Advisory Committee on Fishery Management

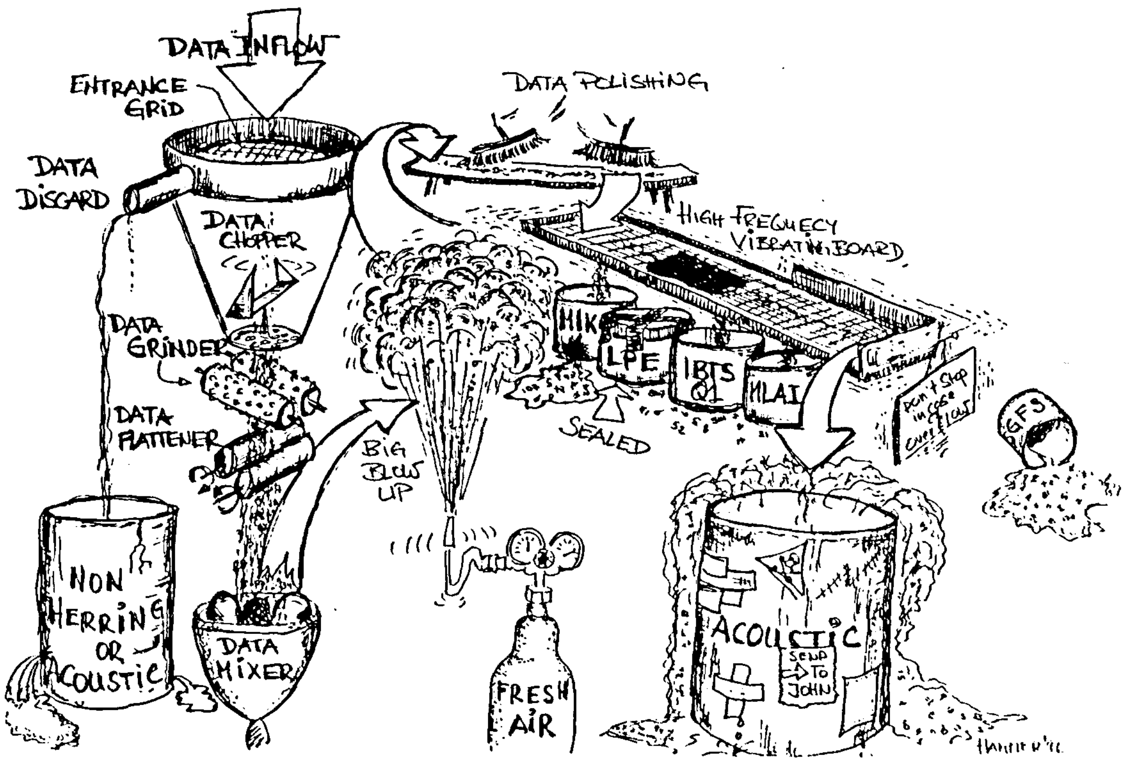
ICES CM1996/Assess: 10

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

ICES Headquarters, Copenhagen, Denmark

9 - 18 April 1996

PART 1 OF 2



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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Participants

Armstrong, M.	United Kingdom
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Hammer, C.	Germany
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Melvin, G.	Canada
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Molloy, J.	Ireland
Mosegaard, H.	Denmark
Munk, P.	Denmark
Nash, R.	United Kingdom
Nichols, J.	United Kingdom
Patterson, K.	United Kingdom
Simmonds, J.	United Kingdom
Toresen, R. (Chairman)	Norway
Torstensen, E.	Norway
Vérin, Y.	France
Winters, G.	Canada
Schnack, D.	(Germany) attended the meeting for 1 day for the discussion on larval surveys.

1.2 Terms of Reference

The Working Group met at ICES Headquarters from 9–18 April 1996 with the following terms of reference (C.Res. 1995/2:13:5):

a) assess the status of and provide catch options (by fleet where possible) for 1997 for the North Sea autumn-spawning herring stock in Division IIIa, Sub-area IV, and Division VIId (separately, if possible, for Divisions IVc and VIId), the herring stocks in Division VIa and Sub-area VII, and the stock of spring-spawning herring in Division IIIa and Sub-divisions 22-24 (Western Baltic);

b) assess the status of and provide catch options for 1997 for the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;

c) provide the data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1995 by statistical rectangle of the North Sea for herring and sprat);

d) provide estimates of the minimum biologically acceptable level of spawning stock biomass (MBAL) for as many stocks as possible, with an explanation of the basis on which the estimates are obtained;

e) prepare medium-term forecasts under different management scenarios, taking into account uncertainties in data and assessments and possible stock-recruitment relationships, and indicate the associated probability of the stocks falling or remaining below MBAL within a stated time period;

f) review the need for, and coverage of herring larvae surveys with a view to enhancing and improving both the surveys and analysis.

1.3 Request from EU and Norway

The Working Group received a request from the Chairman of ACFM to prepare information to respond to the following request from the European Commission and Norway:

ICES is requested to predict for the North Sea autumn spawning herring stock in 1997 to 2002 the development of:

– SSB in 1997 to 2002
– the catches of adult herring defined as mature herring

– the catches of juvenile herring defined as immature herring

based on assumed recruitment of: 0.1; 0.5 and 1.0 of average recruitment and with stochastic recruitment around the conventional stock-recruitment relationship for the stock;

and levels of exploitation of:

F(juv): 0.00; 0.02; 0.05; 0.1; 0.2 and status quo
F(adult): 0.3

ICES is also requested to analyse various harvest strategies, including and excluding exploitation of juveniles, that will bring the SSB of the stock to 1.5 and 2.0 million tonnes in 2002 with a probability equal to or greater than 50% assuming stochastic recruitment around the conventional stock-recruitment relationship for the stock.

The response to this request was prepared as a separate paper to ACFM, for its meeting in May 1996.

1.4 Report of the Planning Group for Herring Surveys

The report of the Planning Group (Anon 1995a) was presented. The group had worked by correspondence during 1995 and work was limited to the coordination of activities. The coordination of the acoustic surveys was carried in Aberdeen and the coordination of larval surveys in Germany and the Netherlands. The Planning Group for Herring Surveys reported preliminary results from the acoustic survey for use in the assessment for the autumn 1995 meeting of ACFM.

The Planning Group also noted that the full area coverage for the larval surveys is now no longer possible. With the current level of survey effort, specific areas of the Channel and North Sea were surveyed in 1994/5 but the data are insufficient for a larval production estimate and only just sufficient for use in a larval abundance model (Patterson and Beveridge W.D. 1996). Larval data were sent to Aberdeen for entry into the Larval Survey Data Base.

The Planning Group assessed the future projected survey effort and found that currently the acoustic survey will be carried out at the same level as recent years and may be able to provide some information on 1 ring fish. However, there is a need for greater effort to enhance the coverage of the larval surveys.

The Planning Group will meet from 27-31 May 1996 in Lysekil, Sweden. It is proposed that the Planning Group will consider the work required to clarify the accuracy and precision of the acoustic surveys with the aim of explaining the apparent differences in estimates between the period before and after 1989. In addition to the current terms of reference the Planning Group should examine the information needed to assess the past performance of the acoustic surveys and ensure that there are data available in sufficient time for a review meeting in early 1997 prior to the meeting of the Herring Assessment Working Group for the Area South of 62°N (HAWG) in 1997. The results of this planning meeting should be made available to the HAWG meeting in 1997.

1.5 Assessment Methods

1.5.1 Use of XSA for North Sea Herring.

The Working Group in 1995 listed a number of *a priori* reasons why the 'XSA' algorithm for assessing pelagic stocks should not be used. In summary, these were:

- The XSA method can be numerically unstable when applied to small and noisy data sets.
- The implementation available did not include an adequate test that the algorithm had found a reliable solution.
- The XSA method does not provide a parameter variance-covariance matrix.
- The method can be highly dependent on the level of shrinkage chosen by the user.
- An assessment of this stock made in 1993 following the 'Advice to Working Groups from ACFM and the Secretariat' now appears highly erroneous, with stock size in 1992 overestimated by three times.

Following ACFM comments, the relative performance of the Working Group's assessment model (an ICA formulation, see Section 2.8.2) and the XSA algorithm were tested in conventional retrospective analyses. The ICA model (using data as described in Section 2.8.2.) was used to calculate a series of stock assessments by successively deleting the final year's data. A similar procedure was followed using the XSA method and using the same data sets, except that the XSA cannot be used to fit to biomass-aggregated indices of abundance, nor can observations taken after the last year of the catch-at-age matrix be included. These data were therefore not included in the XSA run. Due to the short time-series of information, only four years of retrospective analyses could be calculated. No shrinkage was used in either method. Shrinkage is not appropriate as the stock has a clear trend of increasing fishing mortality in recent years. In cases where it could not be determined that the XSA algorithm had converged, the algorithm was iterated 150 times.

Results are shown in Figure 1.5.1. Both methods consistently under-estimate fishing mortality and over-estimate stock size in the retrospective analyses, but the tendency is much stronger in the case of the XSA algorithm. The ICA model formulation appeared to perform with substantially less bias in retrospective analysis.

1.5.2 Further evaluation of Integrated Catch at Age analysis

Some testing of the consequences of violation of the separability assumption in ICA has been made (Patterson, W.D. 1996). This paper compared the performance of a separable model with an ADAPT 'tuned' approach similar to that of XSA, and addressed two questions:

1. In a situation of stable selection, which method gives the best (lowest mean squared error) estimates of stock size and fishing mortality?
2. In a situation where fishing mortality is increasing and selection on the youngest fish is also increasing, does the conclusion from question 1 remain the same?

These concerns were addressed using 100 Monte-Carlo simulations, for three different levels of variability in the catch-at-age observations and four levels of variability in a simulated survey index (CV= 0, 0.05 or 0.2 for the catches at age, and CV= 0.1, 0.3, 0.5 and 0.8 for the survey). Comparative results are summarised in Figures 1.5.2 - 1.5.5. In the first case with no deviation from separability, the ICA algorithm performed better (as measured by mean squared errors in stock biomass and in fishing mortality) than the ADAPT 'tuned-VPA' approach, for all levels of observation error. In the case of deviation from separability, the ICA algorithm still returned estimates with lower mean squared error, except for the case of estimating fishing mortality when catches at age are highly-variable (CV = 20%) and the age-structured survey index is also highly variable (CV= 80%). However, in such an extreme situation of deviation from constant selection and very noisy data, both methods performed extremely badly in estimating fishing mortality (CV > 170%). For both methods, fishing mortality was estimated much less accurately than stock size, which implies that it is preferable to base catch forecasts on stock size estimates and either a target fishing mortality, or on a recent historic mean.

In consideration of these matters, the Working Group retained the ICA model as its standard assessment model as no other model has yet been shown to perform better for its purposes.

1.5.3 A Method for Assessment under Misreporting

The Working Group noted in 1995 that there was substantial area-misreporting of catches. Catches from around Shetland were reported as from Division VIa(N); catches from the eastern central North Sea were reported from Division IIIa, and catches from Divisions IVc and VIId were reported from Division IVb. Furthermore, the Working Group again noted that 'the relationship between official catches and actual catches is not known'. This misreporting effectively invalidated the Division VIa(N) assessment. Concern was also raised that changes in catch misreporting practices may in some measure account for the successive revision in stock size estimates made by the Working Group, and may account for perceived inconsistencies between catch and survey data.

A model was presented which allowed calculation of stock assessments without the use of landings data (Patterson, W.D. 1996). This model (termed a missing-catch model, MCM) has been structured to reflect current perceptions of data availability for the stocks in question. The following assumptions and simplifications have been made:

1. Catch data are assumed unreliable and are not used.
2. Knife-edge selection is assumed and partially-recruited fish are not included in the analysis.
3. Sampling of the proportions by age in the catches and in the stock are treated as independent of estimates of catches and of abundance respectively.
4. Random sampling for ages in both catch and survey are assumed.
5. Instead of attempting to estimate annual fishing mortalities, a linear trend in fishing mortality with time is fitted.

The model combines features of three assessment methods. Firstly, the separation of proportion-at-age data from landings, and the structure of the maximum-likelihood function follows Haist *et al.* (1993). As an extension to that model structure, the proportion-at-age data from acoustic surveys are treated separately from total abundance estimates.

Secondly, the assumption of uniform selection pattern and the exclusion of landings information which are assumed erroneous follows Cook (1995). The treatment of fishing mortality is a simplification based on Liu and Pitcher (1995).

These authors used a bound-constrained optimisation to fit a separable model with annual estimates of fully-recruited fishing mortality. The estimates were constrained to lie within upper and lower bounds which were simple linear trends with time. As here the observations are few and uncertain, a very strong constraint is applied such that the upper bound coincides with the lower bound. This allows the model to be reparameterised such that only two fishing mortality parameters need be estimated - an intercept (fishing mortality at the start of the period when catches are no longer known) and a slope (annual change in fishing mortality thereafter). Some alternative formulations could be tested (including quadratic and cubic terms), but in practice these were not found to improve the model fits.

Defining the following variables,

a,y - subscripts denoting age and year
N - population abundance
W - weight of fish at age and year
PC - proportions of fish at age and year in the catches
PA - proportions of fish at age and year in the acoustic survey
UA - abundance of fish from an acoustic survey
UL - abundance of fish from a larval survey
QL,QA - 'catchabilities' for the larval and acoustic surveys
F - fishing mortality
f_1,f_2 - parameters of the fishing mortality trend
τ_2 - effective sample size when sampling for proportions at age. See Haist *et al.* (1993) for a discussion of this parameter
σ^2 - survey variance
n_{pc}, n_u - number of observations of proportions in the catches of survey variance respectively.
ξ and alpha are estimates of variances of the proportions of fish by age in the catches, calculated on the assumption of random sampling from a multinomial distribution. $\xi_{a,y}$ is calculated as $PC_{a,y}(1-PC_{a,y},) + 0.01$. See Haist *et al.* (1993) for details.

Fishing mortality and abundance estimates from historic VPA have been assumed to be known precisely up to a given year (1981 for West of Scotland herring). Thereafter, fishing mortality is structured as

$$F_{a,y} = f_1 + f_2.(y - 1981) \qquad (1.5.3.1)$$

The usual catch equations are assumed to hold and are used as the structural model. Natural mortality estimates are as used in the conventional assessment. As absolute estimates of stock size cannot be calculated when catches are not known, all abundance estimates are scaled to VPA-estimated values used at the start of the analysis.

Stock biomass in the structural model is simply calculated as:

$$B_y = \sum_a N_{a,y} W_{a,y} \qquad (1.5.3.2)$$

Parameters QL, QA, f_1-f_2 and relative recruitments $N_{3,1976\text{-}1995}$ are found by maximising the log-likelihood term:

$$-\frac{1}{2}\Sigma_{a,y}\left(\ln(2\pi\,\xi_{a,y})+\ln(\tau^2)+\frac{(PC_{a,y}-\hat{P}C_{a,y})^2}{\tau^2\xi_{a,y}}\right)$$
$$-\frac{1}{2}\Sigma_{a,y}\left(\ln(2\pi\,\alpha_{a,y})+\ln(\tau^2)+\frac{(PA_{a,y}-\hat{P}A_{a,y})^2}{\tau^2\alpha_{a,y}}\right)$$
$$-\frac{1}{2}\Sigma_{y}\left(\ln(2\pi)+\ln(\sigma^2)+\frac{(\ln(QL\ \ B_yK)-\ln(UL_y))^2}{\sigma^2}\right)$$
$$-\frac{1}{2}\Sigma_{y}\left(\ln(2\pi)+\ln(\sigma^2)+\frac{(\ln(QA\ \ B_y)-\ln(UA_y))^2}{\sigma^2}\right)$$

(1.5.3.3)

The variances of the model components (τ^2 and σ^2) were found by iterative recalculation using the following estimates of variance, as appropriate:

$$\hat{\tau}^2=\Sigma_{a,y}\frac{(PC_{a,y}-\hat{P}C_{a,y})^2/(\xi_{a,y}+0.01)}{n_{pc}}$$

(1.5.3.4)

and

$$\hat{\sigma}^2=\Sigma_y\frac{(\ln(UL_y)-\ln(QL.B_y))^2}{n_u}$$

(1.5.3.5)

The model was implemented in an 'EXCEL' spreadsheet. It has not yet been tested by simulation (although a similar model has been tested and used by Patterson, (W.D.1996) for demersal stocks). It has been used by the Working Group to examine the consequences for the conventional stock assessments of relaxing the assumption that landings are known, and to investigate likely trends in misreporting.

1.6 Landing statistics and biological sampling

At the 1995 HAWG meeting (Anon. 1995d) a Sub-Group was established with the task of trying to evaluate current landings statistics and biological sampling systems. A description of current systems in each country was presented to the Working Group (Dalskov, W.D.1996).

For most countries the sections dealing with the national authorities' monitoring system were written by administrators and enforcement officers and the biological sections by scientists.

All countries have a national authority monitoring system. In all countries some form of licensing system has been introduced. Vessel quotas, weekly quotas and other management measures are implemented. It is a general rule that fishermen have to report catches in logbooks or other catch sheets. For nearly all countries, all landings sold must be reported to the national authorities. Despite these systems there are still problems in obtaining the correct landing/catch figures. It is known that there are numerous ways in which errors can occur such as: overweight in boxes or bins and brailers, misreporting from one area to another and "black" or clandestine landings.

Discards and slipping also occur in herring and sprat fisheries due to market conditions and due to high grading. The quantity of discards is not known.

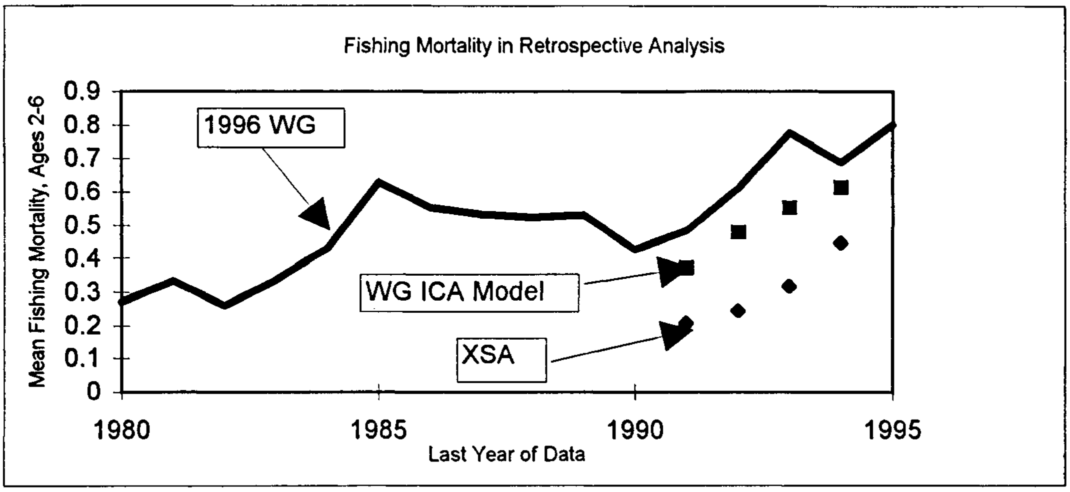
The ways in which biological sampling programmes are conducted are also numerous. All countries take samples, but no overall evaluation of these programmes has been made. The fish are measured, aged and for some samples other biological characters are recorded, such as sex, maturity and vertebral counts.

Over the years sampling intensity has been improved for many fisheries, but generally the sampling level is still far below the standard accepted by the Working Group.

The Working Group asked the Sub-Group to address the following topics and report on their findings to the 1997 meeting of the Working Group.

- Suggestions for a sampling design which could be implemented in all countries.
- Comparison of age/length keys from IBTS, commercial catches and other survey data.
- Investigate the differences in mean age at length for different samples.
- Examine the accepted minimum sampling intensity.
- Address ways in which the amount of discarding, misreporting and "black" landings could be estimated.
- Investigate differences in mean weights obtained from fresh and frozen fish at different times of the year.

The Working Group recommended that all countries establish a programme for observers to sail regularly on commercial fishing trips.



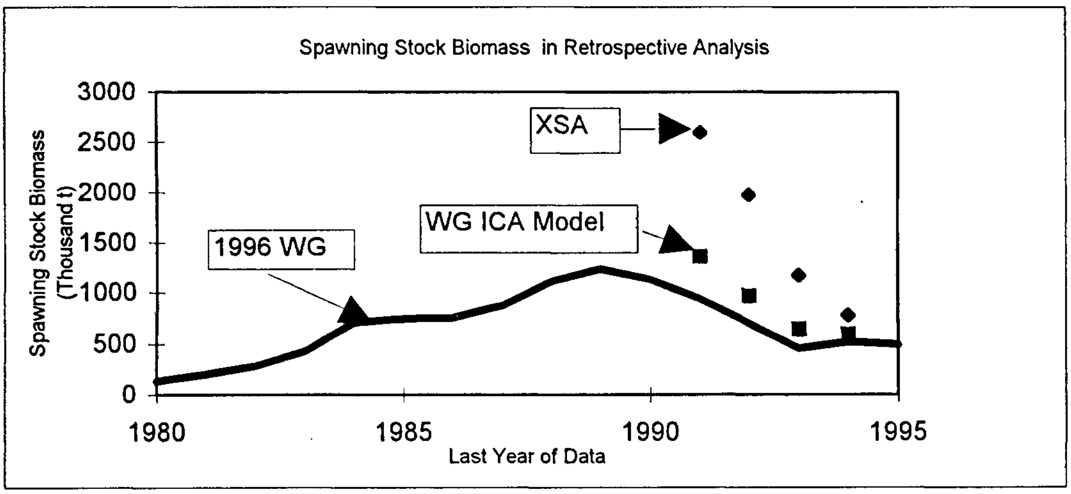


Figure 1.5.1. North Sea Herring. Estimates of spawning stock size and fishing mortality estimated by the 1996 Working Group (Bold Line). Square markers, estimates of fishing mortality and stock size in the last years of retrospective analyses made using the Working Group's assessment model. Diamond markers, estimates of fishing mortality and stock size in the last years of retrospective analyses made using the 'XSA' method. No shrinkage used in either method.

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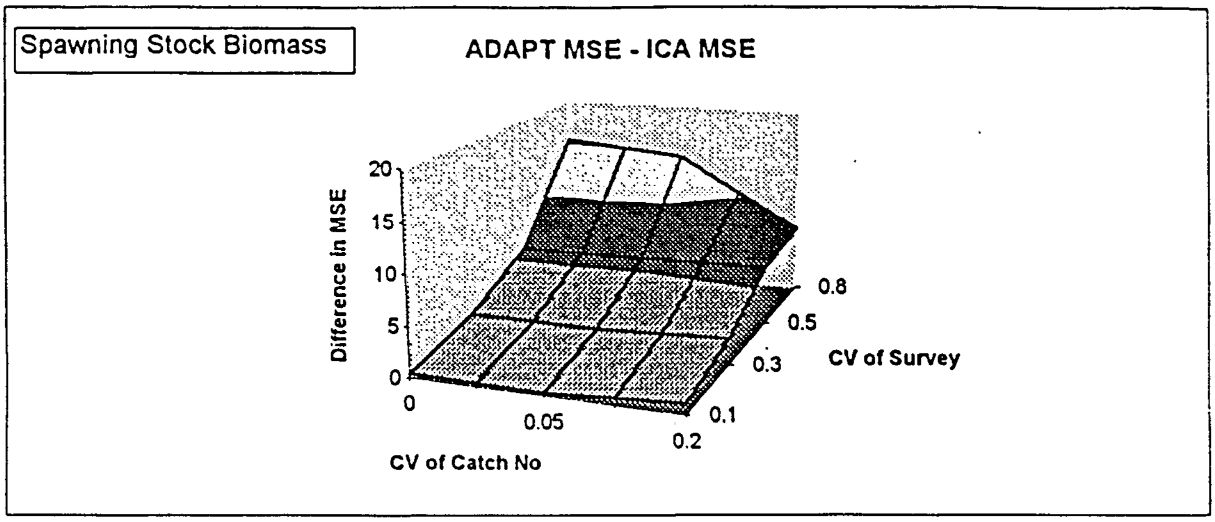

Figure 1.5.2. Difference in the mean squared error of spawning stock biomass estimates in the last year of available data from ICA compared with ADAPT, for simulations in which fishing mortality is constant over time and conforms to a separable pattern. The height of the contour surface indicates the reduction in mean squared error resulting from using the ICA rather than the ADAPT algorithm.

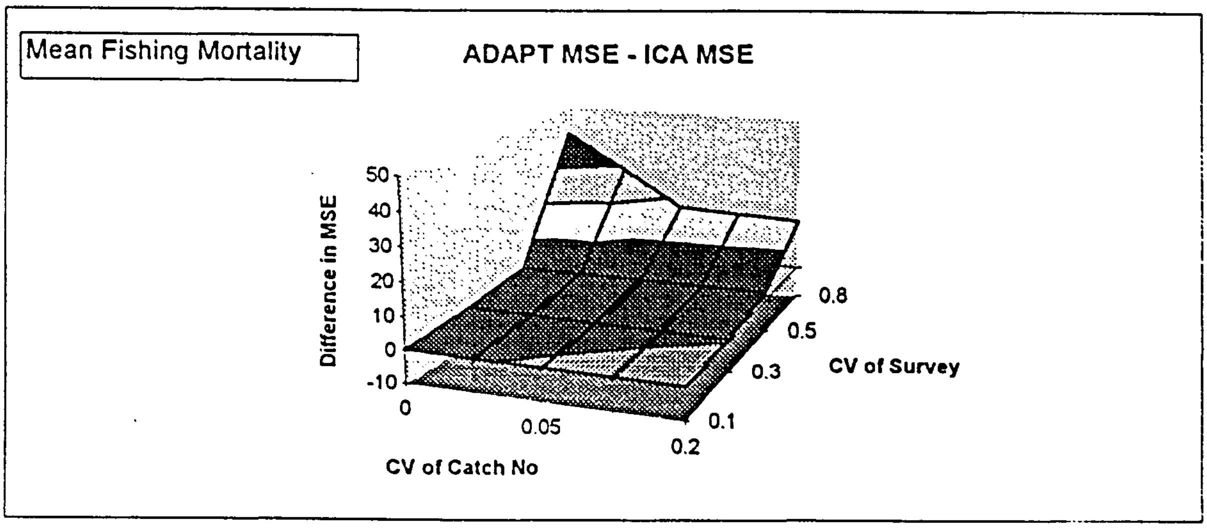

Figure 1.5.3. Difference in the mean squared error of fishing mortality estimates in the last year of available data from ICA compared with ADAPT, for simulations in which fishing mortality is constant over time and conforms to a separable pattern. The height of the contour surface indicates the reduction in mean squared error resulting from using the ICA rather than the ADAPT algorithm.

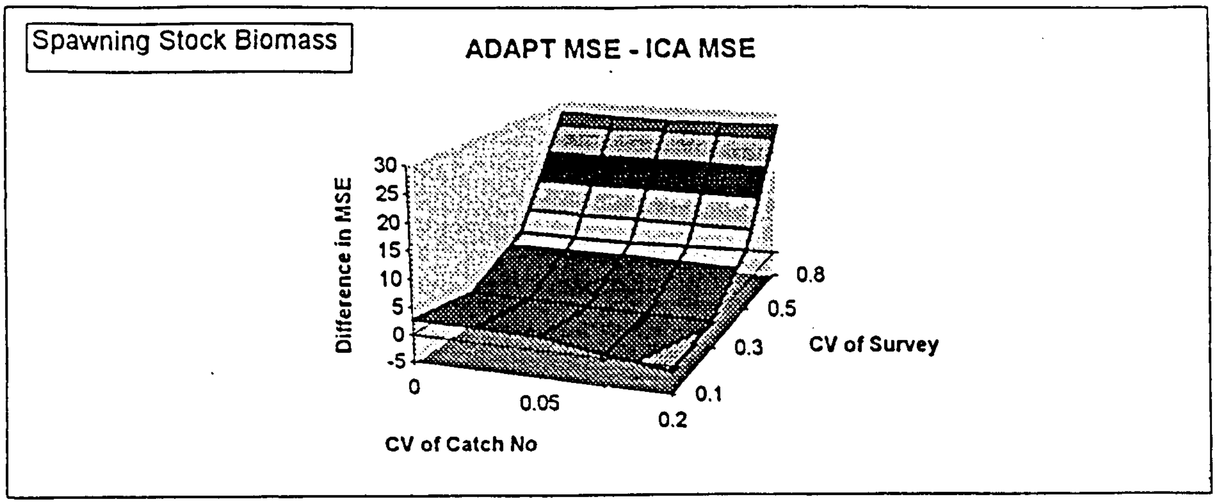

Figure 1.5.4. Difference in the mean squared error of spawning stock biomass estimates in the last year of available data from ICA compared with ADAPT, for simulations in which fishing mortality is increasing with time and selection is increasing on the youngest ages. The height of the contour surface indicates the reduction in mean squared error resulting from using the ICA rather than the ADAPT algorithm.

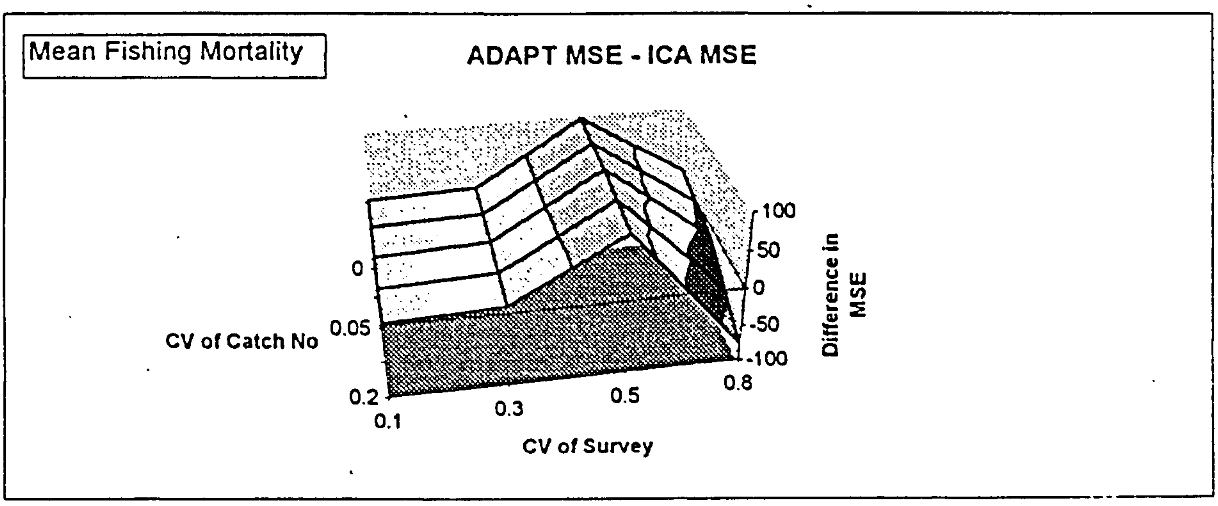

Figure 1.5.5. Difference in the mean squared error of fishing mortality estimates in the last year of available data from ICA compared with ADAPT, for simulations in which fishing mortality is increasing with time and selection is increasing on the youngest ages. The height of the contour surface indicates the reduction in mean squared error resulting from using the ICA rather than the ADAPT algorithm.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1995 and 1996

In 1994 ACFM noted that the spawning stock biomass had declined since 1989 but stated that the stock was above MBAL and advised that an increase in long-term yield could be achieved by reducing the fishing mortality on this stock.

ACFM noted that the catches of juveniles in 1992-93 reached the highest levels since the early 1980s and that such an exploitation pattern would endanger the future spawning stock biomass. A closure of all fisheries in Sub-area IV and Division IIIa where herring are landed as by-catch would result in a long-term net gain in the order of 23% in total yield and 98% in spawning stock biomass when mean recruitment is assumed.

In the 1994 ACFM report a small number of scenarios was presented of catch options for the five different fleets exploiting North Sea herring but no formal TAC advice was given.

The forecast for 1995 for North Sea autumn spawners taken in the North Sea and in Division IIIa using the same fishing mortality in 1995 as in 1993 would give a total catch of 655,000 tonnes, of which 555,000 t would be taken in the North Sea and 100,000 t in Division IIIa.

For the southern North Sea and Channel (Downs herring) it was stated that a catch in 1995 at the same level as the TAC for 1994 (50,000 t) would allow the stock to remain at a fairly stable level.

The TACs adopted by the management bodies for 1995 were: Divisions IVa,b: 390,000 t; Divisions IVc and VIId: 50,000 t.

At the ACFM meeting in 1995 it was stated that the stock was considered to be outside safe biological limits. SSB had declined since 1989 and the most recent assessment indicated that it had fallen below 800,000 t - the level which is considered to be the minimum biologically acceptable level (MBAL) for this stock.

The forecast for 1996 for North Sea autumn spawners taken in the North Sea and in Division IIIa using the same fishing mortality in 1996 as in 1994 will give a total catch of 572,000 t, which 494,000 t should be taken in the North Sea and 78,000 t in Division IIIa.

ACFM recommended a significant reduction in exploitation in order to rebuild SSB and suggested that F in 1996 be reduced by at least 50% of levels observed in 1994.

The TACs adopted by the management bodies for 1996 are: Divisions IVa,b: 263,000 t; Divisions IVc and VIId: 50,000 t.

2.1.2 Catches in 1995

Total landings in 1995 are given in Table 2.1.1 for the total North Sea and for each division in Tables 2.1.2 to 2.1.5.

The total catch in 1995 of 534,000 t is higher than 1994 (467,000 t.) and at the same level as in 1993 (524,000 t.). The increasing catch level is due to an increase in Danish landings despite more and more effort being put into reducing by-catch of herring in the small-meshed fishery. In 1995 the by-catch level of herring in the sprat fishery was 20,000 t higher than in 1994 when the level was very low due to a large sprat stock. The sprat fishery in 1995 was also at a high level. By-catches of herring in the small-meshed fishery (64,000 t) are not counted against the TAC. The 1995 catch exceeded the TAC by 94,000 t.

In all of the five last years, TACs have been exceeded by a significant amount. In the text table below, this excess of the catches over the TACs (in '000 t) for Sub-area the Division IV and Division VIId is shown for the years 1991 to 1995.

Year	1991	1992	1993	1994	1995
TAC	420	430	430	440	440
Official Landings	400	403	409	414	415
Working Group Landings	561	544	521	465	534
Excess of landings over TAC	141	114	91	25	94

Misreporting of landings continued in 1995. Danish human consumption landings reported as having been taken in the Skagerrak have been transferred to the North Sea. There are strong indications that catches taken in the North Sea were reported as having been taken in Division VIa North (see Section 5). Only misreported landings from Division VIa North have been transferred in 1995. This year, unallocated landings have increased drastically. Discards and slipping also occur in the North Sea due to market conditions and due to high grading. This amount is not known and could in some seasons be substantial.

As in previous years, Norwegian catches of Norwegian spring spawners (counted against another TAC) were removed.

In Divisions IVc and VIId, the estimated catch of close to 63,000 t is 10,000 t lower than in previous years and at the same level as in 1991. The landings exceeded the TAC by 13,000 t for that area.

2.2 Biological Composition of the Catch

2.2.1 Catch in number and weights at age

Quarterly and annual catches in numbers and mean weights at age were compiled for each division and for the total North Sea. Table 2.2.1 provides a breakdown of numbers caught by age group for each division on a quarterly and annual basis for 1995. North Sea catches in numbers at age over the years 1970-1995 are given in Table 2.2.2.

The catches in numbers of Division IIIa-Western Baltic spring spawners caught in the North Sea in 1987-1995 and transferred to the Division IIIa-Western Baltic stock are presented in Table 2.2.3. The estimated numbers of North Sea autumn spawners caught in Division IIIa in 1987-1995 and transferred to the North Sea assessment are given in Table 2.2.4. Table 2.2.5 summarises the total catch in numbers at age of North Sea autumn spawners used in the assessment.

The total catch in number in the North Sea in 1994 (9.6 billion) is 2.8 billion higher than in 1994 but lower than in the years 1992 and 1993. In 1995 the catch of 0-ringers (6.3 billion) has been increased compared to 1994 (3.7 billion) but less than 1992 and 1993 when the landings of 0-ringers were 7.6 billion and 7.0 billion respectively.

In 1995 the 2-ringers were dominant in the catches in Divisions IVa and IVb (Table 2.2.6). In previous years catches in this area consisted predominantly of 3-ringers and older (especially year classes 1985 and 1986). In the Southern North Sea, in 1995, 3-ringers and older were dominant in the landings and the age composition is also shown in Table 2.2.1.

Catches of juvenile North Sea autumn spawners were also taken in Division IIIa. These catches (1.7 billion 0-ringers and 1.1 billion 1-ringers) were higher than in 1994 but much lower than in 1993 and 1992. The total catch of 0- and 1-ringers in 1992 and 1993 were among the highest recorded and this reduction in catch in young herring indicates a major change in exploitation pattern in the fisheries. As in the North Sea the reduction in juvenile herring catches is probably related to high abundance of the sprat stock.

The SOP by age and division for each quarter is given in Table 2.2.7.

Table 2.2.8 gives the age compositions separately for the catch of the human consumption fishery (fleet A), the small-mesh industrial fishery (fleet B) in the North Sea, the human consumption fishery in Division IIIa (fleet C), the mixed clupeoid fishery in Division IIIa (fleet D) and other landings for industrial purposes in Division IIIa (fleet E). It should be remembered that fleet B refers only to Denmark and that it was not possible to split the small meshed catches from Norway. Norwegian small meshed catches are included in fleet A.

2.2.2 Quality of catch and biological data

The relationship between official and actual catches is unknown. Estimates of discards were not provided by any country, but discards occur in the fisheries of most countries and could be a considerable amount. The larger proportion of 2-ringers in the catches in 1995 may have caused a relatively high discarding of this age group but no data were available to support this assumption.

Sampling of commercial landings for age, length and weight was low in some fisheries and in other fisheries no samples have been taken at all (Table 2.2.9). So, again this year uncertainties can be expected in the biological composition of the catches.

The Working Group therefore still strongly recommends that adequate sampling be conducted of herring in all fisheries in the North Sea in which clupeoids are caught.

2.2.3 Treatment of spring spawning herring in the North Sea

Norwegian spring spawners are taken close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal spring spawners in the southern North Sea are caught in small quantities in most years. These catches are given in Tables 2.1.1 and 2.1.5. With the exception of 1990, these catches are included in the assessment of the North Sea autumn spawners.

Western Baltic and Division IIIa spring spawners are taken in the deeper parts of the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1. The Table specifies the estimated amount of Division IIIa/Western Baltic spring spawners which are transferred from the North Sea assessment to the assessment of the Division IIIa/Western Baltic. The methods of separating these fish are described in former reports from this Working Group (Anon. 1990).

The method assumes that for autumn spawners, the mean vertebral count is 56.5 and for spring spawners 55.80. The fractions of spring spawners (fsp) are estimated from the formula (56.50-v)/0.7, where v is the mean vertebral count of the (mixed) sample. The method is quite sensitive to within stock variation (e.g. between year classes) in mean vertebral counts. The same method has been applied to separate the two components in the summer acoustic survey.

To calculate the proportion of spring spawners caught in the transfer area, five samples which have been taken in May and June 1995 were used for the second quarter (Figure 2.2.1), and six samples taken in July and August were used for the third quarter (Figure 2.2.2).

The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 1995 are as follows:

Quarter	2 - ring (%)	3 - ring (%)	4 + ring (%)	No of rectangles sampled	Catch in transfer area (t)	Catch of Spring Spawners in the North Sea (t)
Q.2	46	0	0	5	8 635	2 054
Q.3	16	44	90	6	18 294	8 261

The quarterly age distributions in Sub-division IVa East were applied to the catches in the whole area. The numbers of spring spawners by age were obtained by applying the estimated proportion by age.

2.3 Recruitment

2.3.1 The IBTS index of 1-ringer recruitment

The 1-ringer index is based on the IBTS over the entire survey area, using daytime-catches (GOV) within all statistical rectangles sampled in the February survey (1st quarter). The weighting procedures, used in the calculation of the index values, are described in last years report (Anon 1995d).

The 1- ringer index for the period 1979-1996 (year classes 1977-1994) is given in Table 2.3.1. and illustrated in Figure 2.3.1. In Figure 2.3.2 the distribution of 1-ringers as measured in the 1996 IBTS (1st quarter) is illustrated. The index value of the 1994 year class indicates a slight increase in recruitment compared to the 1993 year class.

2.3.2 The MIK index of recruitment

The 0-ringer index is based on night time catches during the IBTS in February using a fine-meshed ring-net (MIK). Only samples of larval herring with a mean larval length of more than 20 mm is used in the index calculation. An index value is determined in the following way:

- mean densities per unit area are calculated within sampled rectangles,
- mean densities are averaged over 8 sections covering the survey area,
- densities for sections are multiplied by the area of each sector,
- abundance's within sections are summed to give a total abundance estimate,
- the total abundance estimate, divided by 10^9, is referred to as the 0-ringer index (see Table 2.3.2.).

The MIK-index based on the 1996 sampling (the 1995 year class) is estimated as 106.2. This estimate indicates a decrease in recruitment relative to the 1994 year class to the level of the 1993 year class. The time series of MIK indices is illustrated in Figure 2.3.1.

The spatial distribution of herring larvae is shown for the year classes 1993-1995 in Figure 2.3.3. Samples where larval mean length exceeded 20 mm are not included. The distribution pattern of the 1995 year class shows a concentration of larvae in the north-western parts of the North Sea. The observed dominance of larvae in the western parts of the North Sea is unusual compared to observations in preceding years. This is illustrated in Figure 2.3.4 where larval abundances estimated for areas west of 2° E are given as proportions of total estimates. During the preceding period (since year class 1978) the proportion has never exceeded 60%, but in 1996 the westerly proportion increased to about 90%.

2.3.3 Relationship between the MIK 0-ringer and the IBTS 1-ringer indices

The relationship between the 0-ringer and the 1-ringer indices is described by a linear relationship (Figure 2.3.5). The present 1-ringer estimate of the 1994 year class and last years 0-ringer estimate of the same year class are included in the series; the estimates agree very well with the general relationship.

2.3.4 Recruitment prediction within the ICA - program

During earlier meetings, the assessment was based on traditional VPA, and the prediction was carried out using the RCT3 regression program. While the ICA-based assessment includes the recruitment indices, the prediction of recruitment is inherent within this program. Contrary to the RCT3 regression where 0-ringer and 1-ringer indices were given different weights, the same weighting of the two indices is used in the ICA procedure. The ICA is now the standard method of the WORKING GROUP's North Sea herring assessment and the RCT3 regression method will not be continued.

The prediction of recruitment (in billions) of 0-ringers by the present year's assessment is 31.8, 50.3 and 44.0 for the year classes 1993 to 1995 respectively. For 1-ringers the estimates are 14.0, 8.8 and 13.3 for the year classes 1992 to 1994 respectively.

2.3.5 Trends in recruitment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn spawners is illustrated by the abundance estimates of year classes 1977-1994 in Figure 2.3.6. Estimates are based on the 1996 ICA assessment. Recruitment during the period is characterised by a significant increase for the year classes 1977 to 1985 followed by a decline to an intermediate level.

2.4 Acoustic Surveys

2.4.1 1995 North Sea Acoustic Survey

The ICES coordinated acoustic survey in Divisions IVa and IVb was carried out by vessels from Norway, Scotland, Germany, Netherlands and Denmark. The following vessels participated in the survey:

GO Sars	24/6 - 21/7/95
Scotia	8 - 27/7/95
Tridens	3 - 24/6/95
Walther Herwig	17/7 - 8/8/95
Dana	1 - 12/7/95

The results of the survey were presented to the meeting in a working document (Simmonds *et al* W.D. 1996). The results of four of the five surveys have been combined. The data from the survey by the Walther Herwig were not included this year as there was uncertainty in the split of the stock by age and maturity. These data were found to be substantially different from the proportions measured during other surveys in adjacent and overlapping parts of the area. The use of the four surveys maintains consistency of the survey area over the time series.

The surveys adequately covered the areas where adult herring were assumed to be distributed. Results were reported in numbers by age group for each statistical rectangle. The estimated distribution of numbers of fish and biomass are shown in Figures 2.4.1 and 2.4.2 respectively.

The highest concentrations of herring were found off the Moray Firth in Scotland. Smaller concentrations were encountered both north east and west of Shetland, with concentrations of younger fish off Aberdeen and Berwick. Data were grouped into 3 areas:

Division IVa west of 6°E
Division IVb west of 6°E
North Sea east of 6°E and Skagerrak

Total numbers were calculated for each area. Age 2-ring and older North Sea autumn spawners were separated from Baltic spring spawners on the basis of vertebrae counts. All 0- and 1-ring fish were allocated as North Sea autumn spawners. Age groups 2- and 3-ring were split into mature (stage 3 and higher) and immature (stages 1 & 2) components. The percentage mature for both 2- and 3-ring fish were comparable with earlier years (see section 2.6) with the exception of 1993 which appears to have been anomalous with respect to maturation of herring.

Table 2.4.1 presents estimated numbers, biomass and mean weight for autumn spawners by age, maturity and area. The acoustic survey estimate of autumn-spawning herring obtained from the North Sea was 1,407,000 t of which 1,081,000 t mature.

The mean weights at age from the acoustic survey show a considerable reduction compared with 1994 for 4- to 7-ringers. The last 4 years' data show strong consistent spatial variation in mean weight at age around the North Sea in July. The 1995 acoustic survey showed an unusually high abundance of fish with the low mean weights at age just off the Moray Firth. The precision of the estimates of relative abundance in different parts of the area is poor and this combined with the large spatial variability of mean weight at age is thought to be responsible for this difference. For a fuller discussion of this see Section 2.6.1.

The level of *Ichthyophonus* infection found on the acoustic survey this year was very low at about 0.2% compared with acoustic survey estimates of 0.8% in 1994, 3.6% in 1993 and 5% in 1992. This confirms the reduction in prevalence of infection from previous years.

