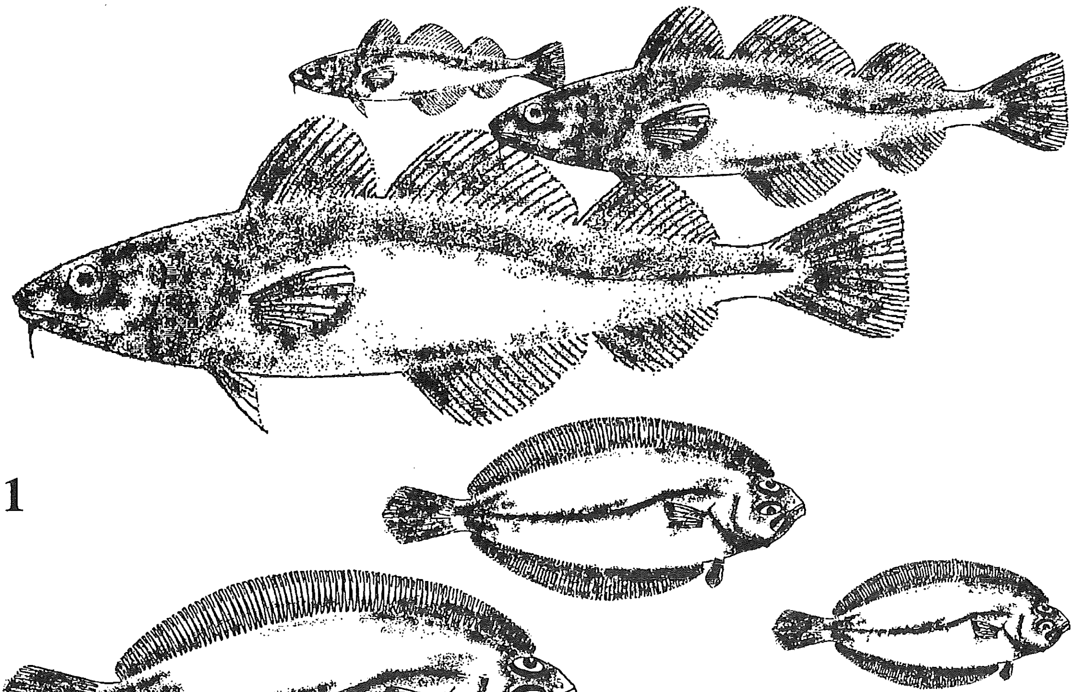
INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L´EXPLORATION DE LA MER

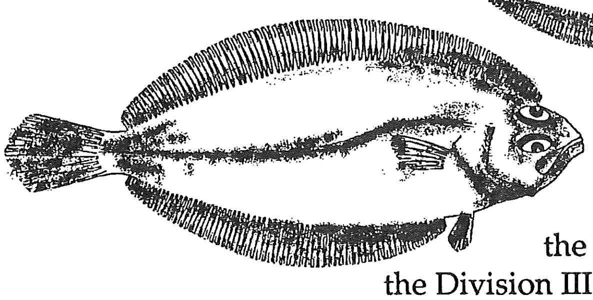
C.M.1993/Assess:5

WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

COPENHAGEN, 6-14 OCTOBER 1992



PART 1



this Working Group supersedes
the Roundfish Working Group
the North Sea Flatfish Working Group
the Division IIIa Demersal Stocks Working Group

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1 INTRODUCTION

1.1 Participants

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U. Damm	Germany
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S. Ehrich	Germany
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R. Millner	UK
S. Reeves	UK
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A. Souplet	France
W. Vanhee	Belgium
M. Vinther	Denmark

R. Grainger and H. Sparholt of the ICES Secretariat also attended the meeting.

1.2 Terms of Reference

The terms of reference for this Working Group meeting are given in Council Resolution C.Res.1991/2:7:13.

A Working Group on the Assessment of Demersal Stocks in the North Sea and the Skagerrak will be established (Chairman: Dr R.M. Cook, UK) and will meet at ICES Headquarters from 6-14 October 1992 to:

a) assess the status of and provide catch options for 1993 within safe biological limits for the stocks of cod, haddock, whiting, saithe, sole and plaice in Sub-area IV, the Skagerrak (except for sole, and including the whole of Division IIIa for haddock, whiting and saithe), and Division VIId, taking into account as far as possible the technical interactions among the stocks due to the mixed-species fisheries;

b) evaluate the status of the stocks of North Sea cod, haddock and whiting and identify any major changes in relation to the advice given by ACFM in 1990 (i.e., that fishing effort in the directed fisheries should be limited to 70% of the 1989 fishing effort) and in 1991;

c) consider how the data set being compiled by the STCF Working Group on Improvements of the Exploitation Pattern of North Sea Fish Stocks might be most appropriately utilized and how the data set should be expanded;

d) provide data requested by the Multispecies Assessment Working Group.

A letter from the chairman of ACFM requested that a combined assessment of plaice in the Skagerrak and Kattegat be performed rather than in the Skagerrak alone.

1.3 Data

It was realised that in embarking on a new area-based working group that it was essential that routine data for assessments would have to be prepared well before the meeting. It is gratifying to report that this was successfully achieved for all the major stocks and very little time was lost at the meeting as a result. Inevitably, some data, such as those from surveys conducted during August and September, could only be included at a late stage so it was not possible to perform complete assessments in advance. This problem is unavoidable unless data of this type are simply excluded.

The irresistible temptation to misreport or withhold information on landings induced by restrictive TACs in the North Sea roundfish fishery means that both catch and effort data for some fleets are of dubious quality. Estimates of illegal activity, however, suggest that the magnitude of the problem is not large, for example, 5-10% of North Sea haddock may be unreported in 1991. Nevertheless, the extent of the problem, by its nature, is difficult to quantify and assessments of these stocks must be interpreted accordingly. Assessments of North Sea cod, haddock and whiting this year all give higher than expected fishing mortality rates which might be symptomatic of pervasive misreporting in recent years.

Industrial by-catch data for haddock and whiting in the North Sea are better for 1991 as they are based on real samples of the catch rather than derived from survey estimates of age compositions. There are, however, discrepancies between these age compositions and those predicted last year for 1991 and this has caused problems in the assessment. The problem, of course is that the earlier data are unreliable and this has affected forecasts not only last year but this year as well.

Sampling of discards by Scotland has continued at the same level. In addition a short-term study of discards by Denmark has provided some information but ways of including this information into the database need to be investigated. A limited discard sampling programme off the English northeast coast has been carried out by England and this may be extended. Only Scottish discards have been used in assessments this year.

In the North Sea flatfish fisheries problems remain with the estimates of total landings and corresponding age compositions. Although substantial discards occur of plaice (and other species), estimates of their quantity and age compositions are not available for inclusion in the VPA database. This emphasizes the continuing need for fishery-independent data to evaluate the apparent trends observed from standard VPA analyses, a problem which applies equally to roundfish.

Severe problems remain with the assessment of roundfish stocks in Division VIId. It is clear that the cod age composition data are badly affected by age-reading errors at least from 1987 to 1989. There is some indication that year classes in this areas are similar in relative strength to the North Sea and it may be worth investigating the use of ALKs from the southern North Sea in order to improve the age composition data. Effort data are now available for three years from France and if the age reading problems have been resolved there is the prospect of undertaking an analytical assessment for cod and whiting in a few years time.

The situation for flatfish in Division VIId is better. The age compositions seem to be adequately estimated in recent years but problems persist with the estimates of landings. This is due not only to the nature of the fishery, which comprises many small vessels landing at numerous ports, but also to deliberate misreporting. Data on discards of all species in this area are lacking.

In Division IIIa, a substantial problem exists with the data for the by-catch from the small-mesh fishery. Work Working Group still needs to be done to separate the human consumption landings from the small-mesh by-catch in the database. Data on the by-catch age compositions are absent for the period 1987-1990 and consideration needs to be given as to how these historical data may be treated.

1.4 Methods

1.4.1 VPA tuning

In recent years the stocks assessed in this new Working Group have been assessed using Laurec-Shepherd tuning as the basis for VPA and hence conventional catch prediction. This approach has been the ACFM-preferred method. A new version of the Lowestoft VPA tuning program was available to the Working Group which in addition to the old standard method also has options for shrinkage and Extended Survivors Analysis (XSA). After discussion it was decided to proceed using the same method for each stock as in the previous assessment unless it was possible to demonstrate that a different approach produced better results. This could be done using a retrospective analysis, for example. However, the choice of method was restricted to Laurec-Shepherd or XSA in order to avoid "guerrilla" tuning.

In general, the method used has been the shrunk Laurec-Shepherd. The use of shrinkage has been discussed by the Working Group on Methods of Fish Stock Assessment in response to patterns in retrospective analysis. It was used last year by the Roundfish Working Group. The benefits of shrinkage appear to be to reduce the variability of Fs on the oldest age groups with comparatively minor effect on the younger values. Use of shrinkage may, therefore, increase precision at the expense of introducing bias. The latter is most likely to be a problem if there are real strong trends in the fishing mortality rate over time. In general, the stocks assessed by this Group have Fs which do not show strong trends over periods of about 5-10 years.

There are theoretical advantages in methods of the ADAPT type of which XSA is an example. In particular, this approach does not assume that the data in the terminal year are exact. However, where several fleets are used in tuning, the difference between XSA and Laurec-Shepherd are likely to be small and runs at the meeting tend to confirm this. The difference between the methods is much smaller than the change produced by shrinkage.

In its present implementation the XSA operative is asked to specify the age above which catchability is constant. This is an eminently sensible way of reducing the number of parameters to be estimated but it can lead to difficulties where the true exploitation pattern is "domed". This implies of course that for the commercial CPUE data the catchability declines beyond a certain age. Constraining catchability to a constant can, therefore, lead to bizarre estimated exploitation patterns. The constancy of catchability for the fully selected ages is more likely to be appropriate for survey data. With this in mind it would be desirable for the method to allow different ages for the commercial and survey CPUE above which catchability is constant. It is noticeable that one of the main differences between XSA and Laurec-Shepherd is that the overall level of F differs throughout the range of years implying a scaling difference and this can be attributed to the way in which F on the oldest age is treated. Some thought should be given to how this problem is handled.

Fleets used in tuning and the range of years involved are given in Table 1.4.1, while effort trends for these fleets are shown in Figures 1.4.1-1.4.6.

As well as the standard ICES approach to VPA tuning, a selection of stocks were analyzed using the ADAPT framework developed in Canada. Details of the method are described in Appendix II. Each stock section makes reference to the results of the analysis where appropriate.

1.4.2 Recruitment analysis

Where several recruitment indices are available for a stock, "Rinkytinx" has been used to obtain the best estimate of recent year classes using all the survey data and VPA. A problem exists with the English Groundfish Survey in 1992 in that there was a change of survey gear from the Granton trawl to the GOV trawl. As a result this survey has been given a low weight in the analyses until a calibration factor can be calculated.

1.4.3 Sensitivity analysis

A sensitivity analysis has been performed on the North Sea roundfish stocks in the same way as was described in last year's report of the Roundfish Working Group. This is a delta method using a program "PREDFAST" developed at the Aberdeen Laboratory.

1.4.4 Risk analysis

A number of approaches to risk analysis were available at the meeting in the form of computer software. These are still in a very preliminary state but in view of the serious condition of a number of stocks it was decided to use them to help in giving management advice.

In the case of North Sea cod and saithe, which appear to have a very low spawning stock biomass, attempts have been made to quantify the probability that the SSB will be below its present (1991) level at the start of 1994. This has been done using the method of Cook *et al.* (1991). The method attempts to estimate the covariance matrix of population number and F estimates for the most recent year in the VPA using a statistical model. These variances are then used with estimates of the variance of the recruiting year classes to obtain a variance of predicted yield and SSB. Results of the method are given in the stock sections. It is important to realise that the method will, if anything, under-estimate the variances, perhaps severely, and, therefore, the risk curves will tend to have slopes which are too steep. This should be borne in mind in interpreting the results.

As well as attempting to quantify short-term risks some attempt has been made to examine risks in the long term under different exploitation regimes. These are simple simulation models which generate recruitment as a stochastic process either from an assumed distribution or from the observed recruitment series. The approaches are described in Appendices III and IV.

1.4.5 Multiplicative model

For haddock in Division IIIa there are no tuning data and the age-composition data are affected by lack of sampling of the small-mesh by-catch in some years. It was decided to use a very simple linear model to parameterize the catch-at-age data and hence make a forecast. The model used is that of Shepherd and Nicholson (1991) and is of the form;

Log(Catch) = year effect + age effect + year-class effect

where "catch" is the catch at age in a particular year. Assuming *status quo* for the year effects into the future enables a prediction of the age compositions. This is the same model used to analyze CPUE data for the Rockall haddock in recent reports of the Roundfish Working Group. The software used is a program "RCMCM" written at the Aberdeen laboratory.

1.4.6 IFAP and ICES computing facilities

At the time of the meeting, the IFAP system was still incomplete and software used by the Group was a mixture of the IFAP system and software used by the former assessment working groups. The problems in using the IFAP system were of three types;

a) Lack of familiarity of the Working Group members with IFAP meant that a lot of learning had to be done. This of course is to be expected.

b) At present the system operates very slowly and is rather cumbersome. Selecting data files for analysis is time-consuming, for example, and has to be repeated in every run.

c) Difficulties were experienced in obtaining standard plotted output. It appeared that the plotting routines selected data incorrectly from files.

Apart from the slowness of the system which may be difficult, other problems should be readily solved and the Group looks forward to an enhanced system for next year. Clearly it is desirable in the future to run all the assessments on the same system to produce output in a standard format with the minimum of hassle.

The Working Group strongly recommends changing the computer facilities so that IFAP is used for maintaining a disaggregated database from which input file for VPA and prediction can be derived. The actual VPA and prediction calculations should be done by separate programs outside IFAP. It would further be desirable to adjust the prediction program to use a similar input file for both yield-per-recruit and short-term prediction program using input from an editable file produced by the VPA program. It would be useful for the VPA program to have a simple facility to run retrospective analyses. It is desirable to have a means of downloading files from the IFAP system onto floppy disk for circulation during the meeting.

The availability of computer terminals is very limited and it would not be possible to carry out the tasks of the Working Group without the use of portable machines and printers brought by the members of the Working Group. Laser printing facilities are in very short supply which makes the production of high quality printed material difficult. The Working Group strongly urges ICES to invest in more terminals and stand-alone printers.

Table 1.4.1. Fleets used in tuning the VPA and the initial year.

		Sub-area IV						Division VIId		Division IIIa	
Country	Fleet	Cod	Had	Whi	Sai	Pla	Sole	Pla	Sole	Cod	Pla
Scotland	GFS	82	82	82							
	TRL	82	82	82							
	SEI	82	82	82							
	LTR	82	82	82							
England	GFS	82	82	82		82					
	TRL	82									
	SEI	82				82					
	TRAM							85	84		
	RYETRL							85			
	BT							85	85		
France	TRB	82	82	82							
	INSTRL								82		
	OFFTRL								82		
Germany	GFS	83	83	83							
	SOLEABT						82				
Netherlands	GFS	82		82							
	BT					82	82				
	TRIDENSBT					85	85				
	TRIDENSPR					82					
Norway	TRL				82						
International	GFS	82	82	82							
Denmark	KATSEI										83
	SKAGSEI									83	83
	DANAMAY										85
Sweden	NEP									83	
	TRL									83	
Belgium	BT							82	82		

Figure 1.4.1

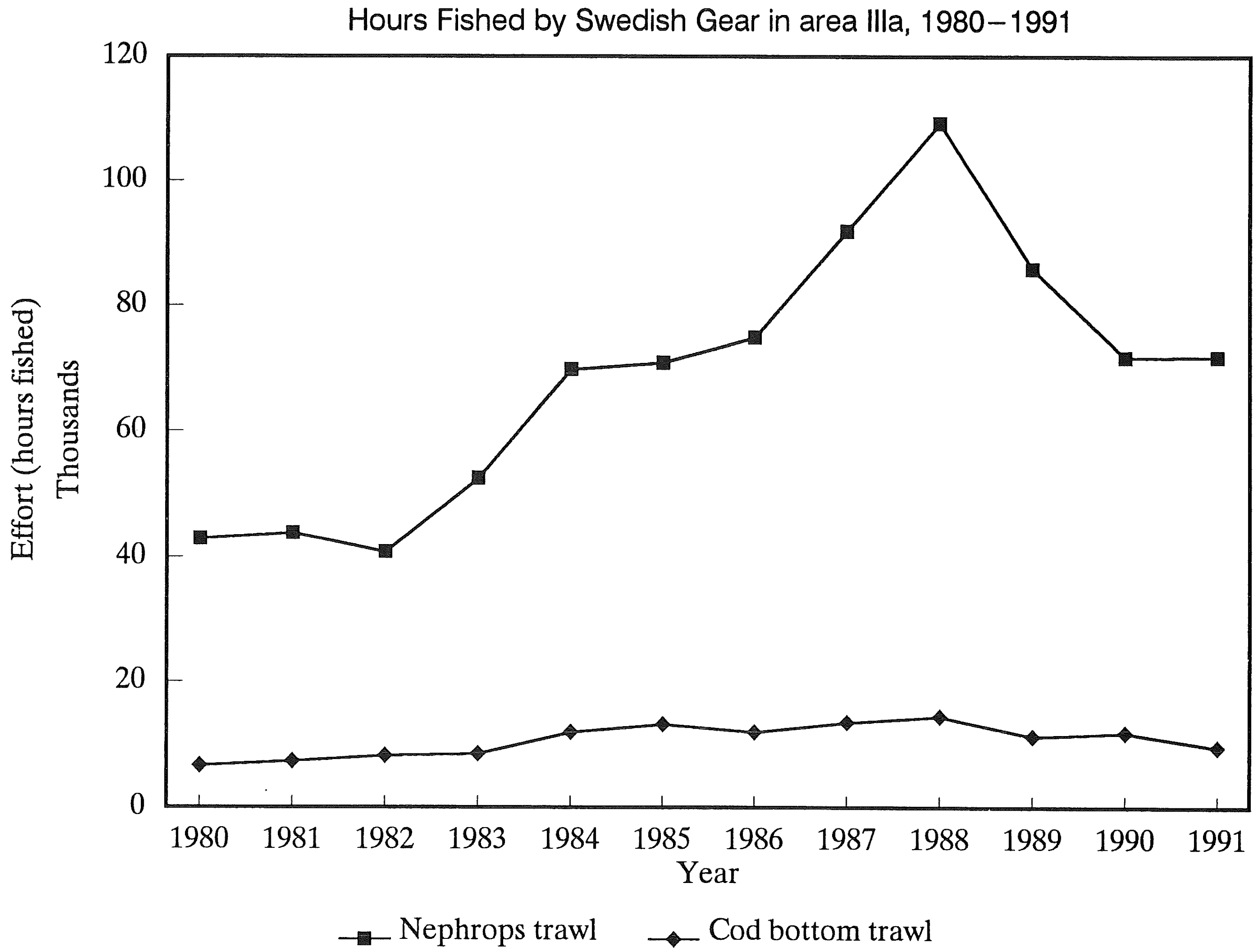

Hours Fished by Swedish Gear in area IIIa, 1980–1991
120
100
80
60
40
20
0
Effort (hours fished)
Thousands
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year
Nephrops trawl
Cod bottom trawl

Figure 1.4.2

GRAPH1.TAB Chart 1

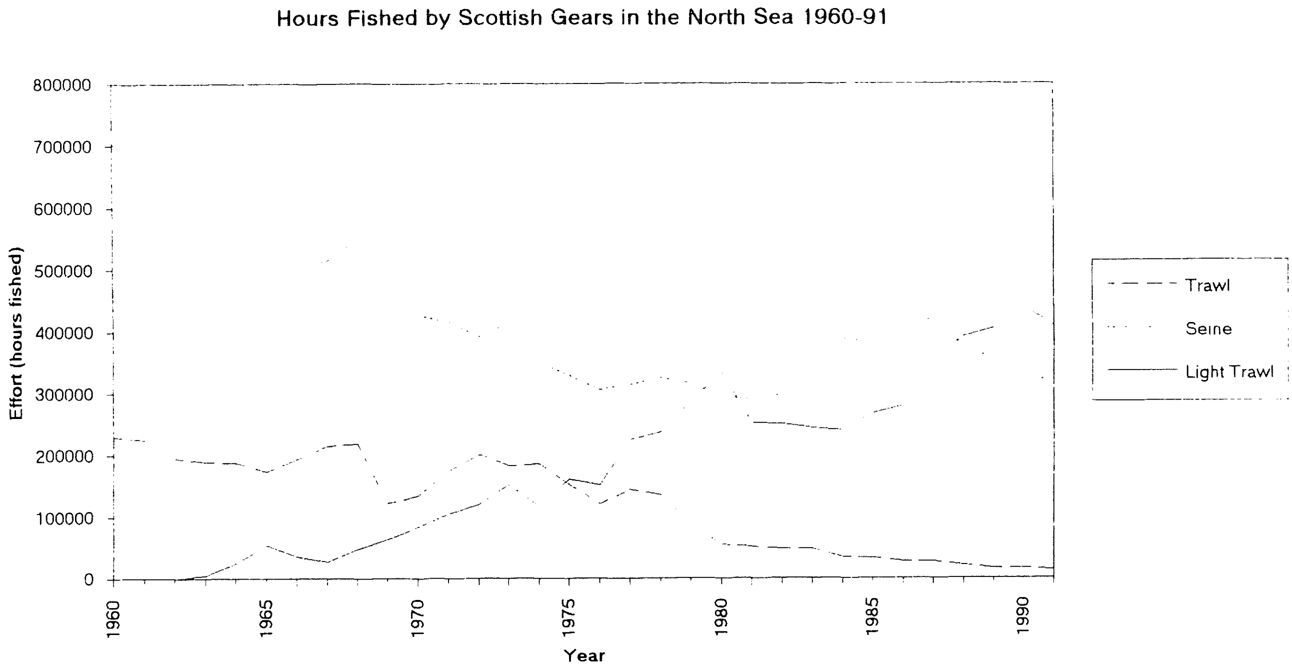


Figure 1.4.3

[CHART1 SCO]Sheet1 Chart 4

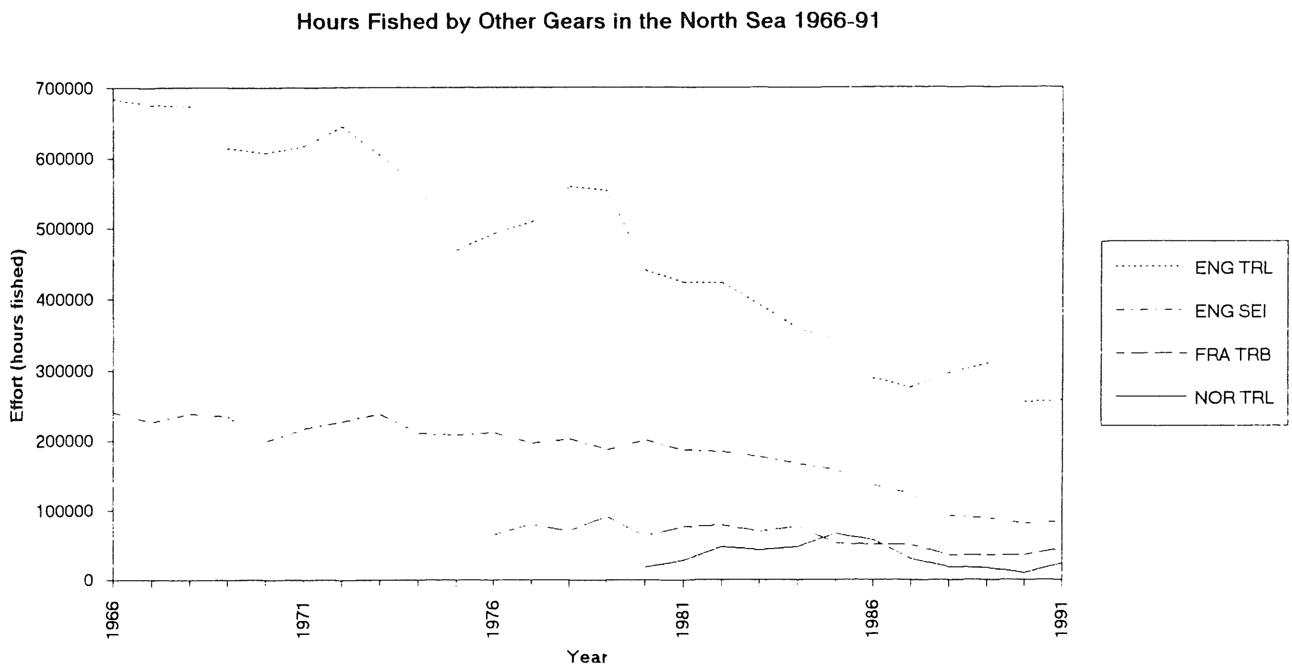


Figure 1.4.4

Chart1

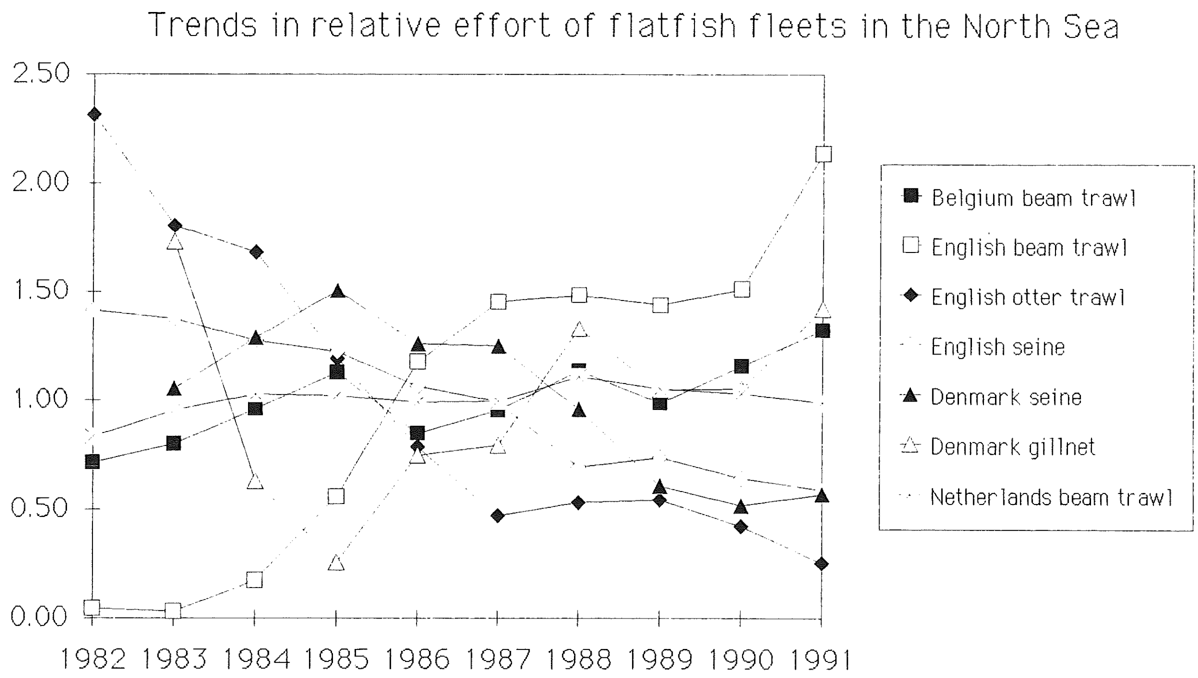


Figure 1.4.5

TAB2.XLS Chart 8

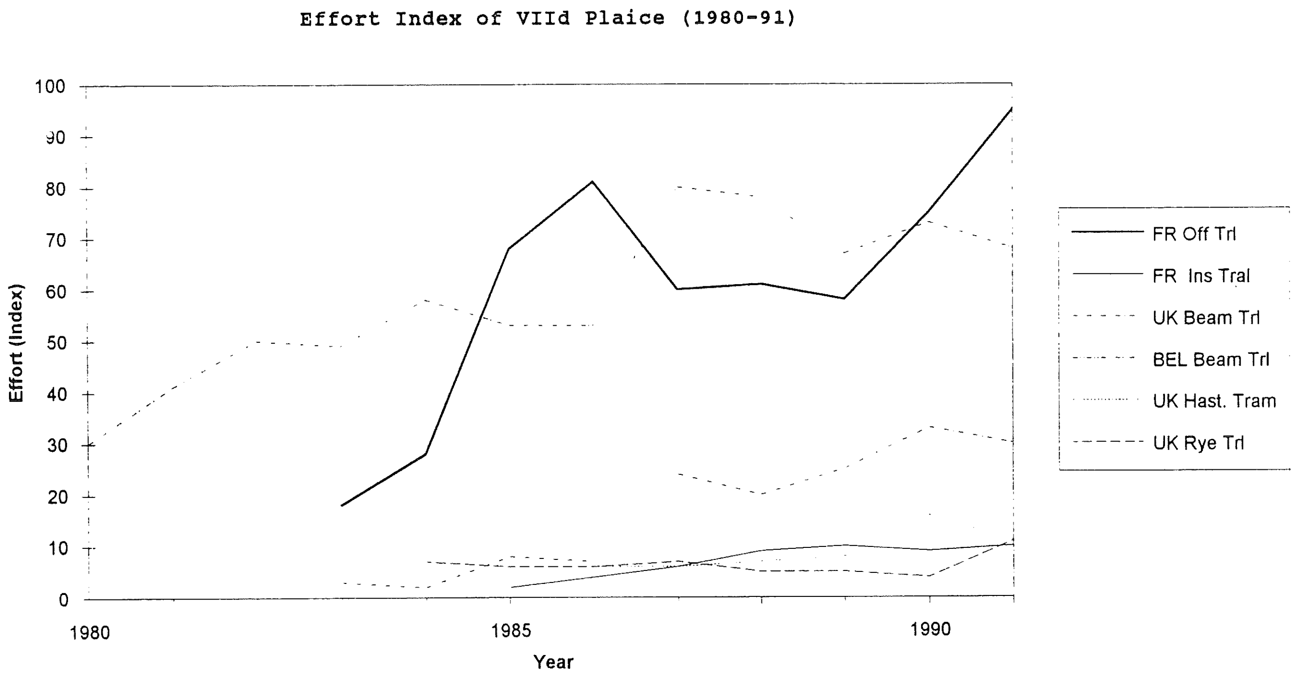
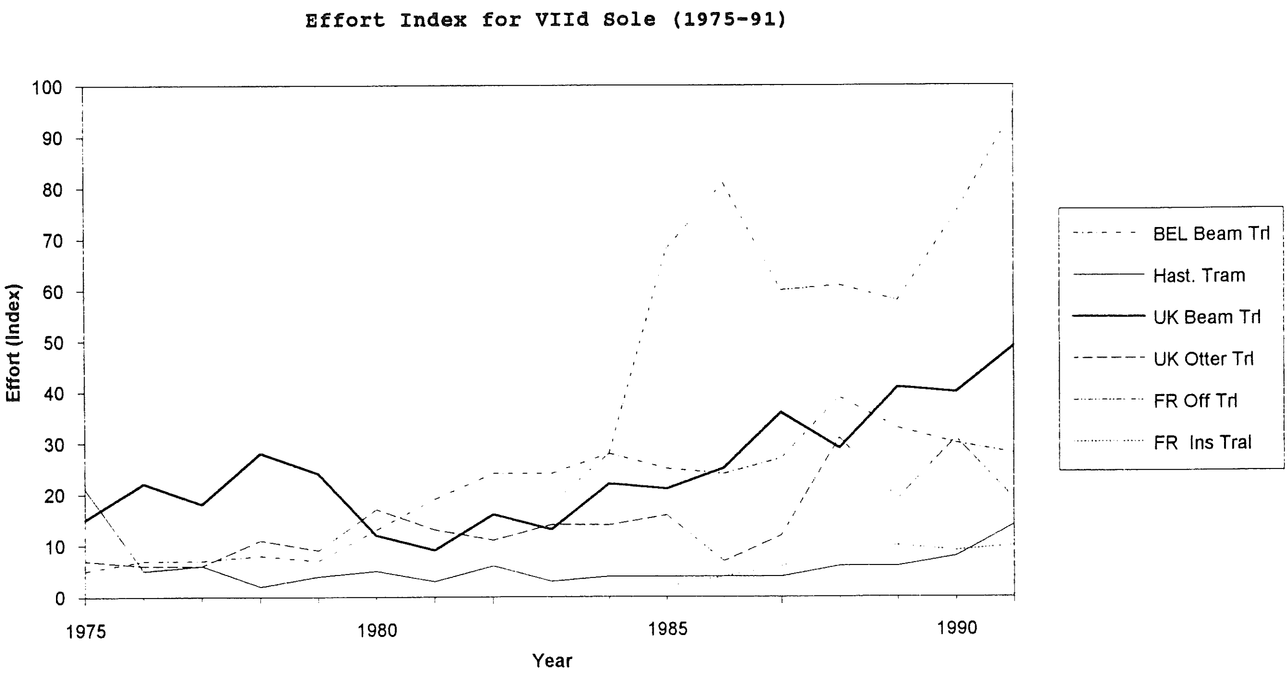


Figure 1.4.6

TAB2.XLS Chart 7



2 DIVISION IIIA

2.1 Overview

As a result of the creation of area-based working groups, a Study Group (*Anon.*, 1992a), met in March 1992 to resolve the data problems for the stocks in Division IIIa assessed by this Working Group.

Plaice in the Kattegat was assessed by the Baltic Demersal Working Group in April, 1992. Due to the decline in the Kattegat stock (probably caused by environmental problems), making the Skagerrak plaice component more important, and inconsistencies in some data, ACFM at its May 1992 meeting found the assessment so unreliable that no advice could be given. At a meeting in September ACFM decided to ask the North Sea and Skagerrak Working Group to make a combined assessment for the Kattegat and the Skagerrak stocks.

The stocks in Division IIIa to be assessed by the North Sea Demersal Working Group are thus cod in Skagerrak and haddock, whiting and plaice in the whole of Division IIIa.

The database for the assessments is generally poor. The major deficiencies are insufficient age sampling or lack of age compositions from certain fisheries, lack of discard data, lack of effort data with associated catches by age (age distributions used for tuning have been derived from fleet catches and overall age distributions) and lack of recruitment indices with a convincing relation to VPA-derived recruitment estimates. Analytical assessments have only been attempted for cod and plaice. For haddock a simplified assessment has been made in the absence of tuning data. Assessments of whiting cannot be made due to the lack of basic age information.

The fleets are described in Section 6. The major part of the whiting landings and important parts of the haddock landings are landed for reduction purposes. These landings are taken as by-catches by a mixed fishery fleet fishing with 32 mm mesh and other fisheries using 32 mm or smaller meshes. The mixed fishery is represented in cluster 3 of the fleet separation table (Appendix 1, Table 13). The overall distribution of the Danish roundfish landings on the human consumption, and by-catches in the mixed fishery and in the other fisheries in 1991 are presented in Table 2.1.1.

Parts of the area (especially the southern part of Kattegat) have been affected by eutrophication and a radical change in the composition of demersal stocks has been the result. Of the stocks assessed by this Working Group, this has mainly affected the plaice. The southern Kattegat stock is now very small and the combined Division IIIa stock is dominated by the Skagerrak stock. The spawning biomass of this stock is presently at a historically low level. The cod stock seems to be in a more stable state although the fishing mortality is high. Little is known about the state of the whiting and haddock stocks, but it is expected that these stocks are closely associated with the North Sea stocks.

2.2 Cod in the Skagerrak (Part of Division IIIa)

2.2.1 Catch trends

Table 2.2.1 shows the landings by country as reported by the Study Group on Division IIIa Demersal Stocks (*Anon.*, 1992a). Also the cod landings from the Norwegian fjords are shown. As these cod are considered to belong to a separate stock (*Anon.*, 1991), they have not been included in the assessment. The total landings have dropped from about 17,800 t in 1990 to about 12,000 t in 1991 with the largest decline in the Danish landings which account for the major part of the total.

The cod landings taken as by-catch in the Danish small-mesh trawl fishery are shown in Table 2.2.2. They have not been included in the assessment because no catch-at-age data were available.

Catch trends are plotted in Figure 2.2.1.

2.2.2 Catch and weight at age, natural mortality and maturity

The Danish age distributions which represent 80% of the landings were raised to the total landings (Table 2.2.3). The same applies to the weight-at-age data (Table 2.2.4).

The weight at age in the stock was assumed to be identical to the weight at age in the catch.

The natural mortality rate was, as in previous years, assumed to be 0.2 for all age groups and years.

All cod are assumed to mature at age 3.

2.2.3 Effort and CPUE, research vessel indices

The Swedish CPUE series based on logbooks are given in Table 2.2.5. Data from the two main (normally 70 - 80% of the total Swedish catches) fleets are available. CPUE data from two Danish fleets are available and shown in Table 2.2.6. These fleets, however, account only for < 10% of the total Danish catches.

Indices for 0-group cod were available from the Norwegian Skagerrak coast (not used in the assessment) and for

1- and 2-group cod from the IBTS in February (former IYFS) (Table 2.2.7).

2.2.4 VPA tuning and results

The age composition for each tuning fleet is the same as the Danish age compositions. Despite this, the fleet data were used in the Laurec-Shepherd (shrunk) method. The output is shown in Table 2.2.8. Plots of log catchability residuals are presented in Figure 2.2.2.

There is some degree of intercorrelation between the residual plots of the various fleets and age groups, especially for Swedish bottom trawlers.

The results of the VPA are shown in Tables 2.2.9 and 2.2.10.

2.2.5 Recruitment

In last year's assessment the preliminary index for 1-group cod (year class 1990) from the IYFS was used to estimate recruitment with RCRTINX2. This is the normal procedure, which has provided rather good estimates (Hagström *et al.*, 1990), and the indices have changed very little or not at all after age reading. The preliminary index for year class 1990, however, was 42.0, while the final index was only 9.3. The otoliths of many of the cod around the size-limit for the preliminary index (25 cm) were extremely difficult to interpret, but after consultations with experts from other institutes it was agreed that many 2-group cod (year class 1989) were smaller than 25 cm. This change from a little more than the average to only about 25% of the average has of course a dramatic effect on the estimated recruitment. The 2-group index, now available for the 1990 year class, indicates that it is small.

The IBTS index for 1-group cod (96, year class 1991) from February 1992 is the highest on record, about three times the average. There has again been a number of extremely difficult otoliths, but not as many as last year.

Applying the indices for 1- and 2-group cod from the IBTS to a RCT3-run gave the results shown in Table 2.2.11. The final estimates are shrunk towards the mean but still the 1990 year class is well below the mean and the 1991 year class well above it.

2.2.6 Long-term trends

Table 2.2.12 and Figure 2.2.1 present the long-term trends for the period 1978-1991.

From a peak in yield and SSB in 1981-1982, resulting much from the large 1979 year class, there is some downward trend for both. Excepting the two peak years 1979 and 1985, there is no obvious trend in year-class strength over the time series available, 1978-1990.

2.2.7 Biological reference points

Input data for an equilibrium prediction are presented in Table 2.2.13 and the results in Table 2.2.14 and Figure 2.2.3. The stock recruitment plot is given in Figure 2.2.4.

Present fishing mortality levels are well above the calculated F_{max} of .25. F_{high} and F_{med} have been calculated as 1.26 and 0.79, respectively.

2.2.8 Catch forecast

The input data for the catch predictions are shown in Table 2.2.15. The exploitation pattern is derived from average Fs from the latest five years, scaled to correspond to the reference F for 1991. Average weights-at-age are from the latest five years. Stock sizes for ages 1, 2, and 3 in 1992 were taken from the RCT3 estimates of the respective year classes at these ages (Table 2.2.11). Recruitment at age 1 in 1993 and 1994 were taken as the average VPA estimate as calculated by RCT3.

Results from the prediction are shown in Table 2.2.16. The *status quo* catch will increase to 17,000 t in 1993 from 14,000 in 1992. SSB is under *status quo* conditions predicted to be 19,000 t in 1993 and then rise to 26,000 t in 1994 if the 1991 year class is as large as assumed.

2.2.9 Long-term advice

From the indications given by the assessment, the stock seems to be in a nearly stable state, without dramatic trends in SSB, recruitment, fishing mortality or yield. The fishing mortality is high and should not be increased in the long term.

2.2.10 Comments on the assessment

The assessment is based on incomplete data. The CPUE values used for tuning are based on general age compositions and discards are not included in the assessment. The results of the assessment must thus be taken as indicative of the general state of the stock.

2.3 Haddock in Division IIIa

2.3.1 Catch trends

The landings for the period 1975-1991 are presented in Table 2.3.1. From 1983 they are split into landings for human consumption and landings used for reduction purposes. The landings for reduction purposes are taken in a mixed fishery using 32 mm mesh size and in other fisheries using 32 mm and smaller meshes. 42% of the landings for reduction were taken in the 32 mm mixed fishery in 1991. Figure 2.3.1 shows trends in landings.

2.3.2 Age compositions and weight at age

Age compositions and weight at age are available from Danish landings, for human consumption landings for the period 1981-1991 and for small-mesh landings from the periods 1981-1986 and 1991. The age compositions from the Danish human consumption landings were used to split the landings from other nations into age compositions for calculation of total international catch. The calculated age distribution in total international catches are presented in Table 2.3.2.

2.3.3 RV indices and CPUE data

An index for 1-group haddock in Division IIIa is available from the International Bottom Trawl Survey in February (Table 2.3.3).

CPUE data are not available.

2.3.4 Multiplicative model of year, age and year class effects

As no CPUE data are available for VPA tuning a multiplicative model (see Section 1.4.5) was used to separate year, age and year class effects on landings per year class. This was based on the age compositions in the human consumption catches in 1987-1991 and total age compositions before that time.

The results of the multiplicative model are presented in Table 2.3.4.

2.3.5 Recruitment

The IBTS 1-group index for Division IIIa is not related to the year-class effects found through the multiplicative model (Figure 2.3.2).

The year-class effects of the multiplicative model are correlated with the recruitment to the North Sea stock as calculated by a VPA at age 1 (Table 2.3.5, Figure 2.3.3).

Values of the 1989-1992 year classes at age 1 were fitted on the basis of a regression of Division IIIa year-class effect against Sub-area IV recruitment based on a VPA. Input to the estimation was an estimate of recruitment of haddock at age 1 in Sub-area IV as calculated by RCT3 (Table 3.3.10b). The results of the analysis are presented in Table 2.3.5.

2.3.6 Long-term trends

Long-terms trends in landings and recruitment (year-class effect) are presented in Figure 2.3.1. Total landings have been very variable with a maximum above 14,000 t in the early 1980s. The last decade has shown landings at around half this level. The earlier peak level in landings is closely associated with the large 1979 year class, which is also clearly reflected in the age composition data of Table 2.3.2. The 1989 year class is according to this analysis also large, but with an associated high CV (Table 2.3.4).

2.3.7 Catch forecasts

A catch prediction was made on basis of the effects of the multiplicative model and the estimated recruitments. The input for the prediction is presented in Table 2.3.6.

The results are given in Table 2.3.7. The fitted retrospective age distributions are to be compared with Table 2.3.2. The model predicts yields to increase from the present levels of around 6,000 t to 9,000 t in 1993-1995 with parallel increases in spawning stock biomass. This increase is associated with the above-average year classes 1991 and 1992 which have been predicted from North Sea indices.

2.3.8 Comments on assessment

The assessment suffers from serious deficiencies in the primary data: the small-mesh landings have not been aged for an important recent period, CPUE data are not available for tuning, and reliable recruitment indices do not exist. The predictions made by the model used relies totally on the correlation with recruitment in the North Sea, which is responsible for the predicted increases in yield and spawning stock biomass.

The older data in the time series (1981-1986) include age compositions from small-mesh fisheries. The series analyzed is thus not a consistent series.

However, the correlation between the year-class effect and North Sea recruitment supports the case for this stock to be assessed in a combined assessment with the North Sea haddock. The management regime distinguishes between North Sea haddock and Division IIIa haddock, and means to split the results of a combined assessment on management areas must be devised for a combined assessment to be justified in terms of management.

2.4 Whiting in Division IIIa

The landings are presented in Table 2.4.1. They are divided on landings for human consumption and for reduction since 1981. The Danish reduction landings have in the past been taken in a mixed-fishery using 32 mm mesh size and in other fisheries using 32 mm and smaller mesh sizes. 56% of the landings for reduction were taken in the mixed fishery in 1991.

2.5 Plaice in Division IIIa

2.5.1 Catch trends

Total international landings as provided by members of the Study Group on Division IIIa Demersal Stocks (*Anon.*, 1992a) and updated by the present Working Group are presented in Table 2.5.1. The landings data are very uncertain for the period 1983-1988. *Anon.* (1991) adjusted the catch data assuming that misreporting of North Sea catches was an important source of bias. The major part of the Kattegat landings since 1984 are from the northern part of Kattegat. Long term trends in yield are plotted in Figure 2.5.1.

2.5.2 Catch and weight at age, natural mortality and maturity

Catch and weight at age are available for the Danish landings of Kattegat and Skagerrak. The catches at age have been raised to total international landings (Table 2.5.2). Weight at age for the combined stock has been calculated as a mean of weight at age in Kattegat and Skagerrak, weighted by landings (Table 2.5.3).

The natural mortality was assumed to be 0.1 for all age groups. Maturity is assumed to be 0 for ages 1 and 2 and 1 for age 3 and older.

2.5.3 Effort and CPUE, research vessel indices

Effort and CPUE were available from logbooks of Danish seiners, Swedish *Nephrops* trawlers and Swedish cod bottom trawlers. The data are available separately for Skagerrak and Kattegat (Table 2.5.4). The data are only available for total landings and were split on age groups on basis of the age compositions in the total Danish landings. CPUE data for 2- and 3-group plaice are furthermore available from "Dana" May surveys (Table 2.5.5). These data files were corrected as reported by *Anon.* (1992a).

2.5.4 VPA tuning and results

The VPA was tuned on the basis of CPUE data from fleets for which there exist a measured age composition. The fleets were the "Dana", May survey, Danish seiners in Kattegat and Danish seiners in Skagerrak. The Laurec-Shepherd tuning with shrinkage towards the mean and tricubic time weighting taper was used. Table 2.5.6 presents the tuning, and the log catchability residuals are plotted in Figure 2.5.2.

The results of the VPA are presented in Tables 2.5.7-2.5.8. The general fishing mortality level represents a significant increase compared to the level in former years' assessments. The data base for this assessment is different because of corrections in the tuning data.

A test tuning, including the whole Swedish fleet, were tried in order to reproduce last year's assessment for the combined Skagerrak and Kattegat stock. The variance ratios were small for several fleets, which are a reflection of the fact that the age compositions of the various fleets are dependent since they are based on the same overall age composition. Plots of log catchability residuals of the Swedish fleets showed that these fleets seems to be more correlated than expected from the fact that the same age compositions have been used. It can be suspected that this correlation is based on the way fleet effort and catches has been calculated. This test run gave almost identical F values as the run without the Swedish fleets.

A separable VPA was run (Table 2.5.9). The residuals (Figure 2.5.3) do not indicate changes in fishing patterns or data inconsistencies.

2.5.5 Recruitment estimates

Recruitment index from the "Dana" May survey was available for year class 1989 as 2-year-olds. The correlation between the stock size and the survey index of 2-year-olds is very poor (Figure 2.5.4). Recruitment was, therefore, estimated using VPA mean value from RCT3 (Tables 2.5.10-2.5.12). This mean over the 7 recent years is more likely to reflect the present situation. Recruitment and catches have decreased drastically in the Kattegat in recent years. The use of a long-term mean for recruitment forecasts would, therefore, not be reasonable.

2.5.6 Long-term trends

The long-term trends are presented in Figure 2.5.1 and Table 2.5.13. The fishing mortality is oscillating around a higher level than in 1978-1986 and the spawning stock biomass has been decreasing since then. Recruitment is at a low level within the historical time series although no recent trend is evident.

2.5.7 Biological reference points

The input data for the equilibrium prediction are presented in Table 2.5.14 and results are presented in Table 2.5.15 and Figure 2.5.5. The present F is approximately 5 times F_{max}. F_{med} is 0.52 and F_{high} is >2.0 (see Figure 2.5.6)

2.5.8 Catch forecast

The input data for the catch prediction are presented in Table 2.5.16. Results with management options are presented in Table 2.5.17. At *status quo* F the catches in 1992 and 1993 are predicted to be at the same level as in 1991. There will be a small increase in the spawning biomass.

2.5.9 Long-term considerations

In view of the change in stock composition in this area, there is no reliable historical information on which to base long-term advice. It appears that F is high and there is a high risk of stock depletion.

2.5.10 Comments on assessment

The present assessment is made as a combined assessment for Skagerrak and Kattegat. This may be reasonable for recent years, where the catches have been small from the southern part of Kattegat and the northern catches might be from associated stocks. The older part of the data set is, however, from a period, where southern Kattegat catches were important. These are believed to originate from a different stock. The present assessment is thus not completely consistent in terms of stock basis.

The combination should just be considered as valid as long as the Kattegat catches maintain a northern distribution. The Kattegat stocks are biologically distinct and should be managed separately. The present combined assessment does in effect not contain an assessment of the Kattegat stocks since they are believed to contribute very little to the total catches.

Table 2.1.1 Distribution of Danish landings in tonnes of roundfish in Division IIIa in 1991 on human consumption and by-catches in a mixed fishery using 32 mm mesh and in the remaining fisheries.

		Human cons.	Mixed fishery	Other fishery	Total
Cod	Kattegat	4664	271	105	5040
	Skagerrak	10396	285	426	11107
Haddock	IIIa	4551	1082	1510	7143
Whiting	Kattegat	185	3505	1344	5034
	Skagerrak	696	3510	4104	8310

Table 2.2.1 Cod landings (t) from the Skagerrak as estimated by the Working Group, 1971-1991.

Year	Open Skagerrak					Total	Norwegian Fjords
	Denmark	Sweden	Norway	Others	Germany		Norway
1971	5,914	2,040	1,355	13	-	9,322	-
1972	6,959	1,925	1,201	22	-	10,107	-
1973	6,673	1,690	1,253	27	-	9,643	-
1974	6,694	1,380	1,197	92	-	9,363	-
1975	14,171	917	1,190	52	-	16,330	-
1976	18,847	873	1,241	466	-	21,427	-
1977	18,618	560	-	675	-	19,853	-
1978	23,614	592	-	260	-	24,466	1,305
1979	14,007	1,279	-	213	-	15,499	1,752
1980	21,551	1,712	402	341	-	24,006	1,580
1981	25,498	2,835	286	294	-	28,913	1,792
1982	23,377	2,378	314	41	-	26,110	1,466
1983	18,467	2,803	346	163	-	21,784	1,520
1984	17,443	1,981	311	156	-	19,891	1,187
1985	14,521	1,914	193	-	-	16,628	990
1986	18,424	1,505	174	-	-	20,103	917
1987	17,824	1,924	152	-	-	19,900	838
1988	14,806	1,648	392	106	-	16,952	769
1989	16,634	1,902	256	34	12	18,838	888
1990	15,788	1,694	143	65	110	17,800	846
1991[1]	10,396	1,579	72	12	12	12,059	854

[1]Preliminary.

Table 2.2.2 By-catch of COD in the Skagerrak by the Danish small-meshed fishery (in tonnes) as estimated by the Working Group.

	Skagerrak
1979	4,009
1980	4,036
1981	5,376
1982	9,119
1983	4,384
1984	1,084
1985	1,751
1986	997
1987	491
1988	1,103
1989	428
1990	687
1991	953

Table 2.2.3 Total international catch at age of cod in the Skagerrak

Catch numbers at age Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,
AGE				
1,	4337,	432,	1066,	389,
2,	11174,	4325,	6593,	11030,
3,	2889,	2956,	4821,	6202,
4,	775,	480,	1748,	1169,
5,	182,	202,	349,	288,
6,	166,	34,	94,	44,
7,	44,	33,	82,	49,
+gp,	52,	28,	11,	6,
TOTALNUM,	19619,	8490,	14764,	19177,
TONSLAND,	24466,	15499,	24006,	28913,
SOPCOF %,	105,	118,	96,	98,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	1080,	1771,	341,	928,	3253,	165,	1035,	794,	846,	432,
2,	4448,	6020,	7067,	5156,	4101,	12289,	2645,	6237,	5243,	2922,
3,	6653,	3368,	3107,	2773,	3441,	2245,	5251,	3163,	3326,	1763,
4,	2009,	1609,	731,	856,	1748,	503,	592,	1564,	529,	871,
5,	242,	290,	280,	207,	347,	137,	150,	172,	432,	194,
6,	175,	85,	70,	124,	60,	69,	56,	104,	49,	81,
7,	73,	32,	22,	33,	39,	17,	8,	18,	50,	32,
+gp,	27,	69,	17,	9,	21,	19,	13,	12,	33,	15,
TOTALNUM,	14707,	13244,	11635,	10086,	13010,	15444,	9750,	12064,	10508,	6310,
TONSLAND,	26110,	21784,	19891,	16628,	20103,	19900,	16952,	18697,	17800,	12059,
SOPCOF %,	94,	96,	99,	94,	95,	95,	100,	95,	96,	97,

Table 2.2.4 Mean weight in the catch at age, cod in the Skagerrak

Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,
AGE				
1,	.5990,	.5990,	.7460,	.6190,
2,	.8600,	.8600,	1.1460,	.9720,
3,	1.8940,	1.8940,	1.5700,	1.9020,
4,	3.4980,	3.4980,	3.3470,	3.7110,
5,	5.5100,	5.5100,	4.8650,	5.2610,
6,	7.0930,	7.0930,	8.9320,	9.4910,
7,	7.3040,	7.3040,	8.3010,	8.5140,
+gp,	9.8880,	9.8880,	11.0850,	10.0940,
SOPCOFAC,	1.0453,	1.1806,	.9560,	.9799,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.6560,	.5900,	.6470,	.6490,	.6830,	.5800,	.6370,	.6120,	.6030,	.5880,
2,	1.2040,	1.0070,	1.1300,	1.0940,	1.1330,	1.0480,	1.1950,	1.0640,	1.1500,	1.2100,
3,	1.8650,	1.9670,	2.1700,	2.0890,	2.0400,	1.8590,	1.8630,	1.7040,	2.1100,	2.1320,
4,	2.7090,	3.3500,	3.6160,	3.5370,	2.6360,	3.8960,	2.9780,	3.2240,	3.7030,	3.3350,
5,	6.1070,	5.7510,	5.5050,	5.4720,	4.7020,	5.8490,	5.8300,	5.6370,	4.6780,	4.9290,
6,	8.0180,	8.0740,	7.8140,	7.7460,	7.5380,	7.9140,	8.0950,	7.8900,	5.5460,	6.9710,
7,	8.7380,	8.5860,	10.3190,	10.2550,	9.1640,	9.6070,	10.2450,	9.6860,	8.5000,	9.0680,
+gp,	12.6580,	11.9630,	12.8560,	12.8540,	9.7770,	12.4670,	13.0600,	10.8000,	10.7450,	11.7800,
SOPCOFAC,	.9401,	.9649,	.9883,	.9442,	.9508,	.9542,	1.0004,	.9516,	.9576,	.9693,

Table 2.2.5 CPUE data by gear type for the Swedish cod fishery expressed as average catch (kg) per hour.

Year	Skagerrak		
	Catch (t)	Effort (hr)	CPUE (kg/hr)
	Bottom trawl		
1978	86	-	24.5
1979	104	-	28.4
1980	263	6,651	39.6
1981	318	7,297	43.6
1982	462	8,178	56.5
1983	329	8,478	38.8
1984	371	11,991	30.9
1985	392	13,168	29.8
1986	347	11,977	29.0
1987	503	13,527	37.7
1988	344	14,405	23.9
1989	178	11,310	28.2
1990	323	11,815	27.3
1991	249	9,561	26.6
	Nephrops trawl		
1978	572	-	18.2
1979	936	-	27.2
1980	1,287	42,987	29.9
1981	1,619	43,785	37.0
1982	1,384	40,815	33.9
1983	1,239	52,536	23.6
1984	1,077	69,779	15.4
1985	1,149	70,869	16.2
1986	736	74,913	9.8
1987	1,062	91,875	11.5
1988	1,002	109,337	9.2
1989	1,243	85,833	12.8
1990	803	71,775	11.2
1991	508	71,854	8.1

Table 2.2.6 CPUE data by seiners and gill net for the Danish cod fishery in the Skagerrak.

Year	Danish seine			Nets		
	Catch (t)	Effort (days)	CPUE (kg/days)	Catch (t)	Effort (days)	CPUE (kg/days)
1983	177	520	340	148	188	787
1984	659	1,996	330	358	701	511
1985	310	716	433	206	449	459
1986	2,184	3,784	577	2,418	2,560	944
1987	919	2,170	423	384	971	396
1988	964	2,528	381	347	999	347
1989	970	3,316	293	132	480	275
1990	719	3,028	237	202	650	311
1991[1]	420	2,825	149	276	956	288

[1]Preliminary.

Table 2.2.7 Indices of 0-group Cod from the Norwegian Skagerrak coast and indices of 1- and 2-groups from the IBTS in February.

Year class	IBTS 1-gr.	IBTS 2-gr.	0-gr.[1]
1974			
1975			6.1
1976			11.4
1977			3.4
1978			6
1979		85	21.4
1980	15	31	7.1
1981	36	30.4	5
1982	28.4	18.6	12.4
1983	23.4	51.8	1.9
1984	13.5	10.5	4.2
1985	77.9	113	20.3
1986	5.4	18.1	4.5
1987	77	23.8	10.1
1988	56	9.6	0.2
1989	30.9	25.3	15.9
1990	9.3	5.0	1.9
1991	96		5.7

[1]Norwegian survey.

Table 2.2.8 Cod in the Skagerrak : tuning summary

```
Cod in the Skagerrak (part of Fishing Area IIIa) (run name: WG1)
CPUE data from file J:\IFAPWORK\WG_200\COD_SKAG\FLEET.WG
Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)
Terminal Fs estimated using  Laurec-Shepherd
Tuning converged after    9 iterations
Regression weights
     , .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
Oldest age F = 1.000*average of 3 younger ages.
Fleets :
       1: Swedish bottom trawl
       2: Swedish Neprops trawl
       3: Danish seine, Skagerrak, Denmark

                        SUMMARY STATISTICS FOR AGE  1
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  ,-9.31   ,  .655, .0008 , .0856,  -.216E-01,   .886E-01, -9.315,   .212
   2  ,-10.13  ,  .757, .0029 , .1254,  -.591E-01,   .100E+00,-10.126,   .245
   3  ,-12.64  ,  .686, .0014 , .0822,   .334E-01,   .923E-01,-12.637,   .222
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .094       .402            .128             .402              .102

                        SUMMARY STATISTICS FOR AGE  2
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  , -6.91  ,  .363, .0094 , .4528,  -.393E-01,   .470E-01, -6.907,   .117
   2  , -7.72  ,  .404, .0320 , .6632,  -.767E-01,   .467E-01, -7.718,   .131
   3  ,-10.23  ,  .200, .0152 , .4345,   .157E-01,   .264E-01,-10.229,   .065
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .468       .160            .107             .160              .445

                        SUMMARY STATISTICS FOR AGE  3
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  , -6.44  ,  .230, .0149 , .7600,  -.334E-01,   .285E-01, -6.442,   .074
   2  , -7.25  ,  .306, .0509 ,1.1132,  -.708E-01,   .318E-01, -7.253,   .099
   3  , -9.76  ,  .127, .0241 , .7293,   .216E-01,   .152E-01, -9.764,   .041
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .773       .104          .944E-01           .104              .818

                        SUMMARY STATISTICS FOR AGE  4
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  , -6.49  ,  .350, .0142 , .7746,  -.722E-01,   .390E-01, -6.489,   .113
   2  , -7.34  ,  .475, .0468 ,1.4948,  -.131E+00,   .412E-01, -7.336,   .154
   3  , -9.81  ,  .293, .0230 , .7433,  -.172E-01,   .393E-01, -9.811,   .095
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .857       .203            .187             .203              .846

                        SUMMARY STATISTICS FOR AGE  5
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  , -6.63  ,  .469, .0124 , .5732,  -.519E-01,   .606E-01, -6.626,   .152
   2  , -7.44  ,  .471, .0423 , .8409,  -.894E-01,   .543E-01, -7.437,   .152
   3  , -9.95  ,  .329, .0201 , .5509,   .300E-02,   .447E-01, -9.948,   .106
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .617       .234            .125             .234              .288

                        SUMMARY STATISTICS FOR AGE  6
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
      ,  q      ,      ,  F   ,  F   ,            ,    Slope ,         ,Intrcpt
   1  , -6.62  ,  .517, .0125 , .6999,  -.840E-01,   .626E-01, -6.620,   .167
   2  , -7.43  ,  .452, .0426 ,1.0248,  -.121E+00,   .408E-01, -7.431,   .146
   3  , -9.94  ,  .329, .0202 , .6714,  -.290E-01,   .433E-01, -9.942,   .106
   Fbar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .760       .236            .130             .236              .302
```

Table 2.2.9 Cod in Skagerrak : fishing mortalities

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,
AGE				
1,	.2491,	.0198,	.0386,	.0311,
2,	.9317,	.4210,	.4608,	.6788,
3,	1.1112,	.6914,	1.2162,	1.0959,
4,	.8697,	.5402,	1.2496,	1.2147,
5,	.5647,	.5858,	.9982,	.7036,
6,	.8973,	.1914,	.6025,	.3103,
7,	.7772,	.4391,	.9516,	.7447,
+gp,	.7772,	.4391,	.9516,	.7447,
FBAR 3- 6,	.8607,	.5022,	1.0166,	.8311,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	FBAR 87-91
AGE											
1,	.0725,	.1032,	.0257,	.0885,	.1149,	.0168,	.0661,	.0688,	.0854,	.0940,	.0662,
2,	.5744,	.7063,	.7432,	.6477,	.6820,	.8109,	.4010,	.6887,	.8369,	.4682,	.6411,
3,	1.2362,	1.2384,	1.0319,	.7516,	1.3272,	1.0499,	1.0493,	1.2411,	1.0275,	.7726,	1.0281,
4,	1.5275,	1.2768,	1.0538,	.9385,	1.8844,	.6923,	.9150,	1.1219,	.7066,	.8566,	.8585,
5,	.9208,	1.0238,	.8064,	1.0396,	1.4460,	.7837,	.4542,	.7603,	1.1967,	.6175,	.7625,
6,	1.3851,	1.0416,	.7511,	1.1012,	1.0417,	1.5476,	.8985,	.6640,	.5074,	.7604,	.8756,
7,	1.2940,	1.1141,	.8704,	1.0264,	1.4574,	1.0079,	.7559,	.8488,	.8036,	.7448,	.8322,
+gp,	1.2940,	1.1141,	.8704,	1.0264,	1.4574,	1.0079,	.7559,	.8488,	.8036,	.7448,	
FBAR 3- 6,	1.2674,	1.1451,	.9108,	.9577,	1.4248,	1.0184,	.8293,	.9469,	.8595,	.7518,	

Table 2.2.10 Cod in Skagerrak : stock no at age

Stock number at age (start of year) Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,
AGE				
1,	21611,	24357,	31003,	14018,
2,	20033,	13792,	19551,	24421,
3,	4667,	6461,	7412,	10097,
4,	1451,	1258,	2650,	1799,
5,	461,	498,	600,	622,
6,	305,	215,	227,	181,
7,	89,	102,	145,	102,
+gp,	105,	86,	19,	12,
0 TOTAL,	48722,	46768,	61608,	51252,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	GMST 78-89	AMST 78-89
AGE													
1,	17022,	19890,	14796,	12076,	32999,	10901,	17835,	13168,	11383,	5305,	0,	18016,	19140,
2,	11126,	12962,	14688,	11806,	9050,	24085,	8776,	13669,	10065,	8556,	3954,	14498,	15330,
3,	10141,	5129,	5237,	5719,	5058,	3746,	8765,	4811,	5620,	3569,	4386,	6129,	6437,
4,	2763,	2412,	1217,	1528,	2208,	1098,	1073,	2513,	1139,	1647,	1349,	1727,	1831,
5,	437,	491,	551,	347,	489,	275,	450,	352,	670,	460,	573,	453,	464,
6,	252,	142,	144,	201,	101,	94,	103,	234,	135,	166,	203,	171,	183,
7,	109,	52,	41,	56,	55,	29,	16,	34,	99,	66,	63,	58,	69,
+gp,	40,	111,	32,	15,	30,	32,	27,	23,	65,	31,	38,		
TOTAL,	41890,	41189,	36706,	31748,	49989,	40260,	37045,	34804,	29175,	19800,	10566,		

Table 2.2.11 Recruitment analysis of Cod in IIIa as 1, 2 and 3 group

Analysis by RCT3 ver3.1 of data from file :

COD3A1.RCI

COD IN THE SKAGERRAK AS 1-GROUP, 1- AND 2-GROUP DATA, YEARCLASSES 79-91

Data for 2 surveys over 13 years : 1979 - 1991

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

	I-----------Regression	----------	---------	----I		I-----------Prediction	-------	-------	--I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.47	8.17	.24	.721	8	4.04	10.07	.305	.465
IYFS2	.64	7.53	.31	.638	9	2.36	9.04	.424	.241
					VPA Mean =		9.77	.384	.294

Yearclass = 1989

	I-----------Regression	----------	---------	----I		I-----------Prediction	-------	-------	--I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.55	7.84	.35	.515	9	3.46	9.73	.425	.267
IYFS2	.58	7.77	.30	.642	10	3.27	9.68	.353	.387
					VPA Mean =		9.74	.373	.346

Yearclass = 1990

	I-----------Regression	----------	---------	----I		I-----------Prediction	-------	-------	--I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.62	7.53	.41	.441	10	2.33	8.99	.525	.235
IYFS2	.64	7.54	.33	.591	11	1.79	8.69	.463	.301
					VPA Mean =		9.70	.373	.464

Yearclass = 1991

	I-----------Regression	----------	---------	----I		I-----------Prediction	-------	-------	--I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.76	7.03	.48	.504	11	4.57	10.53	.631	.371
IYFS2									
					VPA Mean =		9.59	.485	.629

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	16902	9.74	.21	.29	1.94	13150	9.48
1989	16565	9.72	.22	.02	.01	11437	9.34
1990	10183	9.23	.25	.32	1.55	5502	8.61
1991	20674	9.94	.38	.45	1.39		

(cont'd)

Table 2.2.11 continued

Analysis by RCT3 ver3.1 of data from file :

COD3A2.RCI

COD IN THE SKAGERRAK AS 2-GROUP, 1- AND 2-GROUP DATA, YEARCLASSES 79-91

Data for 2 surveys over 13 years : 1979 - 1991

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	---------	I	I----------	Prediction	--------	I	
IYFS1	.44	8.01	.22	.715	8	4.04	9.78	.287	.447
IYFS2	.59	7.44	.26	.690	9	2.36	8.84	.361	.282
					VPA Mean =		9.51	.368	.271

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	---------	I	I----------	Prediction	--------	I	
IYFS1	.52	7.67	.34	.495	9	3.46	9.47	.412	.239
IYFS2	.54	7.66	.25	.694	10	3.27	9.42	.302	.445
					VPA Mean =		9.48	.359	.316

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	---------	I	I----------	Prediction	--------	I	
IYFS1	.61	7.30	.41	.410	10	2.33	8.73	.530	.211
IYFS2	.61	7.40	.30	.625	11	1.79	8.49	.418	.339
					VPA Mean =		9.43	.362	.451

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	---------	I	I----------	Prediction	--------	I	
IYFS1	.61	7.29	.42	.407	10	4.57	10.10	.554	.299
IYFS2									
					VPA Mean =		9.42	.362	.701

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	12604	9.44	.19	.28	2.11	10048	9.22
1989	12698	9.45	.20	.02	.01	8601	9.06
1990	7815	8.96	.24	.31	1.58		
1991	15178	9.63	.30	.31	1.06		

(cont'd)

Table 2.2.11 continued

Analysis by RCT3 ver3.1 of data from file :

COD3A3.RCI

COD IN THE SKAGERRAK AS 3-GROUP, 1- AND 2-GROUP DATA, YEARCLASSES 79-91

Data for 2 surveys over 13 years : 1979 - 1991

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	I	I-----------	Prediction	---------	I	
IYFS1	.39	7.30	.26	.495	8	4.04	8.89	.342	.255
IYFS2	.47	7.01	.20	.733	9	2.36	8.12	.267	.418
					VPA Mean =		8.65	.302	.327

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	I	I-----------	Prediction	---------	I	
IYFS1	.76	5.97	.64	.167	9	3.46	8.61	.777	.049
IYFS2	.45	7.07	.18	.789	10	3.27	8.55	.211	.665
					VPA Mean =		8.60	.322	.286

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	I	I-----------	Prediction	---------	I	
IYFS1	.77	5.95	.66	.165	9	2.33	7.74	.866	.050
IYFS2	.45	7.08	.18	.791	10	1.79	7.89	.253	.587
					VPA Mean =		8.59	.321	.363

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	I	I-----------	Prediction	---------	I	
IYFS1	.77	5.92	.68	.161	9	4.57	9.46	.920	.108
IYFS2									
					VPA Mean =		8.59	.321	.892

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	4862	8.49	.17	.23	1.80	3557	8.18
1989	5264	8.57	.17	.02	.01		
1990	3419	8.14	.19	.25	1.61		
1991	5905	8.68	.30	.27	.80		

Table 2.2.12 Cod in Skagerak : summary of VPA results and recruitment analysis

Summary (without SOP correction)

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	FBAR 3- 6,
1978,	21611,	50475,	20301,	24466,	.8607,
1979,	24357,	48949,	22498,	15499,	.5022,
1980,	31003,	72406,	26871,	24006,	1.0166,
1981,	14018,	64274,	31860,	28913,	.8311,
1982,	17022,	57107,	32546,	26110,	1.2674,
1983,	19890,	48705,	23918,	21784,	1.1451,
1984,	14796,	46930,	20760,	19891,	.9108,
1985,	12076,	42332,	21579,	16628,	.9577,
1986,	32999,	52780,	19988,	20103,	1.4248,
1987,	10901,	45843,	14280,	19900,	1.0184,
1988,	17835,	45345,	23497,	16952,	.8293,
1989,	16902,	43309,	20707,	18697,	.9469,
1990,	16565,	39932,	21494,	17800,	.8595,
1991,	10183,	30965,	17492,	12059,	.7518,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),	

Table 2.2.13 Cod in Skagerrak : Input data for equilibrium prediction

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	0.2000	0.0000	0.0000	0.0000	0.604	0.0565	0.604
2	.	0.2000	0.0000	0.0000	0.0000	1.133	0.5470	1.133
3	.	0.2000	1.0000	0.0000	0.0000	1.934	0.8771	1.934
4	.	0.2000	1.0000	0.0000	0.0000	3.427	0.7324	3.427
5	.	0.2000	1.0000	0.0000	0.0000	5.385	0.6505	5.385
6	.	0.2000	1.0000	0.0000	0.0000	7.283	0.7470	7.283
7	.	0.2000	1.0000	0.0000	0.0000	9.421	0.7100	9.421
8+	.	0.2000	1.0000	0.0000	0.0000	11.770	0.7100	11.770
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : WGLT
Date and time: 13OCT92:18:08

Table 2.2.14 Cod in Skagerrak : Equilibrium prediction results

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0.000	0	5.517	28658	3.698	27126	3.698	27126
0.0500	0.0376	0.125	698	4.896	22536	3.079	21007	3.079	21007
0.1000	0.0752	0.216	1103	4.439	18236	2.625	16709	2.625	16709
0.1500	0.1128	0.287	1339	4.089	15096	2.277	13572	2.277	13572
0.2000	0.1504	0.343	1470	3.813	12736	2.003	11214	2.003	11214
0.2500	0.1879	0.388	1537	3.589	10919	1.782	9400	1.782	9400
0.3000	0.2255	0.425	1564	3.405	9492	1.600	7976	1.600	7976
0.3500	0.2631	0.457	1566	3.250	8354	1.447	6840	1.447	6840
0.4000	0.3007	0.483	1552	3.118	7433	1.318	5922	1.318	5922
0.4500	0.3383	0.507	1528	3.005	6679	1.207	5170	1.207	5170
0.5000	0.3759	0.527	1499	2.906	6054	1.110	4548	1.110	4548
0.5500	0.4135	0.545	1467	2.820	5532	1.026	4028	1.026	4028
0.6000	0.4511	0.560	1434	2.743	5091	0.952	3590	0.952	3590
0.6500	0.4886	0.574	1401	2.675	4716	0.886	3218	0.886	3218
0.7000	0.5262	0.587	1369	2.614	4395	0.827	2899	0.827	2899
0.7500	0.5638	0.598	1339	2.559	4118	0.774	2625	0.774	2625
0.8000	0.6014	0.609	1309	2.509	3878	0.727	2387	0.727	2387
0.8500	0.6390	0.618	1281	2.464	3668	0.683	2180	0.683	2180
0.9000	0.6766	0.627	1255	2.422	3484	0.644	1998	0.644	1998
0.9500	0.7142	0.635	1231	2.384	3321	0.608	1837	0.608	1837
1.0000	0.7518	0.642	1208	2.349	3177	0.575	1696	0.575	1696
1.0500	0.7893	0.649	1187	2.317	3048	0.545	1569	0.545	1569
1.1000	0.8269	0.656	1167	2.286	2933	0.517	1457	0.517	1457
1.1500	0.8645	0.662	1148	2.258	2829	0.491	1356	0.491	1356
1.2000	0.9021	0.667	1131	2.232	2736	0.467	1265	0.467	1265
1.2500	0.9397	0.672	1115	2.208	2652	0.445	1183	0.445	1183
1.3000	0.9773	0.677	1099	2.185	2575	0.424	1109	0.424	1109
1.3500	1.0149	0.682	1085	2.163	2505	0.405	1041	0.405	1041
1.4000	1.0525	0.686	1072	2.143	2441	0.387	979	0.387	979
1.4500	1.0900	0.690	1060	2.124	2382	0.370	923	0.370	923
1.5000	1.1276	0.694	1048	2.106	2328	0.354	871	0.354	871
1.5500	1.1652	0.698	1037	2.089	2278	0.339	824	0.339	824
1.6000	1.2028	0.702	1027	2.073	2232	0.325	780	0.325	780
1.6500	1.2404	0.705	1017	2.057	2189	0.311	739	0.311	739
1.7000	1.2780	0.708	1008	2.042	2149	0.299	702	0.299	702
1.7500	1.3156	0.711	999	2.028	2112	0.287	667	0.287	667
1.8000	1.3532	0.714	991	2.015	2077	0.275	635	0.275	635
1.8500	1.3907	0.717	984	2.002	2044	0.265	605	0.265	605
1.9000	1.4283	0.720	976	1.990	2014	0.255	576	0.255	576
1.9500	1.4659	0.723	970	1.978	1985	0.245	550	0.245	550
2.0000	1.5035	0.725	963	1.967	1958	0.236	525	0.236	525
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Computation of ref. F: Simple mean, age 3 - 6
F-0.1 factor : 0.2029
F-max factor : 0.3281
F-0.1 reference F : 0.1526
F-max reference F : 0.2466
Recruitment : Single recruit

Table 2.2.15 Cod in Skagerrak : Input for catch prediction

Prediction with management option table: Input data

Year: 1992								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	20674.000	0.2000	0.0000	0.0000	0.0000	0.604	0.0565	0.604
2	7815.000	0.2000	0.0000	0.0000	0.0000	1.133	0.5470	1.133
3	5264.000	0.2000	1.0000	0.0000	0.0000	1.934	0.8771	1.934
4	1349.000	0.2000	1.0000	0.0000	0.0000	3.427	0.7324	3.427
5	573.000	0.2000	1.0000	0.0000	0.0000	5.385	0.6505	5.385
6	203.000	0.2000	1.0000	0.0000	0.0000	7.283	0.7470	7.283
7	63.000	0.2000	1.0000	0.0000	0.0000	9.421	0.7100	9.421
8+	38.000	0.2000	1.0000	0.0000	0.0000	11.770	0.7100	11.770
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1993								
Age	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	14618.000	0.2000	0.0000	0.0000	0.0000	0.604	0.0565	0.604
2	.	0.2000	0.0000	0.0000	0.0000	1.133	0.5470	1.133
3	.	0.2000	1.0000	0.0000	0.0000	1.934	0.8771	1.934
4	.	0.2000	1.0000	0.0000	0.0000	3.427	0.7324	3.427
5	.	0.2000	1.0000	0.0000	0.0000	5.385	0.6505	5.385
6	.	0.2000	1.0000	0.0000	0.0000	7.283	0.7470	7.283
7	.	0.2000	1.0000	0.0000	0.0000	9.421	0.7100	9.421
8+	.	0.2000	1.0000	0.0000	0.0000	11.770	0.7100	11.770
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1994								
Age	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	14618.000	0.2000	0.0000	0.0000	0.0000	0.604	0.0565	0.604
2	.	0.2000	0.0000	0.0000	0.0000	1.133	0.5470	1.133
3	.	0.2000	1.0000	0.0000	0.0000	1.934	0.8771	1.934
4	.	0.2000	1.0000	0.0000	0.0000	3.427	0.7324	3.427
5	.	0.2000	1.0000	0.0000	0.0000	5.385	0.6505	5.385
6	.	0.2000	1.0000	0.0000	0.0000	7.283	0.7470	7.283
7	.	0.2000	1.0000	0.0000	0.0000	9.421	0.7100	9.421
8+	.	0.2000	1.0000	0.0000	0.0000	11.770	0.7100	11.770
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : WGPRED
Date and time: 13OCT92:17:44
Recruitment ages 1-3 1992 : RCT3 values for the res[ective year classes, table 2.2.11
Recruitment age 1 1993-1994 : average recruitment value as calculated by RCT3

Table 2.2.16 Cod in Skagerrak : Catch prediction

Prediction with management option table

Year: 1992					Year: 1993					Year: 1994	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.7518	41751.056	20406.439	14253.847	0.0000	0.0000	46125.926	19166.096	0.000	72216.360	49822.323
.	.	.	.	.	0.2000	0.1504	.	19166.096	4292.035	65890.491	43648.873
.	.	.	.	.	0.4000	0.3007	.	19166.096	8062.814	60357.628	38266.717
.	.	.	.	.	0.6000	0.4511	.	19166.096	11379.968	55512.838	33570.940
.	.	.	.	.	0.8000	0.6014	.	19166.096	14302.008	51265.551	29470.992
.	.	.	.	.	1.0000	0.7518	.	19166.096	16879.592	47537.535	25888.658
.	.	.	.	.	1.2000	0.9021	.	19166.096	19156.614	44261.166	22756.335
.	.	.	.	.	1.4000	1.0524	.	19166.096	21171.136	41377.945	20015.542
.	.	.	.	.	1.6000	1.2028	.	19166.096	22956.190	38837.230	17615.654
.	.	.	.	.	1.8000	1.3531	.	19166.096	24540.465	36595.145	15512.814
.	.	.	.	.	2.0000	1.5035	.	19166.096	25948.897	34613.650	13668.999
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : WGPRED
Date and time : 13OCT92:17:44
Computation of ref. F: Simple mean, age 3 - 6
Basis for 1992 : F factors

Table 2.2.17

Stock: Cod - Skagerrak

Assessment Quality Control Diagram 1

Average F(2-6,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.99				
1989	1.12	1.02			
1990	1.05	0.85	1.14		
1991	0.96	0.80	1.05	1.05	
1992	1.02	0.83	0.95	0.86	0.75

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	19.8	20.0	24.0				
1989		16.7	21.3	25.7			
1990			18.6	23.0	19.4		
1991				17.8	17.0	17.5	
1992					13.1	14.3	16.9
					Actual	Current	Forecast

$$Actual\ SQC = Landings(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

Remarks:

(cont'd)

Table 2.2.17 (cont'd)

Stock: Cod - Skagerrak

Assessment Quality Control Diagram 3

Recruitment (age 1) Unit: millions						
Date of assessment	Year class					
	1986	1987	1988	1989	1990	1991
1988	12.2	31.7				
1989	7.0	30.0	27.0			
1990	10.8	22.3	15.0	16.7		
1991	10.3	17.1	14.0	16.4	17.0	
1992	10.9	17.8	16.9	16.6	10.2	20.7

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	10.7	19.0	15.0[1]	27.0[1]				
1989	12.7	20.8	14.0	24.0[1]	27.2[1]			
1990	13.5	21.9	18.6	24.0	17.5[1]	15.6[1]		
1991	13.9	23.3	19.5	18.7	15.1	15.5[1]	16.1[1]	
1992	14.3	23.5	20.7	21.5	17.5	20.4	19.2[1]	25.9[1]

[1]Forecast.

Remarks: *Status quo* forecast used.

Table 2.3.1 Landings of haddock in Division IIIa (in tonnes) as supplied by Working Group members.

Year	Denmark Human consumption	Denmark Reduction	Denmark Total	Norway	Sweden	Others	Total consumption	Total reduction and consumption
				Human consumption				
1975	-	-	5,015	122	921	57	-	6,115
1976	-	-	7,488	191	1,075	301	-	9,055
1977	-	-	6,907	156	2,485	215	-	9,763
1978	-	-	4,978	168	1,435[2]	56	-	6,637
1979	-	-	4,120	248	361	56	-	4,785
1980	-	-	7,172	288	373	57	-	7,890
1981	-	-	9,568	271	391	120	-	10,350
1982	-	-	11,151	196	396	329	-	12,072
1983	6,425	7,225	13,650	756	608	221	8,010	15,235
1984	5,516	2,707	8,223	321	499	30	6,366	9,073
1985	6,522	954	7,476	279	351	15	7,167	8,121
1986	3,265	1,682	4,947	226	151	5	3,647	5,329
1987	3,584	1,449	5,033	148	71	36	3,803	5,288
1988	2,543	1,480	4,023	245	64	48	2,852	4,380
1989	3,889	360	4,249	138	66	5	4,098	4,458
1990	3,887	1,968	5,855	84	102	27	4,100	6,068
1991	3,894	2,593	6,487	111	80	1	4,086	6,679

Table 2.3.2 Haddock IIIa. Catch at age, Thousands

CATCH-AT-AGE DATA

YEAR	81	82	83	84	85	86	87[1]	88[1]
1	30.0	314.0	1113.0	18.0	.0	51.0	381.0	375.0
2	9903.0	2299.0	4624.0	6554.0	8279.0	903.0	3282.0	1683.0
3	4962.0	12055.0	2728.0	4481.0	3687.0	3722.0	866.0	1863.0
4	771.0	1113.0	4004.0	713.0	1049.0	686.0	734.0	303.0
5	151.0	209.0	525.0	524.0	78.0	230.0	122.0	158.0
6	84.0	22.0	63.0	91.0	176.0	33.0	42.0	43.0
7	36.0	11.0	11.0	6.0	29.0	27.0	10.0	14.0
8	3.0	6.0	6.0	16.0	6.0	28.0	6.0	16.0
TOTAL	15940.0	16029.0	13074.0	12403.0	13304.0	5680.0	5443.0	4455.0

CATCH-AT-AGE DATA

YEAR	89[1]	90[1]	91
1	32.0	1040.0	7614.0
2	1540.0	1347.0	2453.0
3	2951.0	1576.0	1085.0
4	510.0	931.0	460.0
5	91.0	144.0	401.0
6	45.0	43.0	64.0
7	12.0	31.0	12.0
8	6.0	20.0	18.0
TOTAL	5187.0	5132.0	12107.0

[1] Age distributions from human consumption fishery only

Table 2.3.3 Recuitment index of Haddock in IIIa : IBTS index, 1-group

Year class	IBTS index
1979	40.4
1980	4.3
1981	47.7
1982	33.8
1983	71.7
1984	160.8
1985	57
1986	250.6
1987	125.2
1988	20.2
1989	8
1990	74
1991	288

Table 2.3.4. Haddock IIIa. Analysis of year, age and year class effects with multiplicative model. Results.

CV = .554E+00 RANK= 37
CONSTANT = -.09
MEAN YEARCLASS EFFECT = 5.31

RESIDUAL SUM OF SQUARES= .272E+02

NUMBER OF OBSERVATIONS = 87

NUMBER OF PARAMETERS = 34

			PARAMETER	S.D.
Year effects				
		82	-.0960	.2131
		83	.3544	.2507
		84	-.2149	.2970
		85	-.1094	.3383
		86	-.0847	.2744
		87	-.2788	.2652
		88	-.2739	.3010
		89	-.1901	.2783
		90	.1871	.2371
		91	.06	–
Age effects				
		2	2.8711	.3169
		3	2.8343	.3503
		4	1.4960	.3729
		5	.0889	.3912
		6	-1.1323	.4107
		7	-2.4476	.4340
		8	-2.8824	.4522
Year class effects				
	73	1	4.0715	.9466
	74	2	5.4912	.7488
	75	3	5.0320	.6283
	76	4	4.9927	.5330
	77	5	5.0225	.4409
	78	6	5.9558	.3896
	79	7	6.2353	.3596
	80	8	4.8937	.3371
	81	9	5.4935	.3468
	82	10	5.6373	.3575
	83	11	5.3404	.3336
	84	12	4.5605	.4120
	85	13	4.9820	.3691
	86	14	5.5211	.3833
	87	15	5.0237	.4022
	88	16	4.0683	.4530
	89	17	6.0180	.6408
	90	18	7.1674	1.2257

Table 2.3.5 Haddock in Division IIIa : correlation between year-class effects in Division IIIa from multiplicative model (MCM) and recruitment in Sub-area IV, age 1.

yrcl.	IV recr.	MCM ycl IIIa	exp MCM IIIa	sd MCM	CV		Log IV recr.
73	8582	4.0720	58.67	0.9470	0.233		9.057
74	15560	5.4910	242.50	0.7490	0.136		9.652
75	1335	5.0320	153.24	0.6280	0.125		7.197
76	1864	4.9930	147.38	0.5330	0.107		7.530
77	2946	5.0230	151.87	0.4410	0.088	x	7.988
78	4638	5.9560	386.06	0.3896	0.065	x	8.442
79	8363	6.2350	510.30	0.3596	0.058	x	9.032
80	1751	4.8940	133.49	0.3370	0.069	x	7.468
81	3707	5.4940	243.23	0.3470	0.063	x	8.218
82	2373	5.6370	280.62	0.3580	0.064	x	7.772
83	7990	5.3400	208.51	0.3340	0.063	x	8.986
84	2052	4.5610	95.68	0.4120	0.090	x	7.627
85	2850	4.9820	145.77	0.3691	0.074	x	7.955
86	5933	5.5210	249.88	0.3833	0.069	x	8.688
87	461	5.0240	152.02	0.4022	0.080	x	6.133
88	932	4.0680	58.44	0.4530	0.111		6.837
89	827	6.0180	410.76	0.6408	0.106		6.718
90	2877	7.1670	1295.95	1.2257	0.171		7.965
*89	1020	4.9352	138.65				6.928
*90	4297	5.4555	244.88				8.366
*91	8423	5.6990	378.62				9.039
*92	7112	5.6378	336.13				8.870

x : CV MCM < 0.1, this range is used for predictive regression
*89, 90, 91 and 92 : MCM predicted from predictive regression with recruitment of age 1 in IV, RCT3

Regressions :
linear

Constant	105.591
Std Err of Y Est	96.7235
R Squared	0.45
No. of Observations	11
Degrees of Freedom	9
X Coefficient(s)	0.032415
Std Err of Coef.	0.011945

log

Constant	2.42885
Std Err of Y Est	0.41916
R Squared	0.35693
No. of Observations	11
Degrees of Freedom	9
X Coefficient(s)	0.3617945
Std Err of Coef.	0.1618749

Table 2.3.6 Haddock in Division IIIa. Inputs for prediction.
Age, year and year-class effects as in Table 2.3.4 except:

YEAR EFFECTS

YEAR	92	93	94	95
EFFECT	.06	.06	.06	.06

YEARCLASS EFFECTS

YEARCLASS	89	90	91	92	93	94
EFFECT	4.94	5.46	5.70	5.64	5.31	5.31

Year class effects 89-92 based on RCT3 estimates of recruitment in IV (table 2.3.4.1), 93 and 94 average year class effect (table 2.3.4.1)

Table 2.3.7. Haddock in IIIa. Results of prediction

FITTED AND FORECAST CATCH-AT-AGE

YEAR	81	82	83	84	85	86	87	88	89	90
1	121.2	219.6	397.8	166.3	85.7	133.0	187.8	114.7	47.5	165.3
2	8267.2	2149.4	6147.9	4020.3	3297.6	1565.8	1954.5	3368.1	2210.8	1245.3
3	6000.0	7879.9	3234.5	3339.3	4284.2	3239.5	1236.9	1884.2	3488.6	3112.7
4	618.6	1563.3	3241.4	480.2	972.7	1150.5	699.5	326.0	533.5	1342.7
5	147.1	150.5	600.6	449.5	130.7	244.0	232.0	172.2	86.2	191.8
6	45.1	43.1	69.6	100.3	147.3	39.5	59.3	68.8	54.8	37.3
7	19.2	12.1	18.2	10.6	30.0	40.6	8.8	16.0	20.0	21.7
8	3.0	12.3	12.2	6.6	7.6	19.7	21.5	5.7	11.1	18.9
TOTAL	15221.4	12030.2	13722.2	8573.2	8955.8	6432.7	4400.2	5955.6	6452.7	6135.7

YEAR	91	92	93	94	95
1	258.6	317.3	298.9	214.9	214.9
2	2748.9	4464.0	5674.9	5344.4	3842.2
3	1112.9	2550.9	4290.7	5454.6	5136.9
4	760.4	282.3	670.2	1127.4	1433.2
5	306.3	180.2	69.3	164.5	276.7
6	52.7	87.4	53.2	20.5	48.6
7	9.4	13.7	23.6	14.4	5.5
8	13.0	5.8	8.8	15.2	9.2
TOTAL	5262.1	7901.7	11089.7	12355.8	10967.3

Summary

YEAR	SSB	TSB	YIELD
81	9838.7	12635.5	11555.5
82	10907.2	11730.6	10638.4
83	6488.7	7922.6	11248.5
84	6937.3	8545.8	6856.5
85	7256.4	8421.6	7491.2
86	5694.7	6280.2	5709.6
87	3918.6	4820.5	3601.7
88	4634.1	6062.4	4543.3
89	5837.6	6692.7	5405.0
90	4277.5	4657.3	5509.4
91	2893.3	3752.9	4127.5
------------forecast------------			
92	4152.3	5556.1	5899.7
93	6241.1	7982.9	8476.6
94	7677.3	9290.4	9864.9
95	7422.6	8607.0	9139.3

Table 2.4.1 Nominal landings (in tonnes) of WHITING from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (Anon., 1992a).

Year	Denmark			Norway	Sweden	Others	Total
1975		19,018		57	611	4	19,690
1976		17,870		48	1,002	48	18,968
1977		18,116		46	975	41	19,178
1978		48,102		58	899	32	49,091
1979		16,971		63	1,033	16	18,083
1980		21,070		65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	777	11,662	12,439	29	675	-	13,215
1990	1,016	17,829	18,845	46	435	73	19,333
1991[1]	881	12,463	13,344	56	557	97	14,054

[1]Preliminary.

Table 2.5.1 PLAICE landings from Division IIIa (in tonnes) as supplied by the Study Group on Division IIIa Demersal Stocks (Anon., 1992a).

Skagerrak

Year	Denmark	Sweden	Netherlands	Germany	Belgium	Norway	Correction	Total
1972	5,095	70	-		-	-		5,165
1973	3,871	80	-		-	-		3,951
1974	3,429	70	-		-	-		3,499
1975	4,888	77	-		-	-		4,965
1976	9,251	81	-		-	-		9,332
1977	12,855	142	-		-	-		12,997
1978	13,383	94	-		-	-		13,477
1979	11,045	105	-		-	-		11,150
1980	9,514	92	-		-	-		9,606
1981	8,115	123	-		-	-		8,238
1982	7,789	140	-		-	-		7,929
1983	6,828	170	594		133	14	-594	7,145
1984	7,560	356	1,580		27	22	-1,580	7,965
1985	9,646	296	2,225		136	18	-2,225	10,096
1986	10,653	215	4,024		505	24	-4,024	11,397
1987	11,370	222	2,209		907	25	-2,209	12,519
1988	9,781	281	2,087		716	41	-2,087	10,819
1989	5,387	320	-	0.1	230	33	-	5,939
1990	8,726	777	-	0.7	471	69	-	10,044
1991[1]	5,849	472	-	3.9	324	68	-	6,717

[1]Preliminary

Kattegat

Year	Denmark	Sweden	Germany	Total Kattegat	Total IIIa
1972	15,504	348	-	15,852	21,017
1973	10,021	231	-	10,252	14,203
1974	11,401	255	-	11,656	15,155
1975	10,158	369	-	10,527	15,492
1976	9,487	271	-	9,758	19,090
1977	11,611	300	-	11,911	24,908
1978	12,685	368	-	13,053	26,530
1979	9,721	281	-	10,002	21,152
1980	5,582	289	-	5,871	15,477
1981	3,803	232	-	4,035	12,273
1982	2,717	201	-	2,918	10,847
1983	3,280	291	-	3,571	10,716
1984	3,252	323	32	3,607	11,572
1985	2,979	403	4	3,386	13,482
1986	2,468	170	+	2,638	14,935
1987	2,868	283	104	3,255	15,775
1988	1,818	210	2.8	2,031	12,850
1989	1,596	135	4.0	1,735	7,674
1990	1,831	201	2.0	2,034	12,078
1991[1]	1,756	267	5.6	2,029	8,746

Table 2.5.2 Plaice in IIIa. Catch at age.

Run title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 19:01

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Catch numbers at age Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,
AGE				
2,	503,	1105,	363,	191,
3,	16129,	9791,	4792,	4059,
4,	40633,	29662,	16421,	13135,
5,	25613,	20812,	12627,	11001,
6,	8234,	7648,	6058,	4318,
7,	637,	2515,	2403,	1431,
8,	65,	170,	953,	548,
9,	65,	75,	204,	214,
10,	49,	50,	54,	119,
+gp,	62,	55,	50,	97,
TOTALNUM,	91990,	71883,	43925,	35113,
TONSLAND,	26530,	21152,	15477,	12273,
SOPCOF %,	97,	100,	100,	100,

Catch numbers at age Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	552,	1569,	2184,	1462,	395,	592,	100,	1045,	3205,	2363,
3,	2168,	10292,	12880,	8990,	4479,	4235,	3121,	3977,	8993,	8735,
4,	9653,	9143,	12555,	22548,	15549,	13081,	12374,	7365,	8905,	9602,
5,	11119,	8503,	4590,	6434,	20027,	18620,	14159,	6489,	10042,	4640,
6,	5825,	2832,	2043,	1767,	4915,	10691,	7055,	2813,	3333,	2878,
7,	1941,	980,	906,	725,	680,	2184,	2822,	1215,	1015,	888,
8,	795,	563,	750,	275,	273,	386,	973,	568,	495,	304,
9,	316,	272,	592,	209,	130,	237,	331,	265,	360,	156,
10,	118,	102,	300,	175,	122,	126,	140,	140,	161,	86,
+gp,	50,	112,	107,	164,	84,	165,	162,	226,	256,	135,
TOTALNUM,	32537,	34368,	36907,	42749,	46654,	50317,	41237,	24103,	36765,	29787,
TONSLAND,	10847,	10716,	11572,	13482,	14035,	15774,	12850,	7674,	12078,	8746,
SOPCOF %,	95,	94,	97,	97,	94,	94,	97,	96,	97,	100,

Table 2.5.3 Plaice in IIIa. Weight at age in the catch and in the stock.

