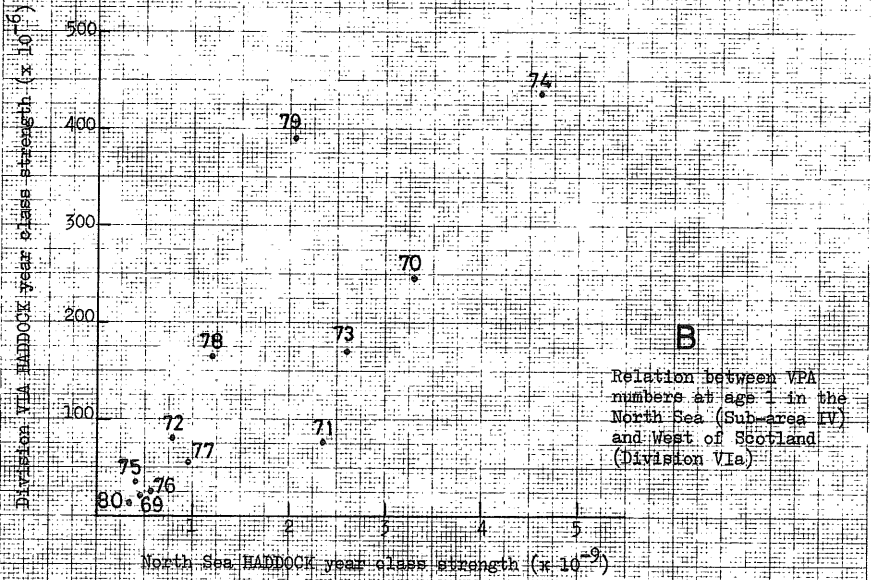
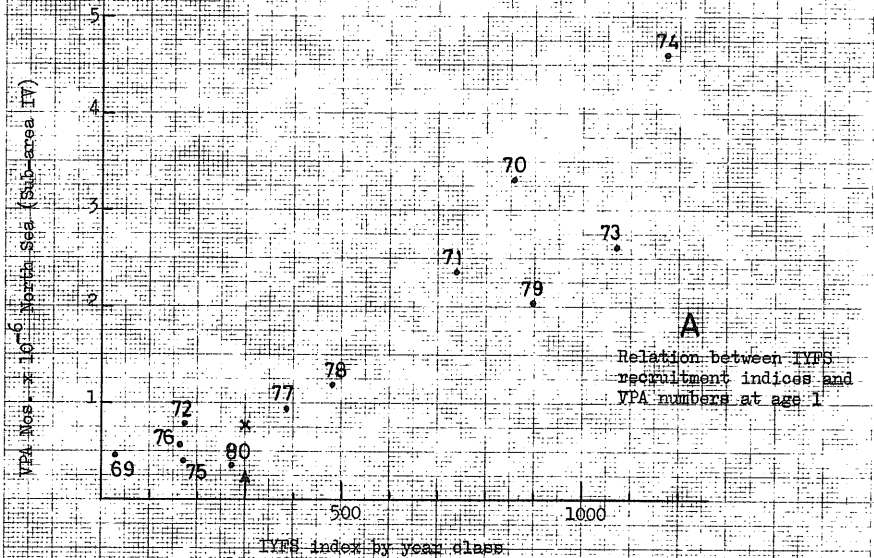
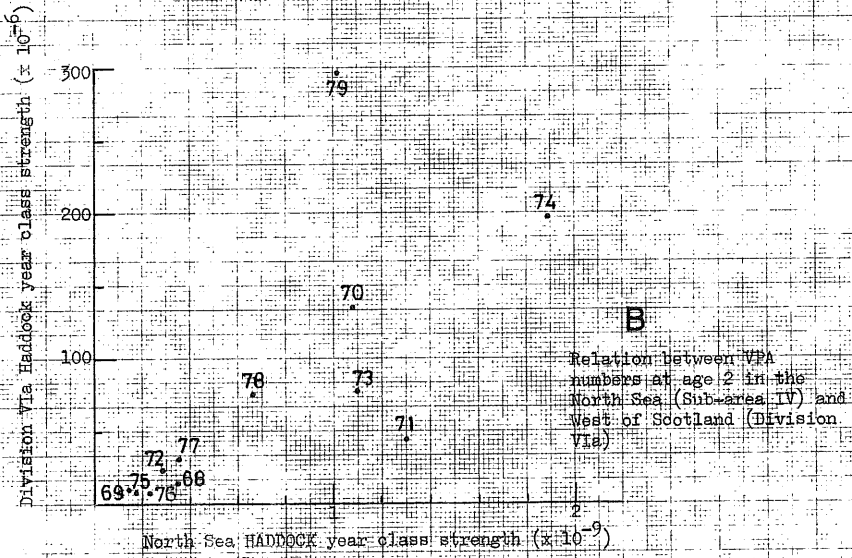
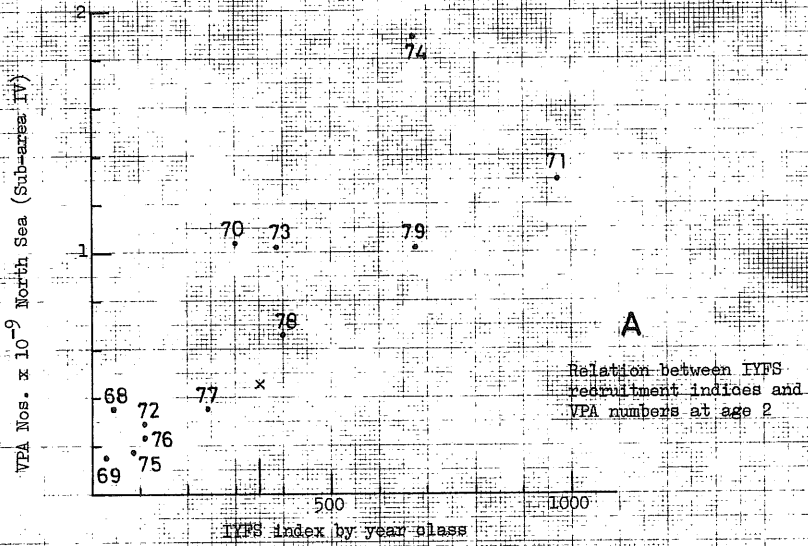


