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International Council for the Exploration of the Sea

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

Copenhagen, 6 - 14 October 1994

PART 1

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1 INTRODUCTION

1.1 Participants

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Henrik Sparholt and Leif Pedersen of the ICES Secretariat assisted during the course of the meeting.

1.2 Terms of Reference

a) assess the status of and provide catch options for 1995 for the stocks of cod, haddock, whiting, saithe, sole and plaice in Sub-area IV, Division IIIa (excluding sole in Division IIIa and cod in the Kattegat), and Division VIId (excluding haddock and saithe), taking into account as far as possible the technical interactions among stocks due to the mixed-species fisheries.

b) for the North Sea roundfish and flatfish stocks and fisheries, provide the information required for ACFM to give advice or guidance on:

   i) medium term management objectives (in terms of spawning stock biomass and mortality rates) and options;

   ii) the appropriateness of controls on catch (or landings) and fishing effort;

   iii) the potential for multispecies and multi-annual catch options.

c) provide the data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1993 by sub-division of the North Sea for all species in the multispecies model that are assessed by this Working Group).

1.3 Methods and Software

At the 1993 meeting of the Working Group, XSA was adopted as the main tool for the analysis of catch at age data. This was continued this year using the most recent version of the Lowestoft VPA package, version 3.1. The package was originally designed for the analysis of a single catch category and as a result does not explicitly deal with catches of discards and industrial by-catch. The latter classifications have been used for many years in roundfish assessments and a number of programs have been written to provide the necessary outputs. This year a new program, INSENS, has been implemented to link the Lowestoft format input and output files to other analytical software in order to automate the assessment procedure and reduce manual editing. This program also acts as an interface to a new catch forecast program, WGFRANS, which as well as performing the traditional short term prediction, performs a detailed sensitivity analysis. The same data input file for the forecast can be used in a medium term projection program, WGMTERM. The medium term projection program generates recruitment from a stock-recruitment relationship. The information needed by the program to do this is supplied from a data file created by a stock-recruitment model fitting program, RECRUIT. This program fits a variety of standard functions to stock-recruitment data.

A description of the programs and details on how to run them is given in a Working Document (Reeves and Cook, 1994). Figure 1.1 is a flowchart showing the program linkages.

1.3.1 Forecast sensitivity analysis

A sensitivity analysis has been performed for all stocks where a forecast is possible. This was done using WGFRANS. This program does a conventional ICES type forecast and then calculates sensitivity measures. Details of the sensitivity analysis are given in Cook (1993). Two types of sensitivity coefficients are produced. These are "rate coefficients" and "proportion of variance coefficients". The rate coefficients are proportional to the slope function at the input parameter values. Thus these coefficients measure how rapidly the forecast quantity changes in response to changes in the input values. They will give, for example, a measure of how large an effect a recruiting year class will have on the forecast. The proportion of variance coefficients attempt to measure how much of the uncertainty in the input values contributes to uncertainty in the forecast value. The pie diagrams shown in the stock sections show how much of the total variance in the forecast is due to each parameter. This analysis requires that the relative coefficient of variation (CV) specified for each input value is approximately right. If these values are also good estimates of the absolute CV then the calculated CV of the response variable (e.g. forecast SSB) can also be calculated. These are presented for most forecasts but care is needed in their interpretation since the source of these values is still under development. The sections below identify the source of these uncertainty values.

1.3.1.1 Population numbers

Standard errors for the VPA survivors are read from the tuning report. A geometric mean is used as the default value for recruitment. The standard error of the log recruitments over the year range used to calculate the GM is used as the CV of this value.

1.3.1.2 Fs at age

The Fs at age by category over the full year range are first divided throughout by the appropriate reference F. This effectively removes the annual variation in F. CVs for these corrected values are then calculated for each age and category. These values are used as CVs for the prediction Fs at age by category.

1.3.1.3 Weights at age

For stock weights at age, and catch weights at age by category, simple CVs are calculated for the full year range.

1.3.1.4 Natural mortality

Where information on annual variation in natural mortality is available from MSVPA, this can be used in estimating CVs for M using a procedure analogous to that used for Fs at age. This has been done for three stocks; cod, haddock and whiting in the North Sea. The values used for CVs of M at age, and also for the year-effect of M (Section 1.3.1.6) are given below.

CVs of natural mortalities for three North Sea roundfish stocks obtained from MSVPA results are given in the text table below.

Age	North Sea Cod	North Sea Haddock	North Sea Whiting
0	0.04	0.03	0.09
1	0.13	0.05	0.11
2	0.10	0.07	0.26
3	0.18	0.19	0.14
4	0.18	0.12	0.14
5	0.18	0.17	0.14
6+	0.18	0.10	0.14
Year effect	0.10	0.21	0.23

If the program run is for one of these three stocks, then the above values will be supplied as defaults. Otherwise, a single default value (0.1) will be supplied for all ages.

1.3.1.5 Maturity

Standard default values are supplied as estimates of the CV of maturity at age. For ages at which maturity is partial, the value will be 0.1. This value will also be supplied for the oldest age at which the proportion mature is zero, and the youngest age at which all fish are mature. At all other ages, the default value is zero.

1.3.1.6 Year effects

As a measure of the annual variation in fishing mortality, CVs are calculated for the reference Fs for each category across the full year-range. For the stocks listed in the table above the year effect of M has been estimated in an analogous manner from MSVPA results. For other stocks, a standard default value (0.1) will be supplied.

Clearly these choices of CVs are open to a variety of criticisms and may not be appropriate for some stocks. However, they do serve as an initial approximation and further work is in progress to refine the methodology. It means that the estimated CVs on the forecast output table should be interpreted with caution. A particular point to note is that this year the CV of the year effect for F was calculated over the full year range of the assessment and this will overestimate the CV if there is a trend in F. As a result the contribution of this parameter to the variability in the forecast is disproportionately high.

1.3.2 Medium-term projections

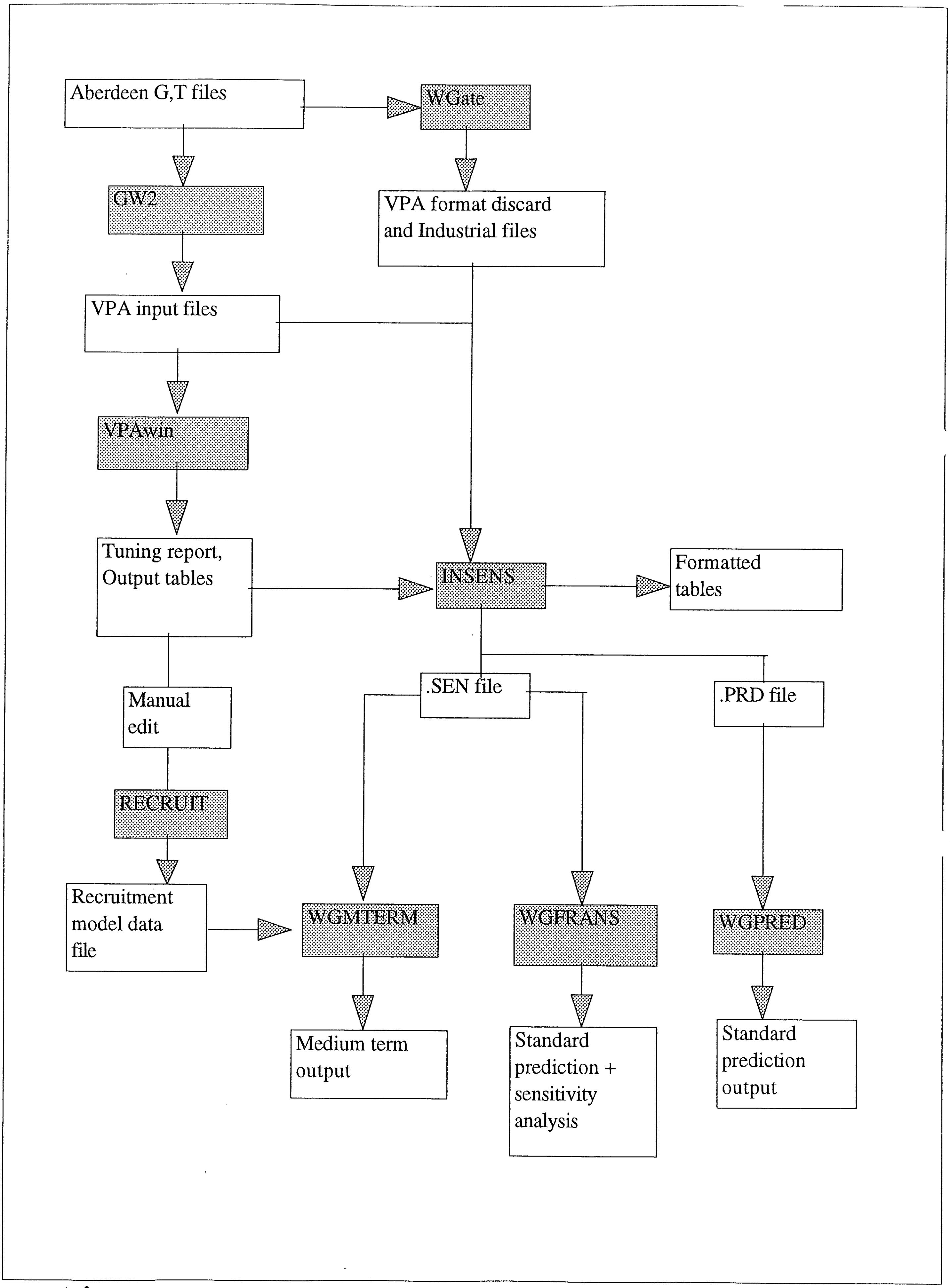
For most stocks medium-term projections were performed using WGMTERM. This is an updated version of the program used for North Sea stocks in 1993. Recruitment is modelled by fitting a conventional stock-recruitment function to the VPA estimated stock-recruitment data. The fitted model is then used to generate recruitment. Stochasticity is introduced by bootstrapping a residual to the estimated recruitment from the model. An option in the program is to simply bootstrap the observed time series of recruitment.

As well as uncertainty in recruitment, WGMTERM chooses starting population values at random from a specified log-normal distribution. This can be done by using the CVs of the survivors estimated from XSA. For simplicity of use, this program uses the same input data file as WGFRANS. However, it does not use the CVs for all the input parameters (only those for the initial populations). Thus the uncertainty in the calculated values output by this program is less than that from WGFRANS for the years where the analyses overlap.

1.3.3 ICES software

The Working Group has been aware of the criticisms from ACFM about the use of non-standard software for some time. The principal problem with using the existing IFAP system has been that IFAP does not have a facility for disaggregating Fs and catch between catch categories of human consumption landings, discards and industrial by-catch. This makes certain standard VPA output tables unsuitable and is particularly difficult when making a catch forecast. The issue was discussed with ICES staff during the meeting and it appears that the problem should be simple to solve. A working document (WD2) records the meeting held and the action needed to make it possible to run roundish assessments on the ICES system.

Figure 1.1 Flowchart showing linkages between program used by the Working Group.



2 COD IN THE SKAGERRAK. HADDOCK, WHITING AND PLAICE IN DIVISION IIIA

2.1 Overview

The stocks in Division IIIa to be considered by the Working Group are cod in the Skagerrak and haddock, whiting and plaice in the whole of Division IIIa.

The reported landings of cod in 1993 increased by approximately 5%. Haddock landings for human consumption decreased by more than 50% to 2,159 t. The industrial landings decreased similarly. Total whiting landings were reduced from 12,240 t in 1992 to 4,560 t in 1993 which is the lowest on record. The human consumption landings amounted to 979 t whereas the industrial landings were 3,581 t. The plaice landings remained stable, the 1993 catch was 11,296 t. About 85 % of the plaice landings were reported from the Skagerrak.

The total effort exerted in Division IIIa has decreased in recent years partly as an effect of the EU withdrawal programme. This programme in this area only affected the Danish fleet which is however dominating the fishery in Division IIIa.

For assessment the time series of age samples from landings for industrial purposes is short, there are gaps in this series and discard data are lacking. Misreporting and non-reporting of catches has occurred in recent years, particularly for cod but the amounts probably vary significantly between years.

The IBTS surveys in February (1979-1994), April (1991-1994), September (1991-1994) and November (1991-1993) provide abundance indices for the roundfish but not for plaice. The abundance indices from April, September and November are not yet useful in the assessments because the time series are too short. There are also data available for 0-group cod from a Norwegian survey. The IBTS (February) and the Norwegian 0-group survey data are presented in Table 2.1.1.

Cod in the Skagerrak is probably not a unit stock but rather linked with the cod population in the Northern North Sea. Mis/non-reporting of landings is a major concern. Nevertheless, an analytical assessment is presented in Section 2.2 although there are several reasons to doubt the validity of this assessment.

Also for haddock in Skagerrak, as for cod, there are doubts whether this is a unit stock.

The landings for industrial purposes were not adequately sampled between 1987 and 1990.

The catch-at-age data available for haddock for these years are therefore not reliable for the youngest age groups. Because IBTS data can only be used to tune the younger age groups there are no relevant tuning indices available for that part of the catch-at-age matrices which is reliable. No analytical assessment of haddock can therefore be made.

Whiting catches are mainly for reduction purposes and the lack of catch at age data for 1987-1990 prevents any analytical assessment.

For plaice in Division IIIa the age compositions available to the Working Group strongly suggested that the age determinations are not internally consistent. This problem also affects data from before 1993. Until the Group feels confident that the basic data reflect the true age compositions of the landings it is not possible to assess this stock (see Section 2.5). The Division IIIa plaice assessments presented in 1993 and possibly also in 1992 suffer from this lack of consistency and can therefore not be considered reliable.

Table 2.1.1 ROUNDFISH in Division IIIa. Indices of 0-group cod from the Norwegian Skagerrak coast and indices of 1- and 2-groups from the IBTS in February, and 1-group whiting and haddock from the February IBTS.

Year class	Cod			Whiting	Haddock
	IBTS	IBTS	Norw.survey		
	1-gr	2-gr	0-gr	1-gr	1-gr
1974				499	
1975			6.1	236	
1976			11.4	99	
1977			3.4	392	
1978			6	561	
1979		85	21.4	722	40.4
1980	15	31	7.1	968	4.3
1981	36	30.4	5	690	47.7
1982	28.4	18.6	12.4	262	33.8
1983	23.4	51.8	1.9	500	71.7
1984	13.5	10.5	4.2	940	160.8
1985	77.9	113	20.3	1,379	57
1986	5.4	18.1	4.5	2,178	250.6
1987	77	23.8	10.1	2,978	125.2
1988	56	9.6	0.2	478	20.2
1989	30.9	25.3	15.9	2255	8
1990	9.3	5	1.9	1,363	74
1991	96	16	5.7	1,672	258
1992	110	7	6.6	1,359	405
1993	82		3.5	525	180
1994			6.0		

2.2 Cod in the Skagerrak (Northern part of Division IIIa)

The assessment presented below is based on the assumption that the Skagerrak cod is a unit stock. Information gathered in recent years suggests this is not the case (see Section 2.2.11).

2.2.1 Catch trends

Annual landings in the period 1971 to 1992 by country are presented in Table 2.2.1. Total catches in 1993 amounted to 14,737 t compared to 14,002 t in 1992. Almost all of the catch was taken by Denmark and Sweden. The annual yield since 1978 is shown in Figure 2.2.1.

The estimated cod landings from the Danish small-mesh trawl fishery amounted to 511 t in 1993 (Table 2.2.2).

The assessment presented below excludes Norwegian catches taken in the fjord areas as these cod are considered to belong to a separate stock (Anon., 1991). Catches from the fishery for reduction purposes have not been included in the assessment as catch-at-age data for this fishery were not available.

2.2.2 Natural mortality, maturity, age composition, mean weight at age

Catch at age information was only available from Denmark and the Danish age distribution was raised to the total catch (Table 2.2.3). The Danish weight-at-age data (Table 2.2.4) were applied to the total catch. Weight-at-age in the stock is assumed to be identical to weight-at-age in the catches.

Natural mortality is assumed to be 0.2 per year for all ages and years. Maturity-at-age was assumed equal to that of the North Sea stock (Table 2.2.5).

2.2.3 Catch, effort and research vessel data

The definitions of fleets were unchanged compared to those used in the 1993 assessment (see Anon., 1994). CPUE data are available from two Swedish fleets accounting for 50–80% of the total Swedish cod landings (Table 2.2.6) and from three Danish fleets which account for about 10% of the annual Danish catches. As no age information was available from the Swedish fisheries only the Danish CPUE data were used in the tuning. Catch/effort data by fleet are shown in Table 2.2.7 while Table 2.2.8 shows CPUE by ages for these Danish fleets.

The IBTS survey covers Division IIIa and provides abundance indices for age groups 1 and 2 for Skagerrak cod. Data for April, September and November are available but only for 1991–1994. Only the February time series (former IYFS survey) covering the years 1981 to 1993 are of sufficient length to be used for tuning (Table 2.1.1).

2.2.4 Catch-at-age analysis

XSA runs using the three Danish CPUE series (1987-1993) and the IBTS (February) data (1981–1993) with F-shrinkage indicated a decrease in fishing mortality within the most recent five years as expected from the decrease in the numbers of vessels in the Skagerrak area and the reduction in annual effort (see Section 2.2.12). F-shrinkage towards previous years may thus bias the estimates and was therefore not applied in the final run. No population shrinkage was used as it was thought unlikely that either the IBTS survey or the commercial fleet catchability would depend on year class abundance. The XSA setup and diagnostics are given in Table 2.2.9.

The log catchability residuals (Figure 2.2.2) show for all commercial fleets large negative residuals for age 1 in 1987. Inspection of age–length information indicated that this may be caused by age reading errors.

The XSA results used in forecast and sensitivity studies are shown in Table 2.2.9. However, due to the XSA procedure of estimating terminal F's for the oldest ages it was impossible to extend the analysis beyond 1987 without applying F-shrinkage. The historical trends of stock sizes and fishing mortalities were therefore derived from a conventional VPA (Tables 2.2.10 and 2.2.11). This VPA was based on the terminal F's found by the XSA tuning and for previous years by setting the F-oldest equal to F_{3-7}.

The retrospective pattern of F_{3-5} (Figure 2.2.3.) shows a considerable underestimation of F in the terminal year. The short time series of tuning data, however, limits the potential for retrospective analysis.

2.2.5 Recruitment

The IBTS age 1 indices for the 1991–1993 year classes are the highest on record (Table 2.1.1) but the age 2 indices for the 1991 and 1992 year classes are both below average. This is considered to be a reflection of the rather noisy relationship between the age 1 and age 2 indices.

The IBTS indices were compared to VPA year class strength using the RCT3 program applying default settings (Table 2.2.12). The 1992 year class at age 2 was estimated to be 10.5 million and the 1993 year class at age 1 to be 18.4 million compared to the geometric mean of age 1 abundance (VPA, 1978–1990) of 16.8 million.

The tuning fleet CPUEs indicate that the 1991 year class is above average and that the 1992 year class is about average (Table 2.2.8).

2.2.6 Long-term trends

The long term-trends in the fisheries are given in Table 2.2.13 and shown in Figure 2.2.1.

Yield and SSB peaked in 1981-82, as a result of the strong 1979 year class. Since then catches and stock size have declined while recruitment has fluctuated without trends between 10 and 20 million individuals except for two strong year classes, 1979 and 1985, where recruitment exceeded 30 million individuals.

2.2.7 Biological reference points

Input data for yield per recruit calculations are given in Table 2.2.14 and the results in Table 2.2.15 and Figure 2.2.4. It is not possible to identify a stock-recruitment relationship from Figure 2.2.5, however, the time period for which data are available is fairly short. It is therefore difficult to establish an estimate of the value of the Minimum Biological Acceptable Level (MBAL) of spawning stock biomass. F-med is calculated at 0.98 suggesting that the population may sustain a fishing mortality at or above 1.0 per year, without significant changes in the level of recruitment. This agrees with the observed trend in the fisheries (Figure 2.2.1).

2.2.8 Catch forecast

Input for the predictions are given in Table 2.2.16. As considerable fleet changes have occurred in the most recent year the exploitation pattern is taken as the F in 1993. Weights-at-age used are the averages of the 1987-1993 period. Stock sizes of age groups 1 and 2 in 1994 are derived from the RCT3 (Table 2.2.12) whereas the stock size of the older age groups was taken from the XSA (Table 2.2.9). Recruitment of age 1 cod in 1994 and 1995 is taken as 16.8 million calculated as the geometric mean of recruitment derived from the VPA results for the period 1978–1991.

Two predictions for 1995 are presented. Table 2.2.17 is based on a *status quo* F in 1994 while Table 2.2.18 is based on a catch constraint equal to the 1994 TAC of 15,500 t. Both predictions suggest a higher catch in 1995 than in 1994 at *status quo* F. The *status quo* catch in 1995 is estimated to be 22–25,000 t. SSB is expected to increase to 21–25,000 t in 1995. The increase in SSB is predominantly caused by the growth and maturation of the strong 1991 year class.

Figure 2.2.6 shows the elasticities of projections of yield for 1994 and 1995 and for SSB in 1995 and 1996. The projections are most sensitive to the F-factor applied (HF's in Figure 2.2.6). Second in importance for accurate projections are the recruitment estimates (abundance, weight-at-age and exploitation). Knowledge of the presumed strong 1991 year class is of particular importance.

Figure 2.2.7, associated with the short-term prognosis, also shows that the F-factor is the single most important parameter. Besides this age 3 abundance (N3 in 1994, N2 in 1995) is of significance. Taken together, these two parameters account for between 50% and 75% of the total variability in the yield and SSB projections.

Probability profiles of the Skagerrak cod yield projections are shown in Figure 2.2.8. The 1995 catch is projected to be between 15,000 – 26,000 t (10 and 90% confidence limits).

2.2.9 Medium-term prediction

Medium-term projections were carried out by the WGMTERM program available at the meeting. As no relationship between stock and recruitment was evident (Figure 2.2.5) future recruitment was derived by bootstrapping estimated strengths of the year classes 1978-1992. 500 bootstraps were made annually for a ten year period. The results are given in Figure 2.2.9.

Beyond the first years, the projections are driven by the recruitment model. These are produced by bootstrapping in a right skew distribution and this distribution is seen within all derived abundance and biomass measures. The increases in median biomass and yield projected before 1996 are the result of the F values up to 1993 being larger than those applied in the prognoses. After that time the annual yield should vary between 18,000 and 34,000 t per year, a result which is not surprising. However note that lower yields around 15,000 t have been seen in recent years. The lack of a stock-recruitment relationship will inevitably predict a stable long-term situation and the simulations are therefore not very enlightening. Based on a pooled Skagerrak-North Sea assessment the simulations would show a rather different picture.

2.2.10 Long-term considerations

The assessment indicates a rather stable population with a decreasing trend in fishing mortality, albeit from a very high level.

It is assumed in the assessment that the Skagerrak cod is a unit stock. Information gathered in recent years suggests that this may not be the case. The recruitment to Skagerrak cod is influenced by drift of larvae/0-group cod from the North Sea (Larsson *et al.* 1994). Swedish annual IBTS surveys in February have only found few mature cod in the Skagerrak (Hagström *et al.* 1990) and the decrease in weight of a given cohort between autumn and winter (Figure 2.2.10) also suggests that the larger and possibly mature cod leave the Skagerrak during the winter for spawning, and return the following summer.

Management based on MBAL considerations may therefore not be appropriate for Skagerrak cod.

2.2.11 Comments on the assessment

Both misreporting (mainly by area) and non-reporting of catches have occurred, but estimates of the amount varies considerably. According to some sources up to half the amount landed may be taken in the North Sea. Estimated non-reporting of up to 20% of the catch adds to the uncertainty. However, it has not been possible to validate any of these guesses.

The assessment is based on incomplete data in so far as data on the small mesh catches and discards are not included.

The assessment quality control diagrams are shown in Table 2.2.19.

The Working Group noted that the TOR for 1995 require that a combined assessment of cod in the Skagerrak, North Sea and the Channel should be considered. This requires intersessional work on establishing CPUE series and surveys series for tuning.

2.2.12 Changes in fleet size and effort in the Skagerrak

2.2.12.1 Changes in fleet sizes

The Danish fishing vessel register contains information on ship size and main vessel type. Table 2.2.20 and Figure 2.2.11 show the numbers of vessels by size and vessel type at mid year. This table includes vessels registered in harbours at or immediately adjacent to the Skagerrak (Frederikshavn, Skagen, Hirtshals, Hanstholm, Tyboron and Lemvig).

Except for the gill-net fleet the numbers of Danish vessels in all the other fleets have decreased by approximately 50% over the recent decade. Although there are some variations most of the reduction has taken place since 1989 e.g. the reduction in the number of trawlers and seiners since 1989 was 42%. The vessels have been condemned under the EU vessel withdrawal programme. The Swedish and Norwegian fleets have been unchanged during this period.

2.2.12.2 Changes in effort

Effort data have been extracted from the Danish log--book system for the period back to 1987. All trips where cod have been recorded as caught in the Skagerrak have been included. Effort has been expressed in days absent from port. The fishing activities were aggregated into the following gear categories :

Cod trawlers using a mesh size ≥ 90 mm.

Nephrops trawlers using a mesh size of 70 mm.

Gill-netters

Danish seine

Effort data are given for vessels broken down by size (12–16 m and >16 m) (Table 2.2.21). These data accounted for 50 % of all Danish cod catches in 1987-1989 while the coverage increased gradually to 65% in 1993. The catches not accounted for are mainly taken by smaller vessels which are not obliged to report log-books. The lower coverage in the first years is due to lack of recording of mesh sizes in the logbooks; this prevents trips being allocated to the selected fleets. The increased coverage between 1987 and 1993 to some extent masks the effort decrease.

The effort data indicate a significant decrease in effort in the *Nephrops* trawl fleet as well as in the Danish seiner fleet whereas the effort from the cod trawlers and gill-netters has remained stable. For calculation of overall joint effort, the CPUEs of the various fleet components has were compared by ANOVA:

$$\ln CPUE = Year + Fleet$$

The year effect is included to account for the effect of variation in stock size. The fleet parameter estimates were back-transformed by taking the exponential and these values were then used as weighting factors applied to individual fleet effort. The weighted effort derived by this procedure shows a substantial decline since 1990 (Table 2.2.21).

Table 2.2.1 COD in the Skagerrak (part of Division IIIa). Landings in tonnes as estimated by the Working Group, (same as official landings, preliminary for 1993).

Year	Open Skagerrak					Total	Norwegian Coast
	Denmark	Sweden	Norway	Germany	Others		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	21,779	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	12	34	18,838	888
1990	15,788	1,694	143	110	65	17,800	846
1991	10,396	1,579	72	12	12	12,071	854
1992	11,194	2,436	270	-	102	14,002	923
1993	11,997	2,574	77	-	91	14,737	909

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

Year	By-catch
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
1992	1,360
1993	511

Table 2.2.3. **Cod in Skagerrak, Catch at age**

Run title : Cod in Skagerrak

At 11/10/1994 22:19

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
1,	4337,	432,	1066,	389,	1080,	1771,
2,	11174,	4325,	6593,	11030,	4448,	6020,
3,	2889,	2956,	4821,	6202,	6653,	3368,
4,	775,	480,	1748,	1169,	2009,	1609,
5,	182,	202,	349,	288,	242,	290,
6,	166,	34,	94,	44,	175,	85,
7,	44,	33,	82,	49,	73,	32,
+gp,	52,	28,	11,	6,	27,	69,
TOTALNUM,	19619,	8490,	14764,	19177,	14707,	13244,
TONSLAND,	24466,	15499,	24006,	28913,	26110,	21784,
SOPCOF %,	105,	118,	96,	98,	94,	96,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	341,	928,	3253,	165,	1035,	794,	846,	432,	1792,	507,
2,	7067,	5156,	4101,	12289,	2645,	6237,	5243,	2922,	4793,	5557,
3,	3107,	2773,	3441,	2245,	5251,	3163,	3326,	1763,	1554,	2141,
4,	731,	856,	1748,	503,	592,	1564,	529,	871,	493,	683,
5,	280,	207,	347,	137,	150,	172,	432,	194,	233,	177,
6,	70,	124,	60,	69,	56,	104,	49,	81,	49,	69,
7,	22,	33,	39,	17,	8,	18,	50,	32,	43,	14,
+gp,	17,	9,	21,	19,	13,	12,	33,	15,	12,	17,
0 TOTALNUM,	11635,	10086,	13010,	15444,	9750,	12064,	10508,	6310,	8969,	9165,
TONSLAND,	19891,	16628,	20103,	19900,	16952,	18838,	17800,	12059,	14002,	14737,
SOPCOF %,	99,	94,	95,	95,	100,	96,	96,	97,	96,	96,

Table 2.2.4: Weight at age, Cod in Skagerrak

Run title : Cod in Skagerrak

At 11/10/1994 22:19

Table 2 Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
1,	.5990,	.5990,	.7460,	.6190,	.6560,	.5900,
2,	.8600,	.8600,	1.1460,	.9720,	1.2040,	1.0070,
3,	1.8940,	1.8940,	1.5700,	1.9020,	1.8650,	1.9670,
4,	3.4980,	3.4980,	3.3470,	3.7110,	2.7090,	3.3500,
5,	5.5100,	5.5100,	4.8650,	5.2610,	6.1070,	5.7510,
6,	7.0930,	7.0930,	8.9320,	9.4910,	8.0180,	8.0740,
7,	7.3040,	7.3040,	8.3010,	8.5140,	8.7380,	8.5860,
+gp,	9.8880,	9.8880,	11.0850,	10.0940,	12.6580,	11.9630,
SOPCOFAC,	1.0453,	1.1806,	.9560,	.9799,	.9401,	.9649,

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.6470,	.6490,	.6830,	.5800,	.6370,	.6120,	.6030,	.5880,	.6580,	.8000,
2,	1.1300,	1.0940,	1.1330,	1.0480,	1.1950,	1.0640,	1.1500,	1.2100,	1.2390,	1.1830,
3,	2.1700,	2.0890,	2.0400,	1.8590,	1.8630,	1.7040,	2.1100,	2.1320,	2.3010,	1.9670,
4,	3.6160,	3.5370,	2.6360,	3.8960,	2.9780,	3.2240,	3.7030,	3.3350,	3.6010,	3.5120,
5,	5.5050,	5.4720,	4.7020,	5.8490,	5.8300,	5.6370,	4.6780,	4.9290,	5.1580,	5.2010,
6,	7.8140,	7.7460,	7.5380,	7.9140,	8.0950,	7.8900,	5.5460,	6.9710,	7.9610,	7.6070,
7,	10.3190,	10.2550,	9.1640,	9.6070,	10.2450,	9.6860,	8.5000,	9.0680,	9.3050,	10.2010,
+gp,	12.8560,	12.8540,	9.7770,	12.4670,	13.0600,	10.8000,	10.7450,	11.7800,	8.6220,	8.6230,
SOPCOFAC,	.9883,	.9442,	.9508,	.9542,	1.0004,	.9588,	.9576,	.9693,	.9614,	.9617,

0
1

TABLE 2.2.5; Cod, Skagerrak

Natural Mortality and proportion mature

Age	Nat Mor	Mat.
1	.200	.010
2	.200	.050
3	.200	.230
4	.200	.620
5	.200	.860
6	.200	1.000
7	.200	1.000
8+	.200	1.000

Table 2.2.6 COD in the Skagerrak. CPUE by gear type for the Swedish fishery CPUE as catch in kg/hour.

Year	Catch (t)	Effort	CPUE
	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
1992	417	15,112	27.6
1993	335	14,977	22.4
	Nephrops trawl (single 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
1992	811	73,518	11.0
1993	858	72,800	11.8

Table 2.2.7 COD in the Skagerrak. CPUE (kg/day) by gear type for the Danish cod fishery.

Year	Catch (tonnes)	Effort	CPUE
Gillnets			
1987	1,102	2,531	435
1988	1,211	2,202	550
1989	1,208	2,112	572
1990	1,367	2,398	570
1991	1,316	2,419	544
1992	1,415	2,532	559
1993	1,398	2,469	566
Nephrops trawl			
1987	218	8,174	27
1988	234	7,224	32
1989	332	8,541	39
1990	384	8,494	45
1991	311	8,536	36
1992	243	5,975	41
1993	244	5,160	47
Danish trawl			
1987	644	2,534	254
1988	472	1,429	330
1989	459	1,354	339
1990	614	2,132	288
1991	406	1,888	215
1992	455	2,002	227
1993	1,043	2,317	450

Table 2.2.8: Tuning cpue-data for cod in Skagerrak

```
104
Danish gill-net
 1987 1993
 1 1 0 1
  1  7
 1   0.8  98.7  68.6  19.3   4.8   2.1   0.6
 1  12.8  57.7 146.5  20.9   4.2   1.7   0.2
 1   5.2  67.8  59.2  65.5   8.9   5.6   0.8
 1   8.9  69.9  91.7  22.2  18.4   2.0   2.4
 1   6.6  64.8  75.6  51.2  11.2   4.2   1.6
 1  27.8 114.7  67.9  24.8  14.0   2.3   2.3
 1   9.3 134.1  94.8  32.3   6.5   2.8   0.3

Danish Nephrops tr.
  1987 1993
  1 1 0 1
   1  7
 1   0.3  18.0   3.0   0.8   0.2   0.1   0.0
 1   1.9   5.5  11.7   1.3   0.4   0.2   0.0
 1   2.3  17.9   7.4   2.5   0.3   0.2   0.0
 1   2.0  16.3   9.6   1.4   1.2   0.1   0.1
 1   2.2  13.2   5.9   2.3   0.5   0.2   0.1
 1   8.1  15.0   4.4   1.3   0.7   0.1   0.1
 1   1.9  25.1   6.7   1.9   0.6   0.2   0.0

 Danish trawlers
  1987 1993
  1 1 0 1
   1  7
 1   1.8 180.7  39.3   6.1   1.4   0.5   0.1
 1  32.2  69.7 130.6  11.1   2.2   0.7   0.1
 1  17.0 136.2  69.9  27.5   2.2   1.0   0.2
 1   9.8  96.0  66.3  10.0   7.1   0.8   0.5
 1  16.5  69.0  32.9  16.9   3.4   1.2   0.3
 1  34.2  88.1  32.2   8.4   3.3   0.6   0.5
 1  33.2 203.8  65.5  16.4   3.4   1.1   0.2

 IBTS
 1981 1993
 1 1 0.05 0.15
 1 2
 1  15   85
 1  36   31
 1  28.4 30.4
 1  23.4 18.6
 1  13.5 51.8
 1  77.9 10.5
 1   5.4 113
 1  77   18.1
 1  56   23.8
 1  30.9  9.6
 1   9.3 25.3
 1  96    5
 1  110  16
```

Table 2.2.9 **XSA setup and output, Skagerrak Cod**

VPA Version 3.1 (MSDOS)

10/10/1994 16:53

Extended Survivors Analysis

Cod in Skagerrak

CPUE data from file g:\ndwg94\iiia\vpadata\codskatu.dat

Catch data for 7 years. 1987 to 1993. Ages 1 to 8.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
Danish gill-net	1987	1993	1	7,	.000,	1.000
Danish Nephrops tr.	1987	1993	1	7,	.000,	1.000
Danish trawlers	1987	1993	1	7,	.000,	1.000
IBTS	1987	1993	1	2,	.050,	.150

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 5

Terminal population estimation :

Final estimates not shrunk towards mean F

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 36 iterations

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

Fishing mortalities

Age,	1987,	1988,	1989,	1990,	1991,	1992,	1993
1,	.017,	.067,	.071,	.098,	.035,	.076,	.022
2,	.807,	.412,	.706,	.910,	.570,	.650,	.354
3,	1.077,	1.045,	1.369,	1.102,	.939,	.691,	.693
4,	.749,	.976,	1.109,	.914,	1.029,	.760,	.766
5,	.812,	.520,	.884,	1.158,	1.106,	.887,	.691
6,	1.696,	.983,	.863,	.683,	.693,	.979,	.726
7,	1.904,	.995,	1.068,	1.635,	1.518,	1.043,	.867

Continued

Table 2.2.9 Continued

1

XSA population numbers

YEAR	AGE 1	2	3	4	5	6	7
1987 ,	1.07E+04,	2.45E+04,	3.76E+03,	1.05E+03,	2.72E+02,	9.34E+01,	2.21E+01,
1988 ,	1.78E+04,	8.65E+03,	8.95E+03,	1.05E+03,	4.09E+02,	9.89E+01,	1.40E+01,
1989 ,	1.27E+04,	1.36E+04,	4.69E+03,	2.58E+03,	3.24E+02,	1.99E+02,	3.03E+01,
1990 ,	1.00E+04,	9.70E+03,	5.50E+03,	9.76E+02,	6.96E+02,	1.09E+02,	6.86E+01,
1991 ,	1.40E+04,	7.43E+03,	3.20E+03,	1.50E+03,	3.20E+02,	1.79E+02,	4.53E+01,
1992 ,	2.72E+04,	1.11E+04,	3.44E+03,	1.02E+03,	4.38E+02,	8.67E+01,	7.34E+01,
1993 ,	2.57E+04,	2.06E+04,	4.73E+03,	1.41E+03,	3.92E+02,	1.48E+02,	2.67E+01,

Estimated population abundance at 1st Jan 1994

,	0.00E+00,	2.06E+04,	1.19E+04,	1.94E+03,	5.37E+02,	1.61E+02,	5.85E+01,

Taper weighted geometric mean of the VPA populations:

,	1.58E+04,	1.24E+04,	4.62E+03,	1.29E+03,	3.92E+02,	1.25E+02,	3.48E+01,

Standard error of the weighted Log(VPA populations) :

,	.4027,	.4444,	.3485,	.3480,	.3040,	.3333,	.6068,

1

Continued

Table 2.2.9 Continued

Fleet : Danish gill-net

Mean log catchability and standard error
of ages with catchability independent of year class strength

Age ,	1,	2,	3,	4,	5,	6,	7
Mean Log q,	-7.5784,	-4.6246,	-3.4892,	-3.2462,	-3.3283,	-3.3283,	-3.3283,
S.E(Log q),	.8779,	.3107,	.1398,	.2354,	.5183,	.2509,	.6217,

Regression statistics :

Ages with q constant w.r.t. time

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.56,	.836,	8.49,	.43,	7,	.51,	-7.58,
2,	1.94,	-2.104,	.13,	.51,	7,	.48,	-4.62,
3,	1.26,	-1.331,	2.19,	.84,	7,	.17,	-3.49,
4,	.73,	1.456,	4.31,	.86,	7,	.16,	-3.25,
5,	.84,	.249,	3.75,	.33,	7,	.47,	-3.33,
6,	1.04,	-.105,	3.26,	.62,	7,	.28,	-3.31,
7,	.63,	1.746,	3.26,	.82,	7,	.31,	-3.09,

1

Fleet : Danish Nephrops tr.

Mean log catchability and standard error
of ages with catchability independent of year class strength

Age ,	1,	2,	3,	4,	5,	6,	7
Mean Log q,	-8.8820,	-6.3571,	-6.0464,	-6.2267,	-6.2034,	-6.2034,	-6.2034,
S.E(Log q),	.7883,	.4237,	.2987,	.2609,	.3893,	.2994,	.6771,

Regression statistics :

Ages with q constant w.r.t. time

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.70,	.497,	9.12,	.36,	7,	.59,	-8.88,
2,	1.46,	-.775,	4.93,	.37,	7,	.64,	-6.36,
3,	.89,	.317,	6.31,	.64,	7,	.29,	-6.05,
4,	1.01,	-.015,	6.22,	.64,	7,	.29,	-6.23,
5,	.55,	1.805,	6.10,	.77,	7,	.18,	-6.20,
6,	1.67,	-1.097,	7.15,	.36,	7,	.49,	-6.22,
7,	-4.82,	-2.976,	-3.65,	.21,	3,	.72,	-5.72,

1

Continued

Table 2.2.9 Continued

Fleet : Danish trawlers

Mean log catchability and standard error
of ages with catchability independent of year class strength

Age ,	1,	2,	3,	4,	5,	6,	7
Mean Log q,	-6.8074,	-4.3394,	-3.8880,	-4.1481,	-4.4018,	-4.4018,	-4.4018,
S.E(Log q),	.7815,	.1495,	.2472,	.2822,	.3593,	.1922,	.1306,

Regression statistics :

Ages with q constant w.r.t. time

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.52,	1.191,	8.18,	.56,	7,	.39,	-6.81,
2,	1.05,	-.288,	4.11,	.89,	7,	.17,	-4.34,
3,	.67,	2.069,	5.38,	.89,	7,	.13,	-3.89,
4,	.71,	1.247,	5.01,	.80,	7,	.19,	-4.15,
5,	.65,	1.102,	4.95,	.68,	7,	.23,	-4.40,
6,	1.53,	-3.381,	4.36,	.89,	7,	.13,	-4.52,
7,	.90,	1.448,	4.29,	.98,	7,	.10,	-4.38,

1

Fleet : IBTS

Mean log catchability and standard error
of ages with catchability independent of year class strength

Age ,	1,	2
Mean Log q,	-6.0583,	-6.4129,
S.E(Log q),	.9381,	.8311,

Regression statistics :

Ages with q constant w.r.t. time

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.48,	1.154,	7.93,	.50,	7,	.44,	-6.06,
2,	.93,	.090,	6.63,	.25,	7,	.85,	-6.41,

1

Continued

Table 2.2.9 Continued

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish gill-net	,	16242.,	.940,	.000,	.00,	1,	.228,	.028
Danish Nephrops tr.	,	12219.,	.844,	.000,	.00,	1,	.283,	.037
Danish trawlers	,	26820.,	.837,	.000,	.00,	1,	.288,	.017
IBTS	,	38519.,	1.004,	.000,	.00,	1,	.200,	.012

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
20580.,	.45,	.25,	4,	.558,	.022

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish gill-net	,	11329.,	.314,	.298,	.95,	2,	.327,	.367
Danish Nephrops tr.	,	13350.,	.400,	.404,	1.01,	2,	.200,	.320
Danish trawlers	,	12048.,	.282,	.086,	.30,	2,	.403,	.349
IBTS	,	9553.,	.667,	.560,	.84,	2,	.071,	.423

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11856.,	.18,	.12,	8,	.646,	.354

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish gill-net	,	2196.,	.227,	.146,	.64,	3,	.340,	.633
Danish Nephrops tr.	,	1873.,	.260,	.083,	.32,	3,	.270,	.710
Danish trawlers	,	1914.,	.216,	.048,	.22,	3,	.366,	.699
IBTS	,	573.,	.667,	.015,	.02,	2,	.024,	1.478

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1937.,	.13,	.08,	11,	.593,	.693

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish gill-net	,	530.,	.196,	.080,	.41,	4,	.337,	.773
Danish Nephrops tr.	,	549.,	.211,	.100,	.47,	4,	.306,	.754
Danish trawlers	,	524.,	.192,	.127,	.66,	4,	.346,	.779
IBTS	,	979.,	.669,	.246,	.37,	2,	.011,	.489

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
537.,	.11,	.05,	14,	.468,	.766

Continued

Table 2.2.9 Continued

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish gill-net ,	151.,	.220,	.110,	.50,	5,	.285,	.722
Danish Nephrops tr. ,	180.,	.222,	.056,	.25,	5,	.335,	.638
Danish trawlers ,	153.,	.209,	.075,	.36,	5,	.376,	.717
IBTS ,	169.,	.672,	.520,	.77,	2,	.004,	.668

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
161.,	.13,	.05,	17,	.367,	.691

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish gill-net ,	54.,	.233,	.110,	.47,	6,	.326,	.768
Danish Nephrops tr. ,	65.,	.231,	.052,	.23,	6,	.315,	.673
Danish trawlers ,	57.,	.217,	.042,	.19,	6,	.358,	.737
IBTS ,	84.,	.678,	.241,	.36,	2,	.001,	.557

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
59.,	.13,	.04,	20,	.319,	.726

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1986

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish gill-net ,	9.,	.260,	.174,	.67,	7,	.257,	.898
Danish Nephrops tr. ,	10.,	.240,	.074,	.31,	6,	.172,	.843
Danish trawlers ,	9.,	.212,	.047,	.22,	7,	.571,	.860
IBTS ,	6.,	.687,	.901,	1.31,	2,	.001,	1.167

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
9.,	.14,	.05,	22,	.373,	.867

Table 2.2.10 : Fishing Mortalities, Conventional VPA initiated by XSA F's, Skagerrak Cod

Run title : Cod in Skagerrak

At 10/10/1994 17:15

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
1,	.2492,	.0198,	.0387,	.0311,	.0725,	.1033,
2,	.9319,	.4211,	.4607,	.6789,	.5759,	.7069,
3,	1.1101,	.6917,	1.2171,	1.0951,	1.2366,	1.2470,
4,	.8825,	.5391,	1.2511,	1.2176,	1.5234,	1.2782,
5,	.5803,	.6035,	.9938,	.7058,	.9271,	1.0146,
6,	.9661,	.1992,	.6361,	.3078,	1.3978,	1.0607,
7,	.8831,	.5077,	1.0234,	.8308,	1.2700,	1.1486,
+gp,	.8831,	.5077,	1.0234,	.8308,	1.2700,	1.1486,
FBAR 3- 5,	.8576,	.6114,	1.1540,	1.0062,	1.2290,	1.1799,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	FBAR 91-93
AGE											
1,	.0259,	.0891,	.1148,	.0174,	.0674,	.0724,	.0989,	.0350,	.0760,	.0220,	.0444,
2,	.7442,	.6547,	.6889,	.8096,	.4170,	.7084,	.9090,	.5712,	.6508,	.3535,	.5252,
3,	1.0342,	.7538,	1.3678,	1.0757,	1.0451,	1.3648,	1.1003,	.9373,	.6920,	.6932,	.7742,
4,	1.0764,	.9438,	1.9057,	.7499,	.9761,	1.1089,	.9152,	1.0273,	.7592,	.7656,	.8507,
5,	.8087,	1.1046,	1.4739,	.8142,	.5247,	.8864,	1.1544,	1.1047,	.8852,	.6910,	.8936,
6,	.7355,	1.1093,	1.2478,	1.6873,	.9837,	.8701,	.6889,	.6953,	.9778,	.7260,	.7997,
7,	.9122,	.9760,	1.4967,	1.9038,	.9952,	1.0685,	1.6352,	1.5178,	1.0431,	.8670,	1.1426,
+gp,	.9122,	.9760,	1.4967,	1.9038,	.9952,	1.0685,	1.6352,	1.5178,	1.0431,	.8670,	
0 FBAR 3- 5,	.9731,	.9341,	1.5825,	.8799,	.8487,	1.1200,	1.0566,	1.0231,	.7788,	.7166,	

1

Table 2.2.11 : Population Numbers, Conventional VPA initiated by XSA's F's, Skagerrak Cod

Run title : Cod in Skagerrak

At 10/10/1994 17:15

Traditional vpa using file input for terminal F

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
1,	21607,	24363,	31001,	13990,	17012,	19874,
2,	20031,	13789,	19557,	24419,	11103,	12954,
3,	4669,	6459,	7409,	10101,	10140,	5110,
4,	1438,	1260,	2648,	1796,	2766,	2411,
5,	452,	487,	602,	620,	435,	494,
6,	291,	207,	218,	182,	251,	141,
7,	82,	91,	139,	95,	110,	51,
+gp,	96,	77,	19,	12,	41,	109,
TOTAL,	48665,	46731,	61592,	51215,	41857,	41143,

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	GMST 78-91	AMST 78-91
AGE													
1,	14684,	11997,	33030,	10563,	17508,	12534,	9896,	13834,	26976,	25698,	0,	16799,	17992,
2,	14674,	11714,	8985,	24110,	8499,	13400,	9546,	7339,	10937,	20470,	20582,	13337,	14294,
3,	5230,	5708,	4983,	3694,	8785,	4586,	5403,	3149,	3394,	4671,	11769,	5758,	6102,
4,	1202,	1522,	2199,	1039,	1031,	2529,	959,	1472,	1010,	1391,	1912,	1624,	1734,
5,	550,	335,	485,	268,	402,	318,	683,	314,	431,	387,	530,	444,	460,
6,	147,	200,	91,	91,	97,	195,	107,	176,	85,	146,	159,	160,	171,
7,	40,	58,	54,	21,	14,	30,	67,	44,	72,	26,	58,	54,	64,
+gp,	31,	16,	29,	24,	22,	20,	44,	21,	20,	32,	20,		
TOTAL,	36558,	31551,	49857,	39810,	36359,	33612,	26705,	26350,	42926,	52820,	35029,		

0
1

<u>Table 2.2.12 :</u> Input data to RCT3 Analysis
Cod in Skagerrak

IBTS, skagerrak age 1

2 15 2

'yc'	'VPA'	'age1'	'age2'
1979	31001	79	85
1980	13990	15	31
1981	17012	36	30.4
1982	19874	28.4	18.6
1983	14684	23.4	51.8
1984	11997	13.5	10.5
1985	33030	77.9	113
1986	10563	5.4	18.1
1987	17508	77	23.8
1988	12534	56	9.6
1989	9896	30.9	25.3
1990	13834	9.3	5
1991	-1	96	16
1992	-1	110	7
1993	-1	82	-1

IBTS, skagerrak age 2

2 15 2

'yc'	'VPA'	'age1'	'age2'
1979	24419	79	85
1980	11103	15	31
1981	12954	36	30.4
1982	14674	28.4	18.6
1983	11714	23.4	51.8
1984	8985	13.5	10.5
1985	24110	77.9	113
1986	8499	5.4	18.1
1987	13400	77	23.8
1988	9546	56	9.6
1989	7339	30.9	25.3
1990	10937	9.3	5
1991	-1	96	16
1992	-1	110	7
1993	-1	82	-1

Table 2.2.12 cont.. ,: RCT3 results, Skagerrak Cod, age 2

Analysis by RCT3 ver3.1 of data from file :
g:\ndwg94\iiia\rct3age2

IBTS, skagerrak age 2

Data for 2 surveys over 15 years : 1979 - 1993

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 = 1990

	Regression				Prediction				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
age1	.74	6.83	.50	.403	11	2.33	8.57	.644	.182
age2	.67	7.15	.35	.588	11	1.79	8.35	.486	.320
					VPA Mean =		9.40	.390	.498

Yearclass = 1991

	Regression				Prediction				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
age1	.75	6.81	.52	.393	11	4.57	10.23	.666	.157
age2	.67	7.15	.35	.582	11	2.83	9.05	.425	.385
					VPA Mean =		9.39	.390	.458

Yearclass = 1992

	Regression				Prediction				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
age1	.75	6.78	.53	.382	11	4.71	10.33	.709	.156
age2	.67	7.14	.36	.576	11	2.08	8.54	.488	.329
					VPA Mean =		9.39	.390	.515

Yearclass = 1993

	Regression				Prediction				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
age1	.76	6.75	.55	.369	11	4.42	10.11	.716	.230
age2									
					VPA Mean =		9.37	.391	.770

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	7433	8.91	.28	.35	1.59		
1991	12018	9.39	.26	.28	1.12		
1992	10456	9.26	.28	.42	2.27		
1993	13939	9.54	.34	.31	.80		

Continued

Table 2.2. 12 cont..: **RCT3 Results, Cod in Skagerrak, Age 1**

Analysis by RCT3 ver3.1 of data from file :
g:\ndwg94\iiia\rct3age1

IBTS, skagerrak age 1

Data for 2 surveys over 15 years : 1979 - 1993

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 = 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
age1	.73	7.15	.48	.438	11	2.33	8.85	.611	.211
age2	.70	7.32	.37	.564	11	1.79	8.58	.521	.290
					VPA Mean =		9.67	.398	.499

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
age1	.69	7.34	.48	.407	12	4.57	10.50	.615	.197
age2	.65	7.58	.44	.458	12	2.83	9.42	.510	.286
					VPA Mean =		9.65	.379	.518

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
age1	.70	7.32	.50	.394	12	4.71	10.59	.652	.188
age2	.65	7.57	.44	.449	12	2.08	8.93	.561	.254
					VPA Mean =		9.64	.378	.559

Yearclass = 1993

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	----------	---------I	I----------	Prediction	----------	----------	---------I
age1	.70	7.30	.51	.379	12	4.42	10.39	.659	.247
age2									
					VPA Mean =		9.63	.377	.753

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	9697	9.18	.28	.35	1.57	13835	9.53
1991	17163	9.75	.27	.27	.99		
1992	15366	9.64	.28	.39	1.87		
1993	18391	9.82	.33	.33	1.00		

Table 2.2.13 **Long term stock trends from conventional VPA initiated by terminal F's from XSA tuning, Skagerrak Cod.**

Run title : Cod in Skagerrak

At 10/10/1994 17:15

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

0, 0	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 5,
1978,	21607,	50144,	11897,	24466,	2.0565,	.8576,
1979,	24363,	48666,	11484,	15499,	1.3497,	.6114,
1980,	31001,	72267,	15346,	24006,	1.5643,	1.1540,
1981,	13990,	64189,	15284,	28913,	1.8917,	1.0062,
1982,	17012,	57073,	15545,	26110,	1.6797,	1.2290,
1983,	19874,	48620,	13413,	21784,	1.6241,	1.1799,
1984,	14684,	46760,	10787,	19891,	1.8440,	.9731,
1985,	11997,	42090,	10723,	16628,	1.5507,	.9341,
1986,	33030,	52451,	10095,	20103,	1.9913,	1.5825,
1987,	10563,	45098,	7984,	19900,	2.4924,	.8799,
1988,	17508,	44310,	9523,	16952,	1.7802,	.8487,
1989,	12534,	41728,	11223,	18838,	1.6785,	1.1200,
1990,	9896,	36728,	9817,	17800,	1.8132,	1.0566,
1991,	13834,	32061,	8319,	12059,	1.4496,	1.0231,
1992,	26976,	46495,	8342,	14002,	1.6785,	.7788,
1993,	25698,	62511,	9941,	14737,	1.4824,	.7166,
Arith. Mean ,	19035,	49449,	11233,	19481,	1.7454,	.9970,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

1

TABLE 2.2.14; Cod, Skagerrak Input for Catch Prediction

Age	1994 Stock Numbers (10**-3)	F and mean Wt at age used in prediction: Scaled Mean F 1993 - 1993	Mean Wt. at age (kg) 1987 - 1993: Stock	Catch	M and maturity: M	P. mat
1	18391	.022	.640	.640	.200	.010
2	10456	.354	1.156	1.156	.200	.050
3	11856	.693	1.991	1.991	.200	.230
4	1937	.766	3.464	3.464	.200	.620
5	537	.691	5.326	5.326	.200	.860
6	161	.726	7.426	7.426	.200	1.000
7	59	.867	9.516	9.516	.200	1.000
8	20	.867	10.871	10.871	.200	1.000

Mean F	(3 - 5)
Unscaled	.717
Scaled	.717

Recruits at age 1 in 1995 = 16799
Recruits at age 1 in 1996 = 16799

Stock numbers in 1994 are VPA survivors.
These are overwritten at Age 1 Age 2
1

Table 2.2.15: **Yield per Recruit and SSB per Recruit for Cod in Skagerrak.**

Yield per Recruit : Cod : Skagerrak

alpha,	Tot F,	Tot Y/R,
.00,	.0000,	.0000,
.10,	.0717,	768.9173,
.20,	.1433,	1188.1251,
.30,	.2150,	1401.6568,
.40,	.2867,	1495.9888,
.50,	.3583,	1522.7694,
.60,	.4300,	1512.6190,
.70,	.5017,	1483.5004,
.80,	.5733,	1445.7895,
.90,	.6450,	1405.3408,
1.00,	.7167,	1365.3356,
1.10,	.7883,	1327.3935,
1.20,	.8600,	1292.2368,
1.30,	.9317,	1260.0856,
1.40,	1.0033,	1230.8903,
1.50,	1.0750,	1204.4666,
1.60,	1.1467,	1180.5729,
1.70,	1.2183,	1158.9529,
1.80,	1.2900,	1139.3578,
1.90,	1.3617,	1121.5575,
2.00,	1.4333,	1105.3449,

SSB per Recruit

alpha,	Tot F,	Tot SSB/R,
.00,	.0000,	11876.2351,
.10,	.0717,	9089.7125,
.20,	.1433,	7036.1431,
.30,	.2150,	5509.7170,
.40,	.2867,	4365.0102,
.50,	.3583,	3498.7002,
.60,	.4300,	2836.9495,
.70,	.5017,	2326.6685,
.80,	.5733,	1929.4384,
.90,	.6450,	1617.2728,
1.00,	.7167,	1369.6427,
1.10,	.7883,	1171.3817,
1.20,	.8600,	1011.2040,
1.30,	.9317,	880.6488,
1.40,	1.0033,	773.3254,
1.50,	1.0750,	684.3702,
1.60,	1.1467,	610.0542,
1.70,	1.2183,	547.4963,
1.80,	1.2900,	494.4542,
1.90,	1.3617,	449.1701,
2.00,	1.4333,	410.2555,

Table 2.2.16 .Input data for catch forecast and linear sensitivity analysis. Cod in Skagerrak.

Populations in 1994			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	18391	.23	WS1	.64	.12	M1	.20	.10	MT1	.01	.10
N2	10456	.45	WS2	1.16	.06	M2	.20	.10	MT2	.05	.10
N3	11856	.18	WS3	1.99	.10	M3	.20	.10	MT3	.23	.10
N4	1936	.13	WS4	3.46	.09	M4	.20	.10	MT4	.62	.10
N5	536	.11	WS5	5.33	.09	M5	.20	.10	MT5	.86	.10
N6	161	.13	WS6	7.43	.12	M6	.20	.10	MT6	1.00	.10
N7	59	.13	WS7	9.52	.07	M7	.20	.10	MT7	1.00	.00
N8	20	.14	WS8	10.87	.16	M8	.20	.10	MT8	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.02	.53	WH1	.64	.12
sH2	.35	.27	WH2	1.16	.06
sH3	.69	.14	WH3	1.99	.10
sH4	.77	.11	WH4	3.46	.09
sH5	.69	.20	WH5	5.33	.09
sH6	.73	.42	WH6	7.43	.12
sH7	.87	.28	WH7	9.52	.07
sH8	.87	.28	WH8	10.87	.16

Year effect M			HC relative eff		
Labl	Value	CV	Labl	Value	CV
K94	1.00	.10	HF94	1.00	.17
K95	1.00	.10	HF95	1.00	.17
K96	1.00	.10	HF96	1.00	.17

Recruitment		
Labl	Value	CV
R95	16799	.23
R96	16799	.23

Stock numbers in 1994 are VPA survivors.

These are overwritten at Age 1 Age 2

Table 2.2.17. Cod in Skagerrak
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 1994	1995						
Mean F Ages H.cons 3 to 5	.72	.00	.29	.43	.50	.57	.72	.86
Effort relative to 1993 H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Biomass at start of year								
Total	59	63	63	63	63	63	63	63
Spawning	15	20	20	20	20	20	20	20
Catch weight (,000t) H.cons	20	0	10	15	16	18	22	25
Biomass at start of 1996								
Total		95	81	75	72	69	64	60
Spawning		42	32	28	26	24	21	19

	Year 1994	1995						
Effort relative to 1993 H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Est. Coeff. of Variation								
Biomass at start of year								
Total	.14	.15	.15	.15	.15	.15	.15	.15
Spawning	.11	.19	.19	.19	.19	.19	.19	.19
Catch weight H.cons	.20	.00	.41	.29	.26	.24	.21	.20
Biomass at start of 1996								
Total		.14	.15	.15	.15	.15	.15	.15
Spawning		.19	.22	.22	.22	.22	.22	.23

Table_____.Cod Skagerrak
Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Total
1	18391	363	363
2	10456	2842	2842
3	11856	5434	5434
4	1936	951	951
5	536	245	245
6	161	76	76
7	59	31	31
8	20	11	11
Wt	59	20	20

Continued

Table 2.2.17 cont...

Forecast for year 1995
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	16799	331	331
2	14730	4003	4003
3	6009	2754	2754
4	4854	2384	2384
5	737	337	337
6	220	104	104
7	64	34	34
8	27	14	14
Wt	63	22	22

Table 2.2.18. Cod Skagerrak. Catch in 1994 constrained by TAC of 15.500 tons
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

		Year						
	1994	1995						
Mean F Ages H.cons 3 to 5	.52	.00	.29	.43	.50	.57	.72	.86
Effort relative to 1993 H.cons	.72	.00	.40	.60	.70	.80	1.00	1.20
Biomass at start of year								
Total	59	69	69	69	69	69	69	69
Spawning	15	23	23	23	23	23	23	23
Catch weight (,000t) H.cons	16	0	12	17	19	21	25	28
Biomass at start of 1996								
Total		103	87	80	77	74	68	64
Spawning		48	37	32	30	28	25	22

		Year						
	1994	1995						
Effort relative to 1993 H.cons	.72	.00	.40	.60	.70	.80	1.00	1.20
Est. Coeff. of Variation								
Biomass at start of year								
Total	.14	.15	.15	.15	.15	.15	.15	.15
Spawning	.11	.18	.18	.18	.18	.18	.18	.18
Catch weight H.cons	.24	.00	.41	.29	.26	.24	.21	.20
Biomass at start of 1996								
Total		.14	.15	.15	.15	.15	.15	.15
Spawning		.19	.22	.22	.22	.22	.22	.22

Table_____.Cod Skagerrak, catch constraint in 1994 of 15,500 tonnes applied
Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons= .72

Populations		Catch number	
Age	Stock No.	H.Cons	Total
1	18391	262	262
2	10456	2140	2140
3	11856	4254	4254
4	1936	750	750
5	536	192	192
6	161	60	60
7	59	25	25
8	20	9	9
Wt	59	16	16

Continued

Table 2.2.18 cont..

Forecast for year 1995
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	16799	331	331
2	14821	4028	4028
3	6636	3041	3041
4	5895	2896	2896
5	913	418	418
6	267	126	126
7	78	42	42
8	35	18	18
Wt	69	25	25

Table 2.2.19

Stock: Cod in the Skagerrak (part of Division IIIa)

Assessment Quality Control Diagram 1

Average F(3-6,u)							
Date of assessment	Year						
	1987	1988	1989	1990	1991	1992	1993
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		
1993	1.04	0.83	0.98	0.88	0.85	0.75	
1994	1.08	0.88	1.05	0.96	0.94	0.83	0.72

Remarks: Tuning without F-shrinkage in 1993..

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F								
Date of assessment	Year							
	1988	1989	1990	1991	1992	1993	1994	1995
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		
1993				12.2	15.1	15.3	18.8	
1994					15.0	16.1	20	22
					SQC[1]	SQC[2]	Current	Forecast

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

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

where $F(y)$, $F(y-1) \wedge F(y-2)$ *are as estimated* $\in$ *the assessment made* $\in$ *year* $(y+1)$.

Remarks: Tuning without F-shrinkage in 1993.

Continued

Table 2.2.19 Continued

Stock: Cod in the Skagerrak (part of Division IIIa)

Assessment Quality Control Diagram 3

Recruitment (age 1) Unit: millions							
Date of assessment	Year class						
	1987	1988	1989	1990	1991	1992	1993
1989	30.0	27.0					
1990	22.3	15.0	16.7				
1991	17.1	14.0	16.4	17.0			
1992	17.8	16.9	16.6[1]	10.2[1]	20.7[1]		
1993	18.0	12.7	16.7	9.8[1]	16.3[1]	20.0[1]	
1994	17.8	12.7	10.0	14.0	27.2	15.4[1]	18.4[1]

[1]RCT3 estimates.

Remarks: Tuning without F-shrinkage in 1993.

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1989	20.8	14.0	24.0[1]	27.2[1]					
1990	21.9	18.6	24.0	17.5[1]	15.6[1]				
1991	23.3	19.5	18.7	15.1	15.5[1]	16.1[1]			
1992	23.5	20.7	21.5	17.5	20.8	19.2[1]	25.9[1]		
1993	23.9	19.8	20.3	15.8	14.7	14.6	19.1[1]	26.4[1]	
1994	9.5	11.2	9.8	8.3	8.3	9.9	14.7	20[1]	21[1]

[1]Forecast.

Remarks: New maturity ogive applied in 1993.

Table 2.2.20 Number of vessel in the Danish fishing fleet registered in ports in or adjacent to Skagerrak. Registered on 30 June each year

Year	Trawlers			Danish Seiners		Gill Netters	
	12 - 16 m	16-21 m	> 21 m	12-16 m	> 16 m	12-16 m	> 16 m
1985	271	142	207	98	95	101	16
1986	266	133	214	99	98	103	14
1987	272	131	216	97	99	104	14
1988	254	120	212	86	97	97	17
1989	240	117	204	81	98	101	17
1990	225	106	195	74	95	104	17
1991	205	98	182	68	90	104	19
1992	184	86	170	62	86	111	19
1993	165	65	150	57	81	116	19
1994	141	54	132	43	61	112	17

Table 2.2.21 Effort (days absent from port) in the Danish Cod fishery in Skagerrak by fleet. Only trips with cod catches included
The weights are backtransformed results from ANOVA analysis, see section 2.2.12.

Fleet	Year							
	1987	1988	1989	1990	1991	1992	1993	Weight
S. Nephr.	7629	6794	7646	7090	5613	4115	3694	0.29
L. Nephr.	3591	3428	4041	4615	3172	1887	1930	0.53
S.Cod	5639	3554	2967	5061	5920	6453	5821	1
L. Cod	7704	5067	4841	9219	8608	8678	8209	1.42
S. Gill	3729	3557	3301	4072	3034	3687	3834	2.7
L. Gill	1371	1187	1496	2451	1499	1672	918	5.46
S. DS	3122	2387	2766	2211	1694	1773	1971	1.18
L. DS.	6317	4451	6480	7097	5964	6287	4631	2.19
Weighted	55766	43186	48736	65182	52889	56004	47404	
Pct of total Danish catch accounted for	50	49	55	61	63	63	65	

S. Nephr	Small Nephrops Trawlers (12- 16 m)
L. Nephr.	Large Nephrops Trawlers (> 16 m)
S. Cod	Small Cod trawlers (12-16 m)
L. Cod	Large Cod trawlers (> 16 m)
S. Gill	Small Gill netters (12-16 m)
L. Gill	Large Gill netters (> 16 m)
S DS	Small Danish seiners (12-16 m)
L. DS	Large Danish seiners (> 16 m)

Fig. 2.2.1 COD in the Skagerrak. Landings, recruitment, fishing mortality and spawning stock biomass.

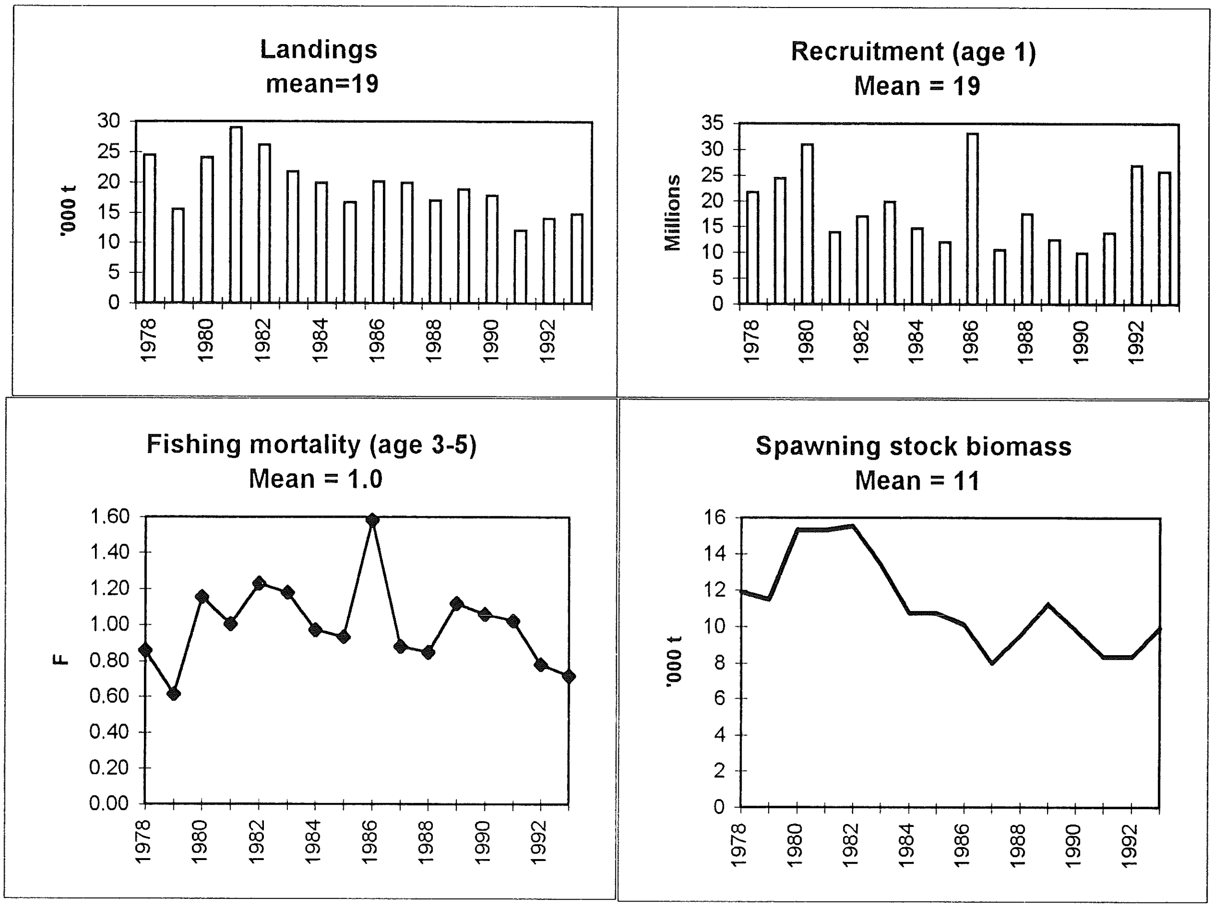


Fig. 2.2.2 COD in the Skagerrak. Log. catchability residuals for different tuning fleets.

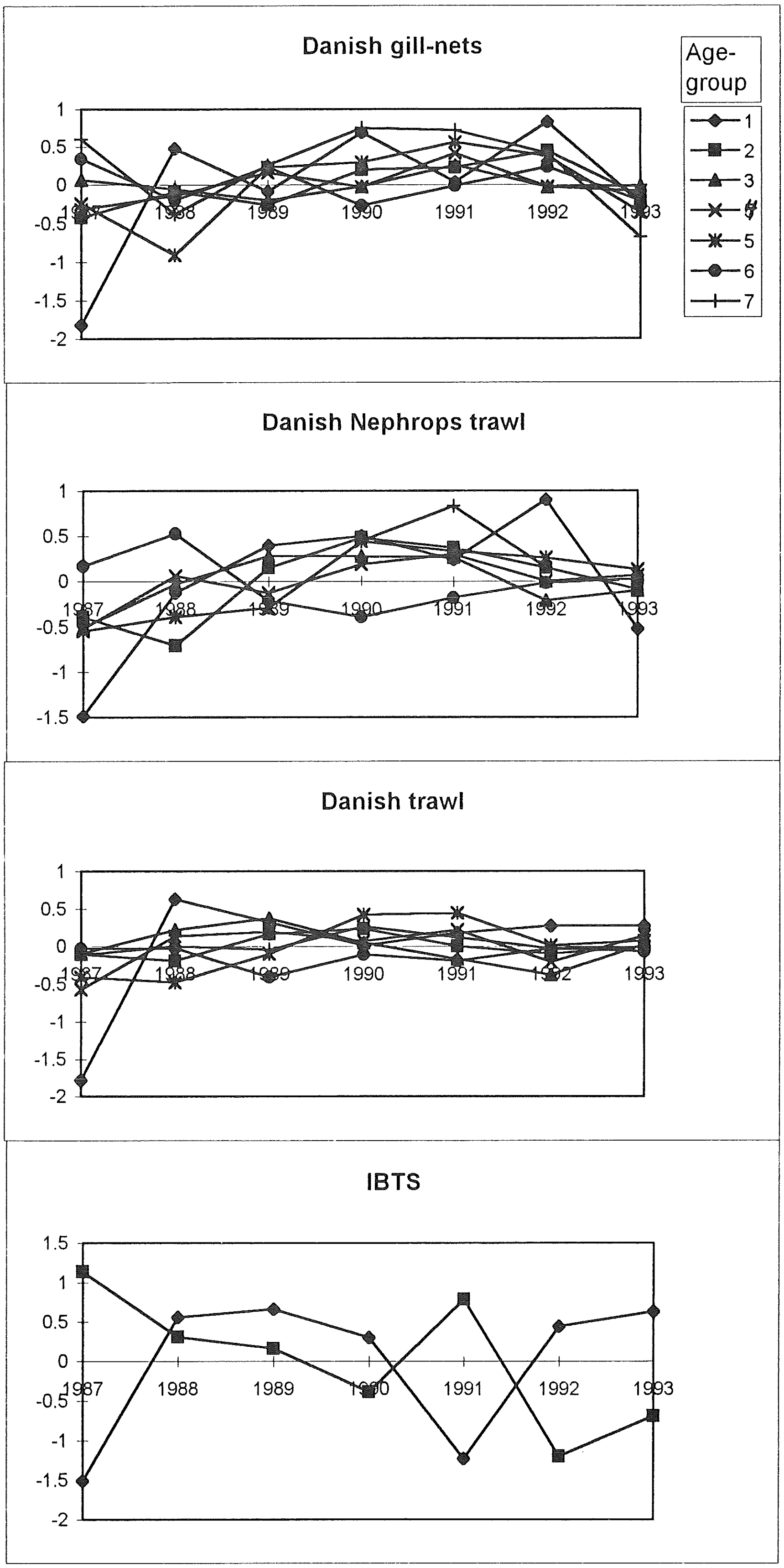


Fig. 2.2.3 COD in the Skagerrak. Retrospective analysis 1993 -1987.

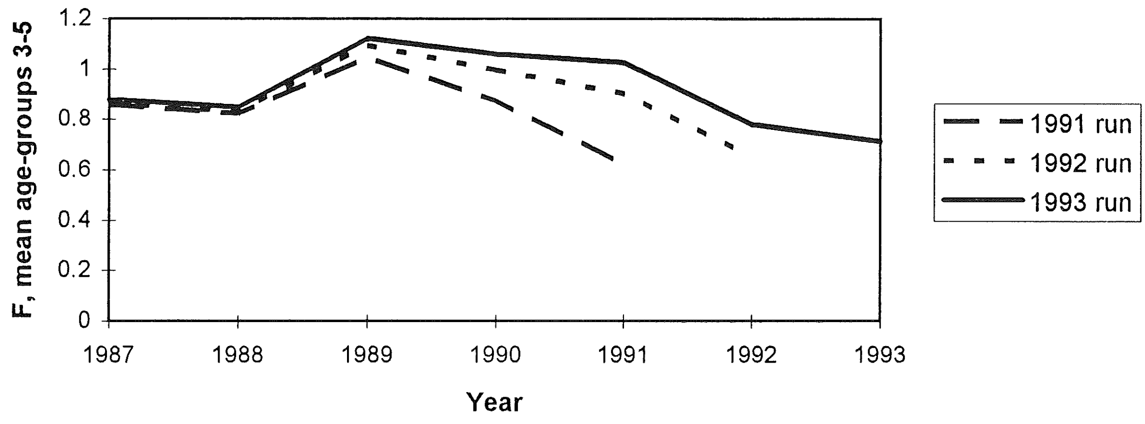


Fig. 2.2.4 Cod in the Skagerrak. Yield per recruit and spawning stock per recruit

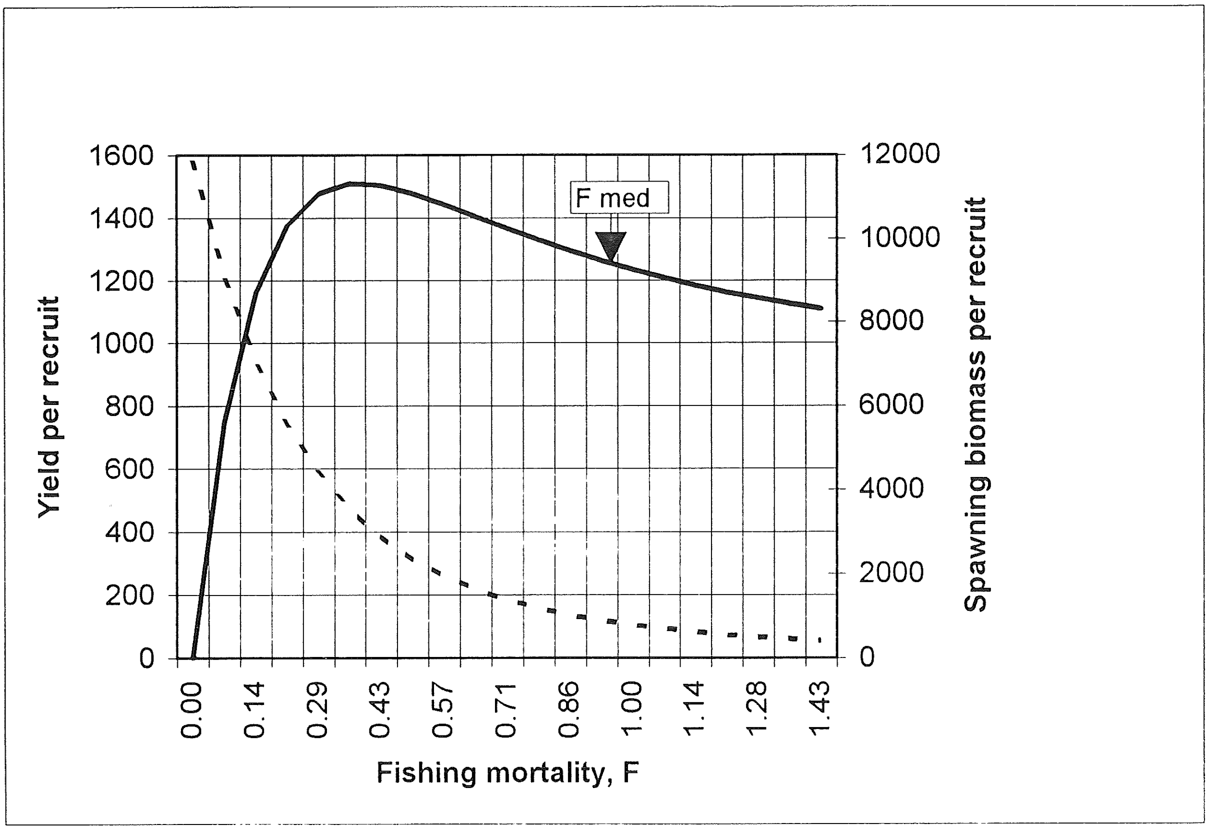


Fig. 2.2.5 COD in the Skagerrak. Recruitment (No. of 1-yr olds) vs. spawning stock biomass.