Run title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 19:01

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,
AGE				
2,	.2360,	.2220,	.2610,	.2300,
3,	.2480,	.2550,	.2740,	.2630,
4,	.2680,	.2670,	.3060,	.2960,
5,	.3220,	.2970,	.3450,	.3570,
6,	.4170,	.3780,	.4140,	.4320,
7,	.5980,	.4510,	.5790,	.5370,
8,	.7520,	.6550,	.6400,	.6710,
9,	.8180,	.9220,	.7530,	.8130,
10,	.9140,	1.0200,	.8110,	.9120,
+gp,	.8430,	1.0440,	.9100,	.9990,
SOPCOFAC,	.9729,	.9998,	.9959,	.9972,

Catch weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.2700,	.2850,	.2770,	.2790,	.2520,	.3400,	.2490,	.2740,	.2910,	.2630,
3,	.3010,	.2740,	.2930,	.2840,	.2770,	.2850,	.2680,	.2630,	.2880,	.2700,
4,	.2860,	.2930,	.3090,	.3070,	.2840,	.2860,	.2690,	.2820,	.2940,	.2590,
5,	.3180,	.3560,	.3770,	.3520,	.3210,	.3030,	.2900,	.3200,	.3370,	.2740,
6,	.3860,	.4230,	.4200,	.4370,	.3980,	.3740,	.3500,	.3760,	.3970,	.3650,
7,	.5440,	.4830,	.4190,	.5470,	.5380,	.5380,	.4740,	.4660,	.4980,	.4920,
8,	.7040,	.5310,	.3900,	.6610,	.6740,	.7380,	.5670,	.6350,	.6850,	.5860,
9,	.8130,	.6470,	.3600,	.7420,	.7910,	.9440,	.7570,	.7390,	.7740,	.6710,
10,	.9120,	.9860,	.4460,	.7540,	.8620,	1.0230,	.8320,	.8250,	.9570,	.8690,
+gp,	.9860,	1.1840,	1.1060,	.9180,	1.0260,	1.1180,	1.1920,	1.0100,	1.1520,	1.0110,
SOPCOFAC,	.9535,	.9439,	.9656,	.9674,	.9366,	.9397,	.9724,	.9581,	.9724,	1.0030,

Table 2.5.4 Catch, effort and CPUE for PLAICE in Division IIIa.

Year	*Nephrops* trawl, Sweden					
	Skagerrak			Kattegat		
	Catch (t)	Effort (hours)	CPUE (kg/hrs)	Catch (t)	Effort (hours)	CPUE (kg/hr)
1980	74.4	42,987	1.73	48.1	14,137	3.40
1981	76.1	43,785	1.74	56.0	13,875	4.04
1982	79.9	40,815	1.95	41.6	14,270	2.92
1983	104.1	52,536	1.98	44.0	11,739	3.75
1984	215.4	69,779	3.09	67.7	13,718	4.94
1985	219.6	70,864	3.10	103.8	13,090	7.93
1986	135.3	74,913	1.81	45.6	16,420	2.78
1987	127.7	91,875	1.39	82.9	19,421	4.27
1988	184.4	109,337	1.66	66.5	16,802	3.96
1989	202.2	85,833	2.36	39.2	15,565	2.52
1990	208.8	71,715	2.91	47.1	14,211	3.31
1991	98.0	71,854	1.36	39.0	10,209	3.82

Year	Cod bottom trawl, Sweden					
	Skagerrak			Kattegat		
	Catch (t)	Effort (hrs)	CPUE (kg/hr)	Catch (t)	Effort (hrs)	CPUE (kg/hr)
1980	16.6	6,651	2.50	91.0	14,866	6.12
1981	12.7	7,297	1.74	95.8	12,454	7.69
1982	18.3	8,178	2.24	94.5	10,443	9.05
1983	22.3	8,478	2.63	177.6	17,321	10.25
1984	54.4	11,991	4.54	145.6	19,168	7.60
1985	46.7	13,168	3.55	133.7	14,112	9.47
1986	34.4	11,977	2.87	66.4	13,157	5.05
1987	25.7	13,526	1.90	108.3	14,448	7.50
1988	38.3	14,405	2.66	102.9	13,458	7.65
1989	38.3	11,310	3.39	63.7	13,508	4.72
1990	66.4	11,815	5.62	86.8	13,843	6.27
1991	32.0	9,561	3.42	127.0	20,271	6.27

Year	Danish seiners, Denmark					
	Skagerrak			Kattegat		
	Catch (t)	Effort (days)	CPUE (kg/day)	Catch (t)	Effort (days)	CPU (kg/day)
1983	-	-	-	332	1,811	183
1984	-	-	-	529	2,379	222
1985	749	1,231	609	241	885	272
1986	3,440	5,330	645	404	1,773	227
1987	2,373	3,977	597	394	1,546	255
1988	2.077	3,856	539	235	1,370	172
1989	1,437	4,015	358	212	1,577	134
1990	1,898	4,080	465	289	1,585	182
1991	1,563	4,734	330	337	1,793	188

Table 2.5.5 Indices of 2- and 3-group plaice in Division IIIa from the "Dana" May surveys.

Year class	2-group			3-group		
	Kattegat	Skagerrak	Combined	Kattegat	Skagerrak	Combined
1983	31.7	49.87	40.8	8.8	36.28	22.5
1984	11.9	7.25	9.6	8.9	34.25	21.6
1985	4.9	2.86	3.9	1.8	7.13	4.5
1986	0.6	0.63	0.6	2.5	7.50	5.0
1987	1.1	2.00	1.6	5.4	21.00	13.2
1988	6.3	1.40	3.9	20.7	55.00	37.9
1989	6.8	0.00	3.4			
1990						

Table 2.5.6 Plaice in IIIa. VPA tuning.

```
VPA Version 3.0 (MSDOS)

At 13/10/1992  19:00

Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

CPUE data from file J:\IFAPWORK\WG_200\PLE_3A\FLEET.3FL

Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)

Terminal Fs estimated using  Laurec-Shepherd (with shrinkage)

Shrinkage Log S.E =   .200

Tuning converged after   11 iterations


Total of the absolute F residuals for all ages in the
last year, between iterations 10 and  11 =   .000

Regression weights
      , .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000

Oldest age F = 1.000*average of 3 younger ages.

Fleet 1, DANA May survey
Fleet 2, Danish seiners, Kattegat, Denmark
Fleet 3, Danish seiners, Skagerrak, Denmark


                         SUMMARY STATISTICS FOR AGE  2
 Fleet , Pred.  , SE(q),Partial,Raised,  SLOPE   ,    SE     ,INTRCPT,  SE
       ,  q     ,      ,  F   ,  F   ,           ,   Slope ,        ,Intrcpt
   1   , -9.24  , 1.195, .0013 , .0334,  -.214E+00,  .172E+00, -9.244,   .405
   2   ,-13.68  ,  .735, .0021 , .0201,   .349E-01,  .990E-01,-13.676,   .238
   3   ,-15.90  , 1.910, .0006 , .0070,   .565E+00,  .278E+00,-15.904,   .682
   Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall) Variance ratio
     .024       .595           .936E-01        .595            .025


                         SUMMARY STATISTICS FOR AGE  3
 Fleet , Pred.  , SE(q),Partial,Raised,  SLOPE   ,    SE     ,INTRCPT,  SE
       ,  q     ,      ,  F   ,  F   ,           ,   Slope ,        ,Intrcpt
   1   , -8.43  ,  .765, .0028 , .0923,  -.651E-01,  .120E+00, -8.429,   .259
   2   ,-12.11  ,  .272, .0098 , .1554,   .154E-01,  .365E-01,-12.113,   .088
   3   ,-12.27  ,  .480, .0223 , .1566,   .136E+00,  .722E-01,-12.266,   .172
   Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall) Variance ratio
     .167       .226           .692E-01        .226            .094


                         SUMMARY STATISTICS FOR AGE  4
 Fleet , Pred.  , SE(q),Partial,Raised,  SLOPE   ,    SE     ,INTRCPT,  SE
       ,  q     ,      ,  F   ,  F   ,           ,   Slope ,        ,Intrcpt
   1   , -8.97  ,  .475, .0016 , .3232,  -.794E-01,  .693E-01, -8.972,   .161
   2   ,-11.85  ,  .281, .0127 , .5244,  -.242E-01,  .370E-01,-11.854,   .091
   3   ,-10.73  ,  .249, .1040 , .5210,   .453E-01,  .445E-01,-10.726,   .089
   Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall) Variance ratio
     .519       .173           .872E-01        .173            .253


                         SUMMARY STATISTICS FOR AGE  5
 Fleet , Pred.  , SE(q),Partial,Raised,  SLOPE   ,    SE     ,INTRCPT,  SE
       ,  q     ,      ,  F   ,  F   ,           ,   Slope ,        ,Intrcpt
   1   , -9.45  ,  .950, .0010 , .5958,  -.230E-01,  .153E+00, -9.446,   .322
   2   ,-11.29  ,  .628, .0224 ,3.4545,  -.175E+00,  .541E-01,-11.291,   .203
   3   ,-10.03  ,  .258, .2092 , .9262,   .789E-01,  .363E-01,-10.027,   .092
   Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall) Variance ratio
    1.073       .231           .218            .231            .893
```

(cont'd)

Table 2.5.6 Plaice in IIIa. VPA tuning (continued)

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-9.79	1.279	.0007	.3484	.193E+00	.190E+00	-9.793	.433
2	-12.11	.568	.0099	2.0895	-.708E-01	.724E-01	-12.107	.184
3	-9.93	.223	.2303	1.0081	.591E-01	.349E-01	-9.931	.080

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.116	.205	.151	.205	.545

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-11.75	.625	.0142	1.2033	-.959E-01	.768E-01	-11.747	.202
3	-10.19	.321	.1772	.8125	.851E-01	.504E-01	-10.193	.115

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.922	.285	.916E-01	.285	.103

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-11.40	.569	.0200	.9878	-.135E+00	.580E-01	-11.405	.184
3	-10.53	.446	.1259	.6117	.158E+00	.520E-01	-10.534	.159

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.750	.351	.115	.351	.108

SUMMARY STATISTICS FOR AGE 9

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-11.16	.466	.0255	.8864	-.979E-01	.514E-01	-11.161	.151
3	-10.58	.486	.1199	.6217	.187E+00	.463E-01	-10.584	.173

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.787	.336	.906E-01	.336	.073

Table 2.5.7 Plaice in IIIa. VPA output, F at age

Run title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 19:01

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,
AGE				
2,	.0086,	.0253,	.0108,	.0075,
3,	.2396,	.2048,	.1308,	.1446,
4,	.7715,	.7935,	.5449,	.5477,
5,	1.0830,	1.0694,	.8429,	.7666,
6,	1.0253,	1.0354,	.9575,	.6944,
7,	.5801,	.9265,	.9967,	.5455,
8,	.2839,	.2646,	1.0173,	.5662,
9,	.4165,	.5409,	.5124,	.5793,
10,	.4268,	.5773,	.8431,	.5643,
+gp,	.4268,	.5773,	.8431,	.5643,
FBAR 4- 8,	.7488,	.8179,	.8718,	.6241,

Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	FBAR 87-91
AGE											
2,	.0112,	.0171,	.0318,	.0309,	.0110,	.0182,	.0041,	.0266,	.0498,	.0241,	.0246,
3,	.0992,	.2636,	.1698,	.1586,	.1121,	.1401,	.1133,	.1962,	.2954,	.1667,	.1824,
4,	.5235,	.6610,	.5205,	.4421,	.3974,	.4808,	.6611,	.3742,	.7633,	.5188,	.5597,
5,	1.1365,	1.0983,	.7328,	.4891,	.7859,	1.0288,	1.3226,	.7819,	1.1385,	1.0729,	1.0689,
6,	1.1165,	.9081,	.7599,	.6167,	.7580,	1.2115,	1.3889,	.9322,	1.1125,	1.1155,	1.1521,
7,	.6893,	.4843,	.7419,	.5923,	.4513,	.8134,	1.1656,	.8565,	.9520,	.9217,	.9418,
8,	.5892,	.3840,	.7462,	.4617,	.4107,	.4428,	.9609,	.6793,	.9406,	.7496,	.7547,
9,	.6634,	.3624,	.7816,	.4192,	.3665,	.6660,	.7480,	.6674,	1.1356,	.7865,	.8007,
10,	.6500,	.4103,	.7566,	.4911,	.4095,	.6407,	.9582,	.7344,	1.0094,	.8193,	.8324,
+gp,	.6500,	.4103,	.7566,	.4911,	.4095,	.6407,	.9582,	.7344,	1.0094,	.8193,	
FBAR 4- 8,	.8110,	.7071,	.7002,	.5204,	.5606,	.7955,	1.0998,	.7248,	.9814,	.8757,	

Table 2.5.8 Plaice in IIIa. VPA output, Stock numbers

Run title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 19:01

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Stock number at age (start of year) Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,
AGE				
2,	61822,	46514,	35359,	26847,
3,	79398,	55461,	41038,	31649,
4,	78909,	56537,	40889,	32581,
5,	40335,	33010,	23137,	21455,
6,	13379,	12357,	10251,	9012,
7,	1513,	4342,	3970,	3561,
8,	276,	767,	1556,	1326,
9,	200,	188,	532,	509,
10,	148,	119,	99,	289,
+gp,	187,	131,	92,	235,
TOTAL,	276167,	209425,	156922,	127463,

Stock number at age (start of year) Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE											
2,	52050,	97277,	73373,	50544,	37982,	34430,	25990,	41832,	69327,	104201,	0,
3,	24110,	46572,	86528,	64315,	44345,	33992,	30591,	23421,	36858,	59683,	92039,
4,	24782,	19756,	32376,	66065,	49658,	35870,	26735,	24715,	17417,	24820,	45710,
5,	17048,	13285,	9230,	17408,	38417,	30196,	20068,	12490,	15382,	7346,	13368,
6,	9019,	4950,	4008,	4014,	9659,	15841,	9767,	4838,	5171,	4458,	2273,
7,	4072,	2672,	1807,	1696,	1960,	4095,	4268,	2204,	1724,	1538,	1322,
8,	1867,	1849,	1490,	778,	849,	1130,	1643,	1204,	847,	602,	554,
9,	681,	937,	1140,	639,	444,	509,	656,	569,	552,	299,	257,
10,	258,	317,	590,	472,	380,	278,	237,	281,	264,	161,	123,
+gp,	109,	349,	211,	442,	262,	365,	274,	454,	420,	252,	165,
TOTAL,	133997,	187966,	210752,	206374,	183955,	156708,	120229,	112007,	147961,	203360,	155810,

Table 2.5.9 Plaice in IIIa. Separable VPA analysis.

Title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 20:25

Separable analysis
from 1978 to 1991 on ages 2 to 10
with Terminal F of .900 on age 5 and Terminal S of .900

Initial sum of squared residuals was 200.287 and
final sum of squared residuals is 17.245 after 40 iterations

Matrix of Residuals

Years, Ages	1978/79,	1979/80,	1980/81,
2/ 3,	-.809,	.645,	-.467,
3/ 4,	.159,	.203,	-.426,
4/ 5,	.528,	.658,	.100,
5/ 6,	.197,	.158,	-.102,
6/ 7,	-.049,	-.145,	.028,
7/ 8,	.312,	-.101,	.283,
8/ 9,	-.780,	-.877,	.679,
9/10,	-.399,	-.393,	-.292,
,	.003,	.003,	.002,
WTS ,	.001,	.001,	.001,

Years, Ages	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,		,,WTS
2/ 3,	-.081,	-.940,	.115,	.436,	.963,	.082,	.653,	-1.807,	.255,	.810,	-.007,	.280,
3/ 4,	.097,	-.833,	.639,	-.059,	.212,	.021,	-.173,	-.375,	.178,	.351,	.001,	.591,
4/ 5,	.244,	-.171,	.635,	.304,	.072,	.066,	-.117,	.192,	-.264,	.120,	.000,	.771,
5/ 6,	-.115,	.182,	.523,	-.281,	-.575,	.085,	.064,	.232,	-.146,	-.234,	.001,	.801,
6/ 7,	-.169,	.362,	.013,	-.445,	-.132,	.049,	.214,	.137,	.002,	-.401,	.001,	1.000,
7/ 8,	-.173,	.047,	-.644,	-.077,	.064,	-.012,	-.075,	.233,	.112,	-.257,	.001,	.883,
8/ 9,	.147,	.264,	-.596,	.391,	.196,	-.089,	-.363,	.326,	.031,	.095,	.000,	.473,
9/10,	.172,	.300,	-.664,	.322,	-.010,	-.209,	-.024,	-.144,	.038,	.340,	.000,	.718,
,	.003,	.002,	.003,	.001,	.000,	.000,	.000,	.000,	.000,	.000,	-.157,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

	1978,	1979,	1980,	1981,						
F-values	.9613,	.9983,	.9884,	.8186,						
	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
F-values	1.0279,	.8899,	.9797,	.7317,	.6853,	.9499,	1.1682,	.9094,	1.2325,	.9000,

Selection-at-age (S)

	2,	3,	4,	5,	6,	7,	8,	9,	10,
S-values	.0164,	.1654,	.5277,	1.0000,	1.0482,	.8219,	.6653,	.7422,	.9000,

Table 2.5.10 Plaice IIIa. Recruitment estimates, age 2.

Analysis by RCT3 ver3.1 of data from file :

age-2.rci

plaice in the skagerrak AND kattegat as 2-group and 3 group; AGE 2; 1992 WG

Data for 2 surveys over 7 years : 1983 - 1989

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------			I
DANA2	.24	10.08	.22	.621	5	1.59	10.47	.317	.303
DANA3	.44	9.43	.22	.627	5	3.66	11.05	.394	.196
					VPA Mean =		10.52	.246	.501

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------			I
DANA2	.65	9.47	.75	.204	6	1.48	10.44	.997	.103
DANA3									
					VPA Mean =		10.63	.338	.897

STOCK NUMBERS = 42357000
=======================

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	40560	10.61	.17	.15	.78	69328	11.15
1989	40516	10.61	.32	.06	.03	104202	11.55

Table 2.5.11 Plaice IIIa. Recruitment estimates, age 3.

Analysis by RCT3 ver3.1 of data from file :

age-3.rci

plaice in the skagerrak AND kattegat as 2-group and 3 group; AGE 3; 1992 WG

Data for 2 surveys over 7 years : 1983 - 1989

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
DANA2	.61	9.42	.70	.214	6	1.48	10.33	.930	.108
DANA3									
					VPA Mean =		10.50	.324	.892

STOCK NUMBERS = 36315000
=========================

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	35773	10.48	.31	.05	.03		

Table 2.5.12 Plaice IIIa. Recruitment estimates, age 4.

Analysis by RCT3 ver3.1 of data from file :

age-4.rci

plaice in the skagerrak AND kattegat as 2-group and 3 group; AGE 4; 1992 WG

Data for 2 surveys over 7 years : 1983 - 1989

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
DANA2	.22	9.74	.12	.857	5	1.59	10.09	.173	.560
DANA3	.49	8.92	.26	.564	5	3.66	10.71	.469	.102
					VPA Mean =		10.13	.257	.338

STOCK NUMBERS = 25084000

Yearclass = 1989

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
DANA2	.22	9.74	.12	.856	5	1.48	10.06	.175	.623
DANA3									
					VPA Mean =		10.13	.257	.377

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	26008	10.17	.15	.13	.76		
1989	24087	10.09	.16	.03	.05		

Table 2.5.13 Plaice in IIIa. VPA output, summary.

Run title : Plaice in Skagerak and Kattegat combined (run name: PLA-3FLEET)

At 13/10/1992 19:01

Table 17 Summary (with SOP correction)

	Traditional vpa		Terminal Fs estimated using		Laurec-Shepherd (with shrinkage)	
	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	SOPCOFAC,	FBAR 4- 8,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1978,	61822,	73515,	59321,	26530,	.9729,	.7488,
1979,	46514,	56917,	46593,	21152,	.9998,	.8179,
1980,	35359,	48868,	39677,	15477,	.9959,	.8718,
1981,	26847,	39297,	33140,	12273,	.9972,	.6241,
1982,	52050,	39787,	26387,	10847,	.9535,	.8110,
1983,	97277,	53522,	27353,	10716,	.9439,	.7071,
1984,	73373,	60919,	41294,	11572,	.9656,	.7002,
1985,	50544,	61149,	47507,	13482,	.9674,	.5204,
1986,	37982,	51240,	42275,	14035,	.9366,	.5606,
1987,	34430,	47864,	36864,	15774,	.9397,	.7955,
1988,	25990,	34107,	27814,	12850,	.9724,	1.0998,
1989,	41832,	31913,	20931,	7674,	.9581,	.7248,
1990,	69327,	44488,	24870,	12078,	.9724,	.9814,
1991,	104201,	55460,	27972,	8746,	1.0030,	.8757,

Recruits from VPA

1989,	37683,	30776,	20931,	7674,
1990,	41133,	35250,	23837,	12078,
1991,	42357,	32955,	21713,	8746,

Recruits from RCT3 VPA mean, TOTALBIO and TOTSBIO are adjusted using mean F 87-91 and M=0.1

Table 2.5.14 Plaice IIIa, Input for equilibrium prediction.

Plaice in Skagerak and Kattegat combined

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	1.000	0.1000	0.0000	0.0000	0.0000	0.283	0.0241	0.283
3	.	0.1000	1.0000	0.0000	0.0000	0.275	0.1784	0.275
4	.	0.1000	1.0000	0.0000	0.0000	0.278	0.5474	0.278
5	.	0.1000	1.0000	0.0000	0.0000	0.305	1.0454	0.305
6	.	0.1000	1.0000	0.0000	0.0000	0.372	1.1268	0.372
7	.	0.1000	1.0000	0.0000	0.0000	0.494	0.9211	0.494
8	.	0.1000	1.0000	0.0000	0.0000	0.642	0.7381	0.642
9	.	0.1000	1.0000	0.0000	0.0000	0.777	0.7831	0.777
10	.	0.1000	1.0000	0.0000	0.0000	0.901	0.8141	0.901
11+	.	0.1000	1.0000	0.0000	0.0000	1.097	0.8141	1.097
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YIELD
Date and time: 14OCT92:09:02

Table 2.5.15

13:55 Tuesday, October 20, 1992 1

Plaice in Skagerak and Kattegat combined

Plaice in Skagerak and Kattegat combined

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0	10.508	7362	9.508	7079	9.508	7079
0.0500	0.0438	0.248	169	8.030	4863	7.030	4579	7.030	4579
0.1000	0.0876	0.384	235	6.677	3566	5.677	3282	5.677	3282
0.1500	0.1314	0.469	261	5.828	2797	4.828	2513	4.828	2513
0.2000	0.1752	0.527	269	5.249	2302	4.249	2018	4.249	2018
0.2500	0.2189	0.569	270	4.829	1965	3.829	1681	3.829	1681
0.3000	0.2627	0.601	267	4.511	1725	3.511	1441	3.511	1441
0.3500	0.3065	0.626	263	4.263	1548	3.263	1265	3.263	1265
0.4000	0.3503	0.647	258	4.064	1415	3.064	1132	3.064	1132
0.4500	0.3941	0.663	253	3.901	1312	2.901	1029	2.901	1029
0.5000	0.4379	0.677	249	3.765	1230	2.765	947	2.765	947
0.5500	0.4817	0.689	246	3.649	1165	2.649	882	2.649	882
0.6000	0.5255	0.699	243	3.550	1111	2.550	828	2.550	828
0.6500	0.5692	0.708	240	3.463	1067	2.463	784	2.463	784
0.7000	0.6130	0.716	237	3.387	1030	2.387	746	2.387	746
0.7500	0.6568	0.723	235	3.319	998	2.319	715	2.319	715
0.8000	0.7006	0.729	234	3.258	971	2.258	687	2.258	687
0.8500	0.7444	0.735	232	3.203	947	2.203	664	2.203	664
0.9000	0.7882	0.740	231	3.154	926	2.154	643	2.154	643
0.9500	0.8320	0.745	230	3.108	908	2.108	624	2.108	624
1.0000	0.8758	0.749	229	3.066	891	2.066	608	2.066	608
1.0500	0.9195	0.753	229	3.028	876	2.028	593	2.028	593
1.1000	0.9633	0.757	228	2.992	863	1.992	579	1.992	579
1.1500	1.0071	0.760	228	2.958	851	1.958	567	1.958	567
1.2000	1.0509	0.764	227	2.927	839	1.927	556	1.927	556
1.2500	1.0947	0.767	227	2.897	829	1.897	546	1.897	546
1.3000	1.1385	0.769	227	2.870	819	1.870	536	1.870	536
1.3500	1.1823	0.772	227	2.844	810	1.844	527	1.844	527
1.4000	1.2261	0.775	227	2.819	802	1.819	519	1.819	519
1.4500	1.2699	0.777	226	2.795	794	1.795	511	1.795	511
1.5000	1.3136	0.780	226	2.773	787	1.773	503	1.773	503
1.5500	1.3574	0.782	226	2.752	780	1.752	496	1.752	496
1.6000	1.4012	0.784	226	2.731	773	1.731	490	1.731	490
1.6500	1.4450	0.786	226	2.712	767	1.712	484	1.712	484
1.7000	1.4888	0.788	226	2.693	761	1.693	478	1.693	478
1.7500	1.5326	0.790	227	2.675	755	1.675	472	1.675	472
1.8000	1.5764	0.792	227	2.657	750	1.657	467	1.657	467
1.8500	1.6202	0.794	227	2.641	745	1.641	461	1.641	461
1.9000	1.6639	0.795	227	2.625	740	1.625	456	1.625	456
1.9500	1.7077	0.797	227	2.609	735	1.609	452	1.609	452
2.0000	1.7515	0.798	227	2.594	730	1.594	447	1.594	447
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

(cont.)

Plaice in Skagerak and Kattegat combined

Yield per recruit: Summary table

(cont.)

Notes: Run name : YIELD
Date and time : 20OCT92:14:03
Computation of ref. F: Simple mean, age 4 - 8
F-0.1 factor : 0.1208
F-max factor : 0.2291
F-0.1 reference F : 0.1058
F-max reference F : 0.2006
Recruitment : Single recruit

Table 2.5.16 Plaice IIIa. Input for catch prediction.

Prediction with management option table: Input data

Year: 1992								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	41357.000	0.1000	0.0000	0.0000	0.0000	0.283	0.0241	0.283
3	36315.000	0.1000	1.0000	0.0000	0.0000	0.275	0.1784	0.275
4	25084.000	0.1000	1.0000	0.0000	0.0000	0.278	0.5474	0.278
5	13368.000	0.1000	1.0000	0.0000	0.0000	0.305	1.0454	0.305
6	2273.000	0.1000	1.0000	0.0000	0.0000	0.372	1.1268	0.372
7	1322.000	0.1000	1.0000	0.0000	0.0000	0.494	0.9211	0.494
8	554.000	0.1000	1.0000	0.0000	0.0000	0.642	0.7381	0.642
9	257.000	0.1000	1.0000	0.0000	0.0000	0.777	0.7831	0.777
10	123.000	0.1000	1.0000	0.0000	0.0000	0.901	0.8141	0.901
11+	165.000	0.1000	1.0000	0.0000	0.0000	1.097	0.8141	1.097
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1993								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	41357.000	0.1000	0.0000	0.0000	0.0000	0.283	0.0241	0.283
3	.	0.1000	1.0000	0.0000	0.0000	0.275	0.1784	0.275
4	.	0.1000	1.0000	0.0000	0.0000	0.278	0.5474	0.278
5	.	0.1000	1.0000	0.0000	0.0000	0.305	1.0454	0.305
6	.	0.1000	1.0000	0.0000	0.0000	0.372	1.1268	0.372
7	.	0.1000	1.0000	0.0000	0.0000	0.494	0.9211	0.494
8	.	0.1000	1.0000	0.0000	0.0000	0.642	0.7381	0.642
9	.	0.1000	1.0000	0.0000	0.0000	0.777	0.7831	0.777
10	.	0.1000	1.0000	0.0000	0.0000	0.901	0.8141	0.901
11+	.	0.1000	1.0000	0.0000	0.0000	1.097	0.8141	1.097
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1994								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	41357.000	0.1000	0.0000	0.0000	0.0000	0.283	0.0241	0.283
3	.	0.1000	1.0000	0.0000	0.0000	0.275	0.1784	0.275
4	.	0.1000	1.0000	0.0000	0.0000	0.278	0.5474	0.278
5	.	0.1000	1.0000	0.0000	0.0000	0.305	1.0454	0.305
6	.	0.1000	1.0000	0.0000	0.0000	0.372	1.1268	0.372
7	.	0.1000	1.0000	0.0000	0.0000	0.494	0.9211	0.494
8	.	0.1000	1.0000	0.0000	0.0000	0.642	0.7381	0.642
9	.	0.1000	1.0000	0.0000	0.0000	0.777	0.7831	0.777
10	.	0.1000	1.0000	0.0000	0.0000	0.901	0.8141	0.901
11+	.	0.1000	1.0000	0.0000	0.0000	1.097	0.8141	1.097
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : PRED2
Date and time: 13OCT92:22:35
Recruitments at age 2, age 3 and age 4 estimated as shrunk VPA GM as calculated from RCT3
Exploitation pattern as mean F for 1987-1991 scaled to 1991 level
Mean weights in the sea and in the stock as mean of 1987-1991

Table 2.5.17

Plaice in Skagerak and Kattegat combined

Plaice in Skagerak and Kattegat combined

Prediction with management option table

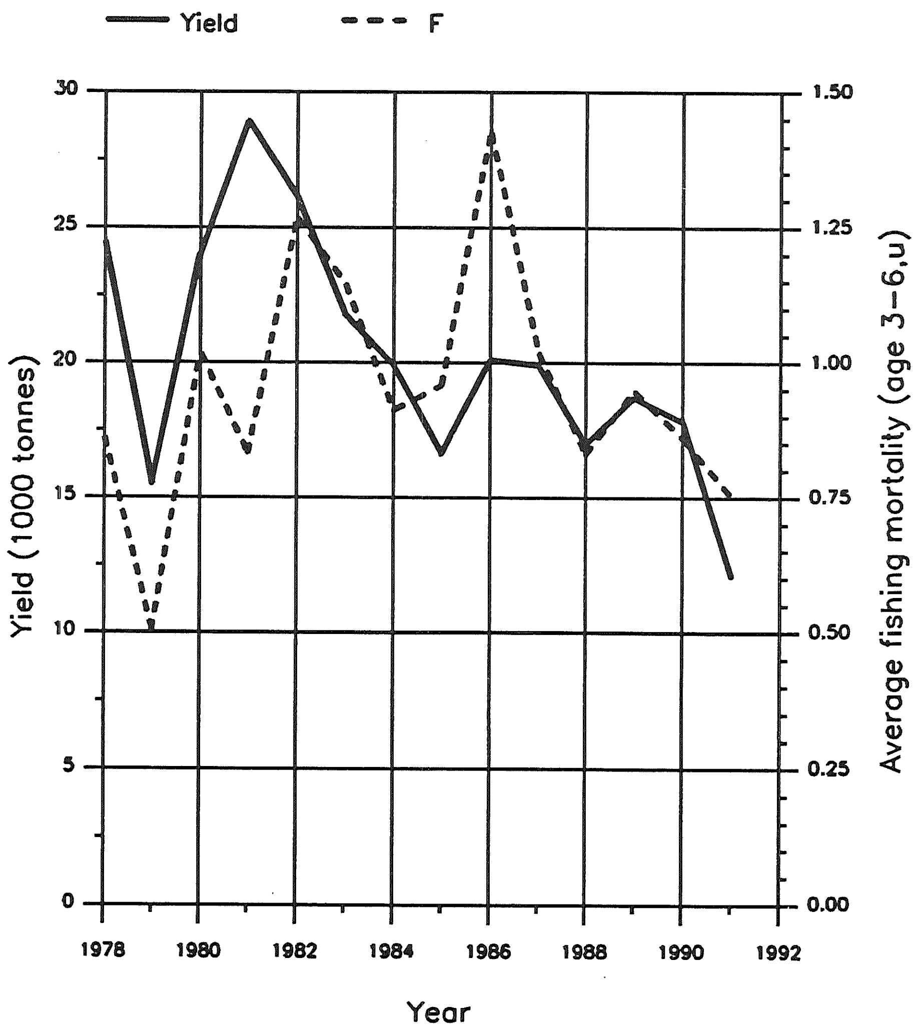
Year: 1992					Year: 1993					Year: 1994	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.8758	35092	23373	8528	0.0000	0.0000	36028	24309	0	46233	34514
.	.	.	.	.	0.2000	0.1752	.	24309	2318	43685	31966
.	.	.	.	.	0.4000	0.3503	.	24309	4331	41491	29772
.	.	.	.	.	0.6000	0.5255	.	24309	6087	39593	27874
.	.	.	.	.	0.8000	0.7006	.	24309	7627	37943	26224
.	.	.	.	.	1.0000	0.8758	.	24309	8984	36502	24783
.	.	.	.	.	1.2000	1.0509	.	24309	10187	35236	23517
.	.	.	.	.	1.4000	1.2261	.	24309	11257	34119	22400
.	.	.	.	.	1.6000	1.4012	.	24309	12215	33128	21410
.	.	.	.	.	1.8000	1.5764	.	24309	13076	32245	20526
.	.	.	.	.	2.0000	1.7515	.	24309	13854	31454	19735
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : PRED2
Date and time : 20OCT92:14:06
Computation of ref. F: Simple mean, age 4 - 8
Basis for 1992 : F factors

Figure 2.2.1

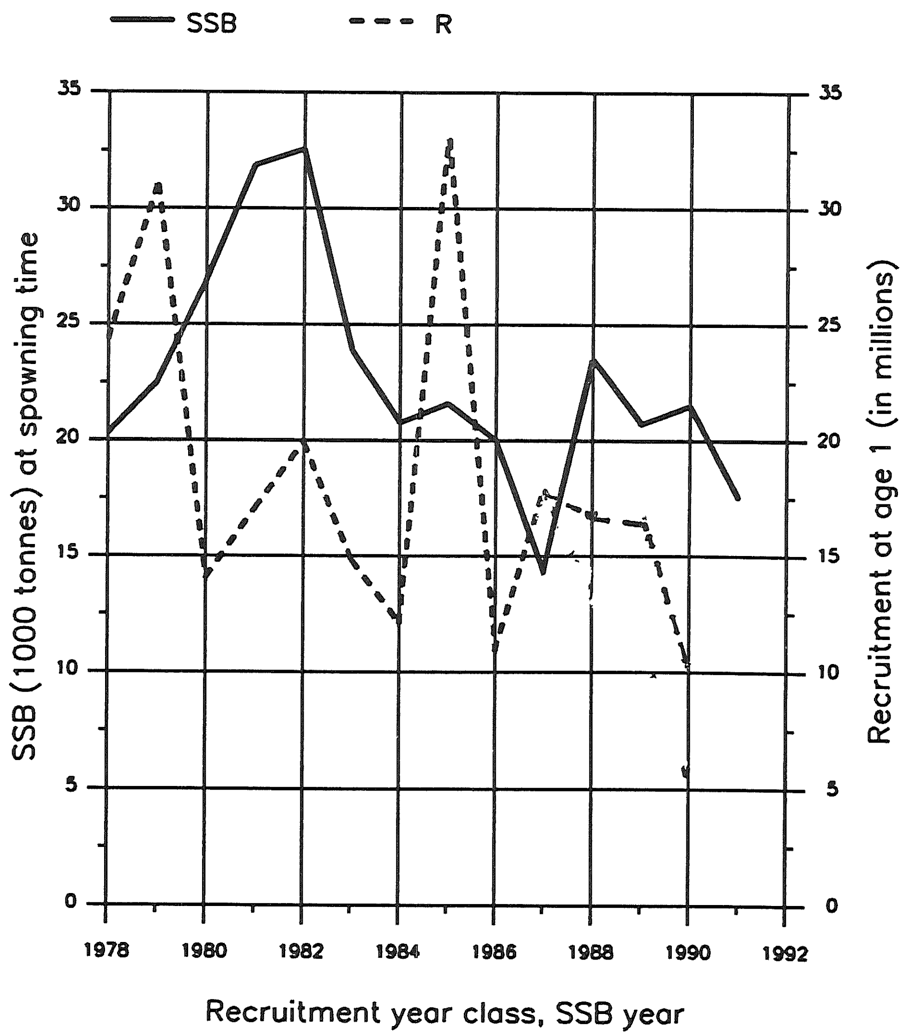
FISH STOCK SUMMARY
STOCK: Cod in the Skagerrak (part of Fishing Area IIIa)
13–10–1992

Trends in yield and fishing mortality (F)



A

Trends in spawning stock biomass (SSB) and recruitment (R)

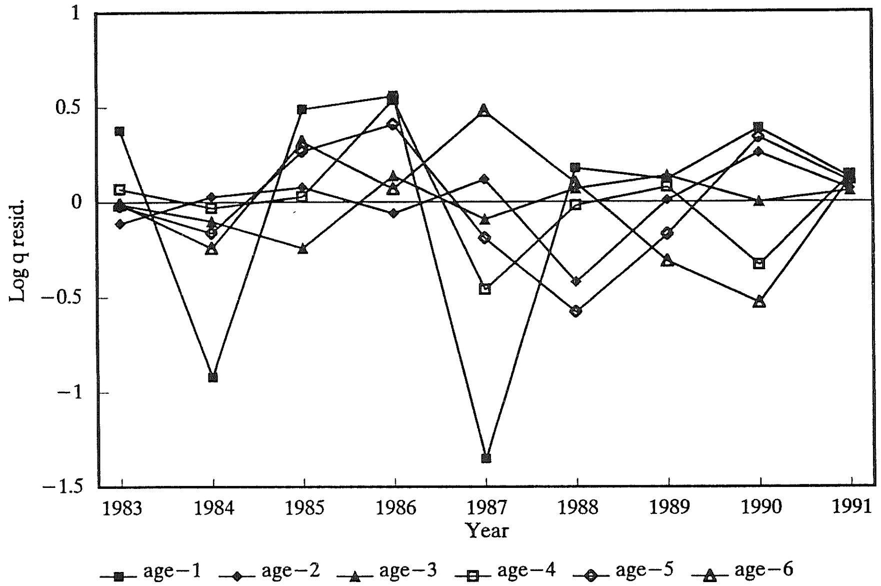


B

Figure 2.2.2

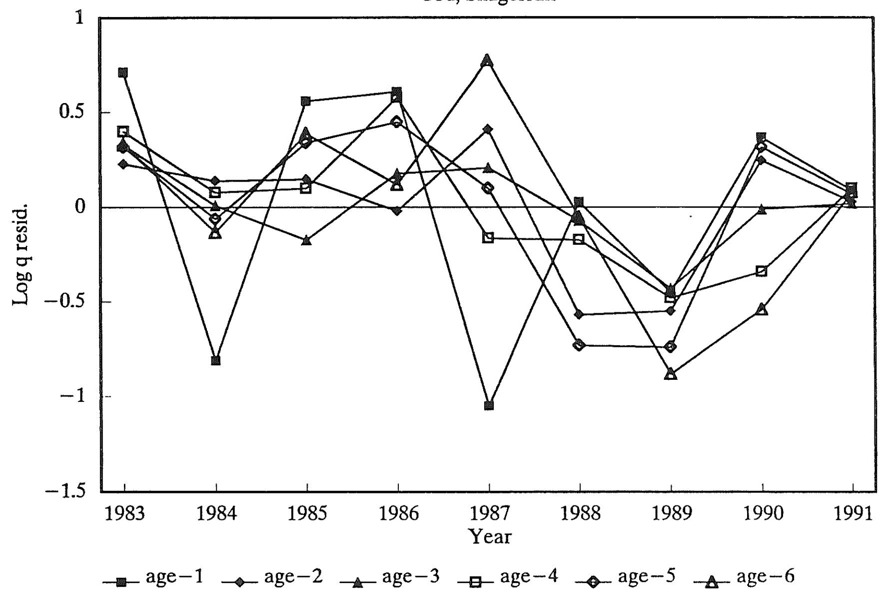
Log catchability residuals, Danish Seine, Den.

Cod, Skagerrak



Log catchability residuals, Swe. bottom trawl

Cod, Skagerrak



Log catchability residuals, Swe. Nephrops trawl

Cod, Skagerrak

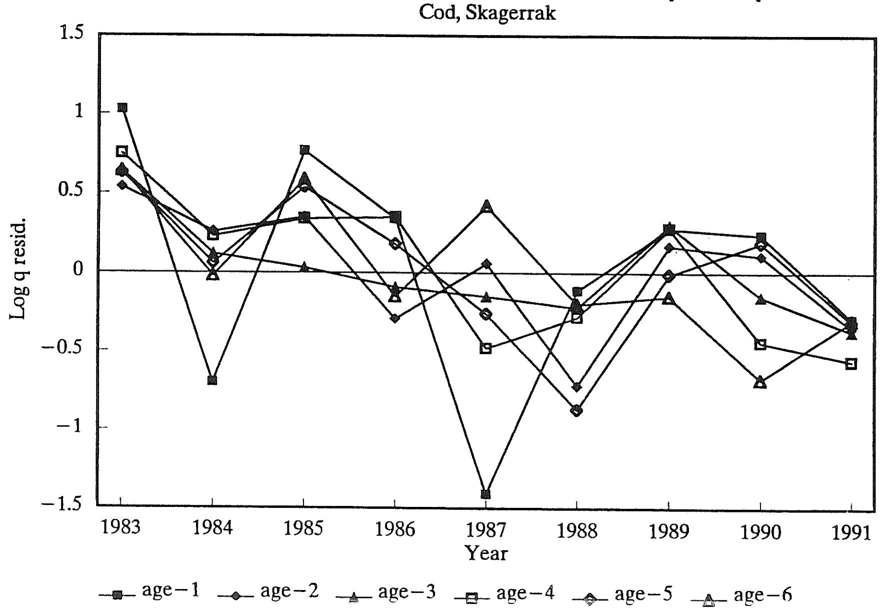
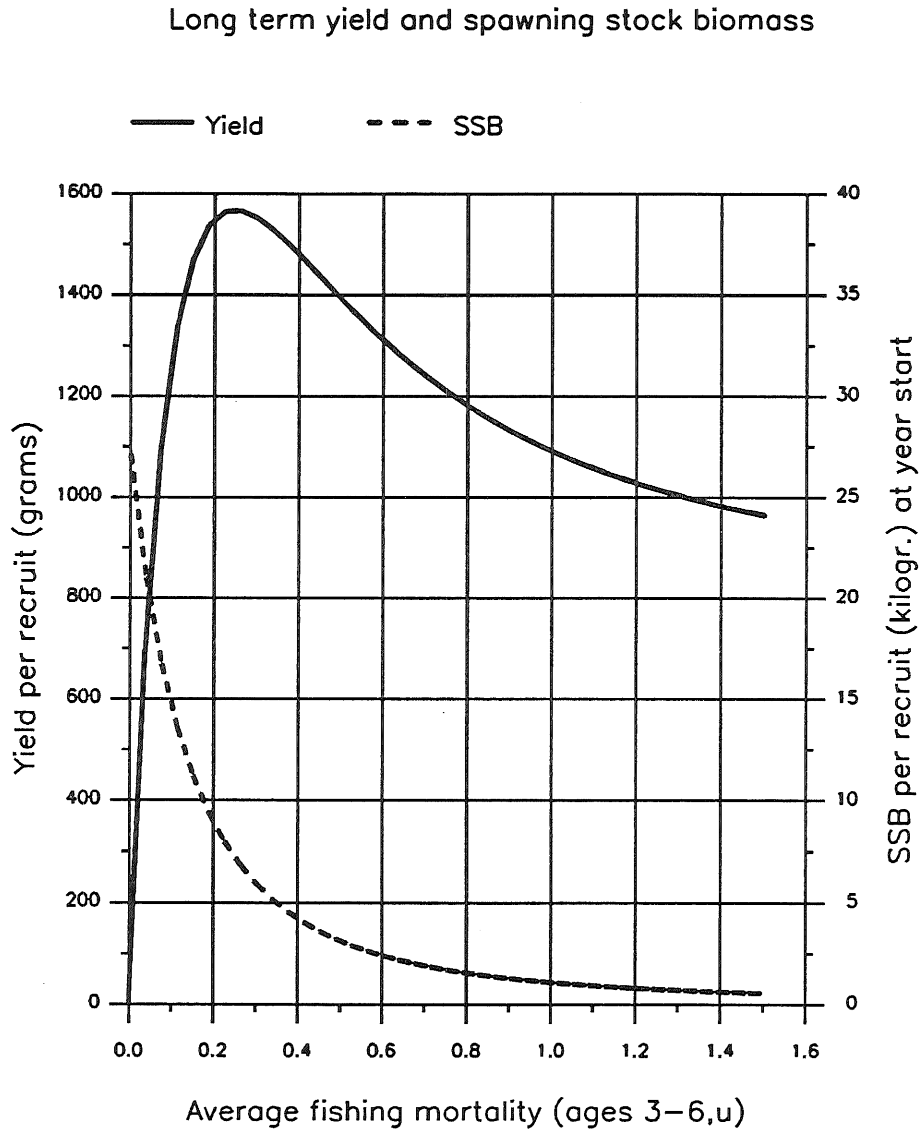
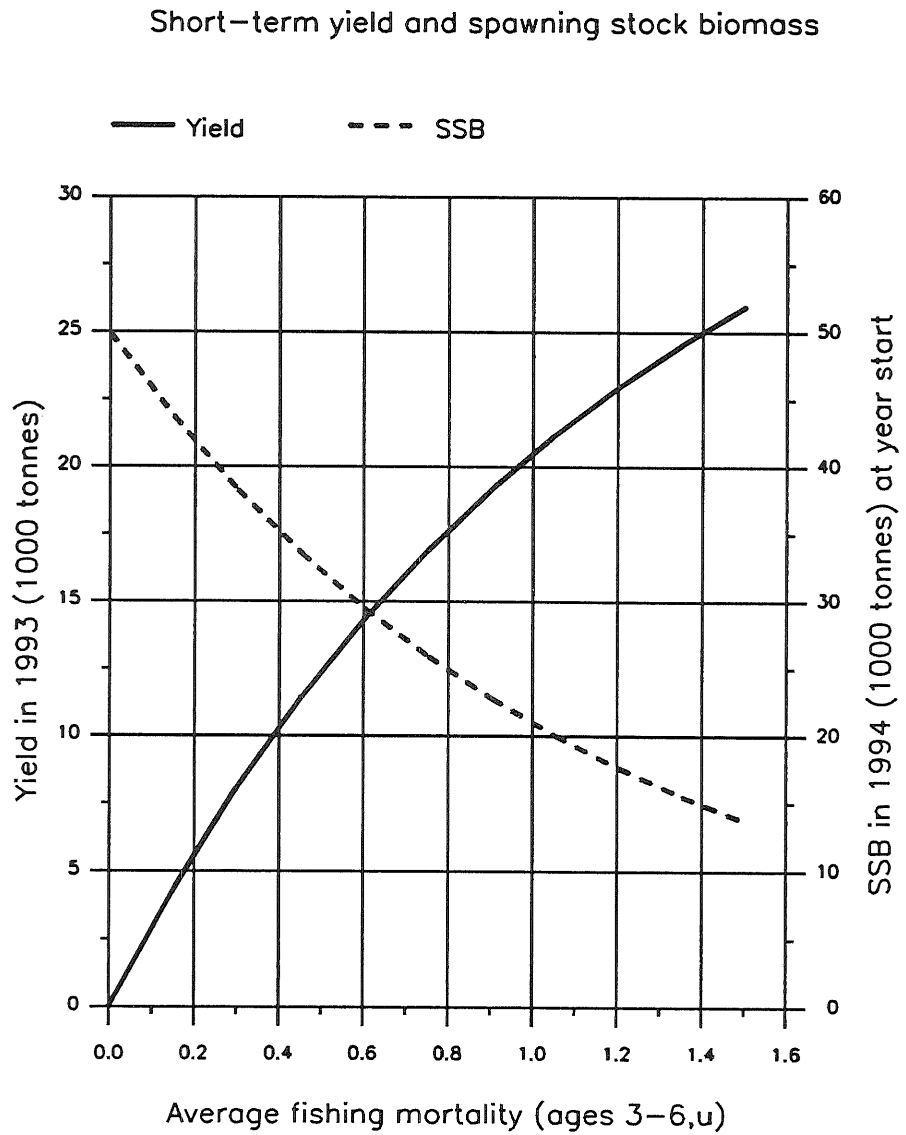


Figure 2.2.3

FISH STOCK SUMMARY
STOCK: Cod in the Skagerrak (part of Fishing Area IIIa)
13 – 10 – 1992



C



D

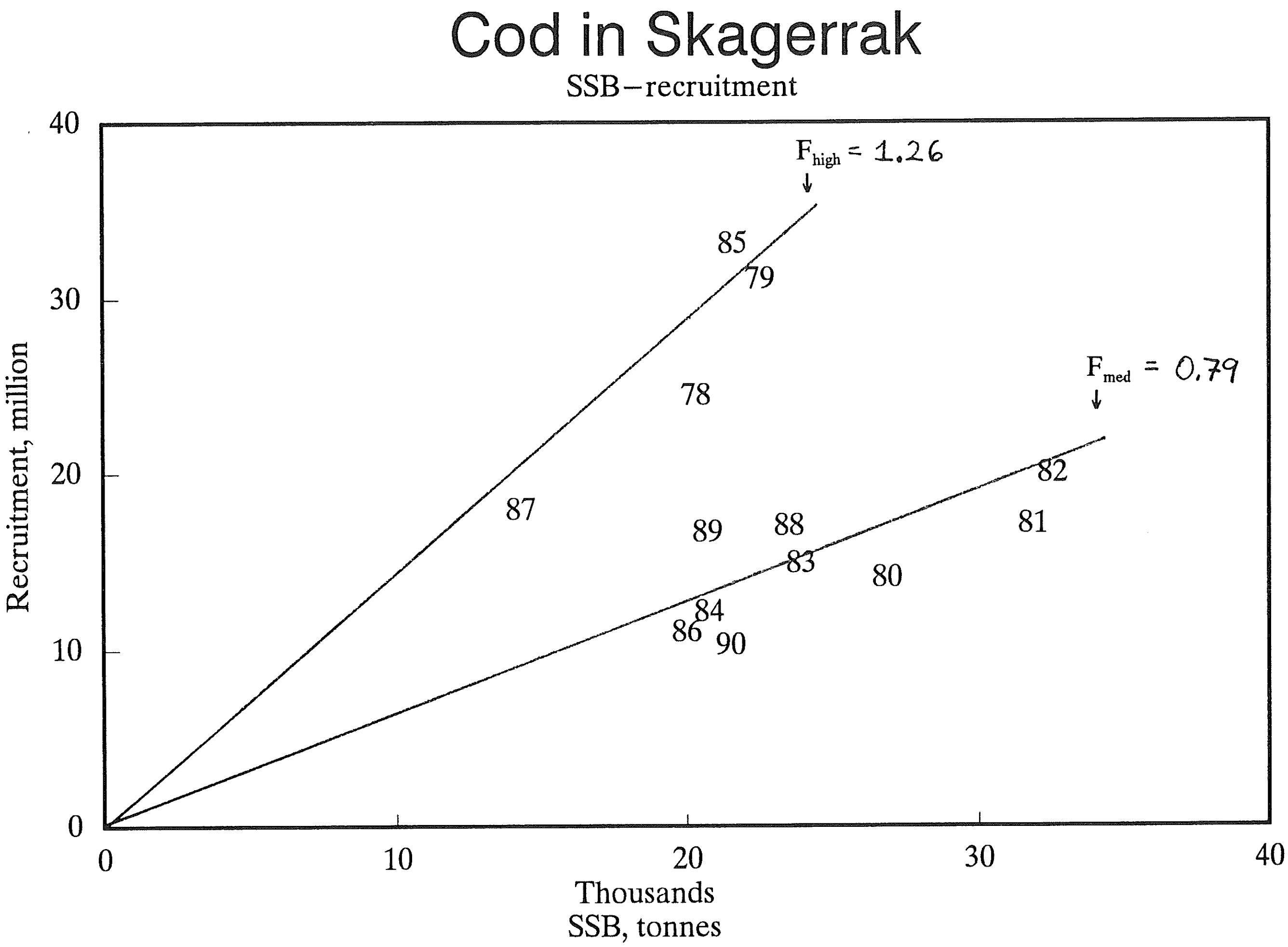

Cod in Skagerrak
SSB–recruitment
40
30
20
10
0
Recruitment, million
F_{high} = 1.26
F_{med} = 0.79
85
79
78
87
89
88
83
80
82
81
84
86
90
0
10
20
30
40
Thousands
SSB, tonnes

Figure 2.2.4

Figure 2.3.1 HADDOCK in Division IIIa. Relation between the recruitment as 1-groups in the North Sea as calculated from a VPA and the year-class effect in catches in Division IIIa. Only year classes with CV of the MCM year-class effect less than 0.1 are included.

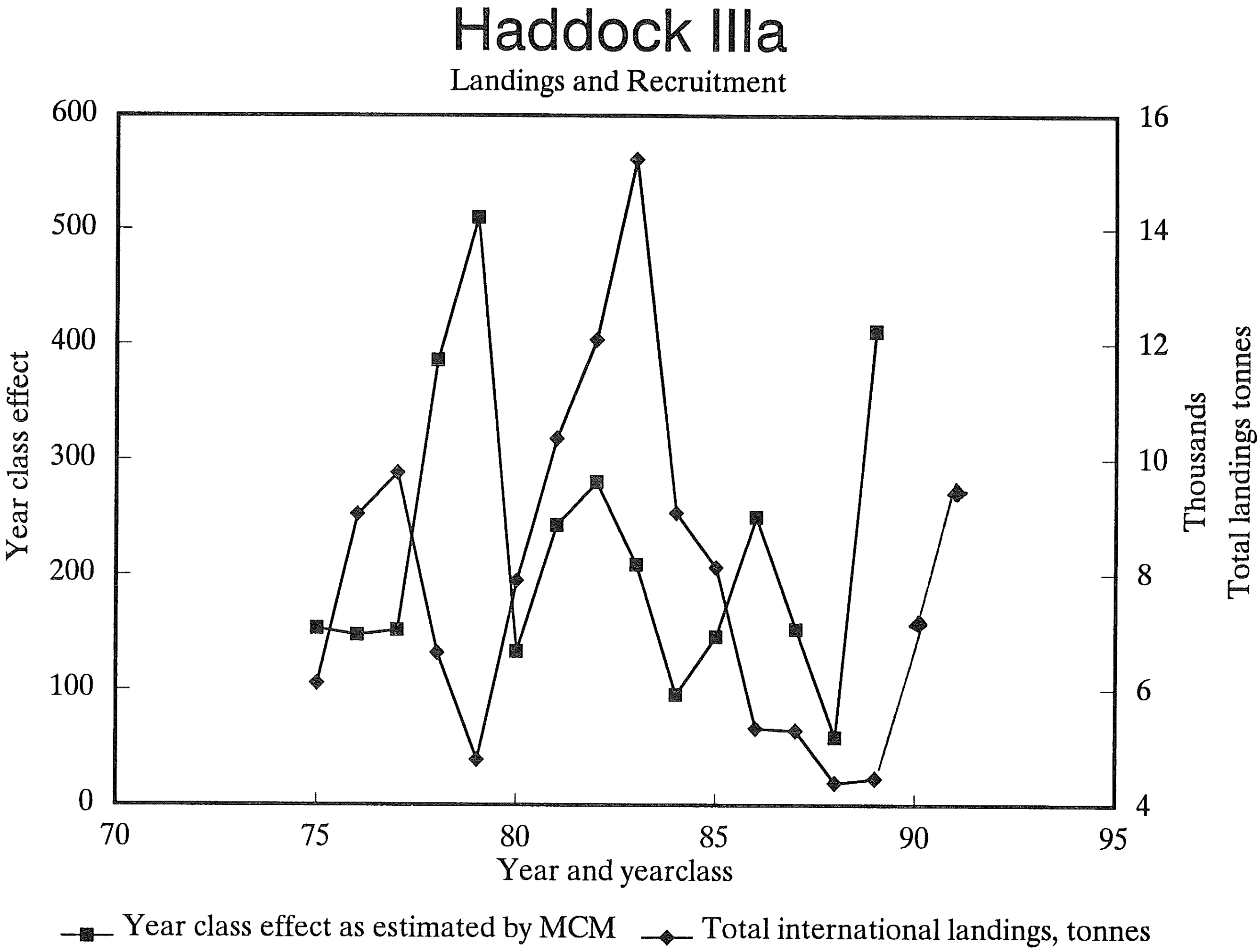


Figure 2.3.2 HADDOCK in Division IIIa, recruitment. Index of 1-group catches in the International Bottom Trawl Survey in February and the year-class effect from a multiplicative model applied to catches. Only year classes with CV of the MCM year-class effect less than 0.1 are included.

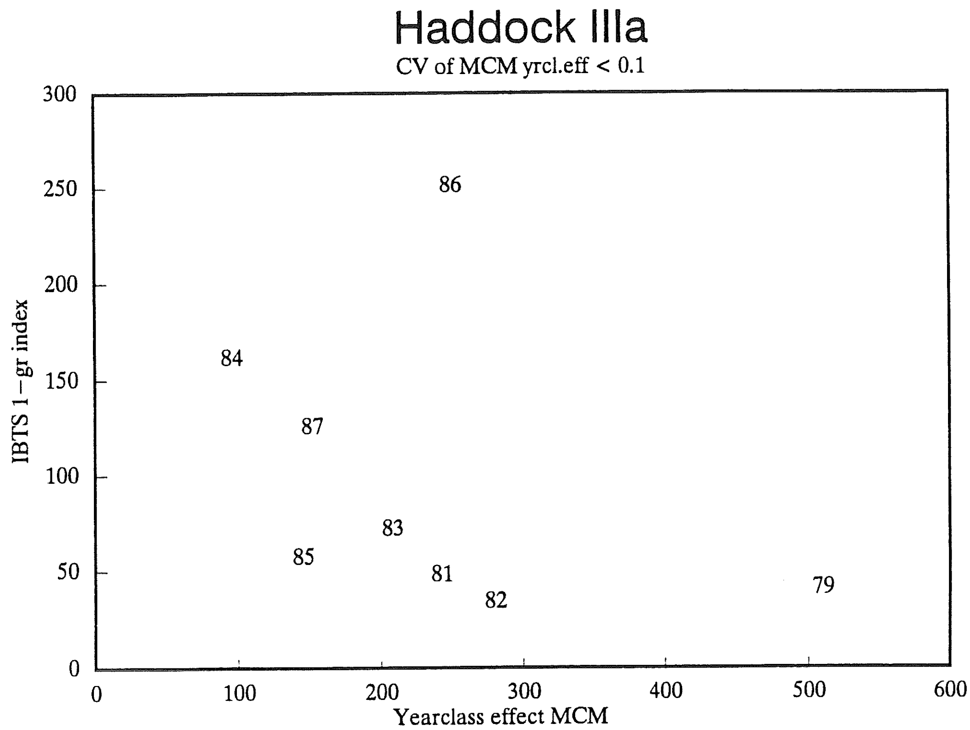


Figure 2.3.3

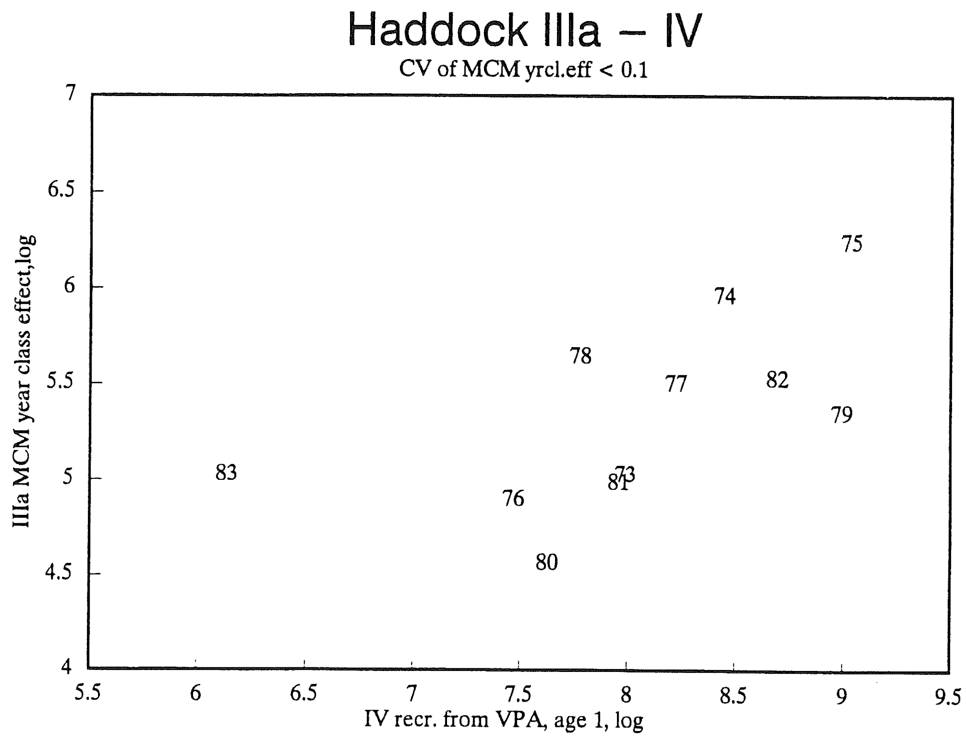
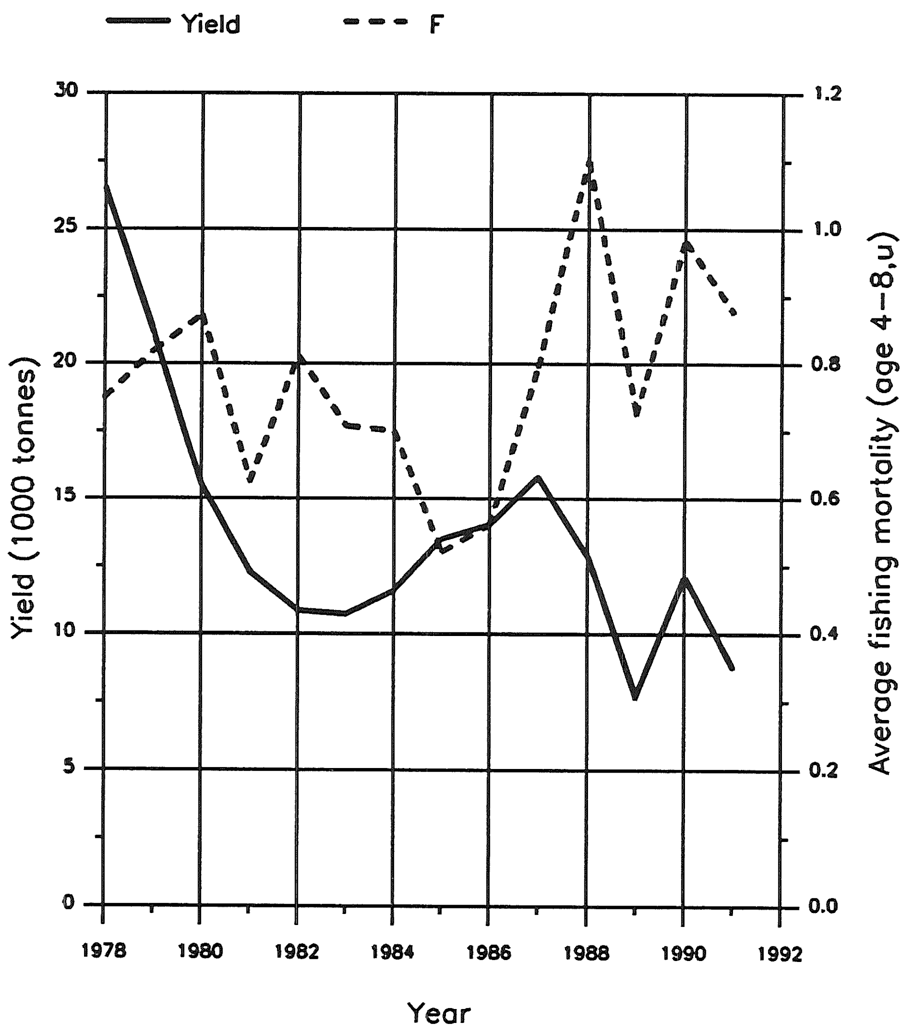


Figure 2.5.1

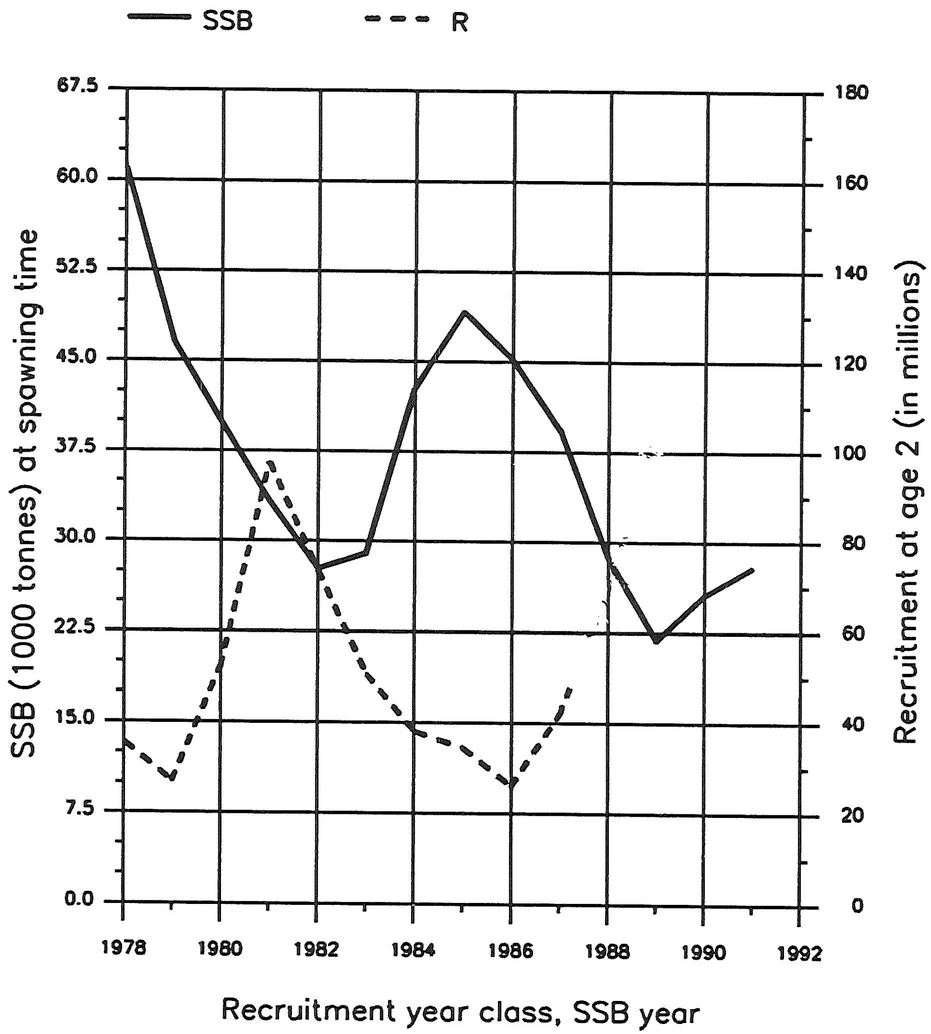
FISH STOCK SUMMARY
STOCK: Plaice in Skagerak and Kattegat combined
13-10-1992

Trends in yield and fishing mortality (F)



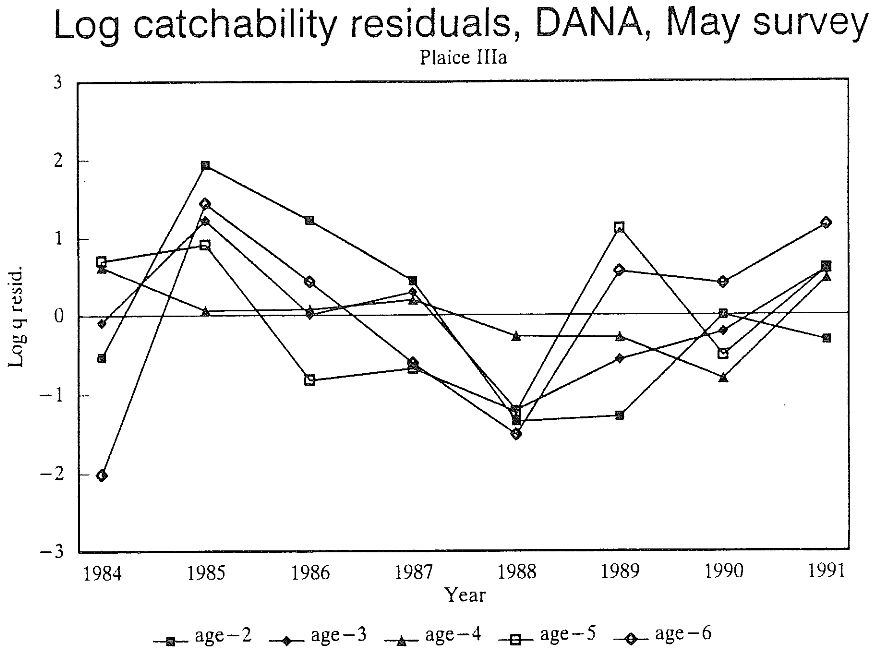
A

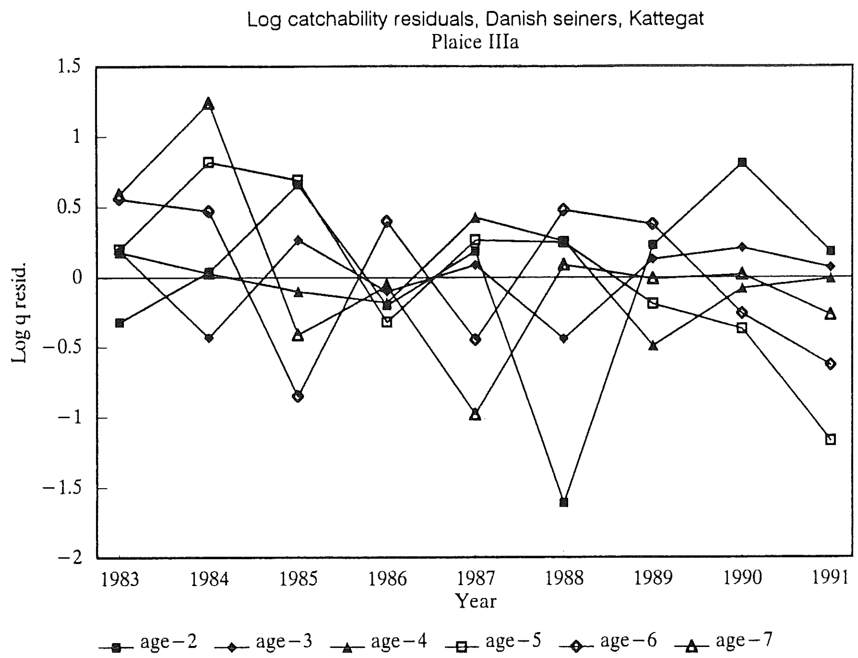
Trends in spawning stock biomass (SSB) and recruitment (R)



B

Figure 2.5.2


Log catchability residuals, DANA, May survey
Plaice IIIa
3
2
1
0
-1
-2
-3
Log q resid.
1984 1985 1986 1987 1988 1989 1990 1991
Year
age-2 age-3 age-4 age-5 age-6


Log catchability residuals, Danish seiners, Kattegat
Plaice IIIa
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Log q resid.
1983 1984 1985 1986 1987 1988 1989 1990 1991
Year
age-2 age-3 age-4 age-5 age-6 age-7

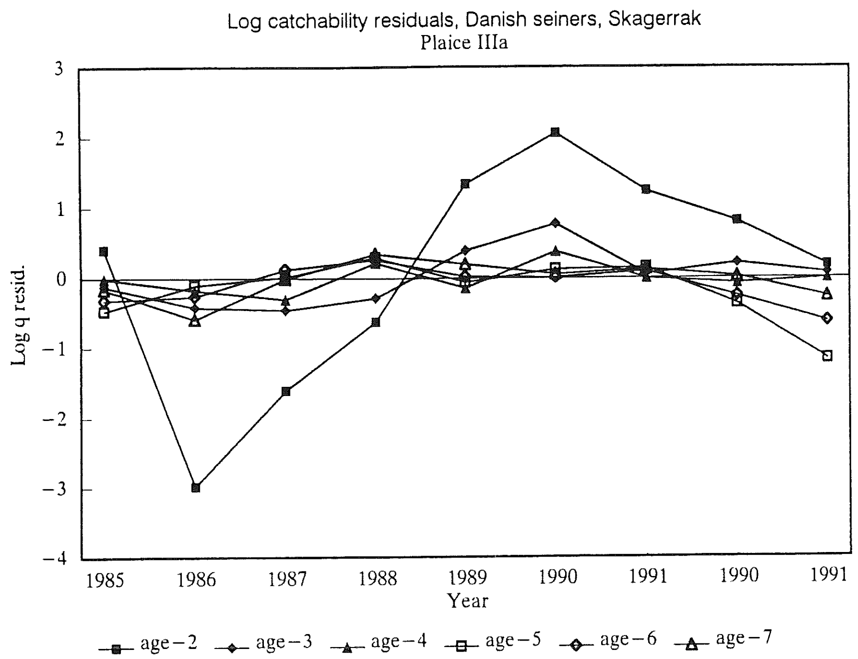
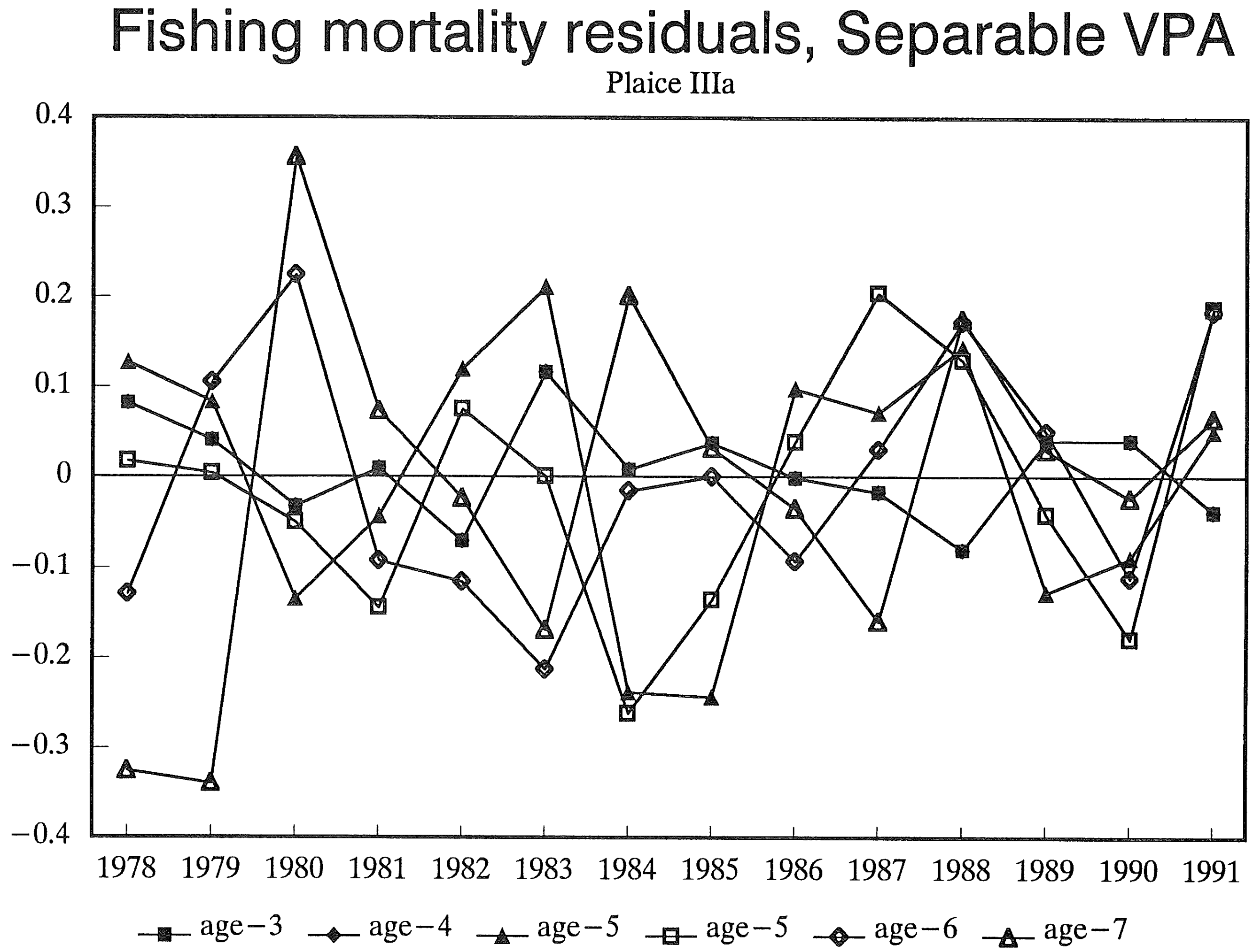

Log catchability residuals, Danish seiners, Skagerrak
Plaice IIIa
3
2
1
0
-1
-2
-3
-4
Log q resid.
1985 1986 1987 1988 1989 1990 1991 1990 1991
Year
age-2 age-3 age-4 age-5 age-6 age-7

Figure 2.5.3



Fishing mortality residuals, Separable VPA
Plaice IIIa
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
age−3
age−4
age−5
age−5
age−6
age−7

Figure 2.5.4 Year class shown

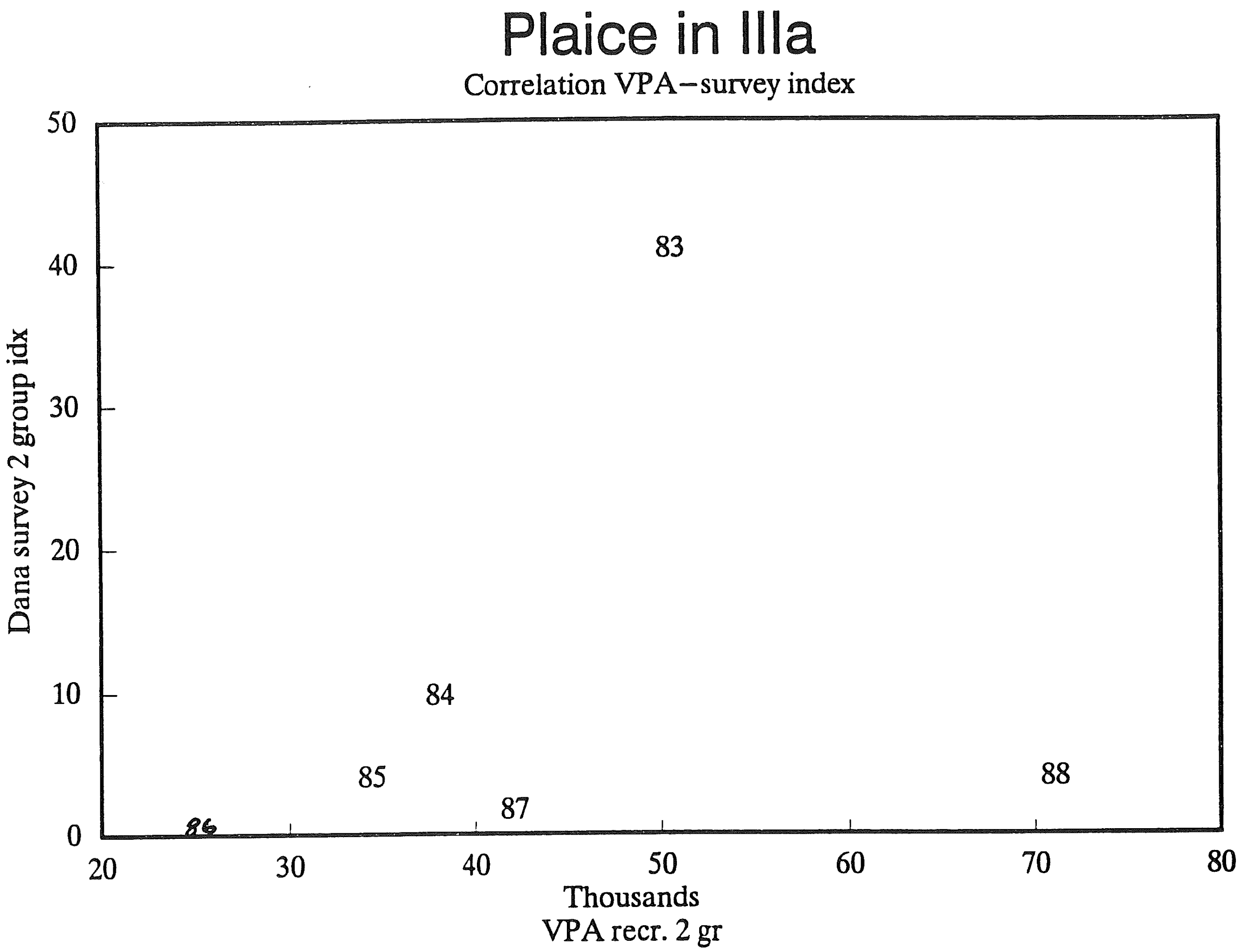
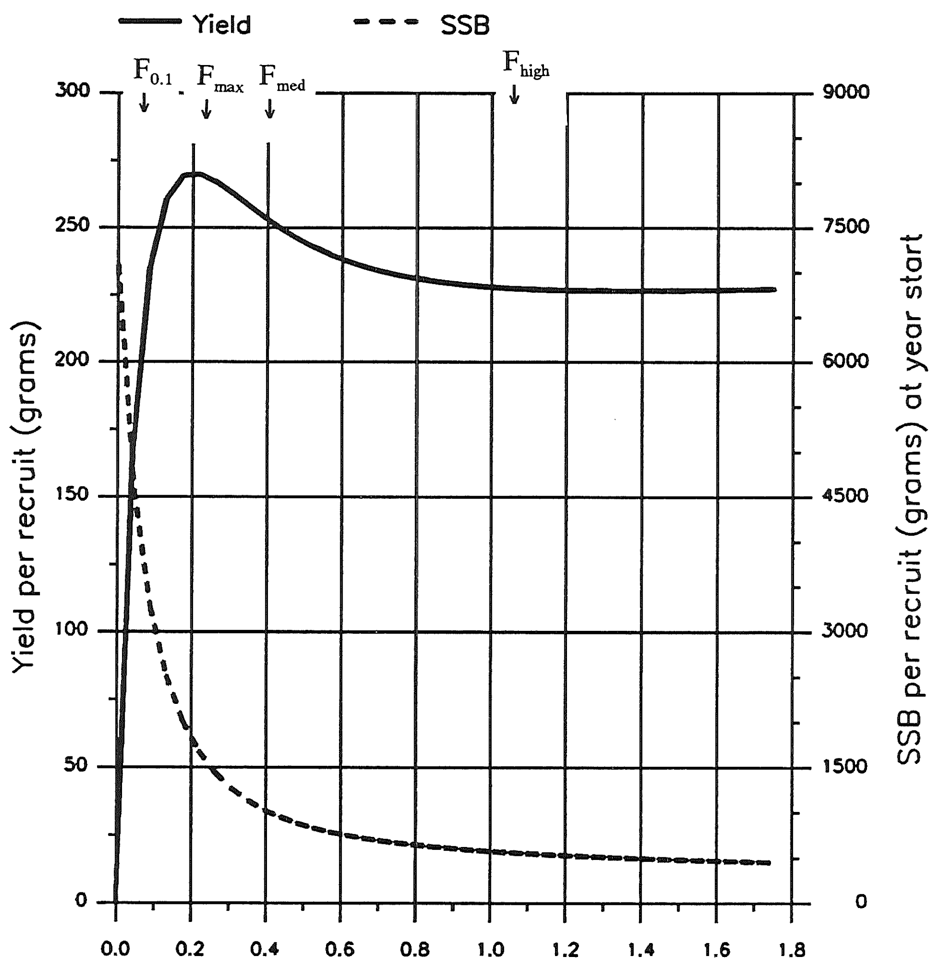


Figure 2.5.5

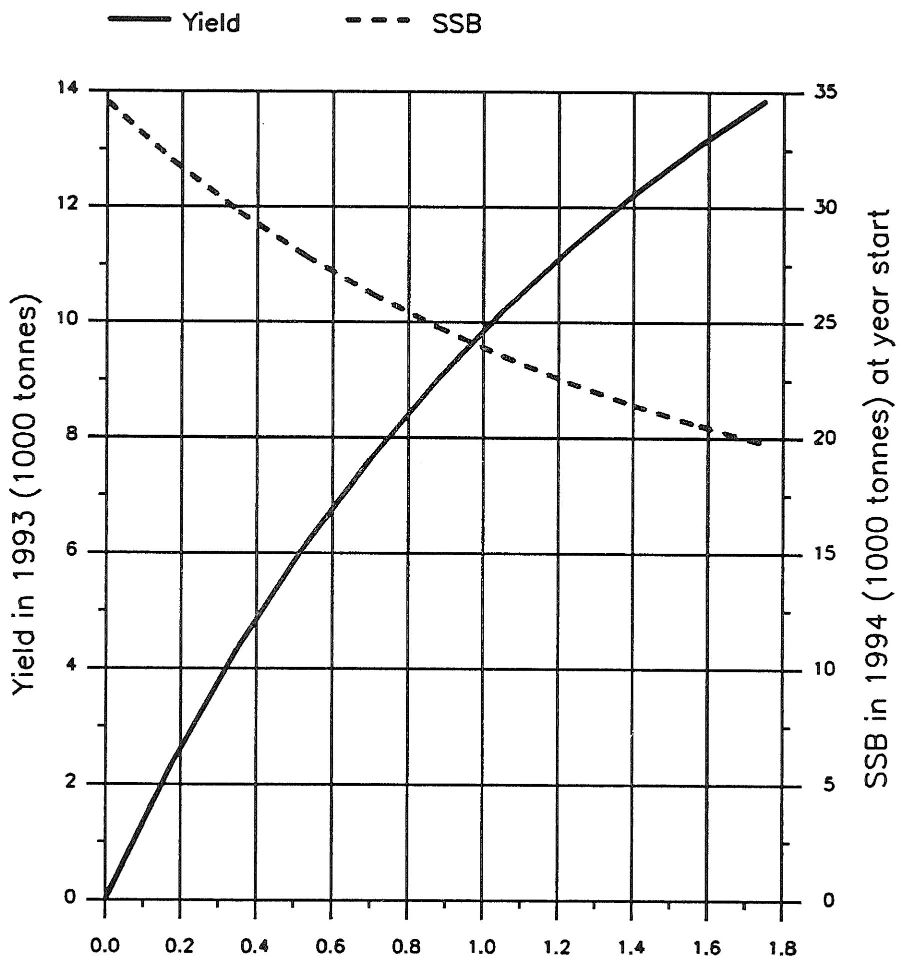
FISH STOCK SUMMARY
STOCK: Plaice in Skagerak and Kattegat combined
20–10–1992

Long term yield and spawning stock biomass



C

Short–term yield and spawning stock biomass



D

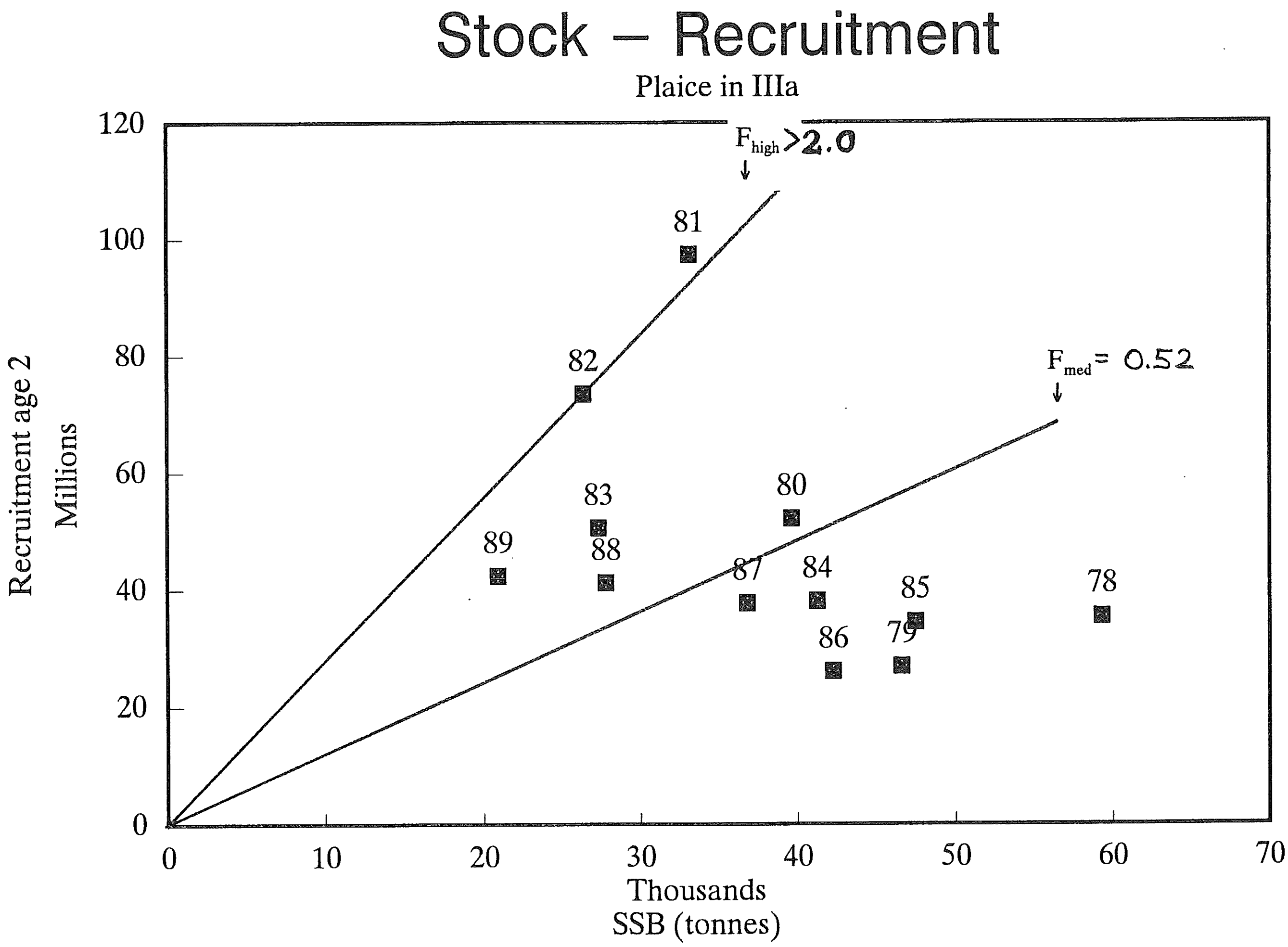

Stock – Recruitment
Plaice in IIIa
Recruitment age 2
Millions
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
Thousands
SSB (tonnes)
Fhigh >2.0
Fmed = 0.52
81
82
83
80
89
88
87
84
85
78
86
79

Figure 2.5.6

3 NORTH SEA (SUB-AREA IV)

3.1 Overview

Virtual population analyses were carried out for four stocks of roundfish (cod, haddock, whiting and saithe) and two stocks of flatfish (sole and plaice) in the North Sea. Fishing mortalities in roundfish species (0.8-1.2) were substantially higher than those in flatfish (around 0.5). All stocks are being overexploited in terms of growth overfishing. Spawning stock biomass has quickly fallen to a historically low level in cod and saithe due to the high fishing mortalities and low recruitment, and are not expected to recover without a substantial decrease in fishing mortality or good recruitment. Spawning stock biomass of haddock is at a historically low level but since future recruitment appears to be above average, the spawning stock is expected to increase. Although exploited at a high fishing mortality, the whiting stock is rather stable and recruitment is around average. Spawning stock biomass of sole and plaice are presently well above historic low levels due to high recruitment in recent years. Nevertheless, the level of fishing mortality remains high and will lead to reductions in SSB towards historic low level in the near future if recruitment reduced to an average level.

3.2 Cod in Sub-area IV

3.2.1 Catch trends

Official landings data are given in Table 3.2.1. Trends in landings from Working Group estimates are given in Table 3.2.2 and graphed in Figure 3.2.1. The Working Group estimate of landings in 1991 is 86,000 t, lower than the agreed TAC of 100,000 t. The landings were 18% lower than in 1990, and they have declined markedly since 1981, when they were at a level of 300,000 t.

3.2.2 Natural mortality, maturity, age compositions, and mean weight at age

Values for natural mortality and maturity are given in Table 3.2.3, and they are unchanged from those used last year. The VPA catch input data are given in Table 3.2.4. They do not include discards or industrial fishery by-catches. Data for 1990 were updated with minor revisions, and data for 1991 were provided by England, Scotland, Netherlands, Denmark, France, and Germany. Mean weight-at-age data, also used for stock weights, are given in Table 3.2.5.

3.2.3 Commercial catch and effort data and research vessel indices

These data were used to tune the VPA and to provide recruitment estimates using program RCT3 (see Section 1.4). The fleets used in the tuning are given in Table 1.4.1. The research vessel indices are given in Table 3.2.6. Fishing effort trends for the commercial fleets are graphed in Figures 1.4.2 and 1.4.3.

3.2.4 VPA tuning and results

3.2.4.1 Laurec-Shepherd and XSA methods

Trial runs were made using the Laurec-Shepherd and XSA methods with shrinkage and a tricubic time taper. These gave similar results, and it was, therefore, decided to use those from the L-S method, as was done last year. Tuning was performed for the period 1982-1991. F for the oldest age was set as the mean for ages 5-9, and the plus group was set at age 11. A summary of the tuning results for each fleet is given in Table 3.2.7. F at age and numbers at age resulting from the tuned VPA are given in Tables 3.2.8 and 3.2.9, respectively. Plots of catchability residuals by fleet are shown in Figure 3.2.2.

3.2.4.2 The ADAPT method

Several calibrations were attempted using the Adaptive framework (ADAPT). Because of a variable natural mortality rate for fish younger than 4 years, ages 1 and 2 were excluded from the analysis and a value of 0.2 was used for mature ages 3+ (0.25 at age 3 and 0.2 at ages 4+ were used in the L-S and XSA calibrations). In addition, all 11 survey indices used in the L-S and XSA tuning could not be used in a single formulation of the version of ADAPT which was available. Three survey indices (FRGGFS, NETGFS, and INTGFS) were excluded because they contained data for only ages 1 and 2 or 1 to 3. Various combinations of 6 of the remaining 8 indices were used in ADAPT, e.g., the 2 survey indices (SCOGFS, ENGGFS) were excluded from one run, the 2 seine indices (SCOSEI, ENGSEI) were excluded from another.

Results from ADAPT were very similar to those obtained with the other tuning methods. The following table compares the results from 5 ADAPT formulations (mean population size in 1991) with those from the L-S with shrinkage:

Age	3	4	5	6	7	8
L-S shrunk	27976	3587	2271	1415	297	282
ADAPT (mean)	27571	3763	2122	1552	275	345

Both analyses estimated the mean F at ages 2-8 in 1991 to be about 0.95. In addition, there was not a great deal of variability in the 5 ADAPT runs, e.g., the range of the age 3 population size in 1991 was 26,100 to 29,100.

