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International Council for the Exploration of the Sea

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PART 1

REPORT OF THE ROUNDFISH WORKING GROUP

Aberdeen, 20-26 October 1989

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2 TERMS OF REFERENCE

The terms of reference for this Working Group are given in C.Res.1988/2:4:12.

"The North Sea Roundfish Working Group will be renamed the Roundfish Working Group (Chairman Mr D.W.Armstrong) and will meet in Aberdeen from 12-24 October 1989 to:

a) evaluate further the validity of the present stock unit definitions for assessment and management purposes, particularly for cod and whiting in Sub-area VII;

b) assess the state of and provide catch options for 1990 within safe biological limits for the stocks of cod, haddock, whiting and saithe in Sub-areas IV and VI (Including Division IIIa for saithe); cod, haddock and whiting in Divisions VIId,e and Divisions VIIb,c,h-k (including Division VIIg for haddock); and saithe in Sub-area VII; for the stocks in Sub-area IV, the assessments should be made on the basis of the following assumptions:

   i) there is no change in the existing minimum mesh regulations from 1989 to 1990;

   ii) a minimum mesh size of 120mm will apply to "fishing for cod" in 1990; in order to make realistic assumptions concerning the definition of "fishing for cod", a range of scenarios should be examined in which the proportion of the total catch of cod taken in the other fisheries remains in the range 30-50%;

c) consider the results of the June 1988 and 1989 meetings of the Multispecies Assessment Working Group, particularly the latter when examining the effects of a minimum mesh size when "fishing for cod";

d) advise on appropriate strategies for for minimizing the potential for exceeding the TACs on individual North Sea roundfish stocks while maximising the overall yield from these stocks;

e) provide quarterly catch-at-age and catch and stock mean weight-at-age data and information on the relative distribution at different ages by quarter for cod, haddock, whiting, and saithe in the North Sea for 1988 as input for the multispecies VPA;

f) assess the effects of the cod box in the German Bight.

3 DATA BASE REVISIONS AND PROBLEMS

Preliminary data were prepared for 1988 and revisions were made to the data for 1987.

Norway provided revised data on saithe in the North Sea for the period 1980-1986. France provided revised data for cod, haddock, whiting, and saithe for the North Sea for the period 1976-1988 and for cod and whiting in Division VIId for the period 1976-1986.

Problems remain, as described in previous reports, in obtaining sufficiently detailed and accurate landings statistics for the Netherlands.

For some nations, it is currently the case that collection of accurate data on landings and age compositions is difficult because of evasion of regulations when fleets have exhausted their quotas. It also appears likely that other nations will soon encounter this problem.

4 STOCK UNIT DEFINITIONS

4.1 General

The question of the validity of the present stock unit definitions used for assessment and management purposes has been considered on previous occasions by the Working Group. The relationship between stocks in the North Sea and the West of Scotland was examined in 1986. For haddock, there is clear evidence that there is a distinct unit stock at Rockall (Division VIb) and we repeat our previous recommendation that this should be a separate management unit. Although there is some interchange between Divisions IVa and VIa, its magnitude is uncertain and and until more data become available it is considered inappropriate to combine the assessments for these two areas.

4.2 Cod and Whiting in Sub-area VII

Currently there are two management areas for Sub-area VII: Division VIIa (Irish Sea) and Divisions VIIb-k. Analytical assessments are made for cod and whiting in Divisions VIIa and Divisions VIIf,g by the Irish Sea and Bristol Channel Working Group and for cod and whiting in Divisions VIId,e by the Roundfish Working Group.

Little is known of the relationships between whiting in the various Divisions of Sub-area VII but we are not aware of any major problems associated with the present management areas.

As regards cod, there have been major management problems relating to landings from Divisions VIId,e in recent years. A working paper on the relationships between cod in Divisions VIId,e and adjacent areas was submitted to the Group. This summarized tagging data from 1964 and also investigated CPUE correlations between rectangles for 40-59ft English trawlers over the period 1972-1985.

There have been no tagging experiments for cod in Divisions VIIe or VIIf,g. There have been several releases in Division VIId and in the southern half of Sub-area IV and results from these are summarized in Table 4.1. A significant proportion of cod released in Division VIId were recaptured in the North Sea (27%) but there was little movement westward to Division VIIe (4%). Cod released in the southern North Sea were mostly recaptured there (96%), with a small proportion (3%) recaptured in Division VIId.

The analysis of CPUE corelations shows that catch rates in Division VIId rectangles were most higly correlated with catch rates in Division IVc rectangles. For Division VIIe, the highest correlations were with rectangles in Divisions VIIe and VIIf.

The evidence suggests that cod in the eastern Channel (Division VIId) have strong links with those in the southern North Sea and that there is little interchange with the western Channel (Division VIIe).

There is little information relating to cod in Division VIIe, although sampling for age distribution has been instituted by UK (England) in 1989 and a tagging experiment is planned. However, there is some indication from the CPUE analysis referred to above that cod in Division VIIe may have links with cod in Divisions VIIf,g. If so it may be appropriate for cod in VIIe to be assessed by the Irish Sea and Bristol Channel Working Group since they already assess cod in Divisions VIIf,g.

5 CONSIDERATION OF RECENT MULTISPECIES WORKING GROUP REPORTS

5.1 Natural Mortality Rates

The Working Group noted the consistency between the most recent multispecies VPA estimates of mean natural mortality rate at age (Anon., 1989a) and those used in recent years for single species assessments (Anon., 1988). No change was made to the assumed values of natural mortality rates used at this meeting.

5.2 Long-Term Predictions

For cod, haddock, whiting, and saithe in the North Sea, long-term predictions of yield and biomass assuming unchanged effort, constant recruitment and unchanged exploitation pattern are essentially similar whether derived from single species or multispecies forecasts (Anon., 1989a). Assuming that 68% of the international human consumption roundfish fleet adopts a 120 mm mesh size then the conclusions drawn from multispecies and single species long-term forecasts diverge considerably (Anon., 1989a). Under multispecies assumptions, the gains suggested by single species assessments are much reduced or, in several cases, reversed.

In addition, the effects of selectively increasing fishing mortality rate on predators (notably whiting) have also been simulated in the multispecies context. Results of these procedures were brought to the attention of the Working Group (Anon., 1989a,; Gislason, 1989). These simulations suggest that a reduction in the biomass of major predator(s) results in long-term gains in the biomass and hence yield of many of the other species included in the simulations.

The results of long-term multispecies forecasts and their implications are thus radically different to those of long-term single species forecasts when the effects of large changes in, for example, mesh size, are estimated. This Working Group has long held doubts over the validity of long-term single species forecasts because they ignore biological interaction, technical interaction, and other factors such as spatial heterogeneity of the exploited stocks. However, doubts still remain over the specification of the multispecies model in which only biological interaction is addressed.

The EC Scientific and Technical Committee on Fisheries is currently assembling fleet and area disaggregated data specifically to examine the effects of spatial heterogeneity and technical interactions. Such a data base is thought prerequisite to the ability to predict the effects of technical measures, even in the short term. For example, when considering the effects of an increased mesh size "when fishing for cod", the multispecies data base does not allow any account to be taken of the different proportions of the different fleets which will adopt the increased mesh size or for their spatial effects. This Working Group can account for the former (see Section 9) but spatial effects are ignored. The ability even to define"fishing for cod" is severely limited by the lack of an adequate data base.

Technical interactions also impinge on experimental manipulations of the multispecies system. Whilst it is entirely appropriate for the Multispecies Assessment Working Group to investigate the behaviour of the multispecies model by selectively increasing fishing mortality rates on individual predator species and assemblages, attention must be drawn to the improbability of achieving such changes without adversely influencing fishing mortality rates on other species.

The conflicting results of single species and multispecies forecasts present a warning that added realism in prediction may well require a reassessment of long-term strategic decisions. Therefore, it is highly desirable that the assumptions under which long-term forecasts are made, and doubts about them, are clearly expressed. Furthermore, until an adequate data base is assembled and account taken of additional features such as spatial heterogeneity and technical interactions then any long-term forecast must be viewed with caution. Even then, doubts will continue to surround the validity of the fundamental assumptions of the recruitment models under which long-term forecasts are made.

6 MINIMIZING THE POTENTIAL FOR EXCEEDING TACs WHILE MAXIMIZING OVERALL YIELD

Little progress was made on this topic largely because the type of information required to address the problem was not available. The Group acknowledged the desirability of obtaining internally consistent TACs for the North Sea roundfish stocks but felt that considerable progress in a number of areas is required before this can be achieved. Particular requirements include a comprehensively disaggregated data base, information on spatial dynamics of fish species and fleets including technical interactions, information on the changes in F-at-age vectors (by species and fleet) likely to accompany a change in the F-at-age vector for any specified species and fleets(s). A model to incorporate all of this information is also required.

A preliminary investigation of the problem was made using the catch forecast program MSFP of B. Mesnil. In the investigation it was assumed that the stocks are completely mixed (i.e., that all species are available at all times to all vessels) and that there is only one fleet. Neither of these assumptions is realistic.

Using the same inputs as for the single species short-term predictions (Sections 12, 16, 20 and 24), catch predictions for 1989 and 1990 were generated for two scenarios:

a) the status quo situation with fishing effort maintained at the 1988 level throughout 1989 and 1990.

b) reduction in effort in 1989 to 90% of the 1988 level followed by further reduction in 1990 to 80% of the 1988 level. This scenario approximates to the recent intentions of ACFM for cod and haddock with associated effects on whiting. In this realisation, however, the reductions in fishing mortality were also applied to saithe.

Predicted catches and associated total and spawning biomasses for the two scenarios are presented in Table 6.1. For each species, catch is broken down into human consumption landings, discards and industrial by-catch. For scenario (a) the results are, not unexpectedly, very similar to single species status quo forecasts. Under scenario (b), landings of all four species are lower in 1989 and 1990 than they are in scenario (a). Again, this is not unexpected. Indeed, similar results could be obtained by running a series of appropriately specified single-species short-term forecasts.

The MSFP program can accommodate different multipliers on the F-at-age arrays for the different species. However, the program requires that the user specifies the different multipliers. The Group is at present not able to make this specification and a considerable amount of analysis will be required before it is able to do so. It was, therefore, felt that any attempt to carry out further simulations at this meeting would produce arbitrary results.

Attention was drawn to the MSF BOX program (an extension of the MSFP program) currently being used by the EC Scientific and Technical Committee on Fisheries in conjunction with an appropriately disaggregated data base. The Group felt that this type of development is prerequisite to answering the type of problem referred to in this Section.

7 QUARTERLY DATA

Quarterly catch-at-age and catch and stock mean weight-at-age data for 1988 are required by the Multispecies Assessment Working Group as input to the MSVPA program. Provisional data for 1988 have already been made available to the Multispecies Group for its meeting of June 1989. Data for 1990 will be prepared when they become available.

Several countries have revised their quarterly data and these revisions have not been included in the multispecies data set. It is recommended that all nations provide a complete set of their quarterly data on age composition and mean weight at age from 1974 (even if unrevised) to the Chairman of this Working Group. The data should be supplied on floppy disc in a format to be defined in a letter to be circulated by the Chairman. In addition, it is recommended that ICES should provide paper-tabulated data on the landings by quarter of each nation fishing in the North Sea for the period 1974-1988. The latter request is made because it is difficult to find quarterly landings data for those nations which do not supply age compositions. At present, quarterly data are "invented" for these nations by apportioning their annual totals according to data submitted in conjunction with age compositions.

A request for information on the relative distribution of roundfish stocks by age group and by quarter for 1988 has also been made - again as input to the Multispecies Working Group. During the meeting of the Study Group on the Feasability of an Atlas of North Sea Fishes (Anon., 1989b), an attempt was made to combine data for 1- and 2-group cod from 3 different surveys in the third quarter of 1987. The results were very promising. In addition, it is noted that the newly-established International North Sea, Skagerrak and Kattegat Bottom Trawl Survey Working Group will consider this matter in more detail. It is, therefore, the opinion of this Group that information on relative distribution by age and by quarter would most easily be obtained via correspondence between the Chairman of the Multispecies Assessment Working Group and the Chairman of the Working Group on Trawl Surveys.

8 THE EFFECTS OF THE COD BOX IN THE GERMAN BIGHT

The cod box was introduced in 1986 to reduce fishing mortality on the strong 1985 year class, and although subsequent year classes have been weak, the box was retained. The recommendation from ACFM was for a mesh size of 120 mm within the box, since this is the smallest mesh size which would afford a significant increase in selectivity for 1-year-old cod. However, the regulation adopted included reference to a minimum mesh size of 100mm which is unlikely to have had much effect. A positive effect of a technical measure such as the cod box would be expected to show up in the VPA as a reduction in fishing mortality rate on 1-year-olds and as an increased local abundance of this age group. No such effects can be detected in the VPA or from survey data. However, the relevant values of fishing mortality rate are as yet unconverged in the VPA. It should be stressed that tagging studies (Anon., 1971) indicate that any beneficial effects of the cod box would be confined to a radius of around 100 miles, the normal limit of cod migrations.

As noted in last year's report, measures like the cod box as recommended are likely to have a positive effect on the level of spawning biomass. However, the Roundfish Working Group does not have the data required to quantify this effect. Such data are currently being assembled by an ad hoc working group of the EC Scientific and Technical Committee for Fisheries and that Group should be able to evaluate the effects of the cod box and other technical measures in due course.

9 FISHING FOR COD WITH 120 mm MESH

The Roundfish Working Group was requested to consider the June 1989 report of the Multipecies Working Group with respect to a mesh change to 120 mm in the demersal fisheries "when fishing for cod". In addition, the Roundfish Working Group was requested to make single-species assessments under the assumption that a minimum mesh size of 120 mm will apply to "fishing for cod" in 1990 and, within this assumption, to constrain the assessments so that the proportion of cod in the total catch taken by those fleets not using the 120 mm mesh was in the range 30-50%.

In its meeting of 1989, the Multispecies Working Group simulated the effects of the required mesh change both including and excluding multispecies effects. The Multispecies Working Group implicitly assumed that at present there is only one fleet fishing in the North Sea and that this fleet uses a towed demersal fishing gear for which mesh changes would affect the selectivity. It was further assumed that the proportion of the fleet which would adopt 120 mm mesh can be estimated as the proportion of the total catch of cod, haddock, whiting, saithe, and plaice represented by cod + saithe + plaice. On this basis, it was estimated that 68% of the present fleet would choose to adopt the 120 mm mesh. The current fleet generates F-at-age vectors on each of the species incorporated in the multispecies assessment data base. These vectors can, therefore, be split into two vectors one of which (32% of the current Fs) will not be changed as a result of increasing mesh size. The other vector (68% of the current Fs) will be changed. The change in this F-at-age vector was simulated by methods previously adopted by the Roundfish Working Group using estimates of selectivity parameters presented in the Multispecies Working Group Report. The original "single" fleet was, therefore, split into two fleets, one "fishing for cod" and exhibiting selectivity associated with using 120 mm mesh, the other "not fishing for cod" and maintaining its current selectivity.

Short- and long-term predictions of the catches and associated stock biomasses were made by the Multispecies Working Group, both including and excluding species interactions. If interactions are excluded, the Multispecies Group estimated for the 9 stocks included in the simulation overall long-term gains of 4.5% in the landings and 16.3% gains in spawning biomass. When interactions were included, there were losses of 6.9% in the landings and of 1.4% in spawning biomass. These overall losses in spawning biomass are, however, comprised of gains for roundfish stocks and losses for other stocks. These increases for the roundfish are only 20-25% of those indicated in the absence of biological interaction. In the short-term predictions, the Multispecies Working Group found only small differences between simulations including and excluding biological interaction.

This Working Group decided to approach the problem by basing its (single-species) simulations on a more realistic fleet disaggregation than was achievable by the Multispecies Group. A 4-species, 13-fleet prediction program using the disaggregated data available to the Roundfish Group was developed during the meeting for this purpose. The species incorporated were cod, haddock, whiting, and saithe. The fleets comprised 7 "national" fleets, 5 Scottish fleets and 1 residual fleet. Most of the national fleets actually consist of several fleets using sometimes very different fishing methods, some of which (e.g., gill netters) would not be affected by changes in mesh size. Unfortunately, the data available to the Group did not permit these fleets to be specified and, therefore, it was assumed that the national fleets all use towed demersal gears whose selectivity can be affected by changes in mesh size.

In parallel with the methods of the Multispecies Working Group, a vector of F-at-age was estimated for each fleet with respect to human consumption landings, discards, and industrial by-catch. The proportion of each fleet which would adopt the 120 mm mesh was estimated by evaluating for each fleet the proportion of the total catch of cod, haddock, whiting, saithe, and plaice represented by cod + saithe + plaice. However, this estimate was not applied to the Dutch, Norwegian, and French fleets where it was thought that a lower proportion than estimated would actually change. Furthermore, it was assumed that none of the Scottish Nephrops trawlers would adopt mesh sizes higher than the 70 mm currently required by regulations. Each fleet's F-at-age vector was split into the proportion not fishing for cod and the proportion fishing for cod. The latter vector was modified in accordance with the estimated effect of the mesh change. Selectivity parameters for saithe were assumed to be the same as those for cod. No change was made to vectors of F for industrial by-catch. The simulations incorporated ages 0-11 and did not accommodate a plus-group.

The estimated proportions of each fleet changing to the 120 mm mesh are shown in Table 9.1 where it can be seen that the proportions are very variable. The mesh sizes currently in use in each of the fleets together with values of L_{50} and L_{25} for the current mesh and for 120 mm mesh are shown in Table 9.2.

Estimates of percentage changes in total catch, human consumption landings, discards, and industrial by-catch, following the adoption of 120 mm mesh when fishing for cod, are presented in Tables 9.3-9.6, respectively.

The Group was unable to accommodate the request to constrain the cod catches of the "non cod" fleet to within certain limits. The main reason for this is that on the basis of the data available the various fleets specified in this work exhibit very differnt exploitation patterns. This makes it nearly impossible to predict a priori the effects on each fleet of the proposed technical measure. The only way in which the Group could attempt to accommodate the request is by trial-and-error, incorporating ever more arbitrary estimates of the proportion of each fleet which would adopt the higher mesh size. Table 9.7 gives values of the proportion of the total catch (human consumption + discards + industrial by-catch) of cod, haddock, whiting, and saithe represented by cod for the fleet retaining current mesh size. The proportion varies considerably between fleets. In addition, the proportion changes from year to year. In this simulation, the year-to-year changes are not great because constant future recruitment is assumed. In reality, with highly varying recruitment, the year-to-year changes would be greater.

Problems also arise here in that the term of reference requests estimates of the proportion of cod in the catch. The catch could be interpreted as meaning the total catch of all species (in which case there is almost no hope of carrying out a simulation) or the total catch of all major demersal species (in which case it should not be forgotten that data are not available to this Group to allow estimation of the catches of plaice and sole).

Recent Scottish investigations (Armstrong et al., 1989) cast doubt on the specification of the selectivity parameters for non-Scottish fleets. For the purpose of this meeting, the Roundfish Working Group used the selectivity data presented in the Multispecies Working Group report for all except the Scottish fleets. It is possible that, given changes to nets which may have occurred relatively recently, the selection parameters imputed to many of the fleets may not be appropriate.

Overall, the results presented here indicate the complexity which emerges when attempts are made to incorporate technical interactions into assessment of the likely effect of a mesh change. In this example, the complexity is further increased by the fact that a mesh change by a proportion of each fleet is being simulated. The estimation of the proportion of each fleet which will, in fact, change to the higher mesh size is difficult and very arbitrary criteria have been adopted since no better basis exists at present. Furthermore, as already indicated, the data available to the Roundfish Group are not sufficiently disaggregated to allow separation of those fleets which will definitely not change their mesh size from those fleets which might do so.

The feeling of the Group was that, although these assessments attempted to simulate more realistically the technical interactions of the fleets than the assessments carried out by the Multispecies Group, the results should be viewed with considerable caution. Attempts should be made to amalgamate considerations of technical interaction, biological interaction and associated effects of spatial and temporal heterogeneity of stocks and the fleets exploiting them. The best prospect for carrying out this kind of work in a satisfactory manner lies in the data base and associated computations currently being prepared or considered by the EC Scientific and Technical Committee for Fisheries.

10 ESTIMATES OF RECRUITMENT

10.1 Recruitment Indices

Recruitment indices for the North Sea stocks of cod, haddock, and whiting (Tables 10.1-10.3) were available from the International Young Fish Survey (1971-1989), the English Groundfish Survey (1977-1988), the Scottish Groundfish Survey (1982-1988), and for cod and whiting from the Dutch Groundfish Survey (1980-1988). Preliminary results for cod from the 1989 Dutch Groundfish Survey will become available during the November meeting of ACFM. Abun--dance indices of cod taken as by-catch in the shrimp fishery by the Federal Republic of Germany were available for the years 1968-1989. The index for the 1989 year class is still provisional.

For the stocks of cod, haddock, and whiting in Division VIa, 1- and 2-group indices are available from Scottish surveys (1982-1989) (Tables 10.4-10.6).

No research vessel surveys are available for saithe.

10.2 Use of Indices

As last year, RCRTINX2 was used to combine the available research vessel indices. The options chosen were:

a) Calibration regression;

b) Shrinkage towards the mean;

c) Minimum variance of prediction of 0.2 for any estimate;

d) Minimum of 5 data points in regression;

e) Tricubic weighting.

To estimate recruitment at age 1 and 2 for the North Sea stocks of cod, haddock, and whiting various recruitment indices were used in conjunction with VPA estimates obtained by Laurec-Shepherd tuning. The results of the RCRTINX2 runs were used when making predictions. Estimated recruitments and associated diagnostics are shown in Table 10.7.

For the stocks of cod, haddock, and whiting in Division VIa, several runs of RCRTINX2 were made using different sets of input data:

a) Using VPA numbers and CPUE data for ages 1 and 2 for Scottish light trawlers and seiners;

b) Using VPA numbers and research vessel indices from the North Sea and from Division VIa;

c) Using VPA numbers, Scottish CPUE data as described above and the results of North Sea VPA.

The results of these runs are presented in Table 10.7. For some stocks, alternative means of estimating recruitment were adopted. The final values adopted are given in the respective stock Sections (13.7, 17.7 and 21.7).

Various attempts were made to estimate recruitment of cod and whiting in Division VIId using North Sea indices but these attempts were abandoned because of the apparent lack of correlation between data for the North Sea and VPA estimates of numbers at age in Division VIId.

11 TUNING METHODS

The Laurec-Shepherd tuning method was used to estimate F-at-age in the last data year and at the highest age for the stocks indicated in the text-table below. The fleets for which effort data are available and which were used in the tuning procedure are also indicated in the text table.

Country	Fleet	Sub-area IV				Division VIa			
		Cod	Had	Whi	Sai	Cod	Had	Whi	Sai
Scotland	GFS	+	+	+					
	TRL	+	+	+	+	+	+	+	+
	SEI	+	+	+	+	+	+	+	+
	LTR	+	+	+	+	+	+	+	+
	NTR	+	+	+		+	+	+	+
England	GFS	+	+	+					
	TRL	+							
	SEI	+							
France	TRB	+	+	+	+				
	TRS	+		+					
	ALL					+	+		+
Netherlands	GFS	+		+					
Norway	LTR				+				
	TRL				+				
International	GFS	+	+	+					

Full diagnostic statistics for each stock will be presented to ACFM on floppy disc.