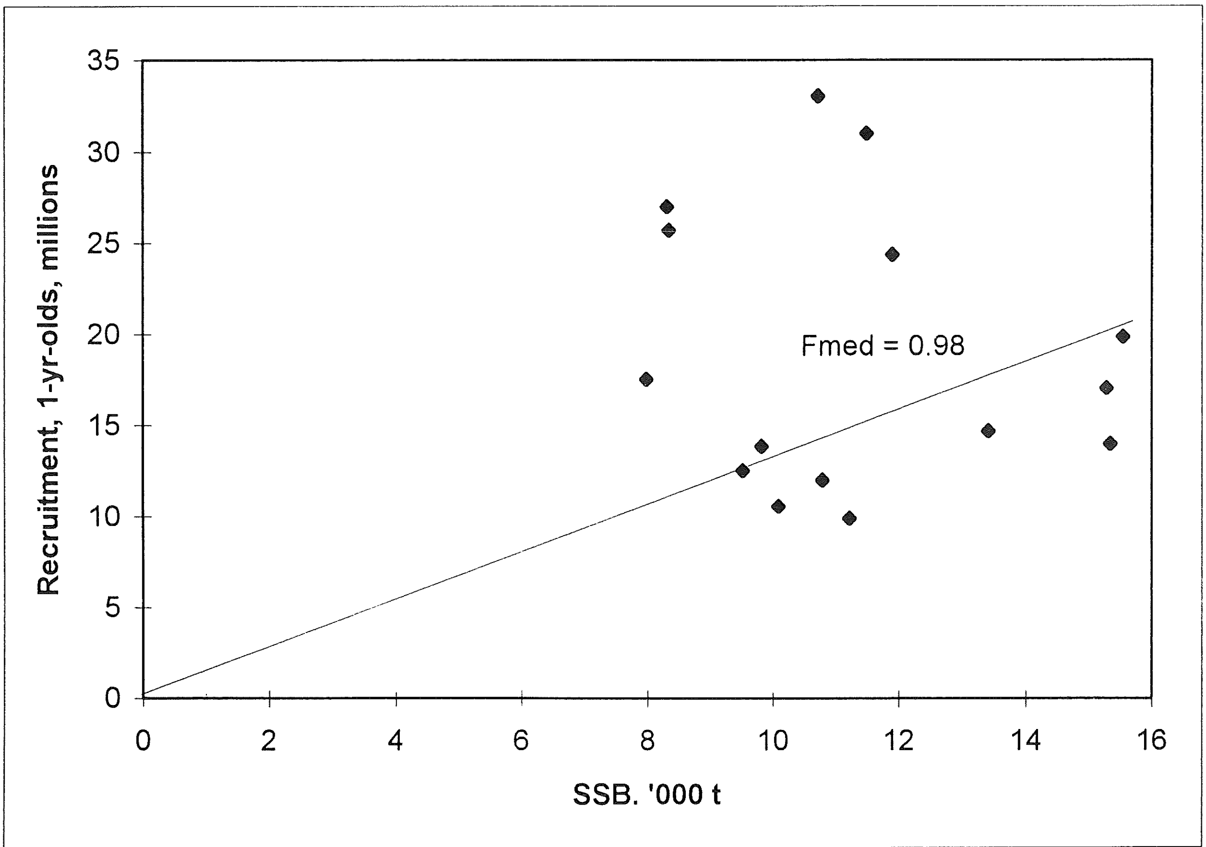


Fig. 2.2.6 COD in the Skagerrak. Sensitivity analysis of short term forecast. Linear sensitivity coefficients (elasticities).
Key to labels is in Table 2.2.16

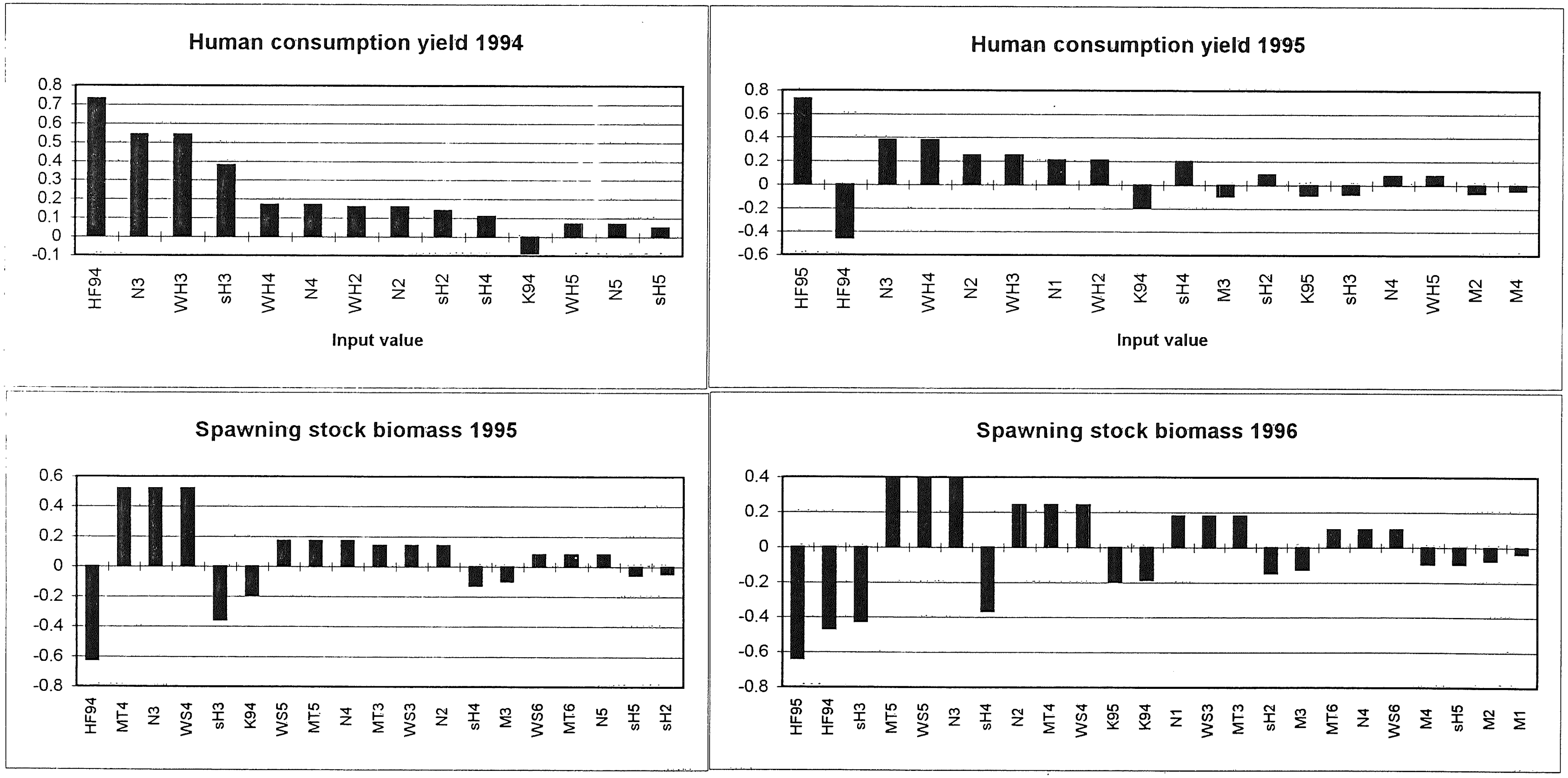


Fig. 2.2.7 COD in the Skagerrak. Sensitivity analysis of short term forcast.
Proportion of total variance contributed by each input value. (See Table 2.2.16 for key to labels)

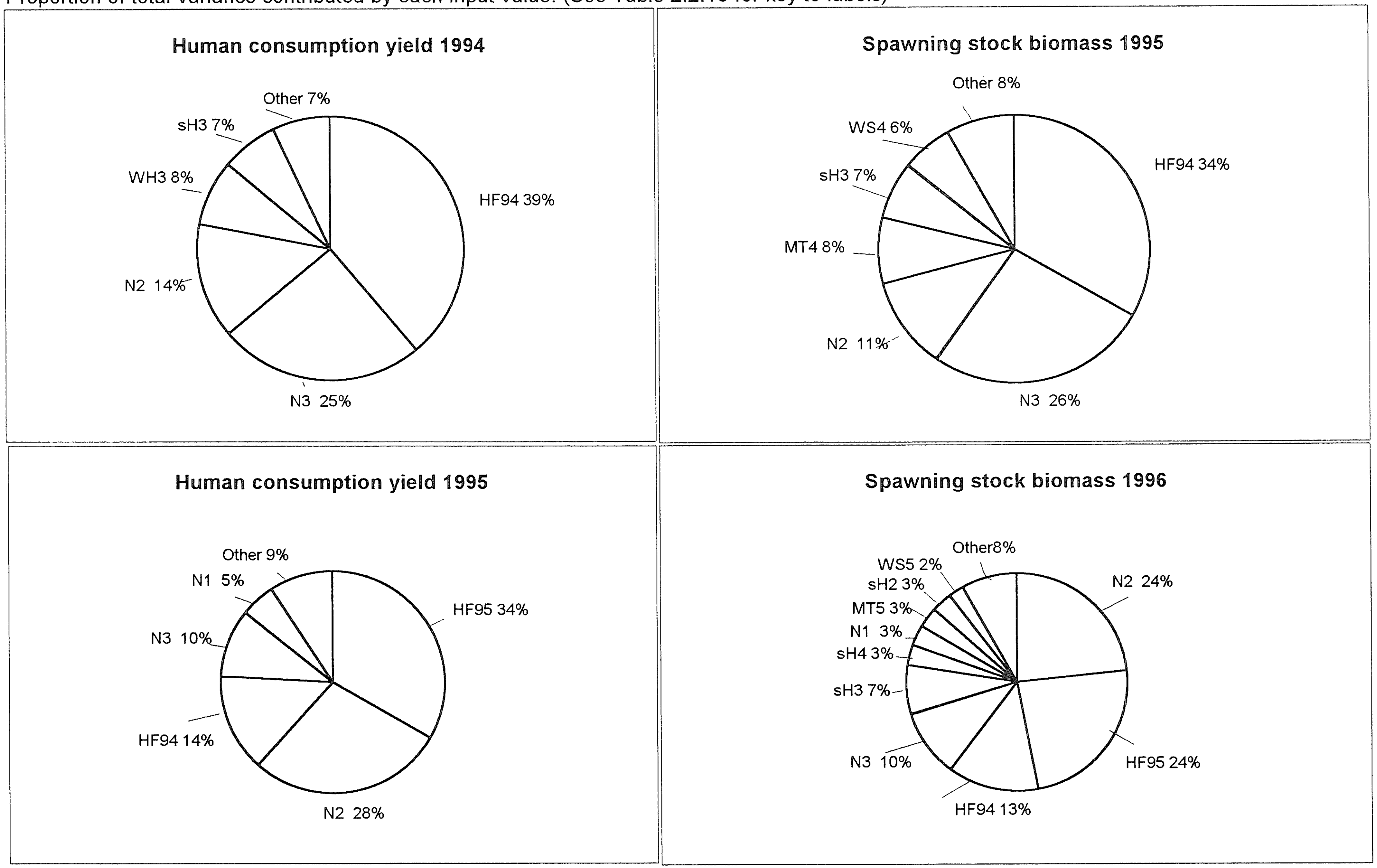


Fig. 2.2.8 COD in the Skagerrak. Sensitivity analysis of short term forecast. Cumulative probability distributions.

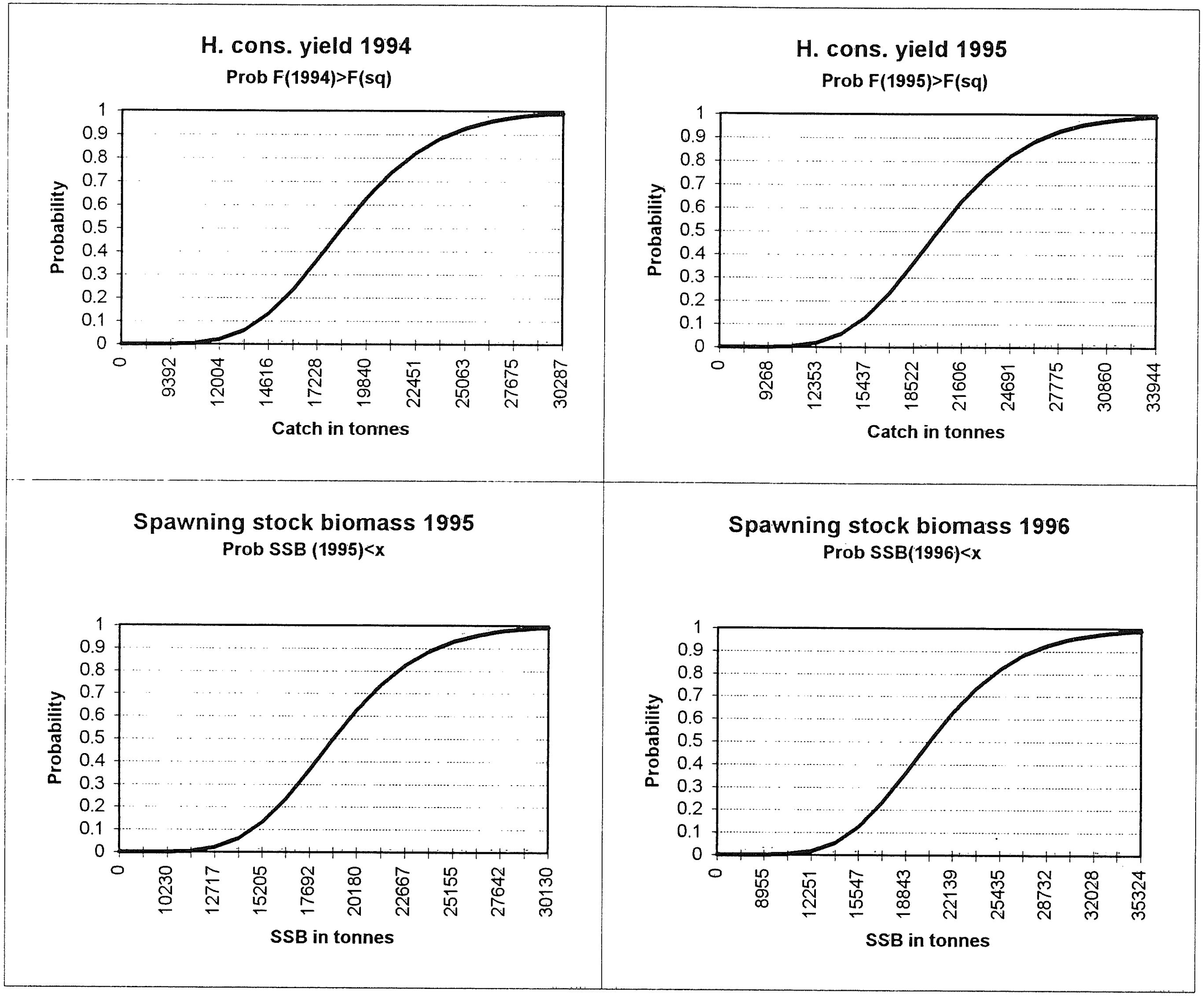


Fig.2.2.9 COD in the Skagerrak. Medium-term simulations.
The upper and lower 5 and 25 % lines are given for each variable.

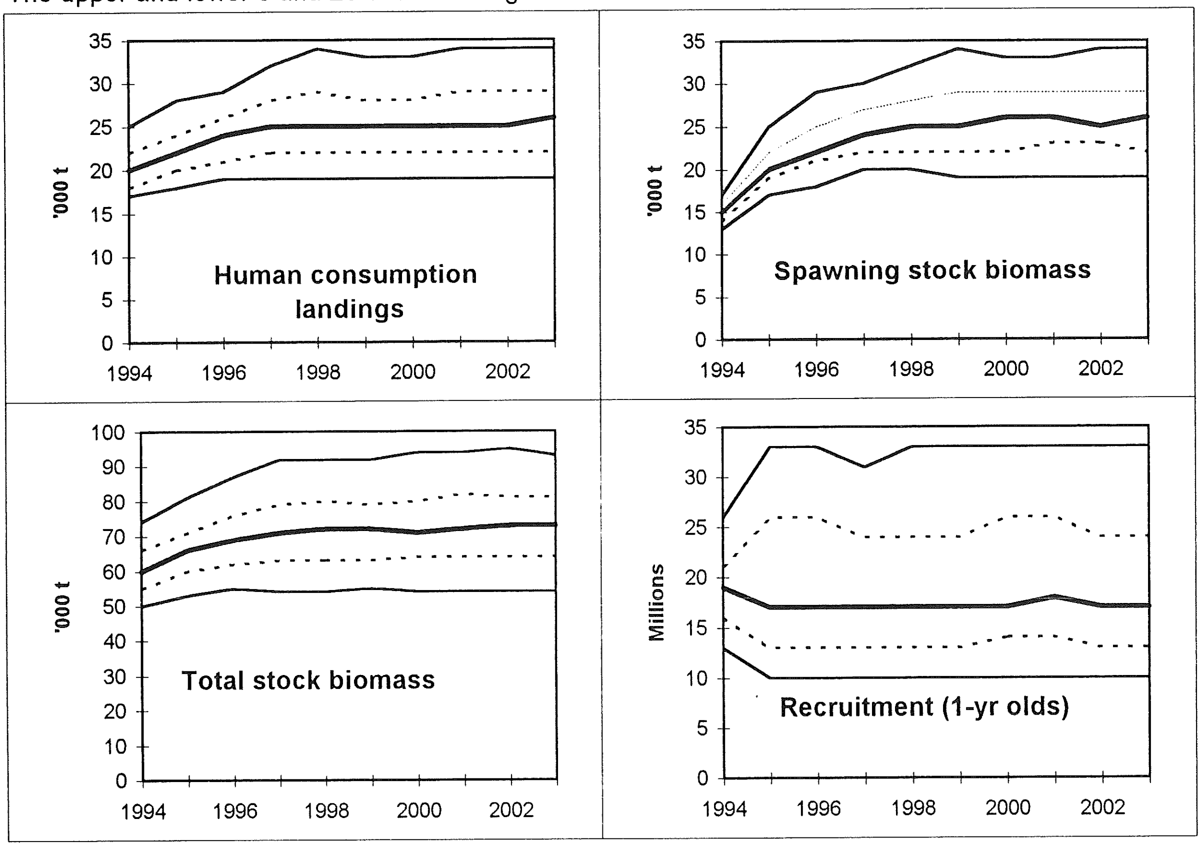


Figure 2.2.10. Cod weights-at-age in the Skagerrak 1993

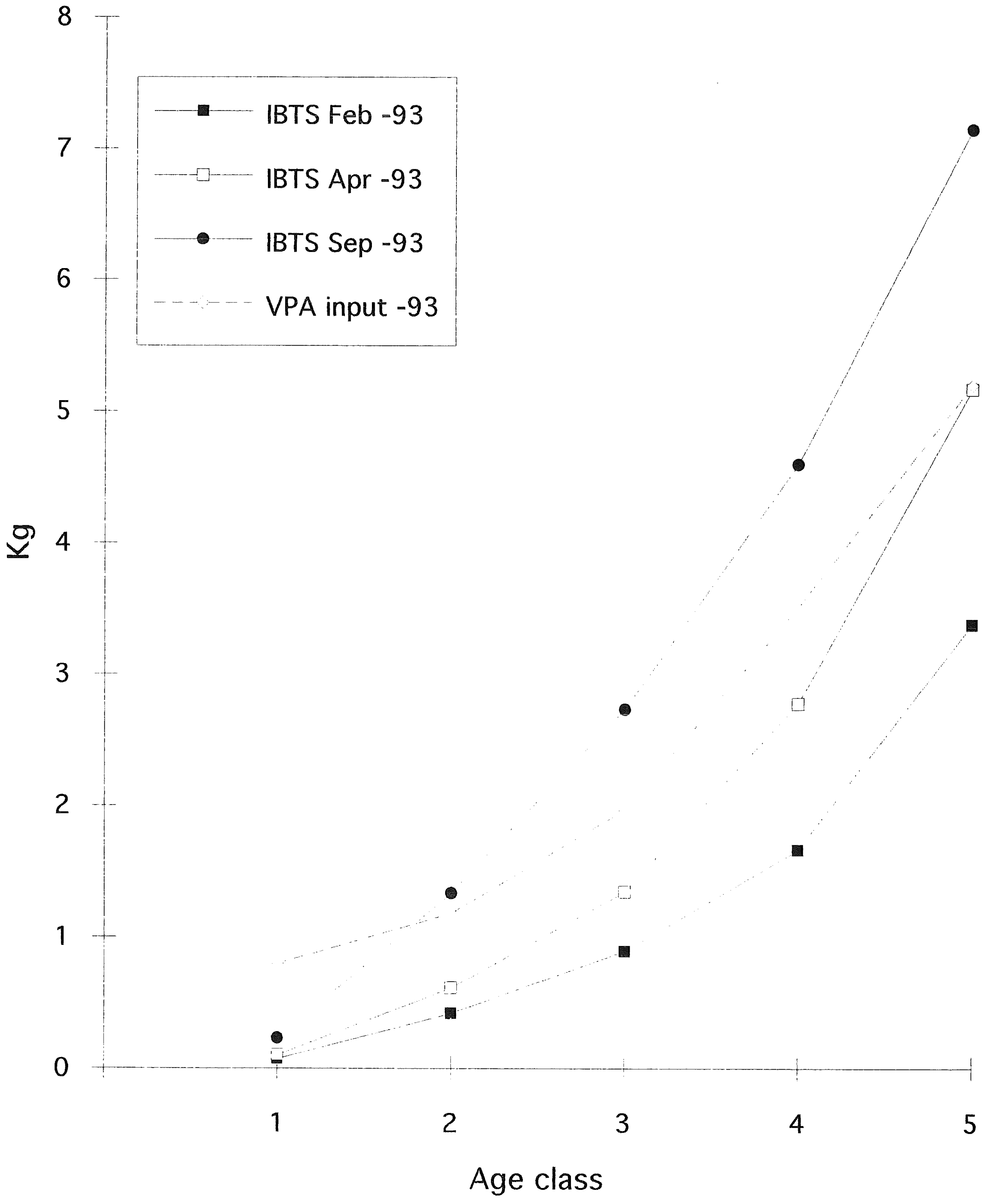
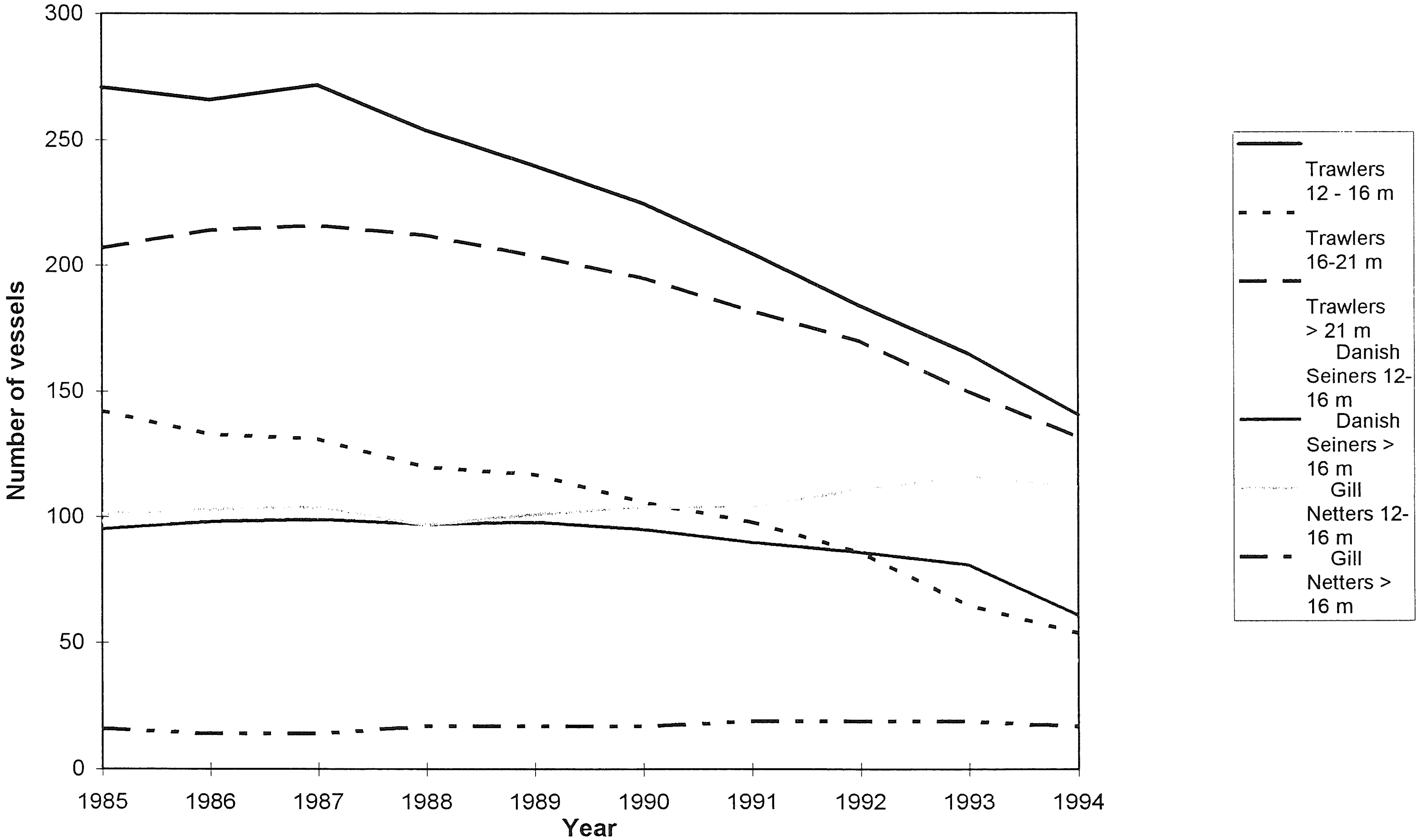


Fig. 2.2.11 Number of vessels registered in Danish ports around Skagerrak



2.3 Haddock

2.3.1 Catch trends

The landings for the period 1975–1993 are presented in Table 2.3.1. After 1983 landings are given separately for human consumption and reduction purposes. About 50% of haddock catches in 1993 came from landings for reduction. Figure 2.3.1 shows trends in landings.

2.3.2 Age composition and weight at age

Age compositions (and weight at age) are available for Danish landings, for human consumption landings for the period 1981–93 and for small-mesh landings for the periods 1981–1986 and 1991–1993. The age compositions are presented in Table 2.3.2.

The age distributions need revision. The 1-group is virtually lacking in the years when the small-mesh fishery was not sampled (1987–1990). This is not considered to reflect the actual fishery.

2.3.3 Research Vessel indices and catch per unit of effort

An index for 1-group haddock in Division IIIa is available from the IBTS February survey (Figure 2.3.1 and Table 2.1.1).

CPUE data for the commercial fisheries are not available.

2.3.4 Long-term trends

Long-term trends in landings and the 1-group index from the IBTS in February are presented in Figure 2.3.1. Total landings reached a maximum of over 15,000 t in 1983 which was associated with the large 1979 year class. In the last decade the catches have been about half this level. In 1993 the total catch was 4,374 t as compared with 9,000 t in 1992. The 1992 IBTS index for 1-group was at that time the highest in the series, and the 1993 index was even higher. In 1994 the index was lower but still above average. The 1991–1993 year classes all seem to be above average.

2.3.5 Comments on assessment

The Division IIIa haddock was not combined with the North Sea haddock. Anon., (1993) found that the recruitment pattern for Division IIIa and North Sea haddock are similar. Also other vital parameters appear to be similar between these two populations. However, no analysis was presented which addressed whether Division IIIa haddock should be assessed as a separate unit or included in the North Sea assessment.

2.4 Whiting

The landings have since 1981 been reported separately for human consumption and reduction purposes. The Danish landings for reduction purposes have been taken in a mixed clupeoid fishery and in an industrial fishery directed at Norway pout and sandeel. This fishery has a by-catch of small, mainly 0-group, whiting. The total catch was 4,560 t in 1993 which is considerably lower than in 1992. About 80 % of the catches came from the industrial fishery. The total landings are shown in Table 2.4.1 and Figure 2.4.1.

IBTS February indices for 1-group whiting have been very high in recent years (Figure 2.4.1), but this is not reflected in the landings. The 1994 index was below average.

No analytical assessment of the stock was possible.

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

Year	Denmark		Total	Norway	Sweden	Others	Total consumption	Total reduction and consumption
	Human consumption	Reduction		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	13,65-	756	608	221	8,010	15,235
1984	5,516	2,707	08,223	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
1992	3,811	4,254	8,065	177	744[2]	14	4,396	9,000
1993	1,570	2,215	3,785	153[1]	436[3]		1,959[1]	4,374[1]

[1]Preliminary.
[2]Includes ~ 350 tonnes landed for reduction.
[3]Includes ~ 200 tonnes landed for reduction.

Table 2.3.2 Haddock in Division IIIa. Catch in numbers ('000).
1987 - 1990 Human consumption fishery only.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1981	30	9903	4962	771	151	84	36	3
1982	314	2299	12055	1113	209	22	11	6
1983	1113	4624	2728	4004	525	63	11	6
1984	18	6554	4481	713	524	91	6	16
1985	0	8279	3687	1049	78	176	29	6
1986	51	903	3722	686	230	33	27	28
1987	381	3282	866	734	122	42	10	6
1988	375	1683	1863	303	158	43	14	16
1989	32	1540	2951	510	91	45	12	6
1990	1040	1347	1576	931	144	43	31	20
1991	7614	2453	1085	460	400	66	12	19
1992	16094	4572	905	284	107	48	7	6
1993	15019	6050	739	116	37	17	10	6

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., 1992b) and updated by the Working Group.

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	881	12,463	13,344	56	557	97	14,054
1992	538	10,675	11,213	67	959	1	12,240
1993[1]	181	3,581	3,762	42	756	1	4,561

[1]Preliminary.

Fig. 2.3.1. HADDOCK in Div. IIIa. Total landings and recruitment index.

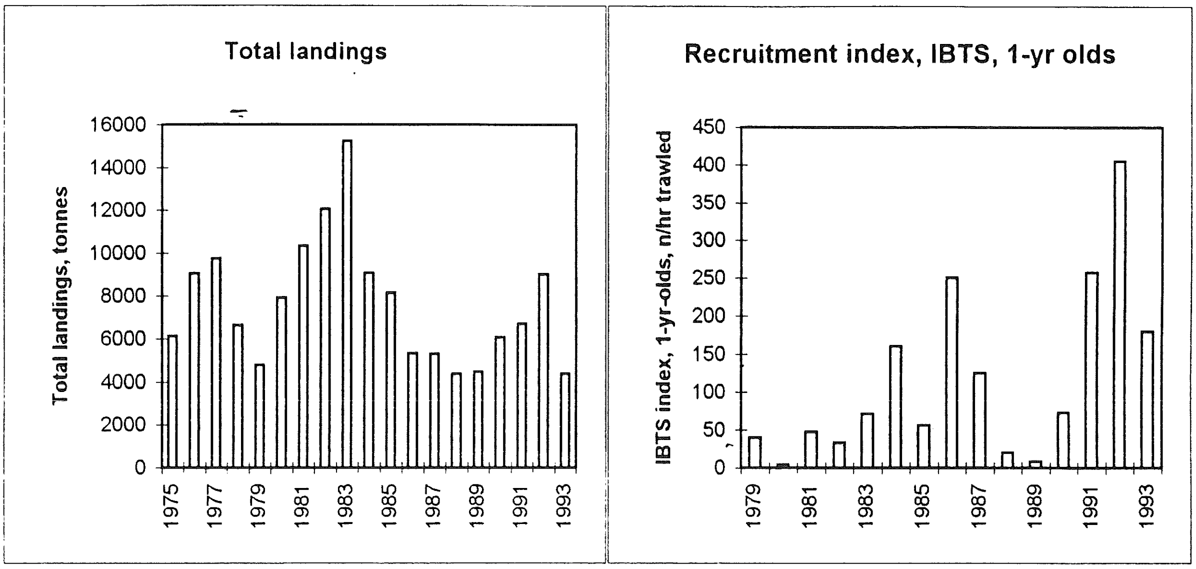
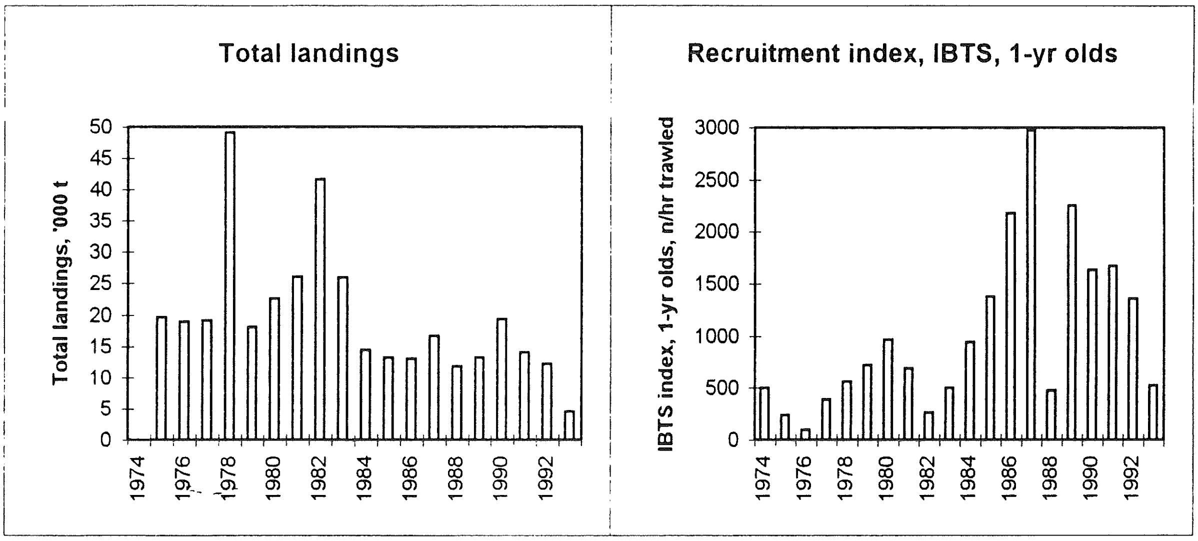


Fig. 2.4.1. WHITING in Div. IIIa. Total landings and recruitment index.



2.5 Plaice

2.5.1 Catch trends

Total international landings in the Kattegat and Skagerrak 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 was a serious source of bias. The major part of the Kattegat landings since 1984 are from the northern part of the Kattegat. The total 1993 catch was 11,300 t. Long-term trends in yield are plotted in Figure 2.5.1.

Division IIIa fisheries in 1993 were affected by TAC constraints for cod and sole and there were unreported catches of these species. There seemed to be no strong urge to land plaice without proper recording in the fishery statistics, but unreported plaice catches may result from illegal activities aimed at landing other species. Also misreporting between areas or misreporting of other species as plaice may invalidate the database. It is, however, not considered that such unreported catches are seriously affecting the quality of the Division IIIa plaice database.

2.5.2 Natural mortality, maturity, age compositions, mean weight at age

As for previous years catch at age data for 1993 were supplied by Denmark accounting for 90 % of the total. These data were until 1993 raised to the total international catch. Mean weights at age for the catches are available for the Danish landings from the Skagerrak and Kattegat separately. The weights at age applied for the combined stock have been calculated as the mean of weights at age in the Kattegat and Skagerrak, weighted by landings. However, as discussed below, these data are considered to be seriously flawed at least for 1993 and possibly for some earlier years as well. Data for 1993 are therefore not raised but given for Denmark only and these data are subject to significant revisions (see Tables 2.5.2 and 2.5.3).

The Working Group observed in its 1993 report that the catch data are not consistent with the assumption of stable exploitation and concluded that either the mortality generated by the fishery is highly variable – making reliable predictions based on procedures used at present impossible – or the sampling data do not reflect the true age composition of the catch.

These problems with the catch–at–age data were further explored between the meetings in 1993 and 1994. The otoliths sampled from Skagerrak catches during the third quarter in 1993 were aged twice by two different groups of readers. On average the two groups of readers differed by more than 1 year. Since the Danish age readings for the Skagerrak for 1993 were done by reader group 1 for the 1st, 2nd and 4th quarters and otoliths from the 3rd quarter were aged by group 2, the ALKs are not internally consistent (see Table 2.5.2).

The Working Group further investigated for which years there may be problems with the ageings. In line with the analysis presented in the 1993 report the Working Group followed the development by age of the catch in numbers for a given year class. Figure 2.5.2 shows this development for year classes 1982–1987 for ages 2 to 7. The catches apparently peak at age 4 or 5 while age group 6, except for the 1986 year class (caught in 1992), is at a much lower level. Similarly the catch of the 1987 year class at age 4 (caught in 1991) and age 5 (caught in 1992) seems very much out of line with the general pattern observed in the data. Taking the problems identified with the age reading procedure into account other years than 1993 and 1992 also need to be reviewed.

The Working Group has therefore refrained from using this database for assessment and projection until the inconsistencies are resolved.

2.5.3 Effort, CPUE, and research vessel indices

2.5.3.1 Catch/effort data for the commercial fisheries

Figure 2.5.4 shows the development in overall effort (days absent from port) in the Danish fleet. The effort of the trip is included if plaice were landed. The figure demonstrates a decrease in effort since 1990 except for gill netters.

The Swedish C/E series were updated (Table 2.5.4). The data are shown for the Skagerrak and Kattegat separately in Figure 2.5.3. This figure shows different trends in CPUE between the Kattegat and the Skagerrak plaice fisheries. At present the fishery is dominated by the catches in Skagerrak.

Age specific CPUE based on log–book information for the Danish fisheries will be available when the ALKs are reliable.

2.5.3.2 Research vessel data

There are no relevant research vessel data available.

2.5.4 Catch–at–age analysis

The catch–at–age analysis presented in Anon., (1993) was based on three Danish commercial catch rate series covering the period 1987–1992. These data series cannot be updated until the age reading problem has been resolved. This is because the tuning data include the ALKs. Therefore, the Working Group did not pursue this analysis.

2.5.5 Conclusion

No analytical assessment was possible at this point in time.

Table 2.5.1 Plaice landings from the Kattegat and Skagerrak (tonnes)
Official figures, excluding misreported landings in the period 1983-1988
See Anon(1992)

Year	Denmark		Sweden		Germany		Belgium	Norway	Total	Total	Total
	Kattegat	Skagerrak	Kattegat	Skagerrak	Kattegat	Skagerrak	Skagerrak	Skagerrak	Kattegat	Skagerrak	IIIa
1972	15504	5095	348	70					15852	5165	21017
1973	10021	3871	231	80					10252	3951	14203
1974	11401	3429	255	70					11656	3499	15155
1975	10158	4888	369	77					10527	4965	15492
1976	9487	9251	271	81					9758	9332	19090
1977	11611	12855	300	142					11911	12997	24908
1978	12685	13383	368	94					13053	13477	26530
1979	9721	11045	281	105					10002	11150	21152
1980	5582	9514	289	92					5871	9606	15477
1981	3803	8115	232	123					4035	8238	12273
1982	2717	7789	201	140					2918	7929	10847
1983	3280	6828	291	170			133	14	3571	7145	10716
1984	3252	7560	323	356	32		27	22	3607	7965	11572
1985	2979	9646	403	296	4		136	18	3386	10096	13482
1986	2468	10653	170	215			505	24	2638	11397	14035
1987	2868	11370	283	222	104		907	25	3255	12524	15779
1988	1818	9781	210	281	2.8		716	41	2030.8	10819	12850
1989	1596	5387	135	320	4	0.1	230	33	1735	5970.1	7705
1990	1831	8726	201	777	2	0.7	471	69	2034	10043.7	12078
1991	1756	5849	267	472	5.6	3.9	315	68	2028.6	6707.9	8737
1992	2071	8522	208	381			537	107	2279	9547	11826
1993	1289	9128	287	175			339	78	1576	9720	11296

Table 2.5.2

LANDINGS IN NUMBER(*10-3) AND MEAN WEIGHT (KG) BY AGE GROUP AND QUARTER.

	PLAICE IN Skagerak IN 1993									
	S									
	QUARTER									
	1		2		3		4		ALL	
	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT
Age										
2					201	0.220	11	0.377	212	0.228
3			36	0.268	850	0.236	17	0.328	903	0.239
4	235	0.244	290	0.243	4225	0.240	157	0.405	4906	0.245
5	815	0.259	1730	0.266	6989	0.264	981	0.294	10514	0.267
6	1276	0.293	3176	0.295	1562	0.343	1709	0.289	7724	0.303
7	1162	0.348	1960	0.373	178	0.571	1804	0.327	5104	0.358
8	348	0.453	544	0.495	169	0.546	413	0.459	1475	0.481
9	39	0.545	96	0.611	42	0.598	71	0.694	248	0.623
10	6	1.137	18	0.756	8	0.702	17	0.820	49	0.820
11	4	1.547	11	0.692			4	1.071	19	0.962
12			4	0.841			1	0.993	5	0.879
13	4	1.427					2	0.746	7	1.183
15	1	1.211			3	0.881			4	0.979
******										
Total	3892	0.321	7863	0.325	14226	0.272	5188	0.329	31169	0.301
Sum of prod.	1248		2559		3867		1706		9380	
Total catch	1190		2508		3768		1662		9128	

Table 2.5.3

LANDINGS IN NUMBER(*10-3) AND MEAN WEIGHT (KG) BY AGE GROUP AND QUARTER.

	PLAICE IN KATTEGAT IN 1993									
	K									
	QUARTER									
	1		2		3		4		ALL	
	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT	NUMBER	MEAN_W-EIGHT
Age										
2	4	0.262	223	0.281	197	0.269	329	0.281	755	0.278
3	144	0.281	56	0.333	331	0.323	510	0.324	1042	0.318
4	268	0.278	41	0.341	137	0.383	211	0.363	657	0.331
5	284	0.326	101	0.309	137	0.430	56	0.491	577	0.363
6	73	0.432	163	0.274	112	0.342	100	0.345	448	0.333
7	21	0.498	71	0.336	106	0.327	57	0.417	255	0.364
8	3	0.454	22	0.525	29	0.428	10	0.634	64	0.495
9	0	1.143	7	0.692	8	0.934	4	1.030	20	0.869
10	3	0.355	4	0.870	9	0.833	5	0.939	20	0.804
11	0	0.907	3	1.101	6	1.000	1	1.529	11	1.097
12			2	1.431	4	1.149	4	1.602	10	1.371
13	0	0.977	2	1.010	8	0.966	1	1.635	11	1.048
14			1	1.459	2	1.359	2	1.248	5	1.328
15	0	2.050	1	1.189	7	0.993	3	2.000	11	1.289
******										
Total	800	0.317	698	0.324	1093	0.366	1295	0.351	3886	0.343
Sum of prod.	253		226		400		455		1335	
Total catch	244		221		391		433		1289	

Table 2.5.4 Plaice in Division IIIa. CPUE in four Swedish fleets.

Year	Nephrops Trawl		Cod Bottom Trawl	
	Skagerrak	Kattegat	Skagerrak	Kattegat
1980	1.73	3.4	2.5	6.12
1981	1.74	4.04	1.74	7.69
1982	1.95	2.92	2.24	9.05
1983	1.98	3.75	2.63	10.25
1984	3.09	4.94	4.54	7.6
1985	3.1	7.93	3.55	9.47
1986	1.81	2.78	2.87	5.05
1987	1.39	4.27	1.9	7.5
1988	1.66	3.96	2.66	7.65
1989	2.36	2.52	3.39	4.72
1990	2.91	3.31	5.62	6.27
1991	1.36	3.82	3.42	6.27
1992	2.18	3.67	2.69	2.77
1993	1.55	1.97	2.69	2.98

Figure 2.5.1 Plaice in Division IIIa. Long-term trends in landings.

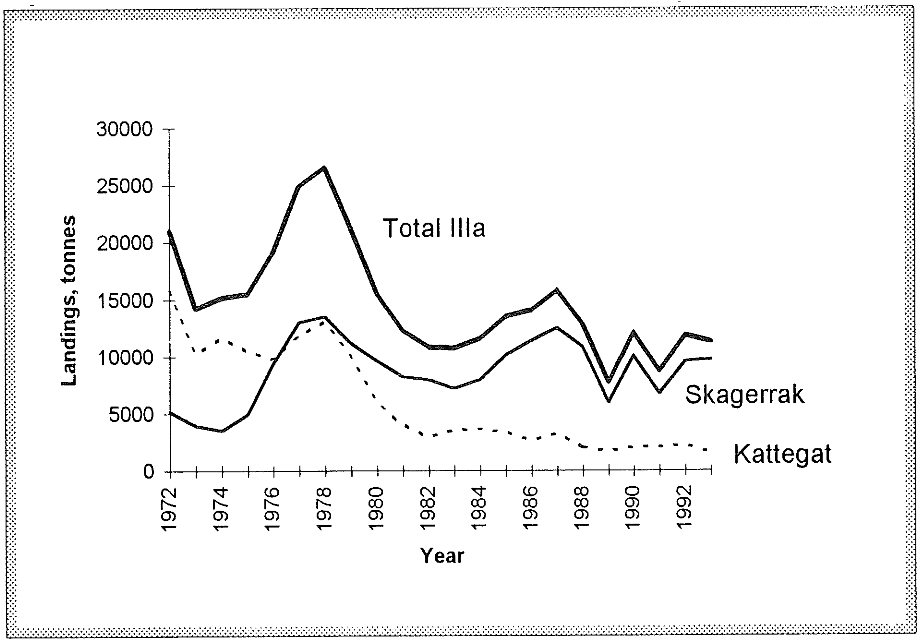


Figure 2.5.2 Plaice in Division IIIa. Total catches by numbers and by year-class.

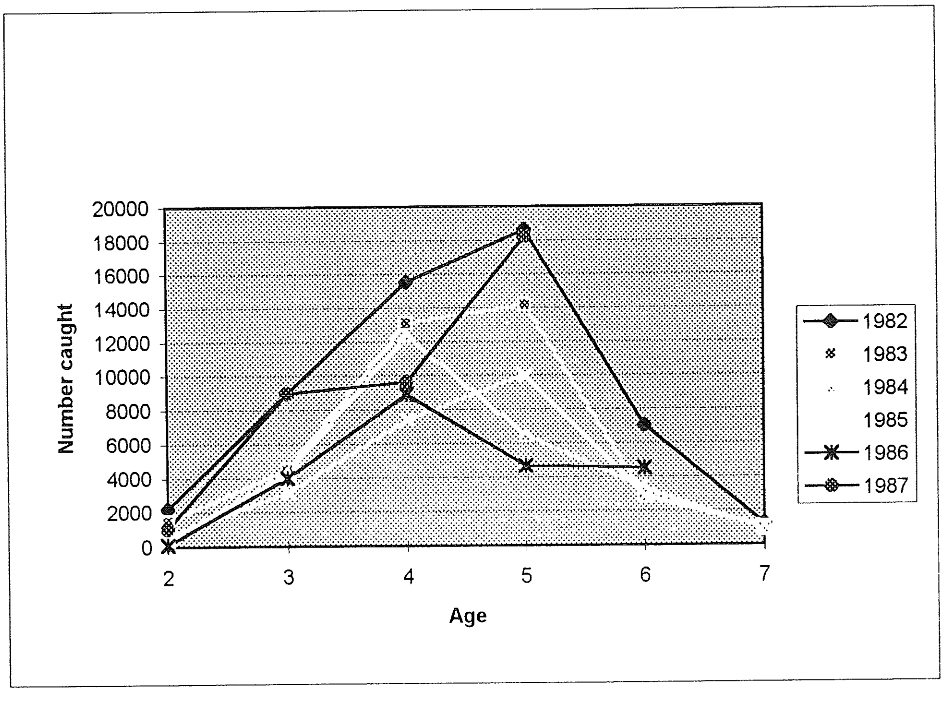


Figure 2.5.3. Swedish CPUE data

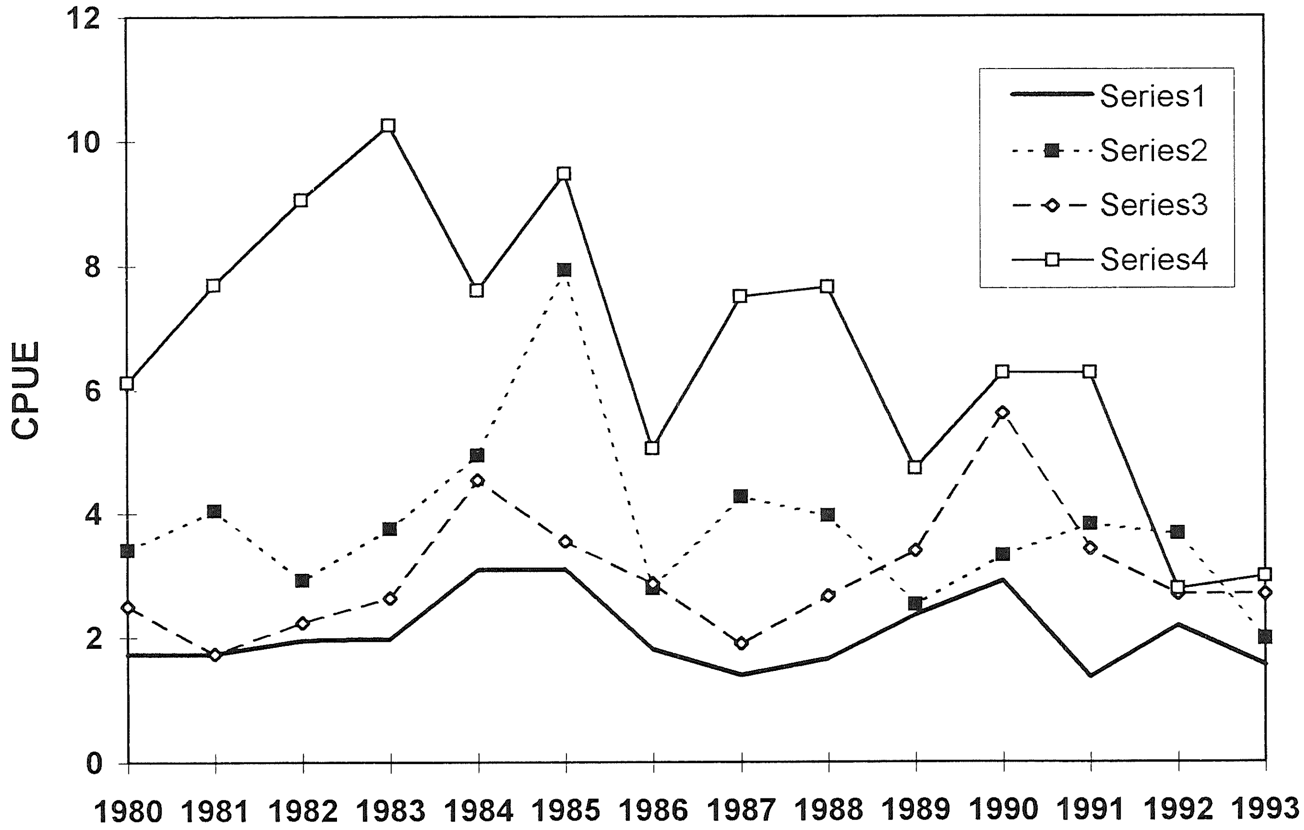
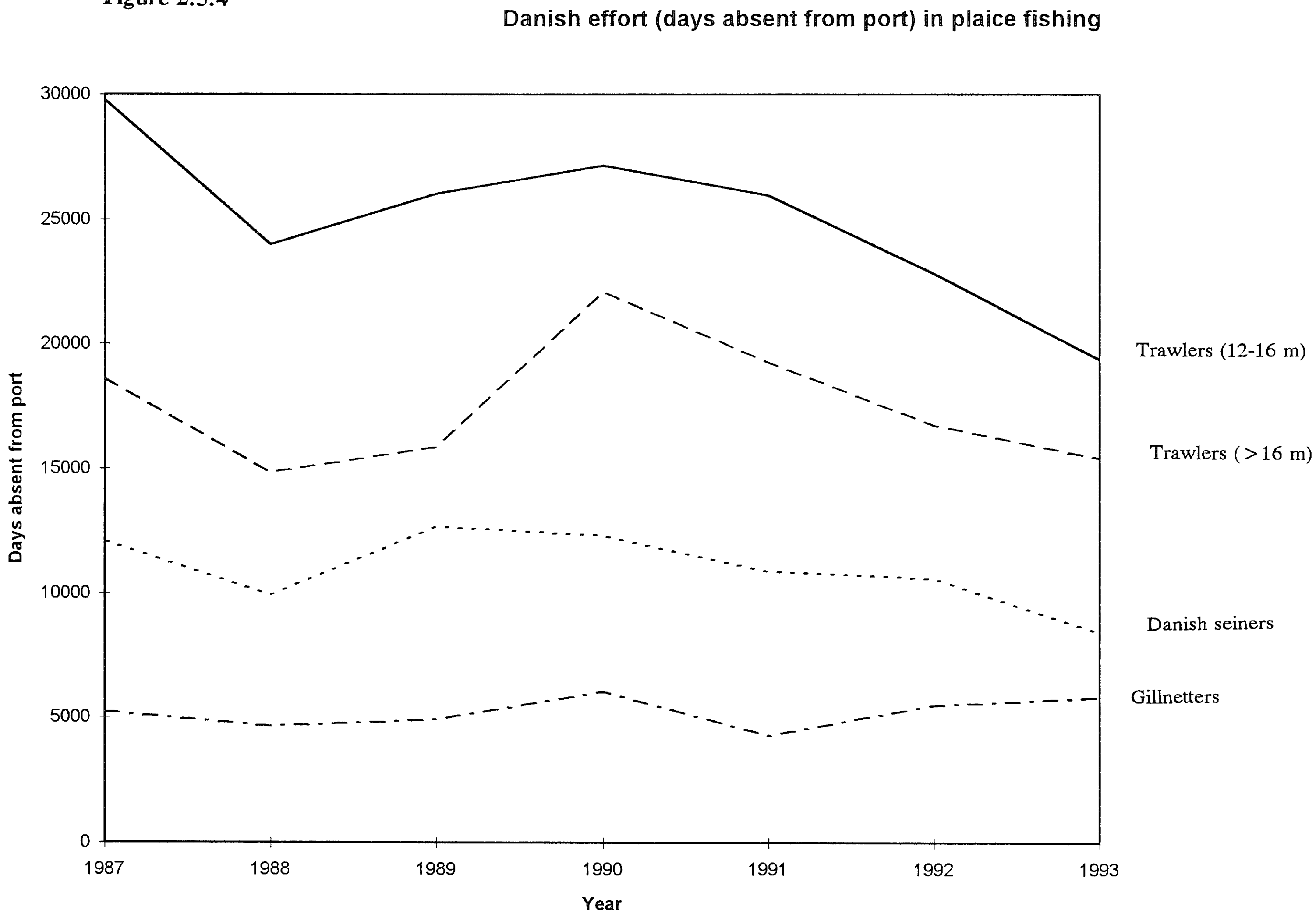


Figure 2.5.4



Danish effort (days absent from port) in plaice fishing
30000
25000
20000
15000
10000
5000
0
Days absent from port
1987
1988
1989
1990
1991
1992
1993
Year
Trawlers (12-16 m)
Trawlers (>16 m)
Danish seiners
Gillnetters

3 NORTH SEA (SUB-AREA IV)

3.1 Overview

Analytical assessments were performed on all four main roundfish stocks and the two principal flatfish stocks which are taken for human consumption. Only whiting are subject to a significant industrial by-catch.

The data available from scientific sources for the assessment of these stocks are relatively good. Most biological sampling of commercial landings has been maintained and discard data are available for haddock and whiting. However, the restrictive TACS of recent years have caused a significant part of the catch of some species to go unreported. This clearly may introduce substantial bias into conventional assessments and inevitably leads to poorer quality results. In 1993 the main stocks affected by misreporting were cod, and in some areas, saithe. Where possible, corrections of the official estimates of landings have been made to account for the missing catch. Unlike 1991 and 1992 it does not appear that haddock was subject to any significant misreporting in 1993.

The roundfish stocks, particularly cod, haddock and whiting, are subjected to a high exploitation rate which may account for the removal of approximately 60% of the biomass each year. This makes the fisheries on them rather dependent on recruiting year classes and makes catch forecasting difficult.

The cod SSB has stabilised in the region of 60,000 t though there is some uncertainty about the 1992 year class which seems to be poor. Present indications are that the 1993 year class may be strong. Thus in the short-term a small recovery in the stock might be expected. Medium-term projections, however, suggest that the underlying problem of heavy exploitation remains and any recovery is not likely to be sustained.

A notable feature of the cod fishery during 1993 was that fishing in the northern North Sea appeared to be more fruitful than in the southern North Sea. Most mis-reporting problems occurred from vessels fishing in the north. In the southern North Sea cod seem to have been scarce and vessels had difficulty reaching their quotas. This may indicate a change in distribution of the stocks and needs to be investigated.

Although haddock have been more abundant in recent years due to a series of better than average year classes, the recovery has not been as strong as predicted and vessels have been unable to take their quotas. This means the fishery is effectively unconstrained. The 1993 year class seems to be poor so some halt to the recovery can be expected. Preliminary indications of the 1994 year class are that it is strong so further recovery may occur in the future. Forward stock projections suggest that this stock is close to the expected longer-term equilibrium.

The assessment of whiting has always been of lower quality than other stocks and estimates of recruitment from surveys do not correlate well with the VPA. An analysis of survey data alone (Section 3.10) shows that the VPA and survey data estimate different historical stock trends. The surveys suggest that the SSB is declining from a peak in the early 1990s while the VPA indicates a very stable SSB over the last decade. It is not possible to determine which analysis is closest to the truth but this conflict in the data undoubtedly causes the regular substantial revisions of year classes in successive assessments.

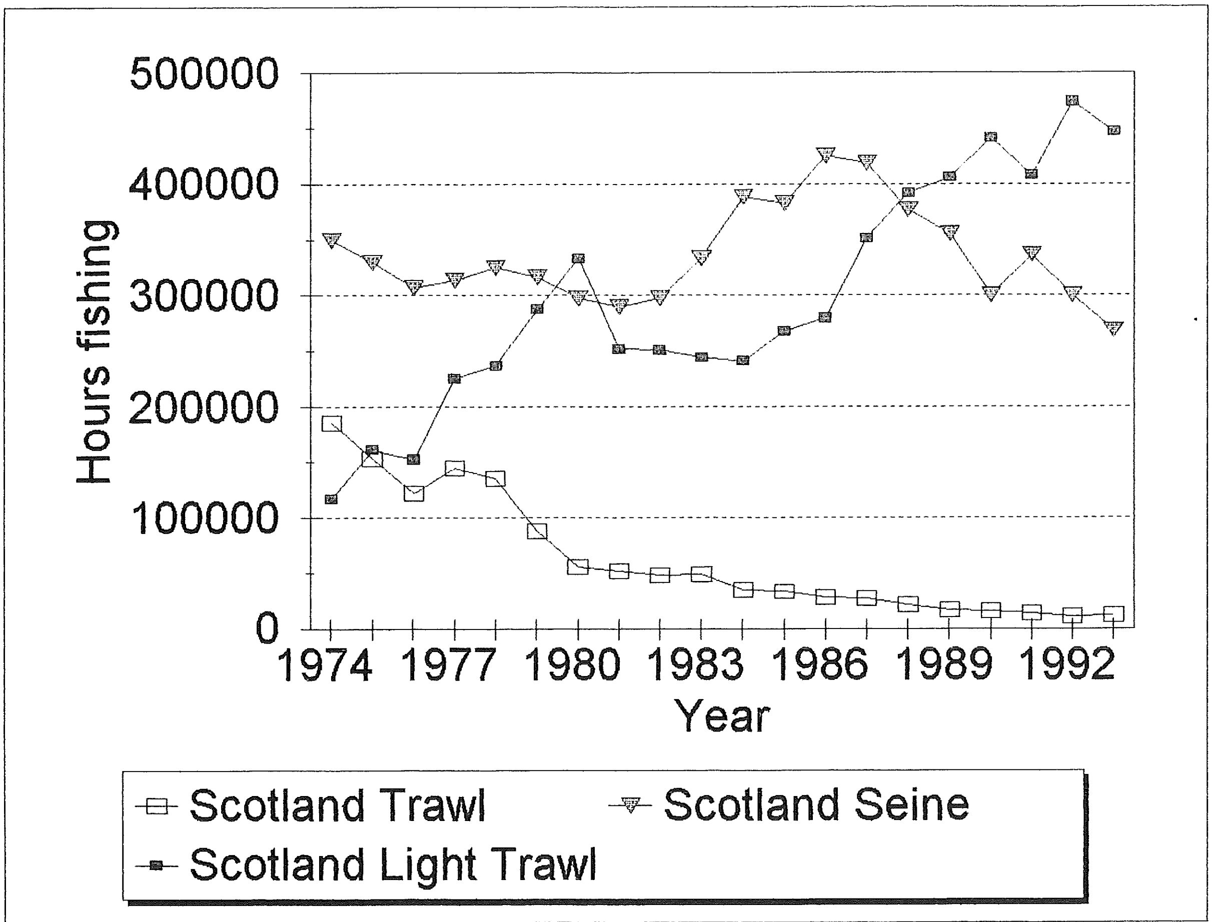
The saithe stock is still at a low level but has stabilized and the SSB now indicates a recovery. During 1993 saithe monthly quotas were exhausted by certain fleets very rapidly suggesting the assessment had been too pessimistic. Similar problems have occurred during 1994. It is difficult to judge whether the problems were caused by the TAC being set at a lower level of F than intended or whether it was simply a problem with the allocation key used to share the TAC between EU member states.

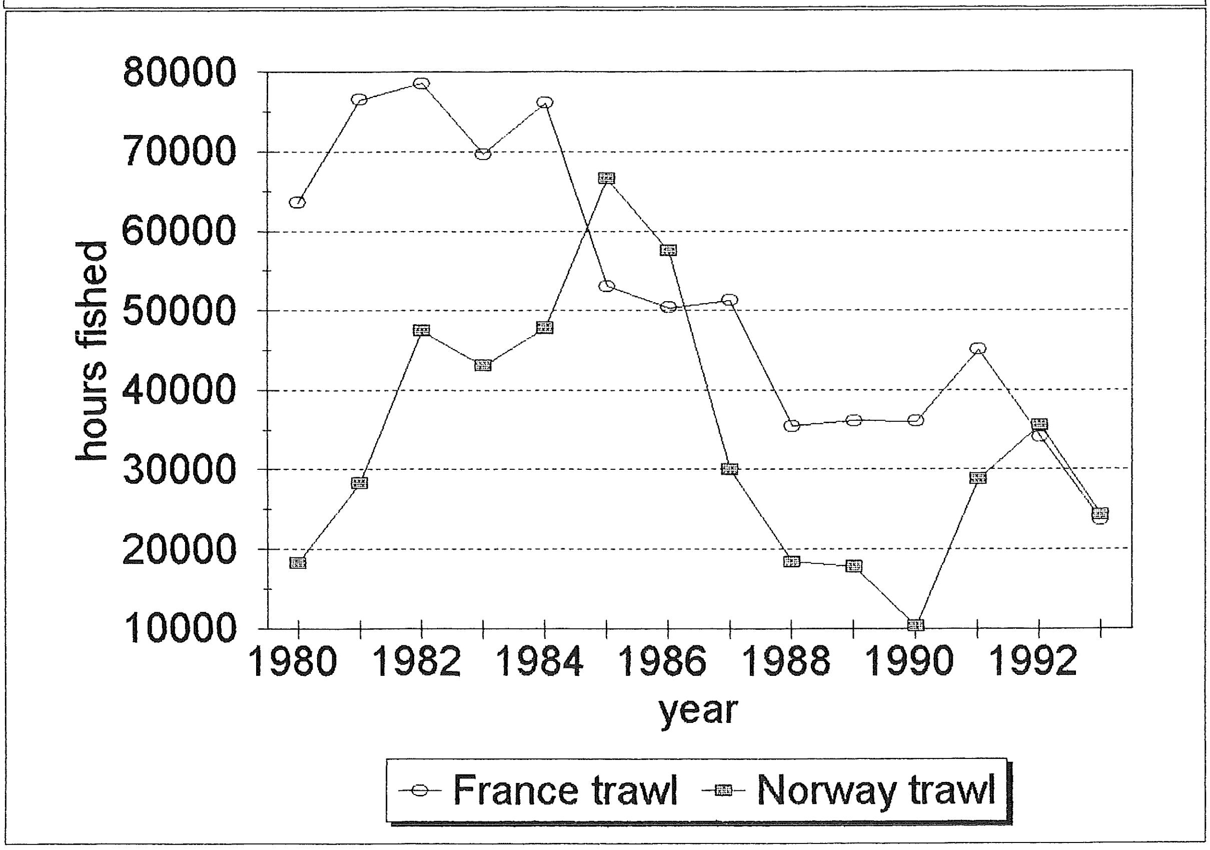
Recent trends in sole SSB have been upwards but in 1993 it has declined. However, the 1991 year class appears to be strong and should argument the SSB in 1994. Catches in 1993 were close to the TAC which does not appear to have been particularly restrictive and unallocated landings are the lowest for many years.

Landings data for plaice have been substantially revised for some years during the 1980s. This has resulted in a downward revision of the stock size. This may explain the tendency of the catch predictions in recent years to be too high. The consequence of this has been that TACs have not been restrictive. Current estimates of the SSB show it to be declining from a peak in 1989 to about 270,000 t. This value is below the presently accepted MBAL of 300,000 t. There is evidence that the growth rate had decreased recently and this may ultimately affect the estimates of recruitment.

Effort trends in the major demersal fleets in the North Sea are shown in Figure 3.1.1. For the Scottish gears, there has been a transfer of effort from seining to trawling, but the overall effort has remained similar. Norwegian and French bottom trawlers have shown a recent decline in effort. These fleets are responsible for most of the saithe catch so some reduction in fishing mortality in this stock might be expected. For England, the main change has been the continued increase in beam trawl effort. The beam trawl effort for Belgium, France and Netherlands in the most recent years has stabilized at a high level.

Figure 3.1.1 Fishing effort of demersal fleets in the North Sea.





Continued

Figure 3.1.1 Continued

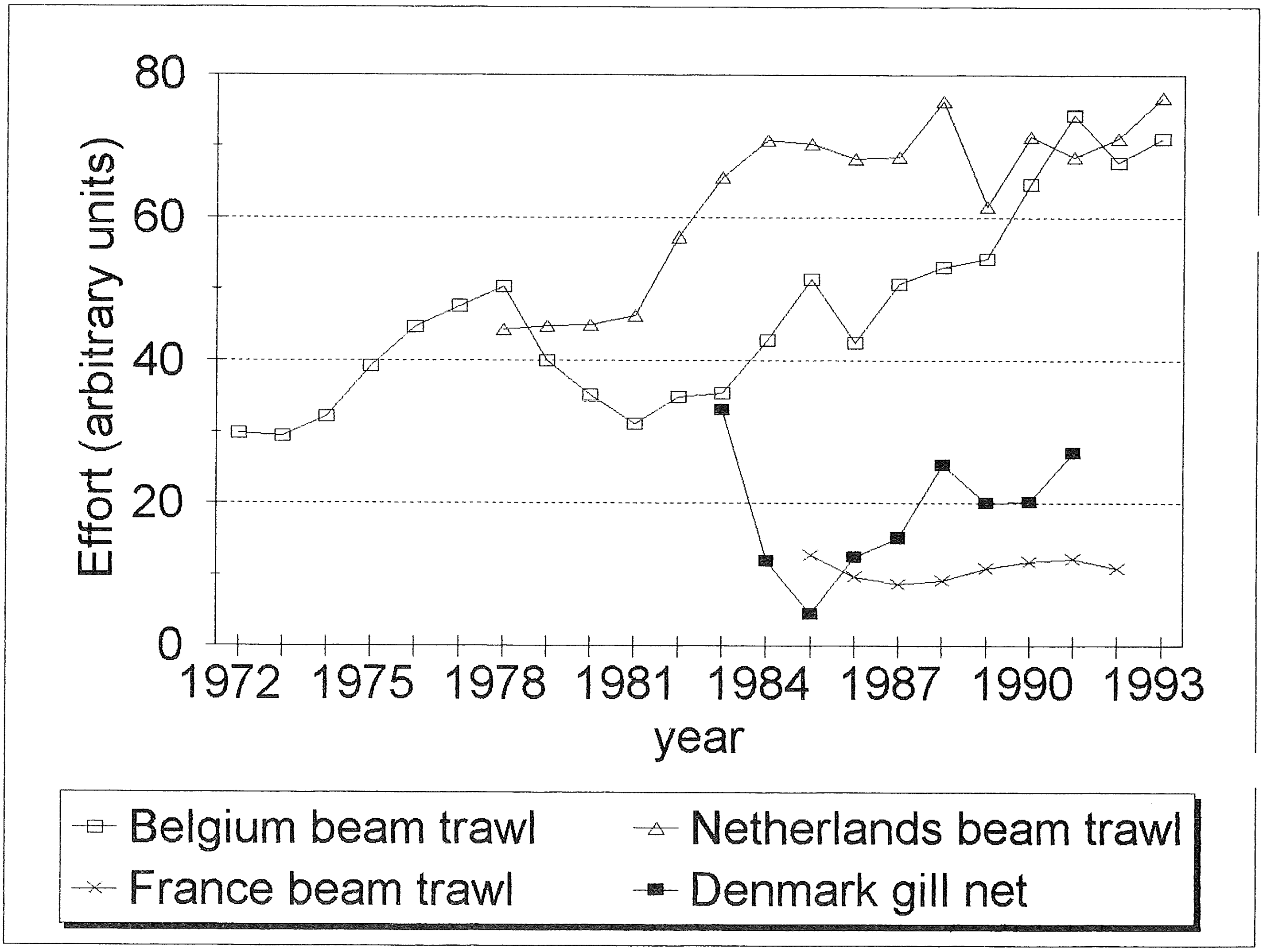


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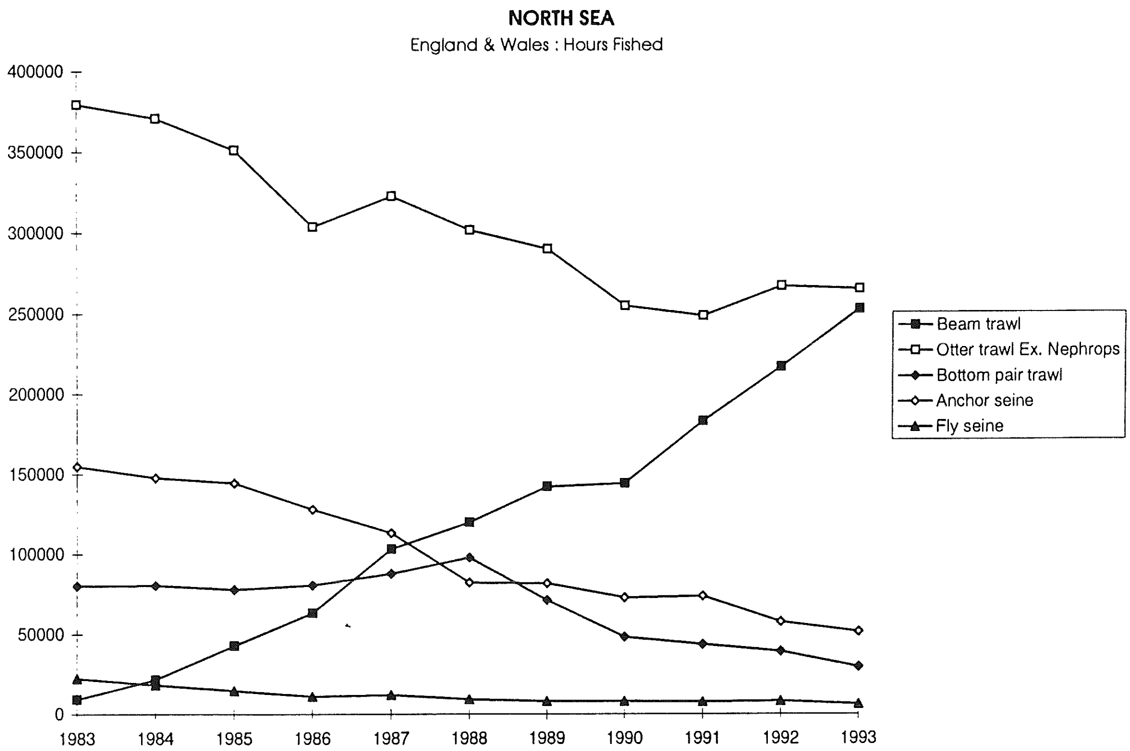
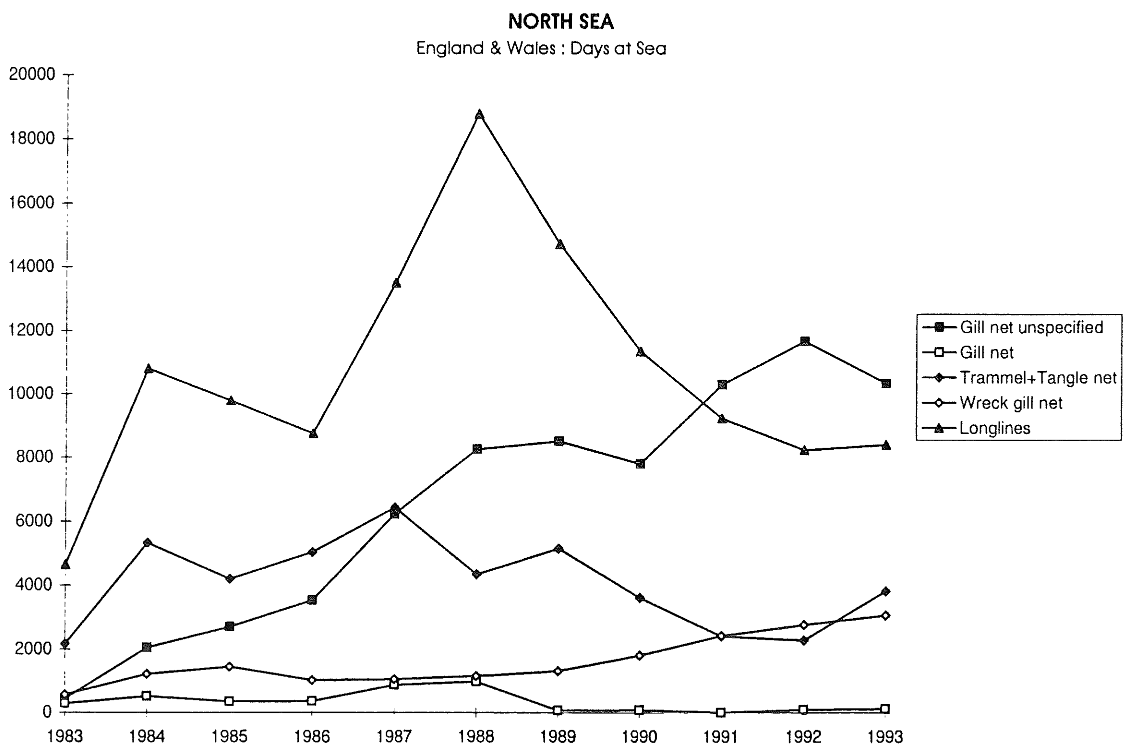
Figure 3.1.1 Continued





3.2 Cod in Sub-Area IV

3.2.1 Catch trends

Landings data from human consumption fisheries for recent years as officially reported as well as those estimated by the Working Group are given in Table 3.2.1. A longer time series of landings from Working Group estimates is given in Table 3.2.2 and graphed in Figure 3.2.1. The Working Group estimate for landings in 1993 was 104,704 t, which is 10,000 t more than the officially reported figure. In recent years the pattern of misreported landings has changed, with greater quantities coming from the north of the area. The agreed TAC in 1993 was 101,000 t. Landings reached a peak of 301,000 t in 1981, and then declined more or less continuously to 89,000 t in 1991. Since then they have increased slightly to 105,000 t in 1993.

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 sources of these data are multispecies VPA as performed by the Multispecies Working Group (natural mortality), and the International Young Fish Survey (maturity). The VPA catch input data are given in Table 3.2.4. They do not include discards or industrial fishery by-catches (see Section 3.2.12). Data for 1992 were updated with minor revisions, and data for 1993 were provided by Denmark, England, France, Germany, the Netherlands, and Scotland. Mean weight at age data for landings are given in Table 3.2.5. These values were also used as stock mean weights, and may not therefore be biologically meaningful. SOP corrections have not been applied to the mean weights at age. The SOP discrepancies are in general rather small and are shown in Table 3.2.5.

3.2.3 Catch, effort, and research vessel data

The fleets used for tuning the VPA are given in Table 3.2.6, and the tuning data are given in Table 3.2.7. The same fleets were used as in last year's assessment, including data for 6 commercial fleets and 4 groundfish surveys.

3.2.4 Catch at age analysis

The method used to tune the VPA was XSA (v3.1), the same method as was used last year. Tuning was performed over a 20 year period, with shrinkage of 0.5 and a tricubic time taper. The recruiting age was set at age 1, and catchability was fixed for ages 6 and above. The age range used for VPA was 1 to 11 (the plus group). Further details are given in Section 3.2.13.

The tuning results for the XSA method are given in Table 3.2.8. The fleet residuals resulting from a Laurec-Shepherd using default options but without shrinkage are plotted in Figure 3.2.2. The input files for these runs included data only for the fleet being examined. Some slight trends are apparent in the results for some ages in some fleets, but there is no evidence that any of the fleets should be excluded.

The estimates of fishing mortality rates and population numbers resulting from the tuning procedure and VPA are given in Tables 3.2.9. and 3.2.10.

The results from a retrospective analysis using XSA with the options specified above are shown in Figure 3.2.3. There is good agreement in the last three years but before that period there is a tendency for F values to be underestimated. However, there are no gross discrepancies and the results show reasonable agreement between successive estimates.