2.4.2 Acoustic Survey Time Series

The series of data from acoustic surveys from 1984 is shown in Table 2.4.2. Following concerns about the consistency of performance of the acoustic surveys since 1994, the series has been examined for consistency of survey strategy and analysis methods. The survey reports from 1985 to 1995 and the planning group reports were examined. Some of the discussion presented below has been presented in previous HAWORKING GROUP reports but for completeness the full arguments are presented again.

The herring abundance estimates from surveys prior to 1987 were obtained by adding together July surveys of the western North Sea with winter surveys of the Skagerrak and part of the eastern North Sea. In 1987 the survey was extended for the first time to cover the whole of the North Sea (Aglen and Simmonds 1988). This was the first survey to try to estimate the stock south of 57°N, east of 3°E along the Norwegian coast and part of the Skagerrak in the period June and July. The techniques for estimating herring in the area south of 58°30'N and east of 5°E used in this survey were different from those developed subsequently to deal with herring found in layers mixed with other fish in these areas. These early surveys provided incomplete area coverage as well as considerable differences in survey design and are inconsistent in approach with the later surveys.

The survey in 1988 (Kirkegaard *et al* 1989) was carried out largely on the same basis as subsequent surveys. However, the survey by Scotia, in an area that contained over 50% of the spawning stock in 1989, was severely disrupted by the explosion of Piper Alpha in early July. The whole operation of the survey was affected and this is reflected in a totally different track design from previous and subsequent years. In 1988, Scotia caught only 38,000 herring compared with catches of 347,000 and 80,000 herring in 1987 (Aglen and Simmonds 1988) and 1989 (Kirkegaard *et al* 1990). Both the quantity and also the number of good catches were reduced in 1988 with good catches in 11 of 24 hauls compared with good catches of herring in 16 hauls in both 1987 and 1989. Difficulties with trace identification were reported on this survey raising some doubts about the quality of the survey. Examination of 2+/3+ mortality (Z) estimated from the surveys 1987 to 1988 and to 1989 shows Z at 0.81 and 0.11 which supports the possibility of an underestimate in 1988. This is based on an assumption of constant fishing mortality and flat age selection in the survey.

Examination of procedures subsequent to 1988 indicates that there are no other procedural reasons to reject the subsequent surveys. Even though the 1989-90 mortality also looks low removal of the 1989 survey is not justified by any similar criteria.

Currently the acoustic surveys show smoothed 2+/3+ mortalities (Simmonds 1994) of 0.76, 0.82 and 0.76 over the last 3 years (Table 2.4.2). If the 1984 to 1988 acoustic surveys are included in the Working Group's assessment model, this leads to estimates of recent mortality around 0.22. This is inconsistent with the mortalities of around 0.78 estimated from the surveys alone, and is a strong indication that the early acoustic surveys are not consistent with the later ones.

For these reasons the years included in the 1996 assessment are the same as for the 1995 assessment with the addition of the 1995 survey.

The Planning Group for Herring Surveys needs to address the issue of what can be done with these earlier surveys, but until that review is complete it would be prudent to use only the surveys from 1989 and subsequent years.

2.5 Larvae Surveys

The reports of the international herring larvae surveys of the North Sea and Adjacent Waters for 1994/95 (Anon, 1995b) and for 1995/96 (Patterson & Beveridge, W.D.1996) were presented. Both reports give maps of the distribution of herring larvae by 1/9th ICES rectangles for all the areas and periods surveyed. Effort on the larvae surveys in 1994/95 and 1995/96 has been reduced to approximately one quarter of the input in the 1980's and now only Germany and The Netherlands take part. Samples taken in Orkney/Shetland in early September 1994 could not be used. In 1995 the area coverage in the Central North Sea, in the only period sampled, was poor. Both the temporal and spatial survey coverage was so low that neither the Larval Abundance Index (LAI) nor the Larval Production Estimate (LPE) could be calculated for 1994/95 or 1995/96. The time periods required for these indices, the annual coverage and the larvae abundance in each period, as a sum of the numbers of herring larvae <10mm per m^{-2} (<17mm. Southern North Sea), are shown in Table 2.5.1.

In the Southern North Sea and Eastern English Channel survey coverage was adequate in both 1994/95 and in 1995/96. In both series the larvae abundance has declined by an order of magnitude from the high values of 1989, 1990 and 1991. This suggests that there has been a considerable reduction in the SSB in this component of the North Sea stock.

As an alternative to the LAI and LPE a multiplicative model (MLAI) (Patterson & Beveridge, W.D.1996) was applied to the limited data sets in the last two series. The model assumes that the abundance of the size categories of larvae, as analysed for the other two indices, is proportional to stock size in each of the sampling units. In spite of the very limited sampling effort, the MLAI estimates of yearly abundance agree well with Working Group estimates of SSB (Figure 2.5.1). The output from this model was accepted by the Working Group for use in the assessment as a replacement for the LPE. It should be noted that the assumptions in the model, that individual period /area estimates of abundance are proportional to SSB, have not been rigorously tested.

The Working Group regretted the loss of the LPE as a tuning index. This proved to be a robust index of SSB for many years until survey effort was substantially reduced in 1992. All the tuning indices used in the assessment have problems, with high internal variances. It is, therefore, vital that more than one index is available to the Working Group for cross validation of trends in SSB. This is particularly so at a time when SSB is rapidly declining and is already below MBAL. Therefore it is considered to be particularly important to have a fishery independent index, based on larvae surveys, for the North Sea. In this context the Working Group would like to see the surveys continued and the effort, in terms of ship time, returned to a level at which a larvae index can be calculated with reasonable and measurable precision. It is worth recalling that during the late 1970's and early 1980's, after the collapse of the North Sea herring stock, the extensive annual larvae surveys were the most reliable indicator of the pace and extent of recovery of the whole North Sea stock and in particular the Central and Southern North Sea components. Furthermore without the larvae surveys of the Southern North Sea and Eastern English Channel it will be impossible to comment, either qualitatively or quantitatively, on the state of this component of the North sea stock for which a separate TAC is set.

The Working Group recognised that it was perhaps unlikely that effort on the larvae surveys would be returned to the level of the 1980's. In order to maximise the benefits of any increase in survey effort, the Planning Group for Herring Surveys is asked to address the following points at their meeting in May 1996.

- The level of spatial and temporal coverage required to provide a reliable LPE.
- The validity of the assumptions made in the multiplicative model.
- The possibility of using all larvae, up to 20mm, in the mutiplicative model.
- The optimum timing and survey area required to provide adequate coverage for the application of the multiplicative model.
- usefulness of a biennial or triennial survey strategy with limited coverage of targeted areas in the intervening years.
- The possibility of EU funding for the North Sea herring larvae surveys.

The Survey Planning Group in May will not be expected to provide definitive answers to these questions until its proposed meeting in February 1997 prior to the next HAWG meeting.

Recommendation

The Working Group strongly recommends that the larvae surveys in the North Sea and Eastern English Channel should be continued and that the effort, in terms of ship time, should be returned to a level at which either the Larval Abundance Index (LAI), the Larval Production Estimate (LPE), or the Multiplicative Model Abundance Index can be calculated with reasonable precision.

2.6 August Scottish Groundfish Surveys

The Aberdeen Marine Laboratory has been conducting bottom trawl surveys in the North Sea since the early 1900s using a variety of vessels and gears. Since 1982 however the survey has been consistent in terms of effort, vessel, area, and time.

The survey is aimed at demersal fish and the gear deployed is a 15m Aberdeen trawl with an average headline height of 2.5 meters and a wing span of about 19m. A stratified-random survey design is used. One tow of one hour's duration is shot in each of up to 93 rectangular areas (Figure 2.6.1) in Divisions IVa and IVb. Fish are sampled, measured and aged according to standard Scottish Office protocols.

Catch rates of demersal fish in this survey have been used for many years in the stock assessment of demersal species, but until recently no programmes existed for extracting information on herring from the database.

Catch rates of herring by age (2 rings and older) from this survey are given in Table 2.6.1.

2.7 Mean Weights-at-age and Maturity-at-Age

2.7.1 Mean Weights at age

The mean weights at age of fish in the catches in 1995 (weighted by the numbers caught) are presented by ICES division and by quarter in Table 2.7.1. Table 2.7.2 shows a comparison of mean weights at age for 2-ringers and older over the years 1986 to 1995.

For Division IVa the mean weights of all ages in the catch are close to the 10 year high. For Division IVb the mean weights of all ages with the exception of 5-ringers, which are below the mean, are between the mean and the 10 year high. The 1989 year class (5-ring in 1995) has increased in weight since 1994 and is now the same weight at 5-rings as the 1988 year class. For Divisions IVc and VIId the mean weights at all ages are close to the 10 year mean.

Table 2.7.3 presents the mean weights at age in the catch during the 3rd quarter in Divisions IVa and IVb for 1988 to 1994. In this quarter most fish are approaching their peak weights just prior to spawning. For comparison the mean weights in the stock from the last five years of summer acoustic surveys are shown in the same table (See Table 2.4.1 for the 1995 values).

Figure 2.7.1 shows a comparison of weights at age in the north western part of the North Sea and the central North Sea by acoustic survey and by catch. The catch data support the wide spatial variability in weights at age observed on the acoustic surveys. Catch reports by Norway and The Netherlands have been combined to provide estimates of weights at age in Division IVa(west). There are no reported catches in July in Division IVb for The Netherlands, so only Norwegian data from Division IVb have been used to give an estimate of weights at age from the commercial catch in Division IVb.

Inspection of the mean weights at age from the acoustic survey in 1995 shows that the older ages (4- to 8-ring) show a reduction in mean weight from earlier years. The reduction is caused by larger estimates of abundance in the south of Division IVa where the fish are found to have lower mean weights at age (Figure 2.7.1). This distribution is also found in all earlier years where data are available (Simmonds *et al* 1993, 1994, 1995 & W.D. 1996). The mean weight at age data from the survey were examined for year and cohort effects in an analysis of variance. The year effect was significant (F_{test};p=0.0055) but the effect of cohorts on weights at age was not (F_{test}; p=0.36). The cause of the year effect particularly in 1995 was likely to be the result of variability in the estimates of abundance in different parts of the survey area. This is most probably due to sampling variability in the acoustic survey, as the abundance is used to weight the mean weights at age from differing parts of the area. To reduce the impact of this sampling variability in the assessment a 3 year running mean has been used to smooth the year effect in mean weight at age.

2.7.2 Maturity Ogive

The percentage of 2- and 3-ringers likely to mature in 1995 was estimated from the summer acoustic survey as those fish in stage three and above. The results are given in the table below for 1988 to 1995.

Age (winter rings)	2	3	Older
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	98.0	100
1992	51.3	100	100
1993	41.6	62.9	100
1994	72.1	85.8	100
1995	72.6	95.4	100

The maturity of 2-ringers in 1994 and 1995 is close to the high of 78% found in 1989 and the maturity of 3-ringers has now recovered from the 63% in 1993 and 86% in 1994 to 95% in 1995.

The maturity ogive is computed from the acoustic survey data in a similar way to the weights at age, and is dependent on the proportions of the stock found with differing maturity in different parts of the area. The precision of the percentage of 2- and 3-ringers mature was investigated from the survey by examining the variance of the observations over the survey area. Spatial autocorrelation (which is present) was ignored and the precision was estimated at $\pm$ 5.8% for % mature 2-ringers and $\pm$ 2.6% for % mature 3-ringers. The presence of autocorrelation with non-random trawl locations implies that the sample variance, for the estimate of % maturity within the survey area, is likely to be an overestimate of the error variance and the precision is probably better than these values indicate. The year to year variability in the percentage mature is substantially greater than 6% and 3% for 2- and 3-ringers respectively. Therefore, in contrast to the weights at age, smoothing for maturity is not appropriate and the maturity ogives shown in the table above have been used in the assessment.

2.8 Stock Assessment

2.8.1 Data Exploration and Preliminary Modelling

Assessment of the stock was done by fitting an integrated catch-at-age model including a separable constraint (Deriso *et. al* 1985; Gudmundsson, 1986). The implementation used was the 'ICA' program (Patterson and Melvin, W.D. 1996). This program allows the use of age-disaggregated indices of stock size and indices of spawning biomass. The model assumes that errors occur not only in the survey indices, but also in the catch at age matrix. This is considered a more realistic approach than using the catches at age as precise values. A full discussion and simulation test of the method as applied to North Sea herring stock assessment is given in Anon. (1994, Appendix I).

Information available for inclusion in the model was the catches in number at age and year (Section 2.2), the MIK index of postlarval abundance (Section 2.3), the acoustic survey index (Section 2.4), the IBTS survey information (Section 1.4), including the first quarter index traditionally used by the Working Group, and also a short time series of 2nd, 3rd and 4th quarter indices. In addition, larvae survey information including a new multiplicative larval abundance index (MLAI) was available, and a newly provided time series of Scottish groundfish surveys (Section 2.6). The Working Group attempted to evaluate the consistency of these different sources of information. Some *a priori* comments about the use of the individual indices in the assessment follow.

In the previous assessment of this stock the traditional LPE index was used from 1983 - 1992. However, information from larval surveys carried out from 1993 onwards was not used in last years assessment (Anon., 1995d) as survey coverage had declined to such an extent that the LPE measure of abundance could no longer be calculated. Consequently, the LPE index has now been replaced by the multiplicative larval abundance index (MLAI), which covers the time period 1973 - 1995 and therefore uses also the information on larval abundance during the period 1993 - 1995 (see Section 2.5). This measure of stock size is more robust to the decline in larval survey coverage than the traditional indices.

The series of acoustic survey indices have been used for the period 1989 to 1995. The reasons for using this selected period have been discussed by the Working Group in 1995 (Anon. 1995d) and are further discussed in Section 2.4.

Initial examination of residuals about the catch at age matrix in separable model fits indicated no substantial deviation from a separable selection pattern from 1992 to 1995 over all ages. The model was therefore fitted over this age and year range, and all ages and years were weighted equally in the analyses. Earlier years in the analysis were computed using a conventional VPA model.

In a number of exploratory analyses, a population model was fitted to each survey index and to the catch at age matrix. The fishing mortalities at reference age (4) (the fishing mortalities +/- one standard deviation) for each model fit are plotted in Figure 2.8.1 to show the fishing mortalities indicated by the different survey indices under different assumptions about the relationship that they bear to stock abundance. All these models include the fit to the catch at age matrix.

The acoustic survey estimates of two-ringers were found to fit poorly to the estimated population abundance. The sensitivity of the estimated fishing mortality to downweighting these apparently noisy observations was tested by fitting three models with these observations assigned arbitrary weights of 1, 0.5 or 0.1. The resultant fits were robust to this change in the weighting factor (Fits 1-3), with all three fits indicating fishing mortalities in the range +/- one s.d. 0.65 to 0.85. It was decided to use the 1989-1995 acoustic survey indices in the further analysis.

The IBTS survey indices for the 2- to 5+-ringers indicate the highest F compared to the other indices (Figure 2.8.1, fit 4), leading to an estimate of fishing mortality between 1.1 and 1.6. As in earlier years the age disaggregated IBTS survey indices were split in two sets: the IBTS 1-ringer indices and the IBTS indices for 2- to 5+-ringers. The 1-ringer index is used principally to predict recruitment and the 2-5 ringer index has been used as an index of adult stock size, and this structure has been maintained for the present assessment. The IBTS survey has performed well and consistently as an estimator of herring spawning stock size in previous assessments, and no strong trends were noticeable in the residuals.

The short time series of 2nd, 3rd and 4th quarter IBTS (1 - 5+ ringers) were tested in separate model fits, but were rejected as indicators of stock size on account of high variance and very low predictions of fishing mortality.

The two recruitment indices (MIK and IBTS age 1) have also been tested in separate fits in order to evaluate their fits to the population models (Figure 2.8.1, Fits 5 and 12). Both appeared to fit well to the historic recruitment information, but are apparently poor predictors of adult stock size and fishing mortality. They were both used as recruitment indices in the final assessment.

The Scottish groundfish survey (SGFS) has also been tested in a separate model fit. It was found to have very strong year-effects in the residuals, and in addition predicted a fishing mortality of 0.3 to 0.45 +/- one s.d. range much lower than and inconsistent with that of the other indices (Figure 2.8.1, Fit 6). Catch rates in 1984 appeared to be outlying values and the fit was repeated excluding these observations (Figure 2.8.1, Fit 7). This made little change to the estimate of fishing mortality. Additional pertinent considerations are that the Scottish Groundfish survey only covers a part of the North Sea herring summer distribution, and does so with a fishing gear that is very inefficient at catching herring. Catch rates in the survey were exceptionally low. For the reasons given above this tuning series was excluded from the final assessment.

The new MLAI index was tested in four separate model fits. These either assumed a power relationship of index value to stock abundance (Fits 8 and 9) or a linear relationship (Fits 10 and 11). Either the entire time series was used (Fits 8 and 10) or only the data from 1983 to 1995 in order to remove possible anomalous effects at low stock sizes. All four gave similar fits with +/- one s.d. range in the range of fishing mortality approximately from 0.5 to 1.2. The linear fits were rejected on account of strong residual patterns. There did not appear to be any objective reason for excluding the early data and so these were retained. The better fit of the power relationship for the MLAI index might be explained by a density dependent effect on the mortality of eggs at high spawning stock biomasses. The exponential fit to the whole data series of this index was used in the assessment.

2.8.2 Stock Assessment

In consideration of the foregoing analyses, the Working Group found few reasons to alter the stock assessment model used last year (Anon. 1995d). The changes made were:

1. The assumption of separability was extended to a four year period, covering 1992 to 1995 rather than a three year range (1992 to 1994) used previously. Recent catch data appear to conform well to the assumption of separability.

2. The LPE larval survey index was replaced with the new MLAI index.

As in last year's assessment of the stock and in the absence of statistical information on the variance of each survey, it was not possible to give particular surveys more weight than others in an objective way. Therefore, equal weights were applied to all surveys and all age groups.

Details on input parameters for the ICA are presented in Table 2.8.1.

In the last year's assessment of the stock the analysis was carried out with a weighting factor of 1 for the stock-recruitment model. Some concern was expressed by ACFM that the inclusion of this model component may result in assessment bias. It was included in order to provide more conservative estimates of recruitment when spawning stock sizes are low. The sensitivity of the assessment to the inclusion of this model term was investigated this year (see text table below). It was found that there were only small differences in the estimated fishing mortality between excluding the stock-recruitment model entirely and including it with a range of weighting factors from 0 to 0.2. A weighting factor of 0.1 was applied to the stock-recruitment model for the present analysis. The model could not find a solution with weighting factors greater than 0.2. Therefore, a weighting factor of 0.1 was chosen for the final assessment.

Weighting factors for the stock-recruitment model	F	F - one sd	F + one sd	SSB
0	0.891	0.746	1.065	498,000
0.01	0.891	0.758	1.048	498,000
0.1	0.888	0.749	1.052	496,000
0.2	0.895	0.753	1.062	492,000

At the Working Group meeting it was discussed whether the estimated fishing mortality might change if a time pattern of the surveys is taken into account relative to the time that catches are actually taken. Test runs indicated that the mean estimated F for ages 2-6 in 1995 varied by less than 0.01 over a range of feasible values of α and β in the tuning.

The final objective function chosen for the stock assessment model was:

$$
\begin{aligned}
&\sum_{a=0,y=1992}^{a=8,y=1995} \lambda_a (\ln(\hat{C}a,y - \ln(C_{a,y}))^2 + \\
&\sum_{y=1976}^{y=1995} (\ln(QV.\hat{S}SB_y) - \ln(MLAI_y))^2 + \\
&\sum_{a=2,y=1983}^{a=5+,y=1996} (\ln(QI_a . N^*_{a,y}) - \ln(IBTS_{a,y}))^2 + \\
&\sum_{1,1979}^{1,1996} (\ln(QL.N^*_{1,y}) - \ln(IBTS_{1,y}))^2 + \\
&\sum_{a=2,y=1989}^{a=9+,y=1995} (\ln(QA_a . N^*_{a,y}) - \ln(ACOUST_{a,y}))^2 + \\
&\sum_{a=0,y=1977}^{a=0,y=1996} (\ln(QM.N^*_{0,y}) - \ln(MIK_y))^2 + \\
&0.1 \sum_{y=1958}^{y=1995} (\ln(N_{0,y+1}) - \ln\left(\frac{A.SSB_y}{B + SSB_y}\right))^2
\end{aligned}
$$

in which QV, QI, QR, QA and QM respectively represent the 'catchabilities' of the MLAI index, the age-disaggregated 2 to 5+ IBTS survey, the IBTS 1-ringer index, the acoustic survey and the MIK index. Lambda is an arbitrary weighting factor set to 1.0 for all ages. Errors in the acoustic survey and the age-disaggregated IBTS index are assumed to be correlated. N^* are population sizes calculated at the time of year corresponding to each of the surveys, and A and B are parameters of the Beverton and Holt stock-recruitment relationship.

The ICA output is presented in Table 2.8.2 and Figures 2.8.2 - 2.8.19. The analysis indicates a mean fishing mortality of 0.80 in 1995 (Mean from ages 2 to 6), and a spawning stock of 496,000 t. At last years ACFM November meeting a working document was presented by Patterson (W.D. 1996) in which the spawning stock biomass for 1995 was estimated at 523,000 tonnes, which was then regarded to be extremely low. Table 2.8.3 shows an overview of variance and residuals obtained from ICA.

A VPA is not presented in this year's report in order to avoid confusion between the results of ICA and VPA. Results from last year's VPA for the period 1958 - 1975, together with the results of this years ICA of the period 1976 - 1995, are used to show the long-term trends in yield, fishing mortality, spawning stock biomass and recruitment, which are given in Figure 2.8.20. The information from the period 1947 to 1957 has been excluded on account of very large SOP discrepancies which have been detected in the ICES database for these years.

2.8.3 Stock in Divisions IVc and VIId

The difference in age structure between the catches in Division IVc, VIId and in the rest of the North Sea clearly indicates that the development of the southern North Sea population is different from that in the rest of the North Sea. The relative abundance of older age groups in the catches in 1995 could indicate either a low mortality rate, or a low recruitment in recent years.

Herring larvae surveys in the southern North Sea and eastern Channel provided independent information on the development of the spawning stock in this area. Figure 2.8.21 shows the larval abundance by sampling period for this area over the period 1980 to 1995. It indicates a sharp decline in the spawning stock biomass since 1990. The spawning stock biomass is expected to be at a low level.

2.9 Evaluation of MBAL for North Sea Herring.

According to the terms of reference this Working Group has been asked to provide an estimate of MBAL with an explanation of the basis on which the estimate is obtained.

The "minimum biologically acceptable level" (MBAL) is defined as the level of spawning stock below which the probability of poor recruitment increases as spawning stock size decreases.

This level may be useful in providing managers with an indication of a lower level of spawning stock above which the stock should, if possible, be maintained (ICES, 1991).

The MBAL of 800,000 tonnes for North Sea herring, which has been used up to now, originates from the time period of a complete ban on directed herring fisheries and represents the spawning stock biomass level at which the fishery would be reopened (ICES, 1977a). The following cited text explains how this level was estimated: 'The relationship between spawning stock and recruitment for the North Sea herring stock suggests that a spawning stock of 800,000 tons is necessary to optimise recruitment. This level of spawning stock biomass is about 1/3 of that estimated at a time when the stock was lightly exploited. Comparisons with the Atlanto-Scandian herring stock and with the Icelandic spring and summer spawning stocks suggest that in these recruitment also declined at spawning stock biomasses of about 1/3 of the lightly exploited level. In the light of this evidence it would appear imperative to rebuild the spawning stock to a level of 800,000 t as quickly as possible. Any other policy must entail a very serious danger of an accelerating decline of the stock to a level where recovery will be very much retarded or may not be possible.' This minimum level of spawning stock biomass of 800,000 tons, which has been necessary to reopen the fishery, has been regarded since 1992 to be the MBAL below which the fishery should be closed, because the probability of poor recruitment increases as spawning stock size decreases below this level.

The Working Group has evaluated the earlier estimate of MBAL, taking into account the new estimates of SSB and recruitment which have become available since the mid-1970's. Figure 2.9.1 (Saville and Bailey, 1980) shows the stock-recruit plot on which the level of 800,000 tonnes was based and Figure 2.9.2 shows the time series 1958 - 1995. The period 1947 - 1957 is not included in this stock recruitment plot because of severe differences in SOP (up to 180%).

In theory, MBAL can be calculated from a variety of stock-recruit models as the level of SSB at which long-term recruitment is maximized. In practice, this estimate is usually imprecise because of the considerable variability in stock-recruit plots. The Working Group on Methods of Fish Stock Assessment has reviewed various aspects of stock-recruit analyses (Anon., 1993b) and suggested several alternative approaches for estimating MBAL. These are:

1. the SSB at 50% of maximum recruitment on the fitted stock-recruit relationship
2. the Serebryakov SSB level using the 90th percentile of survival and the 90th percentile of recruitment and
3. 20% of the virgin biomass estimated from the intersection of the replacement line and the fitted stock-recruit relationship.

In order to evaluate these MBAL estimates the Methods Working Group suggested the following discrimination criteria:

a) for each estimate tabulate the ratio of mean recruitment above and below MBAL. Estimation methods which show a clear reduction in recruitment below MBAL are preferable.
b) graph the probability of recruitment in the upper and lower quartiles of the data over the range of observed SSB. This will show the risks/expectations associated with each MBAL estimate.
c) calculate the range of the SSB data as a proportion of virgin biomass. A wider range of data provides a better basis for estimating MBAL.
d) calculate and tabulate the linear slope of the stock-recruit data above and below each MBAL estimate assuming lognormal errors. In general, if the slope below MBAL is positive and if the slope above is less than the slope below, the MBAL estimate is sensible.

For the North Sea herring the Methods Working Group estimated alternative MBALs which are listed in the table below (Anon. 1993b);

Method	MBAL	Ratio of mean recruitment above and below MBAL
BH50	494,000 t	2.44
RK50	416,000 t	2.70
SRBY	592,000 t	2.44
20VB	2,150,000 t	1.52

The Working Group evaluated each of the above estimates in relation to the current MBAL estimate (800,000 tonnes) using the discrimination guidelines outlined previously and the diagnostic plots, reproduced below, from Anon. (1993b). It was noted that the range of SSB estimates is quite large (min=.005 and max=0.41 of the virgin estimate of SSB) so that the above estimates of MBAL can be considered to be well estimated. With respect to the slope of the stock-recruit data above and below the MBAL estimate (Figure 2.9.3) all estimates appear to be sensible. However, the slope below the MBAL shows some increase between 500,000 tonnes and 1,000,000 tonnes indicating that the inflection point in the stock-recruit relationship is somewhat larger than 500,000 tonnes and perhaps closer to 1,000,000 tonnes. Further, the plot of the probability of recruitment in the upper and lower quartiles against the SSB (Figure 2.9.4) shows that there is a sharp decrease in the probability of good recruitment below SSB levels of about 800,000 tonnes; likewise there is a concomitant increase in the probability of poor recruitment when SSB levels fall below 800,000 tonnes.

The above analysis demonstrates that there is enhanced risk of recruitment overfishing at MBAL levels below the current MBAL of 800,000 tonnes. In addition, published studies show that the schooling behaviour of pelagic fish stocks increases their risk of over-exploitation at reduced stock sizes characteristic of North Sea herring in its present state. For these reasons the Working Group recommends that the current MBAL level of 800,000 t be retained.

2.10 Short-term projection by area and fleet

The starting point for the projection is the stock of North Sea autumn-spawners in the North Sea and Division IIIa combined at 1 January 1996. The ICA estimate of all age groups from 0 - 9+ is used (Table 2.8.2). 0-ringers at 1 January 1997 are set at 44,084 million.

The reference fishing mortalities for 2-ringers and older fish by age, fleet and area are calculated by combining the exploitation patterns, the 1995 fishing level and the distribution of the catch in numbers by fleet (Table 2.10.1). Mean weights at age in the stock were taken as the average over the last two years, and maturity at age, natural mortality and proportions of F and M before spawning are taken from the ICA input for the year 1995 (Table 2.8.2). The fishing pattern for the total stock is taken from the separable ICA for 2-ringers and older (Table 2.8.3). For 0- and 1-ringers the fishing mortalities by fleet are calculated from catch and stock numbers in 1995. The input data for the prediction are shown in Table 2.10.2.

Catch predictions for 1996 and 1997 were made for the same five fleets as in last year's assessment:

a) Human consumption fisheries in the North Sea. A minor part of the catches taken in this fishery may be landed for industrial purposes;
b) Small-mesh fisheries in the North Sea. Landings used for industrial purposes;
c) Human consumption landings in Division IIIa. A part of the catches taken in this fishery may be landed for industrial purposes;
d) Mixed clupeoid landings in Division IIIa. Some landings taken under the "mixed clupeoid quota" may be included in the catches taken by fleet E;
e) Other industrial landings in Division IIIa.

Mean weights at age in the 1995 catches by fleet were applied for the predictions.

To get a projection as realistic as possible, the calculations were carried out by fleet and area. The proportion of 0- and 1-ringers that occur in Division IIIa is likely to vary between years depending on the size of the year class. The procedure for splitting and the results are shown in Section 3.2.2.

The 2-ringers, and especially the larger ones, migrate from Division IIIa to the North Sea during the year and very few 3-ringers and older age groups are found in Division IIIa. Total mixing of 2-ringers in Division IIIa and the North Sea was assumed. Therefore, the stock numbers of 2-ringers given in Table 2.10.1 are the same for Division IIIa and the North Sea. 3-ringers and older were assumed to be exclusively in the North Sea.

The 1996 MIK index was used to predict the proportion of 1-ringers in 1997 based on the result of the regression given in Table 2.8.1 of Anon. (1994). The IBTS 1-ringer catches in 1996 were used to separate the 1-ringers between the North Sea and Division IIIa. The proportion of 0-ringers by area in 1997 is based on a hypothetical MIK index value which corresponds to the mean 0-ringer abundance in 1947-1994.

The projections were, based on the following relationship between F_{95} and F_{96}: $F_{96} = 0.79 F_{95}$; which equals a mean $F_{2\text{-}6}$ of 0.633. The F of 1996 is TAC constrained and therefore the F *status quo* is inappropriate. The catches of the human consumption fishery in 1996 are set equal to the TAC for fleet A. For other fleets the yield is assumed to be equal to the actual catches in 1995. A summary of the predictions for 1996 is shown in Table 2.10.3. The predicted SSB in 1996 is 410,000 t.

The predictions for 1997 are given in Table 2.10.4 with different combinations of fishing mortality by fleet under the assumptions of catches as outlined above. As assumed for the model, the migration between areas for 0- and 1-ringers and the proportion of 2-ringers taken in Division IIIa is relatively small. For that reason the predictions are given independently for the North Sea and the Division IIIa fleets. **The prediction shows that even with complete closure of the entire herring fishery in 1997 the MBAL of 800,000 t cannot be reached by the end of the year. If a closure is introduced in 1997, the SSB will only reach 680,000 t by the end of 1997.**

The prediction also shows that a reduction in the exploitation of herring by fleet B has little or no effect on the SSB in the short, but a significant effect in the medium term (see Section 2.11).

The predictions made here assume that the TAC of 313,000 t for the human consumption fishery in 1995 will be a genuine limit on the fishery. Given the known problems with misreporting and under-reporting, this assumption may not hold, and the calculations made here may in consequence be an over-estimate of the future stock sizes.

2.11 Medium-term projections

The Working Group considered a request from the EU and Norway to provide a set of prediction options expressed in terms of catches of mature and immature herring, and in terms of fishing mortalities on mature and immature herring (Section 1.3). These measures of fishing mortality are not straightforward to interpret in the context of the fleet-disaggregated model currently used by the Working Group and ACFM. In particular, some of the requested prediction options appear infeasible given present estimates of selection patterns by different fleets. Pending clarification of this matter, a sub-group of the Working Group undertook to respond to ACFM in a separate document before its meeting in May.

The method used for the calculation of stochastic medium-term projections follows that described in Anon. (1996). It is summarised here for convenience. Firstly , define the vector of parameters **X**, comprising the fishing mortality at reference age, the selections at age, the fitted populations in 1995 and the expected recruitment in 1996. This is estimated by the assessment procedure (on a logarithmic scale) with a variance-covariance matrix **C**. The projection method is based in drawing Monte-Carlo pseudo-data sets to initiate the projections from a distribution with mean X and with multivariate normal errors **C**. Recruitment is treated slightly differently. A Beverton-Holt stock-recruit relationship fitted with an assumption of autocorrelated errors was assumed, as recommended by Anon. (1995d). A non-parametric bootstrap method was used to generate recruitments in the pseudo-data for the projections. The 'ICPROJ' version 2.0 programme (Patterson, WD 1996) was used to calculate the projections.

In order to be consistent with the deterministic projections, stock weights and catch weights at age as used by the Working Group for 1995 were used in the projections. No attempt was made to model uncertainty in these parameters. Following choices made for the short-term deterministic projections, the maturity ogive as measured in 1995 has been assumed to hold for the years 1996 and thereafter. For 1996, a catch constraint of 313,000 t for fleet 'A' was imposed, and fishing mortality in the other fleets was assumed equal to their estimated values in 1995.

A summary of input data (additional to that used in the assessment) for the projections is given in Table 2.11.1. In this example, fishing mortality in all years is constrained to the estimated values for 1995, except that a catch constraint of 313,000 t has been imposed for fleet A in 1996. The fit of the stock-recruit relationship used is given in Figure 2.11.1.

Results of the simulations are presented as plots of the expected trajectories of stock size, recruitment and catches by fleet, showing the 5, 25, 50, 75 and 95th percentiles of the Monte-Carlo simulations.

The following six scenarios were modelled in the stochastic projections:

1. A complete closure of the fishery, with all fishing mortalities constrained to zero from 1997 to 2002. This shows (Figure 2.11.2) a rapid increase in stock size, with a probability greater than 95% of stock size recovering above the 800 000t MBAL by 1998.

2. Fishing at *status quo* levels from 1997 to 2002, defined as the estimated fishing mortality in 1995 (Figure 2.11.3). This shows a continued decline in stock size, with an estimated probability that the stock will recover above MBAL by 2002 of less than 2%.

3. Fishing at F=0.3 by the human consumption fleet in the North Sea (Fleet A), with zero fishing mortality by the other fleets (Figure 2.11.4). This scenario indicates a 50% chance that the stock will recover above MBAL by 1998, and an 80% probability that it will do so thereafter.

4. Fishing at F=0.3 by the human consumption fleet in the North Sea (Fleet A), with an assumption of 50% reduction in fishing mortality by the other fleets, relative to 1995 (Figure 2.11.5.). This shows a 50% probability that stock size will increase above MBAL by 1999.

5. Fishing at F=0.1 by the human consumption fishery in the North Sea (Fleet A), with a closure of all other fleets catching North Sea herring. This indicates that the probability that the spawning biomass will recover above MBAL by 1998 is over 80% (Figure 2.11.6).

6. Fishing at F=0.3 by the human consumption fishery in the North Sea (Fleet A), with continued fishing at *status quo* F by the other fleets (Figure 2.11.7). In this scenario the stock has a 50% chance of recovering above MBAL by the year 2000.

These scenarios indicate that at recent levels of fishing mortality the spawning stock is very likely to decline further. If all fishing on herring were to cease in 1997, the stock is estimated to recover above MBAL in 1998 with better than 50% probability (Figure 2.11.2, panel 5). If the only management action taken was to reduce fishing mortality in fleet A to 0.3, the stock is estimated to remain in a high risk situation (with a greater than 50% chance of being below MBAL) until about the year 2000 (Figure 2.11.7). If , as an additional measure, the fishing mortality in the remaining fleets were to be reduced by 50%, the projected stock development improves slightly and the stock is projected to recover above MBAL with better than 50% probability by 1999 (Figure 2.11.5 panel 5). A reduction in the effort by fleets B-F to zero catch would bring more rapid improvements in the stock size, with the stock projected to recover above MBAL by 1998 with 50% probability.

Another restriction explored was the reduction in fishing mortality by fleet A to 0.1. This is the most conservative of the catch options modelled, and leads to a prediction that SSB will return above MBAL in 1998 with over 80% probability.

Other target levels of biomass could be considered. Table 2.11.2. shows the estimated probabilities that the stock will recover above levels of 800 000t, 1.5 million t and 2.0 million t. The only one of the options explored which will allow the stock to recover above 2.0 million t with better than 50% probability is the reduction of the human consumption fishery in the North Sea to 0.1 and a closure of the fisheries B-F. However, allowing a fishery by fleet A to be prosecuted with F=0.3 is projected to allow a recovery of the stock above 1.5 million t by 2002, with better than 50% probability.

2.12 Management Considerations

The 1996 assessment shows the stock to be in a serious state of decline and well below the firmly established MBAL of 800,000t. The 90% confidence limits on the 1995 SSB estimate of 496,000 t are 296,000 t and 582,000 t. The MBAL represents approximately one third of the projected lightly exploited stock and was the target SSB level for reopening the North Sea fishery after the closure in 1977 (ICES, 1977a). There is strong evidence from the stock and recruitment relationship and from the collapse and recovery of other herring stocks that this is a reasonable MBAL for this stock. It is therefore of paramount importance that the SSB is brought back above this level quickly. With recruitment currently below the average of recent years and the MIK surveys suggesting a continued fall, any other policy will seriously jeopardise the viability of this stock.

Various management options are considered in Section 2.11. An option to reduce F to 0.3 on the North Sea human consumption fishery and to 0.5 F95 on all the other fisheries would return SSB to above MBAL by 1999 with a probability of 50%. However, the Working Group considers that the management measures for these fisheries are so ineffective that this is a high risk strategy and is of the strongly held opinion that all fisheries for North Sea autumn spawners should be closed immediately. This would quickly rebuild the stock to above 800,000 t by 1998 with a probability of 95%.

The by-catch of herring in the juvenile fisheries increased in 1995 compared with the low levels of 1994 which the Working Group (Anon. 1995d) considered was related to high sprat abundance. The Working Group continues to be concerned about the impact that the industrial fisheries, taking juvenile herring, have on herring recruitment and SSB. It is also worth noting that the total catch of North Sea autumn spawners, taken in all areas, comprises more than 80% immature fish. Indications of low sprat abundance suggest that a high fishing mortality will be exerted on juvenile herring in 1996.

The Working Group continues to be aware of large scale misreporting of catches in several parts of the North Sea into adjacent areas (Anon. 1995d). Evidence of such misreporting from Division IVa to VIaN at the 4°/5° boundary was provided to the Working Group. This allowed those catches to be moved into the North Sea assessment for the first time, with some confidence.

The situation in the southern North Sea and eastern English Channel area appears to be particularly serious. The larvae surveys in 1994/95 and 1995/96 indicate a very low and declining SSB in this separately managed component of the North Sea stock.

The Working Group considered a proposal from one sector of the herring fishing industry that, due to the poor state of the stocks, all fisheries in which herring are caught should be closed:

- From 1 to 31 August in Area IVa North of 58°30'N
- From 1 September to 1 May in Subarea IV and Divisions IIIa and VIId, South of 58°30'N

The Working Group considered that such a measure would be highly efficacious in allowing the herring stocks in this area to recover.

2.13 Requests from the Multispecies Assessment Working Group

The Multispecies Assessment Working Group requested data on quarterly catches and mean weights at age in the catch and stocks for 1995, by statistical rectangle of the North sea for herring. But these data, at this level of detail are not available, and they are provided in the same form as previous years.

2.13.1 Quarterly data base (numbers and mean weights at age)

Quarterly catch-at-age data, together with quarterly weights at age in the catch and in the stock at spawning time for North Sea herring for 1995 are provided in Table 2.13.1.

Weight-at-age data for the stock at spawning time are best provided by samples taken during the July acoustic surveys which cover Divisions IVa and IVb, and these are shown in the bottom line of Table 2.13.1.

A comparable breakdown of catches of spring spawners taken in the North Sea and transferred to Division IIIa is shown in Table 2.2.3.

2.13.2 Geographical distribution of the catches in the North Sea in 1995

Data on the geographical distribution of catches in the North Sea (Sub-area IV and Division VIId) in 1995 were available from Denmark, the Netherlands, Norway, Sweden , the U.K. (Scotland and England), Germany and France. The data represent 85% of the total catch, and include both juveniles and adults. Figures 2.13.1 - 2.13.12 show the catches by ICES rectangle for each month.

2.14 Quality of the Assessment

The assessments carried out from 1990 onwards show a systematic overestimate of the spawning stock biomass. During the years 1990 - 1995 the spawning stock biomass has been reduced by each new assessment as is shown in Table 2.14.1.

Figure 2.14.1 shows the spawning stock biomass estimates by year (solid line) obtained from last year's assessment (Anon., 1995d). The annual forecasts made by the Working Groups held between 1982 - 1993 are indicated by the broken line. Over the period 1984 - 1988 these forecasts correspond relatively well with the spawning stock biomass estimates, but not for the later years, when the forecasts were well above the spawning stock biomass. This overestimation may have been caused by a number of factors such as an increase in survey efficiency of the acoustic surveys, misreporting of catches, black landings and other factors.

In order to improve the assessment, the quality of both the catch data and tuning indices needs to be improved. The issues are addressed in various sections throughout the report. They have resulted in a number of recommendations from the Working Group. Of these, the recommendation to obtain better direct information on the fisheries by the more extensive use of observers, is particularly important.

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1983-1994. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1984	1985	1986	1987	1988	1989
Belgium	5,080	3,482	414	39	4	434
Denmark	38,777	129,305	121,631	138,596	263,006	210,315[2]
Faroe Islands	-	-	623	2,228	810	1,916
France	20,320	14,400	9,729	7,266	8,384	29,085
Germany, Fed.Rep.	11,609	8,930	3,934	5,552	13,824	38,707
Netherlands	44,308	79,335	85,998	91,478	82,267	84,178
Norway[4]	98,706	159,947	223,058	241,765	222,719	221,891[2]
Sweden	886	2,442	1,872	1,725	1,819	4,774
UK (England)	1,689	5,564	1,404	873	8,097	7,980
UK (Scotland)	31,393	55,795	77,459	76,413	64,108	68,106
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	64,487	74,220	21,089	58,972	33,411	26,749[2]
Total landings	317,255	533,420	547,211	624,907	698,449	694,135[2]
Discards[3]	-	-	-	-	-	4,000
Total catch	317,255	533,420	547,211	624,907	698,449	698,135
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	-	6,958	17,386	19,654	23,306	19,869
Coastal type	-	520	905	490	250	2,283

Country	1990	1991	1992	1993	1994[1]	1995[1]
Belgium	180	163	242	56	144	12
Denmark	159,280[2]	194,358[2]	193,968[2]	164,817	121,559	153,361
Faroe Islands	633	334	-	-	-	-
France	23,480	24,625	16,587	12,627	27,941	29,504
Germany	43,191	41,791	42,665	41,669	38,394	43,798
Netherlands	69,828	75,135	75,683	79,190	76,155	78,491
Norway[4]	157,850[2]	124,991[2]	116,863	122,815	125,522	131,026
Sweden	3,754	5,866	4,939	5,782	5,425	5,017
UK (England)	8,333	11,548	11,314	19,853	14,216	14,676
UK (Scotland)	56,812	57,572	56,171	55,531	49,919	44,802
UK (N.Ireland)	-	92	-	-	-	-
Unallocated landings	21,081	24,435	25,867	18,410	5,749	33,594
Total landings	544,422	560,910	544,299	520,550	465,024	534,281
Discards[3]	8,660	4,617	4,950	3,470	2,510	-
Total catch	553,082	565,527	549,249	524,020	467,534	534,281
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	8,357	7,894	7,854	8,928	13,228	10,315
Coastal type	1,136	252[5]	202[5]	201[5]	215[5]	203[5]

[1]Preliminary.
[2]Working Group estimates.
[3]Any discards prior to 1989 were included in unallocated landings.
[4]Catches of Norwegian spring spawners removed (taken under a separate TAC).
[5]Landings from the Thames estuary area.

Table 2.1.2 HERRING, catch in tonnes in Division IVa West. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990
Denmark	48,590	50,184	25,268	29,298	9,037
Faroe Islands	275	102	810	1,916	633
France	462	285	266	-[1]	2,581
Germany, Fed.Rep.	2,510	3,250	9,308	26,528	20,422
Netherlands	42,900	44,358	32,639	24,600	29,729
Norway	63,848	55,311	30,657	41,768	24,239
Sweden	-	768	1,197	742	-
UK (N.Ireland)	1	-	-	-	-
UK (England)	-	4,820	4,820	5,104	3,337
UK (Scotland)	-	66,774	48,791	58,455	46,431
Unallocated landings	71,285	16,092	-	3,173	4,621
Total Landings	-	221,032	153,751	191,584	141,030
	229,870				
Discards[2]	-	-	-	900	750
Total catch	229,870	237,124	153,751	192,484	141,780

Country	1991	1992	1993	1994	1995[3]
Denmark	5,980	10,751	10,604	20,017	17,748
Faroe Islands	334	-	-	-	-
France	3,393	4,714[4]	3,362	11,658	10,427
Germany	20,608	21,836	17,342[4]	18,364	17,095
Netherlands	29,563	29,845	28,616	16,944	24,696
Norway	37,674	39,244	33,442	56,422	56,124
Sweden	1,130	985	1,372	2,159	1,007
UK (N.Ireland)	92	-	-	-	-
UK (England)	4,873	4,916	4,742	3,862	3,091
UK (Scotland)	42,745	39,269	36,628[4]	44,687	40,159
Unallocated landings	5,492	4,855	-8,271[5]	2,944	26,018
Total Landings	151,884	156,415	127,837	177,327	196,365
Discards[2]	883	850	825	550	-
Total catch	152,767	157,265	128,662	177,877	196,365

[1]Included in Division IVb.
[2]Any discards prior to 1989 were included in unallocated.
[3]Preliminary.
[4]Including IVa East.
[5]Negative unallocated catches due to misreporting from other areas.