12 COD IN SUB-AREA IV

12.1 Catch Trends

Official landings data are given in Table 12.1. Trends in landings from Working Group estimates are given in Table 12.2 and are graphed in Figure 12.1. Provisional landings in 1988 were 150,000 t compared to a TAC of 160,000 t and were the lowest in the last 20 years. Landings have declined markedly since 1981.

12.2 Natural Mortality Rate and Maturity at Age

These values are given in Table 12.3. They are unchanged from those used last year.

12.3 Age Compositions

The VPA input data for the last 20 years are given in Table 12.4. They do not include estimates of discards or industrial by-catches. Data for 1988 were provided by England, Scotland, Netherlands, Denmark, France, Belgium, and the Federal Republic of Germany.

12.4 Mean Weights at Age

Total international mean weights at age for the catch are given in Table 12.5. These were also used as stock weights at age.

12.5 Commercial Catch/Effort Data and Research Vessel Indices

These data were used to tune the VPA and to provide recruitment estimates. The fleets used in the tuning are indicated in the text table in Section 11. The research vessel indices are given in Table 10.1.

12.6 VPA Tuning

Fishing mortality-at-age and numbers-at-age resulting from the tuning are given in Tables 12.6 and 12.7, respectively.

12.7 Abundance Estimates of the 1986-1989 Year Classes

Methods employed for deriving estimates of recruitment are described in Section 10. The results from RCRTINX2, used as input values for prediction, are given in Table 10.7.

12.7.1 The 1986 year class in 1988

The RCRTINX2 estimate is 102 millions which compares with the estimate derived from tuning of 95 millions. It was decided to adopt the RCRTINX2 estimate.

12.7.2 The 1987 year class in 1988

This abundance was estimated by RCRTINX2 to be 193 millions compared to the estimate from tuning of 157 millions. Last year's Working Group estimate of this year class was 277 millions but this was revised by ACFM in May 1989 to 198 millions.

12.7.3 <u>The 1988 year class in 1989</u>

This was estimated to be 329 millions at age 1. Last year an average year class value (arithmetic mean) of 412 millions had to be assumed by the Working Group in the absence of research vessel data. In the ACFM assessment of May 1989, an estimate of 251 millions was used. The differences are due to additional research vessel data now available.

12.7.4 <u>The 1989 year class in 1990</u>

The only survey data available at present are the 0-group index from the English Groundfish Survey of 1989. The RCRTINX2 estimate is 315 millions at age 1. This estimate is very preliminary and, because of the use of shrinkage in RCRTINX2, is not much different from the long-term geometric mean of 351 millions.

12.8 Long-term Trends in Biomass, Fishing Mortality and Recruitment

Historical trends in mean fishing mortality, biomass and recruitment are shown in Table 12.8 and Figure 12.1. Fishing mortality peaked in 1982 and appears to have declined somewhat thereafter. Spawning stock biomass reached another historically low value of 88,000 t in 1988 but appears to have increased to 91,000 t at the beginning of 1989. No trend in recruitment is apparent. The 1986 and 1987 year classes were below average but the 1988 year class is about average.

12.9 Catch and Biomass Predictions

The input data for catch predictions are given in Table 12.9. The F values for age 1 (0.164) and age 2 (0.918) are the mean for the period 1984-1988 and replace the tuned values of 0.177 and 0.940 (Table 12.6).

12.9.1 <u>Status quo prediction</u>

The results of a <u>status quo</u> catch prediction are given in Table 12.10. The <u>status quo</u> catch in 1989 is 136,000 t compared to 144,000 t predicted by ACFM last year. The same fishing mortality in 1990 results in a catch of 143,000 t. Spawning biomass will fall from 91,000 t in 1989 to 83,000 t in 1990, with a further fall to 80,000 t at the beginning of 1991. Catches and associated biomasses in 1990 under a range of F values are given in Table 12.10 and Figure 12.2.

12.9.2 <u>Prediction assuming TAC taken in 1989</u>

The results of this catch prediction are given in Table 12.11. The TAC of 124,000 t for 1989 implies a reduction of F of 12% in 1989 compared to 1988. This will result in no change in spawning biomass in 1990 (91,000 t). In the prediction made by ACFM in November last year, this level of catch implied a reduction in F of 20%. Catches and associated biomasses in 1990 under a range of F values are given in Table 12.11 and Figure 12.2.

12.9.3 Catch at age data for 1989

Provisional estimates for the total number landed at each age for the first six months of 1989 are given in Table 12.12. This shows an unexpectedly high number of 2-year-old fish. Since these data are very preliminary and do not include all countries it is difficult to assess the significance of the material.

12.10 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 12.2

12.11 Safe Biological Limits

The stock/recruitment scatter diagram is shown in Figure 12.3. F_{med} is 0.72 and F_{high} is 0.92 and the current value of F is 0.8.

Spawning biomass at the beginning of 1989 was estimated to be 91,000 t which is among the lowest in the historical series. The minimum acceptable spawning biomass advised by ACFM is 150,000 t.

13 COD IN DIVISION VIa

13.1 Catch Trends

Official landings data are given in Table 13.1. Trends in landings are shown in Figure 13.1. Working Group estimates of landings are given in Table 13.2. Landings in 1988 were 20,456 t which is an increase of 1,500 t on 1987. The agreed TAC for Sub-area VI for 1988 was 18,430 t.

13.2 Natural Mortality and Maturity at Age

These values are given in Table 13.3. They are unchanged from those used last year.

13.3 Age Compositions

The VPA input data are given in Table 13.4. These data do not include discards or industrial by-catch. Data for 1988 were supplied by Scotland, England, Ireland, and France.

13.4 Mean Weight at Age

Total international mean weights at age for the catch are given in Table 13.5. These values were also used as stock mean weights at age.

13.5 Commercial Catch/Effort Data and Research Vessel Indices

These data were used to tune the VPA and to provide recruitment estimates. The fleets used in the tuning are indicated in the text table in Section 11. The research vessel indices are given in Table 10.4.

13.6 VPA Tuning

Fishing mortality rates and numbers at age for the tuned VPA are presented in Tables 13.6 and 13.7, respectively.

13.7 Abundance Estimates of the 1987-1989 Year Classes

The results from the RCRTINX2 method are given in Table 10.7. Various research vessel indices for both Division VIa and Sub-area IV, as well as CPUE indices for Scottish light trawlers and seiners in Division VIa were input. It was decided that the RCRTINX2 results were unacceptable since the correlations between the indices and VPA were generally low.

13.7.1 The 1986 year class in 1988

The catches of this year class in 1987, 1988, and the first half of 1989 all indicate that it is very abundant. In these circumstances (lacking a definitive estimate of abundance from RCRTINX2 or other methods) the Methods Working Group suggests selection of an appropriate quantile of the historical recruitment series. The upper quartile of the historical VPA series for age 2 is 8-9 millions but this value is equalled by the catch in 1988. It was, therefore, decided to set the abundance of this year class to the highest estimated historical abundance for age 2 (1979 year class). This results in an estimate of 16 million fish.

13.7.2 The 1987 and later year classes

The value adopted for these year classes was 10 million, the geometric mean recruitment for the period 1969-1988.

13.8 Long-Term Trends in Biomass, Fishing Mortality and Recruitment

Estimates of biomass, fishing mortality and recruitment are given in Table 13.8 and plots are shown in Figure 13.1. Spawning biomass has declined from 1981 to reach a historically low level in 1986 of 18,000 t but is estimated to have increased in the following two years. Mean fishing mortality shows an upward trend but has apparently stabilized in the past 5 years. Recruitment in the past decade has been at a higher level than in previous years.

13.9 Catch and Biomass Predictions

Input data for predictions are given in Table 13.9. Stock numbers at age 3 and older in 1988 are the tuned values from VPA. The values for ages 1 and 2 in 1988 are the estimates obtained as described in Section 13.7. The tuned F values for ages 1 and 2 in 1988 have been replaced by average Fs for the period 1984-1988.

13.9.1 Status quo catch prediction

The *status quo* catch in 1989 is predicted as 20,000 t (Table 13.10), which is close to the TAC for Sub-area VI of 18,430 t. The *status quo* catch in 1990 is predicted to be 17,000 t. Spawning stock biomass will fall from 27,000 t in 1989 to 23,000 t at the start of 1990, and to 19,000 t at the start of 1991. The latter is close to the lowest recorded value from VPA.

13.10 Catch at Age Data for 1989

Catch-at-age data for the first quarter of 1989 for Scotland are given in Table 13.11. The 1986 year class is prominent in the landings.

13.11 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 13.2

13.12 Safe Biological Limits

The stock-recruit scatter diagram is shown in Figure 13.3. Values for Fmed(0.68) and Fhigh(1.05) are shown in Figure 13.2. The current level of F is close to Fhigh. Spawning biomass is among the lowest recorded in the historic series.

14 COD IN DIVISION VIb

No age composition data are available for this stock. Landings are small and are given in Table 14.1.

15 COD IN SUB-AREA VII

15.1 Cod in Divisions VIId,e

In recent years, an analytical assessment has been attempted for cod in Divisions VIId,e. In fact, age composition data are available only for cod in Division VIId and this has been raised to include landings in Division VIIe. However, recent studies have suggested that there is little interchange of cod between the two areas and that there are closer links between Division VIId and Sub-area IV, and between Division VIIe and Divisions VIIf,g (see Section 4). It was, therefore, decided to restrict the analytical assessment to Division VIId and to predict catches in Division VIIe by the SHOT method.

The Group notes that the assessment of cod in Divisions VIIb-k has been considered several times during 1989, both by ACFM and the STCF.

15.2 Cod in Division VIId

15.2.1 Catch trends

Recent nominal landings are given in Table 15.1 which also includes Working Group estimates. The latter are plotted in Figure 15.1. There have been significant revisions to these estimates. Landings in 1986-1988 have been well above those for previous years.

15.2.2 Natural mortality and maturity at age

The values used are shown in Table 15.2

15.2.3 Age compositions and mean weight at age

The VPA age composition input data are given in Table 15.3, and the mean weight-at-age data (used as both catch and stock mean weights) are given in Table 15.4. The data were revised to take account of revisions in the landings data. Data for 1988 were provided by France and England.

15.2.4 VPA

No data are available for tuning the VPA and, therefore, a separable VPA was run. Trial values of terminal F and S were input and final values of F = 1 for age 3 and S = 1 were adopted. The log catch ratio residuals are given in Table 15.5. They indicate the high variability of the catch at age data. The separably-generated population numbers at age in 1988 were used to initiate a conventional VPA and the resulting estimates of F and N at age are given in Tables 15.6 and 15.7, respectively. The values of fishing mortality rate in 1985 and 1986 appear to be anomalous.

15.2.5 Estimates of recruitment

There are as yet no recruitment indices for this area; however, a survey was initiated by France in October 1988. The VPA estimates for age 1 do not correlate with any of the recruitment indices or with historical VPA values from the North Sea.

15.2.5.1 The 1987 year class in 1988

In the absence of other data, the number implied by the use of mean fishing mortality for the period 1976-1985 (0.126) was accepted. The value so obtained was 6 millions.

15.2.5.2 The 1988 and later year classes

These were estimated to be 6.6 million fish at age 1, the geometric mean for the period 1976-1988.

15.2.6 Long-term trends in biomass, fishing mortality, and recruitment

Historical values of biomass, fishing mortality, and recruitment are given in Table 15.8 and are plotted in Figure 15.1. Total biomass has apparently increased in recent years as a result of increased recruitment.

15.2.7 Catch and biomass predictions

Input data for predictions are given in Table 15.9 and the results are given in Table 15.10 and Figure 15.2. The predicted status quo catch for 1989 is 11,000 t followed by 9,000 t in 1990. Spawning biomass is predicted to increase from 4,000 t in 1989 to 5,000 t in 1990 but will fall to 3,000 t at the start of 1991.

15.2.8 Yield and biomass per recruit

Plots of yield and biomass per recruit are shown in Figure 15.2.

15.2.9 Safe biological limits

The stock/recruit scatter diagram is shown in Figure 15.3. Values for F_{med} (1.2) and F_{high} (1.7) are shown in Figure 15.2. The current level of F is estimated to be 1.33.

15.2.10 Reliability of assessment

It was pointed out last year that the data on which this assessment is based are less reliable than for most other stocks dealt with by this Working Group. Although there has been some improvement in the data base, it remains likely that the reliability of the assessment is lower than for the other stocks.

15.3 Cod in Division VIIe

15.3.1 Catch trends

Nominal landings for recent years together with Working Group estimates are given in Table 15.11

15.3.2 Catch prediction

There are no age- and few length-composition data for past years. Sampling of landings in England started this year.

It was decided to carry out a SHOT forecast for this area using recruitment data for Divisions VIIf,g since there is some evidence that cod in these two areas are linked. The results of the SHOT forecast using Working Group estimates of landings are given in Table 15.12. Status quo landings are predicted to fall from 1,600 t in 1988 to 1,100 t in 1989, reducing further to 800 t in 1900. These predictions are sensitive to the assumption of constant yield/biomas ratios over the years and to the recruitment weights adopted.

16 HADDOCK IN SUB-AREA IV

16.1 Catch Trends

Official landings figures are given in Table 16.1. Total international catches and total international discards as estimated by the Working Group are given in Table 16.2. Catch trends are plotted in Figure 16.1. Total human consumption landings in 1988 were 105,000 t which is rather lower than the fairly stable range of landings (130,000-160,000 t) in the period 1981-1986. Industrial by-catch remains low at 4,000 t.

The agreed TAC for 1988 was 185,000 t and was largely based on an overestimate of the abundance of the 1986 year class.

16.2 Natural Mortality and Maturity at Age

These values are given in Table 16.3 and are the same as those used last year.

16.3 Age Compositions

Total international catch at age are given in Table 16.4. Age compositions for human consumption landings were supplied for 1988 by Belgium, France, Federal Republic of Germany, England, Denmark, and Scotland. Age compositions for discards were supplied by Scotland, and for industrial by-catch by Denmark and Norway.

16.4 Mean Weights at Age

Total international mean weights at age are given in Table 16.5. These values are also used as stock mean weights at age.

16.5 Commercial Catch/Effort Data and Research Vessel Indices

These data were used to tune the VPA and to provide recruitment estimates. The commercial fleet data used to tune the VPA are indicated in the text table in Section 11. The research vessel indices are presented in Table 10.2.

16.6 VPA Tuning

The estimates of F-at-age and numbers-at-age resulting from the tuning are given in Tables 16.6 and 16.7, respectively.

16.7 Abundance Estimates of the Year Classes 1986-1988

Methods for estimating recruitment are described in Section 10.

16.7.1 1986 year class in 1988

The abundance of the 1986 year class at age 2 was estimated by RCRTINX2 as 944 million. This value may be compared to the value of 1,020 million obtained by Laurec-Shepherd tuning. The predicted abundance of this year class at age 2 made by last year's Working Group (April 1988) was 707 million. In the review of the 1989 TAC presented to the ACFM meeting of May 1989, the predicted abundance of this year class at age 2 was 751 million.

16.7.2 1987 year class in 1988

The RCRTINX2 estimate of the 1987 year class at age 1 is 553 million which compares favorably with the estimate of 576 million obtained from Laurec-Shepherd tuning. The Roundfish Working Group of April 1988 estimated this abundance as 825 million. In the revue of the 1989 TAC of May 1989, this year class was estimated at 470 million. While these results are somewhat variable they all indicate that the 1987 year class is one of the least abundant on record.

16.7.3 1988 year class in 1989

The RCRTINX2 estimate of this year class at age 1 is 980 million. In the review document presented to ACFM in May 1989, this year class was estimated at 1,300 million at age 1. These values may be compared to the estimate made by ACFM in November 1988 of 1,219 million.

16.7.4 1989 year class in 1990

RCRTINX2 allows prediction of the abundance of this year class using abundance indices at age 0 in 1989 from the Scottish and English Groundfish Surveys carried out in August-September. The estimated abundance is 1,900 million, indicating yet another poor year class. (The approximately equivalent number at age 0 in 1989 is 1,900*exp(2.05)=14,870 million.)

16.7.5 Abundance of the 1990 and 1991 year classes at age 0

The abundances of these year classes were assumed to be 26,392 million, the geometric mean value for the period 1969 to 1988.

16.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

Trends in biomass, fishing mortality and recruitment are given in Table 16.8 and are plotted in Figure 16.1. Human consumption fishing mortality rate is currently among the highest on record. Industrial by-catch fishing mortality remains at the low level of recent years.

As noted above, recent recruitments have been poor. Since 1984, only the 1986 year class has been of average abundance, all other year classes being below average. This has resulted in the estimate of total stock size at the start of 1988 (which excludes 0-group haddock) being the lowest on record at 398,000 t. The 1988 spawning biomass is slightly higher than in the period 1978-1980 but is among the lowest on record at 149,000 t. At the start of 1989, total stock size is estimated to be 329,000 t, while spawning stock size is estimated at 137,000 t.

16.9 Catch and Biomass Predictions

Input data for predictions are given in Table 16.9. Values of F at ages 0, 1 and 2 in 1988 obtained by tuning were replaced by mean Fs for the period 1984-1988.

16.9.1 Prediction for 1989

The agreed TAC is 68,000 t. If catches for human consumption and as industrial by-catch do not exceed this value, the human consumption fishing mortality rate will decrease by 50% compared to that of 1988.

In recent weeks, Scottish fishing vessels have been prohibited from landing haddock from the North Sea because their quota of the North Sea TAC has been exhausted. However, landings of other species are permitted and, therefore, fishing will continue. It is inevitable that haddock will be caught by this fishery and these catches will not be recorded in official statistics. In these circumstances it is difficult to forecast the real fishing mortality rate on haddock in 1989. There is some preliminary evidence that Scottish fishing effort in the North Sea decreased prior to the prohibition on landings of haddock. It is also likely that the landings prohibition will lead to a further decrease in fishing effort. The Group decided that the best that can be done at present is to assume that human consumption fishing mortality on haddock will be reduced by 10% during 1989.

The prediction presented in Table 16.10 and graphically in Figure 16.2 is contingent on this assumption. In the absence of a prohibition on landings, it is predicted that human consumption landings in 1989 would be 92,000 t, industrial by-catch would be 3,000 t and discards would be 17,000 t. If landings do not exceed the TAC of 68,000 t, it is, therefore, expected that discarding will be increased by 24,000 t. Spawning biomass at the start of 1990 is expected to be 89,000 t which is well below any previously recorded level.

16.9.2 Catch predictions for 1990

If human consumption fishing mortality rate in 1990 reverts to the level of 1988, it is expected that landings will be 64,000 t (61,000 t human consumption + 3,000 t industrial by-catch) and 24,000 t will be discarded. Spawning biomass at the start of 1991 is expected to decrease further to 76,000 t.

16.10 Safe Biological Limits

The stock-recruitment plot is shown in Figure 16.3. In its report of 1987, the Group suggested that 100,000 t should be the lowest acceptable level for spawning biomass. It appears that, given the sequence of poor recruitments in recent years, spawning biomass is about to fall well below this level. If the assumptions made about likely changes in fishing mortality in 1989 are correct, it appears that a reduction in fishing mortality in 1990 to 60% of the 1988 level is required to leave a spawning biomass in the sea of 98,000 t at the start of 1991. To achieve this result, landings in 1990 would need to be limited to 46,000 t (43,000 t human consumption + 3,000 t industrial by-catch).

16.11 Further Comments on the Abundance of the 1986 Year Class

The predictions referred to above depend critically on the estimated abundance of the 1986 year class in 1988 since this is at present the year class on which the fishery is almost totally dependent. As indicated in Section 16.7.1, the abundance of this year class at age 2 estimated at this meeting is about 30% greater than predictions of this abundance made previously. The current estimate of abundance depends heavily on IYFS indices at age 1 and 2 which are more heavily weighted by RCRTINX2 than the other indices currently available. In the recent past, it has repeatedly been found (retrospectively) that abundance estimates of haddock based purely or largely on IYFS indices have been considerable overestimates. This has been the major contributor to setting TACs for the last 5 years which have been too great for the fleet to catch.

An alternative estimate of the abundance of the 1986 year class at age 2 was made using only the Scottish and English Groundfish Survey data. The abundance estimated in this way is 734 million. This value is much more in line with previous predictions.

If this value is accepted, the predicted landings in 1989, assuming a 10% reduction in fishing mortality, are 80,000 t. (Alternatively, strict adherence to the TAC of 68,000 t implies a reduction in fishing mortality to 70% of the 1988 level). The associated *status quo* landings in 1990 are 57,000 t. Spawning biomass in 1988 is 134,000 t, decreasing to 117,000 t in 1989, 79,000 t in 1990, and 72,000 t in 1991.

16.12 Working Group Advice on TAC for 1990

Given the uncertainty about probable catches and hence fishing mortality in 1989, the Group suggests that the TAC for 1990 should be set at a level which, on the basis of the results presented in Table 16.10, will reduce fishing mortality by 20% compared to 1988. This will result in a TAC for 1990 of 56,000 t (53,000 t human consumption + 3,000 t industrial by-catch) and a potential spawning biomass at the start of 1991 of 86,000 t.

The situation should be reviewed early in 1990, when the index of abundance of the 1989 year class at age 1 will be available from the IYFS and when catch-at-age data reflecting the actual yield in 1989 will also be available.

16.13 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 16.2.

16.14 Catch at Age Data for 1989

Provisional estimates of the total international age composition for the first half of 1989 are given in Table 16.11. These data are very preliminary and were not provided by all nations which usually contribute to the data set. It is, therefore, difficult to assess the significance of this material.

17 HADDOCK IN DIVISION VIa

17.1 Catch Trends

Officially reported landings are given in Table 17.1. Total international catches and total international discards estimated by the Working Group are given in Table 17.2. Catch trends are plotted in Figure 17.1. Total human consumption landings in 1988 were 21,000 t compared to 27,000 t in 1987 and 20,000 t in 1986.

There is no TAC explicitly applicable to Division VIa. The TAC for the whole of Sub-area VI is 35,000 t.

17.2 Natural Mortality and Maturity at Age

These values are given in Table 17.3.

17.3 Age Compositions

Total international catch at age are given in Table 17.4. Age compositions for human consumption landings for 1988 were supplied by France, England, Ireland, and Scotland. Age compositions for discards were supplied by Scotland.

17.4 Mean Weights at Age

Total international mean weights at age are given in Table 17.5. These values were also used as stock weights at age.

17.5 Commercial Catch/Effort Data and Research Vessel Indices

The commercial catch and effort data used to tune the VPA are indicated in the text table in Section 11. Abundance indices from research vessel surveys and from Scottish light trawlers and seiners used in attempts to estimate recent recruitment are shown in Table 10.5.

17.6 VPA Tuning

Values of F-at-age and numbers-at-age resulting from tuning are shown in Tables 17.6 and 17.7, respectively.

17.7 Abundance Estimates of the Year Classes 1986-1988

Methods for estimating recruitment are described in Section 10. None of the many attempts by the Group to estimate recruitment, using various combinations of indices as input to RCRTINX2, was considered satisfactory.

17.7.1 1986 year class in 1988

This abundance was estimated as 150 million from RCRTINX2, using Scottish CPUE data at ages 1 and 2 for light trawlers and seiners and North Sea estimates of abundance at age 2 as input. This value compares reasonably well with that of 135 million obtained from Laurec-Shepherd tuning. In last year's report, this value was predicted as 68 million.