ADAPT indicated that the CVs on the population estimate in 1991 were between 0.08 and 0.12 for ages 3-7 and about 0.15 - 0.25 at ages 8+. The results at these older ages tended to be more variable, but are not crucial to the assessment in any case, as they constitute such a small proportion of the population. ADAPT agreed with the other methods in showing a recent decline in the population numbers of ages 3+ from between 55 and 110 million fish in the early to mid-1980s to about 25 to 35 million in 1990 and 1991.

3.2.5 Recruitment estimates

Research vessel indices were used for estimating the numbers in the sea for ages 1 and 2 in 1991, and age 1 in 1992. The methods used for deriving estimates of recruitment are described in Section 1.4. The results of the RCT3 program, used as final values, are given in Tables 3.2.10 and 3.2.11.

The estimate of the 1989 year class in 1991 (age 2) is 54 millions, identical to that forecast last year. The estimate derived from tuning is 41 millions. The 1990 year class in 1991 (age 1) is estimated to be 155 millions, which is slightly reduced from last year's estimate of 193 millions. The value from tuning is 168 millions. The 1991 year class in 1992 (age 1) is estimated to be 345 millions, close to the preliminary value of 383 millions estimated last year. No preliminary estimate of the 1992 year class is yet available, since the 0-group catches from the English Groundfish Survey this year using the new gear are not yet reliably calibrated (see Section 1.4). Preliminary information on the strength of this year class should be available to ACFM from the Dutch Groundfish Survey in October-November.

The 1993 and later year classes were set at the long-term mean of 265 millions at age 1, the VPA mean used for shrinking from program RCT3.

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

Historical trends in mean fishing mortality, spawning stock biomass, and recruitment are shown in Table 3.2.12 and Figure 3.2.1. Mean fishing mortality has increased over the period 1963 to 1982, and subsequently appears to have stabilised at around 0.9. Spawning biomass has decreased from a peak of 263,000 t in 1970 to a historically low level of 55,000 t in 1991. Recruitment has fluctuated considerably over the period but the frequency of good year classes has become reduced in recent years.

3.2.7 Biological reference points

A stock-recruitment scatter plot is shown in Figure 3.2.3, which also shows F_{med} (0.79) and F_{high} (1.29). The level of F estimated for 1991 (0.93) is above F_{med}. Spawning stock biomass at the start of 1992 is now estimated at 51,000 t, which is 15,000 t less than predicted by last year's ACFM assessment. The minimum spawning stock level advised by ACFM is 150,000 t. A yield-per-recruit and spawning stock biomass per recruit plot is shown in Figure 3.2.4. The current F is well above $F_{0.1}$ and F_{max}.

3.2.8 Catch predictions

The input data for catch prediction are given in Table 3.2.13. The tuned values for F at age 1 and 2 in 1991 were replaced as usual by mean values, for the period 1987-1991.

The results of a *status quo* catch prediction are given in Table 3.2.14 and Figure 3.2.4. The predicted catch for 1992 is 100,000 t, the same value as the TAC. This compares with a value of 107,000 t predicted in last year's assessment. Spawning biomass is predicted to fall to 47,000 t by the end of the year. The same level of F in 1993 would result in a catch of 124,000 t, with spawning biomass at 52,000 t by the end of the year. Risk analysis (see Section 1.4.4) indicates that with the current level of F there is a 90% probability that the SSB will fall below the 1991 level (55,000 t) in 1994 (Figure 3.2.5).

A second prediction assuming F in 1992 is reduced to 70% of the 1989 level (as advised by ACFM) is shown in Table 3.2.15. The predicted catch is 81,000 t in 1992, with the spawning stock at 58,000 t by the end of the year. The same level of F in 1993 results in a catch of 115,000 t, with spawning stock at 73,000 t by the end of the year.

3.2.9 Long-term considerations

The state of this stock continues to give rise to considerable concern. It appears that the recent management measures such as restrictive TACs, increasing mesh size, the cod box in the German Bight, and fleet effort restrictions in some countries, may have resulted at best in a stabilization of fishing mortality at a high level. The spawning biomass is continuing to fall at an alarming rate. There has been no strong recruitment since the year class spawned in 1985, though the 1991 year class appears to be at or slightly above average. The possibility that the current level of spawning biomass is resulting in relatively weak year classes must be seriously considered. The stock/recruitment plot (Figure 3.2.3) suggests that this is the case.

The results of the risk analysis described in Appendix III are given in Figures 3.2.6 and 3.2.7 and Table 3.2.16. The table gives a summary of the different exploitation strategies simulated. Figure 3.2.6 shows the means and

CVs for yield and SSB resulting from each of these strategies. Figure 3.2.7 shows how often the fishery would have to be closed under each management strategy (assuming this to be a feasible management option). The higher yields and SSBs with low CVs are associated with strategies which imply F reductions of around 20% from current values, together with a minimum SSB around 100,000 t to avoid the risk of closure of the fishery. With the current level of F, there is a relatively high risk of closure in order to maintain a level of SSB in excess of 100,000 t.

It should be pointed out that these calculations assume log-normal recruitment which is independent of stock size. If the current level of SSB is resulting in reduced recruitment, then the risk analyses shown above will be too optimistic.

Given the very poor state of the spawning stock biomass due to poor recruitment since 1985 and the very high level of fishing mortality, the need for effective management is becoming more urgent. A closure of the fishery does not seem feasible, because these are mainly mixed fisheries on cod, haddock and whiting. A substantial reduction in fishing mortality achieved, for example, by reducing the number of days spent at sea as recommended by ACFM in 1991, is highly desirable in the short and long term to reduce the risk of stock collapse. Future enhancement of the spawning stock biomass may further be achieved by protecting the juvenile cod in the areas where they are most abundant. These areas occur, for example, in the southeastern North Sea, and off the northeast English coast, and can be defined more precisely from recent distribution data for 0- and 1-group cod.

An overall reduction in fishing effort will also be beneficial for the recovery of other species exploited by the same fleets.

3.2.10 Comments on assessment

The current assessment is more pessimistic than that performed last year. The relative low mean F estimated last year for 1990 is confirmed but F appears to have increased again in 1991. The stock numbers and biomasses estimated for the start of 1992 from the current assessment are lower than those predicted last year, for example, the total biomass being 12% less and the spawning biomass 23% less. This appears to be a consequence of scaling the mean F values used for 1991 in last year's assessment to the relatively low 1990 values, together with lower estimates of the 1990 and 1991 year classes from new survey information. Quality control data are shown in Tables 3.2.17 and 3.2.18.

3.3 Haddock in Sub-area IV

3.3.1 Catch trends

Official landings figures are given in Table 3.3.1. Total international catches (for human consumption and industrial purposes) and total international discards as estimated by the Working Group are given in Table 3.3.2. Long-term catch trends are plotted in Figure 3.3.1.

The Working Group estimated the total human consumption landings to be 44,000 t in 1991. This is likely to be an underestimate of the actual landings due to non-reporting and misreporting of catches. No estimates of the level of misreporting were available, but estimates of non-reporting in one country suggested a level of 8 - 10 %. This was considered to be within the noise level of the data, so no correction was made for non-reporting.

The uncertainty over the actual level of catches makes comparisons with previous years difficult. However, the Working Group estimate suggests that catches during 1991 reached a new historically low level, and thus continued the declining trend of recent years. However, estimates of discards and industrial by-catch are higher than in the two preceding years, suggesting an increase in the numbers of young fish present.

The agreed TAC for 1991 was 50,000 t.

3.3.2 Natural mortality, maturity, age composition and mean weights at age

The values used for natural mortality and proportion mature at age are unchanged from previous years and are given in Table 3.3.3.

Total international catch-at-age data are given in Table 3.3.4. Age compositions for human consumption landings were supplied by Denmark, England, France and Scotland. Age compositions for discards were supplied by Scotland. For industrial by-catches, Denmark provided age compositions and Norway provided length frequency data which were attributed to age using Scottish age/length keys. Minor revisions were made to the 1990 data.

Total international mean weights at age in the catch, which are also used as mean weights in the stock, are given in Table 3.3.5.

3.3.3 Commercial catch-effort data and research vessel surveys

The fleets used in tuning the VPA, and the range of years used for each fleet are given in Table 1.4. Effort trends in the commercial fleets are shown in Figures

1.4.2 and 1.4.3. The survey indices used in estimating recent recruitment are given in Table 3.3.6.

3.3.4 VPA tuning and VPA results

An initial tuning run was made using the same method as used last year, i.e.,shrunk Laurec-Shepherd with a tricubic taper over ten years. Diagnostics from this run are shown in Table 3.3.7, and the log catchability residuals for each tuning fleet are plotted in Figure 3.3.2.

The values for F at age in 1991 estimated by this tuning are noticeably higher than in previous years, and it has also resulted in a corresponding upward revision of the 1990 F values. The reasons for this upward revision are not clear, particularly as the total international catches in 1991 were rather similar to the values predicted in 1990. The tuning diagnostics show high raised Fs for some groundfish survey series, suggesting that these, rather than the commercial data, could be pushing the estimates upward. However, values were still unexpectedly high when the VPA was tuned using only commercial CPUE data. To investigate whether non-reporting of landings could be causing this result, the total international landings were increased in line with the estimated level of non-reporting (Section 3.3.1). This resulted in higher values of F at age in 1991. A tuning run using Laurec-Shepherd tuning without shrinkage produced estimates of terminal F which were even higher, and a run using shrunk XSA produced similar values to the shrunk Laurec-Shepherd. The plots of log catchability residuals suggest trends in catchability in the German and International Groundfish surveys, but the use of a steep taper, together with shrinking to the mean, should minimize any effects of such trends.

All tuning methods, and sub-sets of the tuning data used, gave essentially similar results, with high Fs in 1991. Thus the Working Group decided to adopt the results from the initial tuning run, using shrunk Laurec-Shepherd with all tuning fleets. Estimates of fishing mortality at age from this tuned VPA are given in Table 3.3.8, and stock numbers at age are given in Table 3.3.9.

3.3.5 Recruitment estimates

Estimates of numbers at ages 0, 1 and 2 in 1991 were made using the RCT3 program. Full outputs are given in Tables 3.3.10a-c. In running the program, the results from the English Groundfish Survey were given a relative weight of 0.1 (Section 1.4). For 1991, RCT3 estimates 66763 million fish at age 0, 4297 million at age 1 and 175 million at age 2. The corresponding tuned VPA estimates are 46358 million, 2877 million and 128 million. The RCT3 estimates suggest that both the 1990 and the 1991 year classes are larger than average.

RCT3 estimates the number of fish of age 0 in 1992 at 56699 million, which suggests that the 1992 year class is also of above average strength. However, this estimate is subject to high uncertainty; as with the downweighting of the English Groundfish Survey, the estimate is based only on the 1992 value of the Scottish Groundfish Survey. This index is one of the highest observed in this series. Only the 1990 and 1991 year classes have higher indices, so there are as yet no converged VPA estimates for comparison with such high values and estimation is thus similar to extrapolation.

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

Long-term trends in mean F, recruitment and biomass totals are given in Table 3.3.11 and plotted in Figure 3.3.1. Human consumption fishing mortality shows a sharp increase over the last couple of years, after remaining fairly stable since about 1983. Discard fishing mortality appears to have declined again following the sharp increase in 1990. Industrial by-catch fishing mortality remains at a low level. Spawning stock biomass is currently at a historically low level of 55,000 t, but possible recovery is indicated by the recent increase in total biomass due to the strength of the 1990 and 1991 year classes.

3.3.7 Biological reference points

F_{med} is indicated on the yield and biomass-per-recruit curve in Figure 3.3.3. It has a value of 0.64, which compares with a *status quo* F of 1.18. F_{max} for total landings (excluding discards) is 0.24. F_{med} and F_{high} are also shown on the stock-recruitment plot in Figure 3.3.4. The value of F_{high} is largely determined by a few very large year classes, and it is thus not defined for the range of Fs on the yield-per-recruit curve.

3.3.8 Catch and biomass predictions

The input data for short-term prediction are given in Table 3.3.12. Numbers at ages 0, 1 and 2 at the start of 1991 were overwritten with RCT3 estimates. For prediction, values of F at age are the mean values over 1987 to 1991 scaled to give a mean value of F over ages 2 to 6 as in 1991. Numbers at age 0 in 1992 are estimated using the RCT3 estimate. In subsequent years, the RCT3 geometric mean VPA is used.

Two predictions are presented; Table 3.3.13 gives the results of a *status quo* prediction, and Table 3.3.14 gives the results of a prediction assuming a 30% reduction on the current estimate of human consumption plus discard fishing mortality in 1989. The latter is in accord with ACFM recommendations. However, it should be noted that with the high estimates of F in 1990 and 1991, a 30% reduction on the 1989 F is equivalent to a 46%

reduction on the 1991 figure. The Working Group suggests that such a reduction is not a realistic possibility, and that the *status quo* prediction is the more relevant.

The *status quo* prediction for 1992 suggests a total catch of 232,000 t, with human consumption landings of 91,000 t. These values are substantially higher than the previous prediction of 142,000 t total catch with 72,000 t human consumption landings. These revisions are due to the combination of the use of an estimate of the 1991 year class (rather than a mean value which was used previously) and the higher Fs at age resulting from the current assessment. The total catch during 1993 is predicted at 358,000 t with 182,000 t landed for human consumption. These 1993 figures are also influenced by the high estimate of the 1992 year class. If this estimate is replaced with the RCT3 geometric mean, the total catch in 1993 is estimated at 304,000 t, with 177,000 t of human consumption landings.

Assuming *status quo*, spawning stock biomass is predicted to increase from the current estimate of 55,000 t at the beginning of 1991 to 105,000 t at the beginning of 1992 and 201,000 t at the beginning of 1993. This recovery is due to the apparent strength of the 1990 and 1991 year classes. The 1992 year class will make some contribution to the spawning stock at the beginning of 1993. Taking a mean value rather than the RCT3 estimate for this year class reduces the estimate of the 1993 spawning stock by 8,000 t.

A sensitivity analysis of the catch prediction is shown in Figure 3.3.5. It shows that the prediction of landings is most sensitive to the estimates of the 1990 and, particularly, the 1991 year classes. These year classes are strong compared to other recent year classes, so they are likely to dominate catches over the forecast period. The prediction of SSB is sensitive to the estimates of the 1991 and 1992 year classes, as well as to F at age 2. The predicted recovery of the spawning stock is dependent upon the size of these year classes, but the extent to which they will increase the spawning stock is determined by the proportions surviving to maturity. This is largely determined by fishing mortality at age 2.

3.3.9 Long-term considerations

A long-term risk analysis of the form outlined in Appendix III was performed for this stock. It should be stressed that in its current implementation, the analysis does not explicitly account for the differences between human consumption landings and discards and industrial by-catch. Thus for this stock, the results should be regarded as a very rough guideline only. All references to yield refer to total international catches over all uses. Table 3.3.15 gives a summary of the different exploitation strategies simulated. Figure 3.3.6 shows the mean yield and coefficient of variation resulting from each of these strategies, and Figure 3.3.7 shows the corresponding plot for SSB. Figure 3.3.8 shows how often the fishery would have to be closed under each exploitation strategy.

An optimal exploitation strategy might be one where mean yield is high, with a low coefficient of variation; where mean SSB is also high and relatively stable, but where the fishery is closed in a relatively low proportion of years. Of the strategies presented here, cases 12 and 17 appear to represent the closest to this optimum. Case 12 has a minimum SSB of 90,000 t and a relative F of 0.9, and leads to the fishery being closed on average every 16 years. Strategy 17 also has a relative F of 0.9, but with a minimum SSB of 120,000 t. Yields are slightly higher and more variable under this strategy, but it leads to the fishery being closed on average every 7 years. In all cases, adopting a high minimum SSB results in a larger and less variable SSB, but leads to a high probability of the fishery being closed.

The results of this analysis are very preliminary, and should be taken only as an illustration. In particular, it is not clear what effect the different exploitation patterns of the human consumption, discard and industrial fisheries would have on the result.

3.3.10 Comments on the assessment

Quality control diagrams for this assessment are presented in Tables 3.3.16. As noted in Section 3.3.4, the mean F in 1990 has been revised upwards in the current assessment. Table 3.3.16 shows the extent of the revision, which is large compared to the corresponding revisions in previous years. The reasons for this are not clear but do not appear to result from, e.g., misreporting problems with the catch data. The other discrepancies in the quality control charts are a result of the apparent strength of the 1991 year class. In the current assessment, a RCT3 estimate has been used for this year class, whereas in the previous assessment a mean value was used. This has meant that current predictions of landings and SSB in 1992 and 1993 are higher than previous estimates. It should also be noted that the current assessment is predicting a very large change in *status quo* catch from human consumption landings of 44,000 t in 1991 to 182,000 t in 1993. This represents a change from the historic low level, to a value approaching the highest recorded.

3.4 Whiting in Sub-area IV

3.4.1 Catch trends

Total nominal landings are given in Table 3.4.1, total international catches as estimated by the Working Group in Table 3.4.2. Total international catches decreased yield and coefficient of variation resulting from each of these strategies, and Figure 3.3.7 shows the corresponding plot for SSB. Figure 3.3.8 shows how often the fishery would have to be closed under each exploitation strategy.

An optimal exploitation strategy might be one where mean yield is high, with a low coefficient of variation; where mean SSB is also high and relatively stable, but where the fishery is closed in a relatively low proportion of years. Of the strategies presented here, cases 12 and 17 appear to represent the closest to this optimum. Case 12 has a minimum SSB of 90,000 t and a relative F of 0.9, and leads to the fishery being closed on average every 16 years. Strategy 17 also has a relative F of 0.9, but with a minimum SSB of 120,000 t. Yields are slightly higher and more variable under this strategy, but it leads to the fishery being closed on average every 7 years. In all cases, adopting a high minimum SSB results in a larger and less variable SSB, but leads to a high probability of the fishery being closed.

The results of this analysis are very preliminary, and should be taken only as an illustration. In particular, it is not clear what effect the different exploitation patterns of the human consumption, discard and industrial fisheries would have on the result.

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3.4 Whiting in Sub-area IV

3.4.1 Catch trends

Total nominal landings are given in Table 3.4.1, total international catches as estimated by the Working Group in Table 3.4.2. Total international catches decreased from 147,000 t in 1990 to 117,000 t in 1991, of which 46,000 t were human consumption landings, 33,000 t discards and 38,000 t industrial by-catch. The low total catch is affected by a considerable reduction of industrial by-catch and discards, whereas the human consumption catch has increased a little compared to 1990. The total landings of 84,000 t in 1991 are only about 60% of last year's prediction and are also well below the total 1991 TAC of 135,000 t. Catch trends for the last 20 years are shown in Figure 3.4.1.

3.4.2 Natural mortality, maturity at age, age compositions and mean weight at age

The natural mortality and maturity at age values used are presented in Table 3.4.3. No changes have been made from last year's report. The age compositions and weight at age in the catch for 1991 were prepared and minor revisions were made on the 1990 data. Human consumption landings data were provided by Scotland, the Netherlands, England and France. Discard data were provided by Scotland. In 1991 the age composition of the industrial by-catch was directly sampled by Denmark, whereas in 1990 the industrial by-catch age compositions were calculated from research vessel surveys (see Section 1.3). Also length distributions of the industrial by-catch from Norway were available. The mean weight at age in the catch was also used as the stock mean weight at age. Total international catch at age and mean weight at age are presented in Tables 3.4.4 and 3.4.5.

3.4.3 Commercial catch/effort data and survey indices

These data were used to tune the VPA and to provide recruitment estimates. The fleets used in the VPA tuning and the number of years available for each fleet are listed in Table 1.4.1. Research vessel indices are given in Table 3.4.6.

3.4.4 VPA tuning and VPA results

The standard Laurec-Shepherd tuning procedure with shrinkage was used to estimate input F for the VPA. Tuning was performed over the last 10 years. A suggested default value of 0.2 was used for shrinkage. The summary statistics are given in Table 3.4.7. Age group 10 was used as plus group and the fishing mortalities for the oldest true age group and the plus group were taken as the mean of the F values of the preceding 5 ages (4-8). The resultant total international fishing mortality rates and stock numbers at age are presented in Tables 3.4.8 and 3.4.9, respectively. Figure 3.4.2 shows the trends in log catchability residuals over the years from 1982 to 1991 for each fleet and age group. The large residual for the scogfs in 1992 is due to an incorrect data value. This has almost no effect on the results since the taper weighted out the value. There are apparently strong in the fishery this year where the quota for one country is being taken up at a faster rate than expected on the basis of *status quo*. In view of the problems with the age compositions already referred to, it seems likely that this forecast is unreliable.

A sensitivity analysis of the *status quo* forecast is given in Figure 3.4.5. The landings are very sensitive the those year classes which are poorly estimated.

There is a further difficulty affecting this forecast. Like last year it assumes no change in the minimum landing size. In fact the MLS in 1992 was lowered from 27 to 23 cm from the 1 June and a mesh size of 90 mm is allowed when fishing for whiting. In theory, the new minimum landing size should lead to a higher forecast and this could be taken into account. However, the UK has retained the old MLS and its share of the total catch is about two thirds of the total landings. It is problematic to know the most appropriate way of dealing with this question. It seems likely that the number of vessels exploiting the new whiting regulation is small because a directed whiting fishery is economically unattractive for many vessels. Thus the problem reduces to considering how the forecast discards might be re-allocated to landings. Table 3.4.15 shows the weight of discards which could be landed in 1993 assuming *status quo* under the new MLS. It assumes that 50% of the 2-year-olds are retained and all fish age 3 and older are retained. Without detailed information on the length composition of all fleets it is difficult to judge how good this assumption is. It is close to the assumption made in the assessment circulated by ACFM to EC-DGXIV in September this year. The estimated quantity of 27,000 t would have to be partitioned according to how the MLS regulation is expected to affect different countries in 1993.

3.4.9 Long-term considerations

The present assessment indicates that the stock is stable and that the fishing mortality rates are high, especially on the older ages, in comparison to many other stocks. Another whiting stock in Division VIa does not appear to be sustaining itself under similar or lower exploitation levels. The present mortality rate is well above F_{med}. Whiting, though a valuable fishery in some countries, tends to be a by-catch species in the mixed gadoid fisheries so the exploitation regime needs to take into account the management of other target species. Although recent experiments have shown that it is possible to fish selectively for whiting at certain times of the year in certain areas, it appears that few fish are taken this way at present.

3.4.10 Comments on the assessment

The North Sea assessment of whiting has a history of being unreliable (see Table 3.4.16). Recruitment indices do not correlate well with VPA estimates and there is no doubt that there are problems with the age composition estimates in some years of the small mesh by-catch. These problems, coupled with the substantial downward revision of a number of year classes suggest that the catch forecast is particularly unreliable this year.

The way of handling the industrial by-catch in the assessment needs to be investigated.

3.5 Saithe in Sub-area IV and Division IIIa

3.5.1 Catch trends

Recent nominal landings are given in Table 3.5.1. Working Group estimates are in Table 3.5.2 and are plotted in Figure 3.5.1. Landings were high in the early 1970s, reaching a maximum of 320,000 t in 1976. Subsequently, landings declined to 114,000 t in 1979, mainly due to the stop in the fishery of the USSR. After that, the landings followed an increasing trend to reach 200,000 t in 1985. Since then the landings have decreased considerably. In 1990 and 1991, the landings are estimated to have been 88,000 t and 96,000 t, respectively. Small amounts of saithe are taken as industrial by-catch. Since 1976, the average industrial by-catch has been 3,000 t (Table 3.5.2). The agreed TAC in 1991 was 125,000 t. 1991 was the sixth successive year that the TAC was not taken.

3.5.2 Natural mortality, maturity at age, age compositions and mean weight at age

Values of natural mortality rate and maturity at age are given in Table 3.5.3. Total international age compositions are given in Table 3.5.4. Data for 1991 were supplied by Denmark, Germany, France, Norway, UK (England) and UK (Scotland) amounting to 88% of the catches. Discards are not included.

The mean weights at age in the landings are given in Table 3.5.5. These are also used as stock mean weights.

3.5.3 Commercial catch/effort and research vessel indices

Commercial catch and effort data used to tune the VPA are indicated in Table 1.4.1. There are no research vessel indices of abundance for saithe, but a series of 0-group indices estimated by observers are shown in Table 3.5.9 and plotted in Figure 3.5.3 The index appears to be able to predict extreme year classes. A limited amount of cruise data is available (Table 3.5.9) and is insufficient to use in analysis.

3.5.4 VPA tuning and VPA results

Fishing mortality rates in 1991 for ages 2-8 were estimated from the Laurec-Shepherd tuning method using shrinkage towards the mean (see Section 1.4). The tuning results are given in Table 3.5.6. and the residuals of the log catchability are plotted in Figure 3.5.2. Table 3.5.7 gives the values of fishing mortality rates, and Table 3.5.8 gives the stock numbers estimated by tuning.

3.5.5 Recruitment estimates

The time series of 0-group indices obtained from observations along the western coast of Norway is shown in Table 3.5.9, and the relation between these indices and the VPA is shown in Figure 3.5.3. In addition, there exist some indices from a Norwegian 0-group survey, but the time series is very short.The observation indices indicate average or above-average year classes from 1990 onwards.

In the absence of reliable abundance estimates, the Group decided to assume mean geometric recruitment at age 1 over the years 1970-1989 for the year classes 1989 onwards (214 million fish).

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

Table 3.5.10 gives a summary of the trends in fishing mortality, biomass and recruitment as estimated by VPA. These data are also plotted in Figure 3.5.1.

In recent years, mean fishing mortality has increased from 0.31 in 1981 to 0.93 in 1986. Since then the fishing mortality has been decreasing. In 1990 and 1991, the fishing mortalities are estimated to have been 0.65 and 0.73, respectively. This reduction is supported by the fact that fishing effort by French and Norwegian trawlers decreased by 28% and 83%, respectively, between 1986 and 1990 (Figure 1.4.1). Total biomass has declined from 693,000 t in 1983 to 338,000 t in 1991, and spawning biomass has declined from 465,000 t in 1974 to 56,000 t in 1991 which is the lowest on record.

3.5.7 Biological reference points

Yield and biomass per recruit are shown in Figure 3.5.4, and the stock/recruitment plot is shown in Figure 3.5.5. F_{med} (0.40) and F_{high} (0.73) are shown in Figure 3.5.3. The current level of F is well above F_{med}. $F_{0.1}$ and F_{max} are calculated to be 0.21 and 0.33, respectively.

3.5.8 Catch predictions

Input data for prediction are given in Table 3.5.11. Average number at age 1 was input for 1991. Results of the predictions assuming average recruitment are given in Table 3.5.12 and in Figure 3.5.4.

3.5.8.1 *Status quo* prediction

Maintenance of the 1991 level of fishing mortality in 1992 will lead to landings of 124,000 t in 1992 and 121,000 t in 1993. Spawning stock size is predicted to increase from 56,000 t in 1991 to 83,000 t in 1993, and then decrease to 79,000 t in 1994. However, the sensitivity analysis shows that the prediction is dependent on age 1 and age 2 in 1991 (Figure 3.5.6). These ages are assumed to be average, and the prediction may, therefore, be uncertain.

A short-term risk analysis (Section 1.4) shows that there is about 60% risk that the spawning stock will come under 55,000 t (the lowest previous record) in 1994 if the current level of fishing mortality is maintained (Figure 3.5.7). Even with 50% reduction in F the risk is about 20% that the spawning stock biomass will decrease.

3.5.8.2 Prediction assuming TAC taken in 1991

The predicted *status quo* catch for 1992 of 123,000 t was sufficiently close to the TAC of 110,000 t that no prediction with TAC constraint was run.

3.5.9 Long-term considerations

The results of a long-term risk analysis (see Appendix III) are shown in Table 3.5.13 and in Figures 3.5.8 and 3.5.9. In general, high mean yield and high mean SSB are associated with strategies which have a high SSB_{min} at which point the fishery is closed in simulation. However, these strategies lead to frequent closure unless the exploitation rate is reduced. A compromise is strategy 16, for example, which has a SSB_{min} of 120,000 t and a reduction in F of 20%.

The current level of F is at F_{high}, which implies that high recruitment is required to sustain spawning stock biomass.

3.5.10 Comments on the assessment

Tables 3.5.14 and 3.5.15 show the quality control sheets. This year's assessment is very consistent with the assessment of last year. The 0-group indices also indicate that using average recruitment for the period 1987 -1992 may be reasonable.

In view of the rapid decline of the spawning stock biomass there is an increasing risk of recruitment problems and this should be seriously considered in formulating management advice.

3.6 North Sea Sole

3.6.1 Catch trends

The agreed TAC for 1991 was 27,000 t. The total nominal landings reported to ICES in 1991 were 26,400 t (Table 3.6.1). The estimate by the Working Group of the total landings in 1991 was 38,000 t compared to 35,100 t in the previous year. The estimated landings in 1990 and 1991 are at historically high levels and are dominated by a very abundant 1987 year class. Trends in landings are given in Figure 3.6.1. The estimates of the total landings in recent years are not very precise and this is still a cause of concern.

3.6.2 Age composition, weight at age, maturity, natural mortality

Age compositions, weight at age and length at age of the landings were available on a quarterly basis from Belgium, the Netherlands, UK (England and Wales) and France, accounting for 95% of the landings. The SOP of the combined age composition was 1% higher than the total landings. No estimates of discards are available to the Working Group.

Weights at age in the stock are second quarter weights of the catch.

The age composition and weights at age in the catch and stock are given in Tables 3.6.2, 3.6.3 and 3.6.4 The levels of sampling of the age compositions and weight at age are given in Table 3.6.5.

A knife-edged maturity ogive was used in all years, assuming full maturation at age 3. Natural mortality has been assumed constant over ages and years at a level of 0.1 except for 1963 when a value of 0.9 was used to take account of the effects of a severe winter (*Anon.*, 1979).

3.6.3 Effort data and CPUE series

The effort and CPUE series were available for the same fleets as in last year's report and now also include French data. Effort data were available for Belgian beam trawl, Dutch beam trawl, French beam trawl and Danish gill net. CPUE data for these fleets were derived from the total landings and effort of these fleets. CPUE data were available for UK beam trawl and UK otter trawl fishing in the Thames area and near the east Anglian coast. Indices of total effort were derived from the total UK landings and the effort of these fleets. Table 3.6.6 and Figures 3.6.2.a and b give the trends in effort and CPUE in standardized units.

In the measured effort series only the Belgian beam trawl shows a significant decline in 1991. The Dutch beam trawl series is rather constant since 1983. The French beam trawl, mainly operating in Division IVc, shows a gradual increase in effort since 1987. Danish gill-net effort shows large fluctuations and was high in 1991.

In the measured CPUE series, UK otter trawl CPUE is rather constant since 1987, with a low value in 1991. The UK beam trawl CPUE shows two periods with different levels, high values in the period 1980-1986 and low values in the period thereafter. The different levels may reflect the local situation of the stock, but it is more likely that they are induced by a change in fleet structure and/or directivity of this fleet towards plaice. The derived CPUE series all show an increase in recent years.

3.6.4 VPA tuning and results

Three fleets were used in the tuning: Dutch beam trawl, Dutch "Tridens" recruitment survey and the German "Solea" survey. An initial run using the same tuning method as last year (Laurec-Shepherd), tuning over 10 years, including the 1991 data gave much lower values of F in recent years compared to last year's assessment. The fishing mortality declines from 1984 onwards and increases slightly in 1990 and 1991. This trend does not correspond with the general trends in effort in the fisheries (Table 3.6.6).

A retrospective analysis was carried out with this method to evaluate its performance to the data set, using a 10-year window. In addition, a retrospective analysis was carried out with 3 other tuning methods: Laurec-Shepherd shrunk with a strong (3-cubic) taper on the last ten years to take account of trends in catchability, XSA and XSA shrunk. In both XSA tuning methods constant catchability was assumed for age 7 and older.

The results of the retrospective analyses are shown in Figures 3.6.3.a-d. The exploitation patterns estimated by the different methods are shown in Figure 3.6.4. In general, all methods tend to overestimate F compared to runs including more years. Fishing mortalities in all runs including the 1991 data are considerably lower compared with the runs excluding the 1991 data. The declining trend in F in the period 1984-1988, when including the 1991 data, also appears in all methods. Since there is no explanation for the observed trends in fishing mortality from the information on effort in the fisheries, it is possible that the observed trends are caused by the quality of the 1991 data. Assuming that this is the case, it is not likely that other methods than those tried by the Working Group will perform better.

"Shrinking" and "tapering" in the SL tuning reduces the fishing mortality in recent years even further compared to the LS not shrunk and not tapered. The results of this method were believed to be unrealistic.

In the young ages, XSA estimates fishing mortalities in 1991 to be higher compared to those in the other tuning methods. From age 7 onwards, however, the exploitation pattern estimated by XSA is unrealistic, showing values of F much higher and variable as observed before (between 1.2 and 6.6 above age 10).

The XSA shrunk method estimates a similar exploitation pattern in 1991 as both LS methods, but on a slightly higher level. Although the trends in F are the same as in the other methods, the increase in 1990 and 1991 brings it to a level which is about the same as in the mid-1980s.

The Working Group decided to accept the XSA shrunk tuning method because the fishing mortality in 1991, estimated by this method, is closer to that in the mid-1980s. However, it cannot explain the trends in fishing mortality in recent years induced by the 1991 data. It can not either explain the lower level of F compared to the retrospective runs. The log catch residuals of the tuning fleets are shown in Figure 3.6.5.a-c. The summary statistics are given in Table 3.6.7.

In addition, several tuning runs were made using the Adaptive Framework (ADAPT), with the same fleets as used in the LS and XSA calibrations. ADAPT with the German survey alone (ages 2-10) indicated a lack of fit of the model, with CVs on most population estimates in 1991 of 0.45 to 0.58. For the other two indices, separate ADAPT formulations showed CVs in the range of 0.20 to 0.34 (ages 2-12) for the Netherlands fleet and 0.22 to 0.44 (ages 1-4) for the "Tridens" survey. In both these calibrations, age 1 was not as well estimated as the other ages.

In the ADAPT with all 3 indices the population estimates at ages 2-6 in 1991 were very similar to those in the XSA-shrunk calibration, e.g., the large 1987 year class was estimated at 197 million at age 4 in ADAPT and 198 million in XSA shrunk. At ages 7+, ADAPT estimated lower population sizes in 1991 (and correspondingly higher Fs) than the XSA-shrunk model, which was similar to the patterns seen in the XSA not shrunk calibration. CVs of the population estimates in 1991 were between 0.23 and 0.37 for all ages in the calibration (ages 2-12). All 3 indices showed positive residuals in the tuning plots at almost all ages in 1991. The exploitation pattern indicated by ADAPT is shown in Figure 3.6.4.

The choice for the "XSA shrunk tuning method" does not mean that this method performs better than the other tuning methods. When the choice had to be made with the 1990 data in the last year, based on the retrospective plots, the LS would have been preferred, as was used by the Flatfish Working Group last year. For an assessment with the 1989 data in the last year in the assessment the "LS shrunk and tapered tuning" would have been preferred, since from that year it shows the least retrospective patterns.

The results of the assessment are shown in Tables 3.6.8 and 3.6.9.

3.6.5 Recruitment

Average recruitment in the period 1957-1989 was 135 million (arithmetic mean) or 97 million (geometric) 1-year-old fish.

Independent indices of recruitment were available from pre-recruit surveys (Demersal Fish Surveys) by Belgium, Germany, the Netherlands and UK (Table 3.6.10). The indices for the Belgian and Dutch series were revised for all years. The national surveys were carried out in many different nursery areas and might reflect recruitment of different sub-stocks. Therefore, as in previous years, a combined index was calculated from these surveys, weighted by area and taking into account differences in efficiency between the survey gears (*Anon.*, 1990). Other recruitment indices are available from the RV "Tridens" surveys (sole net surveys) for ages 1, 2 and 3 and from the RV "Solea" survey: age 3 (Table 3.6.11).

The size of recent year classes was estimated using log regressions between the indices with the 1-year-olds from the VPA using RCT3. The options used in RCT3 are calibrative regression type shrunk to the mean. These are not the same options as used in last year's report. However, since the results between both methods did not give different results the new options were preferred because these were more consistent with those used in the other stocks. The results of RCT3 are shown in Table 3.6.12.

<u>1989 year class</u>: This year class is estimated to be well above GM recruitment by all surveys except by the 0-group survey, which estimates it to be very low. The mean estimate is 147 million.

<u>1990 year class</u>: All surveys indicate this year class well below GM recruitment. However, in the UK nurseries it was the strongest in the series as 1-group. The mean estimate is 51 million.

<u>1991 year class</u>: This year class appears to be an exceptionally strong one in all continental nurseries. On the UK coast it is around average strength. The survey estimates range between 229 and 355 million. The mean estimate is 276 million. Also the beam trawl surveys carried out by the Netherlands and Belgium (Table 3.6.11), which series is still too short for the use of prediction purposes, confirm this year class to be a very good one.

<u>1992 year class</u>: For this year class only the DFS 0-group index is available. In the continental nurseries it

was virtually absent. However, in the UK nurseries it is above average. The combined index estimates it to be only 11 million. The overall estimate, including to the RCT3 VPA mean, is 55 million.

3.6.6 Long-term trends

Trends in landings, recruitment, fishing mortality and spawning biomass are shown in Figures 3.6.1.a-b and in the assessment summary table (Table 3.6.13).

Although there is considerable variation in the level of recruitment from year to year, recruitment in the periods 1957-1965 and in the period after 1980 has been higher than in the period 1964-1979. Recently two exceptional strong year classes 1987 and 1991 appeared. Previously, exceptionally strong year classes appeared in 1958 and 1963. These exceptional year classes were all produced after a cold spring by different levels of SSB.

Trends in landings are related to the recruitment of strong year classes in the fishery and a gradual increase in fishing mortality. In the early period 1957-1963 landings increased from 12,000 t to 26,000 t mainly because of the good 1958 year class. They declined sharp in 1964 as a result of a reduction of the stock caused by excessive mortality in the severe winter of 1963. Landings increased thereafter in the period 1965-1969 from 17,000 to 33,000 t because of the 1963 year class and an increase of fishing mortality. In the period thereafter they declined to a level around 20,000 t with variations reflecting variations in recruitment. In 1990 and 1991 they increased sharply to a historically high level and consisted mainly of the strong 1987 year class.

Fishing mortality increased gradually in the period 1957-1966. It increased sharply in 1967-1969, mainly because of the introduction of the beam trawl and continued to increase gradually until the mid-1980s. The recent trends, indicated by the VPA are discussed in Section 3.6.4.

Spawning stock biomass was high in the early period. The historically high value of 149,000 t was in 1961. It dropped after the cold 1963 winter and increased to 103,000 t in 1967 and 1968. Thereafter it decreased gradually because of an increase in fishing mortality and low levels of recruitment. Its lowest level was 26,000 t in 1981. It increased sharply in 1990 to 94,000 t when the 1987 year class recruited to the fishery.

The recent trends in SSB have been evaluated recently by the Study Group on the Fecundity of Sole and Plaice in Sub-areas IV, VII and VIII (*Anon.*, 1992b). This Study Group evaluated the results of sole egg surveys in the North Sea in 1984, 1988, 1989, 1990 and 1991, carried out by the Netherlands, UK, Belgium and Germany. The estimates of female SSB by these surveys were in general a factor of 2 higher compared to those in last year's VPA. Applying the same method as used by this Study Group to calculate the female SSB from the total stock in this year's assessment gave higher estimates of female SSB. Figure 3.6.6. shows a plot between the female SSBs estimated by the surveys and the present assessment. The discrepancies between the two methods have become smaller although at high stock levels the surveys still estimate the stock to be 35-50% higher.

3.6.7 Biological reference points

The input parameters for the yield and biomass-per-recruit calculations are given in Table 3.6.14. The weights at age used were the averages of the last 3 years in the catch and in the stock. The exploitation pattern used was the average of the last 3 years in the VPA scaled to the 1991 level. The stock numbers in 1992 for ages 1-3 were estimated from recruitment estimates and the F-at-age in the last 3 years. The results of the calculations are given in Table 3.6.15 and Figure 3.6.7.c. Current fishing mortality, $F_{2\text{-}8}$ = 0.47 corresponds to a yield/recruit of 0.183 kg and a SSB/recruit of 0.305 kg. The present fishing mortality is well beyond F_{max}.

The biological reference points are as follows:

$F_{0.1}$	F_{low}	F_{max}	F_{med}	F_{91}	F_{high}
0.12	0.06	0.28	0.38	0.47	0.88

Figure 3.6.8 shows the SSB recruitment plot. At the observed levels of biomass these are no indications that recruitment has declined at low levels of biomass.

3.6.8 Catch forecast

Catch forecasts for 1992 and 1993 were obtained using the new IFAP program. The input parameters are given in Table 3.6.14.

Table 3.6.16 and Figure 3.6.7.d give the Management Option Table. In the prediction, *status quo* fishing mortality has been assumed for 1992.

The expected status quo catch is 32,400 t. The spawning stock biomass will decrease from 74,000 t in 1992 to 54,000 t in 1993. The size of the SSB in 1994 will depend on the choice of the preferred level of fishing mortality in 1993. In 1994 the strong 1991 year class will recruit to the SSB which will increase for all levels of fishing mortality below 1.8 * F_{91}. At a *status quo* level of F, the expected catch is 28,900 t leaving a SSB of 70,000 t in 1994.

The expected *status quo* catch in 1992 is higher than predicted last year because the present assessment indicates a higher 1987 year class compared to last year's assessment.

3.6.9 Long-term considerations

In the past, management advice of North Sea sole was based on the following objective: "To prevent the spawning stock from falling below the historically safe level of 40,000 t and maintain it at a level of 50,000 t. This objective comprises a buffer of 10,000 t to allow for two successive poor year classes."

The historically safe level of 40,000 t has been preferred, since it was a low level where the stock had not shown signs of recruitment overfishing. The extra 10,000 t buffer was added to prevent the risk that SSB would fall immediately below 40,000 t when a poor year class recruit to the fishery as happened in 1980 and 1981. As a consequence of the two successive poor year classes 1977 and 1978, the SSB decreased from 47,000 t in 1979 to 26,000 t in 1981.

The SSB/recruitment plot (Figure 3.6.8) shows that SSB has been 7 times in 35 years below 40,000 t in the historical period. On these occasions the stock produced 3 below-average year classes, amongst which the poorest observed, 3 above-average year classes and a very good year class. In fact, there is no empirical evidence that recruitment has declined at SSB levels below 40,000 t. The historically safe level of SSB could, therefore, be reconsidered as proposed by the Flatfish Working Group in 1990.

Two types of risk analysis have been carried out to estimate the probability of the stock declining below certain levels of SSB at different levels of fishing mortality.

Figure 3.6.9 shows this for 6 levels of fishing mortality using model SPLIR as described in Annex IV. The model had been run over 1000 years. At the present level of fishing mortality the equilibrium SSB in this period was 50,000 t. However, in 65% of all years the SSB was below that level. In 40% of all years it was below the present Minimum Acceptable Level of 40,000 t. At a level of 0.9 * *status quo* F, the equilibrium SSB was 57,000 t. In 20% of the years it was below 40,000 t. At a level of 0.8 * *status quo* F, the equilibrium SSB was 66,000 t. In 8% of the years it was below 40,000 t. At these three levels of F the similar average catches will be expected to be around 25,000 t (flat-topped yield). In 60-70% of all years the expected catch will be below that level (Figure 3.6.10).

Tables 3.6.17 and 3.6.18 show the results of a historical reconstruction of the fishery using model REVISIT as described in Annex IV. The model assumes that the present exploitation pattern starts in the beginning of the historical time period for which we have recruitment data and that in consecutive years recruitment occurs as it has been observed. In a period of 35 years assuming *status quo* F, the average SSB would be 52,000 t. In 22 years it would have been below that level. In 11 years it would have been below 40,000 t. At a level of 0.8 * *status quo* F the average SSB would have been 66,000 t. Only in 1 year was SSB below 40,000 t.

In defining Long-Term-Management Objectives the risk of the stock falling below MBAL should be taken into account. In practice it would mean to agree on a level of F (effort) which minimizes this risk to an acceptable level.

3.6.10 Comments on the assessment

The consistency of this assessment and previous assessments is shown in Tables 3.6.19.a-d (Quality Control Diagrams). Historically the North Sea sole assessment, as carried out in previous meetings of the Flatfish Working Group, has been reasonably consistent. However, there is a considerable inconsistency between the present assessment and those carried out in previous years. Estimates of SSB are higher, mainly because of lower estimates of fishing mortality and a higher estimate of the 1987 year class (454 million now, compared to 332 million last year and 450 million in the year before).

All methods, except XSA not shrunk, tried by the Working Group estimate a low level of fishing mortality. The XSA not shrunk was considered unrealistic because of its erratic exploitation pattern. The lack of consistency between this year's assessment and those carried out in previous years is a reason of concern. It has already been pointed out that the reason for the problems probably originate from the quality of the catch data.

The signals from the egg surveys, beam trawl survey and from the fishery indicate that the stock is presently in a good condition. However, given the uncertainties in the assessment it is difficult to assess its present position very precisely.

This is also the case for the level of fishing mortality and its exploitation pattern. An over- or underestimate of F will affect the results of the risk analysis as well, but not the arguments for setting the level of MBAL since these were taken from historical trends.

The labels of the position of the *status quo* fishing mortality in the risk analysis plot using the SPLIR model refer to the level of fishing mortality indicated by the present assessment. If a different F-level is assumed for *status quo* fishing mortality these labels should be modified accordingly.

3.7 North Sea Plaice

3.7.1 Catch trends

Table 3.7.1 shows the landings by country as reported to ICES and the Working Group estimate of the total international landings. Total landings decreased in 1991 from the record level of around 165,000 t to a level just over 150,000 t (Figure 3.7.1). There is continuing uncertainty about the actual level of the unreported landings.

3.7.2 Age composition, weight-at-age, maturity and natural mortality

Data on age compositions and weight-at-age were available on a quarterly basis from Belgium, Denmark, Netherlands, UK, France, accounting for 95% of the total international landings. The sampling level is shown in Table 3.7.2. The catch at age, catch-weight-at-age and stock-weight-at-age matrices are given in Table 3.7.3, 3.7.4 and 3.7.5, respectively. Stock-weight-at-age was the measured 1st quarter weights in the catches, but the weights of the 1-year-olds was arbitrarily set at 0.150 kg. Over the last 10 years there is a clear tendency for a reduction in the weight of those youngest age groups that are fully or almost fully recruited to the fisheries (age groups 4-8). Maturation was assumed to be constant at 50% at age-group 2 and 3 and 100% at age group 4 and older. Natural mortality was assumed to be constant for all age groups at M = 0.10.

3.7.3 Catch-per-unit effort and research vessel indices

The catch-per-unit of effort data from the commercial fisheries that were available to the Working Group are given in Table 3.7.6. Relative trends in commercial CPUE are shown in Figure 3.7.2, showing different trends over the last five years. An increase in the CPUE since 1985 was observed in the Belgium beam trawl, the UK beam trawl and the UK and Danish seine fleets. A decrease was observed in the Netherlands beam trawl and the UK otter trawl fleets. All commercial indices indicated a substantial decrease between 1990 and 1991. An increase in CPUE between 1985 and 1989 and a decrease since 1990 is also observed in the survey indices (Table 3.7.7). Figure 3.7.3 shows the trends in the cumulative numbers per hour fishing for successive age groups. For instance, age 2+ denotes the CPUE of all plaice of age group 2 and older. In both survey indices the strong 1985 year class can be recognized.

3.7.4 Tuning of the VPA and VPA results

Tuning included effort and corresponding catch-at-age data for two commercial fleets and three surveys. The commercial fleets comprised the Netherlands beam trawl (1982-1991) and the English seine fleet (1982-1991); the surveys used are the Netherlands Beam Trawl Survey (BTS; 1985-1991), the English Groundfish survey (1982-1991) and the "Tridens" pre-recruit survey (1982-1991). The survey effort equals one. As in previous years the Belgium commercial series was excluded because of the low sampling level. The UK commercial trawl series was excluded because no separate age compositions are available for these fleets.

Four tuning runs were carried out over the period 1982-1991: Laurec-Shepherd (LS), LS-shrunk, Extended Survivor Analysis (XSA) and XSA-shrunk. The trends in fishing mortality and SSB are shown in Figure 3.7.4 and 3.7.5, respectively. The results of LS and XSA were close, but the options with shrinkage gave somewhat lower F estimates. The discrepancy is mainly due to the higher F values for the older age groups as estimated by the tuning methods without shrinkage (Figure 3.7.6). The estimated F of the most heavily exploited age groups does not differ between the four methods. As expected, the shrinkage stabilizes the estimated Fs on the older, generally poorer sampled, age groups.

The summary statistics of the SL-shrunk tuning run are given in Table 3.7.8. The Netherlands beam trawl fleet shows the lowest SE(q) beyond age group 4 and thus has the largest influence on the terminal F estimates (Figure 3.7.7). For age groups 1 and 2 the pre-recruit survey ("Tridens" SNS survey) performs best.

Figure 3.7.8 shows the catchability plots for the five fleets from which there appears to be no consistent trends in q with time. In an extra run with the LS-shrunk method it appeared that application of a strong taper (tricubic over 10 years) did not affect the estimated terminal Fs. The F(2-10)u in 1991 was estimated at 0.459 compared to 0.455 in the LS-shrunk without a taper.

A retrospective analysis was conducted to explore the variability in the estimated terminal Fs. Figure 3.7.9 indicates that for the 5-year period investigated, the terminal F value varied by about 0.1 as found in last year's report (*Anon.*, 1992c). The VPA-run tuned with the LS-shrunk method was chosen as the final run. Results are presented in Tables 3.7.9 and 3.7.10.

Inspection of the matrix of F-at-age (Table 3.7.9) shows that there has occurred a change in the exploitation pattern between the early 1980s and the most recent years which has shifted from a peak in F on age groups 3 or 4 to a peak on age group 5 (Figure 3.7.10). The change already occurred in the 3-year period before the establishment of the plaice box in 1989.

A trial run with the ADAPT program used for tuning VPAs in Canada was explored and showed similar results with an F(2-10)u = 0.43 in 1991. The coefficients of variation of the estimated stock numbers in the final year varied between 0.14 and 0.31. The CVs for age groups 2-9 were all <0.20.

3.7.5 Recruitment estimates

Various pre-recruit surveys for North Sea plaice have been conducted since 1970 comprising all of the main nursery areas. A summary is given in Table 3.7.11. The indices for the continental survey of the Netherlands and Belgium were revised. In the recruitment prediction the "Tridens" 0-, 1- and 2-group index and the combined 0- and 1-group index are used. The latter is an average of the continental, UK and German surveys weighted by the surface area of the nursery grounds sampled.

Recruitment estimates were calculated with RCT3 for year classes 1988, 1989, 1990, 1991 and 1992. The output is given in Table 3.7.12. All surveys were significantly correlated with VPA estimates at age 1. Although the recommended option of shrinkage towards the mean was accepted, the weighting factors of the mean were generally <=0.1 and hardly affected the predictions. All year classes born between 1986 and 1992 appear to be above the average with the 1990 year class estimated as particularly strong (50% above AM). The mean over the period 1971-1990 are 512 (arithmetic mean) and 461 (geometic mean).

3.7.6 Long-term trends

Trends in SSB, recruitment, yield and F are shown in Figure 3.7.1 and Table 3.7.13. In the historic perspective North Sea plaice can be characterized as a rather stable stock. Despite the steady increase in fishing mortality between 1958 and 1980 to a constant level of around 0.4 in the 1980s, the spawning stock biomass has not fallen below 300,000 t and even increased to a level of about 400,000 t in 1988, which is mainly due to the increase in the average level of recruitment in the 1970s and to the increase in growth rate in the 1960s. In recent years it appears that the growth rate has started to decline (Figure 3.7.11). Recent pre-recruit indices indicates that the relatively high recruitment is maintained.

3.7.7 Biological reference points

The ICES Flatfish Working Group has previously used as biological reference points F_{max}, F_{low}, F_{med}, F_{high} and a minimum biologically acceptable level of SSB.

A long-term prediction was carried out using input data given in Table 3.7.14. Results are given in Table 3.7.15 and Figure 3.7.13. The yield-per-recruit curve is flat-topped. At F_{max} each recruit contributes 0.25 kg to the catch and 1.10 kg to the SSB.

The stock/recruitment relationship is shown in Figure 3.7.12 together with the lines defining F_{low} = 0.13 (1.65 kg SSB per recruit), F_{med} = 0.32 (0.75 kg SSB per recruit) and F_{high} = 0.59 (0.44 kg SSB per recruit). On the yield-per-recruit curve it is seen that the current F(2-10,u) = 0.46 is well above F_{max} (0.23) and F_{med}, but below F_{high}.

At previous Working Group meetings the minimum biologically acceptable level of SSB was set at the lowest level observed since 1958 which corresponds to about 300,000 t. The absolute value of the SSB, however, is very sensitive for various input parameters such as natural mortality, maturity-age relationship, and stock-weights-at-age. It was, therefore, preferred to define the minimum SSB as the level reached during the time period 1978-1982. At this level there is no indication of a reduction in recruitment. The stock/recruitment plot even suggests that recruitment decreases at higher levels of SSB, but this might be due to the change in the level of the average recruitment which has not necessarily to be related to SSB.

3.7.8 Catch forecast

A short-term catch prediction was carried out using input values given in Table 3.7.16. The exploitation pattern was taken as the average pattern over the last three years scaled to the F(2-10,u) of 1991. Weight at age in the stock and catch were taken as the average over the last three years, thus taking account for the observed decrease in recent years. The predicted *status quo* catch forecasts for 1992 is 171,000 t, slightly below the agreed TAC of 175,000 t, and 170,000 t for 1993, leaving an estimated SSB of 369,000 t at the beginning of 1994 (Table 3.7.17).

3.7.9 Long-term considerations

A 'plaice box' in the southeastern North Sea was established in 1989, in order to protect the undersized plaice from discarding and to improve the exploitation pattern. In this 'plaice box' trawling is not allowed during the second and third quarter, with a derogation for the smaller vessels of <300 Hp. It is expected that a complete closure of the 'plaice box' and a homogeneous reallocation of fishing effort outside the box would result in a 25% increase in the average level of recruitment in plaice and 11%-27% in sole (*Anon.*, 1987; Rijnsdorp and van Beek, 1991). Important further gains can be expected by closing the box for the complete year. Extending the box to include the coastal areas on the UK coast and along the continental coast between 51°N and 53°N will only marginally enhance the recruitment of plaice, but will substantially enhance recruitment in sole (Rijnsdorp and van Beek, 1991). No studies are yet available on the effects of the 'plaice box' on other species, e.g., cod and whiting.

A measure of the effect of the 'plaice box' on the survival of plaice in this area can be obtained by comparing the rate of decline of cohorts in the pre-recruit survey carried out in the southeastern North Sea. Comparison of the log-catch ratio of the 3- over the 2-group index from the "Tridens" autumn survey (Table 3.7.11) before and after the establishment of the 'plaice box' in 1989 shows a significantly higher ratio ("apparent survival"; t-test, $P<0.05$) after the introduction of the box.

However, there are trends in the fishery like an increase in the fleet of small vessels within the box and an attraction of larger vessels in the fourth quarter of the year, which may reduce future gains or even have an overall negative effect in the long run.

A risk analysis was conducted to explore the effect of recruitment variability on the probability of the SSB to fall below certain levels using a similar method as for North Sea sole with input values for the level and pattern of exploitation, weight-at-age in the catch, weight-at-age in the stock similar to those used in the prediction (Table 3.7.16). It was further assumed that future recruitment has a mean and coefficient of variation as observed between 1958 - 1991. The results of the risk analysis are shown in Figure 3.7.14. At the current level of fishing mortality, the SSB will vary in 90% of the years between 200-350,000 t and has a probability of $P = 0.76$ to fall below the level of 300,000 t. In the situation with a 'plaice box', assuming 25% increase in recruitment, the SSB will vary in 90% of the years between 250-400,000 t and will have a probability of 0.39 to fall below 300,000 t.

3.7.10 Comments on the assessment

The present assessment gives a rather favourable picture of the state of North Sea plaice. Fishing mortality has been stable over the last decade, SSB is well above the minimum historical level reached between 1978-1982 and the recruitment of recent year classes appear to be all well above the average level. However, some provisos should be made. First, there is uncertainty about the accuracy of the total international landings and corresponding age compositions. The broad correspondence between the VPA results and the available fishery-independent data sets, in particular trawl and egg surveys (see Figure 3.8.2 in *Anon.*, 1992c) gives some confidence in the VPA results for the years in which the VPA has converged. The estimated level of F in 1991, however, is rather inaccurate as indicated by the retrospective analysis which indicated that the terminal F could change by 0.1 or more when an extra year of data was added to the analysis, and which is also reflected in the quality control diagrams (Table 3.7.18). There are indications that the present estimate of F for 1991 may be too low, and consequently the corresponding SSB too high. At first, the landings in 1991 were below the *status quo* predictions. Secondly, all commercial CPUE indices indicated a substantial decrease in 1991 compared to 1989 and 1990, which is also observed in the Netherlands beam trawl survey, and which according to the complaints of the fishing industry continues in 1992. Up to August 1992, the reported landings were below the comparable proportion of the annual quota in 1991 in the Netherlands (-13%), Denmark (-6%) and France (-20%), were equal to 1991 in Germany and higher in Belgium (+20%) and the UK (+6%). Therefore, it seems unlikely that the predicted *status quo* catch (170,000 t) will be taken in 1992.

Given the apparent discrepancy between the VPA results and the information from the fishing industry for which the causes are not yet fully understood, the results of the assessment should be interpreted with caution. However, there is certainly no need for immediate concern given the rather good recruitment, the apparently better survival of young plaice in the southeastern North Sea, and the stable character of the exploitation and the SSB of this stock as indicated from the historic perspective.

Table 3.2.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1981-1991, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Belgium	8,744	6,604	6,704	5,804	4,815	6,604	6,693	5,508	3,398	2,934	2,331
Denmark	64,968	61,454	48,828	46,751	42,547	32,892	36,948	34,905	25,782	21,601	18,998
Faroe Islands	38	65	361	-	71	15	57	46	35	96	23[1]
France	11,369	8,399	7,159	8,129	4,834	8,402	8,199	8,323	2,578[1,3]	n/a	975[1,3]
Germany	29,741	18,525	20,333	13,453	7,675	7,667	8,230	7,707	11,430	11,725	7,085[1]
Netherlands	51,281	36,490	34,111	25,460	30,844	25,082	21,347	16,968[4]	12,028	8,445[1]	6,830[1]
Norway[2]	6,766	12,163	6,625	7,005	5,766	4,864	5,000	3,585	4,813	5,168	5,314[1]
Poland	7	62	75	7	-	10	13	19	24	53	15
Sweden	321	453	422	575	748	839	688	367	501	620	784
UK (Engl.& Wales)	59,856	54,277	53,860	35,605	29,692	25,361	29,960	23,496	18,250	15,596	12,878[1]
UK (Isle of Man)	-	-	-	-	-	-	-	-	1	-	-
UK (N. Ireland)	-	-	-	-	-	-	-	-	124	26	26
UK (Scotland)	53,921	57,308	58,581	54,359	60,931	45,748	49,671	41,382	31,480	31,120	28,419[1]
Russia	-	-	-	-	-						
Total	287,012	255,800	237,059	197,148	187,923	157,484	166,806	142,306	110,444	105,000[4]	83,678

[1]Preliminary.
[2]Figures do not include cod caught as industrial by-actch.
[3]Includes Division IIa (EC).
[4]Working Group estimate.
n/a = Not available.

Table 3.2.2 Annual weight and numbers of COD caught in Sub-area IV between 1972 and 1991.

	Weight (1000 tonnes)				Number (millions)			
Year	Total	H.Con	Disc	By-cat	Total	H.Con	Disc	By-cat
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
1989	116	116	0	0	75	75	0	0
1990	105	105	0	0	76	76	0	0
1991	86	86	0	0	53	53	0	0

Table 3.2.3 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

Table 3.2.4 Total international catch at age ('000) of COD in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	3692	24742	14690	30081	5182	62744	24930	34113	60868	19833	1
2	180833	30259	55617	42487	90267	42275	158836	85844	96114	175920	2
3	46369	52342	10765	17073	16172	22918	13094	40458	29562	27563	3
4	5474	13409	14937	4203	6016	4104	8417	3332	10272	7649	4
5	2627	2102	4365	6816	1542	2055	2809	3130	1590	3802	5
6	3084	1057	907	1863	2764	752	941	675	1172	740	6
7	1618	1010	414	405	837	1030	366	365	412	555	7
8	589	466	373	176	119	335	372	129	191	131	8
9	376	76	313	206	61	237	140	145	71	63	9
10	108	55	76	86	57	23	33	39	54	36	10
11	17	154	178	57	39	87	40	16	25	20	11

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	64836	23837	63854	7894	82591	21633	17716	21312	11413	13372	1
2	59947	121826	57773	111118	20828	105617	49801	28688	49554	20518	2
3	53238	17518	27764	15712	28918	6962	35706	14633	8444	14569	3
4	7287	10104	3461	6874	3954	7625	2508	8023	3764	2293	4
5	3193	2501	3119	1150	2584	1348	2227	868	1952	1148	5
6	1883	1167	939	1116	521	955	558	884	252	889	6
7	355	562	415	328	498	209	274	219	244	177	7
8	218	142	233	162	148	188	58	124	38	117	8
9	72	70	57	73	60	46	52	22	44	23	9
10	25	22	43	13	39	31	11	24	9	3	10
11	15	18	19	23	19	11	16	9	3	8	11

Table 3.2.5 Total international mean weight at age (kg) of COD in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	0.616	0.559	0.594	0.619	0.568	0.542	0.568	0.549	0.546	0.725	1
2	0.836	0.869	1.039	0.899	1.027	0.973	0.938	0.940	0.998	0.827	2
3	2.086	1.919	2.217	2.348	2.477	2.161	2.025	2.447	2.002	2.256	3
4	3.968	3.776	4.156	4.226	4.575	4.603	4.242	4.583	4.578	4.759	4
5	6.011	5.488	6.174	6.404	6.505	6.716	6.599	6.687	6.390	7.188	5
6	8.246	7.453	8.333	8.691	8.630	8.832	8.945	8.557	9.156	8.851	6
7	9.766	9.019	9.889	10.107	10.137	10.075	9.972	10.938	9.805	10.059	7
8	10.228	9.810	10.791	10.910	11.341	11.052	11.099	11.550	11.867	11.519	8
9	11.875	11.077	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	9
10	12.530	12.359	12.425	12.976	14.140	13.134	12.778	14.148	14.081	14.897	10
11	14.350	12.886	13.731	14.431	14.371	14.361	13.981	15.478	15.392	18.784	11

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	0.587	0.634	0.593	0.582	0.570	0.621	0.561	0.672	0.712	0.652	1
2	0.948	0.917	0.996	0.920	0.909	0.937	0.836	1.044	0.933	1.024	2
3	1.851	1.814	2.144	2.126	1.823	1.955	1.912	1.832	2.144	1.979	3
4	4.512	3.960	4.041	4.228	3.890	3.671	3.242	3.604	3.755	4.110	4
5	6.848	6.589	6.255	6.457	6.426	6.017	5.971	5.174	6.112	6.147	5
6	8.993	8.454	8.423	8.475	8.158	8.280	7.864	7.842	8.348	7.985	6
7	10.740	9.919	10.317	10.406	9.956	9.911	9.723	9.498	10.523	9.637	7
8	12.500	11.837	11.352	12.034	11.713	11.413	11.607	11.087	10.742	10.936	8
9	13.469	12.797	13.505	13.033	12.710	12.149	13.489	12.774	12.610	13.547	9
10	12.890	12.562	13.408	13.209	13.566	15.542	14.353	14.066	15.285	13.250	10
11	14.609	14.427	13.471	14.415	13.160	16.430	15.768	14.578	14.631	13.161	11

Table 3.2.6 COD in the North Sea. Research vessel indices.

13	23	2											
'YEARCLASS'	'IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS1'	'SGFS2'	'DGFS0'	'DGFS1'	'DGFS2'	'FRGSF'	'GGFS1'	'GGFS2'
1970	98.3	34.5	-1	-1	-1	-1	-1	-1	-1	-1	90.4	-1	-1
1971	4.1	10.6	-1	-1	-1	-1	-1	-1	-1	-1	1.3	-1	-1
1972	38.0	9.5	-1	-1	-1	-1	-1	-1	-1	-1	1.6	-1	-1
1973	14.7	6.2	-1	-1	-1	-1	-1	-1	-1	-1	3.6	-1	-1
1974	40.3	19.9	-1	-1	-1	-1	-1	-1	-1	-1	8	-1	-1
1975	7.9	3.2	-1	-1	4.5	-1	-1	-1	-1	-1	7.8	-1	-1
1976	36.7	29.3	-1	62.7	12.5	-1	-1	-1	-1	-1	28.2	-1	-1
1977	12.9	9.3	13.9	22.8	5.8	-1	-1	-1	-1	-1	27.2	-1	-1
1978	9.9	14.8	12.6	24.2	6.7	-1	-1	-1	-1	4.5	31.1	-1	-1
1979	16.9	25.5	18.6	50.8	13.9	-1	-1	-1	163.8	11.2	35.5	-1	-1
1980	2.9	6.7	10.2	11.4	2.9	-1	3.5	43.2	46.9	1.6	14.1	-1	-1
1981	9.2	16.6	74.2	32.4	11	6.1	7.8	176.8	83	2.3	23.2	-1	3.5
1982	3.9	8	2.5	15.4	4.7	3.3	3.9	26.9	21.8	1.6	9	5.9	2.4
1983	15.2	17.6	95.1	61.2	11.9	8.2	11.4	121.5	121.3	3.1	43	2.6	22.4
1984	.9	3.6	.4	4.3	1.2	.7	1	1.3	3.6	.2	.9	2.3	2.6
1985	17.0	28.8	8.3	34.4	10.7	8	6.9	143.6	111.2	8	9.5	15.4	11.4
1986	8.8	6.1	1.2	14.2	4.1	2.2	2.9	37	41.5	1.7	2.3	7	9.5
1987	3.6	6.3	.4	8.4	2.5	1.6	1.3	36.2	17.8	2.2	2.1	2	7.
1988	13.1	15.2	16.8	22.8	5.1	5.6	4.9	16.6	16.6	1.9	4.2	90.2	14.7
1989	3.4	4.1	6	6.1	1.6	1.1	1.5	13.7	9.2	0.7	.6	11.9	6.2
1990	2.4	4.5	3.9	7.5	0.8	3	1.9	23.5	7.2	-1	-1	15.5	3.6
1991	13.0	-1	48.4	12.0	-1	5.4	-1	39.8	-1	-1	-1	13.4	-1
1992	-1	-1	8.5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Table 3.2.7

VPA Version 3.0 (MSDOS)

COD IN THE NORTH SEA

CPUE data from file A:COD4EF.DAT

Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Shrinkage Log S.E = .20

Regression weights
.020, .116, .284, .482, .670, .820, .921, .976, .997, 1.000

Oldest age F = 1.000*average of 5 younger ages.

Fleet

1 SCOGFS
2 SCOTRL
3 SCOSEI
4 SCOLTR
5 ENGGFS
6 ENGTRL
7 ENGSEI
8 FRATRB
9 FRGGFS
10 NETGFS
11 INTGFS

SUMMARY STATISTICS FOR AGE 1

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-17.72	.333	.0000	.0890	.736E-01	.539E-01	-17.718	.123
2	-17.09	.600	.0005	.0507	.144E+00	.953E-01	-17.088	.222
3	-16.72	.970	.0184	.0278	.364E+00	.118E+00	-16.720	.359
4	-17.14	.636	.0147	.0353	.152E+00	.101E+00	-17.142	.236
5	-16.18	.252	.0000	.1666	-.250E-01	.446E-01	-16.184	.094
6	-16.94	.811	.0114	.0445	.220E+00	.124E+00	-16.937	.300
7	-17.15	.789	.0030	.0414	.328E+00	.821E-01	-17.150	.292
8	-16.77	.387	.0024	.0786	.144E+00	.475E-01	-16.768	.143
9	-16.36	1.120	.0000	.0703	.373E+00	.150E+00	-16.356	.415
10	-15.77	.541	.0000	.2718	-.138E+00	.843E-01	-15.765	.200
11	-17.04	.487	.0000	.2657	-.906E-02	.877E-01	-17.041	.180

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.121	.142	.163	.163	1.309

SUMMARY STATISTICS FOR AGE 2

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-16.58	.252	.0000	.8333	.492E-02	.453E-01	-16.585	.093
2	-15.24	.602	.0033	.6103	.336E-01	.108E+00	-15.237	.223
3	-14.55	.537	.1619	.5115	.174E+00	.746E-01	-14.548	.199
4	-15.46	.397	.0785	.6522	.645E-01	.677E-01	-15.464	.147
5	-16.36	.221	.0000	1.0369	-.523E-02	.397E-01	-16.361	.082
6	-15.18	.304	.0657	.6863	.527E-01	.516E-01	-15.184	.113
7	-15.39	.377	.0175	.9055	.104E+00	.571E-01	-15.389	.140
8	-15.65	.270	.0072	1.0889	.348E-01	.471E-01	-15.649	.100
9	-15.58	.522	.0000	.5859	.202E+00	.584E-01	-15.580	.194
10	-17.12	.566	.0000	.7568	.115E+00	.934E-01	-17.116	.210
11	-15.51	.255	.0000	.9394	.408E-01	.435E-01	-15.513	.094

(cont'd)

Table 3.2.7 (cont'd)

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.870	.987E-01	.595E-01	.987E-01	.363

SUMMARY STATISTICS FOR AGE 3

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-16.32	.366	.0000	.8938	-.356E-01	.648E-01	-16.319	.136
2	-15.01	.406	.0041	.5720	.215E-01	.728E-01	-15.012	.150
3	-14.62	.335	.1504	.7096	.706E-01	.550E-01	-14.621	.124
4	-15.34	.220	.0891	.6030	.256E-01	.385E-01	-15.337	.081
5	-16.61	.299	.0000	1.2274	-.119E-01	.536E-01	-16.612	.111
6	-15.22	.178	.0631	.8259	-.543E-02	.320E-01	-15.223	.066
7	-15.66	.294	.0134	.9088	.119E-01	.528E-01	-15.658	.109
8	-15.32	.314	.0100	1.3062	-.780E-01	.493E-01	-15.322	.116
9	-15.08	.721	.0000	1.0271	.808E-01	.129E+00	-15.081	.267
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.863	.956E-01	.818E-01	.956E-01	.733

SUMMARY STATISTICS FOR AGE 4

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-16.00	.275	.0000	1.9261	-.386E-01	.476E-01	-16.005	.102
2	-15.28	.354	.0031	.9285	.903E-01	.552E-01	-15.277	.131
3	-14.85	.326	.1196	1.1366	.591E-01	.549E-01	-14.850	.121
4	-15.57	.238	.0703	1.1685	.463E-01	.396E-01	-15.574	.088
5	-16.99	.885	.0000	.7551	-.585E-01	.158E+00	-16.994	.328
6	-15.62	.264	.0425	1.1066	-.234E-01	.469E-01	-15.620	.098
7	-15.73	.352	.0124	.8645	.117E-01	.633E-01	-15.730	.131
8	-15.16	.281	.0117	1.6780	-.105E+00	.345E-01	-15.163	.104
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.178	.109	.890E-01	.109	.670

SUMMARY STATISTICS FOR AGE 5

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-15.97	.468	.0000	2.3869	-.163E+00	.614E-01	-15.974	.173
2	-15.58	.315	.0023	.3773	.957E-01	.455E-01	-15.585	.117
3	-14.96	.268	.1074	.7089	.755E-01	.403E-01	-14.958	.099
4	-15.92	.267	.0495	.6037	.938E-01	.349E-01	-15.924	.099
5	-16.65	.530	.0000	1.9551	-.135E+00	.826E-01	-16.650	.196
6	-16.03	.353	.0283	1.2971	-.680E-01	.589E-01	-16.027	.131
7	-15.28	.395	.0195	.8628	-.779E-01	.656E-01	-15.278	.146
8	-15.68	.446	.0070	.9771	-.132E+00	.655E-01	-15.684	.165
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.800	.124	.166	.166	1.802

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-15.92	.521	.0000	2.4404	-.102E+00	.866E-01	-15.919	.193
2	-15.84	.485	.0018	.9242	.112E+00	.780E-01	-15.837	.180
3	-14.86	.380	.1183	.9291	.114E+00	.552E-01	-14.861	.141
4	-16.04	.303	.0439	.8118	.114E+00	.369E-01	-16.044	.112
5	No data for this fleet at this age							

(cont'd)

Table 3.2.7

VPA Version 3.0 (MSDOS)

COD IN THE NORTH SEA

CPUE data from file A:COD4EF.DAT

Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Shrinkage Log S.E = .20

Regression weights
.020, .116, .284, .482, .670, .820, .921, .976, .997, 1.000

Oldest age F = 1.000*average of 5 younger ages.

Fleet	
1	SCOGFS
2	SCOTRL
3	SCOSEI
4	SCOLTR
5	ENGGFS
6	ENGTRL
7	ENGSEI
8	FRATRB
9	FRGGFS
10	NETGFS
11	INTGFS

SUMMARY STATISTICS FOR AGE 1

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-17.72	.333	.0000	.0890	.736E-01	.539E-01	-17.718	.123
2	-17.09	.600	.0005	.0507	.144E+00	.953E-01	-17.088	.222
3	-16.72	.970	.0184	.0278	.364E+00	.118E+00	-16.720	.359
4	-17.14	.636	.0147	.0353	.152E+00	.101E+00	-17.142	.236
5	-16.18	.252	.0000	.1666	-.250E-01	.446E-01	-16.184	.094
6	-16.94	.811	.0114	.0445	.220E+00	.124E+00	-16.937	.300
7	-17.15	.789	.0030	.0414	.328E+00	.821E-01	-17.150	.292
8	-16.77	.387	.0024	.0786	.144E+00	.475E-01	-16.768	.143
9	-16.36	1.120	.0000	.0703	.373E+00	.150E+00	-16.356	.415
10	-15.77	.541	.0000	.2718	-.138E+00	.843E-01	-15.765	.200
11	-17.04	.487	.0000	.2657	-.906E-02	.877E-01	-17.041	.180

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.121	.142	.163	.163	1.309

SUMMARY STATISTICS FOR AGE 2

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-16.58	.252	.0000	.8333	.492E-02	.453E-01	-16.585	.093
2	-15.24	.602	.0033	.6103	.336E-01	.108E+00	-15.237	.223
3	-14.55	.537	.1619	.5115	.174E+00	.746E-01	-14.548	.199
4	-15.46	.397	.0785	.6522	.645E-01	.677E-01	-15.464	.147
5	-16.36	.221	.0000	1.0369	-.523E-02	.397E-01	-16.361	.082
6	-15.18	.304	.0657	.6863	.527E-01	.516E-01	-15.184	.113
7	-15.39	.377	.0175	.9055	.104E+00	.571E-01	-15.389	.140
8	-15.65	.270	.0072	1.0889	.348E-01	.471E-01	-15.649	.100
9	-15.58	.522	.0000	.5859	.202E+00	.584E-01	-15.580	.194
10	-17.12	.566	.0000	.7568	.115E+00	.934E-01	-17.116	.210
11	-15.51	.255	.0000	.9394	.408E-01	.435E-01	-15.513	.094

(cont'd)

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.870	.987E-01	.595E-01	.987E-01	.363

SUMMARY STATISTICS FOR AGE 3

Fleet ,	Pred. , q ,	SE(q),	Partial, F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1	,-16.32 ,	.366,	.0000 ,	.8938,	-.356E-01,	.648E-01,	-16.319,	.136
2	,-15.01 ,	.406,	.0041 ,	.5720,	.215E-01,	.728E-01,	-15.012,	.150
3	,-14.62 ,	.335,	.1504 ,	.7096,	.706E-01,	.550E-01,	-14.621,	.124
4	,-15.34 ,	.220,	.0891 ,	.6030,	.256E-01,	.385E-01,	-15.337,	.081
5	,-16.61 ,	.299,	.0000 ,	1.2274,	-.119E-01,	.536E-01,	-16.612,	.111
6	,-15.22 ,	.178,	.0631 ,	.8259,	-.543E-02,	.320E-01,	-15.223,	.066
7	,-15.66 ,	.294,	.0134 ,	.9088,	.119E-01,	.528E-01,	-15.658,	.109
8	,-15.32 ,	.314,	.0100 ,	1.3062,	-.780E-01,	.493E-01,	-15.322,	.116
9	,-15.08 ,	.721,	.0000 ,	1.0271,	.808E-01,	.129E+00,	-15.081,	.267
10	, No data for this fleet at this age							
11	, No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.863	.956E-01	.818E-01	.956E-01	.733

SUMMARY STATISTICS FOR AGE 4

Fleet ,	Pred. , q ,	SE(q),	Partial, F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1	,-16.00 ,	.275,	.0000 ,	1.9261,	-.386E-01,	.476E-01,	-16.005,	.102
2	,-15.28 ,	.354,	.0031 ,	.9285,	.903E-01,	.552E-01,	-15.277,	.131
3	,-14.85 ,	.326,	.1196 ,	1.1366,	.591E-01,	.549E-01,	-14.850,	.121
4	,-15.57 ,	.238,	.0703 ,	1.1685,	.463E-01,	.396E-01,	-15.574,	.088
5	,-16.99 ,	.885,	.0000 ,	.7551,	-.585E-01,	.158E+00,	-16.994,	.328
6	,-15.62 ,	.264,	.0425 ,	1.1066,	-.234E-01,	.469E-01,	-15.620,	.098
7	,-15.73 ,	.352,	.0124 ,	.8645,	.117E-01,	.633E-01,	-15.730,	.131
8	,-15.16 ,	.281,	.0117 ,	1.6780,	-.105E+00,	.345E-01,	-15.163,	.104
9	, No data for this fleet at this age							
10	, No data for this fleet at this age							
11	, No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.178	.109	.890E-01	.109	.670

SUMMARY STATISTICS FOR AGE 5

Fleet ,	Pred. , q ,	SE(q),	Partial, F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1	,-15.97 ,	.468,	.0000 ,	2.3869,	-.163E+00,	.614E-01,	-15.974,	.173
2	,-15.58 ,	.315,	.0023 ,	.3773,	.957E-01,	.455E-01,	-15.585,	.117
3	,-14.96 ,	.268,	.1074 ,	.7089,	.755E-01,	.403E-01,	-14.958,	.099
4	,-15.92 ,	.267,	.0495 ,	.6037,	.938E-01,	.349E-01,	-15.924,	.099
5	,-16.65 ,	.530,	.0000 ,	1.9551,	-.135E+00,	.826E-01,	-16.650,	.196
6	,-16.03 ,	.353,	.0283 ,	1.2971,	-.680E-01,	.589E-01,	-16.027,	.131
7	,-15.28 ,	.395,	.0195 ,	.8628,	-.779E-01,	.656E-01,	-15.278,	.146
8	,-15.68 ,	.446,	.0070 ,	.9771,	-.132E+00,	.655E-01,	-15.684,	.165
9	, No data for this fleet at this age							
10	, No data for this fleet at this age							
11	, No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.800	.124	.166	.166	1.802

SUMMARY STATISTICS FOR AGE 6

Fleet ,	Pred. , q ,	SE(q),	Partial, F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1	,-15.92 ,	.521,	.0000 ,	2.4404,	-.102E+00,	.866E-01,	-15.919,	.193
2	,-15.84 ,	.485,	.0018 ,	.9242,	.112E+00,	.780E-01,	-15.837,	.180
3	,-14.86 ,	.380,	.1183 ,	.9291,	.114E+00,	.552E-01,	-14.861,	.141
4	,-16.04 ,	.303,	.0439 ,	.8118,	.114E+00,	.369E-01,	-16.044,	.112
5	, No data for this fleet at this age							

(cont'd)

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
6	-16.18	.098	.0242	1.2673	-.174E-01	.166E-01	-16.180	.036
7	-14.80	.506	.0314	.7348	-.646E-01	.882E-01	-14.803	.187
8	-16.36	.374	.0035	1.2541	-.601E-01	.639E-01	-16.361	.139
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.140	.845E-01	.747E-01	.845E-01	.781

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	No data for this fleet at this age							
3	-14.85	.469	.1202	.6456	.205E+00	.434E-01	-14.845	.174
4	-16.21	.435	.0373	.8063	.105E+00	.689E-01	-16.207	.161
5	No data for this fleet at this age							
6	-16.33	.354	.0208	1.8402	-.667E-01	.592E-01	-16.334	.131
7	-14.62	.172	.0379	1.1180	-.522E-01	.249E-01	-14.616	.064
8	No data for this fleet at this age							
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.040	.139	.131	.139	.880

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	No data for this fleet at this age							
3	-14.68	.326	.1413	.6554	.106E+00	.452E-01	-14.684	.121
4	-16.21	.296	.0371	.5125	.603E-01	.489E-01	-16.212	.110
5	No data for this fleet at this age							
6	No data for this fleet at this age							
7	-14.16	.230	.0595	.4354	.283E-01	.402E-01	-14.164	.085
8	No data for this fleet at this age							
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.605	.159	.903E-01	.159	.323

SUMMARY STATISTICS FOR AGE 9

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	No data for this fleet at this age							
3	-14.64	.526	.1470	.4397	.154E+00	.775E-01	-14.644	.195
4	-16.40	.471	.0308	.5795	.910E-01	.784E-01	-16.400	.174
5	No data for this fleet at this age							
6	No data for this fleet at this age							
7	-14.32	.339	.0507	1.1523	-.699E-01	.559E-01	-14.324	.126
8	No data for this fleet at this age							
9	No data for this fleet at this age							
10	No data for this fleet at this age							
11	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.966	.244	.186	.244	.584

Table 3.2.8 Total international fishing mortality rate at age of COD in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	0.034	0.132	0.096	0.107	0.039	0.133	0.088	0.116	0.116	0.112	1
2	0.897	0.708	0.833	0.737	0.931	0.862	1.022	0.838	0.959	1.003	2
3	0.918	0.853	0.691	0.787	0.830	0.763	0.862	0.966	0.951	0.992	3
4	0.667	0.794	0.663	0.671	0.755	0.536	0.751	0.579	0.737	0.732	4
5	0.724	0.589	0.660	0.742	0.561	0.638	0.890	0.711	0.611	0.680	5
6	0.817	0.737	0.550	0.668	0.786	0.593	0.691	0.550	0.643	0.651	6
7	0.792	0.706	0.737	0.512	0.736	0.784	0.656	0.639	0.788	0.736	7
8	1.043	0.556	0.622	0.836	0.275	0.758	0.745	0.510	0.846	0.630	8
9	1.242	0.346	0.930	0.867	0.796	1.419	0.869	0.751	0.598	0.775	9
10	0.923	0.587	0.700	0.725	0.631	0.839	0.772	0.634	0.704	0.694	10
11	0.923	0.587	0.700	0.725	0.631	0.839	0.772	0.634	0.704	0.694	11

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	0.183	0.137	0.189	0.110	0.233	0.140	0.196	0.133	0.166	0.122	1
2	1.005	1.116	1.002	1.034	0.797	0.923	0.963	0.983	0.893	0.870	2
3	1.237	1.166	1.022	1.020	1.032	0.809	1.190	1.043	1.107	0.864	3
4	0.835	0.886	0.804	0.813	0.829	0.918	0.831	1.047	0.906	1.178	4
5	0.798	0.793	0.774	0.697	0.856	0.773	0.771	0.794	0.802	0.800	5
6	0.885	0.789	0.810	0.716	0.815	0.942	0.889	0.828	0.564	1.140	6
7	0.770	0.733	0.737	0.762	0.841	0.952	0.798	1.153	0.575	1.040	7
8	0.740	0.836	0.793	0.736	0.989	0.936	0.779	1.120	0.612	0.605	8
9	0.879	0.568	1.013	0.628	0.683	1.035	0.736	0.800	2.043	0.966	9
10	0.815	0.744	0.826	0.708	0.837	0.928	0.795	0.939	0.919	0.910	10
11	0.815	0.744	0.826	0.708	0.837	0.928	0.795	0.939	0.919	0.910	11

Table 3.2.9 Stock numbers at age ('000) of COD in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	159493	288994	231557	426209	195803	725980	425700	449080	799893	271006	1
2	352680	69260	113841	94516	172010	84606	285603	175100	179686	319985	2
3	85645	101314	24043	34865	31862	47795	25172	72396	53390	48510	3
4	12275	26644	33628	9383	12365	10820	17363	8280	21464	16060	4
5	5561	5159	9858	14186	3928	4756	5184	6706	3798	8406	5
6	6014	2208	2343	4171	5532	1835	2057	1744	2696	1687	6
7	3223	2175	865	1107	1750	2064	830	844	823	1160	7
8	987	1196	879	339	543	686	772	353	365	307	8
9	572	285	562	387	120	338	263	300	173	128	9
10	196	135	165	181	133	44	67	90	116	78	10
11	30	380	386	121	91	166	81	36	53	44	11

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	556052	268322	533286	109134	568319	237931	143016	246463	107287	168441	1
2	108919	208033	105144	198451	43922	202267	92917	52844	96953	40838	2
3	82688	28095	48010	27196	49723	13948	56615	25007	13938	27975	3
4	14004	18691	6820	13454	7635	13799	4835	13409	6865	3588	4
5	6322	4972	6307	2498	4888	2727	4512	1724	3854	2271	5
6	3486	2329	1841	2382	1018	1701	1031	1708	638	1415	6
7	721	1178	866	670	953	369	543	347	611	297	7
8	455	273	463	339	256	336	117	200	90	282	8
9	134	178	97	172	133	78	108	44	53	40	9
10	48	45	82	29	75	55	23	42	16	6	10
11	29	38	36	50	36	20	31	17	5	15	11

Table 3.2.10

Analysis by RCT3 ver3.1 of data from file :

A:CODIV1.RCX

COD IV RCT3 INPUT VALUES; AGE 1; 1992 WG

Data for 13 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
IYFS1	.95	3.63	.50	.614	19	1.48	5.04	.596	.046
IYFS2	1.09	3.07	.34	.780	19	1.63	4.84	.413	.096
EGFS0	.53	4.59	.50	.627	12	1.95	5.62	.580	.005
EGFS1	.88	3.10	.24	.882	13	1.96	4.82	.304	.018
EGFS2	1.07	3.75	.19	.923	14	.96	4.77	.238	.029
SGFS1	1.08	3.98	.26	.871	8	.74	4.78	.356	.130
SGFS2	1.02	4.00	.20	.910	9	.92	4.93	.259	.245
DGFS0	.50	3.80	.34	.774	9	2.69	5.15	.428	.090
DGFS1	.61	3.48	.25	.881	10	2.32	4.90	.322	.159
DGFS2	1.19	4.24	.44	.692	11	.53	4.87	.555	.053
FRGSF	.65	4.25	.36	.759	19	.47	4.56	.457	.079
GGFS1	1.81	1.68	2.34	.076	7	2.56	6.31	3.006	.002
GGFS2	2.14	1.09	1.50	.170	8	1.97	5.31	1.859	.005
					VPA Mean =		5.78	.606	.045

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
IYFS1	1.04	3.43	.51	.648	20	1.22	4.70	.616	.049
IYFS2	1.13	2.95	.33	.812	20	1.70	4.87	.400	.117
EGFS0	.66	4.21	.68	.516	13	1.59	5.27	.790	.003
EGFS1	.90	3.01	.24	.898	14	2.14	4.94	.288	.023
EGFS2	1.09	3.71	.18	.939	15	.59	4.35	.237	.033
SGFS1	1.10	3.93	.25	.891	9	1.39	5.46	.303	.203
SGFS2	1.09	3.87	.22	.908	10	1.06	5.03	.265	.267
DGFS0	.57	3.51	.40	.741	10	3.20	5.33	.480	.081
DGFS1	.64	3.35	.26	.888	11	2.10	4.70	.326	.176
DGFS2									
FRGSF									
GGFS1	3.14	-1.46	3.84	.032	8	2.80	7.33	4.827	.001
GGFS2	2.50	.23	1.63	.164	9	1.53	4.05	2.053	.004
					VPA Mean =		5.68	.662	.043

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
IYFS1	1.01	3.54	.47	.681	21	2.64	6.20	.548	.158
IYFS2									
EGFS0	.67	4.18	.67	.516	14	3.90	6.80	.822	.007
EGFS1	.88	3.07	.23	.901	15	2.56	5.34	.266	.067
EGFS2									
SGFS1	1.14	3.84	.27	.865	10	1.86	5.95	.328	.440
SGFS2									
DGFS0	.59	3.43	.40	.730	11	3.71	5.61	.468	.217
DGFS1									
DGFS2									
FRGSF									
GGFS1	3.84	-3.35	4.47	.021	9	2.67	6.88	5.438	.002
GGFS2									
					VPA Mean =		5.61	.656	.110

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
IYFS1									
IYFS2									
EGFS0	.68	4.17	.68	.508	14	2.25	5.69	.787	.065
EGFS1									
EGFS2									
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
FRGSF									
GGFS1									
GGFS2									
					VPA Mean =		5.58	.657	.935

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	138	4.93	.13	.07	.28	108	4.68
1990	155	5.05	.14	.10	.56	168	5.13
1991	345	5.85	.22	.11	.24		
1992	266	5.59	.64	.03	.00		

Table 3.2.11

Analysis by RCT3 ver3.1 of data from file :

A:CODIV2.RCX

COD IV RCT3 INPUT VALUES; AGE 2; 1992 WG

Data for 13 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

Survey/ Series	I-----------Regression	----------I				I-----------Prediction	----------I		
	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.93	2.74	.49	.615	19	1.48	4.12	.580	.046
IYFS2	1.09	2.13	.36	.744	19	1.63	3.90	.446	.078
EGFS0	.52	3.67	.49	.626	12	1.95	4.68	.568	.005
EGFS1	.87	2.18	.25	.864	13	1.96	3.89	.322	.015
EGFS2	1.06	2.83	.21	.901	14	.96	3.84	.266	.022
SGFS1	1.02	3.11	.25	.870	8	.74	3.87	.340	.135
SGFS2	.96	3.14	.18	.921	9	.92	4.02	.229	.296
DGFS0	.49	2.90	.36	.743	9	2.69	4.21	.442	.080
DGFS1	.60	2.57	.26	.863	10	2.32	3.96	.338	.136
DGFS2	1.17	3.31	.45	.673	11	.53	3.93	.564	.049
FRGSF	.63	3.37	.33	.778	19	.47	3.66	.423	.087
GGFS1	1.60	1.17	2.06	.087	7	2.56	5.27	2.648	.002
GGFS2	2.09	.24	1.47	.162	8	1.97	4.36	1.825	.005
					VPA Mean =		4.84	.591	.045

Yearclass = 1990

Survey/ Series	I-----------Regression	----------I				I-----------Prediction	----------I		
	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.02	2.52	.51	.643	20	1.22	3.78	.612	.050
IYFS2	1.13	2.00	.36	.781	20	1.70	3.93	.432	.100
EGFS0	.65	3.29	.67	.512	13	1.59	4.33	.783	.003
EGFS1	.90	2.09	.25	.884	14	2.14	4.00	.305	.020
EGFS2	1.08	2.78	.20	.920	15	.59	3.42	.267	.026
SGFS1	1.06	3.04	.24	.889	9	1.39	4.51	.294	.215
SGFS2	1.04	2.99	.20	.913	10	1.06	4.09	.247	.306
DGFS0	.56	2.59	.42	.709	10	3.20	4.39	.500	.074
DGFS1	.63	2.44	.27	.871	11	2.10	3.76	.344	.157
DGFS2									
FRGSF									
GGFS1	2.81	-1.70	3.43	.037	8	2.80	6.18	4.316	.001
GGFS2	2.47	-.65	1.61	.154	9	1.53	3.11	2.037	.004
					VPA Mean =		4.74	.650	.044

Yearclass = 1991

Survey/ Series	I-----------Regression	----------I				I-----------Prediction	----------I		
	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.04	2.51	.50	.657	20	2.64	5.24	.588	.138
IYFS2									
EGFS0	.65	3.29	.68	.508	13	3.90	5.83	.854	.007
EGFS1	.89	2.08	.25	.885	14	2.56	4.38	.298	.054
EGFS2									
SGFS1	1.06	3.04	.25	.888	9	1.86	5.00	.306	.508
SGFS2									
DGFS0	.57	2.57	.43	.703	10	3.71	4.67	.512	.181
DGFS1									
DGFS2									
FRGSF									
GGFS1	2.74	-1.59	3.38	.038	8	2.67	5.73	4.247	.003
GGFS2									
					VPA Mean =		4.71	.657	.110

Yearclass = 1992

Survey/ Series	I-----------Regression	----------I				I-----------Prediction	----------I		
	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	.65	3.28	.70	.502	13	2.25	4.75	.823	.061
EGFS1									
EGFS2									
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
FRGSF									
GGFS1									
GGFS2									
					VPA Mean =		4.68	.661	.939

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	54	4.01	.12	.07	.28	42	3.74
1990	62	4.13	.14	.10	.52		
1991	136	4.91	.22	.10	.20		
1992	108	4.68	.64	.02	.00		

Table 3.2.12 Mean fishing mortality, biomass and recruitment of COD in Sub-area IV between 1972 and 1991.

	Mean Fishing Mortality			Biomass		Recruits	
	Ages 2 to 8		Ages 0 to 0	1000 tonnes		Age 1	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1972	0.837	0.000	0.000	755	217	71	159
1973	0.706	0.000	0.000	603	194	72	289
1974	0.680	0.000	0.000	561	210	73	232
1975	0.707	0.000	0.000	621	188	74	426
1976	0.696	0.000	0.000	525	162	75	196
1977	0.705	0.000	0.000	712	142	76	726
1978	0.803	0.000	0.000	709	143	77	426
1979	0.685	0.000	0.000	705	148	78	449
1980	0.791	0.000	0.000	887	161	79	800
1981	0.775	0.000	0.000	741	174	80	271
1982	0.896	0.000	0.000	737	168	81	556
1983	0.903	0.000	0.000	557	135	82	268
1984	0.849	0.000	0.000	624	116	83	533
1985	0.825	0.000	0.000	411	107	84	109
1986	0.880	0.000	0.000	540	95	85	568
1987	0.893	0.000	0.000	455	86	86	238
1988	0.889	0.000	0.000	326	79	87	143
1989	0.995	0.000	0.000	344	73	88	246
1990	0.780	0.000	0.000	281	62	89	137
1991	0.928	0.000	0.000	258	56	90	155
Arit-mean recruits at age 1 for period 1972 to 1991							346
Geom-mean recruits at age 1 for period 1972 to 1991							294

Table 3.2.13 Input for catch prediction of COD in Sub-area IV.