3.2.5 Recruitment estimates

The research vessel indices used in the RCT3 program for estimating recruitment are given in Table 3.2.11, the same surveys being used as in last year's assessment. The indices for the English groundfish surveys after 1991 have been corrected to take account of the change of gear to the GOV trawl in 1992. The results of the RCT3 analyses are given in Tables 3.2.12 and 3.2.13. They were used as estimates for ages 1 and 2 in 1994 (year classes 1992 and 1993), and age 1 in 1995 (1994 year class).

The 1992 year class was estimated last year to be 199 million at age 1. The latest survey estimate is 165 million at age 1 in 1993 and 68 million at age 2 in 1994. By contrast, the XSA estimate for this year class is 82 million at age 1, with 34 million survivors at age 2 in 1994. It was decided to accept the survey estimate in preference to the tuned estimate (see Section 3.2.14).

Last year' preliminary estimate for the 1993 year class was 224 million at age 1. Additional survey data now available indicate a much stronger year class, with an estimate of 406 million at age 1, and this value was adopted.

The preliminary estimate adopted for the 1994 year class (based on a single survey 0-group index and shrunk to the mean) is 326 million at age 1. The 1995 year class at age 1 was set at 250 million, the VPA shrunk mean from the RCT3 program; the estimate has a coefficient of variation of 68%.

3.2.6 Historical stock trends

Historical trends in mean fishing mortality, spawning stock biomass, and recruitment are shown in Table 3.2.14 and Figure 3.2.1. Mean fishing mortality increased over the period 1963 to 1982, but subsequently appears to have stabilised at a value around 0.9. Spawning biomass decreased from a peak of 284,000 t in 1968 to a historical low of 57,000 t in 1993. Recruitment has fluctuated considerably over the period but the frequency of good year classes has become reduced in recent years. Most of the year classes spawned since 1985 have been below the geometric mean, with the exception of the 1991 year class which is near average, and the 1993 year class which appears to be above average.

3.2.7 Biological reference points

A stock–recruitment scatter plot is shown in Figure 3.2.4, which also shows Fmed (0.75) and F *status quo* (0.94) replacement lines. For *status quo* F, stock replacement in the long term will occur only at atypical levels of recruitment. The minimum spawning stock level advised by ACFM is 150,000 t, which is the lowest level of SSB from which the stock has been seen to recover. The probability that this level could be reached with the current F is extremely low (see Section 3.2.9).

A yield per recruit and spawning stock biomass per recruit plot is shown in Figure 3.2.5, the input data being the same as that used for catch prediction. It can be seen that the current level of F is well above Fmed.

3.2.8 Short–term forecast

The input data for catch predictions are given in Table 3.2.15, including estimated CVs and parameter labels for the sensitivity plots. The CVs used for the population numbers are the values associated with the RCT3 or XSA estimate as appropriate. For all other parameters, the values supplied by the program INSENS were used (Reeves & Cook, 1994).

The results of a *status quo* landings prediction for 1994 are given in Tables 3.2.16 and 3.2.17, and shown graphically in Figure 3.2.6. Landings of 143,000 t are predicted for 1994, which compares with a value of 131,000 t from the previous assessment. The SQ landings for 1995 are predicted to be 170,000 t. Spawning biomass is predicted to be 69,000 t at the start of 1995, and 74,000 t in 1996.

The agreed TAC for 1994 is 102,000 t, and Table 3.2.18 and 3.2.19 indicate that this would imply a reduction in F of 37%, and an SSB of 95,000 t at the start of 1995. The same level of F in 1995 would produce landings of 203,000 t, and SSB would reach 93,000 t by the end of the year.

The results of sensitivity analyses of the *status quo* catch prediction (see Section 1.3.1) are shown in Figures 3.2.7, 3.2.8, and 3.2.9. The input data are included in Table 3.2.15 (input to catch prediction).

Figure 3.2.7 shows the sensitivity of the predictions to the various input parameters used. It shows for example that the yield in 1995 is very dependent on the size of the 1993 year class, which is estimated to be above average. The influence of the 1992 year class, the size of which is in some doubt, is relatively small.

Figure 3.2.8 shows the proportion of the total variance of the estimated yields and spawning biomasses contributed by the input parameters. For yield in 1995, most of the variance is contributed by the estimates of fishing mortality in 1994 and 1995, and by the estimate of the recruits at age 1.

Figure 3.2.9 shows probability profiles for yields and biomasses in 1994 and 1995. These show for example that there is virtually no possibility that the spawning biomass will reach a level of 150,000 t in 1995 or in 1996.

3.2.9 Medium–term projections

The method used for these projections is explained in Section 1.3.2. The input parameters for medium–term projections for yield, spawning stock biomass, and recruitment are given in Tables 3.2.15 and 3.2.20. The stock–recruitment relationship assumed was a Shepherd curve with a moving average term. The projections were run for *status quo* F and for a 30% reduction in F, and the results are shown in Figures 3.2.10 and 3.2.11. The line in the stock–recruitment plots is the trajectory of recruitment over time. For *status quo* F both yield and spawning biomass are likely to decline in the medium term, although the latter is likely to increase slightly in the short term. For a reduction in F of 30%, significant increases in yield and spawning biomass are predicted. However, it should be noted that these results are dependent on the assumption of the stock–recruitment curve.

3.2.10 Long–term considerations

The state of this stock continues to give rise to concern. The analyses presented here all indicate that the current level of fishing mortality, which is above Fmed, is not sustainable in the long term. The spawning stock biomass remains at an historical low level, and only two year classes in the past 9 years have been at or above average level. Unless F is reduced, spawning stock biomass is unlikely to rise in the medium term or in the long term. It could also be increased by improving the exploitation pattern, but it is not clear how this could be done unless more species selective gear is developed.

3.2.11 Comments on assessment

There was a relatively high level of unreported landings in 1993, amounting to 10% of the total catch. These estimates are uncertain. The 1992 year class has been revised downwards by 17%, and is among the weakest in the series. The commercial data suggest an even weaker year class, and if true the SQ landings in 1994 would be around 20,000 t smaller. Apart from revisions to year class strengths, this year' assessment is consistent with that of last year. Quality control data are given in Table 3.2.21. These indicate that there has been a tendency to overestimate year class strength.

3.2.12 Inclusion of discards

Assessments were also run using a database which included Scottish estimates of discards raised to total international discards. This database was also used by the EC Cod Task Force group in 1993, which carried out assessments to investigate the effects of various technical measures. It was decided not to use the assessments for the following reasons. First, Scottish fleets do not fish in the southern North Sea where the abundance and age composition of the cod stocks differs from that in the north. Second, separable VPA analysis indicates that inclusion of discards significantly increases the noise in the data for the younger age groups. Third, in the tuning results Scottish fleets are ascribed less weight than some other fleets. This seems inconsistent with the fact that the Scottish fleet data includes real estimates of discards, whereas such data for other fleets are assumed from Scottish data. Fourth, inclusion of discards is less important in landings prediction calculations than for the assessment of technical measures.

3.2.13 Tuning runs

Various preliminary XSA tuning runs were performed to check that the values used last year were still appropriate: in particular, the recruiting age (age 1), the "catchability plateau" age (age 6), and the shrinkage (0.5). These did not indicate that any changes to these values were necessary. These outputs are in the Working Group files and are available for ACFM.

3.2.14 The 1992 year class

All indications are that this is a very poor year class. However, the estimates of the survivors at age 2 in 1994 from the surveys (RCT3) and from the commercial data (XSA tuning) differ by a factor of two, with the latter estimate being the smaller, and in fact the smallest on record. To investigate the conflicting estimates, an RCT3 analysis was carried out which included cpue for age 1 for the 6 commercial fleets in the tuning file in addition to the survey data. The survey fleets received around 90% of the weighting in the combined estimate, indicating that there is relatively little signal in the commercial CPUE data for age 1. On this basis, it was decided to reject the tuned estimate in favour of the RCT3 output using the survey data.

Catch predictions assuming the lower estimate for the 1992 year class were also run and are available for ACFM. The *status quo* catch predicted for 1994 is 125,000 t, followed by 158,000 t in 1995.

Table 3.2.1 Nominal catch (in tonnes) of COD in Sub-area IV, 1983-1993, as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993[1]
Belgium	6,704	5,804	4,815	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374
Denmark	48,828	46,751	42,547	32,892	36,948	34,905	25,782	21,601	18,997	18,479	19,547
Faroe Islands	361	-	71	15	57	46	35	96	23	109	46
France	7,159	8,129	4,834	8,402	8,199	8,323	2,578[1,3]	1,641[1,3]	975[1,3]	2,146[1]	2,162[1,3]
Germany	20,333	13,453	7,675	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,808[1]
Netherlands	34,111	25,460	30,844	25,082	21,347	16,968[4]	12,028	8,445[1]	6,830[1]	11,133	10,220
Norway[2]	6,625	7,005	5,766	4,864	5,000	3,585	4,813	5,168	5,425	10,053[1]	8,760[1]
Poland	75	7	-	10	13	19	24	53	15	-	-
Sweden	422	575	748	839	688	367	501	620	784	823	646
UK (Engl.& Wales)	53,860	35,605	29,692	25,361	29,960	23,496	18,250	15,596	14,481	14,836	14,894
UK (Isle of Man)	-	-	-	-	-	-	1	-	-	15	-
UK (N. Ireland)	-	-	-	-	-	-	124	26	70	72	47
UK (Scotland)	58,581	54,359	60,931	45,748	49,671	41,382	31,480	31,120	28,748	28,204	18,191
Russia	-	-	-								-
Total	237,059	197,148	187,923	157,484	166,806	142,306	110,444	99,025	85,957	97,672	94,695
Unreported landings	-3,397	7,723	5,043	5,745	8,671	7,815	5,180	5,726	2,554	332	10,009
Landings as used by Working Group	233,662	204,871	192,966	163,229	175,477	150,121	115,624	104,751	88,511	97,340	104,704

[1]Preliminary.
[2]Figures do not include cod caught as industrial by-catch.
[3]Includes Division IIa (EC).

Table 3.2.2 Cod, North Sea. Annual Weight and numbers caught, 1963 to 1993.

Year	Wt.('000 t)	Nos.(millions)
1963	108	63
1964	116	57
1965	173	99
1966	212	124
1967	242	135
1968	277	153
1969	194	80
1970	219	128
1971	315	232
1972	341	254
1973	228	132
1974	202	107
1975	185	109
1976	209	131
1977	182	140
1978	263	218
1979	249	173
1980	265	204
1981	301	244
1982	273	198
1983	234	184
1984	205	162
1985	193	150
1986	163	143
1987	175	148
1988	150	109
1989	116	76
1990	105	71
1991	89	53
1992	97	64
1993	105	65

Table 3.2.3 Cod. North Sea. Natural mortality and proportion mature.

Age	Nat Mor	Mat.
1	.800	.010
2	.350	.050
3	.250	.230
4	.200	.620
5	.200	.860
6	.200	1.000
7	.200	1.000
8	.200	1.000
9	.200	1.000
10	.200	1.000
11+	.200	1.000

Table 3.2.4 Cod, North Sea. International catch at age ('000), Total, 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	3326	4799	16458	19080	11186	5956	2865	53007	44637	4044
2	44923	22763	50636	63713	72833	83300	23136	33435	152155	188099
3	7104	20791	17837	29463	33405	42689	31342	18669	16777	47822
4	3538	4277	9461	6331	11133	12409	13683	13203	6787	5646
5	2682	1872	2378	3484	3353	5925	4560	6236	7019	2787
6	1165	1711	959	1270	2000	1421	2827	1747	2663	3131
7	84	561	640	476	880	873	592	937	884	1642
8	464	110	293	366	357	305	418	210	445	599
9	14	88	52	123	139	149	147	184	222	378
10	6	13	74	58	42	109	48	97	77	111
11+	0	4	8	83	16	23	75	39	90	17

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	25720	15737	30891	5456	63760	26066	35074	61426	20309	67025
2	32923	57410	45769	96518	43641	164497	88778	98320	181522	61935
3	54846	11305	17838	17397	23837	13688	41508	30425	28738	55457
4	13764	15332	4426	6189	4309	8741	3448	10540	7957	7606
5	2154	4445	7010	1623	2114	2884	3207	1632	3894	3300
6	1098	924	1893	2820	770	964	692	1194	751	1934
7	1028	429	409	854	1043	375	374	420	560	364
8	478	380	179	123	342	381	133	195	135	226
9	81	318	211	63	239	144	148	73	65	76
10	57	78	87	60	24	34	40	55	36	26
11+	154	178	57	39	87	42	16	25	20	16

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	24397	65103	8127	86222	21932	18091	21989	10663	12985	23957
2	126068	59931	115145	19674	107796	49354	28679	45775	20287	26734
3	18125	28651	16236	29392	7357	35879	14816	8105	14676	6906
4	10487	3565	7072	3862	7971	2425	8266	3559	2366	4425
5	2573	3196	1176	2655	1388	2288	838	1890	1168	808
6	1196	963	1136	529	980	561	903	242	934	425
7	573	424	334	503	213	274	223	232	187	276
8	148	238	166	151	192	58	126	34	119	46
9	74	58	75	61	48	52	23	42	24	35
10	23	44	14	39	31	11	24	8	3	15
11+	20	20	23	20	11	16	10	3	8	8

Age	1993
1	4083
2	46950
3	9061
4	2554
5	1397
6	365
7	187
8	110
9	15
10	9
11+	12

Table 3.2.5 Cod, North Sea. International mean weight at age (kg), Total catch, 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	.523	.505	.569	.579	.587	.676	.609	.586	.549	.591
2	.994	.875	.883	.998	1.037	1.016	.979	.926	.902	.841
3	2.572	2.399	2.162	2.433	2.386	2.323	2.286	2.035	2.124	2.134
4	4.288	4.624	4.363	4.145	3.182	4.545	4.191	3.953	4.105	4.057
5	6.287	6.578	6.813	7.023	6.766	6.304	6.297	6.069	6.279	6.009
6	8.714	8.729	8.963	9.585	9.574	8.290	8.271	7.860	8.328	8.255
7	11.308	10.872	10.742	11.728	11.981	9.917	9.697	9.663	10.058	9.803
8	10.959	11.045	11.049	11.954	12.464	11.705	11.405	10.066	10.758	10.268
9	13.210	12.658	12.373	14.048	13.497	12.630	12.800	11.685	12.247	11.919
10	12.755	12.537	13.186	14.725	14.175	14.566	13.751	12.472	12.457	12.565
11+	.000	7.090	14.308	15.556	19.014	14.830	14.867	14.215	14.683	14.078

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	.547	.591	.580	.550	.542	.535	.543	.510	.552	.581
2	.909	1.028	.896	.989	1.019	.896	.910	.983	.729	.952
3	1.971	2.236	2.329	2.446	2.183	1.993	2.385	1.960	2.018	1.816
4	3.951	4.152	4.272	4.514	4.635	4.217	4.495	4.407	4.367	4.434
5	5.683	6.178	6.449	6.507	6.744	6.648	6.601	6.351	6.685	6.719
6	7.598	8.395	8.710	8.577	8.849	8.971	8.440	9.033	8.593	8.753
7	9.326	9.919	10.244	10.032	10.043	10.051	10.819	9.748	9.607	10.476
8	10.183	10.727	10.938	11.273	11.010	11.130	11.488	11.669	10.984	12.131
9	11.464	12.240	12.451	12.847	11.747	12.370	12.967	12.688	12.686	12.980
10	12.748	12.628	13.156	13.910	13.135	12.782	14.049	13.984	13.975	12.555
11+	13.767	14.008	14.617	14.342	14.259	14.141	15.202	15.189	16.052	14.676

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.639	.596	.581	.564	.606	.618	.676	.748	.675	.692
2	.926	1.009	.918	.911	.937	1.034	1.065	.959	1.066	1.128
3	1.871	2.178	2.125	1.808	1.944	2.070	1.849	2.183	2.039	2.600
4	4.035	4.139	4.220	3.945	3.627	3.280	3.660	3.790	4.310	4.299
5	6.835	6.362	6.439	6.367	5.985	6.011	5.350	6.133	6.411	6.622
6	8.705	8.617	8.436	8.081	8.190	7.910	7.972	8.307	8.353	8.622
7	10.105	10.482	10.370	9.877	9.873	9.684	9.739	10.506	10.010	10.312
8	12.091	11.509	11.943	11.640	11.330	11.566	11.341	10.638	11.086	10.604
9	12.852	13.796	13.000	12.574	11.981	13.381	13.035	12.500	13.961	11.801
10	12.448	13.631	13.144	13.438	15.729	14.345	14.115	15.094	12.817	14.173
11+	14.234	13.678	14.288	12.987	15.735	15.709	14.349	14.585	13.715	15.579

Age	1993
1	.679
2	1.027
3	2.592
4	4.768
5	6.617
6	8.115
7	9.588
8	9.210
9	12.452
10	13.070
11+	14.516

Cod. North Sea.
Sum of products corrections.

Year	SOP	Year	SOP
1963	0.9539	1979	0.9957
1964	0.9056	1980	1.0036
1965	1.0121	1981	1.0864
1966	0.9503	1982	0.9772
1967	0.9427	1983	0.9512
1968	0.8955	1984	0.9577
1969	0.8815	1985	0.9703
1970	0.9996	1986	0.9929
1971	1.014	1987	0.9783
1972	0.9566	1988	0.8986
1973	0.9286	1989	0.9706
1974	0.9716	1990	1.046
1975	0.9642	1991	0.9892
1976	0.9686	1992	1.0055
1977	0.9566	1993	1.0251
1978	0.9953		

Table 3.2.6. Fleets used for tuning the VPA.

FLEET	CODE	YEAR RANGE	AGE RANGE
Scottish trawl	SCOTRL	1974-1993	1-6
Scottish seine	SCOSEI	1974-1993	1-9
Scottish light trawl	SCOLTR	1974-1993	1-7
English trawl	ENGTRL	1974-1993	1-7
English seine	ENGSEI	1974-1993	1-8
French trawl	FRATRB	1976-1993	1-6
Scottish groundfish survey	SCOGFS	1982-1993	1-6
English groundfish survey	ENGGFS	1977-1993	1-5
Dutch groundfish survey	NETGFS	1980-1993	1-2
International groundfish survey	INTGFS	1974-1993	1-6

Table 3.2.7 Tuning file. North Sea Cod : 1963-1993.

```
110
SCOTRL
 1974 1993
 1 1  .00 1.00
  1  6
  185432.000    608.628   1270.039    997.503    883.318    155.119     36.625
  152977.000    366.513   1667.583    450.049    276.712    284.022     39.680
  121841.000    131.192   1323.106    688.503    154.583     86.444     88.478
  144348.000    440.259    603.784    880.519    238.998     73.377     32.495
  135220.000    325.501   1525.784    306.228    194.872     68.526     17.132
   87467.000    227.224    963.598    471.280     77.845     49.442     24.195
   55475.000    162.000    894.000    399.000    134.000     21.000     21.000
   51553.000    103.000    996.000    416.000    122.000     55.000     15.000
   47889.000    570.000    334.000    425.000     80.000     19.000      7.000
   48339.000    184.000   1473.000    215.000    116.000     24.000     10.000
   34574.000    338.000    826.000    370.000     35.000     18.000      8.000
   33103.000     90.000    857.000    215.000     87.000     10.000      5.000
   27839.000    265.000    201.000    270.000     21.000     11.000      1.000
   27208.000    290.000    646.000     41.000     42.000      9.000      2.000
   21559.000     27.000    343.000    158.000      8.000      8.000      4.000
   16657.000     62.552     31.654    144.553     44.025      3.199      2.402
   14325.000     13.805    292.107     16.757     20.051      4.564      1.083
   13495.000     44.018     92.605    101.429      7.543      6.828      1.676
   10887.000     50.928     97.323     29.464     32.442      1.124      1.180
   11657.000      4.513    119.250     29.888      4.089      6.053       .607
SCOSEI
 1974 1993
 1 1  .00 1.00
  1  9
  349604.000   4616.137   7517.676   1926.382   1298.214    301.521     64.612     45.467     27.520     17.948
  329432.000   2316.706  11039.990   2269.608    707.741    599.543    100.560     11.456      6.365     16.548
  307165.000    690.154  18306.430   3715.522    475.525    230.051    145.228     47.553     12.852      5.141
  313913.000   3265.836   5140.535   3655.306    850.404    210.814     60.743     41.686     28.585      7.146
  325246.000   2068.410  17863.100   1682.404   1032.991    245.199     58.265     27.919     25.491      9.711
  316419.000   2845.023   9048.144   3673.835    431.884    389.034     75.552     49.616     21.425     13.532
  297227.000   1228.000   6850.000   2692.000    953.000    166.000    103.000     38.000     17.000     10.000
  289672.000   1036.000  16139.000   2852.000    846.000    248.000     22.000     13.000     15.000      4.000
  297730.000   4866.000   5731.000   7201.000    983.000    348.000    181.000     30.000     25.000     14.000
  333168.000   1570.000  15575.000   2121.000   1508.000    266.000    115.000     46.000     22.000     18.000
  388085.000   5407.000  11123.000   4228.000    507.000    426.000    121.000     52.000     29.000      7.000
  382910.000    603.000  20362.000   2770.000    926.000    141.000    119.000     29.000     27.000     11.000
  425017.000   5828.000   2853.000   7374.000    886.000    307.000     46.000     41.000     15.000      8.000
  418536.000   1489.000  14713.000    744.000   1557.000    310.000    204.000     27.000     39.000     17.000
  377132.000    843.000   7092.000   4632.000    202.000    472.000    132.000     56.000     16.000     10.000
  355735.000   1794.375   3724.773   3381.039   1163.871     97.129    197.193     47.576     19.923      2.548
  270869.000    338.808  11282.500    979.909    600.105    260.588     34.679     45.046     10.307      3.306
  336675.000   1683.715   4677.835   2942.886    237.871    171.403    111.523     32.503     24.863      7.482
  300217.000   1033.127   4028.890    921.556    604.523     95.735     57.940     31.101      8.656      8.230
  268413.000    256.256   5485.173    766.073    206.070    140.437     26.039     19.304      9.039      2.315
```

Continued

Table 3.2.7 Continued

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SCOLTR
 1974 1993
 1 1  .00 1.00
  1  7
  116982.000      502.494     1297.288      479.504      411.629       43.790        5.474        8.758
  161009.000     1089.310     1759.828      875.963      135.458      127.557        6.773        1.129
  152419.000      309.756     3856.045      488.778      118.956       44.756       45.933       11.778
  224824.000     2311.478     2019.749      865.128      131.893       83.830       26.826       14.531
  236929.000     2738.441     6530.501      814.492      327.739       61.906       33.988        8.497
  207494.000     2370.702     7023.190     2172.443      213.880       73.296       18.024        3.605
  333197.000     2098.000     6076.000     2383.000      623.000       81.000       18.000        5.000
  251504.000      819.000     6207.000     1748.000      348.000       97.000       13.000        7.000
  250870.000     5260.000     3288.000     2574.000      422.000      123.000       44.000        9.000
  244349.000     1474.000     7021.000     1138.000      513.000      124.000       35.000       16.000
  240725.000     3020.000     3352.000     1712.000      200.000       95.000       40.000       11.000
  268136.000      471.000     6514.000      946.000      321.000       43.000       23.000        4.000
  279767.000     4372.000     1232.000     1951.000      265.000      101.000       13.000        9.000
  351131.000     2210.000     6119.000      573.000      506.000       49.000       34.000       11.000
  391988.000      402.000     3291.000     1907.000      133.000      148.000       33.000       14.000
  405883.000     1637.965     1254.487     1659.275      588.684       50.579       47.073       13.885
  398153.000      289.110     5073.073      462.881      403.779      158.676       22.756       10.009
  408056.000     1791.573     1873.642     2090.660      135.800       92.660       47.319        8.066
  473955.000     1370.129     2687.812      731.170      632.218       43.088       35.552       11.645
  447064.000      244.623     4774.196     1232.046      160.045       78.198        9.648        5.037
ENGTRL
 1974 1993
 1 1  .00 1.00
  1  7
  557947.000      821.000     4129.000      792.000     1925.000      617.000      157.000       68.000
  469958.000     1866.000     2623.000     1156.000      303.000      738.000      267.000       44.000
  493436.000      480.000     6058.000     1508.000      727.000      163.000      395.000      100.000
  509862.000     2570.000     1905.000     2013.000      616.000      320.000       98.000      127.000
  559930.000     2029.000    10576.000     1093.000      987.000      338.000      117.000       57.000
  553020.000     1329.000     7698.000     3341.000      393.000      403.000       99.000       54.000
  442036.000     1881.000     3786.000     2106.000      865.000      122.000      114.000       38.000
  423658.000      615.000    12703.000     1886.000      535.000      250.000       38.000       48.000
  424272.000     4074.000     3063.000     3802.000      587.000      298.000      179.000       35.000
  392364.000      711.000    14220.000     1185.000      907.000      127.000       87.000       49.000
  358387.000     3469.000     3459.000     2656.000      267.000      217.000       42.000       32.000
  342844.000      675.000     8212.000     1047.000      533.000       72.000       54.000       16.000
  288867.000     9097.000     2107.000     2388.000      209.000      161.000       15.000       12.000
  275899.000      447.000    10435.000      682.000      596.000       36.000       26.000        3.000
  296092.000     1173.000     2102.000     2428.000       90.000      126.000       17.000       10.000
  310444.000      985.000     1958.000      718.000      501.000       25.000       34.000        5.000
  255314.000      573.000     3101.000      513.000      134.000      101.000       11.000       13.000
  258037.000      880.000     1559.000     1092.000       88.000       25.000       17.000        2.000
  223702.000     1463.000     2171.000      481.000      234.000       19.000        5.000        5.000
```

Continued

Table 3.2.7 Continued

ENGSEI
1974 1993
1 1 .00 1.00
1 8

210623.000	597.000	2764.000	411.000	1085.000	487.000	116.000	40.000	32.000
208508.000	2585.000	2437.000	764.000	127.000	350.000	145.000	14.000	13.000
211284.000	281.000	8523.000	895.000	479.000	116.000	290.000	84.000	17.000
196103.000	2630.000	2453.000	1577.000	245.000	182.000	60.000	103.000	31.000
203382.000	898.000	12831.000	746.000	547.000	131.000	78.000	21.000	37.000
187180.000	1718.000	7004.000	2438.000	162.000	280.000	76.000	35.000	14.000
201169.000	2111.000	7760.000	1370.000	611.000	146.000	210.000	54.000	29.000
185423.000	343.000	12689.000	1053.000	398.000	359.000	61.000	74.000	12.000
183209.000	1486.000	3191.000	2473.000	330.000	294.000	189.000	38.000	31.000
177004.000	566.000	4741.000	573.000	557.000	207.000	150.000	104.000	18.000
167699.000	1232.000	1513.000	1215.000	147.000	290.000	72.000	50.000	32.000
157815.000	125.000	3242.000	326.000	241.000	72.000	117.000	40.000	27.000
136358.000	890.000	312.000	572.000	65.000	139.000	34.000	52.000	13.000
123281.000	262.000	2395.000	82.000	184.000	44.000	77.000	10.000	22.000
91178.000	297.000	879.000	594.000	19.000	80.000	19.000	12.000	3.000
88782.000	343.000	748.000	216.000	138.000	9.000	46.000	7.000	8.000
80537.000	176.000	1009.000	116.000	45.000	58.000	4.000	15.000	3.000
84346.000	129.000	262.000	207.000	33.000	26.000	38.000	6.000	16.000
67810.000	408.000	463.000	57.000	42.000	10.000	8.000	8.000	2.000
54574.000	44.000	497.000	41.000	19.000	22.000	4.000	3.000	2.000

FRATRB
1976 1993
1 1 .00 1.00
1 6

64396.000	231.000	912.000	451.000	136.000	41.000	20.000
80107.000	347.000	308.000	389.000	116.000	31.000	5.000
69739.000	276.000	680.000	130.000	163.000	51.000	12.000
89974.000	263.000	639.000	397.000	67.000	41.000	7.000
63577.000	204.000	738.000	419.000	194.000	25.000	10.000
76517.000	113.000	1529.000	413.000	219.000	65.000	7.000
78523.000	420.000	358.000	491.000	245.000	75.000	17.000
69720.000	379.000	1273.000	284.000	182.000	37.000	8.000
76149.000	974.000	865.000	604.000	121.000	59.000	11.000
53003.000	192.000	752.000	239.000	133.000	17.000	6.000
50350.000	469.000	169.000	474.000	125.000	36.000	2.000
51234.000	415.000	758.000	58.000	118.000	19.000	5.000
35482.000	100.000	315.000	345.000	25.000	33.000	4.000
36133.000	349.150	151.951	131.981	78.384	3.212	2.160
36097.000	45.839	352.149	51.215	28.645	7.475	.808
45075.000	129.353	92.647	109.162	16.003	8.173	2.506
34138.000	159.420	203.140	66.287	29.039	2.341	.721

Continued

Table 3.2.7 Continued

```
SCOGFS
 1982 1993
 1 1  .50  .75
  1  6
     77.000         .473        .270        .440        .139        .071        .046
     79.000         .257        .617        .143        .156        .059        .018
     82.000         .672        .320        .208        .041        .047        .013
     83.000         .055        .948        .163        .093        .025        .020
     80.000         .641        .084        .317        .046        .032        .015
     73.000         .160        .547        .025        .067        .021        .005
     86.000         .140        .248        .142        .022        .028        .010
     86.000         .483        .116        .145        .081        .017        .007
     85.000         .097        .417        .050        .063        .022        .008
     90.000         .273        .139        .120        .012        .005        .004
     87.000         .559        .168        .063        .058        .025        .016
     87.000         .302        .652        .088        .022        .010        .003
ENGGFS
 1977 1993
 1 1  .50  .75
  1  5
    111.000        6.959        .497        .359        .064        .012
    113.000        2.581       1.412        .111        .112        .015
    117.000        2.835        .679        .234        .032        .042
    115.000        5.847        .771        .176        .084        .013
    114.000        1.295       1.581        .145        .044        .046
     72.000        2.331        .209        .237        .038        .027
     74.000        1.139        .811        .089        .082        .021
     82.000        5.020        .389        .146        .033        .017
     73.000         .314        .868        .078        .041        .015
     82.000        2.819        .094        .166        .024        .009
     77.000        1.095        .820        .021        .047        .011
     75.000         .627        .305        .149        .001        .032
     85.000        1.942        .211        .101        .052        .005
     86.000         .523        .433        .052        .012        .010
     87.000         .654        .135        .063        .011        .003
     74.000        1.806        .117        .034        .026        .006
```

Continued

Table 3.2.7 Continued

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NETGFS
 1980 1993
 1 1  .75  1.00
  1  2
      1.000        .164        .005
      1.000        .047        .011
      1.000        .083        .002
      1.000        .022        .002
      1.000        .121        .002
      1.000        .004        .003
      1.000        .111        .000
      1.000        .042        .008
      1.000        .018        .002
      1.000        .017        .002
      1.000        .009        .002
      1.000        .007        .001
      1.000        .045        .001
      1.000        .002        .001
INTGFS
 1974 1993
 1 1  .00  .25
  1  6
      1.000        .015        .010          -1          -1          -1          -1
      1.000        .040        .006          -1          -1          -1          -1
      1.000        .008        .020          -1          -1          -1          -1
      1.000        .037        .003          -1          -1          -1          -1
      1.000        .013        .029          -1          -1          -1          -1
      1.000        .010        .009          -1          -1          -1          -1
      1.000        .017        .015          -1          -1          -1          -1
      1.000        .003        .026          -1          -1          -1          -1
      1.000        .009        .007          -1          -1          -1          -1
      1.000        .004        .016        .003        .002        .001        .002
      1.000        .015        .008        .004        .001        .001        .001
      1.000        .001        .018        .004        .002        .001        .001
      1.000        .017        .004        .007        .002        .001        .001
      1.000        .009        .029        .001        .002        .001        .001
      1.000        .004        .006        .006        .001        .001        .001
      1.000        .013        .006        .005        .002        .000        .001
      1.000        .003        .015        .002        .001        .001        .001
      1.000        .002        .004        .003        .007        .003        .008
      1.000        .013        .004        .001        .001        .000        .001
      1.000        .013        .020        .002        .001        .001        .000
```

Table 3.2.8. Tuning results

6/10/1994 18:39

Extended Survivors Analysis

NORTH SEA COD : 1963 - 1993 : NO DISCARDS OR SOP CORRECTION : PREP. 6/10/94

CPUE data from file codivef.dat

Catch data for 31 years. 1963 to 1993. Ages 1 to 11.

Fleet,	,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SCOTRL	,	1974,	1993,	1,	6,	.000,	1.000
SCOSEI	,	1974,	1993,	1,	9,	.000,	1.000
SCOLTR	,	1974,	1993,	1,	7,	.000,	1.000
ENGTRL	,	1974,	1993,	1,	7,	.000,	1.000
ENGSEI	,	1974,	1993,	1,	8,	.000,	1.000
FRATRB	,	1976,	1993,	1,	6,	.000,	1.000
SCOGFS	,	1982,	1993,	1,	6,	.500,	.750
ENGGFS	,	1977,	1993,	1,	5,	.500,	.750
NETGFS	,	1980,	1993,	1,	2,	.750,	1.000
INTGFS	,	1974,	1993,	1,	6,	.000,	.250

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 29 iterations

Regression weights
, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Continued

Table 3.2.8 Continued

Fleet : SCOTRL

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.93,	.266,	17.33,	.55,	20,	.66,	-17.73,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.18,	-.544,	16.12,	.49,	20,	.70,	-15.44,
3,	.98,	.089,	14.99,	.65,	20,	.47,	-15.09,
4,	.86,	.669,	14.48,	.70,	20,	.38,	-15.34,
5,	1.27,	-1.006,	17.66,	.59,	20,	.45,	-15.67,
6,	1.38,	-1.038,	19.08,	.42,	20,	.68,	-15.80,

Fleet : SCOSEI

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.91,	.516,	17.04,	.76,	20,	.42,	-17.50,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.11,	-.617,	15.15,	.76,	20,	.39,	-14.80,
3,	.87,	.923,	14.15,	.83,	20,	.29,	-14.73,
4,	.89,	.751,	14.27,	.81,	20,	.28,	-14.94,
5,	1.18,	-.927,	16.30,	.73,	20,	.32,	-15.08,
6,	1.30,	-.796,	17.41,	.42,	20,	.68,	-15.09,
7,	******,	-4.469,	******,	.00,	20,	149.57,	-15.09,
8,	1.99,	-3.173,	24.12,	.50,	20,	.60,	-14.83,
9,	1.69,	-1.924,	21.83,	.44,	20,	.77,	-14.77,

Fleet : SCOLTR

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.70,	1.778,	16.03,	.78,	20,	.40,	-17.59,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.92,	.723,	15.22,	.88,	20,	.25,	-15.56,
3,	.95,	.365,	15.08,	.85,	20,	.27,	-15.32,
4,	.96,	.299,	15.34,	.82,	20,	.27,	-15.63,
5,	1.02,	-.114,	16.20,	.79,	20,	.28,	-16.06,
6,	1.32,	-1.107,	19.07,	.54,	20,	.53,	-16.21,
7,	2.45,	-2.150,	31.01,	.18,	20,	1.08,	-16.44,

Fleet : ENGTRL

Regression statistics :

Ages with q dependent on year class strength

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Log q

Continued

1,	1.39,	-.914,	19.49,	.36,	20,	.99,	-17.51,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.15,	-.726,	15.99,	.69,	20,	.46,	-15.40,
3,	1.12,	-.870,	15.94,	.84,	20,	.28,	-15.34,
4,	.84,	1.370,	14.60,	.88,	20,	.21,	-15.66,
5,	.68,	3.000,	13.49,	.90,	20,	.18,	-16.00,
6,	.71,	2.345,	13.61,	.87,	20,	.23,	-16.21,
7,	.59,	3.078,	12.16,	.85,	20,	.21,	-16.19,

Fleet : ENGSEI

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	.95,	.287,	17.50,	.79,	20,	.38,	-17.75,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	.77,	1.669,	14.58,	.84,	20,	.30,	-15.48,
3,	.65,	3.998,	13.81,	.93,	20,	.18,	-15.68,
4,	.70,	2.919,	13.71,	.90,	20,	.19,	-15.71,
5,	.59,	5.298,	12.33,	.94,	20,	.13,	-15.25,
6,	.61,	3.436,	11.88,	.88,	20,	.21,	-14.89,
7,	.75,	1.974,	12.59,	.86,	20,	.20,	-14.67,
8,	.96,	.150,	14.03,	.62,	20,	.48,	-14.36,

Fleet : FRATRB

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	1.75,	-1.719,	21.18,	.34,	18,	1.03,	-17.40,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.05,	-.309,	16.07,	.78,	18,	.36,	-15.85,
3,	.86,	.884,	14.71,	.80,	18,	.32,	-15.41,
4,	.78,	1.306,	13.96,	.78,	18,	.30,	-15.29,
5,	.65,	1.942,	13.14,	.76,	18,	.30,	-15.79,
6,	.75,	1.615,	14.14,	.80,	18,	.29,	-16.47,

Fleet : SCOGFS

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	1.11,	-.377,	18.02,	.57,	12,	.62,	-17.45,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	.76,	2.332,	15.17,	.92,	12,	.19,	-16.34,
3,	.82,	1.005,	15.00,	.79,	12,	.33,	-16.03,
4,	.71,	2.006,	13.88,	.85,	12,	.23,	-15.81,

Continued

Table 3.2.8 Continued

5,	1.06,	-.136,	16.21,	.35,	12,	.70,	-15.72,
6,	1.42,	-.803,	19.11,	.30,	12,	.89,	-15.61,

Fleet : ENGGFS

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	.93,	.561,	15.75,	.87,	17,	.29,	-16.00,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	.79,	2.257,	15.26,	.92,	17,	.20,	-16.23,
3,	.93,	.445,	16.00,	.82,	17,	.30,	-16.40,
4,	.62,	1.495,	13.76,	.60,	17,	.47,	-16.66,
5,	.96,	.126,	16.09,	.50,	17,	.53,	-16.42,

Fleet : NETGFS

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	.54,	4.312,	13.98,	.90,	14,	.24,	-15.36,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.04,	-.125,	16.82,	.58,	13,	.56,	-16.64,

Fleet : INTGFS

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	1.29,	-.677,	18.68,	.36,	20,	1.00,	-17.28,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.00,	.001,	16.05,	.77,	20,	.38,	-16.05,
3,	.90,	.560,	15.28,	.79,	11,	.30,	-15.87,
4,	9.99,	-2.160,	71.79,	.01,	11,	6.52,	-15.30,
5,	-1.70,	-4.100,	-3.05,	.28,	9,	.61,	-14.88,
6,	2.19,	-.945,	21.45,	.08,	10,	1.58,	-13.73,

Continued

Table 3.2.8 Continued

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	14166.,	.803,	.000,	.00,	1,	.032,	.177
SCOSEI	,	27078.,	.476,	.000,	.00,	1,	.090,	.096
SCOLTR	,	26394.,	.458,	.000,	.00,	1,	.097,	.099
ENGTRL	,	60410.,	1.041,	.000,	.00,	1,	.019,	.044
ENGSEI	,	27410.,	.439,	.000,	.00,	1,	.105,	.095
FRATRB	,	43783.,	1.091,	.000,	.00,	1,	.017,	.061
SCOGFS	,	94789.,	.649,	.000,	.00,	1,	.048,	.028
ENGGFS	,	49721.,	.313,	.000,	.00,	1,	.208,	.054
NETGFS	,	25418.,	.300,	.000,	.00,	1,	.226,	.102
INTGFS	,	233043.,	1.058,	.000,	.00,	1,	.018,	.012
P shrinkage mean	,	105000.,	.65,,,,				.052,	.026
F shrinkage mean	,	15846.,	.50,,,,				.088,	.159

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
34321.,	.14,	.17,	12,	1.211,	.077

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	37362.,	.455,	.257,	.56,	2,	.038,	.720
SCOSEI	,	31743.,	.274,	.008,	.03,	2,	.105,	.807
SCOLTR	,	34005.,	.243,	.075,	.31,	2,	.134,	.770
ENGTRL	,	57112.,	.377,	.087,	.23,	2,	.057,	.525
ENGSEI	,	43390.,	.297,	.435,	1.46,	2,	.088,	.646
FRATRB	,	52452.,	.326,	.075,	.23,	2,	.077,	.560
SCOGFS	,	65374.,	.286,	.024,	.08,	2,	.099,	.472
ENGGFS	,	52217.,	.217,	.047,	.22,	2,	.166,	.562
NETGFS	,	36474.,	.262,	.537,	2.05,	2,	.109,	.733
INTGFS	,	79037.,	.353,	.017,	.05,	2,	.065,	.405
F shrinkage mean	,	26457.,	.50,,,,				.062,	.912

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
44261.,	.09,	.08,	21,	.927,	.637

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	5430.,	.357,	.161,	.45,	3,	.049,	.905
SCOSEI	,	4659.,	.235,	.259,	1.10,	3,	.107,	.999
SCOLTR	,	6259.,	.208,	.134,	.65,	3,	.138,	.823
ENGTRL	,	5362.,	.250,	.109,	.44,	3,	.108,	.913
ENGSEI	,	3397.,	.272,	.245,	.90,	3,	.075,	1.210
FRATRB	,	4294.,	.269,	.243,	.90,	3,	.084,	1.052
SCOGFS	,	5381.,	.258,	.101,	.39,	3,	.083,	.911
ENGGFS	,	5165.,	.200,	.220,	1.10,	3,	.138,	.935
NETGFS	,	4303.,	.263,	.004,	.02,	2,	.043,	1.050
INTGFS	,	4806.,	.263,	.151,	.58,	3,	.094,	.980
F shrinkage mean	,	4561.,	.50,,,,				.081,	1.013

Continued

Table 3.2.8 Continued

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4932.,	.08,	.05,	30,	.653,	.964

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	939.,	.317,	.161,	.51,	4,	.064,	1.242
SCOSEI	,	1160.,	.219,	.074,	.34,	4,	.129,	1.096
SCOLTR	,	1050.,	.199,	.041,	.20,	4,	.152,	1.164
ENGTRL	,	1403.,	.215,	.013,	.06,	4,	.139,	.974
ENGSEI	,	1057.,	.255,	.133,	.52,	4,	.095,	1.159
FRATRB	,	868.,	.261,	.175,	.67,	4,	.086,	1.298
SCOGFS	,	1116.,	.255,	.046,	.18,	4,	.091,	1.122
ENGGFS	,	1115.,	.216,	.100,	.46,	4,	.073,	1.123
NETGFS	,	1407.,	.264,	.074,	.28,	2,	.019,	.972
INTGFS	,	959.,	.275,	.147,	.54,	4,	.054,	1.227
F shrinkage mean	,	1618.,	.50,,,,				.100,	.887

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1142.,	.09,	.04,	39,	.455,	1.106

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	2293.,	.272,	.095,	.35,	5,	.098,	.439
SCOSEI	,	1326.,	.204,	.097,	.47,	5,	.165,	.669
SCOLTR	,	1331.,	.193,	.151,	.78,	5,	.176,	.668
ENGTRL	,	1516.,	.213,	.024,	.11,	5,	.136,	.606
ENGSEI	,	1093.,	.256,	.066,	.26,	5,	.094,	.768
FRATRB	,	883.,	.277,	.142,	.51,	5,	.073,	.888
SCOGFS	,	1051.,	.275,	.229,	.83,	5,	.066,	.790
ENGGFS	,	1467.,	.280,	.130,	.46,	5,	.065,	.621
NETGFS	,	1169.,	.265,	.094,	.35,	2,	.009,	.733
INTGFS	,	1310.,	.335,	.144,	.43,	5,	.045,	.675
F shrinkage mean	,	1044.,	.50,,,,				.072,	.793

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1323.,	.08,	.05,	48,	.583,	.671

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	118.,	.277,	.154,	.55,	6,	.097,	1.336
SCOSEI	,	138.,	.221,	.069,	.31,	6,	.127,	1.223
SCOLTR	,	102.,	.209,	.048,	.23,	6,	.158,	1.443
ENGTRL	,	109.,	.227,	.043,	.19,	6,	.146,	1.394
ENGSEI	,	98.,	.278,	.091,	.33,	6,	.094,	1.476
FRATRB	,	86.,	.287,	.074,	.26,	6,	.102,	1.582
SCOGFS	,	114.,	.329,	.250,	.76,	6,	.062,	1.358
ENGGFS	,	151.,	.295,	.065,	.22,	5,	.033,	1.157
NETGFS	,	198.,	.268,	.128,	.48,	2,	.004,	.983

Continued

Table 3.2.8 Continued

INTGFS	,	243.,	.286,	.469,	1.64,	4,	.013,	.859
F shrinkage mean	,	263.,	.50,,,,				.165,	.814

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
128.,	.11,	.06,	54,	.551,	1.273

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1986

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	169.,	.277,	.092,	.33,	6,	.063,	.694
SCOSEI	,	129.,	.255,	.044,	.17,	7,	.127,	.838
SCOLTR	,	110.,	.233,	.153,	.66,	7,	.152,	.932
ENGTRL	,	63.,	.244,	.111,	.46,	7,	.160,	1.305
ENGSEI	,	79.,	.270,	.052,	.19,	7,	.164,	1.142
FRATRB	,	65.,	.288,	.129,	.45,	6,	.066,	1.280
SCOGFS	,	127.,	.332,	.348,	1.05,	6,	.040,	.848
ENGGFS	,	61.,	.309,	.285,	.92,	5,	.021,	1.333
NETGFS	,	126.,	.272,	.088,	.32,	2,	.002,	.851
INTGFS	,	162.,	.403,	.267,	.66,	6,	.028,	.716
F shrinkage mean	,	118.,	.50,,,,				.177,	.888

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
98.,	.12,	.06,	60,	.468,	1.002

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1985

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	57.,	.278,	.091,	.33,	6,	.042,	1.010
SCOSEI	,	70.,	.304,	.034,	.11,	8,	.196,	.888
SCOLTR	,	69.,	.246,	.102,	.41,	7,	.105,	.893
ENGTRL	,	55.,	.256,	.109,	.42,	7,	.112,	1.035
ENGSEI	,	66.,	.296,	.047,	.16,	8,	.167,	.917
FRATRB	,	51.,	.292,	.114,	.39,	6,	.043,	1.075
SCOGFS	,	36.,	.341,	.230,	.67,	6,	.026,	1.333
ENGGFS	,	55.,	.343,	.155,	.45,	5,	.013,	1.031
NETGFS	,	79.,	.280,	.311,	1.11,	2,	.001,	.816
INTGFS	,	129.,	.416,	.399,	.96,	6,	.018,	.573
F shrinkage mean	,	73.,	.50,,,,				.278,	.862

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
66.,	.16,	.04,	62,	.214,	.920

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1984

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	10.,	.274,	.116,	.42,	6,	.029,	.889
SCOSEI	,	15.,	.337,	.118,	.35,	9,	.231,	.648
SCOLTR	,	10.,	.215,	.087,	.41,	7,	.066,	.846
ENGTRL	,	7.,	.226,	.139,	.61,	7,	.068,	1.136
ENGSEI	,	9.,	.297,	.237,	.80,	8,	.097,	.953
FRATRB	,	7.,	.282,	.078,	.28,	6,	.031,	1.132

Continued

Table 3.2.8 Continued

SCOGFS	,	9.,	.321,	.186,	.58,	6,	.019,	.900
ENGGFS	,	5.,	.287,	.309,	1.07,	5,	.011,	1.285
NETGFS	,	8.,	.331,	.000,	.00,	1,	.001,	1.036
INTGFS	,	10.,	.456,	.206,	.45,	5,	.010,	.839
F shrinkage mean	,	8.,	.50,,,,				.436,	1.032

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
9.,	.23,	.06,	61,	.244,	.917

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1983

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	6.,	.289,	.062,	.21,	6,	.014,	.831
SCOSEI	,	15.,	.350,	.074,	.21,	9,	.135,	.425
SCOLTR	,	7.,	.259,	.086,	.33,	7,	.037,	.775
ENGTRL	,	9.,	.267,	.054,	.20,	7,	.040,	.613
ENGSEI	,	14.,	.296,	.192,	.65,	8,	.060,	.465
FRATRB	,	7.,	.301,	.169,	.56,	6,	.015,	.750
SCOGFS	,	5.,	.355,	.133,	.37,	6,	.009,	.932
ENGGFS	,	12.,	.342,	.156,	.46,	5,	.004,	.512
NETGFS	,	6.,	.300,	.121,	.40,	2,	.000,	.821
INTGFS	,	5.,	.429,	.096,	.22,	6,	.006,	.982
F shrinkage mean	,	5.,	.50,,,,				.678,	.967

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
6.,	.34,	.09,	63,	.269,	.811

Table 3.2.9 Cod, North Sea. International F at age, Total, 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	.025	.020	.060	.057	.035	.046	.021	.109	.077	.035
2	.543	.375	.468	.554	.510	.638	.395	.584	.886	.906
3	.373	.598	.658	.631	.742	.746	.604	.751	.771	.927
4	.455	.417	.628	.534	.539	.716	.589	.576	.712	.673
5	.453	.465	.433	.500	.610	.623	.635	.591	.704	.737
6	.559	.592	.463	.437	.606	.570	.702	.536	.545	.814
7	.166	.580	.460	.441	.622	.587	.496	.531	.576	.790
8	.766	.341	.697	.525	.710	.454	.629	.326	.521	1.036
9	.296	.308	.265	.729	.386	.753	.413	.637	.691	1.237
10	.451	.461	.467	.531	.592	.603	.580	.528	.613	.933
11+	.451	.461	.467	.531	.592	.603	.580	.528	.613	.933

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	.134	.097	.105	.040	.132	.090	.117	.114	.111	.184
2	.733	.838	.751	.959	.866	1.038	.845	.957	1.005	1.013
3	.869	.696	.799	.855	.770	.876	.971	.953	1.001	1.253
4	.800	.664	.680	.757	.543	.760	.583	.738	.737	.845
5	.592	.660	.747	.573	.640	.891	.713	.612	.679	.804
6	.742	.551	.666	.789	.594	.691	.547	.641	.643	.890
7	.701	.744	.506	.736	.781	.660	.639	.777	.722	.765
8	.558	.614	.831	.278	.761	.750	.520	.845	.619	.736
9	.357	.934	.856	.802	1.427	.885	.758	.614	.768	.888
10	.595	.707	.728	.642	.852	.793	.649	.716	.706	.844
11+	.595	.707	.728	.642	.852	.793	.649	.716	.706	.844

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.137	.188	.117	.241	.144	.198	.146	.154	.146	.127
2	1.130	1.020	1.054	.761	.930	.964	.957	.867	.827	.855
3	1.181	1.031	1.044	1.034	.858	1.171	1.072	.946	.908	.894
4	.897	.812	.815	.795	.956	.824	1.027	.863	.857	.819
5	.796	.778	.701	.861	.762	.824	.776	.695	.795	.835
6	.790	.811	.716	.819	.957	.831	.960	.533	.929	.778
7	.733	.736	.756	.834	.978	.794	.991	.706	1.098	.805
8	.840	.795	.737	.975	.938	.800	1.142	.384	1.029	.909
9	.576	1.008	.625	.675	1.023	.713	.870	1.985	.504	1.029
10	.737	.820	.707	.821	.911	.731	.914	.845	.853	.704
11+	.737	.820	.707	.821	.911	.731	.914	.845	.853	.704

Age	1993
1	.077
2	.637
3	.964
4	1.107
5	.671
6	1.273
7	1.002
8	.920
9	.917
10	.811
11+	.811

Table 3.2.10 Cod, North Sea. Tuned stock numbers at age (100**-3) 1963 to 1994, (numbers in 1994 are VPA survivors.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	197724	366650	421752	512132	484881	196726	204636	765657	903201	173987
2	127785	86614	161530	178474	217327	210373	84402	90028	308500	375913
3	25843	52338	41927	71322	72284	92007	78320	40056	35375	89669
4	10702	13857	22413	16912	29544	26815	33983	33337	14720	12744
5	8134	5560	7475	9790	8118	14115	10725	15442	15347	5910
6	3007	4232	2859	3969	4862	3613	6195	4656	7000	6214
7	609	1408	1916	1473	2100	2172	1672	2514	2231	3322
8	958	422	645	990	776	923	988	834	1211	1027
9	61	365	246	263	479	312	480	431	493	589
10	17	37	219	154	104	267	120	260	187	202
11+	0	12	23	221	40	55	186	104	215	30

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	306634	253157	460884	207798	770266	451497	475593	850690	288108	593618
2	75466	120539	103202	186382	89712	303363	185398	190187	341065	115842
3	107001	25542	36749	34304	50318	26584	75689	56123	51487	87965
4	27631	34931	9916	12878	11363	18151	8625	22316	16858	14737
5	5325	10169	14726	4113	4944	5404	6952	3941	8734	6602
6	2317	2411	4303	5713	1899	2135	1815	2790	1750	3627
7	2254	903	1138	1810	2126	858	876	860	1204	753
8	1234	915	351	561	710	797	363	378	324	478
9	298	578	405	125	348	271	308	177	133	143
10	140	171	186	141	46	68	92	118	78	51
11+	376	383	121	89	165	83	36	53	44	30

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	284947	565611	109984	600522	244185	150444	242157	111509	142676	299997
2	221802	111681	210506	43971	212035	95018	55472	94069	42956	55404
3	29640	50472	28391	51681	14470	58929	25528	15016	27863	13241
4	19566	7089	14023	7782	14311	4777	14230	6806	4542	8748
5	5183	6530	2578	5082	2877	4505	1716	4172	2352	1578
6	2419	1915	2455	1047	1759	1100	1618	647	1705	869
7	1220	899	697	983	378	553	392	508	311	551
8	287	480	353	268	349	116	205	119	205	85
9	188	101	177	138	83	112	43	53	66	60
10	48	86	30	78	58	24	45	15	6	33
11+	41	39	50	38	21	33	18	5	16	17

Age	1993	1994
1	82472	0
2	118739	34321
3	16600	44261
4	4218	4932
5	3159	1142
6	560	1323
7	327	128
8	202	98
9	28	66
10	18	9
11+	23	15

Table 3.2.11

COD IV RCT3 INPUTVALUES; AGE 1*100; 1994 WG

13 25 2

'YEARCL	'VPA '	'IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS1'	'SGFS2'	'DGFS0'	'DGFS1'	'DGFS2'	'FRGSF'	'GGFS1'	'GGFS2'
1970	903	9830	3450	-1	-1	-1	-1	-1	-1	-1	-1	9040	-1	-1
1971	174	410	1060	-1	-1	-1	-1	-1	-1	-1	-1	130	-1	-1
1972	307	3800	950	-1	-1	-1	-1	-1	-1	-1	-1	160	-1	-1
1973	253	1470	620	-1	-1	-1	-1	-1	-1	-1	-1	360	-1	-1
1974	461	4030	1990	-1	-1	-1	-1	-1	-1	-1	-1	800	-1	-1
1975	208	790	320	-1	-1	447	-1	-1	-1	-1	-1	780	-1	-1
1976	770	3670	2930	-1	6270	1250	-1	-1	-1	-1	-1	2820	-1	-1
1977	451	1290	930	1389	2284	580	-1	-1	-1	-1	-1	2720	-1	-1
1978	476	990	1480	1256	2423	670	-1	-1	-1	-1	450	3110	-1	-1
1979	851	1690	2550	1855	5084	1386	-1	-1	-1	16380	1120	3550	-1	-1
1980	288	290	670	1023	1136	290	-1	351	4320	4690	160	1410	-1	-1
1981	594	920	1660	7424	3237	1096	614	78	17680	8300	230	2320	-1	350
1982	285	390	800	255	1540	475	325	391	2690	2180	160	900	590	240
1983	566	1520	1760	9510	6122	1189	819	1143	12150	12130	310	4300	260	2240
1984	110	90	360	38	430	115	66	104	130	360	20	90	230	260
1985	600	1700	2880	828	3438	1065	801	695	14360	11120	800	950	1540	1140
1986	244	880	610	121	1422	407	219	288	3700	4150	170	230	700	950
1987	150	360	630	38	836	248	162	135	3620	1780	220	210	200	720
1988	242	1310	1520	1678	2285	504	561	49	1660	1660	190	420	9020	1470
1989	112	340	410	598	608	155	114	154	1370	920	70	60	1190	620
1990	142	240	450	383	752	159	303	193	2350	720	110	-1	1550	360
1991	-1	1300	1990	4840	2440	650	642	749	3980	4540	70	-1	1340	-1
1992	-1	1270	440	1684	742	295	347	334	1160	170	-1	-1	-1	450
1993	-1	1480	-1	377	2637	-1	1158	-1	2410	-1	-1	-1	3080	-1
1994	-1	-1	-1	2134	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Table 3.2.12

Analysis by RCT3 ver3.1 of data from file :

codiv1a.rcx

COD IV RCT3 INPUTVALUES; AGE 1*100; 1994 WG

Data for 13 surveys over 25 years : 1970 - 1994

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 = 1991

Survey/ Series	Regression: Slope	Regression: Inter-cept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
IYFS1	.86	.05	.50	.674	21	7.17	6.25	.581	.042
IYFS2	1.04	-1.45	.33	.824	21	7.60	6.42	.395	.091
EGFS0	.55	2.12	.71	.506	14	8.48	6.79	.867	.019
EGFS1	.86	-.75	.24	.900	15	7.80	5.98	.280	.182
EGFS2	.85	.48	.19	.937	16	6.48	5.99	.217	.303
SGFS1	.88	.47	.37	.784	10	6.47	6.18	.464	.066
SGFS2	1.34	-1.71	1.16	.257	11	6.62	7.18	1.479	.007
DGFS0	.57	.93	.46	.687	11	8.29	5.65	.543	.048
DGFS1	.60	.83	.25	.895	12	8.42	5.88	.294	.165
DGFS2	.81	1.38	.46	.712	13	4.26	4.82	.553	.046
FRGSF									
GGFS1	5.01	-28.22	6.57	.011	9	7.20	7.86	8.009	.000
GGFS2									
					VPA Mean =		5.64	.684	.030

Yearclass = 1992

Survey/ Series	Regression: Slope	Regression: Inter-cept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
IYFS1	.87	.01	.50	.678	21	7.15	6.24	.589	.046
IYFS2	1.04	-1.46	.33	.827	21	6.09	4.85	.399	.101
EGFS0	.55	2.10	.73	.494	14	7.43	6.21	.861	.022
EGFS1	.86	-.74	.24	.900	15	6.61	4.95	.292	.189
EGFS2	.84	.52	.19	.939	16	5.69	5.31	.216	.346
SGFS1	.88	.46	.38	.780	10	5.85	5.63	.453	.078
SGFS2	1.32	-1.61	1.14	.265	11	5.81	6.09	1.366	.009
DGFS0	.58	.88	.47	.680	11	7.06	4.94	.571	.049
DGFS1	.60	.83	.25	.893	12	5.14	3.91	.364	.121
DGFS2									
FRGSF									
GGFS1									
GGFS2	1.99	-7.46	1.42	.201	10	6.11	4.70	1.722	.005
					VPA Mean =		5.60	.686	.034

Continued

Table 3.2.12 Continued

Yearclass = 1993

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	.88	-.03	.50	.677	21	7.30	6.37	.615	.109
IYFS2									
EGFS0	.56	2.06	.75	.479	14	5.93	5.37	.886	.052
EGFS1	.86	-.72	.24	.899	15	7.88	6.03	.293	.481
EGFS2									
SGFS1	.88	.45	.38	.775	10	7.06	6.68	.532	.146
SGFS2									
DGFS0	.58	.82	.48	.671	11	7.79	5.36	.577	.124
DGFS1									
DGFS2									
FRGSF									
GGFS1	4.62	-25.78	6.18	.012	9	8.03	11.33	8.075	.001
GGFS2									
					VPA Mean =		5.56	.685	.088

Yearclass = 1994

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	.57	2.01	.78	.460	14	7.67	6.35	.974	.328
EGFS1									
EGFS2									
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
FRGSF									
GGFS1									
GGFS2									
					VPA Mean =		5.52	.680	.672

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	392	5.97	.12	.10	.76		
1992	165	5.11	.13	.18	2.03		
1993	406	6.01	.20	.18	.77		
1994	326	5.79	.56	.39	.48		

Table 3.2.13

Analysis by RCT3 ver3.1 of data from file :

codiv2a.rcx

COD IV RCT3 INPUTVALUES;AGE 2*100; 1994 WG

Data for 13 surveys over 25 years : 1970 - 1994

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 = 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	.87	-.98	.54	.623	20	5.48	3.81	.650	.040
IYFS2	1.05	-2.48	.38	.768	20	6.11	3.94	.458	.081
EGFS0	.51	1.50	.66	.534	13	5.95	4.51	.762	.029
EGFS1	.86	-1.65	.27	.877	14	6.62	4.03	.322	.163
EGFS2	.87	-.62	.22	.913	15	5.08	3.81	.269	.235
SGFS1	.78	.18	.28	.860	9	5.72	4.62	.343	.144
SGFS2	1.24	-2.07	1.14	.256	10	5.27	4.47	1.354	.009
DGFS0	.52	.42	.44	.697	10	7.76	4.46	.525	.062
DGFS1	.61	-.23	.27	.875	11	6.58	3.79	.346	.141
DGFS2	.77	.63	.47	.695	12	4.71	4.28	.559	.054
FRGSF									
GGFS1	2.84	-14.25	3.88	.030	8	7.35	6.58	4.896	.001
GGFS2	2.35	-10.82	1.81	.131	9	5.89	3.02	2.282	.003
					VPA Mean =		4.78	.665	.038

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	.88	-1.03	.54	.630	20	7.17	5.30	.637	.041
IYFS2	1.05	-2.52	.38	.773	20	7.60	5.48	.460	.079
EGFS0	.50	1.50	.67	.528	13	8.48	5.78	.830	.024
EGFS1	.86	-1.64	.27	.877	14	7.80	5.03	.315	.167
EGFS2	.87	-.58	.22	.916	15	6.48	5.03	.252	.261
SGFS1	.78	.18	.29	.858	9	6.47	5.20	.364	.125
SGFS2	1.22	-1.97	1.12	.264	10	6.62	6.12	1.455	.008
DGFS0	.52	.39	.45	.691	10	8.29	4.73	.538	.057
DGFS1	.61	-.23	.28	.873	11	8.42	4.91	.329	.153
DGFS2	.78	.61	.48	.688	12	4.26	3.92	.591	.047
FRGSF									
GGFS1	2.77	-13.86	3.83	.031	8	7.20	6.10	4.817	.001
GGFS2									
					VPA Mean =		4.75	.671	.037

Continued

Table 3.2.13 Continued

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	.89	-1.09	.55	.631	20	7.15	5.29	.655	.045
IYFS2	1.05	-2.54	.38	.779	20	6.09	3.88	.474	.086
EGFS0	.51	1.49	.69	.519	13	7.43	5.25	.826	.028
EGFS1	.85	-1.63	.27	.877	14	6.61	4.01	.334	.173
EGFS2	.86	-.55	.21	.919	15	5.69	4.34	.254	.298
SGFS1	.78	.18	.29	.856	9	5.85	4.72	.357	.151
SGFS2	1.20	-1.87	1.11	.273	10	5.81	5.13	1.352	.011
DGFS0	.53	.34	.46	.684	10	7.06	4.07	.571	.059
DGFS1	.61	-.23	.28	.870	11	5.14	2.91	.430	.104
DGFS2									
FRGSF									
GGFS1									
GGFS2	2.27	-10.37	1.72	.144	9	6.11	3.52	2.163	.004
					VPA Mean =		4.72	.676	.042

Yearclass = 1993

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	.90	-1.15	.56	.628	20	7.30	5.42	.692	.089
IYFS2									
EGFS0	.51	1.48	.71	.506	13	5.93	4.49	.854	.058
EGFS1	.85	-1.60	.27	.877	14	7.88	5.07	.330	.390
EGFS2									
SGFS1	.77	.18	.29	.854	9	7.06	5.64	.419	.242
SGFS2									
DGFS0	.54	.29	.47	.675	10	7.79	4.45	.582	.126
DGFS1									
DGFS2									
FRGSF									
GGFS1	2.61	-12.91	3.71	.033	8	8.03	8.08	5.066	.002
GGFS2									
					VPA Mean =		4.68	.677	.093

Continued

Table 3.2.13 Continued

Yearclass = 1994

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	.51	1.45	.74	.490	13	7.67	5.36	.942	.340
EGFS1									
EGFS2									
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
FRGSF									
GGFS1									
GGFS2									
					VPA Mean =		4.63	.676	.660

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	60	4.10	.13	.10	.59		
1991	152	5.03	.13	.10	.63		
1992	68	4.22	.14	.18	1.78		
1993	163	5.10	.21	.18	.73		
1994	131	4.88	.55	.35	.40		

Table 3.2.14 Cod, North Sea. Mean fishing mortality, biomass and recruitment, 1963 - 1993.

Year	Mean F Ages 2 to 8	Stock Biomass ('000 tonnes) Total	Spawning	Recruits Age 1 Yclass	Million
1963	.473	439	140	1962	198
1964	.481	549	168	1963	367
1965	.544	682	194	1964	422
1966	.517	864	231	1965	512
1967	.620	921	249	1966	485
1968	.619	842	284	1967	197
1969	.578	686	282	1968	205
1970	.556	918	269	1969	766
1971	.674	1111	262	1970	903
1972	.840	802	228	1971	174
1973	.714	648	209	1972	307
1974	.681	592	218	1973	253
1975	.711	645	197	1974	461
1976	.707	546	167	1975	208
1977	.708	758	148	1976	770
1978	.809	721	149	1977	451
1979	.688	727	151	1978	476
1980	.789	897	164	1979	851
1981	.772	677	167	1980	288
1982	.901	773	173	1981	594
1983	.910	598	145	1982	285
1984	.855	665	123	1983	566
1985	.832	429	111	1984	110
1986	.869	560	98	1985	601
1987	.911	468	89	1986	244
1988	.887	374	85	1987	150
1989	.989	352	76	1988	242
1990	.713	271	64	1989	112
1991	.921	254	62	1990	143
1992	.842	368	61	1991	300
1993	.939	272	57	1992	165*
Arithmetic mean recruits, age 1, 1963 to 1991:					391
Geometric mean recruits, age 1, 1963 to 1991:					329

*RCT3 estimate

Table 3.2.15 Cod North Sea. Input data for catch forecast and linear sensitivity analysis.

Populations in 1994			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	406000	.20	WS1	.69	.10	M1	.80	.13	MT1	.01	.10
N2	68000	.18	WS2	1.05	.08	M2	.35	.10	MT2	.05	.10
N3	44260	.09	WS3	2.25	.11	M3	.25	.18	MT3	.23	.10
N4	4931	.08	WS4	4.17	.09	M4	.20	.18	MT4	.62	.10
N5	1142	.09	WS5	6.23	.06	M5	.20	.18	MT5	.86	.10
N6	1323	.08	WS6	8.27	.05	M6	.20	.18	MT6	1.00	.10
N7	128	.11	WS7	10.03	.06	M7	.20	.18	MT7	1.00	.00
N8	98	.12	WS8	10.58	.06	M8	.20	.18	MT8	1.00	.00
N9	65	.16	WS9	12.75	.05	M9	.20	.18	MT9	1.00	.00
N10	9	.23	WS10	13.85	.06	M10	.20	.18	MT10	1.00	.00
N11	14	.34	WS11	14.55	.22	M11	.20	.18	MT11	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.14	.45	WH1	.69	.10
sH2	.88	.17	WH2	1.05	.08
sH3	1.02	.12	WH3	2.25	.11
sH4	1.00	.11	WH4	4.17	.09
sH5	.80	.11	WH5	6.23	.06
sH6	.95	.15	WH6	8.27	.05
sH7	.98	.17	WH7	10.03	.06
sH8	.93	.25	WH8	10.58	.06
sH9	1.13	.45	WH9	12.75	.05
sH10	.88	.10	WH10	13.85	.06
sH11	.88	.21	WH11	14.55	.22

Year effect M			HC relative eff		
Labl	Value	CV	Labl	Value	CV
K94	1.00	.10	HF94	1.00	.20
K95	1.00	.10	HF95	1.00	.20
K96	1.00	.10	HF96	1.00	.20

Recruitment		
Labl	Value	CV
R95	326000	.56
R96	250000	.68

Stock numbers in 1994 are VPA survivors.
These are overwritten at Age 1 Age 2

Table 3.2.16 Cod North Sea. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 1994	1995						
Mean F Ages								
H.cons 2 to 8	.94	.00	.38	.56	.66	.75	.94	1.13
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Biomass at start of year								
Total	495	507	507	507	507	507	507	507
Spawning	63	69	69	69	69	69	69	69
Catch weight (,000t)								
H.cons	143	0	84	118	132	146	170	192
Biomass at start of 1996								
Total		725	594	543	521	501	465	435
Spawning		180	125	105	96	88	74	62

	Year 1994	1995						
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Est. Coeff. of Variation								
Biomass at start of year								
Total	.13	.28	.28	.28	.28	.28	.28	.28
Spawning	.08	.21	.21	.21	.21	.21	.21	.21
Catch weight								
H.cons	.18	.00	.46	.32	.28	.26	.23	.21
Biomass at start of 1996								
Total		.24	.29	.30	.31	.31	.33	.34
Spawning		.19	.27	.27	.27	.27	.27	.27

Table 3.2.17 Cod North Sea. Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	406000	36352	36352
2	68000	34506	34506
3	44260	25565	25565
4	4931	2865	2865
5	1142	579	579
6	1323	749	749
7	128	74	74
8	98	55	55
9	65	41	41
10	9	5	5
11	14	8	8
Wt	495	143	143

Forecast for year 1995
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	326000	29189	29189
2	158912	80639	80639
3	19816	11446	11446
4	12430	7221	7221
5	1491	757	757
6	418	237	237
7	417	240	240
8	39	22	22
9	32	20	20
10	17	9	9
11	8	4	4
Wt	507	170	170

Table 3.2.18 Cod North Sea.

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.
TAC constraint of 102000 tonnes applied.

	Year 1994	1995						
Mean F Ages								
H.cons 2 to 8	.59	.00	.38	.56	.66	.75	.94	1.13
Effort relative to 1993								
H.cons	.63	.00	.40	.60	.70	.80	1.00	1.20
Biomass at start of year								
Total	495	564	564	564	564	564	564	564
Spawning	63	95	95	95	95	95	95	95
Catch weight (,000t)								
H.cons	102	0	101	140	158	174	203	227
Biomass at start of 1996								
Total		800	644	585	559	536	494	458
Spawning		231	160	133	122	111	93	78

	Year 1994	1995						
Effort relative to 1993								
H.cons	.63	.00	.40	.60	.70	.80	1.00	1.20
Est. Coeff. of Variation								
Biomass at start of year								
Total	.13	.25	.25	.25	.25	.25	.25	.25
Spawning	.08	.21	.21	.21	.21	.21	.21	.21
Catch weight								
H.cons	.28	.00	.46	.32	.28	.25	.22	.20
Biomass at start of 1996								
Total		.22	.27	.29	.29	.30	.31	.33
Spawning		.19	.27	.27	.27	.27	.27	.27

Table 3.2.19 Cod North Sea. Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons= .63

Age	Stock No.	H.Cons	Total
	Populations	Catch number	
1	406000	23417	23417
2	68000	24887	24887
3	44260	18820	18820
4	4931	2105	2105
5	1142	415	415
6	1323	547	547
7	128	54	54
8	98	40	40
9	65	30	30
10	9	4	4
11	14	5	5
Wt	495	102	102

Forecast for year 1995
F multiplier H.cons=1.00

Age	Stock No.	H.Cons	Total
	Populations	Catch number	
1	326000	29189	29189
2	167229	84859	84859
3	27465	15864	15864
4	18122	10528	10528
5	2155	1093	1093
6	563	319	319
7	594	342	342
8	56	32	32
9	45	28	28
10	26	14	14
11	11	6	6
Wt	565	203	203

Table 3.2.20 Cod North Sea. Model parameters for stock recruitment.

Shepherd curve
Moving average term fitted

Residual sum of squares=	5.8492
Number of observations=	29
Number of parameters =	4
Residual mean square =	0.234
Coefficient of determination =	0.3662
Adj. coeff. of determination =	0.2902

Parameter Correlation matrix

1			
-0.8104	1		
-0.6944	0.5607	1	
0.1301	-0.1157	-0.1321	1

Parameter	s.d.
2.7467	0.3513
245.8722	19.8139
4.8188	2.1522
-0.4164	0.1865

Table 3.2.21

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	1992	1993
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		
1993	0.89	0.88	0.95	0.72	0.85	0.86	
1994	0.91	0.89	0.99	0.71	0.92	0.84	0.94

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F								
Date of assessment	Year							
	1988	1989	1990	1991	1992	1993	1994	1995
1989	150	136	143					
1990		179	142	119				
1991			121	100	108			
1992				87	100	124		
1993					97	142	131	
1994					102	99	143	170
				\ SQC[1]	\ SQC[2]	\ Current	\ Forecast	

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

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

where F(y), F(y - 1) and F(y - 2) are as estimated in the assessment made in year (y + 1).