Figure 6.4 North Sea II-group HADDOCK
x Estimated recruitment for the year class 1981



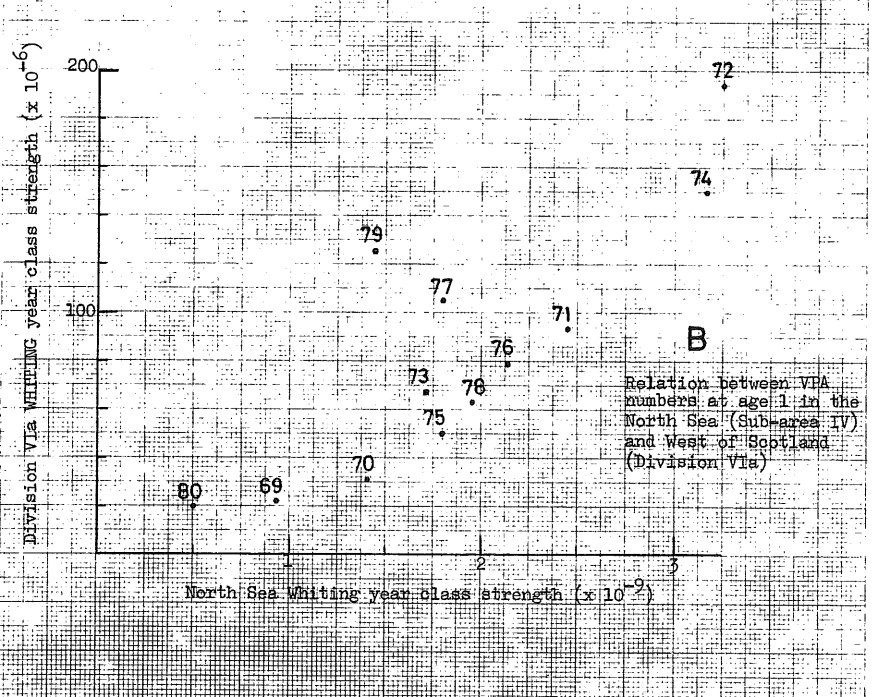
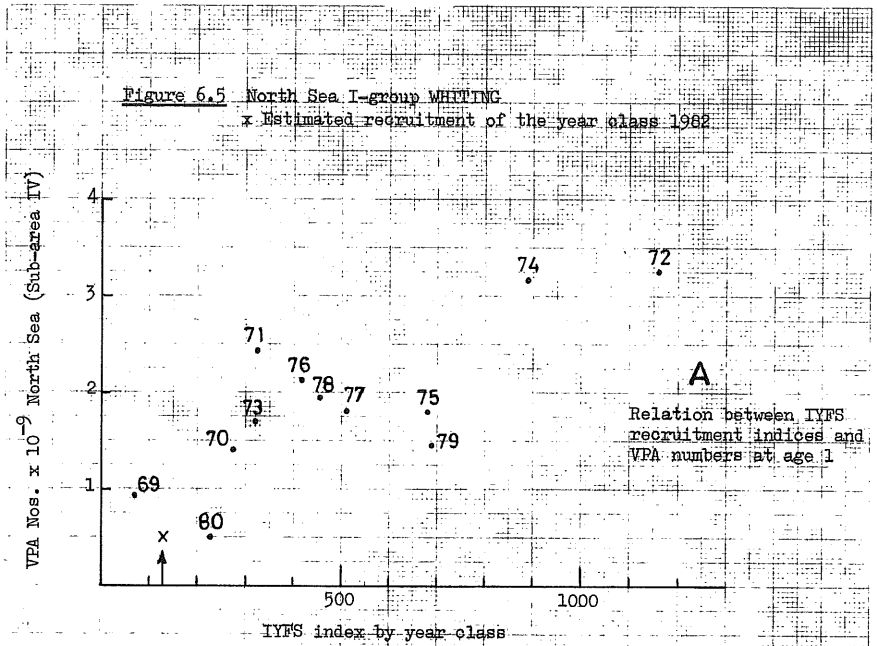