Table 2.1.3 HERRING, catch in tonnes in Division IVa East. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989
Denmark	-	4,540	7,101	47,183	44,269
Faroe Islands	-	-	2,126	-	-
France	-	-	159	45	-
Netherlands	-	-	-	200	-
Norway[1]	109,975	118,408	145,843	153,496	168,365
Sweden	-	-	957	622	612
UK (Scotland)	-	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Unallocated landings	-	-	-	-	-
Total landings	109,975	122,348	156,186	201,546	213,246
Discards[2]	-	-	-	-	-
Total catch	109,975	122,948	156,186	201,546	213,246

Country	1990	1991	1992[3]	1993	1994	1995[3]
Denmark	44,364	48,875	53,692	43,224	43,787	45,257
Faroe Islands	-	-	-	-		-
France	892	-	-[4]	4	14	+
Netherlands	-	-	-	-		-
Norway[1]	121,405	77,465	61,379	56,215	40,658	62,224
Sweden	2,482	114	508	711	1,010	2,081
UK (Scotland)	-	173	196	-[4]		-
Germany	5,604	-[4]	-[4]	-[4]		-
Unallocated landings	-	-	-	-		-
Total landings	174,747	126,627	115,775	100,154	85,469	109,562
Discards[2]	-	-	-	-		-
Total catch	174,747	126,627	115,775	100,154	85,469	109,562

[1]Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
[2]Any discards prior to 1989 would have been included in unallocated.
[3]Preliminary.
[4]Included in IVa West.

Table 2.1.4 HERRING, catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990
Denmark	67,966	81,280	190,555	136,239	105,614
Belgium	-	-	-	-	-
France	605	387	617	14,415[5]	10,289
Faroe Islands	348	-	-	-	-
Germany, Fed.Rep.	1,424	2,302	4,516	11,880	17,165
Netherlands[4]	21,101	31,371	37,192	47,388	28,402
Norway	40,682	40,111	38,566	11,758	12,207
Sweden	1,872[2]	-	-	3,420	1,276
UK (England)	1,101[1]	329	2,011	957	3,200
UK (Scotland)	6,057	9,639	15,317	9,651	10,381
Unallocated landings	1,594	20,829	1,969	-23,947[7]	-15,616[7]
Total landings	142,750	186,248	290,743	211,711	172,914
Discards[4]	-	-	-	1,900	2,560
Total catch	142,750	186,248	290,743	213,611	175,474

Country	1991	1992	1993	1994[6]	1995[6]
Denmark	138,555	125,229	109,994	55,060	87,917
Belgium	3	13	-	-	-
France	4,120	2,313	2,086	5,492	7,639
Faroe Islands	-	-	-	-	-
Germany	20,479	20,005	23,628	14,796	21,707
Netherlands[4]	26,266	26,987	31,370	39,052	30,065
Norway	9,852	16,240	33,158	28,442	12,678
Sweden	4,622	3,446	3,699	2,256	1,929
UK (England)	2,715	3,026	3,804	7,337	9,688
UK (Scotland)	14,587	16,707	18,904	5,101	4,654
Unallocated landings	3,180	-13,637[7]	-16,415[7]	-26,988[7]	10,831[7]
Total landings	224,376	200,329	210,228	130,548	165,355
Discards[4]	1,072	1,900	245	460-	-
Total catch	225,448	202,229	210,473	131,008	165,455

[1]Includes catches misreported from Division IVc.
[2]Includes Division IVa catches.
[3]Included in Division IVa.
[4]Any discards prior to 1989 were included in unallocated.
[5]Includes catch in Division IVa.
[6]Preliminary.
[7]Negative unallocated catches due to misreporting from other areas.

Table 2.1.5 HERRING, catch in tonnes in Divisions IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990
Belgium	414	39	4	434	180
Denmark	535	31	-	509	265
France	8,662	6,435	7,456	14,670	9,718
Germany, Fed.Rep.	-	-	-	299	-
Netherlands	21,997	15,749	12,236	12,240	11,697
Norway	-	-	-	-	-
UK (England)	303	544	1,266	1,919	1,796
UK (Scotland)	117	-	-	-	-
Unallocated landings	19,495	22,051	31,442	47,523	32,076
Total landings	51,523	44,849	52,404	77,594	55,732
Discards[1]	-	-	-	1,200	5,350
Total catch	51,523	44,849	52,404	78,794	61,082
Coastal spring spawners included above	496	250	250	2,283	1,136

Country	1991	1992	1993	1994[2]	1995[2]
Belgium	163	229	56	144	12
Denmark	948	4,296	995	2,695	2,441
France	17,112	9,560	7,171	10,777	11,433
Germany	704	824	649	4,964	4,996
Netherlands	19,306	18,851	19,204	20,159	23,730
Norway	-	-	-	-	-
UK (England)	3,960	3,372	11,307	3,016	1,896
UK (Scotland)	67	-	-	131	-
Unallocated landings	15,763	34,649	43,096	29,792	18,397
Total landings	58,023	71,781	82,478	71,678	62,905
Discards[1]	2,662	2,200	2,400	2,400	-
Total catch	60,685	73,981	84,878	74,078	62,905
Coastal spring spawners included above	252	202	201	215	203

[1]Any discards prior to 1989 would have been included in unallocated.
[2]Preliminary.

Table 2.2.1 North Sea Herring, Millions caught by age group (winter ring), year class, division and quarter.

Catches in : 1995

Division	Quarter	0 1994	1 1993	2 1992	3 1991	4 1990	5 1989	6 1988	7 1987	8 1986	9+ 1985	Total	0+1 ring
	I	0.0	0.0	11.9	18.2	1.8	0.2	0.2	0.3	0.3	0.3	33.4	0.0
	II	0.0	0.1	122.4	66.4	17.4	12.3	3.3	2.9	3.4	2.4	230.6	0.1
(West of 2E)	III	0.0	9.4	261.7	162.1	56.7	21.2	14.1	12.6	21.9	21.2	581.0	9.4
	IV	4.3	26.6	157.8	62.6	11.8	4.2	2.0	2.8	3.8	5.7	281.5	30.9
	Total	4.3	36.1	553.8	309.3	87.7	37.9	19.6	18.6	29.4	29.6	1126.4	40.4
	I	0.0	0.0	61.0	97.1	10.2	1.1	1.1	1.5	1.4	2.2	195.7	0.0
	II	0.0	10.6	51.9	16.2	7.9	3.9	1.0	0.9	0.6	0.7	93.9	10.6
(East of 2E)	III	0.0	8.2	36.7	20.8	13.7	3.7	2.7	1.8	0.5	0.2	88.4	8.2
	IV	5.5	32.3	149.4	117.6	29.8	4.7	4.5	6.3	11.6	6.6	368.4	37.8
	Total	5.5	51.2	299.1	251.8	61.6	13.4	9.3	10.5	14.1	29.8	746.3	56.7
	I	0.0	49.6	2.9	12.9	2.2	0.3	0.1	0.1	0.1	0.1	68.4	49.6
	II	0.0	94.4	56.2	8.1	6.4	2.9	1.3	0.5	1.2	0.4	171.3	94.4
IVb	III	5070.3	106.8	199.3	140.9	27.0	10.1	11.6	4.3	3.4	6.8	5580.8	5177.2
	IV	1174.4	130.6	58.1	22.6	7.5	6.8	1.0	1.1	0.5	0.5	1403.2	1305.0
	Total	6244.7	381.5	316.4	184.6	43.1	20.1	14.1	6.1	5.2	7.9	7223.6	6626.2
	I	0.0	3.5	4.9	20.4	12.9	11.8	1.7	0.4	0.7	0.4	56.7	3.5
	II	0.0	0.2	2.3	3.1	1.6	2.1	0.3	1.0	0.5	0.0	11.3	0.2
IVc + VIId	III	0.0	0.3	11.3	4.8	1.9	1.6	0.5	0.2	0.0	0.0	20.6	0.3
	IV	25.3	10.3	201.6	89.7	35.8	32.1	10.2	3.9	1.2	1.0	410.9	35.6
	Total	25.3	14.3	220.1	118.0	52.2	47.5	12.6	5.5	2.5	1.4	499.4	39.6
	I	0.0	53.1	80.7	148.6	27.1	13.3	3.1	2.4	2.6	23.1	354.0	53.1
Total	II	0.0	105.4	232.8	93.8	33.3	21.2	5.9	5.3	5.7	3.5	507.0	105.4
North	III	5070.3	124.7	509.1	328.7	99.3	36.6	28.9	19.0	25.9	28.4	6270.7	5195.1
Sea	IV	1209.4	199.9	566.9	292.5	85.0	47.8	17.6	14.1	17.1	13.8	2464.0	1409.3
	Total	6279.8	483.1	1389.4	863.7	244.6	118.8	55.5	40.8	51.3	68.7	9595.7	6762.9

Table 2.2.2 Numbers (millions) of herring caugth per age group (winter rings) in the North Sea ,1970-1995.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1970	898.1	1196.2	2002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5249.3
1971	684.0	4378.5	1146.8	662.5	208.3	26.9	30.5	26.8		12.4	7176.7
1972	750.4	3340.6	1440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6045.5
1973	289.4	2368.0	1344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4906.6
1974	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3189.3
1975	263.8	2460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3753.3
1976	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1482.0
1977	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7	+	656.3
1978	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	791.7	161.2	108.1	91.8	32.1	21.8	2.3	1.4	0.4	0.2	1211.0
1981	7888.7	447.0	264.3	56.9	39.5	28.5	22.7	18.7	5.5	1.1	8772.9
1982	9556.7	840.4	268.4	230.1	33.7	14.4	6.8	7.8	3.6	1.1	10963.0
1983	10029.9	1146.6	544.8	216.4	105.1	26.2	22.8	12.8	11.4	12.2	12128.2
1984	2189.4	561.1	986.5	417.1	189.9	77.8	21.7	24.2	10.6	17.8	4496.1
1985	1292.9	1620.2	1223.2	1187.6	367.6	124.1	43.5	20.0	13.2	15.9	5908.2
1986	704.0	1763.2	1155.1	827.1	458.3	127.7	61.1	20.2	13.4	14.6	5144.7
1987	1797.5	3522.4	2005.4	687.2	481.1	248.9	75.7	23.9	7.9	8.1	8858.1
1988	1292.9	1970.8	1955.5	1185.1	398.1	260.6	128.6	37.9	15.1	8.4	7253.0
1989	1955.8	1899.5	927.7	1383.6	828.1	218.3	129.4	63.3	20.7	8.7	7435.1
1990	853.9	1477.4	592.8	763.3	849.1	375.9	80.1	54.4	28.4	11.8	5087.1
1991	1594.2	1244.4	771.2	553.1	548.5	493.5	201.4	38.8	25.0	12.6	5482.7
1992	7598.2	643.4	960.9	411.8	334.6	341.5	360.1	144.7	37.7	23.2	10856.1
1993	6981.7	1283.9	760.4	597.7	306.7	216.2	223.7	185.9	85.8	41.2	10683.2
1994	3717.3	450.5	1391.9	491.3	345.4	114.2	95.5	75.7	69.5	44.8	6796.1
1995	6279.8	483.1	1389.7	863.7	244.6	118.8	55.5	40.8	51.3	68.7	9595.7

Table 2.2.3 Catches(numbers in millions) of IIIa spring spawners taken in the North Sea, and transfered to assessement of IIIa spring spawning stock. (1987-1995)

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987			35.5	35.0	25.0	8.9	2.8	0.7	0.1	0.1	108.1
1988			44.6	108.9	19.5	8.2	2.2	0.4			183.8
1989			27.3	52.7	38.3	11.6	8.7	3.8	1.7	0.2	144.3
1990			12.4	14.7	21.8	3.6	3.0	2.1	0.7	0.4	58.7
1991			6.7	15.1	18.0	9.1	3.1	0.8	0.3		53.0
1992			0.3	9.9	11.1	8.4	8.6	2.5	0.7	0.6	42.1
1993			4.2	10.8	12.3	8.4	5.9	4.7	1.7	1.0	49.0
1994			8.8	28.2	16.3	11.0	8.6	3.4	3.2	0.7	80.2
1995			22.4	11	14.9	4	2.9	1.9	0.5	0.2	57.8

Table 2.2.4 Catches(numbers in millions) of North Sea autumn spawners taken in IIIa, and transfered to assessement of North Sea autumn spawners.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	6238.0	3153.0	117.0								9508.0
1998	1830.0	5792.0	292.0								7914.0
1989	1028.2	1170.5	654.8								2853.5
1990	397.9	1424.3	283.7								2105.9
1991	712.3	822.7	330.2								1865.2
1992	2407.5	1587.1	283.8	26.8	26.6	16.0	12.3	5.5	1.0		4366.6
1993	2910.7	2403.8	377.5								5691.9
1994	542.2	1239.7	305.2								2087.1
1995	1722.84	1069.58	126.37								2918.8

Table 2.2.5 Total catch (numbers in millions) per age of North Sea autumn spawning stock used for assessment

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	8035.5	6675.4	2086.9	652.2	456.1	240.0	72.9	23.2	7.8	8.0	18258.0
1988	3122.9	7762.8	2202.9	1076.2	378.6	252.4	126.4	37.5	15.1	8.4	14983.2
1989	2984.0	3070.0	1555.2	1330.9	789.8	206.7	120.7	59.5	19.0	8.5	10144.3
1990	1251.8	2901.7	864.1	748.6	827.3	372.3	77.1	52.3	27.7	11.4	7134.3
1991	2306.5	2067.1	1094.8	538.0	530.5	484.4	198.4	38.0	24.7	12.6	7294.9
1992	10005.7	2230.5	1244.4	428.7	350.1	349.1	363.8	147.6	38.0	22.6	15180.6
1993	9892.4	3687.7	1133.6	586.9	294.4	207.8	217.8	181.2	84.1	40.2	16326.1
1994	4259.5	1690.2	1688.3	463.1	329.1	103.2	86.9	72.3	66.3	44.1	8803.0
1995	8002.6	1552.7	1493.7	852.7	229.7	114.8	52.6	38.9	50.8	68.5	12456.7

Table 2.2.6 Percentage age composition of North Sea HERRING (2-ringers and olders) in the catch.
Catches in : 1995

Division	age in W.Rings Quarter	2 1992	3 1991	Older >= 1990	Total (millions)
	I	35.7	54.6	9.7	33.4
IVa West	II	53.1	28.8	18.1	230.4
	III	45.8	28.4	25.8	571.5
	IV	63.0	25.0	12.1	250.7
	Total	51.0	28.5	20.5	1086.0
	I	31.2	49.6	19.2	195.7
IV a East	II	62.4	19.5	18.1	83.3
	III	45.8	26.0	28.2	80.2
	IV	45.2	35.6	19.2	330.5
	Total	43.4	36.5	20.1	689.6
	I	15.2	68.8	16.0	18.8
IVb	II	73.0	10.5	16.4	76.9
	III	49.4	34.9	15.7	403.6
	IV	59.2	23.0	17.7	98.2
	Total	53.0	30.9	16.1	597.4
	I	9.1	38.4	52.5	53.1
IVc + VIId	II	21.1	28.3	50.6	11.1
	III	55.7	23.5	20.8	20.3
	IV	53.7	23.9	22.4	375.3
	Total	47.9	25.7	26.5	459.8
	I	30.6	51.8	17.7	247.8
IVa + IVb	II	59.0	23.2	17.8	390.6
	III	47.2	30.7	22.1	1055.3
	IV	53.8	29.9	16.4	679.4
	Total	49.3	31.4	19.3	2373.0
	I	26.8	49.4	23.8	300.9
Total	II	58.0	23.4	18.7	401.6
North	III	47.3	30.6	22.1	1075.6
Sea	IV	53.8	27.7	18.5	1054.7
	Total	49.0	30.5	20.5	2832.9

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Table 2.2.7 Catches (SOP,tons) of North Sea Herring, by quarter and division.
Catches in : 1995

		0	1	2	3	4	5	6	7	8	9+	SOP
Quarter	Division	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	Total
	IVa W	0	0	1332	2458	294	39	51	63	70	64	4371
I	IVa E	0	0	6824	13123	1619	195	249	297	325	325	22959
	IVb	0	833	103	1902	353	55	30	34	20	20	3349
	IVc	0	83	404	1928	1527	1586	269	66	120	66	6049
	Total	0	917	8662	19411	3793	1874	600	461	535	476	36728
	IVa W	0	22	16448	11624	3262	2319	743	688	882	635	36624
II	IVa E	0	624	6958	2620	1526	838	267	264	173	181	13449
	IVb	0	2380	5968	1232	1314	531	275	120	254	91	12165
	IVc	0	5	192	313	202	306	45	170	89	5	1326
	Total	0	3030	29566	15788	6304	3995	1330	1242	1396	912	63564
	IVa W	1	762	39445	31960	13309	5063	4074	3617	7011	6929	112170
III	IVa E	0	478	6221	3806	2670	766	643	375	142	50	15153
	IVb	42591	5278	29738	25816	5543	2259	3147	1189	1003	1979	118543
	IVc	0	23	1312	626	308	320	106	48	10	12	2765
	Total	42592	6541	76716	62209	21830	8408	7971	5228	8167	8970	248631
	IVa W	96	2297	23186	10774	2340	998	457	632	921	1410	43111
IV	IVa E	132	3017	20417	20394	6028	1056	998	1458	2845	1614	57959
	IVb	11446	6797	6899	3196	1283	1274	228	272	138	131	31663
	IVc	346	650	23264	12468	6372	6178	2135	863	243	261	52780
	Total	12021	12760	73766	46832	16023	9506	3818	3225	4146	3415	185512
Total N. Sea	1995	54612	23247	188711	144239	47950	23783	13719	10157	14244	13773	534436

Table 2.2.8 North Sea Autumn Spawning Herring

Landings of Herring from the North Sea and Div. IIIa in 1995.
Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: HC in the North Sea B: Small meshed fishery in the North Sea C: Human consumption in Div. III
D: Mixed clupeoid fleet in Div IIIa E: Industrial fishery (for reduction) in Div IIIa

1. Quarter

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1			53.12	17.3	17.69	29.5	230.76	14.6	225.62	23.2	527.19	19.0
2	76.47	110.0	4.23	52.1	39.99	136.3	2.32	31.2	20.78	50.3	143.79	105.7
3	146.94	131.0	1.66	134.9							148.60	131.0
4	26.94	139.9	0.16	160.6							27.10	140.0
5	13.28	140.9	0.02	181.5							13.30	141.0
6	3.08	191.8	0.02	229.5							3.10	192.0
7	2.38	190.0	0.02	194.3							2.40	190.0
8+	25.65	209.4	0.05	225.2							25.70	209.4
Total	294.74		59.28	23.8	57.68	103.55	233.08	14.7	246.40	25.5	891.18	63.7
SOP (t)		39,710		1,412		5,973		3,435		6,272		56,802

2. Quarter

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1	28.92	62.3	76.48	16.4	24.27	35.1			236.36	30.8	366.03	30.6
2	213.78	137.7	3.62	33.6	12.83	92.2			13.48	58.1	243.71	129.3
3	93.75	168.0	0.05	158.6							93.80	168.0
4	33.27	189.0	0.03	167.8							33.30	189.0
5	21.19	188.0	0.01	177.0							21.20	188.0
6	5.90	224.0									5.90	224.0
7	5.30	236.0									5.30	236.0
8+	9.20	250.5									9.20	250.5
Total	411.31	151.1	80.19	17.3	37.10	54.82			249.84	32.3	778.44	94.6
SOP (t)		62,134		1,391		2,034		0		8,066		73,624

3. Quarter

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			5070.30	8.0			79.34	13.2	1170.18	10.4	6319.82	8.5
1	36.31	77.8	88.39	41.4	76.02	76.6	6.01	30.2	183.99	41.1	390.72	51.3
2	507.70	151.0	1.32	144.2	7.18	131.4	0.06	89.8	7.49	92.2	523.75	149.9
3	328.15	189.1	0.44	178.8							328.59	189.1
4	99.22	220.1	0.06	162.8							99.28	220.0
5	33.58	250.6	0.02	173.8							33.60	250.5
6	26.69	298.8	0.01	211.0							26.70	298.7
7	17.50	299.7									17.50	299.7
8+	53.70	319.5									53.70	319.5
Total	1102.85	183.3	5160.54	8.6	83.20		85.41	14.4	1361.66	15.0	7793.66	35.3
SOP (t)		202,173		44,506		6,766		1,234		20,412		275,091

4. Quarter

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	11.57	30.7	1197.83	9.8	5.64	12.5	97.00	16.9	370.68	18.1	1682.72	12.2
1	90.80	85.0	109.10	46.5	39.38	78.0	2.09	38.5	27.39	41.8	268.76	63.6
2	561.45	130.3	5.45	96.5	20.66	130.4	0.07	46.0	1.51	71.0	589.14	129.9
3	291.07	160.1	1.43	131.8							292.50	160.0
4	85.00	189.0									85.00	189.0
5	47.80	199.0									47.80	199.0
6	17.60	217.0									17.60	217.0
7	14.10	229.0									14.10	229.0
8+	30.90	245.2									30.90	245.2
Total	1150.29		1313.81	13.3	65.68		99.16	17.4	399.58	19.9	3028.52	66.4
SOP (t)		168,060		17,526		5,836		1,721		7,957		201,100

Total Year

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	11.57	30.7	6268.13	8.3	5.64	12.5	176.34	15.2	1540.86	12.2	8002.54	9.3
1	156.03	79.14	327.09	33.3	157.36	65.2	238.86	15.2	673.36	31.5	1552.70	37.6
2	1359.40	138.07	14.62	72.4	80.66	127.3	2.45	33.0	43.26	60.7	1500.39	134.5
3	859.91	167.05	3.58	139.4							863.49	166.9
4	244.43	196.20	0.25	162.0							244.68	196.2
5	115.85	205.28	0.05	177.5							115.90	205.3
6	53.27	257.29	0.03	223.3							53.30	257.3
7	39.28	259.06	0.02	194.3							39.30	259.0
8+	119.45	271.33	0.05	225.2							119.50	271.3
Total	2959.19	159.53	6613.82	9.8	243.66	84.58	417.65	15.3	2257.48	18.9	12491.80	48.6
SOP (t)		472,078		64,835		20,608		6,390		42,707		606,617

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Table 2.2.9 Landings by area and quarter in tons, number of samples, number of fish measured and aged from commercial landings in 1995

HERRING

Country	Quarter	Landings in '000tons	Number of samples	Number of fish measured	Number of fish aged
Belgium	1				
	2				
	3				
	4	+			
	Total	0.0	0	0	0
Denmark	1	29.5	12	582	574
	2	6.8	9	308	251
	3	61.1	16	1,364	1,195
	4	53.5	34	1,949	1,522
	Total	150.9	71	4,203	3,542
France	1	0.6	1	321	88
	2	5.8	1	191	50
	3	12.1	0	0	0
	4	11.0	3	625	243
	Total	29.5	5	1,137	381
Germany	1	0.3	0		
	2	3.3	0		
	3	30.0	?	21,328	1,588
	4	10.1	?	21,438	272
	Total	43.7	0	42,766	1,860
Netherlands	1	5.3	9	1,063	225
	2	4.3	3	466	75
	3	35.3	13	2,498	575
	4	39.6	32	3,939	800
	Total	84.5	57	7,966	1,675
Norway	1	0.7	1	100	100
	2	36.3	23	2,300	2,300
	3	43.1	16	1,600	1,600
	4	51.0	17	1,700	1,700
	Total	131.1	57.0	5700.0	5,700
Sweden	1	0.0	0		
	2	1.4	0		
	3	1.9	0		
	4	1.7	0		
	Total	5.0	0	0	0
UK (England)	1	0.1	0		
	2	0.1	0		
	3	12.3	0		
	4	2.1	0		
	Total	14.6	0	0	0
UK (Scotland)	1	+	0	0	0
	2	5.6	20	4,608	788
	3	53.2	67	12,872	3,744
	4	13.7	20	4,088	898
	Total	72.5	107	21568.0	5,430

Country	Quarter	Landings in '000tons	Number of samples per 000 tons	Number of fish measured per 000 tons	Number of fish aged per 000 tons
All countries	All	531.8	0.6	156.7	35.0

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Table 2.3.1.

IBTS 1-ringer indices (1st quarter)

Year class	Year of sampling	1-ringer index
1977	1979	172
1978	1980	312
1979	1981	431
1980	1982	772
1981	1983	1260
1982	1984	1443
1983	1985	2083
1984	1986	2542
1985	1987	3684
1986	1988	4530
1987	1989	2313
1988	1990	1016
1989	1991	1159
1990	1992	1162
1991	1993	2943
1992	1994	1667
1993	1995	1188
1994	1996	1729

Table 2.3.2 Density and abundance estimates of 0-ringers caught in February during the IBTS. Values given for year classes by areas are density estimates in numbers per square metre. Total abundance is found by multiplying density by area and summing up

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	South Bight	0-ringers abundance
Area $m^2 \times 10^9$	83	34	86	102	37	93	31	31	no. in 10^9
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992	0.168	0.039	0.672	0.444	0.734	0.268	0.345	0.285	190.1
1993	0.358	0.212	0.260	0.187	0.120	0.119	0.223	0.028	101.7
1994	0.148	0.024	0.417	0.381	0.332	0.148	0.252	0.169	126.9
1995	0.260	0.086	0.699	0.092	0.266	0.018	0.001	0.020	106.2

Table 2.4.1 Numbers (*10^{-6}), Biomass(t*10^{-3}) and Mean Weight(g) of North Sea Autumn Spawning Herring (Millions) by ICES area for 1995

Numbers (Millions)	IVa	IVb	IVa&b	East of 6°E	Total North Sea
0	1.27	0.00	1.27	274.15	275.43
1	553.89	2651.91	3205.80	100.93	4201.96
2I	746.29	65.65	811.94	228.37	1040.31
2M	2372.59	157.31	2529.90	229.04	2758.94
3I	56.48	22.14	78.63	15.98	94.61
3M	1766.97	104.45	1871.42	89.93	1961.35
4	599.10	55.19	654.29	2.00	656.29
5	165.43	106.07	271.50	0.58	272.09
6	104.29	70.55	174.84	0.42	175.26
7	107.44	14.85	122.29	12.59	134.88
8	105.17	0.84	106.01	4.17	110.18
9	83.79	0.21	84.01	0.08	84.09
Tot	6662.72	3249.18	9911.89	1307.75	11219.64
Immature	1357.93	2739.70	4097.64	968.93	5066.57
Mature	5304.78	509.47	5814.25	338.82	6153.07
Biomass (Tonnes *10^{-3})	IVa	IVb	IVa&b	East of 6°E	North Sea
0	0.01	0.00	0.01	1.12	1.13
1	35.16	160.66	195.82	50.01	247.03
2I	72.10	0.00	78.45	16.79	95.24
2M	365.37	20.55	385.92	17.17	403.09
3I	7.16	2.55	9.71	1.61	11.32
3M	334.36	15.73	350.09	9.25	359.34
4	122.26	8.49	130.75	0.30	131.06
5	38.14	14.80	52.94	0.10	53.04
6	28.92	10.90	39.82	0.08	39.90
7	30.08	2.39	32.48	2.14	34.62
8	32.34	0.18	32.52	0.73	33.25
9	27.21	0.04	27.25	0.01	27.27
Tot	1093.12	236.31	1335.77	72.07	1407.84
Immature	114.43	163.21	283.99	42.28	326.27
Mature	978.68	73.09	1051.78	29.79	1081.56

Table 2.4.1 (Continued)

Weight (g)	IVa	IVb	IVa&b	East of 6°E	North Sea
0	7.00	0.00	7.00	4.08	4.10
1	63.48	60.58	61.08	51.02	57.78
2I	96.62	0.00	96.62	73.51	91.55
2M	154.00	130.61	152.54	74.95	146.10
3I	126.78	115.26	123.53	100.76	119.69
3M	189.23	150.58	187.07	102.84	183.21
4	204.07	153.91	199.84	152.20	199.69
5	230.54	139.56	195.00	176.90	194.96
6	275.37	157.40	228.13	194.10	228.05
7	280.03	161.16	265.59	169.98	256.67
8	307.47	219.28	306.77	174.83	301.77
9	324.70	209.04	324.41	175.70	324.26
Tot	164.06	72.73	134.76	55.11	125.48
Immature	84.27	59.57	69.31	43.64	64.40
Mature	184.49	143.47	180.90	87.92	175.78

Table 2.4.2 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1995. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 1995 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

Age (rings)	Numbers (millions)											
	Year											
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179	3,710	3,280	3,799
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272
6	44	41	36	77	174	281	395	748	1,311	788	321	175
7	52	17	24	38	43	120	211	262	474	546	238	135
8	39	23	6	11	23	44	134	112	155	178	220	110
9+	41	19	8	20	14	22	43	56	163	116	132	84
Total	5,478	5,484	7,542	20,165	13,496	16,377	18,262	12,781	17,173	19,326	13,003	11,220
Z(2+/3+)		0.92	0.57	1.01	0.81	0.11	0.11	0.56	0.37	0.73	1.17	0.55
Smoothed Z(2+/3+)		0.79	0.78	0.76	0.60	0.34	0.26	0.35	0.56	0.76	0.82	0.76
SSB('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082

SSB defined as all fish > maturity stage III.

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Table 2.5.1 Temporal and spatial coverage of the larvae surveys in 1994/95 and 1995/96 within the standard areas and time periods required for the calculation of LAI and LPE. The contribution of each survey, as the sum of numbers of herring larvae per m^{-2} per survey period, are also shown.

		1994/95			1995/96		
Area	Period	Samples	Days	Larvae m^{-2}	Samples	Days	Larvae m^{-2}
Buchan	1 -15 Sep.	None			None		
	16 -30 Sep.	None			None		
Orkney/Shetland	1 -15 Sep.	28	3	Not usable	None		
	16 -30 Sep.	89	5	1,260	122	8	8,741
		None					
Central North Sea	1 -15 Sep.	None			None		
	16 -30 Sep.	76	5	1,465	None		
	1 -15 Oct.	52	4	50	38	3	51
	16 - 30 Oct.	None			None		
Southern North Sea	16 - 31 Dec.	29	3	450	62	4	73
	1 - 15 Jan.	117	10	675	131	8	232
	16 - 31 Jan.	None			66	3	196

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Table 2.6.1. Abundance of herring from August Scottish Groundfish Surveys. Recorded catch rates of herring per 10 hours' fishing.

Year	Valid Hauls	Age						
		2	3	4	5	6	7	8
1982	76	535	154	56	41	20	24	8
1983	78	1143	353	141	45	36	21	13
1984	82	399	75	28	8	2	3	3
1985	83	1798	645	161	130	11	9	7
1986	79	564	311	158	22	9	3	1
1987	73	917	261	149	105	19	6	1
1988	85	2033	1008	190	89	49	11	1
1989	86	1104	1233	458	79	66	38	1
1990	85	585	770	642	188	56	19	5
1991	90	1784	943	635	433	177	44	17
1992	87	541	246	128	117	136	21	6
1993	87	844	307	128	105	93	73	17
1994	87	2096	368	128	49	42	27	18
1995	87	1637	528	124	156	66	38	26

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Table 2.7.1 North sea Herring,
Mean weigth (g) at age (w.r.) and year class weighted by number caught

Catches in : 1995

Division	Quarter	0 1994	1 1993	2 1992	3 1991	4 1990	5 1989	6 1988	7 1987	8 1986	9+ 1985
IV a (W of 2E)	I	0	0	112	135	160	180	220	191	218	224
	II	0	154	134	175	187	188	226	241	258	266
	III	60	81	151	197	235	239	289	286	320	326
	IV	23	86	147	172	198	236	233	224	244	249
	Total	23	85	145	184	219	222	272	268	302	305
IV a (E of 2 E)	I	0	0	112	135	159	182	233	194	225	225
	II	0	59	134	161	193	214	258	293	286	257
	III	0	58	169	183	195	208	240	208	266	213
	IV	24	93	137	173	202	225	223	231	246	244
	Total	24	80	135	159	192	214	233	227	247	241
IV b	I	0	17	36	147	161	202	212	244	148	148
	II	0	25	106	152	206	183	205	253	220	240
	III	8	49	149	183	205	223	270	273	298	289
	IV	10	52	119	141	171	188	234	246	253	253
	Total	9	40	135	174	197	205	261	266	272	282
IVc + VIId	I	0	24	83	95	118	135	161	156	164	164
	II	0	24	82	100	123	148	159	163	162	200
	III	0	79	116	131	163	201	221	257	247	280
	IV	14	63	115	139	178	193	210	223	205	272
	Total	14	53	114	130	161	177	203	208	184	241
IVa	Total	23	82	142	172	208	220	260	253	284	290
IVa + IVb	I	0	17	109	136	160	185	229	197	219	219
	II	0	29	127	171	193	193	227	253	253	261
	III	8	52	151	190	221	231	277	276	316	316
	IV	10	64	138	169	196	212	227	231	246	246
	Total	9	48	140	173	205	216	260	256	283	289
Total North Sea	I	0	17	107	131	140	141	192	190	204	210
	II	0	29	127	168	189	188	224	236	244	261
	III	8	52	151	189	220	230	276	276	316	316
	IV	10	64	130	160	189	199	217	229	243	248
	Total	9	48	136	167	196	200	247	249	278	287

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Table 2.7.2 Comparison between mean weights (g) at age in catch of North Sea Herring (adults) from earlier years and 1985-1994.

Division	Age in winter rings								
	Year	2	3	4	5	6	7	8	9+
IVa	1987	118	157	186	214	237	260	278	304
	1988	126	150	176	200	218	237	260	263
	1989	129	157	175	210	233	246	268	256
	1990	123	154	177	194	229	234	251	295
	1991	146	164	181	198	214	231	263	275
	1992	149	184	189	208	223	240	243	285
	1993	133	156	193	210	234	249	268	319
	1994	135	171	201	223	246	258	278	295
	1995	142	172	208	220	260	253	284	290
IVb	1987	70	131	179	215	233	225	273	244
	1988	98	136	175	195	208	244	228	205
	1989	93	162	199	225	280	276	273	333
	1990	102	145	194	219	250	272	259	277
	1991	119	173	196	220	225	277	257	263
	1992	81	179	198	213	232	255	272	313
	1993	102	146	199	220	236	261	275	306
	1994	122	150	177	205	237	251	255	245
	1995	135	174	197	205	261	266	272	282
IVa+IVb	1986	122	158	184	210	223	245	253	263
	1987	99	152	186	214	237	259	278	304
	1988	112	147	176	199	217	238	257	263
	1989	116	158	179	212	237	250	269	259
	1990	113	152	181	198	232	238	252	290
	1991	131	167	184	203	217	239	262	272
	1992	100	183	191	209	224	243	250	290
	1993	116	152	195	212	234	251	269	317
	1994	131	164	192	218	245	258	277	292
	1995	140	173	205	216	260	256	283	289
IVc+VIId	1986	108	139	164	185	208	174	202	232
	1987	105	128	148	164	198	211	197	234
	1988	103	132	156	178	197	185	165	
	1989	110	127	151	182	198	201	198	179
	1990	118	131	152	171	195	216	208	231
	1991	123	165	184	200	212	196	237	161
	1992	100	183	191	209	224	243	250	290
	1993	113	139	152	174	182	191	211	216
	1994	117	145	172	191	209	224	229	218
	1995	114	130	161	177	203	208	184	241
Total North Sea	1986	121	153	182	207	221	238	252	262
	1987	99	149	180	211	234	258	278	295
	1988	111	145	174	197	216	237	253	263
	1989	115	153	173	208	231	247	265	259
	1990	114	149	177	193	229	236	250	287
	1991	130	166	184	203	217	235	259	271
	1992	103	175	189	207	223	237	249	287
	1993	115	145	189	204	228	244	256	310
	1994	130	159	181	214	240	255	273	281
	1995	136	167	196	200	247	249	278	287

Table 2.7.3 Herring mean weight at age in the third quarter in Divisions IVa and IVb.

AGE (w.r.)	Mean weigths (g) at age in the catch													
	Third quarter (Divisions IVa and IVb)									July Acoustic Survey				
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
1	54	58	42	58	73	51	53	55	52	65	78	69	60	58
2	134	124	126	128	164	127	145	131	151	158	142	115	138	132
3	182	179	179	180	189	200	161	164	190	198	209	147	209	180
4	219	207	207	208	210	215	179	192	221	224	219	202	220	200
5	248	244	244	228	229	235	199	218	231	236	243	225	251	195
6	265	274	274	256	246	252	221	245	277	260	255	277	289	228
7	286	288	288	267	276	276	239	258	276	275	272	286	315	257
8	310	296	296	272	296	286	240	277	316	298	312	305	323	302
9+	342	350	350	295	293	330	283	292	316	317	311	340	346	324

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Table 2.8.1 Input parameters for ICA

```
Reading /users/fish/ifad/ifapwork/hawg/her_47d3/MATPROP.I66

Ogive in  1996  assumed = ogive in  1995
Reading /users/fish/ifad/ifapwork/hawg/her_47d3/FPROP.I66

Reading  /users/fish/ifad/ifapwork/hawg/her_47d3/MPROP.I66


Reading /users/fish/ifad/ifapwork/hawg/her_47d3/FLEET.I66

Reading /users/fish/ifad/ifapwork/hawg/her_47d3/SSB.I66

MLAI: Multiplicative Larval Abundance In

    No of years for separable constraint ? --> 4
 Reference age for separable constraint ?  --> 4
              S to be fixed on last age ? --> 1
First age for calculation of reference F --> 2
Last age for calculation of reference F  --> 6
           Use default weighting (Y/N) ?  --> n
Enter relative weights at age
 Weight for age     0  --> 1
 Weight for age     1  --> 1
 Weight for age     2  --> 1
 Weight for age     3  --> 1
 Weight for age     4  --> 1
 Weight for age     5  --> 1
 Weight for age     6  --> 1
 Weight for age     7  --> 1
 Weight for age     8  --> 1
 Weight for age     9  --> 1

Enter relative weights by year
Weight for year  1992  --> 1
Weight for year  1993  --> 1
Weight for year  1994  --> 1
Weight for year  1995  --> 1
Specify weights for year and age:
Enter year, age, new weight or -1,-1,-1 to finish
-1,-1,-1
 Is the last age of index  1 a plus group ? (Y/N)--> y
 Is the last age of index  2 a plus group ? (Y/N)--> y
 Is the last age of index  3 a plus group ? (Y/N)--> n
 Is the last age of index  4 a plus group ? (Y/N)--> n

You must choose a catchability model for each index.

Models :     A   Absolute: Index = Abundance + e
             L   Linear:   Index = Q . Abundance + e
             P   Power:    Index = Q . Abundance^K + e

   where Q and K are parameters to be estimated, and
   e is a lognormally-distributed error.

Model for SSB index  1 is to be (A/L/P) ?--> p
Model for aged index  1 is to be (A/L/P) ?--> l
Model for aged index  2 is to be (A/L/P) ?--> l
Model for aged index  3 is to be (A/L/P) ?--> l
Model for aged index  4 is to be (A/L/P) ?--> l

 Enter the time lag in entire years between spawning and the stock si
ze
of fish aged 0   on 1 January  --> 1
```

Table 2.8.1 continued

```
No of years for separable analysis :  4
Age range in the analysis          :  0 9
Year range in the analysis         :  1976 1995
Number of indices of SSB           :  1
Number of age-structured indices   :  4
Stock-Recruit relationship to be fitted.
Parameters to estimate             :  39

Enter lowest feasible F --> 0.05
Enter highest feasible F --> 1

ICA1 has terminated.
Do you want to continue with ICA2 (Y/N, Default: Y)?>y

Weighting options :
         1  - Recalculate all weights iteratively.
         2  - Enter new weights by hand.

Enter your choice --> 2
Enter weight for biomass index  1 --> 1
Enter weight for aged index  1 at age  2 --> 1
Enter weight for aged index  1 at age  3 --> 1
Enter weight for aged index  1 at age  4 --> 1
Enter weight for aged index  1 at age  5 --> 1
Enter weight for aged index  1 at age  6 --> 1
Enter weight for aged index  1 at age  7 --> 1
Enter weight for aged index  1 at age  8 --> 1
Enter weight for aged index  1 at age  9 --> 1
Enter weight for aged index  2 at age  2 --> 1
Enter weight for aged index  2 at age  3 --> 1
Enter weight for aged index  2 at age  4 --> 1
Enter weight for aged index  2 at age  5 --> 1
Enter weight for aged index  3 at age  1 --> 1
Enter weight for aged index  4 at age  0 --> 1
Enter weight for stock-recruit model --> 1
You should enter estimates of the extent to which
errors in each age of the age structured indices
are correlated. These may range from zero
(independence) to 1 (correlated errors) .

Enter value for aged index  1 --> 1

Enter value for aged index  2 --> 1
Enter value for aged index  3 --> 1
Enter value for aged index  4 --> 1
Do you want to shrink the final populations ? (Y/N) --> n
```

Table 2.8.2 Output data ICA North Sea

CATCH NUMBERS AT AGE (Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	238.	257.	130.	542.	1263.	9520.	11957.	13297.	6662.	4179.	3664.	8036.	3123.	2984.	1252.	2307.	10006.	9892.	4260.	8003.
1	127.	144.	169.	159.	245.	872.	1116.	2449.	1737.	3228.	4723.	6675.	7763.	3070.	2902.	2067.	2231.	3688.	1690.	1553.
2	902.	45.	5.	34.	134.	284.	299.	574.	1095.	1316.	1246.	2087.	2203.	1555.	864.	1095.	1244.	1134.	1688.	1494.
3	117.	186.	6.	10.	92.	57.	230.	216.	422.	1173.	827.	652.	1076.	1331.	749.	538.	429.	587.	463.	853.
4	52.	11.	5.	10.	32.	40.	34.	105.	193.	366.	458.	456.	379.	790.	827.	531.	350.	294.	329.	230.
5	35.	7.	0.	2.	22.	29.	14.	26.	78.	124.	128.	240.	252.	207.	372.	484.	349.	208.	103.	115.
6	6.	4.	0.	0.	2.	23.	7.	23.	22.	43.	61.	73.	126.	121.	77.	198.	364.	218.	87.	53.
7	4.	2.	0.	1.	1.	19.	8.	13.	24.	20.	20.	23.	38.	60.	52.	38.	148.	181.	72.	39.
8	1.	1.	0.	1.	0.	6.	4.	11.	11.	13.	13.	8.	15.	19.	28.	25.	38.	84.	66.	51.
9	0.	0.	0.	0.	0.	1.	1.	12.	18.	16.	15.	8.	8.	9.	11.	13.	23.	40.	44.	69.

INDICES OF SPAWNING STOCK BIOMASS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
1	.190E+03	.482E+03	.831E+03	.117E+04	.795E+03	.170E+04	.334E+04	.476E+04	.741E+04	.112E+05	.601E+04	.106E+05	.191E+05	.228E+05	.332E+05	.165E+05	.697E+04	.65

AGE - STRUCTURED INDICES

INDEX : 1 from 1989 to 1995

	1989	1990	1991	1992	1993	1994	1995
2	.373E+07	.297E+07	.283E+07	.418E+07	.371E+07	.328E+07	.380E+07
3	.375E+07	.353E+07	.150E+07	.163E+07	.189E+07	.957E+06	.206E+07
4	.161E+07	.337E+07	.210E+07	.140E+07	.909E+06	.429E+06	.656E+06
5	.488E+06	.135E+07	.198E+07	.151E+07	.795E+06	.363E+06	.272E+06
6	.281E+06	.395E+06	.748E+06	.131E+07	.788E+06	.321E+06	.175E+06
7	.120E+06	.211E+06	.262E+06	.474E+06	.546E+06	.328E+06	.135E+06
8	.440E+05	.134E+06	.112E+06	.155E+06	.178E+06	.220E+06	.110E+06
9	.220E+05	.430E+05	.560E+05	.163E+06	.116E+06	.132E+06	.840E+05

INDEX : 2 from 1983 to 1996

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	.109E+03	.161E+03	.716E+03	.661E+03	.838E+03	.410E+04	.775E+03	.580E+03	.794E+03	.377E+03	.762E+03	.109E+04	.129E+04	.195E+03
3	.420E+02	.750E+02	.256E+03	.235E+03	.117E+03	.783E+03	.411E+03	.322E+03	.283E+03	.181E+03	.236E+03	.199E+03	.152E+03	.460E+02
4	.140E+02	.320E+02	.260E+02	.570E+02	.560E+02	.550E+02	.860E+02	.271E+03	.250E+03	.630E+02	.450E+02	.640E+02	.460E+02	.140E+02
5	.340E+02	.700E+01	.360E+02	.170E+02	.440E+02	.260E+02	.100E+02	.700E+02	.170E+03	.102E+03	.640E+02	.400E+02	.900E+01	.900E+01

INDEX : 3 from 1979 to 1996

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
1	.172E+03	.312E+03	.431E+03	.772E+03	.126E+04	.144E+04	.208E+04	.254E+04	.368E+04	.453E+04	.231E+04	.102E+04	.116E+04	.116E+04	.294E+04	.167E+04	.119E+04	.17

INDEX : 4 from 1977 to 1996

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
0	.171E+02	.131E+02	.521E+02	.101E+03	.767E+02	.134E+03	.918E+02	.115E+03	.181E+03	.177E+03	.271E+03	.169E+03	.714E+02	.259E+02	.699E+02	.201E+03	.190E+03	.10

FISHING MORTALITY

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.1440	.0966	.0451	.0839	.1263	.4855	.3379	.4050	.2192	.0863	.0626	.1617	.1256	.1309	.0574	.1105	.2506	.3174	.2816	.3270
1	.2374	.2904	.1979	.1649	.1135	.2870	.2274	.2553	.1988	.3837	.3172	.3741	.5893	.4290	.4470	.3012	.2878	.3646	.3234	.3756
2	1.3236	.2117	.0236	.0935	.3589	.3251	.2625	.3064	.3039	.4056	.4561	.4053	.3626	.4035	.3677	.5664	.5756	.7292	.6468	.7512
3	1.3554	1.3508	.0396	.0646	.4125	.2705	.510[illegible]	.3278	.4144	.6694	.5192	.4949	.4045	.[illegible]	.3697	.4411	.5655	.7164	.6355	.7380

Table 2.8.2 (Cont'd)

4	1.6993	.3770	.0956	.0870	.2872	.2967	.2414	.4397	.5139	.7306	.5723	.5768	.5690	.5561	.4691	.4614	.6804	.8619	.7646	.8879
5	1.4691	1.1027	.0142	.0477	.2429	.3933	.1500	.2673	.5969	.6467	.5378	.5922	.6482	.6205	.4905	.4899	.5910	.7486	.6640	.7712
6	.9237	.5841	.0662	.0106	.0609	.3820	.1362	.3325	.3273	.7006	.6862	.5963	.6351	.6578	.4384	.4668	.6563	.8314	.7375	.8565
7	1.3972	.5345	.0439	.3594	.0859	.8233	.1947	.3610	.6156	.5035	.7405	.5350	.6227	.6192	.5903	.3566	.6179	.7827	.6943	.8063
8	1.3776	.7718	.1103	.1610	.2734	.4915	.3189	.4071	.5066	.7068	.6617	.6321	.7097	.6609	.5821	.5449	.6804	.8619	.7646	.8879
9	1.3776	.7718	.1103	.1610	.2734	.4915	.3189	.4071	.5066	.7068	.6617	.6321	.7097	.6609	.5821	.5449	.6804	.8619	.7646	.8879

NUMBERS AT AGE (Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	2777.	4376.	4647.	10587.	16659.	37651.	64183.	61133.	52584.	79388.	95006.	84045.	41444.	38056.	35323.	34579.	64759.	52296.	31766.	50282.	44025.
1	930.	885.	1461.	1634.	3581.	5401.	8524.	16841.	15001.	15536.	26790.	32829.	26303.	13447.	12282.	12270.	11391.	18543.	14006.	8818.	13338.
2	1377.	270.	243.	441.	510.	1176.	1491.	2498.	4800.	4524.	3894.	7177.	8308.	5368.	3221.	2890.	3340.	3142.	4737.	3729.	2228.
3	171.	272.	162.	176.	298.	264.	630.	850.	1362.	2624.	2234.	1828.	3545.	4283.	2656.	1652.	1215.	1391.	1123.	1838.	1303.
4	66.	36.	58.	127.	135.	161.	165.	309.	501.	737.	1100.	1088.	913.	1937.	2313.	1503.	870.	565.	556.	487.	719.
5	47.	11.	22.	47.	106.	92.	108.	117.	180.	271.	321.	562.	553.	467.	1005.	1309.	857.	399.	216.	234.	181.
6	11.	10.	3.	20.	41.	75.	56.	84.	81.	90.	129.	170.	281.	262.	227.	557.	726.	430.	171.	101.	98.
7	6.	4.	5.	3.	18.	35.	46.	44.	55.	53.	40.	59.	85.	135.	123.	133.	316.	341.	169.	74.	39.
8	1.	1.	2.	4.	2.	15.	14.	34.	28.	27.	29.	17.	31.	41.	66.	62.	84.	154.	141.	76.	30.
9	0.	0.	1.	2.	5.	5.	11.	16.	30.	32.	26.	26.	21.	23.	30.	48.	58.	65.	84.	95.	64.