Remarks:

Continued

Table 3.2.21 Continued

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	1992	1993
1989	193	329[1]					
1990	201	324	161[2]				
1991	142	316	140	216			
1992	143	246	137	155	345		
1993	150	257	113	150	410	199	
1994	150	242	112	143	300	165	406

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

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1989	88	91	82[1]	80[1,2]					
1990	84	85	87	78[1,3]	71[1,3]				
1991	79	73	66	64	66[1,3]	68[1,3]			
1992	79	73	62	56	51	47[1,4]	52[1,5]		
1993	82	76	65	60	64	58	62[1,5]	66[1,5]	
1994	85	76	64	62	61	57	63	69[1]	74[1]

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

Remarks:

Figure 3.2.1

North Sea Cod

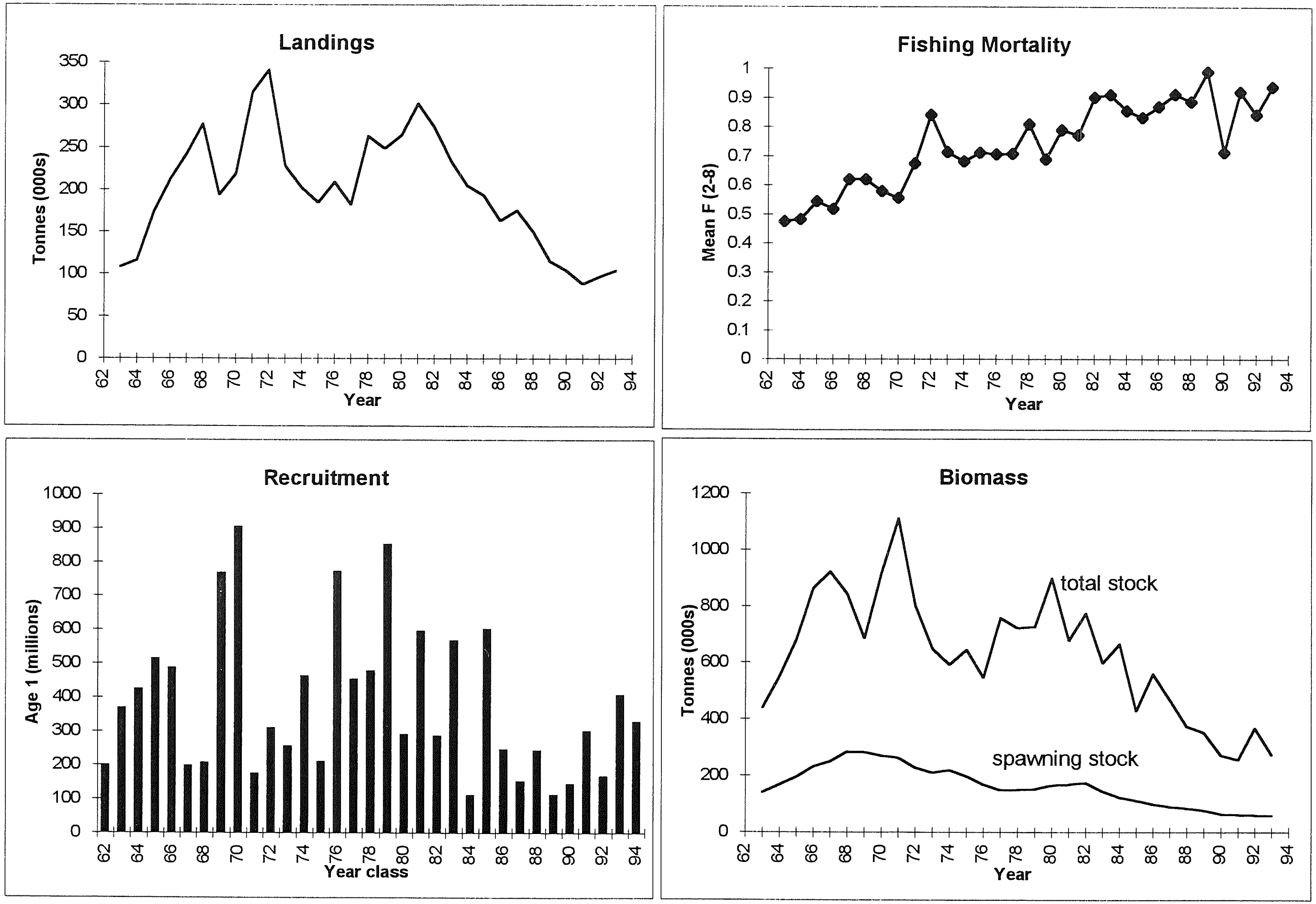
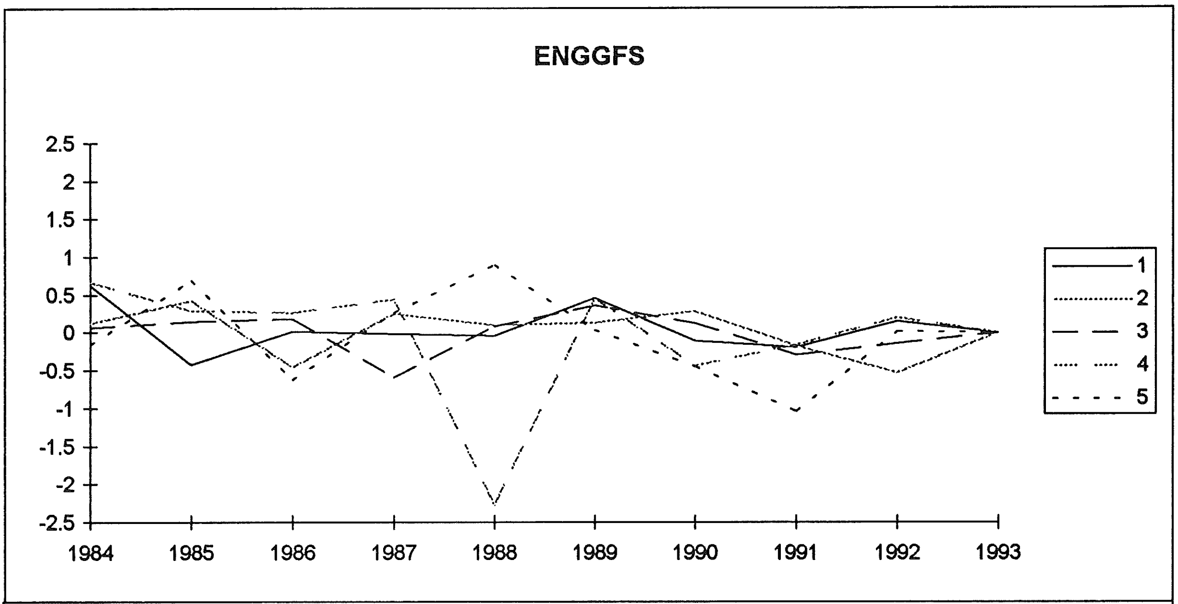
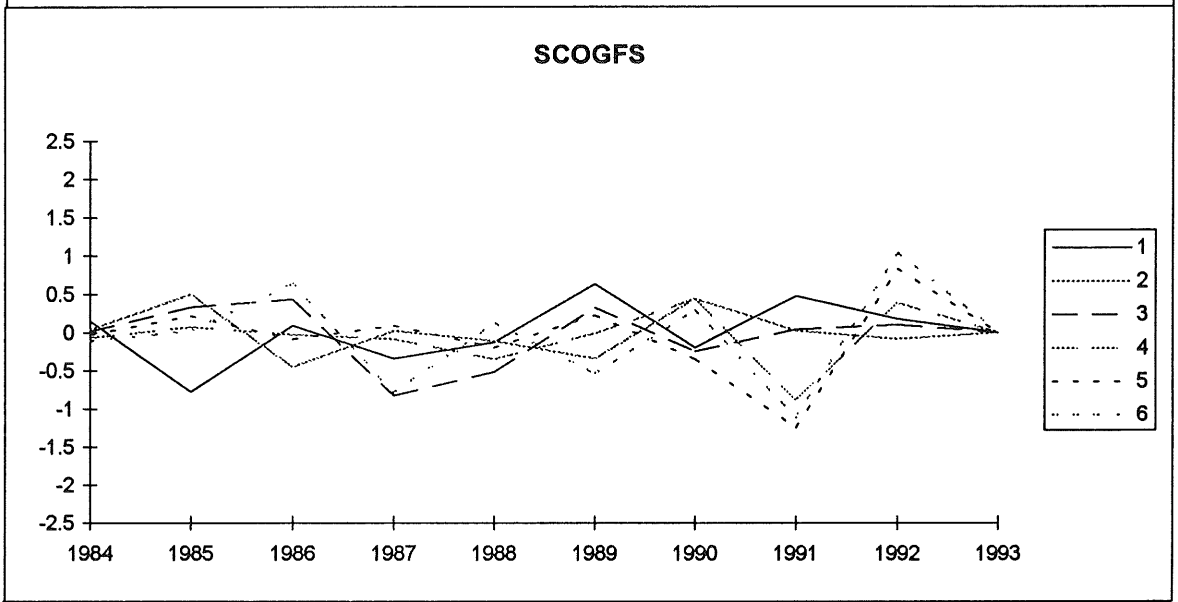


Figure 3.2.2





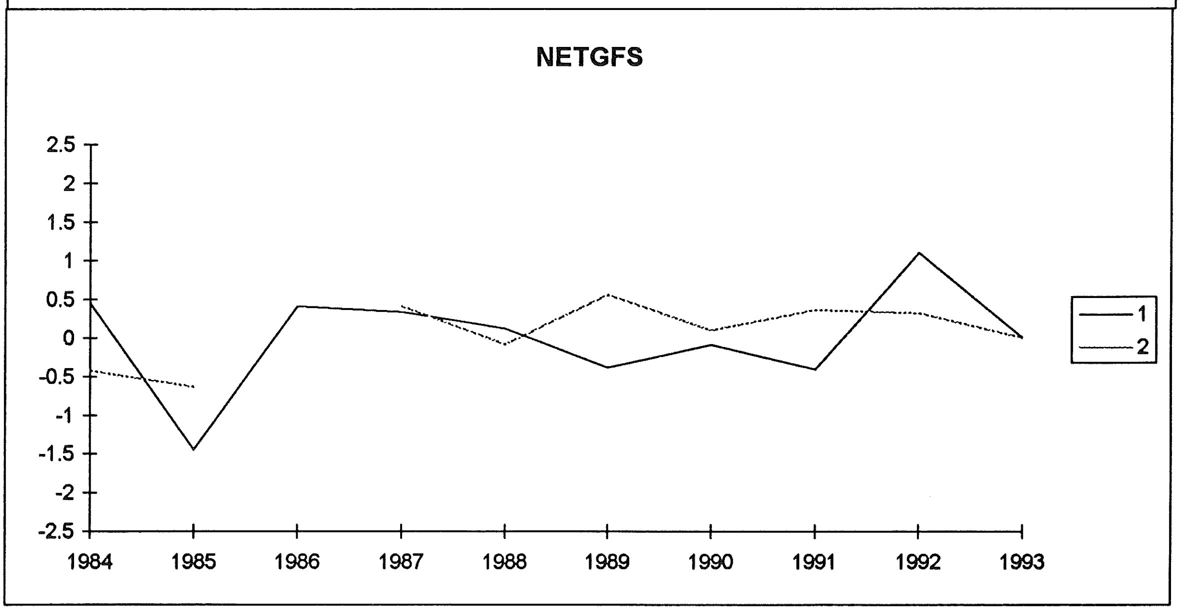


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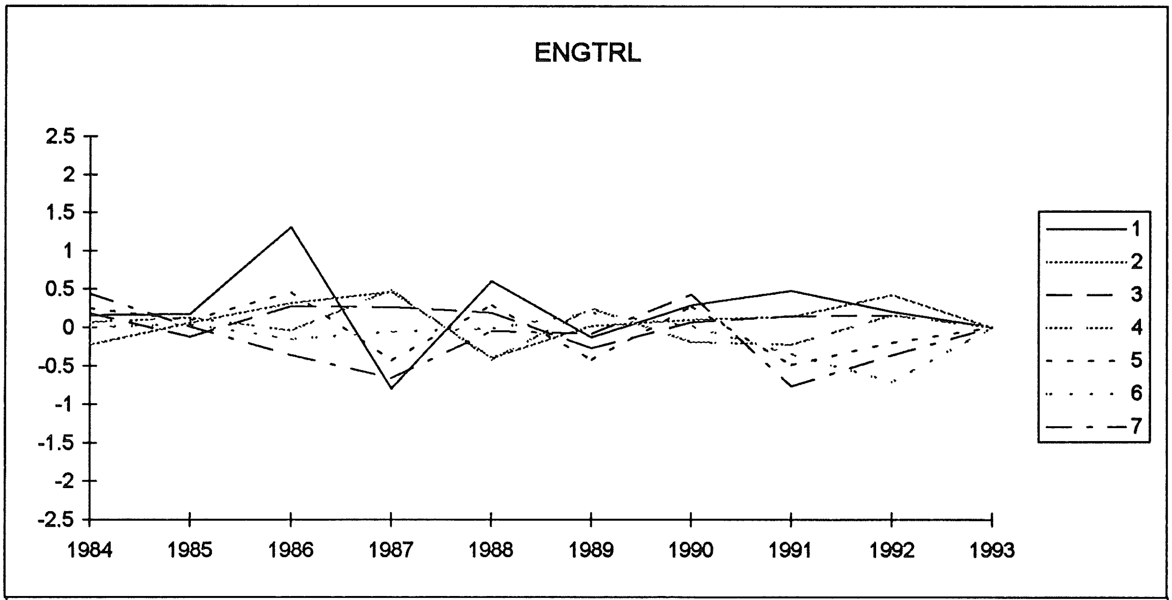
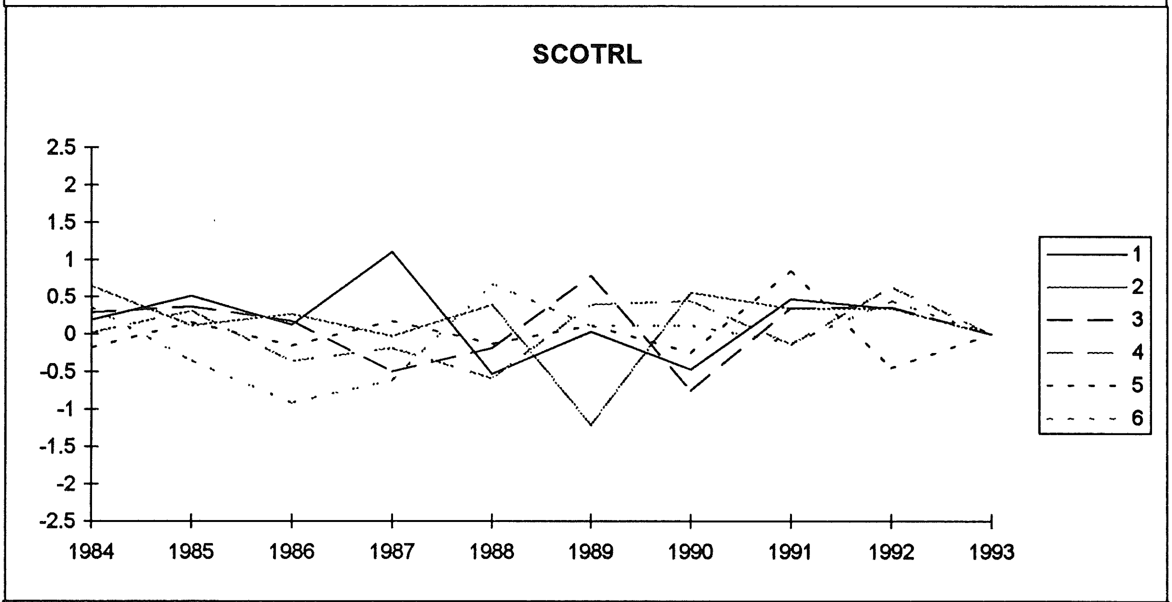
Figure 3.2.2 Continued





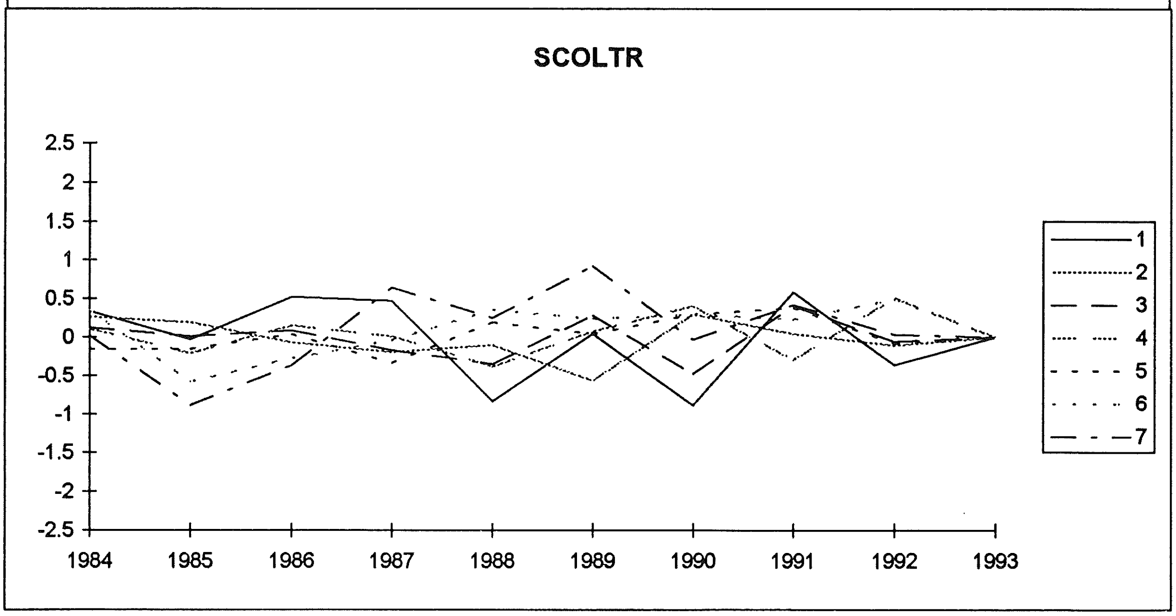


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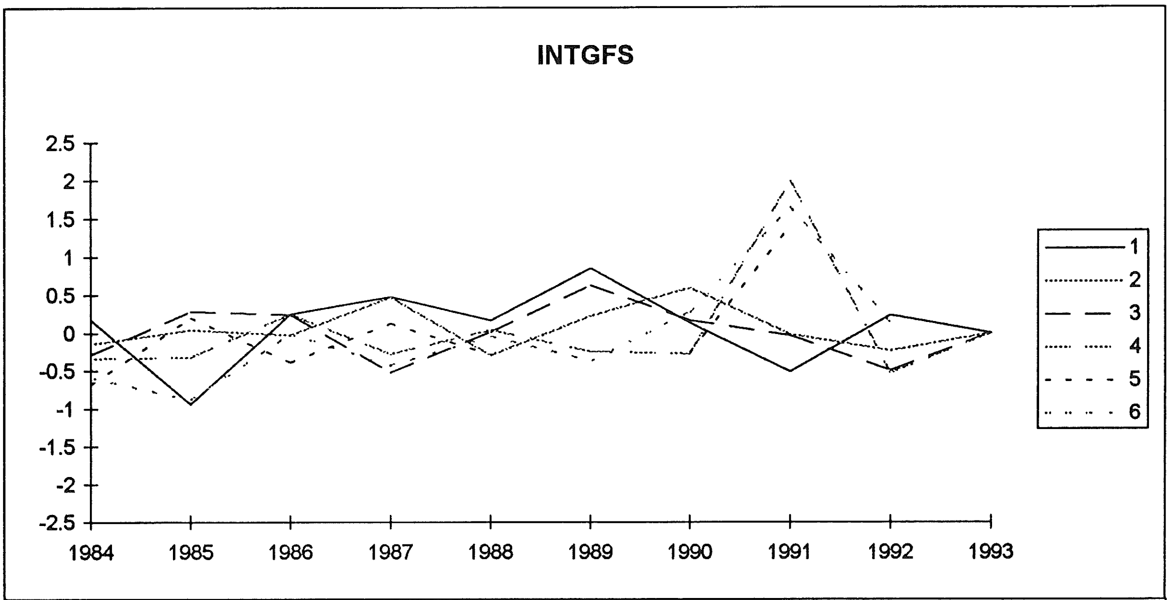
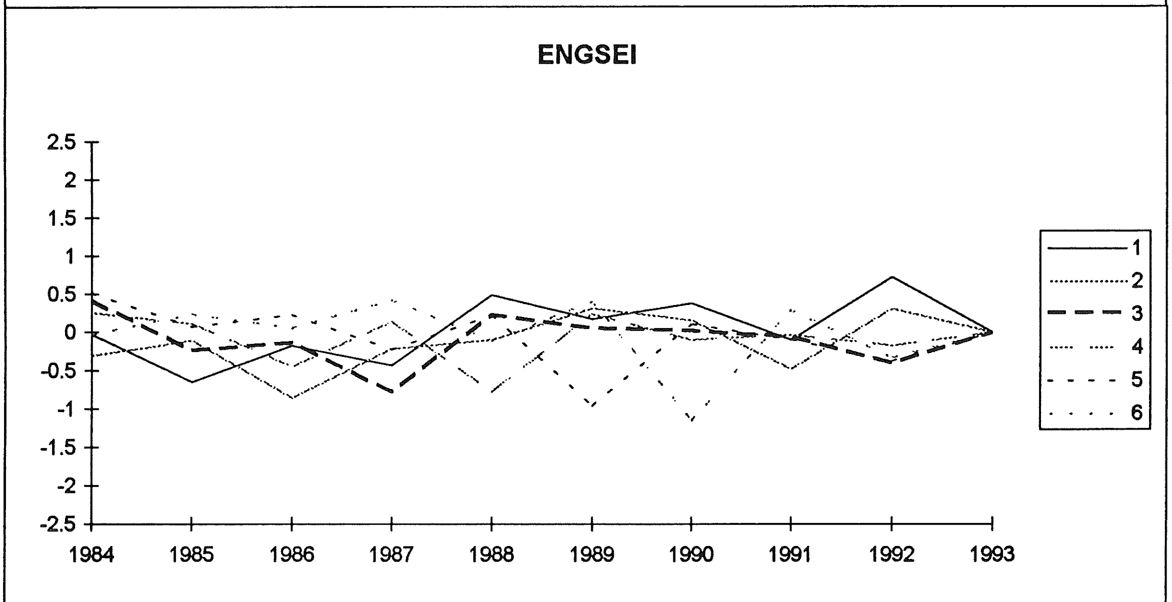
Figure 3.2.2 Continued





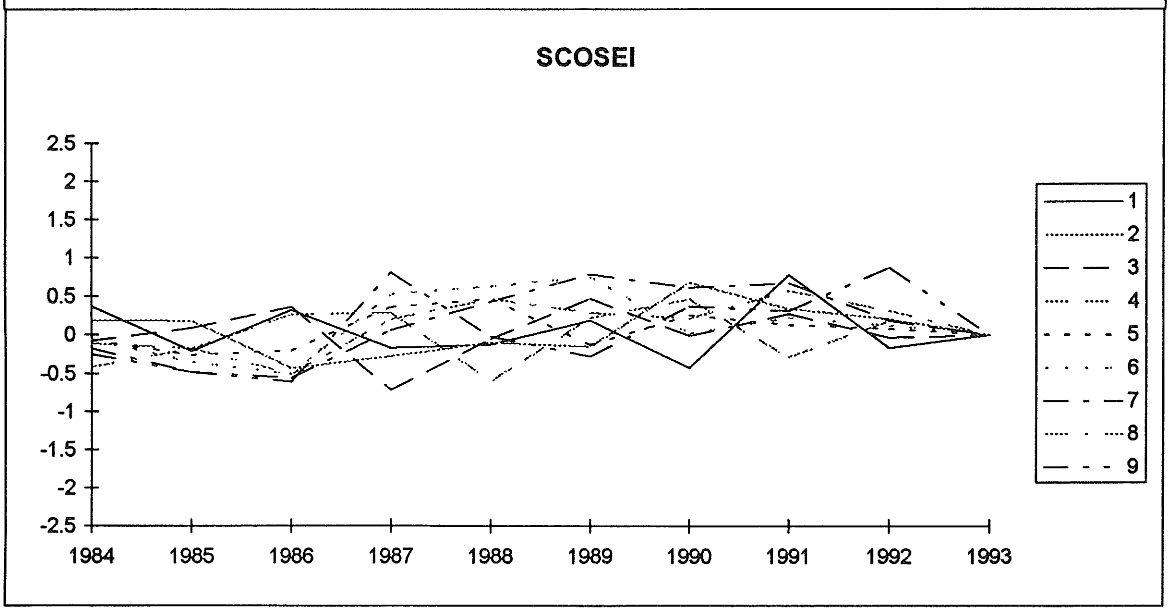


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Figure 3.2.2 Continued

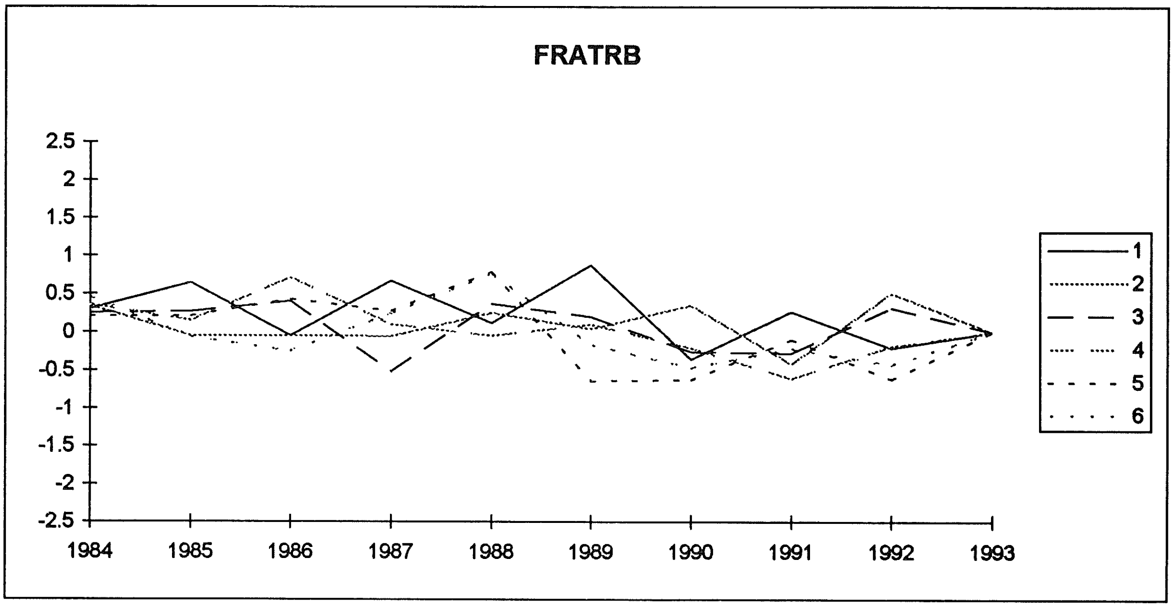


Figure 3.2.3

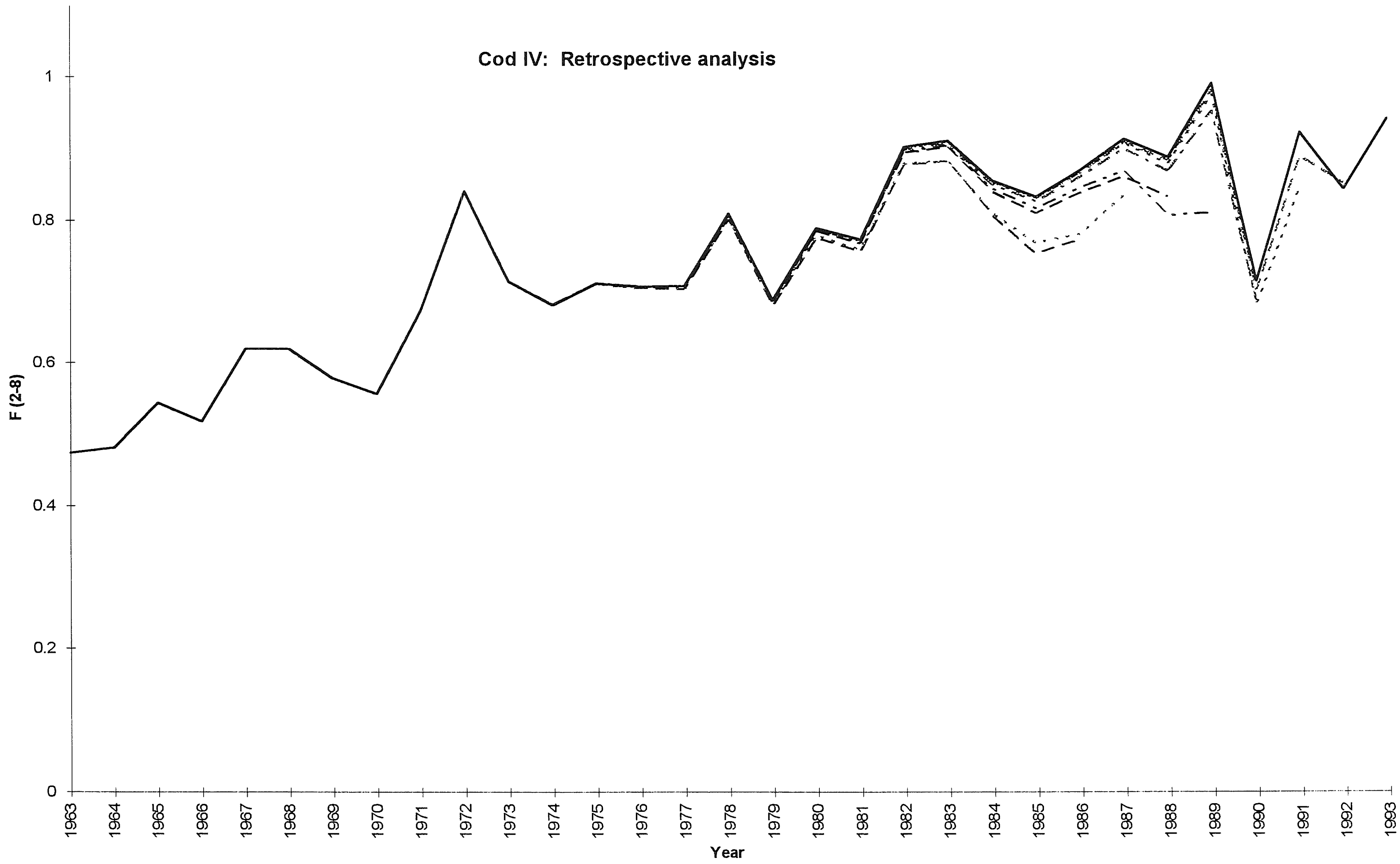
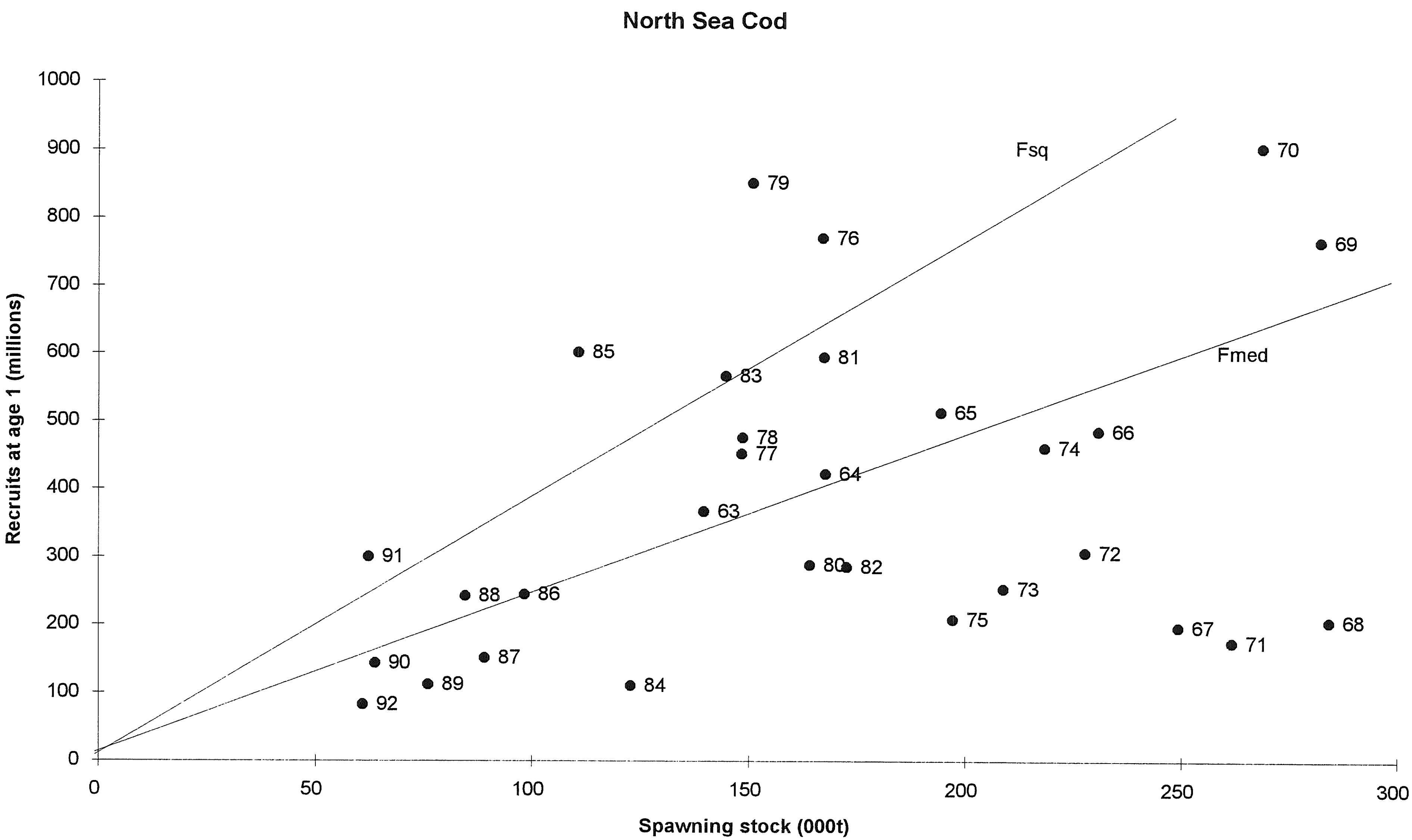

Cod IV: Retrospective analysis
F (2-8)
0
0.2
0.4
0.6
0.8
1
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
Year

Figure 3.2.4


North Sea Cod
Recruits at age 1 (millions)
Spawning stock (000t)
Fsq
Fmed
0
100
200
300
400
500
600
700
800
900
1000
0
50
100
150
200
250
300
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
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85
86
87
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89
90
91
92

Figure 3.2.5

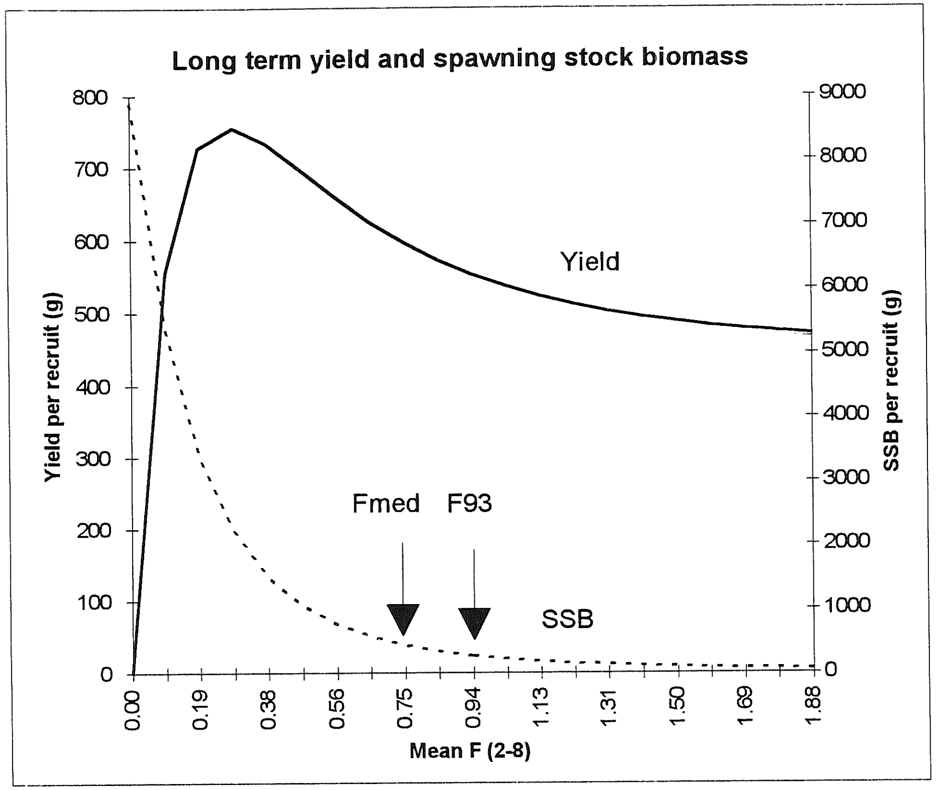


Figure 3.2.6

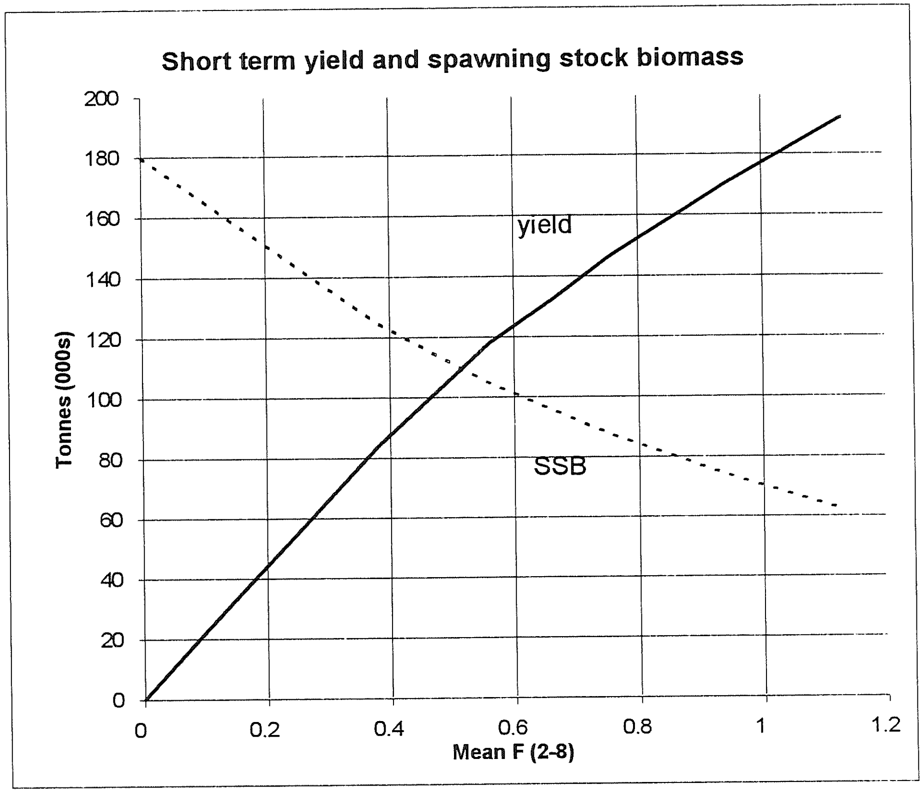


Figure 3.2.7 Cod IV. Sensitivity analysis of short term forecast. Linear sensitivity coefficients (elasticities). Key to labels in Table 3.2.15.

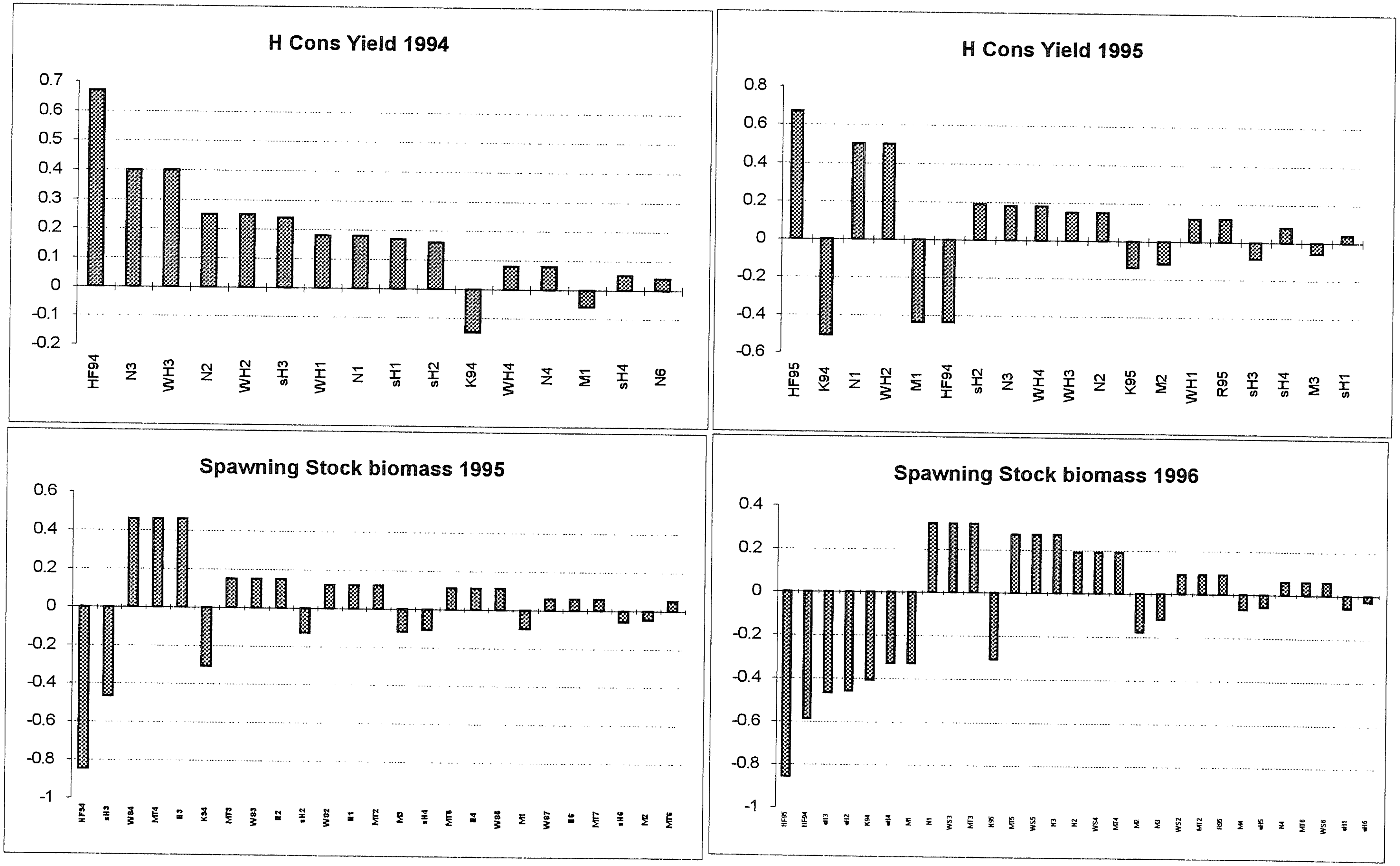


Figure 3.2.8 Cod IV. Sensitivity analysis of short term forecast. Proportion of total variance contributed by each input. Key to labels in Table 3.2.15.

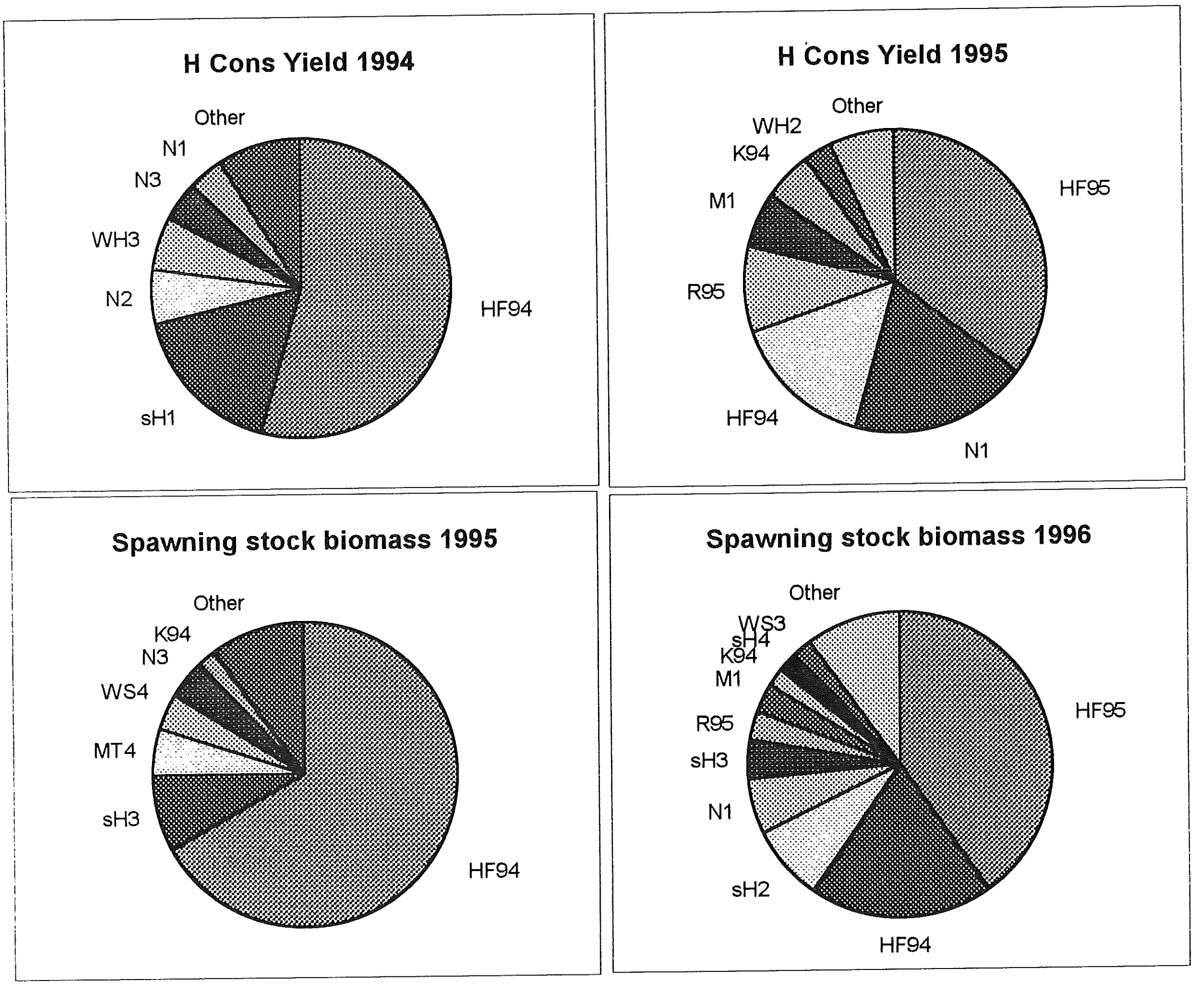


Figure 3.2.9 Cod IV. Sensitivity analysis of short term status quo forecast. Cumulative probability distributions.

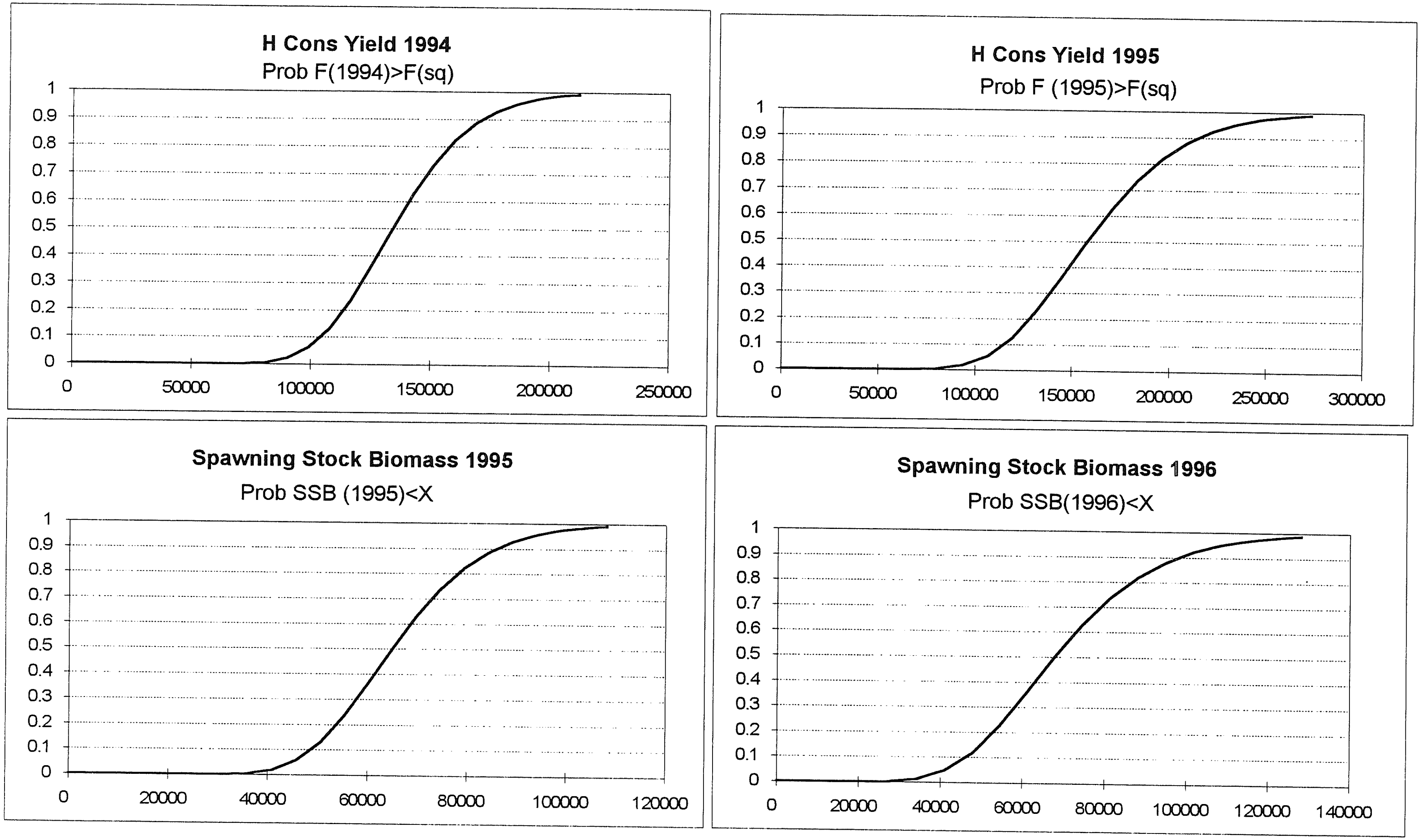


Figure 3.2.10 Cod North Sea. Medium term projections. Solid lines show 5,25,50,75 and 95 percentiles.
Dashed lines show five sample trajectories. Age two using RCT3 values.
Number of simulations= 500 Relative H. Cons effort = 1.00

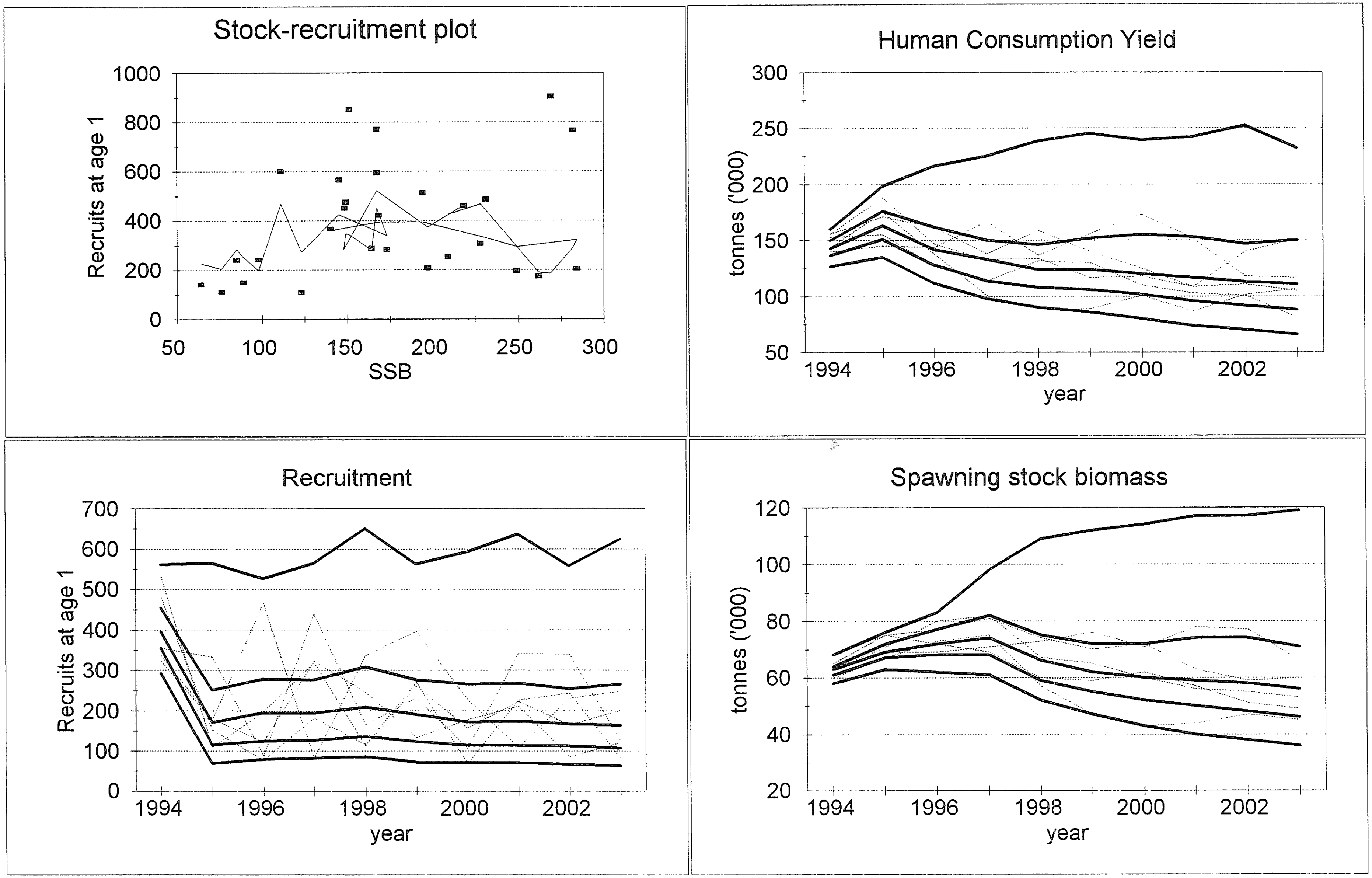
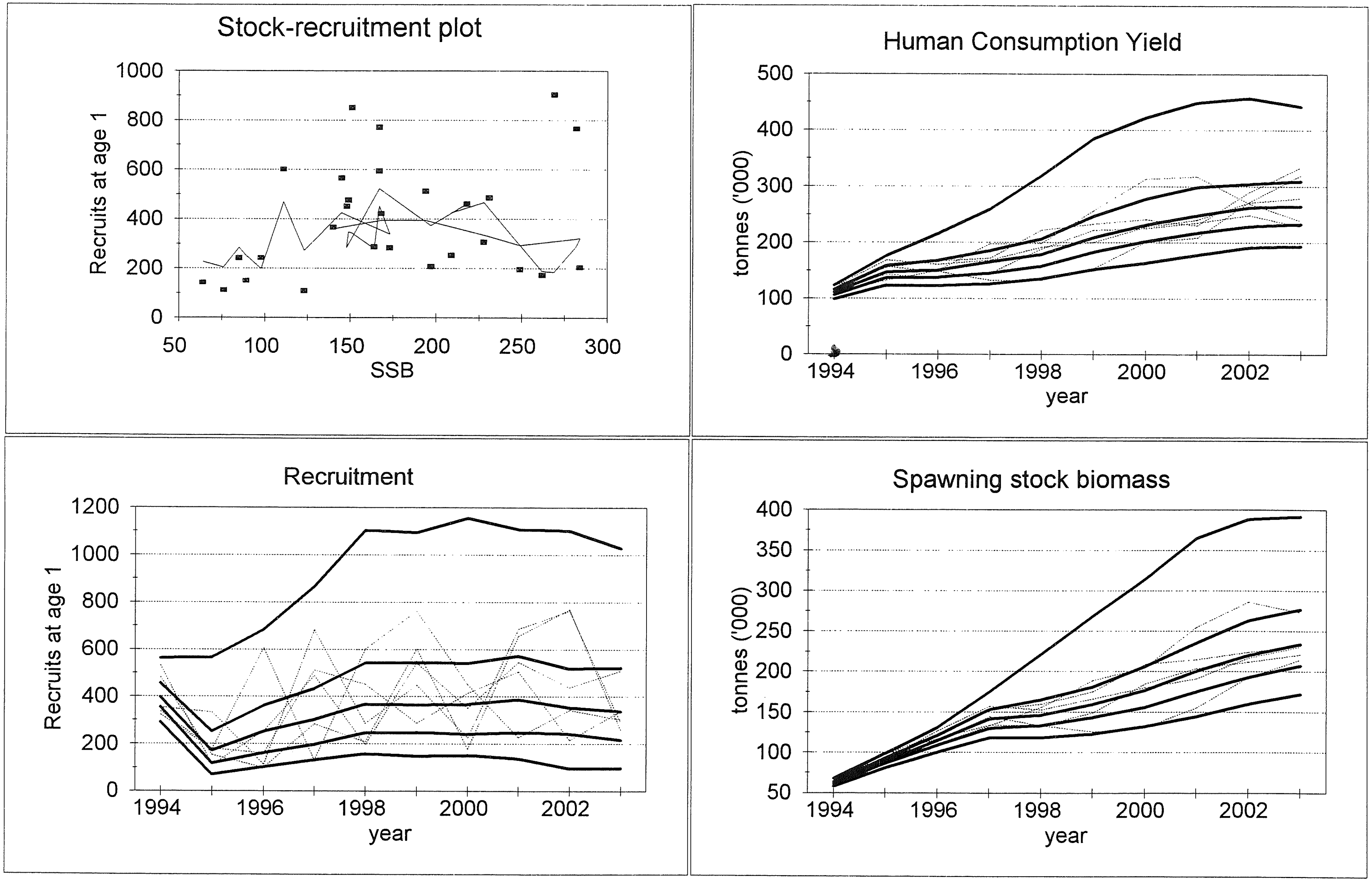


Figure 3.2.11 Cod North Sea. Medium term projections. Solid lines show 5,25,50,75 and 95 percentiles.
Dashed lines show five sample trajectories. Age two using RCT3 values.
Number of simulations= 500 Relative H. Cons effort = .70



3.3 Haddock in Sub-Area IV

3.3.1 Catch trends

Human consumption landings in 1993 were around 80 thousand t. This figure fell well short of the agreed TAC of 133 thousand t. As a result of the non-restrictive TAC, mis-reporting is thought to have been negligible, and there is close agreement between the Working Group and official estimate of human consumption landings (Table 3.3.1). The figure represents a slight increase relative to recent years, but compared to earlier years, landings are still at a low level. Levels of discards and industrial by-catch (Table 3.3.2) have increased in recent years, largely due to the strength of recent year classes. Long-term trends in catches for all categories are shown in Figure 3.3.1.

3.3.2 Natural mortality, maturity, age compositions, mean weight at age

Natural mortality estimates are given in Table 3.3.3, along with the maturity ogive. Both are as used previously. The mortality estimates originate from MSVPA. The maturity ogive is based on IYFS data.

Age composition data for the human consumption landings were supplied by Denmark, England, France and Scotland. Discards were estimated from Scottish data. For the industrial by-catch, Denmark supplied age compositions, and Norway supplied length compositions which were converted to ages using Scottish discard age-length keys. The catch at age data are given in Table 3.3.4. Catch numbers in 1993 were dominated by 1 and 2 year-old fish. At age 1, 0.6% of the fish were retained for human consumption, 68% were discarded, and the remainder were taken as industrial by-catch. At age 2, 28% were retained, and 67% discarded. At age 3, the figures were 79% retained and 17% discarded. At older ages, virtually all fish were landed for human consumption.

In previous years the age-composition data have been SOP corrected during the raising process. This year, no SOP correction has been applied. Preliminary runs indicated that the SOP correction factors were slight, and that the correction made very little difference to the result of the assessment. The exception was in the years 1960 to 1962, when the SOP correction caused large discrepancies. For this reason, all subsequent runs have used only data from 1963 onwards. Summaries of the trial runs with and without SOP correction are retained in the Working Group files. The uncorrected weights at age in the total catch, which are also used as stock weights at age, are given in Table 3.3.5. The SOP correction factors are also shown in Table 3.3.5.

3.3.3 Catch, effort and research vessel data

The fleets used in tuning are summarised in Table 3.3.6, and the tuning data are given in Table 3.3.7. The German Groundfish survey data were not used in the present assessment as there was no survey during 1993.

In the previous assessment, most commercial data were excluded from the tuning as they were thought likely to have been adversely affected by extensive mis-reporting. In 1993 mis-reporting was thought to have been negligible so the quality of the commercial CPUE data for the most recent year is likely to have improved relative to 1992. For this reason, comparative XSA runs with the commercial data included and excluded were made. These are summarised in Section 3.3.12. The final XSA run used the survey and the commercial data.

3.3.4 Catch-at-age analysis

The catch-at-age analysis for this stock used XSA with ages 0 and 1 treated as recruits (Section 3.3.13), and the q-plateau set at age 7. The default values were accepted for all other settings. The previous assessment of this stock treated age 12 as the plus-group. Preliminary separable VPA runs indicated that 10 would be a more appropriate plus-group age, as the catch numbers at the older ages are very small. All subsequent runs have used age 10 as the plus group. The diagnostics from the final XSA run are given in Table 3.3.8, and plots of the log catchability residuals for each fleet from this run are given in Figure 3.3.2. The log catchability residuals show that all the CPUE series are rather noisy, and that there is some evidence of a marked year-effect in 1992.

Of the CPUE series at age 0, the Scottish (SCOGFS) and English (ENGGFS) surveys receive the most weight in the estimate of survivors, although the F-shrinker is also important. The survivor estimates from these two survey series are rather similar, and somewhat smaller than the F shrinkage mean. At age 1, these two surveys are again the most important, and the IYFS index also receives some weight. The relative weighting of the F-shrinkage mean is smaller at this age. The survivor estimate indicated by the English survey series is slightly above the F shrinkage mean. The estimate from the Scottish survey series is approximately twice this value, and the IYFS estimate is intermediate between the ENGGFS and the SCOGFS estimates. At ages 2 and older, the estimates from most fleets receive similar weighting, and the individual fleet survivor estimates are more homogeneous.

Stock numbers at age from the current XSA are given in Table 3.3.9, and tuned Fs at age are given in Table 3.3.10. Retrospective trends in mean F are given in Figure 3.3.3. In previous assessments, with 1991 and 1992 as the terminal years, mean F in the terminal year was estimated as being at a historically high level. The retrospective analysis indicates that in both cases these were substantial over-estimates, which have been revised downwards with the addition of subsequent years of data. The pattern of high Fs has not been repeated in the current assessment, where mean total F in 1993 is estimated as being lower than in 1992, although the 1992 value (1.07) is still close to the historical high (1.18 in 1969). Nonetheless, it is clear that the estimate of current F is subject to high uncertainty.

3.3.5 Recruitment estimates

A number of 1994 survey indices are available for this stock, so it is appropriate to use RCT3 to utilise this additional information. The RCT3 input file for the run at age 0 is given in Table 3.3.11; the runs for ages 1 and 2 used the same recruitment indices but estimates of the strength of each year class at the appropriate age from the current XSA. Output from the RCT3 runs for each age is given in Tables 3.3.12a–c

Indices of the 1994 year class as 0–group are available from the English and Scottish groundfish surveys (Table 3.3.11). The index from the Scottish survey is 66% higher than any other index in the series. Apart from the 1993 year class, all 0–group indices since 1990 have been higher than all preceding indices. This means that for most of the high indices, no comparable converged estimates are available, so the values fall beyond the range of the RCT3 regression. This is illustrated in Figure 3.3.4. In the case of the English survey at age 0, the 1994 index is high, but lower than that for the 1981 year class, so the index does fall within the range covered by the RCT3 regression. Thus for prediction of recruitment, the Scottish age 0 indices have been given zero weight.

Both indices of the 1994 year class are high, so the year class is likely to be strong. The shrunk RCT3 estimate of 45 billion at age 0, which has been used in the prediction, makes it comparable in strength with the 1986 year class. In view of the large indices, this may be a conservative estimate. At age 1 (the 1993 year class), XSA estimates the numbers at the start of 1994 as 2.9 billion, whereas the RCT3 estimate is 1.5 billion. The XSA estimate has a CV of 0.26, and the CV of the RCT3 estimate is 0.20. The XSA estimate is above the tapered geometric mean (2.4 billion) whereas all indices indicate that this year class is relatively weak. For this reason the RCT3 estimate of numbers at age 1 at the start of 1994 has been used in prediction. At age 2, the XSA and RCT3 estimates are comparable (1.07 billion and 1.04 billion respectively) and have similar CVs (0.16 and 0.18) so the XSA estimate has been retained at this age. XSA estimates of survivors at older ages have also been used as population numbers in the prediction.

For recruitment at age 0 in 1995 and subsequent years, the long–term geometric mean value of 25 billion has been used. This value has a CV of 1.11.

3.3.6 Historical stock trends

Trends in fishing mortality, recruitment and biomass since 1963 are given in Table 3.3.13 and Figure 3.3.1. Mean total fishing mortality has fluctuated around 1, and the present assessment indicates that it is currently slightly above this level. Recruitment shows considerable variation, with the 1992 year class being the strongest since 1974. Total biomass shows peaks corresponding to the recruitment of the occasional strong year classes, but these do not survive to have much impact on the spawning stock, which declined from 1985 to a historical low in 1991. Since then, a slight increase is indicated.

3.3.7 Biological reference points

The stock–recruitment scatter plot is given in Figure 3.3.5. It is characterised by large variations in year class strength. Over the range of spawning stock sizes for which data are available, there is no clear link between stock biomass and recruitment. The reference points F_{med} and F_{93} are indicated on the scatter plot. F_{93} is above F_{med}. The reference points are also indicated on the human consumption yield–per–recruit curve (Figure 3.3.6).

3.3.8 Short–term forecast

Input parameters to the short–term catch prediction are given in Table 3.3.14, together with the CVs of these parameters. The population numbers used are described in Section 3.3.5. Weights at age in the stock and for each catch category are mean values over the years 1989 to 1993. Details of the Fs at age used for each category are given at the base of Table 3.3.14. The CVs used for the population numbers are the values associated with the RCT3 or XSA estimate as appropriate. For all other parameters, the values supplied by the program INSENS were used (see Reeves & Cook, 1994).

The catch options table is given in Table 3.3.15. Assuming *status quo* in 1994, and 1995, the forecast indicates human consumption landings of 155 thousand t in 1994, and 118 thousand t in 1995. The predicted 1994 catch is close to the agreed TAC of 160 thousand t. However, the indications from the fishery are that the TAC will not be taken. SSB is predicted to increase from its 1993 level of 130 thousand t to 194 thousand t at the start of 1994, to decrease to 158 thousand t at the start of 1995, and then to increase slightly to 163 thousand t at the start of 1996. Under these assumptions, the estimate of human consumption landings in 1995 has a CV of 27%. If relative F in 1995 is assumed to be 70% of that in 1993, then 1995 human consumption landings of 94 thousand t (CV 30%) are indicated. This scenario would lead to a SSB of 193 thousand t at the start of 1996.

Detailed forecast tables for the *status quo* option are given in Table 3.3.16. It can be seen that the 1992 year class forms the most important component of the human consumption catch in both 1994 and 1995.

The linear sensitivity analysis is summarised in Figure 3.3.7. The estimate of human consumption yield in 1994 is particularly sensitive to the level of F in 1994, and also to the population numbers, weights at age and selectivities at ages 2 and, to a lesser extent, 3. The estimate of the 1995 yield is again sensitive to assumptions made about the 1992 year class and its associated mortalities etc. This also applies to the estimate of the 1995 SSB, but by 1996 the SSB becomes dependent upon the contribution of the 1994 year class.

The importance of the 1992 year class is more apparent from the partial variances of the sensitivity analysis (Figure 3.3.8). It can be seen that the uncertainty associated with the estimate of this year class as 2 year-olds, together with the estimate of human consumption F at this age in 1994, accounts for over 80% of the variance of the estimate of the human consumption yield in 1994. The variance in the estimate of the 1995 yield is less clear-cut, as much of the uncertainty derives from the year-effects on M and human consumption F. Apart from these factors, it is still apparent that most of the variance in the estimate is due to uncertainty in parameters associated with the 1992 year class. The picture for the 1995 SSB is similar to that for the 1995 yield, in that the year effects are the most influential factors, with the remaining variance coming from uncertainties in the numbers, weights, mortalities and maturity of the 1992 year class. The variance in the estimate of the 1996 SSB is almost wholly driven by factors influencing the contribution of the 1994 year class to the spawning stock.

Cumulative probability distributions from the sensitivity analysis of the short-term forecast are given in Figure 3.3.9. It can be seen that the risk of F exceeding *status quo* F for any given level of human consumption catch is greater in 1995 than in 1994. The probability of the SSB falling below the historically low level of 61 thousand t in either 1995 or 1996 is small.

3.3.9 Medium-term projections

A Beverton-Holt curve was fitted to the stock-recruitment data as the basis of the medium-term projections. The parameters of this model fit are given in Table 3.3.17. The fitted curve is virtually flat, so the projections effectively used random recruitment. Projections were run assuming *status quo* (Figure 3.3.10a), and assuming relative human consumption effort of 0.7 (Figure 3.3.10b). The projections assuming *status quo* indicate that on average, under the current level of exploitation, recruitment, spawning stock and yield are likely to decline. With a relative F of 0.7, the spawning stock is forecast to remain at about current levels.

3.3.10 Long-term considerations

Apart from 1993, all year classes since 1990 have been at or above the long-term geometric mean. This has led to an increase in spawning stock from the historical low in 1991 which itself followed from a series of small year classes. Mean total F for this stock is close to 1 which means that strong year classes do not survive to make much contribution to the spawning stock. Although this stock has sustained exploitation at around the current level for at least 20 years, it is clear that the fishery will continue to be dependent upon the strength of incoming year classes. Yields could be improved by reducing the exploitation rate on younger fish.

The spawning stock has recently increased from a historical low of 61 thousand t in 1991. This has implications for any consideration of a MBAL for this stock.

3.3.11 Comments on the assessment

The previous assessment of this stock predicted a *status quo* human consumption catch for 1994 of 244 thousand t, whereas the current assessment indicates a figure of 155 thousand t. The large discrepancy between the two estimates results from a combination of the over-estimation of F in the 1993 assessment, coupled with over-estimation of the strength of the 1991 and 1992 year classes in that assessment.

The two previous assessments of this stock have estimated very high values for F in the most recent year. This may have been due to mis-reporting problems in 1991, and particularly in 1992. The high values were considered at the time to be unrealistic. The current estimate of *status quo* F is more in line with historical values, and is thus considered more plausible. The present prediction is heavily dependent upon the estimate of the 1992 year class. The RCT3 and XSA estimates of this year class at age 2 are similar, which may give some grounds for confidence in the value used. However, this estimate remains the weak link in the present catch forecast.

It is clear from the results of the previous two assessments (Table 3.3.18), and from the retrospective of the current VPA (Figure 3.3.3), that there have been problems with the assessment of this stock in recent years. However, there are grounds for believing that the present assessment may be more reliable than the two previous assessments of this stock.

3.3.12 Selection of CPUE series for tuning

In the previous assessment the Working Group set aside most of the commercial CPUE data for this stock due to concerns over mis–reporting. There was not thought to be any such problem with the 1993 data. To investigate whether it would be appropriate to include the commercial data in the catch at age analysis in the present assessment, retrospective XSA runs were made with and without the commercial CPUE series. The retrospective run using only the survey data is summarised in Figure 3.3.11. This can be compared with the retrospective for all fleets in Figure 3.3.3. The overall trends in mean F from the comparative runs are compared in Figure 3.3.12, and the survivor estimates from the two runs are given in Table 3.3.19 along with their standard errors. The retrospectives do not indicate any clear preference. The over–estimation of mean F in 1992 is worse if the commercial data are included, but the discrepancies are less in earlier years. With 1993 as the terminal year, the trends resulting from the two runs are similar. The only difference is that F in 1993 is estimated as being slightly lower if only the survey data are used. The survivor estimates from the two runs are also comparable. However, at all ages, the standard error of the estimate using commercial data is lower than that where the commercial data were excluded. For this reason, the commercial data were included in the final XSA run.

3.3.13 Selection of recruiting ages in XSA

Retrospective XSA was used to determine which ages should be treated as recruits in this assessment. A series of XSA runs were made in which the first age for constant recruitment was varied systematically from 0 to 3. Retrospective trends in the numbers estimated at the youngest ages from these runs are given in Figure 3.3.13. Trends in numbers are used as these give a clear picture of the performance of XSA in estimating recruiting year classes. From the trends in numbers at age 0, it can be seen that there is a clear improvement in retrospective pattern if fish at age 0 are treated as recruits rather than given constant catchability. There is a further slight improvement if age 1 fish are also regarded as recruits. There is no perceptible improvement if age 2 fish are also treated as recruits. For this reason, age 2 was taken as the first age for constant catchability. The choice of recruiting ages does not seem to influence the estimation of numbers at age 1 or 2.

Table 3.3.1 Nominal catch (in tonnes) of HADDOCK in Sub-area IV, 1983-1993, as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]	1993[1]
Belgium	985	494	719	317	165	220	145	192	168	415	292
Denmark	25,653	16,368	23,821	16,397	7,767	9,174	2,789	1,993	1,330	1,476	3,582
Faroe Islands	51	-	5	4	23	35	16	6	15	13	25
France	11,250	8,103	5,389	4,802	3,889	2,193	1,702[1,3]	1,115[1,3]	631[1,3]	508[3]	1,215[3]
Germany, Fed.Rep.	3,654	2,571	2,796	1,984	1,231	802	447	749	535	764	347
Netherlands	1,722	1,052	3,875	1,627	1,093	894	328	102	100	148	192
Norway[2]	3,862	3,959	3,498	5,190	2,610	1,590	1,697[1]	1,572	2,069	3,133	2,651
Poland	150	17	-	1	-	-	-	-	-	-	-
Sweden	1,360	1,518	1,942	1,550	937	614	1,051	900	957	1,289	908
UK (Engl.& Wales)	15,476	12,340	13,614	8,137	7,491	5,537	2,704	2,093	2,154	3,228	4,241
UK (Isle of Man)	-	-	-	-	-	-	-	-	-	11	-
UK (N. Ireland)	-	-	-	-	-	-	137	11	48	73	18
UK (Scotland)	100,390	87,479	112,549	126,650	84,063	84,104	53,252	34,459	36,443	39,512	66,732
Total	164,553	133,901	168,208	166,659	109,269	105,163	64,268	43,192	44,450	50,570	80,203
WG estimates human consumption landings	159,000	128,000	159,000	166,000	108,000	105,000	76,000	51,000	45,000	70,000	80,000
Unallocated landings	-5,553	-5,901	-9,208	-659	-1,269	-163	11,732	7,808	550	19,430	-203

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

TABLE 3.3.2; Haddock, North Sea
Annual weight and numbers caught, 1963 to 1993.

Year	Wt.('000 t)				Nos.(millions)			
	Total	H.cons	Disc.	Ind BC	Total	H.cons	Disc.	Ind BC
1963	271	68	189	14	1968	189	1246	532
1964	379	131	160	89	1507	375	644	488
1965	298	162	62	75	1104	391	254	460
1966	346	226	74	47	1873	420	490	963
1967	246	147	78	21	1936	272	448	1216
1968	302	105	162	34	1693	218	838	637
1969	929	331	260	338	3775	932	1203	1640
1970	806	525	101	180	2393	1229	515	649
1971	444	235	177	32	2401	478	1282	641
1972	351	193	128	30	1721	429	760	531
1973	305	179	115	11	1294	466	660	169
1974	364	150	167	48	2410	372	1091	947
1975	448	147	260	41	2972	375	1862	736
1976	368	166	154	48	1644	410	788	446
1977	217	137	44	35	910	334	226	350
1978	174	86	77	11	1039	199	418	422
1979	141	83	42	16	1484	189	286	1009
1980	216	99	95	22	1446	218	541	687
1981	207	130	60	17	1345	276	298	771
1982	226	166	41	19	987	317	181	489
1983	238	159	66	13	1287	297	388	601
1984	213	128	75	10	864	246	412	206
1985	251	159	86	6	967	354	458	155
1986	220	166	52	3	832	357	308	168
1987	172	108	59	4	650	222	333	95
1988	171	105	62	4	644	254	362	29
1989	106	76	27	2	336	162	156	18
1990	86	51	32	3	267	87	165	15
1991	90	45	40	5	461	96	218	146
1992	129	70	48	11	781	173	267	340
1993	170	80	80	11	857	167	441	249

TABLE 3.3.3; Haddock, North Sea
Natural Mortality and proportion mature

Age	Nat Mor	Mat.
0	2.050	.000
1	1.650	.010
2	.400	.320
3	.250	.710
4	.250	.870
5	.200	.950
6	.200	1.000
7	.200	1.000
8	.200	1.000
9	.200	1.000
10+	.200	1.000

TABLE 3.3.4; Haddock, North Sea
International catch at age ('000), Total , 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	2781	114447	276355	723597	525815	12666	63198	400927	234247	239684
1	1556144	6841	220366	694333	1126519	1162164	18467	163596	1640324	674770
2	365101	1236277	10847	22207	93043	448221	3366562	164774	68125	584783
3	22215	131176	560715	5998	4965	19660	294133	1600951	46627	40262
4	13456	9157	28788	414853	3591	1927	7672	54460	398542	20923
5	6064	5380	4366	9691	178917	2497	2407	1054	10274	155968
6	520	2487	1937	1042	2444	45248	2542	1142	456	3520
7	659	291	457	604	214	321	19651	249	194	188
8	584	243	109	168	216	40	204	5862	146	33
9	61	239	91	90	57	13	24	67	1573	26
10+	18	25	42	25	33	5	7	30	169	416

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	59336	607605	44831	166725	115057	286912	861724	375010	639159	284195
1	363600	1218616	2099168	167392	250643	455054	347973	659547	133370	278884
2	575284	177186	639756	1053760	105830	144842	198337	323135	414142	85023
3	243816	336815	58977	209277	387271	29664	39470	68716	138789	292608
4	6324	54893	108935	9827	39301	110365	7047	9837	14528	40927
5	4503	1888	15751	30934	4260	8342	26613	1784	1899	3234
6	39910	1350	968	4904	6097	1223	2124	7573	376	697
7	1279	11009	613	204	1265	1994	249	562	2451	269
8	111	242	2692	75	130	383	459	114	123	788
9	29	23	261	744	28	110	145	153	64	29
10+	165	41	80	62	199	90	74	113	62	27

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	662983	95101	140040	104239	9417	10806	12757	55522	125307	270820
1	158998	431642	179402	203053	276954	29023	66405	66499	221457	199983
2	249532	161447	523166	176032	243353	482631	38475	80937	74991	261043
3	72131	118166	74392	310545	45705	87429	194114	13857	21613	34471
4	124743	21300	36030	26095	65665	13155	17398	44923	3341	6830
5	16133	32019	5184	9180	4526	18434	2472	2945	11781	1250
6	1660	3684	7164	1169	2750	1547	3917	688	882	5282
7	289	588	939	1745	517	615	480	1069	377	488
8	59	76	207	227	748	152	189	157	584	320
9	191	37	54	98	126	135	79	60	135	314
10+	68	131	113	117	139	95	50	50	57	161

Age	1993
0	140747
1	345411
2	254839
3	105441
4	6813
5	1619
6	421
7	1097
8	139
9	99
10+	201

TABLE 3.3.5; Haddock, North Sea
International mean weight at age (kg), Total catch, 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	.011	.011	.011	.011	.011	.010	.011	.017	.012	.024
1	.110	.125	.089	.110	.096	.121	.066	.093	.113	.116
2	.250	.244	.250	.261	.278	.251	.218	.235	.252	.244
3	.478	.421	.384	.376	.461	.514	.415	.361	.364	.401
4	.706	.694	.683	.545	.597	.742	.805	.755	.508	.517
5	.810	.852	.923	1.002	.641	.894	.908	.913	.902	.616
6	1.014	.935	1.272	1.316	1.065	.840	1.046	1.218	1.289	1.014
7	1.164	1.446	1.231	1.580	1.521	1.580	1.093	1.364	1.534	1.379
8	1.184	1.194	1.545	1.979	1.969	2.226	2.018	1.445	1.344	2.302
9	1.576	1.516	1.794	1.796	2.123	2.598	2.995	2.523	1.295	2.029
10+	1.837	1.882	2.301	3.005	2.383	2.009	3.342	3.919	2.073	1.727
SOP	0.9358	1.0162	1.1143	1.0451	0.9378	0.9864	1.0433	1.1656	1.0157	0.9893

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	.044	.024	.021	.013	.019	.011	.009	.012	.009	.011
1	.112	.128	.101	.125	.108	.144	.095	.104	.074	.100
2	.244	.227	.244	.225	.243	.255	.290	.284	.262	.292
3	.380	.345	.360	.402	.347	.419	.441	.486	.476	.459
4	.598	.551	.455	.513	.603	.440	.634	.732	.745	.779
5	.664	.900	.694	.585	.613	.715	.662	1.046	1.149	1.154
6	.748	.905	1.306	.915	.804	.736	.927	.936	1.489	1.425
7	1.072	.960	1.175	1.931	1.187	.931	1.180	1.394	1.185	1.668
8	1.306	1.528	1.117	1.772	1.948	1.368	1.183	1.599	1.663	1.454
9	2.931	2.358	1.831	1.296	2.323	2.077	1.456	1.593	1.773	2.608
10+	1.906	2.594	2.538	2.417	1.809	2.136	2.260	2.150	1.734	2.143
SOP	0.9673	0.9810	0.9824	0.9852	0.9726	0.9843	1.0016	0.9993	0.9986	0.9881

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.022	.010	.013	.018	.008	.024	.033	.044	.029	.018
1	.134	.141	.149	.106	.126	.164	.198	.192	.177	.106
2	.296	.300	.277	.241	.265	.217	.290	.291	.319	.309
3	.447	.489	.476	.397	.404	.417	.362	.435	.472	.487
4	.649	.674	.663	.617	.613	.589	.600	.475	.641	.748
5	.913	.807	.856	.871	1.026	.747	.811	.778	.650	1.017
6	1.209	1.096	1.051	1.272	1.273	1.283	.983	.968	1.045	.894
7	1.152	1.098	1.466	1.213	1.426	1.424	1.376	1.163	1.231	1.391
8	1.910	1.876	1.846	1.738	1.526	1.543	1.662	1.533	1.480	1.518
9	1.371	2.454	2.135	1.554	1.862	1.612	1.697	2.031	1.772	1.894
10+	1.734	2.044	2.042	2.590	2.185	2.312	2.222	2.585	2.009	2.015
SOP	0.9910	1.0004	1.0154	1.0125	1.0169	0.9994	0.9397	1.2092	1.0107	0.9430

Age	1993
0	.010
1	.115
2	.279
3	.447
4	.684
5	.900
6	1.189
7	1.108
8	1.597
9	1.737
10+	1.874
SOP	1.0120

Table 3.3.6 **Haddock, North Sea**
Summary of fleets used in catch-at-age analysis

Fleet	Abbreviation	Year range	Age range
Scottish Trawlers	SCOTRL	1974 - 1993	1 - 10
Scottish Seiners	SCOSEI	1974 - 1993	0 - 10
Scottish Trawlers	SCOTRL	1974 - 1993	0 - 8
French Trawlers	FRATRB	1976 - 1993	0 - 10
English Groundfish Survey (August)	ENGGFS	1977 - 1993	0 - 7
Scottish Groundfish Survey (August)	ENGGFS	1982 - 1993	0 - 6
International Groundfish Survey	INTGFS	1974 - 1993 *	1 - 6

* Ages 1-2 only, ages 3-6 from 1982 onwards.