Figure 6.6 North Sea II-group WHITING
x Estimated recruitment of the year class 1981

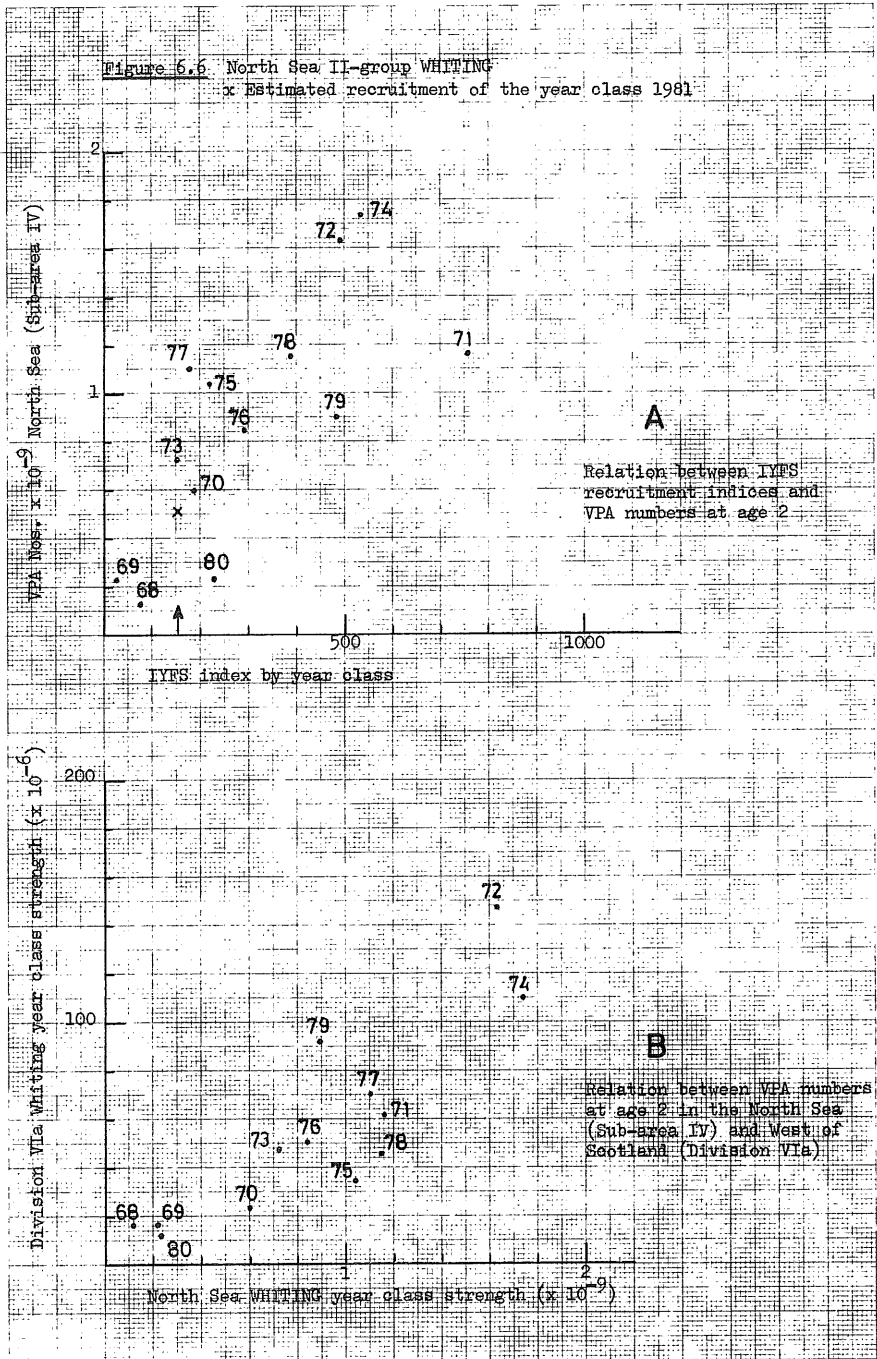
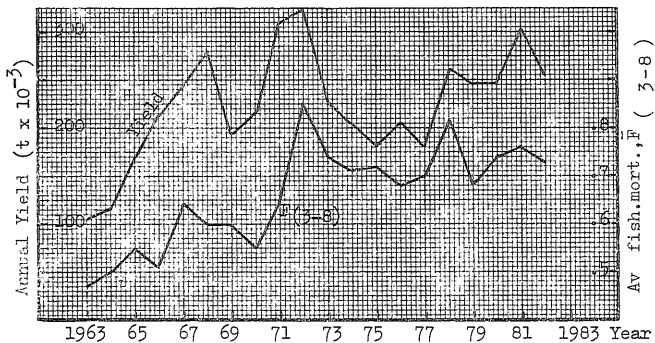