STOCK SUMMARY

Year	Recruits $x10^6$	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Ref. F Fbar 2- 6
1976	2777.	364690.	80883.	174800.	2.1611	1.3542
1977	4376.	217466.	52039.	46000.	.8839	.7253
1978	4647.	232149.	69754.	11000.	.1577	.0478
1979	10587.	389836.	113338.	25100.	.2215	.0607
1980	16659.	637699.	138352.	70764.	.5115	.2725
1981	37651.	1161416.	202259.	174879.	.8646	.3335
1982	64183.	1837346.	284593.	275079.	.9666	.2602
1983	61133.	2454221.	431239.	387202.	.8979	.3347
1984	52584.	2683918.	705297.	409489.	.5806	.4313
1985	79388.	3243063.	739715.	609108.	.8234	.6306
1986	95006.	3737281.	753988.	660553.	.8761	.5543
1987	84045.	4118225.	870150.	773411.	.8888	.5331
1988	41444.	3760970.	1115899.	875923.	.7849	.5239
1989	38056.	3303446.	1239849.	768886.	.6201	.5308
1990	35323.	3102114.	1135261.	619963.	.5461	.4271
1991	34579.	2934939.	939038.	635929.	.6772	.4851
1992	64759.	2983679.	698944.	694206.	.9932	.6138
1993	52296.	2944492.	457767.	647000.	1.4134	.7775
1994	31766.	2284487.	517081.	538000.	1.0405	.6897
1995	50282.	2002690.	495946.	607,000	1.0587	.8010

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1992	.6804	.5922	.7817
2	1993	.8619	.7538	.9855
3	1994	.7646	.6626	.8822
4	1995	.8879	.7493	1.0522

Separable Model: Selection (S) by age

Table 2.8.2 (Cont'd)

5	0	.3683	.3054	.4442
6	1	.4230	.3506	.5104
7	2	.8460	.7111	1.0065
8	3	.8312	.6916	.9990
	4	1.0000	Fixed : Reference age	
9	5	.8685	.7266	1.0381
10	6	.9646	.8164	1.1397
11	7	.9081	.7663	1.0762
	8	1.0000	Fixed : last true age	

Separable Model: Populations in year 1995

12	0	50281604.	42547782.	59421185.
13	1	8818064.	7566360.	10276838.
14	2	3728780.	3249521.	4278724.
15	3	1838004.	1605740.	2103865.
16	4	486914.	417613.	567716.
17	5	234410.	198541.	276759.
18	6	100576.	83878.	120597.
19	7	73866.	60637.	89982.
20	8	76471.	62051.	94242.

Separable Model: Populations at age 8

21	1992	84080.9139	63727.7268	110934.4462
22	1993	154079.4773	123796.7835	191769.8073
23	1994	140902.8263	114562.0760	173299.9887

Recruitment in Year 1996

24	0	44025185.9437	32855887.2776	58991467.2217

SSB Index catchabilities

25	1	Power Model : Q	.37182E+01	.34842E+01	.39679E+01
26	1	Power Model : K	-.85393E+01	-.93762E+01	-.77024E+01

Age-structured index catchabilities

Age-Structured Index 1

Linear model fitted. Slopes at age:

27	2 Q	.15260E+01	.11220E+01	.20754E+01
28	3 Q	.16530E+01	.12147E+01	.22496E+01
29	4 Q	.18957E+01	.13922E+01	.25813E+01
30	5 Q	.21854E+01	.16034E+01	.29786E+01
31	6 Q	.24402E+01	.17880E+01	.33302E+01
32	7 Q	.23876E+01	.17443E+01	.32682E+01
33	8 Q	.23828E+01	.17308E+01	.32804E+01
34	9 Q	.22098E+01	.15989E+01	.30542E+01

Age-Structured Index 2

Linear model fitted. Slopes at age:

35	2 Q	.17322E-03	.14839E-03	.20220E-03
36	3 Q	.11388E-03	.97507E-04	.13300E-03
37	4 Q	.72297E-04	.61872E-04	.84479E-04
38	5 Q	.42830E-04	.36615E-04	.50100E-04

Age-Structured Index 3

Linear model fitted. Slopes at age:

39	1 Q	.13822E-03	.12883E-03	.14829E-03

Table 2.8.2 (Cont'd)

Age-Structured Index 4

Linear model fitted. Slopes at age:

40 . 0 Q	.30114E-05	.28161E-05	.32203E-05

Parameters of the B.-H. stock-recruit relationship

41	a	.6678108E+08	.4679592E+08	.9530131E+08
42	b	.5131011E+06	.2657074E+06	.9908369E+06

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))
and weights (W) used in the analysis.

Age	1992	1993	1994	1995	
0	.77364E-01	.69733E-01	-.16863E+00	-.12895E+00	.10000E+01
1	.19062E+00	-.19638E-03	-.39600E+00	-.14737E+00	.10000E+01
2	-.28898E-01	-.23292E+00	-.15975E+00	-.14875E+00	.10000E+01
3	-.11321E+00	-.10621E+00	-.43420E-01	-.31623E-01	.10000E+01
4	-.16053E+00	-.60631E-01	.14452E+00	-.17882E+00	.10000E+01
5	-.46548E-01	.32254E-01	.28947E-01	-.49886E-01	.10000E+01
6	.85015E-01	-.64599E-01	.19190E-01	-.52878E-01	.10000E+01
7	.58140E-01	.22891E-01	-.11455E+00	-.68404E-02	.10000E+01
8	-.44193E-01	-.14171E-01	-.84100E-01	.16347E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

Biomass Index Residuals: log(Observed Index) - log(Expected Index)

Idx	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	
1	-.10543E+01	.45580E+00	.61573E+00	.31785E+00	-.32790E+00	-.64201E-01	.15970E+00	-.31203E-01	-.23427E+00	.11717E+00	-.53192E+00	-.15014E+00	.11124E+00	.1

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1989	1990	1991	1992	1993	1994	1995
2	-.40077E+00	-.13629E+00	.34506E-01	.28313E+00	.30946E+00	-.26954E+00	.17417E+00
3	-.29630E+00	.95113E-01	-.24599E+00	.21419E+00	.30505E+00	-.20287E+00	.12537E+00
4	-.46233E+00	.49956E-01	.48407E-02	.26294E+00	.36493E+00	-.42427E+00	.20182E+00
5	-.34248E+00	-.16258E+00	-.41475E-01	.16453E+00	.37494E+00	.15789E+00	-.15391E+00
6	-.40418E+00	-.43855E-01	-.28509E+00	.11534E+00	.22708E+00	.20024E+00	.18787E+00
7	-.59069E+00	.51803E-01	.60811E-01	-.69597E-01	.87042E-01	.22838E+00	.23121E+00
8	-.38064E+00	.22047E+00	.85798E-01	.17259E+00	-.19491E+00	.52787E-01	.38647E-01
9	-.42068E+00	-.56143E-01	-.29090E+00	.67599E+00	.31633E+00	.13816E+00	-.36852E+00

Aged Index 2

Table 2.8.2 (Cont'd)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
2	-.12725E+01	-.15360E+01	.33281E-01	.11205E+00	-.27095E+00	.11629E+01	-.58963E-01	.15554E+00	.61307E+00	-.27497E+00	.51652E+00	.44958E+00	.87185E+00	-.4
3	-.74222E+00	-.61919E+00	-.24857E-02	.46563E-01	-.45476E+00	.76823E+00	-.63333E-01	.16223E+00	.52041E+00	.40269E+00	.55880E+00	.58858E+00	-.15578E+00	-.1
4	-.37383E+00	-.16970E-01	-.57205E+00	-.21537E+00	-.22153E+00	-.64892E-01	-.37267E+00	.58255E+00	.93171E+00	.13791E+00	.26510E+00	.61552E+00	.44041E+00	-.1
5	.10591E+01	-.71990E+00	.70659E+00	-.19489E+00	.33061E+00	-.33873E+00	-.12516E+01	.22365E+00	.73383E+00	.28136E+00	.23140E+00	.32225E+00	-.85337E+00	-.5

Aged Index 3

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	
1	-.68561E-01	-.26671E+00	-.32414E+00	-.20788E+00	-.39413E+00	-.15474E+00	.21028E+00	-.14644E+00	.30975E-01	.49808E+00	.46746E+00	-.25618E+00	-.15206E+00	-.8

Aged Index 4

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
0	.40318E+00	.69873E-01	.63205E+00	.84714E+00	-.19774E+00	-.19313E+00	-.51321E+00	-.16138E+00	-.13539E+00	-.33981E+00	.21900E+00	.44888E+00	-.32616E+00	-.1

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1992 to 1995

Variance	:	.0367
Skewness test statistic	:	-3.2510
Kurtosis test statistic	:	1.3135
Partial chi-square	:	.0405
Probability of chi-square	:	1.0000
Degrees of freedom	:	13

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Power catchability relationship assumed.
Last age is a plus-group.

Variance	:	.1741
Skewness test statistic	:	-1.2192
Kurtosis test statistic	:	.5070
Partial chi-square	:	.4375
Probability of chi-square	:	1.0000
Number of observations	:	20
Degrees of freedom	:	18
Weight in the analysis	:	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

Table 2.8.2 (Cont'd)

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	2	3	4	5	6	7	8	9
Variance	:	.0765	.0589	.1066	.0603	.0645	.0789	.0455	.1628
Skewness test stat.	:	-.2646	-.1117	-.5594	.1696	-.7291	-1.5896	-.9192	.5741
Kurtosis test stat.	:	-.7611	-.8880	-.6743	-.5760	-.6352	.5299	-.3132	-.5258
Partial chi-square	:	.0303	.0243	.0461	.0271	.0296	.0387	.0239	.0872
Prob. of chi-square	:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Number of data	:	7	7	7	7	7	7	7	7
Degrees of freedom	:	6	6	6	6	6	6	6	6
Weight in analysis	:	.1250	.1250	.1250	.1250	.1250	.1250	.1250	.1250

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

Age	:	2	3	4	5
Variance	:	.5673	.2996	.2980	.4448
Skewness test stat.	:	-.8989	-.5383	-.3340	-.4454
Kurtosis test stat.	:	-.1441	-.7477	-.2309	-.6387
Partial chi-square	:	1.1467	.7846	.9733	1.8720
Prob. of chi-square	:	1.0000	1.0000	1.0000	.9998
Number of data	:	14	14	14	14
Degrees of freedom	:	13	13	13	13
Weight in analysis	:	.2500	.2500	.2500	.2500

DISTRIBUTION STATISTICS FOR ln AGED INDEX 3

Linear catchability relationship assumed.

Age	:	1
Variance	:	.0739
Skewness test stat.	:	.7968
Kurtosis test stat.	:	-.7978
Partial chi-square	:	.1731
Prob. of chi-square	:	1.0000
Number of data	:	18
Degrees of freedom	:	17
Weight in analysis	:	1.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 4

Linear catchability relationship assumed.

Age	:	0
Variance	:	.2131
Skewness test stat.	:	-1.2312
Kurtosis test stat.	:	1.1725
Partial chi-square	:	.9713
Prob. of chi-square	:	1.0000
Number of data	:	20
Degrees of freedom	:	19
Weight in analysis	:	1.0000

**Table 2.8.3 Herring in Sub-area IV and Divisions VIId and IIIa.
Overview of variance and residuals obtained from ICA.**

Total weighted SSQ is : 16.30736868962008

Unweighted Residuals About the Model fit

Wt	Start SSQ	End SSQ	df	Variance	IV
Separable model:	.3120	.5569	13	.0428	23.34213
Biomass idx 1	3.1737210	3.1330548	18	.1741	.24613
Aged index 1	5.1761153	3.9232121	48	.0817	.52415
Aged index 2	22.1325041	20.9253840	52	.4024	.10646
Aged index 3	1.3826401	1.2566817	17	.0739	.57954
Aged index 4	4.1172569	4.0486699	19	.2131	.20105

Partition of the weighted residuals

Catch at Age Matrix : .5569E+00 for 36 observations.

SSB Index 1 3.13305 20

Aged Index 1

Age:	2	3	4	5	6	7	8	9
Wted SSQ:	.5741E-01	.4414E-01	.7991E-01	.4521E-01	.4835E-01	.5917E-01	.3411E-01	.1221E+00
No data:	7	7	7	7	7	7	7	7

Aged Index 2

Age:	2	3	4	5
Wted SSQ:	.1844E+01	.9736E+00	.9685E+00	.1446E+01
No data:	14	14	14	14

Aged Index 3

Age:	1
Wted SSQ:	.1257E+01
No data:	18

Aged Index 4

Age:	0
Wted SSQ:	.4049E+01
No data:	20

CALCULATION OF REFRENCE "AREA-FISHING-MORTALITIES"

REF.-F

Revised by P. Sparre 15. May 1995

Age	North Sea Catches			Div.III a Catches				Total	Total
	Fleet A	Fleet B	Total N.S.	Fleet C	Fleet D	Fleet E	Total IIIa	Stock	Catch
0	11.57	6268.13	6279.70	5.64	176.34	1540.86	1722.84		8002.54
1	156.03	327.09	483.12	157.36	238.86	673.36	1069.58		1552.70
2	1359.40	14.62	1374.02	80.66	2.45	43.26	126.37	1500.39	1500.39
3	859.91	3.58	863.49						863.49
4	244.43	0.25	244.68						244.68
5	115.85	0.05	115.90						115.90
6	53.27	0.03	53.30						53.30
7	39.28	0.02	39.30						39.30
8	119.45	0.05	119.50						119.50
9			0.00						0.00

a) N(1.Dec) = (N(1.Jan) *exp(-M/2) - C) *exp(-M/2)

Age	M	exp(-M/2)	Total Stock N	Split factors N.S.	Split factors IIIa	Stock N 1. Jan N.S.	Stock N 1. Jan III a	Stock N 31. Dec. a) N.S.	Stock N 31. Dec. a) III a	F b) N.S.	F b) III a
0	1.00	0.6065	44025.0	0.78	0.22	34339.5	9685.5	8824.0	2518.1	0.3588	0.3471
1	1.00	0.6065	13338.0	0.31	0.69	4134:8	9203.2	1228.1	2736.9	0.2140	0.2127
2	0.30	0.8607	2228.0	1.00	1.00	2228.0	2228.0				

F = ln(N(1.Jan)/N(31.Dec))-M

Age	North Sea Catches			III a Ctaches			
	Fleet A	Fleet B	Total N.S.	Fleet C	Fleet D	Fleet E	Total IIIa
0	0.001	0.358	0.359	0.001	0.036	0.310	0.347
1	0.069	0.145	0.214	0.031	0.048	0.134	0.213
2	0.804	0.009	0.888	0.048	0.001	0.026	
3	0.735	0.003	0.738				
4	0.887	0.001	0.888				
5	0.771	0.000	0.771				
6	0.856	0.000	0.857				
7	0.806	0.000	0.806				
8	0.888	0.000	0.888				

Age group 2 is the total F (from ICA) distributed on all 5 fleets

These are the Fs from ICA, including age gr 2

Table 2.10.1. Computation of reference Fs for catch prediction of North Sea herring

Revised by P. Sparre and H. Sparholt 30.10.95 and further by H. Sparholt 31.10.95.

Input data revised by

NORTH SEA HERRING SHORT TERM PREDICTION PROGRAM, WG 1996

Fleet	Description	
A:	IV HC	*North Sea Human Consumption*
B:	IV IND	*North Sea Industrial*
C:	IIIa HC	*IIIa Human consumption*
D:	IIIa MC	*IIIa "Mixed Clupeid"*
E:	IIIa IND.	*IIIa Industrial*
F:	Fl. 22+24	*Western Baltic Combined fisheries*

The prediction is based on the following assumptions:
Age group 0 : Some migrate to IIIa, depending on year class
Age group 1 : Some migrate to IIIa, depending on year class
Age group 2: All fish in III a migrates back to the North Sea during the year
Age groups >3: Only in North Sea

Age group 0 : So Migration takes place 1 January
Age group 1 : So (distribution from MIK)
Age group 2: All f (distribution from IBTS)
d (Total "area-mixing" assumed)
Age gr 3+: (No area-mixing assumed, only in North Sea)

INPUT DATA (indicated with Bold Italic)
Comments with Italic

1996 1996

Table 1

NORTH SEA HERRING STOCK SIZE 1. JANUARY					1996		
	STOCK NUMBER	MEAN WEIGHT AT AGE IN THE STOCK		MATURITY OGIVE	NATURAL MORTALITY		
AGE		SPAW.	1. JAN.		M	M/2	exp(-M/2)
0	44025.0	7	7	0.00	1.00	0.50	0.6065
1	13338.0	61	61	0.00	1.00	0.50	0.6065
2	2228.0	135	135	0.73	0.30	0.15	0.8607
3	1303.0	192	192	0.95	0.20	0.10	0.9048
4	719.0	209	209	1.00	0.10	0.05	0.9512
5	181.0	222	222	1.00	0.10	0.05	0.9512
6	98.0	259	259	1.00	0.10	0.05	0.9512
7	39.0	286	286	1.00	0.10	0.05	0.9512
8	30.0	312	312	1.00	0.10	0.05	0.9512
9+	64.0	335	335	1.00	0.10	0.05	0.9512
TOTAL	62025.0						0.9512

Table 2

NORTH SEA HERRING. MEAN WEIGHT AT AGE IN THE CATCH BY FLEET						1995
	IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24
AGE	A	B	C	D	E	F
0	30.7	8.3	12.5	15.2	12.2	0
1	79.14	33.3	65.2	15.2	31.6	0
2	138.07	72.4	127.3	33	60.7	0
3	167.05	139.4	0	0	0	0
4	196.2	162	0	0	0	0
5	205.28	177.5	0	0	0	0
6	257.29	223.3	0	0	0	0
7	259.06	194.3	0	0	0	0
8	278	226.2	0	0	0	0
9+	287	226.2	0	0	0	0

Table 3

FISHING MORTALITY BY FLEET RELATIVE TO AREA *)						1995
	IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24
AGE	A	B	C	D	E	F
0	0.0007	0.3582	0.0011	0.0355	0.3104	0
1	0.0691	0.1449	0.0313	0.0475	0.1339	0
2	0.8046	0.0087	0.0477	0.0014	0.0256	0
3	0.7349	0.0031	0	0	0	0
4	0.8870	0.0009	0	0	0	0
5	0.7709	0.0003	0	0	0	0
6	0.8560	0.0005	0	0	0	0
7	0.8059	0.0004	0	0	0	0
8	0.8876	0.0004	0	0	0	0
9	0.8876	0.0004	0	0	0	0

*) These are "area-mortalities", NOT traditional fishing mortalities computed in sheet 2

Table 2.10.2 Excel short term prediction of North Sea herring

[G:\ACFM\HAWG96\HER_47D3\PER2x96.xls (calculation)]

1996 | 1996

Table 4 1996

NORTH SEA HERRING STOCK SIZE 1. JANUARY					
	TOTAL NUMBER from table 1	STOCK NUMBERS BY AREA (Split factor) * (Total Number)		split factors	
a	*b*	*c*	*d*	*e*	*f*
AGE	Total	IV a)	IIIa b)	IV a)	IIIa b)
0	44025.0	34339.5	9685.5	*0.78*	*0.22*
1	13338.0	4134.8	9203.2	*0.31*	*0.69*
2	2228.0	2228.0	2228.0	*1*	*1*
3	1303.0	1303.0	0.0	1	0
4	719.0	719.0	0.0	1	0
5	181.0	181.0	0.0	1	0
6	98.0	98.0	0.0	1	0
7	39.0	39.0	0.0	1	0
8	30.0	30.0	0.0	1	0
9+	64.0	64.0	0.0	1	0
TOTAL	62025.0	43136.3	21116.7		

Table 5 1996

1996		NORTH SEA HERRING. F-FACTORS							
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
F-Factor	*1*	*0.749*	*0.938*	*2.23*	*1.78*	*0.65*	*0*	*1*	*1*
(Total Factor)*(F-Factor)		0.749	0.938	2.23	1.78	0.65	0		

Z = Ftotal + M, where *Ftotal = Fleet(1)*Factor(1)+.. +Fleet(n)*Factor(n)*

Table 6 1996

TOTAL FISHING MORTALITY BY FLEET RELATIVE TO AREA					
	Total North Sea F		Total IIIa F		
AGE	F(N.S.)	Z(N.S.)	F(IIIa)	Z(IIIa)	
0	0.3365	1.3365	0.2676	1.2676	
1	0.1877	1.1877	0.2414	1.2414	
2	0.7363	1.1620	0.1257	1.1620	
3	0.5533	0.7533	0.0000	0.0000	
4	0.6652	0.7652	0.0000	0.0000	
5	0.5777	0.6777	0.0000	0.0000	
6	0.6416	0.7416	0.0000	0.0000	
7	0.6040	0.7040	0.0000	0.0000	
8	0.6651	0.7651	0.0000	0.0000	
9	0.6651	0.7651	0.0000	0.0000	

Table 7 1996 EXCEL 5, File: per2x.XLS

1996		NORTH SEA HERRING. CATCH AT AGE BY FLEET					
N(North Sea) * F(fleet) * (1-exp(-Z))/Z(North Sea)				N(IIIa) * F(fleet) * (1-exp(-Z(IIIa)))/Z(IIIa)			
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
AGE	TOTAL e)	A	B	C	D	E	F
0	7842.2	9.4	6363.9	13.9	347.2	1107.8	
1	1726.5	125.3	328.8	367.9	445.7	458.8	
2	970.1	793.9	10.7	140.2	3.4	21.9	
3	506.5	503.9	2.6				
4	334.2	333.8	0.4				
5	75.9	75.9	0.0				
6	44.4	44.4	0.0				
7	16.9	16.9	0.0				
8	13.9	13.9	0.0				
9+	29.7	29.7	0.0				
TOTAL	11560.5	1947.0	6706.6	522.0	796.3	1588.6	

Table 2.10.2 Excel short term prediction of North Sea herring, continued

[G:\ACFM\HAWG96\HER_47D3\PER2x96.xls (calculation)]

Table 8 *1996*

NORTH SEA HERRING. FISHING MORTALITY BY FLEET (TOTAL) *)						1996	
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24
a	b	c	d	e	f	g	h
AGE	TOTAL a)	A b)	B	C	D	E	F
0	0.348	0.000	0.282	0.001	0.015	0.049	0.000
1	0.240	0.017	0.046	0.051	0.062	0.064	0.000
2	0.705	0.577	0.008	0.102	0.002	0.016	0.000
3	0.561	0.558	0.003				
4	0.671	0.670	0.001				
5	0.582	0.581	0.000				
6	0.647	0.646	0.000				
7	0.609	0.608	0.000				
8	0.671	0.670	0.000				
9+	0.671	0.670	0.000				
AVG 2-6	0.633	0.607	0.002	0.102	0.002	0.016	0.000

a) = ln(N(o)/(N(o)*exp(-M/2)-C) *exp(-M/2) - M b) = F(total) * C(fleet)/C(total)

Table 9 1996

1996	NORTH SEA HERRING. YIELD AT AGE BY FLEET						
C * W (body weight)				C * W (body weight)			
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
AGE	TOTAL e)	A a)	B a)	C b)	D c)	E c)	F c)
0	72074.9	288.0	52820.5	173.9	5277.2	13515.3	
1	66076.4	9913.0	10950.5	23984.9	6774.8	14453.2	
2	129678.5	109608.5	774.1	17852.8	112.2	1330.8	
3	84536.8	84170.6	366.2				
4	65564.8	65495.5	69.3				
5	15588.7	15581.4	7.3				
6	11422.2	11415.2	7.0				
7	4380.2	4378.1	2.1				
8	3876.3	3874.6	1.7				
9+	8537.0	8533.5	3.5				
TOTAL	461735.7	313258.4	65002.1	42011.6	12164.2	29299.2	

Table 10 1996

NORTH SEA HERRING STOCK SIZE and SSB				
	TOTAL NUMBER	STOCK BIOMASS a)	b)	1996
	from table 1	1st Jan.	Spaw.time	Spaw.time
AGE	Total	Biomass	SS numbers	SSB c)
0	44025.0	308175.0	0.0	0
1	13338.0	813618.0	0.0	0
2	2228.0	300780.0	829.5	111980
3	1303.0	250176.0	743.2	142698
4	719.0	150271.0	429.0	89657
5	181.0	40182.0	114.6	25448
6	98.0	25382.0	59.4	15390
7	39.0	11154.0	24.3	6939
8	30.0	9360.0	17.9	5585
9+	64.0	21440.0	38.2	12793
TOTAL	62025.0	1930538.0	2256.1	410488

a) = N*w(1.jan)

b) = N*Maturity*exp(-Z*.67)

c) = N*w(spaw.time)*Maturity*exp(-Z*.67)

Table 11 SUMMARY RESULTS FOR YEAR 1996

		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	11560.5	1947.0	6706.6	522.0	796.3	1588.6	0.0	8653.6	2906.9
YIELD	461735.7	313258.4	65002.1	42011.6	12164.2	29299.2	0.0	378260.5	83475.1
SSB	410488.5		AVG F 2-6	0.633					

Table 2.10.2 Excel short term prediction of North Sea herring, continued

[G:\ACFM\HAWG96\HER_47D3\PER2x96.xls (calculation)]

1997 | 1997

Table 1 1997

NORTH SEA HERRING STOCK SIZE 1. JANUARY					
	TOTAL NUMBER from table 1	STOCK NUMBERS BY AREA (Split factor) * (Total Number)		split factors	
AGE	Total a)	IV a)	IIIa b)	IV c)	IIIa d)
0	*44083.9*	34385.4	9698.5	0.78	0.22
1	11439.4	3546.2	7893.2	0.31	0.69
2	3859.6	3859.6	3859.6	*1*	*1*
3	815.6	815.6	0.0	1	0
4	608.5	608.5	0.0	1	0
5	332.6	332.6	0.0	1	0
6	91.5	91.5	0.0	1	0
7	46.4	46.4	0.0	1	0
8	19.2	19.2	0.0	1	0
9+	43.5	43.5	0.0	1	0
TOTAL	61340.2	43748.6	21451.2		

a) = N(a+1, y+1) = (N(a,y)*exp(-M/2) - C(a,y))*exp(-M/2) for ages 1-9. N(o) is input

c) for age groups 0 ond 1: splitfactor = N(N.S. last year)/N(total,last year) for age group 2: both split factor = 1.0

d) for age groups 0 ond 1: splitfactor = N(IIIa. last year)/N(total,last year) for age group 2: both split factor = 1.0

Table 2 1997

0.58146		NORTH SEA HERRING. F-FACTORS							
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
F-Factor	*0.8*	*1*	*1*	*1*	*1*	*1*	*0*	*1*	*1*
(Total Factor)*(F-Factor)		0.8	0.8	0.8	0.8	0.8	0		

Z = Ftotal + M, where *Ftotal = Fleet(1)*Factor(1)+..+Fleet(n)*Factor(n)*

Table 3 1997

TOTAL FISHING MORTALITY BY FLEET RELATIVE TO AREA					
	Total North Sea F		Total IIIa F		
AGE	F(N.S.)	Z(N.S.)	F(IIIa)	Z(IIIa)	
0	0.2871	1.2871	0.2777	1.2777	
1	0.1712	1.1712	0.1702	1.1702	
2	0.7103	1.0701	0.0598	1.0701	
3	0.5904	0.7904			
4	0.7103	0.8103			
5	0.6170	0.7170			
6	0.6852	0.7852			
7	0.6450	0.7450			
8	0.7103	0.8103			
9	0.7103	0.8103			

Table 4 1997

1997	NORTH SEA HERRING. CATCH AT AGE BY FLEET							number at end of year
N(North Sea) * F(fleet) * (1-exp(-Z))/Z(North Sea)				N(IIIa) * F(fleet) * (1-exp(-Z(IIIa)))/Z(IIIa)				
AGE	TOTAL	A	B	C	D	E	F	
0	7075.2	13.1	5541.6	5.0	155.6	1359.8		no value
1	1406.4	372.6	242.1	116.5	176.8	498.4		11926.3
2	1683.2	1525.1	16.4	90.5	2.7	48.5		3355.3
3	332.8	331.4	1.4					1410.5
4	296.2	295.9	0.3					366.6
5	146.5	146.4	0.1					268.9
6	43.5	43.4	0.0					161.6
7	21.1	21.1	0.0					41.5
8	9.3	9.3	0.0					21.9
9+	21.2	21.2	0.0					8.5
TOTAL	11035.4	2779.6	5802.0	211.9	335.2	1906.7		19.2

Table 2.8.xx.F EXCEL 5 "work book" for short term prediction of North Sea Herring

SHEET 3

Table 5 *1997*

NORTH SEA HERRING. FISHING MORTALITY BY FLEET (TOTAL) *)				1997			
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24
AGE	TOTAL a)	A b)	B	C	D	E	F
0	0.307	0.001	0.241	0.000	0.007	0.059	0.000
1	0.227	0.060	0.039	0.019	0.028	0.080	0.000
2	0.707	0.640	0.007	0.038	0.001	0.020	0.000
3	0.600	0.597	0.002				
4	0.717	0.716	0.001				
5	0.622	0.621	0.000				
6	0.691	0.691	0.000				
7	0.650	0.650	0.000				
8	0.717	0.717	0.000				
9+	0.717	0.717	0.000				
AVG 2-6	0.667	0.653	0.002	0.038	0.001	0.020	0.000

a) = ln(N(o)/{N(o)*exp(-M/2)-C} *exp(-M/2) - M   b) = F(total) * C(fleet)/C(total)

Table 2.10.2 Excel short term prediction of North Sea herring, continued

Table 6 1997

0.58146	NORTH SEA HERRING. YIELD AT AGE BY FLEET						
C * W (body weight)				C * W (body weight)			
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
AGE	TOTAL e)	A	B	C	D	E	F
0	65415.5	402.6	45995.5	62.2	2365.4	16589.7	
1	63532.3	29488.5	8063.5	7593.9	2687.3	15699.3	
2	226309.2	210565.7	1187.5	11519.3	90.7	2945.9	
3	55559.7	55367.4	192.4				
4	58103.8	58054.8	49.0				
5	30069.0	30057.8	11.2				
6	11178.7	11173.3	5.5				
7	5470.8	5468.7	2.1				
8	2598.3	2597.4	0.9				
9+	6075.2	6073.2	2.0				
TOTAL	524312.5	409249.3	55509.5	19175.4	5143.4	35234.9	

Yield 1997

Table 7 1997

NORTH SEA HERRING STOCK SIZE and SSB				
	TOTAL NUMBER	STOCK BIOMASS a)	b)	1
	from table 1	1st Jan.	Spaw.time	Spaw.time
a	*b*	*c*	*d*	*e*
AGE	Total	Biomass	SS numbers	SSB c)
0	44083.9	308587.3	0.0	0
1	11439.4	697800.7	0.0	0
2	3859.6	521045.1	1435.3	193772
3	815.6	156586.1	453.4	87054
4	608.5	127179.3	352.0	73575
5	332.6	73844.3	205.1	45532
6	91.5	23707.6	53.9	13953
7	46.4	13282.2	28.1	8034
8	19.2	5991.3	11.1	3466
9+	43.5	14569.8	25.2	8429
TOTAL	61340.2	1942593.6	2564.1	433816

a) = N*w(1.jan)

b) = N*Maturity*exp(-Z*.67)

c) = N*w(spaw.time)*Maturity*exp(-Z*.67)

Table 8 SUMMARY RESULTS FOR YEAR 1997

		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	11035	2779.6	5802.0	211.9	335.2	1906.7	0.0	8581.6	2453.8
YIELD	524313	409249.3	55509.5	19175.4	5143.4	35234.9	0.0	464758.8	59553.7
SSB	433816		AVG F 2-6	[illegible]					

1998 1998

Table 1 1998

NORTH SEA HERRING STOCK SIZE 1. JANUARY and SSB		
	NUMBER from table 4	
a	*b*	total
AGE	Total a)	biomass
1	11926.3	727502
2	3355.3	452962
3	1410.5	270812
4	366.6	76613
5	268.9	59685
6	161.6	41864
7	41.5	11867
8	21.9	6843
9+	8.5	2842
TOTAL	17561.0	1650990

Table 2.10.2 Excel short term prediction of North Sea herring, continued

[G:\ACFM\HAWG96\HER_47D3\PER2x96.xls (calculation)]

NORTH SEA HERRING SHORT TERM PREDICTION PROGRAM, WG 1996

SUMMARY OF CALCULATIONS

Revised by P. Sparre 15. May 1995

Fleet	Description	
A:	IV HC	*North Sea Human Consumption*
B:	IV IND	*North Sea Industrial*
C:	IIIa HC	*IIIa Human consumption*
D:	IIIa MC	*IIIa "Mixed Clupeid"*
E:	IIIa IND.	*IIIa Industrial*
F:	Fl. 22+24	*Western Baltic Combined fisheries*

This version 30.10.1995
Further revised by H. Sparholt 31.10. 1995
Input data revised by

Table 1 1996

1996		NORTH SEA HERRING. F-FACTORS							
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL a)	A	B	C	D	E	F	IV	IIIa
F-Factor	*1*	*0.749*	*0.938*	*2.23*	*1.78*	*0.65*	*0*	*1*	*1*
(Total Factor)	1	0.749	0.938	2.23	1.78	0.65	0		

Input to sheet 3

Table 2 SUMMARY RESULTS FOR YEAR 1996

		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	11561	1947	6707	522	796	1589	0	8654	2907
YIELD	461736	313258	65002	42012	12164	29299	0	378261	83475
SSB*.001	410		AVG F 2-6	0.633					

Copied from sheet 3

Table 3 1997

1997		NORTH SEA HERRING. F-FACTORS							
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
F-Factor	*0.8*	*1*	*1*	*1*	*1*	*1*	*0*	*1*	*1*
(Total Factor)*(F-Factor)		0.8	0.8	0.8	0.8	0.8	0		

Input to sheet 3

Table 4 SUMMARY RESULTS FOR YEAR 1997

		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22+24	A+B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	11035	2780	5802	212	335	1907	0	8582	2454
YIELD	524313	409249	55509	19175	5143	35235	0	464759	59554
SSB*.001	434		AVG F 2-6	0.667					

Copied from sheet: 3

BIOMASS AT 1st JANUARY	1998	1651

Table 2.10.3 Excel short term predictions for North Sea herring

[G:\ACFM\HAWG\HER_47D3\PER2X96.XLS (Summary)]

Table 2.10.4 **Short-term prediction of North Sea herring for 1997**

(Total catch 1996 = 462,000 t; F in 1996 = 0.633; SSB in 1996 = 413,000 t.)

Input variable: Factor of fleets A, B, C, D and E; No fleet kept constant

F(97) multiplier rel. to F(95) by fleet A	B	C	D	E	'000 t Yield A	'000 t Yield B	'000 t Yield C	'000 t Yield D	'000 t Yield E	000 t SSB	Average F
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	683	0.00
0.20	0.20	0.20	0.20	0.20	123	15	5	1	9	613	0.19
0.35	0.35	0.35	0.35	0.35	217	27	10	2	17	557	0.30
0.40	0.40	0.40	0.40	0.40	229	28	10	3	18	550	0.32
0.60	0.60	0.60	0.60	0.60	319	41	15	4	26	493	0.48
0.80	0.80	0.80	0.80	0.80	397	53	19	5	34	442	0.64
1.00	1.00	1.00	1.00	1.00	463	68	23	6	43	397	0.80
1.20	1.20	1.20	1.20	1.20	521	76	25	7	48	356	0.96
1.40	1.40	1.40	1.40	1.40	571	86	28	8	55	319	1.13
1.60	1.60	1.60	1.60	1.60	614	96	31	9	61	285	1.29
1.80	1.80	1.80	1.80	1.80	652	106	33	10	67	251	1.46
2.00	2.00	2.00	2.00	2.00	684	114	35	11	73	228	1.63

Input variable: Factor of fleet A; Fleets B, C, D and E kept constant

F(97) multiplier rel. to F(95) by fleet A	B	C	D	E	'000 t Yield A	'000 t Yield B	'000 t Yield C	'000 t Yield D	'000 t Yield E	000 t SSB	Average F
0.00	1	1	1	1	0	65	28	6	44	666	0.02
0.20	1	1	1	1	119	68	27	6	44	601	0.17
0.35	1	1	1	1	206	68	26	6	44	553	0.30
0.40	1	1	1	1	223	68	26	6	44	543	0.33
0.60	1	1	1	1	314	68	25	6	43	489	0.48
0.80	1	1	1	1	393	68	24	6	43	441	0.64
1.00	1	1	1	1	463	68	23	6	43	397	0.80
1.20	1	1	1	1	524	67	22	6	43	356	0.96
1.40	1	1	1	1	558	67	21	6	43	320	1.12
1.40	1	1	1	1	625	67	21	6	42	286	1.29
1.60	1	1	1	1	667	67	20	6	42	255	1.46
1.00	1	1	1	1	705	67	20	6	42	227	1.63

Input variable: Factor of fleet C and D; Fleets A, B and D kept constant

F(97) multiplier rel. to F(95) by fleet A	B	C	D	E	'000 t Yield A	'000 t Yield B	'000 t Yield C	'000 t Yield D	'000 t Yield E	000 t SSB	Average F
1	1	0.00	1	0.00	477	65	0	7	0	401	0.79
1	1	0.20	1	0.20	474	65	5	7	9	400	0.79
1	1	0.40	1	0.40	471	65	9	6	17	399	0.80
1	1	0.60	1	0.60	469	65	14	6	26	399	0.80
1	1	0.80	1	0.80	467	65	18	6	34	398	0.80
1	1	1.00	1	1.00	463	65	22	6	41	397	0.80
1	1	1.20	1	1.20	461	65	26	6	49	396	0.80
1	1	1.40	1	1.40	458	65	30	6	56	395	0.80
1	1	1.60	1	1.60	456	65	34	6	63	395	0.80
1	1	1.80	1	1.80	453	65	38	6	69	394	0.81
1	1	1.90	1	1.90	451	65	42	6	76	393	0.81

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Table 2.10.4 Continued

Input variable: Factor of fleet B; Fleets A, C, D and E kept constant											
F(97) multiplier rel. to F(95) by fleet					'000 t	'000 t	'000 t	'000 t	'000 t	000 t	Average
A	B	C	D	E	Yield A	Yield B	Yield C	Yield D	Yield E	SSB	F
1	0.00	1	1	1	466	0	22	6	41	398	0.797
1	0.20	1	1	1	466	13	22	6	41	398	0.797
1	0.40	1	1	1	465	28	22	6	41	397	0.798
1	0.60	1	1	1	464	41	22	6	41	397	0.798
1	0.80	1	1	1	464	53	22	6	41	397	0.799
1	1.00	1	1	1	463	65	22	6	41	397	0.799
1	1.20	1	1	1	463	76	22	6	41	397	0.800
1	1.40	1	1	1	462	87	22	6	41	396	0.801
1	1.60	1	1	1	462	97	22	6	41	396	0.801
1	1.80	1	1	1	461	107	22	6	41	396	0.802
1	2.00	1	1	1	460	116	22	6	41	396	0.802
1	2.20	1	1	1	460	125	22	6	41	395	0.803
1	2.40	1	1	1	459	133	22	6	41	395	0.803
1	2.60	1	1	1	459	141	22	6	41	395	0.804
1	2.80	1	1	1	458	149	22	6	41	395	0.804
1	3.00	1	1	1	458	156	22	6	41	394	0.805
1	3.20	1	1	1	457	163	22	6	41	394	0.805
1	3.40	1	1	1	457	170	22	6	41	394	0.806
1	3.60	1	1	1	456	176	22	6	41	394	0.806
1	3.80	1	1	1	456	183	22	6	41	393	0.807
1	4.00	1	1	1	455	189	22	6	41	393	0.807

Table 2.11.1. Input data for the projections.

```
Projection input file 'ICPROJ v. 2.0'
Number of fleets          Number of Years
  5                        6
Catch Ratio for each fleet at age in 1995 : Including discarded fish
Age      Fleet A      Fleet B      Fleet D      Fleet E       Fleet F
0        0.001        0.783        0.001        0.022         0.193
1        0.100        0.211        0.101        0.154         0.434
2        0.906        0.01         0.054        0.002         0.029
3        0.996        0.004        0            0             0
4        0.999        0.001        0            0             0
5        1.000        0.000        0            0             0
6        0.999        0.001        0            0             0
7        0.999        0.001        0            0             0
8        1.000        0.000        0            0             0
9        1.000        0.000        0            0             0
Retention Ogive for each fleet by Age in All years
0        1.           1.        1.           1.           1.
1        1.           1.        1.           1.           1.
2        1.           1.        1.           1.           1.
3        1.           1.        1.           1.           1.
4        1.           1.        1.           1.           1.
5        1.           1.        1.           1.           1.
6        1.           1.        1.           1.           1.
7        1.           1.        1.           1.           1.
8        1.           1.        1.           1.           1.
9        1.           1.        1.           1.           1.
Exploitation  Constraint by Year  (-ve values: F-constraints; +ve values, Catch constraints)
1996  313000    -1.0         -1.          -1.      -1.
1997  -1.       -1.0         -1.          -1.      -1.
1998  -1.       -1.0         -1.          -1.      -1.
1999  -1.       -1.0         -1.          -1.      -1.
2001  -1.       -1.0         -1.          -1.      -1.
2002  -1.       -1.0         -1.          -1.      -1.
Mean weight at age in the catches of each fleet
0        0.0307       0.0083           0.0125          0.0152         0.0122
1        0.07914      0.0383           0.0652          0.0152         0.0315
2        0.13807      0.0724           0.1273          0.033          0.0607
3        0.16705      0.1394           0.1             0.001          0.001
4        0.1962       0.162            0.1             0.001          0.001
5        0.20528      0.1775           0.1             0.001          0.001
6        0.25729      0.2233           0.1             0.001          0.001
7        0.25906      0.1943           0.2             0.001          0.001
8        0.278        0.2252           0.2             0.001          0.001
9        0.287        0.2252           0.2             0.001          0.001
Mean weights at age in the discards by each fleet
0        0.0307      0.0083          0.0125          0.0152        0.0122
1        0.07914     0.033           0.0652          0.0152        0.0315
2        0.13807     0.0724          0.1273          0.033         0.0607
3        0.16705     0.1394          0.1             1             1
4        0.1962      0.162           0.1             1             1
5        0.20528     0.1775          0.1             1             1
6        0.25729     0.2233          0.1             1             1
7        0.25906     0.1943          0.2             1             1
8        0.278       0.2252          0.2             1             1
9        0.287       0.2252          0.2             1             1
```

Table 2.11.2. North Sea Herring. Estimates of the probability that the stock will reach levels of spawning biomass of the traditional MBAL of 800 000t, or above levels of 1.5 Million t or 2.0 Million t, at spawning time in the year 2002.

Strategy	P(SSB>800 000t)	P(SSB > $1.5.10^6$t)	P(SSB>2.10^6)
No fishing by any fleet	ca. 1.0	ca. 1.0	ca. 1.0
$F=F_{1995}$, all fleets	ca. 0.0	ca. 0.0	ca. 0.0
$F_A=0.3$ $F_{IND}=0.0$	0.97	0.63	0.35
$F_A=0.3$ $F_{IND}=0.5\ F_{1995}$	0.82	0.3	0.12
$F_A=0.1$ $F_{IND}=0.0$	ca. 1.0	0.99	0.87

Table 2.13.1 **Herring total North Sea, 1995.**
Numbers (millions) and weights (g) at age (winter rings) per year class of herring caught in each quarter. Spring spawners transferred to Division IIIa, and North Sea autumn spawners caught in Division IIIa are not included.