Table 3.3.7; North Sea Haddock, Tuning data.

NORTH SEA HADDOCK : 1963-1993 : NO SOP CORRECTION : PREP. 6/10/94
107
ENGGFS
1977 1993
1 1 .50 .75
0 7

89.000	47.597	5.946	2.853	5.485	.823	.064	.081	.012
93.000	33.319	12.730	2.434	.222	2.065	.199	.005	.069
94.000	82.298	27.781	5.133	.820	.102	.411	.033	.004
89.000	33.288	55.475	14.891	2.287	.243	.038	.126	.020
91.000	139.909	15.760	39.958	6.877	.675	.058	.003	.055
58.000	16.318	18.297	4.628	6.844	.595	.137	.057	.008
58.000	48.252	12.656	6.352	1.243	1.261	.154	.024	.008
63.000	14.393	37.758	3.880	1.939	.263	.301	.065	.008
54.000	13.277	10.074	12.862	1.140	.377	.106	.069	.022
64.000	17.024	9.583	2.862	2.165	.178	.112	.024	.023
61.000	1.367	17.198	2.629	.325	.419	.029	.020	.002
57.000	3.462	1.628	10.461	.883	.091	.159	.023	.007
63.000	5.940	5.146	.911	2.500	.159	.019	.038	.009
64.000	18.040	4.253	1.269	.183	.562	.031	.017	.008
64.000	16.853	7.363	.615	.148	.031	.140	.003	.004
57.000	47.181	11.222	5.571	.333	.028	.007	.048	.002
54.000	7.332	13.289	3.164	.899	.003	.009	.000	.005

SCOTRL
1974 1993
1 1 .00 1.00
1 10

185432.000	24687.340	12441.880	33937.960	7266.360	164.315	204.881	1545.851	32.659	3.959	6.928
152977.000	3967.860	51489.930	5732.411	14273.930	1931.670	73.340	57.266	384.785	15.070	7.033
121841.000	519.180	26436.420	19667.620	1281.039	2992.304	581.634	15.614	5.855	87.831	9.759
144348.000	4244.245	3508.486	36340.290	7477.774	442.319	986.376	175.508	19.610	4.902	34.317
135220.000	10354.390	9842.843	2166.696	17050.170	1753.883	166.481	326.805	60.046	15.750	1.969
87467.000	6125.792	13666.730	4000.550	736.827	4471.022	327.467	55.552	71.146	28.264	8.771
55475.000	1779.000	20663.000	5687.000	1065.000	192.000	1159.000	104.000	11.000	18.000	4.000
51553.000	706.131	22690.270	11281.760	998.299	88.965	10.676	284.689	7.117	1.779	1.779
47889.000	1094.381	2839.038	19736.750	3147.658	142.277	56.136	47.426	102.594	.968	.968
48339.000	2372.000	6782.000	2288.000	7619.000	1173.000	168.000	21.000	5.000	20.000	2.000
34574.000	4738.000	2981.000	3689.000	768.000	1889.000	290.000	15.000	4.000	1.000	7.000
33103.000	952.000	16276.000	1168.000	839.000	157.000	337.000	52.000	10.000	1.000	1.000
27839.000	2371.000	5764.000	6873.000	337.000	147.000	26.000	82.000	11.000	3.000	1.000
27207.000	26079.000	7721.000	2148.000	1844.000	119.000	94.000	30.000	19.000	5.000	3.000
21559.000	959.000	5575.000	1929.000	330.000	392.000	22.000	13.000	2.000	7.000	3.000
16657.000	504.059	340.782	1479.922	277.650	67.411	47.570	8.979	10.063	2.496	.381
15870.000	348.328	745.790	78.266	377.101	50.005	11.500	12.265	5.101	1.075	.297
13495.000	875.171	557.453	161.385	18.036	96.341	13.733	8.621	10.590	1.172	.867
10887.000	1041.132	857.433	184.875	45.049	9.359	38.544	5.142	2.190	3.952	.176
11657.000	2711.383	1916.628	848.606	90.719	57.833	40.658	17.027	2.253	1.365	.840

Continued

Table 3.3.7; (continued)

SCOSEI
1974 1993
1 1 .00 1.00
0 10

349604.000	8979.000	352418.500	49505.790	91398.180	14074.560	472.249	250.581	2559.354	51.401	3.213	8.567
329432.000	227.000	481086.700	164257.500	16156.310	26984.020	3891.731	158.482	115.451	556.261	23.090	11.545
307165.000	900.000	35867.850	334476.900	60741.050	2713.709	8661.450	1101.472	57.972	13.956	156.740	10.736
313913.000	4408.000	34038.510	38282.320	137965.300	13935.870	1821.004	1600.407	375.231	25.953	7.569	69.207
325246.000	1665.000	161079.200	70589.700	15041.160	46353.430	2497.527	506.182	710.412	90.781	30.612	3.167
316419.000	543.000	83633.110	78818.400	17215.490	3040.091	8073.241	648.019	70.002	113.003	24.001	4.000
297227.000	210.000	131314.000	128306.000	26205.000	3393.000	501.000	2415.000	123.000	20.000	56.000	23.000
289672.000	345.000	10372.520	135839.300	57004.670	5325.372	721.629	104.856	595.213	15.420	22.616	1.028
297730.000	1445.000	31210.260	31675.920	122790.500	14820.180	708.566	150.648	40.519	238.959	1.039	9.351
333168.000	18122.000	29138.000	78479.000	31059.000	51404.000	6560.000	597.000	122.000	15.000	71.000	27.000
388035.000	422.000	120827.000	63301.000	49174.000	9403.000	14940.000	1590.000	253.000	18.000	8.000	38.000
382910.000	2055.000	29263.000	163148.000	32562.000	15661.000	2245.000	2787.000	302.000	46.000	19.000	9.000
425017.000	8204.000	33567.000	71027.000	150225.000	12350.000	3993.000	469.000	594.000	56.000	11.000	19.000
418734.000	137.000	43346.000	96542.000	19393.000	28324.000	1950.000	1151.000	195.000	279.000	30.000	16.000
377132.000	498.000	11561.000	201347.000	37412.000	4735.000	7414.000	718.000	290.000	80.000	70.000	27.000
355735.000	145.043	22005.550	20850.720	93743.340	8137.483	1047.946	1546.961	214.023	84.910	37.906	12.827
300076.000	573.835	28820.520	36924.770	7106.183	20906.980	1116.668	236.496	316.157	52.136	22.280	4.163
336675.000	2229.712	65974.260	30122.640	9227.586	1435.867	4863.141	297.413	118.372	177.000	41.013	10.325
300217.000	1229.842	30325.720	63639.800	8326.875	1459.706	279.996	1139.677	76.306	54.721	51.436	17.337
268413.000	2916.299	74586.640	87636.220	34139.770	2278.392	432.112	96.954	304.803	27.712	14.260	13.853

SCOLTR
1974 1993
1 1 .00 1.00
0 8

116982.000	3000.000	45083.340	8861.859	15534.880	2445.424	32.535	22.040	297.012	6.297
161009.000	51.000	128624.200	27964.420	2592.387	5536.114	554.374	13.859	14.925	82.090
152419.000	92.000	3358.274	59847.740	11557.550	653.685	1802.970	336.591	7.183	5.131
224824.000	3257.000	10150.530	6509.983	42301.470	3616.414	404.480	816.219	102.676	15.557
236929.000	1692.000	45937.480	11850.250	3091.469	13107.290	833.748	117.333	179.891	25.853
287494.000	465.000	44659.330	23158.440	4111.361	714.071	3644.370	203.021	20.002	57.006
333197.000	180.000	92522.000	46283.000	8062.000	755.000	197.000	1015.000	61.000	18.000
251504.000	436.000	7982.088	58365.970	13787.230	1535.049	162.823	20.228	323.647	12.137
250870.000	352.000	24595.650	10301.240	34027.960	4012.853	135.633	68.326	7.139	59.148
244349.000	63648.000	19623.000	48607.000	6934.000	11768.000	1254.000	124.000	27.000	4.000
240775.000	514.000	56731.000	22104.000	13254.000	2053.000	3357.000	398.000	97.000	15.000
268136.000	3545.000	38815.000	57009.000	4845.000	2746.000	408.000	859.000	126.000	27.000
279767.000	4382.000	26266.000	26197.000	30891.000	2643.000	958.000	117.000	290.000	41.000
351128.000	97.000	26257.000	32847.000	6206.000	6843.000	471.000	358.000	68.000	113.000
391988.000	209.000	2926.000	57523.000	14068.000	2366.000	2923.000	167.000	84.000	28.000
405883.000	2093.652	19083.510	4042.493	29853.510	2797.031	522.405	607.394	104.723	28.976
441084.000	162.056	9555.038	15313.900	2092.821	8041.234	525.268	131.705	206.902	35.110
408056.000	1041.467	44104.210	12184.130	3249.607	545.417	2142.209	218.492	76.933	140.938
473955.000	1837.141	20418.710	30454.070	3751.482	728.394	138.804	737.219	93.823	50.253
447064.000	231.182	39858.460	38601.010	19433.560	1462.887	347.109	80.072	262.039	28.057

Continued

Table 3.3.7; (continued)

FRATRB
1976 1993
1 1 .00 1.00
0 10

64396.000	58.443	2678.223	23497.210	3472.086	210.884	462.649	130.000	12.000	5.000	43.000	5.000
80107.000	501.459	4213.958	2566.941	11834.450	1611.668	226.384	444.000	121.000	18.000	5.000	28.000
69739.000	263.360	16183.010	6280.871	1147.042	5427.229	447.611	73.306	143.000	39.000	11.000	2.000
89974.000	131.163	15238.960	12555.940	2224.345	383.425	2193.062	198.000	31.000	65.000	32.000	5.000
63577.000	37.189	21338.520	15296.330	4106.412	558.224	153.000	830.000	71.000	20.000	33.000	11.000
76517.000	113.442	2513.441	27947.050	9779.163	1208.452	145.235	27.000	355.000	18.000	14.000	6.000
78523.000	306.843	7902.542	4243.175	23759.480	3745.909	202.000	58.000	32.000	112.000	1.000	2.000
69720.000	8780.794	5080.131	11493.720	3742.530	7380.574	1247.718	162.105	32.000	8.000	31.000	7.000
76149.000	147.171	16178.930	6588.083	5577.432	1014.534	1972.159	304.000	53.000	13.000	8.000	20.000
53003.000	492.035	4647.160	12668.880	2188.263	1078.188	166.122	337.231	56.000	12.000	6.000	4.000
50350.000	570.771	2711.739	3687.491	6564.965	666.742	374.286	65.000	150.000	31.000	8.000	5.000
51234.000	30.910	5037.144	5116.296	1318.562	1840.800	185.000	146.000	31.000	55.000	10.000	4.000
35482.000	23.619	381.287	6137.304	1344.683	230.178	465.028	57.000	33.000	10.000	8.000	2.000
36133.000	47.864	921.427	455.842	2555.221	298.437	58.938	126.751	26.956	13.867	5.313	3.140
36097.000	1043.085	1117.270	1349.147	247.492	1115.344	102.179	31.982	61.516	11.967	4.899	1.510
45075.000	94.454	2721.776	764.422	216.605	34.659	186.362	21.289	10.809	18.391	5.120	2.076
34138.000	224.775	938.516	1809.478	217.914	45.137	8.710	38.315	4.697	2.912	3.404	1.162
23721.000	199.410	2872.650	2949.286	1216.883	79.686	26.846	5.643	20.599	2.430	2.257	2.763

SCOGFS
1982 1993
1 1 .50 .75
0 6

77.000	9.507	19.159	7.670	10.288	.889	.056	.015
79.000	17.405	14.326	12.725	2.938	3.598	.420	.097
82.000	7.161	35.845	6.462	2.754	.448	.536	.077
83.000	6.790	16.397	24.741	1.929	.853	.116	.180
88.000	13.975	18.628	4.591	4.785	.285	.213	.030
73.000	2.023	17.419	5.140	.774	.937	.060	.034
86.000	3.490	4.019	17.045	1.461	.235	.194	.020
86.000	3.714	7.621	1.837	4.937	.267	.033	.058
85.000	26.886	8.517	2.040	.272	.876	.060	.009
90.000	31.239	15.345	1.602	.189	.045	.144	.018
87.000	71.906	33.365	8.378	.418	.070	.026	.070
87.000	7.473	50.773	12.006	2.340	.052	.035	.009

Continued

Table 3.3.7; (continued)

```
INTGFS
 1974 1993
 1 1  .00  .25
  1  6
       1.000     1.092      .110       -1        -1        -1        -1
       1.000     1.168      .385       -1        -1        -1        -1
       1.000      .177      .670       -1        -1        -1        -1
       1.000      .162      .084       -1        -1        -1        -1
       1.000      .385      .108       -1        -1        -1        -1
       1.000      .480      .240       -1        -1        -1        -1
       1.000      .896      .402       -1        -1        -1        -1
       1.000      .268      .675       -1        -1        -1        -1
       1.000      .526      .252       -1        -1        -1        -1
       1.000      .307      .400      .089      .114      .013      .002
       1.000     1.057      .219      .134      .022      .022      .005
       1.000      .229      .828      .105      .034      .004      .007
       1.000      .579      .244      .294      .018      .006      .002
       1.000      .885      .326      .048      .061      .005      .003
       1.000      .092      .688      .098      .013      .014      .002
       1.000      .210      .097      .281      .017      .002      .005
       1.000      .220      .110      .031      .051      .003      .002
       1.000      .679      .131      .024      .004      .009      .002
       1.000     1.115      .371      .019      .003      .001      .002
       1.000     1.242      .543      .155      .009      .001      .001
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Table 3.3.8 Haddock, North Sea. XSA Diagnostics.

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Lowestoft VPA Version 3.1

   6/10/1994  19:44

Extended Survivors Analysis

NORTH SEA HADDOCK : 1963-1993 : NO SOP CORRECTION : PREP. 6/10/94

CPUE data from file hadivef.dat

Catch data for  31 years. 1963 to 1993. Ages  0 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,  year, year,  age ,  age
ENGGFS                ,  1977, 1993,   0,     7,   .500,   .750
SCOTRL                ,  1974, 1993,   1,     9,   .000,  1.000
SCOSEI                ,  1974, 1993,   0,     9,   .000,  1.000
SCOLTR                ,  1974, 1993,   0,     8,   .000,  1.000
FRATRB                ,  1976, 1993,   0,     9,   .000,  1.000
SCOGFS                ,  1982, 1993,   0,     6,   .500,   .750
INTGFS                ,  1974, 1993,   1,     6,   .000,   .250


Time series weights :

     Tapered time weighting applied
     Power =    3 over  20 years


Catchability analysis :

     Catchability dependent on stock size for ages <    2

        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  2


     Catchability independent of age for ages >=    7


Terminal population estimation :

     Survivor estimates shrunk towards the mean F
     of the final   5 years or the   5 oldest ages.

     S.E. of the mean to which the estimates  are shrunk =    .500

     Minimum standard error for population
     estimates derived from each fleet =    .300

     Prior weighting not applied


Tuning converged after   23 iterations



Regression weights
      ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000


Fishing mortalities
   Age,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993

     0,  .016,  .016,  .006,  .007,  .004,  .004,  .006,  .012,  .015,  .017
     1,  .128,  .212,  .165,  .107,  .142,  .170,  .157,  .156,  .134,  .132
     2,  .677,  .622, 1.033,  .912,  .798,  .829,  .994,  .765,  .811,  .711
     3,  .999,  .960, 1.234, 1.051, 1.348, 1.137, 1.032,  .993, 1.315, 1.202
     4, 1.141, 1.112, 1.292, 1.082, 1.164, 1.303,  .993,  .819, 1.168, 1.176
     5, 1.221, 1.048, 1.053,  .853, 1.158,  .730,  .840,  .817,  .902, 1.072
     6, 1.086, 1.060,  .713, 1.149,  .826,  .837,  .455,  .657, 1.176,  .924
     7,  .800,  .944,  .824,  .826,  .888,  .667,  .573,  .488,  .989,  .841
     8,  .553,  .747,  .624, 1.110,  .620,  .768,  .474,  .726, 1.056,  .882
     9, 1.154, 1.018, 1.028,  .880,  .594,  .784,  .590, 1.012, 1.211, 1.228
```

Continued

Table 3.3.8 Continued

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1984	1.69E+07	8.17E+06	4.01E+05	2.12E+05	3.55E+04	5.02E+04	6.15E+03	1.18E+03	1.97E+02	5.94E+01
1985	2.41E+07	2.15E+06	1.38E+06	1.37E+05	6.08E+04	8.82E+03	1.21E+04	1.70E+03	4.34E+02	9.28E+01
1986	4.86E+07	3.05E+06	3.34E+05	4.96E+05	4.08E+04	1.56E+04	2.53E+03	3.43E+03	5.41E+02	1.68E+02
1987	3.91E+06	6.22E+06	4.97E+05	7.96E+04	1.13E+05	8.72E+03	4.45E+03	1.02E+03	1.23E+03	2.37E+02
1988	7.55E+06	5.00E+05	1.07E+06	1.34E+05	2.17E+04	2.97E+04	3.04E+03	1.15E+03	3.64E+02	3.33E+02
1989	8.14E+06	9.69E+05	8.34E+04	3.24E+05	2.71E+04	5.27E+03	7.64E+03	1.09E+03	3.89E+02	1.60E+02
1990	2.73E+07	1.04E+06	1.57E+05	2.44E+04	8.09E+04	5.73E+03	2.08E+03	2.71E+03	4.58E+02	1.48E+02
1991	2.86E+07	3.49E+06	1.71E+05	3.89E+04	6.77E+03	2.33E+04	2.02E+03	1.08E+03	1.25E+03	2.34E+02
1992	5.02E+07	3.64E+06	5.74E+05	5.34E+04	1.12E+04	2.32E+03	8.44E+03	8.59E+02	5.43E+02	4.95E+02
1993	2.30E+07	6.37E+06	6.12E+05	1.71E+05	1.12E+04	2.72E+03	7.72E+02	2.13E+03	2.62E+02	1.55E+02

Estimated population abundance at 1st Jan 1994

	0.00E+00	2.90E+06	1.07E+06	2.01E+05	4.00E+04	2.68E+03	7.62E+02	2.51E+02	7.53E+02	8.87E+01

Taper weighted geometric mean of the VPA populations:

	2.11E+07	2.69E+06	4.15E+05	1.25E+05	3.27E+04	9.55E+03	3.42E+03	1.34E+03	4.60E+02	1.81E+02

Standard error of the weighted Log(VPA populations) :

	.8269	.8515	.8461	.9566	1.0174	.9931	.8537	.6200	.6975	.6766

Log catchability residuals.

Fleet : ENGGFS

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.85	.901	17.05	.79	17	.45	-17.08
1	1.15	-1.056	15.63	.84	17	.39	-15.52

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.89	.820	14.82	.86	17	.36	-15.05
3	.88	.982	14.76	.88	17	.37	-15.15
4	.72	1.509	14.15	.74	17	.63	-15.61
5	.85	1.131	14.51	.85	17	.43	-15.45
6	.83	.605	14.23	.58	16	.68	-15.47
7	1.34	-.633	18.40	.26	17	1.09	-15.58

Fleet : SCOTRL

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	1.27	-.642	17.28	.36	20	1.18	-16.76

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.00	.008	14.55	.77	20	.48	-14.55
3	.84	1.195	13.69	.85	20	.42	-14.05
4	.89	.828	13.50	.85	20	.45	-13.89
5	1.00	.024	13.77	.75	20	.60	-13.79
6	1.13	-.363	14.45	.45	20	.99	-13.74
7	1.27	-.735	15.50	.42	20	.77	-13.72
8	.91	.440	13.11	.71	20	.46	-13.78
9	.76	1.939	11.74	.87	20	.28	-13.78

Continued

Table 3.3.8 Continued

Fleet : SCOSEI

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	-.25	-.45	.27	.97	-.20	-1.60	-.72	-1.07	.43	1.01

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	.73,	1.046,	20.51,	.61,	20,	.70,	-21.82,
1,	1.42,	-1.739,	16.84,	.62,	20,	.69,	-16.24,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.36,	-2.965,	14.40,	.87,	20,	.34,	-14.01,
3,	1.02,	-.369,	13.60,	.97,	20,	.19,	-13.56,
4,	.94,	1.021,	13.42,	.97,	20,	.19,	-13.61,
5,	.87,	2.051,	13.22,	.96,	20,	.21,	-13.83,
6,	.84,	2.323,	13.05,	.95,	20,	.20,	-14.02,
7,	.96,	.278,	13.87,	.83,	20,	.30,	-14.15,
8,	.80,	1.695,	12.71,	.88,	20,	.27,	-14.34,
9,	.82,	.956,	12.59,	.73,	20,	.43,	-14.25,

Fleet : SCOLTR

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	.81,	.411,	21.09,	.32,	20,	1.25,	-22.06,
1,	1.09,	-.415,	16.95,	.66,	20,	.63,	-16.76,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.05,	-.371,	15.14,	.86,	20,	.36,	-15.04,
3,	.93,	1.082,	14.55,	.96,	20,	.20,	-14.76,
4,	.98,	.246,	14.67,	.94,	20,	.26,	-14.75,
5,	.87,	1.383,	14.14,	.91,	20,	.32,	-14.91,
6,	.85,	1.489,	13.93,	.90,	20,	.29,	-14.98,
7,	.75,	1.931,	12.97,	.85,	20,	.27,	-14.91,
8,	.90,	.973,	14.00,	.90,	20,	.25,	-14.91,

Fleet : FRATRB

Age , 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	.77,	.760,	20.45,	.52,	18,	.84,	-21.54,
1,	1.11,	-.587,	17.10,	.73,	18,	.54,	-16.86,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.96,	.304,	14.90,	.85,	18,	.37,	-14.98,
3,	.84,	1.479,	14.07,	.89,	18,	.35,	-14.51,
4,	.75,	2.768,	13.39,	.92,	18,	.31,	-14.40,
5,	.84,	1.153,	13.48,	.84,	18,	.45,	-14.30,
6,	.88,	.773,	13.44,	.80,	18,	.45,	-14.18,
7,	.86,	.535,	13.01,	.60,	18,	.53,	-13.94,
8,	1.12,	-.414,	14.74,	.54,	18,	.67,	-13.81,
9,	1.53,	-1.349,	17.99,	.39,	18,	.88,	-13.57,

Continued

Table 3.3.8 Continued

Fleet : SCOGFS

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	.96,	.193,	17.59,	.71,	12,	.57,	-17.62,
1,	1.27,	-1.962,	15.45,	.86,	12,	.38,	-15.30,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.99,	.120,	14.74,	.91,	12,	.28,	-14.76,
3,	.82,	1.829,	14.38,	.92,	12,	.30,	-14.98,
4,	.76,	3.678,	14.05,	.97,	12,	.21,	-15.20,
5,	1.00,	.033,	15.25,	.84,	12,	.45,	-15.28,
6,	.87,	.655,	14.41,	.76,	12,	.49,	-15.33,

Fleet : INTGFS

Age , 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	1.12,	-.918,	15.46,	.86,	20,	.36,	-15.39,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.23,	-2.603,	14.30,	.93,	20,	.25,	-14.04,
3,	1.01,	-.099,	14.03,	.89,	11,	.35,	-14.00,
4,	.97,	.318,	14.13,	.93,	11,	.30,	-14.25,
5,	.97,	.661,	14.31,	.98,	11,	.15,	-14.49,
6,	1.66,	-3.037,	17.91,	.73,	11,	.53,	-14.04,

Continued

Table 3.3.8 Continued

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1993

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS	,	1749395,	.472,	.000,	.00,	1,	.274,	.000
SCOTRL	,	1,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	6920629,	.752,	.000,	.00,	1,	.108,	.000
SCOLTR	,	778848,	1.340,	.000,	.00,	1,	.034,	.000
FRATRB	,	4764014,	.884,	.000,	.00,	1,	.078,	.000
SCOGFS	,	1785570,	.599,	.000,	.00,	1,	.171,	.000
INTGFS	,	1,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean	,	2689954,	.85,,,,				.086,	.019
F shrinkage mean	,	5110634,	.50,,,,				.249,	.010

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2904714,	.25,	.26,	7,	1.029,	.017

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS	,	946059,	.318,	.310,	.98,	2,	.240,	.148
SCOTRL	,	2233068,	1.290,	.000,	.00,	1,	.015,	.066
SCOSEI	,	953498,	.527,	.534,	1.01,	2,	.087,	.147
SCOLTR	,	639866,	.591,	.027,	.05,	2,	.070,	.212
FRATRB	,	883842,	.485,	.186,	.38,	2,	.103,	.158
SCOGFS	,	1980361,	.366,	.179,	.49,	2,	.181,	.074
INTGFS	,	1403696,	.399,	.000,	.00,	1,	.154,	.102
P shrinkage mean	,	414541,	.85,,,,				.039,	.311
F shrinkage mean	,	809619,	.50,,,,				.111,	.171

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1071213,	.16,	.13,	14,	.830,	.132

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS	,	159176,	.248,	.109,	.44,	3,	.156,	.838
SCOTRL	,	192013,	.447,	.078,	.18,	2,	.051,	.736
SCOSEI	,	206636,	.286,	.145,	.51,	3,	.122,	.698
SCOLTR	,	145478,	.299,	.146,	.49,	3,	.113,	.890
FRATRB	,	145852,	.304,	.389,	1.28,	3,	.107,	.888
SCOGFS	,	275280,	.226,	.143,	.63,	3,	.193,	.564
INTGFS	,	300763,	.239,	.219,	.91,	2,	.174,	.527
F shrinkage mean	,	153306,	.50,,,,				.085,	.859

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
201310,	.10,	.09,	20,	.848,	.711

Continued

Table 3.3.8 Continued

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	35396,	.239,	.160,	.67,	4,	.115,	1.289
SCOTRL ,	31761,	.367,	.241,	.65,	3,	.057,	1.369
SCOSEI ,	39998,	.224,	.127,	.57,	4,	.159,	1.202
SCOLTR ,	41953,	.228,	.197,	.86,	4,	.156,	1.169
FRATRB ,	35758,	.276,	.267,	.97,	4,	.093,	1.282
SCOGFS ,	40626,	.217,	.164,	.76,	4,	.134,	1.191
INTGFS ,	46688,	.213,	.103,	.48,	3,	.156,	1.096
F shrinkage mean ,	41094,	.50,,,,				.130,	1.183

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
39980,	.10,	.06,	27,	.558,	1.202

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	1222,	.304,	.571,	1.87,	5,	.051,	1.778
SCOTRL ,	3200,	.381,	.149,	.39,	4,	.063,	1.057
SCOSEI ,	2879,	.224,	.088,	.39,	5,	.186,	1.128
SCOLTR ,	3259,	.225,	.134,	.59,	5,	.185,	1.046
FRATRB ,	2142,	.329,	.178,	.54,	5,	.072,	1.337
SCOGFS ,	1599,	.271,	.114,	.42,	5,	.107,	1.560
INTGFS ,	3263,	.226,	.213,	.94,	4,	.181,	1.045
F shrinkage mean ,	2974,	.50,,,,				.155,	1.106

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2682,	.12,	.08,	34,	.691,	1.176

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	533,	.384,	.090,	.23,	6,	.064,	1.322
SCOTRL ,	1388,	.392,	.346,	.88,	5,	.058,	.721
SCOSEI ,	735,	.215,	.096,	.45,	6,	.209,	1.096
SCOLTR ,	842,	.240,	.170,	.71,	6,	.145,	1.008
FRATRB ,	648,	.364,	.226,	.62,	6,	.066,	1.183
SCOGFS ,	808,	.295,	.185,	.62,	6,	.103,	1.034
INTGFS ,	582,	.218,	.117,	.54,	5,	.206,	1.258
F shrinkage mean ,	1005,	.50,,,,				.149,	.899

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
762,	.12,	.06,	41,	.560,	1.072

Continued

Table 3.3.8 Continued

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	167,	.352,	.131,	.37,	6,	.031,	1.187
SCOTRL	,	342,	.399,	.579,	1.45,	6,	.048,	.749
SCOSEI	,	221,	.196,	.073,	.37,	7,	.259,	1.004
SCOLTR	,	245,	.233,	.115,	.50,	7,	.173,	.939
FRATRB	,	144,	.342,	.176,	.52,	7,	.084,	1.291
SCOGFS	,	265,	.295,	.105,	.36,	7,	.096,	.892
INTGFS	,	330,	.218,	.140,	.64,	6,	.168,	.768
F shrinkage mean	,	312,	.50,,,,				.140,	.798

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
251,	.11,	.07,	47,	.594,	.924

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1986

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	515,	.492,	.153,	.31,	8,	.051,	1.074
SCOTRL	,	651,	.454,	.110,	.24,	7,	.072,	.927
SCOSEI	,	854,	.211,	.032,	.15,	8,	.315,	.771
SCOLTR	,	912,	.268,	.044,	.16,	8,	.184,	.736
FRATRB	,	453,	.390,	.134,	.34,	8,	.086,	1.160
SCOGFS	,	631,	.300,	.126,	.42,	7,	.041,	.945
INTGFS	,	483,	.221,	.220,	1.00,	6,	.072,	1.117
F shrinkage mean	,	927,	.50,,,,				.179,	.728

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
753,	.13,	.05,	53,	.355,	.841

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1985

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	43,	.443,	.204,	.46,	8,	.023,	1.366
SCOTRL	,	91,	.383,	.054,	.14,	8,	.103,	.869
SCOSEI	,	74,	.213,	.051,	.24,	9,	.242,	.992
SCOLTR	,	105,	.227,	.014,	.06,	9,	.295,	.789
FRATRB	,	53,	.381,	.140,	.37,	9,	.089,	1.211
SCOGFS	,	79,	.326,	.069,	.21,	7,	.023,	.952
INTGFS	,	111,	.237,	.039,	.16,	6,	.041,	.759
F shrinkage mean	,	115,	.50,,,,				.185,	.736

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
89,	.14,	.04,	57,	.308,	.882

Continued

Table 3.3.8 Continued

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1984

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS	,	24,	.404,	.121,	.30,	8,	.018,	1.554
SCOTRL	,	39,	.315,	.120,	.38,	9,	.173,	1.183
SCOSEI	,	28,	.218,	.054,	.25,	10,	.215,	1.421
SCOLTR	,	34,	.197,	.077,	.39,	9,	.148,	1.293
FRATRB	,	27,	.375,	.209,	.56,	10,	.090,	1.457
SCOGFS	,	19,	.309,	.179,	.58,	7,	.020,	1.740
INTGFS	,	38,	.225,	.094,	.42,	6,	.036,	1.207
F shrinkage mean	,	53,	.50,,,,				.300,	.990

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
37,	.17,	.05,	60,	.315,	1.228

TABLE 3.3.9; Haddock, North Sea
Tuned Stock Numbers at age (10**-5), 1963 to 1994, (numbers in 1994 are VPA survivors)

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	20875	62985	199321	709751	3579952	143310	101868	833061	783325	214829
1	249990	2677	7698	24668	88774	458978	18404	12887	105806	100001
2	7676	41191	484	513	1695	12112	83054	3453	1758	13131
3	496	2156	17489	236	162	374	4449	28109	966	621
4	282	190	521	8672	131	82	118	869	7763	341
5	114	101	68	152	3093	70	47	24	196	2529
6	14	38	34	16	37	913	35	17	10	68
7	13	7	9	10	3	8	338	5	3	4
8	12	5	3	3	3	1	4	99	2	1
9	1	4	2	1	1	0	0	1	28	0
10+	0	0	1	0	1	0	0	1	3	8

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	724608	1317261	112830	160109	249127	385347	705028	152894	318450	198311
1	26796	93069	167397	14364	20013	31658	48578	87670	18337	38702
2	16248	3553	12534	22949	2025	2745	4086	7805	13947	2937
3	4014	6181	931	3164	6756	491	654	1115	2586	5958
4	128	975	1842	204	617	1844	121	161	262	789
5	81	44	275	473	73	134	462	32	39	76
6	659	25	19	82	107	21	34	137	10	15
7	24	179	9	7	23	33	6	9	44	5
8	2	8	47	1	4	7	9	3	2	14
9	1	0	4	14	1	2	3	3	1	0
10+	3	1	1	1	4	1	1	2	1	0

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	652975	169459	240869	485803	39134	75537	81409	272834	286308	502051
1	24510	81682	21474	30506	62166	5004	9686	10434	34924	36408
2	6211	4010	13795	3338	4969	10725	834	1569	1713	5737
3	1273	2120	1366	4964	796	1338	3238	244	389	534
4	2058	355	608	408	1125	217	271	809	68	112
5	253	502	88	156	87	297	53	57	233	23
6	33	61	121	25	44	30	76	21	20	84
7	6	12	17	34	10	12	11	27	11	9
8	1	2	4	5	12	4	4	5	12	5
9	4	1	1	2	2	3	2	1	2	5
10+	1	2	2	2	3	2	1	1	1	2

Age	1993	1994
0	229558	0
1	63660	29047
2	6116	10712
3	1708	2013
4	112	400
5	27	27
6	8	8
7	21	3
8	3	8
9	2	1
10+	3	1

TABLE 3.3.10; Haddock, North Sea
International F at age, Total , 1963 to 1993.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	.004	.052	.039	.029	.004	.002	.017	.014	.008	.032
1	.153	.060	1.059	1.028	.342	.060	.023	.342	.437	.167
2	.870	.457	.320	.753	1.110	.601	.683	.874	.641	.785
3	.708	1.169	.451	.340	.427	.905	1.383	1.037	.792	1.328
4	.779	.787	.982	.781	.373	.309	1.336	1.237	.872	1.190
5	.892	.894	1.254	1.219	1.020	.501	.835	.658	.863	1.144
6	.519	1.279	1.008	1.311	1.324	.793	1.649	1.409	.678	.851
7	.819	.624	.872	1.087	1.140	.584	1.026	.700	1.022	.673
8	.782	.844	.507	.984	1.944	.656	.961	1.057	1.295	.464
9	.766	.895	.935	1.089	1.174	.573	1.175	1.024	.957	.874
10+	.766	.895	.935	1.089	1.174	.573	1.175	1.024	.957	.874

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	.002	.013	.011	.030	.013	.021	.035	.071	.058	.041
1	.370	.355	.337	.309	.337	.398	.178	.188	.182	.180
2	.566	.939	.977	.823	1.017	1.034	.899	.705	.451	.436
3	1.165	.961	1.266	1.385	1.048	1.154	1.151	1.199	.937	.813
4	.820	1.016	1.109	.787	1.279	1.134	1.085	1.176	.990	.886
5	.958	.644	1.004	1.283	1.048	1.170	1.012	.971	.780	.638
6	1.106	.888	.835	1.071	.989	1.048	1.176	.938	.548	.754
7	.905	1.142	1.577	.410	.928	1.121	.615	1.285	.954	1.016
8	1.170	.416	1.015	.849	.502	.835	.871	.643	1.194	.986
9	1.003	.831	1.133	.900	.950	1.118	.920	.829	.974	1.073
10+	1.003	.831	1.133	.900	.950	1.118	.920	.829	.974	1.073

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.029	.016	.016	.006	.007	.004	.004	.006	.012	.015
1	.160	.128	.212	.165	.107	.142	.170	.157	.156	.134
2	.675	.677	.622	1.033	.912	.798	.829	.994	.765	.812
3	1.028	.998	.960	1.234	1.051	1.348	1.137	1.032	.993	1.315
4	1.161	1.141	1.112	1.292	1.082	1.164	1.303	.993	.819	1.168
5	1.216	1.222	1.048	1.053	.853	1.158	.730	.840	.817	.902
6	.821	1.086	1.060	.713	1.149	.826	.837	.455	.657	1.176
7	.845	.800	.944	.825	.826	.887	.667	.573	.488	.989
8	.644	.553	.747	.624	1.110	.620	.768	.474	.726	1.056
9	.686	1.154	1.018	1.028	.880	.594	.784	.590	1.012	1.211
10+	.686	1.154	1.018	1.028	.880	.594	.784	.590	1.012	1.211

Age	1993
0	.017
1	.132
2	.711
3	1.202
4	1.176
5	1.072
6	.924
7	.841
8	.882
9	1.228
10+	1.228

Table 3.3.11; North Sea Haddock
RCT3 input values (age 0)

HADDOCK IN RCT3 INPUT VALUES   Age 0   1994 WG
10   24   2

'YEARCLASS'	'VPA'	'IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'	'GGFS1'	'GGFS2'
1971	783325	740	971	-1	-1	-1	-1	-1	-1	-1	-1
1972	214829	187	110	-1	-1	-1	-1	-1	-1	-1	-1
1973	724608	1092	385	-1	-1	-1	-1	-1	-1	-1	-1
1974	1317261	1168	670	-1	-1	-1	-1	-1	-1	-1	-1
1975	112830	177	84	-1	-1	32.1	-1	-1	-1	-1	-1
1976	160109	162	108	-1	66.8	26.2	-1	-1	-1	-1	-1
1977	249127	385	240	534.8	136.9	54.6	-1	-1	-1	-1	-1
1978	385347	480	402	358.3	295.5	167.3	-1	-1	-1	-1	-1
1979	705028	896	675	875.5	623.3	439.1	-1	-1	-1	-1	-1
1980	152894	268	252	374	173.2	79.8	-1	-1	99.6	-1	-1
1981	318450	526	400	1537.5	315.5	109.5	-1	248.8	161.1	-1	72.8
1982	198311	307	219	281.3	218.2	61.6	123.5	181.3	78.8	93.9	47.2
1983	652975	1057	828	831.9	599.3	238.2	220.3	436.7	298.1	272.9	259.6
1984	169459	229	244	228.5	186.6	44.7	87.3	197.6	57.4	129.7	38
1985	240869	579	326	245.9	149.7	43.1	81.8	232.9	70.4	142.3	154.4
1986	485803	885	688	266	281.9	183.5	174.7	239.3	198.2	307.4	179.9
1987	39134	92	97	22.4	28.6	14.5	27.7	46.7	21.4	68.6	45.3
1988	75537	210	114	60.7	81.7	19.8	40.6	88.6	24	135	54.7
1989	81409	219	131	94.3	66.4	9.6	43.2	100.2	17.8	180	54.9
1990	272834	679	371	281.9	115	97.7	316.3	170.5	96.3	601	129.2
1991	-1	1115	543	263.3	196.9	58.6	347.1	383.2	138	480.1	-1
1992	-1	1242	504	827.7	246.1	90.2	827	583.6	208	-1	163.5
1993	-1	229	-1	135.8	80.7	-1	85.9	126.5	-1	186.8	-1
1994	-1	-1	-1	943	-1	-1	1376.2	-1	-1	-1	-1

IYFS	International Young Fish Survey	First quarter
EGFS	English Groundfish Survey	Third quarter
SGFS	Scottish Groundfish Survey	Third quarter
GGFS	German Groundfish Survey	Second quarter

Table 3.3.12a; North Sea Haddock, RCT3 output, Age 0.

Analysis by RCT3 ver3.1 of data from file :

HADIVO.RCX

HADDOCK IN RCT3 INPUT VALUES Age 0 1994 WG

Data for 10 surveys over 24 years : 1971 - 1994

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

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	1.00
EGFS1	1.00
EGFS2	1.00
SGFS0	.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 = 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	1.25	4.82	.33	.888	20	7.02	13.57	.403	.136
IYFS2	1.29	4.99	.31	.896	20	6.30	13.11	.369	.162
EGFS0	.87	7.45	.50	.771	14	5.58	12.31	.574	.067
EGFS1	1.08	6.73	.37	.860	15	5.29	12.44	.419	.126
EGFS2	.85	8.71	.35	.871	16	4.09	12.18	.395	.142
SGFS0									
SGFS1	1.45	4.71	.28	.922	10	5.95	13.36	.360	.170
SGFS2	.98	7.95	.31	.897	11	4.93	12.77	.373	.159
GGFS1	2.07	1.34	1.11	.443	9	6.18	14.13	1.503	.010
GGFS2									
						VPA Mean =	12.22	.875	.029

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	1.24	4.85	.32	.895	20	7.13	13.67	.406	.137
IYFS2	1.28	5.04	.28	.917	20	6.22	12.98	.332	.206
EGFS0	.87	7.47	.50	.779	14	6.72	13.31	.609	.061
EGFS1	1.09	6.70	.37	.862	15	5.51	12.69	.431	.122
EGFS2	.86	8.69	.35	.872	16	4.51	12.55	.409	.136
SGFS0									
SGFS1	1.46	4.70	.28	.922	10	6.37	13.98	.405	.138
SGFS2	.98	7.95	.31	.899	11	5.34	13.17	.394	.146
GGFS1									
GGFS2	1.70	4.55	.75	.620	10	5.10	13.22	.948	.025
						VPA Mean =	12.19	.880	.029

Continued

Table 3.3.12a (continued)

Yearclass = 1993

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	4.88	.31	.902	20	5.44	11.56	.370	.287
IYFS2									
EGFS0	.87	7.48	.49	.788	14	4.92	11.76	.582	.116
EGFS1	1.09	6.67	.37	.864	15	4.40	11.48	.448	.196
EGFS2									
SGFS0									
SGFS1	1.46	4.68	.28	.921	10	4.85	11.77	.346	.329
SGFS2									
GGFS1	2.03	1.48	1.10	.451	9	5.24	12.13	1.355	.021
GGFS2									
					VPA Mean =		12.15	.888	.050

Yearclass = 1994

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	.87	7.49	.49	.798	14	6.85	13.47	.637	.666
EGFS1									
EGFS2									
SGFS0									
SGFS1									
SGFS2									
GGFS1									
GGFS2									
					VPA Mean =		12.12	.900	.334

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	390812	12.88	.15	.18	1.46		
1992	514112	13.15	.15	.17	1.34		
1993	118131	11.68	.20	.08	.15		
1994	450053	13.02	.52	.64	1.50		

Continued

Table 3.3.12b; North Sea Haddock, RCT3 output, Age 1.

Analysis by RCT3 ver3.1 of data from file :

HADIV1.RCX

HADDOCK IN RCT3 INPUT VALUES   Age 1   1994 WG

Data for   10 surveys over   24 years : 1971 - 1994

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

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	1.00
EGFS1	1.00
EGFS2	1.00
SGFS0	.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 =   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	2.82	.32	.893	20	7.02	11.48	.390	.149
IYFS2	1.28	2.97	.31	.896	20	6.30	11.03	.367	.168
EGFS0	.87	5.36	.52	.756	14	5.58	10.24	.594	.064
EGFS1	1.08	4.67	.38	.850	15	5.29	10.37	.432	.121
EGFS2	.85	6.65	.35	.865	16	4.09	10.11	.402	.140
SGFS0									
SGFS1	1.45	2.69	.28	.918	10	5.95	11.29	.368	.167
SGFS2	.97	5.89	.32	.887	11	4.93	10.70	.389	.149
GGFS1	2.04	-.55	1.08	.452	9	6.18	12.04	1.468	.011
GGFS2									
						VPA Mean =	10.15	.870	.030

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	1.23	2.85	.31	.900	20	7.13	11.58	.392	.150
IYFS2	1.27	3.02	.28	.918	20	6.22	10.90	.328	.213
EGFS0	.87	5.38	.51	.764	14	6.72	11.25	.630	.058
EGFS1	1.08	4.64	.38	.853	15	5.51	10.62	.445	.116
EGFS2	.85	6.63	.36	.867	16	4.51	10.48	.415	.133
SGFS0									
SGFS1	1.45	2.67	.29	.918	10	6.37	11.91	.413	.135
SGFS2	.98	5.89	.32	.890	11	5.34	11.10	.410	.137
GGFS1									
GGFS2	1.67	2.60	.73	.630	10	5.10	11.14	.922	.027
						VPA Mean =	10.12	.874	.030

Continued

Table 3.3.12b (continued)

Yearclass = 1993

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	1.22	2.89	.30	.908	20	5.44	9.50	.356	.312
IYFS2									
EGFS0	.87	5.40	.51	.774	14	4.92	9.69	.602	.109
EGFS1	1.09	4.61	.38	.855	15	4.40	9.42	.461	.186
EGFS2									
SGFS0									
SGFS1	1.45	2.66	.29	.917	10	4.85	9.70	.352	.319
SGFS2									
GGFS1	2.00	-.42	1.08	.459	9	5.24	10.07	1.324	.023
GGFS2									
					VPA Mean =		10.08	.882	.051

Yearclass = 1994

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	.87	5.41	.50	.785	14	6.85	11.40	.658	.649
EGFS1									
EGFS2									
SGFS0									
SGFS1									
SGFS2									
GGFS1									
GGFS2									
					VPA Mean =		10.05	.894	.351

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	49813	10.82	.15	.18	1.42		
1992	64846	11.08	.15	.17	1.30		
1993	14950	9.61	.20	.08	.15		
1994	55605	10.93	.53	.64	1.48		

Table 3.3.12c; North Sea Haddock, RCT3 output, Age 2.

Analysis by RCT3 ver3.1 of data from file :

HADIV2.RCX

HADDOCK IN RCT3 INPUT VALUES Age 2 1994 WG

Data for 10 surveys over 24 years : 1971 - 1994

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

Survey weighting applied :

SURVEY	WEIGHT
IYFS1	1.00
IYFS2	1.00
EGFS0	1.00
EGFS1	1.00
EGFS2	1.00
SGFS0	.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 = 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	1.22	1.06	.28	.913	20	7.02	9.64	.348	.173
IYFS2	1.26	1.25	.26	.926	20	6.30	9.19	.304	.226
EGFS0	.89	3.44	.56	.730	14	5.58	8.42	.639	.051
EGFS1	1.08	2.82	.38	.852	15	5.29	8.55	.432	.112
EGFS2	.85	4.81	.35	.871	16	4.09	8.29	.395	.134
SGFS0									
SGFS1	1.47	.76	.31	.905	10	5.95	9.50	.402	.130
SGFS2	.98	4.04	.32	.888	11	4.93	8.89	.392	.136
GGFS1	2.05	-2.44	1.08	.455	9	6.18	10.25	1.475	.010
GGFS2									
					VPA Mean =		8.32	.871	.028

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	1.22	1.07	.28	.917	20	7.13	9.75	.356	.167
IYFS2	1.26	1.26	.23	.941	20	6.22	9.07	.277	.276
EGFS0	.89	3.47	.55	.740	14	6.72	9.45	.676	.046
EGFS1	1.09	2.79	.38	.851	15	5.51	8.80	.450	.104
EGFS2	.86	4.80	.35	.871	16	4.51	8.66	.410	.125
SGFS0									
SGFS1	1.47	.75	.31	.905	10	6.37	10.13	.451	.104
SGFS2	.98	4.05	.32	.891	11	5.34	9.30	.412	.125
GGFS1									
GGFS2	1.66	.83	.71	.649	10	5.10	9.32	.892	.027
					VPA Mean =		8.30	.877	.027

Continued

Table 3.3.12c (continued)

Yearclass = 1993

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.21	1.08	.28	.921	20	5.44	7.68	.329	.373
IYFS2									
EGFS0	.89	3.50	.54	.751	14	4.92	7.87	.644	.098
EGFS1	1.10	2.75	.39	.851	15	4.40	7.60	.473	.181
EGFS2									
SGFS0									
SGFS1	1.48	.73	.32	.905	10	4.85	7.89	.384	.274
SGFS2									
GGFS1	2.02	-2.31	1.09	.462	9	5.24	8.27	1.332	.023
GGFS2									
						VPA Mean =	8.27	.887	.051

Yearclass = 1994

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	.89	3.51	.54	.764	14	6.85	9.61	.701	.622
EGFS1									
EGFS2									
SGFS0									
SGFS1									
SGFS2									
GGFS1									
GGFS2									
						VPA Mean =	8.24	.899	.378

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	8287	9.02	.14	.18	1.49		
1992	10377	9.25	.15	.17	1.32		
1993	2406	7.79	.20	.08	.16		
1994	8895	9.09	.55	.67	1.46		

TABLE 3.3.13; Haddock, North Sea
Mean fishing mortality, biomass and recruitment, 1963 - 1993.

Year	Mean F H.cons Ages 2 to 6	Mean F Disc. Ages 2 to 6	Ind BC Ages 0 to 3	Stock Biomass ('000 tonnes) Total	Stock Biomass ('000 tonnes) Spawning	Recruits Age 0 Yclass	Recruits Age 0 Million	
1963	.587	.124	.054	2999	136	1963	2088	
1964	.729	.076	.114	1157	412	1964	6299	
1965	.676	.070	.177	801	525	1965	19932	
1966	.735	.108	.125	786	443	1966	70975	
1967	.675	.141	.087	1118	229	1967	357995	
1968	.479	.091	.065	5967	256	1968	14331	
1969	.881	.099	.184	2172	765	1969	10187	
1970	.825	.135	.117	1301	824	1970	83306	
1971	.632	.109	.055	1693	417	1971	78333	
1972	.891	.145	.050	1688	304	1972	21483	
1973	.787	.125	.033	915	303	1973	72461	
1974	.650	.140	.101	1564	261	1974	131726	
1975	.774	.205	.085	2143	239	1975	11283	
1976	.821	.156	.122	872	304	1976	16011	
1977	.818	.130	.169	555	234	1977	24913	
1978	.887	.192	.061	643	128	1978	38535	
1979	.943	.089	.057	653	104	1979	70503	
1980	.838	.082	.086	1218	147	1980	15289	
1981	.633	.088	.064	656	234	1981	31845	
1982	.588	.068	.068	821	292	1982	19831	
1983	.803	.149	.052	731	246	1983	65298	
1984	.904	.096	.032	1449	192	1984	16946	
1985	.858	.081	.018	832	230	1985	24087	
1986	.876	.184	.023	649	213	1986	48580	
1987	.858	.147	.015	1035	151	1987	3913	
1988	.881	.152	.020	413	154	1988	7554	
1989	.742	.200	.017	364	121	1989	8141	
1990	.613	.215	.018	306	68	1990	27283	
1991	.726	.067	.024	716	61	1991	28631	
1992	.955	.106	.031	611	99	1992	51411	*
1993	.859	.139	.033	994	130	1993	11813	*
Arithmetic mean recruits, age 0, 1963 to 1991						:	45785	
Geometric mean recruits, age 0, 1963 to 1991						:	25064	

* RCT3 estimates.

Table 3.3.14; Haddock North Sea
Input data for catch forecast and linear sensitivity analysis.

Populations in 1994			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N0	45005300	.64	WS0	.03	.56	M0	2.05	.03	MT0	.00	.10
N1	1495000	.20	WS1	.16	.26	M1	1.65	.05	MT1	.01	.10
N2	1071200	.16	WS2	.30	.10	M2	.40	.07	MT2	.32	.10
N3	201300	.10	WS3	.44	.11	M3	.25	.19	MT3	.71	.10
N4	39999	.10	WS4	.63	.16	M4	.25	.12	MT4	.87	.10
N5	2700	.12	WS5	.83	.19	M5	.20	.17	MT5	.95	.10
N6	800	.12	WS6	1.02	.18	M6	.20	.10	MT6	1.00	.10
N7	300	.11	WS7	1.25	.17	M7	.20	.10	MT7	1.00	.00
N8	800	.13	WS8	1.56	.19	M8	.20	.10	MT8	1.00	.00
N9	100	.14	WS9	1.83	.23	M9	.20	.10	MT9	1.00	.00
N10	100	.17	WS10	2.15	.25	M10	.20	.10	MT10	1.00	.00

HC selectivity			HC.catch wt			Dis selectivity			Discrd catch wt		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
sH0	.00	.00	WH0	.00	5.57	sD0	.00	1.40	WD0	.05	.25
sH1	.01	.81	WH1	.32	.13	sD1	.13	.95	WD1	.17	.16
sH2	.38	.33	WH2	.38	.08	sD2	.47	.30	WD2	.24	.09
sH3	.98	.24	WH3	.48	.11	sD3	.22	.46	WD3	.29	.14
sH4	1.09	.19	WH4	.64	.15	sD4	.07	.97	WD4	.35	.30
sH5	.90	.19	WH5	.84	.19	sD5	.02	1.65	WD5	.38	.54
sH6	.84	.27	WH6	1.03	.18	sD6	.02	2.20	WD6	.32	1.02
sH7	.75	.31	WH7	1.26	.17	sD7	.00	5.57	WD7	.07	5.57
sH8	.84	.43	WH8	1.56	.19	sD8	.00	5.57	WD8	.51	5.57
sH9	1.04	.21	WH9	1.83	.23	sD9	.00	.00	WD9	.00	.00
sH10	1.04	.21	WH10	2.14	.21	sD10	.00	5.57	WD10	.61	5.57

Ind selectivity			Industrial wt		
Labl	Value	CV	Labl	Value	CV
sI0	.01	.79	WI0	.01	.51
sI1	.04	.61	WI1	.09	.49
sI2	.05	.37	WI2	.22	.14
sI3	.04	.59	WI3	.41	.19
sI4	.03	1.16	WI4	.56	.28
sI5	.03	1.40	WI5	.69	.43
sI6	.01	1.52	WI6	.98	.55
sI7	.02	3.23	WI7	1.07	.72
sI8	.00	4.99	WI8	1.10	.96
sI9	.00	3.49	WI9	.69	1.22
sI10	.00	2.75	WI10	.28	1.72

Year effect M			HC relative eff			Ind reltive eff		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
K94	1.00	.21	HF94	1.00	.15	IF94	1.00	.70
K95	1.00	.21	HF95	1.00	.15	IF95	1.00	.70
K96	1.00	.21	HF96	1.00	.15	IF96	1.00	.70

Recruitment		
Labl	Value	CV
R95	25064300	1.11
R96	25064300	1.11

Stock numbers in 1994 are VPA survivors. These are overwritten at Age 0 Age 1

Human consumption + discard Fs are obtained from mean exploitation pattern over 1989 to 1993.
This is scaled to give a value for mean F (ages 2 to 6) equal to that in 1993, i.e. .998

Fs are distributed between consumption and discards by mean proportion retained over 1989 to 1993.
N.B. Above value for H.cons+Disc. ref F is value for both catch categories combined.

Bycatch Fs are obtained from mean exploitation pattern over 1989 to 1993.
This is scaled to give a value for mean F (ages 0 to 3) equal to that in 1993, i.e. .033

Table 3.3.15; Haddock North Sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 1994	1995						
Mean F Ages								
H.cons 2 to 6	1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC 0 to 3	.03	.03	.03	.03	.03	.03	.03	.03
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass at start of year								
Total	674	1142	1142	1142	1142	1142	1142	1142
Spawning	194	158	158	158	158	158	158	158
Catch weight (,000t)								
H.cons	155	0	62	84	94	103	118	131
Discards	91	0	36	53	60	68	82	96
Ind BC	14	17	16	16	15	15	15	14
Total Landings	168	17	78	100	110	118	133	145
Total Catch	259	17	114	153	170	186	215	241
Biomass at start of 1996								
Total		1064	961	922	905	890	862	839
Spawning		312	233	205	193	182	163	147

	Year 1994	1995						
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Est. Coeff. of Variation								
Biomass at start of year								
Total	.15	.67	.67	.67	.67	.67	.67	.67
Spawning	.13	.26	.26	.26	.26	.26	.26	.26
Catch weight								
H.cons	.23	.00	.40	.32	.30	.29	.27	.27
Discards	.30	.00	.87	.85	.84	.84	.85	.86
Ind BC	.79	.95	.97	.98	.98	.99	1.00	1.00
Biomass at start of 1996								
Total		.68	.74	.77	.78	.79	.81	.83
Spawning		.39	.46	.49	.51	.52	.55	.58

Table 3.3.16; Haddock North Sea
Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations Stock No.	Catch number H.Cons	Discards	By-catch	Total
0	45005300	0	38074	228442	266516
1	1495000	4131	86073	26166	116370
2	1071200	226344	283380	28218	537941
3	201300	102728	22980	3673	129381
4	39999	23178	1381	595	25154
5	2700	1452	29	40	1521
6	800	414	10	5	429
7	300	144	0	4	148
8	800	417	0	2	419
9	100	60	0	0	60
10	100	59	0	0	60
Wt	674	155	91	14	259

Forecast for year 1995
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations Stock No.	Catch number H.Cons	Discards	By-catch	Total
0	25064300	0	21204	127224	148428
1	5713206	15789	328930	99995	444714
2	242471	51234	64144	6387	121765
3	293106	149579	33460	5348	188387
4	45686	26474	1577	679	28730
5	9534	5128	102	142	5372
6	857	443	11	6	460
7	273	131	0	3	135
8	113	59	0	0	59
9	282	168	0	0	168
10	58	34	0	0	34
Wt	1143	118	82	15	215

Table 3.3.17; North Sea Haddock
Diagnostics from Stock-recruitment model fit.

```
North Sea Haddock, SSB & recruitment, 1994 WG

Data read from file hadivsr.dat

Beverton-Holt curve
Moving average term NOT fitted

IFAIL on exit from E04FDF =, 0

Residual sum of squares=, 34.4771
Number of observations=, 30

Number of parameters =, 2
Residual mean square =, 1.2313

Coefficient of determination =, .0102
Adj. coeff. of determination =, -.0251

IFAIL from E04YCF=, 0

Parameter Correlation matrix

,  1.0000,
,  -.9933,   1.0000,

 Parameter,s.d.

 667.8402,   1172.7173,
  48.2119,    104.3630,
```

Table 3.3.18

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	1992	1993
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		
1993	0.99	0.99	0.87	0.99	0.92	1.31	
1994	1.01	1.06	0.97	0.86	0.81	1.07	1.02

Remarks: Laurec-Shepherd tuning used 1989-1992, XSA used in 1993.

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F								
Date of assessment	Year							
	1988	1989	1990	1991	1992	1993	1994	1995
1989	109	85	53					
1990	83	63	61					
1991		52	46	77				
1992			47	102	195			
1993				52	69	176	257	
1994					69	94	168	133
					SQC[1]	SQC[2]	Current	Forecast

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

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

where F(y), F(y−1) ∧ F(y−2) are as estimated ∈ the assessment made ∈ year (y+1).

Remarks: Human consumption and by-catch used as landings F_{hc} and F_{dicc} used as F for calculating SQC.

Continued

Table 3.3.18 Continued

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

Assessment Quality Control Diagram 3

Recruitment (age 0) Unit: milllions							
Date of assessment	Year class						
	1988	1989	1990	1991	1992	1993	1994
1989	7650						
1990	10512	1280					
1991	7802	7879	32729				
1992	7265	8351	33509	66763			
1993	8017	7927	25254	45919	83110	17559	
1994	7554	8141	27283	28631	51411	11813	45005

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1989	134[2]	117[2]	79[1,2]	72[1,2]					
1990	149	122	86	81[1]	150[1]				
1991	150	122	76	64	99[1]	122[1]			
1992	149	119	71	55	105	201[1]	235[1]		
1993	155	125	77	58	89	165	248[1]	177[1]	
1994	154	121	68	61	99	130	194	158[1]	163[1]

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

Remarks: 1993 XSA used, 1989-1992 Laurec-Shepherd tuning used.

Table 3.3.19 North Sea Haddock. Survivor estimates with and without commercial tuning data.

Age	Survey data only		Commercial and survey data	
	N	SE	N	SE
0	2750540	0.3	2904714	0.26
1	1176441	0.17	1071213	0.16
2	227225	0.13	201310	0.1
3	40908	0.14	39980	0.1
4	2153	0.18	2682	0.12
5	680	0.17	762	0.12
6	271	0.17	251	0.11
7	621	0.25	753	0.13
8	89	0.27	89	0.14
9	40	0.32	37	0.17

Figure 3.3.1 Haddock North Sea. Long term trends in yield, fishing mortality recruitment and biomass.

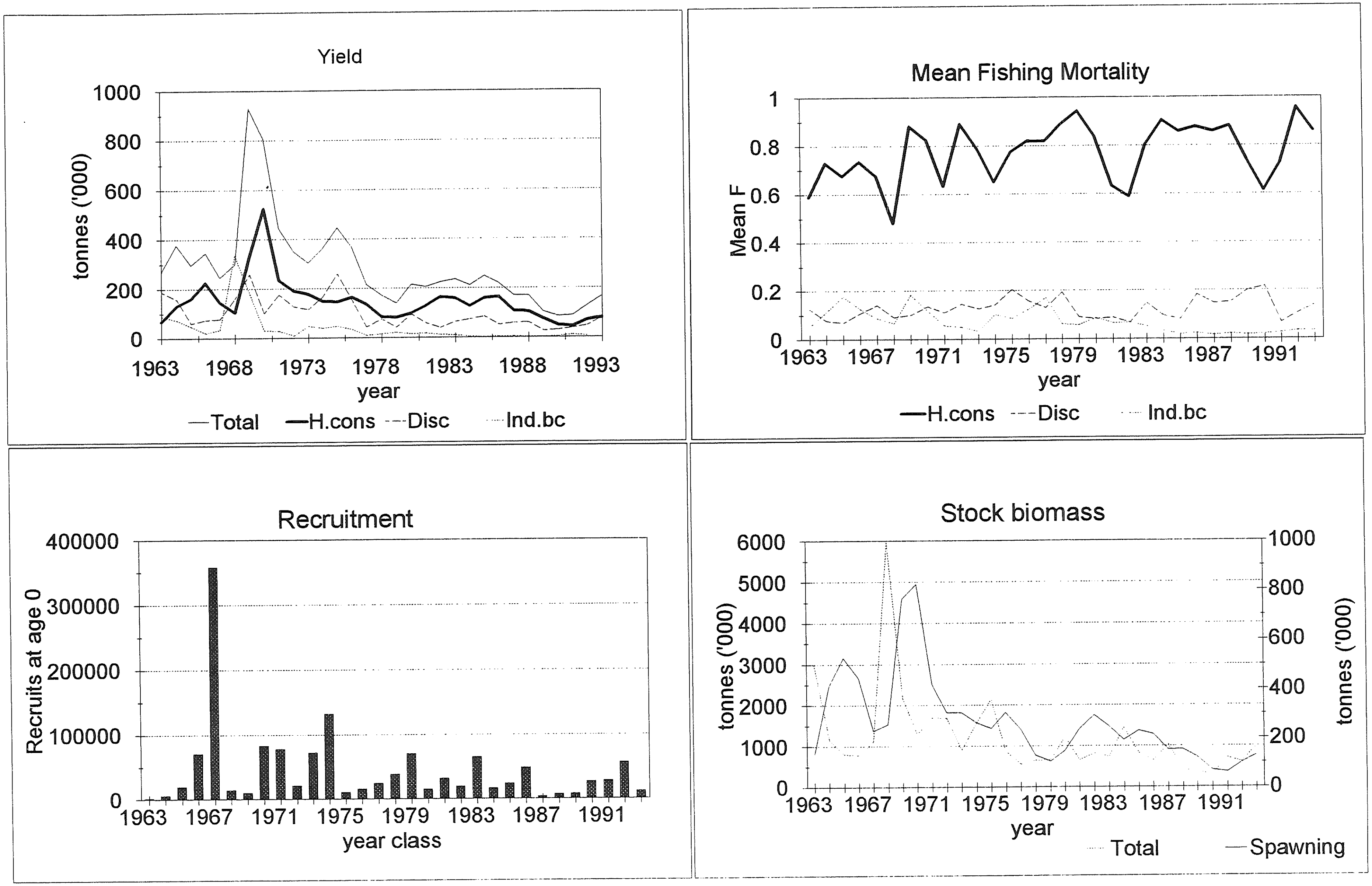


Figure 3.3.2 Haddock North Sea.
Log catchability residuals by fleet

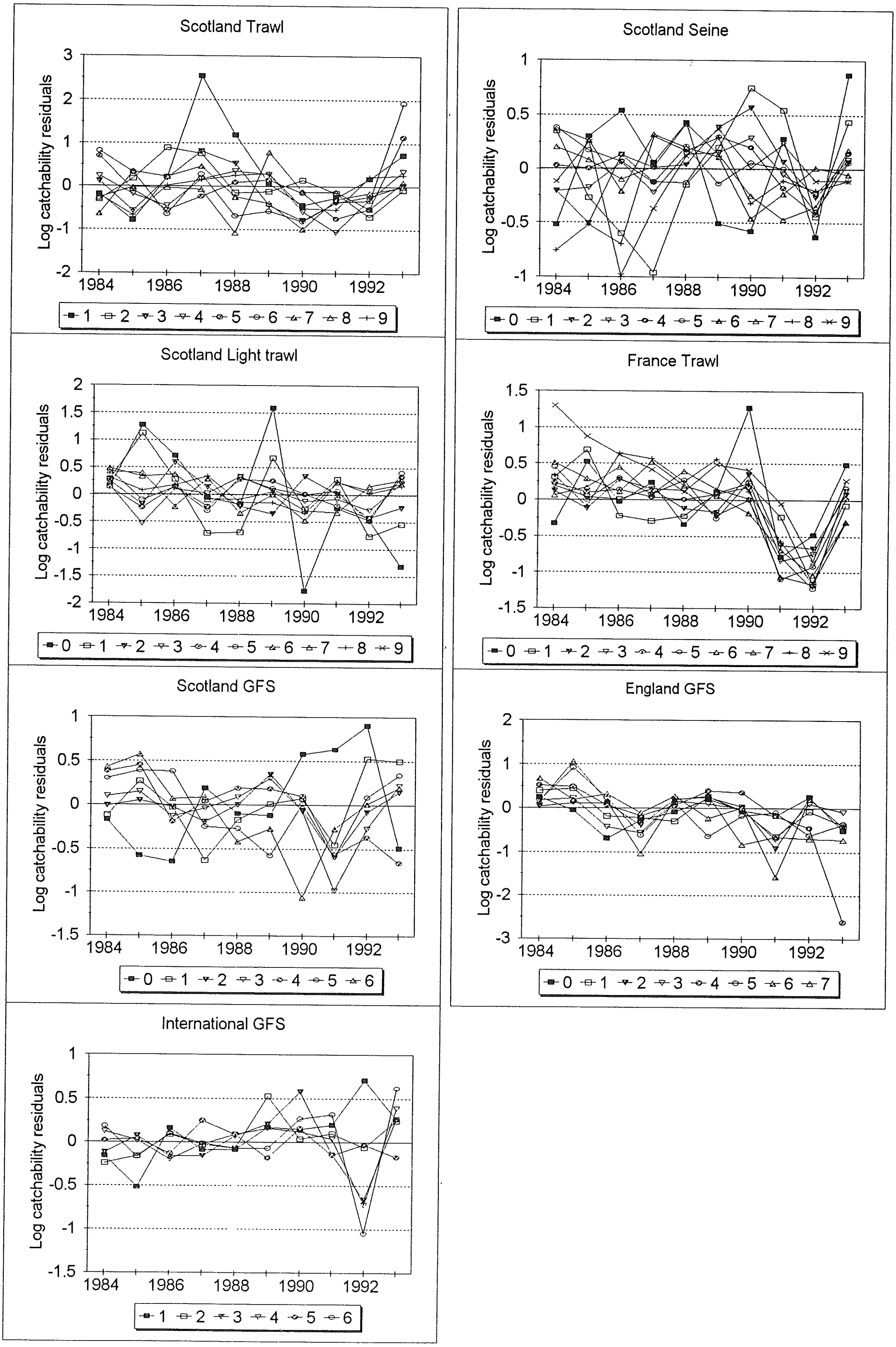


Figure 3.3.3 **Haddock, North Sea**

Retrospective analysis, mean F

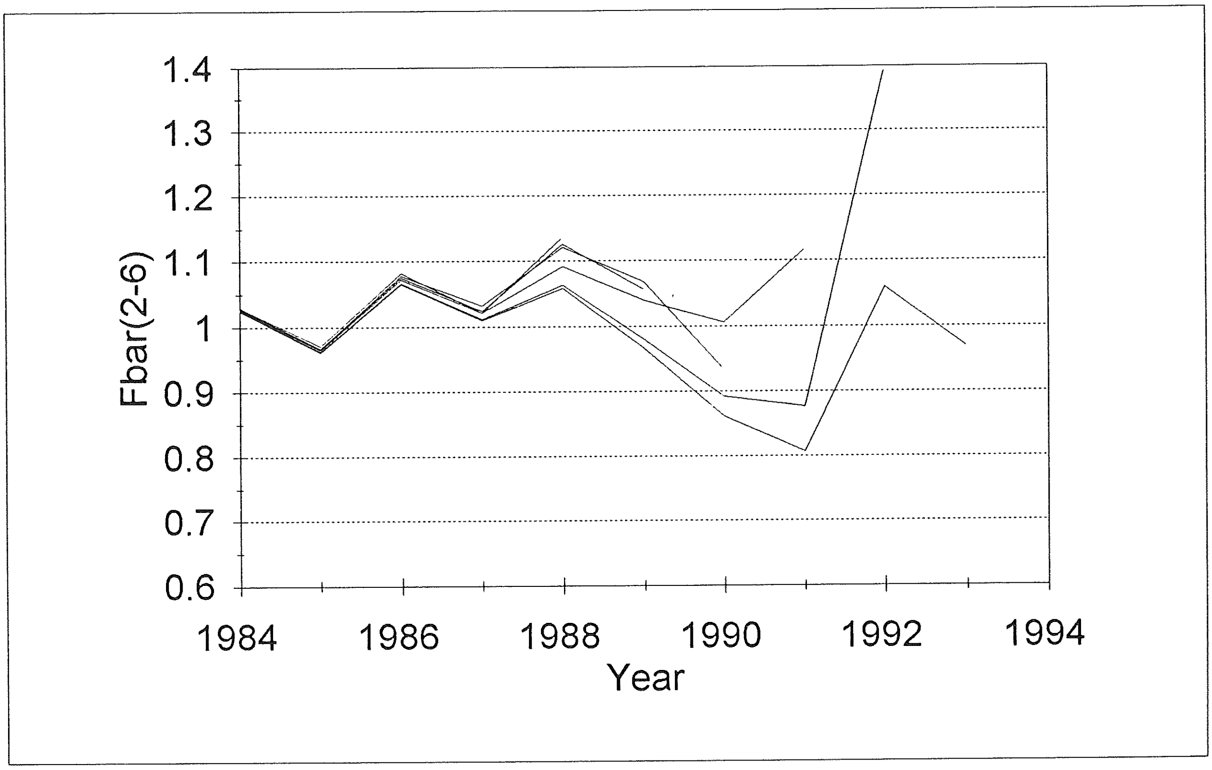


Figure 3.3.4 **North Sea Haddock**
Correlation of English and Scottish Survey indices with converged VPA (age 0)
Arrows indicate values for most recent indices

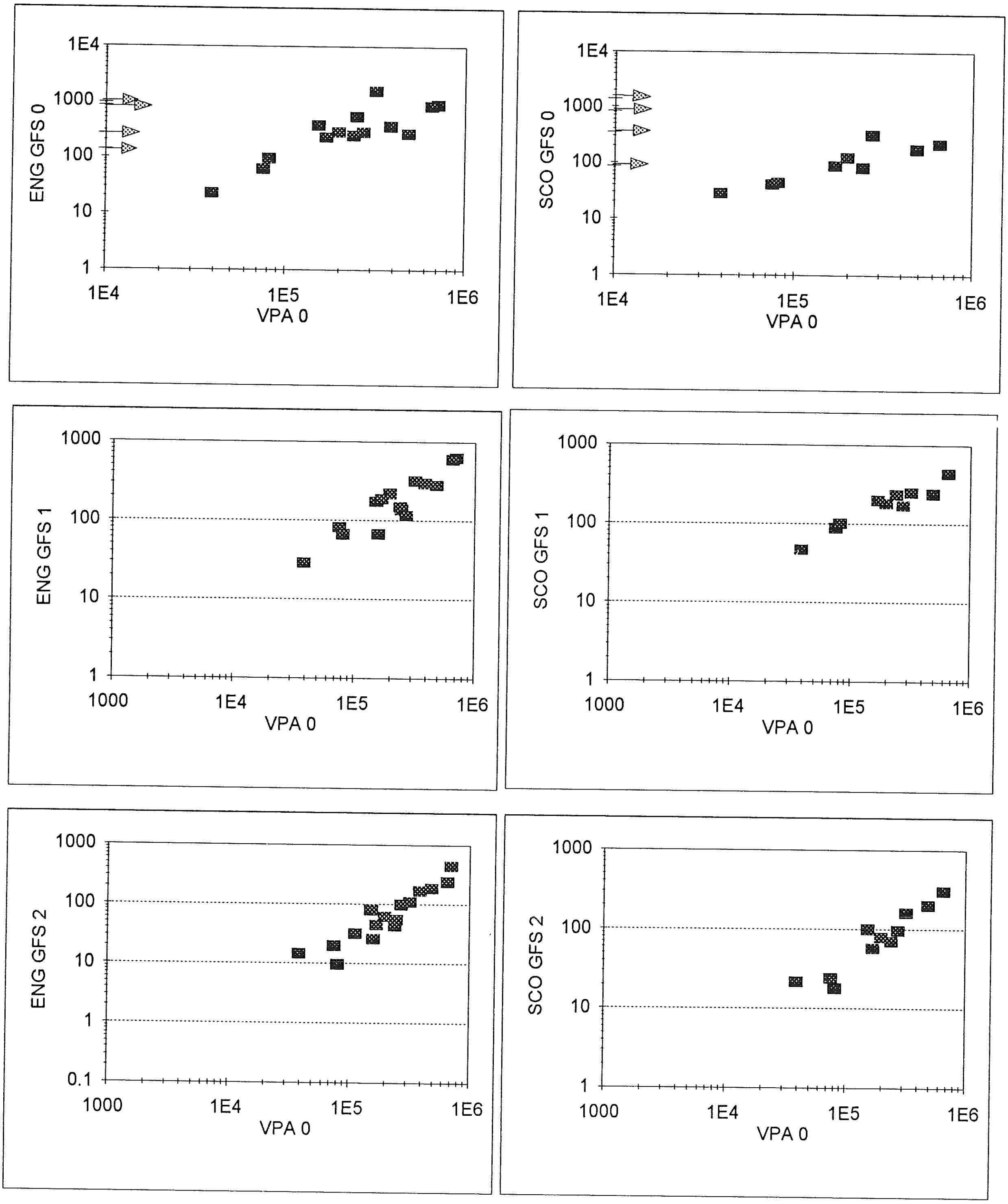


Figure 3.3.5 Haddock, North Sea
Stock and Recruitment

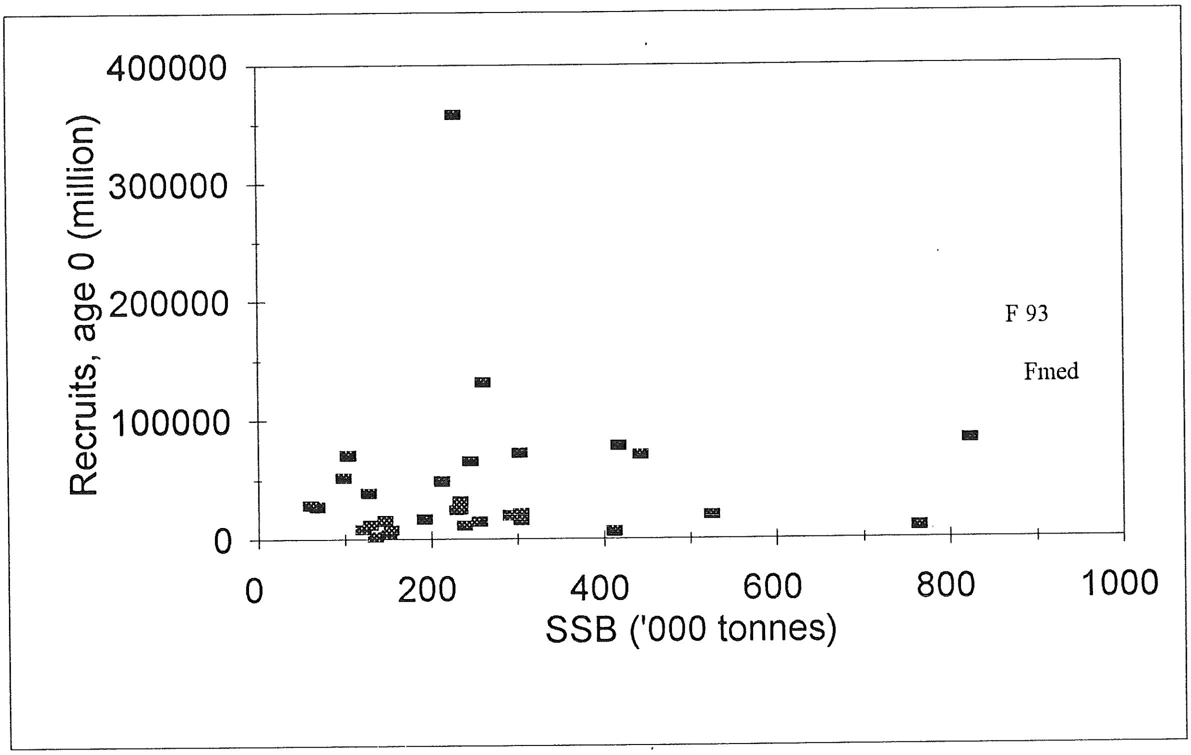


Figure 3.3.6 Haddock, North Sea
Human consumption yield and spawning stock per recruit

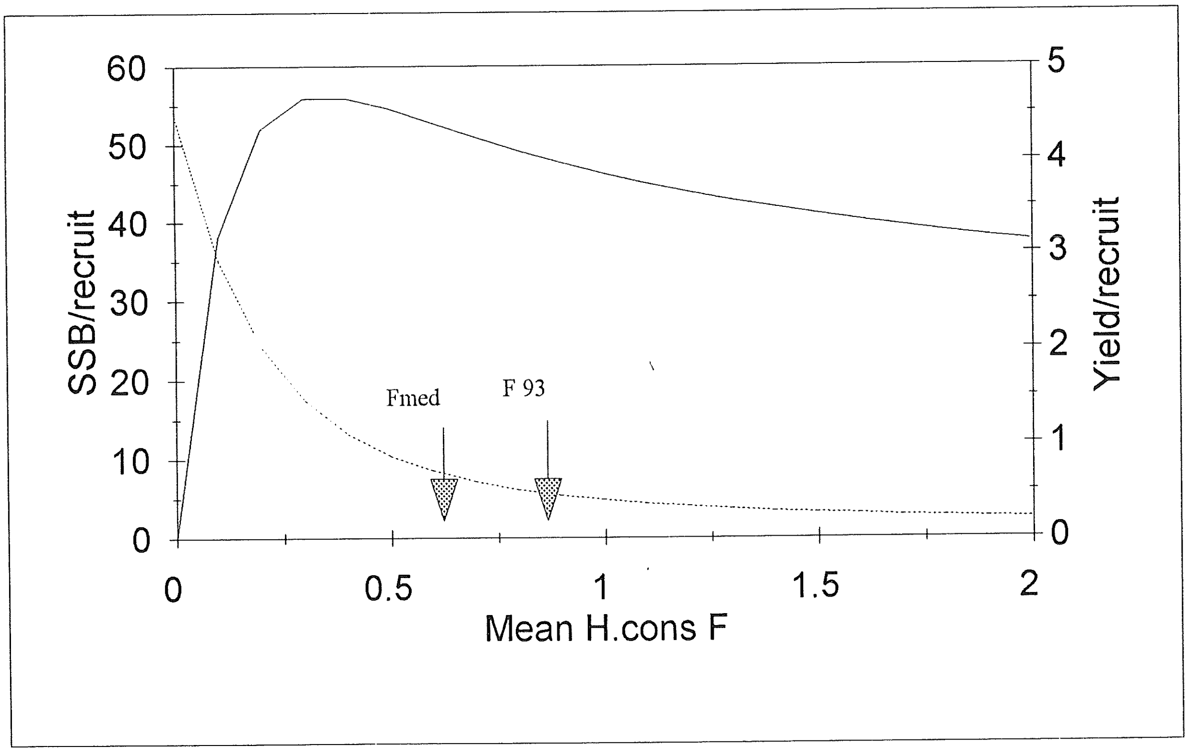


Figure 3.3.7 Haddock North Sea. Sensitivity analysis of short term forecast. Linear sensitivity coefficients (elasticities). Key to labels is in Table 3.3.14.