Age	1991 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 1987 to 1991: H.Con.	Scaled mean F: Disc	Scaled mean F: Ind	Mean values for period 1987 to 1991, Mean Weight (Kg.): H.Con.	Mean Weight: Disc	Mean Weight: Ind	Mean Weight: Stock	Prop. Ret.
1	155000	0.146			0.152			0.644			0.644	1.000
2	54000	0.869			0.907			0.955			0.955	1.000
3	27975	0.864			1.046			1.964			1.964	1.000
4	3588	1.178			1.019			3.676			3.676	1.000
5	2271	0.800			0.822			5.884			5.884	1.000
6	1415	1.140			0.911			8.064			8.064	1.000
7	297	1.040			0.943			9.858			9.858	1.000
8	282	0.605			0.846			11.157			11.157	1.000
9	40	0.966			1.165			12.914			12.914	1.000
10	6	0.910			0.937			14.499			14.499	1.000
11	15	0.910			0.937			14.914			14.914	1.000

Mean F	Age 2 to 8	Age 0 0	Age 2 to 8	Age 0 0
Unscaled	0.928	0.000	0.889	0.000
Scaled			0.928	0.000

Recruits at age 1 in 1992 = 345000
Recruits at age 1 in 1993 = 265000
Recruits at age 1 in 1994 = 265000
Recruits at age 1 in 1995 = 265000

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

Mean F for ages 2 to 8 in 1991 for human consumption landings + discards = 0.928 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1987 to 1991
rescaled to produce a mean value of F for ages 2 to 8 equal to that for 1991

Mean F for ages 0 to 0 in 1991 for small-mesh fisheries = 0.000 .
Industrial fishery F-at-age in the prediction are averages for the period 1987 to 1991 .
rescaled to produce a mean value of F for ages 0 to 0 equal to that for 1991

Values of N in 1991 from VPA have been overwritten
for the following ages .....

Age 1
Age 2

Values of F for these ages in 1991 from VPA have been overwritten
with scaled mean values used for predictions for 1992 onwards

Table 3.2.14 Predicted catches and biomasses ('000 t) of COD in Sub-area IV 1992 to 1993.

	Year 1991	1992	1993								
Biomass 1 Jan of Year											
Total	258	363	371	371	371	371	371	371	371	371	371
Spawning	56	51	47	47	47	47	47	47	47	47	47
Mean F Ages											
Human Cons. 2 to 8	0.93	0.93	0.00	0.19	0.37	0.56	0.74	0.93	1.11	0.17	0.25
Small-mesh 0 to 0	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(1991)										F0.1	Fmax
Human Consumption	1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.18	0.27
Catch weight											
Human Consumption	86	100	0	33	61	85	106	124	139	30	43
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	86	100	0	33	61	85	106	124	139	30	43
Total catch	86	100	0	33	61	85	106	124	139	30	43
Biomass 1 Jan of Year+1											
Total	363	371	564	513	470	434	404	378	356	517	497
Spawning	51	47	123	103	86	73	61	52	44	105	97

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
1	345000	33894			33894
2	60188	31080			31080
3	15954	9356			9356
4	9187	5409			5409
5	905	466			466
6	836	460			460
7	371	208			208
8	86	45			45
9	126	80			80
10	12	7			7
11	2	1			1
Wt	363135	99908	0	0	99908

Stock at start of and catch during 1993
for F(1993) = F(1992)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	265000	26034			26034
2	133114	68738			68738
3	17119	10039			10039
4	4363	2569			2569
5	2716	1399			1399
6	325	179			179
7	275	155			155
8	118	62			62
9	30	19			19
10	32	18			18
11	5	3			3
Wt	370884	123990	0	0	123990

Table 3.2.15 Predicted catches and biomasses ('000 t) of COD in Sub-area IV 1992 to 1993.

		Year										
		1991	1992	1993								
Biomass 1 Jan of Year												
Total		258	363	396	396	396	396	396	396	396	396	396
Spawning		56	51	58	58	58	58	58	58	58	58	58
Mean F	Ages											
Human Cons.	2 to 8	0.93	0.70	0.00	0.19	0.37	0.56	0.74	0.93	1.11	0.00	0.00
Small-mesh	0 to 0	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(1991)											F0.1	Fmax
Human Consumption		1.00	0.75	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.00	0.00
Catch weight												
Human Consumption		86	81	0	37	68	95	118	138	155	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		86	81	0	37	68	95	118	138	155	0	0
Total catch		86	81	0	37	68	95	118	138	155	0	0
Biomass 1 Jan of Year+1												
Total		363	396	596	540	492	452	419	391	367	0	0
Spawning		51	58	145	121	101	85	71	60	51	0	0

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
1	345000	25850			25850
2	60188	25575			25575
3	15954	7805			7805
4	9187	4506			4506
5	905	382			382
6	836	379			379
7	371	172			172
8	86	37			37
9	126	68			68
10	12	6			6
11	2	1			1
Wt	363135	81338	0	0	81338

Stock at start of and catch during 1993
for F(1993) = F(1991)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	265000	26034			26034
2	138271	71401			71401
3	21467	12589			12589
4	5665	3335			3335
5	3502	1804			1804
6	400	220			220
7	345	194			194
8	149	78			78
9	37	24			24
10	43	24			24
11	6	3			3
Wt	395668	137799	0	0	137799

Table 3.2.16 Results from management scenario simulations from risk analysis. Case numbers identify strategies which are plotted in Figure 3.2.6.

case	min. ssb	relative F	mean yield	C.V. Yield	Mean SSB	C.V. SSB	Prop. closed
1	30	.8	200	.274	136	.255	0
2	30	.9	185	.255	101	.224	0
3	30	1	181	.3	80	.26	0
4	30	1.1	183	.327	67	.279	0
5	30	1.2	182	.303	55	.254	0
6	60	.8	199	.262	135	.244	0
7	60	.9	197	.301	108	.26	.004
8	60	1	195	.384	94	.276	.042
9	60	1.1	189	.501	91	.341	.118
10	60	1.2	190	.592	91	.363	.186
11	90	.8	203	.307	142	.246	.018
12	90	.9	206	.382	127	.259	.062
13	90	1	204	.551	127	.306	.158
14	90	1.1	206	.641	128	.342	.228
15	90	1.2	207	.756	127	.379	.286
16	120	.8	211	.391	168	.232	.082
17	120	.9	222	.523	168	.289	.154
18	120	1	216	.655	164	.316	.24
19	120	1.1	209	.762	156	.343	.304
20	120	1.2	208	.815	151	.355	.348
21	150	.8	219	.477	199	.249	.146
22	150	.9	223	.638	199	.286	.234
23	150	1	216	.73	190	.298	.304
24	150	1.1	219	.819	184	.321	.352
25	150	1.2	216	.884	179	.353	.396

Table 3.2.17

Stock: Cod in Sub-area IV (North Sea)

Assessment Quality Control Diagram 1

Average F(2-8,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.86[1]				
1989	0.83	0.80			
1990	0.86	0.83	0.83		
1991	0.89	0.88	0.98	0.75	
1992	0.89	0.89	1.00	0.78	0.93

[1]1987 value may be inflated by high estimate for age 3.

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	174[1]	177	160				
1989		150	136	143			
1990			179	142	119		
1991				121	100	108	
1992					78	100	124
					Actual	Current	Forecast

$$\textit{Actual SQC} = \textit{Landings}(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

[1]No correction applied because 1987 value may be inflated by about 0.05.

Remarks:

(cont'd)

Table 3.2.17 (cont'd)

Stock: Cod in Sub-area IV (North Sea)

Assessment Quality Control Diagram 3

Recruitment (age 1) Unit: millions					
Date of assessment	Year class				
	1987	1988	1989	1990	1991
1988	277[1]				
1989	193	329[2]			
1990	201	324	161[3]		
1991	142	316	140	216	
1992	143	246	137	155	345

[1]Amdended by ACFM to 205. [2]Amended by ACFM to 299.
[3]As revised by ACFM.

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	95	96	105[1]	122[1,2]				
1989	93	88	91	82[1]	80[1,2]			
1990[4]	89	84	85	87	78[1,3]	71[1,3]		
1991	86	79	73	66	64	66[1,3]	68[1,3]	
1992	86	79	73	62	56	51	47[1,5]	52[1,6]

[1]Forecast. [2]Assuming TAC taken in 1988, F(89) = 0.7(87). [3]Assuming *status quo* F in 1990.
[4]As revised by ACFM. [5]Assuming *status quo* F in 1991. [6]Assuming *status quo* F in 1993.

Remarks:

Table 3.3.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1981-1991, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Belgium	1,217	966	985	494	719	317	165	220	145	192	168
Denmark	13,198	22,704	25,653	16,368	23,821	16,397	7,767	9,174	2,789	1,993	1,330
Faroe Islands	46	6	51	-	5	4	23	35	16	6	15
France	11,966	15,988	11,250	8,103	5,389	4,802	3,889	2,193	1,702[1]	n/a	631[4]
Germany, Fed.Rep.	3,387	4,510	3,654	2,571	2,796	1,984	1,231	802	447	714	565
Netherlands	2,279	1,021	1,722	1,052	3,875	1,627	1,093	895[3]	328	n/a	103
Norway[2]	2,283	2,888	3,862	3,959	3,498	5,190	2,610	1,590	1,664[1]	1,483	1,840
Poland	31	317	150	17	-	1	-	-	-	-	-
Sweden	1,301	1,874	1,360	1,518	1,942	1,550	937	614	1,051	900	957
UK (Engl.& Wales)	14,570	16,403	15,476	12,340	13,614	8,137	7,491	5,537	2,704	2,093	2,073
UK (N. Ireland)	-	-	-	-	-	-	-	-	137	11	2
UK (Scotland)	82,798	107.773	100,390	87,479	112,549	126,650	84,063	84,104	53,252	34,459	36,272
Total	133,076	174,450	164,553	133,901	168,208	166,659	109,269	104,269	64,235	n/a	43,956

[1]Preliminary.
[2]Figures do not include haddock caught as industrial by-actch.
[3]Working Group estimate.
[4]Includes Division IIa (EC).
n/a = Not available.

Table 3.3.2 Annual weight and numbers of HADDOCK caught in Sub-area IV between 1972 and 1991.

Year	Weight (1000 tonnes) Total	H.Con	Disc	By-cat	Number (millions) Total	H.Con	Disc	By-cat
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	1447	218	541	687
1981	207	130	60	17	1352	274	298	780
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	254	362	29
1989	104	76	26	2	296	168	111	17
1990	87	51	33	3	314	108	192	14
1991	90	44	40	5	458	99	216	143

Table 3.3.3 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
12	0.200	1.000

Table 3.3.4 Total international catch at age ('000) of HADDOCK in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	240896	59872	601412	44946	167173	114954	285843	841439	374960	646419	0
1	675831	364822	1213867	2096827	167599	250138	454092	344756	659594	134440	1
2	584076	567133	174389	632672	1046110	104310	142668	198147	323151	413156	2
3	40150	237498	326659	57630	204506	376976	28695	39551	68715	138189	3
4	20948	6099	53137	106048	9555	38062	107172	7068	9837	14457	4
5	155922	4399	1832	15320	30044	4087	8153	26742	1784	1883	5
6	3516	38829	1320	952	4793	5939	1190	2134	7573	374	6
7	188	1237	10672	601	198	1230	1942	250	562	2462	7
8	33	106	236	2628	73	128	377	461	114	123	8
9	27	28	23	258	728	27	108	145	153	63	9
10	402	108	31	61	58	190	14	52	70	23	10
11	11	48	3	11	3	2	60	11	29	30	11
12		5	5	7		1	14	11	13	8	12

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	278705	639815	95502	139623	56507	9419	10808	10705	55509	123861	0
1	275372	156146	432175	179244	160285	277273	29040	47212	80305	219596	1
2	83827	247634	161719	526391	177699	246818	482791	33538	99911	75443	2
3	287840	71192	118503	75488	320291	46723	87436	179456	17030	21997	3
4	40322	123246	21366	36620	27068	67312	13155	17549	55549	3403	4
5	3198	15955	32134	5271	9504	4628	18433	2540	3572	12043	5
6	691	1645	3698	7286	1208	2816	1547	4001	830	902	6
7	268	286	590	954	1808	530	615	496	1279	385	7
8	780	59	76	209	235	768	152	195	189	596	8
9	29	189	37	54	101	130	135	82	73	137	9
10	15	52	110	22	43	32	48	28	39	48	10
11	7	6	14	88	29	47	13	12	8	5	11
12	4	8	8	4	48	64	34	11	16	5	12

Table 3.3.5 Total international mean weight at age (kg) of HADDOCK in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	0.024	0.044	0.024	0.021	0.013	0.019	0.012	0.009	0.012	0.009	0
1	0.116	0.112	0.128	0.101	0.125	0.108	0.144	0.095	0.104	0.074	1
2	0.242	0.241	0.226	0.241	0.224	0.241	0.253	0.291	0.284	0.262	2
3	0.388	0.372	0.343	0.356	0.401	0.345	0.418	0.442	0.486	0.476	3
4	0.506	0.585	0.548	0.450	0.512	0.602	0.441	0.637	0.732	0.744	4
5	0.606	0.648	0.891	0.680	0.588	0.613	0.719	0.664	1.046	1.147	5
6	1.000	0.724	0.895	1.245	0.922	0.802	0.742	0.933	0.936	1.479	6
7	1.366	1.044	0.953	1.124	1.933	1.181	0.954	1.187	1.394	1.180	7
8	2.241	1.302	1.513	1.093	1.784	1.943	1.398	1.187	1.599	1.634	8
9	2.006	2.796	2.315	1.720	1.306	2.322	2.124	1.468	1.593	1.764	9
10	1.651	1.726	2.508	2.217	2.425	1.780	2.868	2.679	1.726	1.554	10
11	2.899	2.020	4.152	2.854	2.528	3.189	1.849	1.624	3.328	1.492	11
12		2.158	2.264	3.426		4.119	2.812	1.748	1.773	2.972	12

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	0.011	0.022	0.010	0.013	0.025	0.008	0.024	0.027	0.044	0.029	0
1	0.100	0.135	0.141	0.149	0.124	0.126	0.164	0.198	0.194	0.177	1
2	0.292	0.297	0.300	0.279	0.242	0.265	0.217	0.300	0.291	0.320	2
3	0.461	0.448	0.488	0.479	0.396	0.405	0.417	0.372	0.429	0.471	3
4	0.784	0.651	0.670	0.668	0.612	0.613	0.589	0.605	0.473	0.638	4
5	1.166	0.916	0.805	0.859	0.864	1.029	0.747	0.811	0.772	0.649	5
6	1.441	1.215	1.097	1.054	1.260	1.278	1.283	0.984	0.968	1.042	6
7	1.672	1.162	1.100	1.470	1.202	1.433	1.424	1.375	1.169	1.230	7
8	1.456	1.920	1.868	1.844	1.719	1.530	1.542	1.659	1.533	1.479	8
9	2.634	1.376	2.425	2.137	1.526	1.865	1.612	1.695	2.034	1.771	9
10	2.164	1.395	1.972	2.193	2.482	2.040	1.674	2.240	2.658	1.943	10
11	1.924	1.907	2.247	1.991	2.632	1.902	3.122	2.159	2.310	2.231	11
12	2.532	3.776	2.841	2.434	2.625	2.499	2.880	2.217	2.580	2.409	12

Table 3.3.6 HADDOCK in the North Sea. Research vessel indices.

Yearclass	IYFS1	IYFS1	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	GGFS1	GGFS2
1971	740	971	-1	-1	-1	-1	-1	-1	-1	-1
1972	187	110	-1	-1	-1	-1	-1	-1	-1	-1
1973	1092	385	-1	-1	-1	-1	-1	-1	-1	-1
1974	1168	670	-1	-1	-1	-1	-1	-1	-1	-1
1975	177	84	-1	-1	32.1	-1	-1	-1	-1	-1
1976	162	108	-1	66.8	26.2	-1	-1	-1	-1	-1
1977	385	240	534.8	136.9	54.6	-1	-1	-1	-1	-1
1978	480	402	358.3	295.5	167.3	-1	-1	-1	-1	-1
1979	896	675	875.5	623.3	439.1	-1	-1	-1	-1	-1
1980	268	252	374	173.2	79.8	-1	-1	99.6	-1	-1
1981	526	400	1537.5	315.5	109.5	-1	248.8	161.1	-1	72.8
1982	307	219	281.3	218.2	61.6	123.5	181.3	78.8	93.9	47.2
1983	1057	828	831.9	599.3	238.2	220.3	436.7	298.1	272.9	259.6
1984	229	244	228.5	186.6	44.7	87.3	197.6	57.4	129.7	38
1985	579	326	245.9	149.7	43.1	81.8	232.9	70.4	142.3	154.4
1986	885	688	266	281.9	183.5	174.7	239.3	198.2	307.4	179.9
1987	92	97	22.4	28.6	14.5	27.7	46.7	21.4	68.6	45.3
1988	210	114	60.7	81.7	19.8	40.6	88.6	24	135	54.7
1989	219	131	94.3	65.7	9.6	43.2	100.2	17.8	180	54.9
1990	679	371	281.9	115	66.6	316.3	170.5	91.9	601	129.2
1991	1115	-1	263.3	134.1	-1	347.1	324	-1	480.1	-1
1992	-1	-1	561.9	-1	-1	228.2	-1	-1	-1	-1

Table 3.3.7 HADDOCK in Sub-area IV. Tuning summary.

VPA Version 3.0 (MSDOS)

At 7/10/1992 18:50

HADDOCK IN THE NORTH SEA

CPUE data from file HAD4EF.DAT

Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Shrinkage Log S.E = .200

Tuning converged after 20 iterations

Total of the absolute F residuals for all ages in the
last year between iterations 19 and 20 = .000

Regression weights

0	.02	.116	.284	.482	.67	.82	.921	.976

Oldest age F = 1.000*average of 5 younger ages.

Fleets

1	SCOGFS,	Scottish Groundfish Survey
2	SCOTRL,	Scottish Trawlers
3	SCOSEI,	Scottish Seiners
4	SCOLTR,	Scottish Light Trawlers
5	ENGGFS,	English Groundfish Survey
6	FRATRB,	French trawlers
7	FRGGFS,	German Groundfish Survey
8	INTGFS,	International Groundfish Survey

(cont'd)

Table 3.3.7 (cont'd)

SUMMARY STATISTICS FOR AGE 0

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-17.97	.385	0	.0056	.137	.0496	-17.973	.143
2	-22.76	1.422	0	.0027	.0865	.254	-22.759	.527
3	-21.88	.586	.0001	.0059	-.121	.0965	-21.876	.217
4	-22.03	1.077	.0001	.0132	-.337	.153	-22.027	.399
5	-17.67	.342	0	.0099	-.0136	.0613	-17.672	.127
6	-21.54	.983	0	.0262	-.106	.173	-21.536	.364
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.006	.220	.129	.220	.345

SUMMARY STATISTICS FOR AGE 1

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-15.6	.325	0	.2168	.035	.0573	-15.597	.121
2	-16.32	.696	.0011	.2769	-.00405	.125	-16.32	.258
3	-16	.577	.0378	.1254	.195	.0779	-16.003	.214
4	-16.65	.423	.0241	.1197	.00626	.0762	-16.646	.157
5	-15.81	.27	0	.2596	-.0328	.0472	-15.81	.1
6	-16.76	.338	.0024	.1919	.00799	.0608	-16.758	.125
7	-15.25	.619	0	.0867	.275	.0463	-15.254	.229
8	-14.68	.239	0	.1366	.103	.0228	-14.677	.089

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.165	.126	.104	.126	.673

SUMMARY STATISTICS FOR AGE 2

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-14.94	.163	0	1.3712	-.0098	.0292	-14.944	.06
2	-14.27	.369	.0085	1.1228	-.00232	.0665	-14.274	.137
3	-13.75	.346	.3605	.8843	.149	.033	-13.747	.128
4	-14.89	.407	.1393	.8478	.0215	.0729	-14.89	.151
5	-15.26	.258	0	1.8507	-.0418	.044	-15.261	.096
6	-14.92	.272	.0149	1.4728	-.0147	.0487	-14.922	.101
7	-14.51	.541	0	.684	.215	.0572	-14.511	.201
8	-13.46	.247	0	.8227	.0945	.0294	-13.459	.092

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.164	.964E-01	.985E-01	.985E-01	1.043

SUMMARY STATISTICS FOR AGE 3

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-15.21	.224	0	2.5899	-.0552	.0354	-15.213	.083
2	-13.99	.438	.0114	1.4804	-.0381	.0778	-13.987	.162
3	-13.37	.258	.524	1.2093	.109	.0257	-13.373	.096
4	-14.62	.233	.182	1.193	.0646	.0352	-14.623	.086
5	-15.45	.247	0	1.8577	-.00114	.0446	-15.449	.092
6	-14.52	.201	.0223	2.2603	-.0577	.03	-14.521	.075
7	-14.2	.811	0	.8339	.29	.101	-14.198	.301
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.654	.995E-01	.118	.118	1.398

(cont'd)

Table 3.3.7 (cont'd)

SUMMARY STATISTICS FOR AGE 4

Fleet	Pred.	SE(q)	Partial	Raised	SLOPE	SE	INTRCPT	SE
0	q		0 F	F	0	Slope		0Intrcpt
1	-15.31	.174	0	1.526	-.028	.0297	-15.311	.064
2	-13.92	.321	.0122	2.1951	-.0564	.0542	-13.916	.119
3	-13.42	.194	.4978	1.141	.0673	.0256	-13.424	.072
4	-14.58	.178	.1905	1.1487	.0572	.0248	-14.577	.066
5	-15.61	.197	0	1.173	.0247	.0343	-15.605	.073
6	-14.39	.252	.0254	2.4932	-.0744	.0369	-14.389	.093
7	-14.5	.948	0	.5749	.273	.14	-14.495	.352
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.366	.834E-01	.107	.107	1.634

SUMMARY STATISTICS FOR AGE 5

Fleet	Pred.	SE(q)	Partial	Raised	SLOPE	SE	INTRCPT	SE
0	q		0 F	F	0	Slope		0Intrcpt
1	-15.55	.277	0	1.3341	-.0798	.0412	-15.546	.103
2	-13.8	.303	.0137	1.6339	-.0197	.0541	-13.801	.112
3	-13.65	.168	.3973	.9515	.0281	.0286	-13.65	.062
4	-14.71	.21	.1673	.9103	.0545	.0325	-14.707	.078
5	-15.67	.366	0	.8657	-.0453	.0639	-15.665	.135
6	-14.23	.281	.0298	1.9286	-.0783	.0423	-14.228	.104
7	-14.7	.963	0	2.4929	.231	.154	-14.697	.357
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.111	.984E-01	.107	.107	1.177

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred.	SE(q)	Partial	Raised	SLOPE	SE	INTRCPT	SE
0	q		0 F	F	0	Slope		0Intrcpt
1	-15.61	.372	0	.753	-.109	.055	-15.605	.138
2	-13.91	.402	.0122	.766	-.065	.0686	-13.914	.149
3	-13.87	.135	.3195	.9369	-.00452	.0243	-13.868	.05
4	-14.84	.297	.1459	.5821	.0323	.0522	-14.844	.11
5	-15.71	.488	0	2.8827	-.153	.0694	-15.714	.181
6	-14.05	.225	.0357	1.5114	-.088	.0259	-14.049	.083
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.971	.984E-01	.140	.140	2.039

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred.	SE(q)	Partial	Raised	SLOPE	SE	INTRCPT	SE
0	q		0 F	F	0	Slope		0Intrcpt
1	-15.65	.38	0	1.3857	-.138	.0482	-15.648	.141
2	-13.78	.407	.014	.5964	-.0422	.0717	-13.779	.151
3	-14.02	.113	.2736	.8608	.011	.02	-14.023	.042
4	-14.8	.225	.1525	.7379	-.0119	.0402	-14.8	.083
5	-15.82	.512	0	.8287	-.0917	.0863	-15.822	.19
6	-13.86	.258	.0432	1.5378	-.0764	.0378	-13.859	.096
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.884	.878E-01	.989E-01	.989E-01	1.271

(cont'd)

Table 3.3.7 (cont'd)

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-15.5	.747	0	1.1102	-.0431	.134	-15.496	.277
2	-13.76	.504	.0142	.7636	.0891	.0852	-13.763	.187
3	-14.22	.462	.2255	.7347	.134	.0684	-14.216	.171
4	-14.86	.345	.1442	.5896	.0459	.0601	-14.856	.128
5	No data for this fleet at this age							
6	-13.75	.383	.0483	1.5664	-.0427	.0674	-13.746	.142
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.852	.198	.139	.198	.497

SUMMARY STATISTICS FOR AGE 9

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-13.86	.704	.0129	1.4467	.111	.121	-13.858	.261
3	-14.21	.651	.2269	.7358	.243	.08	-14.21	.241
4	No data for this fleet at this age							
5	No data for this fleet at this age							
6	-13.63	.334	.0543	1.459	.0278	.0593	-13.629	.124
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.041	.274	.109	.274	.158

SUMMARY STATISTICS FOR AGE 10

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-13.68	.655	.0154	.8167	.128	.109	-13.682	.243
3	-14.04	.445	.2683	1.2101	.0973	.0725	-14.043	.165
4	No data for this fleet at this age							
5	No data for this fleet at this age							
6	-13.45	.349	.0652	1.5124	.0586	.0594	-13.446	.129
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.164	.253	.939E-01	.253	.137

Table 3.3.8 Total international fishing mortality rate at age of HADDOCK in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	0.029	0.002	0.012	0.010	0.027	0.012	0.018	0.030	0.062	0.051	0
1	0.155	0.341	0.324	0.307	0.284	0.306	0.357	0.161	0.171	0.167	1
2	0.795	0.572	0.938	0.978	0.826	1.007	1.009	0.892	0.704	0.454	2
3	1.323	1.163	0.960	1.264	1.380	1.040	1.110	1.133	1.195	0.940	3
4	1.194	0.783	1.004	1.110	0.788	1.248	1.099	1.034	1.116	0.981	4
5	1.165	0.942	0.599	0.988	1.285	1.030	1.113	0.994	0.862	0.690	5
6	0.886	1.113	0.855	0.732	1.031	1.005	1.023	1.060	0.891	0.434	6
7	0.511	0.945	1.157	1.368	0.323	0.838	1.172	0.618	0.935	0.846	7
8	0.270	0.614	0.462	1.069	0.584	0.357	0.677	1.043	0.641	0.538	8
9	0.179	0.387	0.253	1.473	1.042	0.451	0.583	0.611	1.343	0.943	9
10	1.727	2.634	1.021	2.424	2.378	0.880	0.453	0.622	0.689	0.761	10
11	0.715	1.139	0.750	1.413	1.072	0.706	0.783	0.792	0.905	0.711	11
12	0.715	1.139	0.750	1.413	1.072	0.706	0.783	0.792	0.905	0.711	12

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	0.035	0.024	0.014	0.015	0.003	0.006	0.004	0.004	0.006	0.006	0
1	0.161	0.141	0.115	0.191	0.120	0.099	0.135	0.108	0.214	0.166	1
2	0.434	0.663	0.664	0.612	1.023	0.913	0.805	0.722	1.287	1.164	2
3	0.811	1.014	0.987	0.950	1.239	1.075	1.335	1.028	1.362	1.654	3
4	0.880	1.147	1.126	1.097	1.292	1.088	1.191	1.280	1.239	1.366	4
5	0.629	1.200	1.221	1.043	1.056	0.851	1.135	0.822	1.102	1.111	5
6	0.590	0.797	1.072	1.088	0.728	1.134	0.794	0.826	0.712	0.971	6
7	0.645	0.523	0.763	0.934	0.912	0.850	0.830	0.646	0.698	0.884	7
8	0.725	0.280	0.254	0.686	0.627	1.452	0.639	0.698	0.550	0.852	8
9	0.229	0.380	0.284	0.290	0.872	0.882	1.216	0.877	0.621	1.041	9
10	0.627	0.834	0.400	0.268	0.395	0.764	1.008	0.928	1.613	1.164	10
11	0.563	0.563	0.555	0.653	0.707	1.016	0.898	0.795	0.839	0.983	11
12	0.563	0.563	0.555	0.653	0.707	1.016	0.898	0.795	0.839	0.983	12

Table 3.3.9 Stock numbers at age ('000) of HADDOCK in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	19743660	66808670	122282600	10476470	14869840	23152560	36694340	66932840	14478540	30306160	0
1	9424671	2469068	8582479	15560200	1335095	1863846	2945788	4637515	8362934	1751440	1
2	1259547	1550260	337283	1191800	2198112	193053	263666	395702	758235	1353135	2
3	60225	381436	586516	88512	300397	645243	47293	64438	108704	251431	3
4	33166	12489	92872	174826	19481	58847	177638	12136	16161	25617	4
5	245356	7830	4444	26503	44886	6896	13159	46090	3360	4122	5
6	6507	62665	2498	2000	8082	10166	2016	3541	13967	1162	6
7	513	2197	16858	870	788	2359	3046	593	1005	4693	7
8	154	252	699	4341	181	467	835	772	262	323	8
9	180	96	112	361	1221	83	268	347	223	113	9
10	526	123	53	71	68	352	43	122	154	48	10
11	24	76	7	16	5	5	120	22	54	63	11
12		8	11	11		3	29	22	23	18	12

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	19082210	63568990	16167210	22468700	46217970	3601516	7264937	6450364	22480360	46358360	0
1	3707249	2372594	7990486	2052422	2850313	5932757	460791	931979	827146	2877208	1
2	284771	606222	395539	1367610	325600	485518	1032039	77305	160729	128225	2
3	576009	123681	209297	136446	497142	78441	130586	309324	25179	29757	3
4	76490	199412	34939	60769	41094	112202	20852	26772	86209	5023	4
5	7478	24711	49309	8828	15802	8790	29428	4935	5796	19451	5
6	1692	3263	6096	11910	2546	4499	3074	7747	1776	1576	6
7	616	768	1204	1708	3285	1007	1186	1137	2777	713	7
8	1649	265	373	460	550	1081	352	423	488	1131	8
9	154	654	164	237	189	241	207	152	172	231	9
10	36	101	366	101	145	65	81	50	52	76	10
11	18	16	36	201	63	80	25	24	16	8	11
12	10	21	19	10	103	109	63	23	30	9	12

Table 3.3.10a

Analysis by RCT3 ver3.1 of data from file :

hadiv0.rcx

HADDOCK IV RCT3 INPUT VALUES; AGE 0; 1991 WG

Data for 10 surveys over 22 years : 1971 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
IYFS1	1.24	2.60	.32	.899	18	5.39	9.29	.370	.182
IYFS2	1.32	2.52	.41	.845	18	4.88	8.97	.483	.107
EGFS0	.87	5.09	.55	.744	12	4.56	9.04	.665	.006
EGFS1	1.06	4.44	.32	.894	13	4.20	8.88	.387	.017
EGFS2	.92	6.01	.33	.881	14	2.36	8.18	.440	.013
SGFS0	1.38	3.58	.24	.954	7	3.79	8.82	.328	.231
SGFS1	1.42	2.52	.27	.938	8	4.62	9.06	.342	.213
SGFS2	1.05	5.17	.30	.915	9	2.93	8.27	.411	.147
GGFS1	2.17	-1.07	.65	.743	7	5.20	10.23	.835	.036
GGFS2	1.73	2.17	.89	.573	8	4.02	9.11	1.127	.020
					VPA Mean =		9.99	.903	.030

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
IYFS1	1.24	2.60	.31	.904	18	6.52	10.67	.369	.181
IYFS2	1.31	2.53	.38	.865	18	5.92	10.31	.440	.127
EGFS0	.86	5.12	.55	.751	12	5.65	9.99	.646	.006
EGFS1	1.06	4.41	.31	.900	13	4.75	9.45	.369	.018
EGFS2	.93	5.98	.34	.885	14	4.21	9.88	.389	.016
SGFS0	1.38	3.59	.24	.954	7	5.76	11.55	.375	.176
SGFS1	1.42	2.52	.27	.938	8	5.14	9.81	.334	.221
SGFS2	1.06	5.17	.30	.916	9	4.53	9.95	.361	.189
GGFS1	2.18	-1.08	.65	.745	7	6.40	12.84	1.190	.017
GGFS2	1.73	2.14	.90	.576	8	4.87	10.56	1.138	.019
					VPA Mean =		9.96	.909	.030

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
IYFS1	1.23	2.60	.31	.910	18	7.02	11.26	.392	.273
IYFS2									
EGFS0	.86	5.15	.55	.759	12	5.58	9.95	.653	.010
EGFS1	1.06	4.39	.31	.906	13	4.91	9.61	.367	.031
EGFS2									
SGFS0	1.38	3.59	.24	.956	7	5.85	11.68	.387	.280
SGFS1	1.42	2.52	.27	.938	8	5.78	10.71	.360	.323
SGFS2									
GGFS1	2.18	-1.10	.65	.748	7	6.18	12.34	1.113	.034
GGFS2									
					VPA Mean =		9.93	.918	.050

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
IYFS1									
IYFS2									
EGFS0	.86	5.18	.55	.769	12	6.33	10.61	.680	.023
EGFS1									
EGFS2									
SGFS0	1.38	3.59	.24	.957	7	5.43	11.11	.356	.852
SGFS1									
SGFS2									
GGFS1									
GGFS2									
					VPA Mean =		9.89	.932	.124

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	7922	8.98	.16	.14	.79		
1990	33841	10.43	.16	.22	2.00		
1991	66763	11.11	.20	.24	1.41		
1992	56699	10.95	.33	.29	.76		

Table 3.3.10b

Analysis by RCT3 ver3.1 of data from file :

hadiv1.rcx

HADDOCK IV RCT3 INPUT VALUES; AGE 1; 1992 WG

Data for 10 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

	I-----------Regression----------I				I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.24	.56	.31	.901	19	5.39	7.22	.364	.193
IYFS2	1.32	.45	.41	.841	19	4.88	6.90	.488	.107
EGFS0	.87	2.99	.57	.729	12	4.56	6.96	.688	.005
EGFS1	1.06	2.37	.33	.888	13	4.20	6.81	.398	.016
EGFS2	.92	3.95	.34	.877	14	2.36	6.11	.447	.013
SGFS0	1.38	1.54	.25	.951	7	3.79	6.76	.337	.224
SGFS1	1.41	.50	.27	.935	8	4.62	7.00	.348	.211
SGFS2	1.05	3.11	.31	.907	9	2.93	6.20	.429	.139
GGFS1	2.15	-3.02	.63	.751	7	5.20	8.16	.812	.039
GGFS2	1.70	.21	.87	.581	8	4.02	7.05	1.098	.021
					VPA Mean =		7.92	.901	.031

Yearclass = 1990

	I-----------Regression----------I				I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.23	.57	.31	.907	19	6.52	8.60	.361	.193
IYFS2	1.31	.48	.38	.864	19	5.92	8.24	.439	.131
EGFS0	.87	3.02	.57	.736	12	5.65	7.92	.668	.006
EGFS1	1.06	2.35	.32	.893	13	4.75	7.38	.380	.017
EGFS2	.92	3.92	.34	.881	14	4.21	7.81	.395	.016
SGFS0	1.38	1.54	.25	.952	7	5.76	9.48	.385	.171
SGFS1	1.41	.50	.27	.935	8	5.14	7.74	.340	.218
SGFS2	1.05	3.11	.31	.909	9	4.53	7.88	.377	.178
GGFS1	2.15	-3.03	.63	.754	7	6.40	10.74	1.158	.019
GGFS2	1.70	.19	.87	.585	8	4.87	8.48	1.110	.021
					VPA Mean =		7.89	.905	.031

Yearclass = 1991

	I-----------Regression----------I				I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.23	.58	.30	.913	19	7.02	9.18	.383	.289
IYFS2									
EGFS0	.86	3.06	.57	.745	12	5.58	7.88	.675	.009
EGFS1	1.06	2.33	.32	.900	13	4.91	7.54	.378	.030
EGFS2									
SGFS0	1.38	1.55	.25	.953	7	5.85	9.61	.398	.269
SGFS1	1.41	.50	.28	.935	8	5.78	8.64	.367	.315
SGFS2									
GGFS1	2.15	-3.05	.63	.757	7	6.18	10.26	1.083	.036
GGFS2									
					VPA Mean =		7.85	.914	.051

Yearclass = 1992

	I-----------Regression----------I				I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	.86	3.09	.57	.754	12	6.33	8.54	.703	.023
EGFS1									
EGFS2									
SGFS0	1.38	1.55	.25	.954	7	5.43	9.04	.365	.846
SGFS1									
SGFS2									
GGFS1									
GGFS2									
					VPA Mean =		7.82	.927	.131

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	1020	6.93	.16	.14	.77		
1990	4297	8.37	.16	.22	1.94		
1991	8423	9.04	.21	.24	1.37		
1992	7112	8.87	.34	.29	.76		

Table 3.3.10c

Analysis by RCT3 ver3.1 of data from file :

hadiv2.rcx

HADDOCK IV RCT3 INPUT VALUES; AGE 2; 1992 WG

Data for 10 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

	I-----------Regression			----------I	I-----------Prediction			---------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.21	-1.11	.26	.928	19	5.39	5.42	.304	.260
IYFS2	1.28	-1.14	.34	.884	19	4.88	5.11	.405	.146
EGFS0	.89	1.09	.61	.698	12	4.56	5.14	.741	.004
EGFS1	1.05	.59	.31	.899	13	4.20	5.00	.376	.017
EGFS2	.92	2.13	.33	.885	14	2.36	4.30	.432	.013
SGFS0	1.39	-.29	.27	.944	7	3.79	4.98	.363	.183
SGFS1	1.42	-1.35	.30	.924	8	4.62	5.21	.379	.167
SGFS2	1.06	1.28	.32	.900	9	2.93	4.40	.448	.120
GGFS1	2.14	-4.76	.61	.765	7	5.20	6.39	.788	.039
GGFS2	1.67	-1.44	.83	.606	8	4.02	5.29	1.046	.022
					VPA Mean =		6.10	.895	.030

Yearclass = 1990

	I-----------Regression			----------I	I-----------Prediction			---------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.21	-1.12	.26	.932	19	6.52	6.77	.304	.256
IYFS2	1.28	-1.15	.32	.899	19	5.92	6.42	.370	.173
EGFS0	.88	1.13	.61	.706	12	5.65	6.12	.718	.005
EGFS1	1.06	.57	.31	.901	13	4.75	5.58	.365	.018
EGFS2	.93	2.10	.33	.887	14	4.21	6.00	.385	.016
SGFS0	1.39	-.29	.27	.945	7	5.76	7.72	.414	.138
SGFS1	1.42	-1.35	.30	.924	8	5.14	5.96	.370	.173
SGFS2	1.06	1.29	.32	.902	9	4.53	6.10	.393	.153
GGFS1	2.15	-4.77	.61	.767	7	6.40	8.96	1.123	.019
GGFS2	1.68	-1.46	.83	.609	8	4.87	6.69	1.058	.021
					VPA Mean =		6.07	.901	.029

Yearclass = 1991

	I-----------Regression			----------I	I-----------Prediction			---------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.21	-1.12	.25	.935	19	7.02	7.36	.326	.389
IYFS2									
EGFS0	.88	1.18	.61	.717	12	5.58	6.08	.724	.008
EGFS1	1.06	.54	.31	.904	13	4.91	5.74	.369	.030
EGFS2									
SGFS0	1.39	-.28	.27	.946	7	5.85	7.86	.428	.226
SGFS1	1.42	-1.35	.30	.924	8	5.78	6.87	.399	.260
SGFS2									
GGFS1	2.15	-4.79	.61	.770	7	6.18	8.47	1.050	.037
GGFS2									
					VPA Mean =		6.05	.911	.050

Yearclass = 1992

	I-----------Regression			----------I	I-----------Prediction			---------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	.87	1.22	.61	.728	12	6.33	6.76	.751	.023
EGFS1									
EGFS2									
SGFS0	1.39	-.28	.27	.948	7	5.43	7.28	.393	.828
SGFS1									
SGFS2									
GGFS1									
GGFS2									
					VPA Mean =		6.02	.926	.149

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	175	5.17	.15	.14	.78		
1990	721	6.58	.15	.21	1.84		
1991	1425	7.26	.20	.24	1.34		
1992	1186	7.08	.36	.32	.79		

Table 3.3.11 Mean fishing mortality, biomass and recruitment of HADDOCK in Sub-area IV between 1972 and 1991.

	Mean Fishing Mortality Ages 2 to 6		Ages 0 to 3	Biomass 1000 tonnes		Recruits Age 0	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1972	0.902	0.146	0.049	1594	290	72	19744
1973	0.775	0.128	0.031	852	283	73	66809
1974	0.629	0.143	0.099	1452	246	74	122283
1975	0.745	0.208	0.083	1990	225	75	10476
1976	0.809	0.158	0.120	827	290	76	14870
1977	0.805	0.132	0.165	523	222	77	23153
1978	0.852	0.191	0.057	604	123	78	36694
1979	0.903	0.088	0.053	630	103	79	66933
1980	0.797	0.082	0.082	1169	144	80	14479
1981	0.591	0.089	0.060	636	229	81	30306
1982	0.551	0.069	0.063	796	286	82	19082
1983	0.789	0.148	0.047	715	241	83	63569
1984	0.895	0.094	0.031	1418	190	84	16167
1985	0.858	0.079	0.017	819	231	85	22469
1986	0.884	0.180	0.011	677	213	86	46218
1987	0.861	0.146	0.014	996	150	87	3602
1988	0.873	0.153	0.019	395	149	88	7265
1989	0.765	0.147	0.015	353	119	89	8351
1990	0.822	0.282	0.018	317	71	90	33509
1991	1.129	0.101	0.030	853	55	91	66763

Arit-mean recruits at age 0 for period 1972 to 1991	34637
Geom-mean recruits at age 0 for period 1972 to 1991	24534

Table 3.3.12 Input for catch prediction of HADDOCK in Sub-area IV.

Age	1991 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 1987 to 1991: H.Con.	Scaled mean F: Disc	Scaled mean F: Ind	Mean values for period 1987 to 1991 — Mean Weight (Kg.): H.Con.	Mean Weight: Disc	Mean Weight: Ind	Mean Weight: Stock	Prop. Ret.
0	66762960	0.000	0.001	0.003	0.000	0.001	0.004	0.001	0.057	0.014	0.027	0.000
1	4297002	0.007	0.100	0.015	0.008	0.114	0.019	0.293	0.179	0.088	0.172	0.064
2	175000	0.385	0.478	0.026	0.437	0.542	0.033	0.362	0.214	0.228	0.279	0.453
3	29757	1.554	0.054	0.045	1.201	0.234	0.034	0.454	0.265	0.385	0.419	0.824
4	5023	1.338	0.011	0.017	1.278	0.089	0.036	0.602	0.321	0.623	0.583	0.934
5	19451	1.094	0.013	0.004	1.096	0.022	0.025	0.809	0.463	0.792	0.802	0.981
6	1576	0.971		0.000	0.982	0.017	0.010	1.125	0.588	1.114	1.111	0.979
7	713	0.884		0.000	0.875		0.014	1.330		1.198	1.326	1.000
8	1131	0.852		0.000	0.948	0.000	0.003	1.551	2.572	1.243	1.549	1.000
9	231	1.041		0.000	1.053		0.000	1.795		1.319	1.795	1.000
10	76	1.164			1.240	0.003	0.000	2.108	3.048	1.400	2.111	0.997
11	8	0.983			1.029			2.345			2.345	1.000
12	9	0.983			1.029			2.517			2.517	1.000

Mean F	1991: Age 2 to 6	1991: Age 0 3	Prediction: Age 2 to 6	Prediction: Age 0 3
Unscaled	1.180	0.022	1.039	0.018
Scaled			1.180	0.022

Recruits at age 0 in 1992 = 56699000
Recruits at age 0 in 1993 = 19732060
Recruits at age 0 in 1994 = 19732060
Recruits at age 0 in 1995 = 19732060

M at age and proportion mature at age are as shown in Table 3.3.3.

Mean F for ages 2 to 6 in 1991 for human consumption landings + discards = 1.180 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1987 to 1991
rescaled to produce a mean value of F for ages 2 to 6 equal to that for 1991

Mean F for ages 0 to 3 in 1991 for small-mesh fisheries = 0.022 .
Industrial fishery F-at-age in the prediction are averages for the period 1987 to 1991 .
rescaled to produce a mean value of F for ages 0 to 3 equal to that for 1991

Values of N in 1991 from VPA have been overwritten
for the following ages .....

Age 0
Age 1
Age 2

Values of F for these ages in 1991 from VPA have been overwritten
with scaled mean values used for predictions for 1992 onwards

Table 3.3.13 Predicted catches and biomasses ('000 tonnes) of HADDOCK in Sub-area IV 1992 to 1993.

	Year										
	1991	1992	1993								
Biomass 1 Jan of Year											
Total	853	1706	1729	1729	1729	1729	1729	1729	1729	1729	1729
Spawning	55	105	201	201	201	201	201	201	201	201	201
Mean F (Ages)											
Human Cons. (2 to 6)	1.18	1.18	0.00	0.24	0.47	0.71	0.94	1.18	1.42	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(1991)										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
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	44	91	0	52	94	129	158	182	202	0	0
Discards	40	129	0	41	76	108	137	163	187	0	0
Small-mesh Fisheries	5	11	17	16	15	14	14	13	13	0	0
Total landings	50	102	17	68	110	144	172	195	214	0	0
Total catch	90	232	17	109	186	252	309	358	401	0	0
Biomass 1 Jan of Year+1											
Total	1706	1729	1291	1192	1110	1042	986	939	900	0	0
Spawning	105	201	478	408	350	304	266	235	209	0	0

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
0	56699000	0	31146	92363	123509
1	8558761	31077	453910	76371	561358
2	730080	173655	209345	12737	395737
3	48252	27253	5809	778	33840
4	4435	2771	195	78	3044
5	998	602	12	14	627
6	5241	2973	65	30	3068
7	489	260		4	265
8	241	136	0	0	136
9	395	237		0	237
10	67	44	0	0	44
11	19	11			11
12	3	2			2
Wt	1705952	91019	129398	11381	231798

Stock at start of and catch during 1993
for F(1993) = F(1992)

Age	Stock No	H.Cons	Discards	By-catch	Total
0	19732060	0	10839	32144	42983
1	7261761	26368	385124	64797	476290
2	1427567	339557	409345	24905	773807
3	177908	100486	21417	2869	124771
4	8651	5405	381	152	5938
5	849	512	10	12	534
6	261	148	3	2	153
7	1565	834		14	847
8	164	93	0	0	93
9	76	46		0	46
10	113	74	0	0	74
11	16	9			9
12	6	4			4
Wt	1729354	181769	162930	13097	357796

Table 3.3.14 Predicted catches and biomasses ('000 tonnes) of HADDOCK in Sub-area IV 1992 to 1993.

	Year											
	1991	1992	1993									
Biomass 1 Jan of Year												
Total	853	1706	1802	1802	1802	1802	1802	1802	1802	1802	1802	1802
Spawning	55	105	245	245	245	245	245	245	245	245	245	245
Mean F Ages												
Human Cons. 2 to 6	1.18	0.64	0.00	0.24	0.47	0.71	0.94	1.18	1.42	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(1991)										F0.1	Fmax
Human Consumption	1.00	0.54	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	44	59	0	63	115	157	191	219	242	0	0
Discards	40	76	0	43	81	114	144	171	196	0	0
Small-mesh Fisheries	5	12	19	18	17	16	15	14	13	0	0
Total landings	50	71	19	81	132	172	206	233	256	0	0
Total catch	90	147	19	124	212	287	350	405	452	0	0
Biomass 1 Jan of Year+1											
Total	1706	1802	1365	1249	1154	1077	1013	960	916	0	0
Spawning	105	245	540	455	387	332	288	252	223	0	0

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
0	56699000	0	16854	92381	109235
1	8558761	17155	250560	77924	345639
2	730080	112625	135772	15269	263666
3	48252	19037	4057	1005	24099
4	4435	1917	135	99	2151
5	998	402	8	17	427
6	5241	1949	43	37	2029
7	489	167		5	172
8	241	88	0	1	89
9	395	157		0	157
10	67	30	0	0	30
11	19	8			8
12	3	1			1
Wt	1705952	58882	75976	12208	147066

Stock at start of and catch during 1993
for F(1993) = F(1992)

Age	Stock No	H.Cons	Discards	By-catch	Total
0	19732060	0	10839	32144	42983
1	7266078	26383	385353	64836	476573
2	1509653	359081	432882	26337	818301
3	278878	157515	33572	4497	195584
4	16716	10444	737	293	11473
5	1590	960	18	22	1000
6	435	247	5	3	255
7	2475	1319		21	1340
8	246	138	0	0	139
9	118	71		0	71
10	183	120	0	0	120
11	28	16			16
12	10	6			6
Wt	1802357	219154	171349	14161	404665

Table 3.3.15 North Sea HADDOCK. Exploitation strategies for risk analysis.

case	min ssb	relative F	mean yield	C.V. Yield	Mean SSB	C.V. SSB	Prop. closed
1	30	.8	215	.523	177	.514	0
2	30	.9	203	.497	147	.494	0
3	30	1	210	.593	135	.596	0
4	30	1.1	228	.621	132	.632	0
5	30	1.2	233	.528	124	.542	.004
6	60	.8	211	.501	174	.488	.004
7	60	.9	228	.574	165	.562	.01
8	60	1	235	.621	154	.597	.028
9	60	1.1	219	.618	132	.568	.052
10	60	1.2	221	.628	125	.56	.076
11	90	.8	217	.573	184	.514	.042
12	90	.9	234	.597	177	.521	.062
13	90	1	229	.668	165	.522	.124
14	90	1.1	224	.614	149	.448	.14
15	90	1.2	228	.759	148	.52	.204
16	120	.8	221	.578	201	.43	.106
17	120	.9	243	.648	200	.468	.14
18	120	1	230	.741	183	.486	.202
19	120	1.1	221	.781	171	.448	.262
20	120	1.2	213	.782	163	.407	.3
21	150	.8	216	.562	213	.319	.166
22	150	.9	227	.698	210	.39	.224
23	150	1	220	.793	202	.395	.294
24	150	1.1	224	.852	197	.417	.332
25	150	1.2	215	.906	190	.416	.382

Table 3.3.16

Stock: Haddock in Sub-area IV (North Sea)

Assessment Quality Control Diagram 1

Average F(2-6,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	1.12				
1989	1.00	1.00			
1990	1.00	1.05	0.95		
1991	1.02	1.05	0.91	0.98	
1992	1.01	1.03	0.91	1.10	1.23

Remarks: Human consumption and discards.
Natural mortality assumptions change in 1987/88 - based on Multispecies Working Group recommendations.
Laurec/Shepherd tuning implemented in 1988.

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	112	113	88				
1989		109	85	53			
1990			83	63	61		
1991				52	46	77	
1992					47	102	195
					Actual	Current	Forecast

$$Actual\ SQC = Landings(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

Remarks: Human consumption and by-catch used as landings. F_{human} and $F_{disc.}$ used as F for calculating actual SQC.

(cont'd)

Stock: Haddock in Sub-area IV (North Sea)

Assessment Quality Control Diagram 3

Recruitment (age 0) Unit: millions					
Date of assessment	Year class				
	1987	1988	1989	1990	1991
1988	6434				
1989[1]	4318	7650			
1990	5736	10512	12800		
1991	3783	7802	7879	32729	
1992	3602	7265	8351	33509	66763

[1]As revised by ACFM.

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	140	140	112[1]	126[1]				
1989	152	134[2]	117[2]	79[1,2]	72[1,2]			
1990	150	149	122	86	81[1]	150[1]		
1991	149	150	122	76	64	99[1]	122[1]	
1992	150	149	119	71	55	105	201[1]	235[1]

[1]Forecast. [2]As revised by ACFM.

Remarks: 1988 Laurec/Shepherd tuning implemented.

Table 3.4.1 Nominal catch (in tonnes) of WHITING in Sub-area IV, 1981-1991, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Belgium	2,623	2,272	2,864	2,798	2,177	2,275	1,404	1,984	1,271	1,040	913
Denmark	16,430	27,043	18,054	19,771	16,152	9,076	2,047	12,112	803	1,207	1,529
Faroe Islands	12	57	18	-	6	-	12	222	1	26	-[1]
France	24,744	23,780	21,263	19,209	10,853	8,250	10,493	10,569	5,277[1,2]	n/a	5,188[1,2]
Germany, Fed.Rep.	601	223	317	286	226	313	274	454	415	692	1,014[1]
Netherlands	14,600	12,218	10,935	8,767	6,973	13,741	8,542	5,087[3]	3,860	3,272[1]	4,029[1]
Norway	27	17	39	88	103	103	74	52	32	55	94[1]
Poland	-	-	1	2	-	-	-	-	-	-	-
Sweden	9	11	44	53	22	33	17	5	17	16	48
UK (Engl.& Wales)	5,964	4,743	4,366	5,017	5,024	3,805	4,485	4,007	1,896	2,124	2,554[1]
UK (N. Ireland)	-	-	-	-	-	-	-	1	61	30	1
UK (Scotland)	31,399	29,640	41,248	42,967	30,398	29,113	37,630	31,804	26,491	27,632	30,458[1]
Total	96,409	100,004	99,149	99,958	71,934	66,709	64,978	66,294	40,124	n/a	45,828

[1]Preliminary.
[2]Includes Division IIa (EC).
[3]Working Group estimate.
n/a = Not available.

Table 3.4.2 Annual weight and numbers of WHITING caught in Sub-area IV between 1972 and 1991.

Year	Weight (1000 tonnes) Total	H.Con	Disc	By-cat	Number (millions) Total	H.Con	Disc	By-cat
1972	188	60	67	61	1927	177	398	1352
1973	266	66	110	90	2164	232	659	1273
1974	290	75	85	130	2572	249	477	1846
1975	300	79	135	86	1965	247	699	1018
1976	361	75	136	150	2285	248	641	1396
1977	342	73	163	106	2470	259	547	1663
1978	178	88	35	55	1727	322	240	1165
1979	233	98	77	59	1869	344	640	886
1980	212	91	76	46	1411	301	466	645
1981	181	79	35	67	1396	257	210	929
1982	129	71	26	33	733	231	168	333
1983	151	79	48	24	1310	253	360	697
1984	135	77	39	19	858	245	317	297
1985	97	54	28	15	686	180	226	280
1986	154	58	78	18	1173	202	572	399
1987	132	62	53	16	917	224	408	285
1988	127	51	28	49	1370	191	227	952
1989	118	40	35	43	859	153	275	431
1990	147	42	54	51	1262	160	524	578
1991	117	46	33	38	1589	184	235	1170

Table 3.4.3 Values of natural mortality rate and proportion mature at age.

Age	Nat Mor	Mat.
0	2.550	0.000
1	0.950	0.110
2	0.450	0.920
3	0.350	1.000
4	0.300	1.000
5	0.250	1.000
6	0.250	1.000
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10	0.200	1.000

Table 3.4.4 Total international catch at age ('000) of WHITING in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	553711	175647	571415	238839	425081	666975	687017	476345	332172	516852	0
1	938136	1153018	755217	954765	479081	1004731	417292	611121	263938	160949	1
2	314926	660398	976000	403599	1119601	474222	305020	457585	406641	334230	2
3	44793	131353	226168	295629	163420	268897	222079	202924	266938	253428	3
4	7445	18039	31516	53896	79425	29031	79704	89752	82466	92315	4
5	56265	5404	4660	8792	14188	20033	6935	26698	47604	24065	5
6	7933	17226	1163	7524	2733	5225	6864	2988	9858	10819	6
7	3284	2375	5496	109	488	505	1707	1528	1003	2770	7
8	243	345	325	1303	18	228	247	250	653	238	8
9	67	118	47	132	527	17	11	33	58	43	9
10	641	50	20	2	28	159	13	5	20	37	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	100512	666558	157321	186585	225026	84650	416511	87146	280698	1034648	0
1	187614	197608	313029	200262	563912	260597	425292	323985	246750	125970	1
2	102148	168127	159701	143659	161516	355267	296398	169309	493649	183888	2
3	226317	107271	108562	83358	159440	120294	174813	183129	123737	180130	3
4	82807	124479	45938	37180	42550	78955	38549	76225	82588	33889	4
5	24577	35013	57100	13531	12526	10892	15476	14049	31601	24544	5
6	6293	8290	13142	17769	3376	4205	1937	4447	1937	5336	6
7	1956	1669	2832	3098	3935	822	417	404	642	549	7
8	385	760	376	831	530	818	60	286	90	255	8
9	49	96	176	94	72	101	73	37	16	4	9
10	30	33	21	9	1	7	38	6		1	10

Table 3.4.5 Total international mean weight at age (kg) of WHITING in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	0.022	0.027	0.026	0.030	0.019	0.022	0.010	0.009	0.013	0.011	0
1	0.071	0.084	0.070	0.100	0.107	0.116	0.074	0.098	0.075	0.082	1
2	0.200	0.166	0.149	0.215	0.194	0.211	0.181	0.166	0.176	0.166	2
3	0.282	0.277	0.257	0.277	0.294	0.322	0.235	0.260	0.253	0.241	3
4	0.388	0.371	0.381	0.376	0.352	0.401	0.327	0.304	0.332	0.326	4
5	0.418	0.439	0.469	0.470	0.443	0.450	0.436	0.419	0.340	0.394	5
6	0.520	0.462	0.519	0.356	0.519	0.468	0.438	0.457	0.466	0.423	6
7	0.575	0.550	0.541	0.817	0.514	0.551	0.477	0.502	0.479	0.473	7
8	0.748	0.738	0.786	0.596	0.554	0.440	0.613	0.584	0.573	0.649	8
9	0.801	0.860	1.032	0.712	0.740	0.734	0.702	0.618	0.539	0.828	9
10	0.822	0.846	0.966	1.022	0.893	0.500	1.247	0.559	0.812	1.032	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	0.029	0.014	0.020	0.014	0.015	0.012	0.013	0.023	0.015	0.017	0
1	0.059	0.105	0.088	0.094	0.105	0.076	0.054	0.068	0.081	0.102	1
2	0.182	0.189	0.188	0.186	0.182	0.146	0.143	0.156	0.136	0.162	2
3	0.252	0.275	0.275	0.265	0.252	0.246	0.222	0.224	0.207	0.212	3
4	0.314	0.326	0.338	0.324	0.315	0.293	0.298	0.264	0.247	0.270	4
5	0.378	0.387	0.384	0.391	0.373	0.371	0.335	0.316	0.277	0.290	5
6	0.484	0.427	0.393	0.429	0.462	0.368	0.413	0.383	0.405	0.328	6
7	0.506	0.457	0.464	0.469	0.465	0.492	0.428	0.438	0.484	0.358	7
8	0.703	0.520	0.586	0.424	0.525	0.458	0.834	0.347	0.639	0.375	8
9	0.783	0.670	0.514	0.497	1.194	0.852	0.588	0.512	0.316	0.500	9
10	1.101	0.502	0.871	0.789	0.528	0.602	0.642	0.828		1.055	10

Table 3.4.6 Survey induces used to estimate recruitment for North Sea WHITING.

WHITING IV RCT3 INPUT VALUES; 1992 WG

'YEARCLASS'	IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'	'DGFS0'	'DGFS1'	'DGFS2'	'GGFS1'	'GGFS2'
1971	332	763	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1972	1156	496	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1973	322	153	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1974	893	535	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	679	219	-1	-1	74	-1	-1	-1	-1	-1	-1	-1	-1
1976	418	293	-1	220	52	-1	-1	-1	-1	-1	-1	-1	-1
1977	513	183	284	247	71	-1	-1	-1	-1	-1	-1	-1	-1
1978	457	391	184	201	125	-1	-1	-1	-1	-1	62	-1	-1
1979	692	485	355	353	288	-1	-1	-1	-1	330	131	-1	-1
1980	227	232	199	183	79	-1	-1	97	166	205	105	-1	-1
1981	161	126	349	277	109	-1	65	58	1393	640	224	-1	15.3
1982	128	179	69	119	108	102	56	37	166	431	141	6.8	12.9
1983	436	359	717	506	170	210	108	97	2649	1330	893	5.7	22.8
1984	341	261	173	159	66	454	158	45	143	783	75	9.6	24.6
1985	456	544	200	152	130	169	111	115	859	384	252	12.2	70.8
1986	669	862	163	228	132	406	141	161	1784	2004	612	91	79.8
1987	394	542	137	188	118	120	97	74	2883	1441	803	15.1	392.3
1988	1465	887	382	295	129	642	404	205	629	1049	196	603.1	248.3
1989	509	675	1170	194	77	427	224	95	1882	963	214	280.2	163.7
1990	1014	748	882	333	140	1943	177	99	5543	214	-1	324.3	73.3
1991	916	-1	167	284	-1	1379	128	-1	806	-1	-1	120.7	-1
1992	-1	-1	486	-1	-1	615	-1	-1	-1	-1	-1	-1	-1

Table 3.4.7

VPA Version 3.2 (MSDOS)

At 12/10/1992 10:46

WHITING IN THE NORTH SEA

CPUE data from file WHI4EF.DAT

Fleet 1 : SCOGFS

Fleet 2 : SCOTRL

Fleet 3 : SCOSEI

Fleet 4 : SCOLTR

Fleet 5 : ENGGFS

Fleet 6 : FRATRB

Fleet 7 : FRGGFS

Fleet 8 : NETGFS

Fleet 9 : INTGFS

Disaggregated Qs

Log transformation

The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.

No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Shrinkage Log S.E = .200

Tuning converged after 126 iterations

Total of the absolute F residuals for all ages in the last year, between iterations125 and 126 = .000

Regression weights

, .020, .116, .284, .482, .670, .820, .921, .976, .997, 1.000

Oldest age F = 1.000*average of 5 younger ages.

SUMMARY STATISTICS FOR AGE 0

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-17.03	.862	.0000	.0300	.247E+00	.133E+00	-17.035	.327
2	No data for this fleet at this age							
3	-24.08	1.468	.0000	.0138	-.110E+00	.262E+00	-24.075	.544
4	-22.98	1.213	.0000	.0642	-.346E+00	.161E+00	-22.981	.449
5	-17.50	1.102	.0000	.1556	.576E-01	.197E+00	-17.498	.408
6	-20.33	1.392	.0001	.2334	-.101E-01	.251E+00	-20.326	.516
7	No data for this fleet at this age							
8	-16.03	1.150	.0000	.1407	.455E-01	.207E+00	-16.027	.426
9	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.026	.470	.160	.470	.116

SUMMARY STATISTICS FOR AGE 1

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-13.62	.469	.0001	.0863	.176E+00	.572E-01	-13.624	.174
2	-18.93	1.161	.0001	.2075	-.285E+00	.183E+00	-18.933	.430
3	-17.53	.914	.0082	.3864	-.158E-01	.164E+00	-17.531	.339
4	-17.75	.808	.0080	.1154	-.214E+00	.125E+00	-17.748	.300
5	-15.61	.412	.0000	.0626	.973E-01	.658E-01	-15.615	.153
6	-15.97	.335	.0053	.1832	-.124E+00	.415E-01	-15.965	.124
7	-16.68	1.590	.0000	.0222	.681E+00	.139E+00	-16.676	.590
8	-14.04	.573	.0000	.0647	.130E+00	.925E-01	-14.042	.212
9	-14.61	.463	.0000	.0559	.199E+00	.446E-01	-14.615	.172

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.133	.180	.134	.180	.554

SUMMARY STATISTICS FOR AGE 2

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-13.11	.283	.0002	.3937	.118E+00	.294E-01	-13.106	.105
2	-16.31	.630	.0011	1.1452	-.246E+00	.731E-01	-16.309	.233
3	-15.32	.601	.0748	.3059	.160E+00	.923E-01	-15.320	.223
4	-16.23	.311	.0364	.5615	-.250E-01	.552E-01	-16.233	.115
5	-15.31	.226	.0000	.5396	-.294E-01	.394E-01	-15.307	.084
6	-14.81	.322	.0166	.5763	-.138E-01	.578E-01	-14.812	.119
7	-15.44	1.037	.0000	.2217	.419E+00	.106E+00	-15.436	.385
8	-14.30	.723	.0000	.5290	.173E-01	.130E+00	-14.301	.268
9	-13.72	.370	.0000	.2988	.176E+00	.236E-01	-13.723	.137

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.494	.122	.902E-01	.122	.549

SUMMARY STATISTICS FOR AGE 3

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-13.10	.366	.0002	.4863	.133E+00	.463E-01	-13.098	.136
2	-15.26	.530	.0032	.8691	-.167E+00	.749E-01	-15.257	.196
3	-14.35	.326	.1969	.5594	.125E+00	.384E-01	-14.352	.121
4	-15.29	.213	.0938	.7632	-.230E-01	.375E-01	-15.285	.079
5	-15.35	.270	.0000	1.0145	.675E-01	.423E-01	-15.353	.100
6	-13.93	.100	.0401	.9327	.263E-02	.180E-01	-13.932	.037
7	-15.21	.886	.0000	.3816	.396E+00	.640E-01	-15.210	.329
8	-14.98	.984	.0000	2.9610	-.173E-02	.177E+00	-14.979	.364
9	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.857	.796E-01	.787E-01	.796E-01	.978

(cont'd)

Table 3.4.7 (cont'd)

```
                         SUMMARY STATISTICS FOR AGE  4
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE      ,INTRCPT,  SE
       ,  q     ,        ,  F   ,  F    ,             ,   Slope ,          ,Intrcpt
   1  ,-13.25   ,   .393, .0002 ,1.1710,   .118E+00,   .572E-01,-13.249,   .146
   2  ,-15.02   ,   .626, .0041 ,5.5642,  -.251E+00,   .698E-01,-15.016,   .232
   3  ,-13.90   ,   .296, .3097 ,1.0056,   .119E+00,   .325E-01,-13.899,   .110
   4  ,-14.91   ,   .153, .1359 ,1.4432,  -.300E-01,   .254E-01,-14.915,   .057
   5  ,-15.25   ,   .395, .0000 , .7427,   .126E+00,   .553E-01,-15.252,   .146
   6  ,-13.54   ,   .095, .0594 ,1.5934,  -
.106E-01,    .167E-01,-13.540,    .035
   7  ,-15.10   , 1.057, .0000 , .2543,   .464E+00,   .831E-01,-15.097,   .392
   8  , No data for this fleet at this age
   9  , No data for this fleet at this age
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
   1.423     .744E-01        .103            .103            1.901
```

```
                         SUMMARY STATISTICS FOR AGE  5
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE      ,INTRCPT,  SE
       ,  q     ,        ,  F   ,  F    ,             ,   Slope ,          ,Intrcpt
   1  ,-13.22   ,   .565, .0002 ,1.1126,   .308E-01,   .105E+00,-13.220,   .217
   2  ,-14.55   ,   .617, .0065 ,2.4334,  -.163E+00,   .951E-01,-14.550,   .229
   3  ,-13.59   ,   .447, .4217 ,1.1857,   .159E+00,   .579E-01,-13.590,   .166
   4  ,-14.66   ,   .263, .1762 ,1.4862,   .211E-01,   .505E-01,-14.655,   .105
   5  ,-15.43   ,   .503, .0000 ,1.3154,   .846E-01,   .855E-01,-15.430,   .186
   6  ,-13.25   ,   .196, .0794 ,2.0059,   .131E-01,   .351E-01,-13.250,   .073
   7  ,-15.02   ,   .856, .0000 , .6690,   .393E+00,   .519E-01,-15.020,   .317
   8  , No data for this fleet at this age
   9  , No data for this fleet at this age
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
   1.583      .136          .898E-01         .136             .437
```

```
                         SUMMARY STATISTICS FOR AGE  6
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE      ,INTRCPT,  SE
       ,  q     ,        ,  F   ,  F    ,             ,   Slope ,          ,Intrcpt
   1  ,-13.16   ,   .275, .0002 ,1.1446,   .921E-01,   .372E-01,-13.157,   .102
   2  ,-14.56   ,   .542, .0064 ,3.2067,  -.249E+00,   .417E-01,-14.563,   .201
   3  ,-13.56   ,   .180, .4336 ,1.3273,   .543E-01,   .260E-01,-13.563,   .067
   4  ,-14.66   ,   .319, .1760 ,1.4936,  -.123E+00,   .376E-01,-14.657,   .118
   5  ,-15.76   ,   .630, .0000 ,1.7865,  -.494E-02,   .113E+00,-15.765,   .233
   6  ,-13.19   ,   .253, .0836 ,2.1129,  -.471E-01,   .425E-01,-13.195,   .094
   7  , No data for this fleet at this age
   8  , No data for this fleet at this age
   9  , No data for this fleet at this age
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
   1.497      .115           .103            .115             .796
```

```
                         SUMMARY STATISTICS FOR AGE  7
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE      ,INTRCPT,  SE
       ,  q     ,        ,  F   ,  F    ,             ,   Slope ,          ,Intrcpt
   1  , No data for this fleet at this age
   2  ,-14.54   ,   .981, .0065 ,3.6598,  -.226E+00,   .158E+00,-14.538,   .363
   3  ,-13.70   ,   .504, .3775 ,1.0613,   .323E-03,   .907E-01,-13.701,   .187
   4  ,-14.84   ,   .607, .1468 ,1.6142,  -.211E+00,   .798E-01,-14.838,   .225
   5  ,-15.75   ,   .791, .0000 , .4607,   .104E+00,   .138E+00,-15.748,   .293
   6  ,-13.07   ,   .207, .0948 ,1.5628,  -.372E-01,   .349E-01,-13.073,   .077
   7  , No data for this fleet at this age
   8  , No data for this fleet at this age
   9  , No data for this fleet at this age
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
   1.390      .175           .124            .175             .501
```

```
                         SUMMARY STATISTICS FOR AGE  8
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE      ,INTRCPT,  SE
       ,  q     ,        ,  F   ,  F    ,             ,   Slope ,          ,Intrcpt
   1  , No data for this fleet at this age
   2  , No data for this fleet at this age
   3  ,-13.40   ,   .447, .5082 ,1.3821,   .908E-01,   .739E-01,-13.404,   .166
   4  ,-14.20   ,   .456, .2785 ,1.7355,   .139E-01,   .823E-01,-14.197,   .170
   5  , No data for this fleet at this age
   6  ,-13.01   ,   .515, .1005 ,6.3473,  -.930E-01,   .868E-01,-13.014,   .191
   7  , No data for this fleet at this age
   8  , No data for this fleet at this age
   9  , No data for this fleet at this age
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
   2.091      .272           .269            .272             .977
```

Table 3.4.8 Total international fishing mortality rate at age of WHITING in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	0.017	0.011	0.017	0.012	0.021	0.033	0.033	0.025	0.045	0.062	0
1	0.326	0.289	0.398	0.229	0.180	0.435	0.161	0.235	0.104	0.174	1
2	0.719	0.822	0.873	0.783	0.956	0.517	0.429	0.502	0.454	0.337	2
3	0.611	1.064	1.059	1.005	1.257	0.872	0.644	0.757	0.836	0.763	3
4	0.588	0.636	1.007	0.984	1.041	0.985	0.853	0.707	1.008	0.984	4
5	0.947	1.407	0.365	1.025	0.879	0.949	0.761	0.905	1.248	1.111	5
6	1.122	0.968	1.866	2.136	1.238	1.087	1.183	0.989	1.185	1.286	6
7	1.966	1.497	1.062	1.063	0.972	0.852	1.619	1.012	1.238	1.601	7
8	0.788	1.570	0.881	0.799	0.489	2.524	1.575	1.303	2.281	1.237	8
9	1.082	1.216	1.036	1.201	0.924	1.280	1.198	0.983	1.396	1.262	9
10	1.082	1.216	1.036	1.201	0.924	1.280	1.198	0.983	1.396	1.262	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	0.013	0.058	0.019	0.011	0.016	0.009	0.025	0.010	0.038	0.026	0
1	0.181	0.209	0.223	0.188	0.268	0.142	0.377	0.152	0.225	0.133	1
2	0.289	0.457	0.493	0.273	0.424	0.514	0.445	0.481	0.719	0.494	2
3	0.520	0.735	0.812	0.688	0.725	0.877	0.683	0.725	1.100	0.857	3
4	0.734	0.731	1.028	0.905	1.185	1.284	0.978	0.893	1.086	1.423	4
5	0.894	0.924	1.047	1.196	1.062	1.451	1.140	1.569	1.521	1.453	5
6	1.152	0.979	1.298	1.327	1.335	1.644	1.377	1.511	1.136	1.497	6
7	0.916	1.278	1.243	1.549	1.475	1.905	0.755	1.502	1.043	1.390	7
8	1.132	1.234	1.251	2.061	1.495	1.904	0.736	2.530	2.694	2.091	8
9	0.966	1.029	1.173	1.408	1.310	1.638	0.997	1.601	1.501	1.597	9
10	0.966	1.029	1.173	1.408	1.310	1.638	0.997	1.601	1.501	1.597	10

Table 3.4.9 Stock numbers at age ('000) of WHITING in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
0	90667140	44711110	92400800	57429940	55823550	56804430	58844000	53916610	20633220	23618840	0
1	5089362	6960247	3453263	7091808	4432758	4267364	4292243	4447189	4107507	1539956	1
2	742604	1420224	2016312	896748	2180769	1431304	1068253	1413094	1360382	1431690	2
3	114111	230649	398165	537114	261266	534359	544255	443441	545375	550806	3
4	19108	43654	56087	97273	138537	52358	157494	201454	146642	166636	4
5	101903	7864	17113	15181	26942	36228	14485	49743	73608	39637	5
6	12998	30785	1500	9256	4244	8716	10919	5271	15670	16465	6
7	4086	3297	9109	181	852	959	2289	2605	1527	3732	7
8	486	469	604	2578	51	264	335	371	775	363	8
9	110	181	80	205	949	26	17	57	83	65	9
10	1050	77	33	2	51	237	20	9	28	56	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
0	20694640	32417680	23253770	47131360	39124420	26333520	46067780	24098690	20632440	110950600	0
1	1733886	1594220	2388859	1781839	3639884	3006450	2037915	3507529	1862881	1550835	1
2	500434	559731	500071	739542	570873	1076790	1008313	540654	1164692	575183	2
3	651533	239072	226009	194694	358950	238111	410586	412074	213043	361953	3
4	181059	272925	80748	70678	68941	122526	69809	146168	140585	49951	4
5	46165	64396	97352	21403	21177	15617	25128	19440	44335	35173	5
6	10159	14712	19909	26615	5042	5702	2849	6258	3152	7541	6
7	3542	2500	4305	4235	5499	1034	858	560	1076	788	7
8	616	1160	570	1017	737	1030	126	330	102	310	8
9	86	163	276	134	106	135	126	49	22	6	9
10	53	56	33	13	2	9	65	8		1	10

Table 3.4.10

Analysis by RCT3 ver3.1 of data from file :

WHIIVO.RCX

WHITING IV RCT3 INPUT VALUES; AGE 0; 1992 WG

Data for 13 surveys over 22 years : 1971 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
DGFS0	1.00
DGFS1	1.00
DGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

	I-----------Regression----------				I	-----------Prediction--			-------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.90	5.04	.43	.531	18	6.23	10.67	.490	.129
IYFS2	1.62	.98	.95	.188	18	6.52	11.52	1.124	.025
EGFS0	1.75	.93	1.07	.133	12	7.07	13.31	1.605	.001
EGFS1	2.97	-5.61	1.18	.114	13	5.27	10.04	1.366	.002
EGFS2	4.17	-9.25	1.74	.057	14	4.36	8.91	2.066	.001
SGFS0	1.05	4.59	.73	.197	7	6.06	10.96	.970	.033
SGFS1	.82	6.40	.41	.426	8	5.42	10.85	.538	.107
SGFS2	.71	7.14	.24	.687	9	4.56	10.37	.291	.366
DGFS0	.60	6.35	.70	.209	9	7.54	10.88	.870	.041
DGFS1	3.29	-11.28	2.53	.022	10	6.87	11.33	3.035	.003
DGFS2	57.01	******	55.62	.000	11	5.37	6.56	65.288	.000
GGFS1	.32	9.34	.46	.384	7	5.64	11.14	.666	.070
GGFS2	.49	8.38	.56	.282	8	5.10	10.86	.726	.059
						VPA Mean =	10.50	.435	.164

Yearclass = 1990

	I-----------Regression----------				I	-----------Prediction--			-------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.86	5.26	.42	.533	18	6.92	11.23	.516	.119
IYFS2	1.47	1.82	.86	.211	18	6.62	11.52	1.049	.029
EGFS0	1.70	1.21	1.04	.136	12	6.78	12.74	1.491	.001
EGFS1	2.89	-5.21	1.16	.115	13	5.81	11.61	1.419	.002
EGFS2	3.60	-6.59	1.45	.078	14	4.95	11.20	1.709	.001
SGFS0	1.05	4.59	.73	.197	7	7.57	12.54	1.417	.016

(cont'd)

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SGFS1	.82	6.39	.41	.423	8	5.18	10.66	.526	.114
SGFS2	.70	7.17	.24	.695	9	4.61	10.40	.289	.377
DGFS0	.61	6.26	.71	.201	9	8.62	11.55	1.006	.031
DGFS1	3.24	-11.03	2.50	.023	10	5.37	6.39	3.429	.003
DGFS2									
GGFS1	.32	9.34	.46	.385	7	5.78	11.18	.679	.068
GGFS2	.49	8.35	.57	.275	8	4.31	10.47	.715	.062
						VPA Mean =	10.48	.422	.177

Yearclass = 1991

	I-----------Regression----------			I	I-----------Prediction---------				I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.82	5.51	.40	.538	18	6.82	11.09	.499	.221
IYFS2									
EGFS0	1.64	1.53	1.02	.140	12	5.12	9.94	1.219	.004
EGFS1	2.81	-4.78	1.15	.115	13	5.65	11.12	1.379	.003
EGFS2									
SGFS0	1.05	4.61	.73	.197	7	7.23	12.17	1.307	.032
SGFS1	.82	6.39	.42	.420	8	4.86	10.39	.523	.201
SGFS2									
DGFS0	.63	6.14	.74	.192	9	6.69	10.37	.909	.067
DGFS1									
DGFS2									
GGFS1	.31	9.35	.46	.387	7	4.80	10.86	.626	.141
GGFS2									
						VPA Mean =	10.46	.408	.331

Yearclass = 1992

	I-----------Regression----------			I	I-----------Prediction---------				I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	1.57	1.90	.99	.145	12	6.19	11.64	1.289	.008
EGFS1									
EGFS2									
SGFS0	1.04	4.65	.74	.198	7	6.42	11.32	1.075	.117
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
						VPA Mean =	10.43	.394	.875

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	41681	10.64	.18	.08	.23		
1990	44186	10.70	.18	.14	.66		
1991	43856	10.69	.23	.15	.40		
1992	38104	10.55	.37	.21	.33		

(cont'd)

Table 3.4.10 (cont'd)

Analysis by RCT3 ver3.1 of data from file :

WHIIV1.RCX

WHITING IV RCT3 INPUT VALUES; AGE 1; 1992 WG

Data for 13 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
DGFS0	1.00
DGFS1	1.00
DGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

Survey/ Series	I-----------Regression Slope	Inter- cept	Std Error	Rsquare	No. Pts---------I	I-----------Prediction Index Value	Predicted Value	Std Error	WAP Weights--------I
IYFS1	.91	2.44	.43	.536	19	6.23	8.09	.489	.135
IYFS2	1.59	-1.42	.92	.199	19	6.52	8.93	1.097	.027
EGFS0	1.95	-2.73	1.20	.109	12	7.07	11.06	1.812	.001
EGFS1	3.29	-9.95	1.32	.094	13	5.27	7.42	1.533	.001
EGFS2	4.32	-12.56	1.80	.054	14	4.36	6.27	2.147	.001
SGFS0	1.07	1.93	.74	.190	7	6.06	8.39	.988	.033
SGFS1	.83	3.80	.41	.429	8	5.42	8.28	.540	.111
SGFS2	.73	4.46	.26	.667	9	4.56	7.79	.310	.336
DGFS0	.63	3.55	.74	.193	9	7.54	8.34	.928	.038
DGFS1	3.27	-13.69	2.51	.023	10	6.87	8.74	3.012	.004
DGFS2	69.42	******	67.73	.000	11	5.37	3.15	79.508	.000
GGFS1	.31	6.78	.45	.394	7	5.64	8.56	.650	.077
GGFS2	.47	5.87	.53	.309	8	5.10	8.27	.688	.068
						VPA Mean =	7.93	.438	.168

Yearclass = 1990

Survey/ Series	I-----------Regression Slope	Inter- cept	Std Error	Rsquare	No. Pts---------I	I-----------Prediction Index Value	Predicted Value	Std Error	WAP Weights--------I
IYFS1	.87	2.66	.42	.538	19	6.92	8.66	.515	.124
IYFS2	1.44	-.58	.84	.224	19	6.62	8.93	1.019	.032
EGFS0	1.90	-2.43	1.18	.111	12	6.78	10.43	1.687	.001
EGFS1	3.22	-9.56	1.31	.094	13	5.81	9.16	1.598	.001
EGFS2	3.72	-9.75	1.51	.074	14	4.95	8.65	1.771	.001
SGFS0	1.06	1.94	.75	.190	7	7.57	10.00	1.444	.016

(cont'd)

SGFS1	.83	3.79	.41	.426	8	5.18	8.08	.528	.118
SGFS2	.72	4.49	.25	.675	9	4.61	7.82	.308	.347
DGFS0	.65	3.46	.76	.187	9	8.62	9.04	1.070	.029
DGFS1	3.22	-13.45	2.48	.024	10	7.35	10.21	3.139	.003
DGFS2									
GGFS1	.31	6.79	.45	.395	7	5.78	8.60	.663	.075
GGFS2	.47	5.85	.54	.301	8	4.31	7.89	.677	.072
						VPA Mean =	7.90	.426	.181

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
IYFS1	.82	2.91	.40	.543	19	6.82	8.51	.498	.224
IYFS2									
EGFS0	1.83	-2.08	1.15	.114	12	5.12	7.31	1.382	.003
EGFS1	3.14	-9.14	1.30	.094	13	5.65	8.63	1.559	.002
EGFS2									
SGFS0	1.06	1.96	.75	.190	7	7.23	9.63	1.333	.031
SGFS1	.83	3.78	.42	.422	8	4.86	7.81	.526	.201
SGFS2									
DGFS0	.67	3.34	.79	.178	9	6.69	7.80	.965	.060
DGFS1									
DGFS2									
GGFS1	.31	6.79	.45	.396	7	4.80	8.28	.612	.149
GGFS2									
						VPA Mean =	7.88	.411	.329

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
IYFS1									
IYFS2									
EGFS0	1.76	-1.68	1.12	.118	12	6.19	9.20	1.464	.006
EGFS1									
EGFS2									
SGFS0	1.05	1.99	.75	.191	7	6.42	8.76	1.097	.115
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
						VPA Mean =	7.86	.397	.878

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	3219	8.08	.18	.09	.23		
1990	3472	8.15	.18	.14	.56		
1991	3355	8.12	.24	.15	.40		
1992	2896	7.97	.37	.22	.34		

(cont'd)

Table 3.4.10 (cont'd)

Analysis by RCT3 ver3.1 of data from file :

WHIIV2.RCX

WHITING IV RCT3 INPUT VALUES; AGE 2; 1992 WG

Data for 13 surveys over 23 years : 1970 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	.10
EGFS1	.10
EGFS2	.10
SGFS0	1.00
SGFS1	1.00
SGFS2	1.00
DGFS0	1.00
DGFS1	1.00
DGFS2	1.00
GGFS1	1.00
GGFS2	1.00

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1989

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
IYFS1	.89	1.38	.40	.572	19	6.23	6.92	.460	.146
IYFS2	1.61	-2.73	.94	.198	19	6.52	7.78	1.113	.025
EGFS0	1.85	-3.32	1.12	.135	12	7.07	9.74	1.691	.001
EGFS1	2.91	-9.03	1.15	.126	13	5.27	6.31	1.330	.002
EGFS2	3.55	-10.08	1.46	.084	14	4.36	5.40	1.737	.001
SGFS0	.89	1.76	.56	.323	7	6.06	7.12	.750	.055
SGFS1	.82	2.66	.39	.486	8	5.42	7.11	.510	.118
SGFS2	.73	3.28	.24	.707	9	4.56	6.63	.292	.360
DGFS0	.84	1.01	1.03	.117	9	7.54	7.37	1.290	.018
DGFS1	5.22	-27.72	4.04	.010	10	6.87	8.17	4.848	.001
DGFS2	-6.64	42.77	6.46	.004	11	5.37	7.11	7.588	.001
GGFS1	.31	5.63	.41	.476	7	5.64	7.38	.596	.087
GGFS2	.64	4.04	.78	.188	8	5.10	7.28	1.010	.030
					VPA Mean =		6.76	.444	.156

Yearclass = 1990

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
IYFS1	.86	1.54	.40	.570	19	6.92	7.49	.493	.131
IYFS2	1.49	-2.05	.87	.217	19	6.62	7.80	1.061	.028
EGFS0	1.80	-3.06	1.10	.137	12	6.78	9.15	1.577	.001
EGFS1	2.87	-8.82	1.15	.125	13	5.81	7.86	1.398	.002
EGFS2	3.24	-8.64	1.29	.103	14	4.95	7.39	1.518	.001
SGFS0	.88	1.76	.57	.324	7	7.57	8.46	1.095	.027

(cont'd)

Table 3.4.10 (cont'd)

SGFS1	.82	2.64	.39	.484	8	5.18	6.92	.498	.129
SGFS2	.73	3.30	.24	.714	9	4.61	6.66	.291	.377
DGFS0	.87	.81	1.07	.111	9	8.62	8.34	1.509	.014
DGFS1	5.04	-26.61	3.90	.011	10	7.35	10.43	4.946	.001
DGFS2									
GGFS1	.31	5.63	.41	.477	7	5.78	7.42	.609	.086
GGFS2	.65	3.97	.80	.181	8	4.31	6.77	1.002	.032
					VPA Mean =		6.74	.434	.169

Yearclass = 1991

	I-----------Regression	----------I			I-----------Prediction	---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.83	1.72	.39	.569	19	6.82	7.35	.487	.227
IYFS2									
EGFS0	1.74	-2.76	1.08	.141	12	5.12	6.18	1.296	.003
EGFS1	2.82	-8.58	1.15	.125	13	5.65	7.39	1.377	.003
EGFS2									
SGFS0	.88	1.78	.57	.326	7	7.23	8.15	1.009	.053
SGFS1	.83	2.63	.40	.482	8	4.86	6.65	.496	.218
SGFS2									
DGFS0	.91	.54	1.13	.103	9	6.69	6.65	1.385	.028
DGFS1									
DGFS2									
GGFS1	.31	5.63	.41	.478	7	4.80	7.11	.563	.169
GGFS2									
					VPA Mean =		6.72	.424	.299

Yearclass = 1992

	I-----------Regression	----------I			I-----------Prediction	---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	1.68	-2.41	1.05	.145	12	6.19	7.98	1.376	.007
EGFS1									
EGFS2									
SGFS0	.88	1.80	.57	.330	7	6.42	7.43	.830	.197
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
					VPA Mean =		6.70	.413	.796

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	998	6.91	.18	.09	.25		
1990	1094	7.00	.18	.14	.59		
1991	1080	6.99	.23	.15	.42		
1992	943	6.85	.37	.22	.35		

Table 3.4.11 Mean fishing mortality, biomass and recruitment of WHITING in Sub-area IV between 1972 and 1991.

	Mean Fishing Mortality			Biomass		Recruits	
	Ages 2 to 6		Ages 0 to 4	1000 tonnes		Age 0	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1972	0.578	0.141	0.116	603	269	72	90667
1973	0.671	0.169	0.159	921	381	73	44711
1974	0.581	0.136	0.294	682	441	74	92401
1975	0.838	0.220	0.142	1102	453	75	57430
1976	0.640	0.169	0.272	1036	581	76	55824
1977	0.565	0.118	0.217	1013	547	77	56804
1978	0.604	0.078	0.103	701	404	78	58844
1979	0.595	0.073	0.105	871	465	79	53917
1980	0.651	0.219	0.093	768	474	80	20633
1981	0.649	0.083	0.171	575	444	81	23619
1982	0.491	0.103	0.100	440	341	82	20695
1983	0.561	0.145	0.068	461	303	83	32418
1984	0.743	0.129	0.068	441	247	84	23254
1985	0.735	0.082	0.055	402	242	85	47131
1986	0.736	0.148	0.055	611	263	86	38984
1987	0.939	0.157	0.070	488	273	87	26333
1988	0.711	0.109	0.166	376	267	88	46065
1989	0.593	0.196	0.152	464	243	89	38134
1990	0.538	0.328	0.216	490	264	90	45240
1991	0.789	0.175	0.121	620	291	91	43856
Arit-mean recruits at age 0 for period 1972 to 1991							45848
Geom-mean recruits at age 0 for period 1972 to 1991							41895

Table 3.4.12 Input for catch prediction of WHITING in Sub-area IV.

Age	1991 Stock and Fishing Mortality: Stock Number	Fishing Mortality: H.Con.	Disc	Ind	Values used in Prediction (F at age, Mean Wt. and Propn. Retained by Consumption Fishery) — Scaled mean F 1987 to 1991: H.Con.	Disc	Ind	Mean values for period 1987 to 1991 — Mean Weight (Kg.): H.Con.	Disc	Ind	Stock	Prop. Ret.
0	43856030	0.000	0.002	0.022	0.000	0.003	0.023	0.138	0.029	0.014	0.016	0.005
1	3472000	0.003	0.058	0.113	0.003	0.062	0.113	0.193	0.084	0.064	0.076	0.057
2	998001	0.073	0.194	0.216	0.079	0.210	0.217	0.225	0.149	0.119	0.149	0.307
3	361898	0.410	0.342	0.105	0.412	0.284	0.206	0.258	0.188	0.198	0.222	0.590
4	49949	0.981	0.200	0.242	0.850	0.228	0.141	0.297	0.205	0.252	0.274	0.777
5	33834	1.295	0.114	0.173	1.201	0.254	0.107	0.337	0.227	0.334	0.318	0.829
6	7541	1.264	0.024	0.209	1.332	0.050	0.154	0.385	0.247	0.423	0.380	0.955
7	788	1.046	0.146	0.198	1.235	0.067	0.114	0.454	0.307	0.451	0.440	0.943
8	310	2.091			1.957	0.047	0.137	0.537	0.266	0.615	0.530	0.971
9	6	1.597			1.570		0.014	0.555		0.701	0.554	1.000
10	1	1.597			1.570		0.014	0.782			0.782	1.000

Mean F	Age 2 to 6	Age 0 4	Age 2 to 6	Age 0 4
Unscaled	0.980	0.140	0.907	0.140
Scaled			0.980	0.140

Recruits at age 0 in 1992 = 38104000
Recruits at age 0 in 1993 = 33860000
Recruits at age 0 in 1994 = 33860000
Recruits at age 0 in 1995 = 33860000

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

Mean F for ages 2 to 6 in 1991 for human consumption landings + discards = 0.980 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1987 to 1991
rescaled to produce a mean value of F for ages 2 to 6 equal to that for 1991

Mean F for ages 0 to 4 in 1991 for small-mesh fisheries = 0.140 .
Industrial fishery F-at-age in the prediction are averages for the period 1987 to 1991 .
rescaled to produce a mean value of F for ages 0 to 4 equal to that for 1991

Values of N in 1991 from VPA have been overwritten
for the following ages .....

Age 0
Age 1
Age 2

Values of F for these ages in 1991 from VPA have been overwritten
with scaled mean values used for predictions for 1992 onwards

Table 3.4.13 Predicted catches and biomasses ('000 of tonnes) of WHITING in Sub-area IV 1982 to 1993.

	Year 1991	1992	1993								
Biomass 1 Jan of Year											
Total	620	545	518	518	518	518	518	518	518	518	518
Spawning	291	305	308	308	308	308	308	308	308	308	308
Mean F Ages											
Human Cons. 2 to 6	0.98	0.98	0.00	0.20	0.39	0.59	0.78	0.98	1.18	0.26	0.64
Small-mesh 0 to 4	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Mean F(Year)/Mean F(1991)										F0.1	Fmax
Human Consumption	1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.27	0.66
Small-mesh Fishery	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Catch weight											
Human Consumption	46	57	0	16	29	41	52	61	69	20	44
Discards	33	48	0	11	21	31	39	47	55	14	33
Small-mesh Fisheries	38	49	55	53	51	50	48	47	46	52	49
Total landings	84	106	55	69	81	91	100	108	115	73	94
Total catch	117	154	55	80	102	121	139	155	170	87	127
Biomass 1 Jan of Year+1											
Total	545	518	568	544	522	504	487	472	459	536	499
Spawning	305	308	381	357	336	317	301	286	273	350	312

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
0	38104000	173	34960	307632	342765
1	3340272	7489	124054	225604	357147
2	1129055	64524	145499	157506	367528
3	392320	91921	63833	46078	201832
4	108220	46584	13405	7828	67817
5	8917	4965	1022	442	6430
6	5413	3332	155	389	3875
7	1314	800	48	74	923
8	161	121	4	9	133
9	31	23		0	23
10	1	1		0	1
Wt	544827	56896	48102	48898	153896

Stock at start of and catch during 1993
for F(1993) = F(1992)

Age	Stock No	H.Cons	Discards	By-catch	Total
0	33860000	154	31066	273368	304588
1	2901553	6506	107761	195972	310239
2	1080795	61766	139279	150773	351818
3	434295	101756	70663	51007	223426
4	112175	48287	13894	8114	70295
5	23706	13200	2718	1176	17095
6	1457	897	42	105	1043
7	907	552	33	51	637
8	261	196	6	14	216
9	15	11		0	11
10	5	4		0	4
Wt	517697	60892	47428	46888	155209

Table 3.4.14 Predicted catches and biomasses ('000 of tonnes) of WHITING in Sub-area IV 1992 to 1993.

	Year										
	1991	1992	1993								
Biomass 1 Jan of Year											
Total	620	545	551	551	551	551	551	551	551	551	551
Spawning	291	305	341	341	341	341	341	341	341	341	341
Mean F Ages											
Human Cons. 2 to 6	0.98	0.56	0.00	0.20	0.39	0.59	0.78	0.98	1.18	0.00	0.00
Small-mesh 0 to 4	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	0.00
Mean F(Year)/Mean F(1991)										F0.1	Fmax
Human Consumption	1.00	0.57	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	46	37	0	19	35	50	62	73	82	0	0
Discards	33	30	0	12	23	33	42	51	59	0	0
Small-mesh Fisheries	38	52	59	57	55	53	51	50	48	0	0
Total landings	84	89	59	76	90	103	113	123	131	0	0
Total catch	117	118	59	88	113	136	156	174	190	0	0
Biomass 1 Jan of Year+1											
Total	545	551	593	565	540	519	500	483	468	0	0
Spawning	305	341	406	378	353	332	313	297	282	0	0

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
0	38104000	99	20039	307735	327873
1	3340272	4341	71903	228207	304451
2	1129055	38969	87873	166012	292854
3	392320	59495	41316	52048	152858
4	108220	32023	9214	9391	50628
5	8917	3601	742	560	4902
6	5413	2389	111	486	2987
7	1314	570	34	92	697
8	161	93	3	11	108
9	31	17		0	17
10	1	1		0	1
Wt	544827	36908	29549	51744	118200

Stock at start of and catch during 1993
for F(1993) = F (1991)

Age	Stock No	H.Cons	Discards	By-catch	Total
0	33860000	154	31066	273368	304588
1	2904738	6513	107879	196187	310579
2	1111541	63523	143242	155062	361827
3	491297	115111	79937	57702	252751
4	151001	65000	18704	10922	94626
5	37560	20914	4307	1864	27085
6	2711	1668	78	195	1941
7	1637	997	60	93	1150
8	455	342	10	24	376
9	36	27		0	27
10	11	8		0	8
Wt	551147	72887	51134	49737	173758

Table 3.4.15 North Sea WHITING. Quantity of discards which could be retained with a 23 cm minimum landing size in 1993.

age	Forecast discards	Mean weight	Proportion retained	catch biomass
0	31066	.029	0	0
1	107761	.084	0	0
2	139279	.149	.5	10376
3	70663	.188	1	13285
4	13894	.205	1	2848
5	2718	.227	1	617
6	42	.247	1	10
7	33	.307	1	10
8	6	.266	1	2
9	0		1	0
10	0		1	0
total weight				27148

Table 3.4.16

Stock: Whiting in Sub-area IV (North Sea)

Assessment Quality Control Diagram 1

Average F(2-6,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.89				
1989	1.17	0.81			
1990	1.07	0.78	0.69		
1991	1.10	0.82	0.81	0.77	
1992	1.10	0.82	0.79	0.87	0.96

Remarks: Humman consumption + discards.