Age (rings)		0	1	2	3	4	5	6	7	8	9	Total	SOP
Year class		1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	(numbers)	('000t)
Quarter	No	0.0	53.1	80.7	148.6	27.1	13.3	3.1	2.4	2.6	2.3	354.0	36.7
I	W		17	107	131	140	141	192	190	204	210		
	No	0.0	105.4	232.8	93.8	33.3	21.2	5.9	5.3	5.7	3.5	507.0	63.6
II	W		29	127	168	189	188	224	236	244	261		
III	No	5070.3	124.7	509.1	328.7	99.3	36.6	28.9	19.0	25.9	28.4	6270.7	248.6
	W	8	52	151	189	220	230	276	276	316	316		
IV		1209.4	199.9	566.9	292.5	85.0	47.8	17.6	14.1	17.1	13.8	2464.0	185.5
	W	10	64	130	160	189	199	217	229	243	248		
Total	No	6279.8	483.1	1389.4	863.7	244.6	118.8	55.5	40.8	51.3	68.6	9595.7	
	W	9	48.0	136	167	196	200	247	249	278	287		534.4

The stocks weights shown below are derived from acoustic survey samples taken in July from Divisions IVa,b and used in the SSVPA

age	0	1	2	3	4	5	6	7	8	9
Year class	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985
Stock weights		58	132	180	200	195	228	257	302	324

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Table 2.14.1 In this quality control diagram the spawning stock biomass estimated at each Herring Assessment Working Group meeting is shown. The spawning stock biomass in each year has been estimated at a lower level then that estimated by the previous Working Groups since 1990.

Stock: North Sea Herring (Fishing Areas IIIa, IV and VIId)

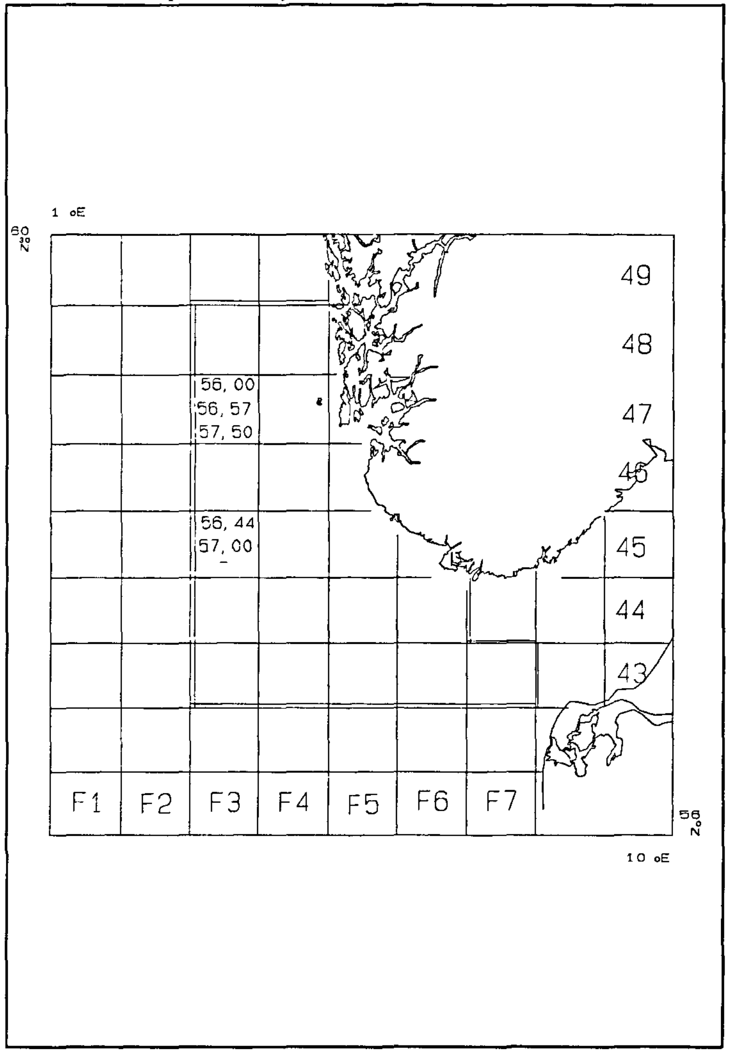
Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)											
Date of assessment	Year										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989	822		[1]	[1]							
1990	1102	1256		[1]	[1]						
1991	1242	1549	1411	1320	1346[1]	1238[1]					
1992	1095	1340	1247	1277	1320	1287[1]	N/A				
1993	1179	1456	1354	1307	1184	1055	965[1]	N/A			
1994	1146	1391	1260	1149	986	730	974	981[1]	N/A		
1995	1068	1286	1138	993	778	484	790	718	690	n/a	
1996	1116	1240	1135	939	699	458	517	496	410	434	n/a

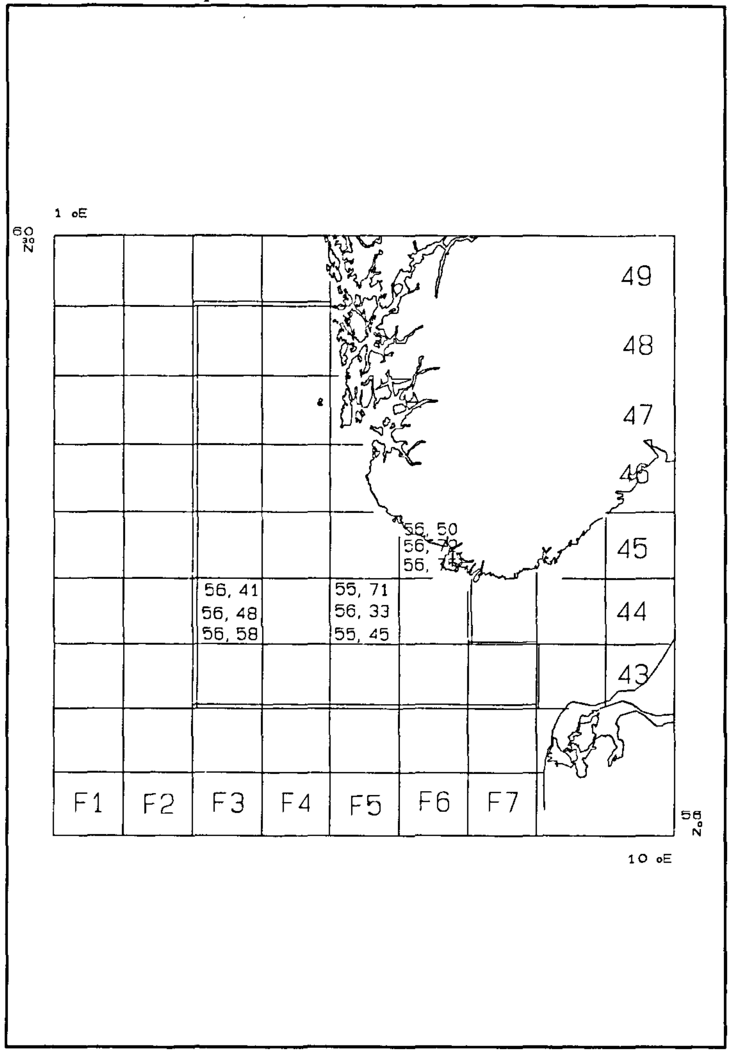
[1]Forecast. (Fsq).

Remarks: 1991-1994 assessments include catches of autumn-spawning herring in Division IIIa.

Samples of May 1995 within the transfer area.



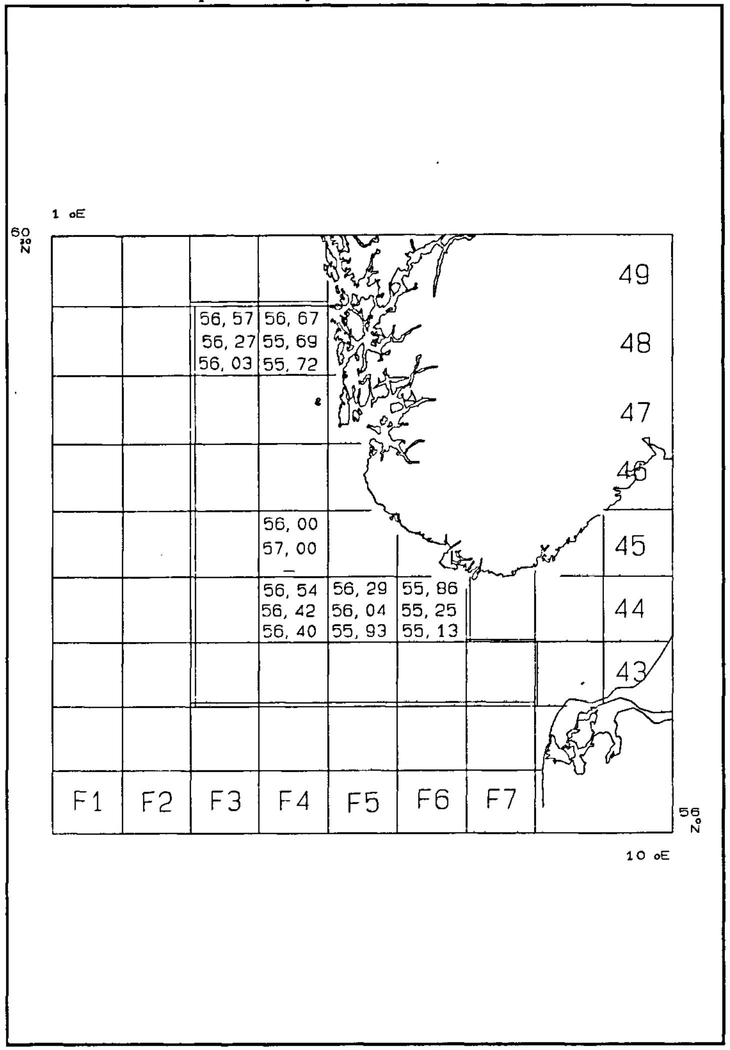
Samples of June within the transfer area



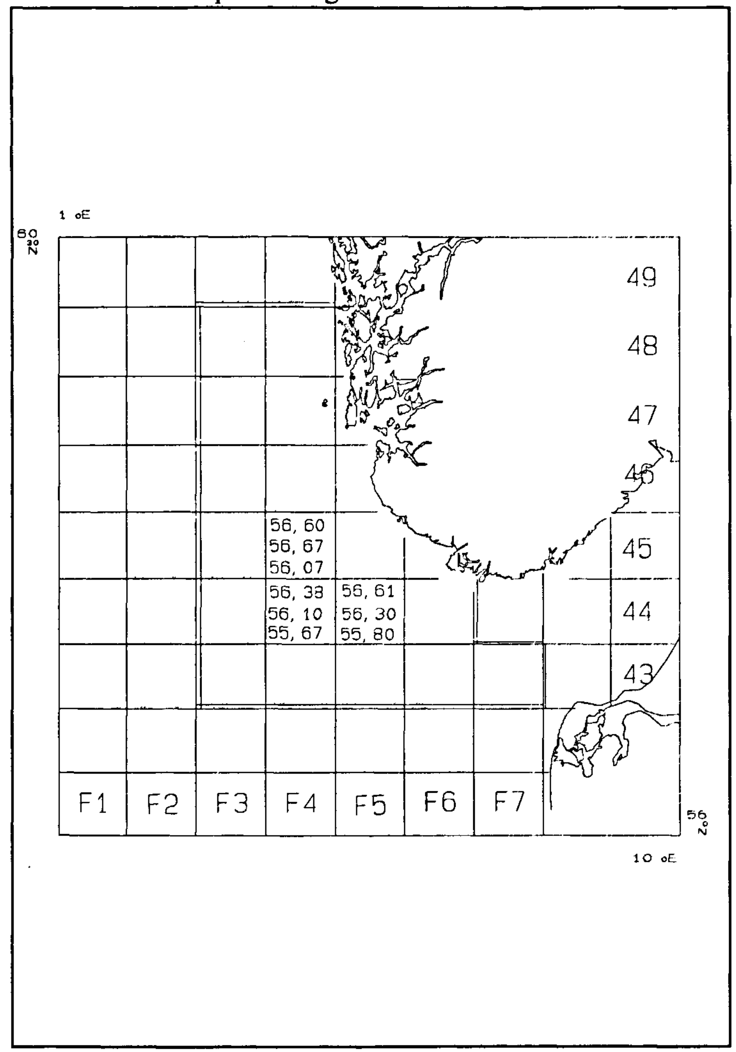
Age	Mean VS	Percentage of Spring Spawners
2	56.2	46
3	56.6	0
4+	56.6	0

Figure 2.2.1 Mean vertebral counts of 2, 3 and 4 ring herring. Quarter 2 - 1995.

Samples of July within the transfer area.



Samples of August in the transfer area



Age	Mean VS	Percentage of Spring Spawners
2	56.4	16
3	56.2	44
4+	55.8	90

Figure 2.2.2 : Mean vertebral count of 2,3 and 4 ring herring. Quarter 3 - 1995.

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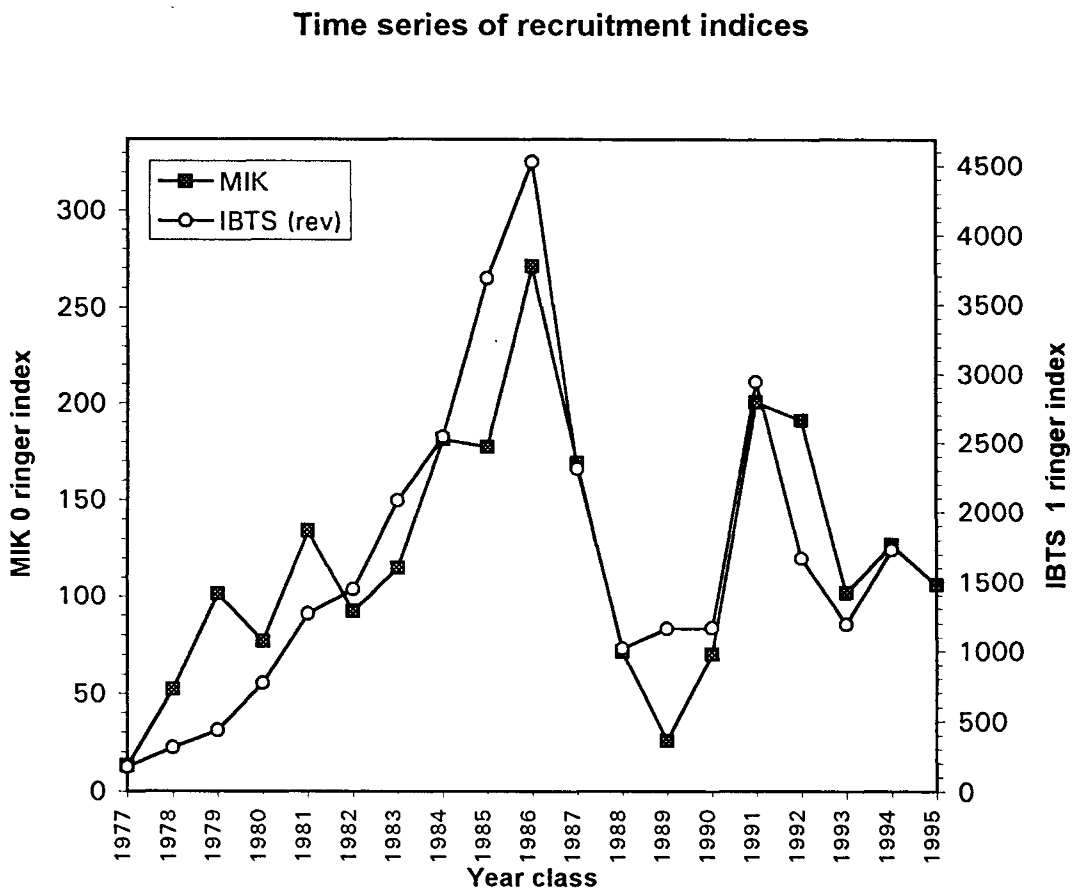


Figure 2.3.1 Trend in MIK 0-ringer and IBTS 1-ringer indices for the year classes 1977-1995

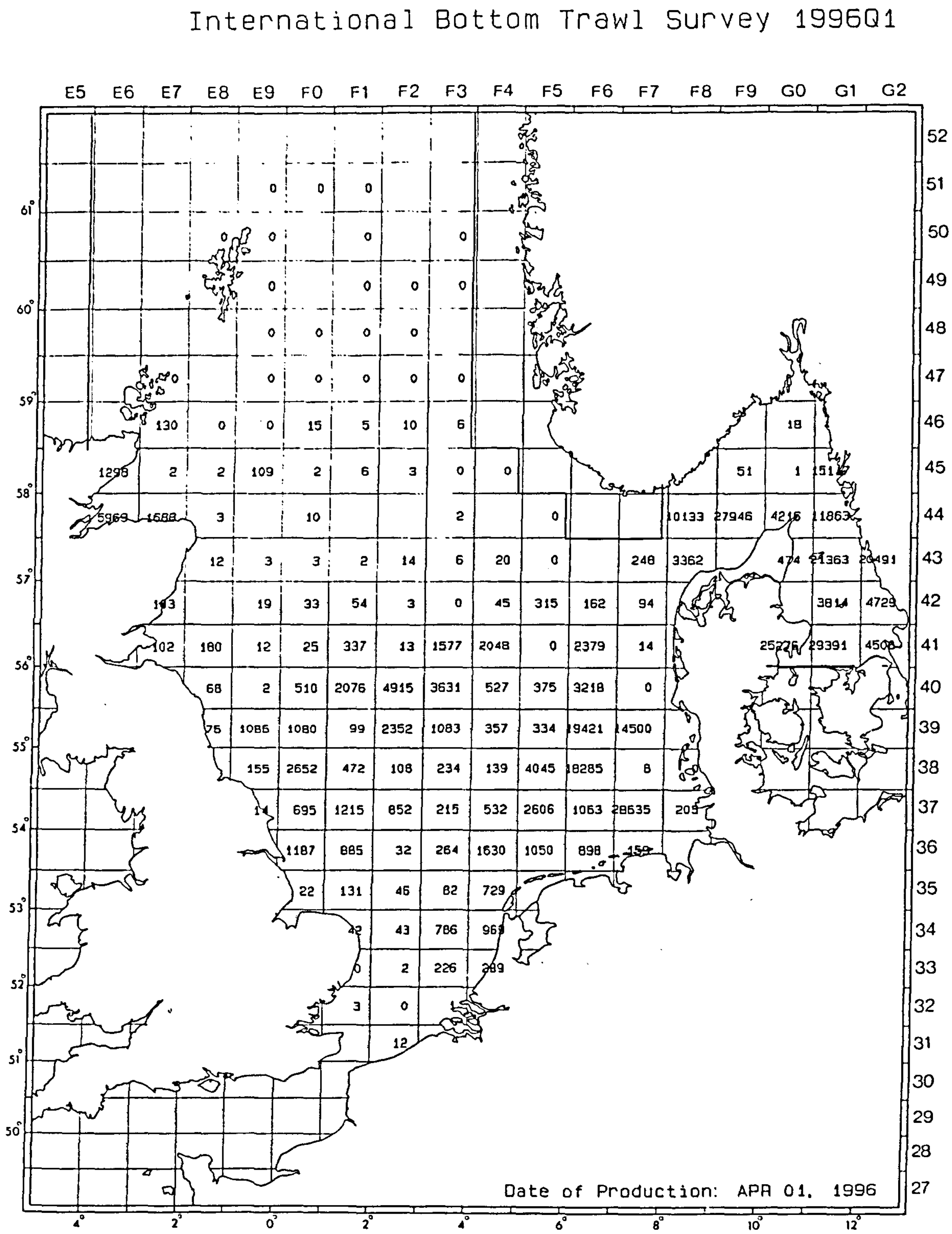


Figure 2.3.2 Abundance estimates of 1-ringer herring from IBTS, first quarter. Values are catch estimates for each statistical rectangle in numbers caught per hour.

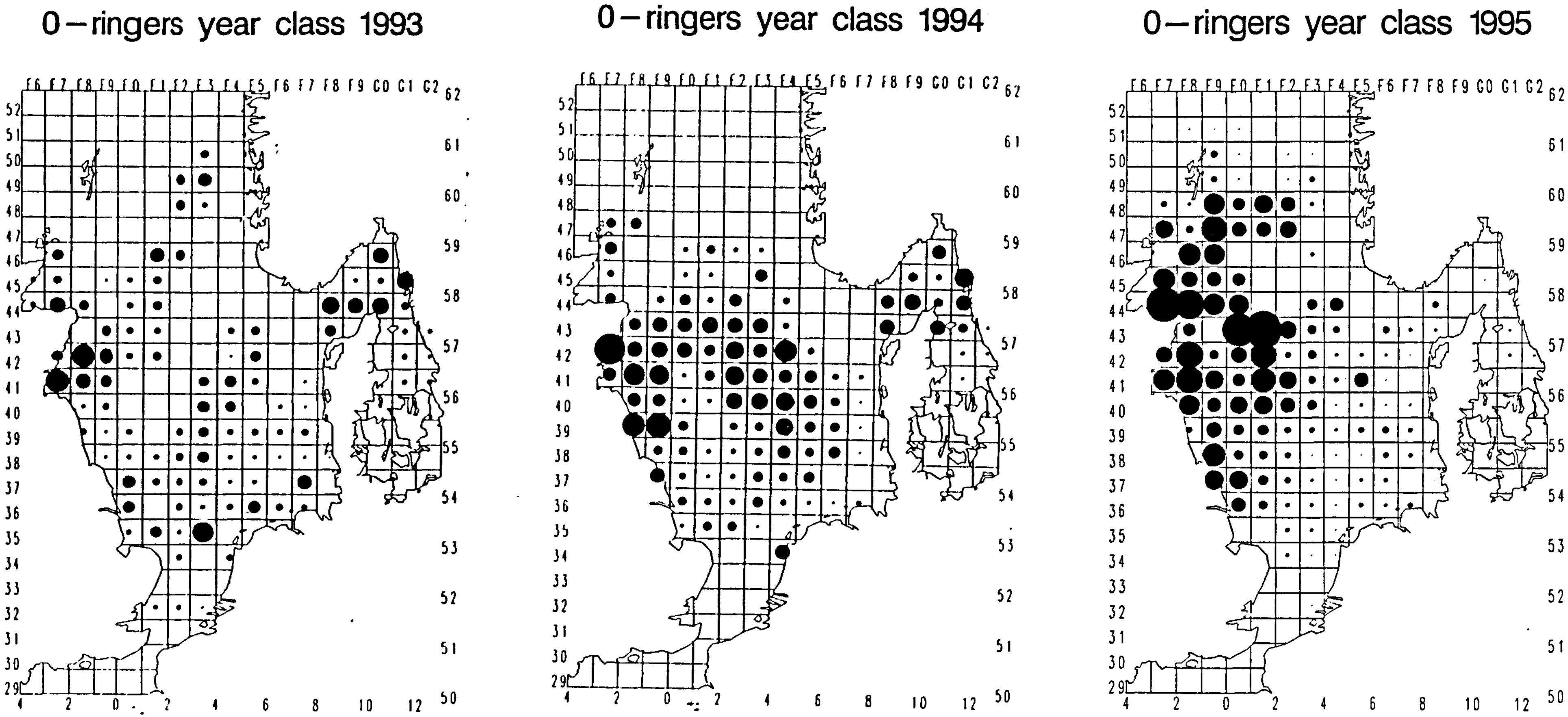


Figure 2.3.3 Distribution of 0-ringer herring, year classes 1993-1995. Abundance estimates of 0-ringers within each statistical rectangle based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1.5 m^{-2}.

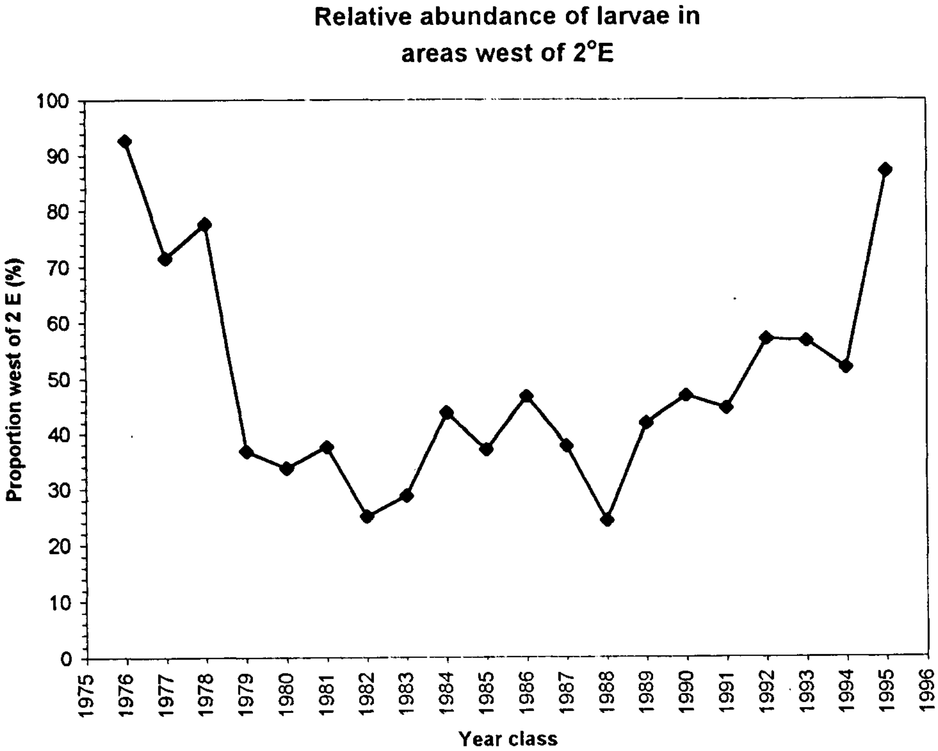


Figure 2.3.4 Changes in relative abundance of larvae across the survey area. Larval abundance in westerly areas (areas west of 2° E) is related to total abundance for year classes 1977 to 1995.

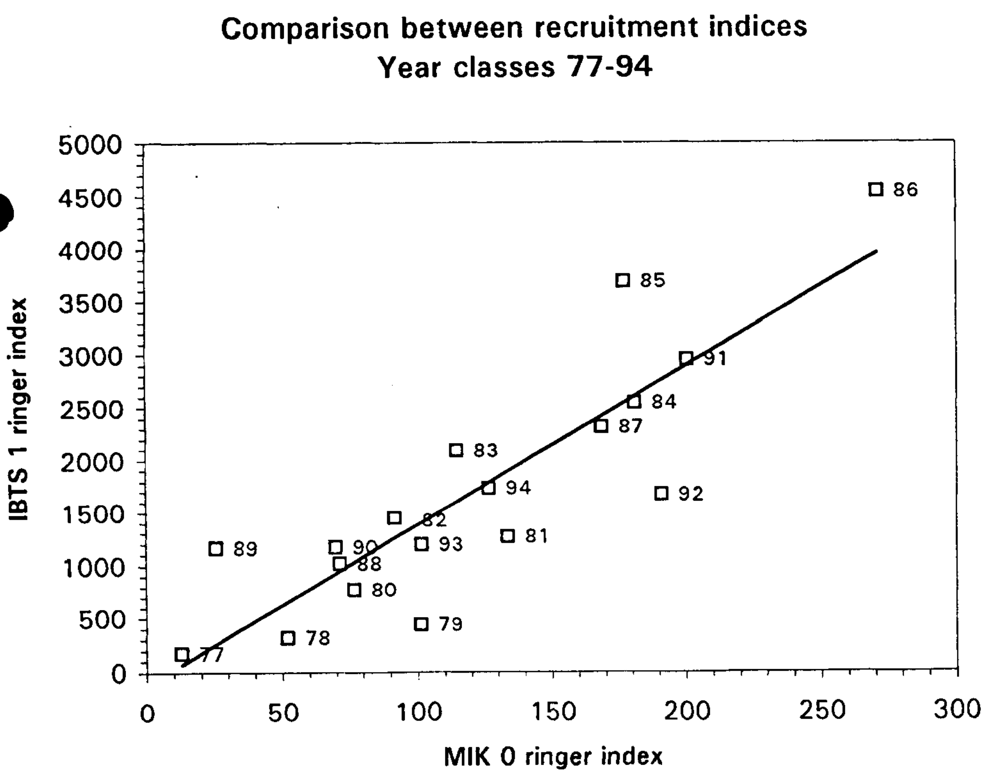


Figure 2.3.5 The IBTS 1-ringer index regressed against the MIK 0-ringer index. Year classes 1977 to 1994.

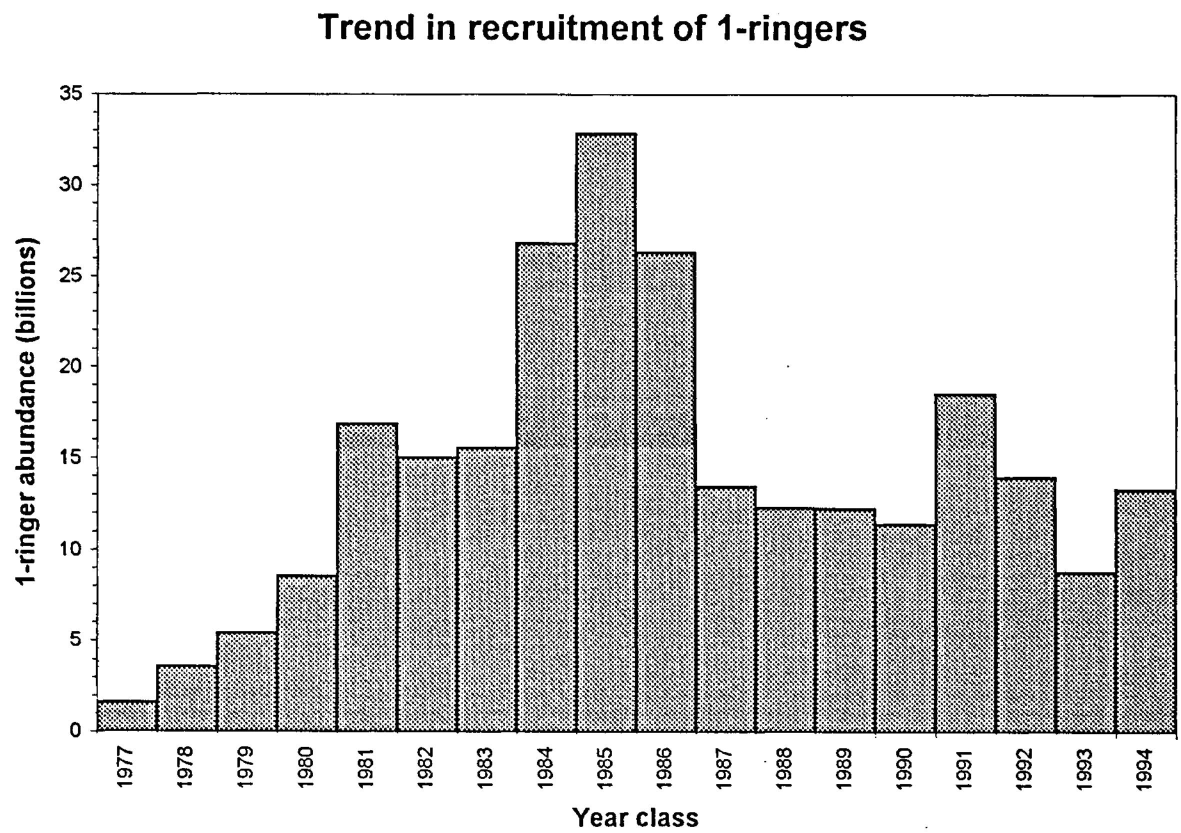


Figure 2.3.6 Trend in recruitment (1-ringers) of year classes 1977 to 1994 as calculated by the ICA programme.

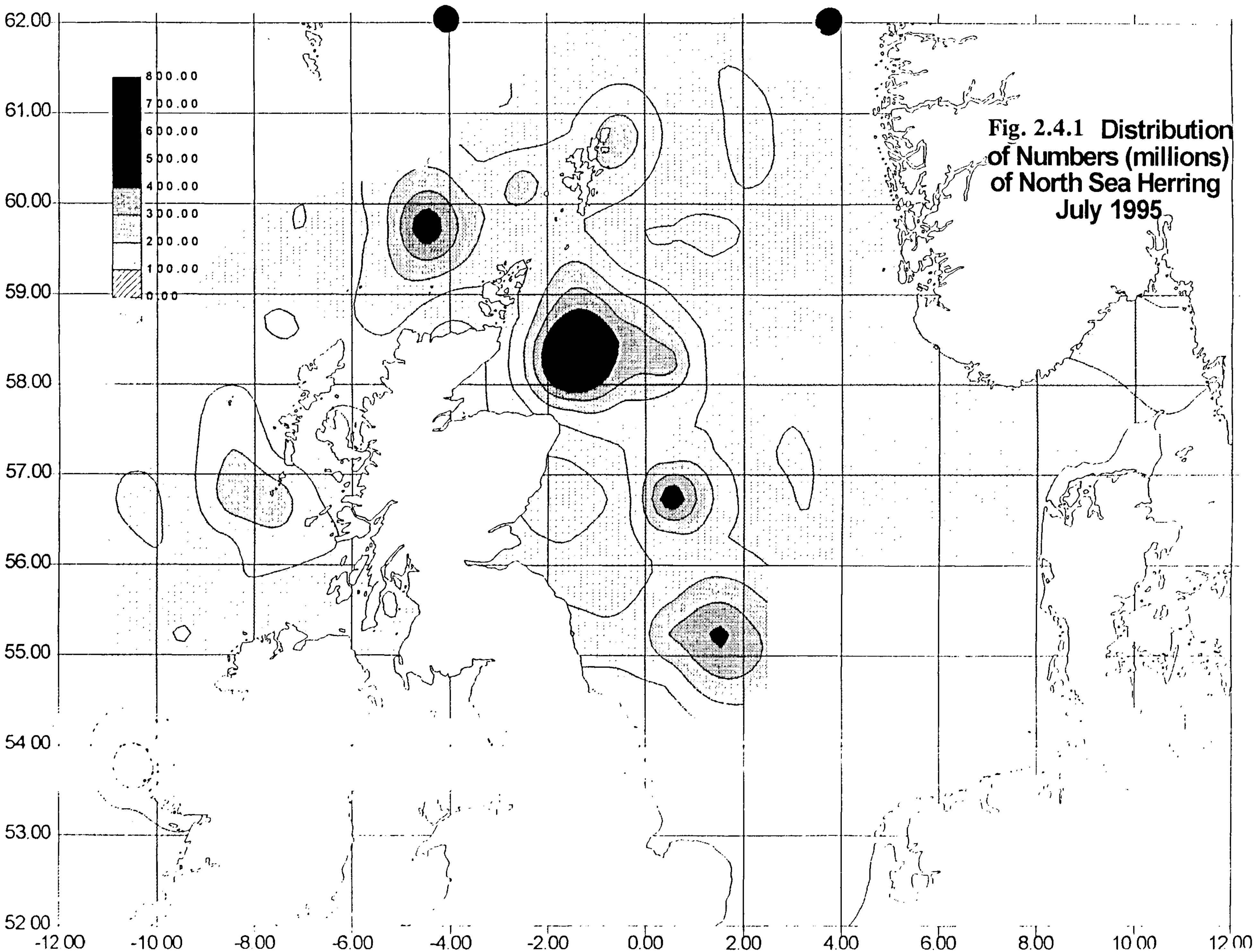


Fig. 2.4.1 Distribution of Numbers (millions) of North Sea Herring July 1995

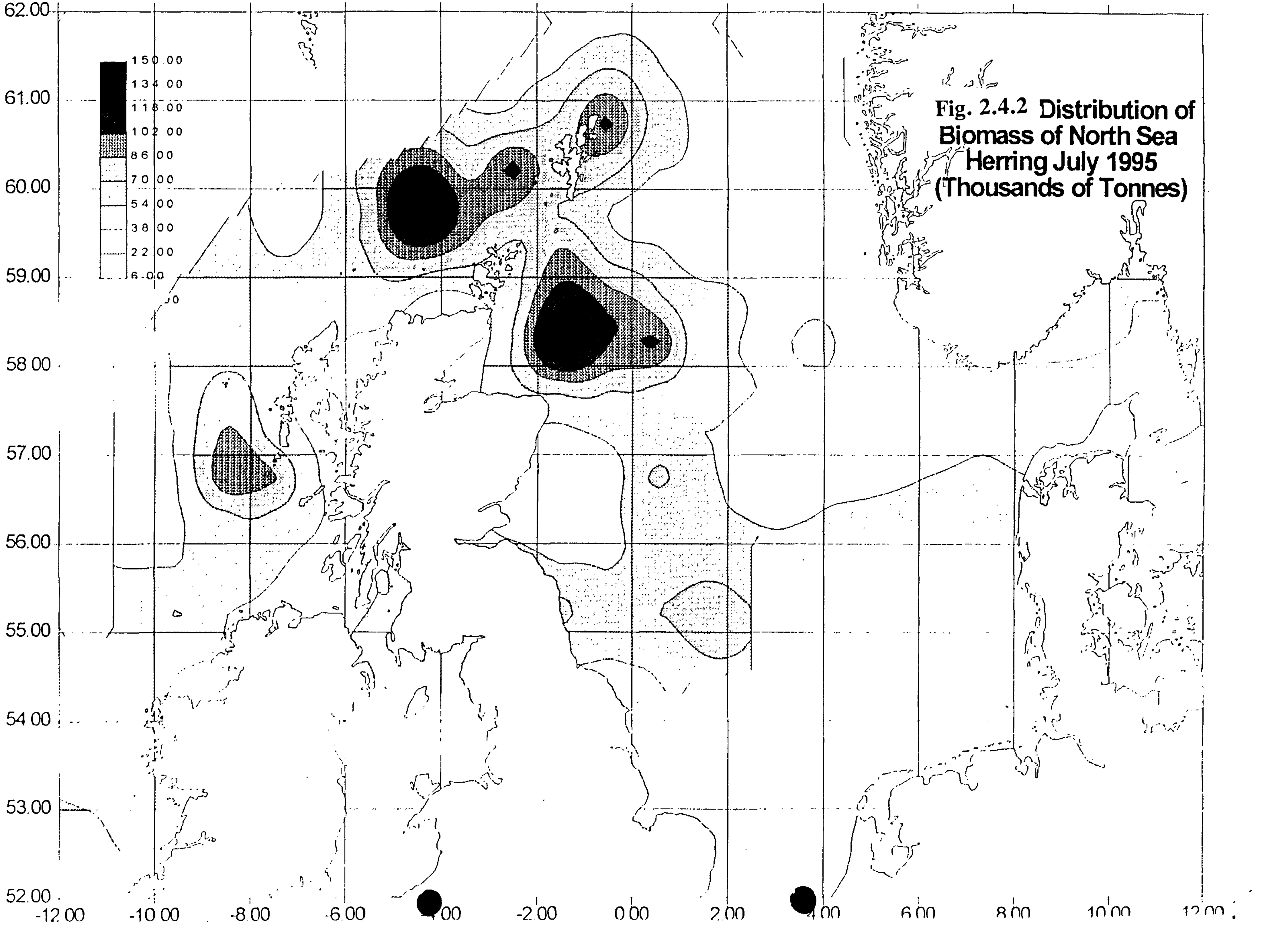


Fig. 2.4.2 Distribution of Biomass of North Sea Herring July 1995 (Thousands of Tonnes)

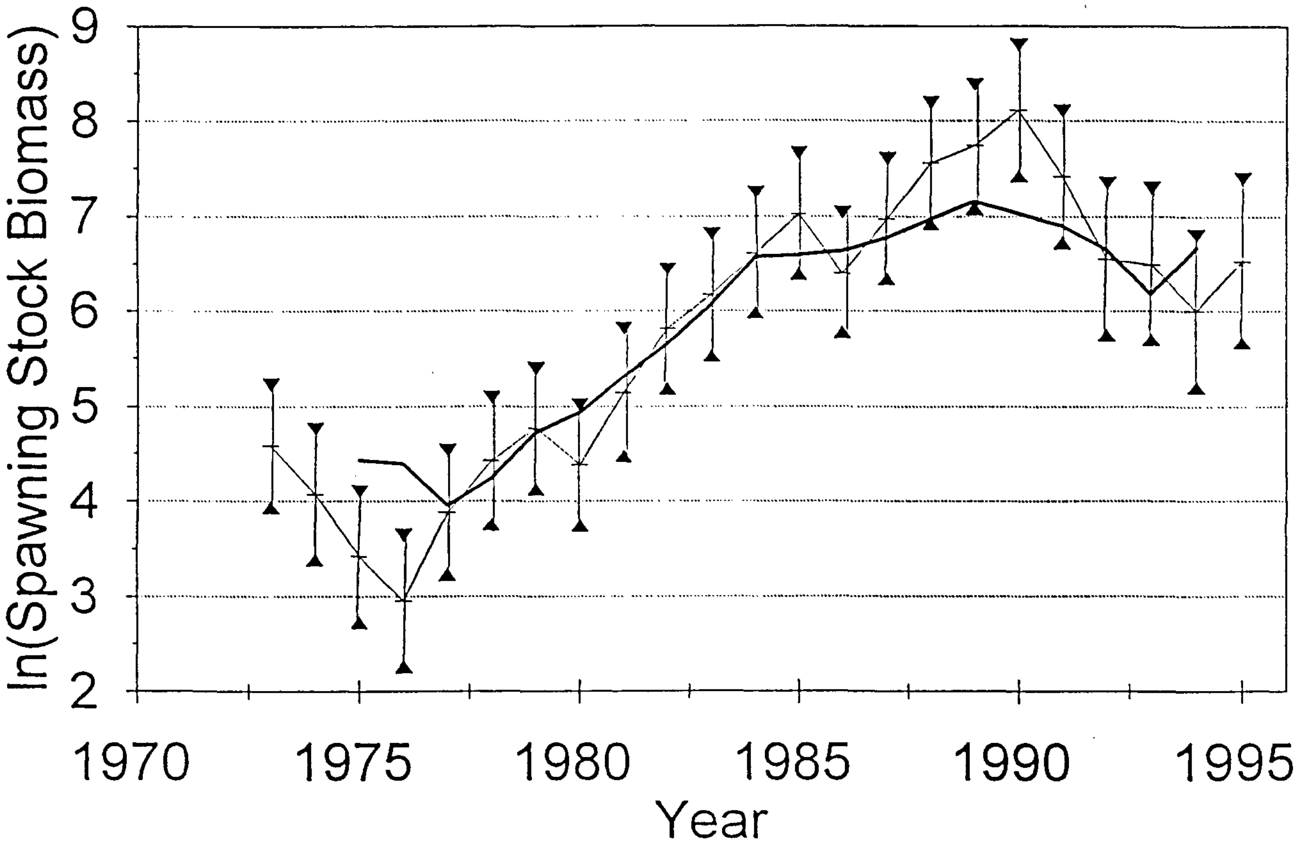


Figure 2.5.1 Time series of estimates of spawning stock size from a population model fitted by the Herring Working Group (Anon.1995d; bold line) and the year effects fitted to the larval abundance in the Multiplicative model (fine line with error bars). The larval abundance model estimates have been rescaled to the mean of the population model estimates. Error bars indicate +/- one s.e. of larval survey abundance estimates.