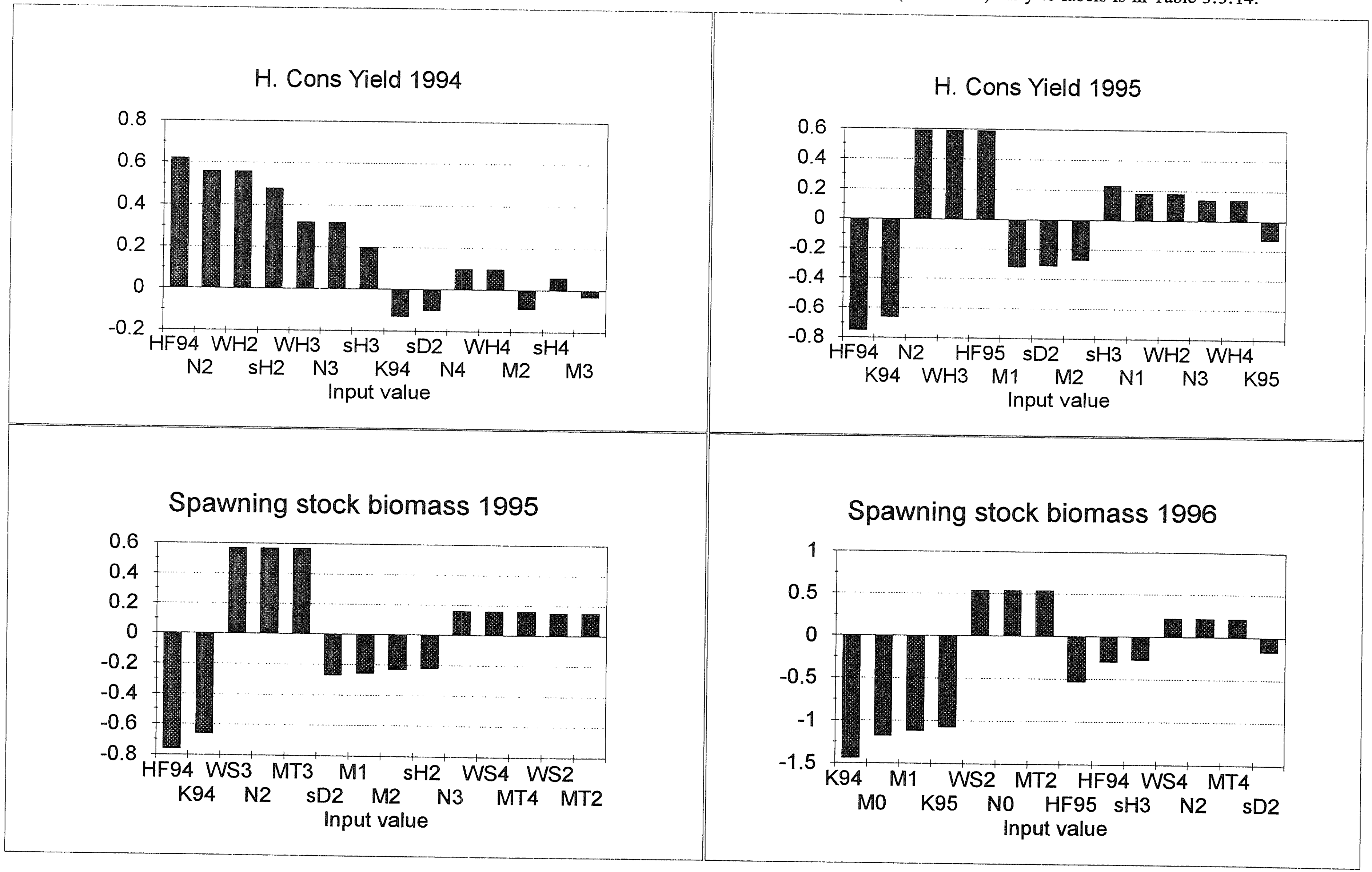


Figure 3.3.8 Haddock North Sea. Sensitivity analysis of short term forecast. Proportion of total variance contributed by each input value. Key to labels is in Table 3.3.14.

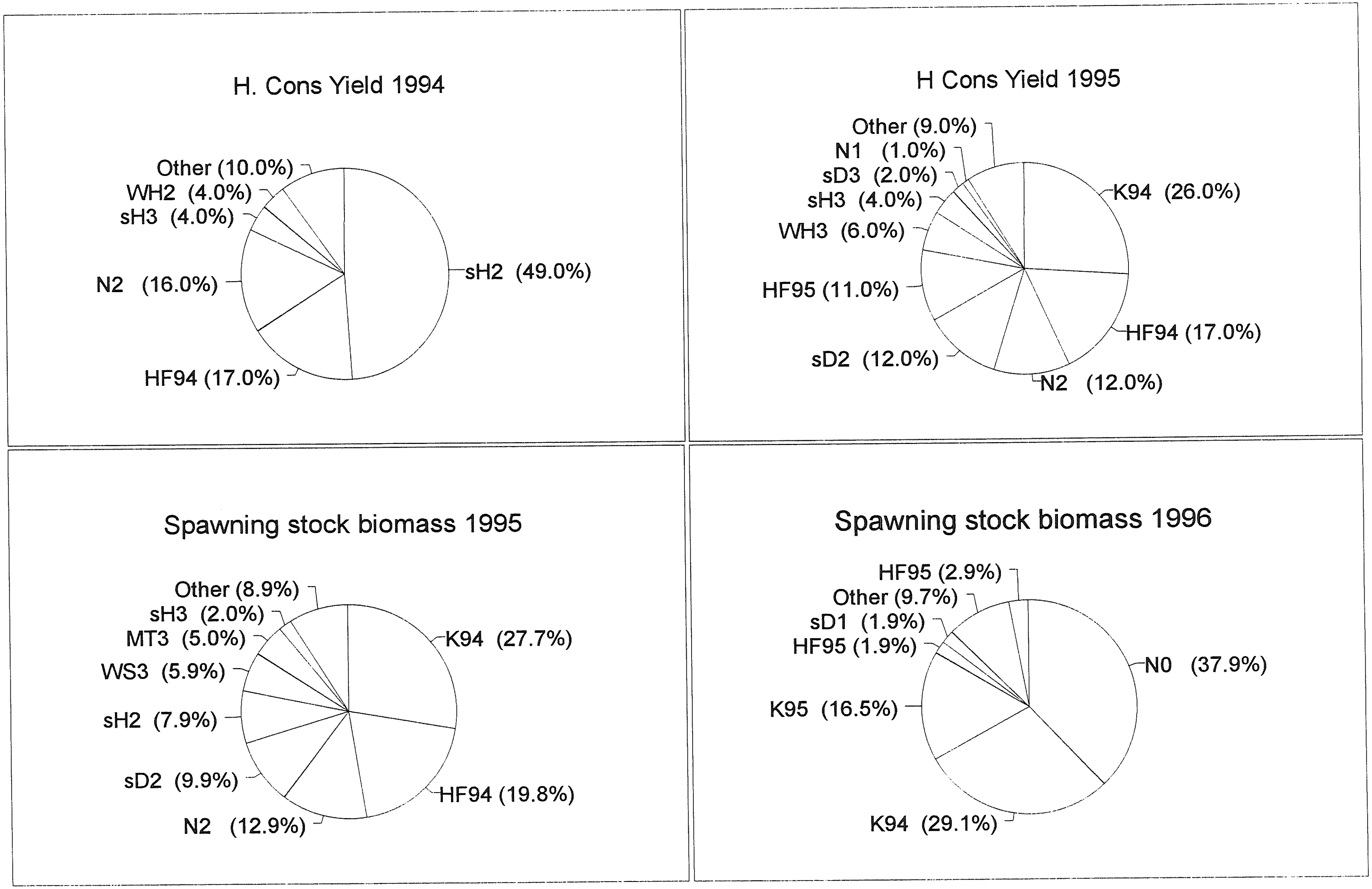


Figure 3.3.9 Haddock North Sea. Sensitivity analysis of short term forecast. Cumulative probability distributions.

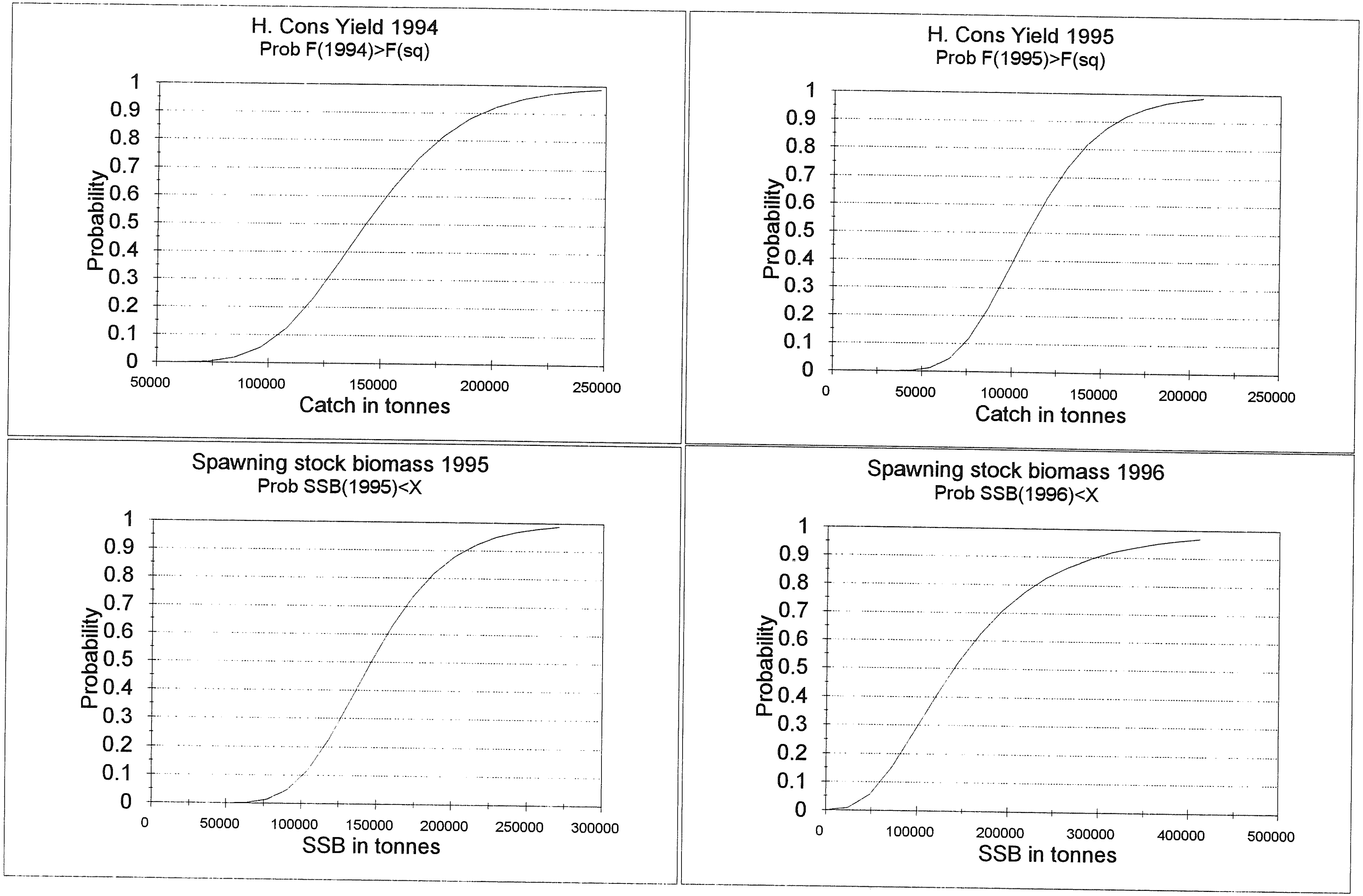


Figure 3.3.10a Haddock North Sea. Medium term projections. Solid lines show 5,25,50,75 and 95 percentiles.
Dashed lines show five sample trajectories. Recruitment on a log scale.
Relative H. Cons effort = 1.00 Relative industrial effort = 1.00

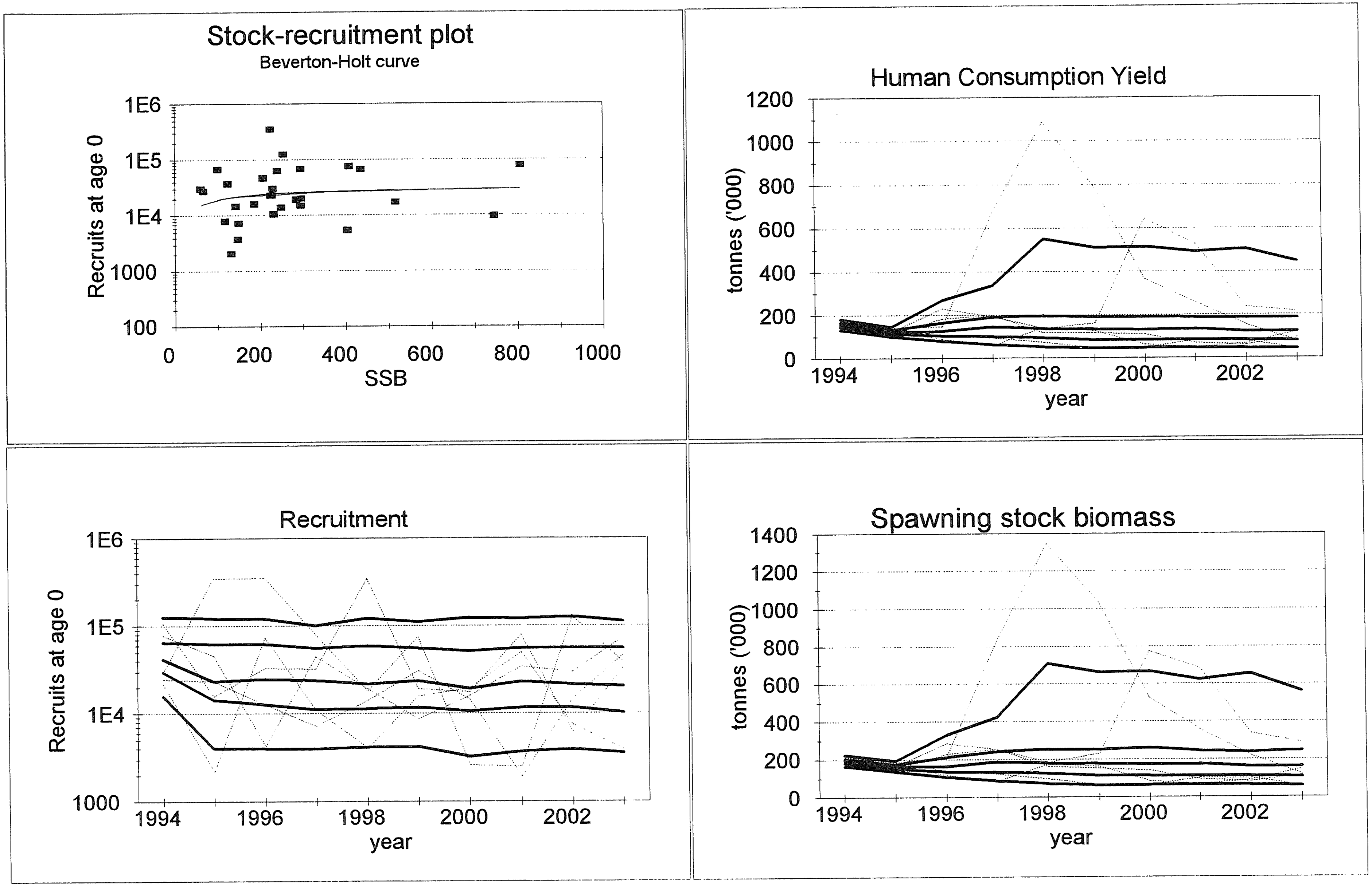


Figure 3.3.10b Haddock North Sea. Medium term projections. Solid lines show 5,25,50,75 and 95 percentiles. Dashed lines show five sample trajectories. Recruitment on a log scale.

Relative H. Cons effort = .70 Relative industrial effort = 1.00

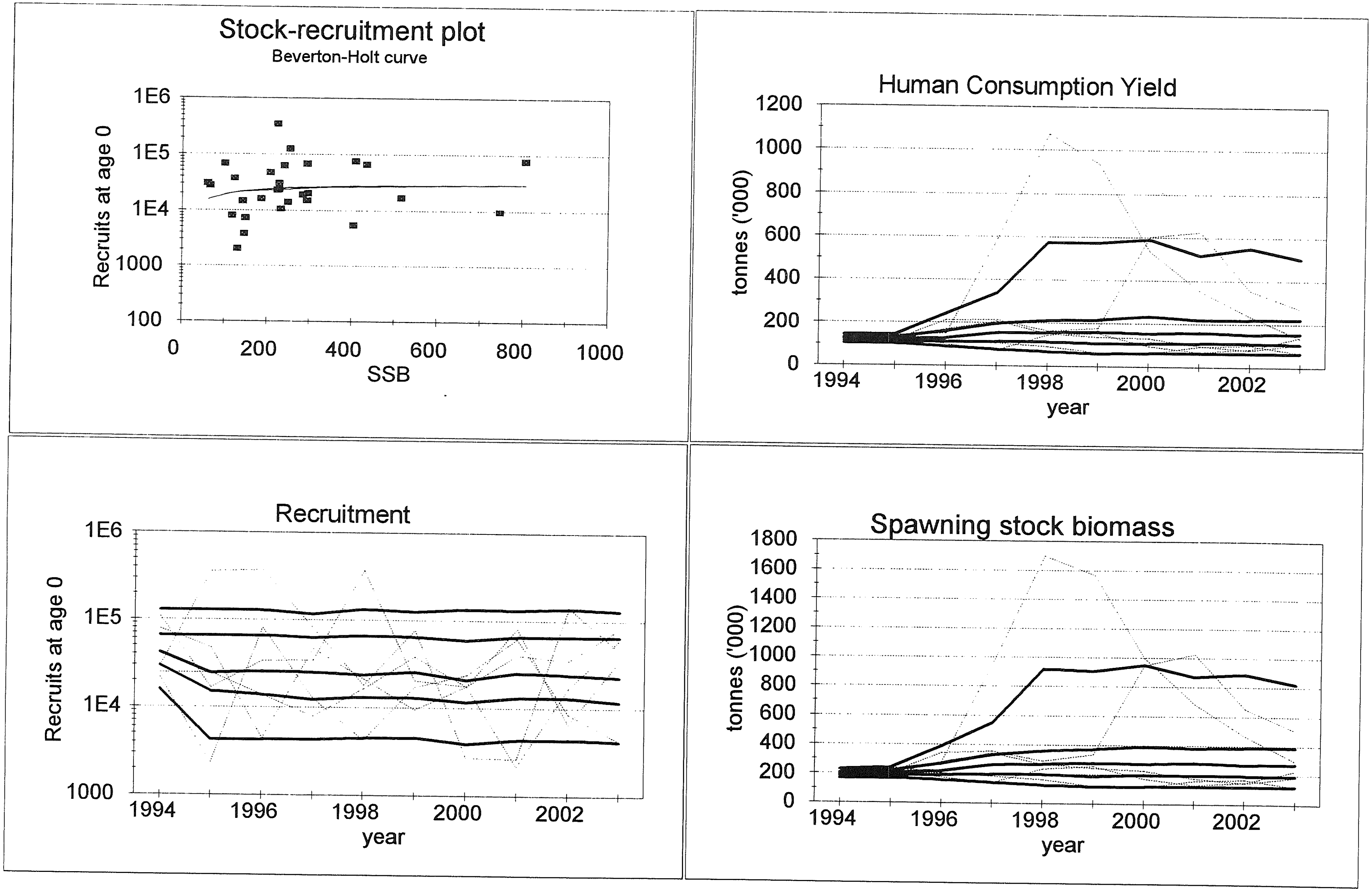


Figure 3.3.11 **Haddock, North Sea**
Retrospective trends in Mean F from XSA using only survey data.

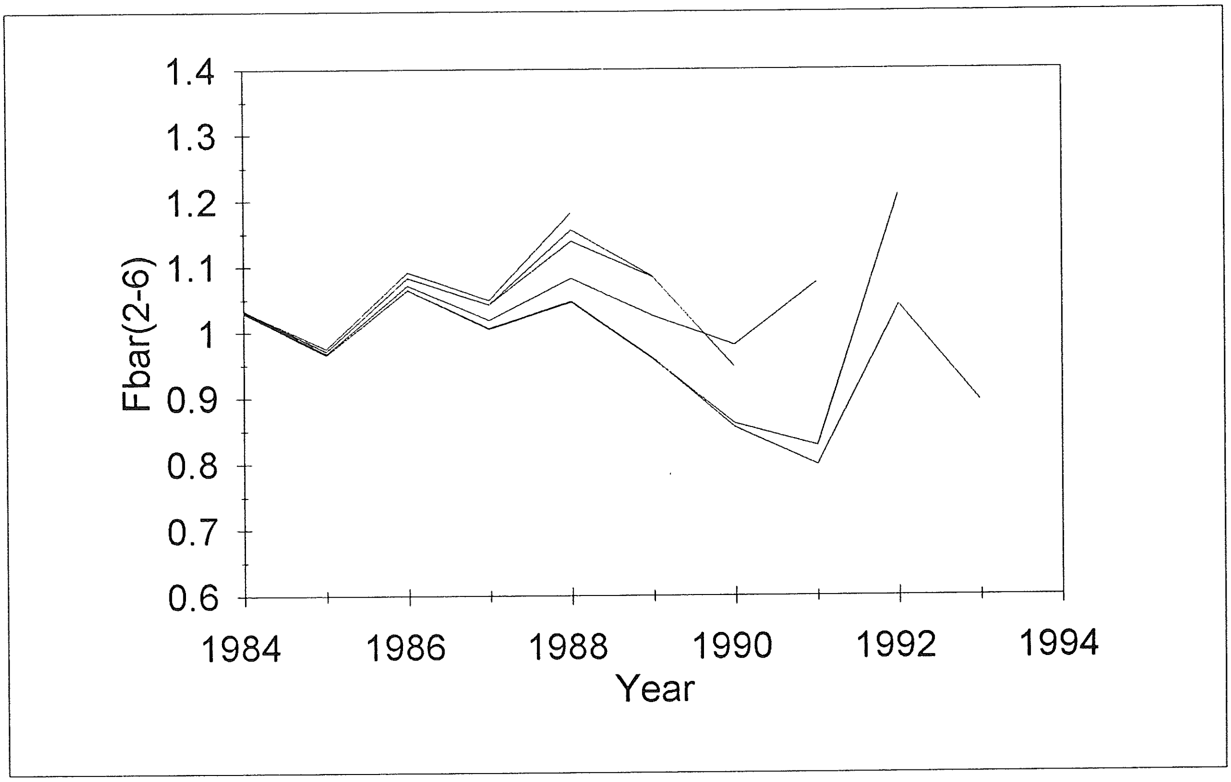


Figure 3.3.12 **Haddock, North Sea**
F trends from XSA runs including and excluding commercial CPUE data
All : Including commercial data; RV : Excluding commercial data

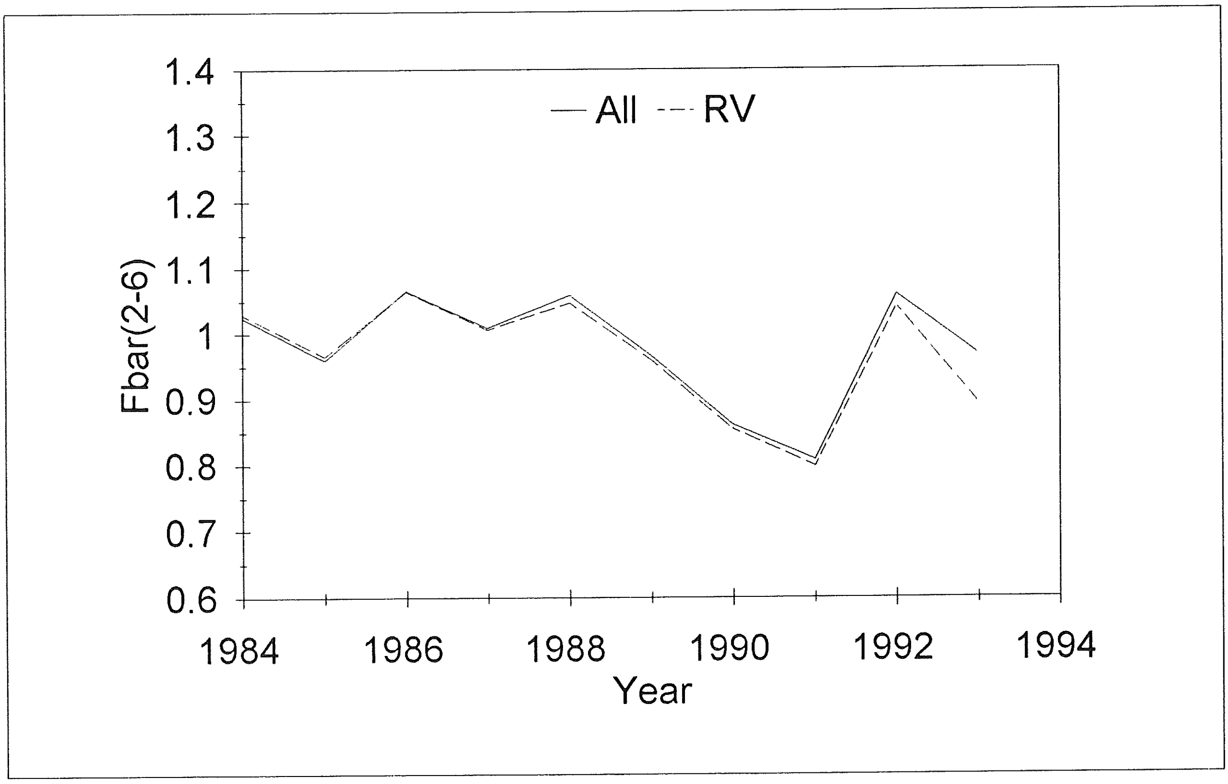
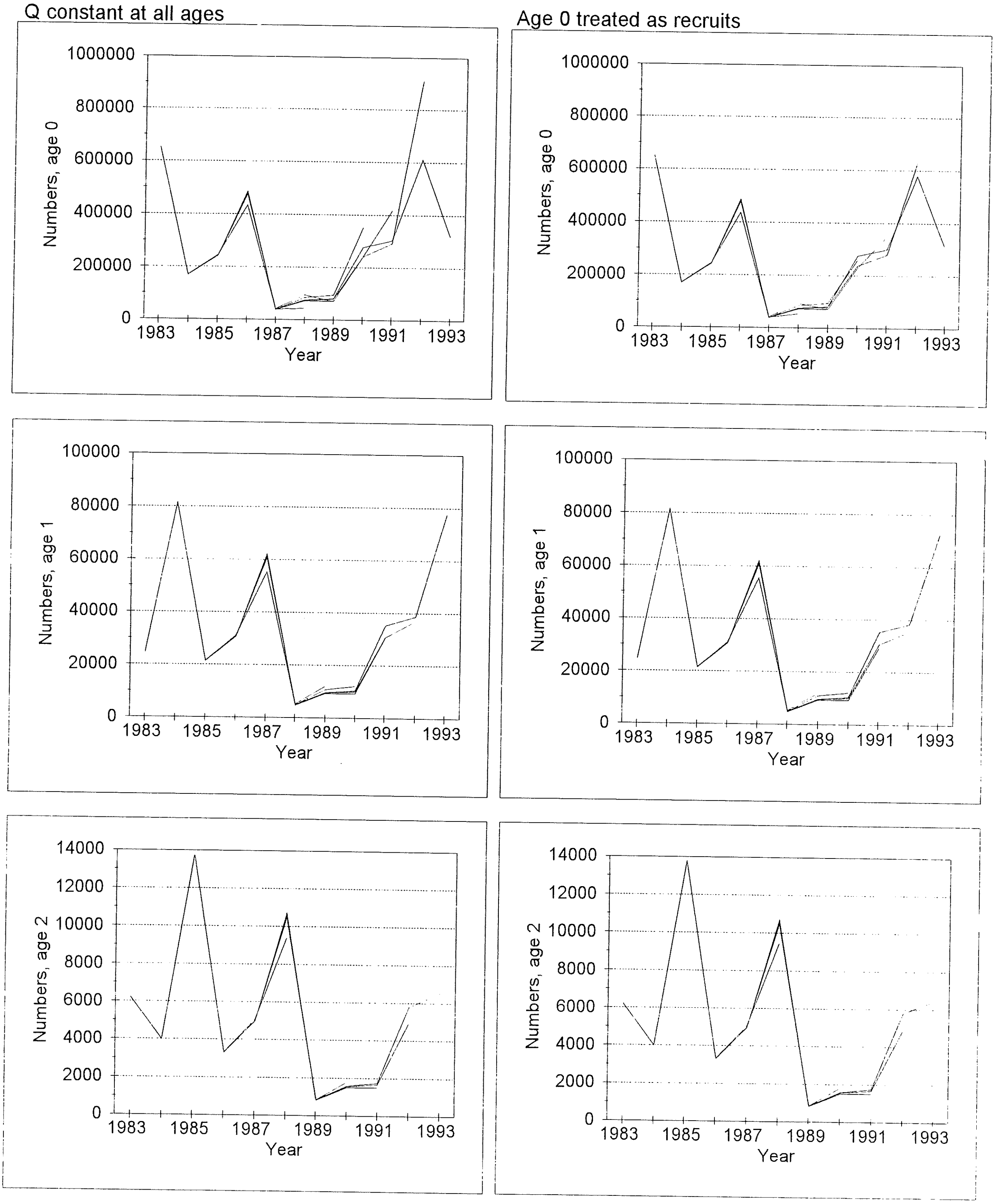


Figure 3.3.13

North Sea Haddock, Retrospective estimation of recruitment

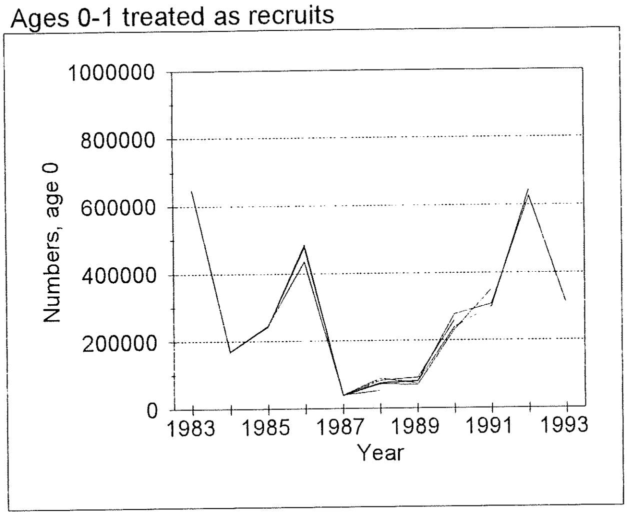


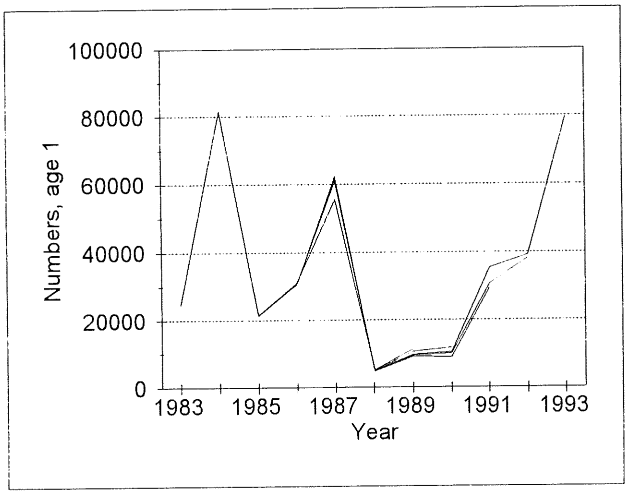
Continued

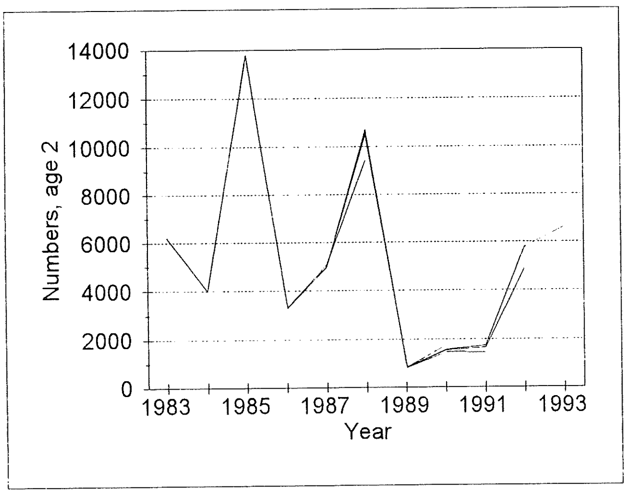
Figure 3.3.13 Continued

North Sea Haddock, Retrospective estimation of recruitment

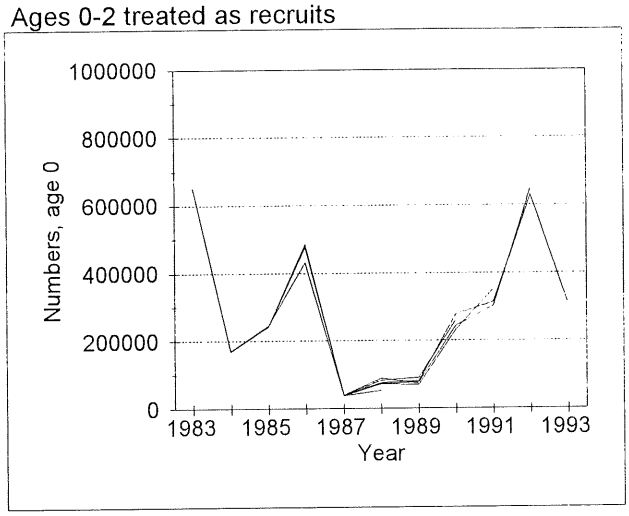
Ages 0-1 treated as recruits

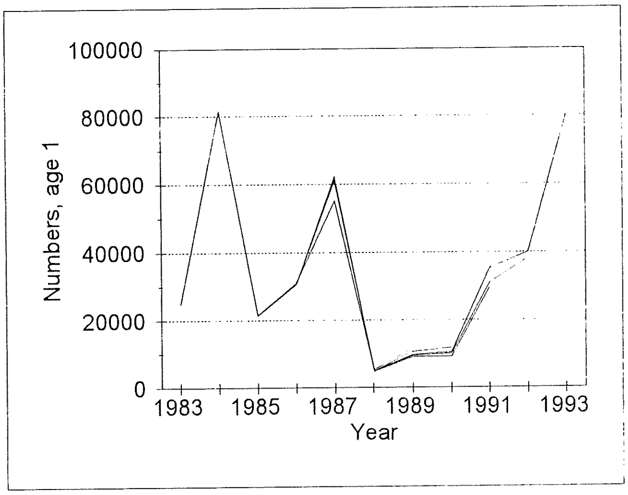


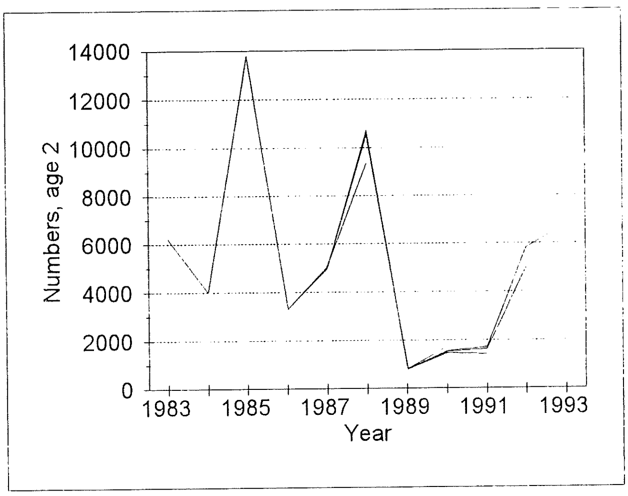




Ages 0-2 treated as recruits







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 were 111,000 t in 1993, of which 48,000 t were human consumption landings, 43,000 t discards and 20,000 t industrial by-catch. The total catches have decreased in recent years from 149,000 t in 1990. The reduction reflects stable human consumption landings and reductions in both discards and industrial by-catch. The total landings of 68,000 t in 1993 are only 76% of last year's prediction and are also well below the total 1993 TAC of 120,000 t. Catch trends for the last 20 years are shown in Figure 3.4.1.

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

The natural mortality and maturity at age values used are included in Table 3.4.3.

The natural mortalities used are rounded averages of the estimates produced by a key MSVPA run.

The maturity ogive is based on IYFS data, average 1981–1985.

Human consumption landings data and age compositions were provided by Scotland, the Netherlands, England and France. Discard data were provided by Scotland. Since 1991 the age-composition of the industrial by-catch has been directly sampled by Denmark, whereas the industrial by-catch age compositions were calculated from research vessel surveys in the period 1985–1990. Length distributions of the industrial by-catch from Norway were available. The Norwegian industrial by-catch was separated into age groups by using the age composition of the Scottish discard age-length key. Mean weights at age were available separately for the human consumption, discard and industrial by-catch component. Total international catch at age and mean weight at age in the catch are presented in Tables 3.4.4 and 3.4.5. The mean weights at age presented are not corrected for sum of products.

The mean weight at age in the catch was also used as the stock mean weight at age.

3.4.3 Catch, effort and research vessel data

Catch and effort data from commercial and survey vessels were used to tune the VPA. CPUE data from surveys were used to provide recruitment estimates. The fleets used in the VPA tuning and the ages and number of years available for each fleet are listed in Table 3.4.6 while the actual values are presented in Table 3.4.7. The International Ground Fish Survey series is available for a longer period for ages 1 and 2 than for the older ages due to lack of proper sampling/ageing of these age groups in the earlier part of the time series.

3.4.4 Catch at age analysis

The VPA was tuned using the extended survivors analysis (XSA) approach (see Section 1.3). The basic input parameters and conditions of the tuning are presented in Table 3.4.8. The full time series was used. On basis of experience from trial runs the catchability was assumed to be independent of age for ages above 5 years. The estimates of terminal F's only changed marginally with variations in this choice. Catchability was allowed to be dependent on stock size below age group 2. After preliminary analysis two fleets - Scottish trawlers (SCOTRL) and the Scottish groundfish survey (SCOGFS) - were excluded from the final VPA tuning due to excessive residuals overall or in the most recent years.

The diagnostics of the final tuning (including residuals for the excluded fleets) are presented in Table 3.4.8. Catchability residuals by age and fleet are presented in Figure 3.4.2.

There are apparent trends in the catchability residuals in some survey fleets which are difficult to explain. The fleets receiving highest weight in the estimation of terminal fishing mortality are the French trawlers and the Scottish light trawlers. The surveys have some influence at ages up to age 6, but less than 10% weight above this age. The mean receives some weight for the youngest and oldest age groups, but receives weights below 0.25 for ages 2 to 6 inclusive.

The results of a retrospective analysis are presented in Figure 3.4.3. The F level has historically been quite variable, and the method has not been able to pick this variation up in a series of years with underestimates of the terminal F. Recent assessments have tended to overestimate F-levels while the assessments in 1987 and 1989 would give a considerable underestimation. The retrospective analysis indicates inconsistencies in the catch at age data in several years.

The stock numbers and fishing mortalities at age estimated with the XSA tuned VPA are presented in Tables 3.4.9 and 3.4.10.

The fishing mortalities in 1992 have been revised 25–50% downwards for ages 2 – 5 relative to last year's assessment. This feature was also found in last year's assessment as reflected in the retrospective analysis (Figure 3.4.2).

The VPA estimates of the sizes of the 1991 and 1992 year classes have been reduced by around 40% relative to the estimates used in last year's prediction which was based on survey indices for these cohorts. The present VPA-based estimates for the two year classes are 2,411 and 2,639 million at age 1 compared to 3,328 and 3,728 million estimated by RCT3 in last year's assessment. This downward revision from recruitment estimates to VPA estimates of year class size has been a recurrent feature of the assessment of this stock for a range of recent assessments and indicates an inconsistency between survey and commercial catch data.

3.4.5 Recruitment estimates

It was attempted to estimate recruitment at ages 0, 1 and 2 in 1994 using the regression technique implemented in the RCT3 program. Input data are presented in Table 3.4.11 while input parameters and run conditions are presented in Table 3.4.12. The results are given in Tables 3.4.12–3.4.14 for ages 0, 1 and 2 respectively.

The RCT3 estimates of the stock at ages 1 and 2 in 1994 deviate considerably from the estimates from the VPA : 1992 year class age 2 : 1,596 (RCT3) and 886 (VPA) million respectively, 1991 year class age 1 : 3,408 (RCT3) and 2,836 (VPA) million. This deviation must be seen in relation to the recent inconsistency between survey and commercial catch data as indicated by a downward revision of year classes as they are estimated from a VPA (see Section 3.4.4).

The continued use of recruitment estimates derived solely from surveys is thus not consistent with the emphasis on catch data in the VPA. It is not possible to decide to which extent the survey or the commercial catch data are closest to reality. The inconsistency between the two sets of data may reflect a sampling problem (poor catch data for parts of the time series and raising of discards from data from one country only) or a genuine difference in the age structure of the populations sampled by the commercial fleets and the survey fleets, for instance due to different geographical coverage and shifts in the geographical distribution of whiting. In the lack of external information indicating the probable reason for the inconsistency the most appropriate approach would be to utilize all information in one XSA run including the survey indices of the most recent year. This option is, however, not currently available. In order to secure consistency between assessments it was therefore decided to utilize the populations as predicted by the XSA for predictions rather than replacing recruitment populations with RCT3 estimates. This means that the most recent survey estimates are not utilized in the prediction. It should be emphasized that the only reason for this choice is that it will ensure consistency between consecutive assessments with respect to recruitment. It is not based on a belief that the recruitment estimates are necessarily 'better' than those derived solely from survey indices.

3.4.6 Historical stock trends

Long-term trends in fishing mortality, recruitment and spawning stock biomass are given in Table 3.4.15 and plotted in Figure 3.4.1.

Fishing mortalities have been highly variable with no clear trend.

Recruitment since 1985 has been variable between the long-term mean and 40% of this value.

The spawning stock biomass has fluctuated within the range 260-300 thousand t over the same period. The spawning stock biomass has been decreasing recently due to the recruitment of two small year classes (1989 and 1990) into the spawning stock, but the spawning stock biomass is no longer dominated by these year classes and is increasing.

3.4.7 Biological reference points

A stock-recruitment plot is shown in Figure 3.4.4. Fmed (0.89) is above the present value of 0.68. Given the high catch by small mesh fisheries it is not clear which yield/recruit reference point is the appropriate one to use. The equilibrium yield (landings) per recruit is plotted in Figure 3.4.5. The input for equilibrium yield prognosis is given in Table 3.4.16.

3.4.8 Short-term forecast

Input data for the short-term catch forecast are given in Table 3.4.16. Results of a *status quo* forecast are presented in Table 3.4.17 and Figure 3.4.6. The TAC in 1994 (100,000 t) is considerably higher than the landings with *status quo* fishing mortality. This TAC is not likely to be taken and a separate forecast based on the TAC has not been made.

The predicted *status quo* catches in 1994 are similar to the predictions made in 1993 for human consumption landings, slightly smaller for discards and only half for industrial by-catches. This is connected to the downward revision of the estimate of recent year classes.

The *status quo* landings forecast for 1995 is 81,000 t (55,000 human consumption, 26,000 t industrial by-catch) with a spawning stock biomass of 360,000 t at the beginning of 1996.

A sensitivity analysis of the *status quo* forecast is presented in Table 3.4.18 (inputs) and Figures 3.4.7 and 3.4.8 (results). The estimate of landings in 1994 is sensitive to the F-level, year classes which are poorly estimated and natural mortality levels in 1994 and to the F–pattern at ages 2 and 3. The estimate of the spawning stock biomass in 1996 is mainly affected by recruitment at age 0 and 1 in 1994, and the natural mortality level and pattern at the youngest ages.

Probability profiles for the yield in 1994 and 1995 and the spawning stock biomass in 1995 and 1996 are presented in Figure 3.4.9. Under *status quo* conditions there is a probability of about 25% that the spawning stock biomass in 1996 will fall below its previously observed minimum of 230,000 t.

3.4.9 Medium–term projection

The inputs for a medium–term projection are similar to the inputs for sensitivity analysis and presented in Table 3.4.18. Due to the appearance of the SSB–R scatter plot only a non–parametric model was implemented. The scatter of points is so wide that the non–parametric model is equivalent to independence between SSB and recruitment. The model utilizes the full data series available and thus does not take a possible shift in recruitment regime in the last decade into account.

The results are presented in Figure 3.4.10. Given the very simple recruitment model used, the SSB is on average expected to increase in the medium term.

The human consumption landings are likewise expected to increase on average, but the probability distribution is very wide, from 50,000 to 120,000 t within 90% probability in the average long–term situation.

3.4.10 Long–term considerations

The present assessment indicates that the stock is stable in the medium term.

The short–term forecast predicts increases in SSB based on estimates of the three most recent year classes being close to the long–term average following two year classes around half the long–term mean.

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.

3.4.11 Comments on the assessment

The forecasts have been shown to be very sensitive to the estimates of recruiting year classes and F–levels (Figure 3.4.8). There are problems with both sets of estimates which indicate inconsistencies between commercial and survey catch data :

- ★ The survey–based estimates of the recruiting year classes have been adjusted considerably downwards in successive assessments as they are estimated by a VPA.
- ★ There is a regular occurrence of trends in the survey data in the VPA tuning.
- ★ A retrospective analysis demonstrates a tendency to overestimation of fishing mortality in recent assessments and important discrepancies in 1987 and 1989 estimates of terminal F relative to converged estimates.
- ★ An assessment with a separable model based on survey catch data alone does not give the same signals concerning the stock history as the VPA (see Section 3.10).

There are thus two sets of problems : 1) that the survey and commercial catch data contain different signals concerning the stock and 2) that international catch age distributions are inconsistent from year to year. It is – as discussed in Section 3.4.5 – not possible to decide to what extent these problems are associated with sampling problems or with genuine changes in the age compositions of the populations sampled by the various fleets, for instance by changes in geographical distributions of age groups or fleets and to differences in geographical coverage of various fleets. It is likewise not possible to decide which data set to rely on – there is no external information available to assist in a judgment of the validity of the various conflicting data sets.

The most appropriate approach in this situation would be to utilize all information available in a single XSA analysis. This is, however, not possible with the present software. The present assessment is based on an XSA-tuned VPA disregarding survey data from 1994. This approach is chosen to ensure consistency from year to year.

Primary discard data are missing for all countries except Scotland. Discards from other fleets are estimated by extrapolation from Scottish data. This introduces a bias in the assessment, but the extent of this bias is limited by the fact that Scotland lands 67% of the total international landing for human consumption.

The North sea assessment of whiting has a history of being unreliable (see Table 3.4.19). 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, suggest that the catch forecasts presented should be treated with caution.

Table 3.4.1 Nominal catch (in tonnes) of WHITING in Sub-area IV, 1982-1993, as officially reported to ICES.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]	1993[1]
Belgium	2,272	2,864	2,798	2,177	2,275	1,404	1,984	1,271	1,040	913	1,030	944
Denmark	27,043	18,054	19,771	16,152	9,076	2,047	12,112	803	1,207	1,529	1,377	1,418
Faroe Islands	57	18	-	6	-	12	222	1	26	-	16	7
France	23,780	21,263	19,209	10,853	8,250	10,493	10,569	5,277[1,2]	4,951[1]	5,188[1,2]	5,115[1]	5,503[1,2]
Germany, Fed.Rep.	223	317	286	226	313	274	454	415	692	865	511	441[1]
Netherlands	12,218	10,935	8,767	6,973	13,741	8,542	5,087[3]	3,860	3,272[1]	4,028[1]	5,390	4,799
Norway	17	39	88	103	103	74	52	32	55	103	223	125[1]
Poland	-	1	2	-	-	-	-	-	-	-	-	-
Sweden	11	44	53	22	33	17	5	17	16	48	22	18
UK (Engl.& Wales)	4,743	4,366	5,017	5,024	3,805	4,485	4,007	1,896	2,124	2,423	2,691	2,769
UK (Isle of Man)	-	-	-	-	-	-	-	-	-	-	6	--
UK (N. Ireland)	-	-	-	-	-	-	1	61	30	47	9	3
UK (Scotland)	29,640	41,248	42,967	30,398	29,113	37,630	31,804	26,491	27,632	30,452	30,643	31,254
Total	100,004	99,149	99,958	71,934	66,709	64,978	66,294	40,124	41,046	46,596	47,033	47,281
Total h,c, catch used by Working Group	73,000	81,000	79,000	55,000	59,000	64,000	52,000	41,000	43,000	47,000	46,000	48,000

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

TABLE 3.4.2 ; Whiting, North Sea

Annual weight and numbers caught, 1960 to 1993.

Year	Wt.('000 t) Total	H. con	Disc.	Ind. b	Nos.(millions) Total	H. con	Disc.	Ind. b
1960	180	48	122	11	1079	208	763	107
1961	325	68	241	16	2191	316	1646	229
1962	221	56	157	8	1526	242	1185	99
1963	258	58	154	45	1555	232	854	470
1964	147	60	59	28	944	239	341	364
1965	185	86	77	22	989	340	490	159
1966	240	105	84	51	1352	387	546	418
1967	234	68	143	23	1579	250	1103	227
1968	261	88	115	58	1622	301	754	566
1969	324	57	115	152	2730	204	626	1900
1970	268	79	74	115	2230	269	381	1580
1971	192	58	63	72	2158	178	458	1521
1972	188	60	67	61	1918	206	398	1314
1973	266	66	110	90	2200	239	659	1302
1974	290	75	85	130	2601	257	477	1867
1975	300	79	135	86	1983	261	699	1023
1976	361	75	136	150	2289	253	641	1395
1977	304	73	125	106	2469	265	547	1657
1978	179	88	35	55	1742	337	241	1163
1979	235	98	78	59	1882	350	645	887
1980	214	92	77	46	1427	311	471	644
1981	183	81	36	67	1408	261	214	932
1982	132	73	27	33	748	241	173	334
1983	154	81	50	24	1320	263	370	688
1984	138	79	41	19	923	252	326	345
1985	99	55	29	15	696	185	232	280
1986	156	59	79	18	1664	203	579	882
1987	134	64	54	16	929	228	416	285
1988	129	52	28	49	1378	195	232	951
1989	120	41	36	43	923	155	280	488
1990	149	43	55	51	1264	158	525	581
1991	119	47	34	38	1599	182	242	1175
1992	104	46	31	27	818	163	216	439
1993	111	48	43	20	1220	157	343	720

TABLE 3.4.3 ; Whiting, North Sea

Natural Mortality and proportion mature

Age	Nat Mor	Mat.
0	2.550	.000
1	.950	.110
2	.450	.920
3	.350	1.000
4	.300	1.000
5	.250	1.000
6	.250	1.000
7	.200	1.000
8	.200	1.000
9	.200	1.000
10+	.200	1.000

TABLE 3.4.4 ; Whiting, North Sea
International catch at age ('000), Total , 1960 to 1993.
The SOP factor is indicated for each year

Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0	60611	213989	75774	104418	231398	63412	84017	174929	100747	1162595
1	483058	1081961	1025371	543285	136615	342470	515035	970537	812634	362134
2	262911	629198	225149	752503	372569	148455	344517	213831	512647	1003771
3	219627	224307	160220	97750	166528	346549	93786	120530	108763	153285
4	21207	35086	32657	45933	23057	75052	265392	23233	47908	27714
5	24540	1404	6385	9518	10974	8372	38302	67325	7188	12703
6	3759	4395	293	1806	2797	3703	8484	7638	29919	1648
7	938	423	444	9	450	792	1542	824	1867	5682
8	2281	133	136	134	2	133	337	125	94	623
9	259	252	15	15	43	2	131	32	23	34
10+	8	21	0	1	14	10	0	3	5	1
SOPf	.97	.98	.99	.99	.98	.98	.97	1.00	1.01	1.03

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	1016520	1271128	538666	179323	577624	239879	424896	664579	686270	476847
1	531392	627724	919299	1170779	762097	958404	479032	1002274	417757	615315
2	79801	105629	320512	671363	986992	406888	1121905	475252	308833	460754
3	535588	17933	47553	133627	230159	302919	164515	271388	229269	205436
4	49607	119791	8052	18504	32150	56230	80533	29249	82902	91266
5	10958	12627	67942	5451	4775	9047	14401	20271	7176	27114
6	3546	2136	10012	18059	1180	7550	2768	5271	7215	3040
7	1160	673	4721	2480	5747	114	492	509	1818	1546
8	1256	161	270	362	343	1401	18	230	260	253
9	129	390	75	122	51	144	536	17	12	33
10+	16	25	938	53	21	2	29	159	14	5
SOPf	1.08	1.01	.96	.99	1.00	.99	1.00	1.20	.99	1.00

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	332203	518592	101142	660386	181010	186791	488975	84835	416938	97197
1	265239	162310	189628	201396	336418	204024	762359	264023	426884	347896
2	411497	337750	104328	171829	168385	146134	165380	360447	299066	184564
3	272172	256595	232483	110046	112870	85250	177767	122418	177535	193395
4	84417	93800	85751	128775	47786	38050	47403	80510	39199	79464
5	49020	24474	25429	36293	59279	13843	14358	11104	15766	14563
6	10208	11022	6494	8609	13556	18255	3380	4288	1975	4658
7	1036	2823	2036	1733	2919	3183	3911	839	425	430
8	681	243	403	786	388	853	529	835	61	307
9	60	44	51	99	181	96	72	103	74	38
10+	20	38	31	34	21	10	1	7	38	6
SOPf	.99	1.00	.99	1.00	.98	1.00	.88	.99	1.00	.95

Age	1990	1991	1992	1993
0	285596	1042713	252094	625072
1	248049	126494	218411	216288
2	491359	184132	153497	163075
3	123342	180839	83533	119010
4	81858	34003	90362	44788
5	31088	24746	10852	45904
6	1909	5376	6288	3980
7	641	574	2612	1562
8	89	261	102	708
9	16	2	7	63
10+	0	1	1	16
SOP	1.02	1.02	1.04	1.01

TABLE 3.4.5 ; Whiting, North Sea
International mean weight at age (kg), Total catch, 1960 to 1993.

Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0	.058	.042	.055	.050	.042	.058	.073	.062	.038	.043
1	.117	.119	.119	.113	.123	.124	.109	.118	.113	.097
2	.191	.193	.187	.195	.174	.205	.188	.198	.187	.172
3	.260	.258	.263	.270	.262	.239	.258	.266	.289	.258
4	.338	.303	.329	.348	.344	.321	.291	.328	.346	.348
5	.349	.412	.393	.404	.425	.408	.381	.339	.464	.397
6	.400	.415	.511	.465	.469	.483	.467	.425	.452	.395
7	.517	.492	.518	.822	.536	.518	.487	.479	.593	.536
8	.448	.385	.540	.625	.601	.635	.733	.626	.727	.669
9	.383	.468	.590	.497	.766	1.256	.744	.621	.780	.729
10+	.398	.475	.000	.610	.694	.613	.000	.486	.842	1.236

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	.020	.036	.022	.027	.026	.030	.019	.018	.010	.009
1	.111	.115	.072	.083	.070	.100	.106	.073	.074	.098
2	.203	.214	.198	.165	.148	.214	.193	.155	.179	.165
3	.239	.274	.277	.271	.251	.275	.293	.264	.235	.256
4	.351	.311	.385	.374	.366	.383	.349	.370	.327	.304
5	.457	.427	.419	.460	.449	.487	.446	.428	.433	.419
6	.423	.517	.525	.464	.494	.497	.524	.460	.437	.455
7	.518	.609	.573	.555	.540	.912	.534	.559	.476	.503
8	.621	.512	.726	.754	.754	.604	.570	.446	.617	.588
9	.747	.727	.778	.840	1.009	.736	.738	.736	.704	.623
10+	.803	.728	.816	.868	.969	1.022	.892	.507	1.266	.563

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.013	.011	.029	.014	.020	.014	.014	.012	.013	.023
1	.075	.082	.060	.106	.086	.094	.092	.076	.054	.068
2	.176	.166	.183	.190	.188	.187	.181	.147	.144	.155
3	.253	.241	.252	.276	.274	.265	.253	.247	.223	.224
4	.332	.327	.314	.328	.338	.324	.321	.300	.298	.265
5	.341	.396	.378	.389	.383	.391	.382	.374	.337	.316
6	.469	.424	.482	.435	.392	.429	.461	.374	.414	.385
7	.484	.474	.506	.467	.462	.469	.464	.492	.432	.435
8	.574	.651	.704	.532	.580	.423	.524	.458	.834	.347
9	.539	.845	.784	.674	.510	.498	1.186	.854	.588	.511
10+	.808	1.032	1.102	.503	.863	.789	.529	.602	.642	.827

Age	1990	1991	1992	1993
0	.015	.017	.012	.012
1	.081	.101	.082	.070
2	.136	.162	.179	.169
3	.208	.212	.247	.241
4	.249	.275	.273	.309
5	.277	.295	.321	.327
6	.409	.332	.337	.342
7	.494	.357	.311	.396
8	.633	.385	.482	.372
9	.350	.496	.773	.406
10+	.000	1.058	1.728	.353

Table 3.4.6 North Sea Whiting : fleets available for VPA tuning, the initial year of the data series and the age groups. The SCOTRL and SCOGFS were not used in the final VPA tuning, see text.

Country	Fleet	Abbreviation	Init. year	Age groups
Scotland	Ground fish survey	SCOGFS	1982	0-6
	Trawlers	SCOTRL	1973	1-7
	Seiners	SCOSEI	1973	1-7
	Light trawlers	SCOLTR	1973	0-8
Netherlands	Ground fish survey	NETGFS	1980	0-3
England	Ground fish survey	ENGGFS	1977	0-6
France	Trawlers	FRATRB	1976	0-9
International	Ground fish survey	INTGFS	1973	1-2
		INTGFS	1983	3-6

Table 3.4.7 Whiting, North Sea. Catch and effort data for VPA tuning.

SCOTRL
1974 1993
1 1 .00 1.00
1 7

185432.000	1736.643	17338.550	7588.655	1013.007	212.551	35.973	548.250
152977.000	1668.518	5944.474	13137.310	2135.277	275.325	41.383	6.897
121841.000	277.158	7939.563	2764.147	3807.712	669.095	117.136	13.553
144348.000	866.893	6202.733	12707.570	1477.233	2265.159	204.798	25.236
135220.000	2267.758	12962.710	15471.940	8608.820	548.489	749.960	70.789
87467.000	2846.209	14530.030	10719.710	7548.380	2829.862	158.777	202.775
55475.000	625.442	10574.640	10029.560	3406.597	2366.799	867.735	29.582
51553.000	238.000	6656.000	8100.000	3500.000	552.000	544.000	105.000
47889.000	271.036	876.800	6531.737	2667.641	915.564	191.192	68.637
48339.000	293.000	1090.000	3125.000	7240.000	1541.000	539.000	50.000
34574.000	335.000	1521.000	1455.000	1124.000	2349.000	472.000	77.000
32674.000	1764.000	3409.000	1692.000	522.000	397.000	629.000	87.000
27839.000	713.000	3640.000	1869.000	495.000	131.000	73.000	68.000
27208.000	1338.000	2394.000	1717.000	592.000	158.000	30.000	11.000
21559.000	19.000	823.000	1301.000	362.000	66.000	10.000	1.000
16657.000	452.044	303.754	1023.773	712.800	174.715	21.876	9.249
13366.000	24.797	584.102	102.052	182.621	59.240	7.886	2.181
13495.000	49.092	174.282	639.824	23.825	62.807	10.229	.945
10887.000	33.967	77.313	91.459	235.512	3.900	13.586	21.703
11657.000	171.268	408.152	368.998	177.451	234.845	5.723	.025

SCOSEI
1974 1993
1 1 .00 1.00
0 7

349604.000	1667.000	45024.770	56767.240	26574.210	4532.645	756.610	107.267	1235.672
329432.000	27.000	54582.630	32133.370	42286.100	11065.220	921.781	113.705	20.975
307165.000	149.000	22230.100	69024.820	13136.200	11560.430	2015.027	281.492	45.849
313913.000	745.441	22348.510	51524.220	38559.490	3508.061	2663.805	391.473	32.711
325246.000	5346.000	15280.870	30303.390	46131.970	16283.830	1126.218	1499.850	213.960
316419.000	302.000	90801.670	41680.650	28869.990	15176.030	6258.471	697.257	160.431
297227.000	669.000	27051.860	74336.840	38957.680	12545.560	9843.901	2697.567	274.548
289672.000	93.000	8727.029	22244.580	25049.320	10552.760	2402.173	2084.163	374.029
297730.000	43.000	3760.845	7159.982	26980.300	13595.560	2826.843	561.447	289.486
333168.000	572.000	11621.000	15212.000	22230.000	35421.000	10215.000	2249.000	425.000
388035.000	296.000	4924.000	24064.000	20786.000	15096.000	21428.000	4750.000	967.000
381647.000	773.000	20066.000	20313.000	19789.000	9005.000	4824.000	8061.000	1371.000
425017.000	137.000	138647.000	47997.000	33606.000	10969.000	2534.000	1058.000	1706.000
418536.000	1357.000	13784.000	52788.000	39145.000	18551.000	3663.000	1105.000	300.000
377132.000	26.000	2501.000	28440.000	44875.000	12635.000	4073.000	679.000	64.000
355735.000	10.127	6870.731	15630.460	41154.740	23525.040	4725.091	1308.520	110.865
252732.000	177.152	13621.970	118993.500	26173.480	28126.800	13926.350	673.570	193.567
336675.000	887.063	11926.920	44593.960	62140.870	10172.590	8465.397	1686.039	189.748
300217.000	426.984	16629.940	19320.040	20784.030	27282.260	2732.422	1904.943	550.611
268413.000	600.995	9569.599	31528.060	25624.680	12160.300	14110.970	877.112	323.664

Continued

Table 3.4.7 Continued

SCOLTR
1974 1993
1 1 .00 1.00
0 8

116982.000	633.000	19116.430	17670.210	5847.375	886.097	170.762	17.339	488.949	40.457
161009.000	4.000	26628.200	13999.750	20259.240	3972.133	490.619	39.342	5.786	215.225
152419.000	29.000	5608.160	30813.910	5567.744	5542.412	930.234	207.086	19.116	1.062
224824.000	709.000	24703.080	30877.230	26163.620	1759.456	2569.652	489.871	36.208	19.169
236929.000	7158.000	8930.432	21071.370	33819.870	16068.990	1070.808	1805.589	711.259	80.647
287494.000	368.000	171183.000	43537.230	23786.850	18557.360	4185.145	389.185	295.179	58.842
333197.000	869.000	20821.660	58806.260	39453.780	9870.979	9734.453	1939.122	149.828	150.869
251504.000	171.000	6577.000	19070.000	21550.000	9706.000	1777.000	1455.000	310.000	9.000
250870.000	6390.000	5221.679	8269.732	27044.900	13131.580	3385.107	658.538	345.724	75.472
244349.000	20095.710	37321.210	17868.980	12523.250	19240.110	6126.091	1217.946	182.988	140.988
240775.000	2541.000	38082.000	15948.000	10695.000	6249.000	8936.000	2349.000	474.000	13.000
267393.000	1218.000	28679.000	9406.000	7683.000	3117.000	1347.000	2932.000	448.000	175.000
279767.000	794.000	8100.000	8503.000	9485.000	4063.000	758.000	420.000	601.000	51.000
351131.000	600.000	18786.000	26106.000	16372.000	6046.000	1202.000	395.000	118.000	131.000
391988.000	60.000	2398.000	15774.000	22509.000	5123.000	1639.000	207.000	31.000	15.000
405883.000	492.409	20345.870	10096.230	21518.320	10927.110	2415.639	453.172	33.442	54.961
371493.000	355.510	3518.714	33795.100	7328.675	8566.872	3272.489	152.520	38.175	5.104
408056.000	688.936	8711.826	11803.480	21682.650	3100.801	2817.552	608.402	48.552	39.543
473955.000	1377.705	17542.490	14403.110	11572.480	15037.750	1463.070	1128.928	297.240	12.397
447064.000	613.941	16415.130	20374.500	14124.280	6405.780	9826.469	556.376	196.717	94.019

FRATRB
1976 1993
1 1 .00 1.00
0 9

64396.000	2718.176	12660.400	45922.730	6144.021	4686.502	1283.520	254.502	42.000	3.000	156.000
80107.000	2587.217	24164.770	21839.020	17682.970	1796.618	2279.117	554.182	54.000	31.000	6.000
69739.000	3351.619	7329.894	23791.080	19206.980	9382.724	836.851	1103.903	227.000	34.000	4.000
89974.000	591.577	61934.950	28649.650	18463.110	11830.260	3952.164	397.490	315.873	45.000	14.000
63577.000	271.805	9010.907	27061.610	18939.110	5826.750	4984.128	1071.911	78.000	71.000	10.000
76517.000	107.483	6395.208	18559.810	20258.030	9102.931	2249.317	1662.444	315.272	16.000	10.000
78523.000	2984.330	8779.621	5953.567	24942.850	14159.820	4423.814	1089.917	542.530	119.000	14.000
69720.000	9847.176	21650.890	16248.500	12814.010	19952.450	6138.934	1102.000	231.451	127.293	19.000
76149.000	1565.244	19118.780	12032.540	9042.073	4992.344	6420.571	1692.968	322.167	32.000	26.000
53003.000	569.315	10538.630	7125.292	5882.456	2466.352	1082.094	1285.727	233.335	34.000	10.000
50350.000	469.844	24185.590	10476.060	8141.797	2748.000	695.045	237.376	238.742	54.704	3.000
51234.000	559.765	9281.398	14857.700	6589.579	3721.511	708.581	209.755	76.000	82.710	10.000
35482.000	1030.389	3151.860	5865.833	7552.072	1901.517	843.631	160.790	42.000	7.158	7.000
36133.000	400.274	8777.309	3328.653	8279.287	3991.235	756.156	229.588	22.130	17.156	1.147
36097.000	7628.034	4106.208	14999.270	4149.499	3876.452	1574.084	90.705	34.860	2.702	.128
45075.000	296.468	3603.230	5310.162	7751.244	1263.257	971.242	211.707	33.271	4.032	.317
34138.000	318.082	4710.102	3988.976	3305.709	4310.230	420.811	274.886	141.965	2.076	.137
20123.000	2001.441	5250.030	4863.051	4372.857	1780.908	2148.507	154.179	71.680	19.411	4.888

Continued

Table 3.4.7 Continued

SCOGFS
1982 1993
1 1 .50 .75
0 6

77.000	7.854	50.281	74.767	74.844	17.248	4.620	1.232
79.000	16.555	44.461	45.666	32.131	40.364	9.173	1.335
80.000	36.289	85.977	30.141	13.912	6.286	7.519	1.435
83.000	14.022	130.881	80.791	20.490	5.268	6.993	1.476
80.000	32.443	88.901	36.140	17.908	2.135	.428	.414
73.000	8.777	102.533	82.989	15.199	5.633	1.177	.253
86.000	55.240	85.191	138.139	38.877	5.981	1.668	.175
86.000	36.722	347.668	63.699	63.030	13.463	1.078	.523
85.000	165.155	190.315	174.505	21.080	21.675	3.995	.425
90.000	124.110	159.210	85.500	68.310	4.590	3.600	.810
87.000	21.063	25.430	11.023	4.811	5.090	.409	.226
87.000	2.149	27.570	10.162	3.680	1.357	1.583	.052

ENGGFS
1977 1993
1 1 .50 .75
0 6

111.000	31.555	24.368	8.260	1.231	.240	.100	.089
113.000	20.838	27.926	5.820	1.192	.390	.057	.025
117.000	41.507	23.474	8.327	2.221	.986	.067	.034
115.000	22.888	40.626	14.384	5.532	1.385	.361	.066
114.000	39.834	20.878	32.836	18.299	.704	.703	.092
72.000	4.991	19.960	5.712	6.185	1.598	.245	.035
74.000	55.038	8.771	8.068	1.410	1.258	.179	.050
82.000	14.147	41.503	8.871	2.470	.727	.630	.310
73.000	14.592	11.591	12.441	1.221	.716	.133	.112
82.000	13.394	12.433	5.405	3.154	.333	.085	.012
77.000	10.573	17.527	10.038	2.077	1.547	.271	.090
75.000	28.627	14.104	9.870	3.409	.484	.130	.013
85.000	99.406	25.053	9.996	6.540	1.423	.293	.016
86.000	75.277	16.347	11.039	3.315	1.994	.280	.040
87.000	14.557	28.974	6.669	3.321	.944	.323	.037
74.000	33.670	19.650	9.672	2.253	1.931	.365	.434
71.000	17.922	17.823	6.840	2.660	.824	.526	.133

INTGFS
1974 1993
1 1 .00 .25
1 6

1.000	.322	.496	-1	-1	-1	-1
1.000	.893	.153	-1	-1	-1	-1
1.000	.679	.535	-1	-1	-1	-1
1.000	.418	.219	-1	-1	-1	-1
1.000	.513	.293	-1	-1	-1	-1
1.000	.457	.183	-1	-1	-1	-1
1.000	.692	.391	-1	-1	-1	-1
1.000	.227	.485	-1	-1	-1	-1
1.000	.161	.232	-1	-1	-1	-1
1.000	.128	.126	.113	.079	.033	.006
1.000	.436	.179	.091	.031	.026	.011
1.000	.341	.359	.066	.019	.007	.007
1.000	.456	.261	.198	.033	.007	.004
1.000	.669	.544	.090	.046	.005	.002
1.000	.394	.862	.315	.034	.012	.001
1.000	1.465	.542	.421	.112	.012	.005
1.000	.509	.887	.202	.093	.017	.004
1.000	1.014	.675	.482	.071	.038	.008
1.000	.916	.748	.261	.169	.016	.014
1.000	1.087	.524	.245	.066	.059	.012

Table 3.4.8 Whiting, North Sea, Tuning diagnostics

VPA Version 3.1 (MSDOS)

8/10/1994 11:16

Extended Survivors Analysis

NORTH SEA WHITING : 1960-1993

CPUE data from file G:\NDWG94\WHI4\WHIIVEF.DAT

Catch data for 34 years. 1960 to 1993. Ages 0 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SCOTRL	1974	1993	1	7,	.000,	1.000
SCOSEI	1974	1993	0	7,	.000,	1.000
SCOLTR	1974	1993	0	8,	.000,	1.000
FRATRB	1976	1993	0	9,	.000,	1.000
SCOGFS	1982	1993	0	6,	.500,	.750
ENGGFS	1977	1993	0	6,	.500,	.750
INTGFS	1974	1993	1	6,	.000,	.250

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting applied :

Fleet	Weight
SCOTRL	.00
SCOSEI	1.00
SCOLTR	1.00
FRATRB	1.00
SCOGFS	.00
ENGGFS	1.00
INTGFS	1.00

Tuning converged after 22 iterations

Regression weights
, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Continued

Table 3.4.8 Continued

Log catchability residuals.