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	79	149	146				
1989		100	138	140			
1990			83	151	152		
1991				96	139	135	
1992					80	106	110
					Actual	Current	Forecast

$$Actual\ SQC = Landings(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

Remarks: Human consumption + industrial by-catch. $F = F_{human} + F_{disc.}$

(cont'd)

Table 3.4.16 (cont'd)

Stock: Whiting in Sub-area IV (North Sea)

Assessment Quality Control Diagram 3

Recruitment (age 0) Unit: millions					
Date of assessment	Year class				
	1987	1988	1989	1990	1991
1988	45109				
1989	39219	70480			
1990	50113	72010	48155		
1991	28474	64780	44169	65840	
1992	26333	46065	38134	45240	43856

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	360	527	478[1]	452[1]				
1989	270	265	325	391[1]	354[1]			
1990	278	283	365	474[1]	444[1,2]	375[1]		
1991	275	273	269	351	400	422[1]	347[1]	
1992	273	267	243	264	291	305	308[1]	286[1]

[1]Forecast. [2]As revised by ACFM.

Remarks:

Table 3.5.1 Nominal catch (in tonnes) of saithe in Sub-area IV and Division IIIa, 1981-1991, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Belgium	12	4	7	32	31	16	4	60	13	23	29
Denmark	6,454	10,114	10,530	8,526	9,033	10,343	7,928	6,868	6,550	5,800	6,314
Faroe Islands	614	746	806	-	895	224	691	276	739	1,650	671[1]
France	42,649	47,064	38,782	43,592	42,200	43,958	38,356	28,913	30,761[1,2]	n/a	14,795[1,2]
Germany	8,246	13,517	13,649	25,262	22,551	22,277	22,400	18,528	14,339	15,006	16,983[1]
Netherlands	123	36	89	181	233	134	334	345	257	207[1]	190[1]
Norway	55,882	72,669	81,330	88,420	101,808	67,341	66,400	40,021	24,737	19,122	33,540[1]
Poland	698	793	415	413	-	495	832	1,016	809	1,244	1,336
Sweden	156	372	548	522	1,764	1,987	1,732	2,064	797	838	1,514
UK (Engl.& Wales)	4,309	5,627	6,845	8,183	5,455	4,480	3,233	3,790	4,441	3,654	1,172[1]
UK (N. Ireland)	-	-	-	-	-	-	-	-	24	-	-
UK (Scotland)	6,529	8,136	6,321	6,970	9,932	15,520	11,911	10,850	8,26	7,383	3,471[1]
Total	125,672	159,078	159,322	182,101	193,902	166,775	153,821	112,731	92,193	n/a	80,015

[1]Preliminary.
[2]Includes IIa(EC), IIIa-d(EC).
n/a = not available.

Table 3.5.2 Annual weight and numbers of SAITHE caught in Sub-area IV between 1972 and 1991.

	Weight (1000 tonnes)				Number (millions)			
Year	Total	H.Con	Disc	By-cat	Total	H.Con	Disc	By-cat
1970	222	163	0	59	142	95	0	47
1971	253	218	0	35	176	143	0	33
1972	246	218	0	28	176	153	0	23
1973	226	195	0	31	169	142	0	27
1974	273	231	0	42	165	120	0	45
1975	278	240	0	38	189	142	0	47
1976	320	253	0	67	310	223	0	87
1977	196	190	0	6	121	117	0	4
1978	135	132	0	3	97	96	0	2
1979	114	113	0	2	68	67	0	1
1980	120	120	0	0	72	72	0	0
1981	123	121	0	1	70	68	0	2
1982	166	161	0	5	115	110	0	5
1983	169	167	0	1	112	111	0	1
1984	198	192	0	6	167	161	0	6
1985	200	192	0	8	206	195	0	11
1986	164	163	0	1	158	156	0	2
1987	149	145	0	4	167	159	0	8
1988	105	104	0	1	93	92	0	1
1989	92	90	0	2	77	74	0	3
1990	88	86	0	2	64	59	0	5
1991	96	96	0	1	123	121	0	1

Table 3.5.3 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	0.150
5	0.200	0.700
6	0.200	0.900
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10	0.200	1.000

Table 3.5.4 Total international catch at age ('000) of SAITHE in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	379	4416	3947	312	235	2015	1215	907	1276	5309	1
2	20189	31275	16150	71766	31335	12891	16503	16787	23095	18195	2
3	40162	47388	61201	50672	199669	22890	30972	14504	14159	22267	3
4	62290	32955	31387	23406	50339	52270	24935	13022	11399	6362	4
5	23108	24967	12123	9005	9902	13082	16771	10031	8338	6151	5
6	20779	15228	20080	6706	5137	4753	2616	7991	6086	3265	6
7	3363	7998	13734	12650	3317	3218	849	2437	5189	2994	7
8	2790	1689	4308	8650	4845	3062	790	577	956	3173	8
9	1550	1165	988	3304	3003	3522	607	349	418	504	9
10	1445	1927	1094	2347	2128	3780	2165	1333	1486	1863	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	1932	270	59	214	104	780	11	4186	291	748	1
2	28263	32798	34455	6622	6078	28876	4887	9119	3399	21487	2
3	27405	23363	75449	124122	47110	29029	27388	14375	30502	58912	3
4	38946	17980	29769	54405	85116	90577	23173	25767	13685	28632	4
5	7934	25161	12081	13039	12197	12429	32280	11554	9135	7356	5
6	5410	4903	12330	4045	4269	1942	2910	9826	3726	2904	6
7	1761	4380	1357	2524	1592	1120	1132	1267	2095	1248	7
8	1210	1333	1113	461	1044	813	452	536	490	711	8
9	846	929	279	267	265	689	492	293	146	311	9
10	794	819	487	254	487	498	394	318	184	211	10

Table 3.5.5 Total international mean weight at age (kg) of SAITHE in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	0.304	0.154	0.268	0.198	0.461	0.429	0.353	0.434	0.253	0.274	1
2	0.510	0.392	0.494	0.494	0.501	0.416	0.520	0.389	0.411	0.585	2
3	0.743	0.780	0.849	0.887	0.690	0.753	0.781	1.080	0.905	0.937	3
4	1.158	1.407	1.556	1.497	1.302	1.251	1.294	1.590	1.812	1.859	4
5	1.897	1.575	2.489	2.478	2.175	1.900	2.120	2.219	2.370	2.694	5
6	2.364	2.543	2.729	3.275	3.036	3.097	3.210	3.071	2.975	3.529	6
7	3.869	3.339	3.353	3.684	4.007	4.146	4.466	3.966	4.047	4.470	7
8	4.184	4.657	4.386	4.190	4.325	4.551	4.784	5.128	5.044	5.424	8
9	4.543	4.502	5.538	5.481	4.981	4.779	5.309	5.947	5.812	6.907	9
10	6.120	6.046	7.525	7.419	6.768	6.257	6.748	7.170	7.322	8.349	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	0.249	0.418	0.181	0.142	0.481	0.360	0.429	0.426	0.216	0.236	1
2	0.498	0.455	0.482	0.481	0.481	0.387	0.547	0.684	0.607	0.286	2
3	1.087	0.982	0.772	0.649	0.648	0.641	0.699	0.832	0.785	0.585	3
4	1.566	1.701	1.600	1.244	1.000	0.838	0.902	0.982	1.154	1.017	4
5	2.497	2.118	2.270	1.889	1.674	1.770	1.326	1.377	1.540	1.455	5
6	3.144	3.058	2.645	2.603	2.294	2.921	2.644	1.905	2.193	2.150	6
7	3.958	3.533	3.715	3.141	3.559	3.782	3.685	3.885	3.195	2.957	7
8	4.908	4.432	4.524	4.521	4.245	4.902	4.654	4.879	4.621	3.976	8
9	5.606	5.336	5.897	5.094	5.779	5.491	5.681	6.350	6.051	4.957	9
10	7.748	6.948	7.720	7.218	7.900	7.040	7.144	8.432	8.209	6.986	10

Table 3.5.6 SAITHE IN THE NORTH SEA. Tuning results

```
CPUE data from file SAI4EF.DAT
Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)
Terminal Fs estimated using  Laurec-Shepherd (with shrinkage)
Shrinkage Log S.E =   .200
Tuning converged after   15 iterations
Total of the absolute F residuals for all ages in the
last year, between iterations 14 and  15 =   .000
Regression weights
      ,  .020,  .116,  .284,  .482,  .670,  .820,  .921,  .976,  .997, 1.000
Oldest age F = 1.000*average of 3 younger ages.
Fleet 1 = FRATRB
Fleet 2 = NORTRL


                      SUMMARY STATISTICS FOR AGE  2
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,  F   ,           ,    Slope ,         ,Intrcpt
   1  ,-16.15  ,  .468, .0044 , .2046,  -.408E-01,   .830E-01,-16.151,   .173
   2  , No data for this fleet at this age
   Fbar       SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .120       .468           0.000           .468            0.000


                      SUMMARY STATISTICS FOR AGE  3
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,  F   ,           ,    Slope ,         ,Intrcpt
   1  ,-14.00  ,  .571, .0374 , .8846,   .526E-01,   .101E+00,-14.001,   .212
   2  ,-13.44  ,  .573, .0342 , .1716,   .485E-01,   .102E+00,-13.443,   .212
   Fbar       SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .390       .404            .364           .404             .808


                      SUMMARY STATISTICS FOR AGE  4
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,  F   ,           ,    Slope ,         ,Intrcpt
   1  ,-12.57  ,  .364, .1570 , .8197,   .505E-01,   .631E-01,-12.568,   .135
   2  ,-12.25  ,  .296, .1127 , .7268,  -.531E-01,   .498E-01,-12.252,   .110
   Fbar       SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
     .770       .230            .387E-01       .230             .028


                      SUMMARY STATISTICS FOR AGE  5
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,     SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,  F   ,           ,    Slope ,         ,Intrcpt
   1  ,-12.09  ,  .148, .2533 ,1.1940,   .292E-01,   .247E-01,-12.089,   .055
   2  ,-12.16  ,  .290, .1230 , .8493,   .550E-01,   .484E-01,-12.164,   .107
   Fbar       SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
    1.059       .132            .115           .132             .762
```

(cont'd)

Table 3.5.6 continued

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.40	.311	.1856	.7997	.207E-01	.555E-01	-12.400	.115
2	-12.43	.516	.0941	.5713	.981E-01	.862E-01	-12.432	.191

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.738	.266	.893E-01	.266	.112

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.88	.313	.1147	.6221	.899E-01	.466E-01	-12.882	.116
2	-12.29	.420	.1083	.7270	.919E-01	.684E-01	-12.291	.156

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.651	.251	.465E-01	.251	.034

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-13.35	.277	.0717	.3731	.996E-01	.353E-01	-13.351	.103
2	-12.54	.852	.0843	1.3028	.693E-01	.151E+00	-12.543	.316

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.516	.263	.222	.263	.712

Table 3.5.7 Total international fishing mortality rate at age of SAITHE in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	0.002	0.018	0.007	0.002	0.002	0.018	0.013	0.004	0.009	0.031	1
2	0.129	0.195	0.086	0.165	0.242	0.133	0.197	0.249	0.124	0.164	2
3	0.362	0.499	0.714	0.422	0.925	0.280	0.538	0.266	0.343	0.170	3
4	0.446	0.572	0.737	0.667	0.996	0.671	0.558	0.457	0.345	0.255	4
5	0.279	0.323	0.427	0.483	0.674	0.785	0.472	0.458	0.601	0.317	5
6	0.525	0.300	0.467	0.447	0.566	0.827	0.347	0.433	0.562	0.502	6
7	0.435	0.393	0.485	0.610	0.416	0.868	0.332	0.635	0.560	0.603	7
8	0.471	0.407	0.382	0.651	0.501	0.862	0.539	0.396	0.554	0.816	8
9	0.477	0.367	0.444	0.569	0.494	0.852	0.406	0.488	0.560	0.646	9
10	0.477	0.367	0.444	0.569	0.494	0.852	0.406	0.488	0.560	0.646	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	0.007	0.001	0.000	0.002	0.001	0.010	0.000	0.015	0.001	0.004	1
2	0.225	0.149	0.105	0.023	0.056	0.253	0.081	0.076	0.015	0.120	2
3	0.396	0.294	0.597	0.660	0.228	0.407	0.405	0.359	0.386	0.390	3
4	0.499	0.491	0.749	1.246	1.483	0.903	0.668	0.843	0.694	0.770	4
5	0.578	0.710	0.732	0.904	1.136	0.949	1.014	0.861	0.851	1.059	5
6	0.510	0.887	0.958	0.583	0.887	0.537	0.607	1.057	0.773	0.739	6
7	0.560	1.056	0.662	0.518	0.480	0.615	0.702	0.588	0.678	0.651	7
8	0.527	1.162	0.875	0.496	0.421	0.485	0.544	0.884	0.475	0.516	8
9	0.532	1.035	0.832	0.532	0.596	0.546	0.618	0.843	0.642	0.635	9
10	0.532	1.035	0.832	0.532	0.596	0.546	0.618	0.843	0.642	0.635	10

Table 3.5.8 Stock numbers at age ('000) of SAITHE in Sub-area IV between 1972 and 1991.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Age
1	237577	267306	637051	196074	138996	126246	103719	266409	163020	194189	1
2	183454	194169	214864	518008	160250	113587	101541	83821	217298	132317	2
3	144998	132001	130812	161348	359459	103009	81378	68276	53525	157089	3
4	189621	82652	65618	52461	86645	116641	63756	38897	42856	31105	4
5	104177	99394	38181	25713	22039	26199	48800	29880	20171	24849	5
6	55645	64515	58944	20386	12982	9198	9784	24922	15471	9058	6
7	10443	26950	39133	30260	10677	6032	3295	5661	13238	7219	7
8	8134	5534	14887	19732	13462	5766	2073	1935	2457	6194	8
9	4471	4159	3015	8322	8425	6681	1994	990	1067	1156	9
10	4169	6880	3340	5911	5970	7170	7107	3779	3790	4274	10

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Age
1	319693	464887	388008	150420	173330	85332	168035	307779	255276	216000	1
2	154196	259997	380373	317621	122960	141817	69160	137565	248207	208739	2
3	91941	100809	183314	280353	254066	95186	90134	52215	104402	200145	3
4	108556	50681	61533	82597	118623	165617	51885	49221	29841	58100	4
5	19744	53986	25384	23817	19458	22032	54974	21776	17342	12211	5
6	14817	9066	21735	10000	7894	5114	6984	16327	7537	6061	6
7	4490	7285	3058	6830	4568	2663	2448	3116	4643	2848	7
8	3233	2101	2075	1291	3331	2313	1179	993	1418	1930	8
9	2243	1563	538	708	644	1791	1166	560	336	722	9
10	2106	1379	939	673	1184	1295	934	608	425	491	10

Table 3.5.9 Norwegian 0-group indices for SAITHE along the Norwegian coast and in the North Sea.

YEAR	OBSER.	VPA	CRUISE
1981	5.4	320	
1982	7.6	465	
1983	5.0	388	
1984	4.6	150	
1985	5.3	173	
1986	2.3	85	20
1987	5.1	168	61
1988	4.3	308	
1989	3.9	255	
1990	6.0		89
1991	7.3		63
1992	5.1		132

Table 3.5.10 Mean fishing mortality, biomass and recruitment of SAITHE in Sub-area IV between 1972 and 1991.

	Mean Fishing Mortality			Biomass		Recruits	
	Ages 3 to 6		Ages 2 to 5	1000 tonnes		Age 1	
Year	H.Con	Disc	By-cat	Total	Sp St	Y.C.	Million
1970	0.364	0.000	0.071	1158	267	69	231
1971	0.291	0.000	0.045	1144	374	70	225
1972	0.360	0.000	0.044	942	410	71	238
1973	0.328	0.000	0.096	833	451	72	267
1974	0.429	0.000	0.161	984	465	73	636
1975	0.404	0.000	0.111	930	400	74	196
1976	0.690	0.000	0.121	775	269	75	139
1977	0.627	0.000	0.014	530	210	76	126
1978	0.472	0.000	0.008	452	195	77	104
1979	0.398	0.000	0.008	491	189	78	266
1980	0.461	0.000	0.002	449	185	79	163
1981	0.308	0.000	0.004	542	192	80	194
1982	0.479	0.000	0.017	581	161	81	320
1983	0.589	0.000	0.006	693	171	82	465
1984	0.738	0.000	0.021	640	138	83	388
1985	0.810	0.000	0.038	565	106	84	150
1986	0.929	0.000	0.005	520	100	85	173
1987	0.676	0.000	0.023	380	102	86	85
1988	0.669	0.000	0.005	339	102	87	168
1989	0.754	0.000	0.024	404	82	88	308
1990	0.649	0.000	0.027	384	66	89	214
1991	0.734	0.000	0.005	331	56	90	214
Arit-mean recruits at age 1 for period 1970 to 1991							240
Geom-mean recruits at age 1 for period 1970 to 1991							214

Table 3.5.11 Input for catch prediction of SAITHE in Sub-area IV.

Age	1991 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 1987 to 1991: H.Con.	Scaled mean F: Disc	Scaled mean F: Ind	Mean values for period 1987 to 1991 — Mean Weight (Kg.): H.Con.	Mean Weight: Disc	Mean Weight: Ind	Mean Weight: Stock	Prop. Ret.
1	214000	0.006			0.006			0.333			0.333	1.000
2	175214	0.144		0.001	0.119		0.000	0.505		0.383	0.502	1.000
3	200145	0.383		0.006	0.391		0.006	0.724		0.494	0.708	1.000
4	58100	0.760		0.009	0.781		0.011	0.998		0.629	0.979	1.000
5	12211	1.055		0.005	0.984		0.004	1.502		0.957	1.494	1.000
6	6061	0.738		0.001	0.780		0.001	2.365		1.058	2.362	1.000
7	2848	0.651			0.682			3.501			3.501	1.000
8	1930	0.516			0.612			4.606			4.606	1.000
9	722	0.635			0.692			5.706			5.706	1.000
10	491	0.635			0.692			7.562			7.562	1.000

Mean F	Age 3 to 6	Age 2 5	Age 3 to 6	Age 2 5
Unscaled	0.734	0.005	0.696	0.017
Scaled			0.734	0.005

Recruits at age 1 in 1992 = 214318
Recruits at age 1 in 1993 = 214318
Recruits at age 1 in 1994 = 214318
Recruits at age 1 in 1995 = 214318

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

Mean F for ages 3 to 6 in 1991 for human consumption landings + discards = 0.734 .
Human consumption + discard F-at-age values in prediction are mean values for the period 1987 to 1991
rescaled to produce a mean value of F for ages 3 to 6 equal to that for 1991

Mean F for ages 2 to 5 in 1991 for small-mesh fisheries = 0.005 .
Industrial fishery F-at-age in the prediction are averages for the period 1987 to 1991 .
rescaled to produce a mean value of F for ages 2 to 5 equal to that for 1991

Values of N in 1991 from VPA have been overwritten
for the following ages .....

Age 1

Values of F for these ages in 1991 from VPA have been overwritten
with scaled mean values used for predictions for 1992 onwards

Table 3.5.12 Predicted catches and biomasses ('000 of tonnes) of SAITHE in Sub-area IV 1982 to 1993.

		Year									
	1991	1992	1993								
Biomass 1 Jan of Year											
Total	331	418	409	409	409	409	409	409	409	409	409
Spawning	56	68	83	83	83	83	83	83	83	83	83
Mean F Ages											
Human Cons. 3 to 6	0.73	0.73	0.00	0.15	0.29	0.44	0.59	0.73	0.88	0.21	0.33
Small-mesh 2 to 5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mean F(Year)/Mean F(1991)										F0.1	Fmax
Human Consumption	1.00	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20	0.29	0.45
Small-mesh Fishery	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Catch weight											
Human Consumption	96	123	0	31	58	82	103	121	137	44	65
Discards	0	0	0	0	0	0	0	0	0	0	0
Small-mesh Fisheries	1	1	1	1	1	1	1	1	1	1	1
Total landings	96	124	1	32	59	83	103	121	138	45	65
Total catch	96	124	1	32	59	83	103	121	138	45	65
Biomass 1 Jan of Year+1											
Total	418	409	555	515	480	449	423	400	380	498	471
Spawning	68	83	176	150	127	108	92	79	67	139	122

Stock at start of and catch during 1992

Age	Stock No	H.Cons	Discards	By-catch	Total
1	214318	1253			1253
2	174136	17778		44	17822
3	124090	36570		527	37097
4	110990	54962		768	55730
5	22029	12685		54	12738
6	3466	1723		2	1725
7	2371	1074			1074
8	1216	510			510
9	943	432			432
10	313	143			143
Wt	418201	123499	0	813	124312

Stock at start of and catch during 1993
for F(1993) = F(1992)

Age	Stock No	H.Cons	Discards	By-catch	Total
1	214318	1253			1253
2	174337	17799		44	17842
3	126504	37282		537	37819
4	68305	33824		472	34297
5	41179	23712		100	23812
6	6713	3337		4	3340
7	1300	589			589
8	982	412			412
9	540	247			247
10	515	236			236
Wt	408891	120809	0	679	121488

Table 3.5.13 North Sea SAITHE.

case	min ssb	relative F	mean yield	C.V. Yield	Mean SSB	C.V. SSB	Prop. closed
1	30	.8	131	.199	135	.202	0
2	30	.9	124	.178	104	.183	0
3	30	1	122	.207	84	.213	0
4	30	1.1	122	.225	70	.233	0
5	30	1.2	122	.211	59	.223	0
6	60	.8	131	.188	134	.192	0
7	60	.9	130	.211	109	.212	.002
8	60	1	128	.274	91	.244	.018
9	60	1.1	123	.396	85	.284	.086
10	60	1.2	124	.515	85	.323	.158
11	90	.8	132	.223	138	.204	.008
12	90	.9	133	.306	122	.205	.052
13	90	1	133	.49	123	.262	.148
14	90	1.1	132	.579	120	.283	.214
15	90	1.2	131	.69	119	.316	.28
16	120	.8	136	.34	159	.192	.074
17	120	.9	141	.471	156	.222	.15
18	120	1	138	.609	154	.263	.236
19	120	1.1	134	.715	149	.271	.306
20	120	1.2	133	.774	144	.294	.348
21	150	.8	140	.462	189	.203	.15
22	150	.9	140	.595	185	.228	.234
23	150	1	138	.696	178	.242	.302
24	150	1.1	139	.777	174	.266	.352
25	150	1.2	137	.851	170	.292	.398

Table 3.5.14

Stock: Saithe in Sub-area IV and Division IIIa (North Sea)

Assessment Quality Control Diagram 1

Average F(3-6,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.40				
1989	0.46	0.40			
1990	0.62	0.51	0.39		
1991	0.69	0.65	0.72	0.64	
1992	0.68	0.67	0.75	0.65	0.73

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	205	168	170				
1989		109	118	120			
1990			94	116	125		
1991				95	91	102	
1992					90	123	121
					Actual	Current	Forecast

$$Actual\ SQC = Landings(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

Remarks:

(cont'd)

Table 3.5.14 (cont'd)

Stock: Saithe in Sub-area IV and Division IIIa (North Sea)

Assessment Quality Control Diagram 3

Recruitment (age 1) Unit: millions					
Date of assessment	Year class				
	1987	1988	1989	1990	1991
1988	283				
1989	166	237			
1990	235[1]	230[1]	232[1]		
1991	187	212[1]	211[1]	211[1]	
1992	168	308	214[1]	214[1]	214[1]

[1]Geometric average recruitment.

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	182	297	301[1]	310[1]				
1989	140	186	236	244[1]	240[1]			
1990	107	125	122	166	206[1]	233[1]		
1991	103	106	87	74	70	79[1]	85[1]	
1992	102	102	82	66	56	68	83[1]	79[1]

[1]Forecast.

Remarks:

Table 3.6.1 Nominal catch (tonnes) of SOLE in Sub-area IV and landings as estimated by the Working Group, 1982-1991.

Year	Belgium	Denmark	France	Germany, Fed. Rep.	Netherlands	UK (Engl. & Wales)	Other countries	Total reported	Unreported landings	Grand Total
1982	1,927	522	686	290	17,749	4031	-	21,577	2	21,579
1983	1,740	730	332	619	16,101	435	+	19,957	4,970	24,927
1984	1,771	818	400	1,034	14,330	586	1	18,940	7,899	26,839
1985	2,390	692	875	303	14,897	774	3	19,934	4,313	24,247
1986	1,833	443	296	155	9,558	647	2	12,934	5,267	18,201
1987	1,644	342	318	210	10,635	676	4	13,829	3,539	17,368
1988	1,199	616	487	452	9,841	740	28	13,363	8,227	21,590
1989	1,596	1,020	313	864	9,620	966	65	14,444	7,377	21,821
1990	2,389	1,428	-	2,296	-	1,484	276	7,873	27,260	35,133
1991	2,977	1,301	465	1,823	18,771	917	145	26,399	11,649	38,048

All landings reported to ICES.
Unreported landings estimated by the Working Group.
1991 data are provisional.
No data on discards available.

Table 3.6.2

Run title : North Sea Sole, sexes combined *** reduced data set ***

At 8/10/1992 16:28

Extended survivors analysis.

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	2660,	389,	191,	165,	373,	92,	10,	115,	837,	124,
2,	26435,	34408,	30734,	16618,	9351,	29208,	13187,	46140,	12023,	14520,
3,	45746,	41386,	43931,	43213,	18494,	21703,	47140,	18211,	103898,	28666,
4,	1843,	21189,	22554,	20286,	17703,	9210,	15248,	22583,	9779,	88904,
5,	3535,	624,	8791,	9403,	7745,	6623,	4400,	4700,	9360,	7537,
6,	4789,	1378,	741,	3556,	5522,	3133,	3890,	1695,	3824,	4223,
7,	1678,	1950,	854,	209,	2272,	1527,	1554,	1455,	1164,	1938,
8,	615,	978,	1043,	379,	110,	892,	898,	655,	1273,	811,
9,	605,	386,	524,	637,	282,	94,	526,	467,	604,	812,
10,	527,	301,	242,	200,	620,	114,	38,	240,	268,	352,
11,	149,	423,	209,	192,	355,	176,	34,	45,	324,	342,
12,	74,	31,	146,	189,	173,	142,	86,	36,	59,	416,
13,	201,	14,	30,	94,	126,	69,	42,	49,	28,	19,
14,	12,	177,	24,	33,	105,	56,	10,	27,	63,	17,
+gp,	315,	230,	243,	267,	305,	167,	111,	95,	215,	174,
TOTALNUM,	89184,	103864,	110257,	95441,	63536,	73206,	87174,	96511,	143719,	148853,
TONSLAND,	21579,	24927,	26839,	24248,	18200,	17367,	21590,	21821,	35133,	38048,
SOPCOF %,	101,	100,	100,	99,	99,	99,	100,	99,	99,	99,

Table 3.6.3

Run title : North Sea Sole, sexes combined *** reduced data set ***

At 8/10/1992 16:28

Extended survivors analysis.

Table 2 Catch weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.1410,	.1340,	.1530,	.1220,	.1350,	.1390,	.1270,	.1180,	.1240,	.1280,
2,	.1880,	.1820,	.1710,	.1870,	.1790,	.1860,	.1750,	.1730,	.1820,	.1860,
3,	.2160,	.2170,	.2210,	.2160,	.2130,	.2050,	.2170,	.2160,	.2260,	.2090,
4,	.3070,	.3010,	.2860,	.2880,	.2990,	.2710,	.2700,	.2880,	.2900,	.2620,
5,	.3710,	.3890,	.3610,	.3570,	.3570,	.3530,	.3530,	.3350,	.3680,	.3140,
6,	.4090,	.4160,	.3860,	.4270,	.4070,	.3740,	.4280,	.3740,	.3900,	.4300,
7,	.4370,	.4670,	.4650,	.4470,	.4850,	.4280,	.4830,	.4560,	.4010,	.4370,
8,	.4910,	.4890,	.5550,	.5440,	.5430,	.4800,	.5190,	.4900,	.4970,	.4620,
9,	.5800,	.5050,	.5750,	.6120,	.5680,	.3800,	.5580,	.4720,	.4570,	.5070,
10,	.5560,	.6090,	.5120,	.6340,	.5360,	.5770,	.5940,	.5090,	.5640,	.5510,
11,	.6280,	.6220,	.6550,	.5090,	.5750,	.6370,	.8070,	.6810,	.6220,	.5250,
12,	.5910,	.6000,	.6310,	.6560,	.6330,	.6120,	.7140,	.6300,	.5170,	.5140,
13,	.7710,	.3340,	.7220,	.7670,	.6310,	.6590,	.7540,	.7110,	.5710,	.8540,
14,	.8980,	.6310,	.8450,	.8010,	.7880,	.7260,	.7710,	.6360,	.4610,	.7680,
+gp,	.7680,	.7560,	.7070,	.6800,	.7150,	.6980,	.6940,	.7290,	.6300,	.5570,
SOPCOFAC,	1.0138,	1.0040,	1.0034,	.9898,	.9936,	.9932,	.9990,	.9855,	.9901,	.9875,

Table 3.6.4

Run title : North Sea Sole, sexes combined *** reduced data set ***

At 8/10/1992 16:28

Extended survivors analysis.

Table 3 Stock weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1300,	.1400,	.1330,	.1270,	.1330,	.1540,	.1330,	.1330,	.1480,	.1380,
3,	.1930,	.2000,	.2030,	.1850,	.1910,	.1920,	.1930,	.1950,	.2030,	.1830,
4,	.2700,	.2850,	.2680,	.2670,	.2780,	.2590,	.2600,	.2900,	.2920,	.2520,
5,	.3590,	.3290,	.3480,	.3240,	.3440,	.3490,	.3350,	.3480,	.3560,	.2980,
6,	.4110,	.4350,	.3860,	.3810,	.4230,	.3810,	.4080,	.3390,	.4380,	.4060,
7,	.4290,	.4640,	.4880,	.3800,	.4940,	.4050,	.4170,	.4100,	.3910,	.4330,
8,	.4760,	.4830,	.5910,	.6260,	.4870,	.4570,	.4720,	.4750,	.4860,	.5010,
9,	.5830,	.5100,	.5670,	.5540,	.5870,	.3080,	.4850,	.4180,	.4710,	.5420,
10,	.5930,	.5830,	.5590,	.5890,	.5460,	.5120,	.4550,	.4620,	.4960,	.5380,
11,	.5700,	.6010,	.6320,	.5170,	.6810,	.6240,	.8290,	.7040,	.6820,	.5120,
12,	.5310,	.7210,	.7310,	.7340,	.6450,	.5800,	.6550,	.7870,	.5500,	.5510,
13,	.7910,	.7410,	.8730,	.7400,	.7370,	.5720,	.5350,	.7170,	.7890,	.4310,
14,	.6110,	.6800,	.9520,	.6420,	.9390,	.6900,	.8470,	.6160,	.4580,	1.1090,
+gp,	.6910,	.7190,	.7000,	.6730,	.8870,	.6810,	.6870,	.7310,	.7490,	.6500,

Table 3.6.5 North Sea SOLE. Summary of the level of sampling in landings in 1991.

Country	Official landings	Number samples	Number measured	Number otoliths
Belgium	2,977	38	3,633	888
Denmark	1,301	-	-	-
France	466	37	2,656	-
Germany	1,823	-	-	-
Netherlands	18,771	72	3,591	3,591
UK	917	113	14,049	858
Others	145	-	-	-

Table 3.6.6 North Sea sole Indices of effort and cpue

	effort						cpue					
	1 Belgium	2 UK-ot	3 UK-bt	4 Netherlands	5 France-bt	6 Denmark	7 Belgium	8 UK-ot	9 UK-bt	10 Netherlands	11 France-bt	12 Denmark
1971	24.0						60.9					
1972	29.8						39.5					
1973	29.4						33.1					
1974	32.2						23.7					
1975	39.2						26.2					
1976	44.7						24.5					
1977	47.6						27.0					
1978	50.3						25.9					
1979	40.0			44.9			38.7			423.2		
1980	35.2	166.8	36.5	45.0			30.9	2.71	12.39	282.1		
1981	31.1	160.1	35.7	46.3			35.3	2.38	10.68	267.8		
1982	34.9	156.9	35.3	57.3			44.7	2.57	11.44	309.8		
1983	35.4	160.3	24.4	65.6		3301	42.3	2.70	17.71	319.9		133
1984	42.8	146.7	34.6	70.8		1203	35.9	3.84	16.27	307.3		301
1985	51.4	170.5	65.5	70.3	12791	488	41.0	4.79	12.46	276.3	25.0	821
1986	42.5	243.6	49.2	68.2	9665	1425	38.9	2.66	13.16	213.4	18.5	174
1987	50.7	257.4	78.3	68.4	8162	1515	29.1	2.63	8.65	204.9	18.0	161
1988	53.0	250.9	87.3	76.2	9150	2539	19.4	2.95	8.48	236.2	15.4	206
1989	54.3	263.9	123.2	61.6	10485	2001	22.7	3.80	8.14	272.7	11.4	207
1990	64.7	819.4	180.4	71.0	11787	2011	24.8	2.16	9.81	380.3	12.4	759
1991	47.2	577.7	210.9	68.0	12116	2712	42.6	2.87	7.86	424.2	16.4	791

1	fishing hours in 1000 HP beam trawl units *10E3	measured
2	otter trawl units *10E2 (areas 3+4)	derived
3	beam trawl units *10E2 (areas 3+4)	derived
4	million HP days beam trawl	measured
5	hours	measured
6	fishing days gill net 2nd quarter	measured
7	Kg/FH 1000 HP beam trawl	derived
8	otter trawl kg/FH (areas 3+4)	measured
9	beam trawl kg/FH (areas 3+4)	measured
10	kg/1000 HP day	derived
11	tonnes/hour	derived
12	kg/fishing day, 2nd quarter	derived

Table 3.5.7 Summary statistics

VPA Version 3.0 (MSDOS)
8/10/1992 10:52

Extended Survivors Analysis
North Sea Sole, sexes combined *** reduced data set ***
CPUE data from file RSOLEF.DAT
Data for 3 fleets over 22 years
Age range from 1 to 14

Fleet,	Alpha,	Beta
Netherlands BT	, .000	, 1.000
Tridens sns	, .000	, 1.000
German survey	, .000	, 1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages
Catchability independent of age for ages >= 7

Terminal population estimation :

Final estimates shrunk towards mean of the last 5 years and the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = .300
Minimum standard error for population estimates derived from each fleet = .300
Prior weighting not applied

Tuning converged after 31 iterations

Total absolute residual between iterations
30 and 31 = .000

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Mean catchability and Standard error.

Netherlands BT

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean Q	-11.11	-6.00	-5.00	-4.98	-5.24	-5.36	-5.58	-5.58	-5.58	-5.58	-5.58	-5.58	-5.58	-5.58
S.E	1.89	.41	.24	.21	.32	.26	.16	.35	.48	.83	1.09	1.24	1.68	1.85

Tridens survey

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean Q	-3.62	-4.49	-5.72	-6.18										
S.E	.17	.38	.61	.56										

German survey

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean Q		-9.07	-7.64	-7.51	-7.76	-8.10	-8.37	-8.37	-8.37	-8.37				
S.E		.66	.58	.52	.64	.60	.77	1.33	1.73	2.12				

Table 3.6.8

Run title : North Sea Sole, sexes combined *** reduced data set ***

At 8/10/1992 16:28

Extended survivors analysis.

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	FBAR 89-91
AGE											
1,	.0182,	.0028,	.0028,	.0021,	.0024,	.0012,	.0000,	.0011,	.0075,	.0026,	.0037,
2,	.2291,	.3048,	.2830,	.3084,	.1394,	.2368,	.2110,	.1255,	.1423,	.1549,	.1409,
3,	.6663,	.5896,	.6987,	.7099,	.5876,	.4839,	.6472,	.4439,	.4048,	.5156,	.4548,
4,	.5354,	.6632,	.6612,	.7257,	.6312,	.5800,	.6603,	.6576,	.4029,	.6384,	.5663,
5,	.6333,	.3078,	.5646,	.5652,	.5977,	.4523,	.5361,	.3837,	.5553,	.5494,	.4961,
6,	.5756,	.4793,	.6406,	.4144,	.6795,	.4551,	.4640,	.3594,	.5457,	.4623,	.4558,
7,	.4364,	.4310,	.5467,	.3283,	.4502,	.3528,	.3797,	.2797,	.3980,	.5216,	.3998,
8,	.3566,	.4345,	.3835,	.4413,	.2562,	.2833,	.3216,	.2422,	.3742,	.4723,	.3629,
9,	.3963,	.3527,	.3890,	.3791,	.6092,	.3226,	.2401,	.2457,	.3274,	.3857,	.3196,
10,	.3967,	.3111,	.3468,	.2239,	.6848,	.4697,	.1865,	.1470,	.1947,	.2870,	.2096,
11,	.5471,	.5655,	.3286,	.4517,	.6776,	.3689,	.2202,	.3148,	.2701,	.3611,	.3153,
12,	.4843,	.1833,	.3425,	.4922,	.8405,	.5594,	.2757,	.3366,	.7585,	.5784,	.5578,
13,	.2369,	.1396,	.2422,	.3435,	.6322,	.8694,	.2811,	.2214,	.4202,	.5009,	.3809,
14,	.4162,	.3013,	.3337,	.4052,	.7051,	.5676,	.2509,	.2644,	.4367,	.4214,	.3741,
+gp,	.4162,	.3013,	.3337,	.4052,	.7051,	.5676,	.2509,	.2644,	.4367,	.4214,	
FBARC,	.5103,	.4852,	.5517,	.5592,	.5286,	.4302,	.5209,	.4324,	.3905,	.4794,	
FBAR 2- 8,	.4904,	.4586,	.5398,	.4990,	.4774,	.4063,	.4600,	.3560,	.4033,	.4735,	
FBAR 3-10,	.4996,	.4461,	.5289,	.4735,	.5620,	.4250,	.4294,	.3449,	.4004,	.4790,	

Table 3.6.9

Run title : North Sea Sole, sexes combined *** reduced data set ***

At 8/10/1992 16:28

Extended survivors analysis.

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	GMST 82-88
AGE												
1,	154967,	145275,	72953,	83674,	161354,	80643,	454386,	105460,	118452,	51002,	0,	134889,
2,	135740,	137689,	131081,	65829,	75554,	145644,	72881,	411136,	95315,	106383,	46031,	103744,
3,	98873,	97677,	91857,	89372,	43757,	59469,	104001,	53402,	328122,	74808,	82448,	80262,
4,	4674,	45949,	49014,	41327,	39761,	22001,	33166,	49263,	30997,	198066,	40421,	27734,
5,	7921,	2476,	21421,	22896,	18097,	19138,	11146,	15505,	23094,	18746,	94650,	12061,
6,	11504,	3805,	1647,	11020,	11772,	9008,	11017,	5900,	9559,	11992,	9792,	7120,
7,	4988,	5854,	2132,	785,	6589,	5399,	5171,	6268,	3727,	5012,	6834,	3671,
8,	2155,	2917,	3442,	1117,	512,	3801,	3433,	3200,	4288,	2265,	2692,	2067,
9,	1944,	1365,	1709,	2123,	650,	358,	2590,	2252,	2273,	2669,	1278,	1286,
10,	1692,	1184,	868,	1048,	1315,	320,	235,	1844,	1594,	1482,	1642,	783,
11,	372,	1030,	785,	555,	758,	600,	181,	176,	1440,	1187,	1007,	542,
12,	203,	195,	529,	511,	320,	348,	375,	131,	116,	995,	749,	332,
13,	1002,	113,	147,	340,	283,	125,	180,	258,	85,	49,	505,	232,
14,	37,	715,	89,	104,	218,	136,	47,	123,	187,	50,	27,	119,
+gp,	969,	927,	897,	839,	630,	403,	525,	431,	635,	529,	344,	
TOTAL,	427040,	447170,	378570,	321539,	361570,	347394,	699334,	655349,	619883,	475235,	288419,	

Table 3.6.10 North Sea Sole
ind·ces of recruitment

	DFS 0-group				DFS 1-group			
year class	nl/bel	uk	ger	comb	nl/bel	uk	ger	comb
67								
68								
69					0.66			11.98
70	12.18			221.00	0.04			0.73
71	7.94			144.07	0.07			1.27
72	0.29			5.26	0.21			3.81
73	4.54	27.48		90.62	0.33			5.99
74	0.83		0.2	15.56	0.03	2.69		1.49
75	8.08	42.79	3.4	167.88	0.19	7.08		5.93
76	3.38	65.30	0.4	81.91	0.22	8.50		6.97
77	1.07	24.81	2.2	32.31	0.03	0.92		0.87
78	4.36	33.58	2.5	95.38	0.11	0.79		2.27
79	20.65	46.97	1.1	391.51	2.05	8.61		40.21
80	19.83	117.89	2.6	401.63	0.51	8.12		12.10
81	15.15	50.57	1.2	293.04	0.67	6.92		14.58
82	17.61	62.73	0.9	340.58	1.11	4.78		21.81
83	4.93	64.00	0.3	109.40	0.41	10.82		11.23
84	9.17	86.91	0.7	194.20	0.10	4.23		3.29
85	15.80	46.58	0.0	300.66	0.58	3.12		11.62
86	3.50	27.03	0.3	72.36	0.24	2.29		5.16
87	28.55	38.22	1.9	534.21	0.76	9.40		17.08
88	2.07	60.72	2.4	61.73	0.28	4.05		6.50
89	2.62	116.40	0.2	83.00	0.22	13.51		8.72
90	2.60	49.70	0.2	62.56	0.03	30.46		11.21
91	19.37	53.55	0.9	369.69	0.61	5.38		12.95
92	0.94	60.58	0.6	36.72				

TRIDENS SNS surveys

year class	sep/oct age 0	april age 1	sep/oct age 1	april age 2	sep/oct age 2	april age3	sep/oct age3	sep/oct age 4
66						79		31
67				583		453	204	7
68		155		548	745		99	0
69		812	4938		1961	415	161	35
70	669		613	150	341	436	73	0
71	6327	294	1410	909	905	31	69	44
72	24	13	4686	310	397	8	174	70
73	847	137	1924	884	887	66	187	85
74	140	13	597	84	79	38	77	27
75	565	91	1413	846	762	365	267	60
76	475	540	3724	1311	1379	203	325	45
77	1620	271	1552	58	388	193	99	13
78	10529	183	104	99	80	14	51	7
79	3908	1027	4483	578	1411	310	231	43
80	5518	186	3739	699	1124	598	107	102
81	3194	871	5098	1242	1137	466	307	59
82	2528	515	2640	1258	1081	513	159	30
83	769	157	2359	847	709	44	67	15
84	3473	225	2151	171	465	171	59	81
85	4268	375	3791	593	955	636	284	50
86	901	159	1890	438	594	273	248	100
87	13690	235	11227	2492	5369	2367	907	607
88	. 523	103	3052	590	1078		527	264
89	2171	421	2900		2515		319	
90	53		1265		114			
91	3640		11081					
92	303							

Table 3.6.11 North Sea Sole
Results of the beam trawl survey in August-September in the southeastern North Sea (Isis, Belgica: number per fishing hour) and in May in the German Bight (Solea: numbers per 2 fishing hours)

Year	Age 0	1	2	3	4	5	6	7	8	9	10+	nos sq
R/V "ISIS" - 8 m beam trawl (daytime fishery)												
1985	-	2.34	6.43	3.58	1.68	0.74	0.21	0.00	-	-	0.02	29
1986	-	6.61	4.92	1.47	0.83	0.53	0.17	0.13	-	0.02	0.05	25
1987	0.05	6.15	11.11	1.60	0.54	0.52	0.17	0.21	0.05	-	0.02	26
1988	-	75.23	12.10	2.58	0.95	0.12	0.16	0.10	0.10	0.02	0.11	27
1989	-	8.00	60.40	3.90	3.60	0.63	0.13	0.20	0.00	0.04	0.03	29
1990	0.09	18.99	20.91	18.34	0.57	0.59	0.48	0.09	0.05	0.01	0.01	27
1991	0.95	3.23	21.15	5.14	5.22	0.11	0.12	0.07	0.02	0.01	0.03	
1992	0.18	61.01	22.19	8.73	1.89	2.47	0.05	0.12	0.07	0.01	0.06	

Year	Age 0	1	2	3	4	5	6	7	8	9	10+	nos sq
R/V "BELGICA" - 8 m beam trawl (daytime fishery)												
1986	-	1.9	1.7	2.7	2.0	1.0	-	0.2	-	-	0.3	8
1987	-	0.0	5.1	1.4	1.3	1.4	0.5	0.1	0.3	0.1	0.2	8
1988	1.3	4.7	2.2	14.3	3.6	2.9	0.8	-	1.7	2.1	1.0	8
1989	-	8.8	17.2	1.9	3.3	0.8	0.2	0.4	0.2	-	0.5	8
1990	-	21.8	5.8	7.5	1.7	1.8	0.8	-	0.5	0.9	1.2	8
1991	-	7.6	12.1	3.8	4.7	0.5	0.4	0.2	0.1	-	0.3	8
1992	-	76.0	23.0	14.3	1.7	1.5	-	1.7	0.1	0.8	0.6	

Year	Age 2	3	4	5	6	7	8	9	10	11+
R/V "SOLEA" - 70 mm net (night fishery)										
1976	0.7	31.5	22.7	10.6	1.6	2.9	1.4	1.2	0.7	2.2
1977	59.8	16.3	31.0	15.9	4.6	0.5	0.4	0.2	0.1	0.4
1978	36.0	34.4	2.5	6.5	2.0	0.3	0.1	0.1	0.0	0.3
1980a	9.2	54.3	48.9	29.5	2.5	6.5	3.2	1.0	0.2	1.3
1980b	4.2	28.6	20.0	14.4	0.6	1.6	0.6	0.2	0.0	0.0
1981	42.2	1.9	10.3	6.1	2.9	0.5	0.9	1.1	0.2	0.3
1982	39.1	76.1	2.3	8.8	4.6	3.4	0.6	1.7	0.6	0.5
1983	129.7	77.1	38.4	1.4	4.0	2.2	2.1	0.4	0.5	0.7
1984	24.8	147.1	55.6	22.8	0.6	2.4	2.3	1.2	0.4	1.0
1985	10.9	77.8	87.9	18.6	6.0	0.5	0.6	0.5	0.3	0.4
1986	7.6	10.8	11.4	10.4	2.9	0.9	0.0	0.2	0.2	0.2
1987	22.0	29.8	13.5	6.8	3.6	1.0	0.2	0.0	0.1	0.0
1988	8.5	24.6	13.1	2.4	1.7	1.1	0.1	0.0	0.0	0.1
1989	17.9	20.3	16.6	3.9	1.2	1.0	0.8	0.2	0.1	0.0
1990	10.2	66.9	9.2	3.1	0.9	0.4	0.2	0.1	0.0	0.0
1991	28.4	86.4	164.3	16.9	12.3	2.0	0.8	0.3	0.7	0.1
1992	3.1	54.6	18.9	41.0	5.2	1.2	1.0	0.1	0.1	0.0

Table 3.6.12 North Sea SOLE, 1-group.

```
Analysis by RCT3 ver3.1 of data from file :rcrtsol.csv
"SOLE NORTH SEA (IV)

Data for    6 surveys over   25 years :  1968 - 1992
Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression
Forecast/Hindcast variance correction used.
```

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	re- cruits
	I-----------Regression----------			I		I-----------Prediction---------			I	
Yearclass = 1989										
"INT-0	1.52	3.82	1.03	.404	14	4.43	10.53	1.175	.029	37421
"TR1S"	.78	5.49	.27	.885	20	7.97	11.69	.295	.467	119372
"INT-1	1.45	8.53	.75	.578	14	2.27	11.82	.837	.058	135944
"TR2S"	.87	5.73	.39	.788	21	7.83	12.53	.435	.214	276509
"TR3S"	1.26	5.08	.64	.580	21	5.77	12.32	.700	.083	224134
"SOL3"	1.06	7.70	.67	.611	15	4.02	11.94	.751	.072	153277
					VPA Mean =		11.44	.731	.076	92967
Yearclass = 1990										
"INT-0	1.52	3.82	1.03	.404	14	4.15	10.11	1.201	.034	24588
"TR1S"	.78	5.49	.27	.885	20	7.14	11.05	.296	.564	62943
"INT-1	1.45	8.53	.75	.578	14	2.50	12.15	.846	.069	189094
"TR2S"	.87	5.73	.39	.788	21	4.74	9.85	.454	.240	18967
					VPA Mean =		11.44	.731	.093	92967
Yearclass = 1991										
"INT-0	1.52	3.82	1.03	.404	14	5.92	12.78	1.186	.050	355045
"TR1S"	.78	5.49	.27	.885	20	9.31	12.73	.313	.721	337729
"INT-1	1.45	8.53	.75	.578	14	2.64	12.34	.853	.097	288662
					VPA Mean =		11.44	.731	.132	92967
Yearclass = 1992										
"INT-0	1.52	3.82	1.03	.404	14	3.63	9.32	1.269	.249	11159
					VPA Mean =		11.44	.731	.751	92967

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	146527	11.89	.20	.18	.79		
1990	50961	10.84	.22	.33	2.18		
1991	275639	12.53	.27	.25	.92		
1992	54663	10.91	.63	.92	2.10		

Table 3.6.13 North Sea Sole assessment Summary (corrected for SOP discrepancy)
Traditional vpa Terminal Fs estimated using XSA -shrunk method

Year	Yield ('000 t)	SOP ('000 t)	Sopfact	SSB ('000 t)	Tot Biom ('000 t)	Recruits age 1 (mill)	F(bar)c	F(2-8)u	Yield/ SSB
1957	12.1	11.6	1.04	82	92	164	0.147	0.137	0.15
1958	14.3	14.2	1.01	86	100	143	0.172	0.161	0.17
1959	13.8	13.7	1.01	94	117	552	0.148	0.133	0.15
1960	18.6	18.7	0.99	100	136	66	0.180	0.168	0.19
1961	23.6	23.2	1.01	149	157	115	0.179	0.161	0.16
1962	26.9	27.0	0.99	146	154	28	0.206	0.183	0.18
1963	26.2	26.4	0.99	146	148	23	0.194	0.249	0.18
1964	11.3	11.7	0.97	52	66	552	0.268	0.228	0.22
1965	17.0	17.8	0.96	47	117	121	0.242	0.246	0.36
1966	33.3	33.7	0.99	103	112	41	0.278	0.240	0.32
1967	33.4	32.7	1.02	103	111	75	0.359	0.308	0.32
1968	33.2	33.3	1.00	88	99	100	0.495	0.372	0.38
1969	27.6	27.0	1.02	72	85	50	0.514	0.423	0.39
1970	19.7	19.8	1.00	63	72	142	0.460	0.351	0.31
1971	23.7	23.4	1.01	53	74	42	0.479	0.444	0.45
1972	21.1	21.3	0.99	56	64	77	0.466	0.393	0.38
1973	19.3	19.0	1.02	43	57	106	0.525	0.452	0.45
1974	18.0	18.2	0.99	42	59	111	0.496	0.462	0.43
1975	20.8	20.6	1.01	44	60	42	0.468	0.462	0.47
1976	17.3	17.0	1.02	44	54	114	0.458	0.404	0.39
1977	18.0	17.7	1.02	37	57	141	0.436	0.381	0.49
1978	20.3	20.4	1.00	38	57	47	0.459	0.493	0.53
1979	22.6	22.3	1.01	47	54	12	0.509	0.460	0.48
1980	15.8	15.5	1.02	37	45	155	0.483	0.441	0.43
1981	15.4	15.0	1.03	26	53	150	0.455	0.445	0.59
1982	21.6	21.3	1.01	36	61	155	0.510	0.490	0.60
1983	24.9	24.8	1.00	43	69	145	0.485	0.459	0.58
1984	26.6	26.7	0.99	46	67	93	0.552	0.540	0.58
1985	24.2	24.4	0.99	43	55	84	0.559	0.499	0.56
1986	18.2	18.3	0.99	37	55	161	0.528	0.477	0.49
1987	17.4	17.5	0.99	32	59	81	0.430	0.406	0.54
1988	21.6	21.6	1.00	43	75	454	0.541	0.460	0.50
1989	21.8	22.1	0.98	38	97	105	0.432	0.356	0.57
1990	35.1	35.4	0.99	94	115+	147*	0.391	0.403	0.37
1991	38.0		0.99	80	101+	51*	0.479	0.474	0.48
1992				74+	94+	275*			
1993						55*			

* indicated by recruitment surveys

Average recruitment (arithmetic)	135
Average recruitment (geometric) in millions at age 1 (period 1957-1989)	97

+corrected for recruitment adjustments

Table 3.6.14 SOLE in the North Sea (Sub-division IV).

Prediction with management option table: Input data

Year: 1992								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	275639.00	0.1000	0.0000	0.0000	0.0000	0.050	0.0040	0.123
2	46031.000	0.1000	0.0000	0.0000	0.0000	0.140	0.1620	0.180
3	101989.00	0.1000	1.0000	0.0000	0.0000	0.194	0.5240	0.217
4	40421.000	0.1000	1.0000	0.0000	0.0000	0.278	0.6530	0.280
5	94650.000	0.1000	1.0000	0.0000	0.0000	0.334	0.5720	0.339
6	9792.000	0.1000	1.0000	0.0000	0.0000	0.394	0.5250	0.398
7	6834.000	0.1000	1.0000	0.0000	0.0000	0.411	0.4610	0.431
8	2692.000	0.1000	1.0000	0.0000	0.0000	0.487	0.4180	0.483
9	1278.000	0.1000	1.0000	0.0000	0.0000	0.477	0.3680	0.479
10	1642.000	0.1000	1.0000	0.0000	0.0000	0.499	0.2420	0.541
11	1007.000	0.1000	1.0000	0.0000	0.0000	0.633	0.3630	0.609
12	749.000	0.1000	1.0000	0.0000	0.0000	0.629	0.6430	0.554
13	505.000	0.1000	1.0000	0.0000	0.0000	0.646	0.4390	0.712
14	27.000	0.1000	1.0000	0.0000	0.0000	0.728	0.4310	0.622
15+	344.000	0.1000	1.0000	0.0000	0.0000	0.710	0.4310	0.639
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Recruits in 1993 55,000 thousands
Recruits in 1994 97,000 thousands (GH)

Table 3.6.15 SOLE in the North Sea (Sub-division IV)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0	10.508	4564	8.603	4387	8.603	4387
0.1000	0.0474	0.278	115	7.736	2833	5.832	2656	5.832	2656
0.2000	0.0947	0.424	160	6.277	1982	4.373	1806	4.373	1806
0.3000	0.1421	0.513	180	5.386	1498	3.482	1322	3.482	1322
0.4000	0.1894	0.573	188	4.791	1195	2.888	1019	2.888	1019
0.5000	0.2368	0.616	191	4.369	993	2.466	817	2.466	817
0.6000	0.2841	0.647	192	4.057	851	2.154	675	2.154	675
0.7000	0.3315	0.672	192	3.817	748	1.915	572	1.915	572
0.8000	0.3789	0.691	190	3.628	671	1.726	495	1.726	495
0.9000	0.4262	0.707	189	3.475	611	1.573	435	1.573	435
1.0000	0.4736	0.719	187	3.349	564	1.448	388	1.448	388
1.1000	0.5209	0.730	186	3.244	526	1.343	350	1.343	350
1.2000	0.5683	0.739	184	3.155	495	1.254	319	1.254	319
1.3000	0.6156	0.747	183	3.078	469	1.177	293	1.177	293
1.4000	0.6630	0.754	181	3.011	447	1.111	271	1.111	271
1.5000	0.7104	0.761	180	2.952	428	1.052	253	1.052	253
1.6000	0.7577	0.766	179	2.899	412	1.000	236	1.000	236
1.7000	0.8051	0.771	178	2.853	398	0.954	222	0.954	222
1.8000	0.8524	0.775	177	2.810	385	0.912	210	0.912	210
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : HS1
Date and time : 20OCT92:16:30
Computation of ref. F: Simple mean, age 2 - 8
F-0.1 factor : 0.2543
F-max factor : 0.5912
F-0.1 reference F : 0.1204
F-max reference F : 0.2800
Recruitment : Single recruit

Table 3.6.16

Sole in the North Sea (Fishing Area IV)

Sole in the North Sea (Fishing Area IV)

Prediction with management option table

Year: 1992					Year: 1993					Year: 1994	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.4736	93924.051	73713.104	32410.937	0.0000	0.0000	91871.695	54426.701	0.000	112313.70	100513.04
.	.	.	.	.	0.2000	0.0947	.	54426.701	6906.730	104934.81	93139.710
.	.	.	.	.	0.4000	0.1894	.	54426.701	13190.986	98240.008	86450.460
.	.	.	.	.	0.6000	0.2841	.	54426.701	18916.233	92158.438	80374.440
.	.	.	.	.	0.8000	0.3789	.	54426.701	24139.123	86626.938	74848.485
.	.	.	.	.	1.0000	0.4736	.	54426.701	28910.246	81589.173	69816.261
.	.	.	.	.	1.2000	0.5683	.	54426.701	33274.794	76994.886	65227.509
.	.	.	.	.	1.4000	0.6630	.	54426.701	37273.157	72799.220	61037.376
.	.	.	.	.	1.6000	0.7577	.	54426.701	40941.443	68962.129	57205.812
.	.	.	.	.	1.8000	0.8524	.	54426.701	44311.950	65447.843	53697.048
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : SOLPRED
Date and time : 09OCT92:19:19
Computation of ref. F: Simple mean, age 2 - 8
Basis for 1992 : F factors

Table 3.6.17

Stock:	**North Sea Sole**	input parameters in bold					
M:	**0.100**	Age	reference F	mat -ogive	W.A.A catch	W.A.A stock
F-factor:	**0.800**					
av. recr.:	**134**					
		1	**0.004**	**0.000**	**0.123**	**0.050**
		2	**0.162**	**0.000**	**0.180**	**0.140**
		3	**0.524**	**1.000**	**0.217**	**0.194**
		4	**0.653**	**1.000**	**0.280**	**0.278**
		5	**0.572**	**1.000**	**0.339**	**0.334**
		6	**0.525**	**1.000**	**0.398**	**0.394**
		7	**0.461**	**1.000**	**0.431**	**0.411**
		8	**0.418**	**1.000**	**0.483**	**0.487**
		9	**0.368**	**1.000**	**0.479**	**0.477**
		10	**0.242**	**1.000**	**0.541**	**0.499**
		11	**0.363**	**1.000**	**0.609**	**0.633**
		12	**0.643**	**1.000**	**0.554**	**0.629**
		13	**0.439**	**1.000**	**0.712**	**0.646**
		14	**0.431**	**1.000**	**0.622**	**0.728**
		15	**0.431**	**1.000**	**0.639**	**0.710**

Summary

year	recruits	catch	SB	SSB
1957	**164**	26	92	67
1958	**143**	26	94	67
1959	**552**	27	116	71
1960	**66**	35	144	71
1961	**115**	47	142	128
1962	**28**	42	125	109
1963	**23**	31	94	89
1964	**552**	23	97	67
1965	**121**	25	123	47
1966	**41**	40	128	110
1967	**75**	39	114	105
1968	**100**	28	92	78
1969	**50**	23	80	65
1970	**142**	21	71	58
1971	**42**	19	69	49
1972	**77**	19	63	53
1973	**106**	16	60	45
1974	**111**	16	62	43
1975	**42**	18	62	46
1976	**114**	18	59	48
1977	**141**	16	62	41
1978	**47**	18	64	44
1979	**12**	19	59	52
1980	**155**	16	54	45
1981	**150**	14	60	33
1982	**155**	18	70	44
1983	**145**	22	81	54
1984	**93**	25	85	62
1985	**84**	25	81	65
1986	**161**	23	78	60
1987	**81**	22	78	54
1988	**454**	23	93	60
1989	**105**	28	118	55
1990	**147**	38	123	102
1991	**51**	37	116	95
1992	**275**	31	106	85
1993	**55**	29	106	68
average	134	25	90	66
long term	134	26	90	67

Table 3.6.18

		input parameters in bold				
Stock:	**North Sea Sole**	Age	reference F	mat -ogive	W.A.A catch	W.A.A stock
M:	**0.100**					
F-factor:	**1.000**					
av. recr.:	**134**					
		1	**0.004**	**0.000**	**0.123**	**0.050**
		2	**0.162**	**0.000**	**0.180**	**0.140**
		3	**0.524**	**1.000**	**0.217**	**0.194**
		4	**0.653**	**1.000**	**0.280**	**0.278**
		5	**0.572**	**1.000**	**0.339**	**0.334**
		6	**0.525**	**1.000**	**0.398**	**0.394**
		7	**0.461**	**1.000**	**0.431**	**0.411**
		8	**0.418**	**1.000**	**0.483**	**0.487**
		9	**0.368**	**1.000**	**0.479**	**0.477**
		10	**0.242**	**1.000**	**0.541**	**0.499**
		11	**0.363**	**1.000**	**0.609**	**0.633**
		12	**0.643**	**1.000**	**0.554**	**0.629**
		13	**0.439**	**1.000**	**0.712**	**0.646**
		14	**0.431**	**1.000**	**0.622**	**0.728**
		15	**0.431**	**1.000**	**0.639**	**0.710**

Summary year	recruits	catch	SB	SSB
1957	**164**	25	77	52
1958	**143**	26	80	52
1959	**552**	27	102	56
1960	**66**	37	129	56
1961	**115**	49	125	111
1962	**28**	41	104	88
1963	**23**	29	72	68
1964	**552**	20	78	47
1965	**121**	25	107	31
1966	**41**	42	112	94
1967	**75**	38	94	85
1968	**100**	26	73	58
1969	**50**	21	61	46
1970	**142**	19	56	42
1971	**42**	17	55	35
1972	**77**	18	50	41
1973	**106**	16	48	33
1974	**111**	15	51	32
1975	**42**	17	51	35
1976	**114**	17	49	38
1977	**141**	16	52	31
1978	**47**	18	55	35
1979	**12**	19	49	42
1980	**155**	15	44	35
1981	**150**	13	50	23
1982	**155**	18	62	35
1983	**145**	23	72	45
1984	**93**	25	74	51
1985	**84**	25	69	53
1986	**161**	22	66	47
1987	**81**	21	66	41
1988	**454**	22	81	48
1989	**105**	29	106	43
1990	**147**	40	109	89
1991	**51**	37	99	78
1992	**275**	30	87	67
1993	**55**	27	88	51
average	134	25	76	52
long term	134	25	76	52

Table 3.6.19

Stock: North Sea Sole

Assessment Quality Control Diagram 1

A

Average F(2-8,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.49				
1989	0.51	0.55			
1990	0.48	0.58	0.53		
1991	0.45	0.52	0.42	0.55	
1992	0.41	0.46	0.36	0.40	0.47

Remarks:

Assessment Quality Control Diagram 2

B

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	18.2	17.5	23.3				
1989		17.6	24.0	29.0			
1990			23.2	38.0	31.0		
1991				28.8	32.0	25.0	
1992					33.6	32.4	28.9
					Actual	Current	Forecast

$$Actual\ SQC = Landings(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

Remarks:

Table 3.6.19 (cont'd)

Stock: North Sea Sole

Assessment Quality Control Diagram 3

d

Recruitment (age 1) Unit: millions					
Date of assessment	Year class				
	1988	1989	1990	1991	1992
1988	poor[1]				
1989	101[1]	52[1]			
1990	106[1]	99[1]	15[1]		
1991	117[1]	125[1]	70[1]	137[1]	
1992	105	147[1]	51[1]	275[1]	55[1]

[1]Predicted from surveys.

Remarks:

Assessment Quality Control Diagram 4

D

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	28.0	31.2	n/a[1]	n/a[1]				
1989	27.6	32.2	27.1	n/a[1]	n/a[1]			
1990	28.8	37.8	29.8	69.9	58.0[1]	46.0[1]		
1991	30.5	40.5	34.1	67.6	56.0	47.0[1]	37.0[1]	
1992	32.2	42.9	38.2	94.2	80.2	73.7	54.4[1]	69.8[1]

[1]Forecast.

Remarks: n/a = not available.

Table 3.7.1 North Sea Plaice. Nominal landings (tonnes) in Sub-area IV as officially reported to ICES, 1981-1991.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Belgium	6,091	7,103	8,916	10,220	9,965	7,232	8,554	11,527	10,939	13,940	14,328
Denmark	23,395	24,532	19,114	23,361	28,236	26,332	21,597	20,259	23,481	26,474	24,305
Faroe Islands	-	-	-	-	-	-	-	43	-	-	-
France	689	1,046	1,185	1,145	1,010	751	1,580	1,773	2,037	n/a	508
Germany	3,453	3,628	2,397	2,485	2,197	1,809	1,794	2,566	5,341	8,747	7,748
Netherlands	40,049	55,715	53,608	61,478	90,950	74,447	76,612	77,724	84,173	n/a	68,266
Norway	18	16	17	17	23	21	12	21	321	1,756	553
Sweden	3	6	22	14	18	16	7	2	12	169	103
UK (Engl. & Wales)	17,230	16,534	13,248	12,988	11,335	12,428	14,891	17,613	19,735	17,563	12,153
UK (N.Ireland)	-	-	-	-	-	-	-	-	540	176	859
UK (Scotland)	4,394	4,355	4,159	4,195	4,577	4,866	5,747	6,884	5,516	6,789	6,587
Total reported	95,322	112,935	102,666	115,903	148,311	127,902	130,794	138,412	152,095	75,614	135,410
Unreported landings[2]	44,425	41,614	41,369	40,244	11,526	37,445	29,700	24,059	17,547	92,092	18,323
Landings as used by WG	139,747	154,549	144,035	156,147	159,837	165,347	160,494	162,471	169,642	167,706	153,733

[1]Provisional.
[2]Estimated by the Working Group.

Table 3.7.2 North Sea plaice: sampling level for length measurements and age compositions in 1991.

	Number of samples	Number measured	Otoliths
Denmark	26	4,847	4,774
England	157	34,188	2,711
Netherlands	78	4709	4,709
Belgium	40	2,537	550

Table 3.7.3

Run title : Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

At 8/10/1992 20:06

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	3334,	1214,	108,	121,	1674,	0,	0,	1260,	1527,	1441,
2,	47776,	119695,	63252,	73552,	67125,	109406,	16122,	46168,	35077,	45127,
3,	209007,	115034,	274209,	144316,	163717,	125510,	264640,	101733,	105040,	85692,
4,	69544,	99076,	53549,	185203,	93801,	108926,	77608,	228268,	116753,	118731,
5,	28655,	29359,	37468,	32520,	84479,	61250,	49738,	51556,	171396,	74811,
6,	16726,	12906,	13661,	15544,	24049,	33146,	26343,	19012,	28652,	80859,
7,	7589,	8216,	6465,	6871,	9299,	10431,	17531,	10407,	8959,	15615,
8,	5470,	4193,	5544,	3650,	4490,	4008,	5667,	7479,	4664,	5567,
9,	4482,	3013,	2720,	2698,	2733,	2038,	3329,	2081,	3875,	3304,
10,	3706,	2947,	2088,	1543,	2026,	1536,	1759,	1672,	1246,	2528,
11,	1134,	2144,	1307,	1030,	1178,	948,	970,	915,	801,	1029,
12,	712,	1219,	1143,	1070,	1084,	615,	963,	623,	511,	649,
13,	575,	581,	455,	727,	806,	505,	526,	433,	339,	384,
14,	519,	344,	310,	371,	628,	281,	533,	326,	244,	322,
+gp,	2007,	1052,	1262,	1057,	1228,	1211,	1703,	1551,	1230,	1222,
TOTALNUM,	401236,	400993,	463541,	470273,	458317,	459811,	467432,	473484,	480314,	437281,
TONSLAND,	154551,	144038,	157973,	159838,	165347,	160494,	162471,	169641,	167707,	153733,
SOPCOF %,	101,	99,	100,	98,	99,	99,	98,	101,	98,	95,

Table 3.7.4

Run title : Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

At 8/10/1992 20:06

Table 3 Stock weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1310,
2,	.2420,	.2110,	.2030,	.2080,	.1950,	.1940,	.2110,	.2150,	.2450,	.2080,
3,	.2650,	.2480,	.2420,	.2430,	.2530,	.2650,	.2380,	.2510,	.2710,	.2630,
4,	.3810,	.3290,	.3380,	.3100,	.3360,	.3300,	.3140,	.2810,	.2820,	.2760,
5,	.4900,	.4940,	.4640,	.4520,	.4400,	.4010,	.4250,	.3590,	.3420,	.3440,
6,	.5890,	.5590,	.5710,	.5360,	.5330,	.5030,	.4670,	.4840,	.4200,	.4050,
7,	.6310,	.6240,	.6490,	.6350,	.6920,	.5730,	.5470,	.5510,	.5550,	.4670,
8,	.6790,	.7120,	.6920,	.6560,	.7790,	.7110,	.6460,	.6120,	.6460,	.6520,
9,	.7260,	.7540,	.7870,	.7640,	.8880,	.7470,	.7070,	.7590,	.7040,	.6620,
10,	.8280,	.7910,	.8980,	.8690,	.9710,	.8170,	.8980,	.8370,	.7630,	.7820,
11,	.9810,	.8240,	.9320,	.9550,	.9530,	1.0090,	.9440,	.7870,	1.0220,	.8720,
12,	1.0660,	1.0110,	1.0420,	.9060,	1.1070,	1.0180,	1.0130,	.9680,	1.1510,	1.0100,
13,	1.1820,	1.1300,	1.2350,	1.0680,	1.1530,	1.0190,	1.0760,	1.2150,	1.0090,	1.0090,
14,	.8970,	1.2570,	1.1270,	1.1080,	1.1260,	1.2140,	1.1490,	.8990,	1.0500,	.9030,
+gp,	1.1970,	1.1240,	1.2350,	1.3080,	1.3540,	1.1140,	.9840,	.8570,	1.0760,	.9860,

Table 3.7.5

Run title : Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

At 8/10/1992 20:06

Table 2 Catch weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.2790,	.2000,	.2330,	.2470,	.2210,	.0000,	.0000,	.2360,	.2710,	.2270,
2,	.2620,	.2500,	.2630,	.2640,	.2690,	.2490,	.2540,	.2800,	.2840,	.2860,
3,	.3110,	.3000,	.2830,	.2900,	.3040,	.3080,	.2780,	.3080,	.2980,	.2950,
4,	.4240,	.3830,	.3750,	.3370,	.3470,	.3590,	.3520,	.3310,	.3180,	.3090,
5,	.5140,	.5150,	.4910,	.4620,	.4250,	.4080,	.4540,	.3900,	.3680,	.3720,
6,	.6080,	.6040,	.6130,	.5770,	.4880,	.5050,	.5120,	.5320,	.4470,	.4650,
7,	.6640,	.6770,	.6840,	.6780,	.6750,	.5880,	.6080,	.6000,	.5950,	.5380,
8,	.7120,	.7710,	.7250,	.7290,	.7510,	.7390,	.7000,	.6670,	.6880,	.6890,
9,	.7380,	.8150,	.8370,	.8040,	.8530,	.8410,	.8150,	.7900,	.7540,	.7600,
10,	.8400,	.8930,	.9160,	.9000,	.9210,	.8260,	.9370,	.8190,	.8200,	.8770,
11,	.9830,	.9130,	.9810,	1.0010,	.9480,	.9990,	.9700,	.9170,	1.0240,	.9520,
12,	1.0450,	.9840,	1.0260,	.9500,	1.0630,	1.0030,	1.0450,	.9480,	1.0860,	.9880,
13,	1.1740,	1.2400,	1.1120,	1.0710,	1.0780,	1.0350,	1.1400,	1.1390,	1.1040,	1.0560,
14,	.9700,	1.2090,	1.2500,	1.1390,	1.0740,	1.0950,	1.1280,	1.0800,	.9760,	1.0240,
+gp,	1.1770,	1.1670,	1.2140,	1.2150,	1.1100,	1.1360,	1.0460,	.9930,	1.0830,	1.1150,
SOPCOFAC,	1.0063,	.9938,	.9959,	.9799,	.9877,	.9872,	.9849,	1.0074,	.9837,	.9530,

Table 3.7.6 North Sea plaice. Commercial catch rate indices.

Year	Belgium beam trawl	UK beam trawl	UK otter trawl	UK seine	Denmark Danish seine	Netherlands beam trawl
	1)	kg/hr	kg/hr	kg/hr	kg/day*10^{-1}	kg/hpd
1972	50.8	-	-	-	-	-
1973	61.8	-	-	-	-	-
1974	60.9	-	-	-	-	-
1975	43.5	-	-	-	-	-
1976	34.3	-	-	-	-	-
1977	43.6	-	-	-	-	-
1978	39.8	-	-	-	-	-
1979	45.8	-	-	-	-	1.67
1980	50.9	76.7	31.3	23.7	-	1.73
1981	57.9	81.4	29.5	29.4	-	1.85
1982	63.5	98.7	32.8	38.2	-	1.71
1983	70.1	60.4	22.6	37.3	62.6	1.44
1984	67.4	52.7	29.7	34.9	60.5	1.44
1985	61.4	42.2	25.1	29.0	59.9	1.51
1986	56.1	48.6	25.8	34.3	69.5	1.65
1987	66.0	59.0	21.1	32.3	60.3	1.44
1988	71.9	58.4	22.6	36.0	73.4	1.30
1989	74.6	53.2	23.0	43.7	76.7	1.38
1990	83.1	49.4	23.0	47.8	80.4	1.24
1991	78.6	41.5	15.0	32.0	61.7	1.18

1) CPUE index based on hours fishing, corrected for HP.

Table 3.7.7 North Sea PLAICE. Results of trawl surveys in Aug-Sep in the southeastern North Sea (Neth, BTS) and in the total North Sea (Engl. groundfish survey).

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10+
>>NETHERLANDS BTS (8 m beam trawl)<<										
1985	113.5	184.9	44.8	17.48	2.43	1.27	0.44	0.22	0.19	0.56
1986	596.0	121.4	52.8	14.35	6.87	0.74	0.47	0.23	0.16	0.28
1987	203.8	710.8	30.0	6.40	3.08	1.14	0.46	0.15	0.13	0.24
1988	541.7	134.4	188.0	13.38	3.58	1.67	1.05	0.47	0.20	0.42
1989	398.0	340.2	51.3	55.00	6.63	0.80	0.39	0.61	0.14	0.30
1990	123.5	112.8	68.7	32.00	8.58	0.84	0.21	0.48	0.22	0.16
1991	174.7	133.6	32.3	12.35	4.19	5.83	0.22	0.20	0.13	0.16
1992	166.33	108.69	21.64	5.23	2.97	2.79	1.44	0.22	0.07	0.09
>>English Groundfish survey<<										
1977	155.37	2423.01	2543.92	2198.46	1648.89	300.41	70.01	152.12	83.19	266.82
1978	124.73	7554.21	2874.82	2493.03	2271.93	1305.75	107.01	102.41	98.84	982.51
1979	6.87	4351.85	5160.18	868.42	616.37	612.29	450.41	39.06	89.03	356.99
1980	496.55	12530.96	3809.27	2546.97	717.49	383.80	300.20	241.82	14.26	530.55
1981	5.37	2866.75	3260.12	1448.98	1605.59	326.86	282.38	259.02	148.03	454.85
1982	605.73	2428.23	6215.59	1311.59	567.65	415.12	242.07	86.65	136.62	479.65
1983	595.08	14139.65	2149.68	1575.94	292.45	302.84	113.00	33.90	37.82	405.20
1984	313.53	6522.25	16994.62	975.79	584.39	239.75	82.26	72.39	40.25	215.00
1985	142.25	10702.67	6376.65	6362.59	427.83	334.36	203.73	123.85	55.55	158.11
1986	1576.66	6988.32	5778.31	2597.24	1886.27	151.65	66.14	48.78	17.31	169.84
1987	47.43	19092.69	4890.72	2224.65	575.86	366.65	153.25	54.41	58.49	157.44
1988	343.35	5298.71	24481.25	3630.28	1528.92	547.19	477.33	154.18	43.20	255.61
1989	1843.33	9114.64	5862.22	11996.48	883.56	517.84	225.38	298.65	37.93	309.61
1990	1290.61	12631.14	11701.34	3199.15	4523.30	512.57	241.82	141.21	274.01	377.76
1991	1779.20	8214.50	6605.20	4520.90	1673.20	1656.00	298.70	225.90	93.90	375.30
>>Belgium BTS (8 m beam trawl)<<										
1989	3.6	3.4	6.7	6.7	0.8	0.2	0.1	0.2	-	0.1
1990	2.8	4.8	4.4	5.2	7.5	0.9	0.5	-	-	-
1991	0.5	7.0	3.5	0.8	1.0	0.2	-	-	-	-
1992	8.0	5.0	5.0	3.0	-	1.0	-	-	-	-

Table 3.7.8

```
VPA Version 3.0 (MSDOS)

 At 14/10/1992  14:15

 Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

 CPUE data from file J:\IFAPWORK\WG_200\PLE_NSEA\FLEET.DAT

 Disaggregated Qs
 Log transformation
 The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
 No trend in Q (mean used)

 Terminal Fs estimated using  Laurec-Shepherd (with shrinkage)

 Shrinkage Log S.E =    .200

 Tuning converged after   25 iterations


 Total of the absolute F residuals for all ages in the
 last year, between iterations 24 and  25 =    .000

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Oldest age F = 1.000*average of 3 younger ages.


  Fleet : FLT13: NETHERLAND BT   (SURVEY)
  Fleet : FLT17: NETHERLANDS A   (BEAM TRAWL FLEET)
  Fleet : FLT18: ENGLISH GROUN   (SURVEY)
  Fleet : FLT19: Netherlands T   (TRIDENS SURVEY)
  Fleet : FLT20: English seine   (FLEET)


                          SUMMARY STATISTICS FOR AGE  1
  Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,     SE      ,INTRCPT,  SE
        ,   q     ,      ,   F    ,  F    ,            ,    Slope  ,        ,Intrcpt
    1   , -7.81   ,   .755, .0004 , .0033,  -.211E-01,   .146E+00, -7.811,   .267
    2   ,-12.31   , 2.635, .0003 , .0009,  -.161E+00,   .288E+00,-12.306,   .794
    3   , -7.09   , 1.202, .0008 , .0007,   .165E+00,   .121E+00, -7.093,   .363
    4   , -2.71   ,   .218, .0664 , .0017,  -.756E-02,   .241E-01, -2.712,   .066
    5   , No data for this fleet at this age
    Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
       .002      .205           .999E-01       .205             .237


                          SUMMARY STATISTICS FOR AGE  2
  Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,     SE      ,INTRCPT,  SE
        ,   q     ,      ,   F    ,  F    ,            ,    Slope  ,        ,Intrcpt
    1   , -7.85   ,   .422, .0004 , .1315,  -.723E-02,   .816E-01, -7.851,   .149
    2   , -6.67   ,   .576, .0861 , .1237,  -.106E+00,   .522E-01, -6.671,   .174
    3   , -4.10   ,   .462, .0165 , .0908,   .820E-01,   .425E-01, -4.102,   .139
    4   , -3.71   ,   .223, .0244 , .0988,   .225E-01,   .235E-01, -3.713,   .067
    5   ,-12.32   ,   .968, .0003 , .1033,  -.235E-01,   .107E+00,-12.324,   .292
    Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
       .097      .170           .475E-01       .170             .078
```

Table 3.7.8 (cont'd)

SUMMARY STATISTICS FOR AGE 3

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.79	.283	.0002	.4057	.255E-01	.536E-01	-8.785	.100
2	-5.50	.380	.2770	.4902	-.107E+00	.191E-01	-5.503	.115
3	-3.87	.409	.0209	.2711	.573E-01	.408E-01	-3.868	.123
4	-5.25	.708	.0053	.2996	.157E+00	.560E-01	-5.246	.213
5	-9.81	.510	.0037	.6251	-.115E+00	.397E-01	-9.810	.154

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.372	.179	.971E-01	.179	.294

SUMMARY STATISTICS FOR AGE 4

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-9.50	.433	.0001	.7221	.671E-01	.784E-01	-9.497	.153
2	-5.41	.287	.3028	.5918	-.473E-01	.272E-01	-5.414	.087
3	-4.18	.378	.0153	.4023	.714E-01	.336E-01	-4.179	.114
4	No data for this fleet at this age							
5	-8.94	.376	.0088	.9674	-.103E+00	.205E-01	-8.939	.113

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.580	.178	.130	.178	.531

SUMMARY STATISTICS FOR AGE 5

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-10.09	.318	.0000	.7399	-.130E-01	.613E-01	-10.091	.112
2	-5.41	.209	.3031	.6464	-.106E-01	.229E-01	-5.413	.063
3	-4.59	.484	.0102	.4541	.783E-01	.463E-01	-4.590	.146
4	No data for this fleet at this age							
5	-8.67	.431	.0115	.8608	-.181E-01	.476E-01	-8.667	.130

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.649	.153	.740E-01	.153	.233

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-10.58	.451	.0000	.3529	-.471E-02	.872E-01	-10.579	.159
2	-5.54	.140	.2669	.5540	-.979E-02	.152E-01	-5.540	.042
3	-4.70	.409	.0091	.4438	.195E-01	.451E-01	-4.701	.123
4	No data for this fleet at this age							
5	-8.77	.473	.0104	.5531	.107E-01	.526E-01	-8.773	.143

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.532	.123	.635E-01	.123	.267

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-10.93	.579	.0000	1.2759	-.197E+00	.698E-01	-10.926	.205
2	-5.63	.170	.2449	.4865	-.132E-01	.184E-01	-5.626	.051
3	-4.79	.528	.0083	.4345	.593E-01	.549E-01	-4.790	.159
4	No data for this fleet at this age							
5	-8.85	.320	.0096	.6060	.455E-01	.318E-01	-8.853	.096

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.523	.140	.112	.140	.641

Table 3.7.8 (cont'd)

```
                         SUMMARY STATISTICS FOR AGE  8
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
         ,  q     ,      ,   F   ,  F   ,             ,   Slope ,        ,Intrcpt
   1  ,-10.63  ,  .513, .0000 , .6760,  .670E-01,  .948E-01,-10.626,  .181
   2  , -5.79  ,  .248, .2072 , .5165, -.495E-01,  .213E-01, -5.793,  .075
   3  , -4.84  ,  .693, .0079 , .1948,  .168E+00,  .495E-01, -4.841,  .209
   4  , No data for this fleet at this age
   5  , -8.98  ,  .572, .0084 , .4025,  .129E+00,  .446E-01, -8.981,  .172
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
    .452      .199            .124           .199             .388
```

```
                         SUMMARY STATISTICS FOR AGE  9
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
         ,  q     ,      ,   F   ,  F   ,             ,   Slope ,        ,Intrcpt
   1  ,-10.75  ,  .134, .0000 , .5464, -.175E-01,  .248E-01,-10.747,  .047
   2  , -5.93  ,  .279, .1816 , .4617, -.412E-01,  .275E-01, -5.925,  .084
   3  , -4.94  ,  .732, .0071 , .2516,  .101E+00,  .733E-01, -4.941,  .221
   4  , No data for this fleet at this age
   5  , -9.02  ,  .531, .0081 , .4179,  .514E-01,  .562E-01, -9.020,  .160
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
    .477      .116          .702E-01         .116             .364
```

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                         SUMMARY STATISTICS FOR AGE 10
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
         ,  q     ,      ,   F   ,  F   ,             ,   Slope ,        ,Intrcpt
   1  , -9.80  ,  .547, .0001 , .8805, -.170E+00,  .738E-01, -9.795,  .193
   2  , -5.95  ,  .321, .1779 , .6035, -.789E-01,  .224E-01, -5.946,  .097
   3  , -3.06  ,  .416, .0467 , .3148,  .604E-01,  .411E-01, -3.063,  .126
   4  , No data for this fleet at this age
   5  , -8.89  ,  .668, .0092 , .2657,  .358E-01,  .733E-01, -8.891,  .201
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
    .414      .218            .160           .218             .539
```

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                         SUMMARY STATISTICS FOR AGE 11
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
         ,  q     ,      ,   F   ,  F   ,             ,   Slope ,        ,Intrcpt
   1  , No data for this fleet at this age
   2  , -6.14  ,  .341, .1471 , .4634, -.898E-01,  .207E-01, -6.136,  .103
   3  , No data for this fleet at this age
   4  , No data for this fleet at this age
   5  , -9.03  ,  .464, .0080 , .2440,  .544E-01,  .480E-01, -9.031,  .140
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
    .327      .275            .180           .275             .430
```

```
                         SUMMARY STATISTICS FOR AGE 12
 Fleet , Pred.   , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
         ,  q     ,      ,   F   ,  F   ,             ,   Slope ,        ,Intrcpt
   1  , No data for this fleet at this age
   2  , -6.11  ,  .526, .1517 , .7039, -.141E+00,  .308E-01, -6.105,  .159
   3  , No data for this fleet at this age
   4  , No data for this fleet at this age
   5  , -9.17  ,  .784, .0070 , .1735,  .122E+00,  .758E-01, -9.166,  .236
  Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
    .345      .437            .270           .437             .382
```

Table 3.7.8 (cont'd)

SUMMARY STATISTICS FOR AGE 13

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	No data for this fleet at this age							
2	-6.20	.553	.1384	.6945	-.138E+00	.376E-01	-6.197	.167
3	No data for this fleet at this age							
4	No data for this fleet at this age							
5	-8.55	.658	.0130	.2754	.615E-01	.699E-01	-8.549	.198

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.315	.423	.195	.423	.211

Table 3.7.9

Run title : Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

At 8/10/1992 20:32

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	FBAR 89-91
AGE											
1,	.0034,	.0022,	.0002,	.0002,	.0013,	.0000,	.0000,	.0034,	.0028,	.0016,	.0026,
2,	.1412,	.1468,	.1350,	.1512,	.1523,	.0955,	.0341,	.0989,	.1092,	.0967,	.1016,
3,	.6825,	.5148,	.5094,	.4516,	.5115,	.4144,	.3112,	.2764,	.3024,	.3725,	.3171,
4,	.6358,	.7187,	.4256,	.6836,	.5272,	.6740,	.4320,	.4272,	.5159,	.5801,	.5077,
5,	.5366,	.5360,	.5800,	.4401,	.6823,	.6937,	.6646,	.5050,	.5829,	.6492,	.5790,
6,	.4548,	.4366,	.4540,	.4475,	.6002,	.5528,	.6463,	.5095,	.5166,	.5322,	.5194,
7,	.3845,	.3752,	.3613,	.3851,	.4670,	.5018,	.5647,	.5060,	.4251,	.5231,	.4847,
8,	.3529,	.3374,	.4146,	.3170,	.4143,	.3338,	.4964,	.4434,	.3953,	.4521,	.4302,
9,	.3848,	.2980,	.3393,	.3237,	.3689,	.2980,	.4516,	.3029,	.3851,	.4769,	.3883,
10,	.3920,	.4170,	.3091,	.2922,	.3813,	.3247,	.4018,	.3813,	.2668,	.4135,	.3539,
11,	.2562,	.3666,	.2928,	.2201,	.3372,	.2748,	.3116,	.3347,	.2823,	.3270,	.3147,
12,	.2817,	.4253,	.3025,	.3676,	.3371,	.2633,	.4379,	.3005,	.2817,	.3453,	.3092,
13,	.3905,	.3471,	.2471,	.2854,	.4614,	.2314,	.3349,	.3192,	.2369,	.3149,	.2903,
14,	.3095,	.3796,	.2808,	.2911,	.3785,	.2565,	.3615,	.3182,	.2670,	.3291,	.3047,
+gp,	.3095,	.3796,	.2808,	.2911,	.3785,	.2565,	.3615,	.3182,	.2670,	.3291,	
FBAR 2-10,	.4406,	.4201,	.3920,	.3880,	.4561,	.4321,	.4448,	.3834,	.3888,	.4551,	
FBARC,	.5480,	.4963,	.4309,	.4542,	.4762,	.5016,	.4553,	.3694,	.4036,	.4581,	
FBARP,	.2634,	.2515,	.2333,	.2397,	.2502,	.2359,	.2044,	.2035,	.2147,	.2280,	

Table 3.7.10

Run title : Plaice in the North Sea (Fishing Area IV) (run name: NSPLAICE)

At 8/10/1992 20:33

Traditional vpa Terminal Fs estimated using Laurec-Shepherd (with shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	GMST 82-89	AMST 82-89
AGE													
1,	1020326,	582503,	608027,	551211,	1395532,	558169,	568855,	394610,	569744,	924175,	0,	657270,	709904,
2,	380747,	920059,	525916,	550062,	498641,	1261138,	505052,	514721,	355860,	514074,	834858,	598970,	644542,
3,	441527,	299141,	718833,	415794,	427869,	387445,	1037181,	441665,	421877,	288674,	422280,	483728,	521182,
4,	154506,	201896,	161761,	390798,	239518,	232143,	231646,	687501,	303126,	282105,	179975,	254250,	287471,
5,	72193,	74024,	89035,	95631,	178502,	127925,	107056,	136073,	405800,	163741,	142906,	105318,	110055,
6,	47916,	38198,	39188,	45107,	55722,	81641,	57845,	49834,	74308,	204998,	77406,	50519,	51931,
7,	24904,	27512,	22336,	22518,	26089,	27666,	42500,	27426,	27091,	40110,	108945,	27089,	27619,
8,	19275,	15341,	17106,	14081,	13863,	14799,	15156,	21864,	14962,	16024,	21510,	16242,	16436,
9,	14698,	12255,	9905,	10225,	9280,	8289,	9590,	8348,	12698,	9118,	9226,	10147,	10324,
10,	11970,	9051,	8231,	6384,	6694,	5806,	5567,	5524,	5580,	7817,	5121,	7147,	7404,
11,	5261,	7319,	5397,	5468,	4313,	4136,	3797,	3371,	3414,	3866,	4678,	4751,	4883,
12,	3041,	3685,	4590,	3644,	3970,	2785,	2843,	2516,	2182,	2329,	2523,	3322,	3384,
13,	1863,	2076,	2179,	3069,	2283,	2564,	1937,	1661,	1686,	1490,	1492,	2167,	2204,
14,	2044,	1141,	1327,	1540,	2087,	1302,	1841,	1254,	1092,	1203,	984,	1529,	1567,
+gp,	7904,	3488,	5404,	4388,	4082,	5613,	5882,	5965,	5504,	4567,	3757,		
TOTAL,	2208175,	2197689,	2219237,	2119920,	2868447,	2721422,	2596747,	2302333,	2204924,	2464292,	1815661,		

Table 3.7.11 North Sea Plaice recruitment indices

Year Class	1-group VPA	Autumn surveys: Tridens 0-group	Autumn surveys: Tridens 1-group	Autumn surveys: Tridens 2-group	Autumn surveys: Tridens 3-group	Spring survey: Tridens 1-group	Spring survey: Tridens 2-group
1967	245	-	-	-	2,813	-	-
1968	326	-	-	9,450	1,008	-	7708
1969	369	-	8,032	23,848	4,484	8,641	-
1970	274	3,678	18,101	9,584	1,631	-	14,840
1971	234	6,708	6,437	4,191	1,261	9,799	8,738
1972	540	9,242	57,238	17,985	10,744	32,980	43,774
1973	451	5,451	15,648	9,171	791	5,835	15,583
1974	335	2,193	9,781	2,274	1,720	3,903	4,610
1975	324	1,151	9,037	2,900	435	1,739	3,424
1976	470	11,544	19,119	12,714	1,577	8,344	15,364
1977	428	4,378	13,924	9,540	456	5,054	7,041
1978	441	3,252	21,681	12,084	785	6,425	10,778
1979	657	27,835	58,049	16,106	1,146	16,567	37,468
1980	421	4,039	19,611	8,503	308	2,594	11,132
1981	1,020	31,542	70,108	14,708	2,480	20,151	45,588
1982	583	23,987	34,884	10,413	1,584	7,615	17,459
1983	608	36,722	44,667	13,788	1,155	11,869	37,339
1984	551	7,958	27,832	7,557	1,232	16,557	16,277
1985	1,395	47,385	93,573	33,021	13,140	56,559	62,290
1986	558	8,818	33,426	14,429	3,709	8,523	16,213
1987	569	21,270	36,672	14,952	3,248	12,835	34,218
1988	-	15,598	37,238	7,287	1,507	10,387	16,677
1989	-	24,198	24,903	11,148	2,371	10,235	-
1990	-	9,559	57,349	22,280	-	-	-
1991	-	17,120	39,834	-	-	-	-
1992	-	4,895	-	-	-	-	-

	Continental surveys: Netherlands 0-group	Continental surveys: Belgium 1-group	UK surveys: 0-group	UK surveys: 1-group	FR Germany: 0-group	Combined continental: 0-group	Combined continental: 1-group
1969	-	2.87	-	-	-	-	-
1970	-	0.93	-	-	-	-	-
1971	4.59	2.63	-	-	-	-	-
1972	2.46	6.79	-	-	-	-	-
1973	2.58	1.96	43.48	-	-	-	-
1974	2.29	3.03	56.91	14.36	11.3	105.73	69.34
1975	2.17	4.03	21.06	4.76	6.9	68.29	77.88
1976	7.03	6.59	59.87	9.08	28.3	226.29	128.65
1977	3.70	3.00	59.02	11.82	24.7	158.38	66.25
1978	8.18	7.91	31.14	9.75	22.0	213.62	153.28
1979	17.07	10.53	17.67	6.60	17.1	355.51	197.67
1980	5.02	6.92	21.35	5.89	15.3	136.20	131.45
1981	28.87	13.83	53.19	12.64	28.0	616.99	263.58
1982	24.01	7.82	16.74	7.08	14.8	476.36	148.97
1983	18.00	5.74	62.39	9.76	13.3	398.70	113.91
1984	10.72	4.65	701.63	19.14	7.1	260.99	103.51
1985	36.98	13.41	52.61	16.68	6.0	721.87	260.00
1986	17.69	9.98	39.96	7.22	3.6	357.80	188.31
1987	23.38	4.97	33.90	7.98	12.6	473.62	98.16
1988	15.50	6.31	48.67	13.88	21.2	341.71	128.37
1989	22.35	6.25	31.71	7.90	21.3	469.64	121.31
1990	22.02	6.88	34.37	12.04	20.9	465.84	136.88
1991	24.47	8.02	17.80	5.65	7.9	497.11	151.17
1992	19.44	-	37.90	-		396.19	-

Table 3.7.12

```
Analysis by RCT3 ver3.1 of data from file :

C:\FWG92\PLAICE\PLA4RECR.CSV

"Plaice North Sea"
Data for      6 surveys over    26 years :  1967 - 1992
Regression type = C
Tapered time weighting applied
power =     3 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression
Forecast/Hindcast variance correction used.
```

Yearclass = 1988

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	-I		I-------	Prediction	----I	
"T-0",	.45	2.11	.29	.669	18	9.65	6.49	.334	.091
"T-1ap	.53	1.50	.24	.742	18	9.25	6.37	.277	.132
"T-1oc	.64	-.25	.17	.858	19	10.53	6.47	.193	.253
"T-2ap	.59	.57	.25	.733	19	9.72	6.26	.286	.124
"T-2oc	.85	-1.61	.32	.630	20	8.89	5.96	.372	.073
"T-3oc	.54	2.40	.40	.522	21	7.32	6.33	.453	.049
"com-0	.71	2.32	.23	.755	14	5.84	6.45	.269	.140
"com-1	1.16	.66	.32	.619	14	4.86	6.29	.370	.074
					VPA Mean =		6.36	.396	.064

Yearclass = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	-I		I-----------	Prediction	---------I	
"T-0",	.46	2.08	.29	.663	18	10.09	6.68	.346	.096
"T-1ap	.52	1.62	.22	.771	18	9.23	6.37	.259	.170
"T-1oc	.65	-.40	.17	.862	19	10.12	6.20	.193	.286
"T-2oc	.87	-1.74	.31	.641	20	9.32	6.33	.357	.090
"T-3oc	.51	2.62	.36	.564	21	7.77	6.57	.421	.065
"com-0	.73	2.19	.24	.744	14	6.15	6.68	.286	.140
"com-1	1.17	.57	.33	.610	14	4.81	6.22	.384	.078
					VPA Mean =		6.38	.392	.075

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------	Regression	----------	-I		I-----------	Prediction	---------I	
"T-0",	.47	1.98	.30	.652	18	9.17	6.25	.355	.124
"T-1oc	.67	-.60	.16	.865	19	10.96	6.75	.198	.391
"T-2oc	.89	-1.99	.31	.646	20	10.01	6.94	.378	.109
"com-0	.76	2.01	.25	.730	14	6.15	6.67	.300	.173
"com-1	1.19	.48	.34	.600	14	4.93	6.36	.396	.099
					VPA Mean =		6.40	.389	.103

Table 3.7.12 (cont'd)

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
"T-0",	.48	1.80	.31	.634	18	9.75	6.52	.376	.131
"T-1oc	.69	-.85	.16	.868	19	10.59	6.50	.193	.461
"com-0	.79	1.79	.26	.714	14	6.21	6.72	.321	.179
"com-1	1.21	.38	.35	.588	14	5.02	6.48	.415	.107
					VPA Mean =		6.43	.387	.123

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
"T-0",	.51	1.54	.33	.612	18	8.50	5.87	.439	.252
"com-0	.84	1.50	.28	.696	14	5.98	6.54	.338	.424
					VPA Mean =		6.45	.387	.325

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	581	6.36	.10	.05	.23		
1989	598	6.39	.11	.07	.43		
1990	750	6.62	.13	.10	.60		
1991	687	6.53	.14	.05	.12		
1992	567	6.34	.22	.19	.77		

Table 3.7.13 North Sea PLAICE. VPA summary (with SOP correction). `inkage)

	RECRUITS x10^6	TOTALBIO kt	TOTSPBIO kt	LANDINGS kt	SOP	F(2-10)u	FBARC	FBARP
1958	431	472	362	73	1.063	0.21	0.25	0.14
1959	434	469	354	79	1.022	0.22	0.24	0.14
1960	406	503	373	88	1.007	0.24	0.28	0.15
1961	359	472	361	86	1.016	0.23	0.28	0.14
1962	317	550	436	87	0.967	0.23	0.28	0.14
1963	314	562	453	107	1.019	0.26	0.32	0.15
1964	1019	634	432	111	1.008	0.27	0.30	0.16
1965	309	589	422	97	1.006	0.27	0.30	0.16
1966	305	602	428	102	1.018	0.26	0.31	0.15
1967	276	607	508	109	1.020	0.24	0.29	0.14
1968	245	567	472	112	1.029	0.22	0.23	0.14
1969	327	560	446	122	1.058	0.25	0.26	0.16
1970	369	515	392	130	0.974	0.33	0.38	0.20
1971	275	521	389	114	1.033	0.32	0.30	0.18
1972	234	511	389	123	1.028	0.34	0.31	0.20
1973	540	514	353	130	1.051	0.38	0.39	0.23
1974	451	484	320	113	1.037	0.39	0.43	0.22
1975	335	524	339	109	1.062	0.37	0.38	0.19
1976	324	461	322	114	1.025	0.31	0.30	0.19
1977	470	479	330	119	1.002	0.33	0.33	0.21
1978	428	456	311	114	0.964	0.33	0.34	0.21
1979	441	471	309	145	0.998	0.46	0.45	0.25
1980	657	491	299	140	1.014	0.40	0.50	0.26
1981	421	493	310	140	1.018	0.40	0.46	0.26
1982	1020	559	300	155	1.006	0.44	0.55	0.26
1983	583	539	318	144	0.994	0.42	0.50	0.25
1984	608	550	320	158	0.984	0.39	0.43	0.23
1985	551	532	345	160	0.980	0.39	0.45	0.24
1986	1396	658	350	165	0.988	0.46	0.48	0.25
1987	558	646	392	160	1.000	0.43	0.50	0.24
1988	569	635	377	162	0.985	0.44	0.45	0.20
1989	**581**	604	433	170	0.989	0.39	0.37	0.21
1990	**598**	585	402	168	0.984	0.39	0.40	0.22
1991	**750**	548	346	154	0.953	0.45	0.46	0.23
1992	**687**							

bold recruitment values estimated from pre-recruit surveys

Table 3.7.14

Plaice in the North Sea (Fishing Area IV)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	0.1000	0.0000	0.0000	0.0000	0.144	0.0029	0.245
2	.	0.1000	0.5000	0.0000	0.0000	0.223	0.1130	0.283
3	.	0.1000	0.5000	0.0000	0.0000	0.262	0.3528	0.300
4	.	0.1000	1.0000	0.0000	0.0000	0.280	0.5648	0.319
5	.	0.1000	1.0000	0.0000	0.0000	0.348	0.6441	0.377
6	.	0.1000	1.0000	0.0000	0.0000	0.436	0.5778	0.481
7	.	0.1000	1.0000	0.0000	0.0000	0.524	0.5392	0.578
8	.	0.1000	1.0000	0.0000	0.0000	0.637	0.4786	0.681
9	.	0.1000	1.0000	0.0000	0.0000	0.708	0.4320	0.768
10	.	0.1000	1.0000	0.0000	0.0000	0.794	0.3937	0.839
11	.	0.1000	1.0000	0.0000	0.0000	0.894	0.3501	0.964
12	.	0.1000	1.0000	0.0000	0.0000	1.043	0.3440	1.007
13	.	0.1000	1.0000	0.0000	0.0000	1.078	0.3229	1.100
14	.	0.1000	1.0000	0.0000	0.0000	0.951	0.3390	1.027
15+	.	0.1000	1.0000	0.0000	0.0000	0.973	0.3390	1.064
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : ALLNEW3
Date and time: 12OCT92:19:05

Table 3.7.15

Plaice in the North Sea (Fishing Area IV)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0	10.508	6291	8.647	5939	8.647	5939
0.2000	0.0910	0.405	219	6.467	2832	4.615	2483	4.615	2483
0.4000	0.1820	0.553	253	4.991	1723	3.149	1376	3.149	1376
0.6000	0.2731	0.626	255	4.270	1254	2.437	910	2.437	910
0.8000	0.3641	0.668	250	3.852	1018	2.027	676	2.027	676
1.0000	0.4551	0.696	246	3.579	884	1.763	544	1.763	544
1.2000	0.5461	0.716	243	3.386	799	1.578	461	1.578	461
1.4000	0.6372	0.731	241	3.240	740	1.441	405	1.441	405
1.6000	0.7282	0.743	239	3.126	698	1.335	365	1.335	365
1.8000	0.8192	0.753	238	3.032	665	1.250	334	1.250	334
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : ALLNEW3
Date and time : 20OCT92:16:14
Computation of ref. F: Simple mean, age 2 - 10
F-0.1 factor : 0.2493
F-max factor : 0.5102
F-0.1 reference F : 0.1135
F-max reference F : 0.2322
Recruitment : Single recruit

Table 3.7.16

Plaice in the North Sea (Fishing Area IV)

Prediction with management option table: Input data

Year: 1992								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	687000.00	0.1000	0.0000	0.0000	0.0000	0.144	0.0029	0.245
2	677543.00	0.1000	0.5000	0.0000	0.0000	0.223	0.1130	0.283
3	443009.00	0.1000	0.5000	0.0000	0.0000	0.262	0.3528	0.300
4	265006.00	0.1000	1.0000	0.0000	0.0000	0.280	0.5648	0.319
5	142906.00	0.1000	1.0000	0.0000	0.0000	0.348	0.6441	0.377
6	77406.000	0.1000	1.0000	0.0000	0.0000	0.436	0.5778	0.481
7	108945.00	0.1000	1.0000	0.0000	0.0000	0.524	0.5392	0.578
8	21510.000	0.1000	1.0000	0.0000	0.0000	0.637	0.4786	0.681
9	9226.000	0.1000	1.0000	0.0000	0.0000	0.708	0.4320	0.768
10	5121.000	0.1000	1.0000	0.0000	0.0000	0.794	0.3937	0.839
11	4678.000	0.1000	1.0000	0.0000	0.0000	0.894	0.3501	0.964
12	2523.000	0.1000	1.0000	0.0000	0.0000	1.043	0.3440	1.007
13	1492.000	0.1000	1.0000	0.0000	0.0000	1.078	0.3229	1.100
14	984.000	0.1000	1.0000	0.0000	0.0000	0.951	0.3390	1.027
15+	3757.000	0.1000	1.0000	0.0000	0.0000	0.973	0.3390	1.064
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1993								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	567000.00	0.1000	0.0000	0.0000	0.0000	0.144	0.0029	0.245
2	.	0.1000	0.5000	0.0000	0.0000	0.223	0.1130	0.283
3	.	0.1000	0.5000	0.0000	0.0000	0.262	0.3528	0.300
4	.	0.1000	1.0000	0.0000	0.0000	0.280	0.5648	0.319
5	.	0.1000	1.0000	0.0000	0.0000	0.348	0.6441	0.377
6	.	0.1000	1.0000	0.0000	0.0000	0.436	0.5778	0.481
7	.	0.1000	1.0000	0.0000	0.0000	0.524	0.5392	0.578
8	.	0.1000	1.0000	0.0000	0.0000	0.637	0.4786	0.681
9	.	0.1000	1.0000	0.0000	0.0000	0.708	0.4320	0.768
10	.	0.1000	1.0000	0.0000	0.0000	0.794	0.3937	0.839
11	.	0.1000	1.0000	0.0000	0.0000	0.894	0.3501	0.964
12	.	0.1000	1.0000	0.0000	0.0000	1.043	0.3440	1.007
13	.	0.1000	1.0000	0.0000	0.0000	1.078	0.3229	1.100
14	.	0.1000	1.0000	0.0000	0.0000	0.951	0.3390	1.027
15+	.	0.1000	1.0000	0.0000	0.0000	0.973	0.3390	1.064
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1994								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	461000.00	0.1000	0.0000	0.0000	0.0000	0.144	0.0029	0.245
2	.	0.1000	0.5000	0.0000	0.0000	0.223	0.1130	0.283
3	.	0.1000	0.5000	0.0000	0.0000	0.262	0.3528	0.300
4	.	0.1000	1.0000	0.0000	0.0000	0.280	0.5648	0.319
5	.	0.1000	1.0000	0.0000	0.0000	0.348	0.6441	0.377
6	.	0.1000	1.0000	0.0000	0.0000	0.436	0.5778	0.481
7	.	0.1000	1.0000	0.0000	0.0000	0.524	0.5392	0.578
8	.	0.1000	1.0000	0.0000	0.0000	0.637	0.4786	0.681
9	.	0.1000	1.0000	0.0000	0.0000	0.708	0.4320	0.768
10	.	0.1000	1.0000	0.0000	0.0000	0.794	0.3937	0.839
11	.	0.1000	1.0000	0.0000	0.0000	0.894	0.3501	0.964
12	.	0.1000	1.0000	0.0000	0.0000	1.043	0.3440	1.007
13	.	0.1000	1.0000	0.0000	0.0000	1.078	0.3229	1.100
14	.	0.1000	1.0000	0.0000	0.0000	0.951	0.3390	1.027
15+	.	0.1000	1.0000	0.0000	0.0000	0.973	0.3390	1.064
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : HS1
Date and time: 20OCT92:15:41

Table 3.7.17

Plaice in the North Sea (Fishing Area IV)

Plaice in the North Sea (Fishing Area IV)

Prediction with management option table

Year: 1992					Year: 1993					Year: 1994	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.4551	617583	385491	170646	0.0000	0.0000	600248	378142	0	723937	527211
.	.	.	.	.	0.2000	0.0910	.	378142	40371	684208	489155
.	.	.	.	.	0.4000	0.1820	.	378142	77256	648053	454636
.	.	.	.	.	0.6000	0.2731	.	378142	110991	615120	423303
.	.	.	.	.	0.8000	0.3641	.	378142	141876	585092	394841
.	.	.	.	.	1.0000	0.4551	.	378142	170184	557686	368966
.	.	.	.	.	1.2000	0.5461	.	378142	196158	532648	345426
.	.	.	.	.	1.4000	0.6372	.	378142	220017	509748	323990
.	.	.	.	.	1.6000	0.7282	.	378142	241959	488781	304457
.	.	.	.	.	1.8000	0.8192	.	378142	262161	469564	286640
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : HS1
Date and time : 20OCT92:15:41
Computation of ref. F: Simple mean, age 2 - 10
Basis for 1992 : F factors

Table 3.7.18 Stock: North Sea Plaice

Assessment Quality Control Diagram 1

Average F(2-10,u)					
Date of assessment	Year				
	1987	1988	1989	1990	1991
1988	0.55				
1989	0.39	0.44			
1990	0.48	0.60	0.55		
1991	0.48	0.56	0.53	0.56	
1992	0.43	0.44	0.38	0.39	0.46

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
1988	155.1	186.0	170.0				
1989		156.9	182.0[1]	171.0[2]			
1990			180.5	189.0	169.0		
1991				162.0	164.0	160.0	
1992					135.7	170.6	170.2
					Actual	Current	Forecast

$$\textit{Actual SQC} = \textit{Landings}(y) \times \frac{F(y-1)}{F(y)} \times \exp\left[-\frac{1}{2}\{F(y-1) - F(y)\}\right]$$

where F(y) and F(y−1) are as estimated in the assessment made in year (y+1).