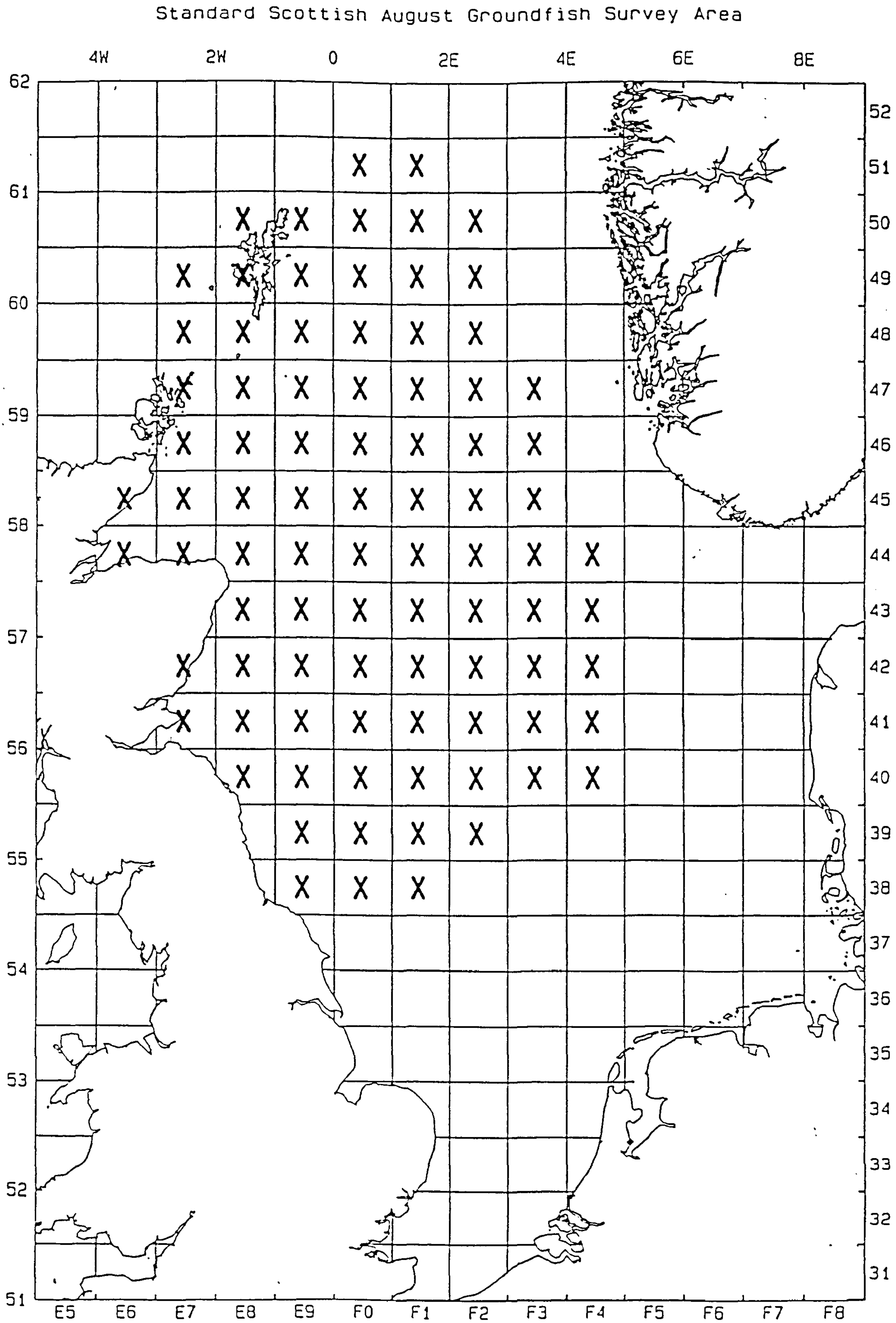
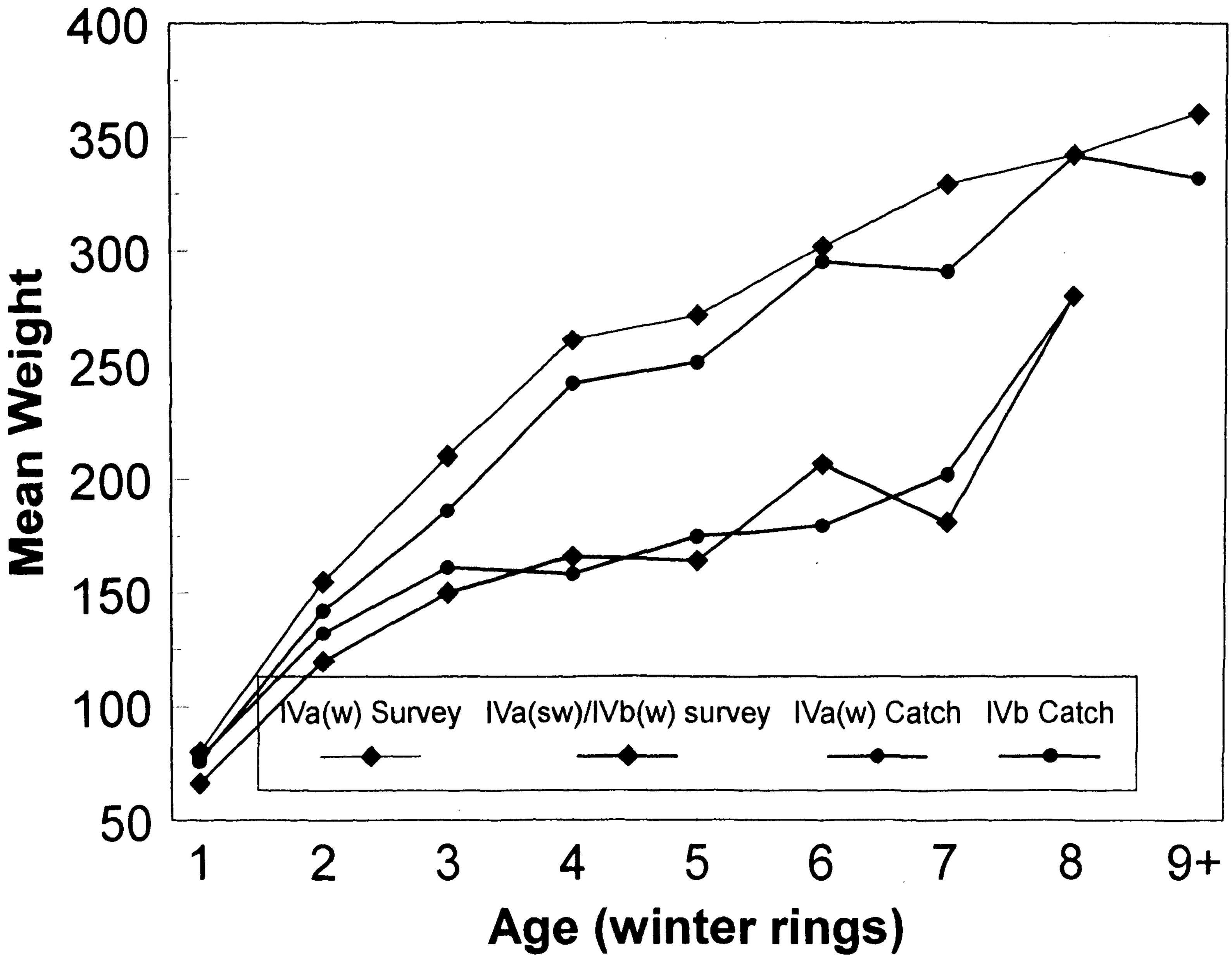


Figure 2.6.1 The spatial coverage of the August Scottish Groundfish surveys. One haul is taken at a random location in each of the marked rectangular areas.

Figure 2.7.1 Comparison of weights at age from acoustic surveys and commercial catches ---- (Ir OTUS FREELANCE for Win of Floppy)



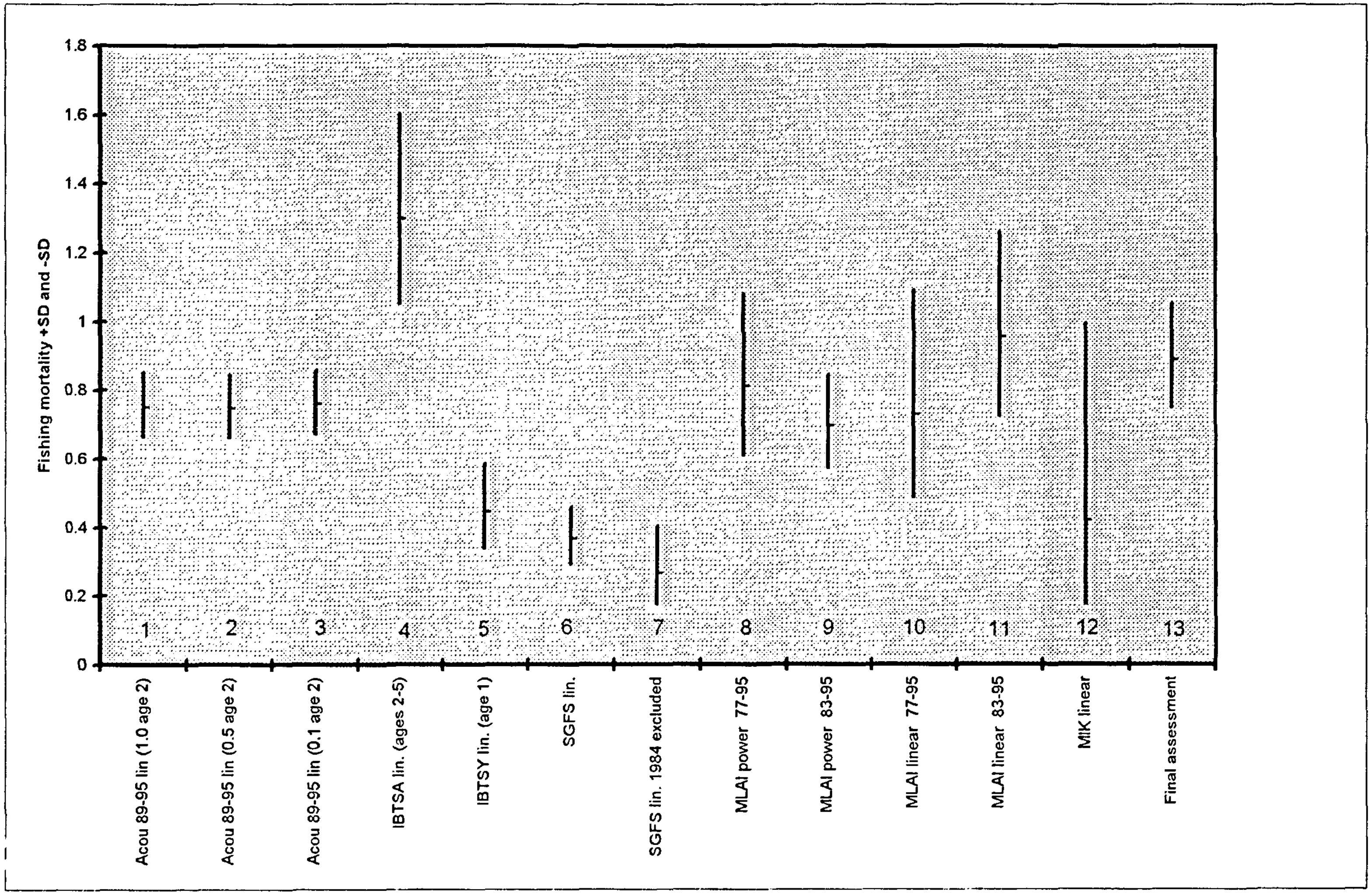
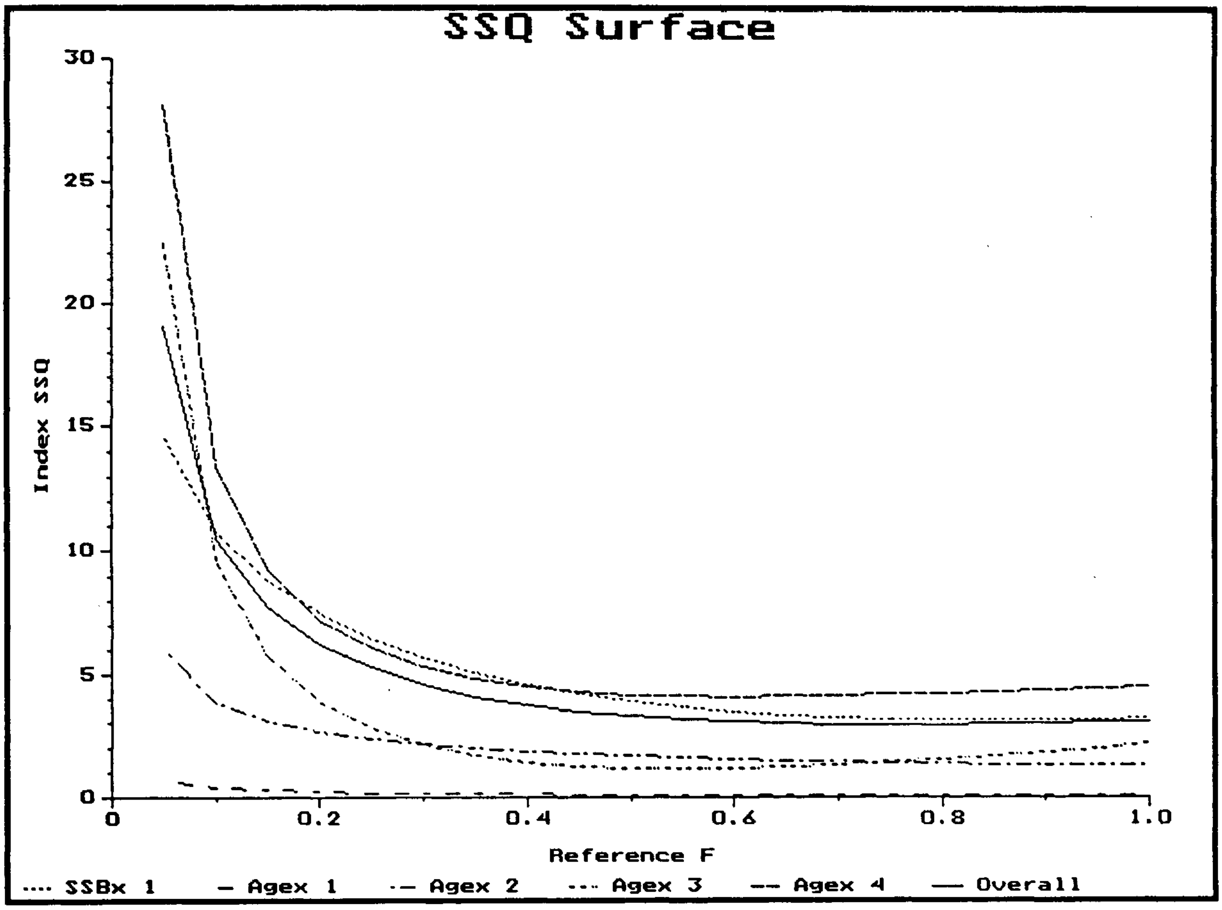


Figure 2.8.1 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of fishing mortality (+/- SD) in population models fitted to the different indices. Base line model fits are given equal weights.

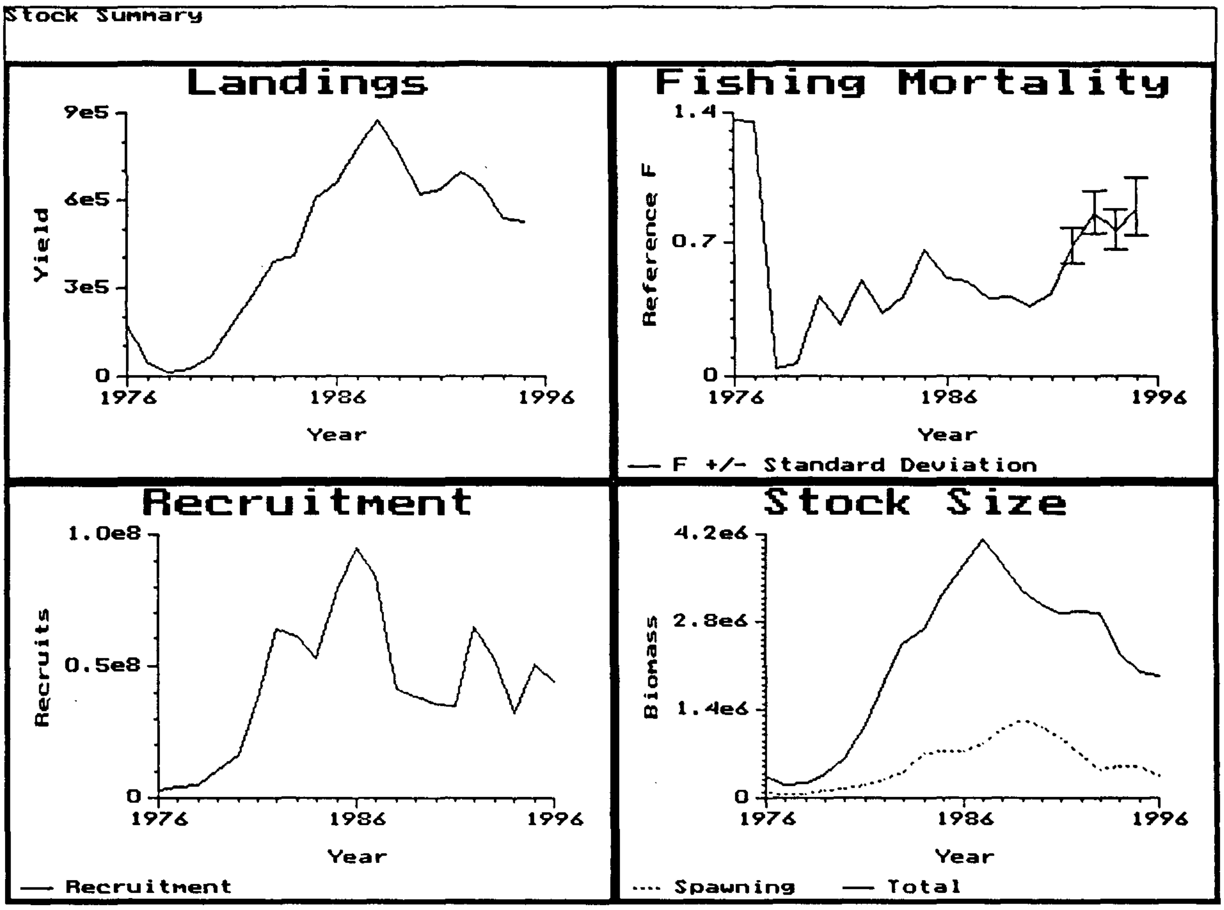
GT:\ACFM\HAWG\HER47D3\F-COMPAR.XLS

Figure 2.8.2



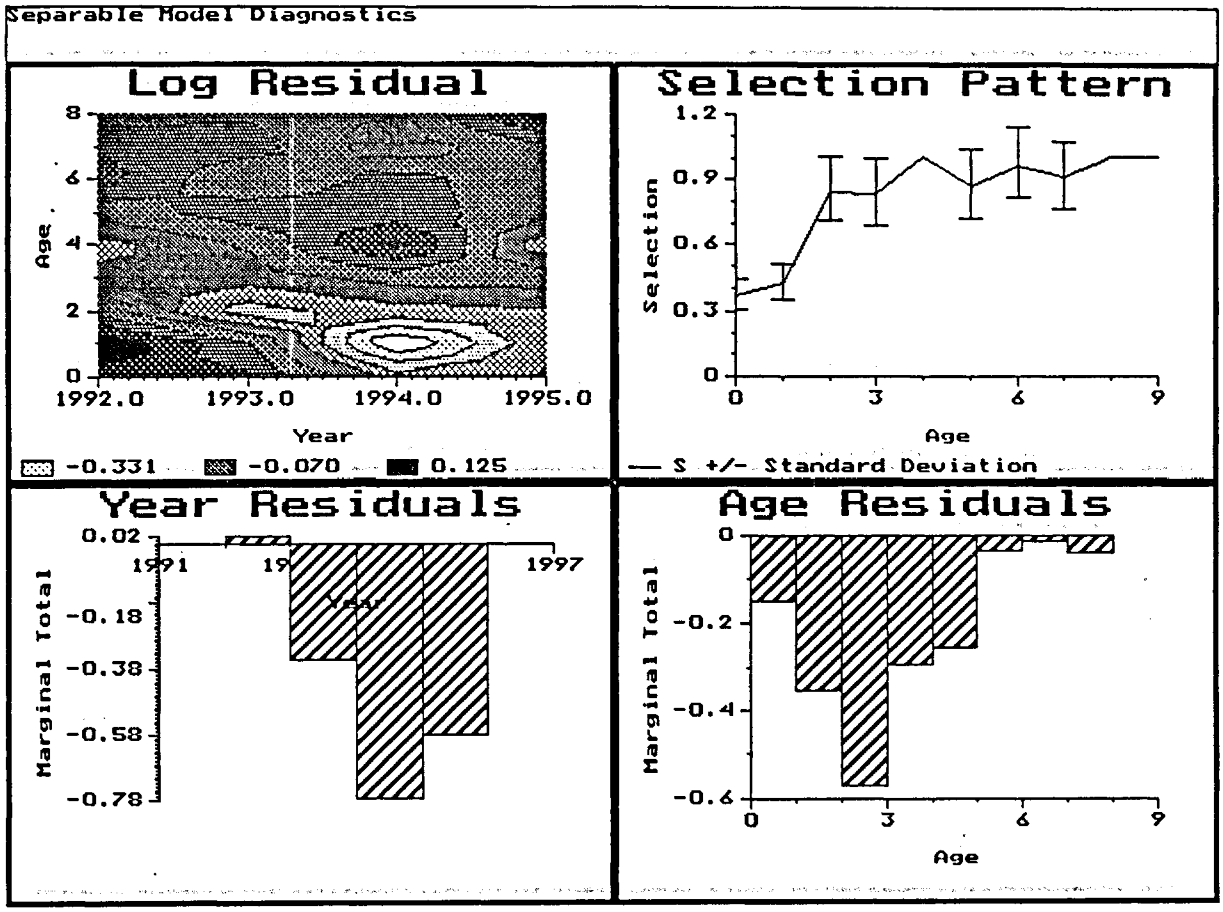
SSQ Surface
Index SSQ
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1.0
Reference F
···· SSBx 1
— Agex 1
·— Agex 2
···· Agex 3
—— Agex 4
—— Overall

Figure 2.8.3



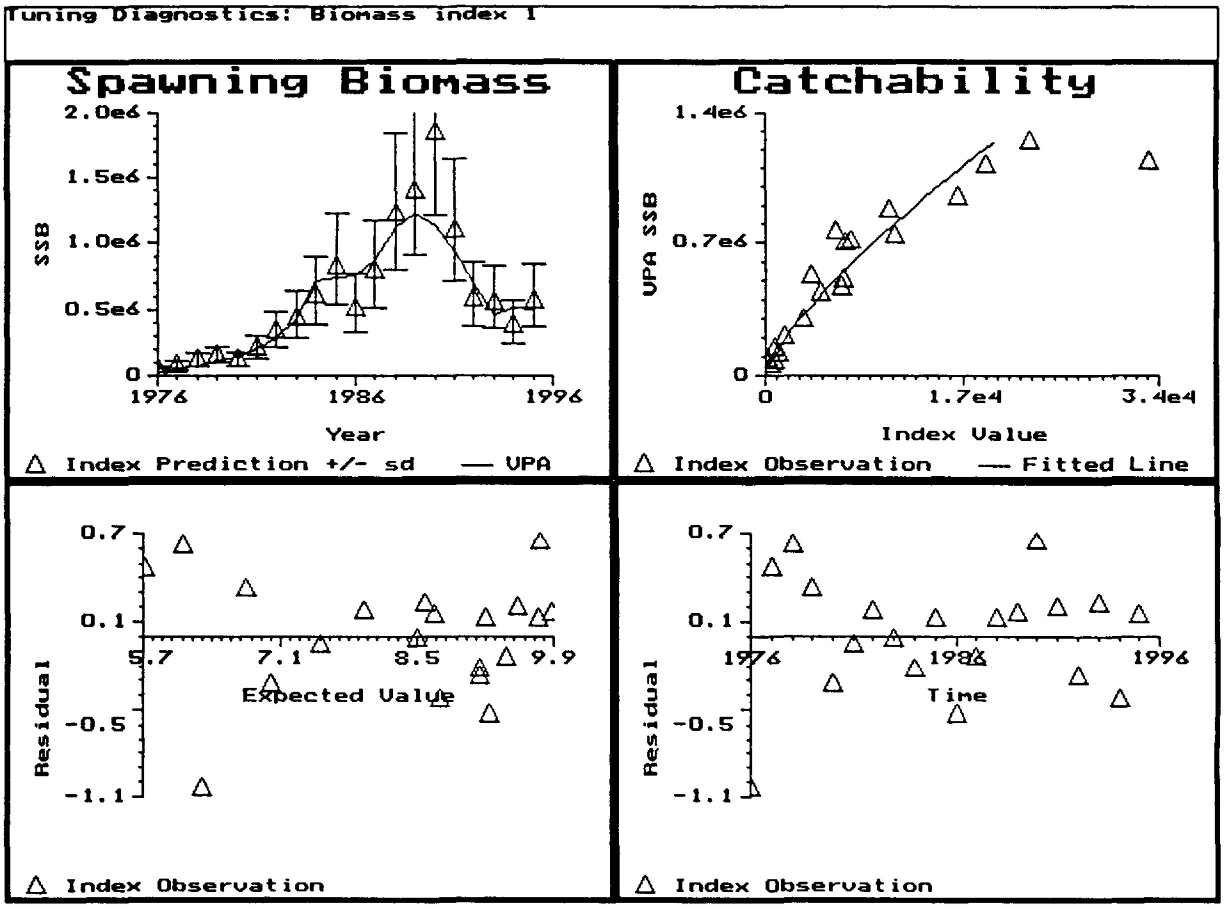
Stock Summary
Landings
9e5
6e5
3e5
0
Yield
1976
1986
1996
Year
Fishing Mortality
1.4
0.7
0
Reference F
1976
1986
1996
Year
F +/- Standard Deviation
Recruitment
1.0e8
0.5e8
0
Recruits
1976
1986
1996
Year
Recruitment
Stock Size
4.2e6
2.8e6
1.4e6
0
Biomass
1976
1986
1996
Year
Spawning
Total

Figure 2.8.4



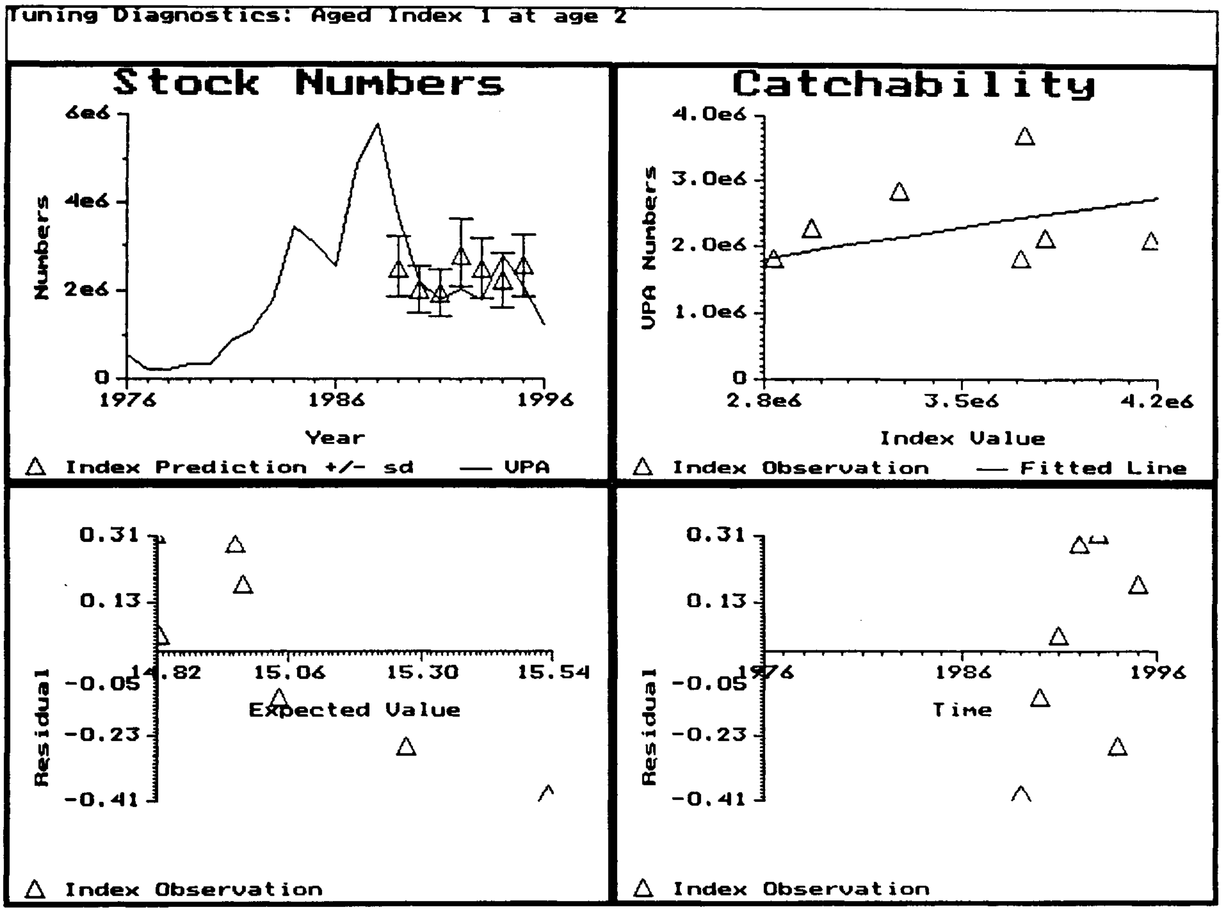
Separable Model Diagnostics
Log Residual
Age
Year
1992.0
1993.0
1994.0
1995.0
-0.331
-0.070
0.125
Selection Pattern
Selection
Age
S +/- Standard Deviation
Year Residuals
Marginal Total
0.02
-0.18
-0.38
-0.58
-0.78
1991
1997
Age Residuals
Marginal Total
Age

Figure 2.8.5



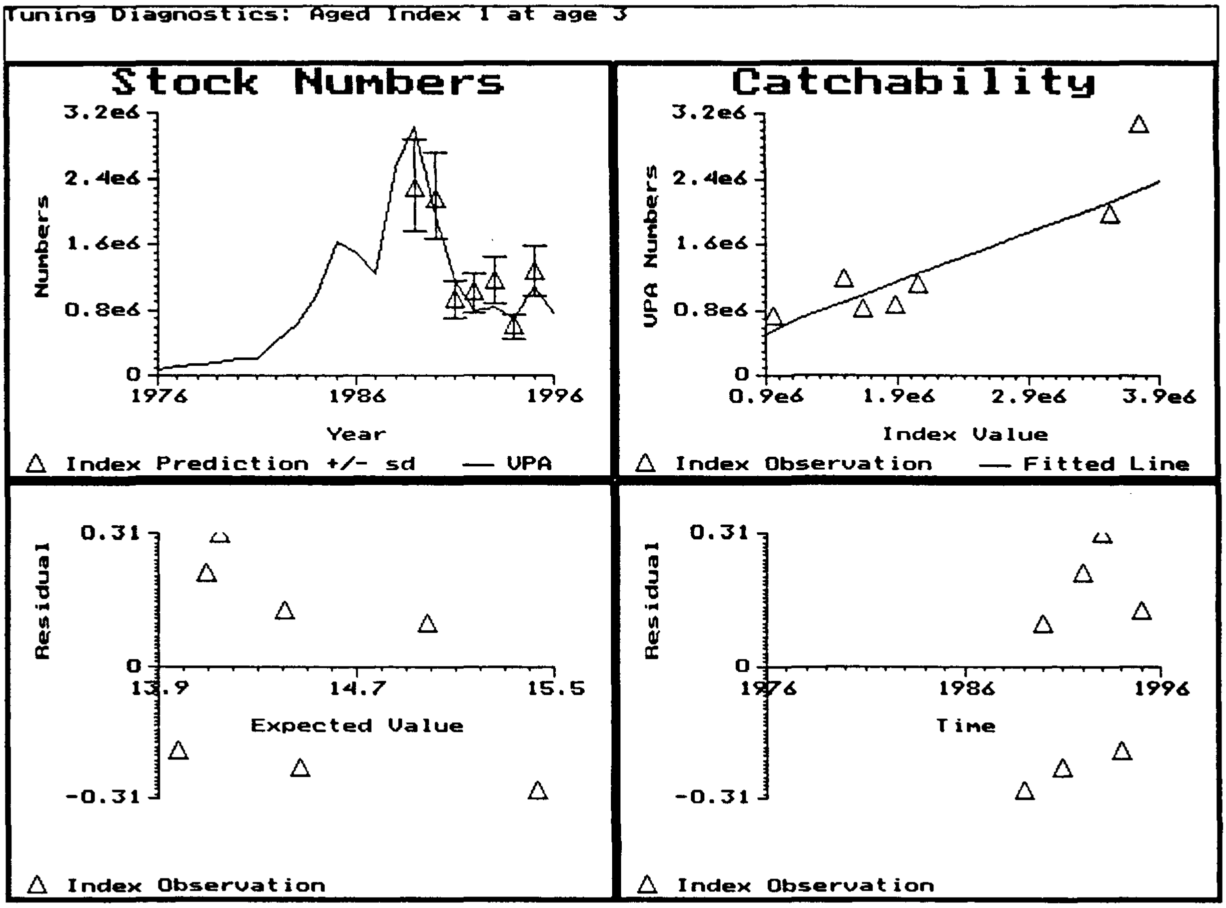
Tuning Diagnostics: Biomass index 1
Spawning Biomass
2.0e6
1.5e6
1.0e6
0.5e6
0
SSB
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
1.4e6
0.7e6
0
VPA SSB
0
1.7e4
3.4e4
Index Value
Index Observation
Fitted Line
0.7
0.1
-0.5
-1.1
Residual
5.7
7.1
8.5
9.9
Expected Value
Index Observation
0.7
0.1
-0.5
-1.1
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.6



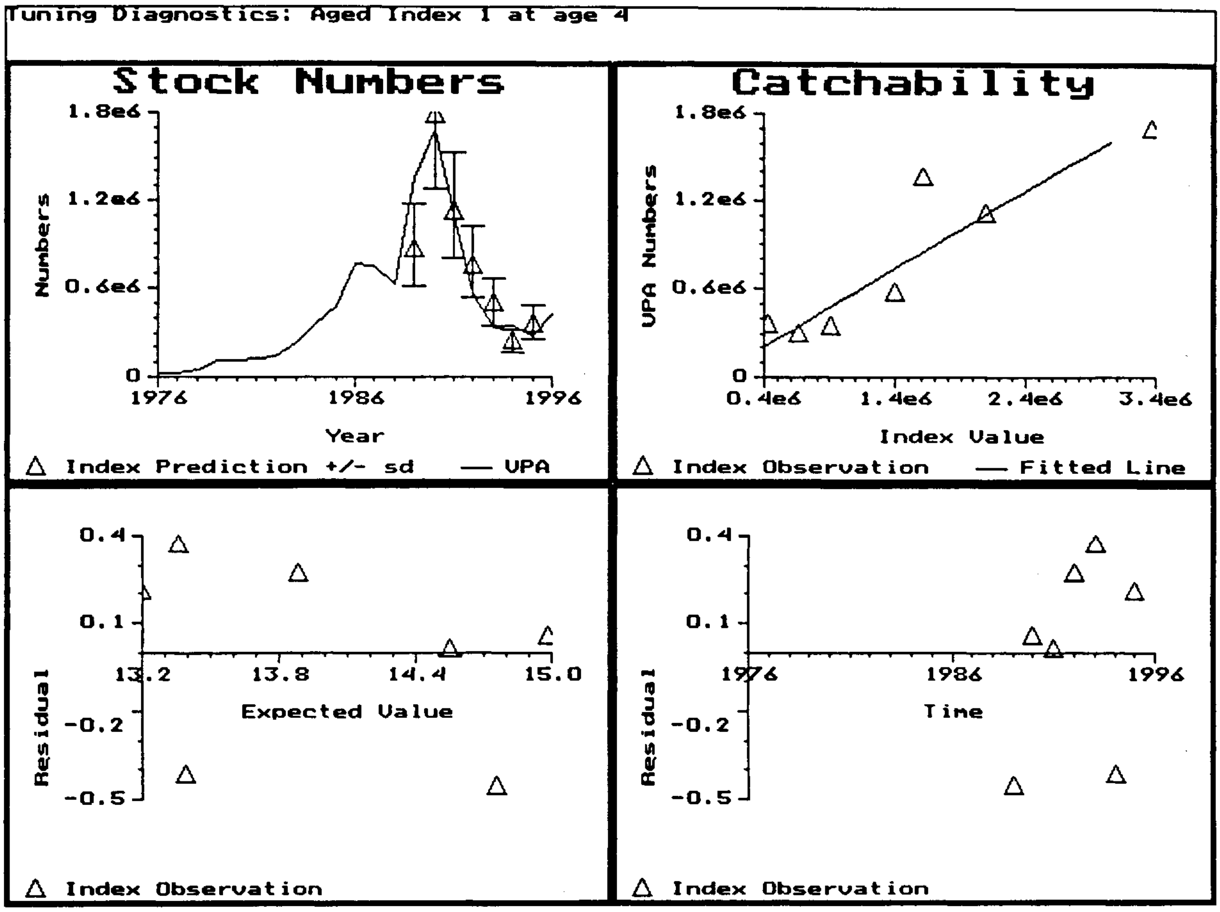
Tuning Diagnostics: Aged Index 1 at age 2
Stock Numbers
Numbers
6e6
4e6
2e6
0
1976
1986
1996
Year
Index Prediction +/- sd
UPA
Catchability
UPA Numbers
4.0e6
3.0e6
2.0e6
1.0e6
0
2.8e6
3.5e6
4.2e6
Index Value
Index Observation
Fitted Line
Residual
0.31
0.13
-0.05
-0.23
-0.41
14.82
15.06
15.30
15.54
Expected Value
Index Observation
Residual
0.31
0.13
-0.05
-0.23
-0.41
1976
1986
1996
Time
Index Observation

Figure 2.8.7



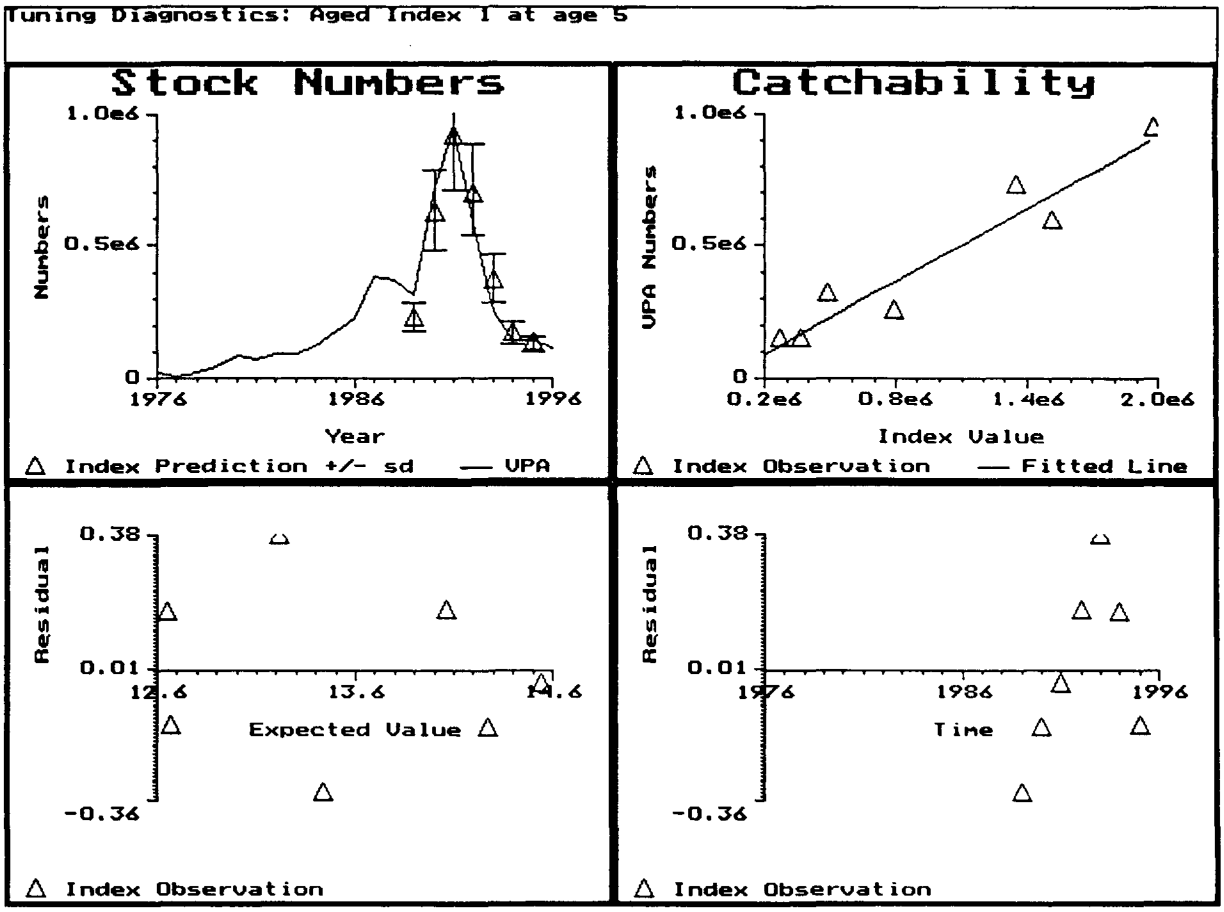
Tuning Diagnostics: Aged Index 1 at age 3
Stock Numbers
Numbers
3.2e6
2.4e6
1.6e6
0.8e6
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
VPA Numbers
3.2e6
2.4e6
1.6e6
0.8e6
0
0.9e6
1.9e6
2.9e6
3.9e6
Index Value
Index Observation
Fitted Line
Residual
0.31
0
-0.31
13.9
14.7
15.5
Expected Value
Index Observation
Residual
0.31
0
-0.31
1976
1986
1996
Time
Index Observation

Figure 2.8.8



Tuning Diagnostics: Aged Index 1 at age 4
Stock Numbers
1.8e6
1.2e6
0.6e6
0
Numbers
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
1.8e6
1.2e6
0.6e6
0
VPA Numbers
0.4e6
1.4e6
2.4e6
3.4e6
Index Value
Index Observation
Fitted Line
0.4
0.1
-0.2
-0.5
Residual
13.2
13.8
14.4
15.0
Expected Value
Index Observation
0.4
0.1
-0.2
-0.5
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.9



Tuning Diagnostics: Aged Index 1 at age 5
Stock Numbers
1.0e6
0.5e6
0
Numbers
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
1.0e6
0.5e6
0
VPA Numbers
0.2e6
0.8e6
1.4e6
2.0e6
Index Value
Index Observation
Fitted Line
0.38
0.01
-0.36
Residual
12.6
13.6
14.6
Expected Value
Index Observation
0.38
0.01
-0.36
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.10