Fleet : SCOTRL

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.54,	.854,	17.06,	.25,	20,	.62,	-19.01,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.75,	.484,	15.75,	.27,	20,	.65,	-16.46,
3,	.67,	.835,	14.51,	.39,	20,	.50,	-15.37,
4,	.66,	1.003,	13.86,	.46,	20,	.53,	-14.97,
5,	.71,	.746,	13.52,	.40,	20,	.77,	-14.74,
6,	.62,	1.681,	12.47,	.66,	20,	.51,	-14.59,
7,	.80,	.315,	13.40,	.20,	20,	1.65,	-14.86,

Fleet : SCOSEI

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	1.46,	-.205,	26.46,	.02,	20,	2.39,	-23.59,
1,	.91,	.123,	17.28,	.15,	20,	.88,	-17.54,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.78,	.593,	15.17,	.42,	20,	.47,	-15.61,
3,	1.75,	-1.899,	16.09,	.39,	20,	.50,	-14.67,
4,	1.20,	-.791,	14.73,	.60,	20,	.40,	-14.23,
5,	.94,	.260,	13.74,	.62,	20,	.50,	-13.96,
6,	1.07,	-.382,	14.22,	.72,	20,	.44,	-13.87,
7,	.92,	.368,	13.44,	.69,	20,	.54,	-13.92,

Fleet : SCOLTR

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	-.94,	-1.414,	12.65,	.05,	20,	1.46,	-22.38,
1,	1.26,	-.225,	18.22,	.07,	20,	1.31,	-17.52,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.91,	.291,	16.01,	.51,	20,	.39,	-16.24,
3,	.98,	.083,	15.33,	.57,	20,	.35,	-15.39,
4,	.85,	.842,	14.51,	.76,	20,	.28,	-15.00,
5,	.80,	1.460,	13.88,	.83,	20,	.28,	-14.74,
6,	.70,	2.501,	12.99,	.88,	20,	.27,	-14.66,
7,	.65,	2.427,	12.24,	.83,	20,	.37,	-14.72,
8,	.76,	1.185,	12.37,	.71,	20,	.56,	-14.33,

Continued

Table 3.4.8 Continued

Fleet : FRATRB

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	6.16,	-.643,	35.15,	.00,	18,	8.50,	-20.25,
1,	1.05,	-.100,	16.05,	.31,	18,	.54,	-15.99,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.93,	.245,	14.82,	.56,	18,	.35,	-14.91,
3,	1.28,	-1.320,	14.43,	.68,	18,	.27,	-14.06,
4,	.90,	.723,	13.47,	.84,	18,	.21,	-13.66,
5,	.88,	.858,	13.05,	.84,	18,	.27,	-13.38,
6,	1.07,	-.350,	13.55,	.74,	18,	.42,	-13.27,
7,	.97,	.330,	12.92,	.91,	18,	.25,	-13.10,
8,	.81,	.913,	11.79,	.70,	18,	.57,	-13.11,
9,	.89,	.607,	12.12,	.75,	18,	.78,	-13.10,

Fleet : SCOGFS

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	-2.35,	-.979,	18.32,	.01,	12,	3.09,	-16.95,
1,	1.38,	-.314,	13.68,	.07,	12,	1.14,	-13.97,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.73,	.395,	13.51,	.20,	12,	.68,	-13.49,
3,	.64,	.720,	13.17,	.32,	12,	.56,	-13.44,
4,	.84,	.340,	13.17,	.35,	12,	.68,	-13.45,
5,	1.12,	-.207,	13.64,	.27,	12,	1.07,	-13.30,
6,	1.10,	-.209,	13.77,	.36,	12,	.98,	-13.35,

Fleet : ENGGFS

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	-6.11,	-1.499,	19.73,	.00,	17,	4.99,	-16.97,
1,	4.29,	-2.505,	17.98,	.05,	17,	1.50,	-15.51,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	2.19,	-2.145,	17.25,	.25,	17,	.68,	-15.28,
3,	1.24,	-.485,	16.04,	.29,	17,	.63,	-15.40,
4,	1.44,	-.952,	17.01,	.32,	17,	.72,	-15.38,
5,	2.53,	-1.749,	23.00,	.12,	17,	1.75,	-15.44,
6,	1.13,	-.250,	16.26,	.26,	17,	1.19,	-15.41,

Continued

Table 3.4.8 Continued

Fleet : INTGFS

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	1.04,	-.067,	15.27,	.25,	20,	.64,	-15.25,

Ages with q constant w.r.t. time

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.56,	-.785,	14.75,	.16,	20,	.90,	-14.35,
3,	.61,	1.499,	13.57,	.65,	11,	.25,	-14.15,
4,	1.02,	-.070,	14.40,	.52,	11,	.48,	-14.33,
5,	.98,	.063,	14.36,	.68,	11,	.46,	-14.42,
6,	1.36,	-.860,	15.87,	.42,	11,	.88,	-14.05,

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SCOTRL	, 1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	, ********,	2.544,	.000,	.00,	1,	.011,	.000
SCOLTR	, 4212203.,	1.527,	.000,	.00,	1,	.031,	.000
FRATRB	, ********,	9.384,	.000,	.00,	1,	.001,	.000
SCOGFS	, 1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	, 6438898.,	5.200,	.000,	.00,	1,	.003,	.000
INTGFS	, 1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean	, 2597759.,	.35,,,,				.642,	.065
F shrinkage mean	, 2977657.,	.50,,,,				.312,	.057

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2835460.,	.28,	.42,	6,	1.523,	.060

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SCOTRL	, 1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	, 930674.,	.858,	.348,	.41,	2,	.066,	.135
SCOLTR	, 772387.,	1.017,	.050,	.05,	2,	.047,	.161
FRATRB	, 1268080.,	.573,	.319,	.56,	2,	.148,	.101
SCOGFS	, 1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	, 852309.,	1.498,	.736,	.49,	2,	.022,	.147
INTGFS	, 1799808.,	.695,	.000,	.00,	1,	.101,	.072
P shrinkage mean	, 828777.,	.38,,,,				.392,	.150
F shrinkage mean	, 581966.,	.50,,,,				.225,	.208

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
886095.,	.23,	.16,	11,	.680,	.141

Continued

Table 3.4.8 Continued

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	528413.,	.500,	.211,	.42,	3,	.102,	.220
SCOLTR	,	355937.,	.394,	.061,	.16,	3,	.168,	.312
FRATRB	,	429174.,	.313,	.202,	.65,	3,	.262,	.265
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	329022.,	.364,	.181,	.50,	3,	.199,	.333
INTGFS	,	545458.,	.448,	.205,	.46,	2,	.125,	.214
F shrinkage mean	,	221958.,	.50,,,,				.143,	.462

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
377626.,	.17,	.10,	15,	.596,	.296

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	131105.,	.280,	.066,	.24,	4,	.177,	.566
SCOLTR	,	93964.,	.267,	.121,	.45,	4,	.187,	.724
FRATRB	,	130922.,	.221,	.239,	1.08,	4,	.269,	.567
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	153563.,	.300,	.230,	.77,	4,	.138,	.501
INTGFS	,	195966.,	.326,	.217,	.67,	3,	.123,	.412
F shrinkage mean	,	100714.,	.50,,,,				.106,	.689

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
128601.,	.12,	.09,	20,	.715,	.575

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	38744.,	.228,	.136,	.60,	5,	.196,	.691
SCOLTR	,	26250.,	.222,	.077,	.35,	5,	.203,	.904
FRATRB	,	34935.,	.191,	.109,	.57,	5,	.268,	.744
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	35546.,	.283,	.130,	.46,	5,	.110,	.735
INTGFS	,	50627.,	.288,	.105,	.37,	4,	.115,	.566
F shrinkage mean	,	27062.,	.50,,,,				.108,	.886

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
34218.,	.11,	.06,	25,	.553,	.755

Continued

Table 3.4.8 Continued

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	28407.,	.228,	.146,	.64,	6,	.157,	.886
SCOLTR	,	23099.,	.213,	.113,	.53,	6,	.204,	1.013
FRATRB	,	25783.,	.181,	.154,	.85,	6,	.286,	.944
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	21176.,	.297,	.099,	.33,	6,	.082,	1.069
INTGFS	,	36274.,	.274,	.029,	.11,	5,	.127,	.750
F shrinkage mean	,	17215.,	.50,,,,				.144,	1.210

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
24823.,	.11,	.06,	30,	.558,	.968

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	1664.,	.271,	.080,	.29,	7,	.182,	1.135
SCOLTR	,	1182.,	.255,	.055,	.22,	7,	.177,	1.379
FRATRB	,	1491.,	.215,	.135,	.63,	7,	.254,	1.211
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	3745.,	.415,	.136,	.33,	7,	.052,	.662
INTGFS	,	3389.,	.328,	.119,	.36,	6,	.102,	.711
F shrinkage mean	,	1524.,	.50,,,,				.232,	1.195

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1674.,	.15,	.07,	35,	.461,	1.131

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1986

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	784.,	.327,	.092,	.28,	8,	.154,	1.031
SCOLTR	,	610.,	.340,	.062,	.18,	8,	.124,	1.199
FRATRB	,	898.,	.238,	.099,	.42,	8,	.362,	.946
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	1836.,	.454,	.335,	.74,	7,	.020,	.571
INTGFS	,	1409.,	.353,	.081,	.23,	6,	.041,	.695
F shrinkage mean	,	626.,	.50,,,,				.298,	1.181

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
778.,	.19,	.06,	38,	.307,	1.035

Continued

Table 3.4.8 Continued

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1985

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	84.,	.299,	.112,	.37,	8,	.043,	2.160
SCOLTR	,	85.,	.433,	.144,	.33,	9,	.066,	2.144
FRATRB	,	99.,	.275,	.154,	.56,	9,	.135,	2.013
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	57.,	.459,	.197,	.43,	7,	.007,	2.507
INTGFS	,	87.,	.361,	.090,	.25,	6,	.013,	2.128
F shrinkage mean	,	89.,	.50,,,,				.737,	2.099

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
90.,	.37,	.03,	40,	.092,	2.096

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1984

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SCOTRL	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOSEI	,	30.,	.341,	.045,	.13,	8,	.042,	1.070
SCOLTR	,	11.,	.468,	.129,	.28,	9,	.067,	1.806
FRATRB	,	21.,	.331,	.296,	.90,	10,	.203,	1.331
SCOGFS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS	,	33.,	.566,	.152,	.27,	7,	.005,	1.008
INTGFS	,	33.,	.418,	.131,	.31,	6,	.010,	1.009
F shrinkage mean	,	24.,	.50,,,,				.674,	1.212

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
23.,	.35,	.08,	41,	.222,	1.262

TABLE 3.4.9 ; Whiting, North Sea
International F at age, Total , 1960 to 1993.

Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0	.005	.010	.003	.021	.023	.007	.005	.005	.027	.176
1	.212	.756	.331	.142	.169	.225	.417	.419	.159	.815
2	.466	.970	.642	.865	.237	.516	.713	.568	.805	.562
3	1.454	1.406	.973	.874	.605	.465	1.012	.783	.867	.803
4	2.294	1.293	.969	1.058	.609	.732	.989	.917	1.060	.667
5	1.526	1.502	1.005	.989	.896	.512	1.291	.830	.947	1.075
6	1.759	1.758	2.714	.990	1.013	.990	2.032	1.125	1.338	.624
7	1.778	1.129	.936	.848	.751	.973	2.139	1.642	1.012	1.105
8	1.918	1.888	1.714	.848	.337	.520	1.932	1.344	.871	1.251
9	1.881	1.534	1.487	.957	.728	.752	1.700	1.186	1.058	.955
10+	1.881	1.534	1.487	.957	.728	.752	1.700	1.186	1.058	.955

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	.090	.064	.020	.014	.022	.014	.026	.041	.040	.031
1	.705	.405	.323	.295	.409	.232	.182	.444	.162	.238
2	.818	.528	.720	.822	.872	.783	.956	.508	.427	.496
3	.915	.552	.629	1.067	1.055	1.014	1.262	.862	.648	.751
4	.802	.623	.612	.638	1.007	1.002	1.039	.977	.863	.698
5	.681	.531	1.037	1.397	.361	1.031	.870	.929	.765	.892
6	1.178	.280	1.252	.971	1.871	2.146	1.234	1.056	1.204	.981
7	1.448	.764	2.247	1.491	1.062	1.088	.957	.823	1.657	.983
8	.788	.802	.823	1.569	.869	.829	.483	2.476	1.601	1.280
9	.990	.605	1.209	1.228	1.046	1.234	.923	1.263	1.218	.958
10+	.990	.605	1.209	1.228	1.046	1.234	.923	1.263	1.218	.958

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.056	.075	.016	.068	.027	.012	.042	.010	.027	.014
1	.104	.175	.180	.208	.232	.192	.348	.142	.360	.140
2	.450	.331	.285	.447	.493	.259	.424	.506	.430	.474
3	.836	.753	.516	.731	.805	.655	.768	.874	.660	.729
4	1.011	.976	.734	.730	1.043	.860	1.247	1.287	.964	.867
5	1.253	1.101	.892	.924	1.055	1.205	1.131	1.449	1.128	1.578
6	1.192	1.279	1.152	.984	1.306	1.348	1.320	1.634	1.363	1.570
7	1.244	1.584	.917	1.286	1.242	1.569	1.448	1.919	.718	1.574
8	2.299	1.225	1.126	1.230	1.255	2.108	1.472	1.888	.732	2.616
9	1.393	1.219	.971	.988	1.147	1.428	1.355	1.612	.943	1.640
10+	1.393	1.219	.971	.988	1.147	1.428	1.355	1.612	.943	1.640

Age	1990	1991	1992	1993
0	.039	.114	.026	.060
1	.227	.106	.157	.141
2	.558	.480	.321	.296
3	.928	.528	.539	.575
4	.991	.877	.656	.754
5	1.238	1.121	.891	.968
6	1.043	.785	1.123	1.131
7	1.069	1.176	1.294	1.036
8	3.363	2.971	.668	2.096
9	1.637	1.340	1.018	1.262
10+	1.637	1.340	1.018	1.262

TABLE 3.4.10; Whiting, North Sea

Tuned Stock Numbers at age (10**-5), 1960 to 1994, (numbers in 1994 are VPA survivors)

Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0	422149	757736	845360	184592	359014	313049	587320	1142476	137431	257870
1	40585	32793	58567	65795	14121	27386	24266	45624	88718	10449
2	8844	12692	5954	16274	22067	4612	8461	6182	11609	29257
3	3413	3539	3068	1998	4368	11096	1755	2644	2234	3309
4	274	562	611	817	588	1680	4910	450	852	661
5	355	20	114	172	210	237	599	1353	133	219
6	51	60	4	33	50	67	111	128	460	40
7	12	7	8	0	9	14	19	11	32	94
8	30	2	2	3	0	4	4	2	2	10
9	3	4	0	0	1	0	2	1	0	1
10+	0	0	0	0	0	0	0	0	0	0

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	424623	731710	963847	474061	973980	601686	590405	598170	621931	568371
1	16886	30315	53581	73754	36514	74436	46310	44913	44849	46644
2	1789	3226	7820	15005	21243	9382	22827	14931	11137	14747
3	10640	504	1214	2427	4207	5664	2733	5597	5726	4635
4	1045	3002	204	456	589	1032	1448	545	1666	2110
5	251	347	1193	82	179	159	281	380	152	520
6	58	99	159	329	16	97	44	92	117	55
7	17	14	58	35	97	2	9	10	25	27
8	25	3	5	5	7	27	1	3	4	4
9	2	9	1	2	1	2	10	0	0	1
10+	0	1	14	1	0	0	1	2	0	0

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	219862	255178	224619	358723	247066	540395	427029	293653	563052	254996
1	43047	16239	18476	17256	26164	18786	41673	31977	22692	42799
2	14212	14999	5271	5966	5421	8027	5996	11376	10725	6121
3	5724	5776	6866	2528	2432	2112	3951	2503	4375	4450
4	1542	1749	1917	2887	858	766	773	1292	736	1593
5	778	415	488	682	1030	224	240	164	264	208
6	166	173	108	156	211	279	52	60	30	67
7	16	39	37	26	45	44	56	11	9	6
8	8	4	7	12	6	11	8	11	1	4
9	1	1	1	2	3	1	1	1	1	1
10+	0	1	1	1	0	0	0	0	1	0

Age	1990	1991	1992	1993	1994
0	268336	346046	346999	385511	0
1	19639	20154	24106	26390	28355
2	14389	6053	7008	7965	8861
3	2429	5251	2389	3243	3776
4	1513	676	2182	982	1286
5	496	416	208	839	342
6	33	112	106	67	248
7	11	9	40	27	17
8	1	3	2	9	8
9	0	0	0	1	1
10+	0	0	0	0	0

Table 3.4.11 WHITING, North Sea. Recruitment indices.

'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	131	1943	177	127	5543	1552	310	324.3	73.3
1991	916	524	167	266	96	1379	293	117	806	272	-1	120.7	-1
1992	1087	637	455	251	106	2417	317	950	453	-1	-1	-1	79
1993	721	-1	252	305	-1	247	2365	-1	-1	-1	-1	181.8	-1
1994	-1	-1	211	-1	-1	648	-1	-1	-1	-1	-1	-1	-1

Table 3.4.12 Whiting North Sea. Recruitment analysis, age 0

WHIIVO.RCX

Data for 13 surveys over 24 years : 1971 - 1994

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 5 points used for regression

Forecast/Hindcast variance correction used.

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	1.05	3.93	.63	.281	21	6.99	11.30	.756	.113
IYFS2	1.72	-.03	1.01	.131	21	6.46	11.11	1.169	.047
EGFS0	-18.04	112.26	15.49	.001	15	6.12	1.80	17.988	.000
EGFS1	3.80	-10.21	1.45	.066	16	5.53	10.79	1.659	.023
EGFS2	2.59	-1.76	.86	.168	17	4.67	10.34	.979	.067
SGFS0	26.66	******	28.04	.000	10	7.79	58.43	38.903	.000
SGFS1	1.32	3.80	.75	.171	11	5.76	11.40	.953	.071
SGFS2	.90	6.27	.32	.538	12	6.86	12.45	.651	.152
DGFS0	1.64	-.96	2.03	.028	12	6.12	9.08	2.411	.011
DGFS1									
DGFS2									
GGFS1									
GGFS2	.78	7.09	.88	.145	10	4.38	10.50	1.059	.057
					VPA Mean =		10.47	.375	.458

Yearclass = 1993

	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	1.01	4.16	.61	.282	21	6.58	10.81	.711	.188
IYFS2									
EGFS0	-10.10	67.54	8.84	.002	15	5.53	11.68	10.241	.001
EGFS1	3.81	-10.28	1.46	.063	16	5.72	11.51	1.731	.032
EGFS2									
SGFS0	193.54	******	205.03	.000	10	5.51	-86.12	******	.000
SGFS1	1.35	3.60	.77	.164	11	7.77	14.12	1.664	.034
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1	.94	6.64	1.69	.041	10	5.21	11.52	2.075	.022
GGFS2									
					VPA Mean =		10.45	.362	.723

Continued

Table 3.4.12 Continued

Yearclass = 1994

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	-6.31	46.25	5.66	.004	15	5.36	12.43	6.681	.003
EGFS1									
EGFS2									
SGFS0	-29.80	190.42	31.87	.000	10	6.48	-2.55	38.925	.000
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
					VPA Mean =		10.44	.351	.997

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	56592	10.94	.25	.26	1.04		
1993	44481	10.70	.31	.29	.88		
1994	34335	10.44	.35	.11	.10		

Table 3.4.13 Whiting North Sea. Recruitment analysis, age 1

WHIIV1.RCX

Data for 13 surveys over 24 years : 1971 - 1994

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 = 1991

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.08	1.26	.62	.321	20	6.82	8.65	.740	.111
IYFS2	1.89	-3.49	1.16	.119	20	6.26	8.34	1.331	.034
EGFS0	-18.64	113.71	16.21	.001	14	5.12	18.19	18.987	.000
EGFS1	4.40	-16.01	1.75	.052	15	5.59	8.58	2.020	.015
EGFS2	3.03	-6.43	1.11	.123	16	4.57	7.43	1.273	.037
SGFS0	-50.96	304.72	50.79	.000	9	7.23	-63.71	69.191	.000
SGFS1	1.32	1.31	.72	.202	10	5.68	8.83	.939	.069
SGFS2	.93	3.56	.36	.518	11	4.77	8.01	.421	.342
DGFS0	1.48	-2.46	1.95	.035	11	6.69	7.47	2.286	.012
DGFS1	8.82	-51.37	6.38	.004	12	5.61	-1.87	8.282	.001
DGFS2									
GGFS1	.88	4.47	1.66	.048	9	4.80	8.67	2.033	.015
GGFS2									
						VPA Mean =	7.90	.408	.364

Yearclass = 1992

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.05	1.46	.61	.316	20	6.99	8.77	.756	.125
IYFS2	1.66	-2.16	1.01	.146	20	6.46	8.53	1.184	.051
EGFS0	-12.06	76.49	10.70	.001	14	6.12	2.67	12.563	.000
EGFS1	4.42	-16.14	1.78	.050	15	5.53	8.32	2.067	.017
EGFS2	2.70	-4.89	.94	.160	16	4.67	7.71	1.086	.061
SGFS0	-22.24	137.76	22.34	.000	9	7.79	-35.53	33.639	.000
SGFS1	1.35	1.16	.74	.196	10	5.76	8.94	.988	.073
SGFS2	.93	3.56	.36	.521	11	6.86	9.95	.742	.130
DGFS0	1.72	-4.10	2.26	.026	11	6.12	6.39	2.726	.010
DGFS1									
DGFS2									
GGFS1									
GGFS2	.72	4.75	.81	.171	10	4.38	7.92	.966	.077
						VPA Mean =	7.88	.395	.457

Continued

Table 3.4.13 Continued

Yearclass = 1993

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	1.65	.60	.313	20	6.58	8.29	.720	.205
IYFS2									
EGFS0	-8.09	54.07	7.35	.003	14	5.53	9.29	8.655	.001
EGFS1	4.49	-16.51	1.83	.046	15	5.72	9.19	2.207	.022
EGFS2									
SGFS0	-13.06	84.38	13.25	.001	9	5.51	12.37	16.393	.000
SGFS1	1.38	.97	.77	.188	10	7.77	11.73	1.824	.032
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1	.94	4.14	1.81	.041	9	5.21	9.03	2.284	.020
GGFS2									
					VPA Mean =		7.87	.384	.720

Yearclass = 1994

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	-5.59	39.92	5.21	.006	14	5.36	9.95	6.294	.004
EGFS1									
EGFS2									
SGFS0	-8.70	59.01	8.95	.002	9	6.48	2.70	11.401	.001
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
					VPA Mean =		7.86	.374	.995

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	3266	8.09	.25	.16	.43		
1992	4243	8.35	.27	.26	.97		
1993	3408	8.13	.33	.29	.81		
1994	2587	7.86	.37	.15	.16		

Table 3.4.14 Whiting North Sea. Recruitment analysis, age 2

WHIIV2.RCX

Data for 13 surveys over 24 years : 1971 - 1994

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 5 points used for regression

Forecast/Hindcast variance correction used.

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	.90	1.33	.40	.562	19	6.92	7.55	.488	.160
IYFS2	1.71	-3.42	1.02	.164	19	6.62	7.92	1.219	.026
EGFS0	4.66	-19.19	3.76	.013	13	6.78	12.41	4.815	.002
EGFS1	2.74	-8.04	1.03	.150	14	5.81	7.88	1.236	.025
EGFS2	2.66	-5.77	1.02	.155	15	4.88	7.23	1.175	.028
SGFS0	1.23	-.18	.82	.193	8	7.57	9.14	1.466	.018
SGFS1	1.03	1.66	.54	.339	9	5.18	6.98	.662	.087
SGFS2	.82	2.95	.26	.682	10	4.85	6.93	.321	.371
DGFS0	1.19	-1.36	1.45	.067	10	8.62	8.93	1.951	.010
DGFS1	4.82	-25.26	3.52	.014	11	7.35	10.19	4.353	.002
DGFS2	-43.38	243.21	39.98	.000	12	5.74	-5.81	46.723	.000
GGFS1	.44	5.12	.74	.228	8	5.78	7.66	.998	.038
GGFS2	.78	3.41	.95	.142	9	4.31	6.76	1.148	.029
						VPA Mean =	6.78	.432	.205

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	.87	1.48	.39	.562	19	6.82	7.42	.481	.165
IYFS2	1.56	-2.55	.93	.187	19	6.26	7.20	1.080	.033
EGFS0	4.82	-20.11	3.97	.012	13	5.12	4.57	4.699	.002
EGFS1	2.71	-7.86	1.02	.150	14	5.59	7.26	1.201	.026
EGFS2	2.47	-4.87	.91	.186	15	4.57	6.40	1.056	.034
SGFS0	1.24	-.22	.82	.193	8	7.23	8.72	1.362	.021
SGFS1	1.04	1.60	.55	.335	9	5.68	7.49	.735	.071
SGFS2	.82	2.96	.26	.689	10	4.77	6.86	.317	.380
DGFS0	1.28	-1.98	1.56	.059	10	6.69	6.61	1.864	.011
DGFS1	4.72	-24.66	3.43	.015	11	5.61	1.82	4.508	.002
DGFS2									
GGFS1	.44	5.11	.75	.225	8	4.80	7.22	.953	.042
GGFS2									
						VPA Mean =	6.76	.423	.214

Continued

Table 3.4.14 Continued

Yearclass = 1992

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
IYFS1	.84	1.65	.39	.564	19	6.99	7.52	.494	.218
IYFS2	1.40	-1.69	.83	.219	19	6.46	7.36	.994	.054
EGFS0	5.10	-21.74	4.31	.010	13	6.12	9.49	5.201	.002
EGFS1	2.67	-7.67	1.02	.150	14	5.53	7.10	1.208	.036
EGFS2	2.29	-4.05	.80	.224	15	4.67	6.63	.942	.060
SGFS0	1.24	-.26	.83	.192	8	7.79	9.42	1.626	.020
SGFS1	1.05	1.53	.56	.330	9	5.76	7.57	.772	.089
SGFS2	.82	2.97	.26	.698	10	6.86	8.56	.565	.166
DGFS0	1.42	-2.89	1.73	.050	10	6.12	5.77	2.119	.012
DGFS1									
DGFS2									
GGFS1									
GGFS2	.84	3.11	1.04	.126	9	4.38	6.79	1.277	.033
					VPA Mean =		6.74	.413	.311

Yearclass = 1993

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
IYFS1	.81	1.81	.38	.572	19	6.58	7.13	.462	.342
IYFS2									
EGFS0	5.60	-24.60	4.87	.008	13	5.53	6.40	5.836	.002
EGFS1	2.64	-7.48	1.02	.151	14	5.72	7.61	1.267	.045
EGFS2									
SGFS0	1.25	-.32	.84	.191	8	5.51	6.58	1.071	.064
SGFS1	1.07	1.44	.58	.324	9	7.77	9.71	1.429	.036
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1	.45	5.05	.78	.218	8	5.21	7.39	1.036	.068
GGFS2									
					VPA Mean =		6.73	.406	.443

Yearclass = 1994

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
IYFS1									
IYFS2									
EGFS0	6.55	-29.97	5.89	.005	13	5.36	5.10	7.248	.003
EGFS1									
EGFS2									
SGFS0	1.26	-.38	.86	.191	8	6.48	7.78	1.234	.095
SGFS1									
SGFS2									
DGFS0									
DGFS1									
DGFS2									
GGFS1									
GGFS2									
					VPA Mean =		6.72	.400	.902

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	1283	7.16	.20	.15	.58		
1991	1117	7.02	.20	.14	.49		
1992	1596	7.38	.23	.23	1.01		
1993	1148	7.05	.27	.24	.77		
1994	908	6.81	.38	.23	.36		

TABLE 3.4.15; Whiting, North Sea. Historical trends in fishing mortality, biomass and recruitment

Mean fishing mortality, biomass and recruitment, 1960 - 1993.

Year	Mean F H. cons. Ages 2 to 6	Mean F Disc. Ages 2 to 6	Mean F Ind. byc. Ages 0 to 4	Stock Biomass ('000 tonnes) Total	Stock Biomass ('000 tonnes) Spawning	Recruits Age 0 Yclass	Recruits Age 0 Million
1960	1.054	.431	.014	758	322	1960	42215
1961	1.003	.376	.017	747	381	1961	75774
1962	.976	.262	.013	914	285	1962	84536
1963	.628	.289	.054	1152	465	1963	18459
1964	.518	.127	.039	704	519	1964	35901
1965	.469	.143	.032	767	457	1965	31305
1966	.923	.174	.131	641	393	1966	58732
1967	.616	.202	.033	798	309	1967	114248
1968	.724	.224	.070	1343	433	1968	13743
1969	.401	.193	.282	729	599	1969	25787
1970	.571	.227	.214	531	362	1970	42462
1971	.354	.128	.065	546	231	1971	73171
1972	.641	.136	.112	645	290	1972	96385
1973	.673	.166	.161	964	400	1973	47406
1974	.584	.134	.295	712	459	1974	97398
1975	.851	.216	.142	1155	476	1975	60169
1976	.641	.167	.272	1078	606	1976	59041
1977	.557	.116	.217	749	438	1977	59817
1978	.615	.077	.103	733	422	1978	62193
1979	.590	.072	.104	909	483	1979	56837
1980	.657	.217	.093	805	497	1980	21986
1981	.645	.083	.171	605	466	1981	25518
1982	.494	.102	.098	467	360	1982	22462
1983	.563	.144	.068	496	324	1983	35872
1984	.742	.127	.076	473	264	1984	24707
1985	.729	.079	.053	431	262	1985	54040
1986	.708	.144	.116	631	281	1986	42703
1987	.936	.157	.069	520	291	1987	29365
1988	.702	.106	.159	407	286	1988	56305
1989	.582	.189	.161	537	271	1989	25500
1990	.465	.274	.189	459	301	1990	26834
1991	.512	.128	.106	448	259	1991	34605
1992	.512	.124	.074	453	267	1992	34700
1993	.488	.189	.061	459	284	1993	38551

Arithmetic mean recruits, age 0, 1960 to 1991 : 48609
Geometric mean recruits, age 0, 1960 to 1991 : 42614

TABLE 3.4.16; Whiting, North Sea. Input for Catch Prediction

Age	1994 Stock Numbers (10**-5)	F and mean Wt at age used in prediction: Scaled Mean F 1989 - 1993 H. cons.	Disc.	Ind. byc.	Mean Wt. at age (kg) 1989 - 1993 Stock	H. cons.	Disc.	Ind. byc.	M and maturity M	P. mat
0	426136	.000	.005	.023	.016	.075	.032	.013	2.550	.000
1	28355	.004	.068	.042	.080	.189	.089	.067	.950	.110
2	8861	.070	.166	.096	.160	.228	.156	.140	.450	.920
3	3776	.273	.214	.084	.226	.259	.193	.223	.350	1.000
4	1286	.510	.185	.061	.274	.300	.213	.253	.300	1.000
5	342	.804	.228	.054	.307	.332	.226	.312	.250	1.000
6	248	.861	.077	.089	.361	.374	.243	.314	.250	1.000
7	17	.912	.168	.065	.399	.430	.271	.340	.200	1.000
8	8	2.093	.032	.088	.444	.441	.281	.228	.200	1.000
9	1	1.332	.000	.009	.507	.508	.000	.080	.200	1.000
10	0	.823	.206	.000	.793	.793	.000	.000	.200	1.000

Mean F	(2 - 6)	(0 - 4)
Unscaled	.693	.118
Scaled	.677	.061

Recruits at age 0 in 1995 = 426136
Recruits at age 0 in 1996 = 426136

Stock numbers in 1994 are VPA survivors.

Human consumption + discard Fs are obtained from mean exploitation pattern over 1989 to 1993.
This is scaled to give a value for mean F (ages 2 to 6) equal to that in 1993, i.e. .677
Fs are distributed between consumption and discards by mean proportion retained over 1989 to 1993.
N.B. Above value for H. con+Disc. ref F is value for both catch categories combined.

Bycatch Fs are obtained from mean exploitation pattern over 1989 to 1993.
This is scaled to give a value for mean F (ages 0 to 4) equal to that in 1993, i.e. .061

Table 3.4.17a.Whiting North Sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year							
	1994	1995						
Mean F Ages								
H.cons 2 to 6	.68	.00	.27	.41	.47	.54	.68	.81
Ind BC 0 to 4	.06	.06	.06	.06	.06	.06	.06	.06
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass at start of year								
Total	509.7	568.2	568.2	568.2	568.2	568.2	568.2	568.2
Spawning	296.5	325.3	325.3	325.3	325.3	325.3	325.3	325.3
Catch weight (,000t)								
H.cons	51.0	.0	25.7	36.5	41.6	46.3	55.2	63.2
Discards	43.5	.0	20.9	30.5	35.1	39.6	48.2	56.4
Ind BC	24.3	29.6	28.2	27.5	27.2	26.9	26.3	25.8
Total Landings	75.3	29.6	53.8	64.1	68.8	73.2	81.5	89.0
Total Catch	118.8	29.6	74.7	94.6	103.9	112.8	129.7	145.4
Biomass at start of 1996								
Total		701.4	657.6	638.5	629.6	621.0	605.0	590.2
Spawning		454.5	411.6	393.0	384.3	375.9	360.3	346.0

	Year							
	1994	1995						
Effort relative to 1993								
H.cons	1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Est. Coeff. of Variation								
Biomass at start of year								
Total	.23	.48	.48	.48	.48	.48	.48	.48
Spawning	.14	.31	.31	.31	.31	.31	.31	.31
Catch weight								
H.cons	.25	.00	.65	.45	.40	.37	.32	.30
Discards	.39	.00	.77	.60	.56	.53	.50	.48
Ind BC	.74	.78	.79	.79	.79	.79	.79	.79
Biomass at start of 1996								
Total		.50	.52	.53	.53	.54	.54	.55
Spawning		.47	.49	.50	.51	.51	.52	.53

Table 3.4.17b Whiting North Sea
Detailed forecast tables.

Forecast for year 1994
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	42613581	0	76373	351318	427691
1	2835499	6981	118683	73304	198969
2	886100	43031	102045	59014	204090
3	377600	67367	52807	20728	140902
4	128600	40504	14693	4845	60041
5	34200	15171	4302	1019	20492
6	24800	12058	1078	1246	14383
7	1700	852	157	61	1070
8	800	632	10	27	668
9	100	68	0	0	68
10	0	0	0	0	0
Wt	510	51	44	24	119

Forecast for year 1995
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	42613600	0	76373	351318	427691
1	3235466	7966	135424	83645	227035
2	978453	47516	112681	65165	225361
3	405382	72323	56693	22253	151269
4	150330	47348	17175	5663	70187
5	44733	19843	5627	1333	26803
6	8991	4372	391	452	5214
7	6916	3468	639	247	4354
8	443	350	5	15	370
9	72	49	0	0	49
10	21	10	3	0	13
Wt	568	55	48	26	130

Table 3.4.18.Whiting North Sea

Input data for catch forecast and linear sensitivity analysis.

Populations in 1994			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N0	42613581	.53	WS0	.02	.63	M0	2.55	.09	MT0	.00	.10
N1	2835499	.42	WS1	.08	.22	M1	.95	.11	MT1	.11	.10
N2	886100	.23	WS2	.16	.11	M2	.45	.26	MT2	.92	.10
N3	377599	.17	WS3	.23	.08	M3	.35	.14	MT3	1.00	.10
N4	128600	.12	WS4	.27	.10	M4	.30	.14	MT4	1.00	.00
N5	34199	.11	WS5	.31	.13	M5	.25	.14	MT5	1.00	.00
N6	24799	.11	WS6	.36	.12	M6	.25	.14	MT6	1.00	.00
N7	1699	.15	WS7	.40	.21	M7	.20	.14	MT7	1.00	.00
N8	800	.19	WS8	.44	.21	M8	.20	.14	MT8	1.00	.00
N9	100	.37	WS9	.51	.29	M9	.20	.14	MT9	1.00	.00
N10	0	.35	WS10	.79	.50	M10	.20	.14	MT10	1.00	.00

HC selectivity			HC.catch wt			Dis selectivity			Discrd catch wt		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
sH0	.00	3.53	WH0	.07	1.17	sD0	.00	1.42	WD0	.03	.47
sH1	.00	.74	WH1	.19	.08	sD1	.07	.73	WD1	.09	.19
sH2	.07	.41	WH2	.23	.05	sD2	.17	.47	WD2	.16	.13
sH3	.27	.20	WH3	.26	.07	sD3	.21	.35	WD3	.19	.14
sH4	.51	.16	WH4	.30	.09	sD4	.18	.53	WD4	.21	.19
sH5	.80	.22	WH5	.33	.12	sD5	.23	1.00	WD5	.23	.24
sH6	.86	.23	WH6	.37	.11	sD6	.08	.91	WD6	.24	.34
sH7	.91	.31	WH7	.43	.20	sD7	.17	2.63	WD7	.27	.85
sH8	2.09	.57	WH8	.44	.22	sD8	.03	2.80	WD8	.28	2.85
sH9	1.33	.21	WH9	.51	.29	sD9	.00	.00	WD9	.00	.00
sH10	.82	.38	WH10	.79	.50	sD10	.21	.00	WD10	.00	.00

Ind selectivity			Industrial wt		
Labl	Value	CV	Labl	Value	CV
sI0	.02	.85	WI0	.01	.59
sI1	.04	.53	WI1	.07	.36
sI2	.10	.43	WI2	.14	.19
sI3	.08	.37	WI3	.22	.16
sI4	.06	.63	WI4	.25	.24
sI5	.05	.91	WI5	.31	.38
sI6	.09	1.35	WI6	.31	.52
sI7	.07	1.73	WI7	.34	.75
sI8	.09	2.60	WI8	.23	1.12
sI9	.01	4.01	WI9	.08	1.77
sI10	.00	5.82	WI10	.00	4.13

Year effect M			HC relative eff			Ind reltive eff		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
K94	1.00	.23	HF94	1.00	.27	IF94	1.00	.68
K95	1.00	.23	HF95	1.00	.27	IF95	1.00	.68
K96	1.00	.23	HF96	1.00	.27	IF96	1.00	.68

Recruitment		
Labl	Value	CV
R95	42613600	.53
R96	42613600	.53

Stock numbers in 1994 are VPA survivors. Human consumption + discard Fs are obtained from mean exploitation pattern over 1989 o 1993. This is scaled to give a value for mean F (ages 2 to 6) equal to that in 1993, i.e. .677. Fs are distributed between onsumption and discards by mean proportion retained over 1989 to 1993. N.B. Above value for H. con+Disc. ref F is value for oth catch categories combined Bycatch Fs are obtained from mean exploitation pattern over 1989 to 1993. This is scaled to give a alue for mean F (ages 0 to 4) equal to that in 1993, i.e. .061

Table 3.4.19

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	1992	1993
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		
1993	1.10	0.82	0.78	0.78	0.70	0.85	
1994	1.09	0.81	0.77	0.74	0.64	0.64	0.68

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F								
Date of assessment	Year							
	1988	1989	1990	1991	1992	1993	1994	1995
1989	100	138	140					
1990		83	151	152				
1991			96	139	135			
1992				84	106	108		
1993				88	94	90	99	
1994					73	65	75	82
					SQC[1]	SQC[2]	Current	Forecast

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

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

where F(y), F(y−1) ∧ F(y−2) are as estimated ∈ the assessment made ∈ year (y+1).

Remarks:

Continued

Table 3.4.19 Continued

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	1992	1993
1989	39212	70480					
1990	50113	72010	48155				
1991	28474	64780	44169	65840			
1992	26333	46065	38134	45240	43856		
1993	28386	52593	23286	20814	48623	49573	
1994	29365	56305	25500	26834	34605	34700	38551

Remarks:

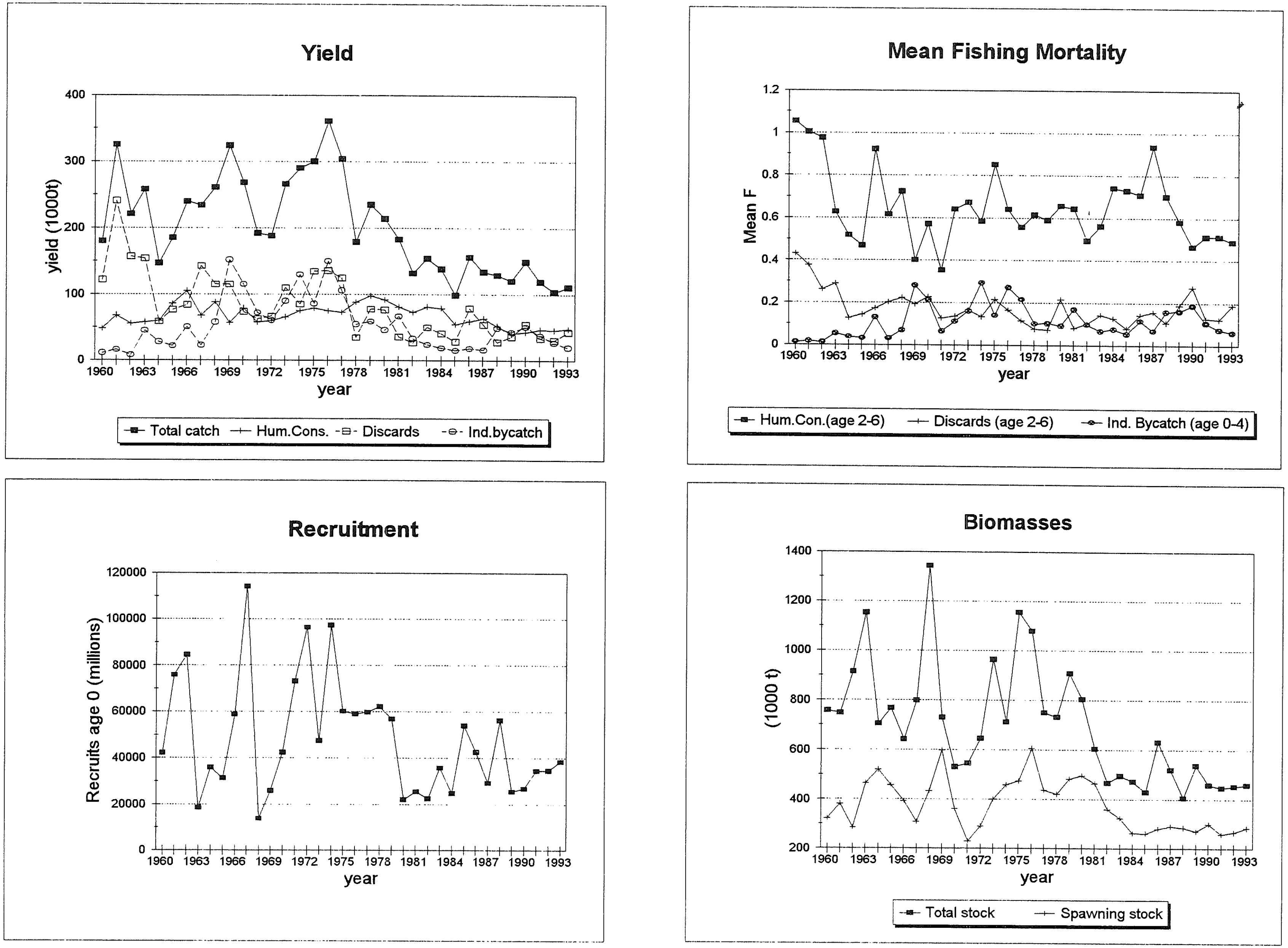
Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1989	265	325	391[1]	354[1]					
1990	283	365	474	444[1]	375[1]				
1991	273	269	351	400	422[1]	347[1]			
1992	267	243	264	291	305	308[1]	286[1]		
1993	279	261	286	228	209	265	315[1]	289[1]	
1994	286	271	301	259	267	284	297	325[1]	360[1]

[1]Forecast.

Remarks:

Figure 3.4.1. WHITING North Sea. Historical trends in yield, fishing mortality, recruitment and biomasses



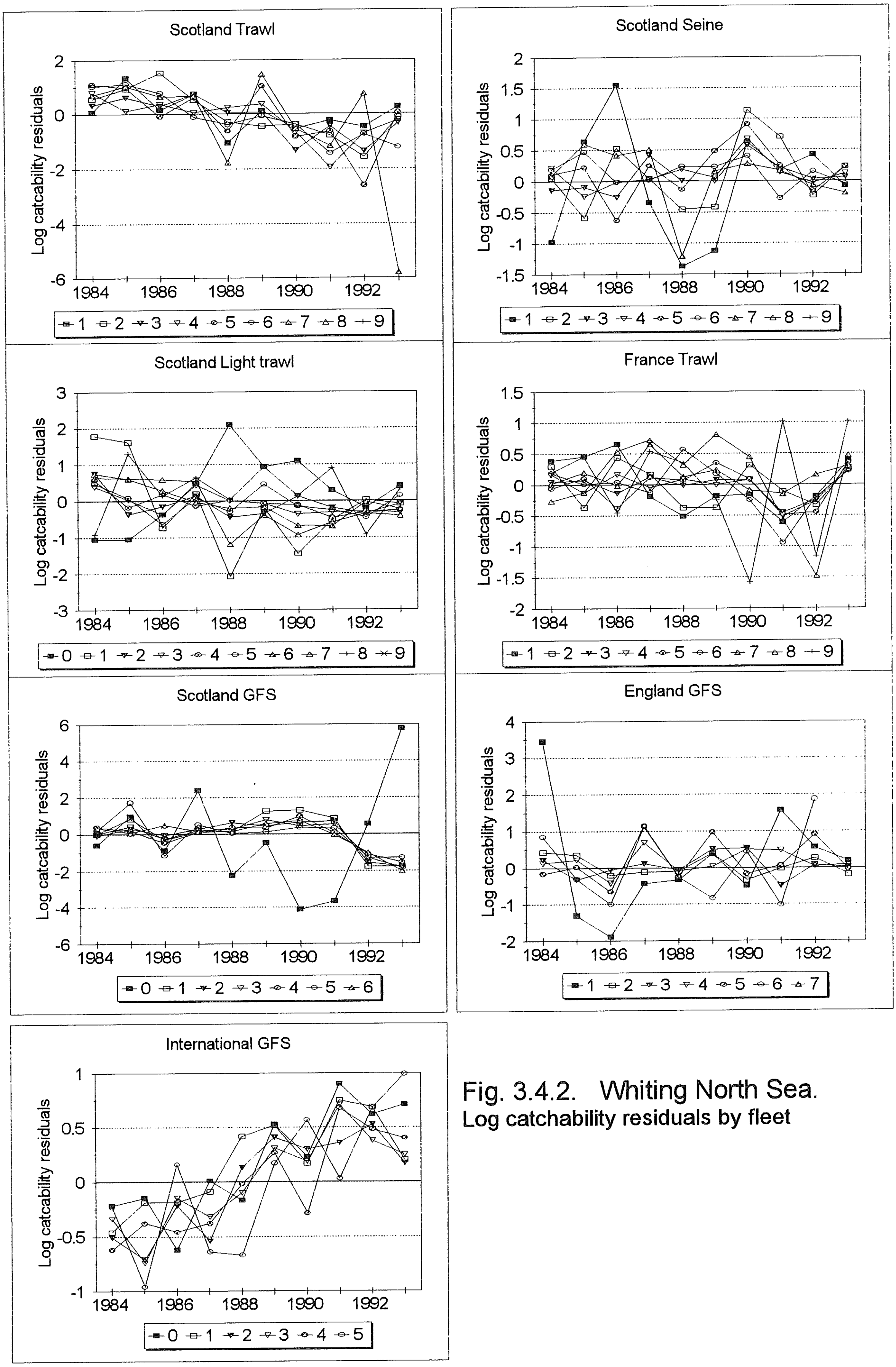


Fig. 3.4.2. Whiting North Sea.
Log catchability residuals by fleet

Figure 3.4.3 Whiting, North Sea. Retrospective XSA, shrunk

Figure 3.4.4 Whiting - North Sea. Recruitment and spawning stock biomass.

Figure 3.4.5. Whiting, North Sea. Yield per recruit

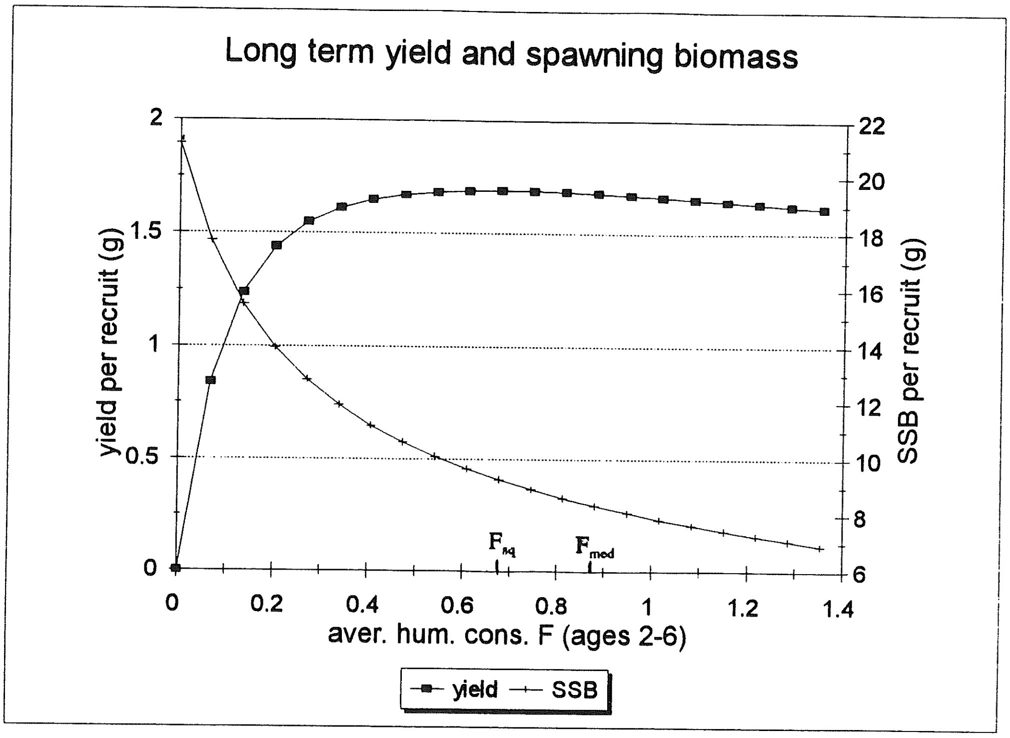


Figure 3.4.6. Whiting, North Sea. Short term forecast

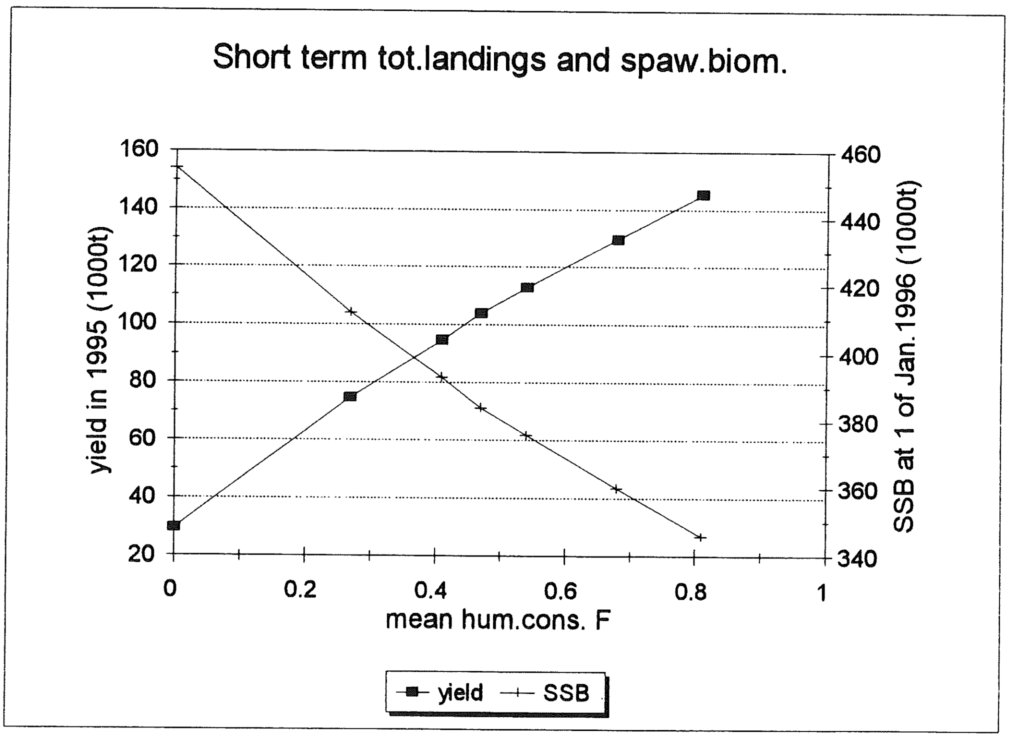


Fig. 3.4.7. Whiting North Sea. Sensitivity analysis of short term forecast.
Linear sensitivity coefficients (elasticities).
Key to labels is in Table 3.4.18.

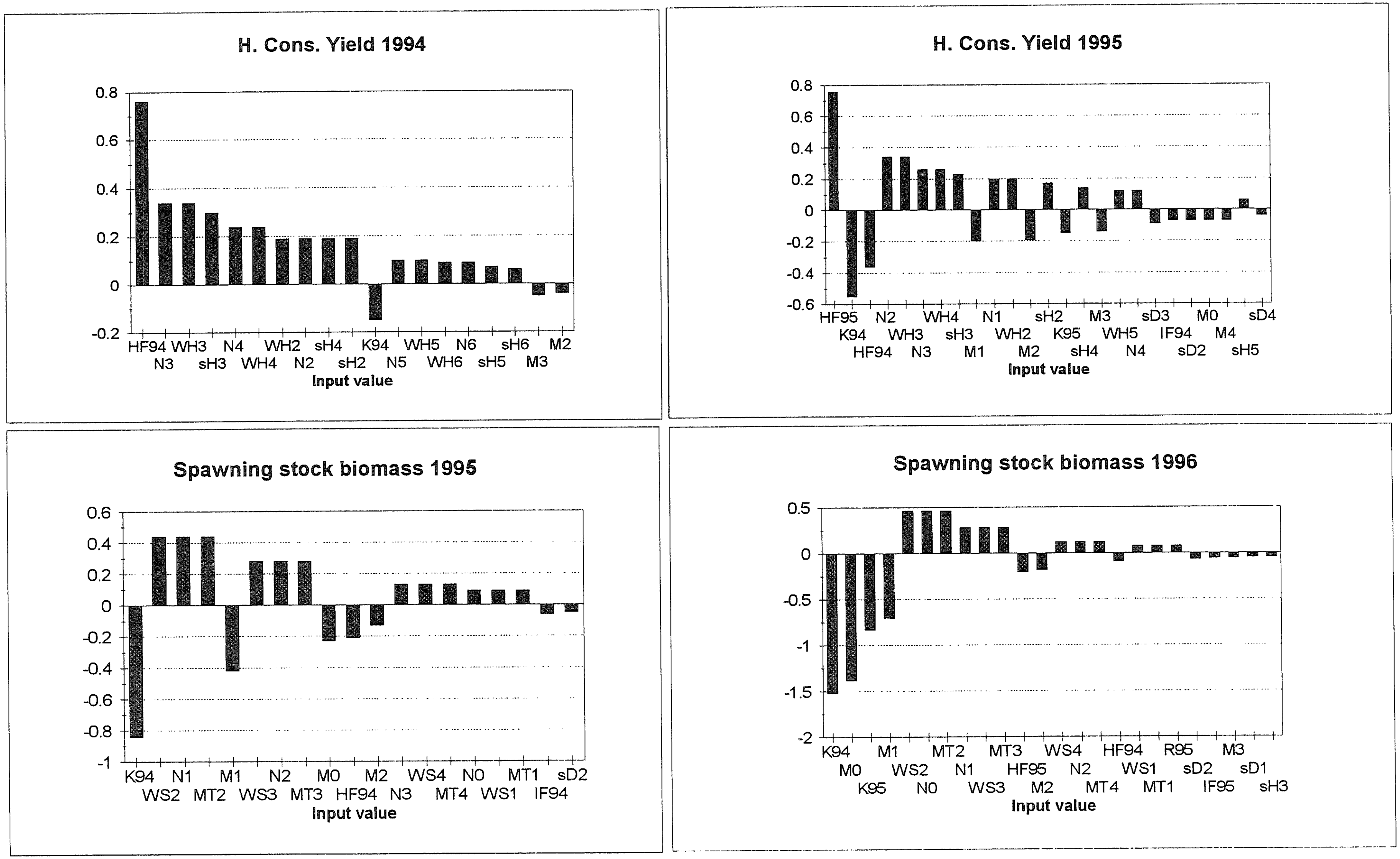
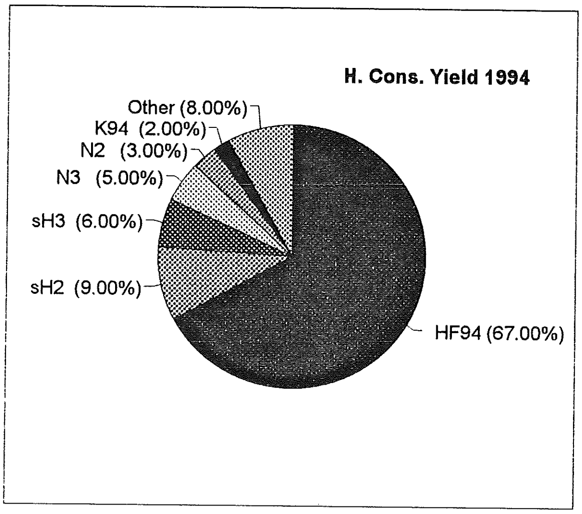
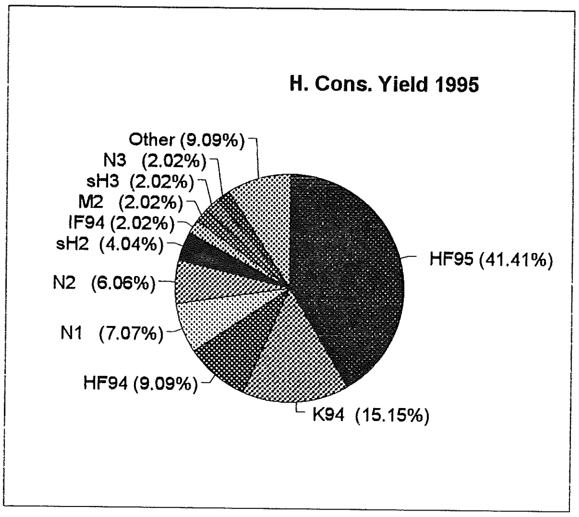
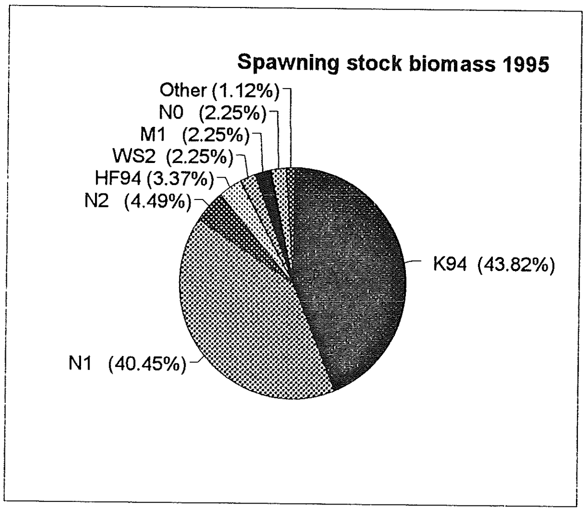


Figure 3.4.8. Whiting, North Sea. Sensitivity analysis of short term forecast.
Proportion of total variance contributed by each input value.
Key to labels is in Table 3.4.18.







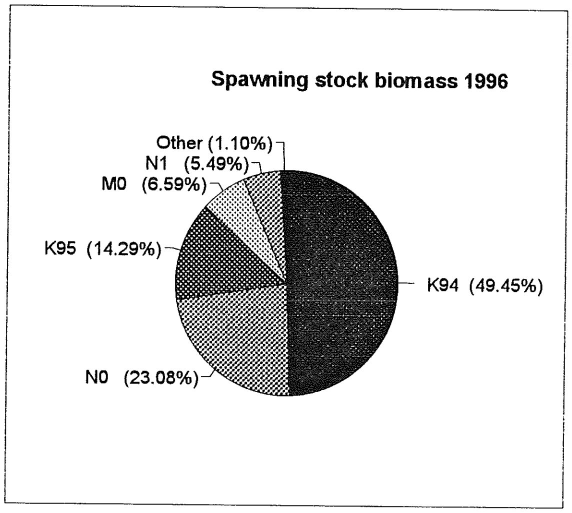


Fig. 3.4.9. Whiting North Sea. Sensitivity analysis of short term forecast.
Cumulative probability distributions.

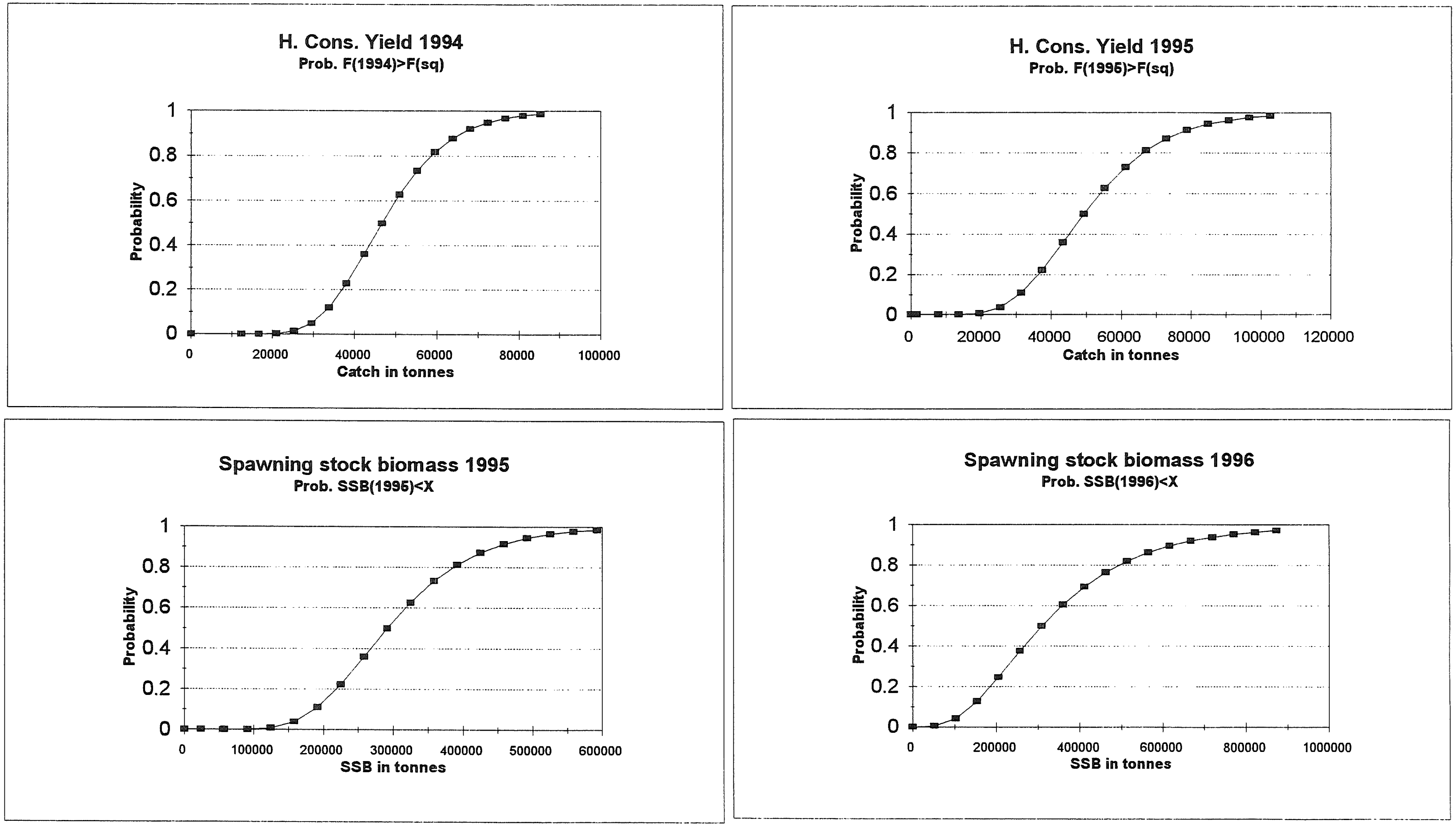
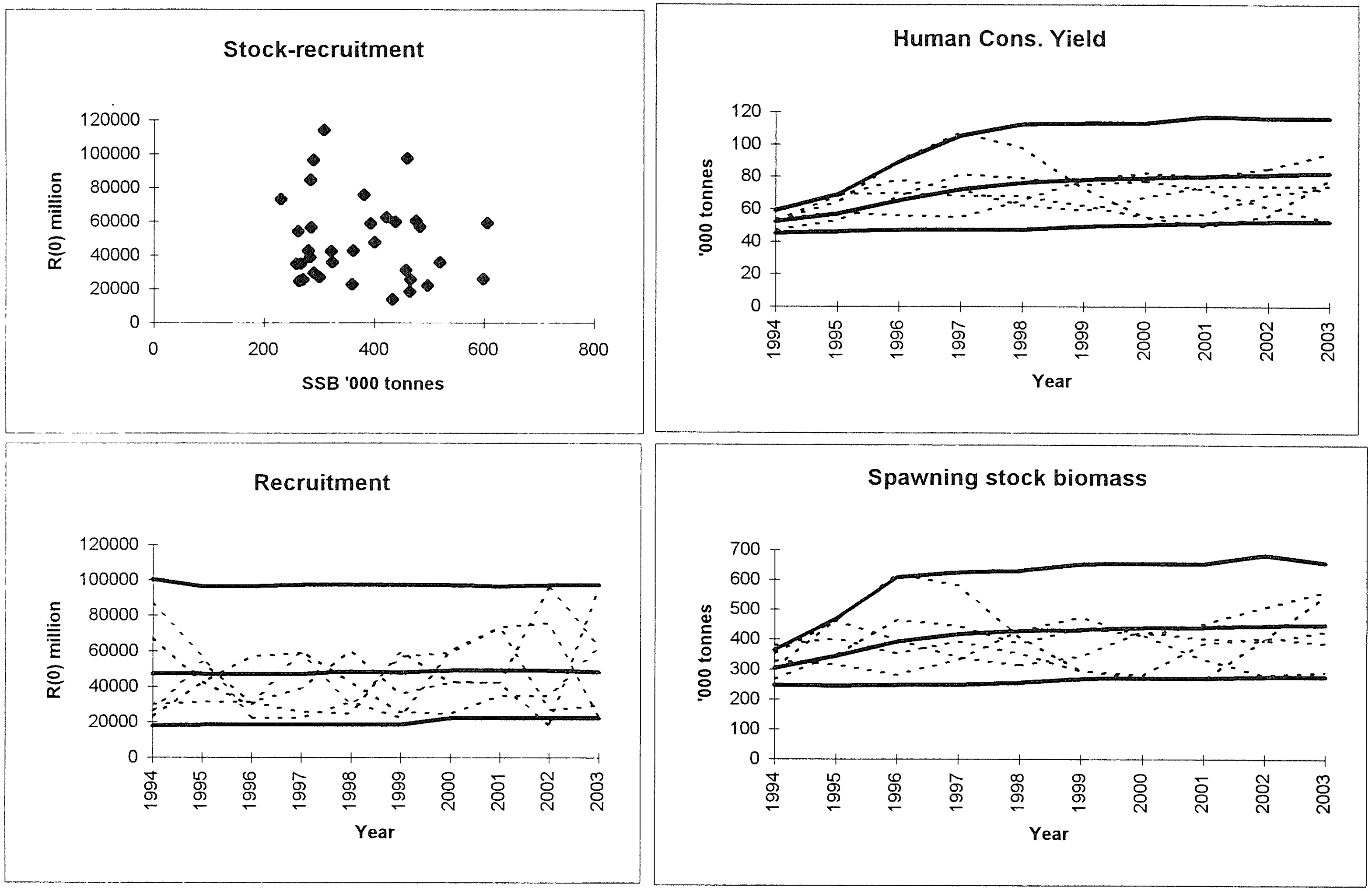


Figure 3.4.10 Whiting, North Sea. Medium term prediction



Recruitment : Random bootstrapped

The mean, 5% quantile and 95% quantile of 500 simulations are presented with the trajectories of 5 predictions

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 discontinuation of the USSR fishery. After that, the landings followed an increasing trend to reach 200,000 t in 1985. Since then, the landings have decreased considerably. In 1992 and 1993, the landings are estimated to be 93,000 t and 105,000 t respectively. Small amounts of saithe are taken as industrial by-catch. Since 1976, the average industrial by-catch has been 2,600 t (Table 3.5.2). The agreed TAC in 1993 was 93,000 t. It appears that the TAC was exceeded in 1993.

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

Conventional values of natural mortality rate and maturity at age based on biological sampling are given in Table 3.5.3. They are unchanged from those used last year. Total international age compositions are given in Table 3.5.4. Data for 1992 were updated with minor changes. Data for 1993 were supplied by Denmark, Germany, France, Norway, UK (England) and UK (Scotland) accounting for 96% 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. SOP corrections have not been applied (see Table 3.5.5a).

3.5.3 Catch, effort and research vessel data

Commercial catch and effort data used to tune the VPA are shown in Table 3.5.6. Scottish and English research vessel indices of abundance for saithe, and a series of 0-group indices estimated by observers are shown in Table 3.5.10. The data from the French trawlers start in 1978 and contain the age groups 2 - 10, while the data from the Norwegian trawler starts in 1980 and contain the age group 3 - 10.

3.5.4 Catch-at-age analysis

Preliminary tunings were done including and excluding the research vessel indices. Including these indices did not improve the assessment. The retrospective analysis with indices included did not perform as well as the VPAs with commercial data only. It was therefore decided to run the tuning without research vessel indices (see Section 3.5.12). The method used to tune the VPA was XSA (v3.1), the same method as was used last year. Tuning was performed over a 15 year period, with shrinkage of 0.5 and a tricubic time taper. Inspection of preliminary retrospective runs indicated that the VPA performed best when the ages 1, 2 and 3 were treated as recruiting ages (see Section 3.5.13). Catchability was fixed for ages 7 and above. The age range used for VPA was 1 to 10 (the plus group), and F for the oldest ages was set at the mean of the 5 younger ages. The tuning results are given in Table 3.5.7. and the residuals of the log catchability are plotted in Figure 3.5.2. Table 3.5.8 gives the fishing mortality rates and Table 3.5.9 the stock numbers estimated by tuning.

A retrospective analysis was run for six years backwards. The results are plotted in Figure 3.5.3. There is reasonable agreement for all runs.

3.5.5 Recruitment estimates

Inspection of plots of research vessel indices against VPA indicated that the indices could give some information on recruitment (Figure 3.5.4). However, the English GFS1 and the Scottish GF1 did not seem to give any information and were therefore taken out of the input files to the RCT3 program (Table 3.5.10). The results of the analysis are given in Tables 3.5.11 and 3.5.12. They were used as estimates for ages 1 and 2 in 1994 (year classes 1993 and 1992). The year class 1993 was estimated to be 214 million at age 1. This is close to the mean, but the coefficient of variation is smaller for the RCT3 estimate than for the long-term geometric mean. The year class 1992 was estimated to be 166 million at age 2. There was no information on the year class 1994, and the geometric mean of 206 million was used for year classes 1994 and onwards.

3.5.6 Historical stock trends

Table 3.5.13 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.

Mean fishing mortality increased substantially from 1981 to 1986. Since then, it has decreased to a level of about 0.5. Total biomass and spawning biomass show a continuous downward trend until 1990 when they were at historically low levels, but the present assessment indicates some improvement of the stock.

3.5.7 Biological reference points

Yield and biomass per recruit are shown in Figure 3.5.6, and input data are in Table 3.5.14. A stock/recruitment plot is shown in Figure 3.5.5. Fhigh (0.70) and Fmed (0.45) replacement lines are shown in Figure 3.5.5. *Status quo* F is now very close to Fmed, and stock replacement will in the long term be sustained with average recruitment.

3.5.8 Short-term forecast

Input data for prediction are given in Table 3.5.14. Ages 1 and 2 are estimated from RCT3. The period for calculations of mean exploitation pattern and mean weights is 1989 to 1993. Results of the predictions assuming average geometric recruitment for year class 1994 and onwards are given in Table 3.5.15, and in Figure 3.5.7. Input data for a sensitivity analysis (see Section 1.3.1) are shown in Table 3.5.16 and the results of this analysis are shown in Figures 3.5.8 - 3.5.10.

Maintenance of the 1993 level of fishing mortality in 1994 will lead to landings of 97,000 t in 1994 and 106,000 t in 1995. Spawning stock size is predicted to increase to 125,000 t.

The sensitivity analysis shows that the prediction of the yield in 1995 is dependent on the fishing mortality levels in 1994 and 1995 together with the numbers of the ages 2, 3 and 4, and the weights of the ages 3, 4 and 5. The prediction of the spawning stock in 1996 is dependent on the fishing mortality levels in 1994 and 1995 together with the numbers of the ages 3 and 4, the relative fishing mortalities of the ages 4 and 5, the stock weight of the ages 5 and 6 and the stock numbers of ages 3 and 4 (Figure 3.5.8). The stock number of age 4 and the fishing mortality level in 1994 and 1995 contributes to most of the variance in the prediction (Figure 3.5.9).

The probability plots show that there is about a 30% probability that the spawning stock will drop below 80,000 t (the lowest previous record) in 1996 if the current level of fishing mortality is maintained (Figure 3.5.10), and with a catch of 106,000 t in 1995 there is about a 60% probability that fishing mortality will be higher than in 1994.

The predicted *status quo* catch for 1994 of 97,000 t was equal to the TAC.

3.5.9 Medium-term projections

The input for these analyses (see Section 1.3.2) are shown in Table 3.5.16 and Table 3.5.17, and the results are presented in Figure 3.5.11. Assuming a Beverton-Holt stock-recruitment relationship with a moving average term (Figure 3.5.11) the yield in 9 years out of 10 is expected to be between about 90,000 t and 200,000 t, but would average 130,000 t. SSB is expected in 9 years out of 10 to be between 110,000 t and 250,000 t, and average 160,000 t.

3.5.10 Long-term considerations

The current level of F is at Fmed, which implies that average recruitment is required to sustain spawning stock biomass. However, with *status quo* exploitation, the medium-term projection indicates that the probability of reaching a spawning stock biomass at the level seen in the 1970s is small. This high level corresponded to a newly started fishery.

3.5.11 Comments on the assessment

Table 3.5.18 gives the quality control sheets. This year's assessment is consistent with the assessment last year. The inclusion of recruitment data seems to have improved the assessment. However, the average recruitment is given a high weight in the RCT3 analysis. The forecast should therefore be treated with caution.

3.5.12 Selection of CPUE series for tuning

Previous assessments of this stock used only two commercial fleets in the tuning. Preliminary runs suggested that indices from English and Scottish groundfish surveys might also be useful at least in the prediction of recruitment for this stock. To investigate this, retrospective trends in mean F from this run, which can be compared with the retrospective using only commercial data in Figure 3.5.3, are given in Figure 3.5.12. The figure also shows retrospective trends in recruitment from the runs with and without the survey data. The retrospective trends are slightly worse if the survey data are included, but their inclusion improves the estimation of recruitment in some years. It is clear that the indices contain some information on recruitment, but they do not improve the retrospective performance of the tuning. For this reason, the indices were used in RCT3 but not in the tuning.

3.5.13 Choice of ages to treat as recruits in XSA

The first age for constant catchability was investigated using retrospective analysis (see Section 3.3.13). Treating age 1 as recruits gave a clear improvement in the retrospective trends in age 1 (Figure 3.5.13), and treating ages 2 and 3 also gave slight improvements in the estimation of these age groups (Figure 3.5.14). For this reason, these ages were treated as recruits. This is also consistent with the biology of the species.

Table 3.5.1 Nominal catch (in tonnes) of saithe in Sub-area IV and Division IIIa, 1983-1993, as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	7	32	31	16	4	60	13	23	29	70	113
Denmark	10,530	8,526	9,033	10,343	7,928	6,868	6,550	5,800	6,314	4,669	4,232
Faroe Islands	806	-	895	224	691	276	739	1,650	671	2,480	2,875
France	38,782	43,592	42,200	43,958	38,356	28,913	30,761[1,2]	29,892[1,2]	14,795[1,2]	9,061[1]	22,615[1,2]
Germany	13,649	25,262	22,551	22,277	22,400	18,528	14,339	15,006	19,574	13,177	14,813[1]
Netherlands	89	181	233	134	334	345	257	206	199	180	79
Norway	81,330	88,420	101,808	67,341	66,400	40,021	24,737	19,122	36,240	50,065	48,725[1]
Poland	415	413	-	495	832	1,016	809	1,244	1,336	1,238	937[1]
Sweden	548	522	1,764	1,987	1,732	2,064	797	838	1,514	3,302	4,955
UK (Engl.& Wales)	6,845	8,183	5,455	4,480	3,233	3,790	4,441	3,654	4,709	3,158	2,426
UK (N. Ireland)	-	-	-	-	-	-	24	-	-	2	3
UK (Scotland)	6,321	6,970	9,932	15,520	11,911	10,850	8,726	7,383	7,962	6,593	5,913
USSR	-	-	-	-	-	-	-	-	116[3]	-	-
Total reported to ICES	159,322	182,101	193,902	166,775	153,821	112,731	92,193	84,818	93,459	93,995	107,704
Unreported landings	9,562	15,900	5,839	-2,459	-4,627	-7,630	-200	3,257	5,464	-1,489	-2,958
Landings as used by W G	168,884	198,001	199,741	164,297	149,194	105,101	91,993	88,075	98,923	92,506	104,746

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

Table 3.5.2 Saithe, North Sea
Annual weight and numbers caught, 1970 to 1993.