[1]171.0 according to SHOT forecast. [2]161.0 according to SHOT forecast.

(cont'd)

Table 3.7.18 (Cont'd)

Stock: North Sea Plaice

Assessment Quality Control Diagram 3

Recruitment (age 1) Unit: millions					
Date of assessment	Year class				
	1988	1989	1990	1991	1992
1988	(660)[1]				
1989	612[1]	750[1]			
1990	574[1]	584[1]	588[1]		
1991	594[1]	617[1]	696[1]	690[1]	
1992	581[1]	598[1]	750[1]	687[1]	567[1]

[1]Predictions from recruitment surveys.

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)								
Date of assessment	Year							
	1987	1988	1989	1990	1991	1992	1993	1994
1988	327	334	n/a[1]	n/a[1]				
1989	379	361	385	364[1]	n/a[1]			
1990	364	348	382	377	345[1]	326[1]		
1991	361	341	383	376	355	354[1]	357[1]	
1992	392	377	433	402	346	385	378[1]	368[1]

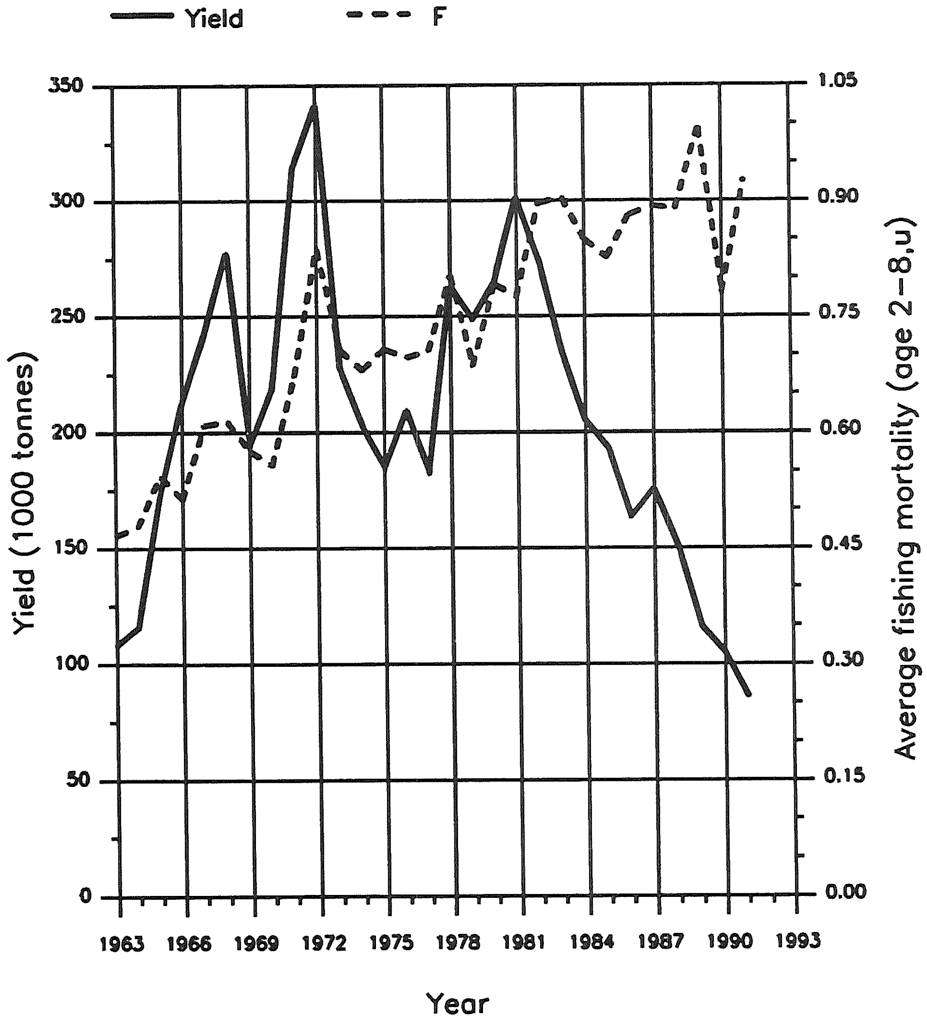
[1]Forecast.

Remarks: n/a = not available.

Figure 3.2.1

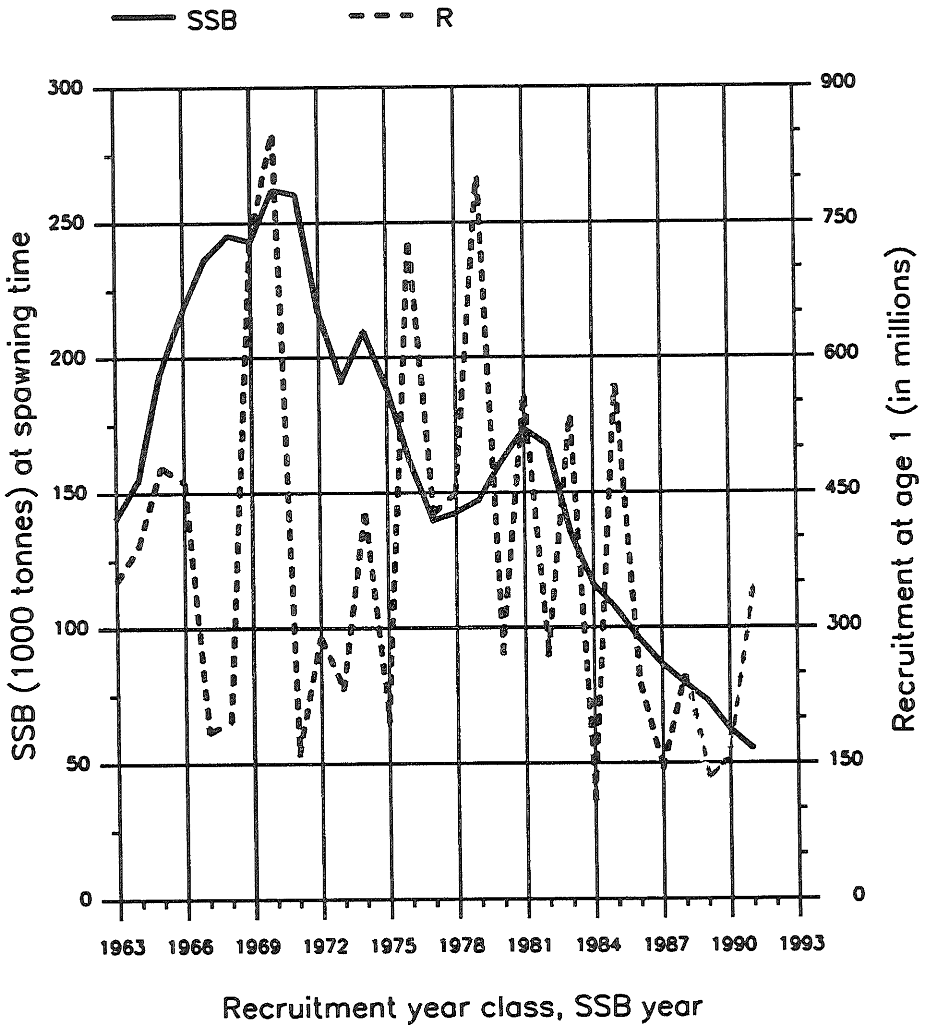
FISH STOCK SUMMARY
STOCK: Cod in the North Sea (Fishing Area IV)
9-10-1992

Trends in yield and fishing mortality (F)



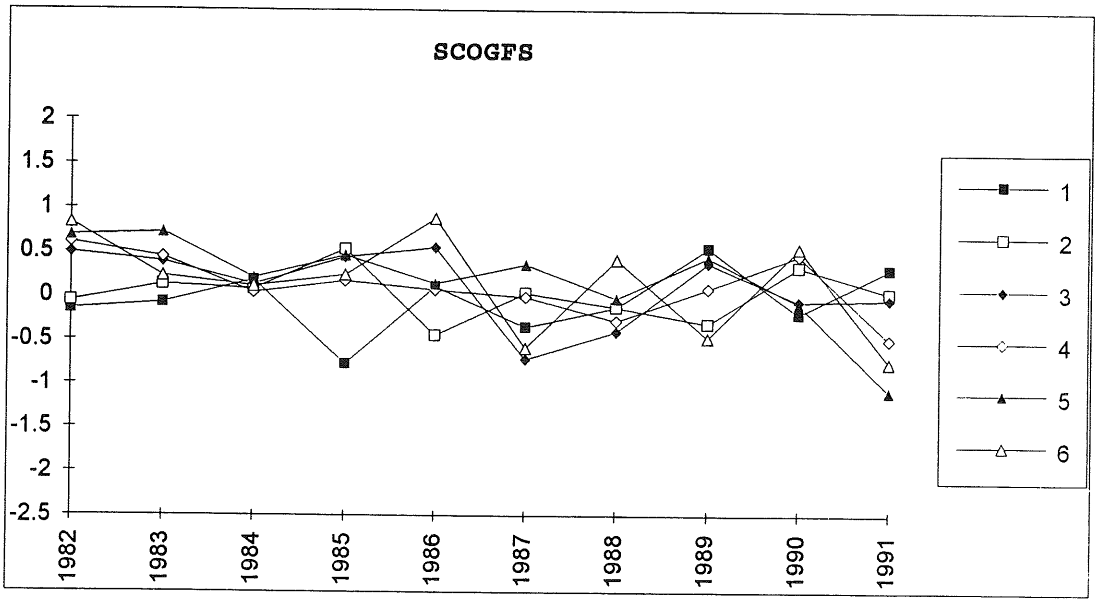
A

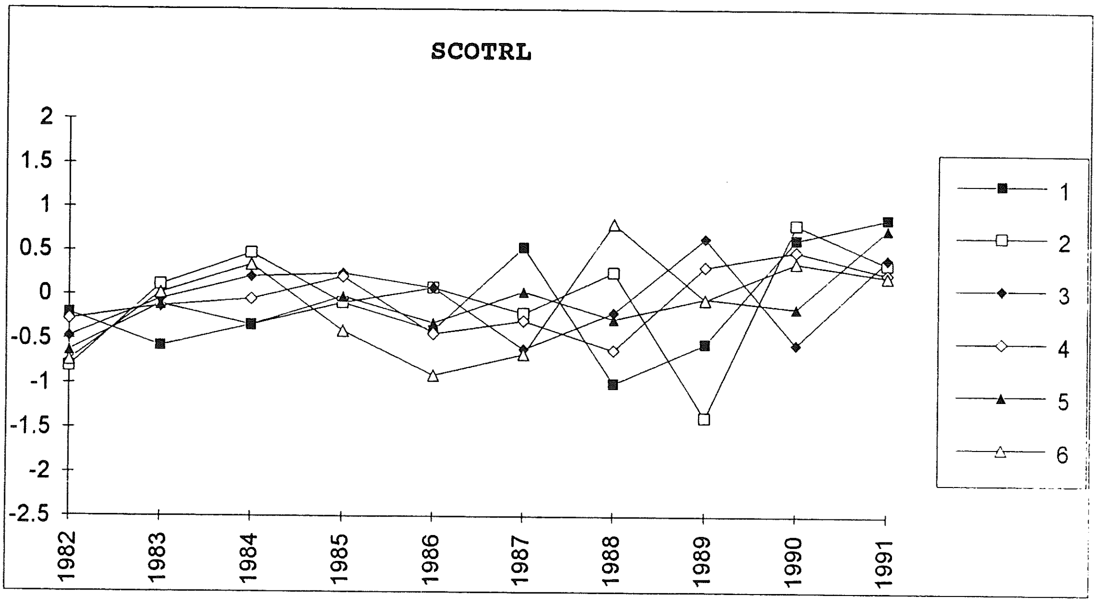
Trends in spawning stock biomass (SSB) and recruitment (R)

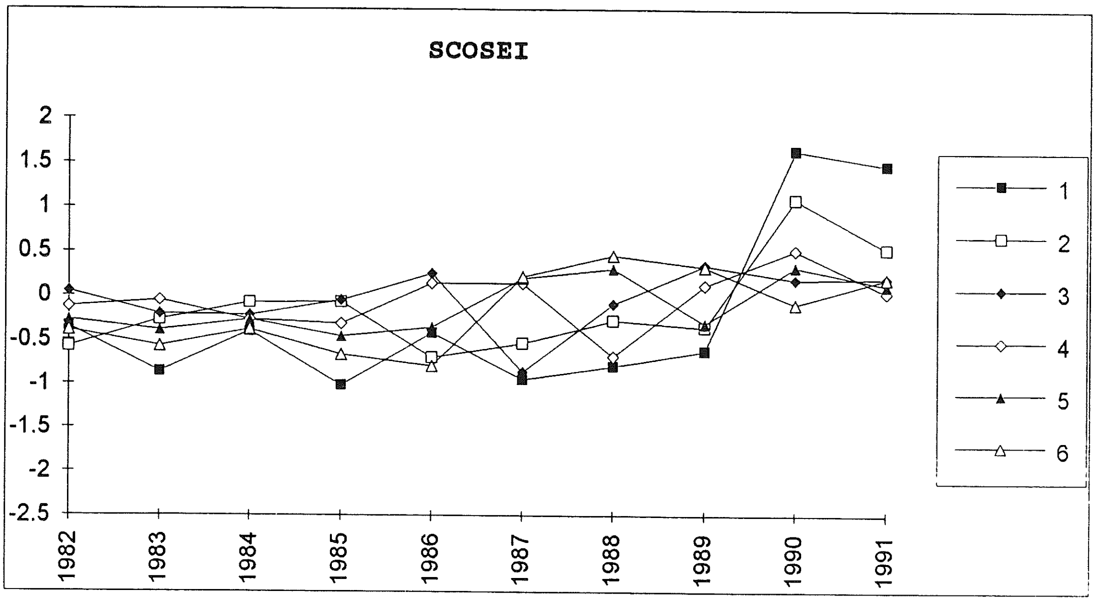


B

Figure 3.2.2 North Sea Cod.
Log q residuals.

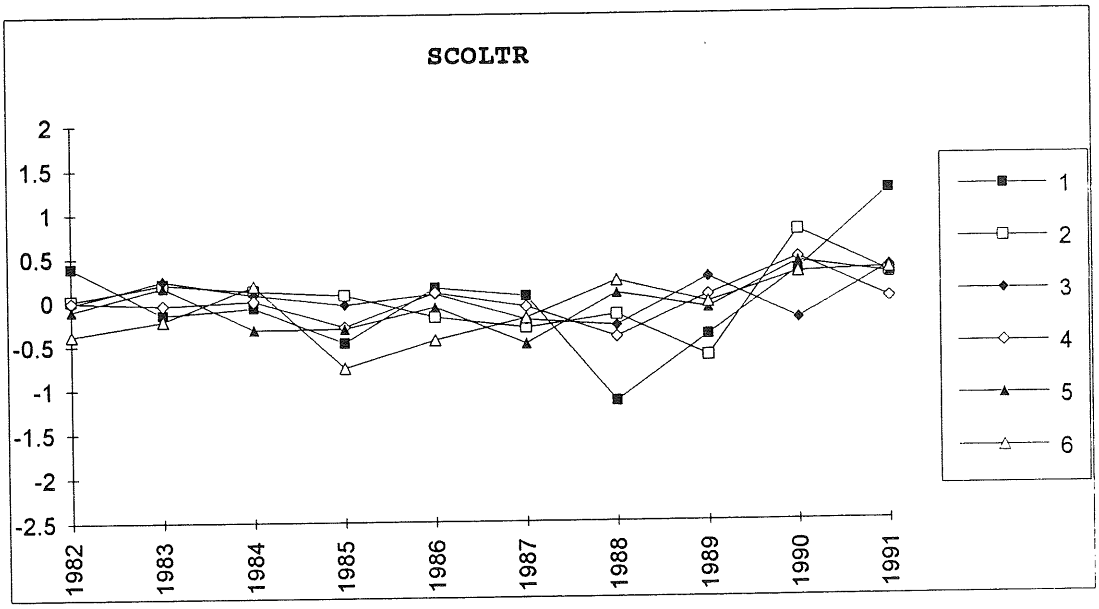


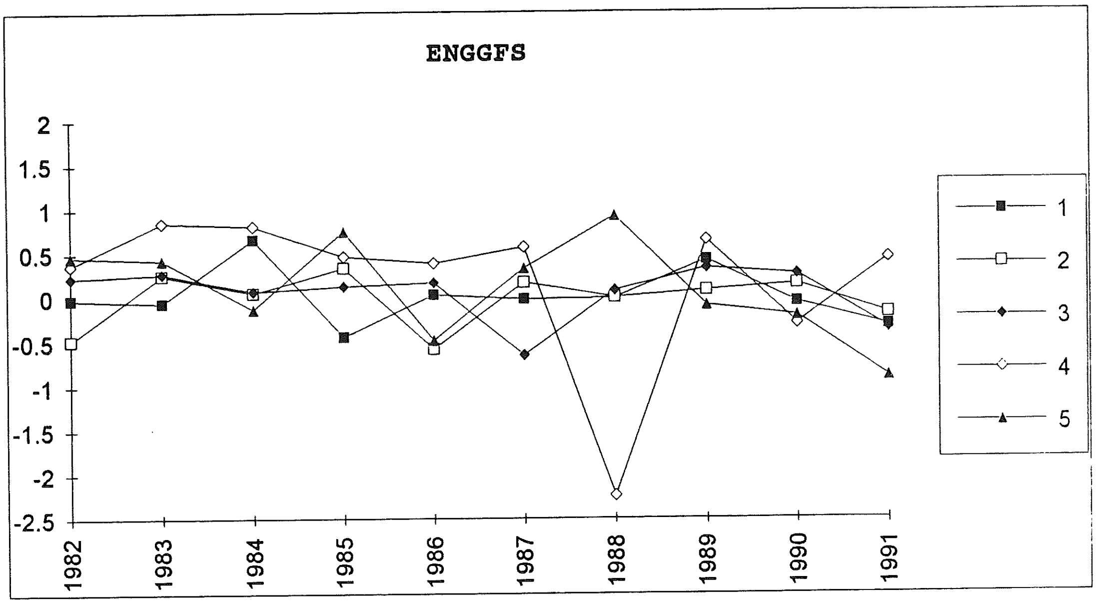


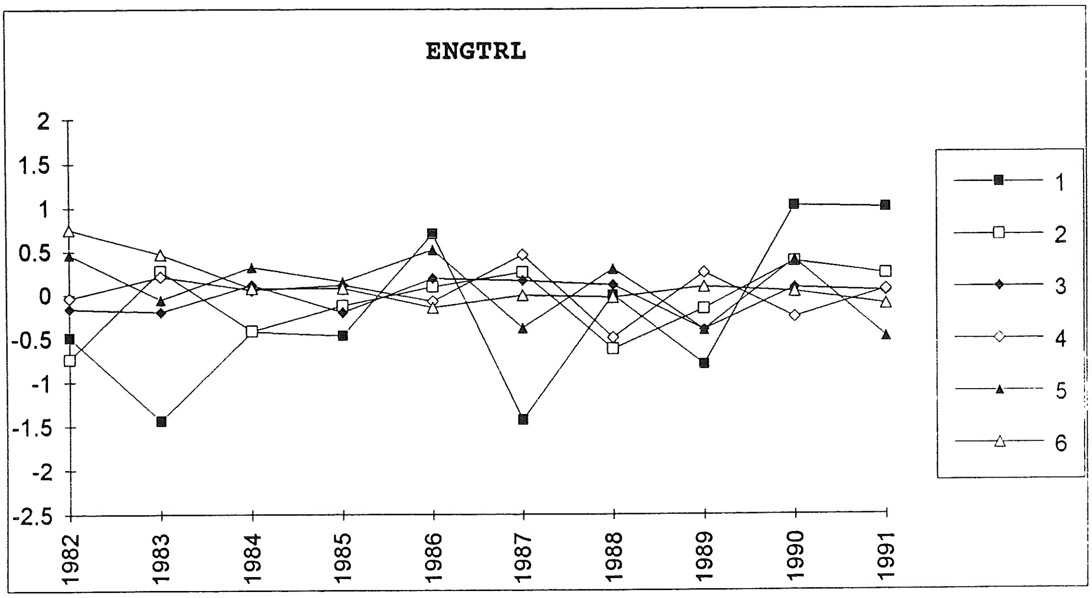


cont'd.

Figure 3.2.2 cont'd.

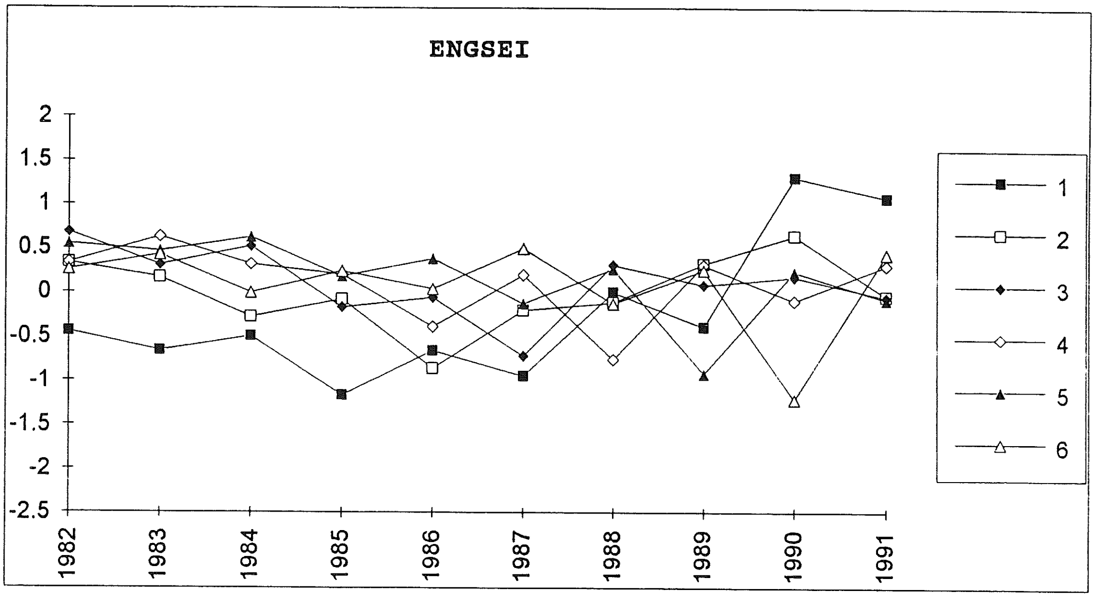


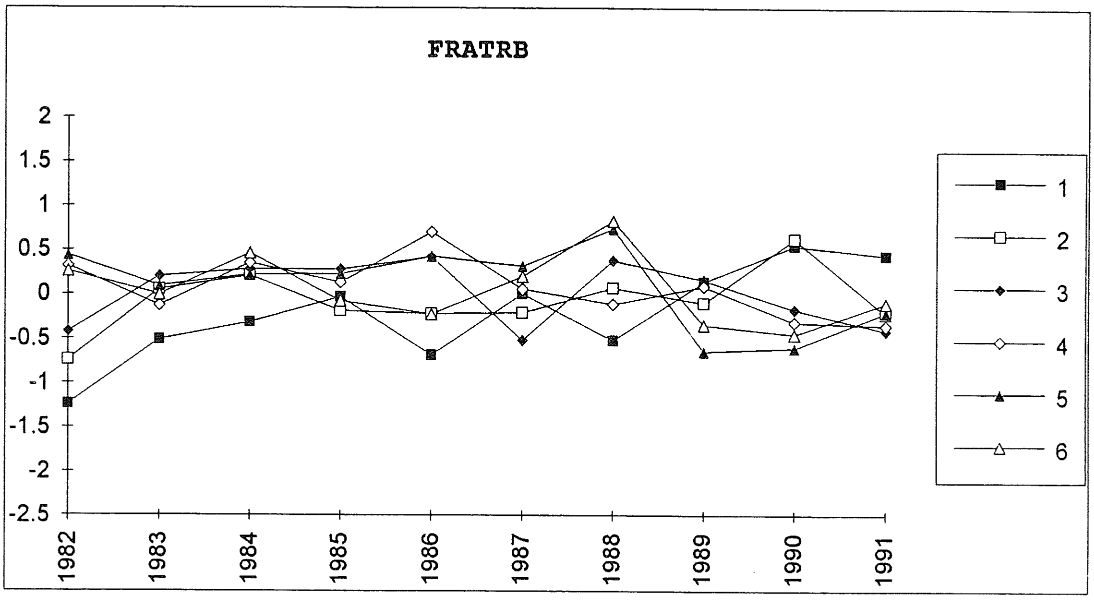


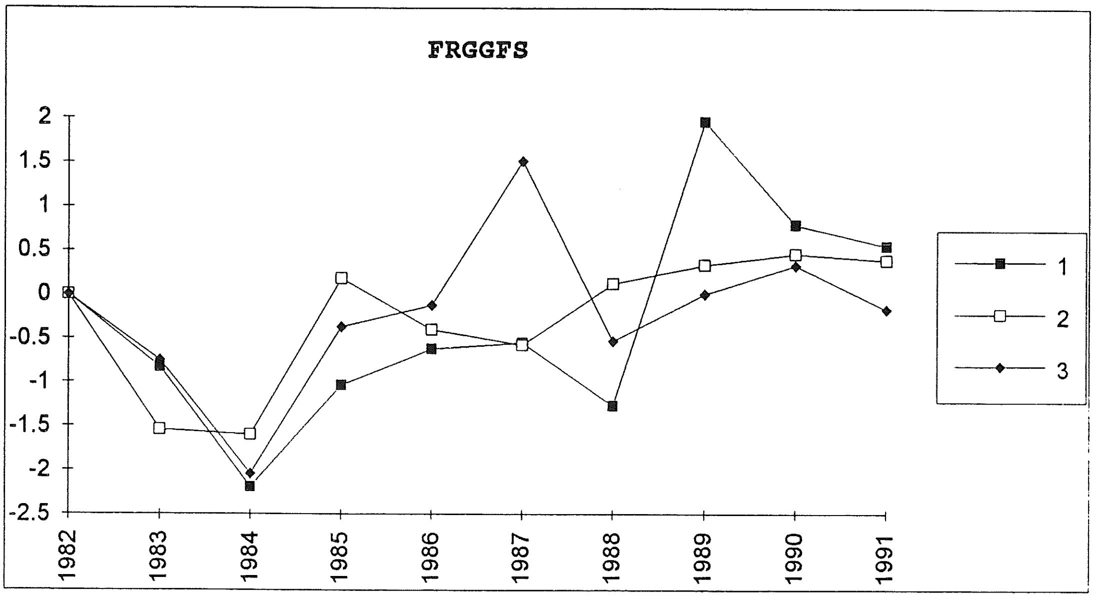


cont'd.

Figure 3.2.2 cont'd.

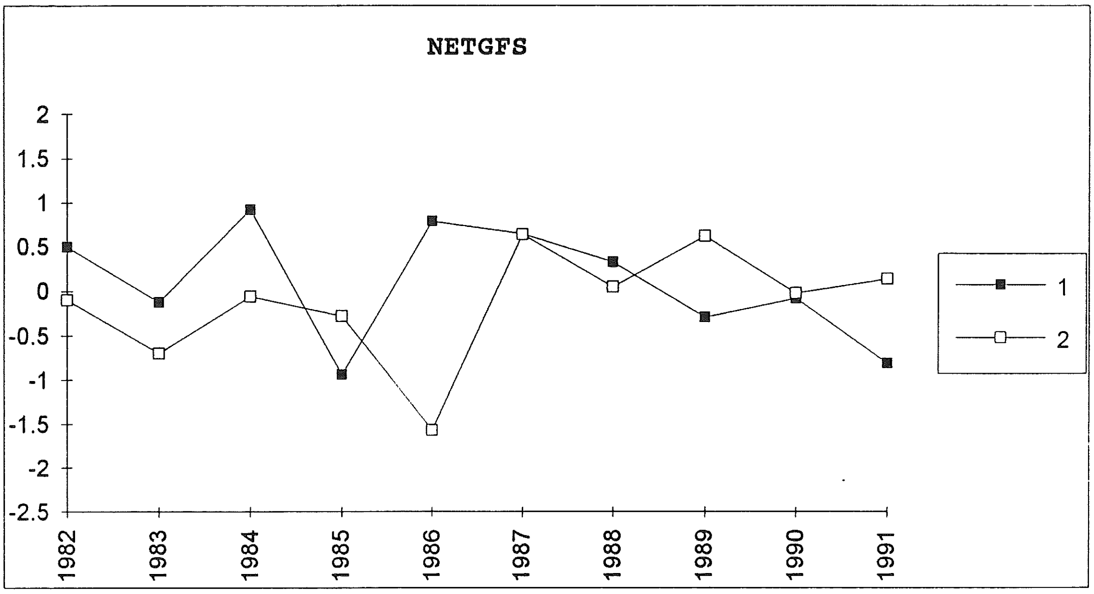






cont'd.

Figure 3.2.2 cont'd.



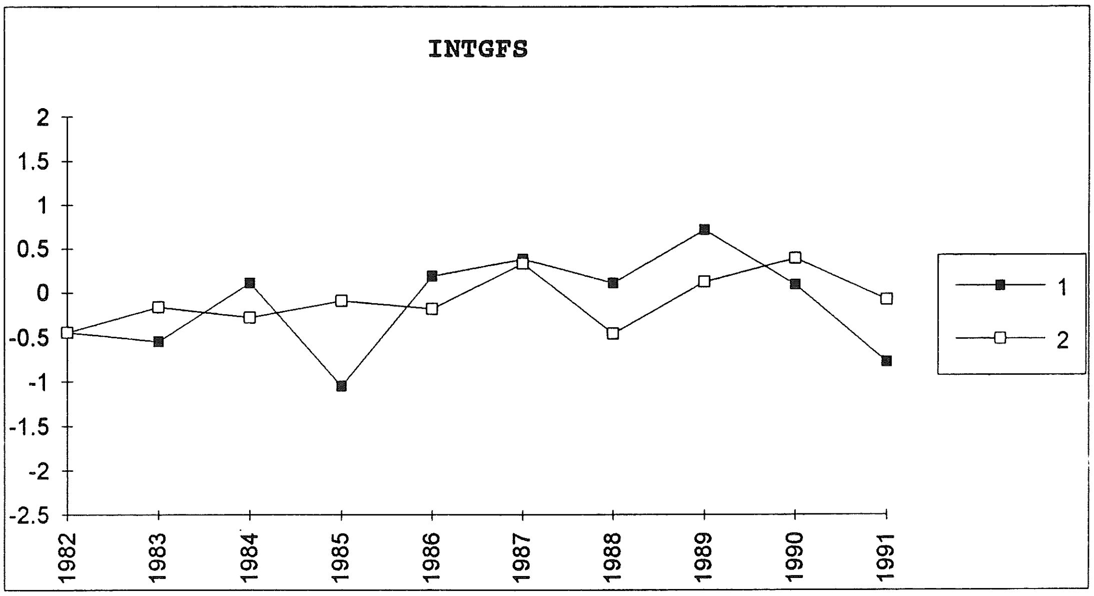


Figure 3.2.3

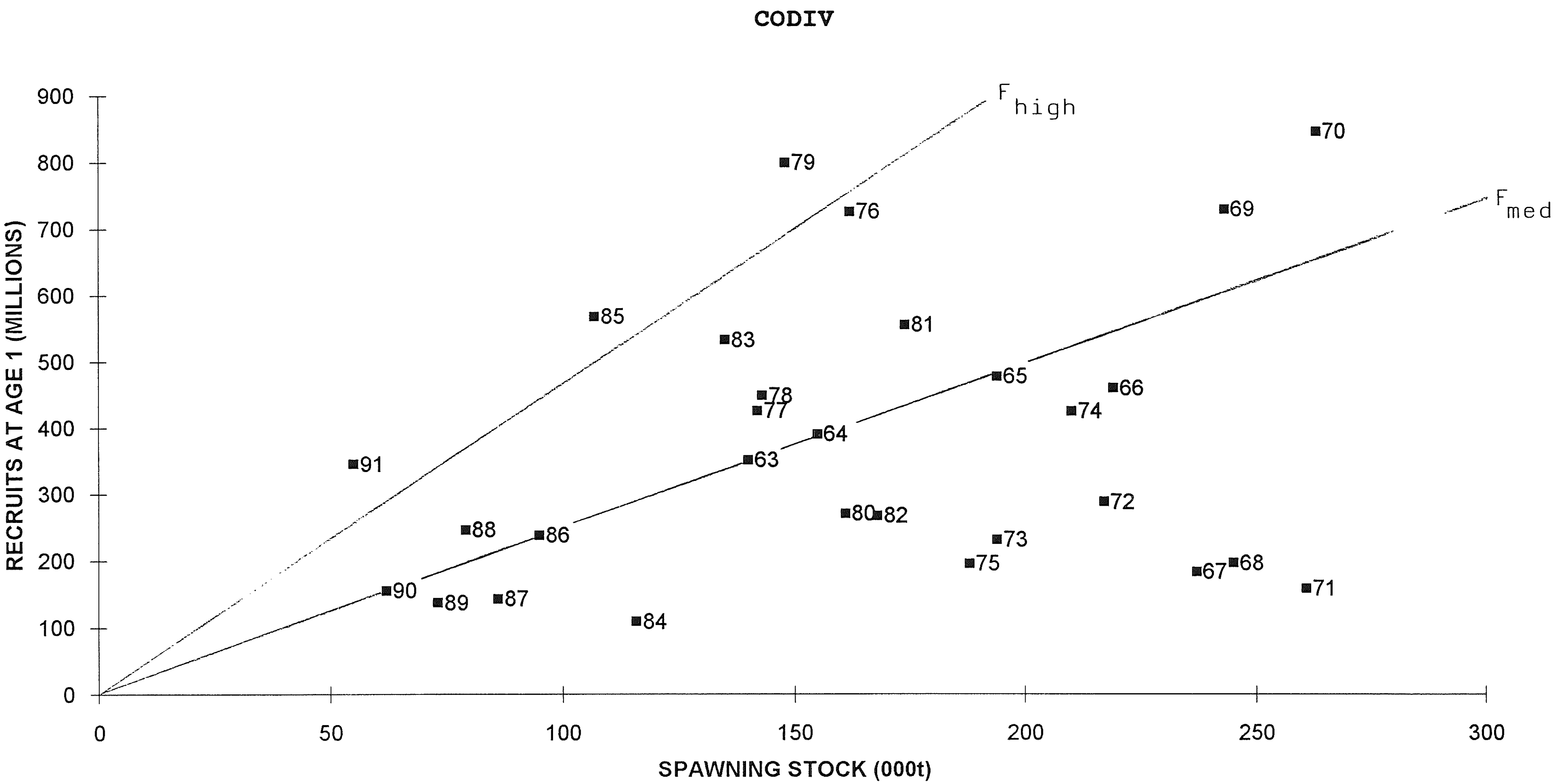

CODIV
RECRUITS AT AGE 1 (MILLIONS)
SPAWNING STOCK (000t)
0
100
200
300
400
500
600
700
800
900
0
50
100
150
200
250
300
F_{high}
F_{med}
70
79
69
76
85
83
81
78
77
65
66
74
64
91
63
72
80
82
88
86
73
75
67
68
90
89
87
71
84

Figure 3.2.4

FISH STOCK SUMMARY
STOCK: Cod in the North Sea (Fishing Area IV)
14–10–1992

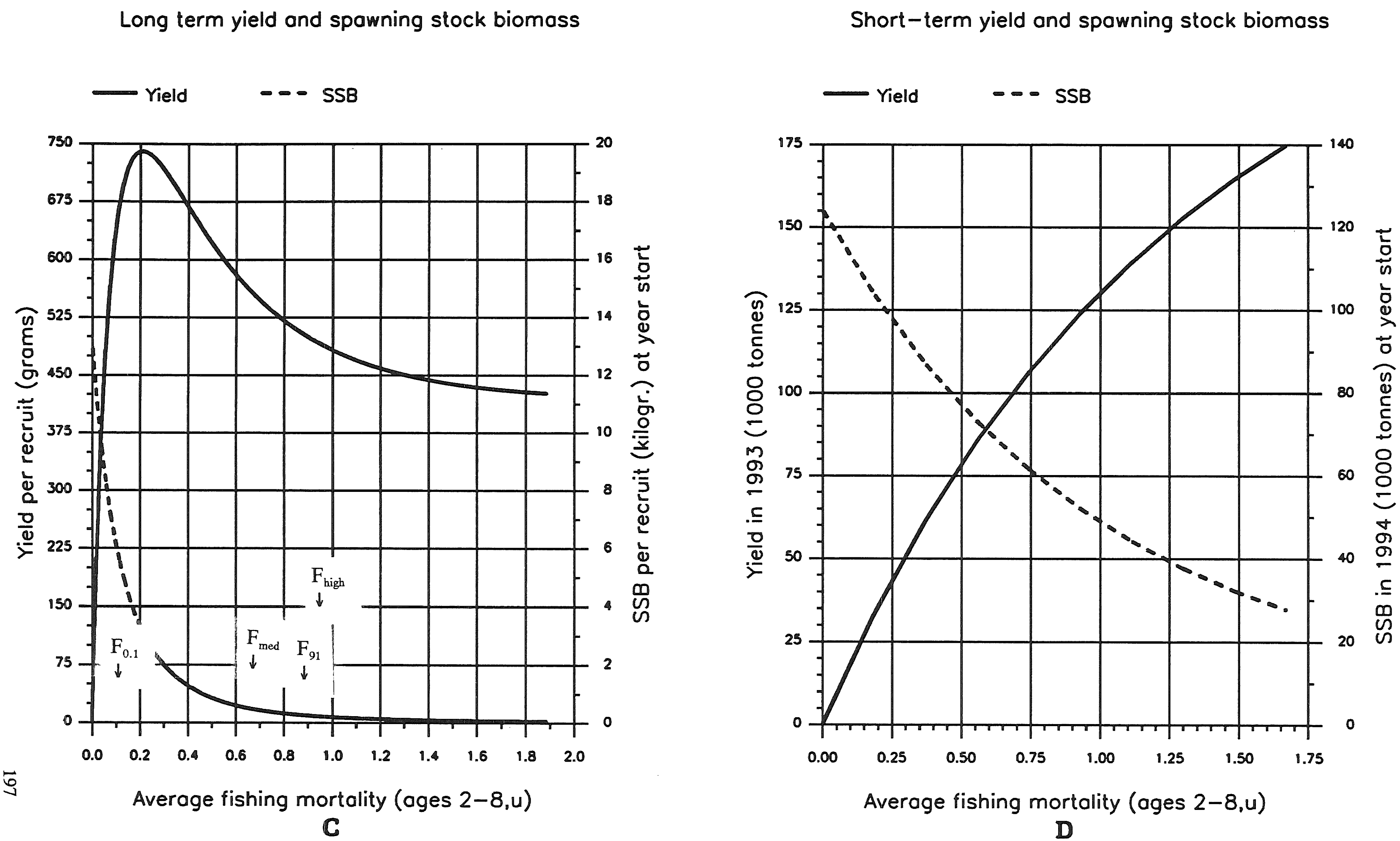
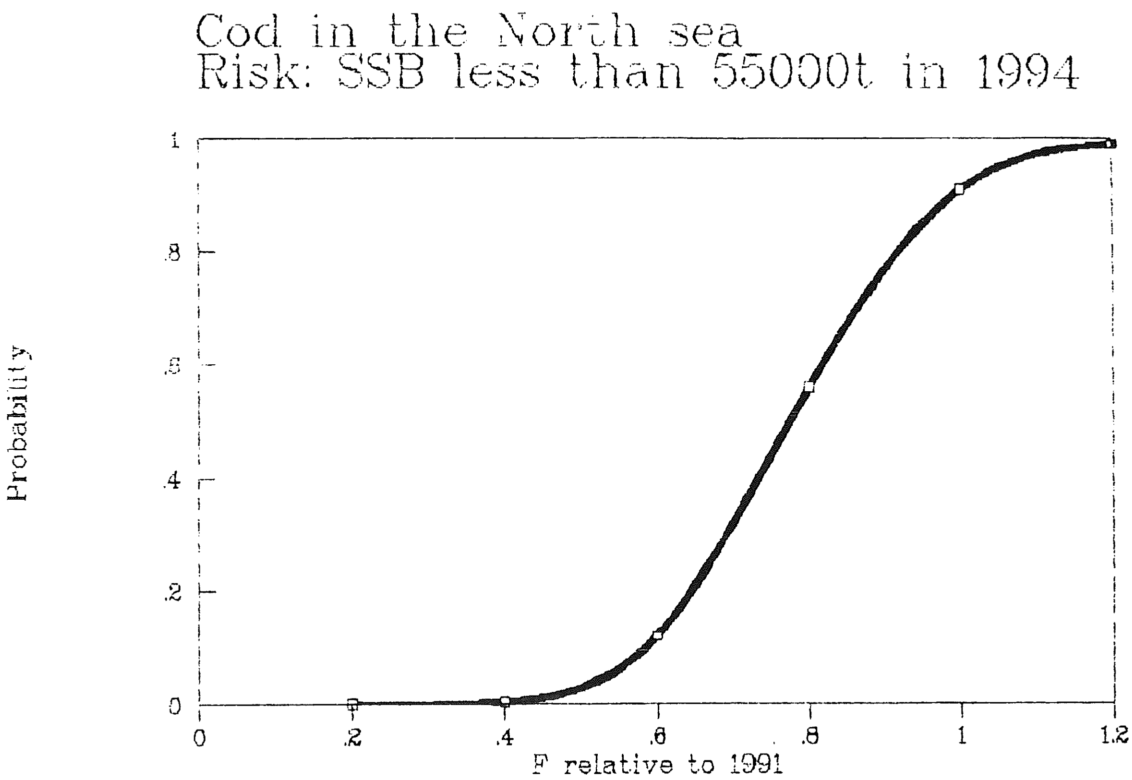
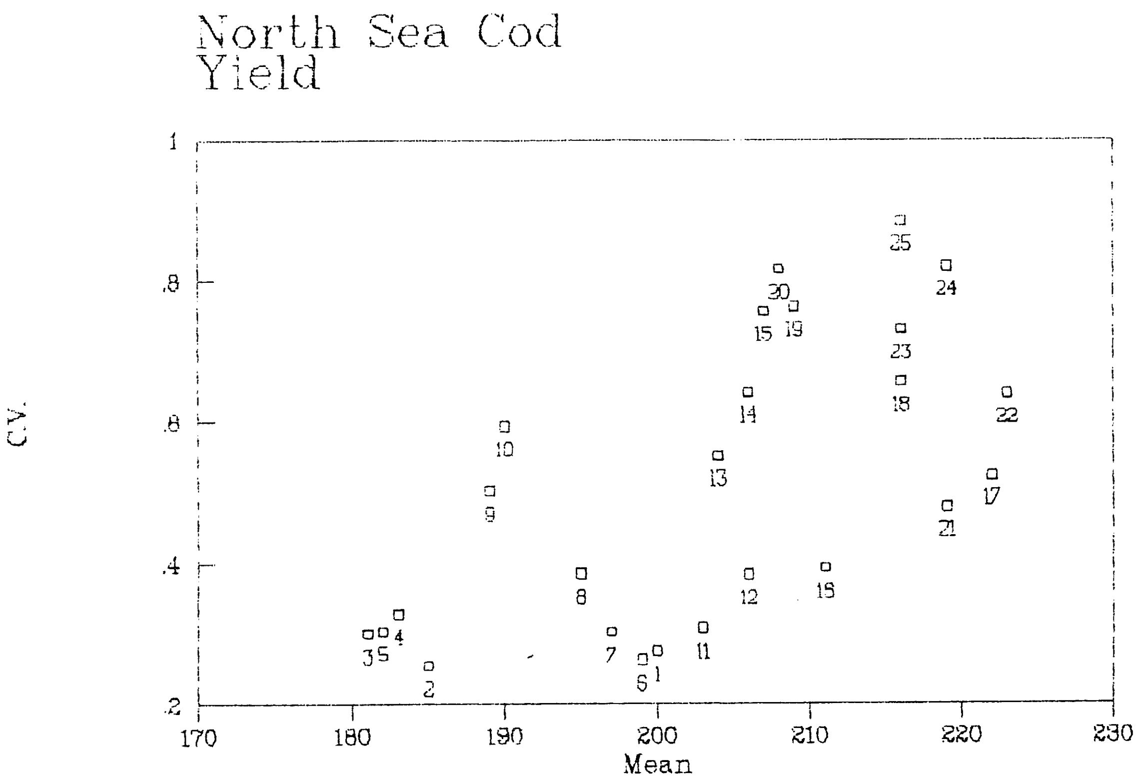


Figure 3.2.5



Cod in the North sea
Risk: SSB less than 55000t in 1994
Probability
1
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1
1.2
F relative to 1991

Figure 3.2.6


North Sea Cod
Yield
1
.8
.6
.4
.2
C.V.
170
180
190
200
210
220
230
Mean

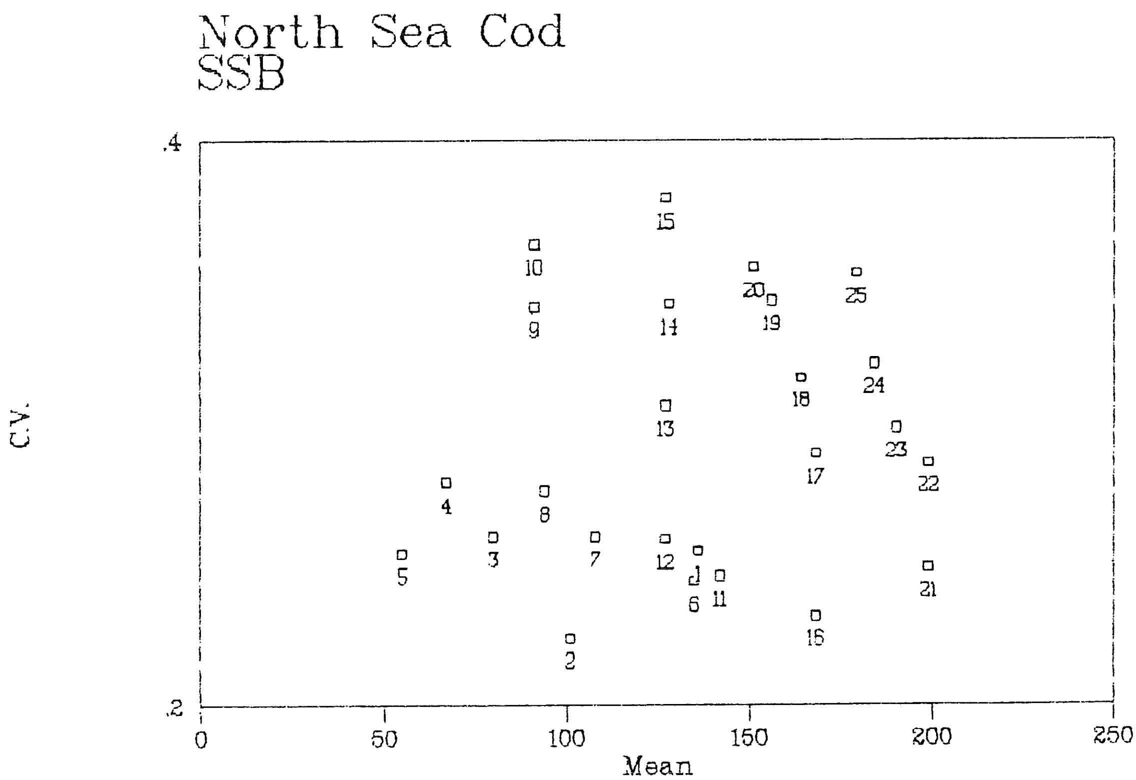

North Sea Cod
SSB
.4
.2
C.V.
0
50
100
150
200
250
Mean

Figure 3.2.7

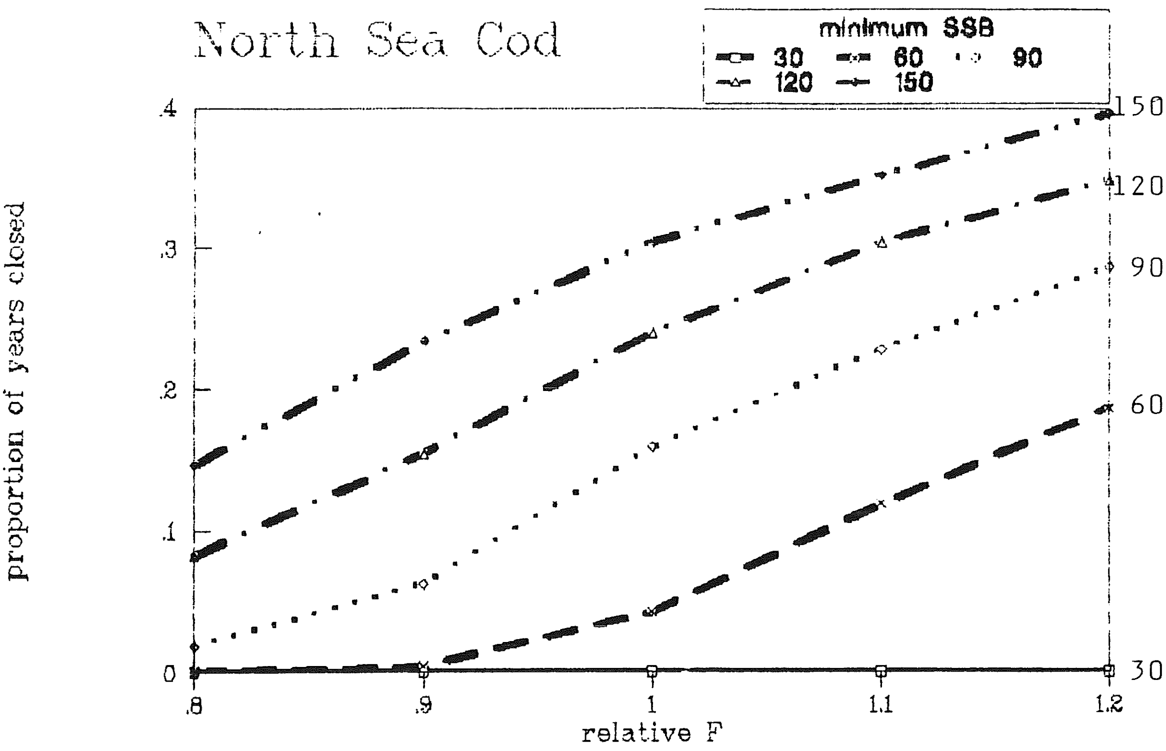

North Sea Cod
minimum SSB
30
60
90
120
150
proportion of years closed
relative F
0
.1
.2
.3
.4
.8
.9
1
1.1
1.2
150
120
90
60
30

Figure 3.3.1 Haddock in IV

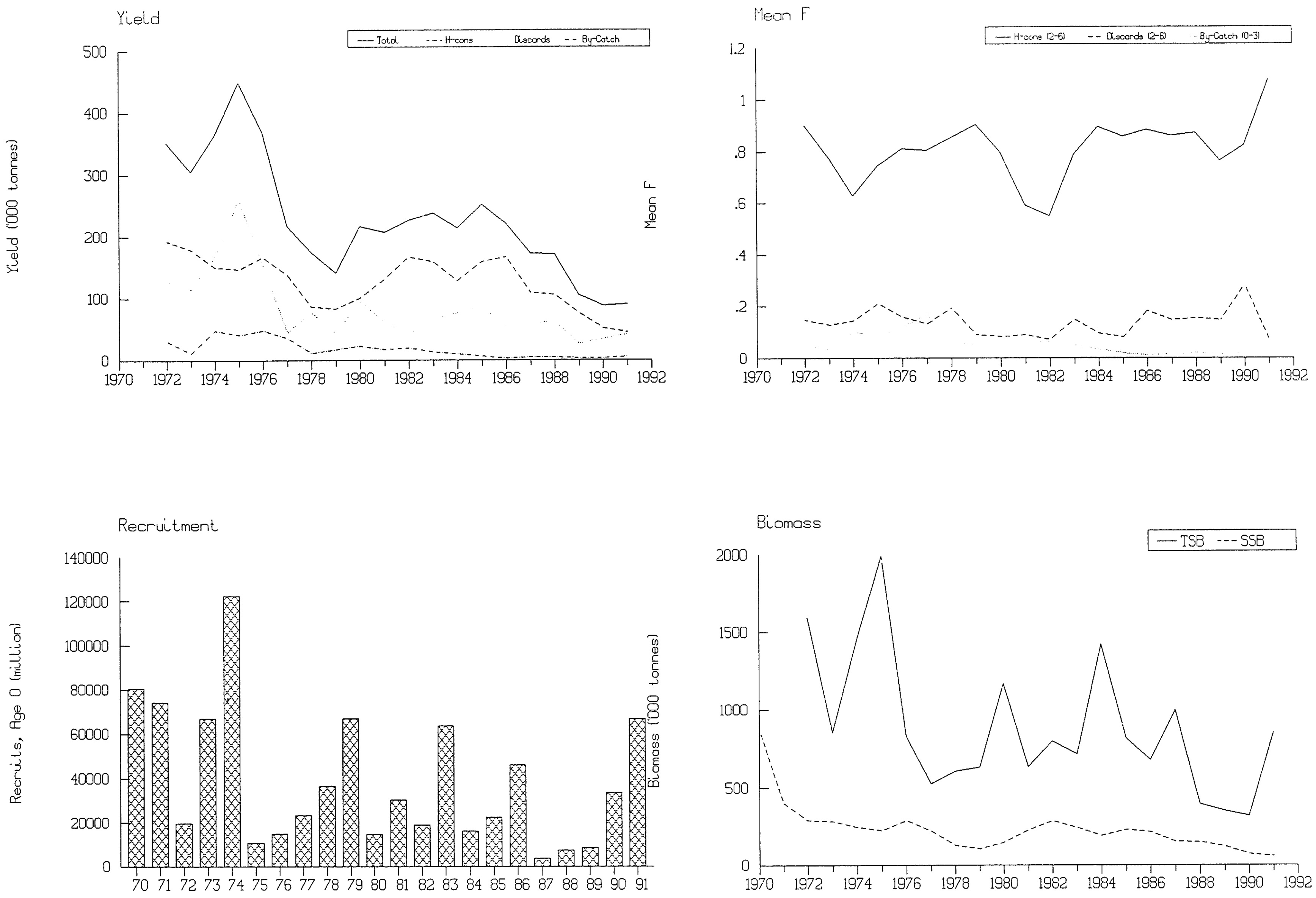
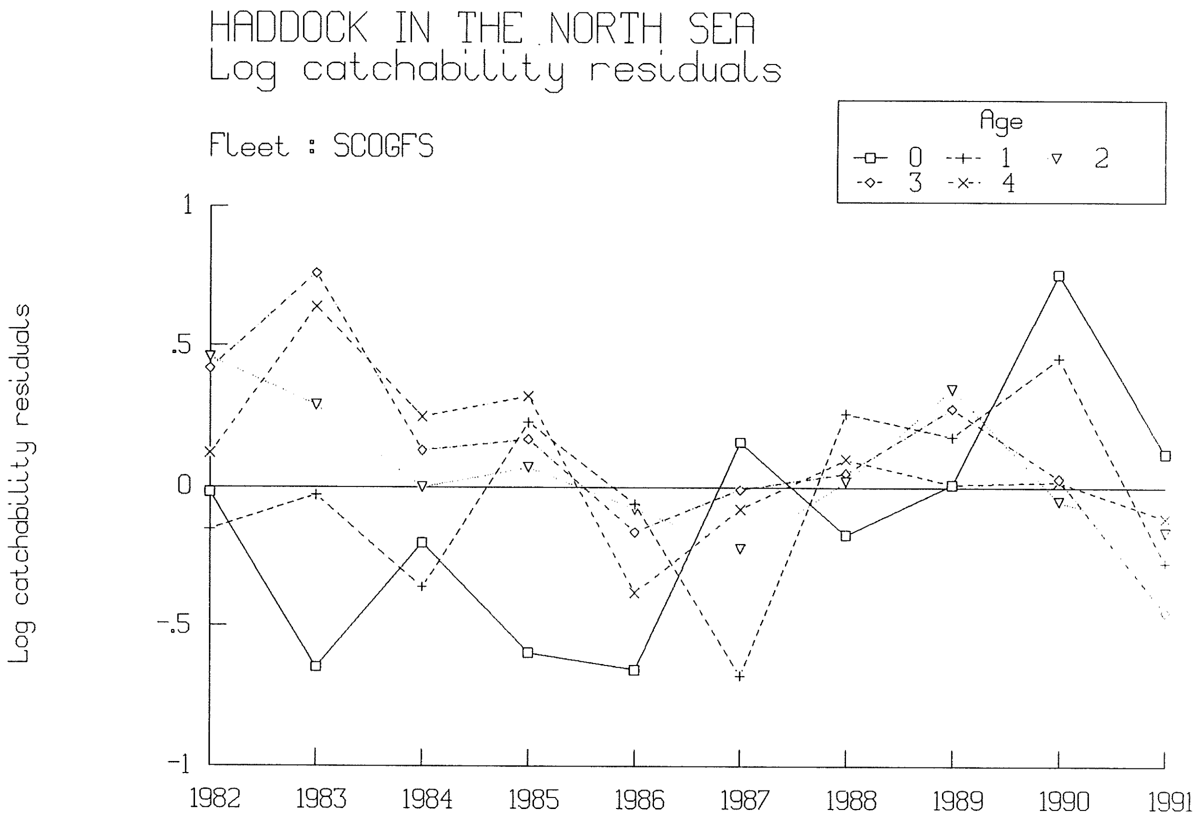
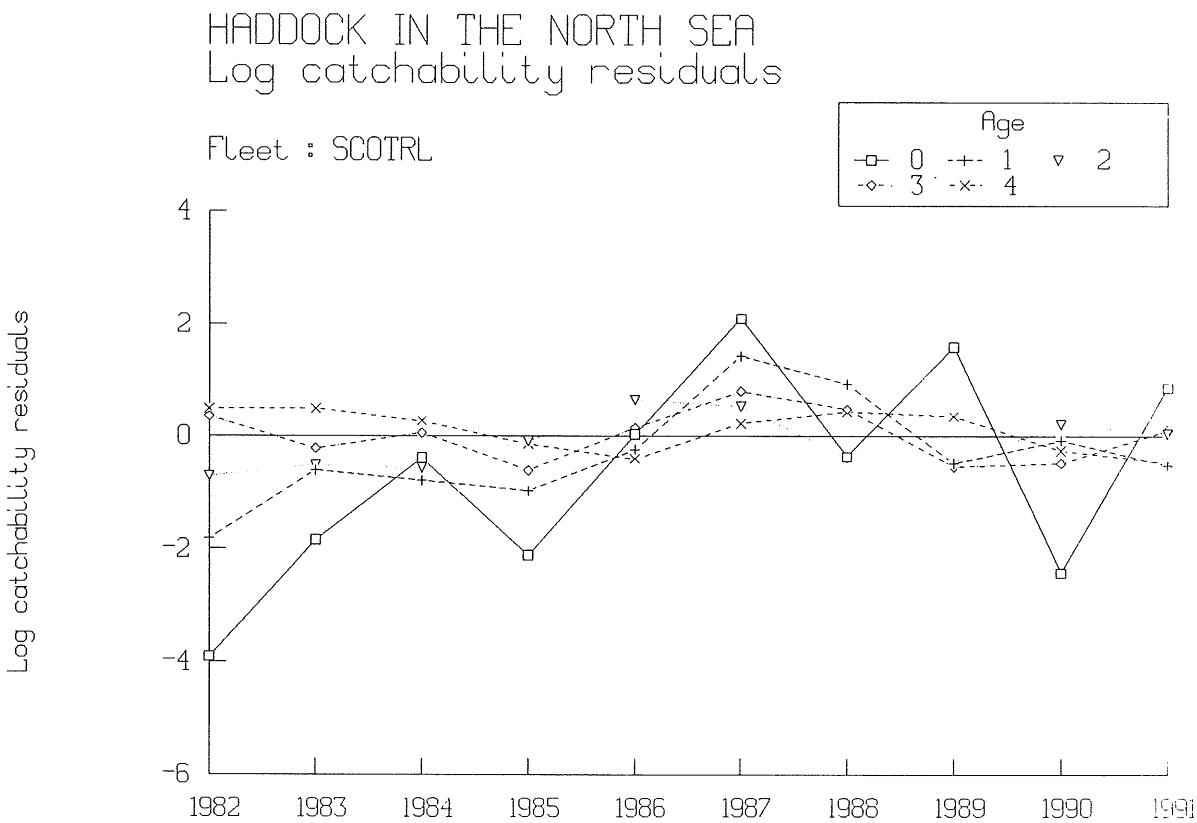


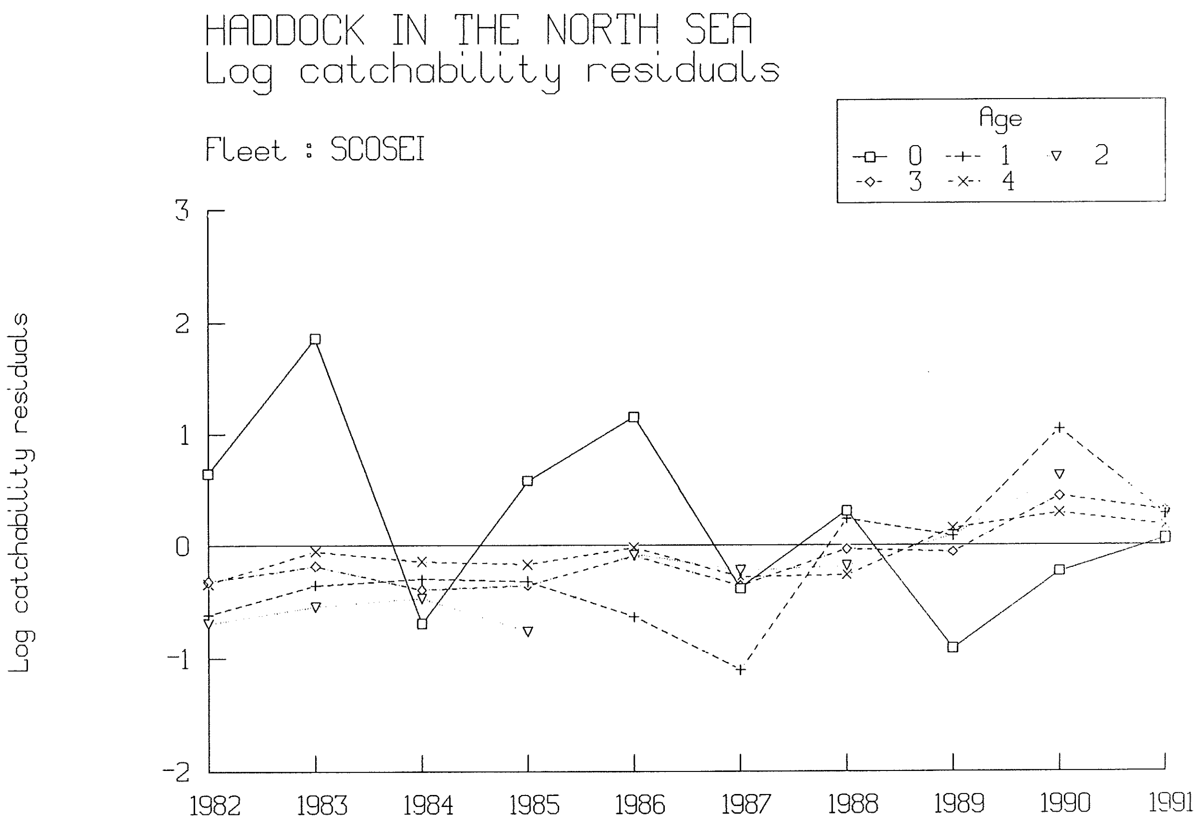
Figure 3.3.2

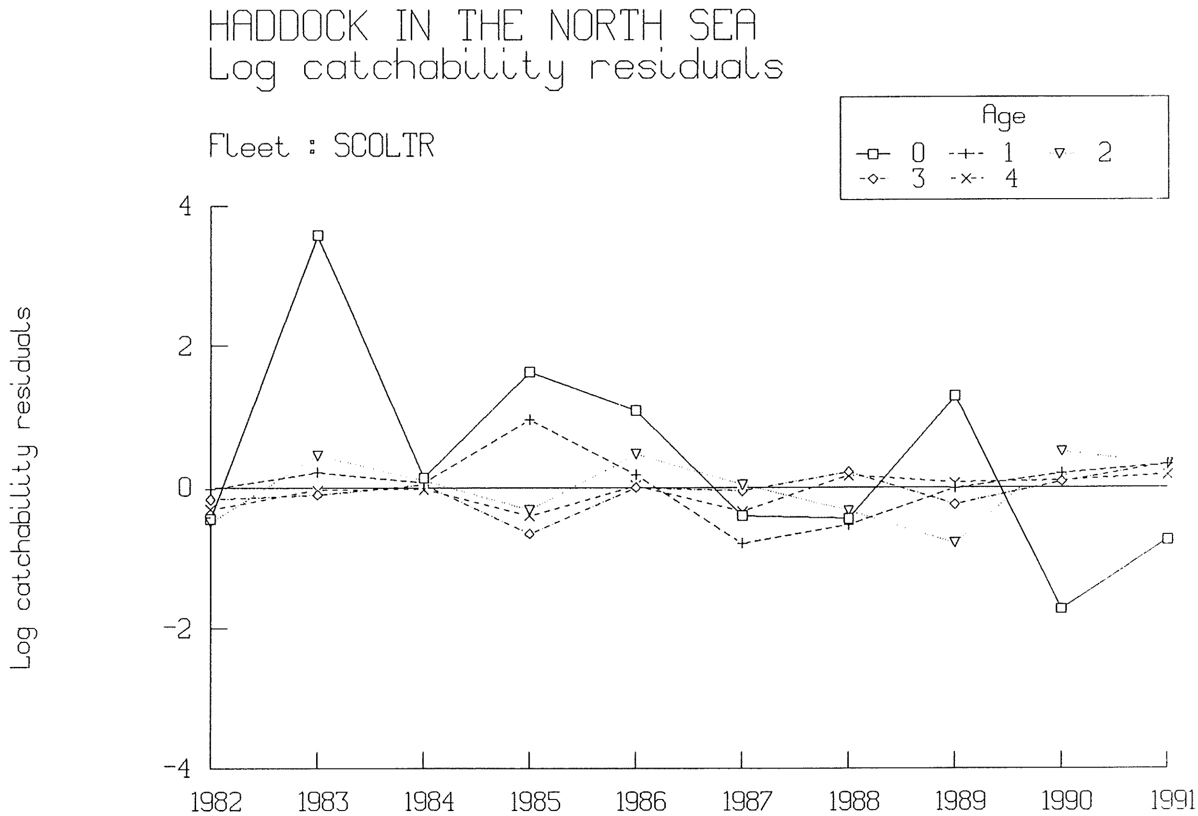




cont'd.

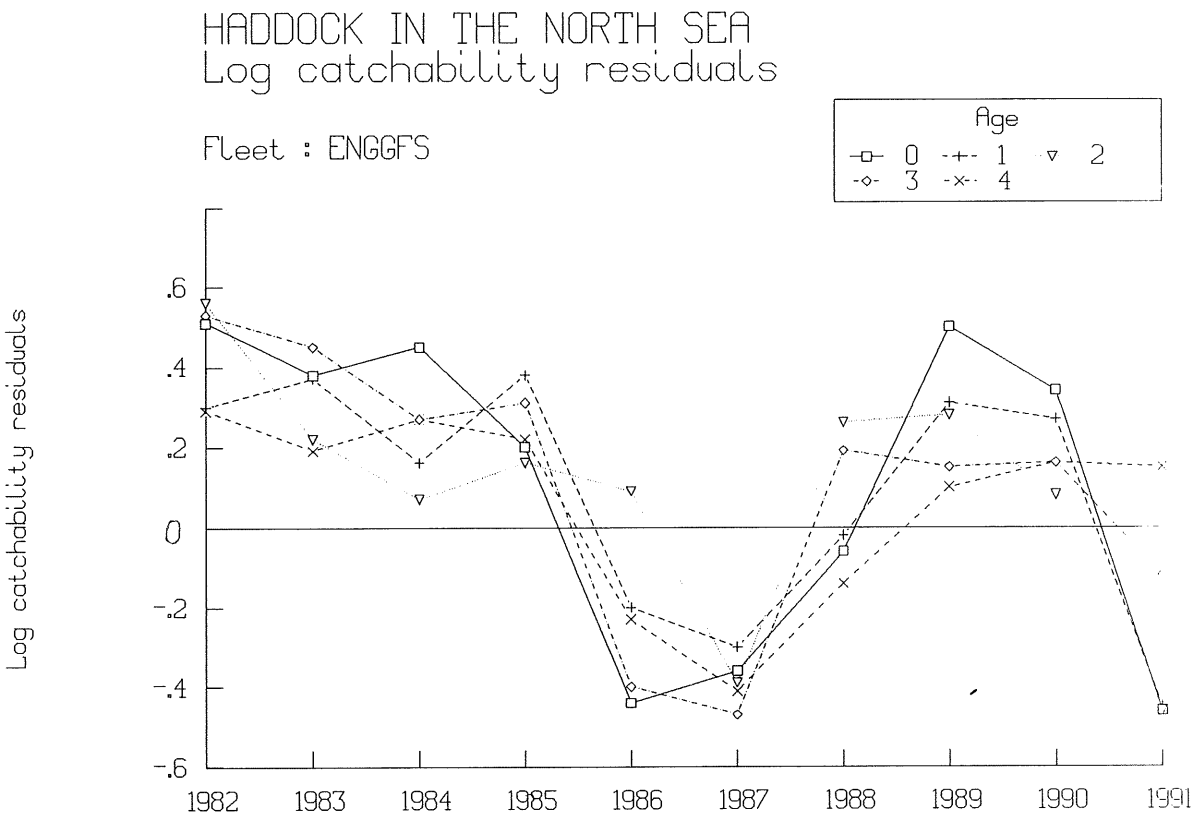
Figure 3.3.2 cont'd.

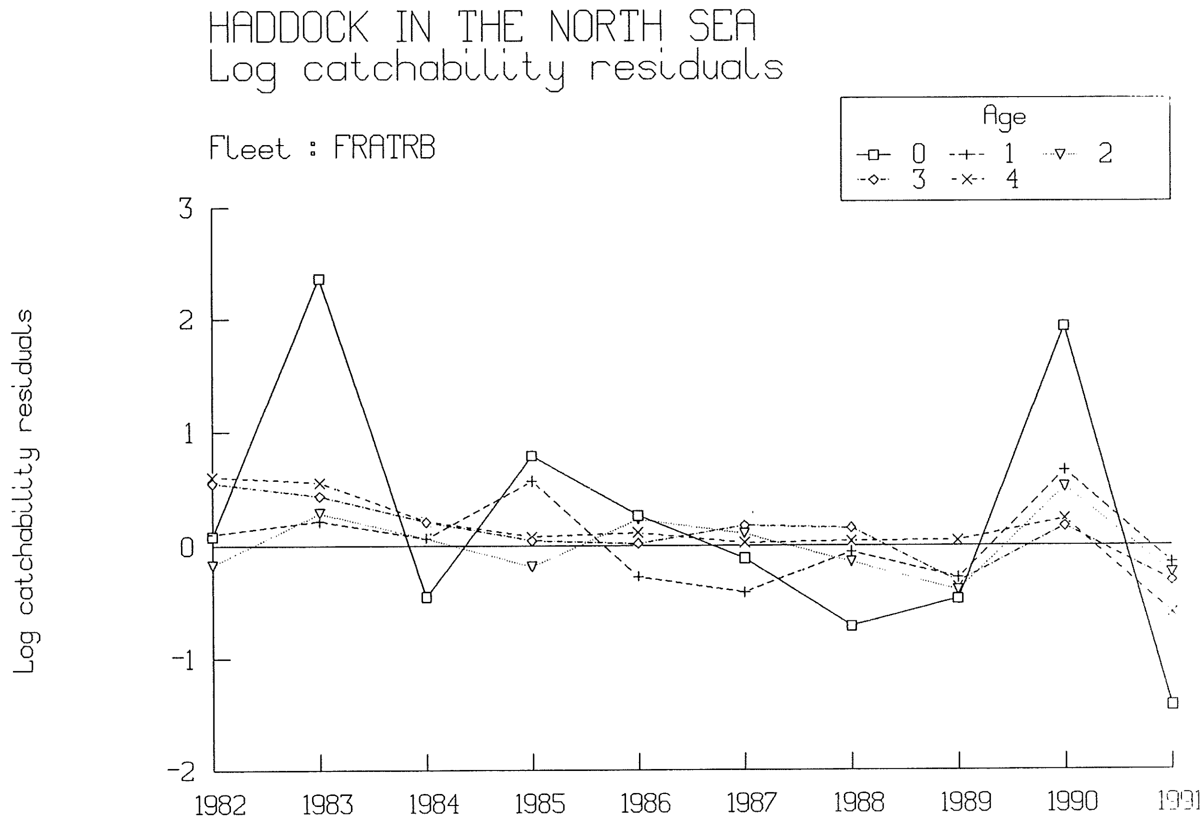




cont'd.

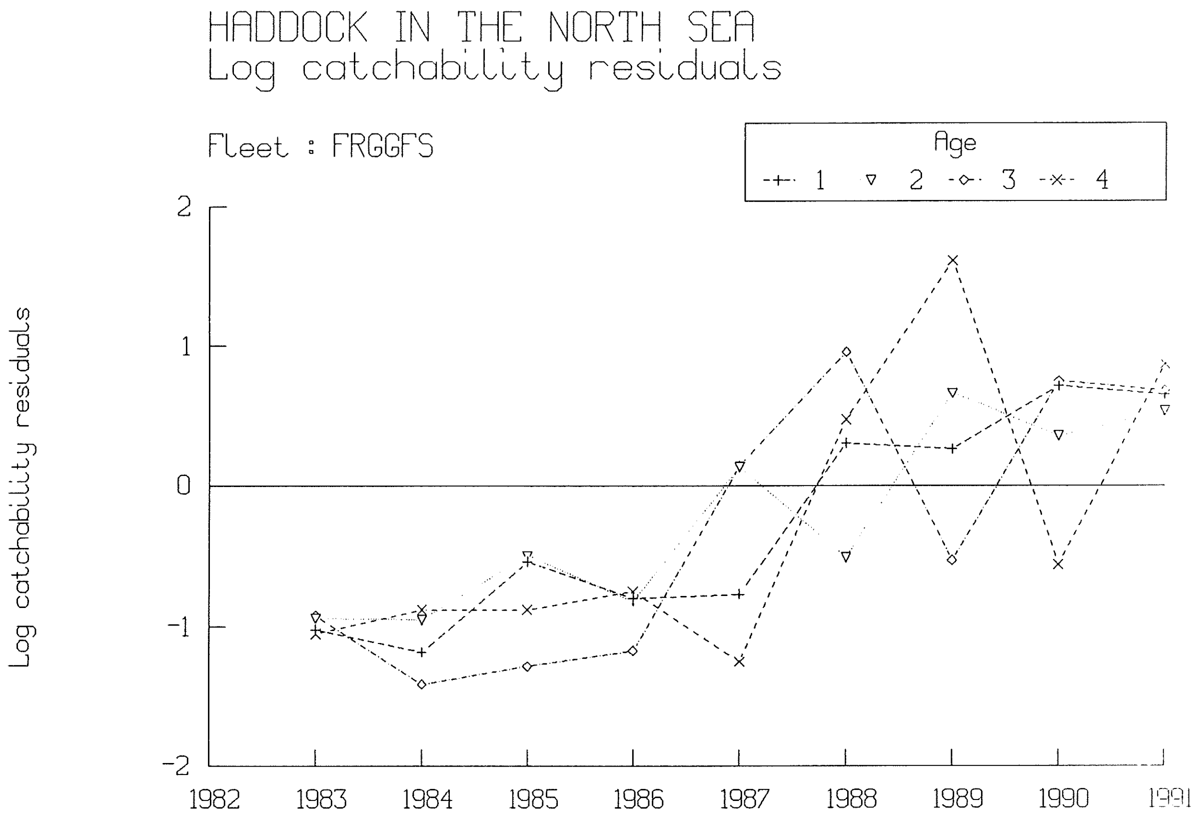
Figure 3.3.2 cont'd.

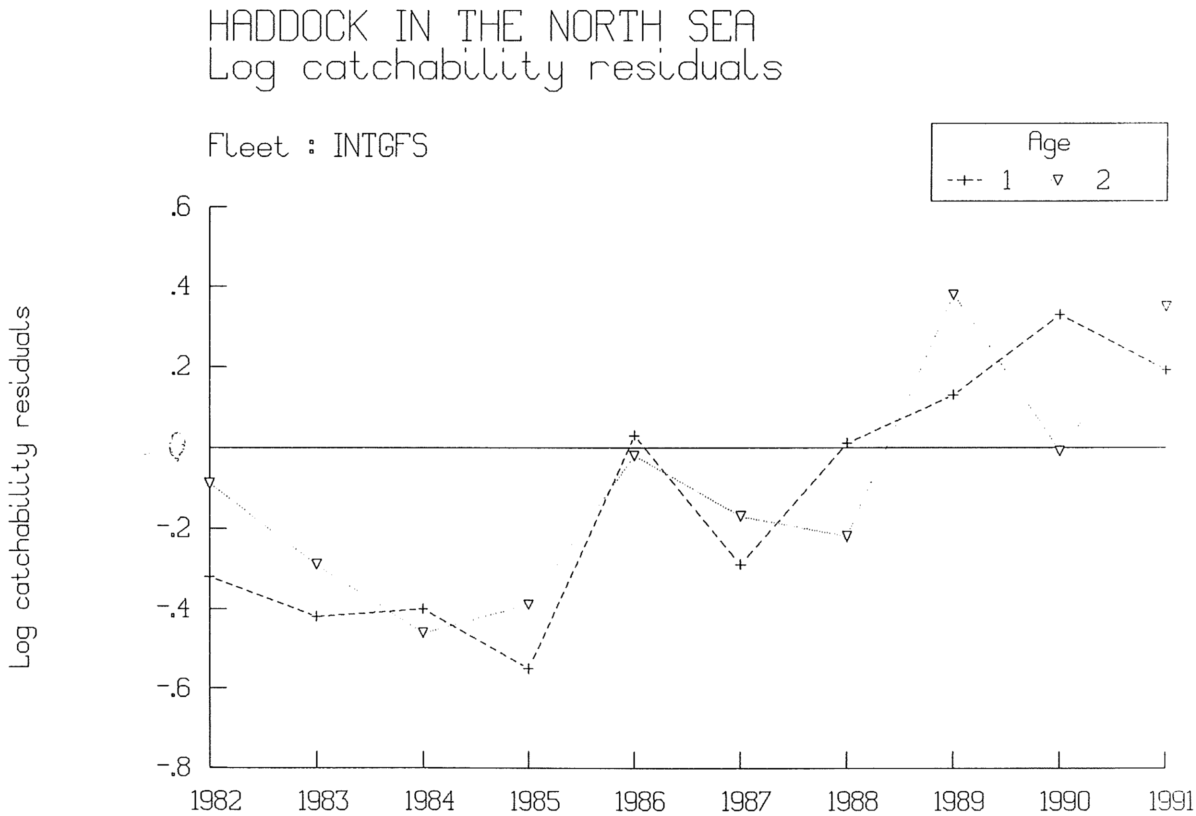




cont'd.

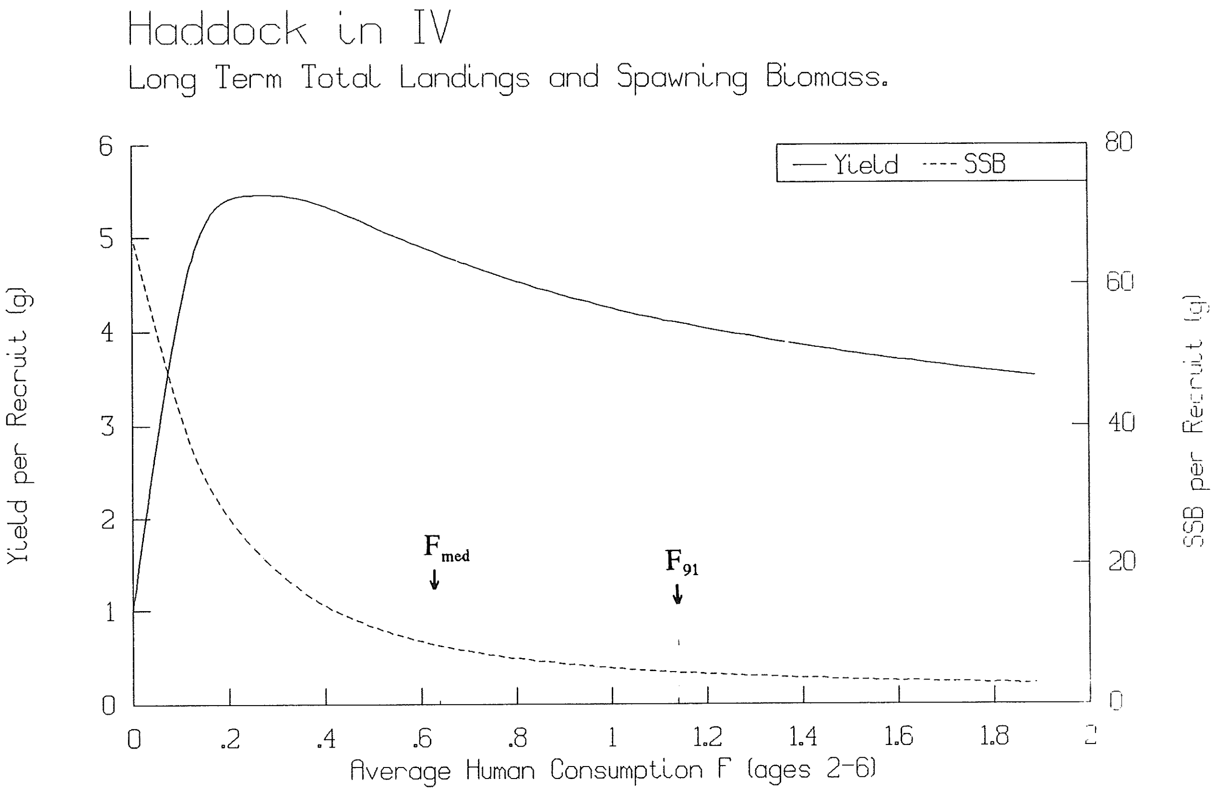
Figure 3.3.2 cont'd.