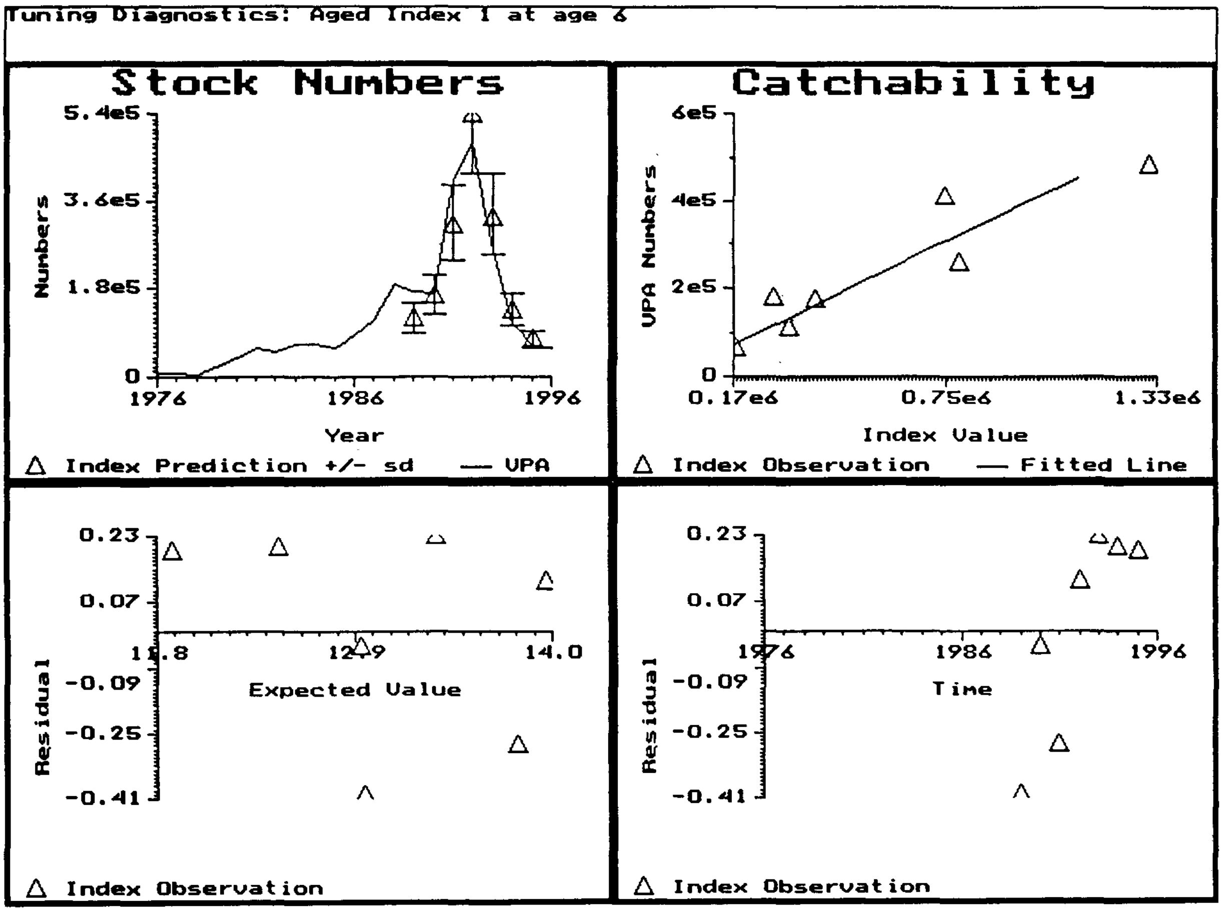
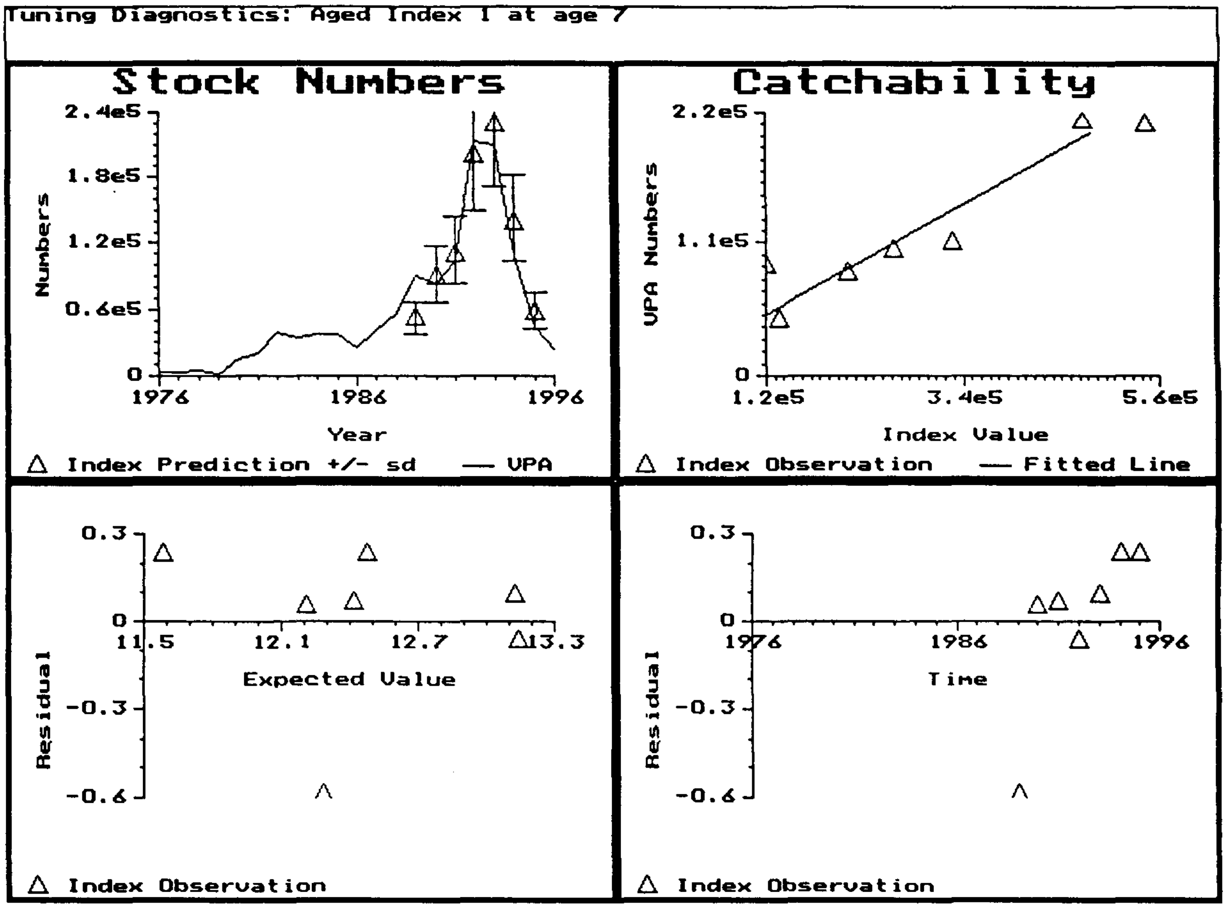
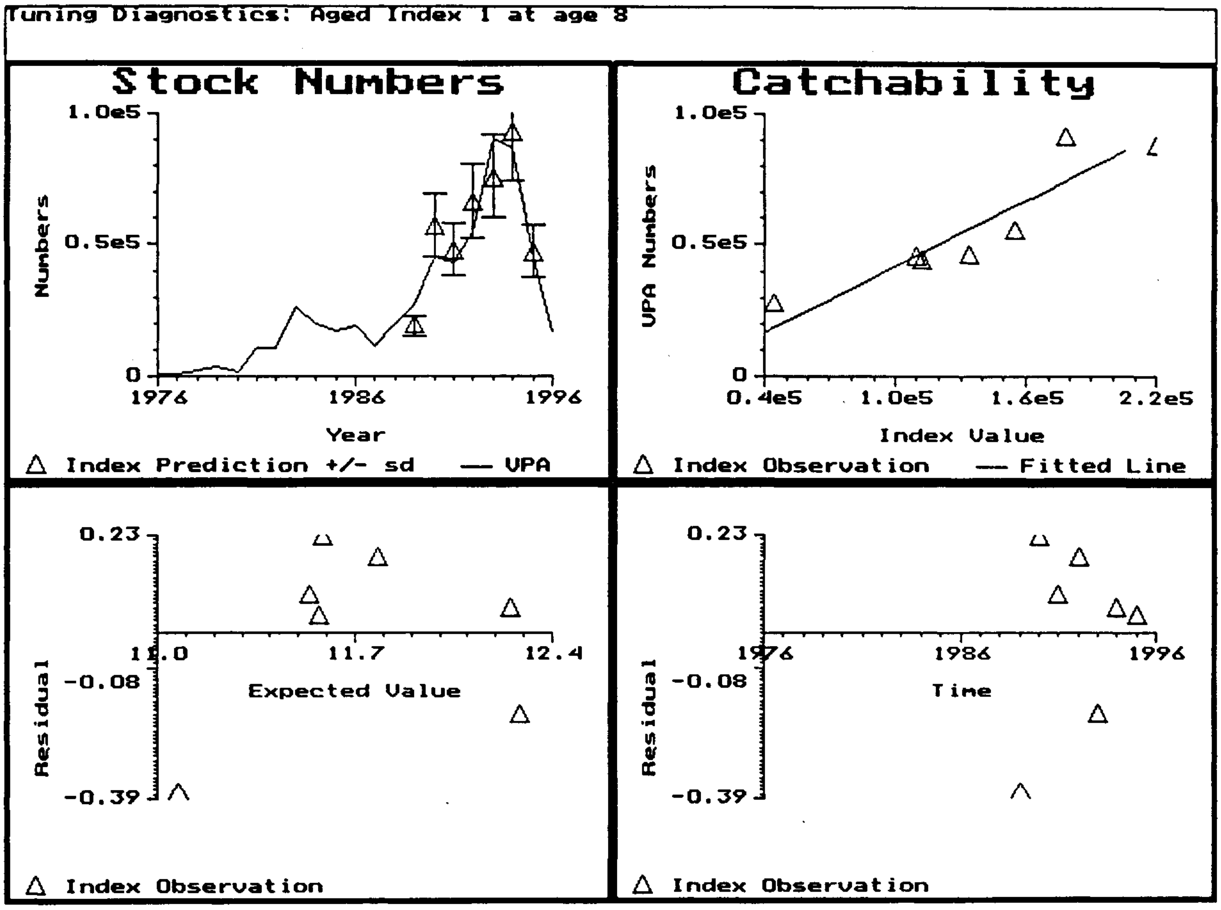

Tuning Diagnostics: Aged Index 1 at age 6
Stock Numbers
Numbers
5.4e5
3.6e5
1.8e5
0
1976
1986
1996
Year
Index Prediction +/- sd
UPA
Catchability
UPA Numbers
6e5
4e5
2e5
0
0.17e6
0.75e6
1.33e6
Index Value
Index Observation
Fitted Line
Residual
0.23
0.07
-0.09
-0.25
-0.41
11.8
12.9
14.0
Expected Value
Index Observation
Residual
0.23
0.07
-0.09
-0.25
-0.41
1976
1986
1996
Time
Index Observation

Figure 2.8.11



Tuning Diagnostics: Aged Index 1 at age 7
Stock Numbers
Numbers
2.4e5
1.8e5
1.2e5
0.6e5
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
VPA Numbers
2.2e5
1.1e5
0
1.2e5
3.4e5
5.6e5
Index Value
Index Observation
Fitted Line
Residual
0.3
0
-0.3
-0.6
11.5
12.1
12.7
13.3
Expected Value
Index Observation
Residual
0.3
0
-0.3
-0.6
1976
1986
1996
Time
Index Observation

Figure 2.8.12



Tuning Diagnostics: Aged Index 1 at age 8
Stock Numbers
1.0e5
0.5e5
0
Numbers
1976
1986
1996
Year
Δ Index Prediction +/- sd
— VPA
Catchability
1.0e5
0.5e5
0
VPA Numbers
0.4e5
1.0e5
1.6e5
2.2e5
Index Value
Δ Index Observation
— Fitted Line
0.23
-0.08
-0.39
Residual
11.0
11.7
12.4
Expected Value
Δ Index Observation
0.23
-0.08
-0.39
Residual
1976
1986
1996
Time
Δ Index Observation

Figure 2.8.13

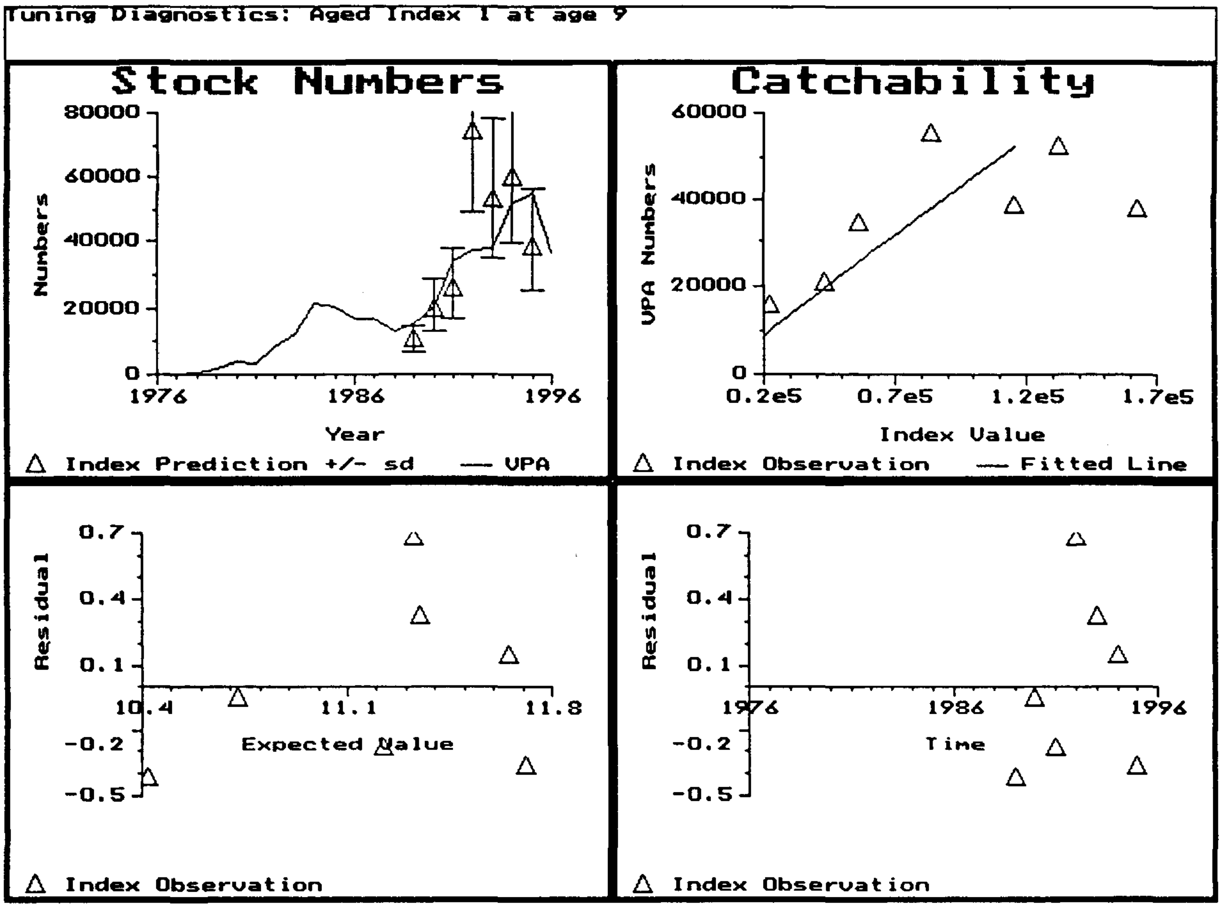

Tuning Diagnostics: Aged Index 1 at age 9
Stock Numbers
80000
60000
40000
20000
0
Numbers
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
60000
40000
20000
0
VPA Numbers
0.2e5
0.7e5
1.2e5
1.7e5
Index Value
Index Observation
Fitted Line
0.7
0.4
0.1
-0.2
-0.5
Residual
10.4
11.1
11.8
Expected Value
Index Observation
0.7
0.4
0.1
-0.2
-0.5
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.14

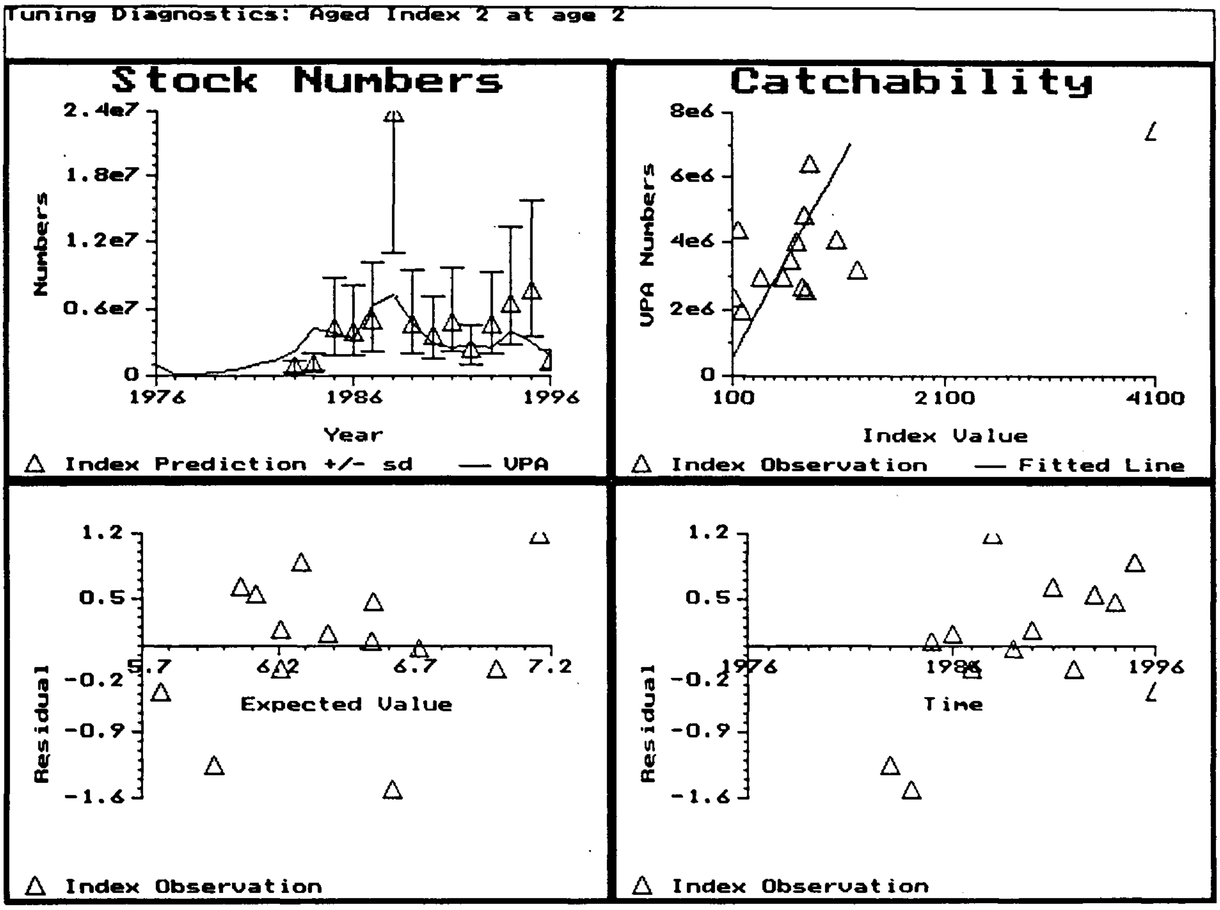

Tuning Diagnostics: Aged Index 2 at age 2
Stock Numbers
Numbers
2.4e7
1.8e7
1.2e7
0.6e7
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
VPA Numbers
8e6
6e6
4e6
2e6
0
100
2100
4100
Index Value
Index Observation
Fitted Line
Residual
1.2
0.5
-0.2
-0.9
-1.6
5.7
6.2
6.7
7.2
Expected Value
Index Observation
Residual
1.2
0.5
-0.2
-0.9
-1.6
1976
1986
1996
Time
Index Observation

Figure 2.8.15

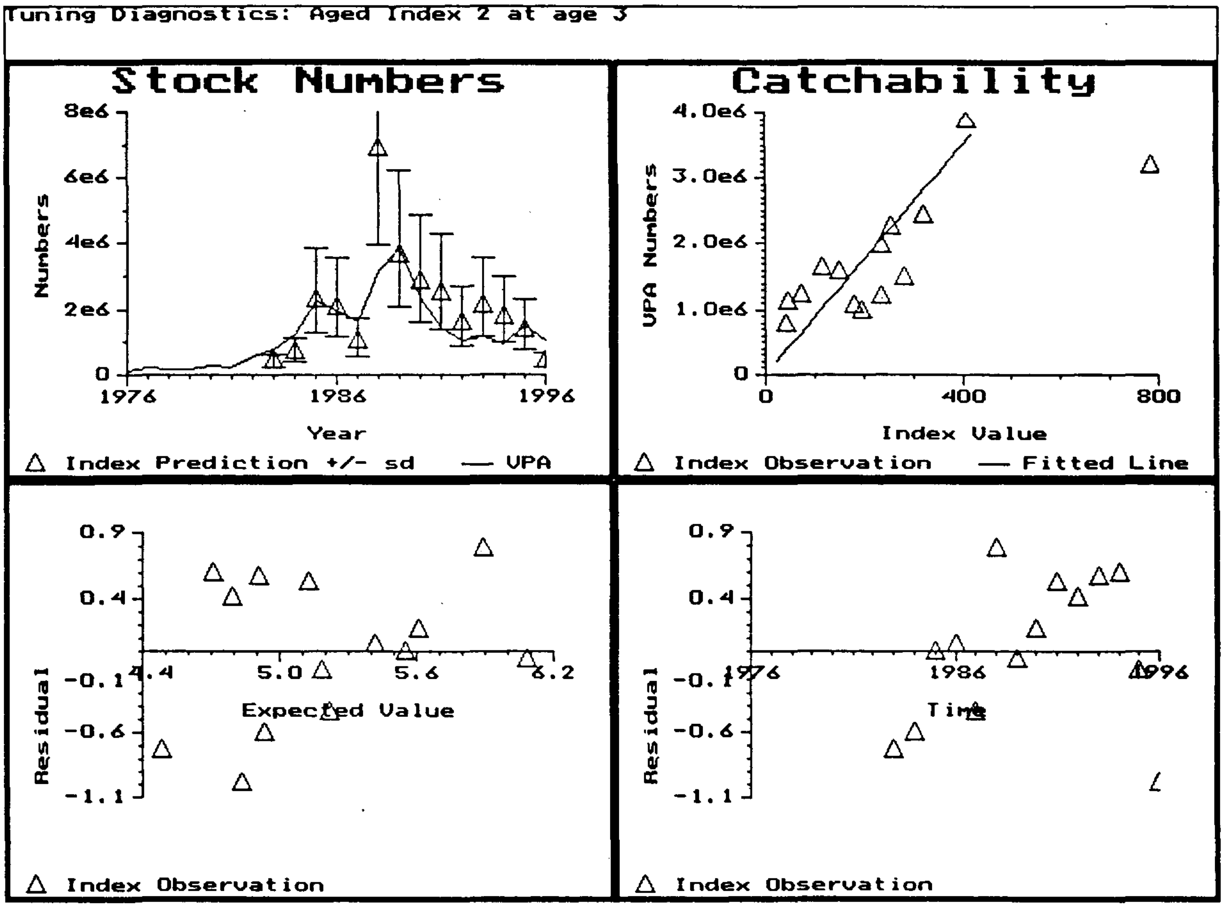
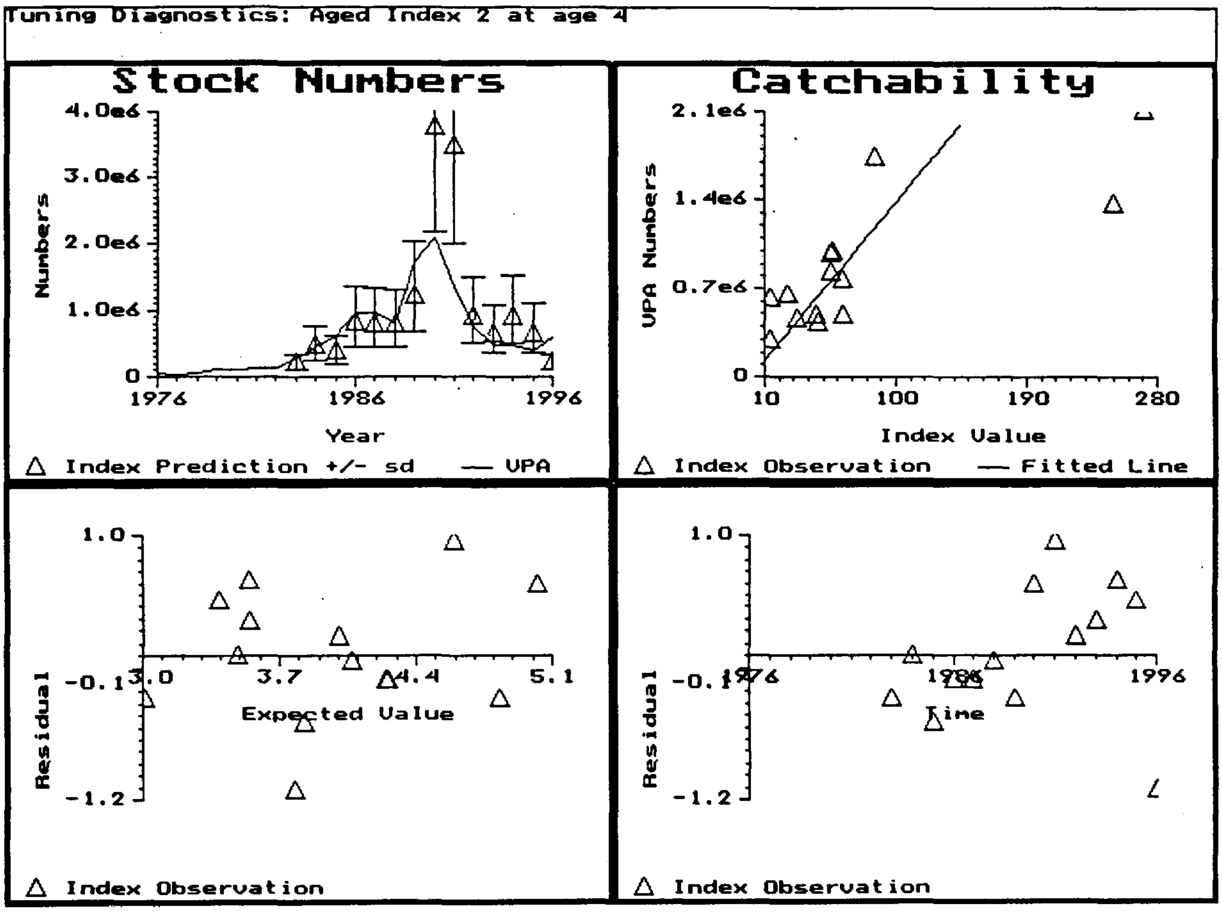
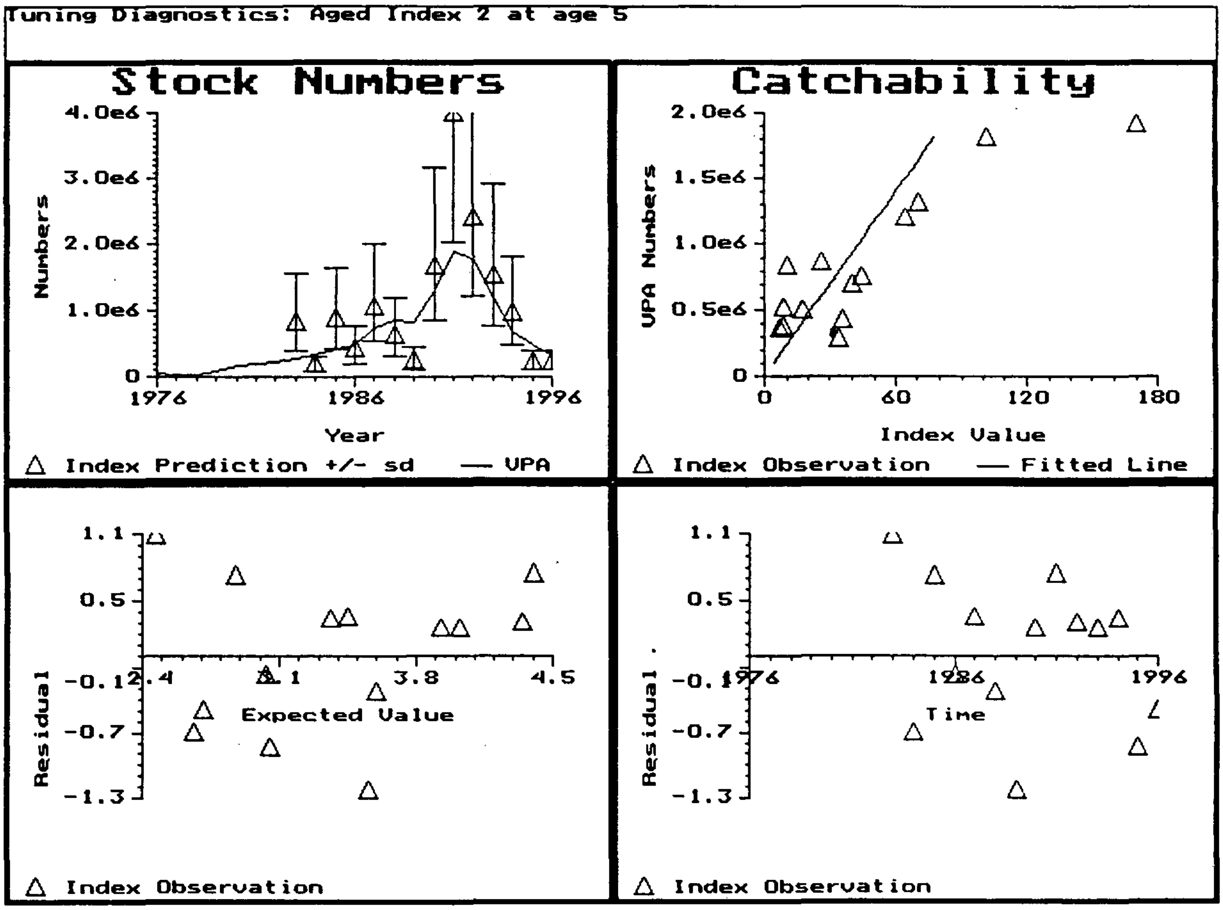

Tuning Diagnostics: Aged Index 2 at age 3
Stock Numbers
Numbers
8e6
6e6
4e6
2e6
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
UPA Numbers
4.0e6
3.0e6
2.0e6
1.0e6
0
0
400
800
Index Value
Index Observation
Fitted Line
Residual
0.9
0.4
-0.1
-0.6
-1.1
4.4
5.0
5.6
6.2
Expected Value
Index Observation
Residual
0.9
0.4
-0.1
-0.6
-1.1
1976
1986
1996
Time
Index Observation

Figure 2.8.16



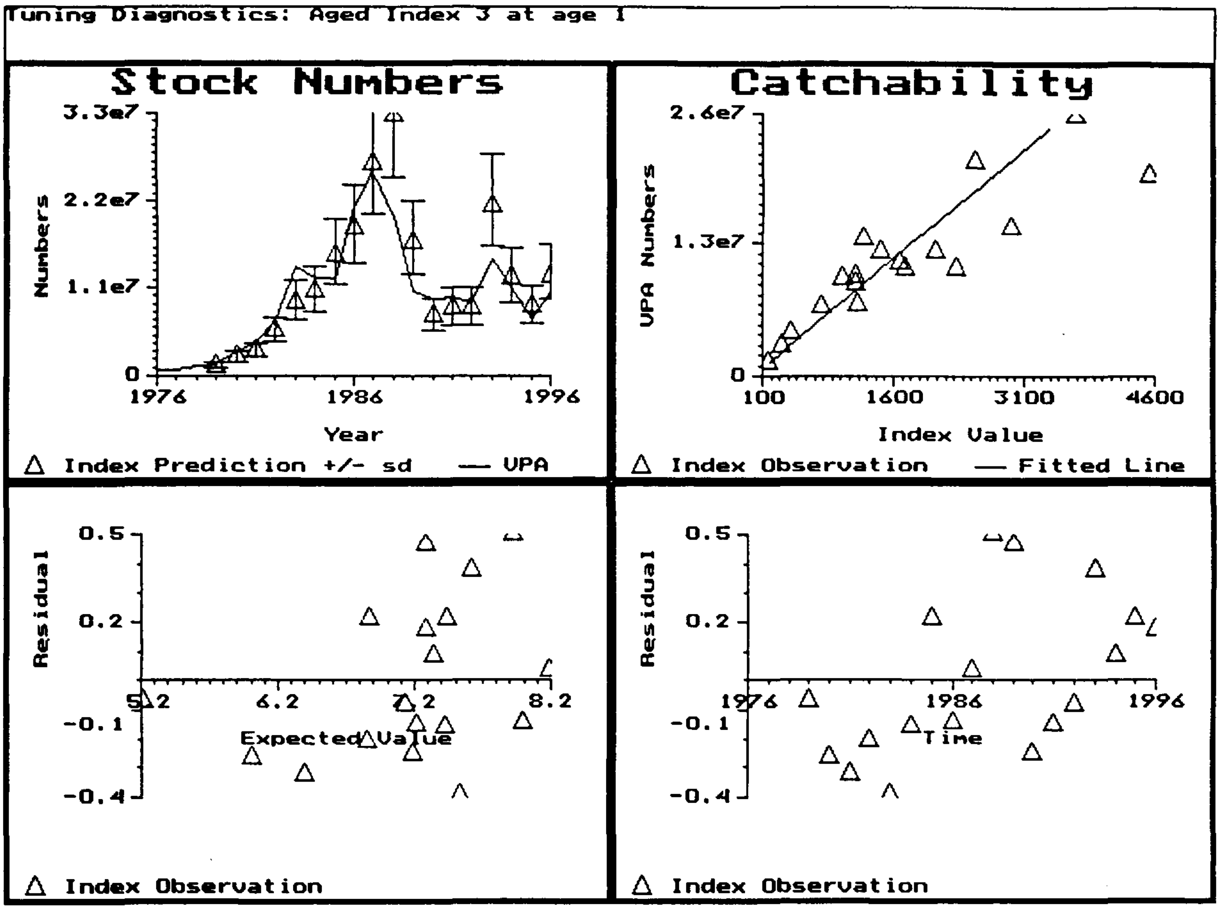
Tuning Diagnostics: Aged Index 2 at age 4
Stock Numbers
Numbers
4.0e6
3.0e6
2.0e6
1.0e6
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
VPA Numbers
2.1e6
1.4e6
0.7e6
0
10
100
190
280
Index Value
Index Observation
Fitted Line
Residual
1.0
-0.1
-1.2
3.0
3.7
4.4
5.1
Expected Value
Index Observation
Residual
1.0
-0.1
-1.2
1976
1986
1996
Time
Index Observation

Figure 2.8.17



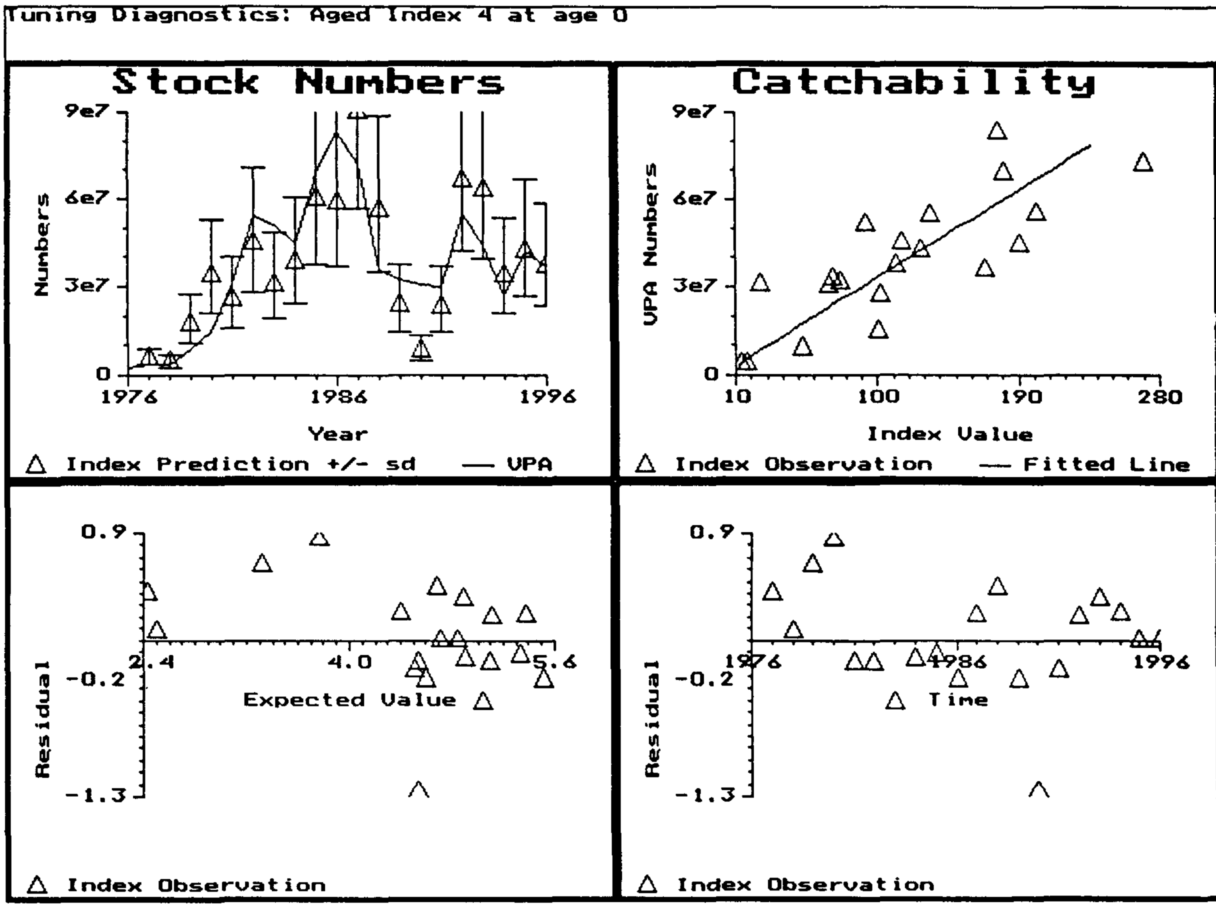
Tuning Diagnostics: Aged Index 2 at age 5
Stock Numbers
4.0e6
3.0e6
2.0e6
1.0e6
0
Numbers
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
2.0e6
1.5e6
1.0e6
0.5e6
0
VPA Numbers
0
60
120
180
Index Value
Index Observation
Fitted Line
1.1
0.5
-0.1
-0.7
-1.3
Residual
2.4
3.1
3.8
4.5
Expected Value
Index Observation
1.1
0.5
-0.1
-0.7
-1.3
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.18



Tuning Diagnostics: Aged Index 3 at age 1
Stock Numbers
Numbers
3.3e7
2.2e7
1.1e7
0
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
VPA Numbers
2.6e7
1.3e7
0
100
1600
3100
4600
Index Value
Index Observation
Fitted Line
Residual
0.5
0.2
-0.1
-0.4
5.2
6.2
7.2
8.2
Expected Value
Index Observation
Residual
0.5
0.2
-0.1
-0.4
1976
1986
1996
Time
Index Observation

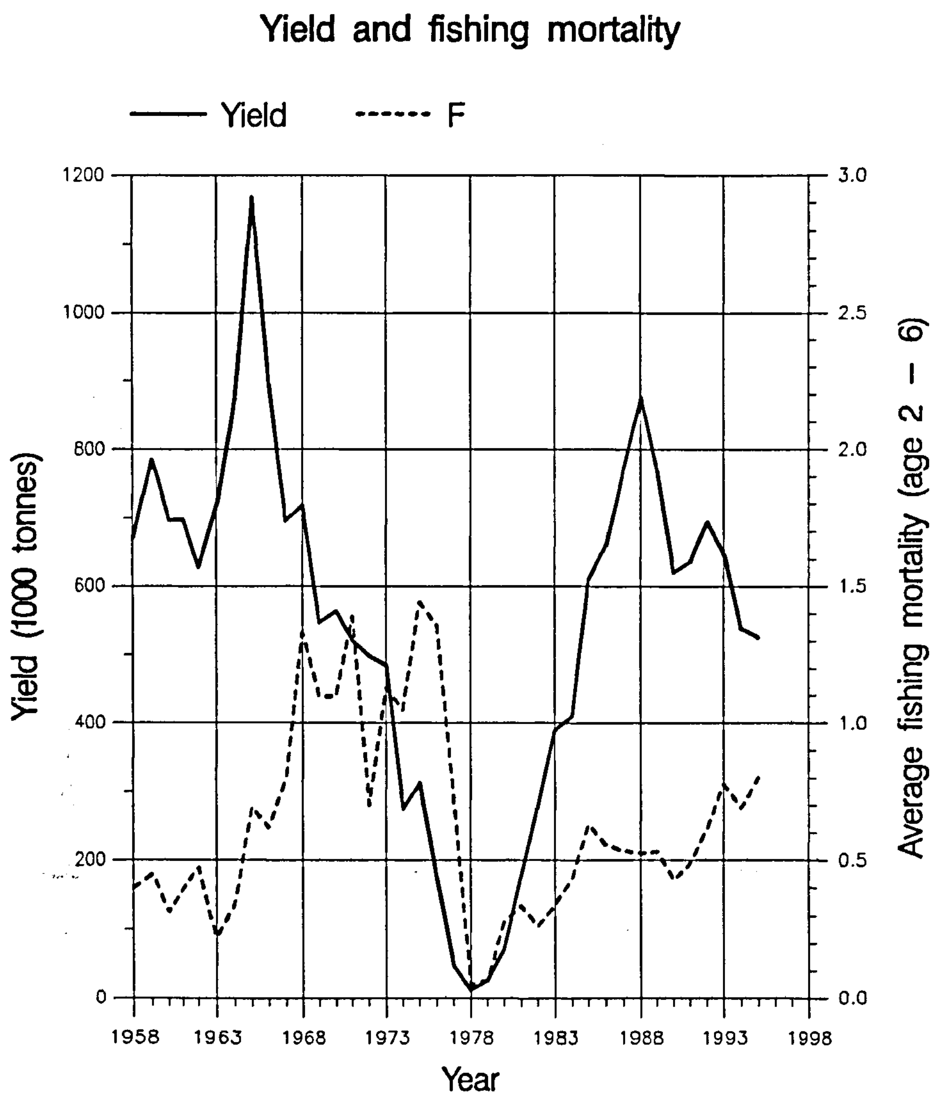
Figure 2.8.19



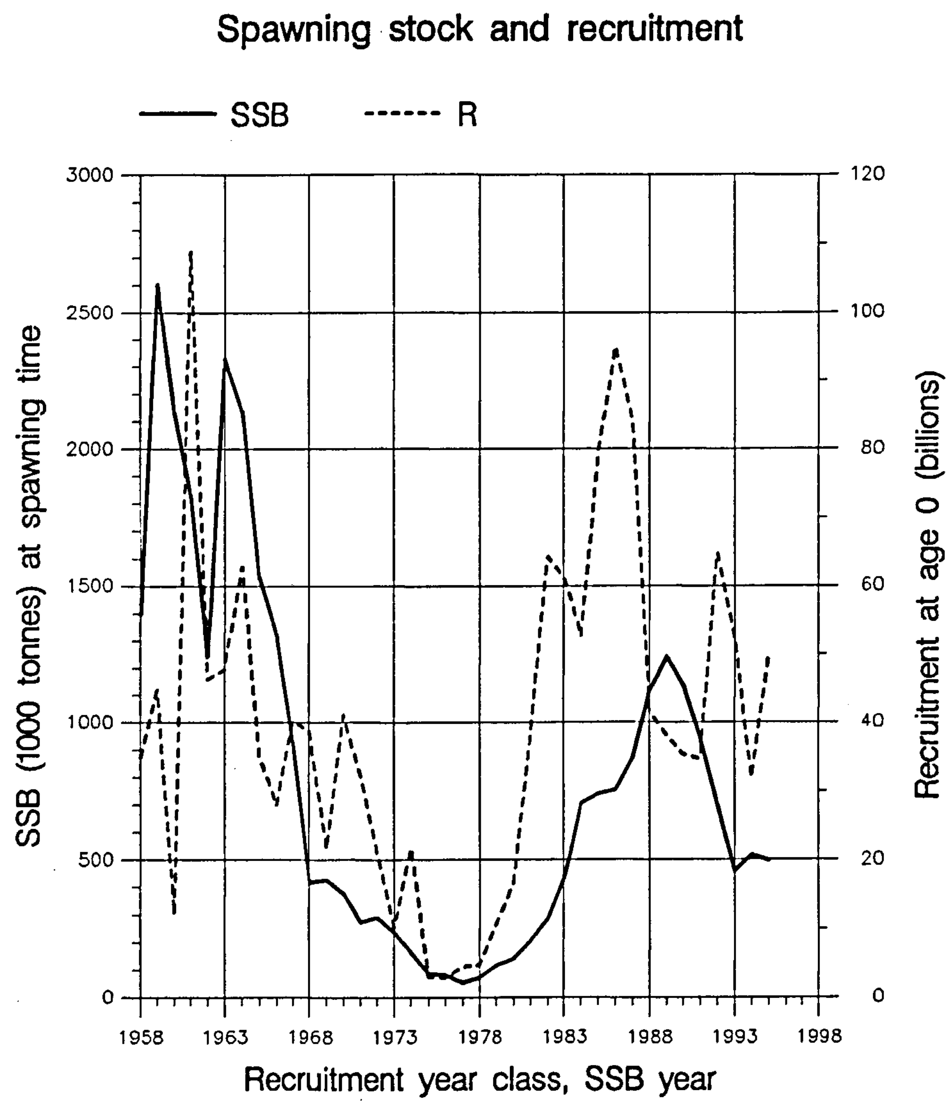
Tuning Diagnostics: Aged Index 4 at age 0
Stock Numbers
9e7
6e7
3e7
0
Numbers
1976
1986
1996
Year
Index Prediction +/- sd
VPA
Catchability
9e7
6e7
3e7
0
VPA Numbers
10
100
190
280
Index Value
Index Observation
Fitted Line
0.9
-0.2
-1.3
Residual
2.4
4.0
5.6
Expected Value
Index Observation
0.9
-0.2
-1.3
Residual
1976
1986
1996
Time
Index Observation

Figure 2.8.20

Fish Stock Summary
Herring in Sub–area IV, Divisions VIId & IIIa (autumn–spawners)
16–4–1996



(run: ICAELT12) A



(run: ICAELT12) B

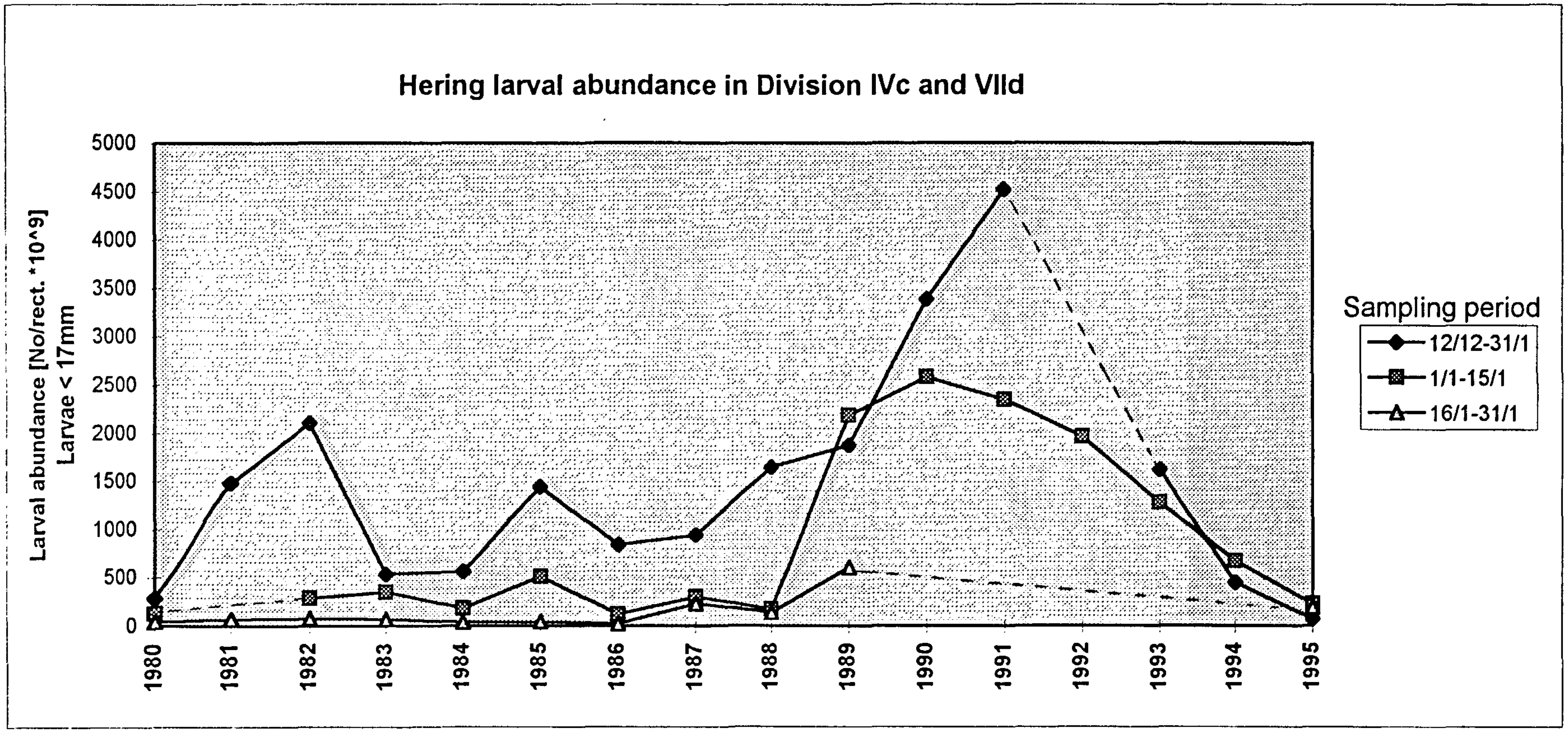


Figure 2.8.21 **Herring larval abundance in Divisions IVc and VIId during the period 1980 - 1995**

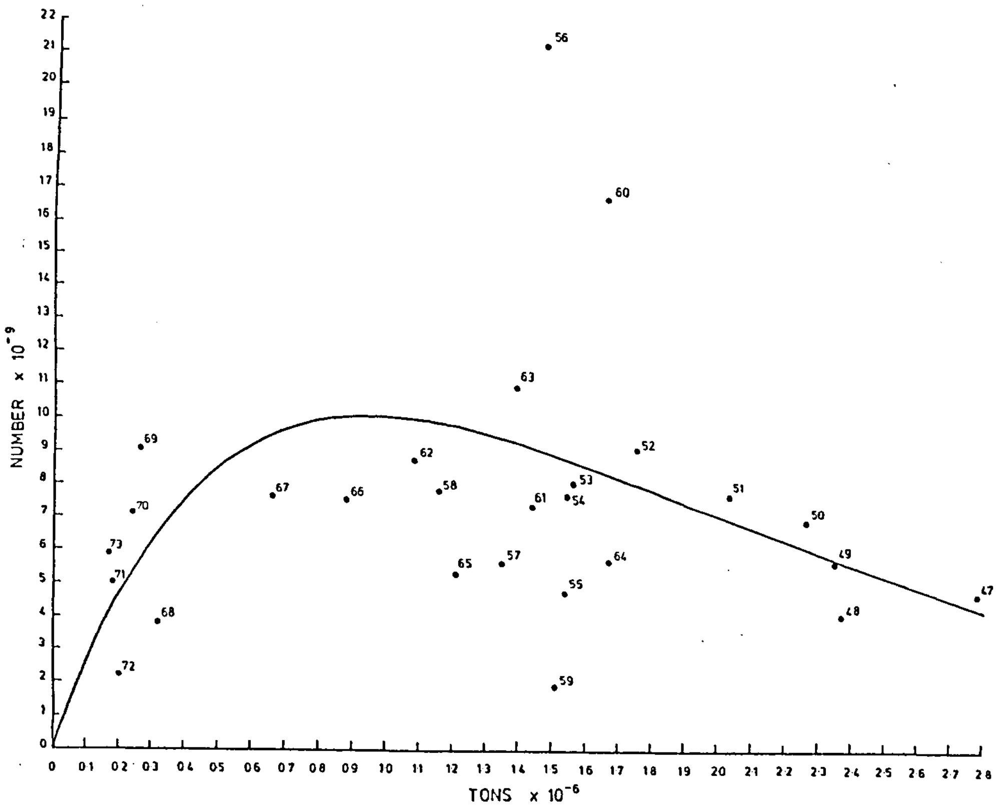


Figure 2.9.1. Recruitment of North Sea autumn spawned herring plotted against spawning stock biomass (2 group and older on 1 Sept. each year). Both estimated by VPA. Figure referring to year classes 1947 to 1973 from Saville and Bailey (1978)

Figure 2.9.2. Recruitment of North Sea autumn spawned herring plotted against spawning stock biomass. Estimates for 1958 to 1976 from VPA (Anon 1995d), estimates for 1977 to 1995 from this years ICA assessment.