17.7.2 1987, 1988 and 1989 year classes at age 1

No acceptable results were obtained from RCRTINX2 for these year classes.

There is a historical relationship between recruitment in Division VIa and that in the North Sea. On this basis, the Group felt that it is legitimate to assume that the year classes of 1987, 1988, and 1989 are all of below-average abundance (this was also indicated by the RCRTINX2 results even though the latter were not accepted). The Group decided to assume the lower quartile value of historical recruitment at age 1 for these year classes. This value is 40 million.

17.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

Trends in biomass, fishing mortality, and recruitment are given in Table 17.8 and are plotted in Figure 17.1. Human consumption fishing mortality in 1988 is estimated to be less than that in 1987 and to approximate to the average level for the last 5 years. Total stock biomass and spawning biomass have been relatively stable in the last 10 years, but the estimates for 1988 are at the lower end of the historical range. In last year's assessment the 1986 year class was estimated as having average abundance. This year's assessment indicates that it is of above-average abundance. All other year classes after that of 1983 are estimated to be of below-average abundance.

17.9 Catch and Biomass Predictions

Input data for predictions are given in Table 17.9. Values of F for 1988 for ages 0, 1 and 2 obtained from tuning were replaced by mean values for the period 1984-1988.

17.9.1 Status quo catch prediction

Table 17.10 and Figure 17.2 give results of predictions assuming that fishing mortality in 1989 will be the same as that in 1988. The predicted human consumption landings in 1989 are 23,000 t. This value is greater than the 18,000 t predicted last year, mainly because of the upward revision of the abundance of the 1986 year class in 1988. Human consumption landings at status quo fishing mortality in 1990 are predicted as 17,000 t. The decline compared to 1989 is due to the expected entry into the fishery of a succession of poor year classes.

In parallel with this sequence of predicted catches, spawning biomass is expected to decrease from 57,000 t in 1988 to 41,000 t at the start of 1990 and to 29,000 t at the start of 1991. The latter value is equal to the lowest on record.

The arbitrary or unsatisfactory nature of the estimates of abundance of the year classes 1986-1989 should not be forgotten when considering the catch and biomass predictions.

17.10 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 17.2.

17.11 Safe Biological Limits

The value of F_{med} (0.52) is shown in Figure 17.2. The value of F_{high} is 2.5. Spawning biomass is expected to reach the lowest recorded level in the near future but the doubts about estimates of recent recruitment should not be forgotten in this context. The stock-recruitment plot is shown in Figure 17.3.

17.12 Catch at Age in the First Quarter of 1989

Scottish catch-at-age data for the first quarter of 1989 are presented in Table 17.11.

18 HADDOCK IN DIVISION VIb

18.1 Catch Trends

Officially reported landings for recent years are given in Table 18.1. The nominal landings in 1988 were 7,678 t which is very similar to the 1987 value.

18.2 Age Compositions

Age compositions were available from Ireland, England, and Scotland. These were used to estimate total international catch at age given in Table 18.2. The 1984 year class dominates the landings, accounting for over 70% of the landed weight.

18.3 Mean Weight at Age

Mean weights at age in the catch are given in Table 18.3.

18.4 Abundance Indices

Table 18.4 gives the abundance indices obtained from various surveys since 1967. During August 1988 and 1989, Scotland conducted surveys at Rockall using the research vessel "Scotia". Only the surveys since 1985 are in any way consistent in that the gear and timing of the surveys were the same, but the vessels were different. In the assessment presented below only the survey data from 1985 were used.

18.5 Assessment

The assessment methodology is described in Cook (1989) and is an extension of the methods used in the 1988 Roundfish Working Group. A linear model has been fitted to the research vessel data to obtain an index of year-class strength corrected for changes in survey vessel. The main departure from last year's methodology is that a constant term has been omitted from the fitted model. This reduces the variance of the parameter estimates and hence makes estimation more robust. Results from fitting the model are presented in Table 18.5. The analysis indicates that the 1986 year class is not as strong as previously thought but that the 1989 year class is strong.

At the 1988 Working Group meeting, the catch-at-age data were analyzed using the same linear model. This year, the catch-at-age data were analyzed using a version of separable VPA. This separable model estimates the parameter values by minimizing the sum of squares of the log catch residuals. The year effects are constrained so that the slope of the year effects with time is the same as that of the slope of effort data with time. Relative effort data for Scottish vessels are given in Table 18.6. The slope of these data with time is 0.1803. Results of fitting the model to the catch-at-age data are given in Table 18.7. The table shows the fitted values of fishing mortality rate, fitted numbers at age, and the log catch residuals. The residuals are large and this inevitably undermines the reliability of the estimated values.

18.6 Catch Forecast

The parameterization of the catch-at-age data provides a basis for a short-term forecast since the estimated values can be used to roll the population forward in much the same way as in a conventional forecast. Estimates of recruitment are also required. These have been obtained by performing a calibration regression of the VPA-estimated populations at age 2 on the survey index at age 0. Table 18.8 gives the input data used, the regression analysis, and the fitted recruitment values at age 2. The regression is plotted in Figure 18.1. It should be noted that the recruitment values from VPA at age 2 for the year classes 1979-1982 are derived from the population vector in 1979 normalised to age 2 assuming status quo fishing mortality in earlier years. This has been done to use as many data points as possible to derive the regression equation.The fitted values have been shrunk towards the mean. The recruitment values used in the catch predictions are those for the year classes 1986-1989.

Table 18.9 gives the estimated spawning stock size and fitted yield for the years 1985-1988 and the predicted values for 1989-1991. An approximation to a 95% confidence interval is given for these estimates. These should not be over-interpreted and simply serve to illustrate the imprecision of the forecast. It should be noted that the present forecasts are substantially lower than those in last year's report. This is primarily due to the re-evaluation of the abundances of the 1985 and 1986 year classes. However, the predictions are now much more in line with recent landings. It is extremely important to interpret the forecasts cautiously since the forecast is incorporated in the TAC for the whole of Sub-area VI. A high TAC for Sub-area VI may be very damaging to haddock in Division VIa if the TAC is dominated by the Rockall forecast as it was for 1989.

19 HADDOCK IN SUB-AREA VII

Nominal landings in Divisions VIId,e are shown in Table 19.1, landings in Divisions VIIb,c are shown in Table 19.2 and landings in Divisions VIIg-k are shown in Table 19.3.

20 WHITING IN SUB-AREA IV

20.1 Catch Trends

Total nominal landings and total international catches as estimated by the Working Group are given in Tables 20.1 and 20.2, respectively. Total international catches in 1988 amounted to 128,000 t, of which 51,000 t were human consumption landings and 49,000 t were industrial by-catch. The industrial by-catch was the highest since 1981. However, total estimated landings were well below the predicted landings for 1988 of 152,000 t given in last year's report and also below the TAC of 120,000 t. Catch trends for the last 20 years are shown in Figure 20.1. The decline of catches and landings in the late 1970s and early 1980s appears to have stopped.

20.2 Natural Mortality and Maturity at Age

Natural mortality rate and proportion mature at age are shown in Table 20.3.

20.3 Age Compositions

Age composition data on human consumption landings were provided by Scotland, Netherlands, England, Belgium, and France. Scotland provided data on discard age compositions. Denmark and Norway provided data on age compositions of industrial by-catch. Total international catch-at-age data are given in Table 20.4.

20.4 Mean Weight at Age

Total international mean weight-at-age data for the catch (also used as stock mean weight at age) are given in Table 20.5.

20.5 Commercial Catch/Effort Data and Research Vessel Indices

Commercial fleet catch and effort data used to tune the VPA are indicated in the text table in Section 11. Research vessel indices are shown in Table 10.3.

20.6 VPA Tuning

Total international fishing mortality rates and stock numbers at age resulting from the VPA tuning are presented in Tables 20.6 and 20.7, respectively.

20.7 Abundance Estimates of the Year Classes 1986-1989

20.7.1 The 1986 year class in 1988

This was estimated by RCRTINX2 to be 962 million compared to a tuned VPA of 1,000 million. Last year's Working Group predicted this abundance as 1,667 million.

20.7.2 The 1987 year class in 1988

RCRTINX2 estimated this year class as 3,044 million compared to the tuned VPA value of 2,022 million. Last year's Working Group predicted this abundance as 3,504 million.

20.7.3 The 1988 year class in 1989

RCRTINX2 estimated this year class as 5,503 million. Natural mortality rate at age 0 is 2.55, and hence the corresponding approximate number at age 0 in 1988 is 5503 x exp(2.55) = 70,480 million. Last year's Working Group estimated this number as the historical arithmetic mean of 4,759 million.

20.7.4 The 1989 year class in 1990

RCRTINX2 estimated this year class using 0-group indices from English and Scottish surveys in 1989 as 3,225 million at age 1 in 1989, corresponding approximately to 41,000 million at age 0 in 1988.

20.7.5 The 1990 and 1991 year classes at age 0

The abundance of these year classes was set at 43,305 million, the geometric mean value for the period 1969-1988.

20.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

These values are given in Table 20.8 and are plotted in Figure 20.1. Mean fishing mortality has decreased and is curently at the lowest value (0.81) since 1983. Industrial by-catch fishing mortality has increased considerably in 1988 to 0.17, the highest value since 1981. Spawning stock biomass has decreased slightly and remains below the average of 378,000 t for the period 1969-1988. The 1988 year class is estimated to have been very abundant, being the third largest since 1969.

20.9 Catch and Biomass Predictions

Input data for predictions are given in Table 20.9. The F values for ages 0-2 have been set to the mean values for the period 1984-1988 and differ from the tuned VPA values.

20.9.1 Status quo prediction

The results of the status quo prediction are given in Table 20.10 and Figure 20.2. The predicted human consumption landings in 1989 are 66,000 t and the industrial by-catch is 72,000 t. The high prediction of industrial by-catch is due to the expected large numbers of young fish in the sea and to the recent apparent increase in fishing mortality rate by the industrial fishery. In 1990, the human consumption landings are expected to be 72,000 t and the industrial by-catch 68,000 t. Spawning stock biomass is expected to rise to 325,000 t 1n 1989 and to 391,000 t in 1990, followed by a fall to 354,000 t in 1991.

20.9.2 TAC prediction

The agreed TAC for North Sea whiting in 1989 is 115,000 t. This TAC was set on the basis of assumed average recruitment in 1988. Due to the strong 1988 year class, the catches by the small-mesh fisheries are expected to be much higher than predicted in the 1988 report. In such a situation strict adherence to the TAC in 1989 would require a 50% reduction in human consumption fishing mortality and this is considered unrealistic. Predictions for 1990 on the assumption of adherence to the TAC in 1989 have not been presented.

20.10 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 20.2

20.11 Safe Biological Limits

The scatter diagram of recruitment and spawning stock is shown in Figure 20.3. The value of F_{med} (0.48) is shown in Figure 20.2. The value of F_{high} (3.0) is too great to indicate on Figure 20.2. Current F is 0.81. The spawning stock is currently above its historical minimum and is expected to increase in 1989 and 1990.

20.12 Age Composition for First Half of 1989

A very preliminary estimate of the age composition of the human consumption landings and discards in the first half of 1989 is shown in Table 20.11. Little use can be made of these data since no corresponding age composition estimates were available for the industrial by-catch which is expected to form an important component of the catch in 1989. Even if these data had been available, they would have been of relatively little use since the majority of the industrial by-catch of whiting is taken in the second half of the year.

21 WHITING IN DIVISION VIa

21.1 Catch Trends

Total nominal landings are given in Table 21.1 and total international landings, as estimated by the Working Group, are given in Table 21.2. Total international landings in 1988 amounted to 11,500 t, which is almost equal to the status quo prediction of 12,000 t made by last year's Working Group. The agreed TAC for Sub-area VI in 1988 was 16,400 t. Catch trends are plotted in Figure 21.1. Recent landings remain at a historically low level.

21.2 Natural Mortality and Maturity at Age

Natural mortality rates and proportion mature at age are given in Table 21.3.

21.3 Age Composition

Total international age composition data are shown in Table 21.4. Age composition data for 1988 were provided by Scotland and Ireland. Data on discards are not yet included in this data set. Landings were dominated by 2-year-old fish which represented 52% by number.

21.4 Mean Weight at Age

Total international mean weight at age data are shown in Table 21.5. These data were also used as stock mean weights at age.

21.5 Commercial Catch/Effort Data and Research Vessel Indices

The commercial catch effort data used to tune the VPA are indicated in the text table in Section 11. Research vessel abundance indices and CPUE data for ages 1 and 2 for Scottish light trawlers and seiners used in various runs of RCRTINX2 are shown in Table 10.6.

21.6 VPA Tuning

Total international fishing mortality rates and stock numbers provided by Laurec-Shepherd tuning are given in Tables 21.6 and 21.7, respectively.

21.7 Abundance Estimates of the Year Classes 1986-1989

Methods used to estimate recruitment are described in Section 10.

21.7.1 The 1986 year class in 1988

Many combinations of research vessel indices and commercial CPUE data were input to RCRTINX2 in an attempt to estimate the abundance of this year class. No fully satisfactory result was obtained. The Working Group decided that the results obtained using Scottish CPUE data for ages 1 and 2 for light trawlers and seiners and North Sea VPA abundances at age 2 gave the most acceptable result. On this basis, the abundance was estimated to be 60 million. This may be compared to the estimate from tuning of 54 million.

21.7.2 The 1987 year class in 1988

The abundance of this year class was estimated to be 40 million at age 1, using the same inputs to RCRTINX2 as those used to estimate the abundance of the 1986 year class. The tuned value is 13 million.

21.7.3 The 1988 and later year classes

These were set at the geometric mean value at age 1 for the period 1969-1988 of 62 million.

21.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

These are given in Table 21.8 and are plotted in Figure 21.1. Mean fishing mortality has increased and is currently 0.89, one of the highest values in the last 20 years. Spawning biomass has increased slightly but remains below the historical average of 32,600 t. The 1987 year class is estimated to be of below-average abundance.

21.9 Catch and Biomass Predictions

Input data for predictions are given in Table 21.9. The F values for ages 1 and 2 in 1988 have been set to the mean value for the period 1984-1988.

21.9.1 Status quo prediction

Results of the status quo prediction are given in Table 21.10 and Figure 21.2. The predicted landings in 1989 and 1990 are both 11,000 t. Spawning stock is expected to fall to 19,000 t in 1989 and 1990, followed by a slight increase to 20,000 t in 1991.

21.9.2 TAC prediction

The agreed TAC for whiting in Sub-area VI in 1989 is 16,400 t. To take this TAC would require an unrealistic increase in fishing mortality in 1989 and no corresponding prediction for 1990 is presented.

21.10 Yield and Biomass per Recruit

Plots of yield and biomass per recruit are shown in Figure 21.2.

21.11 Safe Biological Limits

The scatter diagram of spawning stock and recruitment is shown in Figure 21.3. The values for F_{med} and F_{high} are shown in Figure 21.2. The current value of F(0.89) is well above F_{med} (0.53) but is close to the value of F_{max} (0.84). The spawning stock is at a low level and is not expected to increase significantly in the near future.

21.12 Catches in 1989

The age composition of landings by Scotland in the first quarter of 1989 are shown in Table 21.11. It is difficult to interpret the significance of these data.

22 WHITING IN DIVISION VIb

Landings of whiting in Division VIb are insignificant (Table 22.1).

23 WHITING IN SUB-AREA VII

23.1 Whiting in Divisions VIId,e

In recent years, analytical assessments have been attempted for whiting in Divisions VIId,e. Age composition data are available from England and France for Division VIId but from England only for Division VIIe, but no data for Division VIIe were available for 1988. It was, therefore, decided to restrict the analytical assessment to Division VIId and to attempt a SHOT forecast for Division VIIe.

23.2 Whiting in Division VIId

23.2.1 Catch trends

Nominal landings are given in Table 23.1, together with Working Group estimates. Total landings have been decreasing since 1976 and were 52,000 t in 1988 (Figure 23.1).

23.2.2 Natural mortality and maturity at age

Natural mortality rates and proportion mature at age are given in Table 23.2.

23.2.3 Age composition and mean weight at age

The VPA input data are given in Tables 23.3 and 23.4, respectively. Further revisions were made to age compositions for the period 1976-1986 to take account of revisions to the landings data. Data for 1988 were provided by England and France. Weight at age in the stock was assumed to be the same as that in the landings.

23.2.4 VPA

No data are available for tuning the VPA. A separable VPA was run. Trial values of F and S were input and final values of F = 1 for age 3 and S = 1 were adopted. The log catch ratio residuals are given in Table 23.5. They indicate the high variability of the catch-at-age data.

The separably generated population numbers were used to initiate a conventional VPA and the resulting estimates of fishing mortality rate and numbers at age are given in Tables 23.6 and 23.7, respectively.

23.2.5 Recruitment estimates

There are no data from which to estimate recent recruitment in this area. The historical VPA estimates of recruitment do not correlate with any of the survey indices in the North Sea or with VPA estimates in that area.

23.2.5.1 The 1987 year class in 1988

In the absence of other data, the number implied by the use of mean fishing mortality rate for the period 1976-1985 (0.036) was adopted. The value so obtained was 67 million.

23.2.5.2 The 1988 and later year classes

These were set at 44 million fish at age 1, the geometric mean for the period 1976-1988.

23.2.6 Long-term trends in fishing mortality, biomass, and recruitment

These are tabulated in Table 23.8 and graphed in Figure 23.1. Fishing mortality has decreased in the last two years but remains at a high level. Total biomass has increased but the spawning biomass is very close to its lowest level.

23.2.7 Catch and biomass predictions

Input data for predictions are given in Table 23.9. Results of predictions are given in Table 23.10 and Figure 23.2.

The predicted *status quo* landings for 1989 are 7,000 t followed by 8,000 t in 1990. Spawning stock is predicted to increase to 15,000 t in 1989 and 1990 and to remain close to this level (14,000 t) in 1991.

23.2.8 Yield and biomass per recruit

Plots of yield and biomass per recruit are shown in Figure 23.2.

23.2.9 Safe biological limits

The stock/recruit scatter diagram is shown in Figure 23.3. The values for F_{med} and F_{max} are shown in Figure 23.2. The current level of F (0.94) is well below F_{max} (1.24). Spawning biomass is low but is above the historical minimum.

23.2.10 Reliability of assessment

Although there have been some improvements in the data base since last year's meeting, it is pointed out that the reliability of this assessment is lower than that for the majority of the other stocks dealt with by this Working Group.

23.3 Whiting in Division VIIe

23.3.1 Catch trends

Nominal landings for recent years together with Working Group estimates are given in Table 23.11.

23.3.2 Catch prediction

In the absence of catch-at-age data for 1986, it was decided to attempt a SHOT forecast. This method needs estimates of recruitment. Recruitment estimates were available from VPA for Divisions VIIa (from the Irish Sea and Bristol Channel Working Group) and

VIId (from this meeting). A separable VPA for the period 1976-1987 was carried out for Division VIIe from which recruitment estimates were obtained. These estimates were not correlated with recruitment in Division VIIa or in Division VIId. It was, therefore, decided that the SHOT forecast for Division VIId should not be attempted.

A precautionary TAC set at the average catch for the period 1976-1988 of 1,300 t could be considered.

23.4 Whiting in Divisions VIIb,c,h-k

Nominal landings for the period 1984-1988 are given in Table 23.12.

24 SAITHE IN SUB-AREA IV AND DIVISION IIIa

24.1 Catch Trends

Recent nominal landings are given in Table 24.1. Working Group estimates are given in Table 24.2 and are plotted in Figure 24.1. Landings were high in the early 1970s, reaching a maximim of 320,000 t in 1976. Subsequently, landings declined to minimum of 114,000 t in 1979, increased to 200,000 t in 1985 but have since fallen again to 149,000 t in 1987 and a preliminary value of 105,000 t in 1988. Small amounts of saithe are taken as industrial by-catch. Since 1976, the average industrial by-catch has been 3,100 t. The agreed TAC for 1988 was 170,000 t.

24.2 Natural Mortality Rate and Maturity at Age

Values of natural mortality rate and maturity at age are given in Table 24.3.

24.3 Age Compositions

Total international age compositions are given in Table 24.4. Data for 1988 were supplied by Denmark, Federal Republic of Germany, France, Norway, Scotland, and England. Discards are not included.

24.4 Mean Weight at Age

Mean weight at age in the landings are given in Table 24.5. These are also used as stock mean weights.

24.5 Commercial Catch/Effort Data

Commercial catch and effort data used to tune the VPA are indicated in the text table in Section 11. There are no research vessel indices of abundance for saithe.

24.6 VPA Tuning

The quality of the catch-at-age data for the older ages is considered to be poor. This is also the case for saithe in Sub-area VI. In the latter case, the use of these poor data led to estimates of biomass which were thought to be over-optimistic. The age composition data for Sub-area VI were, therefore, aggregated into a plus-group for ages 10 and older. A similar procedure was adopted for saithe in Sub-area IV but this had little effect on the results. Fishing mortality rates estimated by Laurec-Shepherd tuning are given in Table 24.6 and stock numbers are given in Table 24.7.

24.7 Recruitment

No data to estimate recent recruitment are available. The number of saithe estimated at age 1 in 1988 (1987 year class) by tuning appeared to be unrealistically low. The Group, therefore, decided to assume geometric mean recruitment at age 1 for the year classes 1987 onwards (237 million fish).

24.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

These are given in Table 24.8 and are plotted in Figure 24.1. In recent years, fishing mortality has increased from 0.31 in 1981 to 0.75 in 1986. Fishing mortality in 1987 and 1988 are estimated to be 0.46 and 0.40, respectively. This reduction is supported by the fact that fishing effort by French and Norwegian vessels (the major catchers of saithe in the North Sea) has decreased by 50% since 1986. Total biomass has declined from 713,000 t in 1983 to 526,000 t in 1988 and spawning biomass has declined from 463,000 t in 1974 to 114,000 t in 1985 which is the lowest on record.

24.9 Catch and Biomass Predictions

Input data for prediction are given in Table 24.9. The fishing mortality rate at age 1 in 1988 is the mean value for the period 1984-1988. Results of the predictions are given in Table 24.10 and Figure 24.2.

24.9.1 Status quo prediction

Maintenance of the 1988 level of fishing mortality in 1989 will lead to landings of 118,000 t in 1989 and 120,000 t in 1990. Predicted spawning stock size is predicted to increase from 186,000 t in 1988 to 240,000 t in 1991. However, the assumptions about recent and future recruitment should not be forgotten in this context.

24.9.2 Prediction assuming that TAC taken in 1989

The Group felt that the increase in fishing mortality required to take the TAC of 170,000 t in 1989 is unrealistic and no predictions on this basis are presented.

24.9.3 Yield and biomass per recruit

Yield and biomass per recruit are shown in Figure 24.2

24.9.4 Safe Biological Limits

The stock/recruit scatter diagram is shown in Figure 24.3. F_{med} (0.45) and F_{high} (0.62) are shown in Figure 24.2. The current level of F is a little lower than F_{med}. Spawning biomass is predicted to increase but this assumes geometric average recruitment for the year classes 1987 onwards.

24.9.5 Catches in 1989

Very provisional estimates of catch-at-age for the first quarter of 1989 are presented in Table 24.11. A catch of 18,000 t is estimated which might indicate a low catch for 1989.