Figure 7.1

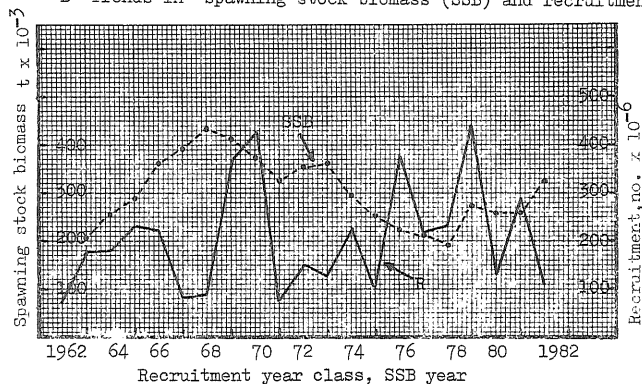
FISH STOCK SUMMARY

COD Sub-area IV
.....
(stock)

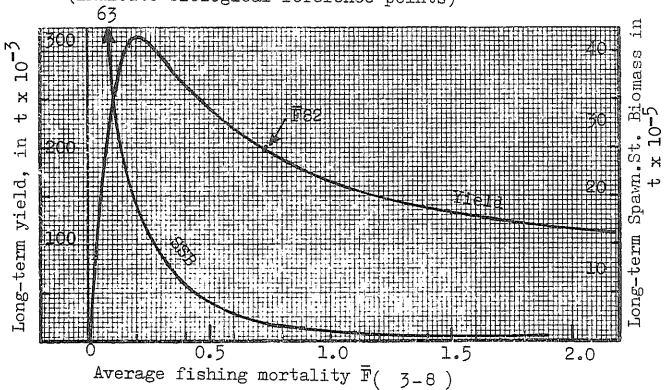
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

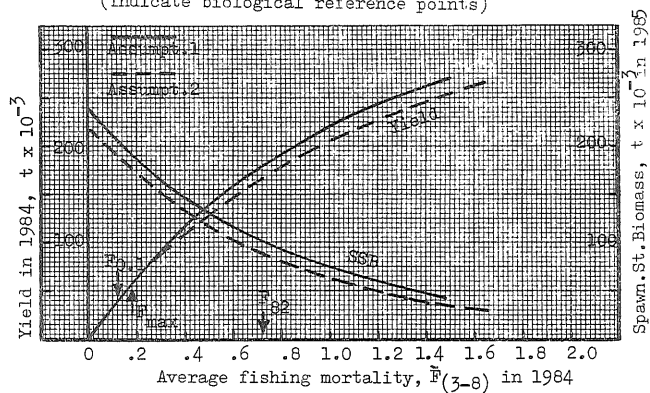


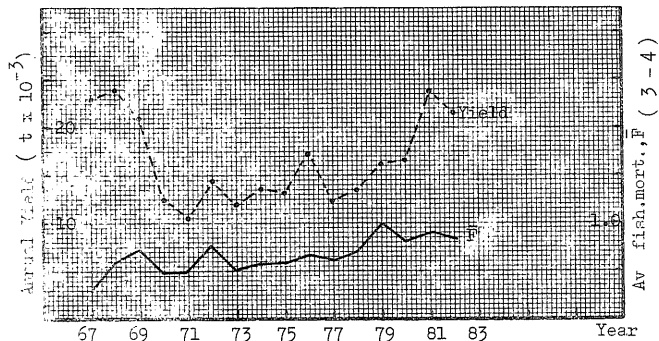
Figure 8.1

FISH STOCK SUMMARY

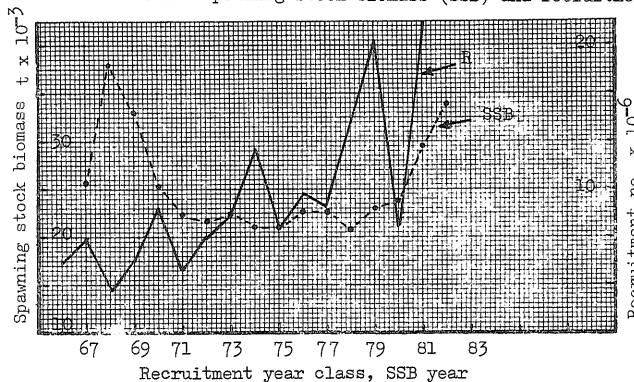
COD Division Via

(stock)

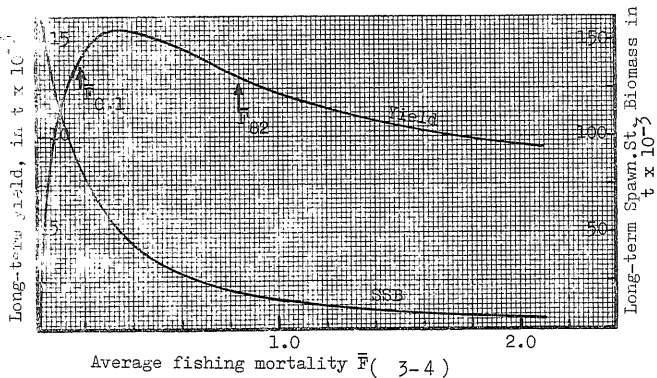
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