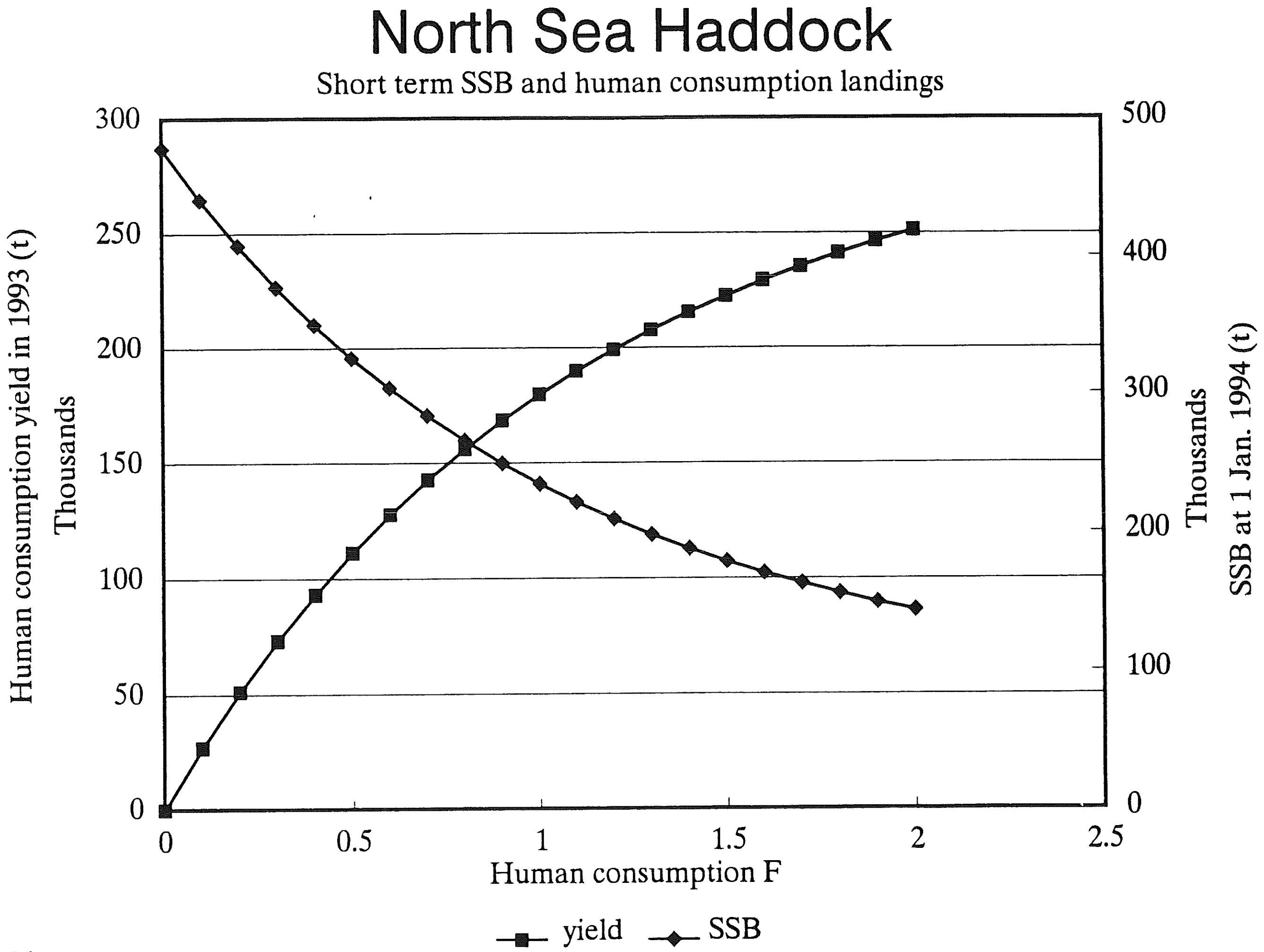


cont'd.

Figure 3.3.3

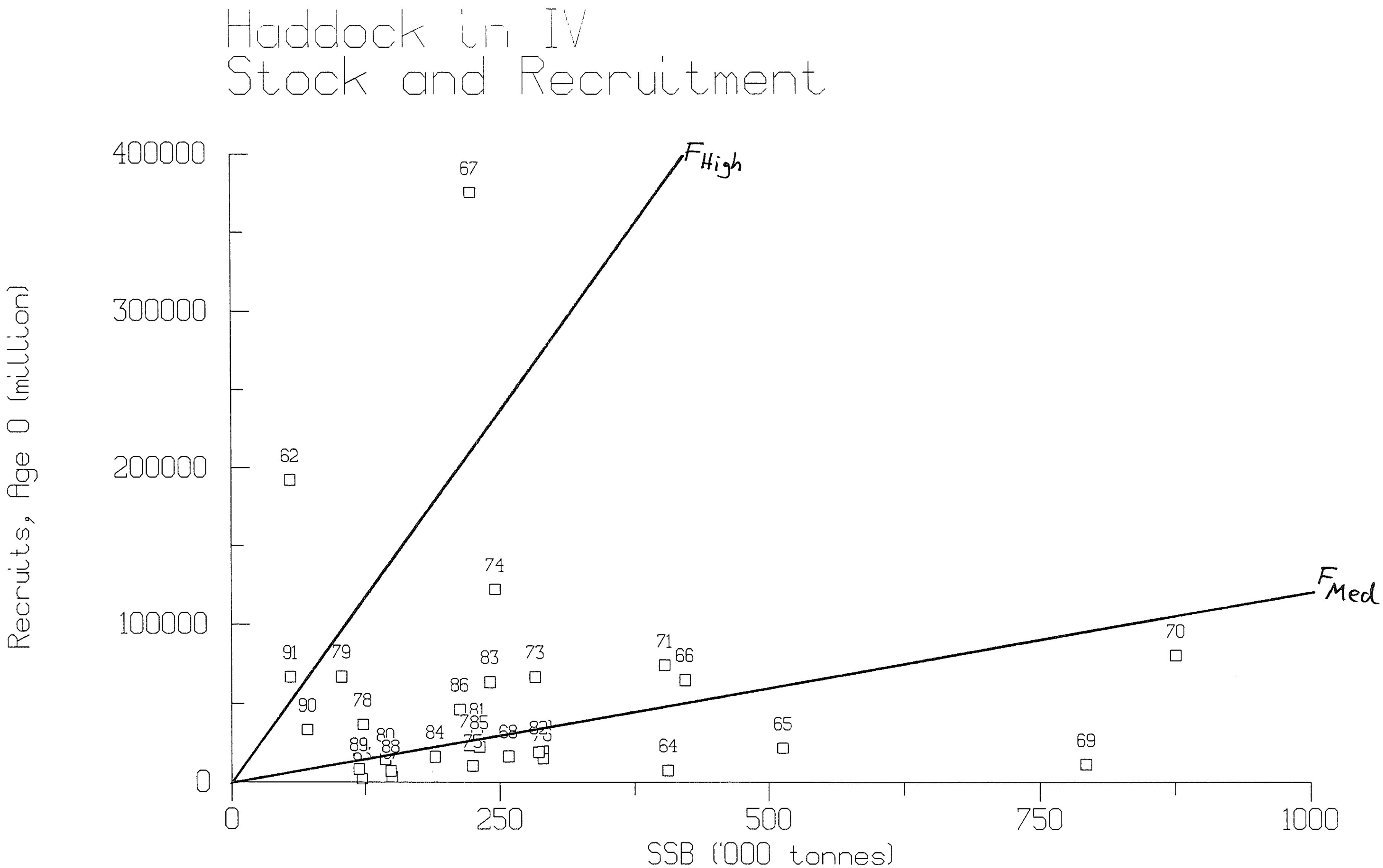


Haddock in IV
Long Term Total Landings and Spawning Biomass.
Yield
SSB
Yield per Recruit (g)
SSB per Recruit (g)
F_{med}
F_{91}
0
1
2
3
4
5
6
0
20
40
60
80
0
.2
.4
.6
.8
1
1.2
1.4
1.6
1.8
2
Average Human Consumption F (ages 2-6)



North Sea Haddock
Short term SSB and human consumption landings
Human consumption yield in 1993 (t)
Thousands
SSB at 1 Jan. 1994 (t)
Thousands
0
50
100
150
200
250
300
0
100
200
300
400
500
0
0.5
1
1.5
2
2.5
Human consumption F
yield
SSB

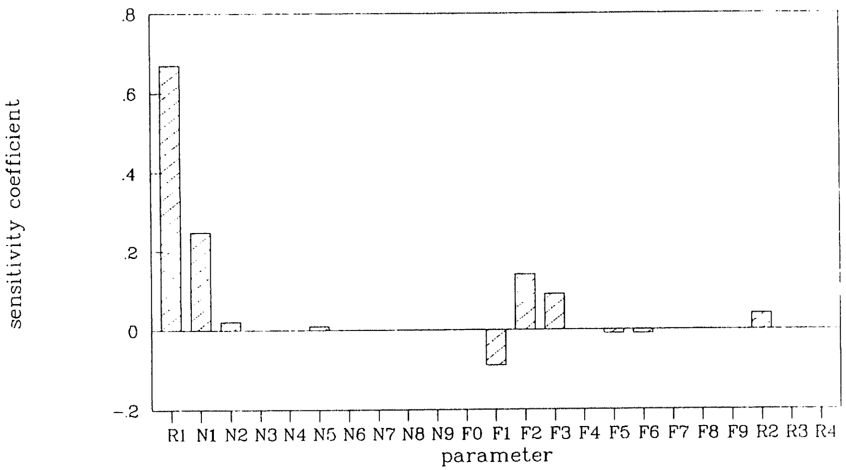
Figure 3.3.4



Haddock in IV
Stock and Recruitment
Recruits, Age 0 (million)
SSB ('000 tonnes)
FHigh
FMed
400000
300000
200000
100000
0
250
500
750
1000
67
62
74
91
79
90
78
86
83
73
71
66
70
65
64
69
84
68

Figure 3.3.5 Sensitivity analysis of catch prediction.

HADDOCK CATCH PREDICTION
Landings in 1993



HADDOCK CATCH PREDICTION
SSB in 1994

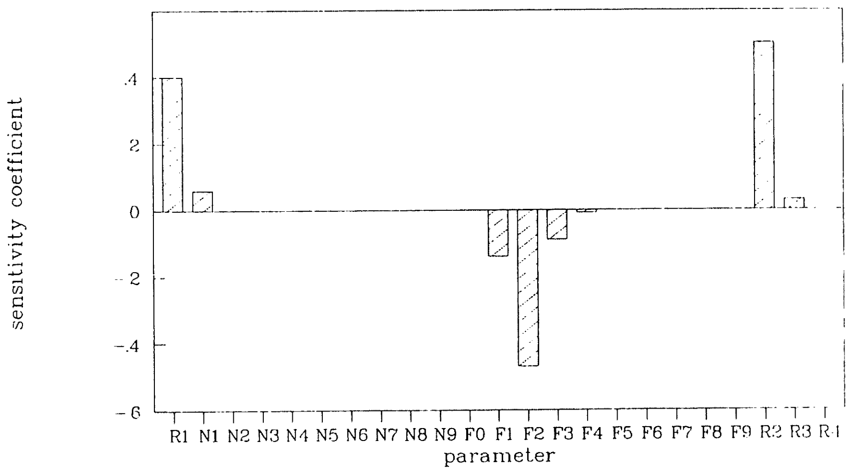


Figure 3.3.6

North Sea Haddock
Yield

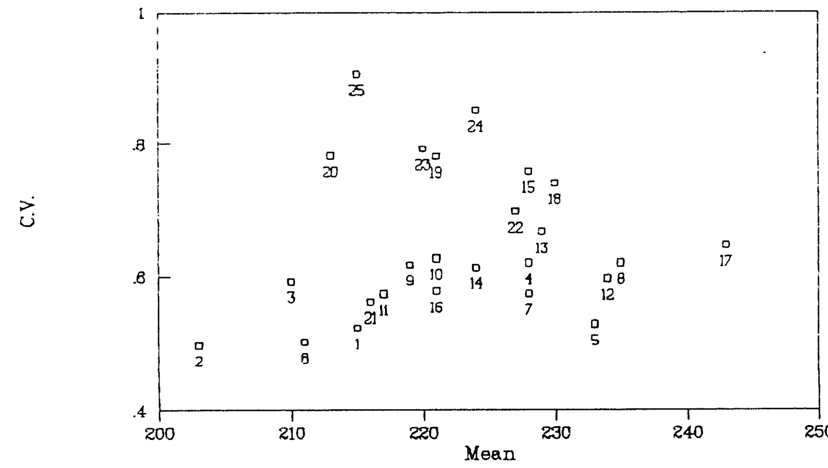


Figure 3.3.7

North Sea Haddock
SSB

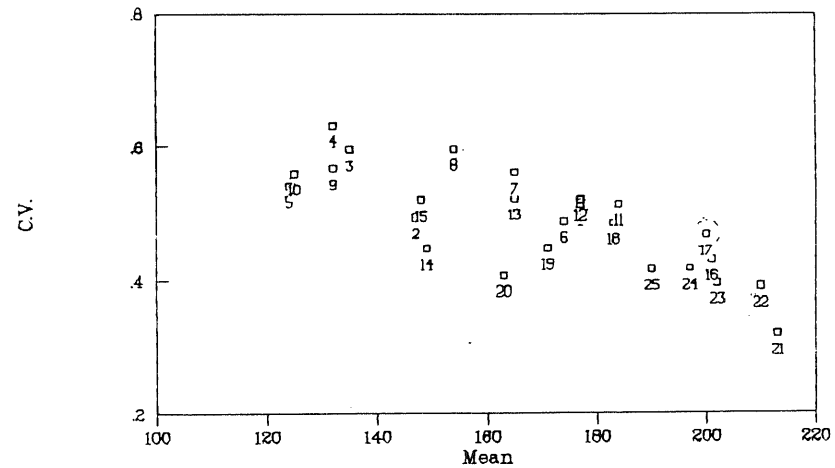
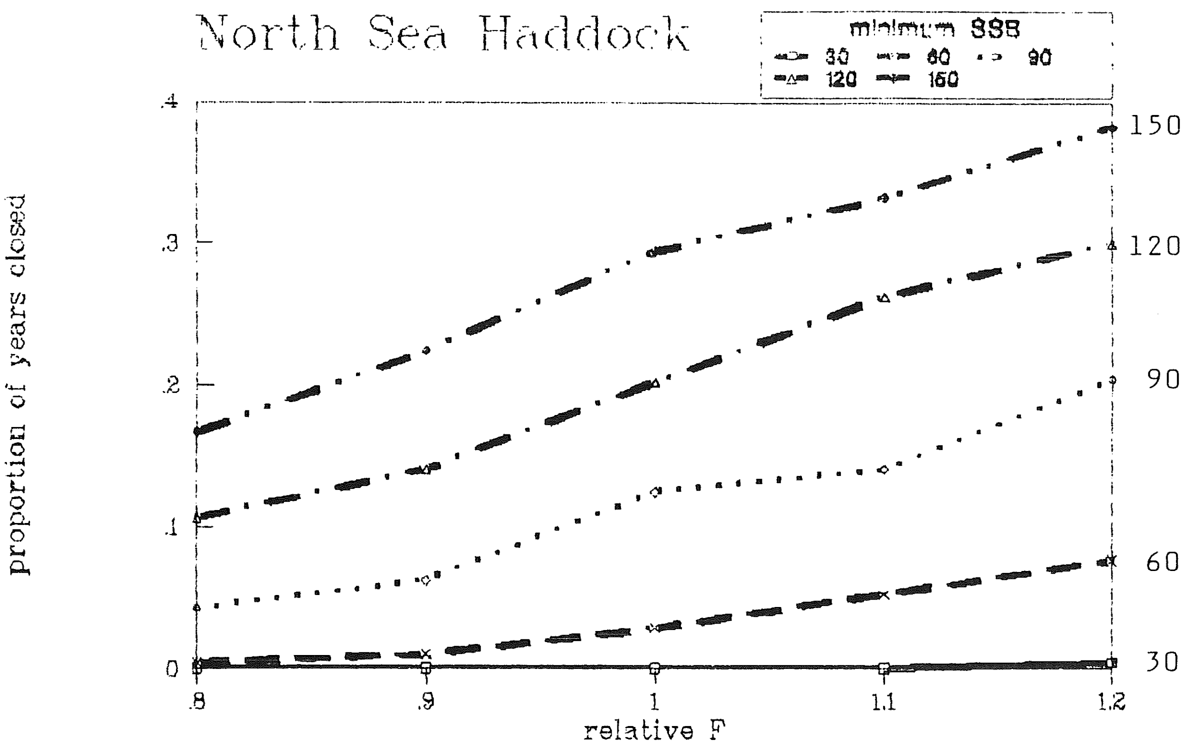


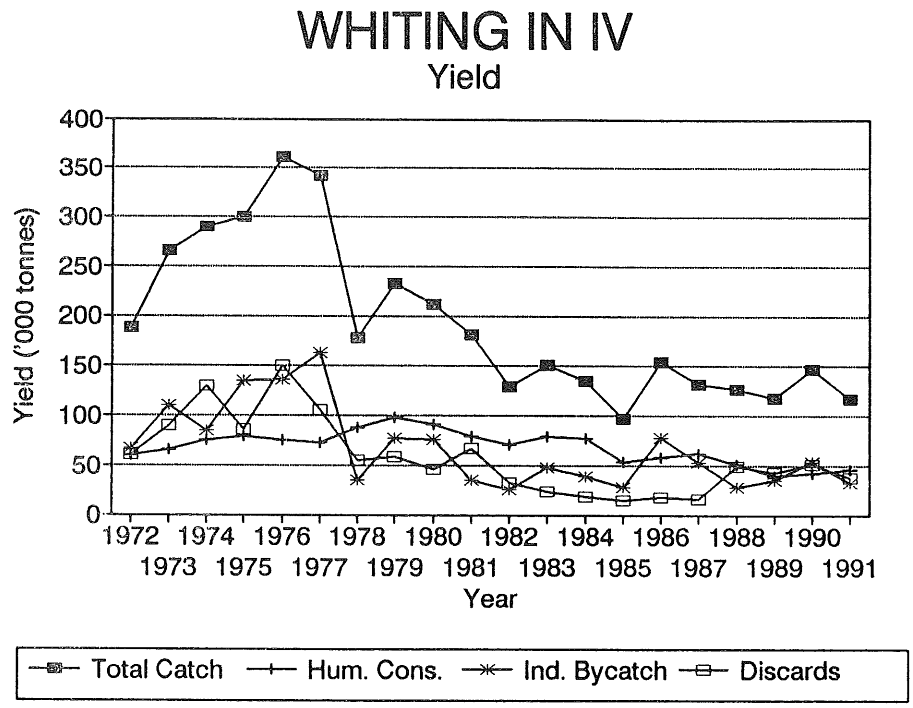
Figure 3.3.8



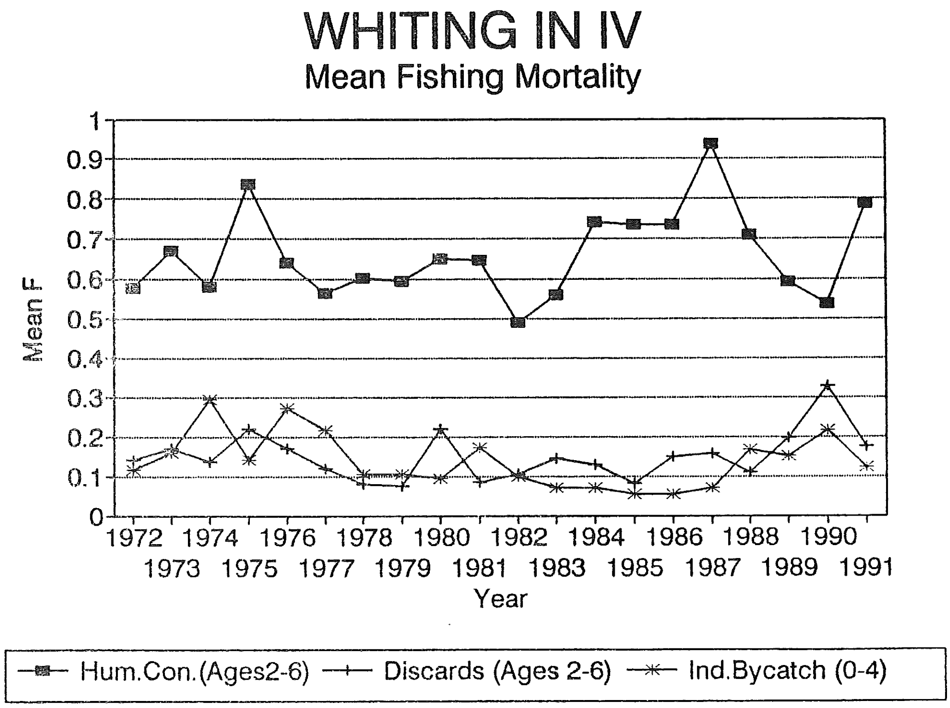
North Sea Haddock
minimum SSB
30
60
90
120
150
proportion of years closed
relative F
0
.1
.2
.3
.4
.8
.9
1
1.1
1.2
150
120
90
60
30

Figure 3.4.1

A



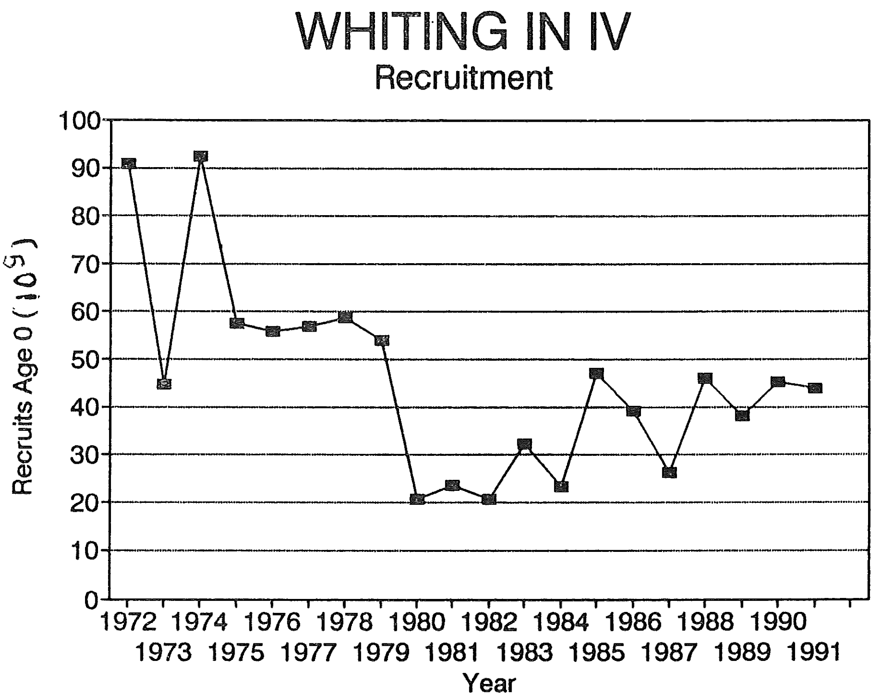
B



cont'd.

Figure 3.4.1 cont'd

C



D

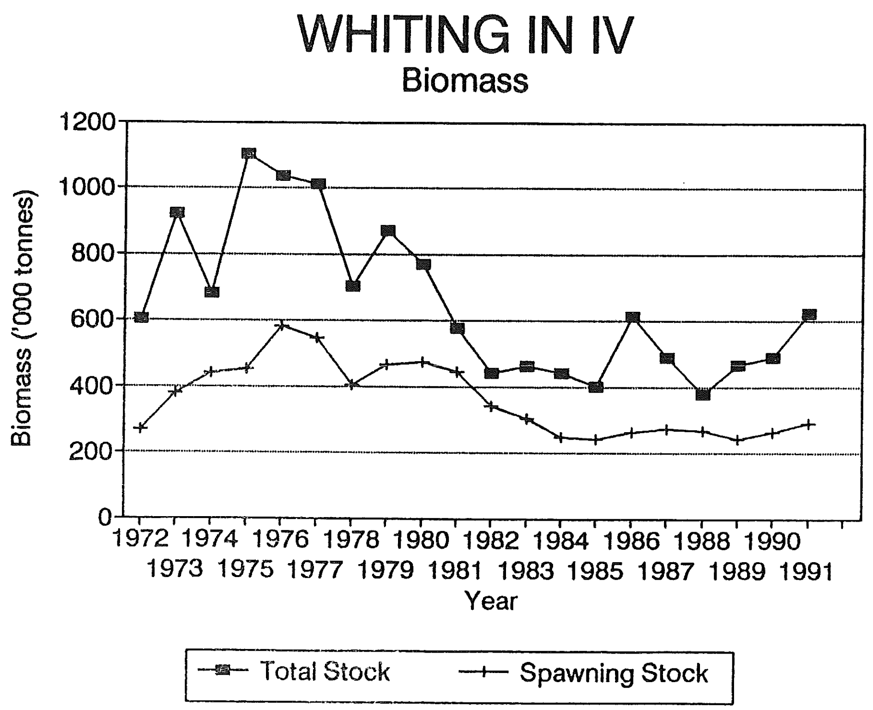
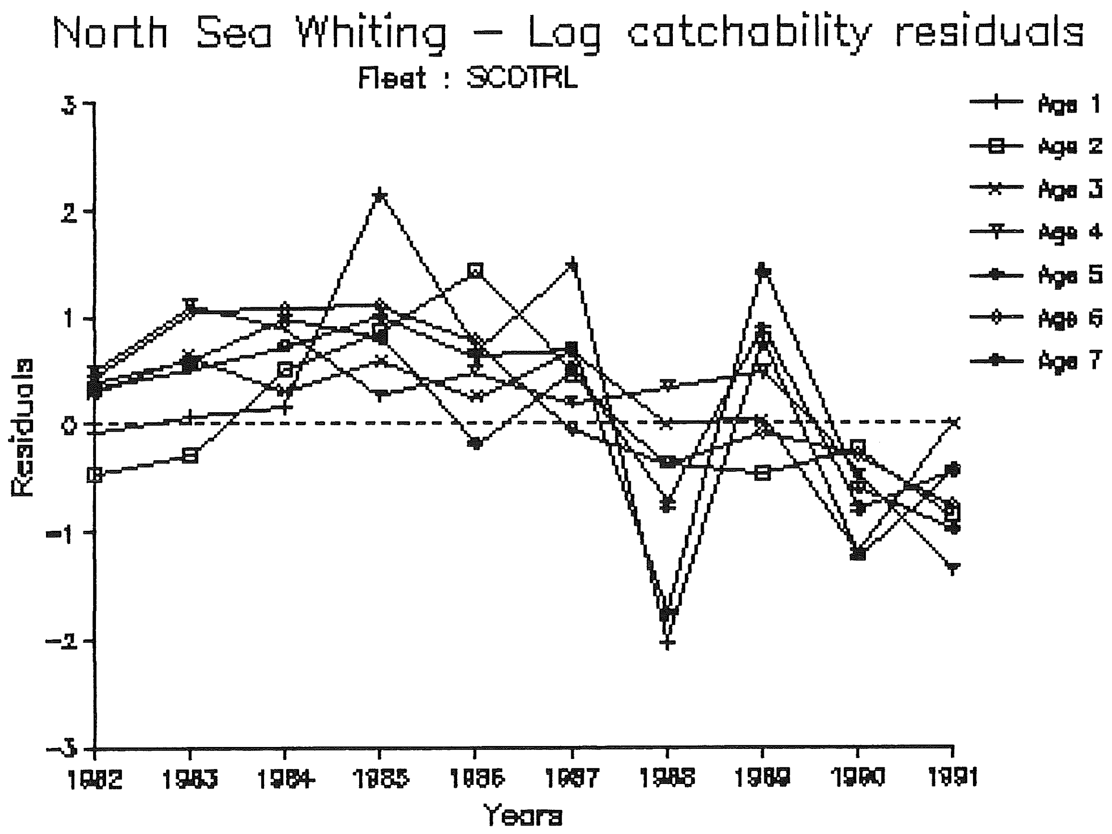
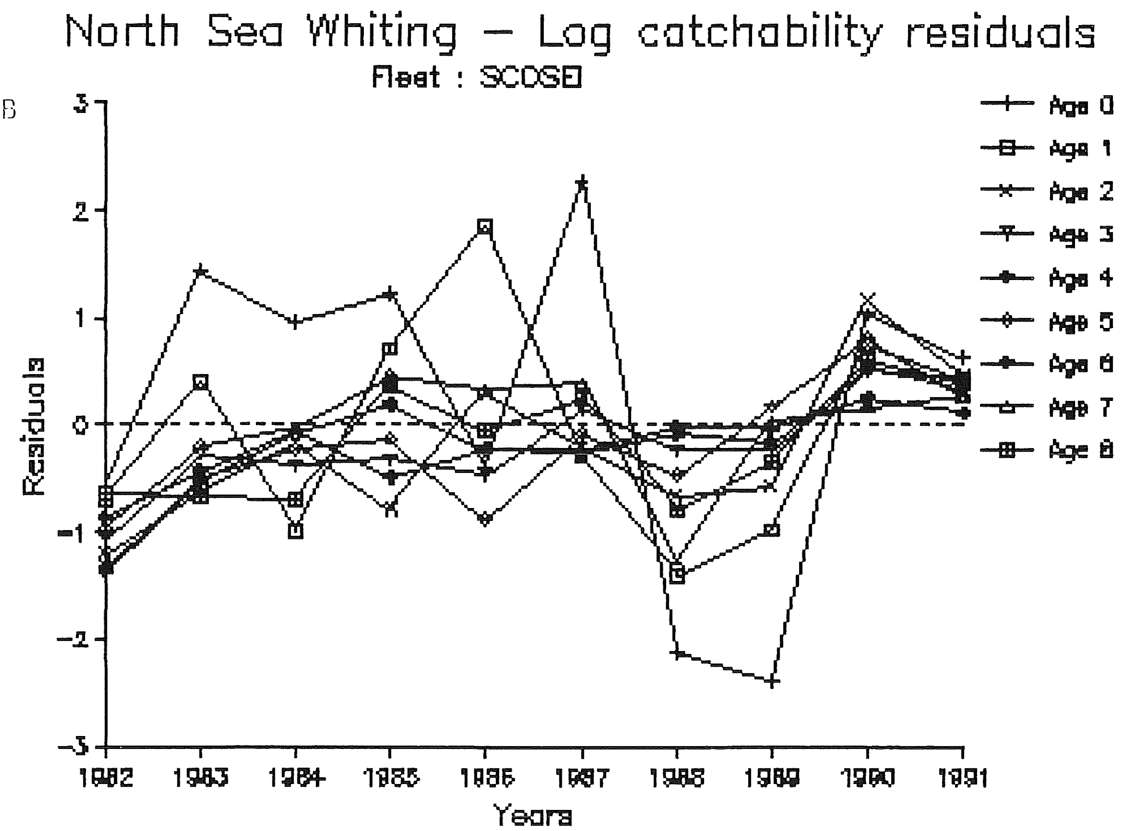


Figure 3.4.2

A



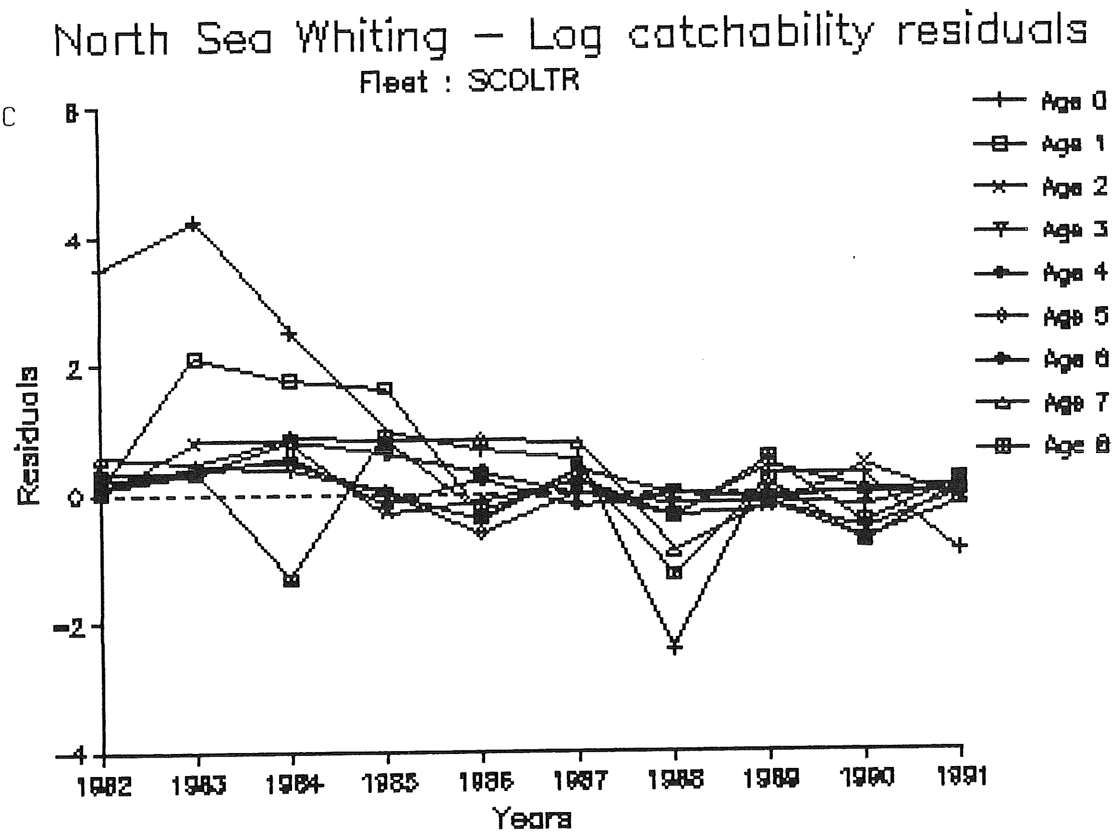
B



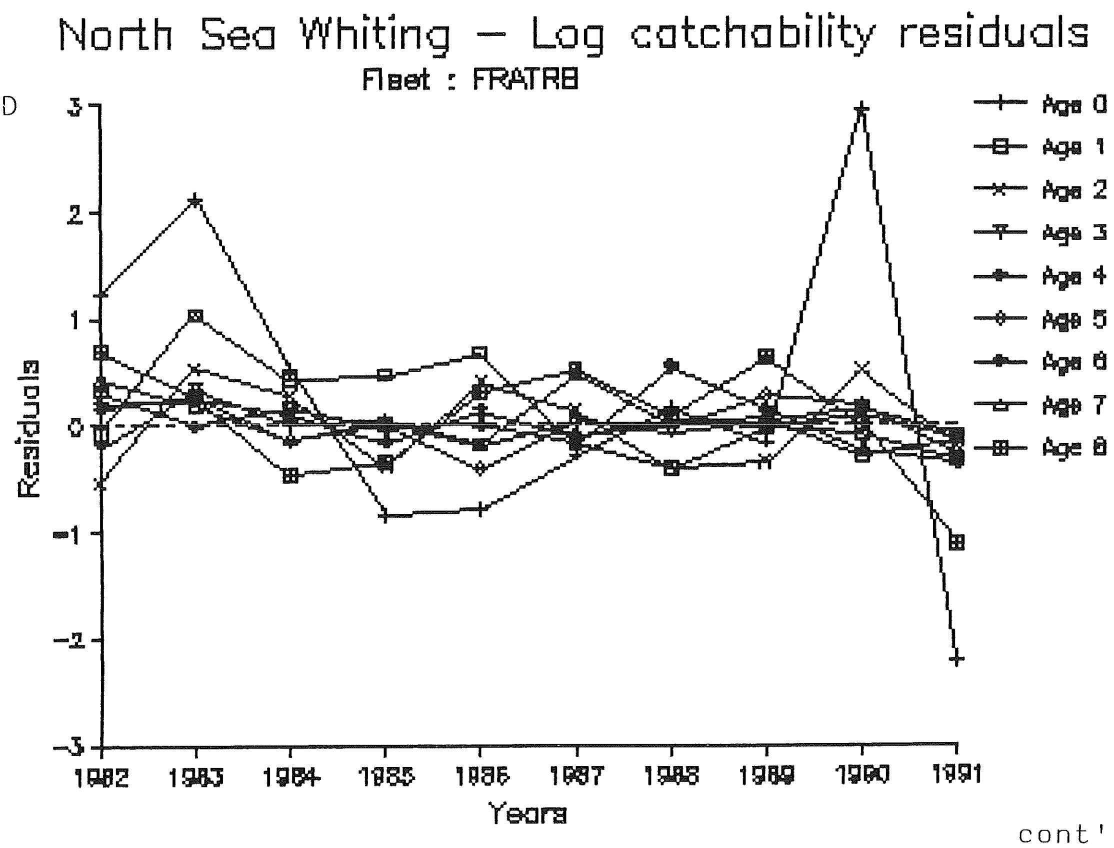
cont'd.

Figure 3.4.2 cont'd.

C



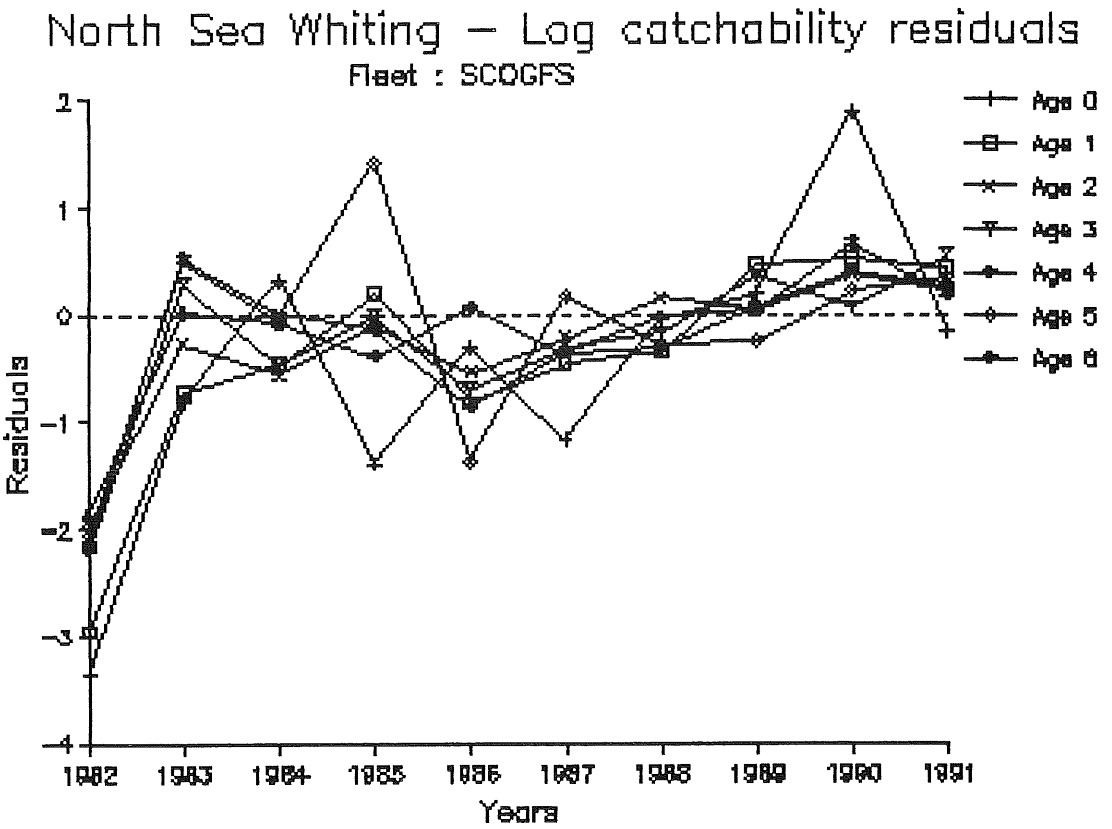
D



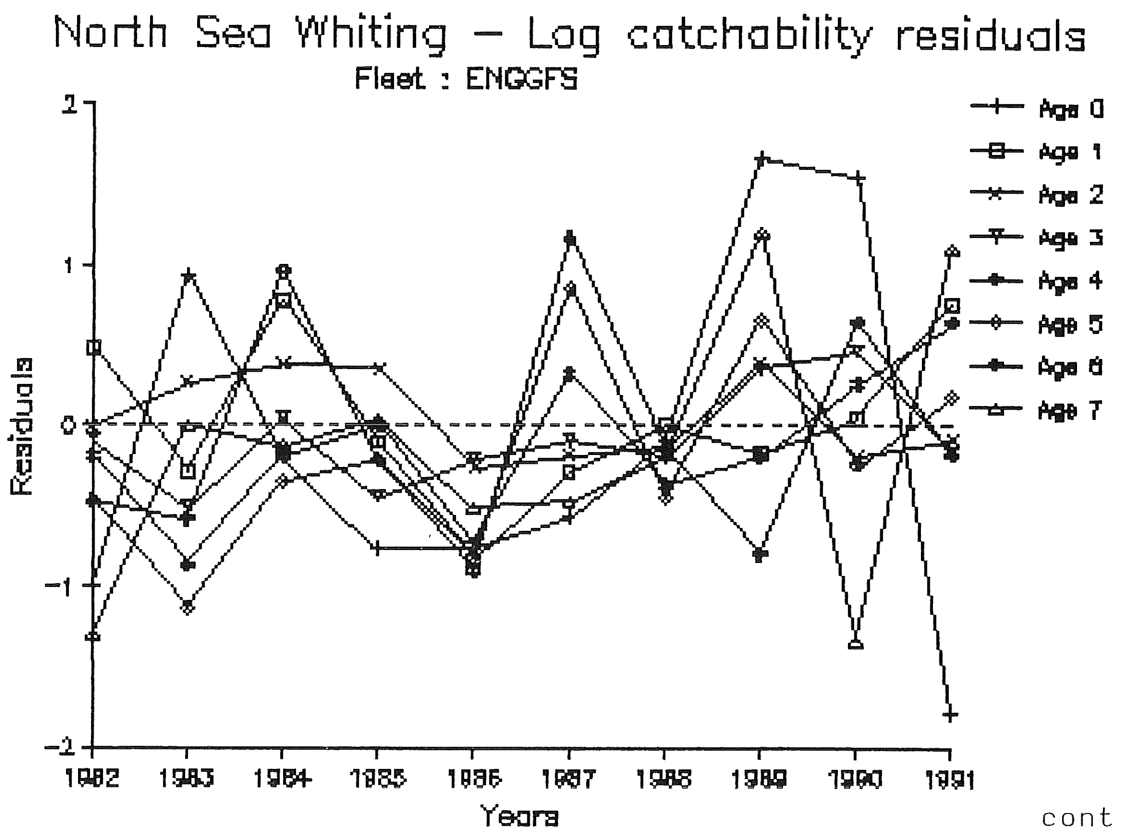
cont'd.

Figure 3.4.2 cont'd.

E



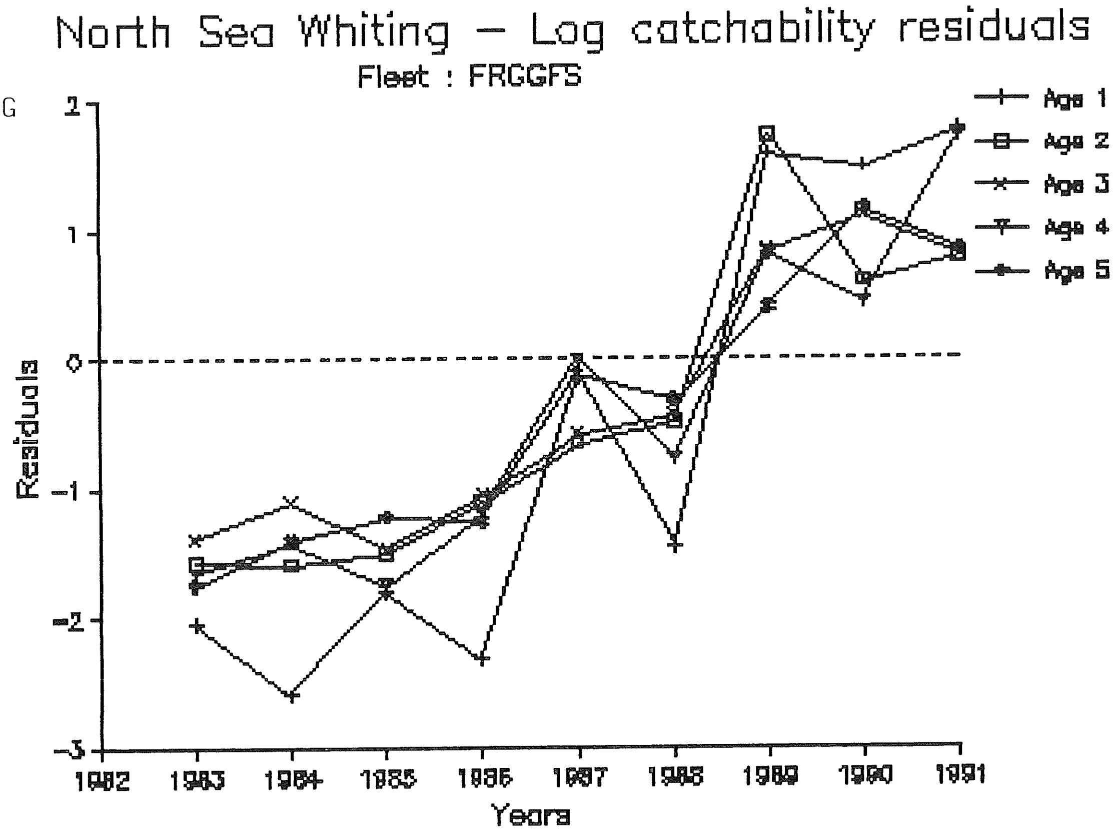
F



cont'd.

Figure 3.4.2 cont'd.

G



H

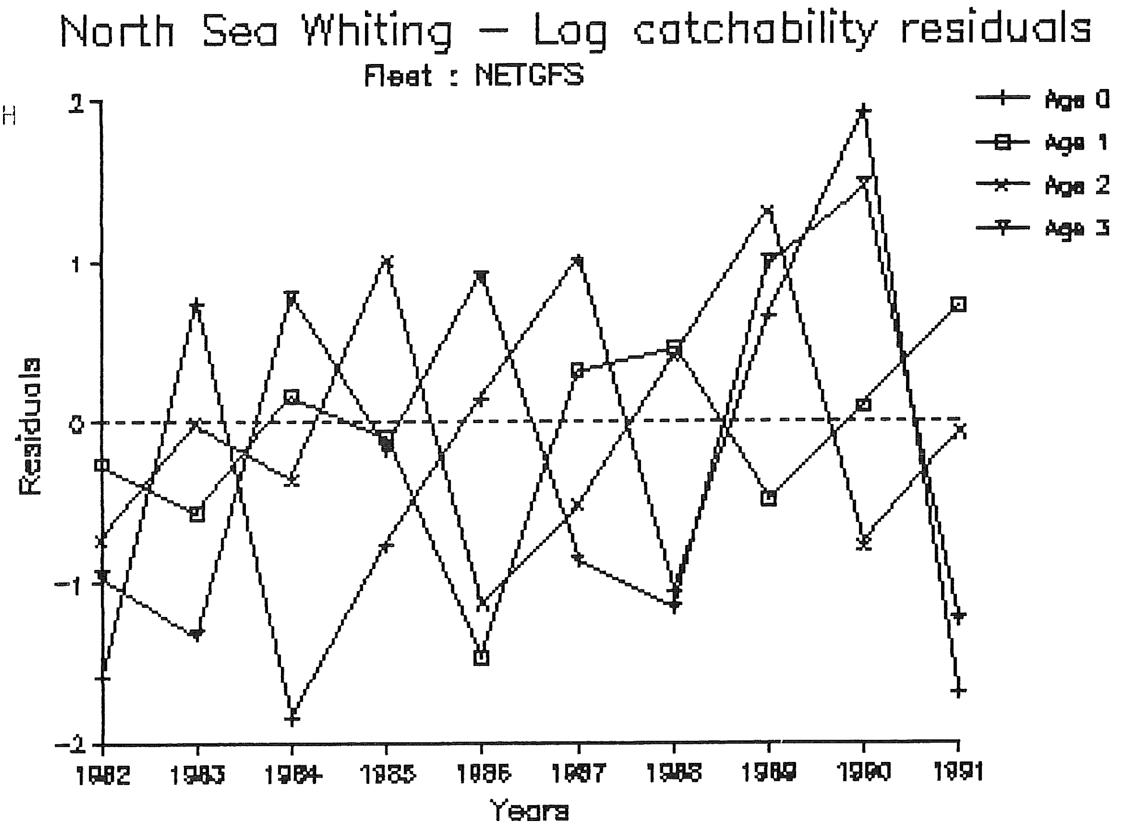


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Figure 3.4.2 cont'd.

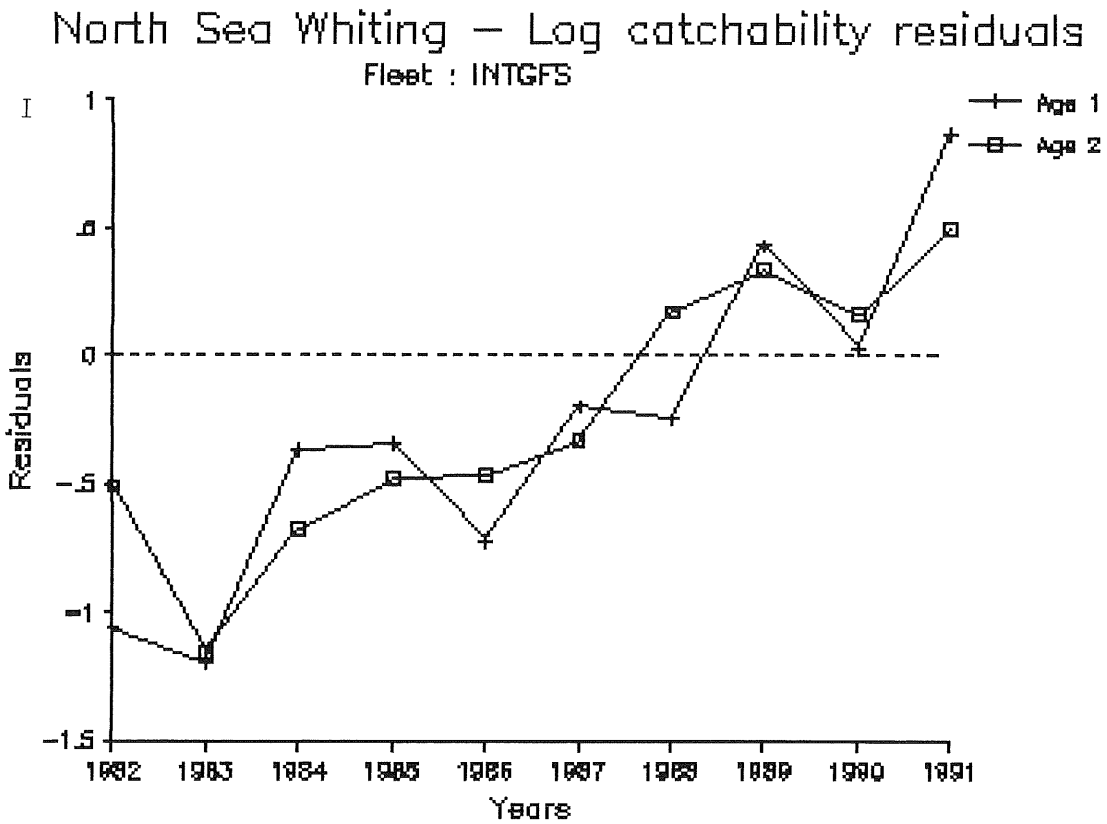


Figure 3.4.3

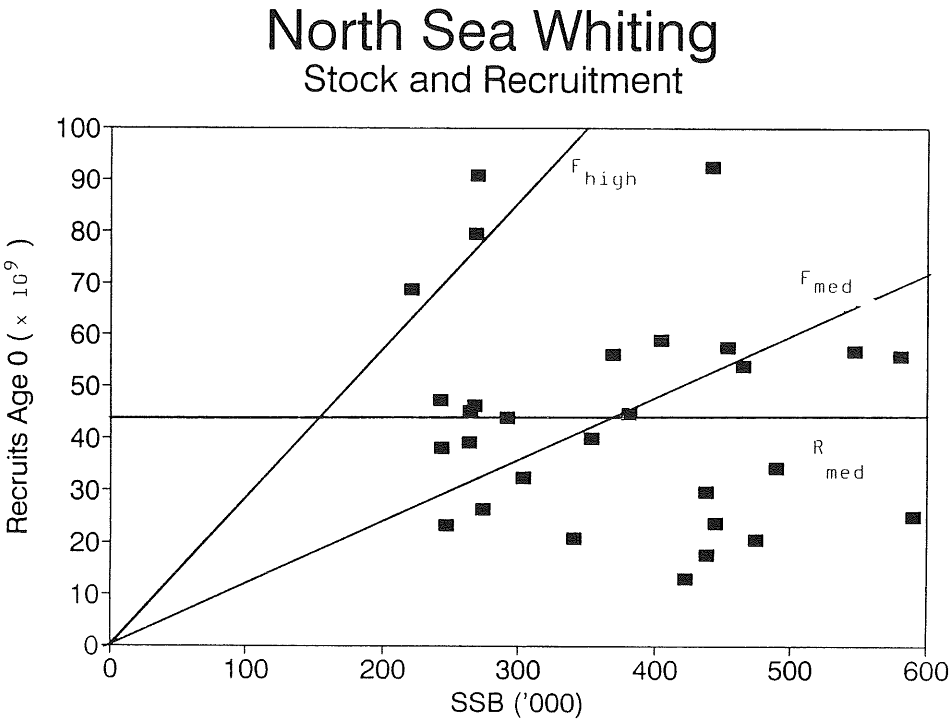

North Sea Whiting
Stock and Recruitment
Recruits Age 0 (x 10^9)
SSB ('000)
F high
F med
R med
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600

Figure 3.4.4A

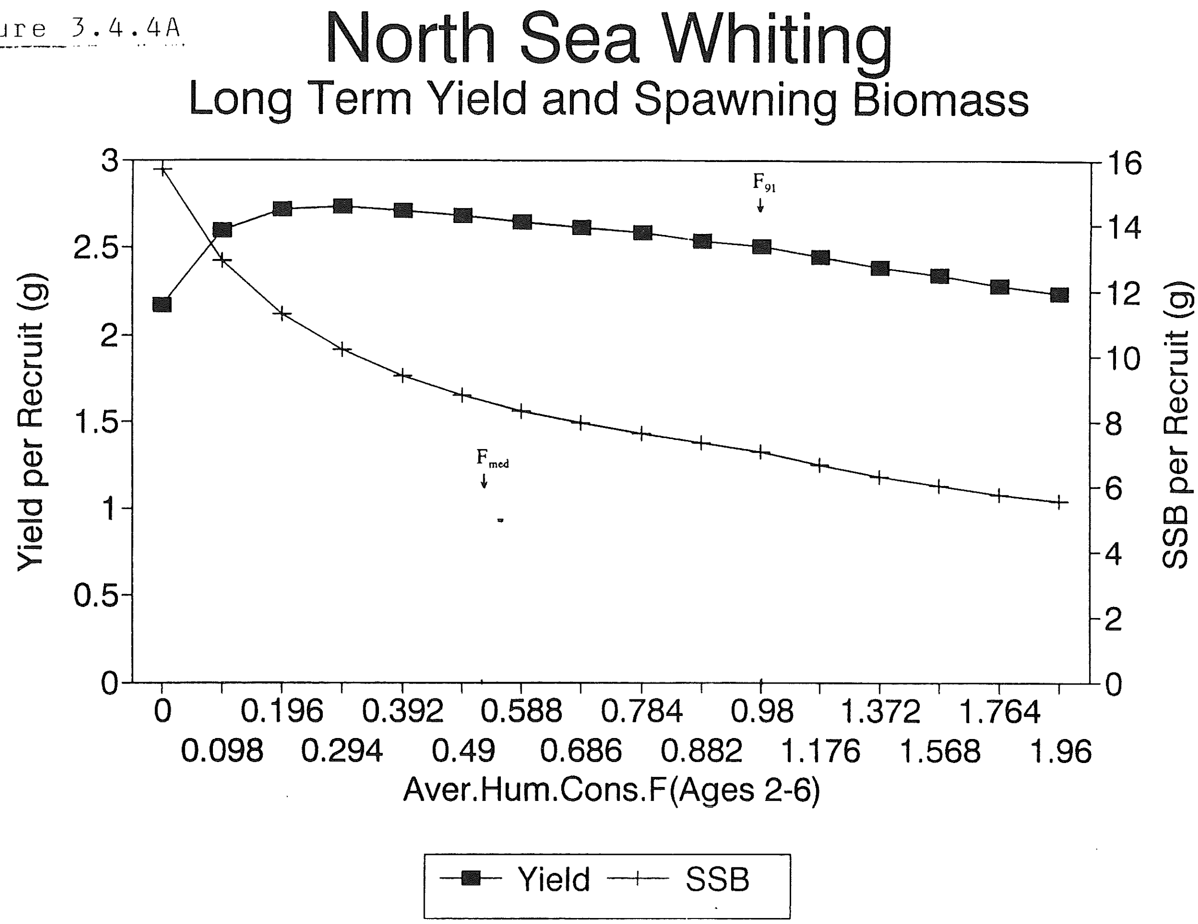


Figure 3.4.4B

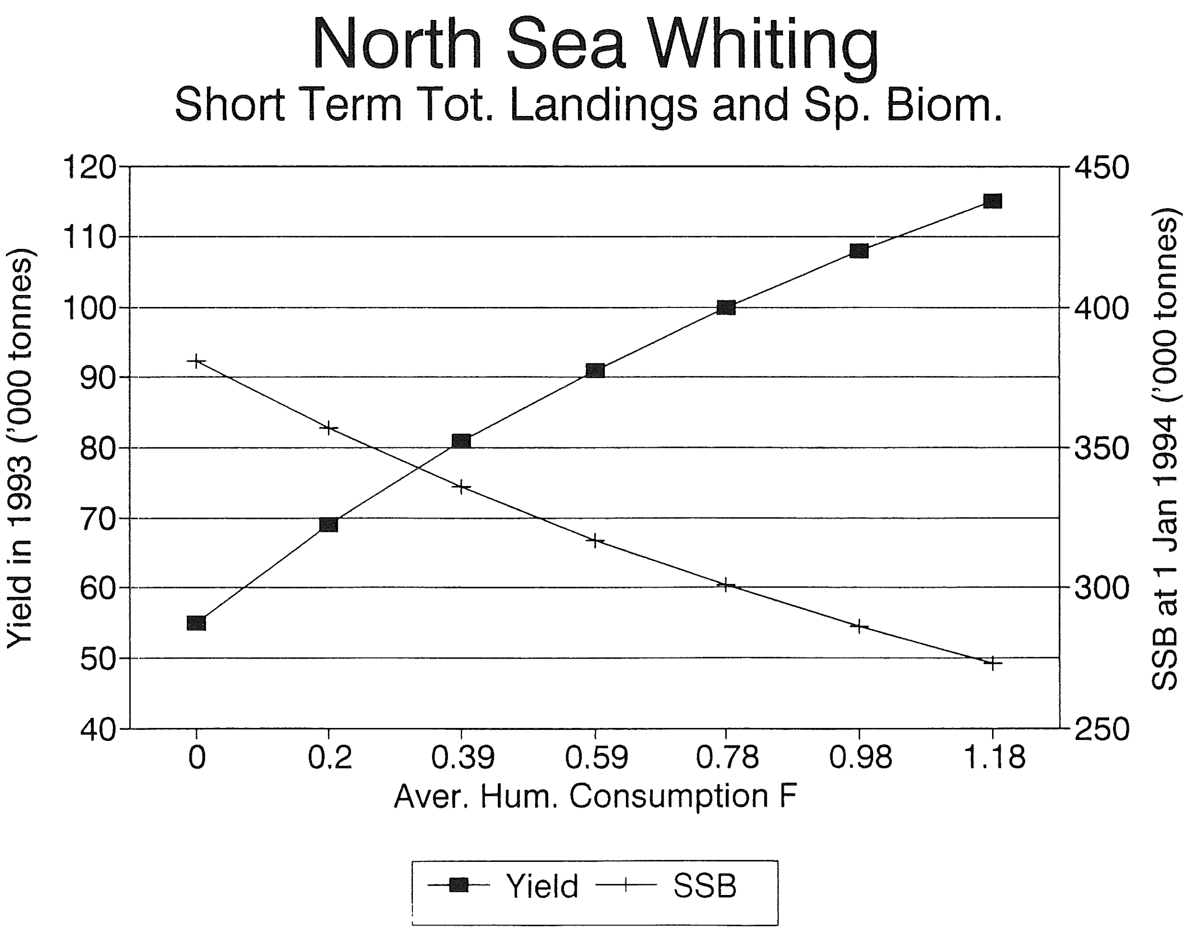
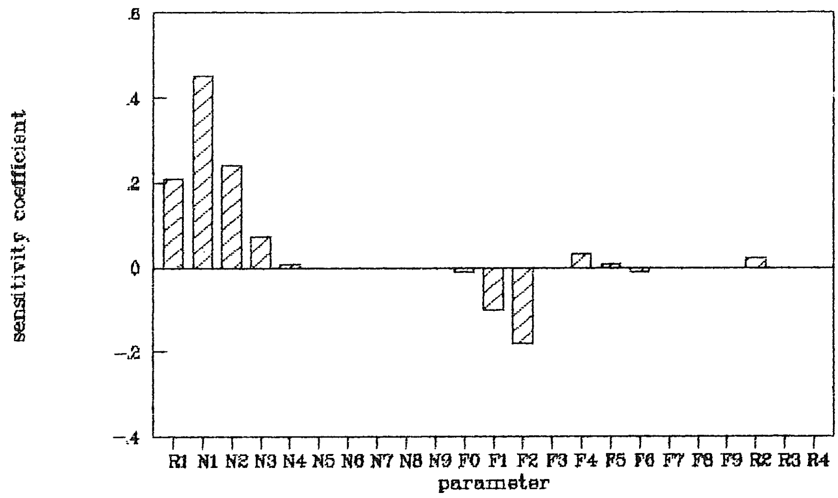


Figure 3.4.5

WHITING CATCH PREDICTION
Landings in 1993



WHITING CATCH PREDICTION
SSB in 1994

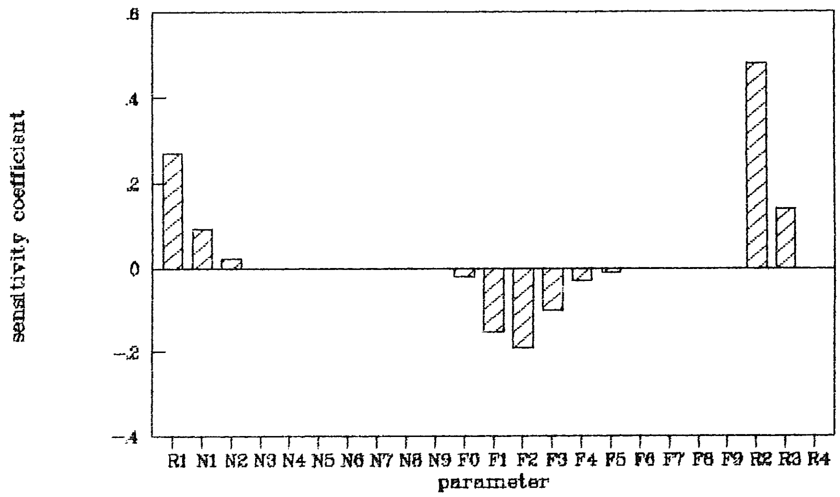
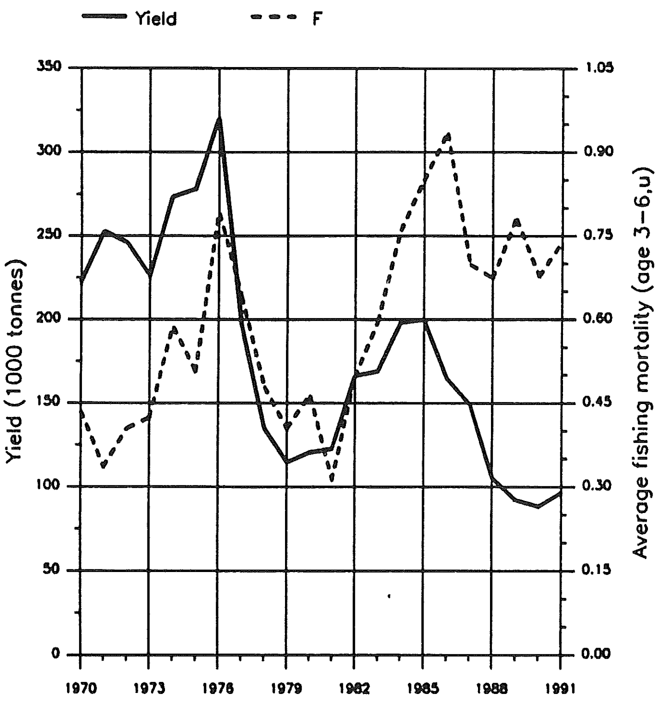


Figure 3.5.1

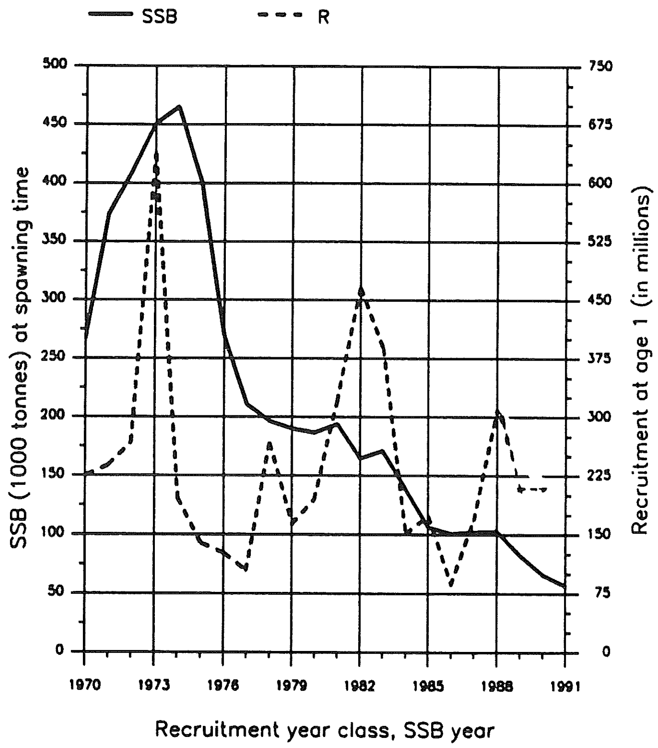
FISH STOCK SUMMARY
STOCK: Saithe in the North Sea Area (Fishing Areas IV and IIIa)
11-10-1992

Trends in yield and fishing mortality (F)



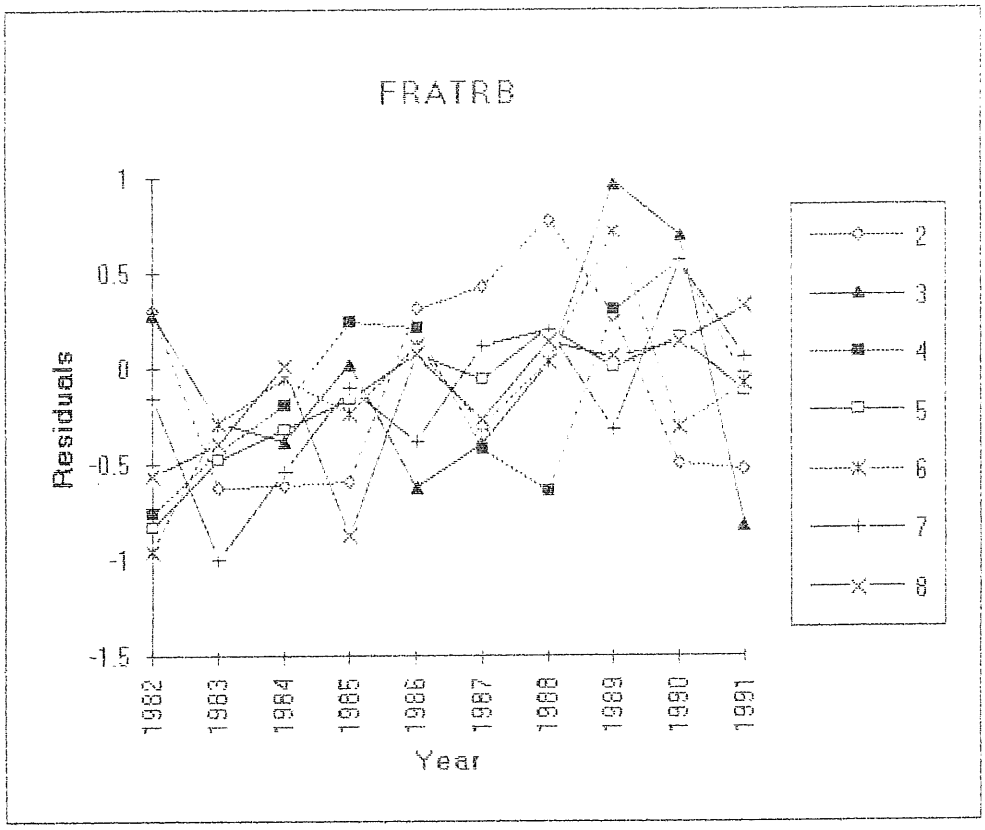
A

Trends in spawning stock biomass (SSB) and recruitment (R)



B

Figure 3.5.2 Saithe - North Sea. Log catchability residuals



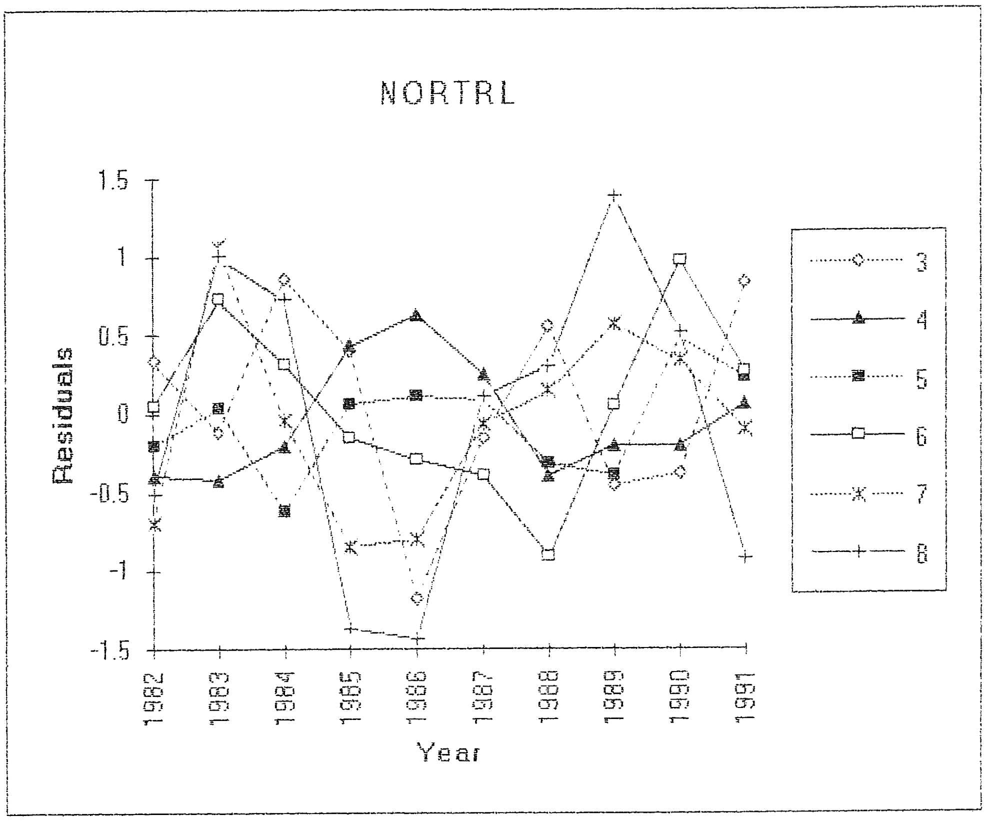


Figure 3.5.3

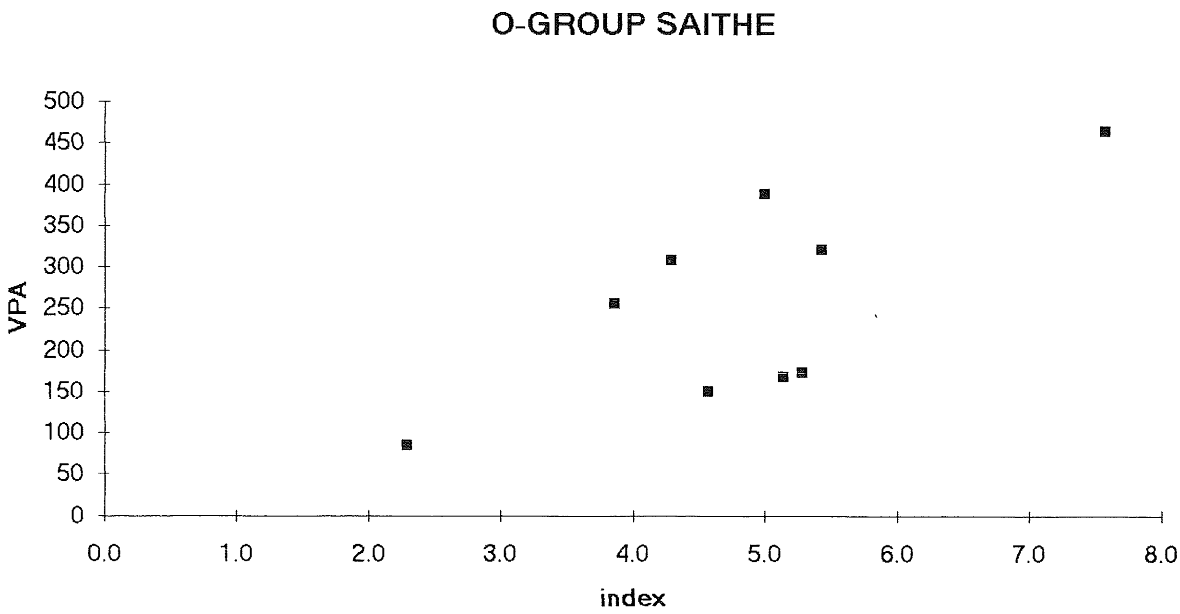
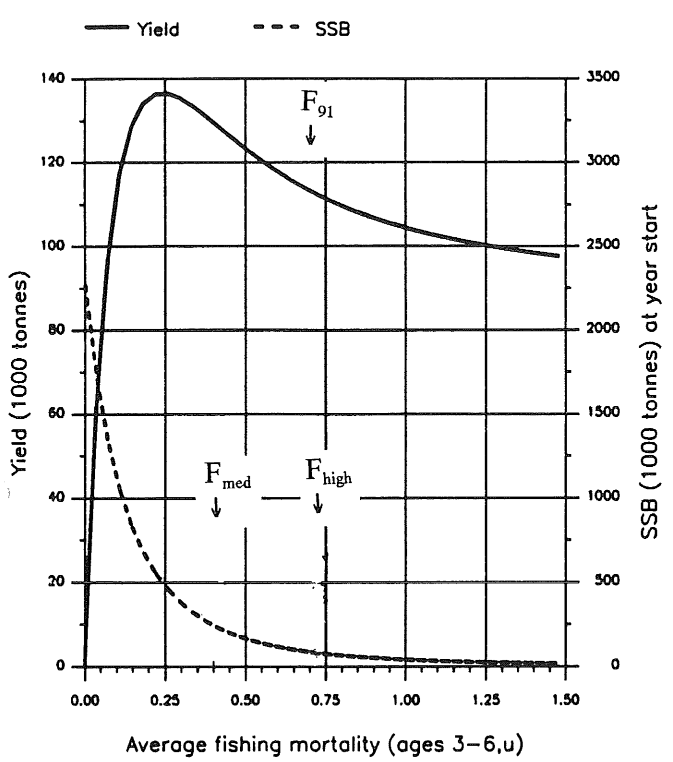
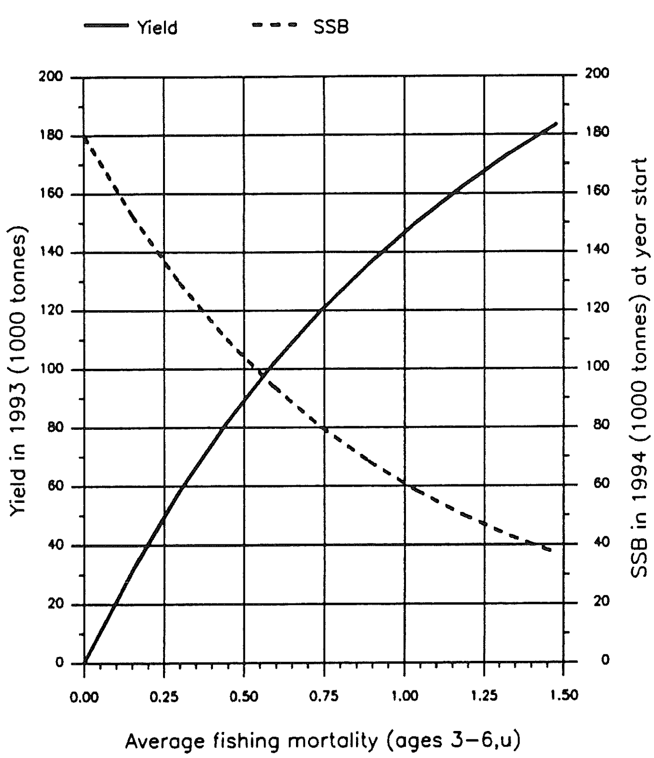

O-GROUP SAITHE
500
450
400
350
300
250
200
150
100
50
0
VPA
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
index

Figure 3.5.4

FISH STOCK SUMMARY
STOCK: Saithe in the North Sea Area (Fishing Areas IV and IIIa)
11-10-1992



C



D

Figure 3.5.5

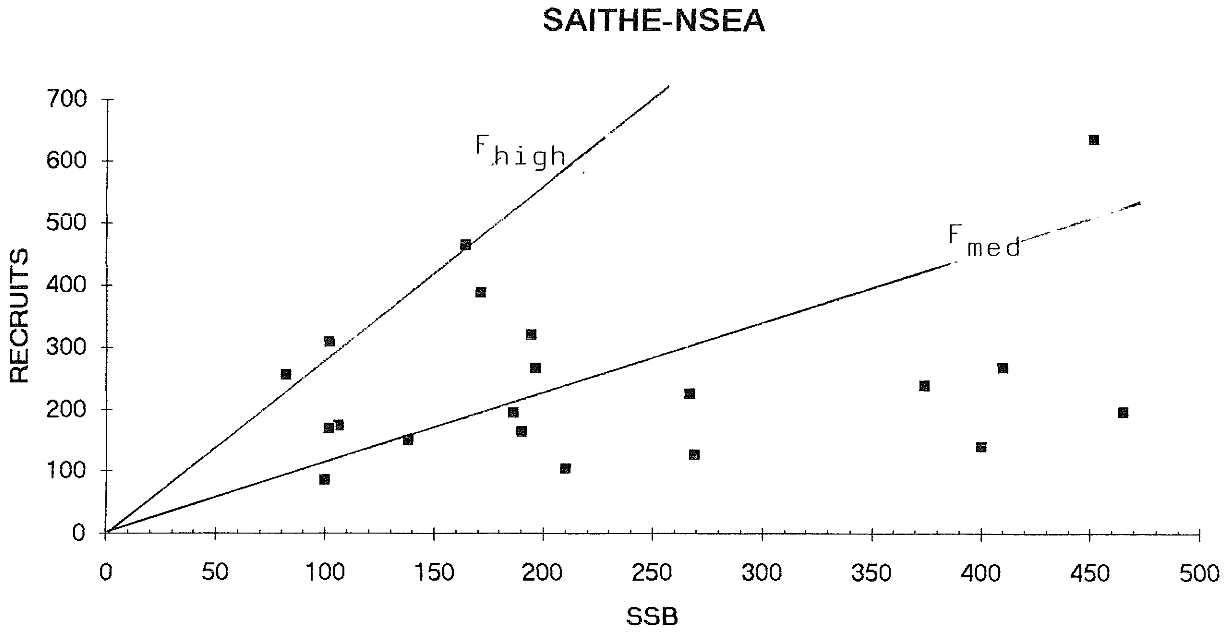
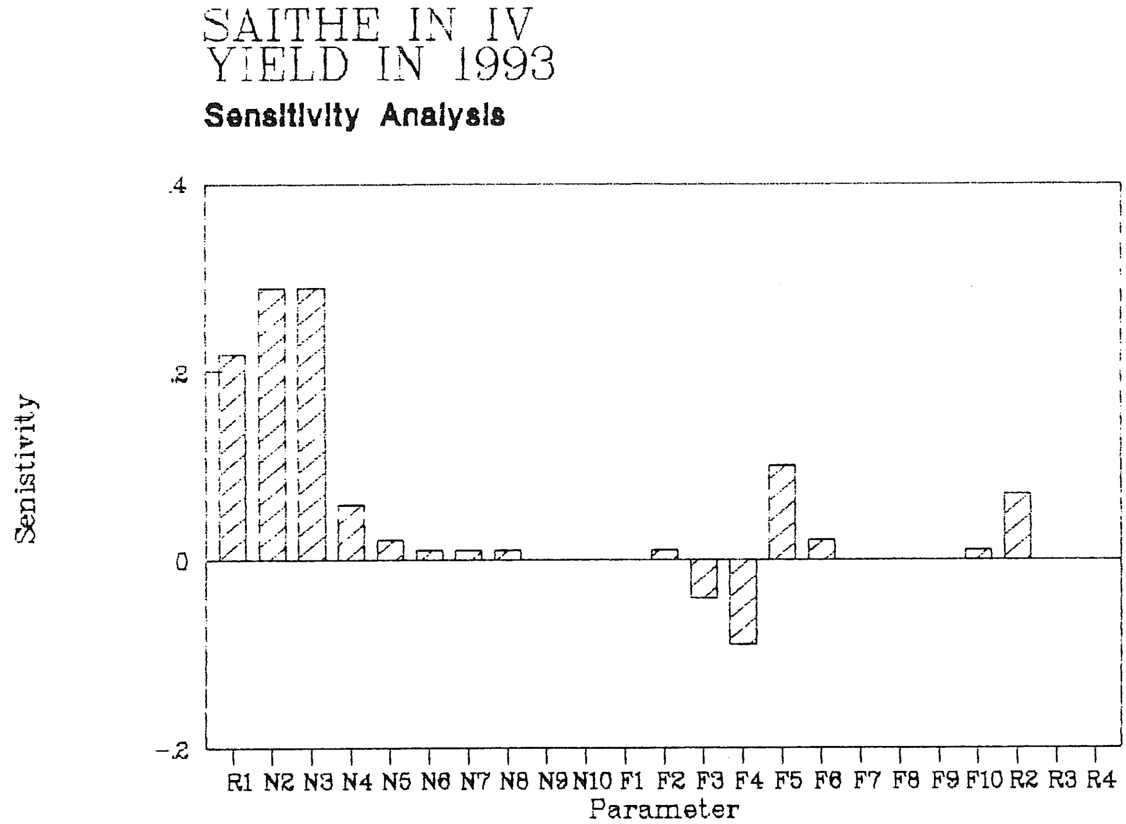

SAITHE-NSEA
RECRUITS
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
350
400
450
500
SSB
F_{high}
F_{med}

Figure 3.5.6


SAITHE IN IV
YIELD IN 1993
Sensitivity Analysis
Senistivity
.4
.2
0
-.2
R1 N2 N3 N4 N5 N6 N7 N8 N9 N10 F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 R2 R3 R4
Parameter

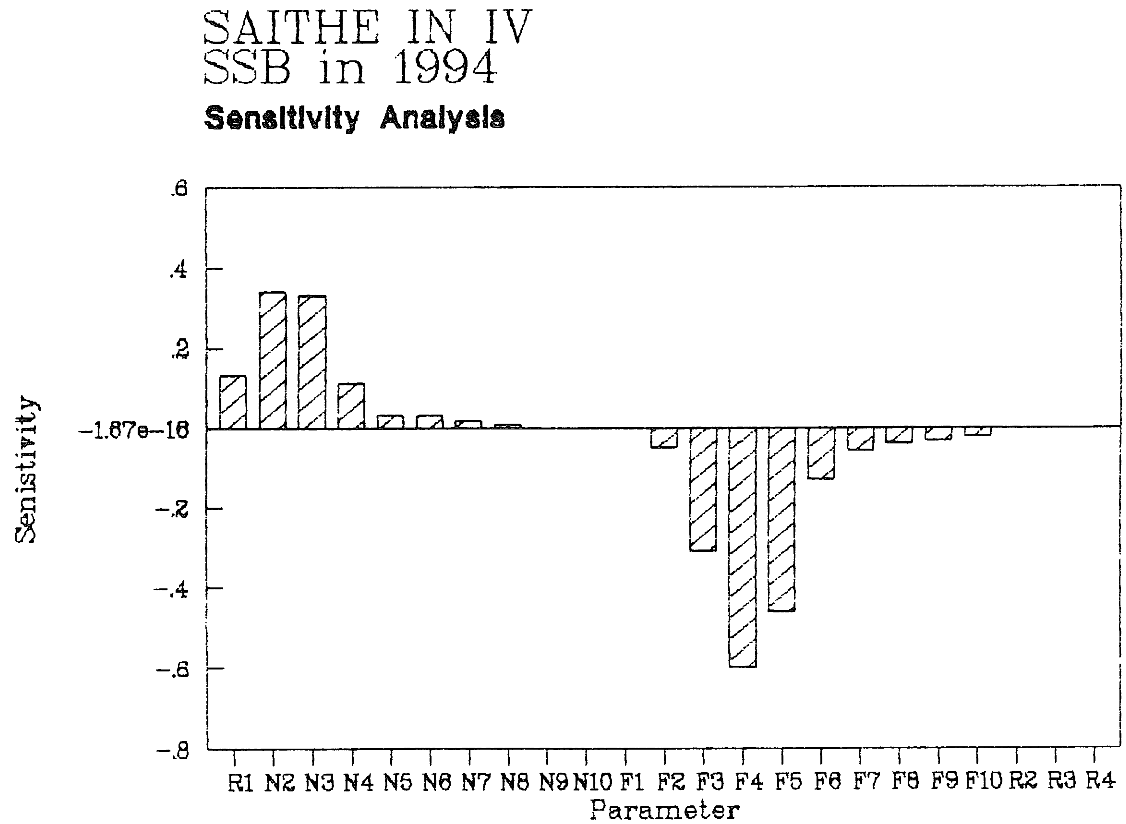
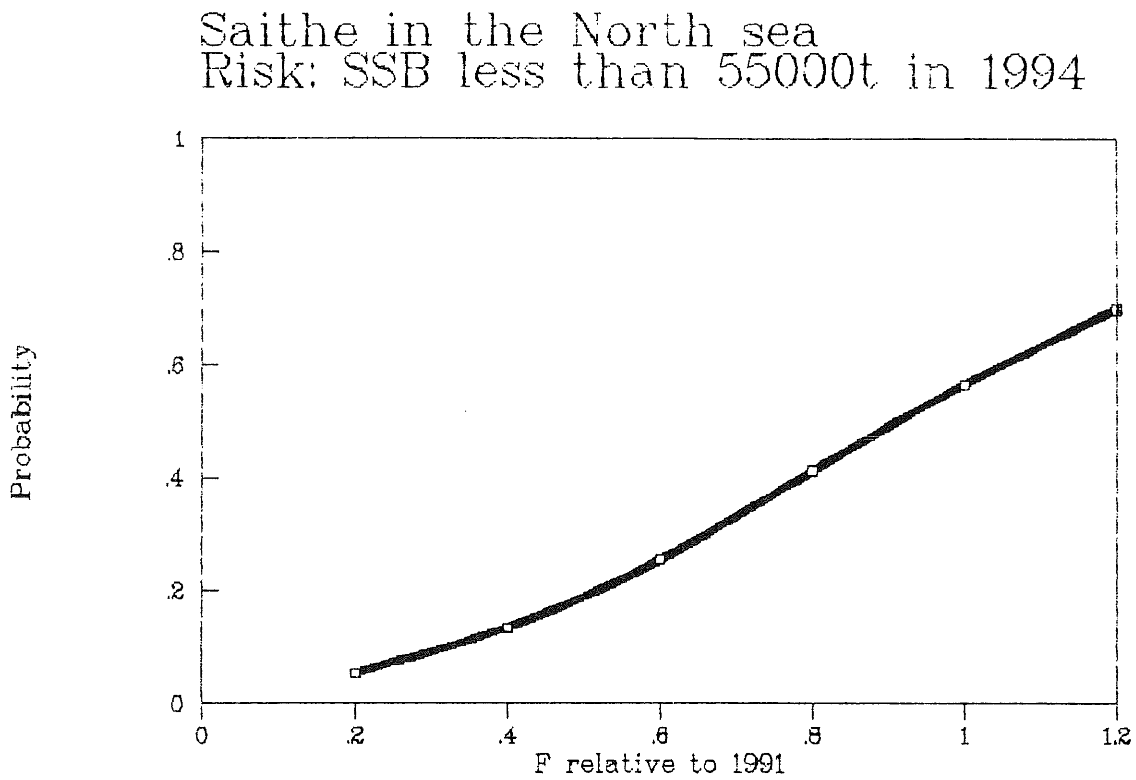
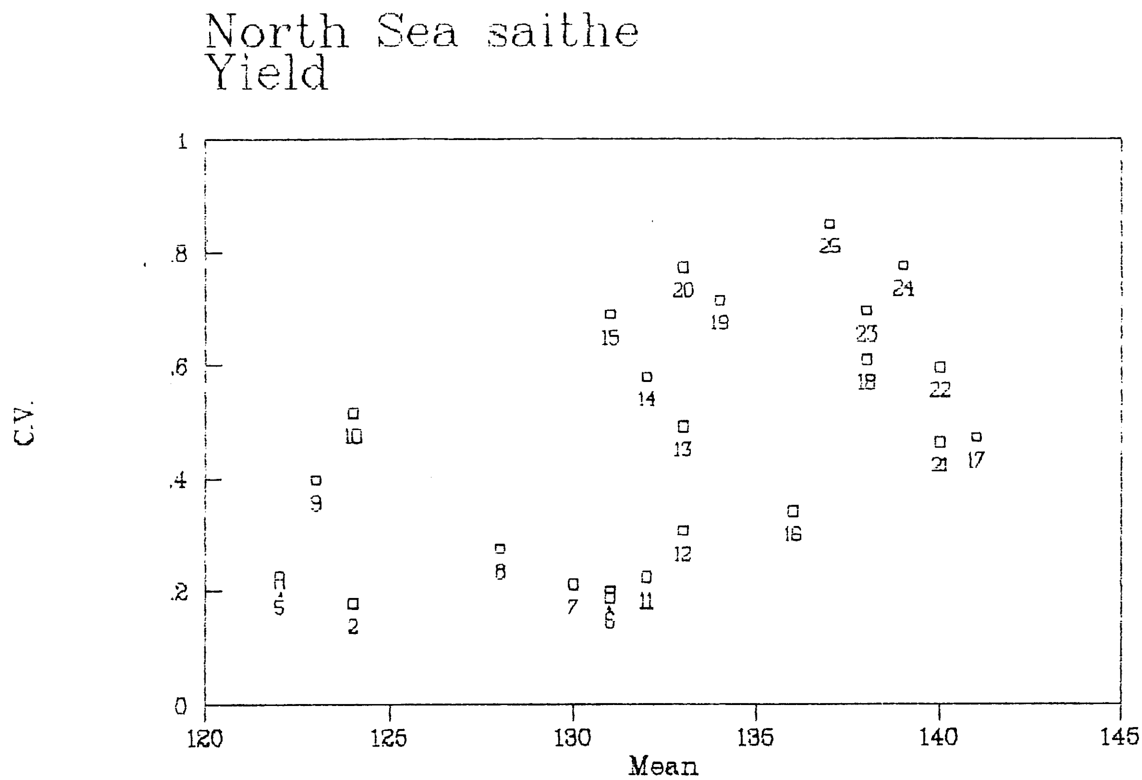

SAITHE IN IV
SSB in 1994
Sensitivity Analysis
Senistivity
.6
.4
.2
-1.67e-16
-.2
-.4
-.6
-.8
R1 N2 N3 N4 N5 N6 N7 N8 N9 N10 F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 R2 R3 R4
Parameter

Figure 3.5.7



Saithe in the North sea
Risk: SSB less than 55000t in 1994
Probability
1
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1
1.2
F relative to 1991