25 SAITHE IN SUB-AREA VI

25.1 Catch Trends

Recent nominal landings are given in Table 25.1. Working Group estimates are given in Table 25.2 and are plotted in Figure 25.1. Landings increased in the early 1970s reaching 42,000 t in 1976. Landings then declined to 25,000 t in the early 1980s and then increased to 40,000 t in 1986. Landings were 31,000 t in 1987 and 34,000 t in 1988. The agreed TAC for 1988 was 35,000 t.

25.2 Natural Mortality Rate and Maturity at Age

Values of natural mortality rate and maturity at age are given in Table 25.3.

25.3 Age Compositions

Total international age compositions are given in Table 25.4. Data for 1988 were supplied by Federal Republic of Germany, France, England, and Scotland.

25.4 Mean Weight at Age

Mean weight at age in the landings are given in Table 25.5. These values were also used as stock mean weights.

25.5 Commercial Catch/Effort Data

The commercial catch and effort data used to tune the VPA are indicated in the text table in Section 11. There are no research vessel indices of abundance for saithe.

25.6 VPA Tuning

When using the full age-range of 1-15 years in the tuning process, very low fishing mortality rates and hence very high stock sizes were estimated for the older age groups. However, it is believed that the quality of the data for older ages is poor, and the Group, therefore, decided to aggregate data for ages 10 and older into a plus-group and to carry out tuning on this revised data set. Table 25.6 gives the fishing mortality rates and Table 25.7 gives the stock numbers estimated by tuning.

25.7 Recruitment

No data are available from which to estimate recent recruitment and the Group decided to assume geometric mean recruitment at age 1 for the year classes 1987 onwards.

25.8 Long-Term Trends in Biomass, Fishing Mortality, and Recruitment

These are given in Table 25.8 and are plotted in Figure 25.1. Fishing mortality has increased in recent years from 0.31 in 1980 to 0.58 in 1986. The estimates for 1987 and 1988 are 0.48 and 0.55, respectively. Total biomass increased from 99,000 t in 1977 to 145,000 t in 1985 and then declined to 116,000 t in 1988. Spawning biomass has declined from 93,000 t in 1974 to 48,000 t in 1988.

25.9 Catch and Biomass Predictions

Input data for predictions are given in Table 25.9. The fishing mortality rate at age 1 in 1988 is the mean value for the period 1984-1988 obtained from tuning. Results of predictions are given in Table 25.10.

25.9.1 Status quo prediction

Maintenance of the 1988 fishing mortality will result in landings in 1989 of 30,000 t followed by 29,000 t in 1990. Assuming geometric average recruitment of the 1987 and later year classes, spawning biomass is expected to decline from 48,000 t in 1988 to 30,000 t in 1991 which is lower than any on record.

25.9.2 Prediction assuming TAC taken in 1989

The agreed TAC for 1989 is 30,000 t which is the status quo predicted catch.

25.10 Yield and Biomass per Recruit

Yield and Biomass per recruit are shown in Figure 25.2.

25.11 Safe Biological Limits

The stock/recruit plot is shown in Figure 25.3. F_{med} (0.30) and F_{high} (0.42) are shown in Figure 25.2. The current level of F is well above F_{high}. Spawning biomass is predicted to fall to a historically low level even assuming geometric mean recruitment for the year classes 1987 onwards.

26 REFERENCES

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Table 4.1 Tagged cod returns.

a) Released in eastern English Channel

Quarter of release	Western Channel No.	Western Channel %	Eastern Channel No.	Eastern Channel %	North Sea No.	North Sea %
1	15	5.6	136	51.1	115	43.2
3	0	0	24	77.4	7	22.6
4	3	1.5	183	92.0	13	6.5
Total	18	3.6	343	69.2	135	27.2

b) Released in Southern North Sea

Quarter of release	Western Channel No.	Western Channel %	Eastern Channel No.	Eastern Channel %	North Sea No.	North Sea %
1	4	0.2	88	4.0	2110	95.8
4	4	0.3	28	2.4	1158	97.3
Total	8	0.2	116	3.4	3268	96.3

There were no recaptures in the Channel of cod tagged in the German Bight, Central North Sea and off the North-East coast.

There have been no tagging experiments in the Western Channel or Celtic Sea.

Table 6.1 Combined North Sea species prediction.

MSFP - NORTH SEA - 1989 WG Status Quo

PREDICTION of CATCHES and BIOMASSES in 1989 - Season # 1

Metier	E1989/E Ref	COD Catches	HADDOCK Catches	WHITING Catches	SAITHE Catches	TOTAL
HCL	1.000	135.55	97.94	65.36	117.84	416.69
Val		.00	.00	.00	.00	.00
DIS	1.000	.00	18.97	57.07	.00	76.04
Val		.00	.00	.00	.00	.00
IBC	1.000	.00	2.56	72.01	.49	75.07
Val		.00	.00	.00	.00	.00
TOTALS	x1000 t.	135.55	119.48	194.44	118.33	
	VALUE kU	.00	.00	.00	.00	
BIOMASS Start		411.63	329.49	730.83	568.38	
BIOMASS Final		422.53	386.97	641.32	597.69	
Final Sp. St. B.		83.07	82.11	390.63	243.81	
Recr. (M) 1989		328.00	14870.00	41290.00	237.09	
Recr. (M) 1990		314.00	26392.31	43304.90	237.09	

MSFP - NORTH SEA - 1989 WG

PREDICTION of CATCHES and BIOMASSES in 1990 - Season # 1

Metier	E1990/E Ref	COD Catches	HADDOCK Catches	WHITING Catches	SAITHE Catches	TOTAL
HCL	1.000	142.57	56.16	70.26	120.25	389.24
Val		.00	.00	.00	.00	.00
DIS	1.000	.00	24.39	55.02	.00	79.41
Val		.00	.00	.00	.00	.00
IBC	1.000	.00	2.77	68.53	.56	71.86
Val		.00	.00	.00	.00	.00
TOTALS	x1000 t.	142.57	83.32	193.80	120.82	
	VALUE kU	.00	.00	.00	.00	
BIOMASS Start		422.53	386.97	641.32	597.69	
BIOMASS Final		452.66	608.57	607.07	627.06	
Final Sp. St. B.		79.73	73.15	353.32	246.11	
Recr. (M) 1990		314.00	26392.31	43304.90	237.09	
Recr. (M) 1991		350.82	26392.31	43304.90	237.09	

cont'd.

Table 6.1 cont'd. $F_{89}/F_{88} = 0.9$ $F_{90}/F_{88} = 0.8$

MSFP - NORTH SEA - 1989 WG
PREDICTION of CATCHES and BIOMASSES in 1989 - Season # 1

Metier	E1989/E Ref	COD Catches	HADDOCK Catches	WHITING Catches	SAITHE Catches	TOTAL
HCL	.900	125.97	91.82	60.38	107.89	386.05
	Val	.00	.00	.00	.00	.00
DIS	.900	.00	17.49	51.88	.00	69.37
	Val	.00	.00	.00	.00	.00
IBC	1.000	.00	2.63	72.77	.50	75.90
	Val	.00	.00	.00	.00	.00
TOTALS	x1000 t.	125.97	111.94	185.03	108.39	
	VALUE kU	.00	.00	.00	.00	
BIOMASS Start		411.63	329.49	730.83	568.38	
BIOMASS Final		435.94	395.44	650.31	610.51	
Final Sp. St. B.		89.96	89.21	399.37	253.29	
Recr. (M) 1989		328.00	14870.00	41290.00	237.09	
Recr. (M) 1990		314.00	26392.31	43304.90	237.09	

MSFP - NORTH SEA - 1989 WG
PREDICTION of CATCHES and BIOMASSES in 1990 - Season # 1

Metier	E1990/E Ref	COD Catches	HADDOCK Catches	WHITING Catches	SAITHE Catches	TOTAL
HCL	.800	127.61	52.90	61.46	102.44	344.41
	Val	.00	.00	.00	.00	.00
DIS	.800	.00	20.28	45.57	.00	65.85
	Val	.00	.00	.00	.00	.00
IBC	1.000	.00	2.94	71.07	.60	74.61
	Val	.00	.00	.00	.00	.00
TOTALS	x1000 t.	127.61	76.12	178.10	103.03	
	VALUE kU	.00	.00	.00	.00	
BIOMASS Start		435.94	395.44	650.31	610.51	
BIOMASS Final		491.56	624.50	630.18	664.61	
Final Sp. St. B.		99.49	86.09	376.11	274.10	
Recr. (M) 1990		314.00	26392.31	43304.90	237.09	
Recr. (M) 1991		350.82	26392.31	43304.90	237.09	

Table 9.1 Current Mesh, Proportion of Fleets Changing to 120mm mesh

Nation	Gear	Current Mesh	Percentage Changing to 120mm Mesh
Denmark	All	90	79
Netherlands	All	90	20 *
Fed. Rep. Germany	All	100	90
Belgium	All	90	78
England	All	90	68
Norway	All	100	0 *
Scotland	Trawl	90	36
Scotland	Seine	90	21
Scotland	Light Trawl	90	27
Scotland	Nephrops Trawl	70	0 *
Scotland	Pair Trawl	90	28
France	All	90	20
Other	All	90	59

See text for specification of percentages marked *

Table 9.2 Current L50 and L25, L50 and L25 for 120mm Mesh

Nation	Gear	Mesh	COD		HAD		WHI	
			L50	L25	L50	L25	L50	L25
SCO	TRL	90	27.0	23.0	25.0	22.0	29.0	25.0
		120	45.0	40.0	33.0	30.0	46.0	42.0
SCO	SEI	90	22.4	18.0	19.6	16.1	24.1	20.3
		120	34.4	30.0	31.1	27.6	33.9	30.1
SCO	LTR	90	24.6	19.9	22.0	19.3	25.8	22.3
		120	41.5	36.8	30.2	27.4	42.6	39.0
SCO	NTR	70	25.0	20.0	22.0	19.0	27.0	24.0
SCO	PTR	90	22.4	18.0	19.6	16.1	24.1	20.3
		120	34.4	30.0	31.1	27.6	33.9	30.1
FRG, NOR	All	100	36.0	32.7	34.0	31.2	38.0	34.5
		120	43.2	39.3	40.8	37.4	45.6	41.5
Other	All	90	32.4	29.5	30.6	28.0	34.2	31.1
		120	43.2	39.3	40.8	37.4	45.6	41.5

Note : Selectivity parameters for saithe assumed to be the same as those for cod

Table 9.3 Percent change in total catch following adoption of 120 mm mesh when fishing for cod.

TOTAL CATCHES

1990	COD	HAD	WHI	SAI
DENALL	-6.1	-24.0	2.6	-10.7
NETALL	-3.3	-11.6	-14.7	-4.4
FRGALL	-34.0	-25.3	-68.1	-18.6
BELALL	-34.6	-49.7	-69.0	-15.0
ENGALL	-20.2	-46.4	-59.7	-12.6
NORALL	2.9	3.0	4.8	0.7
SCOTRL	-7.1	-12.0	-30.8	-8.4
SCOSEI	1.5	-2.7	-8.9	0.0
SCOLTR	-2.7	-7.2	-22.7	-4.4
SCONTR	4.0	2.2	2.2	0.6
SCOOTH	1.3	-5.8	-16.0	-0.3
FRAALL	-2.3	-9.2	-14.6	-0.8
OTHOTH	-14.1	-34.5	-4.8	-12.9
ALLALL	-8.2	-10.5	-11.9	-3.6

1990	COD	HAD	WHI	SAI
SSB	0.0	0.0	0.0	0.0
TB	0.0	0.0	0.0	0.0

TOTAL CATCHES

1991	COD	HAD	WHI	SAI
DENALL	0.7	-31.8	5.9	-9.8
NETALL	2.1	-10.3	-9.4	-2.9
FRGALL	-30.3	-42.8	-66.2	-18.1
BELALL	-28.5	-57.6	-66.8	-14.0
ENGALL	-14.3	-51.5	-56.6	-12.1
NORALL	9.2	8.7	12.9	2.1
SCOTRL	0.9	-14.1	-23.9	-8.7
SCOSEI	8.5	0.3	-0.6	1.0
SCOLTR	4.3	-6.7	-16.3	-3.2
SCONTR	9.7	3.6	4.5	1.7
SCOOTH	7.4	-5.0	-8.9	0.8
FRAALL	5.0	-7.1	-8.8	1.0
OTHOTH	-8.2	-38.2	-0.9	-12.0
ALLALL	-2.0	-10.7	-6.9	-2.3

1991	COD	HAD	WHI	SAI
SSB	3.8	7.0	6.1	0.8
TB	3.8	1.4	3.6	0.9

TOTAL CATCHES

1992	COD	HAD	WHI	SAI
DENALL	5.2	-31.7	7.0	-8.5
NETALL	4.3	-8.2	-6.3	-1.7
FRGALL	-28.4	-44.4	-64.7	-15.8
BELALL	-26.3	-59.7	-65.0	-11.5
ENGALL	-11.4	-52.6	-54.3	-9.8
NORALL	12.7	12.7	18.6	2.9
SCOTRL	4.5	-11.5	-18.6	-7.4
SCOSEI	12.5	4.0	5.6	2.1
SCOLTR	7.8	-3.0	-11.7	-2.3
SCONTR	11.7	5.1	5.3	2.4
SCOOTH	10.7	-1.6	-4.6	1.6
FRAALL	8.7	-5.2	-5.1	2.6
OTHOTH	-4.8	-39.3	2.0	-9.9
ALLALL	1.4	-8.0	-3.5	-1.1

1992	COD	HAD	WHI	SAI
SSB	10.0	11.4	9.6	2.4
TB	6.1	2.6	5.3	1.7

TOTAL CATCHES

2010	COD	HAD	WHI	SAI
DENALL	12.1	-22.1	6.7	-4.8
NETALL	6.4	-4.3	-6.6	0.8
FRGALL	-26.9	-26.2	-64.2	-13.9
BELALL	-22.8	-51.7	-64.7	-8.8
ENGALL	-5.1	-45.9	-53.4	-6.8
NORALL	16.4	18.7	18.2	5.2
SCOTRL	7.5	-2.2	-15.5	-4.2
SCOSEI	16.6	11.8	7.6	6.1
SCOLTR	10.9	4.2	-10.0	0.9
SCONTR	12.7	6.2	5.2	2.5
SCOOTH	14.1	6.1	-3.5	5.6
FRAALL	11.0	3.6	-4.5	4.7
OTHOTH	0.1	-32.1	2.3	-7.5
ALLALL	5.8	0.2	-2.8	1.3

2010	COD	HAD	WHI	SAI
SSB	22.0	20.3	10.2	7.1
TB	9.1	5.4	5.6	3.7

Table 9.4 Percent change in human consumption landings following adoption of 120 mm mesh when fishing for cod.

HUMAN CONSUMPTION LANDINGS

1990	COD	HAD	WHI	SAI
DENALL	-6.1	-12.6	0.0	-10.7
NETALL	-3.3	-9.4	-13.8	-4.4
FRGALL	-34.0	-12.1	-69.9	-18.8
BELALL	-34.6	-39.3	-69.1	-15.0
ENGALL	-20.2	-38.6	-59.9	-12.6
NORALL	2.9	3.0	5.8	0.7
SCOTRL	-7.1	-1.8	-30.0	-8.4
SCOSEI	1.5	0.6	-5.0	0.0
SCOLTR	-2.7	0.4	-21.3	-4.4
SCONTR	4.0	4.6	4.7	0.6
SCOOTH	1.3	-0.4	-10.9	-0.3
FRAALL	-2.3	-6.2	-13.9	-0.8
OTHOTH	-14.1	-29.4	-51.2	-12.9
ALLALL	-8.2	-4.5	-17.6	-3.7

HUMAN CONSUMPTION LANDINGS

1991	COD	HAD	WHI	SAI
DENALL	0.7	-16.6	0.0	-9.8
NETALL	2.1	-7.4	-6.4	-2.9
FRGALL	-30.3	-13.9	-67.2	-18.1
BELALL	-28.5	-44.8	-66.2	-14.0
ENGALL	-14.3	-42.5	-55.6	-12.1
NORALL	9.2	12.2	16.1	2.1
SCOTRL	0.9	2.3	-22.1	-6.7
SCOSEI	8.5	8.0	5.2	1.0
SCOLTR	4.3	6.5	-13.2	-3.2
SCONTR	9.7	10.2	13.0	1.7
SCOOTH	7.4	5.7	-1.7	0.8
FRAALL	5.0	-0.1	-6.1	1.0
OTHOTH	-8.2	-31.2	-46.3	-12.0
ALLALL	-2.0	0.0	-9.4	-2.4

HUMAN CONSUMPTION LANDINGS

1992	COD	HAD	WHI	SAI
DENALL	5.2	-17.4	0.0	-6.5
NETALL	4.3	-5.0	-0.9	-1.7
FRGALL	-28.4	-15.7	-65.0	-15.8
BELALL	-26.3	-50.2	-63.4	-11.5
ENGALL	-11.4	-45.9	-51.9	-9.8
NORALL	12.7	17.7	24.5	2.9
SCOTRL	4.5	5.4	-15.5	-7.4
SCOSEI	12.5	12.6	14.6	2.1
SCOLTR	7.8	10.5	-6.2	-2.3
SCONTR	11.7	12.3	18.0	2.4
SCOOTH	10.7	9.5	6.1	1.6
FRAALL	8.7	2.6	-0.2	2.6
OTHOTH	-4.8	-34.1	-42.1	-9.9
ALLALL	1.4	3.0	-2.7	-1.1

HUMAN CONSUMPTION LANDINGS

2010	COD	HAD	WHI	SAI
DENALL	12.1	-4.9	0.0	-4.6
NETALL	6.4	0.2	-0.7	0.8
FRGALL	-26.9	1.4	-64.2	-13.9
BELALL	-22.8	-40.2	-62.6	-8.8
ENGALL	-5.1	-37.2	-50.0	-6.8
NORALL	16.4	25.3	27.9	5.2
SCOTRL	7.5	17.0	-11.0	-4.2
SCOSEI	16.6	20.9	19.0	6.1
SCOLTR	10.9	19.0	-2.9	0.9
SCONTR	12.7	15.3	19.0	2.5
SCOOTH	14.1	18.1	9.3	5.6
FRAALL	11.0	13.9	1.3	4.7
OTHOTH	0.1	-24.8	-40.0	-7.5
ALLALL	5.8	12.2	0.1	1.3

Table 9.5 Percent change in discards following adoption of 120 mm mesh when fishing for cod.

DISCARDS

1990	COD	HAD	WHI	SAI
DENALL	0.0	-72.7	0.0	0.0
NETALL	0.0	-15.6	-15.7	0.0
FRGALL	0.0	-72.4	-65.7	0.0
BELALL	0.0	-72.0	-68.8	0.0
ENGALL	0.0	-62.2	-59.5	0.0
NORALL	0.0	3.2	2.6	0.0
SCOTRL	0.0	-27.7	-32.9	0.0
SCOSEI	0.0	-12.5	-14.9	0.0
SCOLTR	0.0	-16.9	-25.0	0.0
SCONTR	0.0	1.7	1.8	0.0
SCOOTH	0.0	-18.4	-21.2	0.0
FRAALL	0.0	-16.2	-15.6	0.0
OTHOTH	0.0	-53.8	-51.7	0.0
ALLALL	0.0	-25.5	-21.4	0.0

DISCARDS

1991	COD	HAD	WHI	SAI
DENALL	0.0	-72.3	0.0	0.0
NETALL	0.0	-14.3	-13.6	0.0
FRGALL	0.0	-72.1	-64.6	0.0
BELALL	0.0	-71.6	-67.9	0.0
ENGALL	0.0	-61.7	-58.2	0.0
NORALL	0.0	5.0	5.5	0.0
SCOTRL	0.0	-26.7	-29.3	0.0
SCOSEI	0.0	-10.6	-11.7	0.0
SCOLTR	0.0	-17.5	-22.4	0.0
SCONTR	0.0	2.3	2.9	0.0
SCOOTH	0.0	-16.8	-18.3	0.0
FRAALL	0.0	-14.9	-13.1	0.0
OTHOTH	0.0	-53.1	-50.3	0.0
ALLALL	0.0	-24.1	-19.0	0.0

DISCARDS

1992	COD	HAD	WHI	SAI
DENALL	0.0	-71.9	0.0	0.0
NETALL	0.0	-13.0	-13.2	0.0
FRGALL	0.0	-72.0	-64.2	0.0
BELALL	0.0	-71.2	-67.6	0.0
ENGALL	0.0	-61.1	-57.9	0.0
NORALL	0.0	6.7	6.1	0.0
SCOTRL	0.0	-25.1	-28.2	0.0
SCOSEI	0.0	-8.8	-11.0	0.0
SCOLTR	0.0	-15.5	-21.9	0.0
SCONTR	0.0	3.1	3.1	0.0
SCOOTH	0.0	-15.0	-18.1	0.0
FRAALL	0.0	-13.6	-12.5	0.0
OTHOTH	0.0	-52.4	-50.0	0.0
ALLALL	0.0	-22.5	-18.5	0.0

DISCARDS

2010	COD	HAD	WHI	SAI
DENALL	0.0	-71.7	0.0	0.0
NETALL	0.0	-12.6	-13.4	0.0
FRGALL	0.0	-71.9	-64.2	0.0
BELALL	0.0	-71.1	-67.6	0.0
ENGALL	0.0	-60.9	-58.0	0.0
NORALL	0.0	7.5	5.9	0.0
SCOTRL	0.0	-24.2	-28.1	0.0
SCOSEI	0.0	-8.0	-11.3	0.0
SCOLTR	0.0	-14.8	-22.0	0.0
SCONTR	0.0	3.2	2.9	0.0
SCOOTH	0.0	-14.4	-18.3	0.0
FRAALL	0.0	-13.1	-12.7	0.0
OTHOTH	0.0	-52.1	-50.1	0.0
ALLALL	0.0	-21.9	-18.6	0.0

Table 9.6 Percent change in industrial by-catch following adoption of 120 mm mesh when fishing for cod.