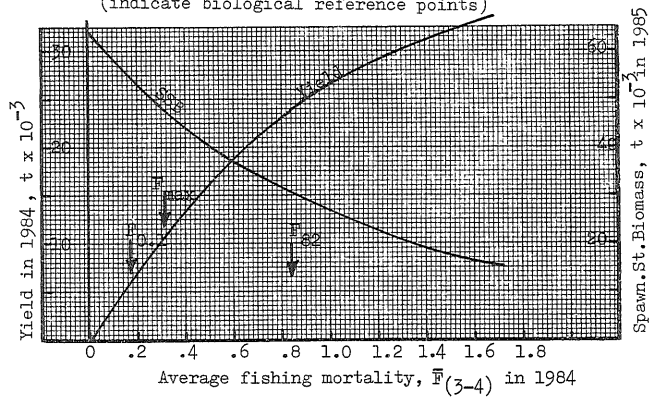


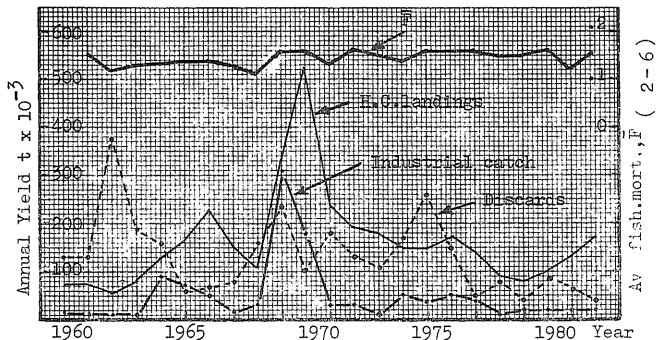
Figure 11.1

FISH STOCK SUMMARY

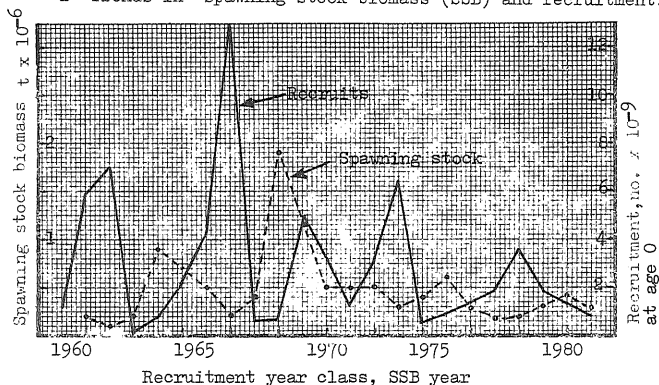
HADDOCK Sub-area IV

(stock)

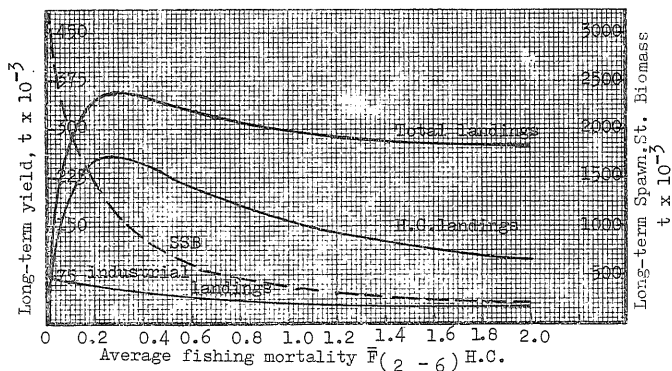
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

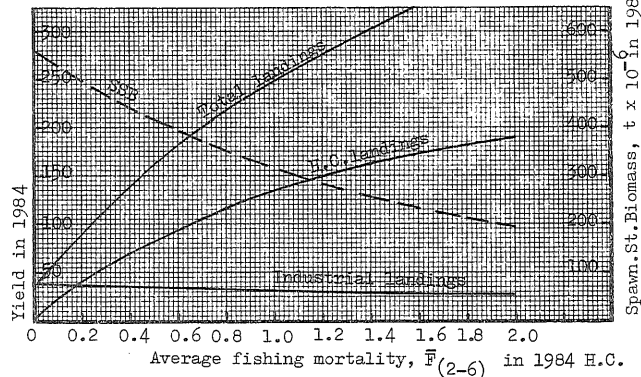
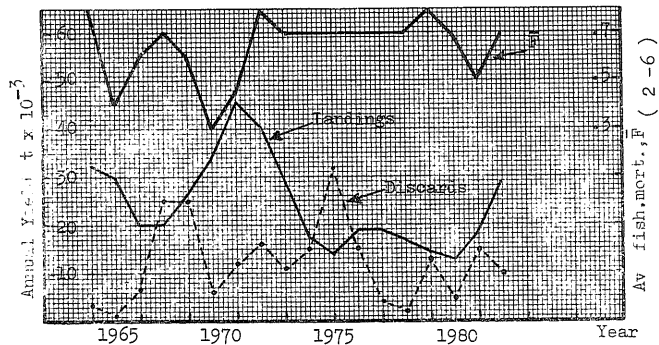