Figure 3.5.8


North Sea saithe
Yield
C.V.
Mean
0
.2
.4
.6
.8
1
120
125
130
135
140
145

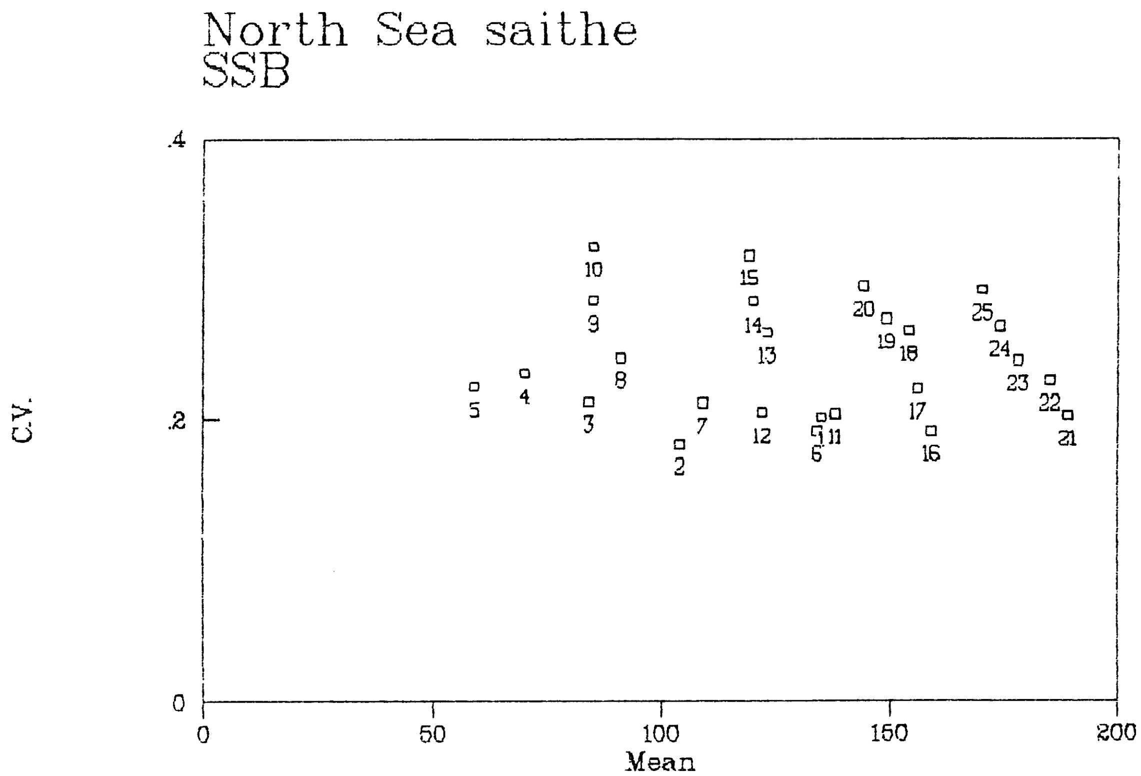

North Sea saithe
SSB
C.V.
Mean
0
.2
.4
0
50
100
150
200

Figure 3.5.9

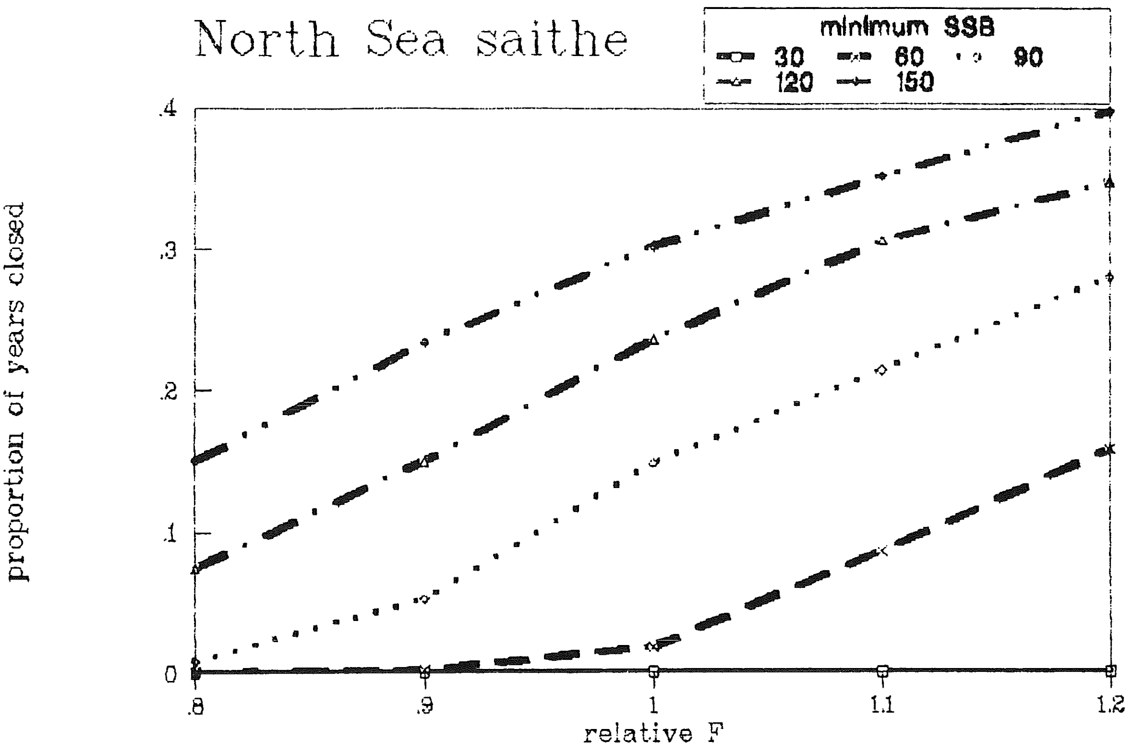
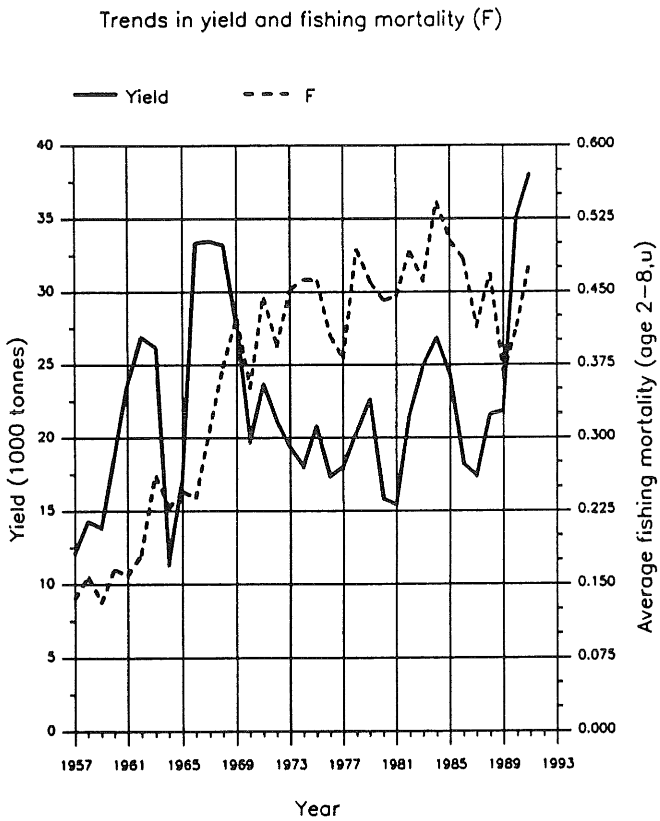
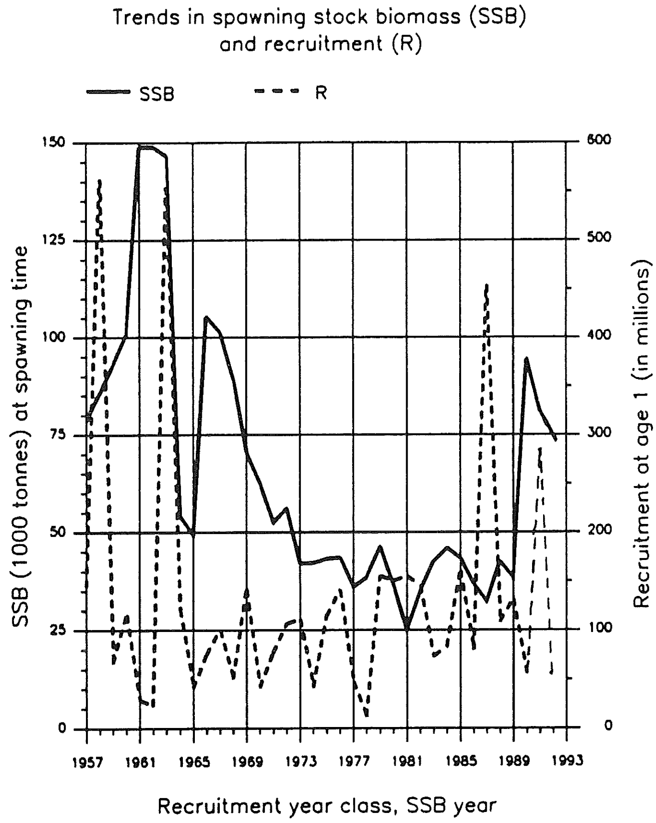

North Sea saithe
minimum SSB
30
60
90
120
150
.4
.3
.2
.1
0
proportion of years closed
.8
.9
1
1.1
1.2
relative F

Figure 3.6.1a,b

FISH STOCK SUMMARY
STOCK: Sole in the North Sea (Fishing Area IV)
11-10-1992



A



B

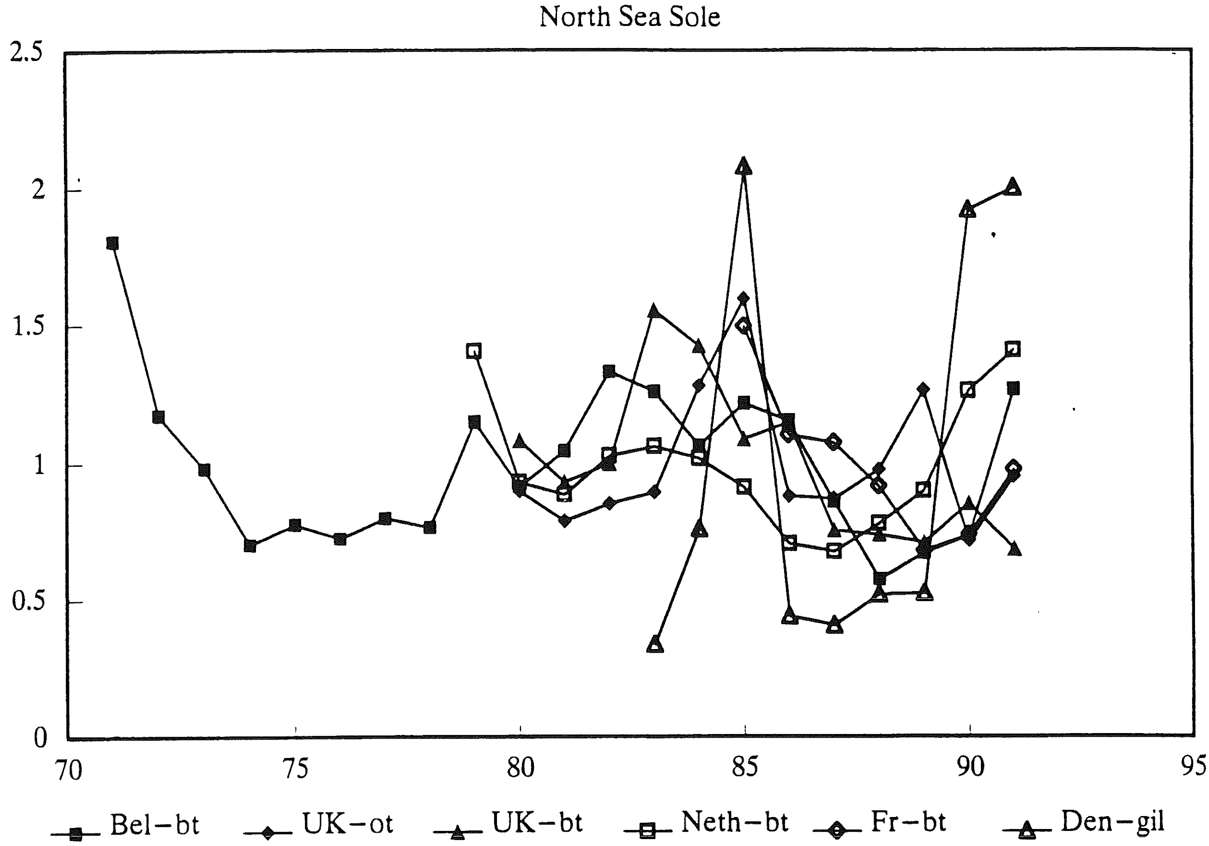


Figure 3.6.2A Relative CPUE indices

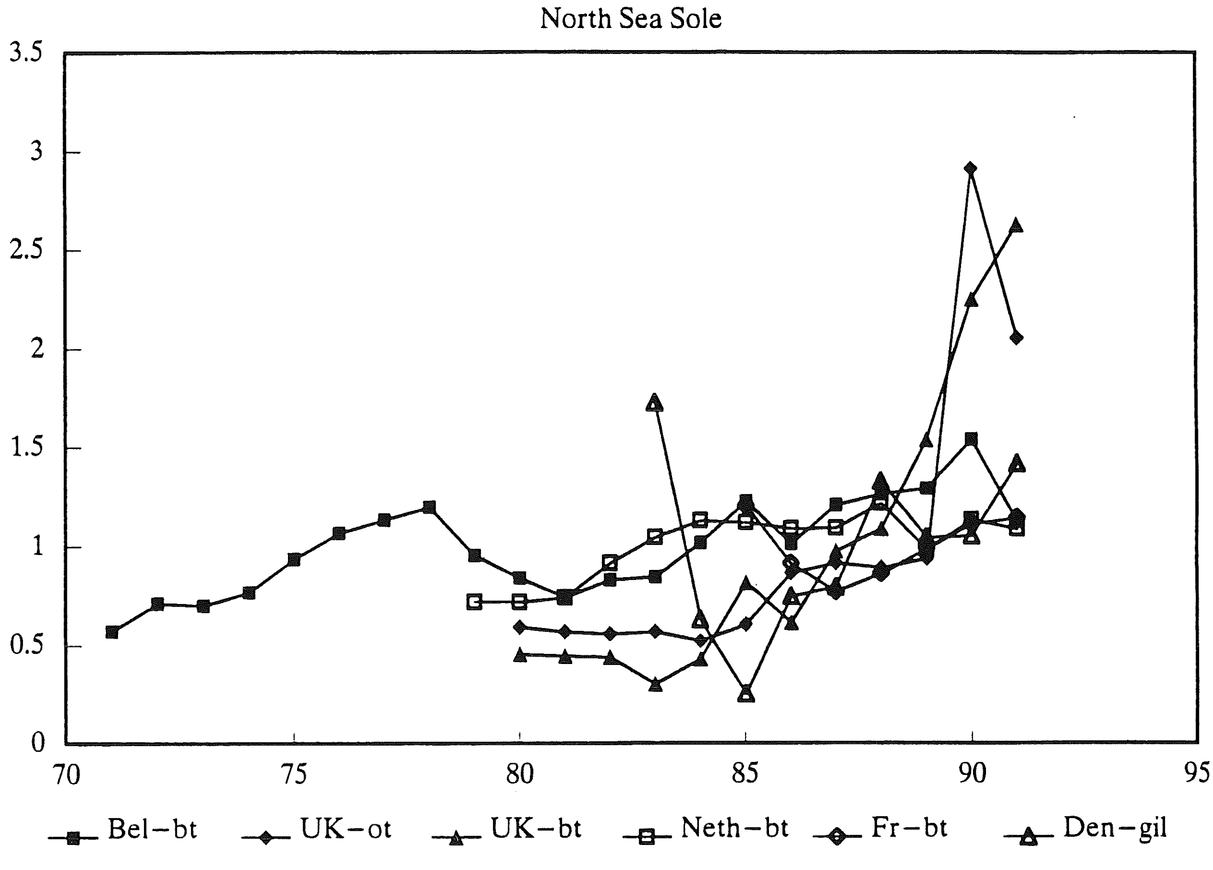


Figure 3.6.2B Relative CPUE indices

Figure 3.6.3

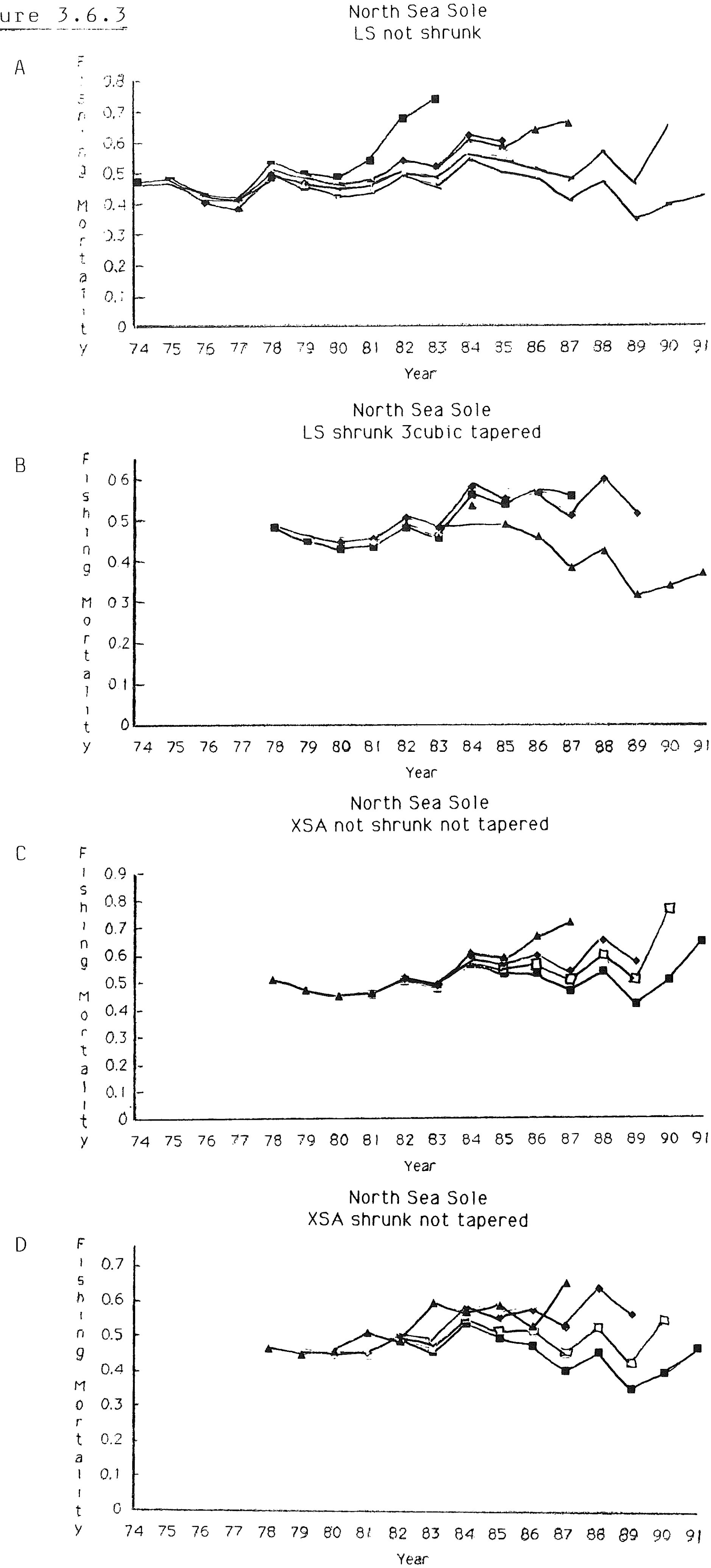
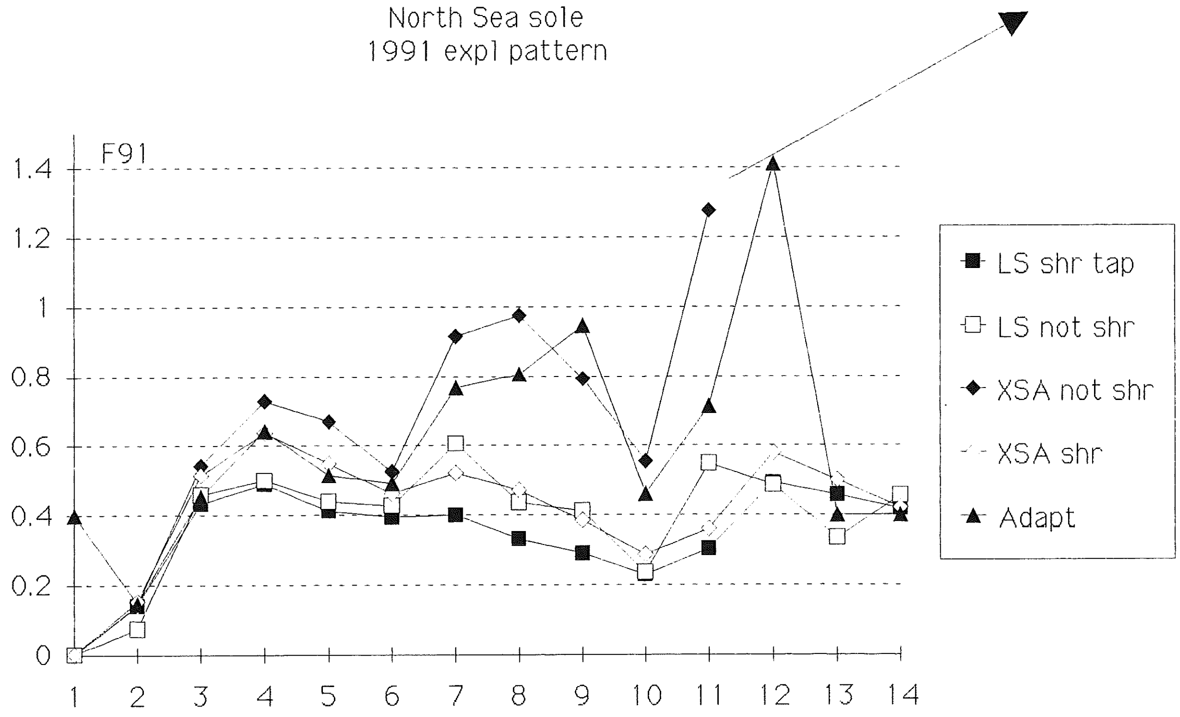

A
North Sea Sole
LS not shrunk
Fishing Mortality
Year
B
North Sea Sole
LS shrunk 3cubic tapered
Fishing Mortality
Year
C
North Sea Sole
XSA not shrunk not tapered
Fishing Mortality
Year
D
North Sea Sole
XSA shrunk not tapered
Fishing Mortality
Year

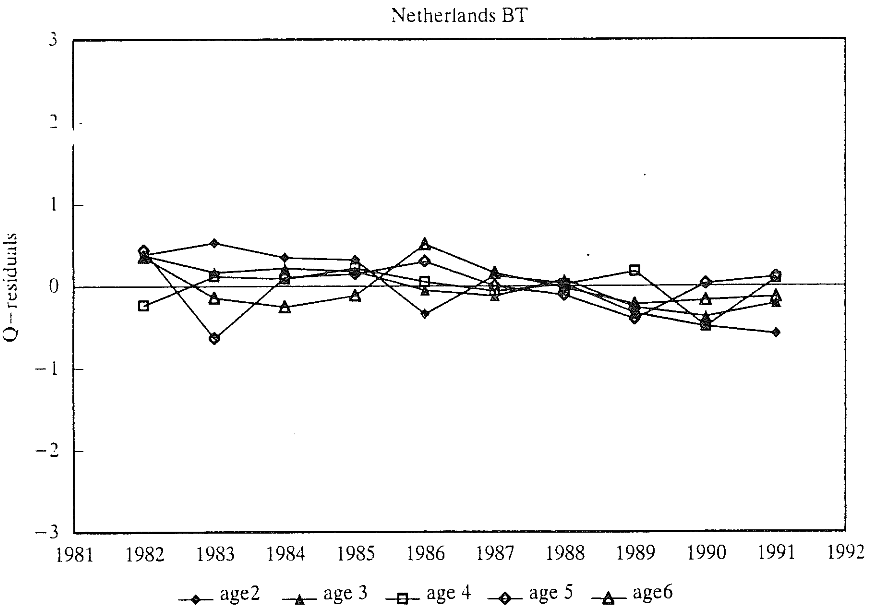
Figure 3.6.4

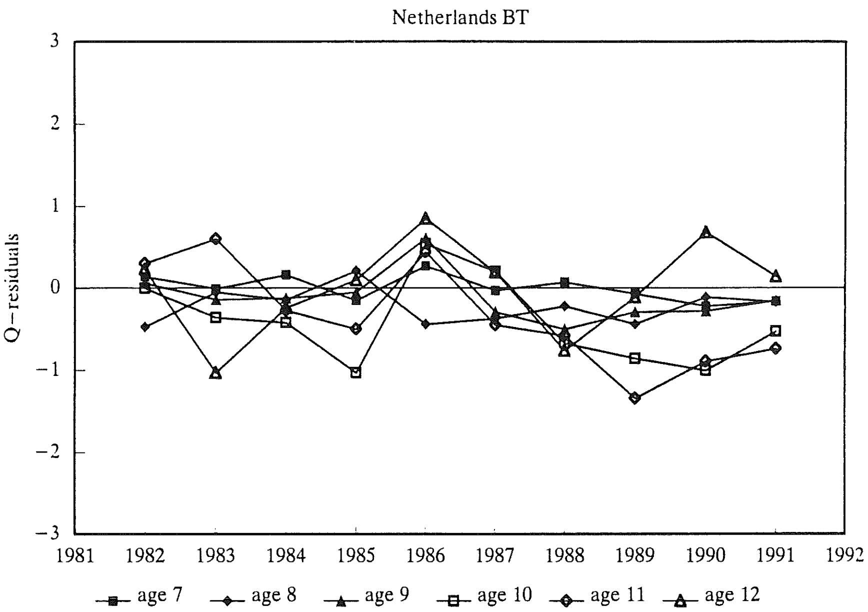


North Sea sole
1991 expl pattern
F91
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
LS shr tap
LS not shr
XSA not shr
XSA shr
Adapt

Figure 3.6.5

NORTH SEA SOLE





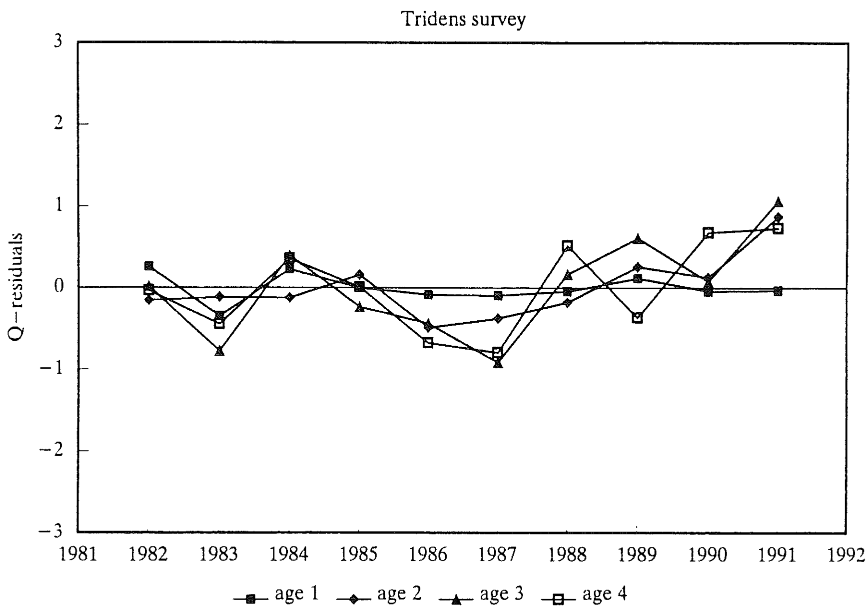
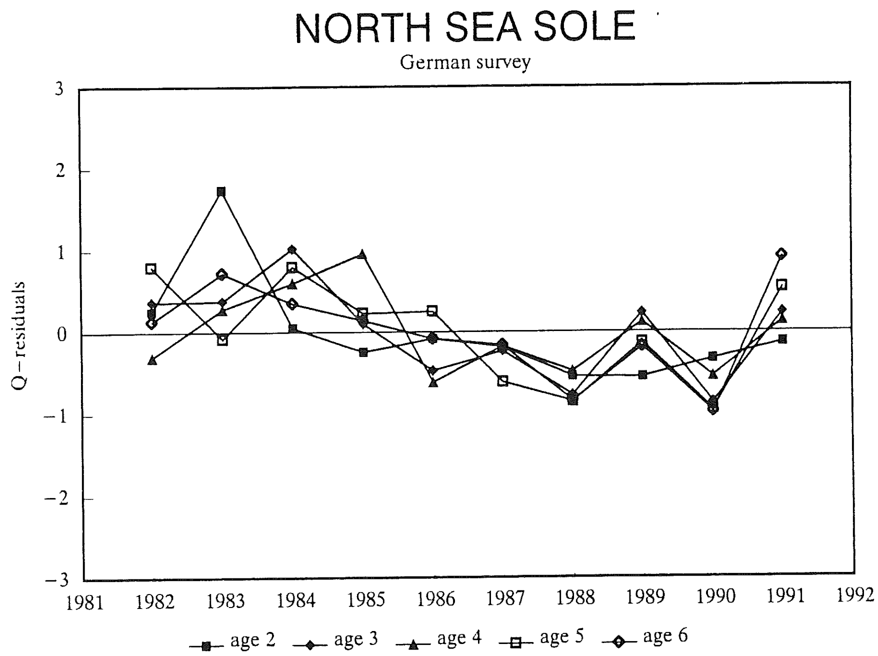


Figure 3.6.5 (cont'd)



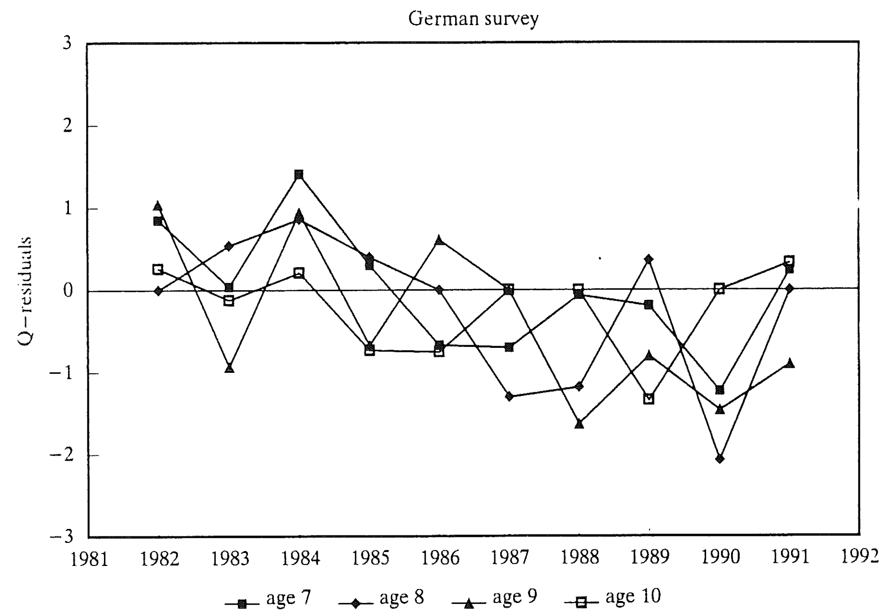


Figure 3.6.6

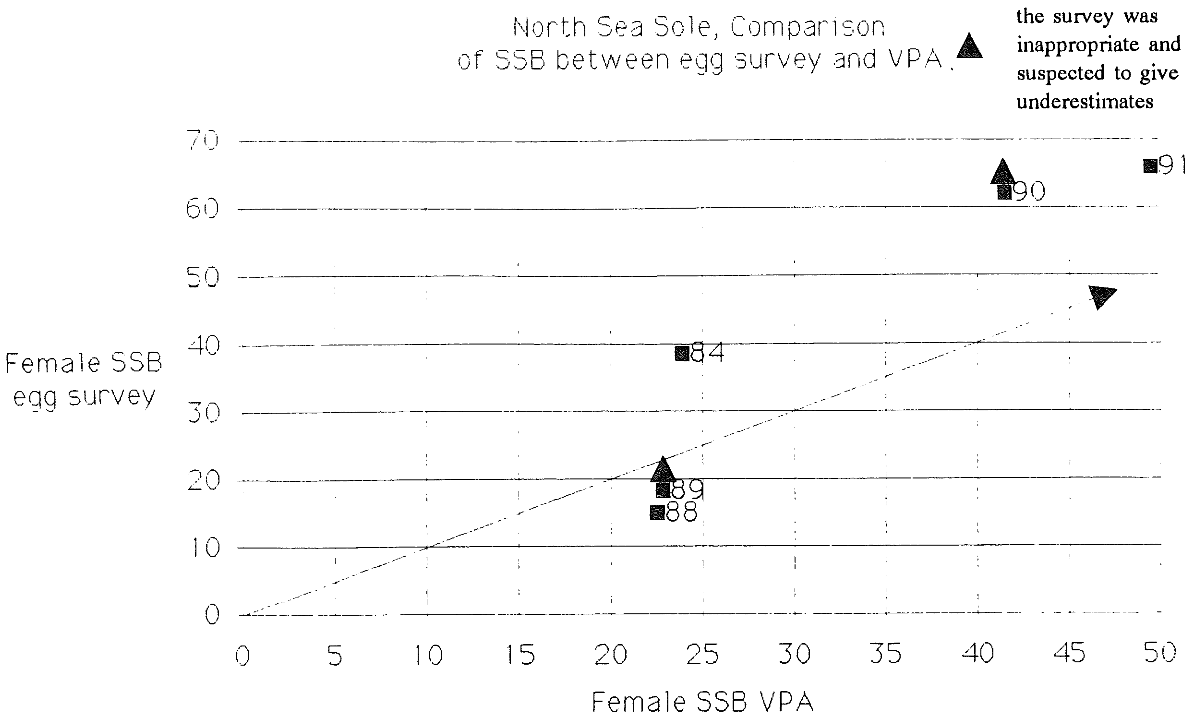

North Sea Sole, Comparison
of SSB between egg survey and VPA.
Marks year where the survey was inappropriate and suspected to give underestimates
Female SSB egg survey
Female SSB VPA
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
40
45
50
84
88
89
90
91

Figure 3.6.7

FISH STOCK SUMMARY
STOCK: Sole in the North Sea (Fishing Area IV)
9 – 10 – 1992

Long term yield and spawning stock biomass

Short–term yield and spawning stock biomass

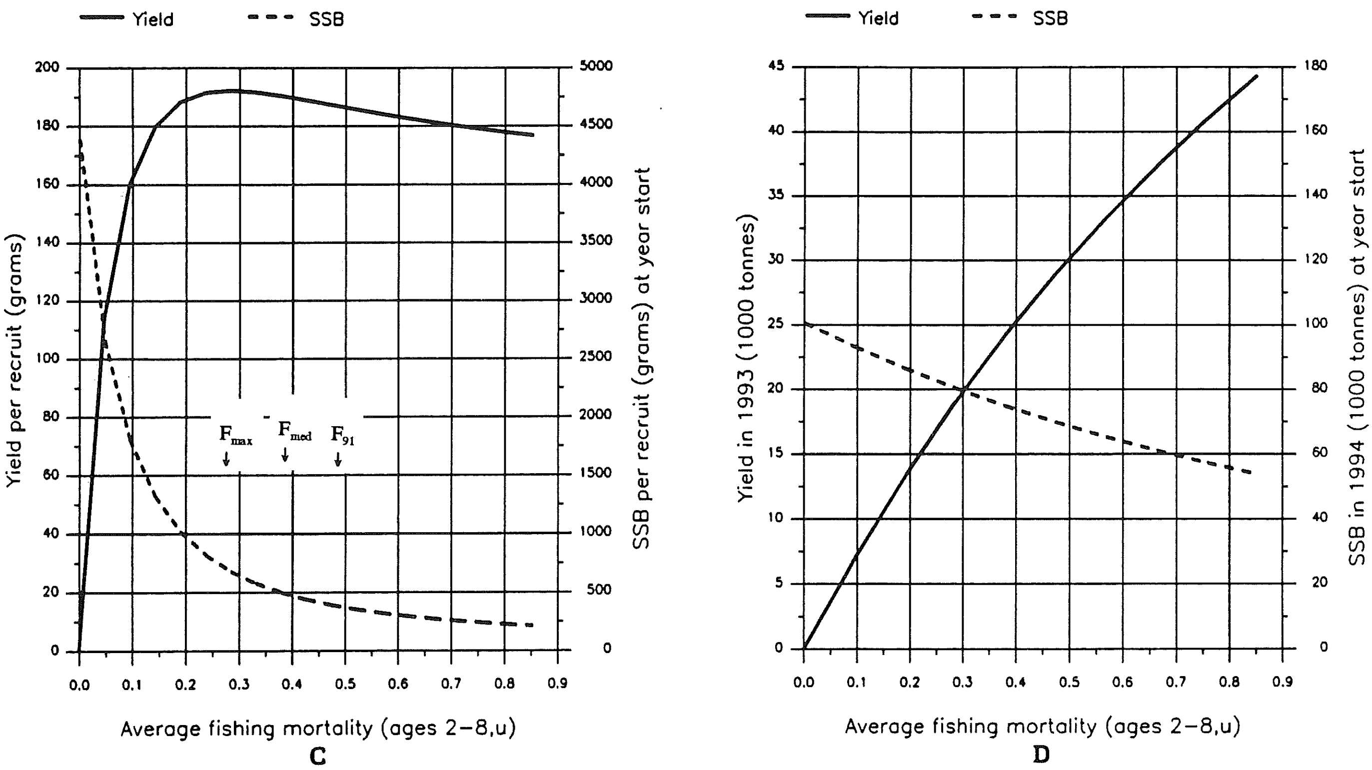


Figure 3.6.8 Sole in the North Sea: Stock - Recruitment

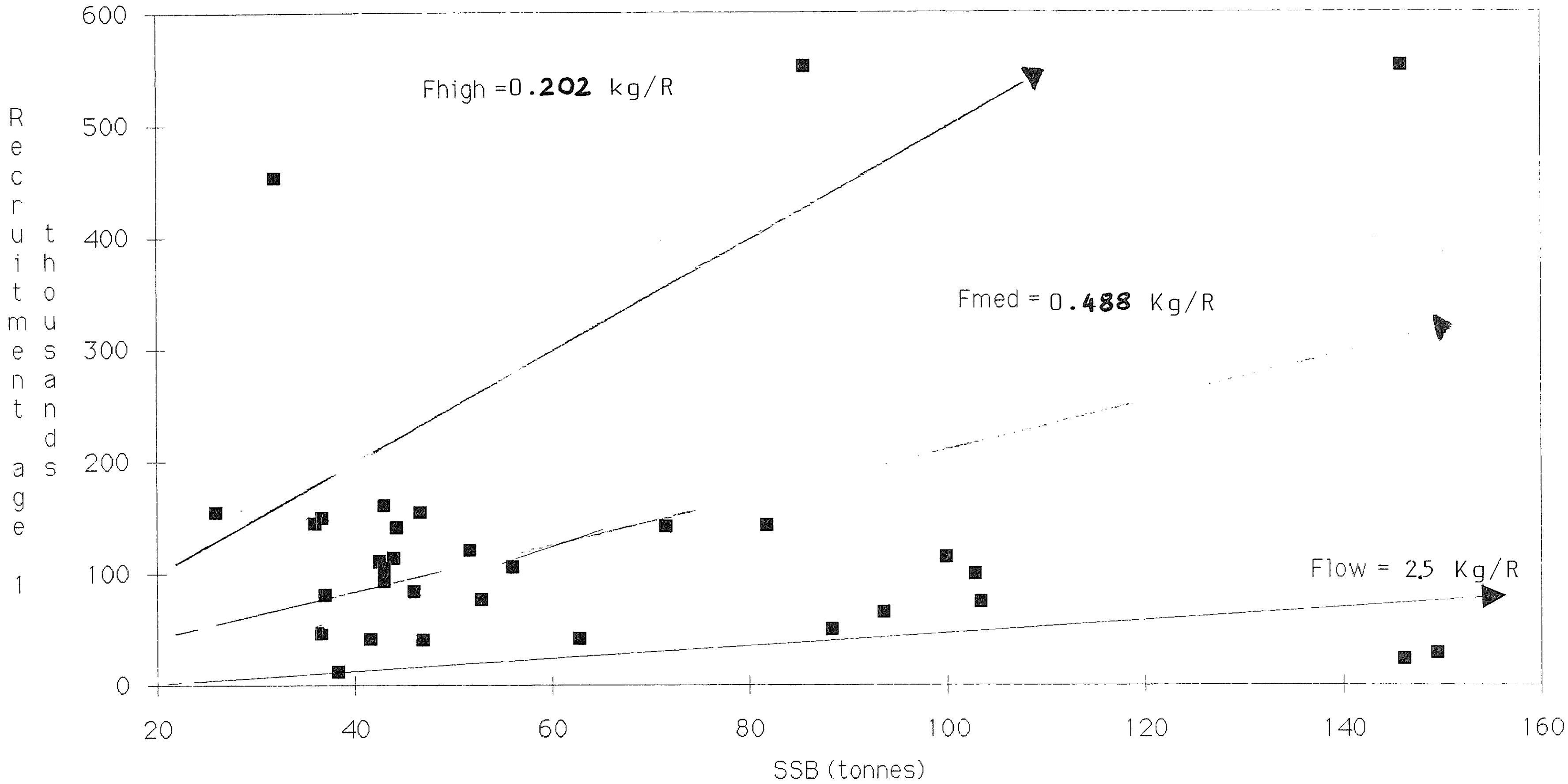


Figure 3.6.9 North Sea Sole
probability SSB < certain level

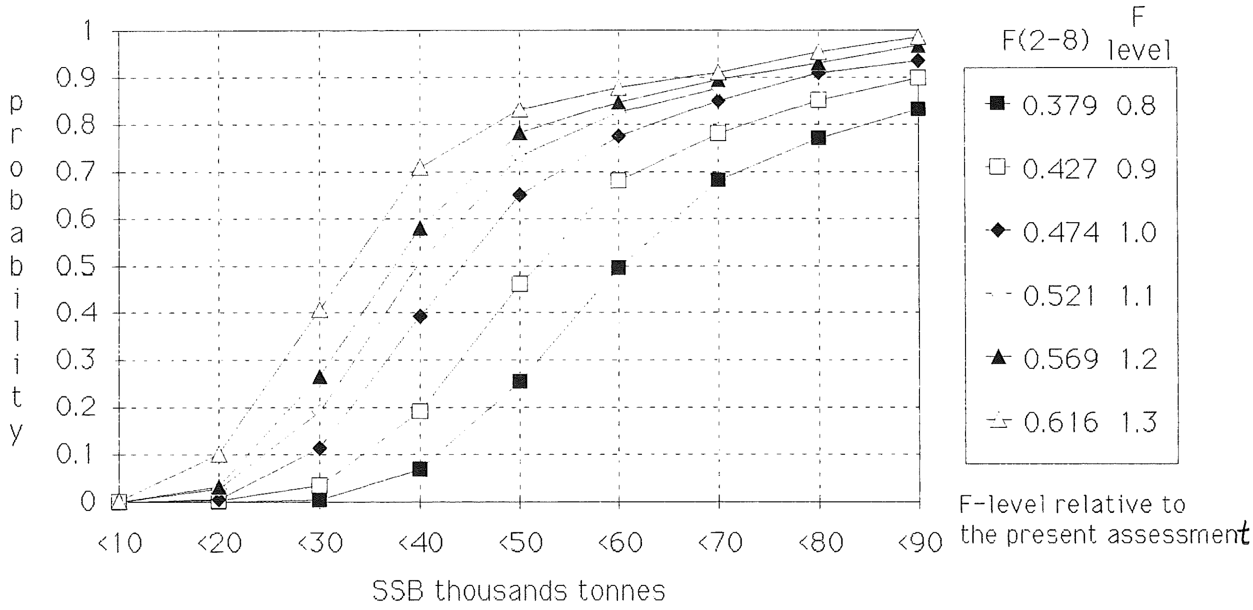
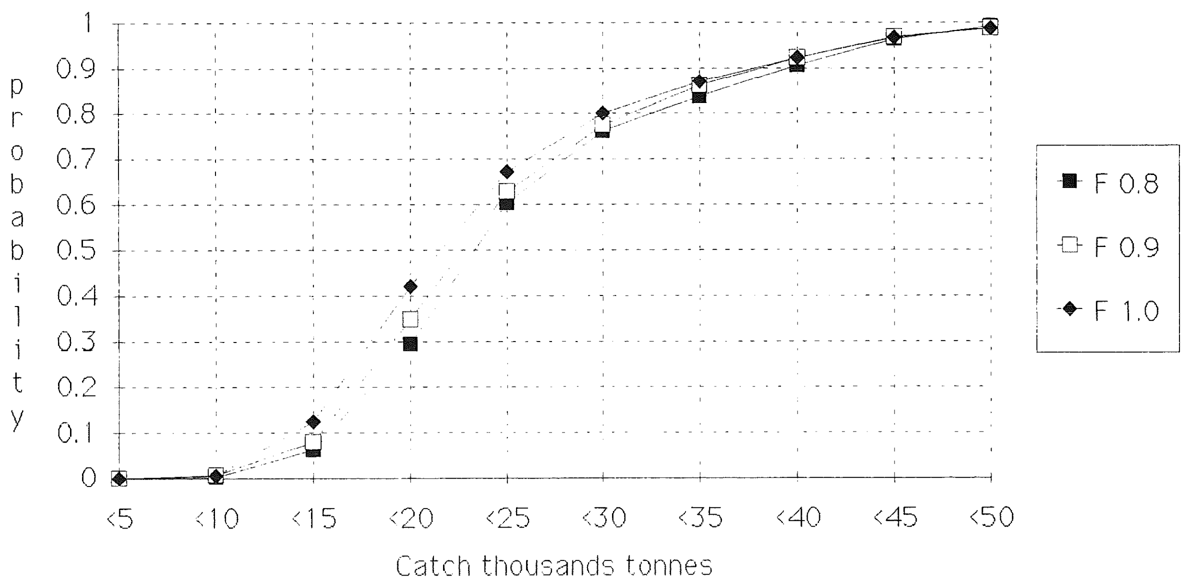


Figure 3.6.10 North Sea Sole
probability catch < certain levels



FISH STOCK SUMMARY
STOCK: Plaice in the North Sea (Fishing Area IV)
14–10–1992

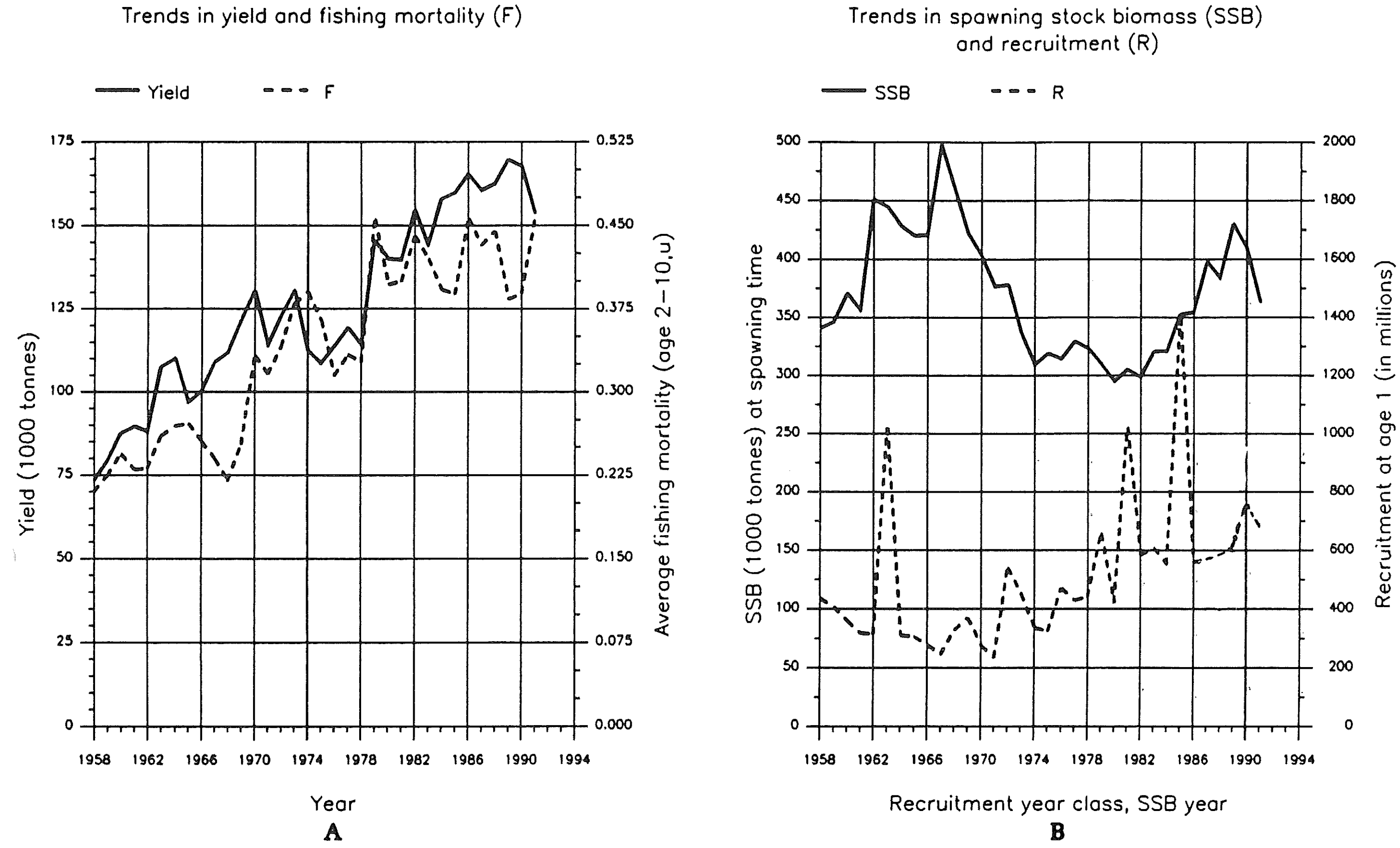


Figure 3.7.1 North Sea plaice: historic trends in yield and average fishing mortality between 1958 and 1991.

Figure 3.7.2 North Sea plaice: trends in standardized CPUE indices for various fleets.

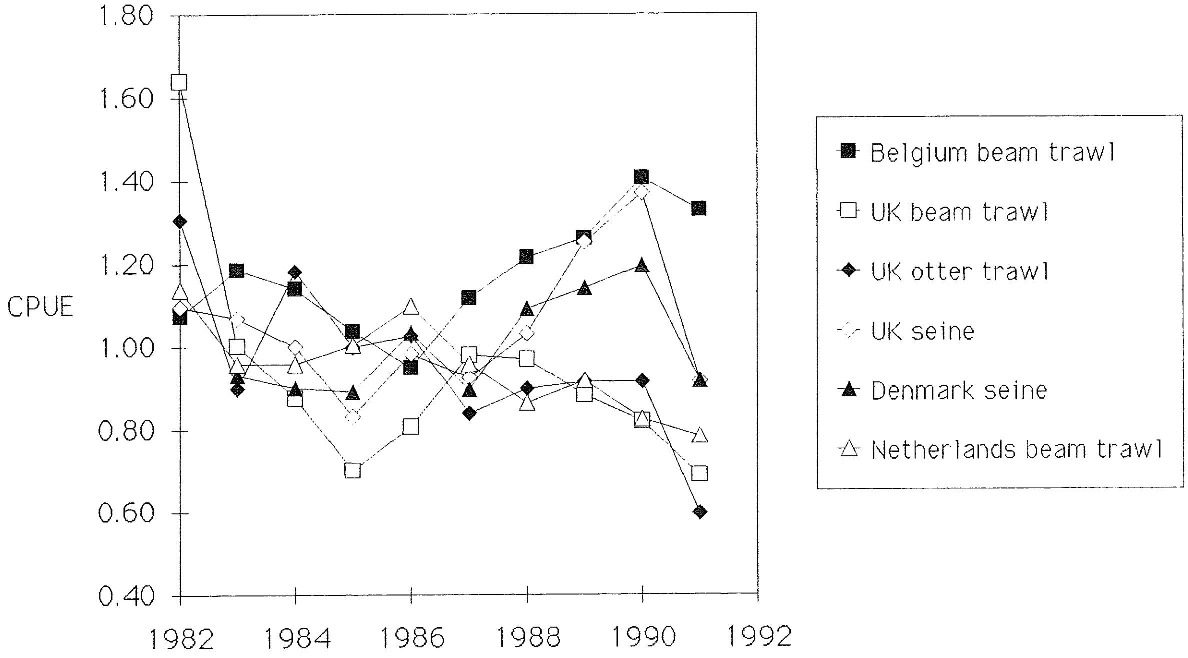
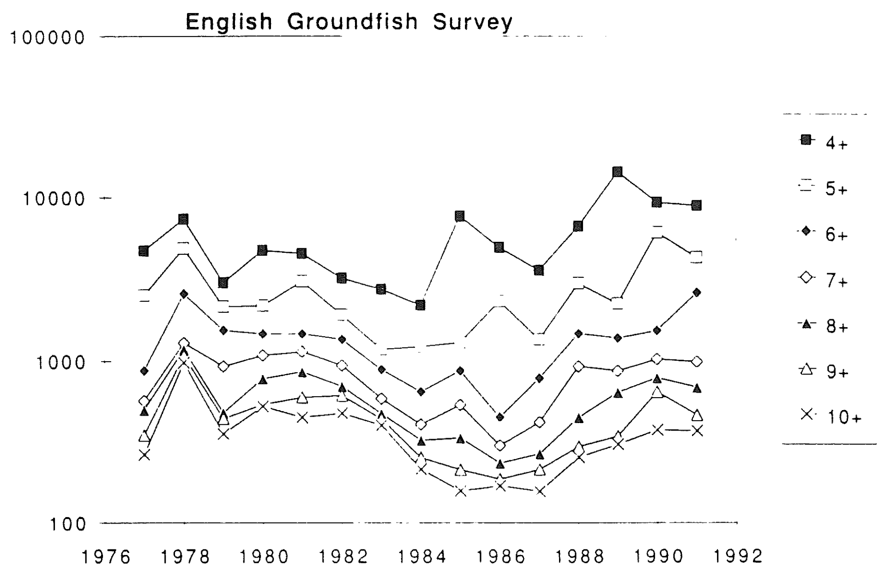


Figure 3.7.3 North Sea plaice: trends in cumulative stock numbers of various age-groups caught per fishing hour in the Netherlands beam trawl survey in the southeastern North Sea and in the English groundfish survey in the total North Sea. 2+ denotes the catch rate of age group 2 and older, 3+ that of age 3 and older etc.

A



nsPLAbtsindex.plot

B

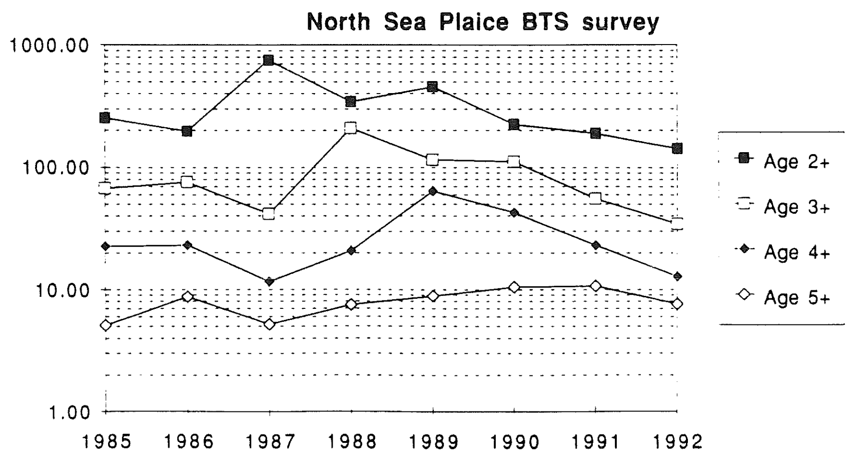


Figure 3.7.4 North Sea plaice: trends in fishing mortality $(F_{2-10})u$ between 1982 and 1991 in four different tuning runs.

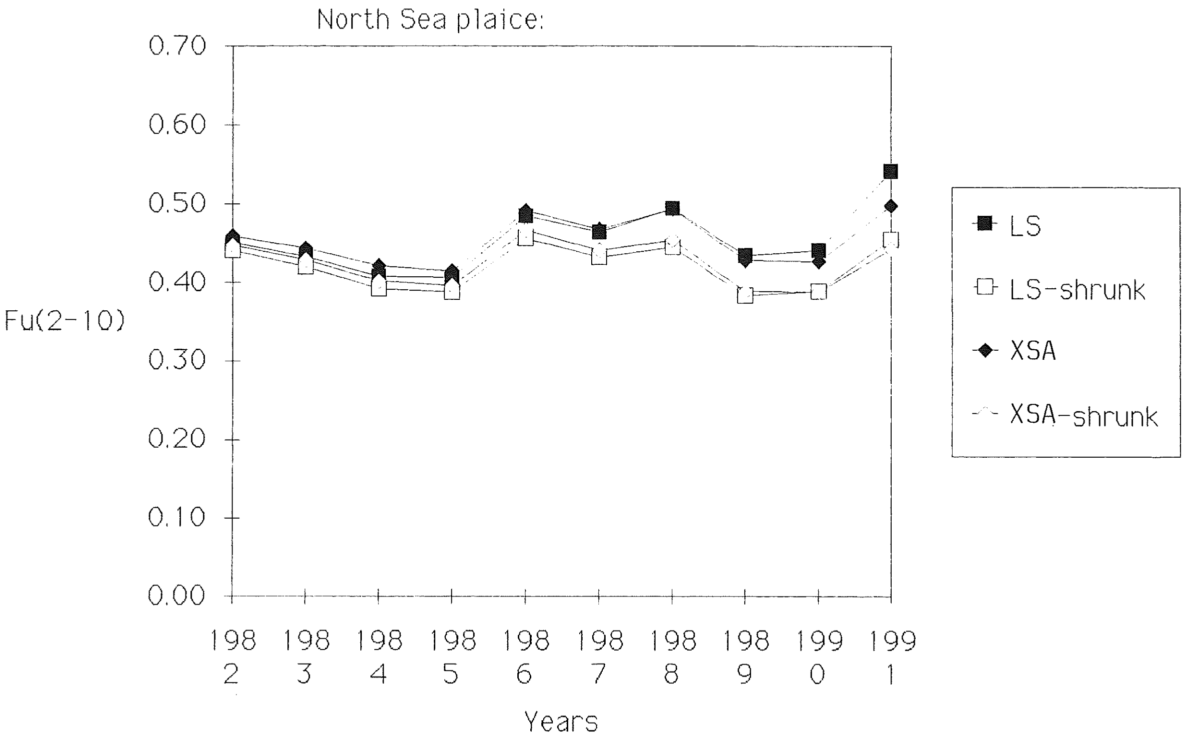


Figure 3.7.5 North Sea plaice: trends in spawning stock biomass between 1982 and 1991 in four different tuning runs.

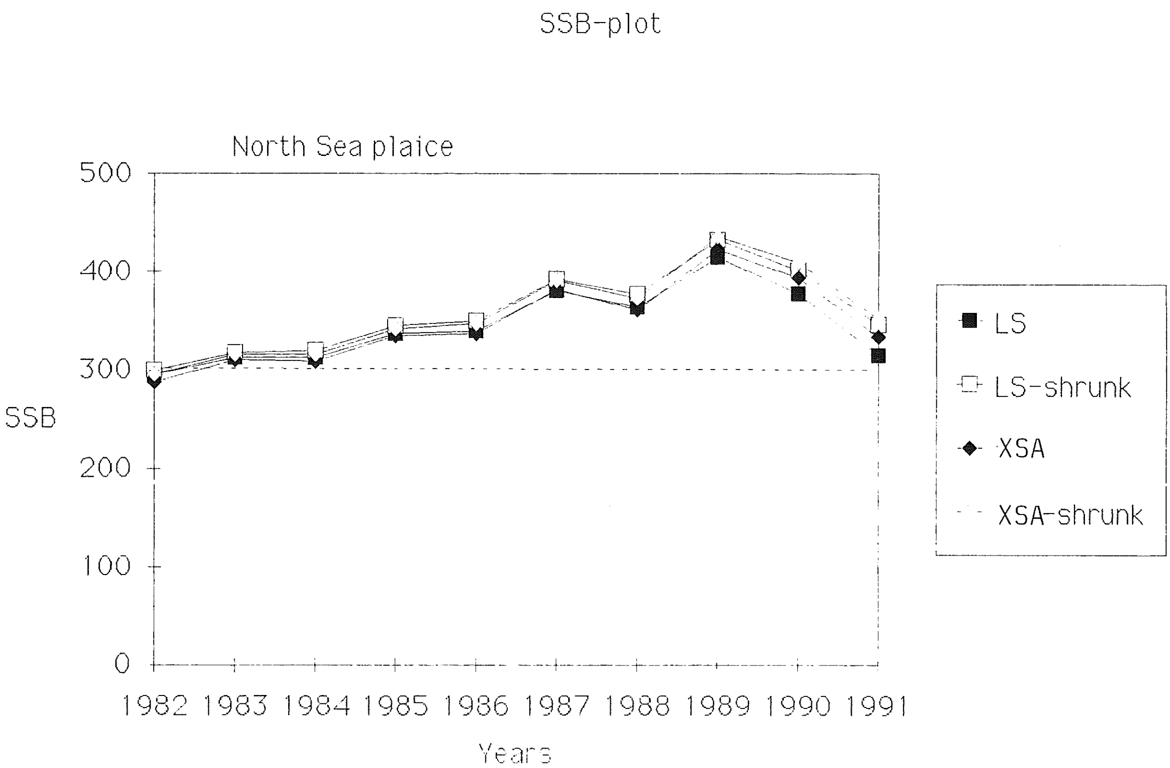


Figure 3.7.6 North Sea plaice: exploitation pattern in 1991 as estimated by four tuning runs.

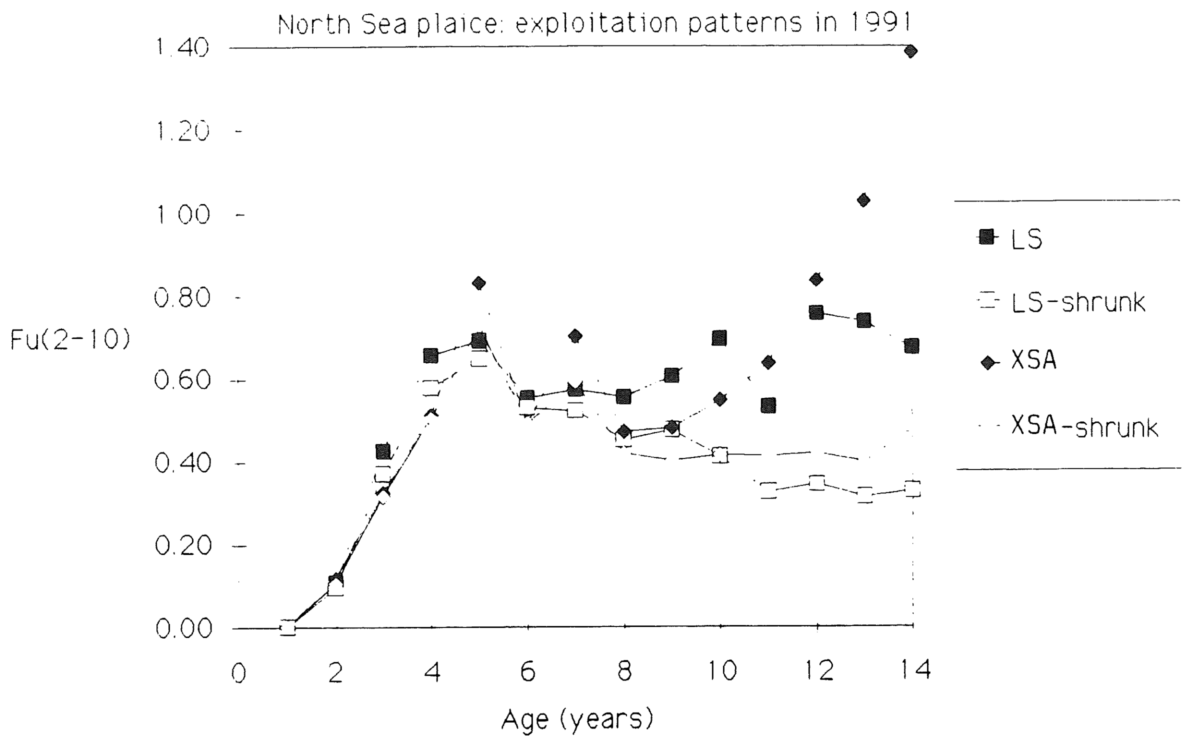


Figure 3.7.7 North Sea plaice: relationship between the standard error of q (SE(q)) for the five tuning fleets using SL-shrunk 1982-1991.

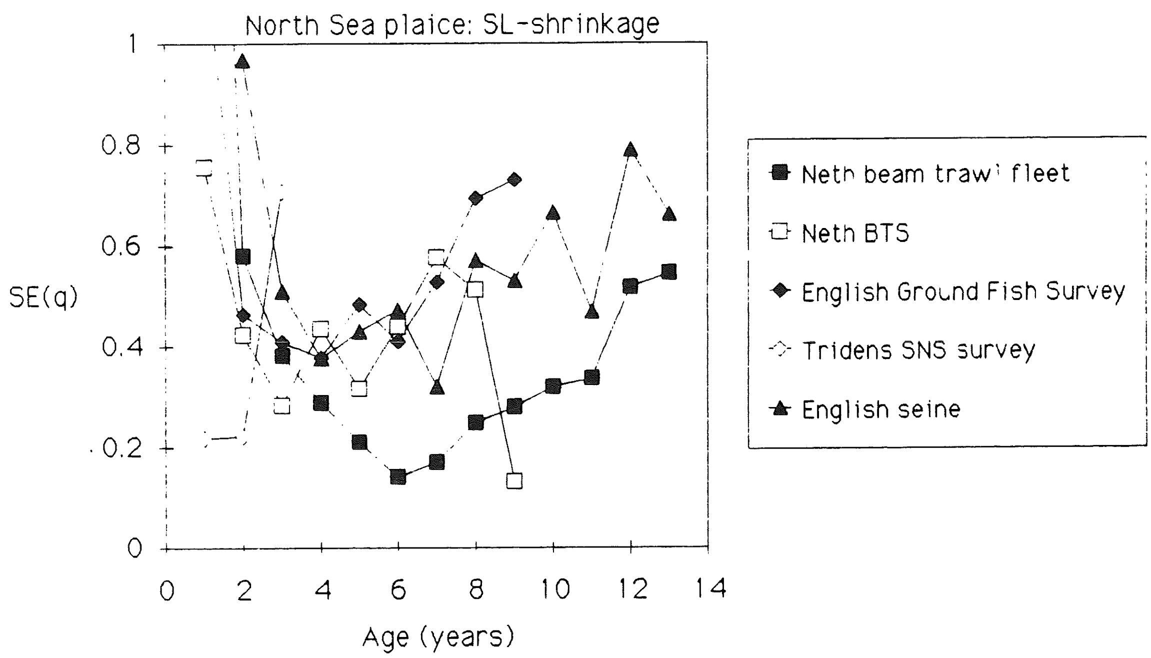
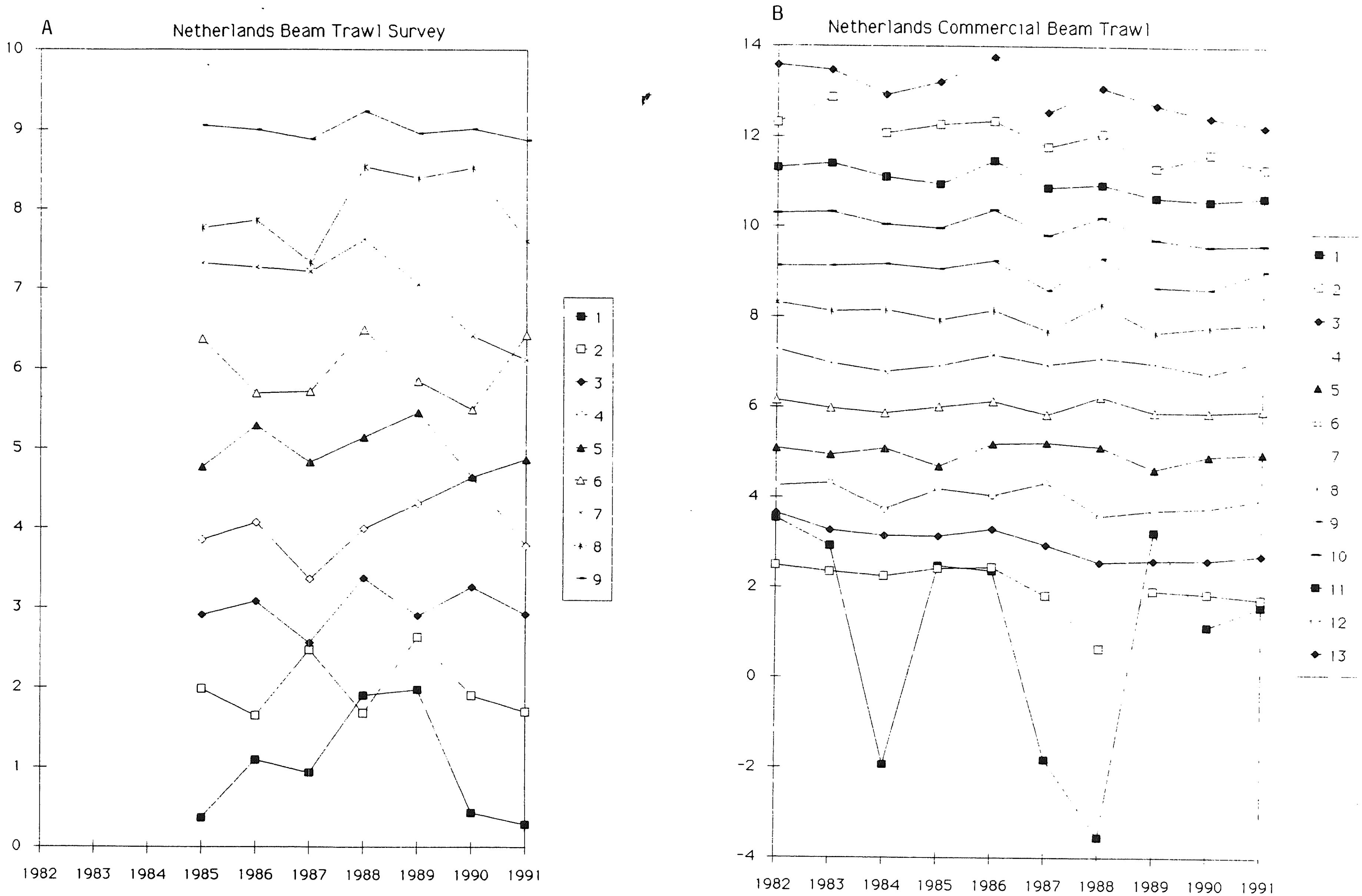
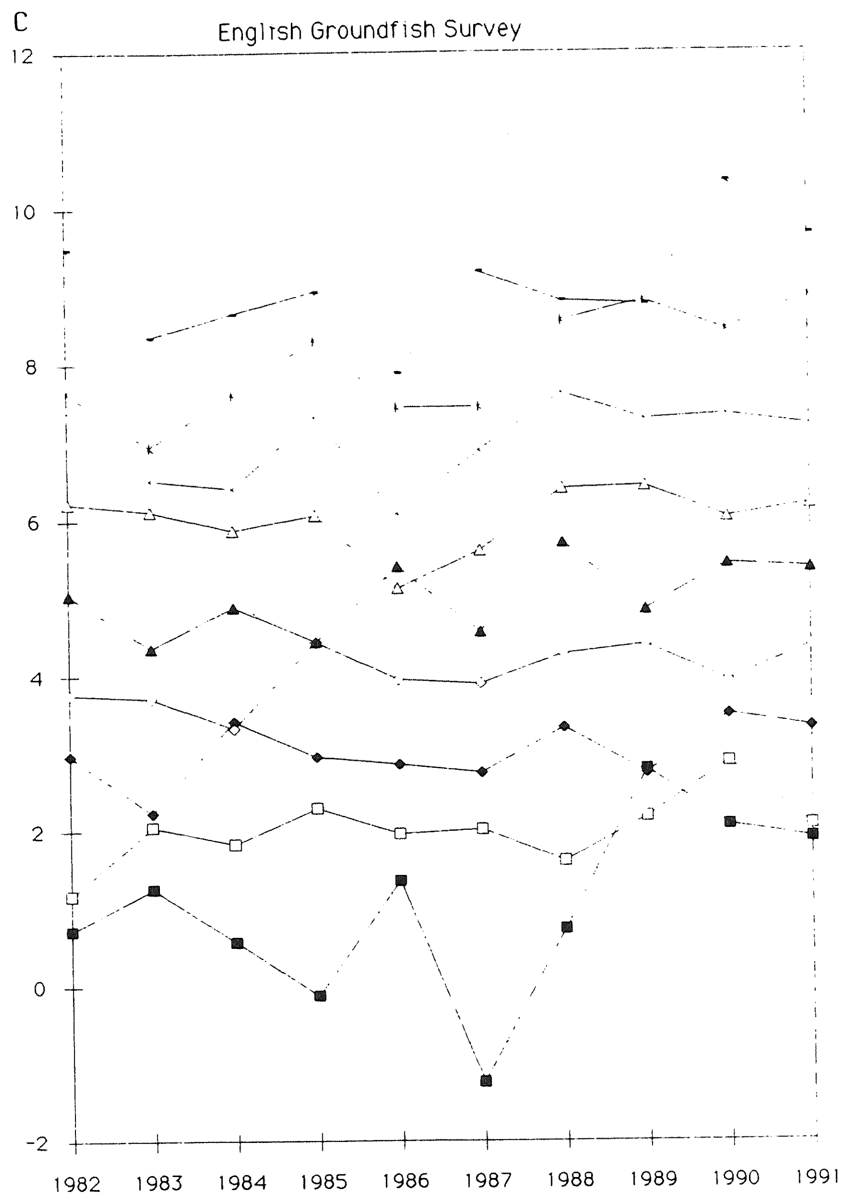


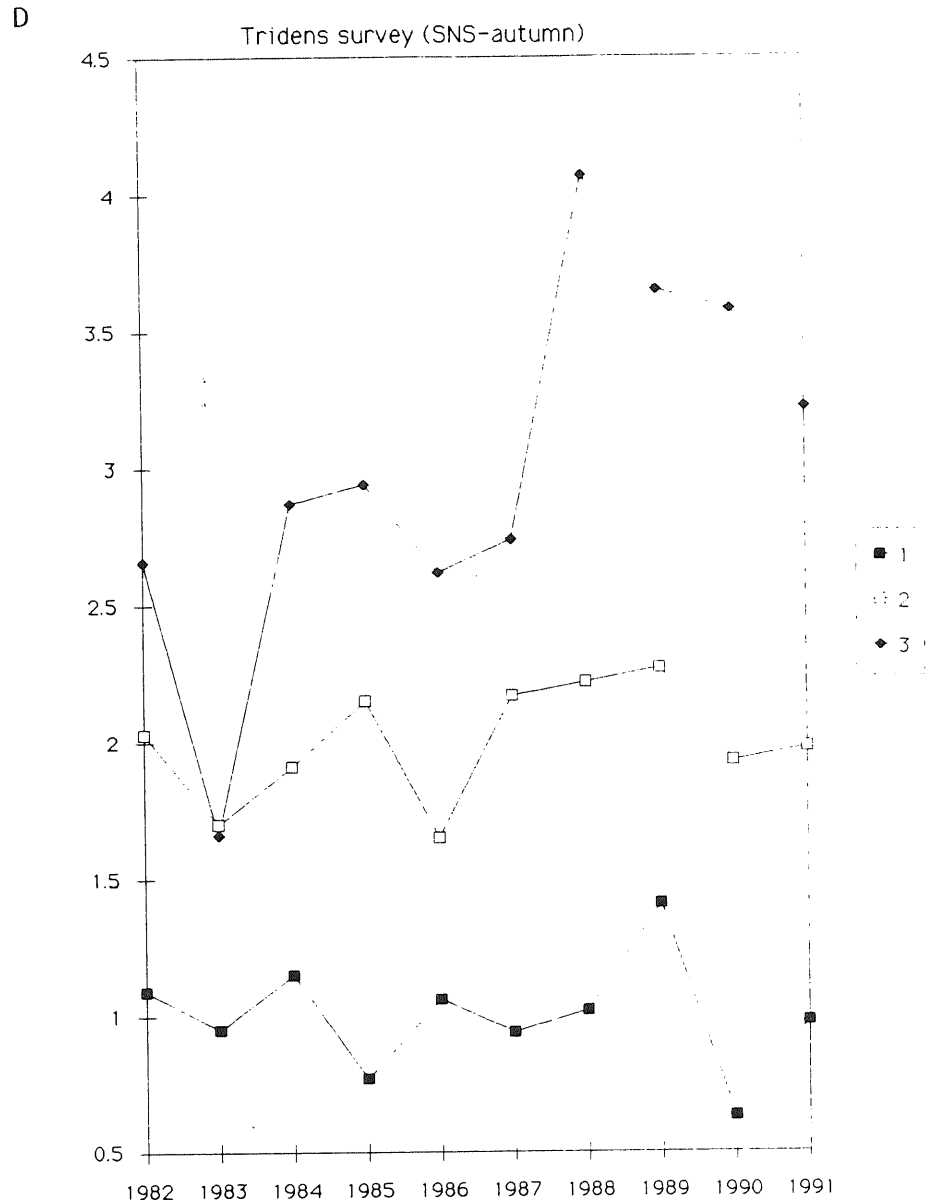
Figure 3.7.8 North Sea plaice: time trends of log catchability residuals plus age for the five tuning fleets using SL-shrunk 1982-1991.



cont'd.

Figure 3.7.8 continued





cont'd.

Figure 3.7.8 continued

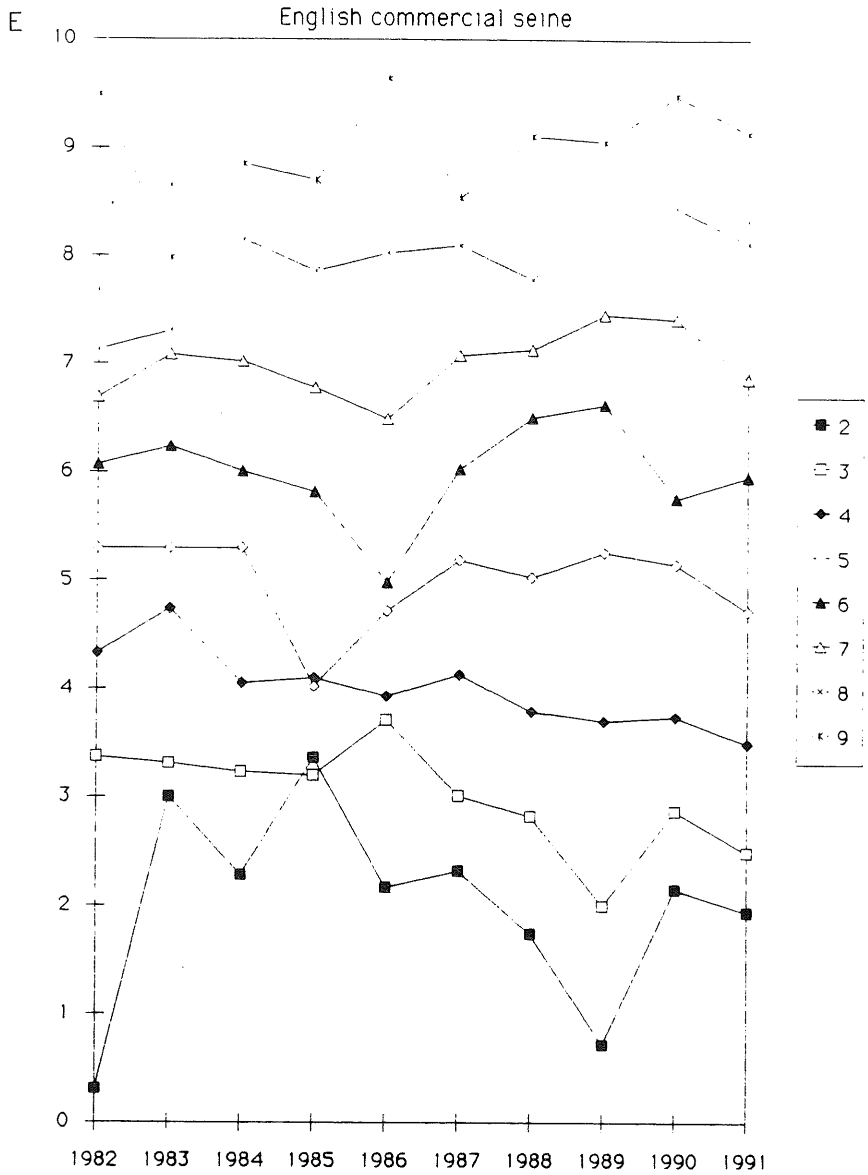


Figure 3.7.9 North Sea plaice: retrospective analysis of tuning of the terminal F using the LS-shrunk method.

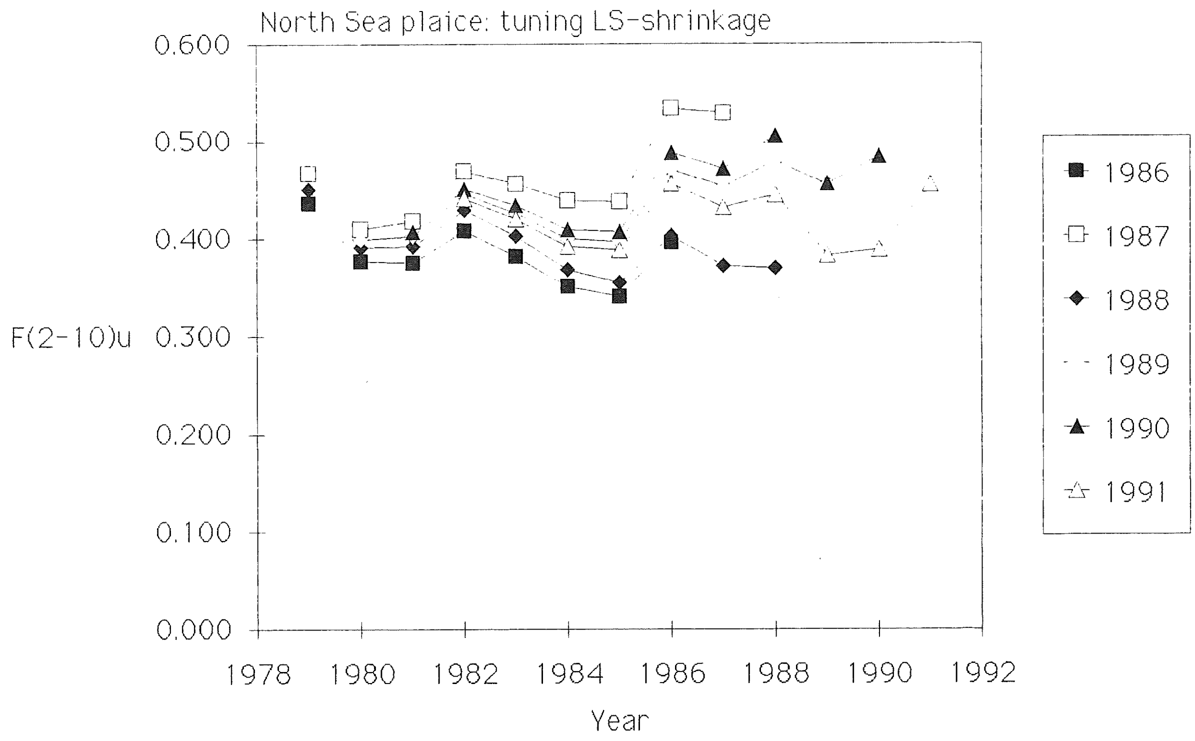


Figure 3.7.10 North Sea plaice: changes in exploitation pattern illustrating the shift away from exploiting age groups 2 and 3 since 1986. The figures give the mean F-at-age over three years from the final VPA tuned with LS-shrunk.

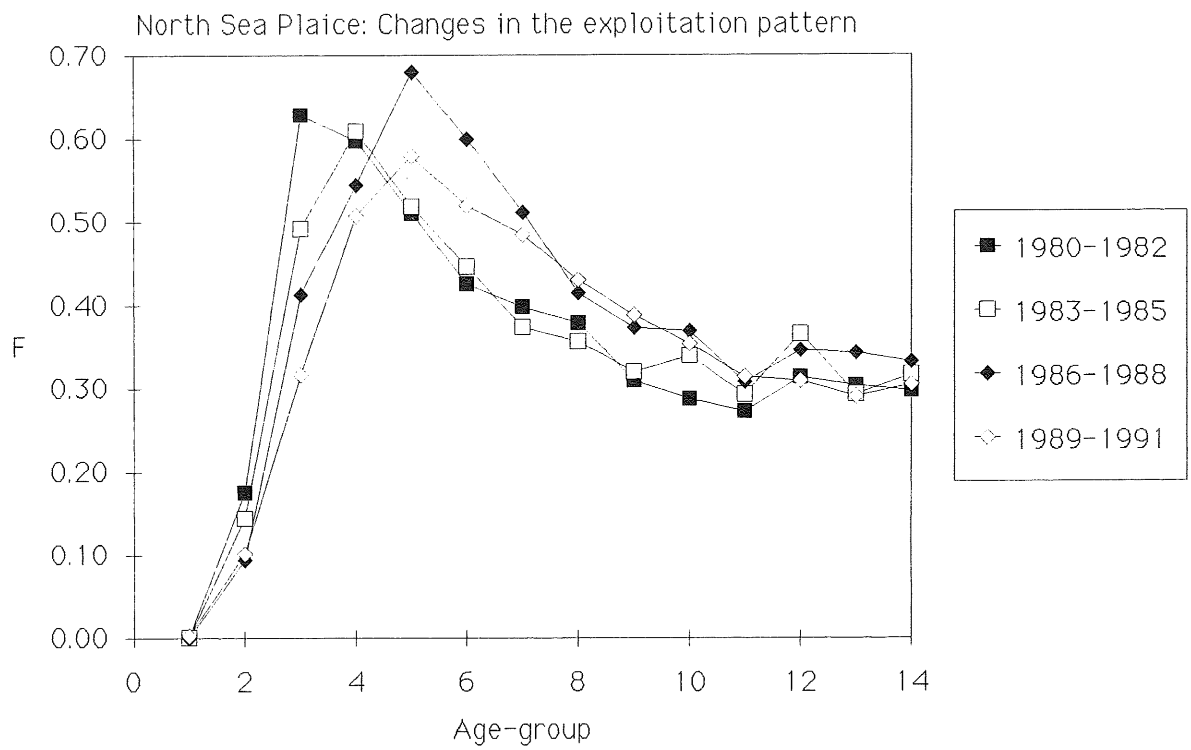


Figure 3.7.11 North Sea plaice: time trends in the mean weight-at-age in the catch of age groups 4 to 9, illustrating the increase in growth during the 1960s and the decrease that started in the late 1980s.

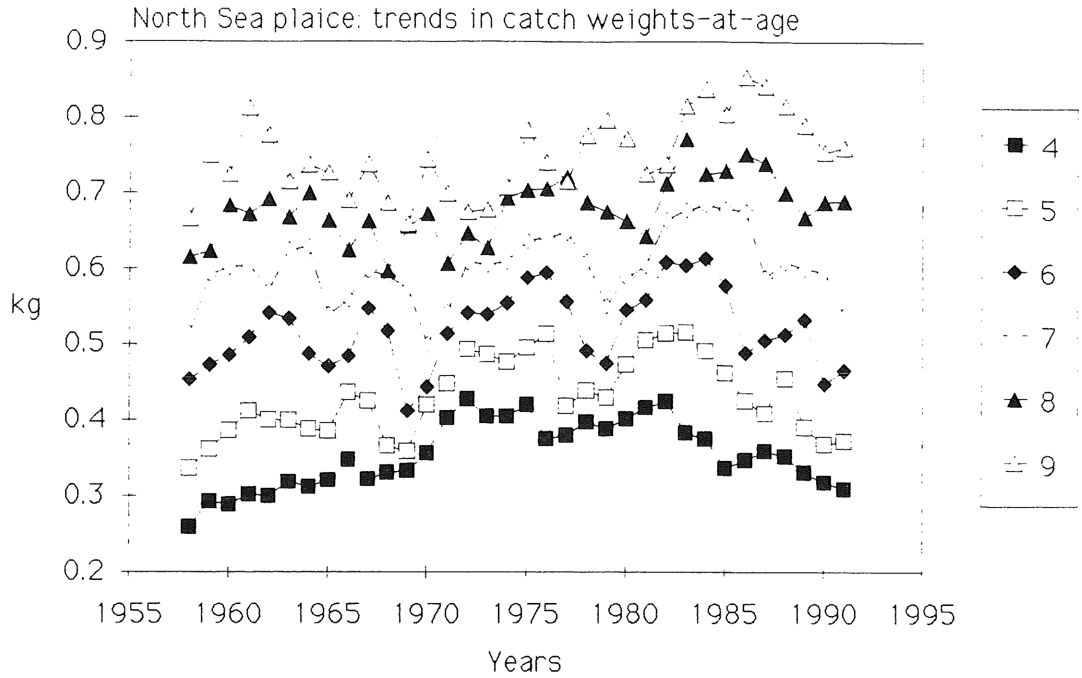
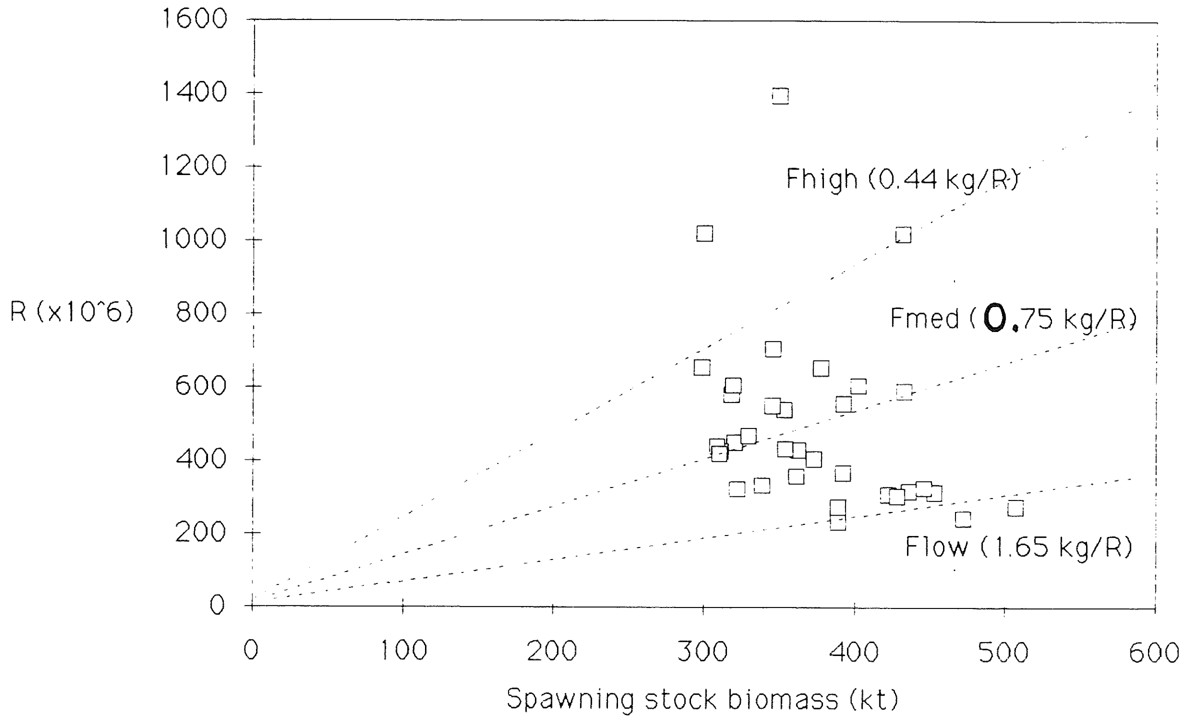


Figure 3.7.12 North Sea plaice: stock recruitment plot with the dashed lines indicating the levels of F_{high}, F_{med} and F_{low}.



FISH STOCK SUMMARY
STOCK: Plaice in the North Sea (Fishing Area IV)
20-10-1992

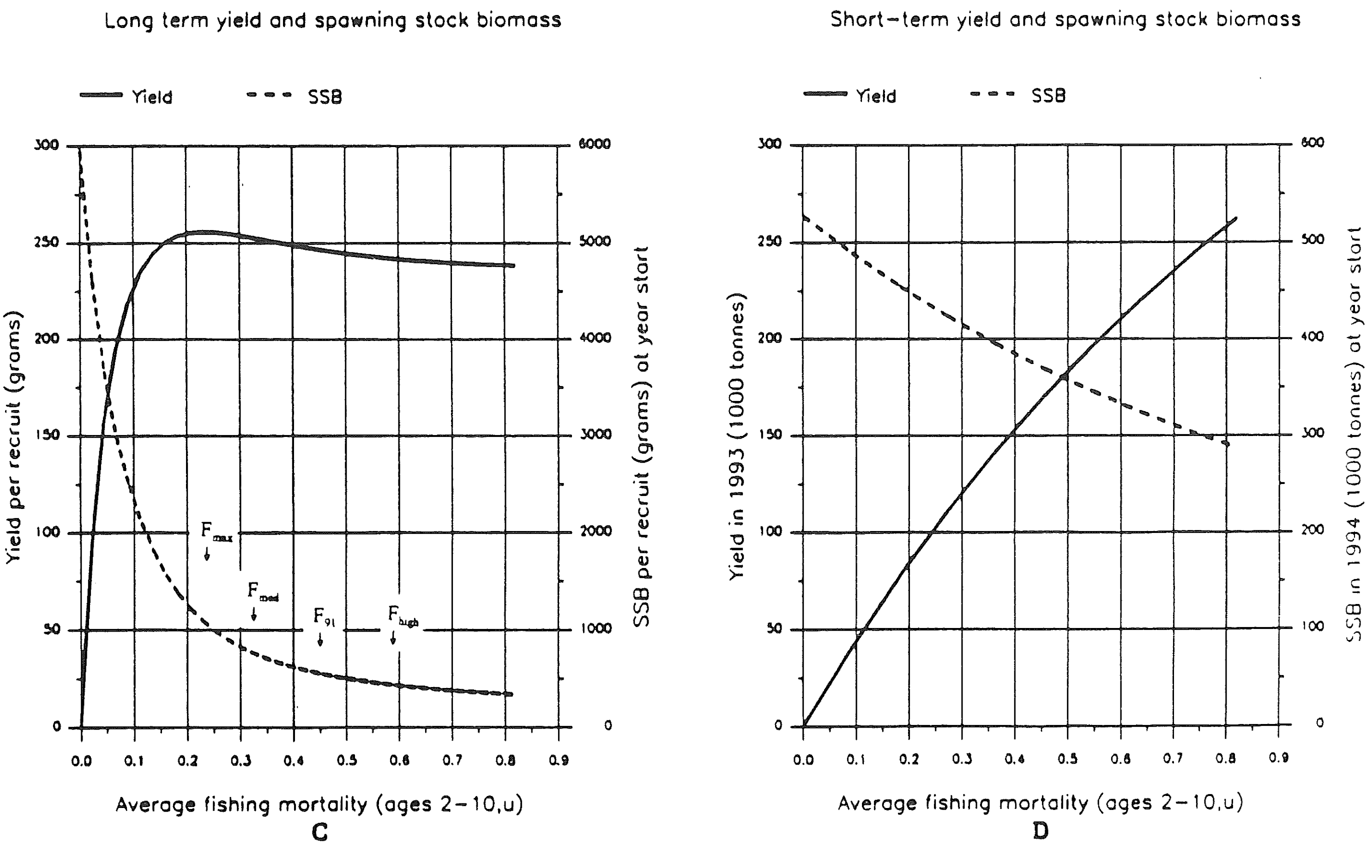


Figure 3.7.13 North Sea plaice: results of the long-term and short-term prediction with the biological reference points indicated.

Figure 3.7.14 North Sea plaice: results of the risk analysis plots assuming future recruitment will be as observed between 1958 and 1991 (top panel) and assuming recruitment will be enhanced by 25% due to the establishment of the plaice box.