INDUSTRIAL CATCHES

1990	COD	HAD	WHI	SAI
DENALL	0.0	1.8	2.6	0.0
NETALL	0.0	0.0	0.0	0.0
FRGALL	0.0	0.0	0.0	0.0
BELALL	0.0	0.0	0.0	0.0
ENGALL	0.0	0.0	0.0	0.0
NORALL	0.0	2.8	4.8	1.3
SCOTRL	0.0	0.0	0.0	0.0
SCOSEI	0.0	0.0	0.0	0.0
SCOLTR	0.0	0.0	0.0	0.0
SCONTR	0.0	0.0	0.0	0.0
SCOOTH	0.0	0.0	0.0	0.0
FRAALL	0.0	0.0	0.0	0.0
OTHOTH	0.0	1.8	3.0	0.0
ALLALL	0.0	2.1	2.7	1.3

INDUSTRIAL CATCHES

1991	COD	HAD	WHI	SAI
DENALL	0.0	4.1	5.9	0.0
NETALL	0.0	0.0	0.0	0.0
FRGALL	0.0	0.0	0.0	0.0
BELALL	0.0	0.0	0.0	0.0
ENGALL	0.0	0.0	0.0	0.0
NORALL	0.0	8.1	13.0	3.5
SCOTRL	0.0	0.0	0.0	0.0
SCOSEI	0.0	0.0	0.0	0.0
SCOLTR	0.0	0.0	0.0	0.0
SCONTR	0.0	0.0	0.0	0.0
SCOOTH	0.0	0.0	0.0	0.0
FRAALL	0.0	0.0	0.0	0.0
OTHOTH	0.0	4.6	7.6	0.0
ALLALL	0.0	4.8	6.4	3.5

INDUSTRIAL CATCHES

1992	COD	HAD	WHI	SAI
DENALL	0.0	6.3	7.0	0.0
NETALL	0.0	0.0	0.0	0.0
FRGALL	0.0	0.0	0.0	0.0
BELALL	0.0	0.0	0.0	0.0
ENGALL	0.0	0.0	0.0	0.0
NORALL	0.0	12.0	18.7	4.2
SCOTRL	0.0	0.0	0.0	0.0
SCOSEI	0.0	0.0	0.0	0.0
SCOLTR	0.0	0.0	0.0	0.0
SCONTR	0.0	0.0	0.0	0.0
SCOOTH	0.0	0.0	0.0	0.0
FRAALL	0.0	0.0	0.0	0.0
OTHOTH	0.0	7.4	10.2	0.0
ALLALL	0.0	7.4	7.8	4.2

INDUSTRIAL CATCHES

2010	COD	HAD	WHI	SAI
DENALL	0.0	8.6	6.7	0.0
NETALL	0.0	0.0	0.0	0.0
FRGALL	0.0	0.0	0.0	0.0
BELALL	0.0	0.0	0.0	0.0
ENGALL	0.0	0.0	0.0	0.0
NORALL	0.0	17.5	18.2	4.2
SCOTRL	0.0	0.0	0.0	0.0
SCOSEI	0.0	0.0	0.0	0.0
SCOLTR	0.0	0.0	0.0	0.0
SCONTR	0.0	0.0	0.0	0.0
SCOOTH	0.0	0.0	0.0	0.0
FRAALL	0.0	0.0	0.0	0.0
OTHOTH	0.0	11.0	10.2	0.0
ALLALL	0.0	10.6	7.4	4.2

Table 9.7 Percentage of Cod in Catch of "Non-cod" Fleets

	1990	1991	1992	2010
DENALL	9	10	11	13
NETALL	53	54	56	58
FRGALL	34	34	33	32
BELALL	51	52	54	56
ENGALL	56	55	53	53
NORALL	7	7	7	8
SCOTRL	15	16	15	14
SCOSEI	22	22	20	19
SCOLTR	24	23	23	22
SCONTR	7	7	8	8
SCOPTR	27	26	24	23
FRAALL	10	11	11	11
OTHALL	14	14	13	13
ALLALL	21	21	21	21

Table 10.1 Cod IV RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS1	SGFS2	DGFS0	DGFS1	DGFS2	FRGFS
1970	847	353	98.3	34.5	-1	-1	-1	-1	-1	-1	-1	-1	90.4
1971	159	69	4.1	10.6	-1	-1	-1	-1	-1	-1	-1	-1	1.3
1972	289	114	38.0	9.5	-1	-1	-1	-1	-1	-1	-1	-1	1.6
1973	232	95	14.7	6.2	-1	-1	-1	-1	-1	-1	-1	-1	3.6
1974	427	172	40.3	19.9	-1	-1	-1	-1	-1	-1	-1	-1	8.0
1975	196	85	7.9	3.2	-1	-1	4.5	-1	-1	-1	-1	-1	7.8
1976	726	286	36.7	29.3	-1	62.7	12.5	-1	-1	-1	-1	-1	28.2
1977	426	175	12.9	9.3	13.9	22.8	5.8	-1	-1	-1	-1	-1	27.2
1978	449	180	9.9	14.8	12.6	24.2	6.7	-1	-1	-1	-1	4.5	31.1
1979	800	320	16.9	25.5	18.6	50.8	13.9	-1	-1	-1	163.8	11.2	35.5
1980	272	109	2.9	6.7	10.2	11.4	2.9	-1	3.5	43.2	46.9	1.6	14.1
1981	557	208	9.2	16.6	74.2	32.4	11.0	6.1	7.8	176.8	83.0	2.3	23.2
1982	271	106	3.9	8.0	2.5	15.4	4.7	3.3	3.9	26.9	21.8	1.6	9.0
1983	528	201	15.2	17.6	95.1	61.2	11.9	8.2	11.4	121.5	121.3	3.1	43.0
1984	105	42	.9	3.6	.4	4.3	1.2	.7	1.0	1.3	3.6	.2	.9
1985	576	-1	17.0	28.8	8.3	34.4	10.7	8.0	6.9	143.6	111.2	8.0	9.5
1986	-1	-1	8.8	6.1	1.2	14.2	4.1	2.2	2.9	37.0	41.5	1.7	2.3
1987	-1	-1	3.6	6.3	.4	8.4	2.5	1.6	1.3	36.2	17.8	-1	2.1
1988	-1	-1	13.1	-1	16.8	22.8	-1	5.6	-1	16.6	-1	-1	3.8
1989	-1	-1	-1	-1	6.0	-1	-1	-1	-1	-1	-1	-1	-1

Table 10.2 Haddock IV RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	DGFS1	DGFS2	FRGFS
1970	10053	1259	855	299	-1	-1	-1	-1	-1	-1	-1	-1	90.4
1971	9426	1550	740	971	-1	-1	-1	-1	-1	-1	-1	-1	1.3
1972	2469	337	187	110	-1	-1	-1	-1	-1	-1	-1	-1	1.6
1973	8579	1192	1092	385	-1	-1	-1	-1	-1	-1	-1	-1	3.6
1974	15550	2197	1168	670	-1	-1	-1	-1	-1	-1	-1	-1	8.0
1975	1332	193	177	84	-1	-1	32	-1	-1	-1	-1	-1	7.8
1976	1859	263	162	108	-1	67	26	-1	-1	-1	-1	-1	28.2
1977	2945	396	385	240	535	137	55	-1	-1	-1	-1	-1	27.2
1978	4636	758	480	402	358	296	167	-1	-1	-1	-1	4.5	31.1
1979	8363	1353	896	675	876	623	439	-1	-1	-1	163.8	11.2	35.5
1980	1750	285	268	252	374	173	80	-1	-1	100	46.9	1.6	14.1
1981	3707	606	526	400	1538	316	110	-1	249	161	83.0	2.3	23.2
1982	2364	394	307	219	281	218	62	124	181	79	21.8	1.6	9.0
1983	8002	1370	1057	928	832	599	238	220	437	298	121.3	3.1	43.0
1984	2062	328	229	244	229	187	45	87	198	57	3.6	.2	.9
1985	2968	-1	579	326	246	150	43	82	233	70	111.2	8.0	9.5
1986	-1	-1	885	688	266	282	184	175	239	198	41.5	1.7	2.3
1987	-1	-1	92	97	22	29	15	28	47	21	17.8	-1	2.1
1988	-1	-1	210	-1	61	82	-1	41	89	-1	-1	-1	3.8
1989	-1	-1	-1	-1	94	-1	-1	43	-1	-1	-1	-1	-1

Table 10.3 Whiting IV RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	DGFS0	DGFS1	DGFS2	
1970	2853	743	274	190	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1971	5089	1420	332	763	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1972	6960	2016	1156	496	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1973	3453	897	322	153	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1974	7092	2181	893	535	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	4433	1431	679	219	-1	-1	74	-1	-1	-1	-1	-1	-1	-1
1976	4267	1068	418	293	-1	220	52	-1	-1	-1	-1	-1	-1	-1
1977	4291	1413	513	183	284	247	71	-1	-1	-1	-1	-1	-1	-1
1978	4443	1359	457	391	184	201	125	-1	-1	-1	-1	-1	-1	62
1979	4099	1428	692	485	355	353	288	-1	-1	-1	-1	-1	330	131
1980	1537	499	227	232	199	183	79	-1	-1	-1	97	166	205	105
1981	1726	558	161	126	349	277	109	-1	-1	65	58	1393	640	224
1982	1595	500	128	179	69	119	108	10	56	37	166	431	141	
1983	2385	738	436	359	717	506	170	21	105	97	2649	1330	893	
1984	1808	581	341	261	173	159	66	44	158	45	143	783	75	
1985	3581	-1	456	544	200	152	130	17	111	115	859	384	252	
1986	-1	-1	669	862	163	228	132	41	141	161	1784	2004	612	
1987	-1	-1	394	542	137	188	118	12	97	74	2883	1441	-1	
1988	-1	-1	1465	-1	382	295	-1	64	404	-1	629	-1	-1	
1989	-1	-1	-1	-1	1170	-1	-1	43	-1	-1	-1	-1	-1	

Table 10.4 Cod VIa RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS1	SGFS2	DGFS0	DGFS1	DGFS2	FRGFS
1970	10453	8329	99.3	34.5	-1	-1	-1	-1	-1	-1	-1	-1	90.4
1971	6301	4496	4.1	10.6	-1	-1	-1	-1	-1	-1	-1	-1	1.3
1972	8521	6061	38.0	9.5	-1	-1	-1	-1	-1	-1	-1	-1	1.6
1973	8297	6033	14.7	6.2	-1	-1	-1	-1	-1	-1	-1	-1	3.6
1974	11452	8289	40.3	19.9	-1	-1	-1	-1	-1	-1	-1	-1	8.0
1975	6541	4491	7.9	3.2	-1	-1	4.5	-1	-1	-1	-1	-1	7.8
1976	9800	6883	36.7	29.3	-1	62.7	12.5	-1	-1	-1	-1	-1	28.2
1977	9577	7188	12.9	9.3	13.9	22.8	5.8	-1	-1	-1	-1	-1	27.2
1978	14979	11426	9.9	14.8	12.6	24.2	6.7	-1	-1	-1	-1	4.5	31.1
1979	20623	15807	16.9	25.5	18.6	50.8	13.9	-1	-1	-1	163.8	11.2	35.5
1980	5977	4478	2.9	6.7	10.2	11.4	2.9	-1	3.5	43.2	46.9	1.6	14.1
1981	15049	10675	9.2	16.6	74.2	32.4	11.0	6.1	7.8	176.8	33.0	2.3	23.2
1982	9094	5348	3.9	8.0	2.5	15.4	4.7	3.3	3.9	26.9	21.8	1.6	9.0
1983	14987	10340	15.2	17.6	95.1	61.2	11.9	8.2	11.4	121.5	121.3	3.1	43.0
1984	5948	3651	.9	3.6	.4	4.3	1.2	.7	1.0	1.3	3.6	.2	.9
1985	12696	-1	17.0	28.8	8.3	34.4	10.7	8.0	6.9	143.6	111.2	8.0	9.5
1986	-1	-1	8.8	6.1	1.2	14.2	4.1	2.2	2.9	37.0	41.5	1.7	2.3
1987	-1	-1	3.6	6.3	.4	8.4	2.5	1.6	1.3	36.2	17.8	-1	2.1
1988	-1	-1	13.1	-1	16.8	22.8	-1	5.6	-1	16.6	-1	-1	3.8
1989	-1	-1	-1	-1	6.0	-1	-1	-1	-1	-1	-1	-1	-1

SWFS1	SWFS2	NSVPA1	NSVPA2	SCSEI1 CPUE	SCSEI2 CPUE	SCLTR1 CPUE	SCLTR2 CPUE
-1	-1	847	353	618	3608	286	2509
-1	-1	159	59	831	3970	1867	1512
-1	-1	289	114	3600	3622	2445	4195
-1	-1	232	95	1598	4232	1827	2465
-1	-1	427	172	2657	3949	3773	3332
-1	-1	196	85	846	2875	1509	1295
-1	-1	726	286	2852	4009	2473	3154
-1	-1	426	175	2240	2984	1082	1878
-1	-1	449	180	3141	5778	1616	5767
-1	-1	800	320	6553	11012	1389	6823
-1	.6	272	109	380	3769	200	2719
.1	3.2	557	208	5564	10833	2908	10333
.2	1.1	271	106	4815	1869	2448	4498
4.0	2.4	528	201	5642	5548	3547	9205
.1	.8	105	42	3625	4242	1632	2961
.3	1.5	576	206	5409	19044	2199	7938
5.2	5.9	254	102	56071	15756	4515	10500
.0	.7	193	77	1538	-1	468	-1
.5	-1	329	110	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

Table 10.5 Haddock VIa RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	SWFS1	SWFS2	NSVPA1
1970	2463	1375	855	299	-1	-1	-1	-1	-1	-1	-1	-1	10053
1971	766	441	740	971	-1	-1	-1	-1	-1	-1	-1	-1	9426
1972	786	223	187	110	-1	-1	-1	-1	-1	-1	-1	-1	2469
1973	1687	766	1092	385	-1	-1	-1	-1	-1	-1	-1	-1	8579
1974	4390	1990	1168	670	-1	-1	-1	-1	-1	-1	-1	-1	15550
1975	373	90	177	84	-1	-1	32	-1	-1	-1	-1	-1	1332
1976	232	73	162	108	-1	67	26	-1	-1	-1	-1	-1	1859
1977	592	342	385	240	535	137	55	-1	-1	-1	-1	-1	2945
1978	1794	842	480	402	358	296	167	-1	-1	-1	-1	-1	4636
1979	4422	3416	896	675	876	623	439	-1	-1	-1	-1	-1	8363
1980	391	318	268	252	374	173	80	-1	-1	100	-1	10	1750
1981	802	517	526	400	1538	316	110	-1	249	161	8	90	3707
1982	456	243	307	219	281	218	62	124	181	79	17	36	2364
1983	3882	2289	1057	828	832	599	238	220	437	298	2064	409	8002
1984	747	407	229	244	229	187	45	87	198	57	110	161	2062
1985	580	-1	579	326	246	150	43	82	233	70	89	65	2968
1986	-1	-1	885	688	266	282	184	175	239	198	528	365	4577
1987	-1	-1	92	97	22	29	15	28	47	21	89	44	553
1988	-1	-1	210	-1	61	82	-1	41	89	-1	17	-1	985
1989	-1	-1	-1	-1	94	-1	-1	43	-1	-1	-1	-1	-1

NSVPA2	SCSEI1	SCSEI2	SCLTR1	SCLTR2
1259	35451	25320	9952	13537
1550	11382	5760	959	1247
337	42006	2901	595	1072
1192	42413	13533	5824	3420
2197	159953	36442	15316	8248
193	20714	2766	1485	253
263	9097	879	801	162
396	10310	8268	2011	2424
758	31709	16357	10367	3192
1353	19250	46345	4074	9008
205	94	3303	17	709
606	7849	7827	3662	5116
394	5524	4036	2821	1672
1370	29383	21950	19228	11421
328	4737	8507	2172	2028
508	4353	6863	1583	3069
944	52735	19412	13831	10953
109	5114	-1	1877	-1
233	-1	-1	-1	-1
-1	-1	-1	-1	-1

Table 10.6 Whiting VIa RCRTINX2 input values.

YEAR CLASS	VPA1	VPA2	IYFS1	IYFS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	DGFS0	DGFS1	DGFS2
1970	309	231	274	190	-1	-1	-1	-1	-1	-1	-1	-1	-1
1971	930	610	332	763	-1	-1	-1	-1	-1	-1	-1	-1	-1
1972	1949	1469	1156	496	-1	-1	-1	-1	-1	-1	-1	-1	-1
1973	674	470	322	153	-1	-1	-1	-1	-1	-1	-1	-1	-1
1974	1512	1103	893	535	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	513	343	679	219	-1	-1	74	-1	-1	-1	-1	-1	-1
1976	802	512	418	293	-1	220	52	-1	-1	-1	-1	-1	-1
1977	1106	746	513	183	284	247	71	-1	-1	-1	-1	-1	-1
1978	778	580	457	391	194	201	125	-1	-1	-1	-1	-1	62
1979	1907	1456	692	485	355	353	288	-1	-1	-1	-1	330	131
1980	400	296	227	232	199	183	79	-1	-1	97	166	205	105
1981	354	263	161	126	349	277	109	-1	65	58	1393	640	224
1982	430	321	128	179	69	119	108	10	56	37	166	431	141
1983	664	478	436	359	717	506	170	21	105	97	2649	1330	893
1984	646	492	341	261	173	159	66	44	158	45	143	783	75
1985	472	-1	456	544	200	152	130	17	111	115	859	384	252
1986	-1	-1	669	862	163	228	132	41	141	161	1784	2004	612
1987	-1	-1	394	542	137	188	118	12	97	74	2883	1441	-1
1988	-1	-1	1465	-1	382	295	-1	64	404	-1	629	-1	-1
1989	-1	-1	-1	-1	1170	-1	-1	43	-1	-1	-1	-1	-1

SWFS1	SWFS2	HSVPA1	NSVPA2	SCSEI1 CPUE	SCSEI2 CPUE	SCLTR1 CPUE	SCLTR2 CPUE
-1	-1	2853	743	1068	5915	283	1674
-1	-1	5089	1420	9736	15977	2142	7434
-1	-1	6960	2016	9384	27525	1170	9692
-1	-1	3453	897	4908	8898	1960	2740
-1	-1	7092	2181	8799	30046	1882	6022
-1	-1	4433	1431	4247	6589	1828	1633
-1	-1	4267	1068	11369	8911	3036	2797
-1	-1	4291	1413	14567	27046	2626	7555
-1	-1	4443	1359	6956	6395	1200	2414
-1	-1	4099	1428	4555	10081	1153	4017
-1	14	1537	499	1724	2212	328	1091
35	80	1726	558	836	3426	556	1794
128	232	1595	500	1403	4886	842	2194
495	179	2385	738	4375	13793	884	4342
314	186	1808	581	2290	13463	344	2005
129	172	3581	1053	1232	8855	200	1848
629	331	4710	963	3558	16578	1009	3236
49	49	3044	831	819	-1	134	-1
102	-1	5508	873	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1

Table 10.7 Predictions and Summary Statistics from RCRTINX2, 1989 Roundfish Working Group

Species	Stock	Age	Year Class	Weighted Average Predicted Abundance at Age (millions)	Internal Standard Error	External Standard Error	Ext S.E. / Int S.E.
Cod	IV	1	1986	254	0.06	0.07	0.89
			1987	193	0.08	0.09	1.11
			1988	328	0.11	0.13	1.20
			1989	314	0.44	0.18	0.41
		2	1986	102	0.08	0.07	0.88
			1987	77	0.09	0.10	1.13
			1988	110	0.13	0.14	1.11
			1989	116	0.41	0.18	0.43
Cod	VIa	1	1986a	22	0.23	0.31	1.37
			1987	8	0.29	0.26	0.95
			1986b	9	0.09	0.14	1.45
			1987	6	0.09	0.06	0.65
			1988	11	0.13	0.09	0.71
			1989	10	0.33	0.12	0.35
			1985c	16	0.18	0.19	1.05
			1986	15	0.18	0.32	1.75
			1987	7	0.21	0.16	0.84
			1988	10	0.24	0.05	0.21
		2	1986a	17	0.28	0.41	1.44
			1987	6	0.39	0.34	0.86
			1986b	6	0.10	0.16	1.55
			1987	4	0.11	0.08	0.71
			1988	6	0.19	0.14	0.73
			1989	6	0.37	0.13	0.37
			1985c	12	0.20	0.22	1.11
			1986	10	0.21	0.38	1.79
			1987	5	0.25	0.20	0.80
			1988	6	0.26	0.10	0.40
Haddock	IV	1	1986	4577	0.12	0.16	1.26
			1987	553	0.17	0.27	1.59
			1988	985	0.17	0.26	1.57
			1989	1914	0.56	0.93	1.67
		2	1986	944	0.13	0.15	1.13
			1987	109	0.16	0.21	1.29
			1988	233	0.19	0.24	1.27
			1989	309	0.63	1.04	1.65
	VIa	1	1986a	246	0.31	0.21	0.66
			1987	81	0.67	0.14	0.21
			1986b	149	0.19	0.19	1.00
			1987	13	0.24	0.48	1.97
			1988	18	0.29	0.41	1.39
			1989	51	0.89	1.44	1.62
			1985c	88	0.26	0.11	0.43
			1986	209	0.27	0.20	0.76
			1987	20	0.46	0.79	1.69

cont'd.

Table 10.7 cont'd.

		2	1986a	156	0.33	0.24	0.72
			1987	45	0.96	0.21	0.22
			1986b	115	0.23	0.20	0.88
			1987	5	0.27	0.42	1.53
			1988	11	0.38	0.46	1.21
			1989	26	1.05	1.61	1.54
			1985c	49	0.30	0.12	0.41
			1986	147	0.30	0.20	0.66
			1987	9	0.61	0.77	1.28
			1988	17	0.58	0.68	1.15
Whiting	IV	1	1986	4710	0.22	0.20	0.91
			1987	3044	0.21	0.16	0.75
			1988	5503	0.28	0.35	1.26
			1989	3223	0.48	0.74	1.53
		2	1986	963	0.15	0.18	1.23
			1987	831	0.15	0.12	0.81
			1988	873	0.17	0.32	1.94
			1989	993	0.49	0.67	1.38
	VIa	1	1986a	84	0.25	0.11	0.47
			1987	33	0.36	0.47	1.30
			1986b	80	0.14	0.13	0.95
			1987	46	0.14	0.13	0.92
			1988	64	0.17	0.26	1.59
			1989	78	0.51	0.81	1.57
			1985c	52	0.23	0.22	0.96
			1986	90	0.23	0.12	0.54
			1987	42	0.30	0.38	1.25
			1988	102	0.40	0.48	1.19
		2	1986a	61	0.28	0.13	0.48
			1987	25	0.42	0.61	1.45
			1986b	89	0.27	0.27	1.01
			1987	55	0.26	0.23	0.89
			1988	108	0.38	0.37	0.99
			1989	57	0.54	0.76	1.41
			1985c	39	0.24	0.22	0.91
			1986	60	0.24	0.10	0.42
			1987	33	0.32	0.41	1.30
			1988	50	0.36	0.00	0.01

a CPUE, Scottish Light Trawl, Scotish Seine
b Research vessel indices, Division VIa and Sub-area IV
c CPUE and North Sea VPA results

Table 12.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Belgium	12,576	9,630	8,744	6,604	6,704
Denmark	48,509	56,404	64,968	61,454	48,828
Faroe Islands	113	150	38	65	361
France	12,559	10,910	11,369	8,399	7,159
German Dem.Rep.	84	63	-	-	-
Germany, Fed.Rep.	20,411	26,343	29,741	18,525	20,333
Ireland	1	-	-	-	-
Netherlands	34,752	45,400	51,281	36,490	34,111
Norway[2]	3,575	4,506	6,766	12,163	6,625
Poland	142	28	7	62	75
Sweden	298	293	321	453	422
UK (England & Wales)	54,923	49,951	59,856	54,277	53,860
UK (Scotland)	42,811	45,044	53,921	57,308	58,581
USSR	17	-	-	-	-
Total	230,771	248,722	287,012	255,800	237,059

Country	1984	1985	1986	1987	1988
Belgium	5,804	4,815	6,604	6,693	5,508
Denmark	46,751	42,547	32,892	36,948	34,890[1]
Faroe Islands	-	71	15	-[1]	-[1]
France	8,129	4,834	8,402	8,199	8,138[1 3]
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	13,453	7,675	7,667	8,230	9,060[1]
Ireland	-	-	-	-	-
Netherlands	25,460	30,844	25,082	21,347	...
Norway[2]	7,005	5,766	4,864	5,000	4,145[1]
Poland	7	-	10	13	19
Sweden	575	748	839	688	367
UK (England & Wales)	35,605	29,692	25,361	29,960	23,496
UK (Scotland)	54,359	60,931	45,748	49,671	41,382
USSR	-	-	-	-	-
Total	197,148	187,923	157,484	166,749	127,005

[1] Preliminary.
[2] Figures from Norway do not include cod caught in Rec.2 fisheries.
[3] Includes Division IIa.