Figure 12.1

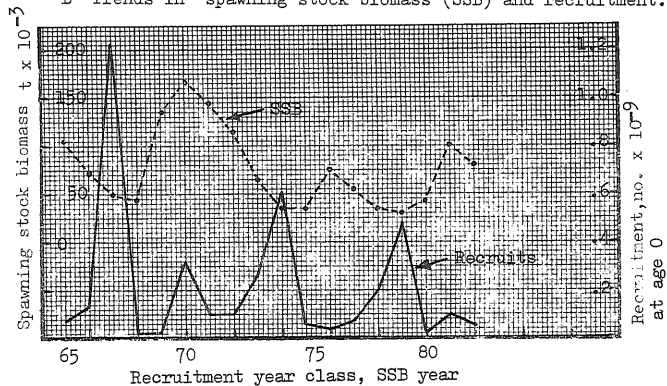
FISH STOCK SUMMARY

HADDOCK Division Via
(stock)

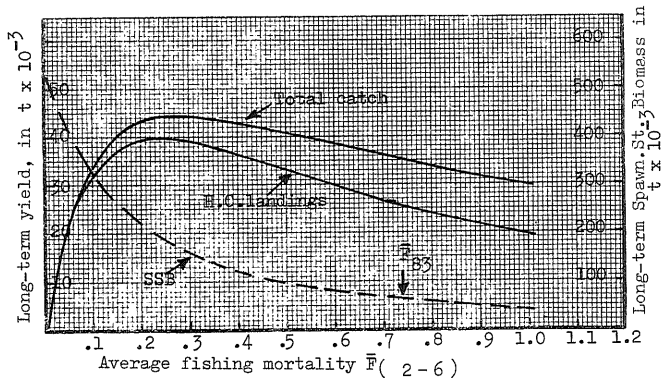
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

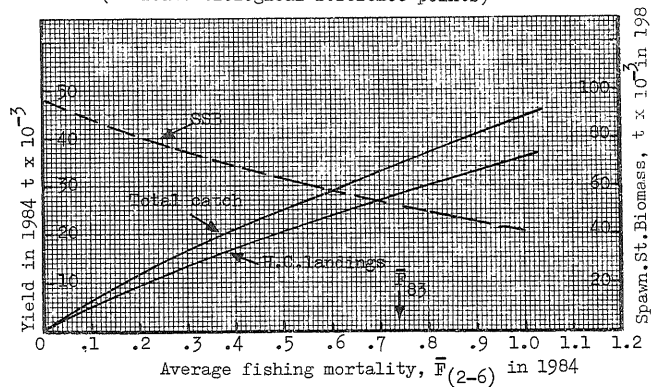


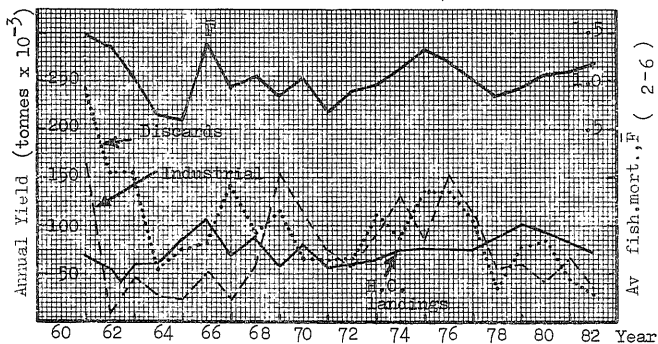
Figure 15.1

FISH STOCK SUMMARY

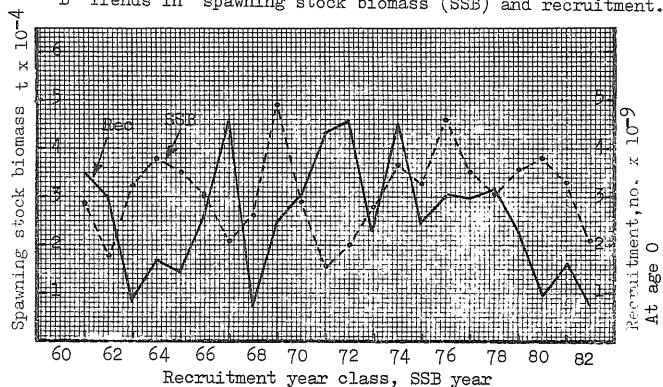
North Sea WHITING

 (stock)