Year	Wt.('000 t)			Nos.(millions)		
	Total	H. con	Ind BC	Total	H. con	Ind BC
1970	222	163	59	146	95	51
1971	253	218	35	178	144	35
1972	246	218	28	179	154	25
1973	226	195	31	172	143	30
1974	273	231	42	166	121	45
1975	278	240	38	190	142	48
1976	320	253	67	236	224	11
1977	196	190	6	122	117	5
1978	135	132	3	99	97	2
1979	114	113	2	68	67	1
1980	120	120	0	73	72	0
1981	123	121	1	71	69	2
1982	166	161	5	115	110	5
1983	169	167	1	112	111	1
1984	198	192	6	168	162	6
1985	200	192	8	207	195	11
1986	164	163	1	159	157	2
1987	149	145	4	166	159	7
1988	105	104	1	94	93	1
1989	92	90	2	78	75	3
1990	88	86	2	63	58	5
1991	99	98	1	96	95	1
1992	93	92	0	70	70	0
1993	105	104	1	74	72	2

Table 3.5.3 Saithe, North Sea
Natural Mortality and proportion mature

Age	Nat Mor	Mat.
1	.200	.000
2	.200	.000
3	.200	.000
4	.200	.150
5	.200	.700
6	.200	.900
7	.200	1.000
8	.200	1.000
9	.200	1.000
10+	.200	1.000

Table 3.5.4 Saithe, North Sea
International catch at age ('000), Total , 1970 to 1993.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	234	669	387	4420	3988	314	240	2036	1237	938
2	2251	11161	20672	31490	16390	72334	22587	12943	16948	16815
3	35813	69382	40971	48840	61811	51167	136608	23022	31381	14492
4	77623	54194	63934	34257	31664	23572	47633	52642	25689	13014
5	13194	30964	23249	25175	12154	9029	9935	13100	17067	10029
6	11529	3676	20859	15343	20132	6718	5165	4761	2650	7992
7	3654	3810	3385	8038	13774	12672	3333	3221	856	2438
8	1596	2496	2806	1696	4320	8664	4873	3065	798	578
9	278	1589	1562	1172	993	3311	3026	3528	613	350
10+	144	545	1469	1934	1106	2353	2141	3792	2202	1336

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	1299	5320	1945	274	59	215	107	799	11	4194
2	23329	18497	28637	32898	34563	6712	6171	28942	4943	9171
3	14147	22382	27581	23482	75559	124467	47409	28971	27542	14579
4	11394	6371	39122	18051	29818	54500	85165	90034	23240	25919
5	8352	6165	7947	25232	12107	13064	12186	12462	32511	11608
6	6100	3272	5421	4916	12369	4060	4270	1951	2923	9884
7	5206	3000	1767	4387	1363	2542	1591	1126	1138	1274
8	959	3178	1217	1336	1120	464	1048	816	456	539
9	420	505	851	932	282	270	262	691	496	294
10+	1508	1873	803	825	494	258	480	500	395	323

Age	1990	1991	1992	1993
1	291	363	293	139
2	3267	12364	5482	6469
3	30215	44155	16387	32202
4	13575	27214	30397	17026
5	9091	6475	11844	10477
6	3709	2970	2826	2803
7	2078	1304	1410	1418
8	487	725	633	1409
9	144	282	460	745
10+	182	204	311	913

Table 3.5.5 Saithe, North Sea
International mean weight at age (kg), Total catch, 1970 to 1993.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.470	.495	.309	.154	.275	.200	.450	.444	.356	.435
2	.744	.666	.517	.397	.506	.483	.497	.425	.530	.390
3	.952	.946	.773	.806	.850	.835	.685	.753	.809	1.083
4	1.475	1.521	1.232	1.478	1.550	1.420	1.416	1.324	1.325	1.597
5	2.150	2.577	2.103	1.729	2.322	2.274	2.367	2.014	2.147	2.227
6	2.810	3.475	2.617	2.806	2.719	2.988	3.283	3.199	3.246	3.079
7	3.750	4.426	4.248	3.662	3.444	3.451	4.301	4.299	4.502	3.980
8	4.640	5.406	4.644	5.126	4.407	3.963	4.651	4.798	4.819	5.147
9	6.020	6.004	4.979	4.959	5.595	5.223	5.346	5.227	5.361	5.960
10+	7.164	6.516	6.695	6.675	7.461	7.043	7.184	6.773	6.769	7.177

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	.259	.274	.251	.394	.182	.143	.482	.363	.425	.418
2	.412	.586	.500	.452	.482	.487	.482	.387	.554	.674
3	.895	.936	1.086	.969	.773	.671	.663	.652	.725	.860
4	1.782	1.840	1.567	1.687	1.603	1.315	1.026	.861	.946	1.023
5	2.328	2.642	2.499	2.101	2.277	1.983	1.723	1.783	1.389	1.434
6	2.929	3.438	3.145	3.032	2.653	2.725	2.317	2.952	2.790	1.965
7	4.005	4.417	3.969	3.499	3.737	3.232	3.577	3.781	3.847	3.881
8	4.988	5.392	4.919	4.400	4.548	4.587	4.259	4.876	4.817	4.875
9	5.749	6.872	5.622	5.293	5.940	5.216	5.776	5.447	5.792	6.350
10+	7.224	8.284	7.779	6.852	7.757	7.333	7.892	6.996	7.240	8.592

Age	1990	1991	1992	1993
1	.215	.441	.625	.321
2	.606	.501	.570	.647
3	.816	.782	.949	.885
4	1.202	1.160	1.191	1.307
5	1.605	1.761	1.610	1.828
6	2.311	2.416	2.239	2.722
7	3.290	3.257	3.703	3.230
8	4.710	4.200	4.363	4.369
9	6.209	5.966	5.403	5.099
10+	8.390	7.337	6.207	6.803

Table 3.5.5a Saithe North Sea.
Sum of products correction

Year	SOP	Year	SOP
1970	0.9453	1982	0.9939
1971	0.8656	1983	1.0058
1972	0.9115	1984	0.9952
1973	0.9155	1985	0.9553
1974	0.9971	1986	0.9769
1975	1.0546	1987	0.9855
1976	1.1370	1988	0.9527
1977	0.9444	1989	0.9656
1978	0.9632	1990	1.1332
1979	0.9968	1991	0.9746
1980	1.0094	1992	0.9962
1981	1.0052	1993	1.0219

Table 3.5.6 Tuning input data for saithe in IV

North Sea Saithe : 1960-1993 : Prepared 29/9/94 : Not SoP corrected.
102
FRATRB
1978 1993
1 1 .00 1.00
2 10

69739.000	248.000	1853.000	3183.000	5447.000	762.000	190.000	154.000	122.000	163.000
89974.000	230.000	4525.000	3618.000	4128.000	2809.000	329.000	87.000	51.000	84.000
63577.000	528.000	3149.000	4450.000	2322.000	1412.000	746.000	104.000	45.000	29.000
76517.000	4538.000	9067.000	2893.000	2423.000	939.000	456.000	258.000	36.000	48.000
78523.000	1285.000	6001.000	10009.000	2630.000	1328.000	543.000	164.000	98.000	21.000
69720.000	799.000	3487.000	5770.000	8617.000	1183.000	270.000	86.000	37.000	29.000
76149.000	1311.000	5482.000	8632.000	5121.000	3837.000	232.000	155.000	33.000	49.000
53003.000	810.000	8447.000	10230.000	3677.000	1194.000	596.000	33.000	40.000	18.000
50350.000	721.000	4648.000	12454.000	3291.000	1124.000	291.000	213.000	33.000	15.000
51234.000	873.000	2062.000	11802.000	3537.000	566.000	268.000	104.000	76.000	20.000
35482.000	451.000	2038.000	2263.000	7860.000	723.000	178.000	54.000	33.000	37.000
36133.000	553.077	3197.885	5199.979	2726.086	2846.718	143.775	37.077	13.706	11.566
36097.000	475.076	4783.261	4360.992	2555.746	525.267	495.450	67.964	31.461	16.020
45075.000	458.002	2493.662	5483.608	1560.596	673.786	230.058	136.771	26.868	13.350
34138.000	385.622	1302.925	3058.332	1080.604	153.874	57.665	24.037	18.272	5.552
23721.000	747.315	4474.987	3433.931	2062.051	216.138	30.675	20.028	15.276	16.720

NORTRL
1980 1993
1 1 .00 1.00
3 10

18317.000	186.000	1290.000	658.000	980.000	797.000	261.000	60.000	82.000
28229.000	88.000	844.000	1345.000	492.000	670.000	699.000	119.000	64.000
47412.000	6624.000	12016.000	2737.000	2112.000	341.000	234.000	19.000	77.000
43099.000	4401.000	4963.000	8176.000	1950.000	2367.000	481.000	357.000	84.000
47803.000	20576.000	7328.000	2207.000	3358.000	433.000	444.000	106.000	51.000
66607.000	27088.000	21401.000	5307.000	1569.000	637.000	56.000	46.000	4.000
57468.000	5297.000	29612.000	3589.000	818.000	393.000	122.000	25.000	33.000
30008.000	2645.000	18454.000	2217.000	290.000	235.000	201.000	198.000	64.000
18402.000	3132.000	2042.000	2214.000	141.000	157.000	74.000	134.000	43.000
17781.000	649.000	2126.000	835.000	694.000	309.000	154.000	65.000	7.000
10249.000	804.000	781.000	924.000	519.000	203.000	63.000	12.000	3.000
28768.000	14348.000	4968.000	1194.000	518.000	203.000	51.000	56.000	1.000
35621.000	3447.000	9532.000	4031.000	1087.000	465.000	165.000	109.000	6.000
24383.000	7571.000	3998.000	2858.000	1006.000	520.000	361.000	249.000	250.000

Table 3.5.7 Tuning diagnostics for saithe in IV

Lowestoft VPA Version 3.1

8/10/1994 12:05

Extended Survivors Analysis

NORTH SEA SAITHE : 1960-1993 : NO SOP CORRECTION : PREPARED 6/10/94

CPUE data from file saiivef.dat

Catch data for 24 years. 1970 to 1993. Ages 1 to 10.

Fleet,		First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FRATRB	,	1978,	1993,	2,	9,	.000,	1.000
NORTRL	,	1980,	1993,	3,	9,	.000,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 14 iterations

1

Regression weights
, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fleet : FRATRB

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
2,	6.21,	-2.199,	37.34,	.02,	16,	3.49,	-16.04,
3,	1.76,	-1.373,	15.71,	.25,	16,	.88,	-13.96,

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
4,	1.08,	-.242,	12.92,	.49,	16,	.50,	-12.79,
5,	.79,	.805,	11.97,	.60,	16,	.32,	-12.46,
6,	.71,	.952,	11.77,	.51,	16,	.41,	-12.85,
7,	1.55,	-.664,	16.12,	.13,	16,	1.07,	-13.38,
8,	1.71,	-1.033,	18.05,	.17,	16,	.97,	-13.70,
9,	3.05,	-2.906,	27.72,	.17,	16,	1.15,	-13.64,

Continued

Table 3.5.7 continued

Fleet : NORTRL

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3,	.93,	.097,	13.42,	.17,	14,	1.14,	-13.55,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4,	.60,	2.779,	11.86,	.84,	14,	.22,	-12.39,
5,	1.07,	-.196,	12.44,	.46,	14,	.41,	-12.29,
6,	.75,	.758,	11.61,	.50,	14,	.41,	-12.41,
7,	1.19,	-.326,	13.08,	.24,	14,	.74,	-12.34,
8,	1.19,	-.245,	13.38,	.15,	14,	1.09,	-12.46,
9,	.80,	.414,	11.22,	.32,	14,	.75,	-12.30,

1

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB ,	1,	.000,	.000,	.00,	0,	.000,	.000
NORTRL ,	1,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	154846,	.45,,,,				.557,	.001
F shrinkage mean ,	21052,	.50,,,,				.443,	.006

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
63959,	.33,	11.11,	2,	33.381,	.002

Age 2 Catchability dependent on age and year class strength

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB ,	13380556,	3.924,	.000,	.00,	1,	.007,	.000
NORTRL ,	1,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	115581,	.49,,,,				.511,	.049
F shrinkage mean ,	80025,	.50,,,,				.482,	.071

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
100278,	.35,	3.48,	3,	10.015,	.057

Age 3 Catchability dependent on age and year class strength

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB ,	261111,	.977,	.810,	.83,	2,	.077,	.106
NORTRL ,	169016,	1.220,	.000,	.00,	1,	.050,	.159
P shrinkage mean ,	63920,	.47,,,,				.462,	.376
F shrinkage mean ,	65168,	.50,,,,				.411,	.370

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
75399,	.31,	.59,	5,	1.862,	.327

Continued

Table 3.5.7 continued

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB	,	28740,	.418,	.345,	.83,	3,	.325,	.429
NORTRL	,	26927,	.456,	.019,	.04,	2,	.276,	.452
F shrinkage mean	,	15812,	.50,,,,				.399,	.680

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
22240,	.27,	.20,	6,	.747,	.526

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB	,	12669,	.311,	.145,	.47,	4,	.350,	.559
NORTRL	,	17744,	.310,	.102,	.33,	3,	.366,	.428
F shrinkage mean	,	8046,	.50,,,,				.284,	.778

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
12597,	.21,	.15,	8,	.716,	.561

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB	,	2572,	.318,	.159,	.50,	5,	.311,	.686
NORTRL	,	6269,	.308,	.109,	.35,	4,	.348,	.340
F shrinkage mean	,	2797,	.50,,,,				.341,	.645

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
3608,	.22,	.16,	10,	.704,	.532

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1986

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB	,	862,	.298,	.278,	.93,	6,	.302,	.912
NORTRL	,	1957,	.286,	.213,	.75,	5,	.349,	.504
F shrinkage mean	,	1839,	.50,,,,				.349,	.529

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1495,	.22,	.17,	12,	.780,	.620

Continued

Table 3.5.7 continued

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1985

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB ,	608,	.295,	.278,	.94,	7,	.311,	1.131
NORTRL ,	1108,	.284,	.177,	.62,	6,	.303,	.766
F shrinkage mean ,	1905,	.50,,,,				.386,	.512

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1133,	.23,	.20,	14,	.871,	.754

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1984

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB ,	264,	.301,	.200,	.66,	8,	.331,	1.268
NORTRL ,	474,	.312,	.285,	.91,	7,	.239,	.885
F shrinkage mean ,	813,	.50,,,,				.430,	.604

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
493,	.25,	.20,	16,	.798,	.863

Table 3.5.8 Saithe, North Sea
International F at age, Total , 1970 to 1993.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.001	.003	.002	.019	.008	.002	.002	.018	.013	.004
2	.007	.066	.129	.194	.088	.200	.177	.132	.202	.250
3	.161	.280	.364	.508	.717	.434	.717	.277	.543	.267
4	.522	.391	.452	.594	.743	.671	.961	.681	.570	.455
5	.547	.407	.289	.322	.433	.484	.678	.782	.488	.456
6	.568	.285	.532	.315	.464	.456	.571	.838	.347	.447
7	.327	.369	.463	.401	.520	.604	.431	.882	.340	.626
8	.227	.390	.513	.446	.392	.741	.494	.930	.560	.405
9	.441	.371	.453	.419	.514	.596	.632	.831	.469	.513
10+	.441	.371	.453	.419	.514	.596	.632	.831	.469	.513

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	.009	.030	.007	.001	.000	.002	.001	.009	.000	.023
2	.125	.166	.225	.148	.104	.023	.054	.237	.074	.077
3	.345	.170	.398	.292	.592	.656	.227	.387	.373	.323
4	.347	.257	.503	.495	.746	1.241	1.489	.893	.621	.732
5	.601	.321	.593	.723	.743	.900	1.113	.950	1.010	.745
6	.561	.501	.521	.945	1.007	.601	.875	.510	.605	1.046
7	.594	.601	.561	1.126	.760	.573	.502	.598	.642	.585
8	.541	.930	.524	1.188	1.047	.641	.494	.524	.520	.736
9	.587	.620	.696	1.035	.888	.785	.968	.723	.716	.770
10+	.587	.620	.696	1.035	.888	.785	.968	.723	.716	.770

Age	1990	1991	1992	1993
1	.002	.002	.002	.002
2	.023	.140	.038	.057
3	.390	.470	.280	.327
4	.569	.745	.703	.526
5	.620	.591	.887	.561
6	.565	.420	.562	.532
7	.642	.394	.360	.620
8	.463	.484	.338	.754
9	.441	.541	.659	.863
10+	.441	.541	.659	.863

Table 3.5.9 Saithe, North Sea
Tuned Stock Numbers at age (10**-3), 1970 to 1994, (numbers in 1994 are VPA survivors)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	236852	230822	241958	266699	541904	187890	141152	127241	103924	268806
2	385733	193706	188376	197748	214356	440065	153548	115348	102334	83967
3	265552	313774	148494	135524	133409	160669	294845	105276	82727	68449
4	210929	185011	194117	84505	66765	53297	85247	117790	65362	39336
5	34615	102458	102437	101080	38190	26012	22307	26694	48806	30269
6	29409	16401	55869	62832	59978	20270	13127	9274	10003	24517
7	14472	13646	10102	26867	37560	30890	10518	6074	3285	5791
8	8690	8543	7725	5208	14724	18288	13824	5595	2059	1915
9	860	5670	4736	3786	2729	8146	7134	6909	1808	963
10+	443	1930	4416	6196	3009	5723	4987	7314	6435	3645

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	165001	197429	325520	473661	394345	157506	185167	94606	166539	203064
2	219231	133915	156827	264753	387553	322808	128761	151505	76734	136340
3	53531	158382	92904	102488	186995	286028	258220	99837	97854	58352
4	42929	31027	109420	51107	62663	84730	121558	168515	55525	55195
5	20431	24838	19638	54187	25510	24323	20057	22462	56502	24432
6	15707	9170	14757	8888	21534	9931	8093	5396	7114	16843
7	12841	7341	4548	7177	2829	6438	4457	2763	2652	3180
8	2536	5803	3295	2125	1907	1083	2971	2210	1243	1142
9	1045	1209	1875	1597	530	548	467	1485	1071	605
10+	3712	4429	1745	1389	914	517	841	1060	842	656

Age	1990	1991	1992	1993	1994
1	127809	198278	158652	78272	0
2	162460	104378	162008	129628	63959
3	103328	130055	74271	127681	100278
4	34583	57258	66527	45980	75399
5	21738	16031	22255	26964	22240
6	9499	9572	7267	7504	12597
7	4846	4422	5150	3392	3608
8	1450	2088	2440	2941	1495
9	448	747	1053	1425	1133
10+	559	535	703	1718	1086

Table 3.5.10 North Sea Saithe : RCT3 input : Age 1

7	21	2						
'YEARCLASS'	'VPA'	'EGFS1'	'EGFS2'	'EGFS3'	'SGFS1'	'SGFS2'	'SGFS3'	'NorW0'
1974	188	-1	-1	484.92	-1	-1	-1	-1
1975	141	-1	104.54	57.36	-1	-1	-1	-1
1976	127	0.00	72.39	104.99	-1	-1	-1	-1
1977	104	1.90	2.79	176.88	-1	-1	-1	-1
1978	269	8.16	18.32	119.76	-1	-1	-1	-1
1979	165	0.00	94.54	2121.11	-1	-1	1370	-1
1980	197	0.00	696.57	546.76	-1	680	370	-1
1981	326	0.00	4.18	4643.56	840	500	26470	54
1982	474	5.09	2715.16	2710.98	3840	8390	40140	76
1983	394	0.00	210.53	1708.74	580	50070	43180	50
1984	158	0.00	318.58	32.55	40	3160	1700	46
1985	185	0.00	17.45	786.60	0	170	1430	53
1986	95	0.00	84.74	176.50	30	350	1320	23
1987	167	0.00	66.56	872.71	50	290	4010	51
1988	203	1.96	580.69	426.48	180	3130	3180	43
1989	128	41.65	202.96	109.95	70	700	1840	39
1990	-1	2.94	18.84	1037.57	380	310	7890	61
1991	-1	23.52	174.35	115.55	80	2010	1390	73
1992	-1	6.06	32.54	-1	220	810	-1	51
1993	-1	0.00	-1	-1	0	-1	-1	50
1994	-1	-1	-1	-1	-1	-1	-1	-1

Table 3.5.11 Recruitment analysis of saithe in IV, age 1.

Analysis by RCT3 ver3.1 of data from file :

c:\ices\nsdem94\sairct1.csv

North Sea Saithe : RCT3 input : Age 1 : 1994 WG,,,,,,

Data for 5 surveys over 20 years : 1974 - 1993

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 = 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
EGFS2	1.13	-.18	2.06	.058	15	3.51	3.80	2.479	.016
EGFS3									
SGFS2	.43	2.19	.63	.421	10	6.70	5.10	.765	.167
SGFS3									
NorW0	2.03	-2.50	.40	.662	9	3.95	5.53	.498	.395
					VPA Mean =		5.27	.482	.422

Yearclass = 1993

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
EGFS2									
EGFS3									
SGFS2									
SGFS3									
NorW0	2.02	-2.45	.40	.659	9	3.93	5.48	.506	.478
					VPA Mean =		5.26	.484	.522

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	204	5.32	.31	.14	.21		
1993	214	5.37	.35	.11	.10		

Table 3.5.12 Recruitment analysis of saithe in IV, age 2.

Analysis by RCT3 ver3.1 of data from file :

c:\ices\nsdem94\sairct2.csv

North Sea Saithe : RCT3 input : Age 2: 1994 WG,,,,,,

Data for 5 surveys over 20 years : 1974 - 1993

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 = 1992

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
EGFS2	1.17	-.56	2.12	.055	15	3.51	3.55	2.559	.015
EGFS3									
SGFS2	.44	1.96	.64	.419	10	6.70	4.89	.772	.165
SGFS3									
NorW0	2.03	-2.71	.40	.666	9	3.95	5.32	.495	.401
						VPA Mean =	5.06	.484	.419

Yearclass = 1993

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
EGFS2									
EGFS3									
SGFS2									
SGFS3									
NorW0	2.02	-2.66	.40	.663	9	3.93	5.28	.503	.483
						VPA Mean =	5.06	.486	.517

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	166	5.11	.31	.15	.21		
1993	174	5.16	.35	.11	.10		

Table 3.5.13 Saithe, North Sea
Mean fishing mortality, biomass and recruitment, 1970 - 1993.

Year	Mean F H. cons. Ages 3 to 6	Mean F Ind BC Ages 2 to 5	Stock Biomass ('000 tonnes) Total	Stock Biomass ('000 tonnes) Spawning	Recruits Age 1 Yclass	Recruits Age 1 Million
1970	.372	.078	1222	276	1969	237
1971	.296	.047	1296	432	1970	231
1972	.363	.047	1020	450	1971	242
1973	.332	.103	890	485	1972	267
1974	.430	.163	958	456	1973	542
1975	.409	.116	842	369	1974	188
1976	.717	.018	742	277	1975	141
1977	.628	.015	563	226	1976	127
1978	.473	.013	460	194	1977	104
1979	.398	.008	494	189	1978	269
1980	.462	.002	448	183	1979	165
1981	.309	.004	544	192	1980	197
1982	.487	.017	586	160	1981	326
1983	.607	.007	685	169	1982	474
1984	.751	.021	648	137	1983	394
1985	.811	.038	591	107	1984	158
1986	.921	.005	538	98	1985	185
1987	.665	.020	396	101	1986	95
1988	.648	.004	364	109	1987	167
1989	.688	.021	379	90	1988	203
1990	.511	.025	339	81	1989	128
1991	.552	.005	391	82	1990	198
1992	.607	.001	433	91	1991	159
1993	.482	.005	395	105	1992	

Arithmetic mean recruits, age 1, 1970 to 1991 : 229
Geometric mean recruits, age 1, 1970 to 1991 : 206

Table 3.5.14 Saithe, North Sea
Input for Catch Prediction

Age	1994 Stock Numbers (10**-3)	Scaled Mean F 1989 - 1993 H. cons.	Scaled Mean F 1989 - 1993 Ind BC	Mean Wt. at age (kg) 1989 - 1993 Stock	Mean Wt. at age (kg) 1989 - 1993 H. cons.	Mean Wt. at age (kg) 1989 - 1993 Ind BC	M	P. mat
1	214000	.005	.000	.404	.407	.050	.200	.000
2	166000	.056	.000	.600	.605	.331	.200	.000
3	100278	.289	.007	.858	.878	.471	.200	.000
4	75399	.541	.008	1.177	1.192	.582	.200	.150
5	22240	.572	.003	1.648	1.655	.617	.200	.700
6	12597	.528	.001	2.331	2.333	.635	.200	.900
7	3608	.442	.000	3.472	3.472	.000	.200	1.000
8	1495	.471	.000	4.503	4.503	.000	.200	1.000
9	1133	.556	.000	5.805	5.805	.000	.200	1.000
10	1086	.556	.000	7.466	7.466	.000	.200	1.000

Mean F	(3 - 6)	(2 - 5)
Unscaled	.568	.011
Scaled	.482	.005

Recruits at age 1 in 1995 = 206460
Recruits at age 1 in 1996 = 206460

Stock numbers in 1994 are VPA survivors.
These are overwritten at Age 1 Age 2

Bycatch Fs are obtained from mean exploitation pattern over 1989 to 1993.
This is scaled to give a value for mean F (ages 2 to 5) equal to that in 1993, i.e. .005

Table 3.5.15 Saithe North Sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

		1994	1995						
Mean F	**Ages**								
H.cons	3 to 6	.48	.00	.19	.29	.34	.39	.48	.58
Ind BC	2 to 5	.00	.00	.00	.00	.00	.00	.00	.00
Effort relative to	1993								
H.cons		1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass at start of year									
Total		461	494	494	494	494	494	494	494
Spawning		99	115	115	115	115	115	115	115
Catch weight (,000t)									
H.cons		97	0	48	69	79	88	106	122
Ind BC		1	1	1	1	1	1	1	1
Total Landings		97	1	49	70	80	89	107	123
Biomass at start of	1996								
Total			651	592	566	554	543	521	501
Spawning			208	169	153	145	138	125	113

		1994	1995						
Effort relative to	1993								
H.cons		1.00	.00	.40	.60	.70	.80	1.00	1.20
Ind BC		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Est. Coeff. of Variation									
Biomass at start of year									
Total		.19	.19	.19	.19	.19	.19	.19	.19
Spawning		.15	.29	.29	.29	.29	.29	.29	.29
Catch weight									
H.cons		.36	.00	.75	.51	.44	.40	.34	.30
Ind BC		1.38	1.37	1.37	1.37	1.37	1.37	1.37	1.37
Biomass at start of	1996								
Total			.18	.19	.19	.20	.20	.20	.20
Spawning			.26	.31	.31	.31	.31	.31	.31

Forecast for year 1994
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	By-catch	Total
1	214000	967	0	967
2	166000	8201	0	8201
3	100278	22848	553	23401
4	75398	28709	425	29134
5	22240	8852	46	8899
6	12596	4722	9	4731
7	3608	1177	0	1177
8	1495	513	0	513
9	1132	442	0	442
10	1086	424	0	424
Wt	461	97	1	98

Forecast for year 1995
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	By-catch	Total
1	206460	933	0	933
2	174335	8613	0	8613
3	128508	29280	709	29989
4	61065	23252	344	23596
5	35651	14190	74	14265
6	10246	3841	7	3848
7	6076	1982	0	1982
8	1899	651	0	651
9	764	298	0	298
10	1041	406	0	406
Wt	495	106	1	107

Table 3.5.16 Saithe North Sea
Input data for catch forecast and linear sensitivity analysis.

Populations in 1994			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	214000	.35	WS1	.40	.36	M1	.20	.10	MT1	.00	.00
N2	166000	.31	WS2	.60	.18	M2	.20	.10	MT2	.00	.00
N3	100278	.35	WS3	.86	.15	M3	.20	.10	MT3	.00	.10
N4	75398	.59	WS4	1.18	.19	M4	.20	.10	MT4	.15	.10
N5	22240	.27	WS5	1.65	.17	M5	.20	.10	MT5	.70	.10
N6	12596	.21	WS6	2.33	.14	M6	.20	.10	MT6	.90	.10
N7	3608	.22	WS7	3.47	.11	M7	.20	.10	MT7	1.00	.10
N8	1495	.22	WS8	4.50	.08	M8	.20	.10	MT8	1.00	.00
N9	1132	.23	WS9	5.81	.08	M9	.20	.10	MT9	1.00	.00
N10	1086	.25	WS10	7.47	.08	M10	.20	.10	MT10	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.01	1.49	WH1	.41	.35
sH2	.06	.72	WH2	.61	.19
sH3	.29	.35	WH3	.88	.16
sH4	.54	.20	WH4	1.19	.19
sH5	.57	.16	WH5	1.66	.17
sH6	.53	.25	WH6	2.33	.14
sH7	.44	.34	WH7	3.47	.11
sH8	.47	.46	WH8	4.50	.08
sH9	.56	.23	WH9	5.81	.08
sH10	.56	.23	WH10	7.47	.08

Ind selectivity			Industrial wt		
Labl	Value	CV	Labl	Value	CV
sI1	.00	2.71	WI1	.05	1.47
sI2	.00	1.28	WI2	.33	.35
sI3	.01	.56	WI3	.47	.24
sI4	.01	.43	WI4	.58	.36
sI5	.00	1.18	WI5	.62	.90
sI6	.00	1.53	WI6	.64	1.12
sI7	.00	2.38	WI7	.00	2.01
sI8	.00	2.07	WI8	.00	1.78
sI9	.00	2.50	WI9	.00	2.29
sI10	.00	2.61	WI10	.00	2.30

Year effect M			HC relative eff			Ind reltive eff		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
K94	1.00	.10	HF94	1.00	.31	IF94	1.00	1.29
K95	1.00	.10	HF95	1.00	.31	IF95	1.00	1.29
K96	1.00	.10	HF96	1.00	.31	IF96	1.00	1.29

Recruitment		
Labl	Value	CV
R95	206460	.45
R96	206460	.45

Stock numbers in 1994 are VPA survivors.,
These are overwritten at Age 1 Age 2 ,
,
,
Bycatch Fs are obtained from mean exploitation pattern over 1989 to 1993.,
This is scaled to give a value for mean F (ages 2 to 5) equal to that in 1993, i.e. .005

Table 3.5.17 Saithe North Sea. Model parameters for stock-recruitment

Beverton-Holt curve
Moving average term fitted

IFAIL on exit from E04FDF = 0

Residual sum of squares= 3.4620

Number of observations= 22

Number of parameters = 3

Residual mean square = .1822

Coefficient of determination = .2029

Adj. coeff. of determination = .1190

IFAIL from E04YCF= 0

Parameter Correlation matrix

1.0000		
-.9865	1.0000	
-.0623	.0691	1.0000,

Parameter,s.d.

4.0781	3.2337
73.0419	81.3251
.3153	.2200

Table 3.5.18

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	1992	1993
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		
1993	0.68	0.67	0.73	0.59	0.59	0.59	
1994	0.67	0.65	0.69	0.51	0.55	0.60	0.48

Remarks:

Assessment Quality Control Diagram 2

Estimated total landings ('000 t) at *status quo* F								
Date of assessment	Year							
	1988	1989	1990	1991	1992	1993	1994	1995
1989	109	118	120					
1990	162	94	116	125				
1991		102	95	91	102			
1992			96	90	123	121		
1993				99	92	89	97	
1994					87	123	97	106
					SQC[1]	SQC[2]	Current	Forecast

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

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

where $F(y)$, $F(y-1) \wedge F(y-2)$ *are as estimated* $\in$ *the assessment made* $\in$ *year* $(y+1)$.

Remarks:

Continued

Table 3.5.18 Continued

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	1992	1993
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]		
1993	179	201	108	191[1]	191[1]	191[1]	
1994	167	203	128	198	214	204	206[1]

[1]Geometric average recruitment.

Remarks:

Assessment Quality Control Diagram 4

Spawning stock biomass ('000 t)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1989	186	236	244[1]	240[1]					
1990	125	122	166	206[1]	233[1]				
1991	106	87	74	70	79[1]	85[1]			
1992	102	82	66	56	68	83[1]	79[1]		
1993	102	84	69	70	81	81	76[1]	85[1]	
1994	109	90	81	82	91	105	99	115[1]	125[1]

[1]Forecast.

Remarks:

Fig. 3.5.1 Saithe North sea and Division IIIa

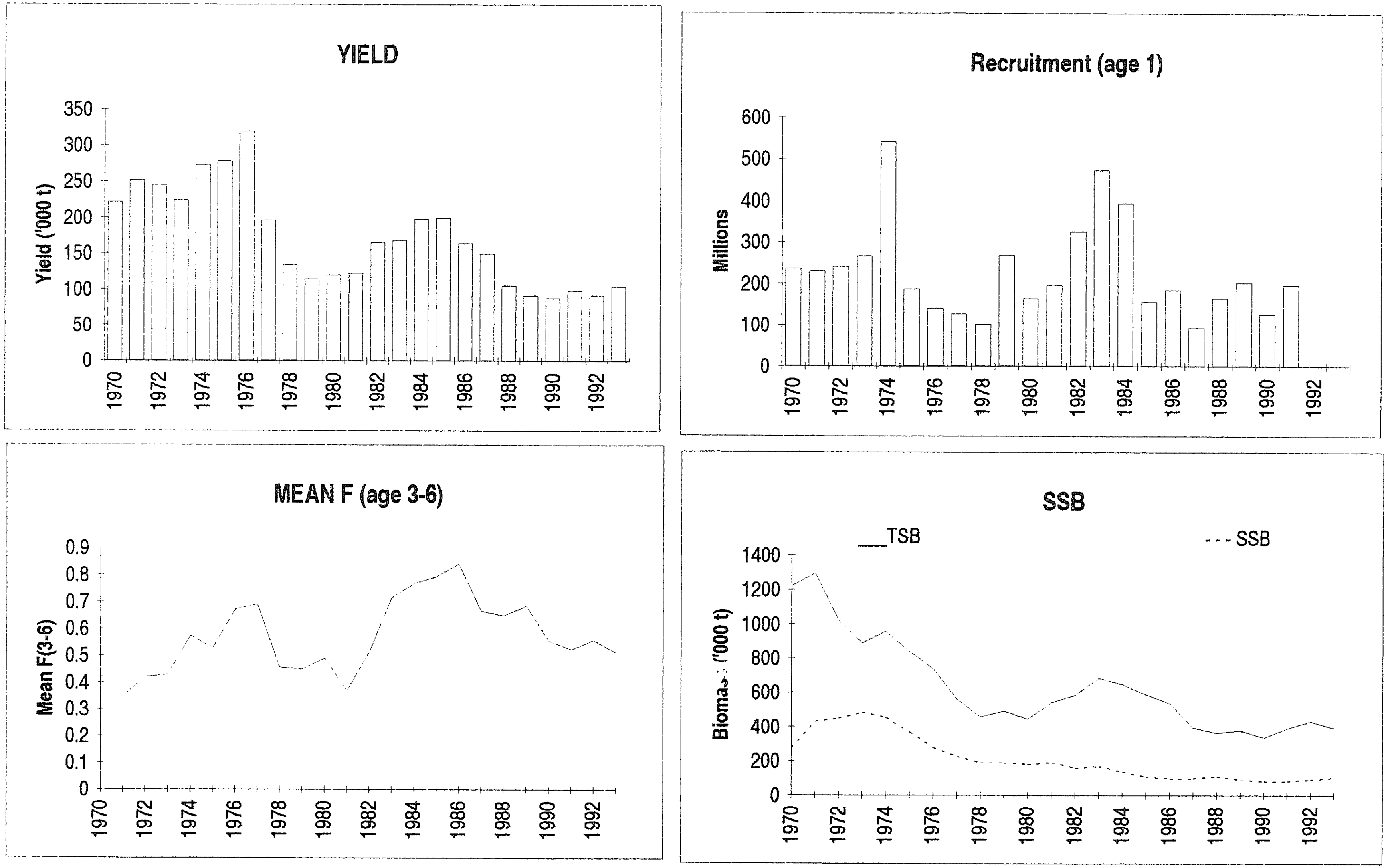
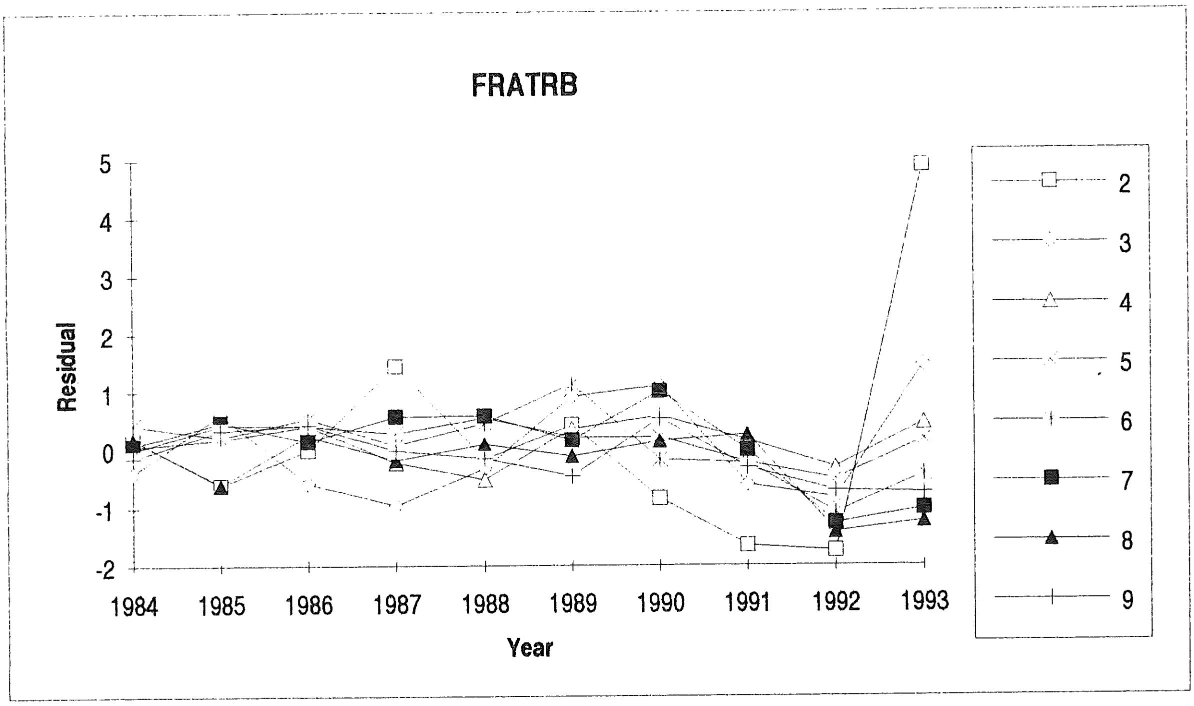


Fig. 3.5.2 Saithe North Sea. Residuals from XSA analysis for French and Norwegians trawlers



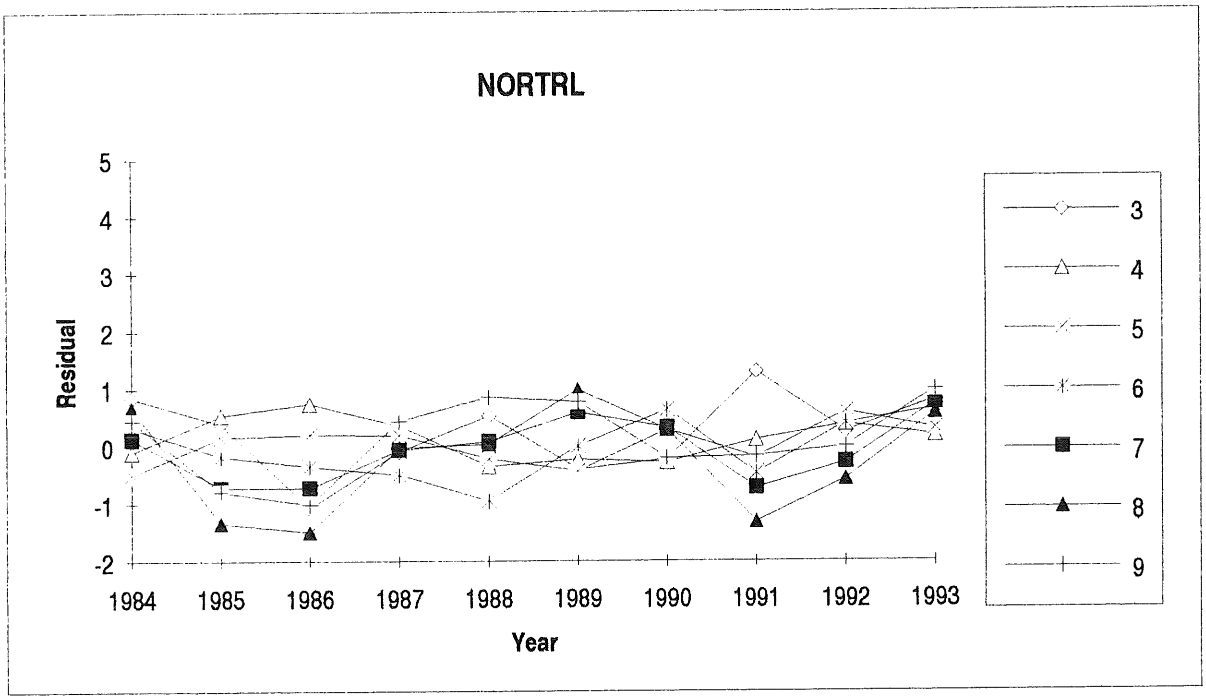


Figure 3.5.3 Saithe North Sea

Retrospective, Commercial data only

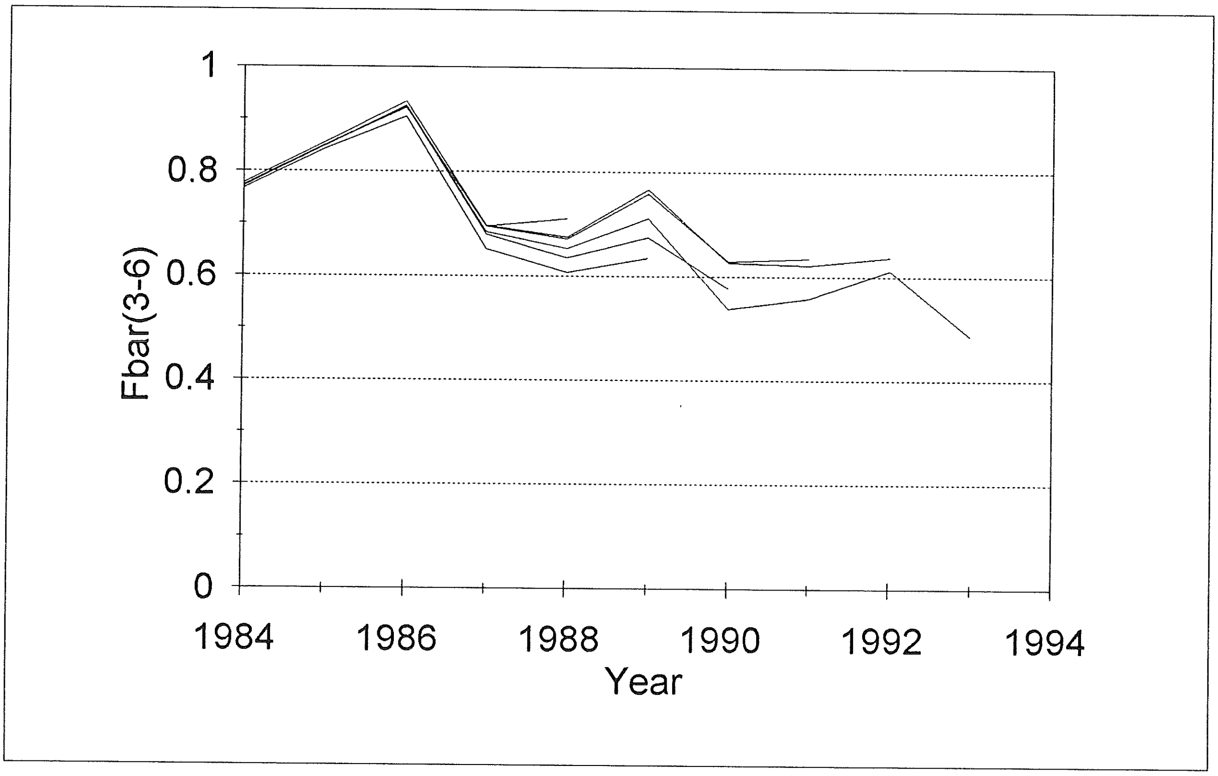


Figure 3.5.4

North sea Saithe
RV indices and VPA estimates (1993 assessment)

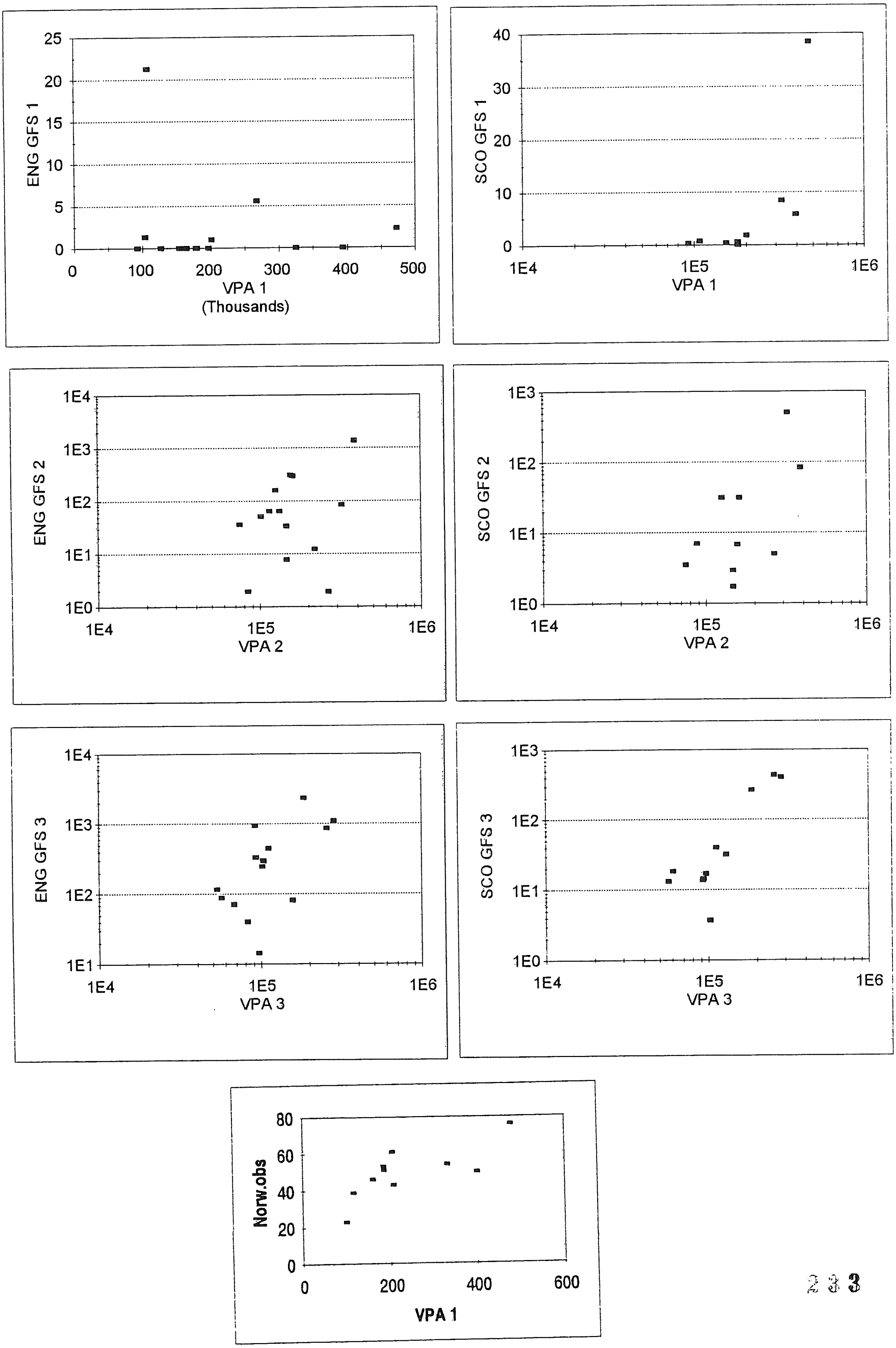
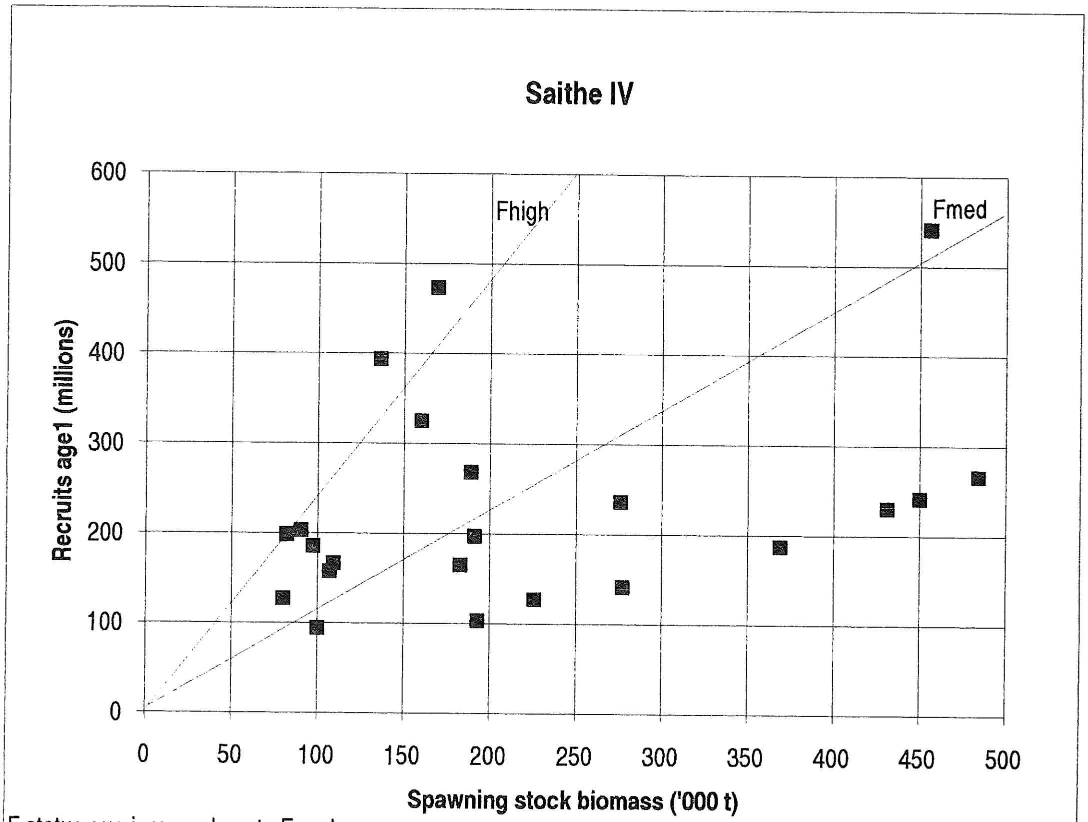


Fig. 3.5.5 Saithe North Sea. Recruitment on spawning stock biomass



F status quo is very close to Fmed

Fig. 3.5.6 Saithe North Sea. Yield per recruit

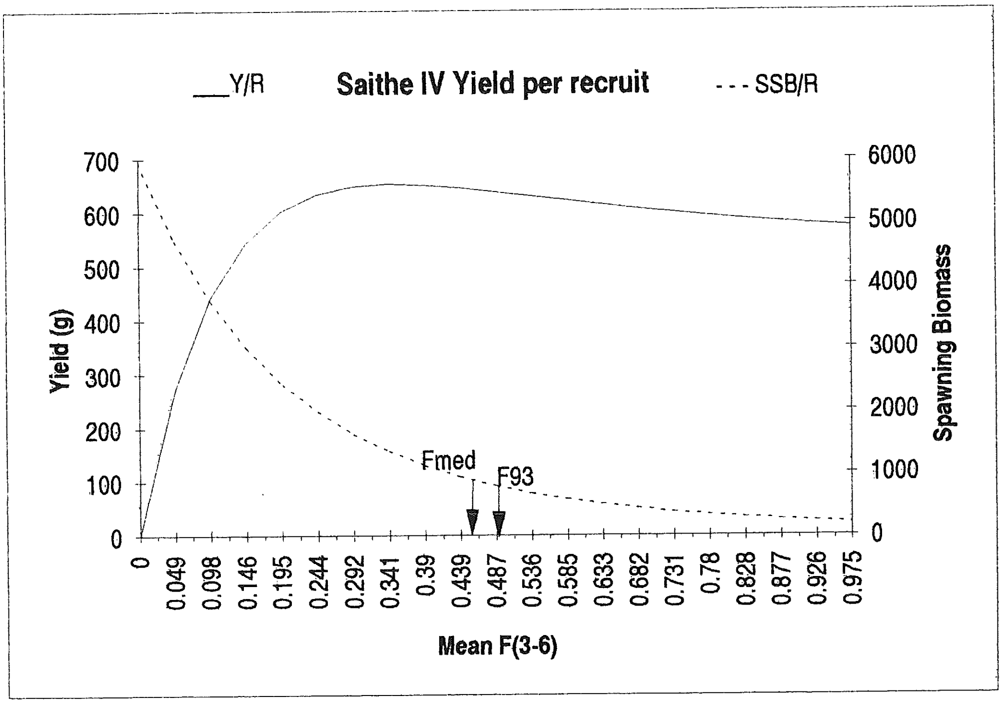


Fig. 3.5.7 Saithe North Sea. Yield and SSB in the short term prediction

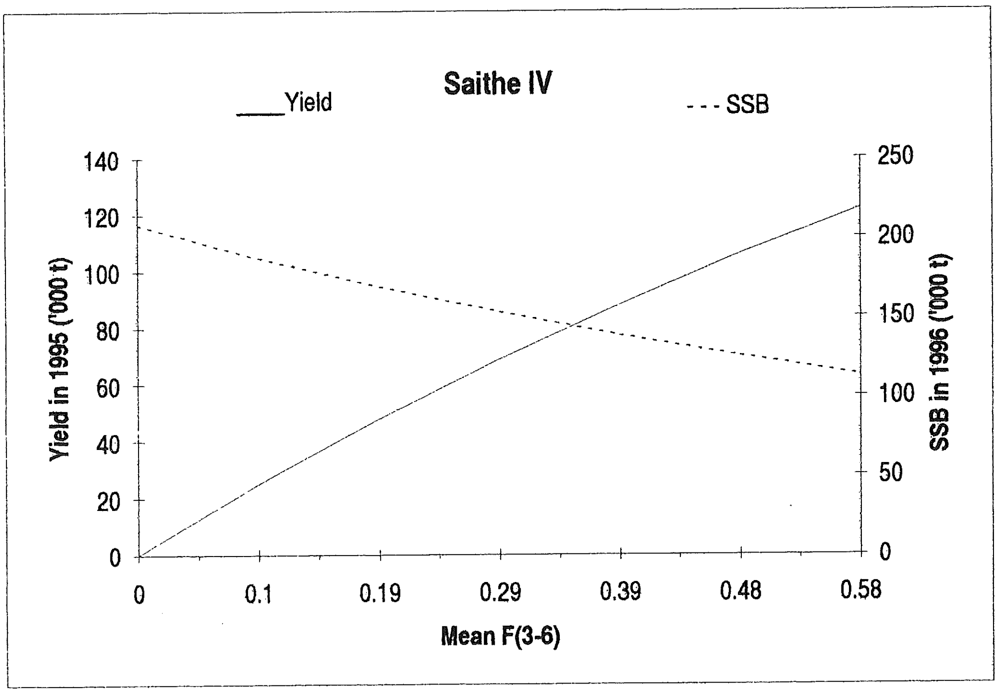
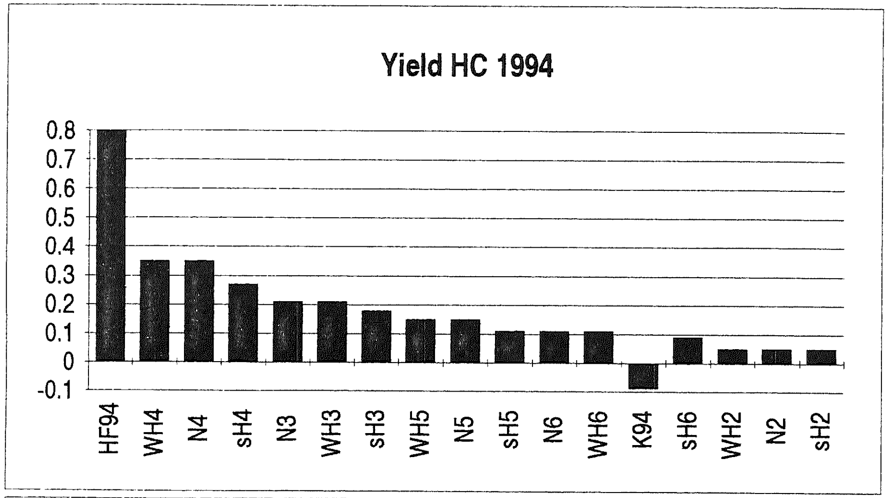
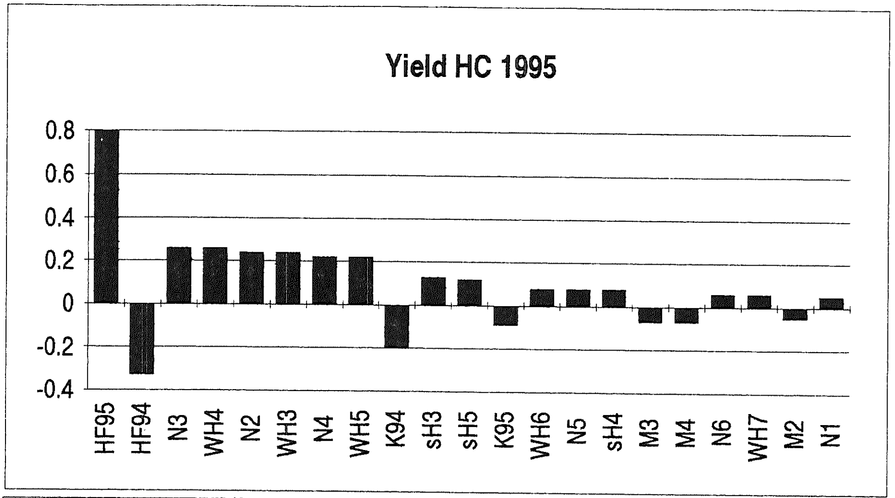
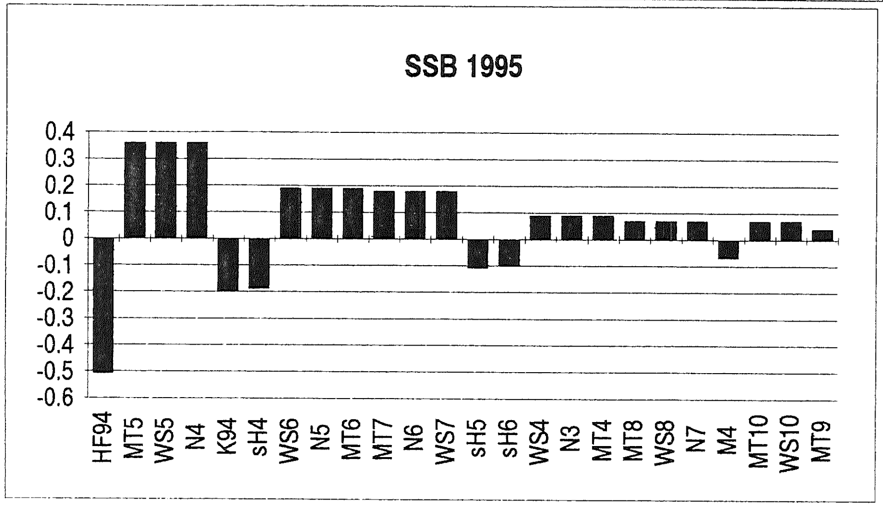


Fig: 3.5.8 Saith North Sea Sensitivity analysis of short term forecast
Linear sensitivity coefficients (elasticities).







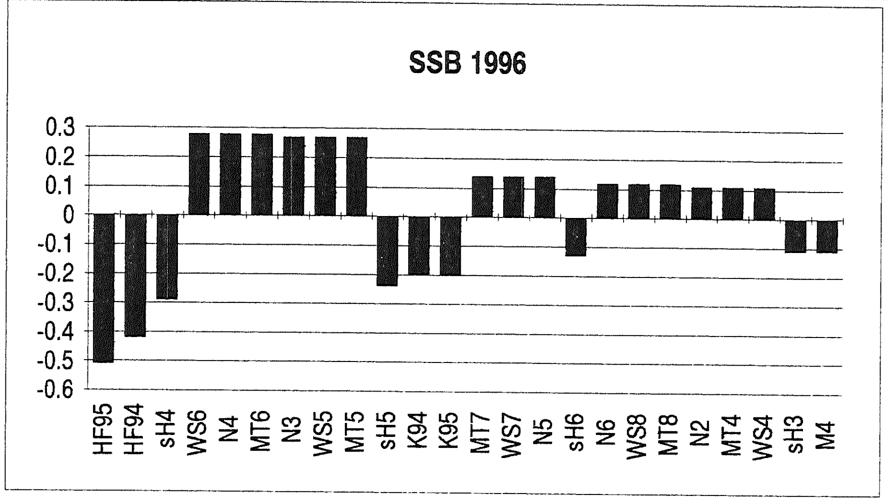


Fig. 3.5.9 Saithe North Sea. Sensitivity analysis of short term forecast. Proportion of total variance contributed by each input value

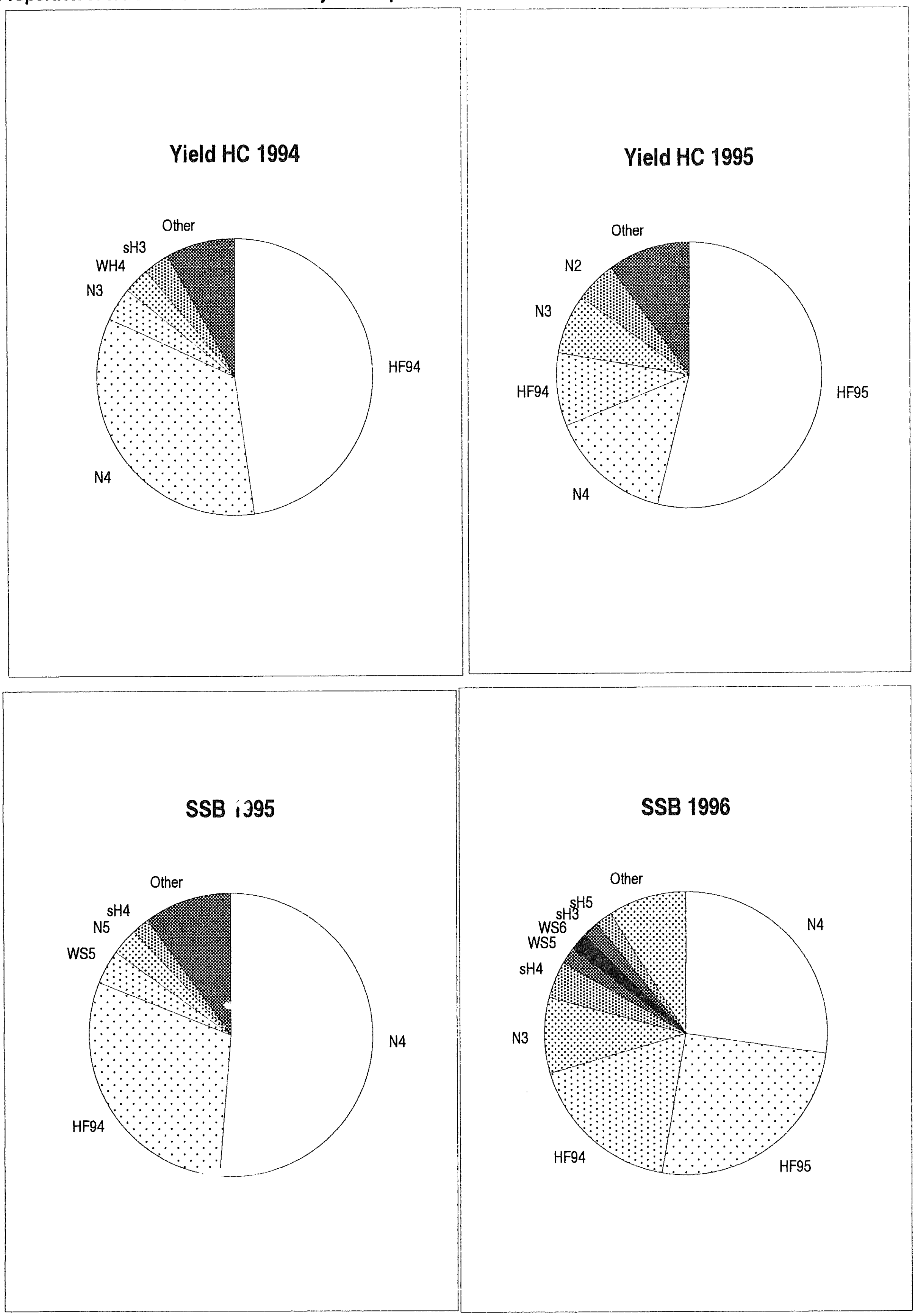


Fig. 3.5.10 Saithe North Sea. Sensitivity analysis of short term forecast.
Cumulative probability distributions

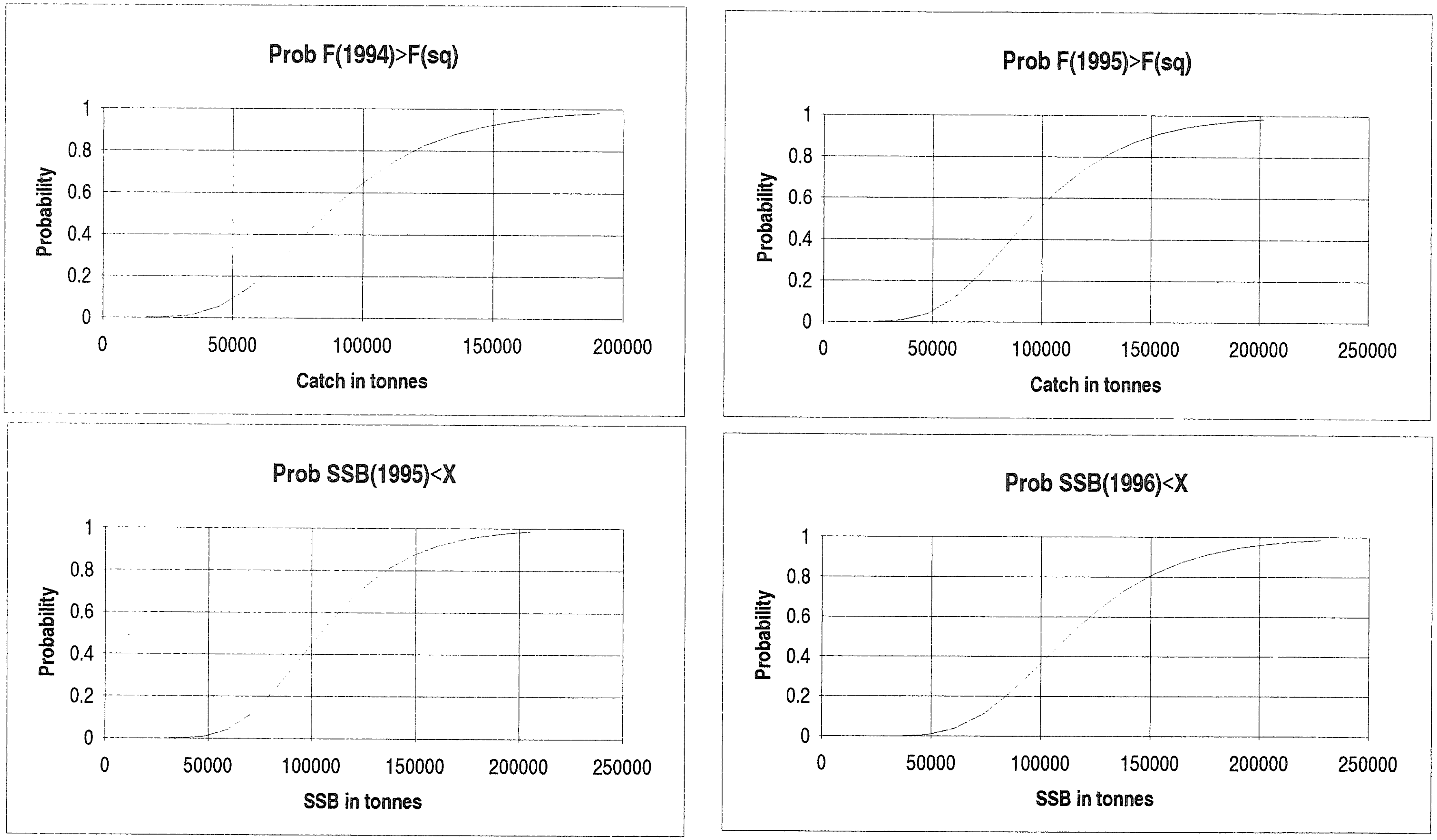


Fig. 3.5.11 Saithe North sea. Mediun term predictions. Solid lines show 5, 25, 50, 75 and 95 percentiles
Dashed lines show five sample trajectories. Number of simulations= 500

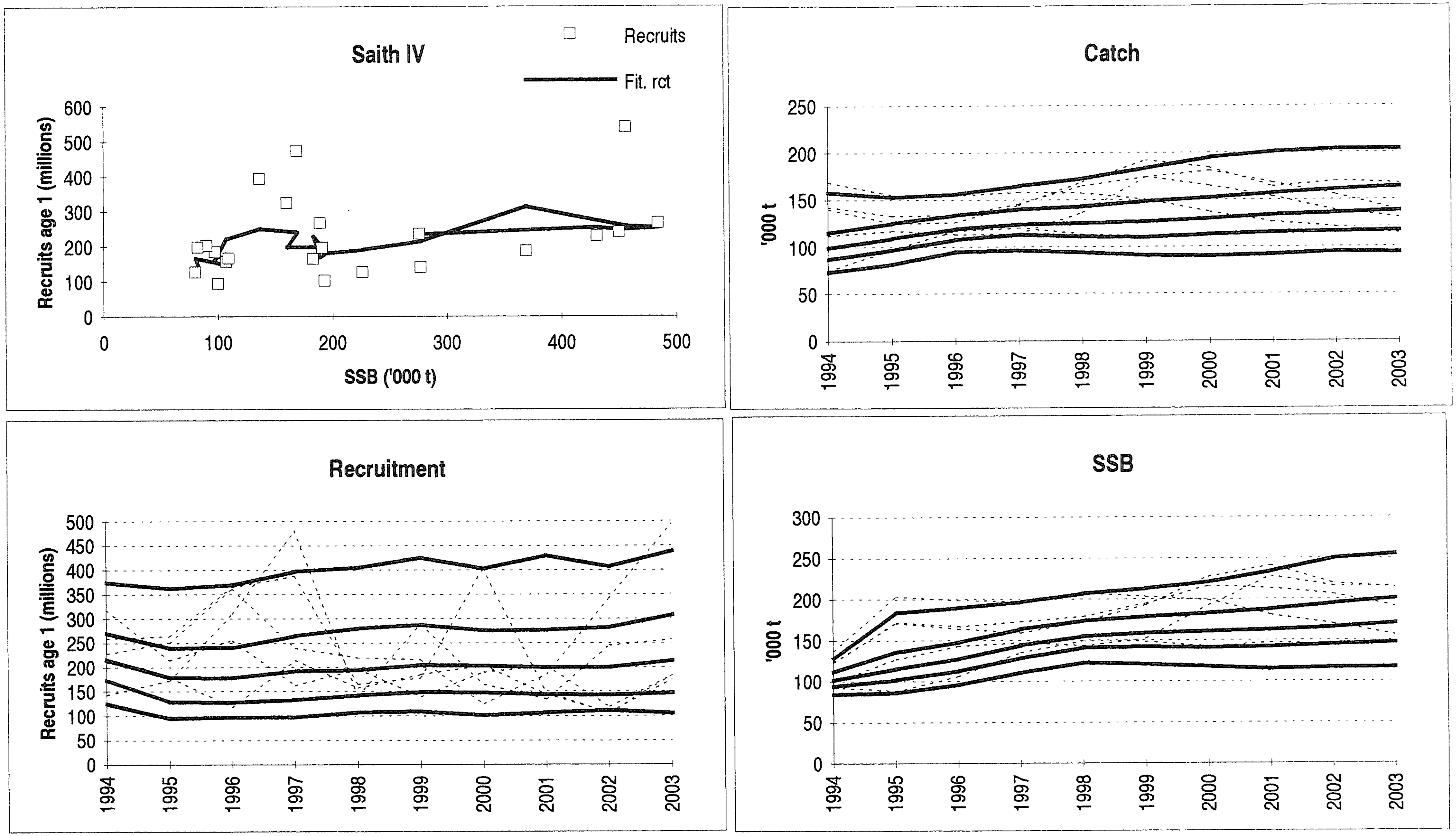
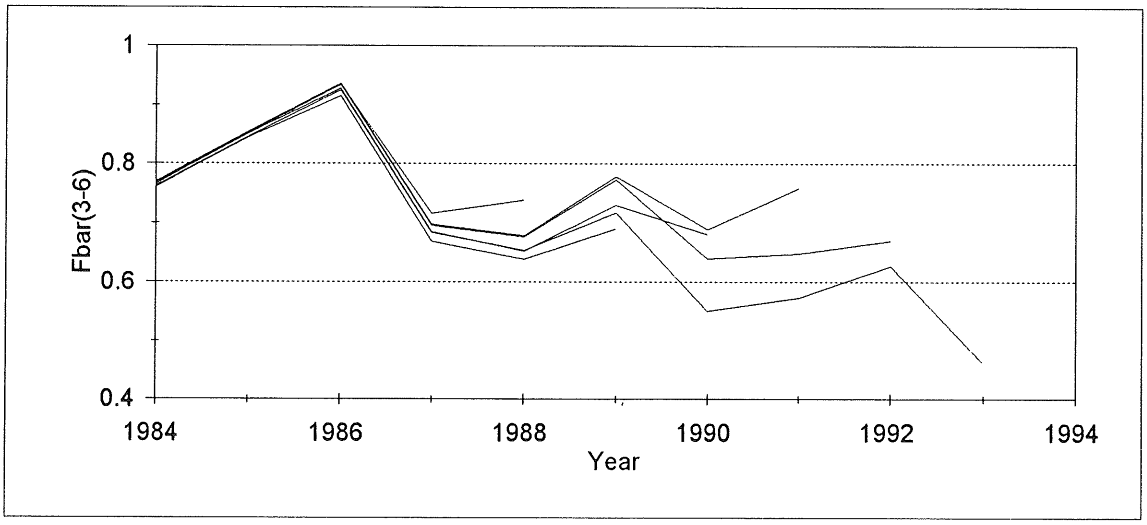


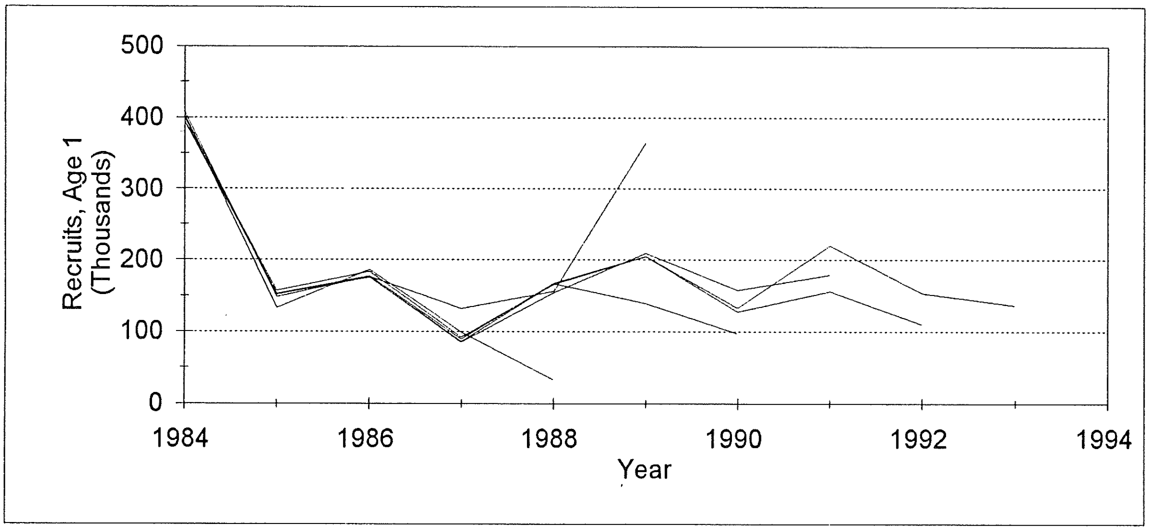
Figure 3.5.12

Saithe, North Sea

Retrospective trends in Mean F, All fleets (survey and commercial)



Retrospective trends in recruitment, All fleets (survey and commercial)



Retrospective trends in recruitment, Commercial data only

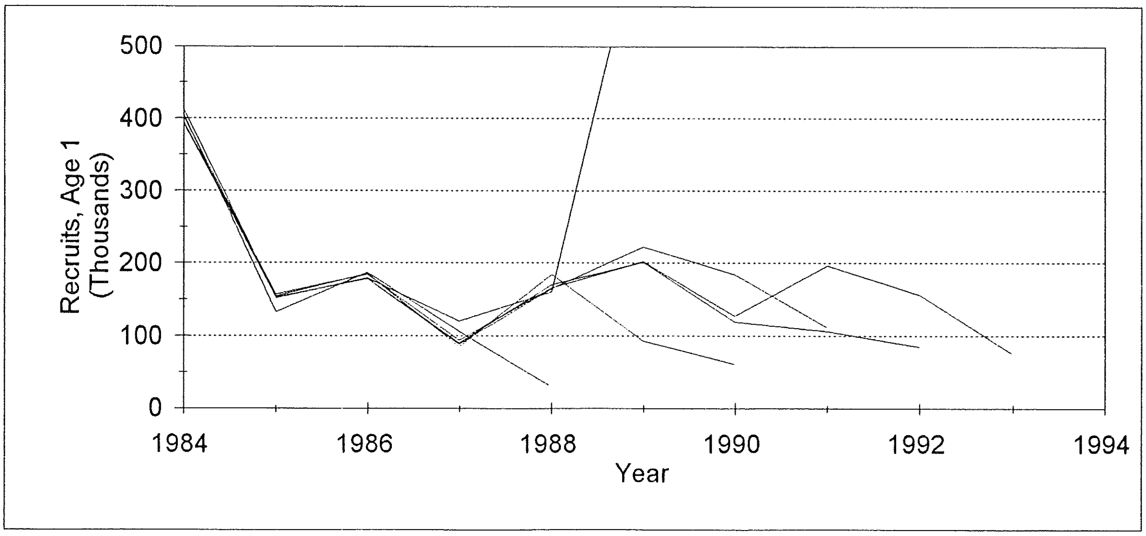


Figure 3.5.13

North Sea Saithe, Retrospective estimation of recruitment

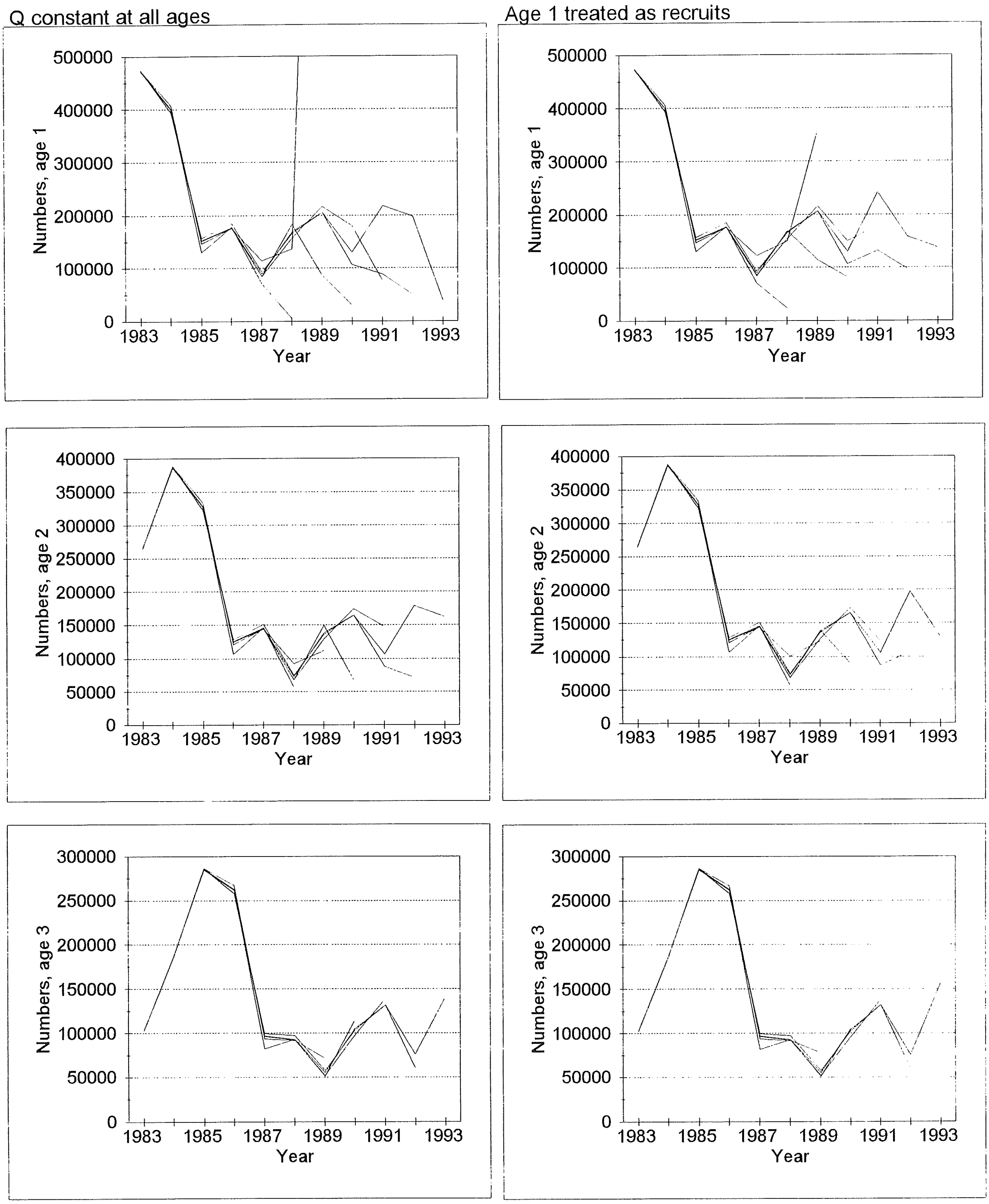


Figure 3.5.14

North Sea Saithe, Retrospective estimation of recruitment

Ages 1-2 treated as recruits | Ages 1-3 treated as recruits