Table 12.2 Annual weight and numbers of cod caught in Sub-area IV between 1969 and 1988.

	Weight (1000 tonnes)				Number (millions)			
Year	Total	H.Con	Disc	By-cat	Total	H.Con	Disc	By-cat
1969	194	194	0	0	77	77	0	0
1970	219	219	0	0	126	126	0	0
1971	315	315	0	0	226	226	0	0
1972	341	341	0	0	245	245	0	0
1973	228	228	0	0	126	126	0	0
1974	202	202	0	0	103	103	0	0
1975	185	185	0	0	103	103	0	0
1976	209	209	0	0	123	123	0	0
1977	182	182	0	0	137	137	0	0
1978	263	263	0	0	210	210	0	0
1979	249	249	0	0	168	168	0	0
1980	265	265	0	0	200	200	0	0
1981	301	301	0	0	236	236	0	0
1982	273	273	0	0	191	191	0	0
1983	234	234	0	0	178	178	0	0
1984	205	205	0	0	158	158	0	0
1985	193	193	0	0	144	144	0	0
1986	163	163	0	0	140	140	0	0
1987	175	175	0	0	145	145	0	0
1988	150	150	0	0	109	109	0	0

Table 12.3 Values of natural mortality rate and proportion mature at age.

Age	Nat Mor	Mat.
1	0.800	0.010
2	0.350	0.050
3	0.250	0.230
4	0.200	0.620
5	0.200	0.860
6	0.200	1.000
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10	0.200	1.000
11	0.200	1.000
12	0.200	1.000
13	0.200	1.000

Table 12.4 Total international catch at age ('000) of cod in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	2842	52719	42972	3692	24742	14690	30081	5182	62744	24930	1
2	21867	32813	148927	180833	30259	55617	42487	90267	42275	158836	2
3	30453	17886	16507	46369	52342	10765	17073	16172	22918	13094	3
4	13222	12904	6475	5474	13409	14937	4203	6016	4104	8417	4
5	4403	6092	6808	2627	2102	4365	6816	1542	2055	2809	5
6	2792	1705	2588	3084	1057	907	1863	2764	752	941	6
7	567	930	856	1618	1010	414	405	837	1030	366	7
8	407	202	439	589	466	373	176	119	335	372	8
9	142	180	219	376	76	313	206	61	237	140	9
10	45	95	74	108	55	76	86	57	23	33	10
11	61	22	66	7	74	149	45	22	9	15	11
12	10	17	24	10	58	25	7	16	43	22	12
13	5				22	5	5	1	35	2	13

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	34113	60868	19833	64836	23837	63854	7894	82591	21633	17783	1
2	85844	96114	175920	59947	121826	57773	111118	20828	105617	49989	2
3	40458	29562	27563	53238	17518	27764	15712	28918	6962	35843	3
4	3332	10272	7649	7287	10104	3461	6874	3954	7625	2517	4
5	3130	1590	3802	3193	2501	3119	1150	2584	1348	2235	5
6	675	1172	740	1883	1167	939	1116	521	955	560	6
7	365	412	555	355	562	415	328	498	209	274	7
8	129	191	131	218	142	233	162	148	188	59	8
9	145	71	63	72	70	57	73	60	46	52	9
10	39	54	36	25	22	43	13	39	31	12	10
11	2	18	16	10	13	13	20	17	6	9	11
12	13	6	1	5	5	4	3	1	2	5	12
13			3			2	0	1	3	2	13

Table 12.5 Total international mean weight at age (kg.) of cod in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	0.544	0.626	0.579	0.616	0.559	0.594	0.619	0.568	0.542	0.568	1
2	0.921	0.961	0.941	0.836	0.869	1.039	0.899	1.027	0.973	0.938	2
3	2.133	2.041	2.193	2.086	1.919	2.217	2.348	2.477	2.161	2.025	3
4	3.852	4.001	4.258	3.968	3.776	4.156	4.226	4.575	4.603	4.242	4
5	5.715	6.131	6.528	6.011	5.488	6.174	6.404	6.505	6.716	6.599	5
6	6.722	7.945	8.646	8.246	7.453	8.333	8.691	8.630	8.832	8.945	6
7	9.262	9.953	10.356	9.766	9.019	9.889	10.107	10.137	10.075	9.972	7
8	9.749	10.131	11.219	10.228	9.810	10.791	10.910	11.341	11.052	11.099	8
9	10.384	11.919	12.881	11.875	11.077	12.175	12.339	12.888	11.824	12.427	9
10	12.743	12.554	13.147	12.530	12.359	12.425	12.976	14.140	13.134	12.778	10
11	11.017	14.473	15.676	14.455	12.892	13.660	13.831	14.705	14.417	13.847	11
12	13.718	14.225	15.176	14.272	12.899	14.049	17.410	14.376	14.513	13.739	12
13	8.095				12.832	14.309	15.662	8.311	14.160	17.148	13

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	0.549	0.546	0.725	0.587	0.634	0.593	0.582	0.570	0.621	0.560	1
2	0.940	0.998	0.827	0.948	0.917	0.996	0.920	0.909	0.937	0.835	2
3	2.447	2.002	2.256	1.851	1.814	2.144	2.126	1.823	1.955	1.904	3
4	4.583	4.578	4.759	4.512	3.960	4.041	4.228	3.890	3.671	3.238	4
5	6.687	6.390	7.188	6.848	6.589	6.255	6.457	6.426	6.017	5.951	5
6	8.557	9.156	8.851	8.993	8.454	8.423	8.475	8.158	8.280	7.857	6
7	10.938	9.805	10.059	10.740	9.919	10.317	10.406	9.956	9.911	9.735	7
8	11.550	11.867	11.519	12.500	11.837	11.352	12.034	11.713	11.413	11.629	8
9	13.057	12.782	13.338	13.469	12.797	13.505	13.033	12.710	12.149	13.397	9
10	14.148	14.081	14.897	12.890	12.562	13.408	13.209	13.566	15.542	14.415	10
11	15.982	16.475	16.987	13.998	14.117	12.886	14.425	13.328	15.917	16.150	11
12	15.394	12.166	18.129	15.879	15.238	14.086	14.348	13.232	16.389	14.592	12
13			28.496			16.359	15.568	10.461	17.462	16.879	13

Table 12.6 Total international fishing mortality rate at age of cod in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	0.021	0.110	0.076	0.034	0.132	0.096	0.107	0.039	0.133	0.088	1
2	0.390	0.583	0.883	0.898	0.709	0.833	0.737	0.931	0.861	1.023	2
3	0.600	0.745	0.774	0.919	0.854	0.693	0.786	0.829	0.763	0.859	3
4	0.578	0.577	0.701	0.670	0.798	0.665	0.674	0.753	0.535	0.753	4
5	0.619	0.580	0.697	0.699	0.595	0.666	0.746	0.566	0.635	0.886	5
6	0.650	0.521	0.524	0.813	0.688	0.560	0.679	0.796	0.604	0.684	6
7	0.434	0.467	0.544	0.743	0.699	0.641	0.527	0.761	0.807	0.678	7
8	0.479	0.271	0.421	0.925	0.494	0.609	0.631	0.287	0.814	0.792	8
9	0.448	0.404	0.527	0.788	0.277	0.736	0.832	0.462	1.583	1.029	9
10	0.356	0.614	0.287	0.545	0.243	0.494	0.456	0.580	0.321	1.087	10
11	0.693	0.301	1.263	0.041	0.909	2.156	0.621	0.199	0.171	0.366	11
12	0.482	0.412	0.608	0.608	0.524	0.928	0.613	0.458	0.739	0.791	12
13	0.482	0.412	0.608	0.608	0.524	0.928	0.613	0.458	0.739	0.791	13

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	0.116	0.116	0.111	0.183	0.136	0.187	0.115	0.230	0.138	0.177	1
2	0.837	0.959	1.003	1.002	1.113	0.985	1.015	0.851	0.901	0.940	2
3	0.966	0.951	0.990	1.236	1.155	1.014	0.975	0.982	0.942	1.119	3
4	0.575	0.738	0.731	0.830	0.885	0.785	0.798	0.745	0.811	1.234	4
5	0.714	0.602	0.682	0.795	0.783	0.770	0.663	0.821	0.619	0.596	5
6	0.546	0.649	0.634	0.889	0.782	0.787	0.709	0.735	0.854	0.572	6
7	0.627	0.777	0.749	0.730	0.742	0.724	0.716	0.824	0.756	0.643	7
8	0.540	0.812	0.613	0.768	0.746	0.812	0.708	0.857	0.891	0.499	8
9	0.859	0.663	0.709	0.829	0.610	0.779	0.659	0.634	0.733	0.665	9
10	0.937	0.951	0.853	0.677	0.657	0.959	0.418	0.929	0.791	0.442	10
11	0.179	2.164	0.883	0.622	0.990	1.121	2.295	1.480	0.347	0.601	11
12	0.629	1.073	0.761	0.726	0.749	0.879	0.959	0.945	0.704	0.570	12
13	0.629	1.073	0.761	0.726	0.749	0.879	0.959	0.945	0.704	0.570	13

Table 12.7 Stock numbers at age ('000) of cod in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	196819	729267	846711	159348	289089	231617	426099	196011	725908	425789	1
2	79424	86584	293516	352541	69195	113884	94544	171960	84700	285570	2
3	75306	37911	34065	85548	101218	23998	34894	31881	47761	25236	3
4	32934	32173	14020	12229	26570	33555	9348	12388	10834	17337	4
5	10417	15134	14795	5697	5122	9798	14126	3899	4775	5196	5
6	6377	4592	6940	6034	2318	2313	4122	5483	1812	2072	6
7	1763	2726	2232	3364	2191	954	1082	1711	2025	811	7
8	1171	936	1398	1061	1310	892	412	523	654	740	8
9	431	594	584	751	345	655	397	179	322	237	9
10	164	225	324	282	280	214	257	141	92	54	10
11	132	94	100	199	134	180	107	133	65	55	11
12	27	54	57	23	157	44	17	47	89	45	12
13	14				60	8	11	4	72	5	13

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	449316	799997	271486	556768	270758	538186	104955	575489	241866	157331	1
2	175140	179792	320032	109134	208354	106237	200648	42045	205478	94683	2
3	72373	53418	48583	82720	28243	48228	27945	51225	12651	58824	3
4	8329	21447	16081	14059	18715	6932	13621	8206	14944	3841	4
5	6685	3838	8393	6339	5017	6327	2589	5023	3190	5439	5
6	1753	2679	1720	3475	2343	1878	2398	1092	1810	1407	6
7	856	831	1146	747	1169	878	700	966	429	631	7
8	337	374	313	444	295	456	348	280	347	165	8
9	274	161	136	139	168	114	166	141	97	116	9
10	69	95	68	55	50	75	43	70	61	38	10
11	15	22	30	24	23	21	24	23	23	23	11
12	31	10	2	10	10	7	6	2	4	13	12
13			6			3	0	2	7	5	13

Table 12.8 Mean fishing mortality, biomass and recruitment of Cod in Sub-area IV between 1969 and 1988.

Year	Mean Fishing Mortality Ages 2 to 8 H.Con	Mean Fishing Mortality Ages 2 to 8 Disc	Ages 1 to 1 By-cat	Biomass 1000 tonnes Total	Biomass 1000 tonnes Sp St	Recruits Age 1 Y.C.	Recruits Age 1 Million
1969	0.536	0.000	0.000	606	251	68	197
1970	0.535	0.000	0.000	924	271	69	729
1971	0.649	0.000	0.000	1110	269	70	847
1972	0.810	0.000	0.000	763	225	71	159
1973	0.691	0.000	0.000	606	197	72	289
1974	0.667	0.000	0.000	561	210	73	232
1975	0.683	0.000	0.000	622	189	74	426
1976	0.703	0.000	0.000	527	163	75	196
1977	0.717	0.000	0.000	713	142	76	726
1978	0.811	0.000	0.000	709	143	77	426
1979	0.687	0.000	0.000	705	147	78	449
1980	0.784	0.000	0.000	887	161	79	800
1981	0.772	0.000	0.000	742	174	80	271
1982	0.893	0.000	0.000	738	168	81	557
1983	0.886	0.000	0.000	559	136	82	271
1984	0.840	0.000	0.000	629	117	83	538
1985	0.798	0.000	0.000	414	109	84	105
1986	0.831	0.000	0.000	549	99	85	575
1987	0.825	0.000	0.000	478	93	86	258
1988	0.800	0.000	0.000	372	88	87	193
Arit-mean recruits at age 1 for period 1969 to 1988							412
Geom-mean recruits at age 1 for period 1969 to 1988							351

Table 12.9 Input for catch prediction of cod in Sub-area IV.

	1988 Stock and Fishing Mortality				Values used in Prediction: F at age, Mean Wt. and Propn. Retained by Consumption Fishery							
					Scaled mean F 1984 to 1988			Mean values for period 1984 to 1988: Mean Weight (Kg.)				
Age	Stock Number	Fishing Mortality H.Con.	Disc	Ind	H.Con.	Disc	Ind	H.Con.	Disc	Ind	Stock	Prop. Ret.
1	193000	0.164			0.164			0.585			0.585	1.000
2	102000	0.918			0.918			0.919			0.919	1.000
3	58809	1.119			0.984			1.990			1.990	1.000
4	3841	1.234			0.855			3.814			3.814	1.000
5	5439	0.596			0.678			6.221			6.221	1.000
6	1406	0.572			0.715			8.239			8.239	1.000
7	631	0.643			0.716			10.065			10.065	1.000
8	165	0.499			0.737			11.628			11.628	1.000
9	116	0.665			0.678			12.959			12.959	1.000
10	38	0.442			0.692			14.028			14.028	1.000
11	23	0.601			1.143			14.541			14.541	1.000
12	13	0.570			0.793			14.530			14.530	1.000
13	5	0.570			0.793			15.346			15.346	1.000

Mean F	Age 2 to 8	Age 1 1	Age 2 to 8	Age 1 1
Unscaled	0.800	0.000	0.819	0.000
Scaled			0.800	0.000

Recruits at age 1 in 1989 = 328000
Recruits at age 1 in 1990 = 314000
Recruits at age 1 in 1991 = 350822
Recruits at age 1 in 1992 = 350822

M at age and proprtion mature at age are as shown in Table 12.3

Mean F for ages 2 to 8 in 1988 for human consumption landings + discards = 0.800 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1984 to 1988
rescaled to produce a mean value of F for ages 2 to 8 equal to that for 1988

Mean F for ages 1 to 1 in 1988 for small-mesh fisheries = 0.000 .
Industrial fishery F-at-age in the prediction are averages for the period 1984 to 1988 .
rescaled to produce a mean value of F for ages 1 to 1 equal to that for 1988

Values of N in 1988 from VPA have been overwritten
for the following ages .....

Age 1
Age 2

Values of F for these ages in 1988 from VPA have been overwritten
with scaled mean values used for predictions for 1989 onwards

Table 12.10 Predicted catches and biomasses ('000 tonnes) of cod in Sub-area IV 1989 to 1990.
$F_{89}=F_{88}$

		Year									
	1988	1989	1990								
Biomass 1 Jan of Year											
Total	372	412	423	423	423	423	423	423	423	423	423
Spawning	88	91	83	83	83	83	83	83	83	83	83
Mean F Ages											
Human Cons. 2 to 8	0.80	0.80	0.00	0.16	0.32	0.48	0.64	0.80	0.96	0.00	0.00
Small-mesh 1 to 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean F(Year)/Mean F(1988)										F0.1	Fmax
Human Consumption	1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Catch weight											
Human Consumption	150	136	0	38	70	98	122	143	161	0	0
Discards	0	0	0	0	0	0	0	0	0	0	0
Small-mesh Fisheries	0	0	0	0	0	0	0	0	0	0	0
Total landings	150	136	0	38	70	98	122	143	161	0	0
Total catch	150	136	0	38	70	98	122	143	161	0	0
Biomass 1 Jan of Year+1											
Total	412	423	667	609	560	518	483	453	427	0	0
Spawning	91	83	176	150	128	109	93	80	68	0	0

Stock at start of and catch during 1989

Age	Stock No	H.Cons	Discards	By-catch	Total
1	328000	34455	0	0	34455
2	73628	38295	0	0	38295
3	28713	16231	0	0	16231
4	14959	7902	0	0	7902
5	915	413	0	0	413
6	2454	1149	0	0	1149
7	650	305	0	0	305
8	272	130	0	0	130
9	82	37	0	0	37
10	49	22	0	0	22
11	20	13	0	0	13
12	10	5	0	0	5
13	6	3	0	0	3
Wt	411736	135525	0	0	135525

Stock at start of and catch during 1990
for F(1990) = F(1989)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	314000	32984	0	0	32984
2	125129	65082	0	0	65082
3	20726	11716	0	0	11716
4	8358	4415	0	0	4415
5	5209	2352	0	0	2352
6	380	178	0	0	178
7	983	461	0	0	461
8	260	124	0	0	124
9	106	48	0	0	48
10	34	16	0	0	16
11	20	13	0	0	13
12	5	3	0	0	3
13	6	3	0	0	3
Wt	422689	142577	0	0	142577

Table 12.11 Predicted catches and biomasses ('000 tonnes) of cod in Sub-area IV 1989 to 1990. TAC constraint in 1989.

	Ages	Year 1988	1989	1990								
Biomass 1 Jan of Year												
Total		372	412	439	439	439	439	439	439	439	439	439
Spawning		88	91	91	91	91	91	91	91	91	91	91
Mean F	Ages											
Human Cons.	2 to 8	0.80	0.70	0.00	0.16	0.32	0.48	0.64	0.80	0.96	0.00	0.00
Small-mesh	1 to 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean F(Year)/Mean F(1988)											F0.1	Fmax
Human Consumption		1.00	0.88	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Catch weight												
Human Consumption		150	124	0	40	74	103	129	151	170	0	0
Discards		0	0	0	0	0	0	0	0	0	0	0
Small-mesh Fisheries		0	0	0	0	0	0	0	0	0	0	0
Total landings		150	124	0	40	74	103	129	151	170	0	0
Total catch		150	124	0	40	74	103	129	151	170	0	0
Biomass 1 Jan of Year+1												
Total		412	439	688	627	575	531	494	462	435	0	0
Spawning		91	91	191	162	138	118	101	86	74	0	0

Stock at start of and catch during 1989

Age	Stock No	H.Cons	Discards	By-catch	Total
1	328000	30573	0	0	30573
2	73628	35223	0	0	35223
3	28713	14982	0	0	14982
4	14959	7258	0	0	7258
5	915	377	0	0	377
6	2454	1049	0	0	1049
7	650	278	0	0	278
8	272	119	0	0	119
9	82	34	0	0	34
10	49	20	0	0	20
11	20	12	0	0	12
12	10	5	0	0	5
13	6	3	0	0	3
Wt	411736	123945	0	0	123945

Stock at start of and catch during 1990 for F(1990) = F(1989)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	314000	32984	0	0	32984
2	127611	66373	0	0	66373
3	23139	13080	0	0	13080
4	9406	4968	0	0	4968
5	5771	2606	0	0	2606
6	413	193	0	0	193
7	1071	502	0	0	502
8	283	135	0	0	135
9	116	52	0	0	52
10	37	17	0	0	17
11	22	14	0	0	14
12	6	3	0	0	3
13	7	3	0	0	3
Wt	438906	150942	0	0	150942

Table 12.12 Estimated age composition of cod in Sub-area IV in first half of 1989.

	Human Consumption				Small Mesh By-catch		International Catch	
	Landings		Discards					
Age	Number	Weight	Number	Weight	Number	Weight	Number	Weight
0								
1	1162	0.460					1162	0.460
2	11971	0.783					11971	0.783
3	13379	1.479					13379	1.479
4	5279	3.475					5279	3.475
5	433	5.688					433	5.688
6	552	7.635					552	7.635
7	131	10.055					131	10.055
8	75	10.683					75	10.683
9	19	13.010					19	13.010
10	22	14.097					22	14.097
11	5	14.115					5	14.115
12	2	17.096					2	17.096
13								
14								
15								
No.	33032		0		0		33032	
Wt.	57518		0		0		57518	

Table 13.1 Nominal catch (in tonnes) of COD in Division VIa, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Belgium	4	57	30	35	21
Denmark	-	27[2]	-	3	-
Faroe Islands	40	3	-	2	-
France	4,590	5,495	7,601	7,160	8,140
Germany, Fed. Rep.	40	1	21	8	205
Ireland	2,237	2,331	2,725	3,527	2,695
Netherlands	20	1	-	-	-
Norway	32	48	40	238	267
Spain	-	-	-	41	52
Sweden	-	-	-	1	-
UK (England and Wales)	2,348	2,302	3,187[3]	2,948	1,141
UK (N. Ireland)	2	2	7	33	37
UK (Scotland)	6,929	7,603	10,339	7,969	8,933
Total	16,242	17,870	23,950	21,965	21,491

Country	1984	1985	1986	1987	1988
Belgium	22	48	88	33	44
Denmark	-	-	-	4	1[1]
Faroe Islands	-	-	-	-	-
France	7,637	7,411	5,096	5,044	6,473[4]
Germany, Fed. Rep.	75	66	53	12	68[1,2]
Ireland	2,316	2,564	1,704	2,442	2,117[1]
Netherlands	-	1	-	-	...
Norway	231	204	174	77	186[1]
Spain	64	28	-	-	...
UK (England & Wales)	692	243	106	306	184[1]
UK (N. Ireland)	32	17	54	138	46
UK (Scotland)	9,483	8,032	4,251	11,143	8,465
Total	20,552	18,614	11,526	19,199	17,584

[1] Preliminary.
[2] Includes Division VIb.
[3] Including 37 tonnes caught in Sub-area VI.
[4] Includes Divisions Vb and VIb.

Table 13.2 Annual weight and numbers of cod caught in Division VIa between 1969 and 1988.

	Weight (1000 tonnes)				Number (millions)			
Year	Total	H.Con	Disc	By-cat	Total	H.Con	Disc	By-cat
1969	22	22	0	0	6	6	0	0
1970	13	13	0	0	4	4	0	0
1971	11	11	0	0	4	4	0	0
1972	15	15	0	0	6	6	0	0
1973	12	12	0	0	5	5	0	0
1974	14	14	0	0	5	5	0	0
1975	13	13	0	0	5	5	0	0
1976	17	17	0	0	7	7	0	0
1977	13	13	0	0	5	5	0	0
1978	14	14	0	0	5	5	0	0
1979	16	16	0	0	6	6	0	0
1980	18	18	0	0	8	8	0	0
1981	24	24	0	0	12	12	0	0
1982	22	22	0	0	8	8	0	0
1983	21	21	0	0	10	10	0	0
1984	21	21	0	0	8	8	0	0
1985	19	19	0	0	9	9	0	0
1986	12	12	0	0	5	5	0	0
1987	19	19	0	0	15	15	0	0
1988	20	20	0	0	12	12	0	0

Table 13.3 Values of natural mortality rate and proportion mature at age.