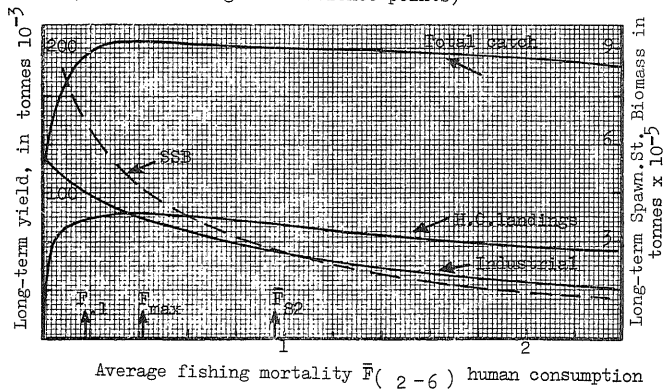
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

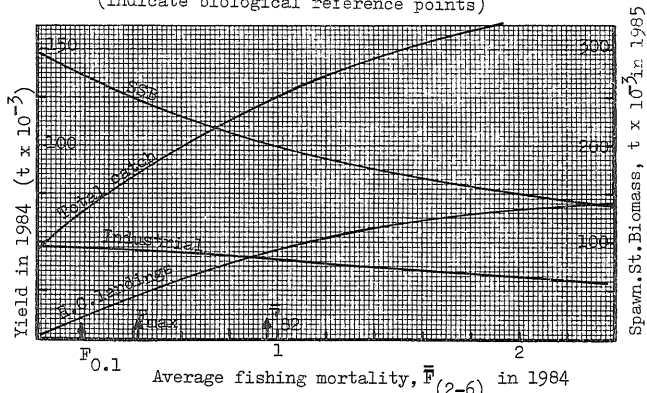
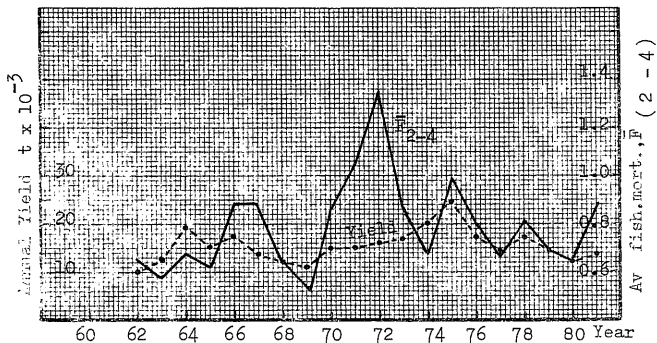


Figure 16.1

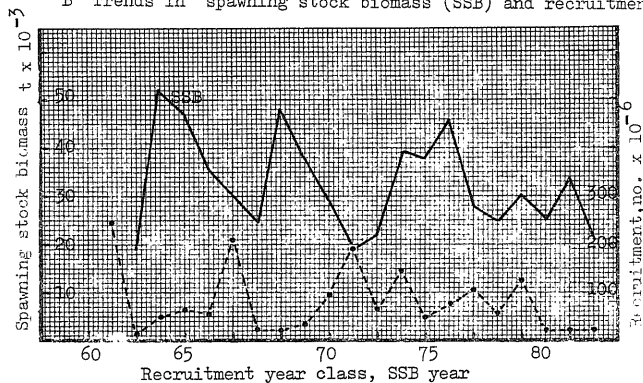
FISH STOCK SUMMARY

..... WHITING Division VIa
 (stock)

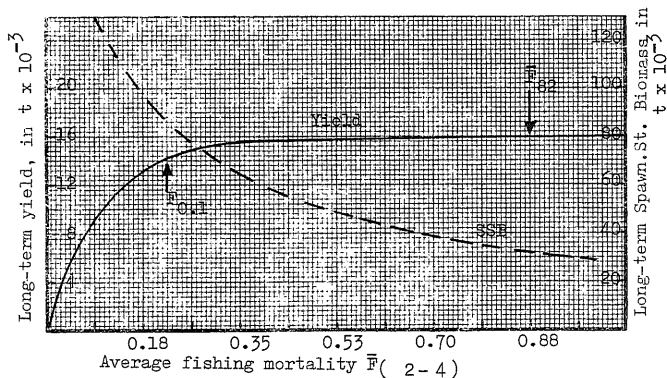
A Trends in Yield and fishing mortality (\bar{F})



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



C Long-term yield and spawning stock biomass (indicate biological reference points)



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

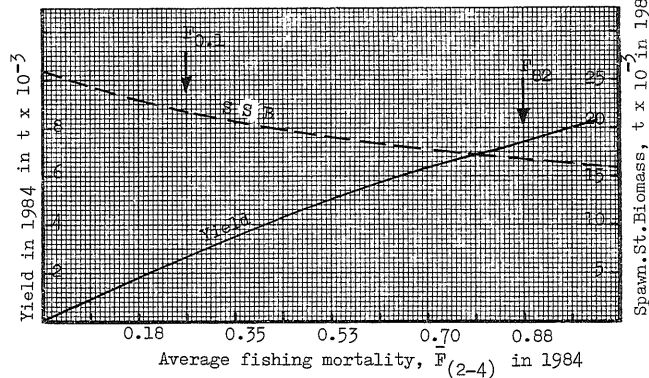




Figure 18.1 COD
 Average relative abundance of O-group, I-group and II group COD in the southern North Sea during the period 1980-82 according to re-search vessel surveys (1st quarter: IYFS; other quarters: Dutch GOV surveys)

Symbols of increasing size indicate increasing percentage of total catch in the delineated area taken within an individual square.