Age	Nat Mor	Mat.
1	0.200	0.000
2	0.200	0.520
3	0.200	0.860
4	0.200	1.000
5	0.200	1.000
6	0.200	1.000
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10	0.200	1.000

Table 13.4 Total international catch at age ('000) of cod in Division VIa between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	64	256	254	735	1015	843	1207	970	1265	723	1
2	1974	1176	1903	2891	1524	2318	1898	3682	1314	1761	2
3	1332	1638	550	1591	1442	778	1187	1467	1639	999	3
4	1943	571	841	409	583	1068	533	638	624	695	4
5	759	476	240	501	161	288	325	256	269	286	5
6	149	153	201	108	193	72	90	215	87	97	6
7	94	26	66	70	63	76	12	44	57	47	7
8	65	21	15	24	28	13	13	7	11	18	8
9	12	23	7	12	10	9	9	4	4	8	9
10		4	7	4	3	5	1	1	6	2	10

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	929	1195	461	1827	2335	2143	1355	792	7873	1004	1
2	1612	3294	7016	1673	4515	2360	5069	1486	4837	8331	2
3	2125	2001	3220	3206	1118	2564	1269	2055	988	2201	3
4	682	796	904	1189	1400	448	1091	411	905	285	4
5	342	191	182	367	468	555	140	191	137	211	5
6	134	77	29	111	148	185	167	40	56	40	6
7	32	27	16	22	40	40	60	16	8	15	7
8	16	8	3	10	16	14	13	9	14	5	8
9	17	1	1	1	2	5	6	4	3	2	9
10	4	1		1	1		0		1		10

Table 13.5 Total international mean weight at age (kg.) of cod in Division VIa between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	0.860	0.595	0.674	0.609	0.597	0.611	0.603	0.616	0.629	0.630	1
2	1.284	0.955	1.046	1.192	1.181	1.103	1.369	1.397	1.160	1.373	2
3	2.821	2.533	2.536	2.586	2.784	2.834	3.078	3.161	2.605	3.389	3
4	4.259	4.678	4.167	4.417	4.601	4.750	5.302	5.005	4.715	5.262	4
5	6.169	6.016	6.023	6.226	5.625	6.144	6.846	6.290	6.269	7.096	5
6	6.374	7.120	6.835	7.585	7.049	7.729	8.572	8.017	7.525	8.686	6
7	7.529	7.350	7.781	7.968	8.208	8.931	9.769	8.754	9.337	9.932	7
8	8.436	8.826	8.238	9.081	8.526	9.317	10.301	9.676	9.489	10.060	8
9	8.300	8.703	9.029	10.369	9.981	12.206	10.843	9.947	12.812	8.694	9
10		7.400	9.925	9.647	12.878	10.538	13.061	10.486	8.925	10.657	10

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	0.693	0.624	0.550	0.692	0.583	0.735	0.628	0.710	0.531	0.806	1
2	1.373	1.375	1.166	1.468	1.265	1.402	1.183	1.211	1.312	1.180	2
3	2.828	3.002	2.839	2.737	2.995	3.168	2.597	2.785	2.783	2.877	3
4	4.853	5.277	4.923	4.749	4.398	5.375	4.892	4.655	4.574	5.123	4
5	6.433	7.422	7.518	6.113	6.305	6.601	6.872	6.336	6.161	6.970	5
6	7.784	8.251	9.314	7.227	8.084	8.606	8.344	8.283	7.989	8.191	6
7	8.570	9.293	10.176	9.587	9.064	10.461	9.540	9.091	9.786	8.868	7
8	9.452	9.473	10.668	10.264	10.979	10.464	10.061	8.742	9.530	12.501	8
9	11.097	8.500	11.271	11.449	12.467	9.131	11.357	12.128	11.299	13.384	9
10	12.736	10.875		10.306	11.882		13.442		16.056		10

Table 13.6 Total international fishing mortality rate at age of cod in Division VIa between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	0.017	0.037	0.027	0.137	0.141	0.119	0.123	0.178	0.153	0.087	1
2	0.341	0.498	0.412	0.478	0.464	0.542	0.423	0.663	0.388	0.330	2
3	0.639	0.529	0.461	0.731	0.467	0.459	0.596	0.682	0.716	0.577	3
4	1.008	0.631	0.575	0.754	0.659	0.769	0.664	0.763	0.709	0.779	4
5	1.116	0.740	0.603	0.828	0.777	0.824	0.565	0.801	0.888	0.857	5
6	0.929	0.711	0.830	0.603	0.925	1.026	0.671	0.938	0.713	0.992	6
7	1.065	0.408	0.794	0.799	0.877	1.309	0.468	0.838	0.710	1.148	7
8	0.746	0.748	0.430	0.748	0.930	0.426	0.841	0.525	0.528	0.511	8
9	0.973	0.648	0.646	0.746	0.834	0.871	0.642	0.773	0.710	0.857	9
10	0.973	0.648	0.646	0.746	0.834	0.871	0.642	0.773	0.710	0.857	10

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	0.071	0.066	0.089	0.143	0.331	0.171	0.288	0.071	0.302	0.427	1
2	0.283	0.380	0.662	0.525	0.620	0.657	0.764	0.588	0.786	0.604	2
3	0.845	0.677	0.794	0.742	0.824	0.898	0.935	0.837	1.037	1.081	3
4	1.040	0.933	0.763	0.792	0.880	0.980	1.390	0.947	1.205	1.026	4
5	1.219	0.981	0.566	0.839	0.866	1.140	1.009	1.042	1.023	1.095	5
6	1.467	1.078	0.369	0.829	1.033	1.083	1.509	0.944	1.080	1.000	6
7	1.158	1.703	0.663	0.529	0.862	0.906	1.458	0.557	0.504	1.037	7
8	2.198	1.165	0.936	1.195	0.985	0.844	0.866	0.956	1.507	0.680	8
9	1.416	1.172	0.660	0.837	0.925	0.991	1.247	0.889	1.064	0.968	9
10	1.416	1.172	0.660	0.837	0.925	0.991	1.247	0.889	1.064	0.968	10

Table 13.7 Stock numbers at age ('000) of cod in Division VIa between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
1	4076	7820	10453	6301	8520	8297	11452	6541	9800	9577	1
2	7491	3280	6172	8329	4496	6061	6033	8289	4481	6883	2
3	3080	4360	1631	3345	4228	2315	2887	3237	3496	2490	3
4	3321	1331	2103	842	1319	2169	1198	1302	1340	1399	4
5	1223	992	580	969	324	558	823	505	497	540	5
6	267	328	388	260	347	122	201	383	186	167	6
7	155	86	132	138	116	112	36	84	123	74	7
8	134	44	47	49	51	40	25	18	30	49	8
9	21	52	17	25	19	16	21	9	9	14	9
10		9	15	9	6	9	2	3	13	4	10

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
1	14979	20623	5977	15049	9094	14987	5948	12695	33161	3165	1
2	7188	11426	15807	4478	10675	5348	10340	3651	9679	20074	2
3	4053	4436	6398	6673	2168	4703	2269	3944	1660	3611	3
4	1145	1426	1845	2367	2602	778	1568	729	1398	482	4
5	526	331	459	704	878	884	239	320	231	343	5
6	188	127	102	213	249	303	231	71	92	68	6
7	51	35	35	58	76	73	84	42	23	26	7
8	19	13	5	15	28	26	24	16	20	11	8
9	24	2	3	2	4	8	9	8	5	4	9
10	6	1		2	2		0		2		10

Table 13.8 Mean fishing mortality, Biomass and recruitment of cod in Division VIa between 1969 and 1988.

	Mean Fishing Mortality			Biomass		Recruits	
	Ages 2 to 5		Ages 1 to 1	1000 tonnes		Age 1	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1969	0.776	0.000	0.000	48	38	68	4
1970	0.599	0.000	0.000	35	27	69	8
1971	0.513	0.000	0.000	34	24	70	10
1972	0.698	0.000	0.000	36	26	71	6
1973	0.592	0.000	0.000	34	25	72	9
1974	0.648	0.000	0.000	35	25	73	8
1975	0.562	0.000	0.000	39	27	74	11
1976	0.727	0.000	0.000	40	29	75	7
1977	0.675	0.000	0.000	33	23	76	10
1978	0.636	0.000	0.000	38	26	77	10
1979	0.847	0.000	0.000	43	26	78	15
1980	0.743	0.000	0.000	53	31	79	21
1981	0.697	0.000	0.000	54	39	80	6
1982	0.724	0.000	0.000	53	37	81	15
1983	0.797	0.000	0.000	45	33	82	9
1984	0.919	0.000	0.000	47	30	83	15
1985	1.025	0.000	0.000	34	24	84	6
1986	0.854	0.000	0.000	31	18	85	13
1987	1.013	0.000	0.000	41	20	86	28
1988	0.952	0.000	0.000	43	25	87	10
Arit-mean recruits at age 1 for period 1969 to 1988							11
Geom-mean recruits at age 1 for period 1969 to 1988							10

Table 13.9 Input for catch prediction of cod in Division VIa.

	1988 Stock and Fishing Mortality				Values used in Prediction: F at age, Mean Wt. and Propn. Retained by Consumption Fishery							
					Scaled mean F 1984 to 1988			Mean values for period 1984 to 1988: Mean Weight (Kg.)				Prop.
Age	Stock Number	Fishing Mortality H.Con.	Disc	Ind	H.Con.	Disc	Ind	H.Con.	Disc	Ind	Stock	Ret.
1	10000	0.264			0.264			0.682			0.682	1.000
2	16000	0.679			0.679			1.258			1.258	1.000
3	3611	1.081			0.957			2.842			2.842	1.000
4	482	1.026			1.109			4.924			4.924	1.000
5	343	1.095			1.061			6.588			6.588	1.000
6	68	1.000			1.122			8.283			8.283	1.000
7	26	1.037			0.892			9.549			9.549	1.000
8	11	0.680			0.970			10.259			10.259	1.000
9	4	0.968			1.031			11.460			11.460	1.000
10		0.968			1.031			14.749			14.749	1.000

Mean F	Age 2 to 5	Age 1 1	Age 2 to 5	Age 1 1
Unscaled	0.952	0.000	0.952	0.000
Scaled			0.952	0.000

Recruits at age 1 in 1989 = 9914
Recruits at age 1 in 1990 = 9914
Recruits at age 1 in 1991 = 9914
Recruits at age 1 in 1992 = 9914

M at age and proprtion mature at age are as shown in Table 13.3

Mean F for ages 2 to 5 in 1988 for human consumption landings + discards = 0.952 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1984 to 1988 rescaled to produce a mean value of F for ages 2 to 5 equal to that for 1988

Mean F for ages 1 to 1 in 1988 for small-mesh fisheries = 0.000 .
Industrial fishery F-at-age in the prediction are averages for the period 1984 to 1988 .
rescaled to produce a mean value of F for ages 1 to 1 equal to that for 1988

Values of N in 1988 from VPA have been overwritten
for the following ages .....

Age 1
Age 2

Values of F for these ages in 1988 from VPA have been overwritten
with scaled mean values used for predictions for 1989 onwards

Table 13.10 Predicted catches and biomasses ('000 tonnes) of cod in Division VIa 1989 to 1990.

	Ages	1988	1989	1990								
Biomass 1 Jan of Year												
Total		43	41	35	35	35	35	35	35	35	35	35
Spawning		25	27	23	23	23	23	23	23	23	23	23
Mean F	Ages											
Human Cons.	2 to 5	0.95	0.95	0.00	0.19	0.38	0.57	0.76	0.95	1.14	0.00	0.00
Small-mesh	1 to 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean F(Year)/Mean F(1988)											F0.1	Fmax
Human Consumption		1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Catch weight												
Human Consumption		20	20	0	5	9	12	15	17	19	0	0
Discards		0	0	0	0	0	0	0	0	0	0	0
Small-mesh Fisheries		0	0	0	0	0	0	0	0	0	0	0
Total landings		20	20	0	5	9	12	15	17	19	0	0
Total catch		20	20	0	5	9	12	15	17	19	0	0
Biomass 1 Jan of Year+1												
Total		41	35	56	49	43	38	34	31	28	0	0
Spawning		27	23	42	36	30	26	22	19	16	0	0

Stock at start of and catch during 1989

Age	Stock No	H.Cons	Discards	By-catch	Total
1	9914	2097	0	0	2097
2	6285	2840	0	0	2840
3	6641	3766	0	0	3766
4	1003	620	0	0	620
5	141	85	0	0	85
6	94	59	0	0	59
7	21	11	0	0	11
8	7	4	0	0	4
9	5	3	0	0	3
10	1	1	0	0	1
Wt	40533	19997	0	0	19997

Stock at start of and catch during 1990
for F(1990) = F(1989)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	9914	2097	0	0	2097
2	6231	2816	0	0	2816
3	2609	1479	0	0	1479
4	2088	1291	0	0	1291
5	271	163	0	0	163
6	40	25	0	0	25
7	25	14	0	0	14
8	7	4	0	0	4
9	2	1	0	0	1
10	2	1	0	0	1
Wt	34773	17017	0	0	17017

Table 13.11 Age Composition of COD in VIa in Scottish Landings
First Quarter 1989 (Numbers in '000's)

Age	Number
1	14
2	255
3	832
4	106
5	23
6	23
7	10
8	+
9	1
10+	0

Tonnes 2764

Table 14.1 Nominal catch (in tonnes) of COD in Division VIb, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Faroe Islands	92	75	2	77	112
France	2	1	4	27	97
Germany, Fed. Rep.	111	136	443	+	195
Norway	138	80	134	51	462
Spain	–	–	70	58	42
UK (England and Wales)	129	1	67	3	163
UK (N.Ireland)	–	–	–	–	–
UK (Scotland)	198	370	143	157	35
Total	670	696	863	373	1,106

Country	1984	1985	1986	1987	1988
Faroe Islands	18	–	1	–[1]	–[1]
France	9	17	5	7	...[1,2]
Germany, Fed. Rep.	–	3	–	–	...[1,2]
Norway	373	202	95	130	195[1]
Spain	241	1,200	1,219	808	...
UK (England & Wales)	161	114	93	69	56
UK (N. Ireland)	–	–	1	–	–
UK (Scotland)	221	437	187	284	254
Total	1,023	1,973	1,601	1,298	505

[1] Preliminary.
[2] Included in Division VIa.

Table 15.1 Nominal catch (in tonnes) of COD in Division VIId, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Belgium	690[1]	151[1]	329	251	368
Denmark	...	...	-	-	-
France	3,998	3,203	3,707	2,696	2,802
Netherlands	-	-	4	1	4
UK(England and Wales)	348	160	206	306	358
Total	5,036	3,514	4,246	3,254	3,532
WG Estimate	4,743	3,892	5,497	4,117	4,020

Country	1984	1985	1986	1987	1988
Belgium	331	501	650	815	486[2]
Denmark	-	-	4	-	+[2]
France	2,492	2,589[1]	9,938[1]	7,541	6,642[3]
Netherlands	-	...	...	-	...
UK(England and Wales)	282	326	830	1,044	867
Total	3,105	3,416	11,422	9,400	7,995
WG Estimate	3,686	3,401	12,395	15,219	10,528

[1] Included in Division VIIe.
[2] Preliminary.
[3] Working Group estimate.

Table 15.2 Values of natural mortality rate and proportion mature at age.

Age	Nat Mor	Mat.
1	0.200	0.000
2	0.200	0.000
3	0.200	0.000
4	0.200	1.000
5	0.200	1.000
6	0.200	1.000

Table 15.3 Total international catch at age ('000) of cod in Division VIId between 1976 and 1988.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Age
1	9	5090	377	236	520	57	891	125	582	14	1
2	646	3697	4641	1229	1539	2115	936	1872	1666	1235	2
3	628	182	1035	996	521	1089	538	817	423	463	3
4	91	56	201	179	230	208	281	196	75	77	4
5	35	14	10	51	20	29	42	42	38	5	5
6	22	5	1	3	6	1	7	7	11	4	6

Age	1986	1987	1988	Age
1	7504	3223	642	1
2	8666	9682	2941	2
3	1677	176	2014	3
4	527	224	281	4
5	61	6	6	5
6	8	1		6

Table 15.4 Total international mean weight at age (kg.) of cod in Division VIId between 1976 and 1988.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Age
1	0.616	0.536	0.560	0.626	0.590	0.598	0.660	0.780	0.699	0.613	1
2	1.316	0.672	1.067	0.951	0.783	0.963	0.707	0.748	0.867	1.355	2
3	2.311	2.012	1.990	2.458	2.302	2.142	2.493	1.744	2.877	2.716	3
4	4.686	4.854	2.906	4.034	4.490	4.406	4.383	4.118	4.286	5.138	4
5	6.049	6.324	6.001	4.684	5.657	5.926	5.825	5.706	5.883	7.390	5
6	7.417	7.802	7.932	6.095	5.880	6.847	6.978	7.707	6.422	7.767	6

Age	1986	1987	1988	Age
1	0.418	0.670	0.951	1
2	0.616	1.356	1.002	2
3	1.257	2.564	2.852	3
4	2.728	3.511	4.214	4
5	5.204	6.137	6.892	5
6	7.952	7.703		6

Table 15.5 Results of separable VPA of cod in Division VIId.

Separable analysis
from 1976 to 1988 on ages 1 to 5
with Terminal F of 1.000 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 220.012 and
final sum of squared residuals is 54.093 after 37 iterations

Matrix of Residuals

Years	1976/77	1977/78
Ages		
1/ 2	-3.971	2.149
2/ 3	0.263	0.200
3/ 4	1.453	-1.146
4/ 5	0.076	-0.216
	0.000	0.000
WTS	1.000	1.000

Years	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	.	WTS
Ages												
1/ 2	0.765	0.050	0.717	-0.771	1.464	-0.693	0.604	-2.977	0.969	1.700	0.006	0.233
2/ 3	0.321	-0.337	-0.585	0.308	-0.719	0.214	-0.442	0.297	0.777	-0.292	0.006	0.946
3/ 4	0.568	0.327	0.047	0.353	0.186	1.155	0.120	0.407	-1.260	-2.203	0.006	0.415
4/ 5	-0.718	0.172	0.367	-0.258	0.261	-0.520	0.228	0.245	-0.424	0.793	0.006	1.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.023	
WTS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	1976	1977	1978
F-values	0.9961	1.0669	1.1394

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
F-values	1.0632	0.3183	0.9806	0.9316	1.1589	1.0132	0.4033	3.0000	1.5199	1.0000

Selection-at-age (S)

	1	2	3	4	5
S-values	0.0621	0.9073	1.0000	1.4597	1.0000

Table 15.6 Total international fishing mortality rate at age of cod in Division VIId between 1976 and 1988.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Age
1	0.001	0.512	0.128	0.056	0.128	0.023	0.248	0.034	0.126	0.001	1
2	0.702	1.203	1.328	0.770	0.605	1.100	0.607	1.247	0.809	0.423	2
3	2.031	0.434	1.570	1.299	0.915	1.244	0.976	2.039	1.155	0.553	3
4	1.494	1.308	1.282	1.631	1.389	1.285	1.496	1.321	1.402	0.672	4
5	0.978	1.025	0.936	1.638	0.823	0.626	1.026	1.007	1.078	0.273	5
6	0.978	1.025	0.936	1.638	0.823	0.626	1.026	1.007	1.078	0.273	6

Age	1986	1987	1988	Age
1	0.401	0.356	0.062	1
2	2.611	1.166	0.644	2
3	1.927	0.391	0.987	3
4	3.995	2.905	2.355	4
5	2.283	1.632	0.937	5
6	2.283	1.632	0.937	6

Table 15.7 Stock numbers at age ('000) of cod in Division VIId between 1976 and 1988.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Age
1	6994	13898	3461	4781	4771	2810	4449	4132	5430	12140	1
2	1396	5718	6820	2494	3702	3437	2249	2841	3270	3921	2
3	773	567	1406	1480	945	1654	937	1004	669	1193	3
4	126	83	301	240	330	310	390	289	107	173	4
5	60	23	18	68	38	67	70	72	63	22	5
6	38	9	2	3	12	2	13	11	18	16	6

Age	1986	1987	1988	Age
1	24906	11790	11745	1
2	9926	13658	6759	2
3	2102	597	3486	3
4	562	251	330	4
5	72	8	11	5
6	9	1		6

Table 15.8 Mean fishing mortality, biomass and recruitment of cod in Division VIId between 1976 and 1988.

	Mean Fishing Mortality Ages 2 to 4		Ages 1 to 1	Biomass 1000 tonnes		Recruits Age 1	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1976	1.409	0.000	0.000	9	1	75	7
1977	0.982	0.000	0.000	13	1	76	14
1978	1.393	0.000	0.000	13	1	77	3
1979	1.233	0.000	0.000	10	1	78	5
1980	0.970	0.000	0.000	10	2	79	5
1981	1.209	0.000	0.000	10	2	80	3
1982	1.026	0.000	0.000	9	2	81	4
1983	1.536	0.000	0.000	9	2	82	4
1984	1.122	0.000	0.000	10	1	83	5
1985	0.549	0.000	0.000	17	1	84	12
1986	2.844	0.000	0.000	21	2	85	25
1987	1.487	0.000	0.000	29	1	86	12
1988	1.329	0.000	0.000	24	1	87	6
Arit-mean recruits at age 1 for period 1976 to 1988							8
Geom-mean recruits at age 1 for period 1976 to 1988							7

Table 15.9 Input for catch prediction of cod in Division VIId.

Age	1988 Stock and Fishing Mortality: Stock Number	Fishing Mortality: H.Con.	Fishing Mortality: Disc	Fishing Mortality: Ind	Values used in Prediction (F at age, Mean Wt. and Propn. Retained by Consumption Fishery) — Scaled mean F 1984 to 1988: H.Con.	Scaled mean F: Disc	Scaled mean F: Ind	Mean values for period 1984 to 1988 — Mean Weight (Kg.): H.Con.	Mean Weight: Disc	Mean Weight: Ind	Mean Weight: Stock	Prop. Ret.
1	5967	0.126			0.183			0.670			0.670	1.000
2	6761	0.644			1.024			1.039			1.039	1.000
3	3486	0.987			0.908			2.453			2.453	1.000
4	331	2.355			2.053			3.975			3.975	1.000
5	11	0.937			1.124			6.301			6.301	1.000
6		0.937			1.124			7.461			7.461	1.000

Mean F	Age 2 to 4	Age 1 1	Age 2 to 4	Age 1 1
Unscaled	1.329	0.000	1.466	0.000
Scaled			1.329	0.000

Recruits at age 1 in 1989 = 6608
Recruits at age 1 in 1990 = 6608
Recruits at age 1 in 1991 = 6608
Recruits at age 1 in 1992 = 6608

M at age and proprtion mature at age are as shown in Table 15.2

Mean F for ages 2 to 4 in 1988 for human consumption landings + discards = 1.329 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1984 to 1988
rescaled to produce a mean value of F for ages 2 to 4 equal to that for 1988

Mean F for ages 1 to 1 in 1988 for small-mesh fisheries = 0.000 .
Industrial fishery F-at-age in the prediction are averages for the period 1984 to 1988 .
rescaled to produce a mean value of F for ages 1 to 1 equal to that for 1988

Recruits in 1988 from F 1976-1985 (0.126)
Recruits in 1989 from R 1976-1988

Table 15.10 Predicted catches and biomasses ('000 tonnes) of cod in Division VIId 1989 to 1990.

	Year 1988	1989	1990								
Biomass 1 Jan of Year											
Total	24	20	17	17	17	17	17	17	17	17	17
Spawning	1	4	5	5	5	5	5	5	5	5	5
Mean F Ages											
Human Cons. 2 to 4	1.33	1.33	0.00	0.27	0.53	0.80	1.06	1.33	1.59	0.00	0.00
Small-mesh 1 to 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean F(Year)/Mean F(1988)										F0.1	Fmax
Human Consumption	1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Catch weight											
Human Consumption	11	11	0	3	5	6	8	9	10	0	0
Discards	0	0	0	0	0	0	0	0	0	0	0
Small-mesh Fisheries	0	0	0	0	0	0	0	0	0	0	0
Total landings	11	11	0	3	5	6	8	9	10	0	0
Total catch	11	11	0	3	5	6	8	9	10	0	0
Biomass 1 Jan of Year+1											
Total	20	17	29	24	21	19	17	15	14	0	0
Spawning	4	5	10	7	5	4	3	3	2	0	0

Stock at start of and catch during 1989

Age	Stock No	H.Cons	Discards	By-catch	Total
1	6608	1005	0	0	1005
2	4307	2544	0	0	2544
3	2907	1596	0	0	1596
4	1064	867	0	0	867
5	26	16	0	0	16
6	4	2	0	0	2
Wt	20455	10800	0	0	10800

Stock at start of and catch during 1990
for F(1990) = F(1989)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	6608	1005	0	0	1005
2	4505	2661	0	0	2661
3	1266	695	0	0	695
4	960	783	0	0	783
5	112	70	0	0	70
6	8	5	0	0	5
Wt	16794	8731	0	0	8731

Table 15.11 Nominal catch (in tonnes) of COD in Division VIIe, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Belgium	9	12	34	42	21
Denmark	2,052[1]	660[1]	-	-	-
France	850	798	779	653	567
Netherlands	-	-	-	-	-
UK(England and Wales)	137	205	222	262	292
Total	3,048	1,675	1,035	957	880
WG Estimate	2,654	1,327	731	493	461

Country	1984	1985	1986	1987	1988
Belgium	15	12	8	10	12
Denmark	-	-	-	+	+[2]
France	390	359	1,305	1,122	1,326[3]
Netherlands	-	1[1]	66[1]	-	-
UK(England and Wales)	236	243	406	524	840
Total	641	615	1,785	1,656	2,178
WG Estimate	385	458	1,447	1,700	1,644

[1] Includes Division VIId.
[2] Preliminary.
[3] Working Group estimate.

Table 15.12 Results of SHOT forecast for cod in Division VIIe.

running recruitment weights

older	.50		G-M =	.00
central	.50		exp(d)	1.00
younger	.00		exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1979	2.7	3.3		.50	.50				5		
1980	1.3	5.8	5	.50	.50	0			3		
1981	.7	2.3	4	.50	.50	0			1		
1982	.5	.8	2	.50	.50	0			1		
1983	.5	3.5	2	.50	.50	0	0	0	1	1	.3
1984	.4	3.7	4	.50	.50	0	0	0	1	1	.4
1985	.5	2.5	3	.50	.50	1	0	0	1	1	.3
1986	1.4	1.9	2	.50	.50	2	0	0	3	1	.3
1987	1.7	12.7	7	.50	.50	2	1	1	3	3	1.4
1988	1.6	3.8	8	.50	.50	2	2	2	3	3	1.7
1989		1.1	2	.50	.50		1	1		2	1.1
1990		4.0	3	.50	.50		1	1		2	.8
1991		4.0									

Table 16.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1979-1988, as officially reported to ICES.

Country	1979	1980	1981	1982	1983
Belgium	732	1,414	1,217	966	985
Denmark	8,248	12,928	13,198	22,704	25,653
Faroe Islands	7	27	46	6	51
France	7,208	7,407	11,966	15,988	11,250
German Dem. Rep.	12	36	-	-	-
Germany, Fed. Rep.	2,549	2,354	3,387	4,510	3,654
Netherlands	955	1,557	2,279	1,021	1,722
Norway[2]	968	1,191	2,283	2,888	3,862
Poland	106	59	31	317	150
Sweden	907	1,165	1,301	1,874	1,360
UK (England and Wales)	10,774	12,195	14,570	16,403	15,476
UK (Scotland)	54,119	64,058	82,798	107,773	100,390
USSR	18	-	-	-	-
Total	86,603	104,391	133,076	174,450	164,553

Country	1984	1985	1986	1987	1988
Belgium	494	719	317	165	220[1]
Denmark	16,368	23,821	16,397	7,767	9,171[1]
Faroe Islands	-	5	4	-[1]	-[1]
France	8,103	5,389	4,802	3,889	2,166[1,3]
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	2,571	2,796	1,984	1,231	825[1]
Netherlands	1,052	3,875	1,627	1,093	859[4]
Norway[2]	3,959	3,498	5,190	2,610	1,505[1]
Poland	17	-	1	-	-
Sweden	1,518	1,942	1,550	937	614
UK (England & Wales)	12,340	13,614	8,137	7,491	5,537
UK (Scotland)	87,479	112,549	126,650	84,063	84,104
USSR	-	-	-	-	-
Total	133,901	168,208	166,659	109,246	105,001

[1] Preliminary.
[2] Figures from Norway do not include haddock caught in Rec. 2 fisheries
[3] Includes Division IIa.
[4] Working Group estimate.

Table 16.2 Annual weight and numbers of haddock caught in Sub-area IV between 1969 and 1988.

	Weight (1000 tonnes)				Number (millions)			
Year	Total	H.Con	Disc	By-cat	Total	H.Con	Disc	By-cat
1969	929	331	260	338	4003	910	1203	1890
1970	806	525	101	180	3382	1245	515	1622
1971	444	235	177	32	2669	473	1282	914
1972	351	193	128	30	1722	428	760	534
1973	305	179	115	11	1280	449	660	171
1974	364	150	167	48	2384	357	1091	936
1975	448	147	260	41	2958	362	1862	734
1976	368	166	154	48	1631	396	788	447
1977	217	137	44	35	896	320	226	350
1978	174	86	77	11	1030	192	418	420
1979	141	83	42	16	1461	189	286	985
1980	216	99	95	22	1446	218	541	687
1981	207	130	60	17	1351	274	298	779
1982	226	166	41	19	971	311	181	480
1983	238	159	66	13	1256	293	389	574
1984	213	128	75	10	866	247	412	207
1985	251	159	86	6	971	359	458	154
1986	220	166	52	3	755	371	308	75
1987	172	108	59	4	657	228	334	95
1988	171	105	62	4	644	253	362	29

Table 16.3 Values of natural mortality rate and proportion mature at age.

Age	Nat Mor	Mat.
0	2.050	0.000
1	1.650	0.010
2	0.400	0.320
3	0.250	0.710
4	0.250	0.870
5	0.200	0.950
6	0.200	1.000
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10	0.200	1.000
11	0.200	1.000

Table 16.4 Total international catch at age ('000) of haddock in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
0	72559	924601	330674	240896	59873	601412	44947	167173	114902	285816	0
1	20469	266147	1809963	675831	364824	1213866	2096826	167599	250134	454082	1
2	3574797	218293	70735	584076	567131	174389	632672	1046110	104307	142666	2
3	303070	1906573	47224	40150	237498	326659	57630	204506	376971	28695	3
4	7584	57362	397328	20948	6099	53137	106048	9555	38061	107170	4
5	2407	1176	10288	155922	4399	1832	15320	30044	4086	8153	5
6	2512	1195	458	3516	38829	1320	952	4793	5939	1190	6
7	19099	256	193	188	1237	10672	601	198	1230	1942	7
8	200	5946	146	33	106	236	2628	73	128	377	8
9	24	67	1578	27	28	23	258	728	27	108	9
10	7	11	159	402	108	31	61	58	190	14	10
11		19	8	11	53	9	18	3	4	74	11

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
0	841382	374941	646338	278691	639788	95488	139603	56476	9415	10800	0
1	344730	659546	134433	275341	156123	432105	179217	160256	277237	29017	1
2	198142	323135	413115	83815	247614	161709	526352	177691	246810	482446	2
3	39550	68713	138182	287823	71188	118498	75485	320284	46722	87377	3
4	7068	9837	14456	40321	123241	21365	36619	27067	67310	13147	4
5	26742	1784	1883	3198	15954	32133	5270	9504	4627	18420	5
6	2134	7573	374	691	1645	3697	7286	1208	2816	1546	6
7	250	562	2462	268	286	590	954	1808	530	614	7
8	461	114	123	780	59	76	209	235	768	152	8
9	145	153	63	29	188	37	54	101	130	134	9
10	52	70	23	15	52	110	22	43	32	48	10
11	23	42	38	11	14	21	93	77	111	48	11

Table 16.5 Total international mean weight at age (kg.) of haddock in Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
0	0.011	0.013	0.011	0.024	0.044	0.024	0.021	0.013	0.019	0.011	0
1	0.063	0.073	0.106	0.116	0.112	0.128	0.101	0.125	0.108	0.144	1
2	0.216	0.222	0.247	0.242	0.241	0.226	0.241	0.224	0.241	0.253	2
3	0.406	0.353	0.362	0.388	0.372	0.343	0.356	0.401	0.345	0.418	3
4	0.799	0.735	0.505	0.506	0.585	0.548	0.450	0.512	0.602	0.441	4
5	0.891	0.873	0.887	0.606	0.648	0.891	0.680	0.588	0.613	0.719	5
6	1.032	1.191	1.267	1.000	0.724	0.895	1.245	0.922	0.802	0.742	6
7	1.094	1.361	1.534	1.366	1.044	0.953	1.124	1.933	1.181	0.954	7
8	2.040	1.437	1.337	2.241	1.302	1.513	1.093	1.784	1.943	1.398	8
9	3.034	2.571	1.275	2.006	2.796	2.315	1.720	1.306	2.322	2.124	9
10	3.264	3.950	1.969	1.651	1.726	2.508	2.217	2.425	1.780	2.868	10
11		3.869	3.848	2.899	2.033	3.019	3.083	2.528	3.499	2.036	11

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
0	0.009	0.012	0.009	0.011	0.022	0.010	0.013	0.025	0.008	0.024	0
1	0.095	0.104	0.074	0.100	0.135	0.141	0.149	0.124	0.126	0.164	1
2	0.291	0.284	0.262	0.292	0.297	0.300	0.279	0.242	0.265	0.217	2
3	0.442	0.486	0.476	0.461	0.448	0.488	0.479	0.396	0.405	0.417	3
4	0.637	0.732	0.744	0.784	0.651	0.670	0.668	0.612	0.613	0.589	4
5	0.664	1.046	1.147	1.166	0.916	0.805	0.859	0.864	1.029	0.747	5
6	0.933	0.936	1.479	1.441	1.215	1.097	1.054	1.260	1.278	1.283	6
7	1.187	1.394	1.180	1.672	1.162	1.100	1.470	1.202	1.433	1.424	7
8	1.187	1.599	1.634	1.456	1.920	1.868	1.844	1.719	1.530	1.541	8
9	1.468	1.593	1.764	2.634	1.376	2.425	2.137	1.526	1.865	1.611	9
10	2.679	1.726	1.554	2.164	1.395	1.972	2.193	2.482	2.040	1.674	10
11	1.686	2.861	1.821	2.145	2.974	2.456	2.012	2.628	2.246	2.948	11

Table 16.6 Total international fishing mortality rate at age of haddock ir Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
0	0.015	0.027	0.011	0.029	0.002	0.012	0.010	0.027	0.012	0.018	0
1	0.020	0.449	0.428	0.155	0.341	0.324	0.307	0.284	0.306	0.358	1
2	0.655	1.032	0.661	0.795	0.572	0.938	0.978	0.826	1.010	1.012	2
3	1.374	1.153	0.804	1.329	1.164	0.960	1.264	1.380	1.042	1.122	3
4	1.217	1.269	0.875	1.198	0.792	1.006	1.110	0.789	1.246	1.105	4
5	0.779	0.632	0.870	1.164	0.953	0.612	0.993	1.285	1.031	1.109	5
6	1.225	1.237	0.545	0.866	1.111	0.878	0.765	1.047	1.005	1.025	6
7	0.988	0.362	0.668	0.452	0.895	1.151	1.488	0.348	0.869	1.170	7
8	0.301	1.023	0.362	0.224	0.500	0.416	1.053	0.728	0.397	0.732	8
9	0.621	0.156	0.864	0.104	0.301	0.187	1.143	1.000	0.674	0.697	9
10	0.783	0.682	0.662	0.562	0.752	0.649	1.088	0.882	0.795	0.947	10
11	0.783	0.682	0.662	0.562	0.752	0.649	1.088	0.882	0.795	0.947	11

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
0	0.030	0.062	0.051	0.035	0.024	0.014	0.014	0.003	0.005	0.003	0
1	0.161	0.171	0.167	0.161	0.142	0.115	0.190	0.115	0.100	0.107	1
2	0.892	0.704	0.454	0.434	0.663	0.668	0.610	1.013	0.851	0.817	2
3	1.143	1.196	0.940	0.810	1.015	0.986	0.961	1.230	1.046	1.090	3
4	1.067	1.146	0.984	0.879	1.146	1.128	1.096	1.340	1.065	1.098	4
5	1.010	0.935	0.735	0.633	1.198	1.216	1.050	1.053	0.944	1.065	5
6	1.050	0.927	0.508	0.666	0.806	1.068	1.075	0.740	1.123	1.023	6
7	0.621	0.912	0.931	0.861	0.652	0.783	0.923	0.884	0.880	0.810	7
8	1.038	0.647	0.511	0.904	0.460	0.357	0.724	0.612	1.317	0.688	8
9	0.713	1.322	0.962	0.212	0.574	0.589	0.467	0.983	0.840	0.878	9
10	0.886	0.949	0.729	0.655	0.738	0.803	0.848	0.854	1.021	0.893	10
11	0.886	0.949	0.729	0.655	0.738	0.803	0.848	0.854	1.021	0.893	11

Table 16.7 Stock numbers at age ('000) of haddock ir Sub-area IV between 1969 and 1988.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Age
0	11177770	80272720	73986970	19743310	66811310	122235600	10458010	14850230	23148380	36694370	0
1	2113430	1417045	10055060	9424714	2469024	8582818	15554170	1332719	1861322	2945266	1
2	8834222	397877	173637	1259322	1550268	337274	1191865	2196966	192602	263188	2
3	446122	3076170	94998	60098	381288	586523	88506	300439	644492	47002	3
4	11882	87917	756235	33098	12394	92760	174831	19476	58879	177070	4
5	4845	2740	19252	245429	7779	4371	26418	44890	6893	13184	5
6	3846	1821	1192	6600	62723	2456	1940	8013	10169	2013	6
7	33043	925	432	566	2273	16905	836	739	2304	3049	7
8	844	10076	527	182	295	760	4378	155	427	791	8
9	56	512	2967	300	119	146	410	1251	61	235	9
10	14	25	358	1023	222	72	99	107	377	25	10
11		41	18	28	109	20	30	6	7	131	11

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Age
0	66938830	14473750	30307230	19020960	63678130	16244530	23393780	45759230	4499243	7708930	0
1	4637527	8363722	1750829	3707410	2364714	8004542	2062379	2969405	5873711	576360	1
2	395607	758247	1353304	284657	606265	394038	1370331	327513	508360	1020728	2
3	64130	108645	251451	576154	123614	209340	135462	498974	79687	145522	3
4	11916	15929	25575	76511	199538	34891	60806	40345	113590	21800	4
5	45661	3192	3945	7446	24728	49409	8792	15831	8228	30484	5
6	3561	13621	1027	1549	3237	6110	11991	2518	4522	2620	6
7	591	1021	4414	506	651	1184	1720	3350	984	1205	7
8	775	260	336	1424	175	278	443	559	1133	334	8
9	311	225	112	165	472	91	159	176	248	249	9
10	96	125	49	35	109	218	41	82	54	88	10
11	42	75	80	26	30	42	177	146	188	88	11

Table 16.8 Mean fishing mortality, biomass and recruitment of haddock in Sub-area IV between 1969 and 1988.

Year	Mean Fishing Mortality Ages 2 to 6 H.Con	Disc	Ages 0 to 3 By-cat	Biomass 1000 tonnes Total	Sp St	Recruits Age 0 Y.C.	Million
1969	0.749	0.092	0.197	2279	795	69	11178
1970	0.753	0.123	0.257	1362	877	70	80273
1971	0.603	0.109	0.074	1555	405	71	73987
1972	0.900	0.146	0.049	1595	291	72	19743
1973	0.779	0.128	0.031	853	283	73	66811
1974	0.636	0.143	0.099	1453	246	74	122236
1975	0.753	0.208	0.083	1990	225	75	10458
1976	0.812	0.158	0.120	826	289	76	14850
1977	0.805	0.132	0.165	522	222	77	23148
1978	0.855	0.192	0.057	604	123	78	36694
1979	0.912	0.088	0.053	629	102	79	66939
1980	0.823	0.082	0.082	1168	144	80	14474
1981	0.615	0.089	0.060	636	228	81	30307
1982	0.567	0.069	0.063	795	285	82	19021
1983	0.791	0.148	0.047	714	241	83	63678
1984	0.894	0.094	0.031	1419	189	84	16245
1985	0.858	0.079	0.017	821	231	85	23394
1986	0.893	0.179	0.011	692	213	86	42651
1987	0.863	0.138	0.014	945	152	87	4318
1988	0.847	0.148	0.017	398	149	88	7650
Arit-mean recruits at age 0 for period 1969 to 1988							37403
Geom-mean recruits at age 0 for period 1969 to 1988							26392

Table 16.9 Input for catch prediction of haddock in Sub-area IV.

Age	1988 Stock and Fishing Mortality: Stock Number	Fishing Mortality H.Con.	Fishing Mortality Disc	Fishing Mortality Ind	Values used in Prediction (F at age , Mean Wt. and Propn. Retained by Consumption Fishery): Scaled mean F 1984 to 1988 H.Con.	Scaled mean F Disc	Scaled mean F Ind	Mean values for period 1984 to 1988, Mean Weight (Kg.) H.Con.	Mean Weight Disc	Mean Weight Ind	Mean Weight Stock	Prop. Ret.
0	7650000		0.001	0.007		0.001	0.007		0.043	0.010	0.016	
1	553000	0.005	0.100	0.021	0.005	0.100	0.021	0.273	0.157	0.049	0.141	0.050
2	944000	0.307	0.460	0.021	0.307	0.460	0.021	0.351	0.203	0.207	0.261	0.409
3	145522	0.939	0.121	0.031	0.888	0.151	0.019	0.469	0.258	0.375	0.437	0.858
4	21804	0.981	0.066	0.052	1.100	0.022	0.018	0.640	0.317	0.633	0.630	0.979
5	30483	1.049	0.004	0.012	1.044	0.003	0.014	0.865	0.356	0.781	0.861	0.997
6	2619	1.023			1.002	0.000	0.000	1.195	0.421	0.555	1.194	1.000
7	1204	0.810			0.853			1.326			1.326	1.000
8	334	0.688			0.737			1.700			1.700	1.000
9	249	0.878			0.749			1.913			1.913	1.000
10	88	0.893			0.881			2.072			2.072	1.000
11	88	0.893			0.881			2.458			2.458	1.000

Mean F	Age 2 to 6	Age 0 3	Age 2 to 6	Age 0 3
Unscaled	0.995	0.017	0.999	0.018
Scaled			0.995	0.017

Recruits at age 0 in 1989 = 14870000
Recruits at age 0 in 1990 = 26392310
Recruits at age 0 in 1991 = 26392310
Recruits at age 0 in 1992 = 26392310

M at age and proprtion mature at age are as shown in Table 16.3

Mean F for ages 2 to 6 in 1988 for human consumption landings + discards = 0.995 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1984 to 1988
rescaled to produce a mean value of F for ages 2 to 6 equal to that for 1988

Mean F for ages 0 to 3 in 1988 for small-mesh fisheries = 0.017 .
Industrial fishery F-at-age in the prediction are averages for the period 1984 to 1988 .
rescaled to produce a mean value of F for ages 0 to 3 equal to that for 1988

Values of N in 1988 from VPA have been overwritten
for the following ages .....

Age 0
Age 1
Age 2

Values of F for these ages in 1988 from VPA have been overwritten
with scaled mean values used for predictions for 1989 onwards

Table 16.10 Predicted catches and biomasses ('000 tonnes) of haddock in Sub-area IV 1989 to 1990.

		Year										
		1988	1989	1990								
Biomass 1 Jan of Year												
Total		398	329	395	395	395	395	395	395	395	395	395
Spawning		149	137	89	89	89	89	89	89	89	89	89
Mean F	Ages											
Human Cons.	2 to 6	1.00	0.90	0.00	0.20	0.40	0.60	0.80	1.00	1.19	0.00	0.00
Small-mesh	0 to 3	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00
Mean F(Year)/Mean F(1988)											F0.1	Fmax
Human Consumption		1.00	0.90	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Small-mesh Fishery		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Catch weight												
Human Consumption		105	92	0	17	32	43	53	61	68	0	0
Discards		62	17	0	6	11	16	20	24	28	0	0
Small-mesh Fisheries		4	3	3	3	3	3	3	3	3	0	0
Total landings		109	95	3	21	35	46	56	64	71	0	0
Total catch		171	112	3	26	45	62	76	88	99	0	0
Biomass 1 Jan of Year+1												
Total		329	395	705	679	657	639	624	611	601	0	0
Spawning		137	89	153	131	113	98	86	76	68	0	0

Stock at start of and catch during 1989

Age	Stock No	H.Cons	Discards	By-catch	Total
0	14870000	0	5171	41092	46263
1	977532	2144	40950	9594	52688
2	93706	15988	23077	1166	40231
3	287797	134277	22162	3192	159630
4	38104	21270	461	383	22114
5	5664	3154	8	49	3211
6	8603	4699	1	2	4703
7	771	379	0	0	379
8	439	195	0	0	195
9	137	62	0	0	62
10	85	43	0	0	43
11	29	15	0	0	15
Wt	329324	92130	17207	2617	111953

Stock at start of and catch during 1990
for F(1990) = F(1989)

Age	Stock No	H.Cons	Discards	By-catch	Total
0	26392310	0	10197	72931	83128
1	1900291	4613	88119	18581	111313
2	167379	30758	44395	2018	77171
3	30846	15343	2532	328	18204
4	86336	51243	1111	830	53184
5	10613	6296	17	87	6400
6	1782	1038	0	0	1039
7	2858	1508	0	0	1508
8	293	140	0	0	140
9	185	89	0	0	89
10	57	31	0	0	31
11	42	23	0	0	23
Wt	395283	61234	24309	2802	88345

Table 16.11 Estimated age composition of haddock in Sub-area IV in first half of 1989.

	Human Consumption Landings		Human Consumption Discards		Small Mesh By-catch		International Catch	
Age	Number	Weight	Number	Weight	Number	Weight	Number	Weight
0								
1	46	0.256	17460	0.122			17506	0.123
2	3723	0.316	15862	0.204			19584	0.226
3	75365	0.360	56020	0.252			131385	0.314
4	12424	0.560	724	0.256			13148	0.543
5	1873	0.712	6	0.309			1880	0.711
6	2723	0.943	6	0.309			2729	0.942
7	413	1.285					413	1.285
8	111	1.646					111	1.646
9	75	1.533					75	1.533
10	21	2.224					21	2.224
11	11	2.086					11	2.086
12	4	1.953					4	1.953
13								
14								
15								
No.	96788		90078		0		186866	
Wt.	40049		19683		0		59731	