APPENDIX A

THE LEWY-METHOD

The basic idea is to evaluate the development of the catchability for each fleet and age group separately. This is an advantage compared to the Gamma and Rho methods. Both these methods consider the catchability of the total fleet. Hence it is not possible to distinguish between technological developments in each fleet and changes in the total fleet composition. As, for example, the structure of the Scottish fleet has changed drastically since 1966 this improvement might be important. Estimation of catchability on fleet disaggregated data should result in better estimates of F than are obtained using the Rho model.

The Model

It is assumed that

F(f,a,y) = q(f,a,y)E(f,y) (1)

where F denotes fishing mortality rate, q catchability coefficient, E the effort, f the fleet, a the age, and y the year.

Contrary to the Gamma method q is assumed to be independent of the number of fish in the sea.

According to (1) q can be estimated as follows

q(f,a,y) = C(f,a,y) / (N(a,y) * E(f,y)) (2)

where C is the catch, and N the average number of fish in the sea estimated from the VPA.

NOTATION

- Age a = 1,2,...,A (A1,A2) is the age range, where reasonable estimates of q are obtainable
Fleet f = 1,2,...,F1
Year y = 1,2,...,Y Y1 = the last year for which estimates of q are used in regression analysis
q(f,a,y) and q-hat(f,a,y) denote catchability coefficients
F(f,a,y) denotes fishing mortality rate for fleet f
C(f,a,y) denotes catch in numbers for fleet f
E(f,y) denotes fishing effort
F(a,y) and FNEW(a,n) denote fishing mortality rates for total mortality rates for total international values
C(a,y) denotes catch in number for total international values
N(a,y) denotes the average number of fish in the sea

Computational Procedure

- 1. Input arbitrary values of F(a,Y) and F(A,y), a = 1,2,...,A, and y = 1,2,...,Y in the VPA
2. Perform VPA
3. Estimate

q(f,a,y) = C(f,a,y) / (E(f,y) * N(a,y)) = C(f,a,y) * F(a,y) / (E(f,y) * C(a,y)) A1 <= a <= A2

4. Perform linear regression for each fleet and age group:

$$\hat{q}(f, a, y) = \alpha(f, a) + \beta(f, a)(y - \bar{y}) \quad y = 1, 2, \dots, Y1$$

5. Estimate $\hat{q}(f, a, Y)$
 6. Estimate $\hat{F}(f, a, Y) = \hat{q}(f, a, Y) \cdot E(f, y)$
 7. Reestimate total international F in year Y

$$F_{NEW}(a, Y) = \sum_f \hat{F}(f, a, Y) \frac{C(a, Y)}{\sum_f C(f, a, Y)} \quad A1 = a < A2$$

8. If $\sum_{a=A1}^{A2} (F_{NEW}(a, Y) - F(a, Y))^2 < 10^{-5}$ then stop else go to 2. (4)

The Variance of Terminal F

From the computational procedure it is possible to calculate the variance and therefore the confidence limits of the estimated terminal F.

Let the age group be given.

For each age group we have that

$$\hat{F}(f, y) = E(f, y) \cdot \hat{q}(f, y) \dots\dots\dots (5)$$

$$F_{NEW}(y) = \sum_f \hat{F}(f, y) \cdot C(y) / \sum_f C(f, y) \dots\dots\dots (6)$$

Assume that the effort, E, and the catches, C, are determined without any sampling or other errors, such that their variances are assumed to be zero. Assume further that the catches of one fleet is stochastically independent on the other fleets. As a consequence $COV(\hat{F}(f, y), \hat{F}(g, y)) = 0$.

The variances of (5) and (6) are now

$$VAR[\hat{F}(f, y)] = (E(f, y))^2 VAR[\hat{q}(f, y)] \dots\dots\dots (7)$$

$$VAR[F_{NEW}(y)] = \sum_f VAR[\hat{F}(f, y)] \cdot (C(y) / \sum_f C(f, y))^2 \dots\dots\dots (8)$$

The variance of the estimated catchability in the last year, $\hat{q}(f, y)$, is estimated by

$$VAR(\hat{q}(f, Y)) = \sigma_f^2 \left(1 + \frac{1}{Y1} + \frac{(Y - \bar{y})^2}{\sum (y - \bar{y})^2} \right) \dots\dots\dots (9)$$

where σ^2 is the variance about the regression line.

The variance (9) should be considered as a minimum value as the variances of the catches and the effort figures of course are bigger than zero. The variance of terminal F estimated in (6) is therefore a lower limit too.