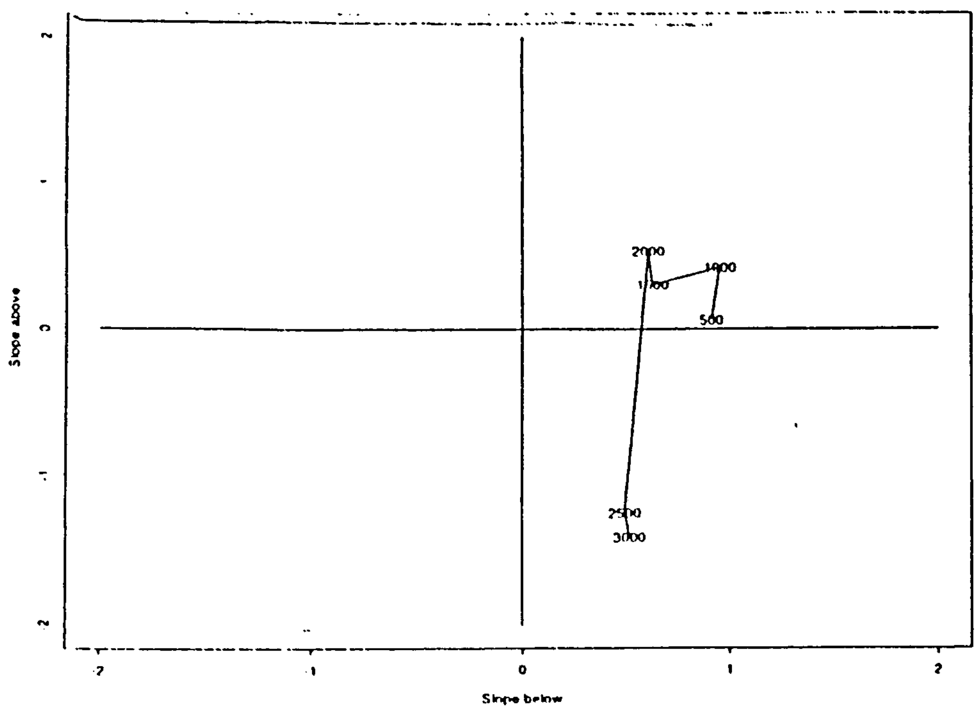


Figure 2.9.3. Diagnostic sheet for estimating MBAL. The slope of the stock-recruitment data above and below the MBAL estimate (from Anon 1993).

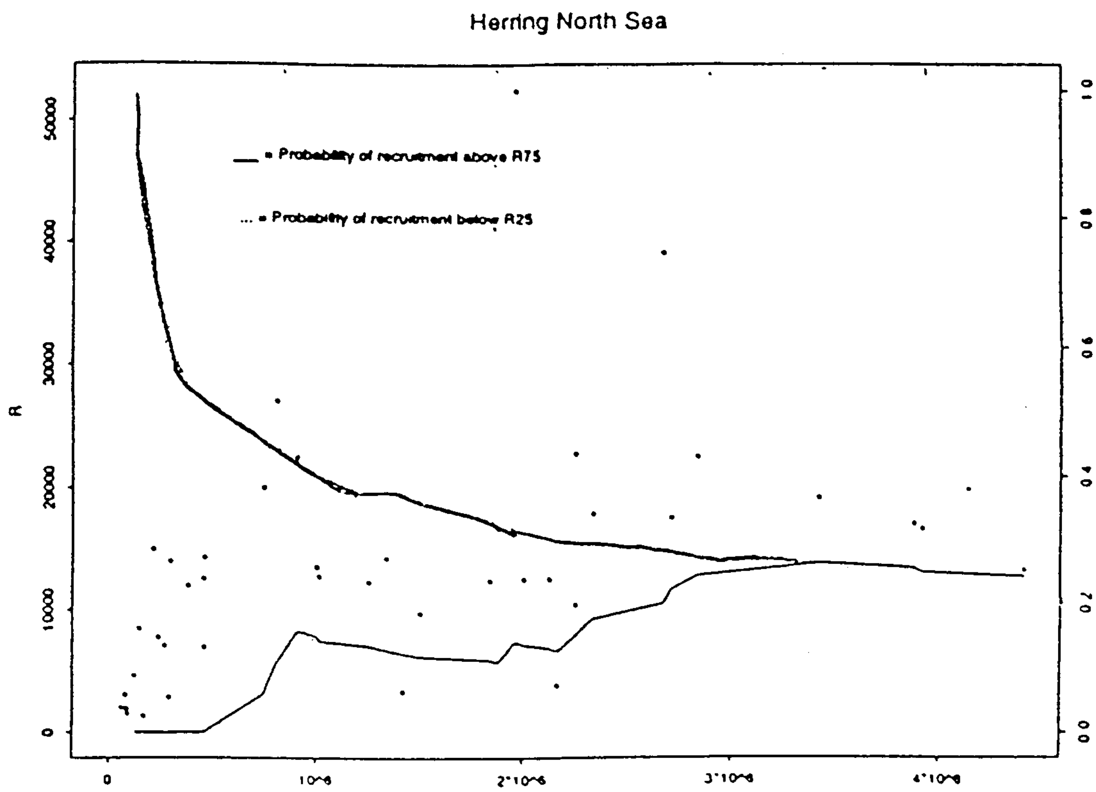


Figure 2.9.4. Plot of recruitment (dots) and the probability of recruitment in the upper and lower quartiles (normal and heavy line, respectively) against the SSB (from Anon 1993).

Figure 2.11.1. North Sea Herring. Diagnostics of the stock-recruit model fit used for the medium-term projections. Top left, the time series of recruitment estimates from the population models (Square markers), the expected values from the stock-recruit model (broken line) and the values fitted from the time-series (full line).

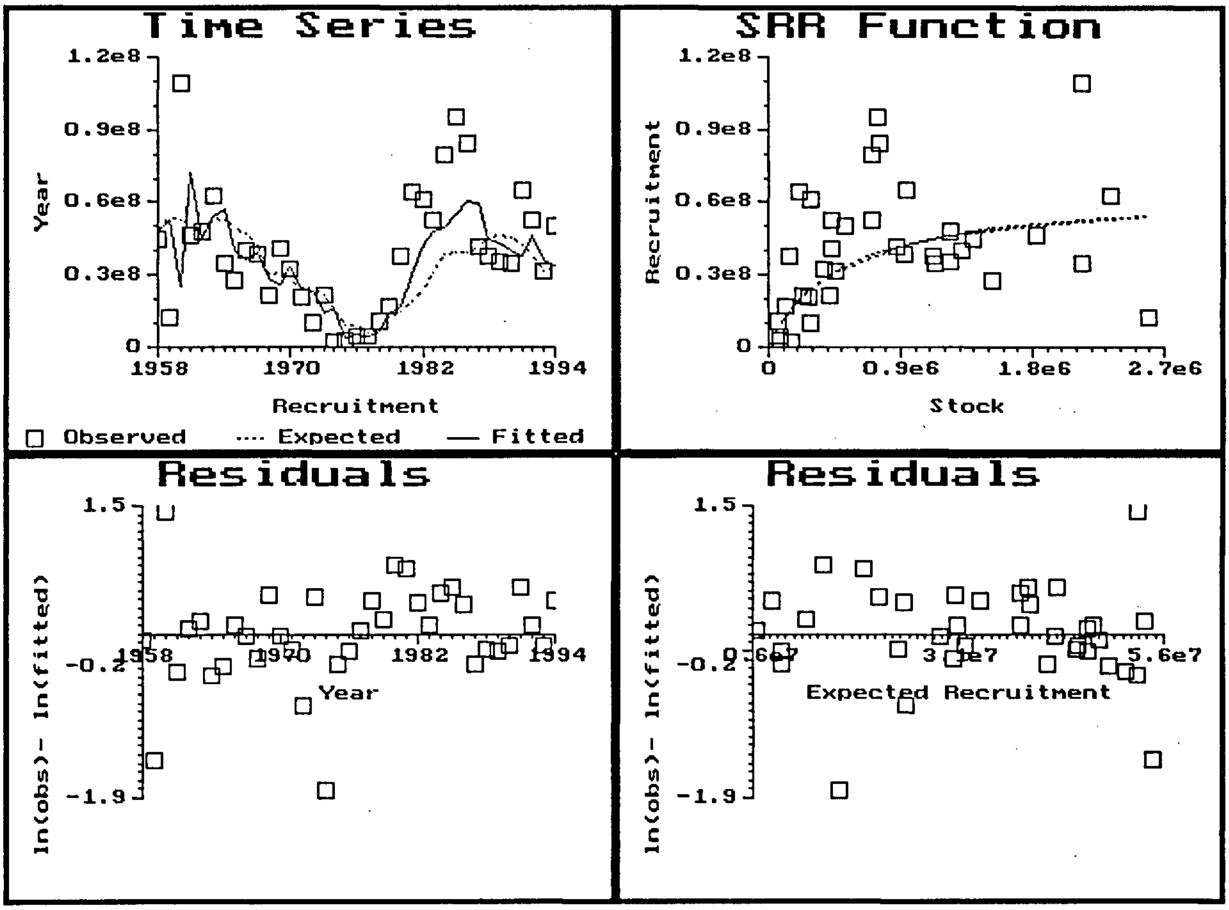
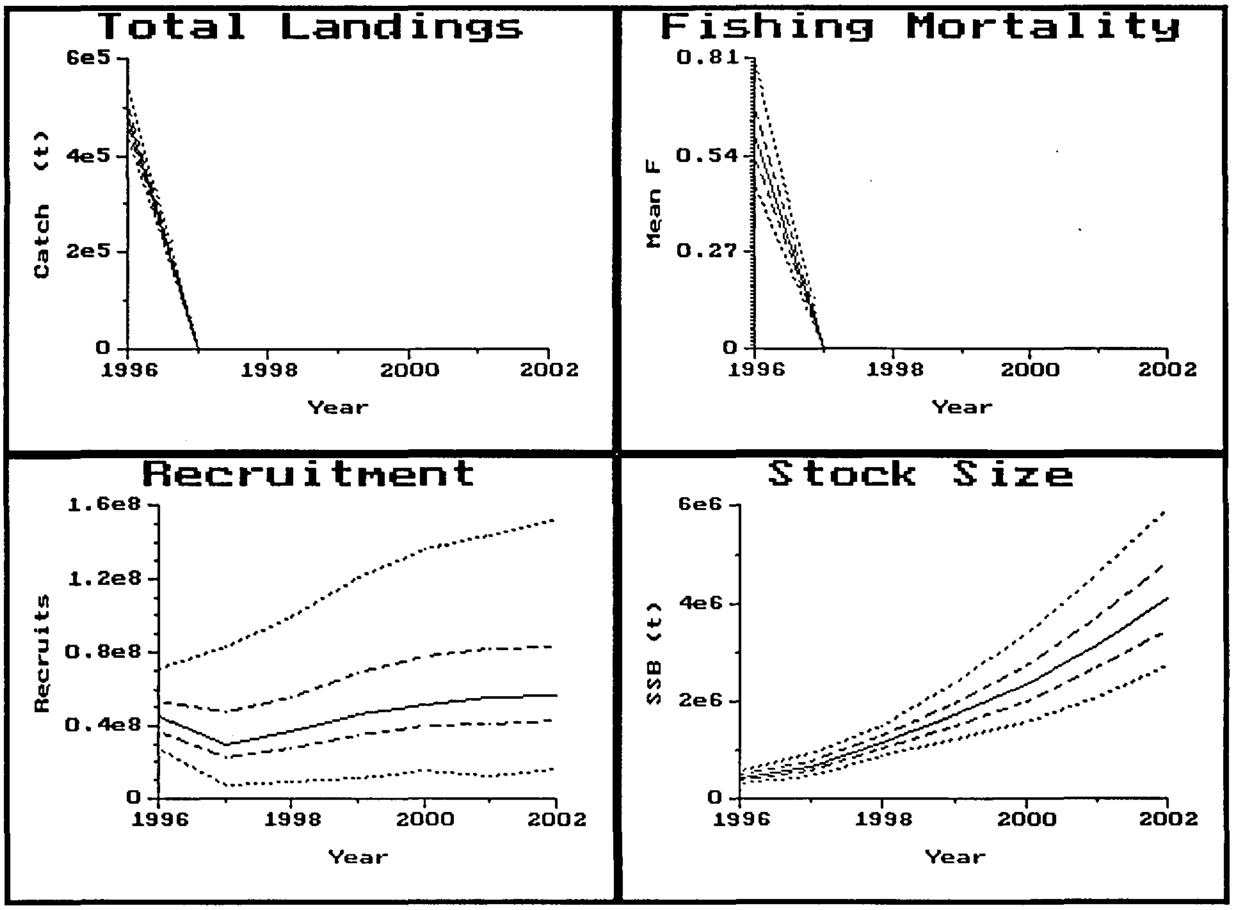


Figure 2.11.2. North Sea Herring. Medium-term projections assuming zero fishing mortality in all fleets. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality by fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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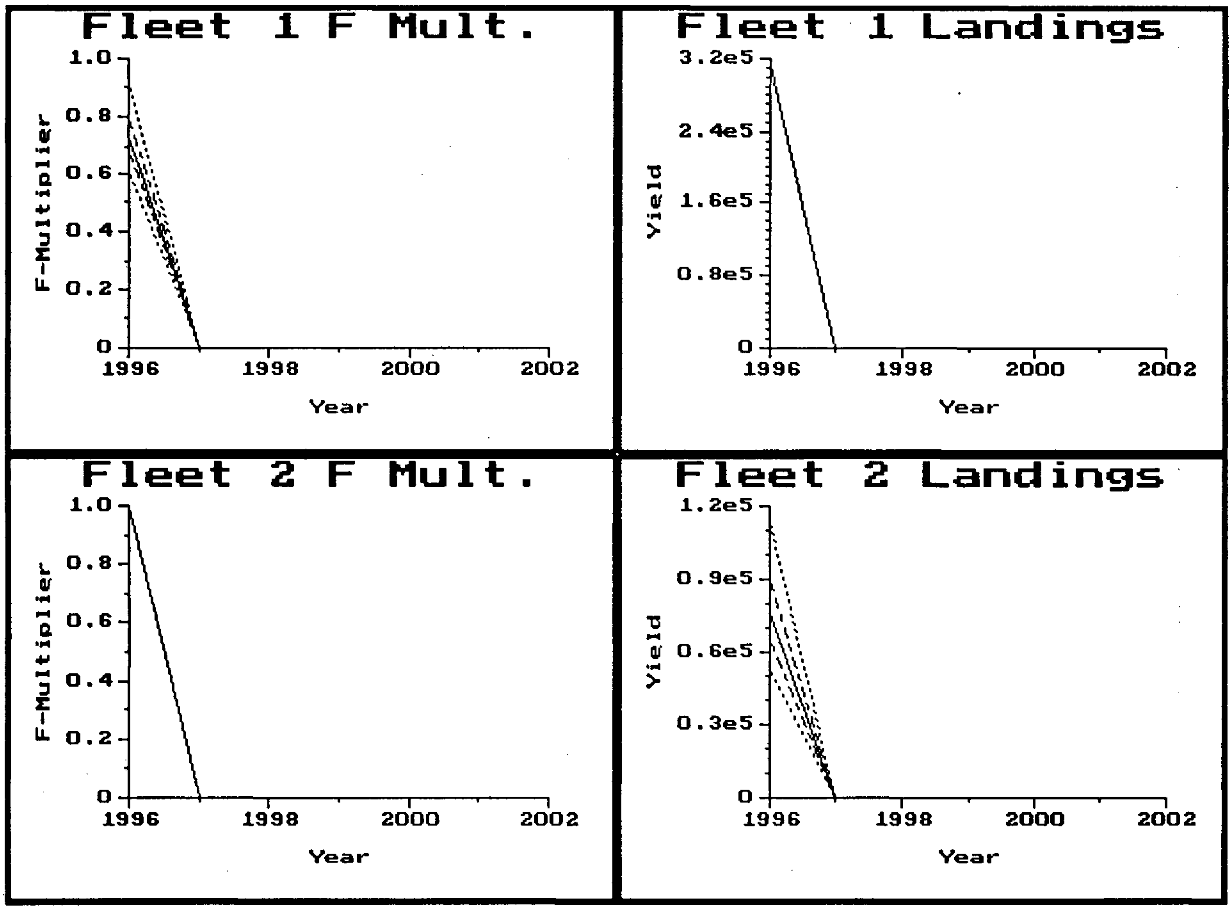

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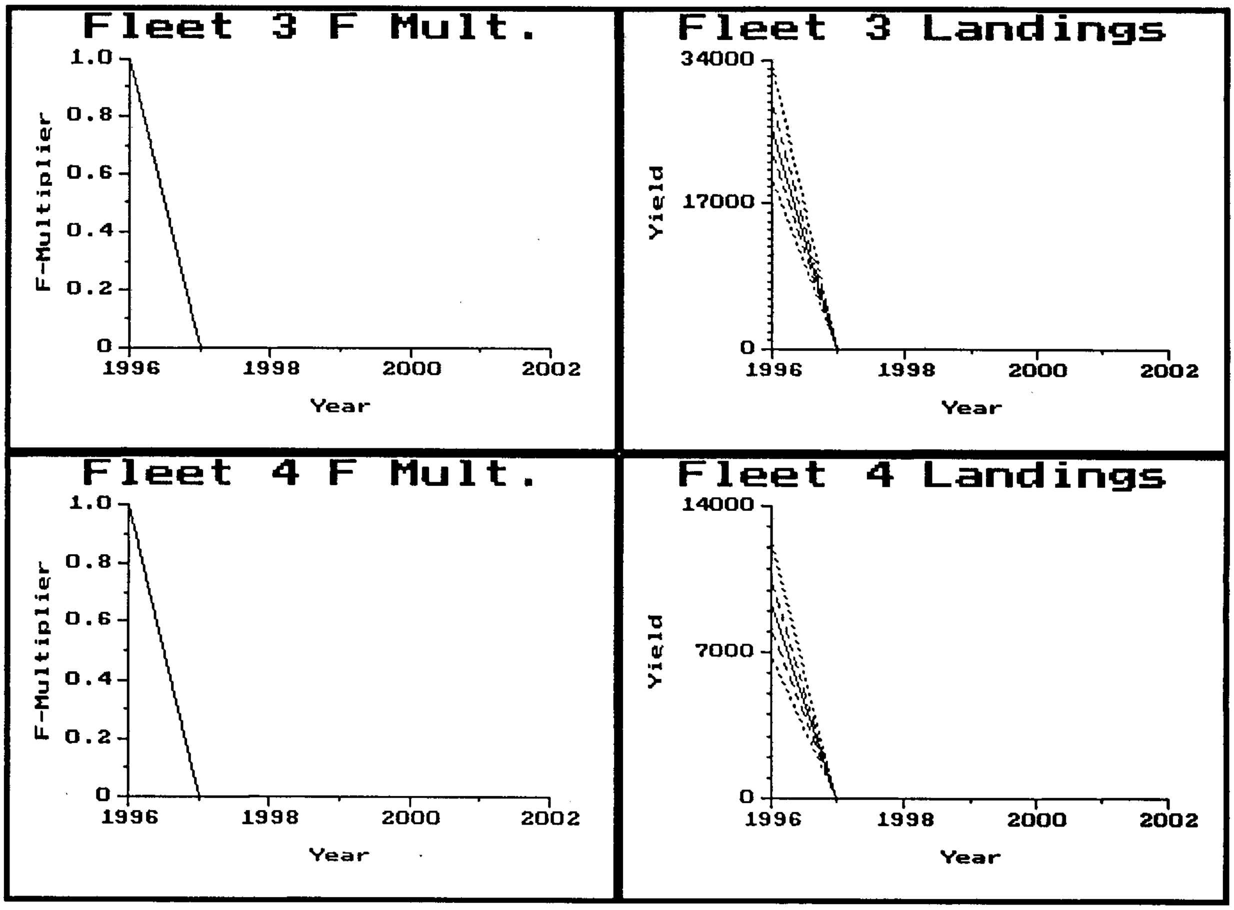

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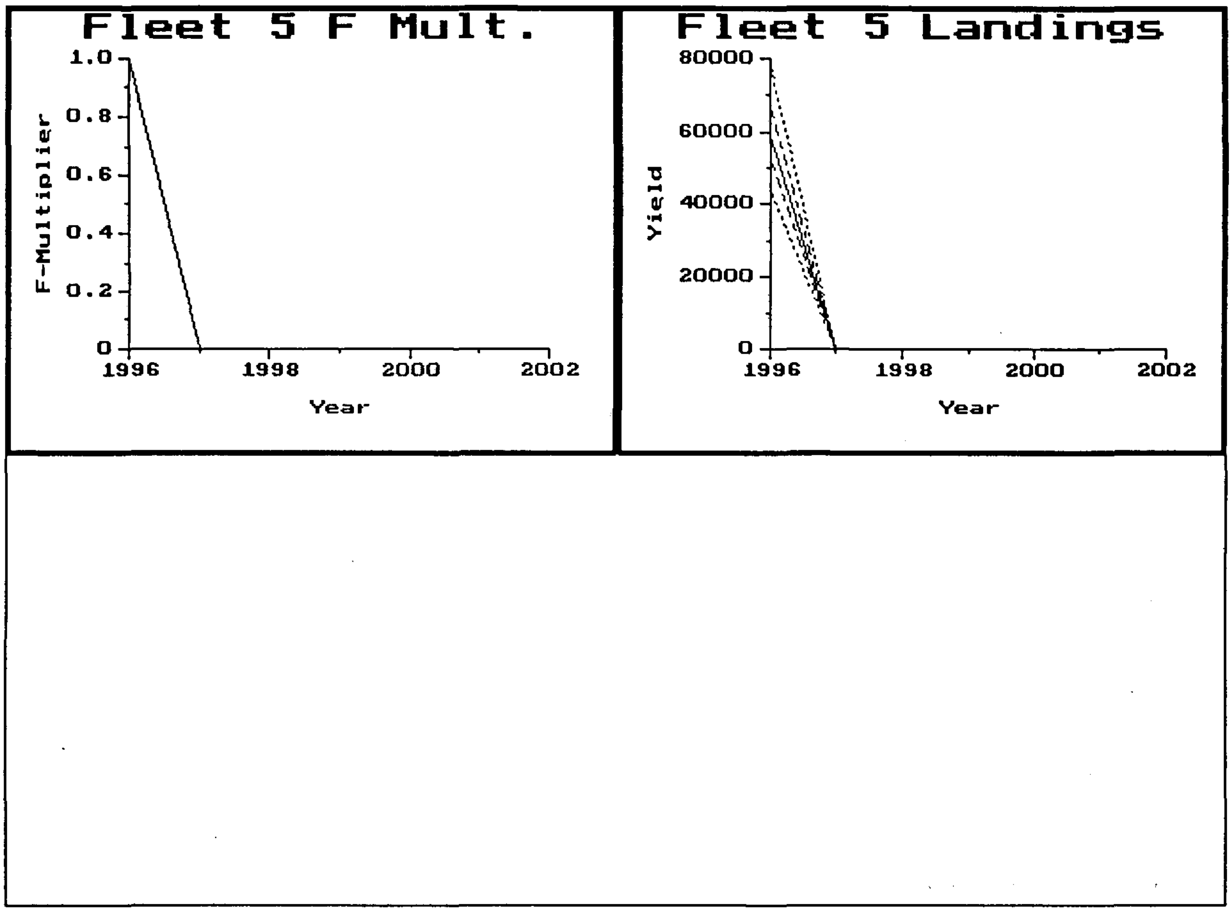

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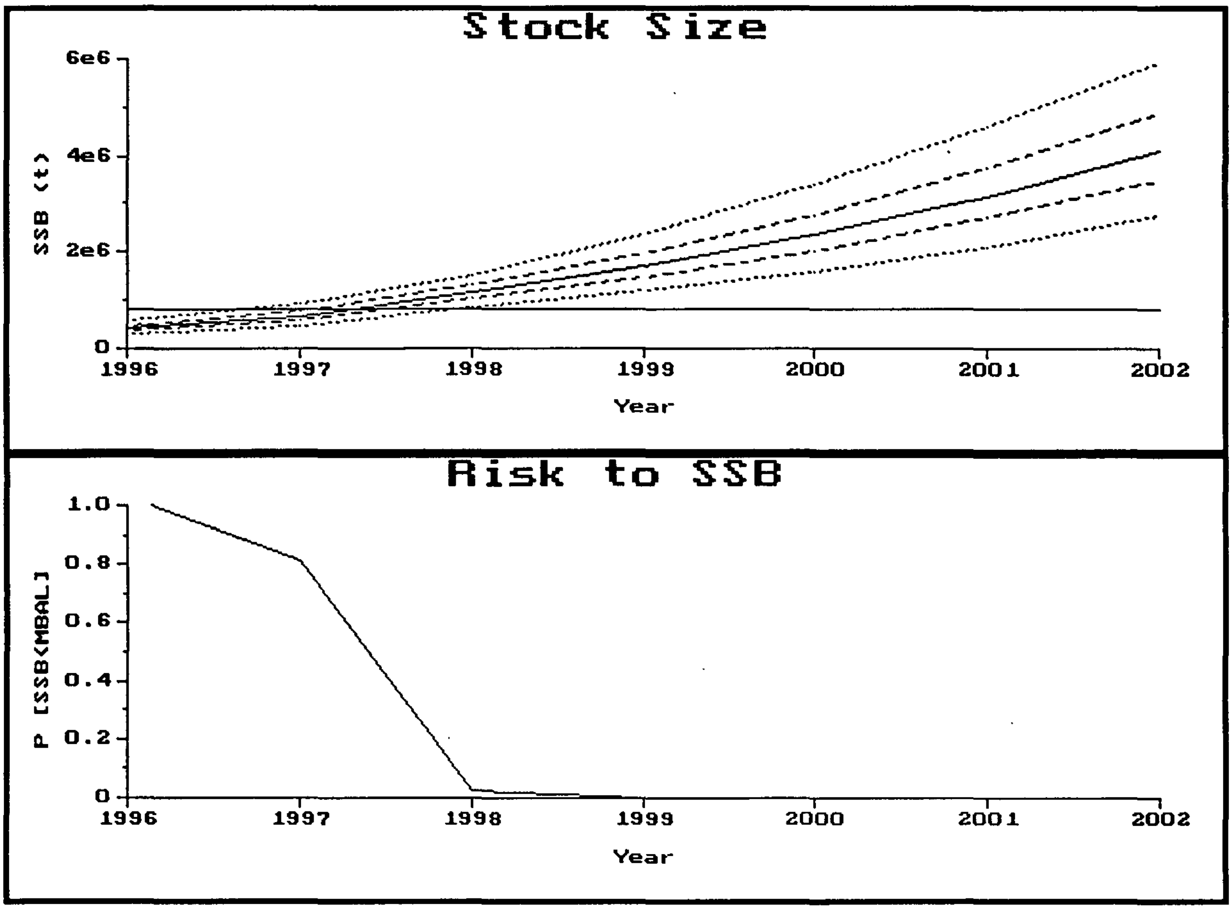
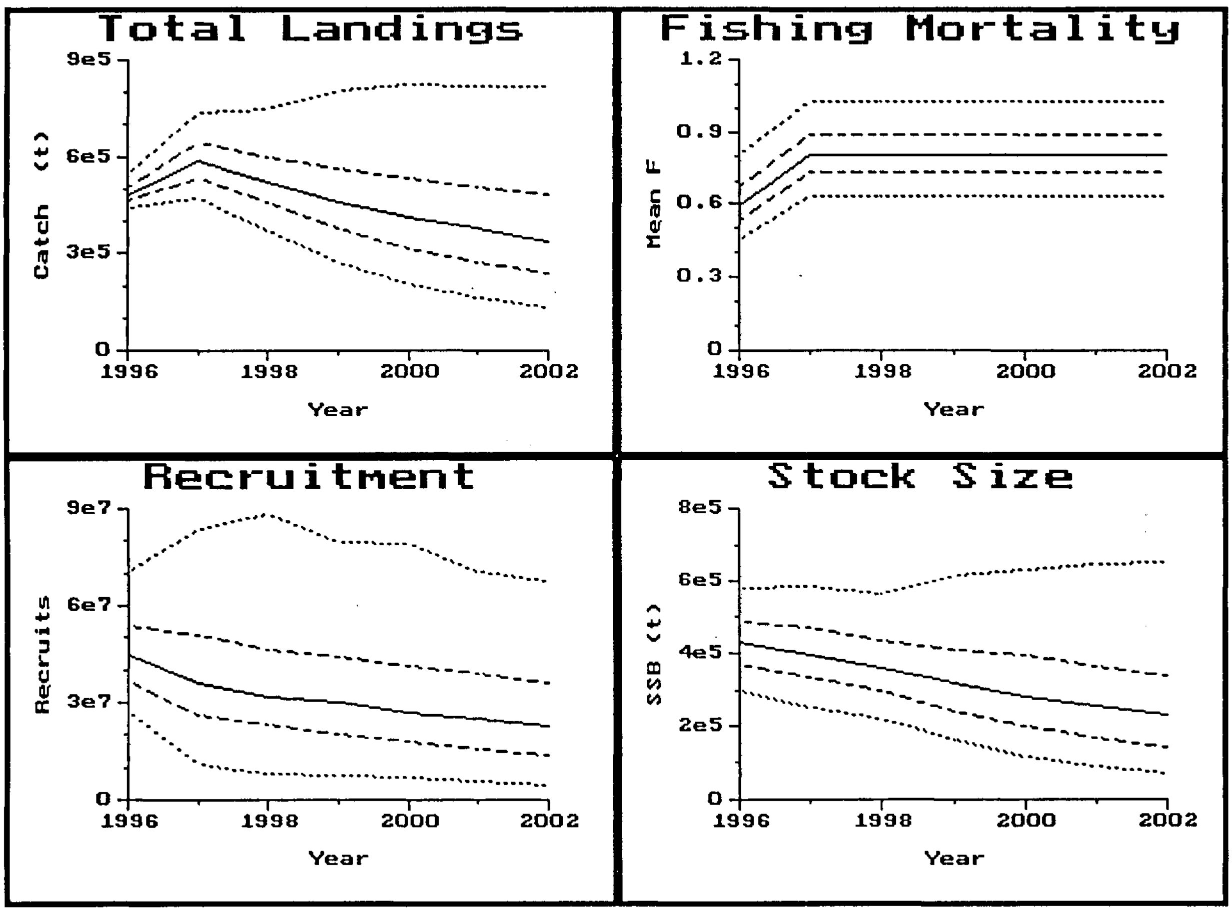


Figure 2.11.3. North Sea Herring. Medium-term projections assuming fishing at *status quo* levels from 1997 to 2002, defined as the estimated fishing mortality in 1995 in all fleets. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality bt fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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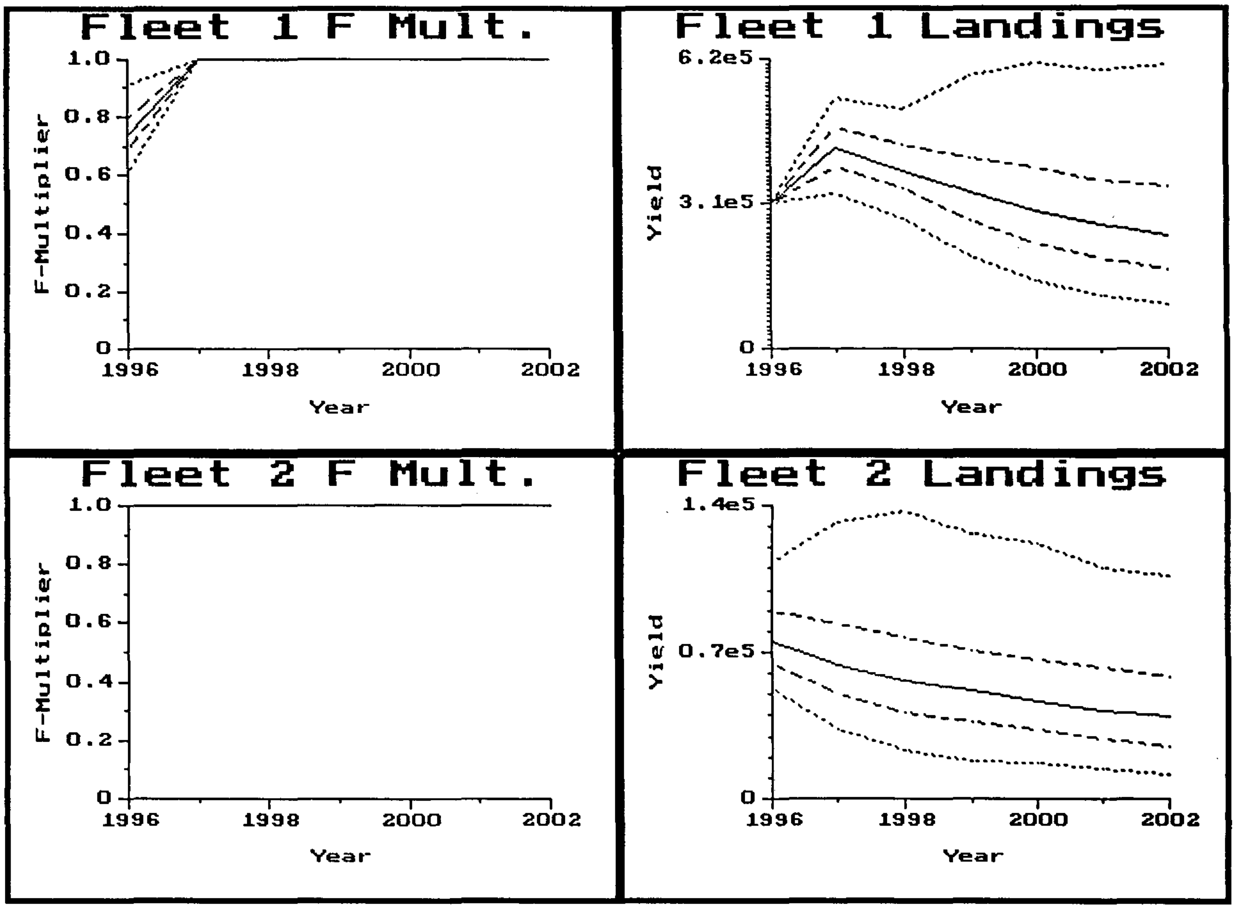

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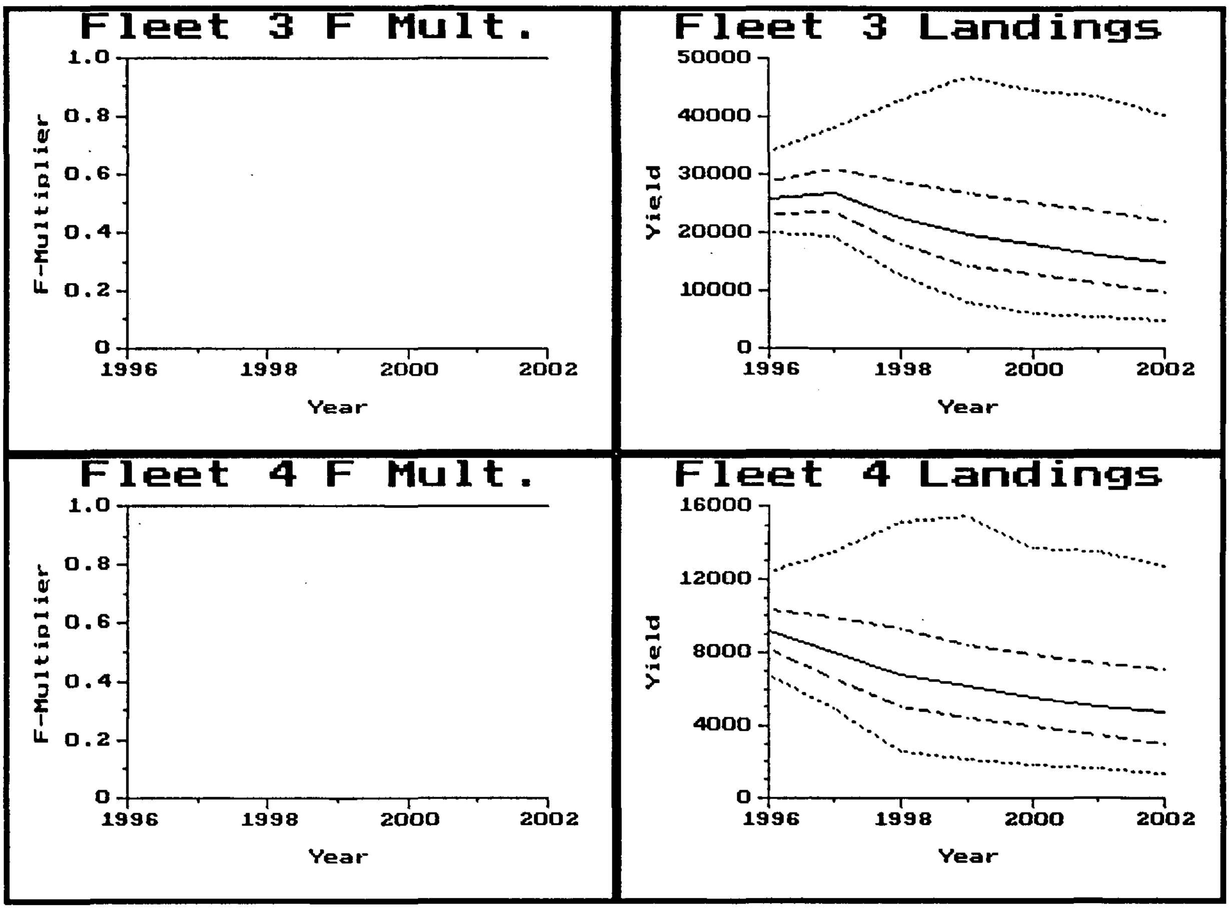

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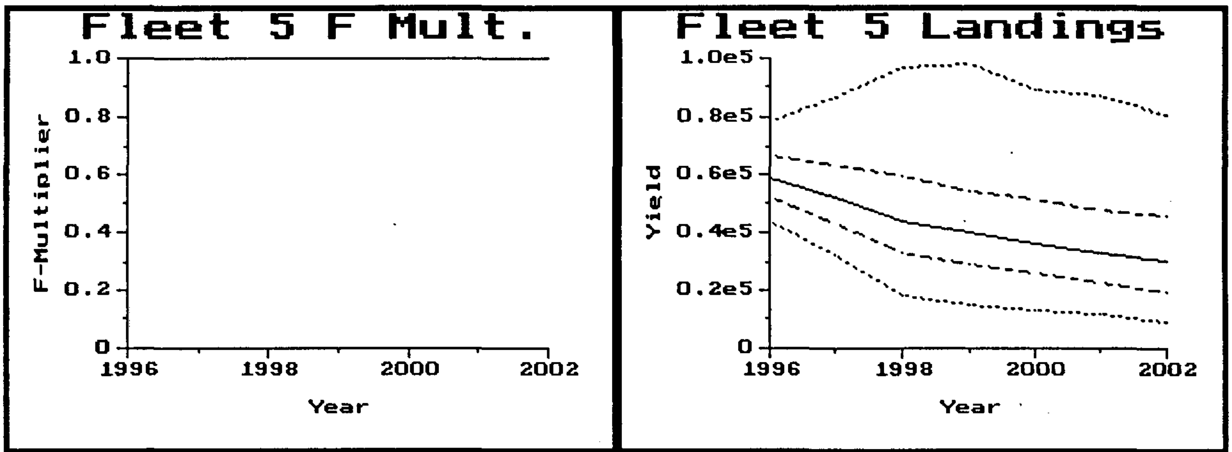

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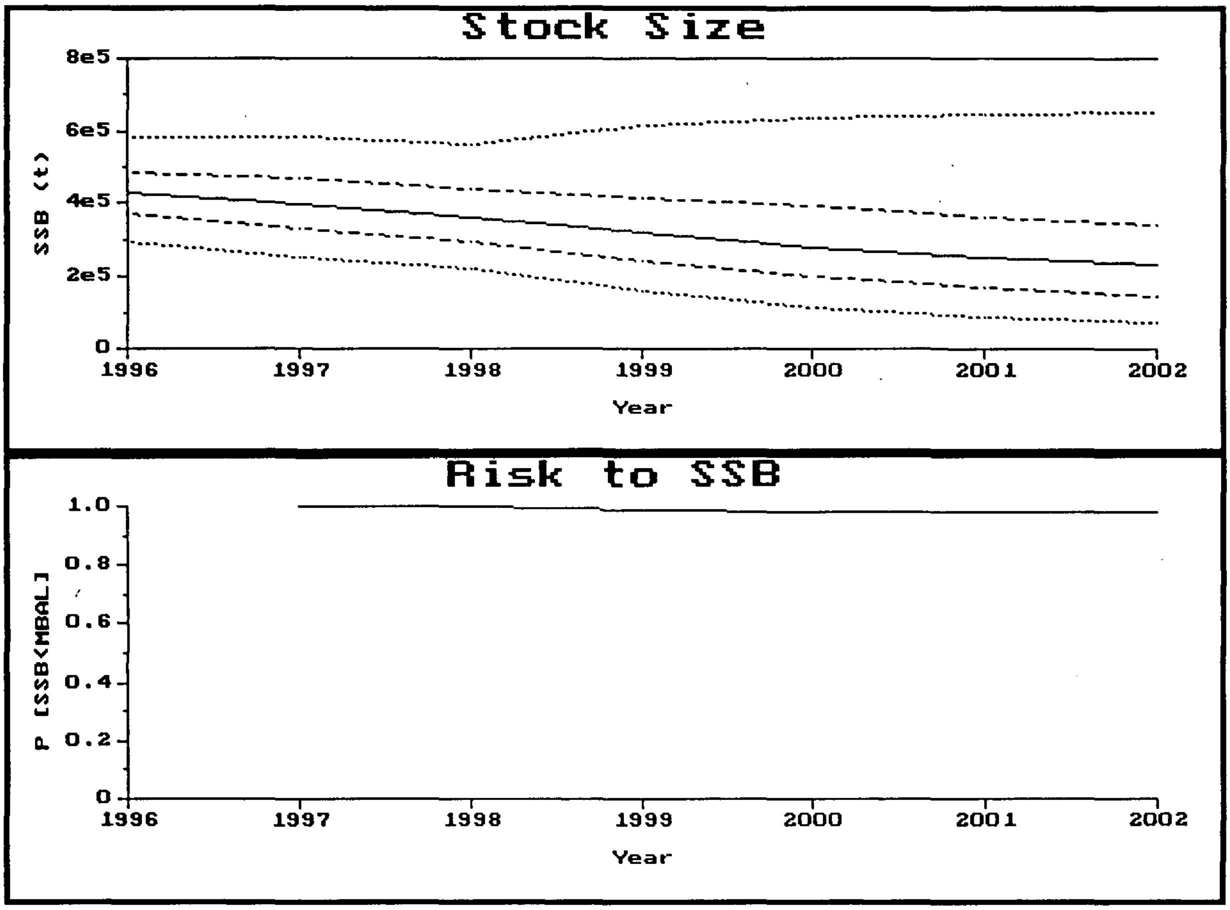
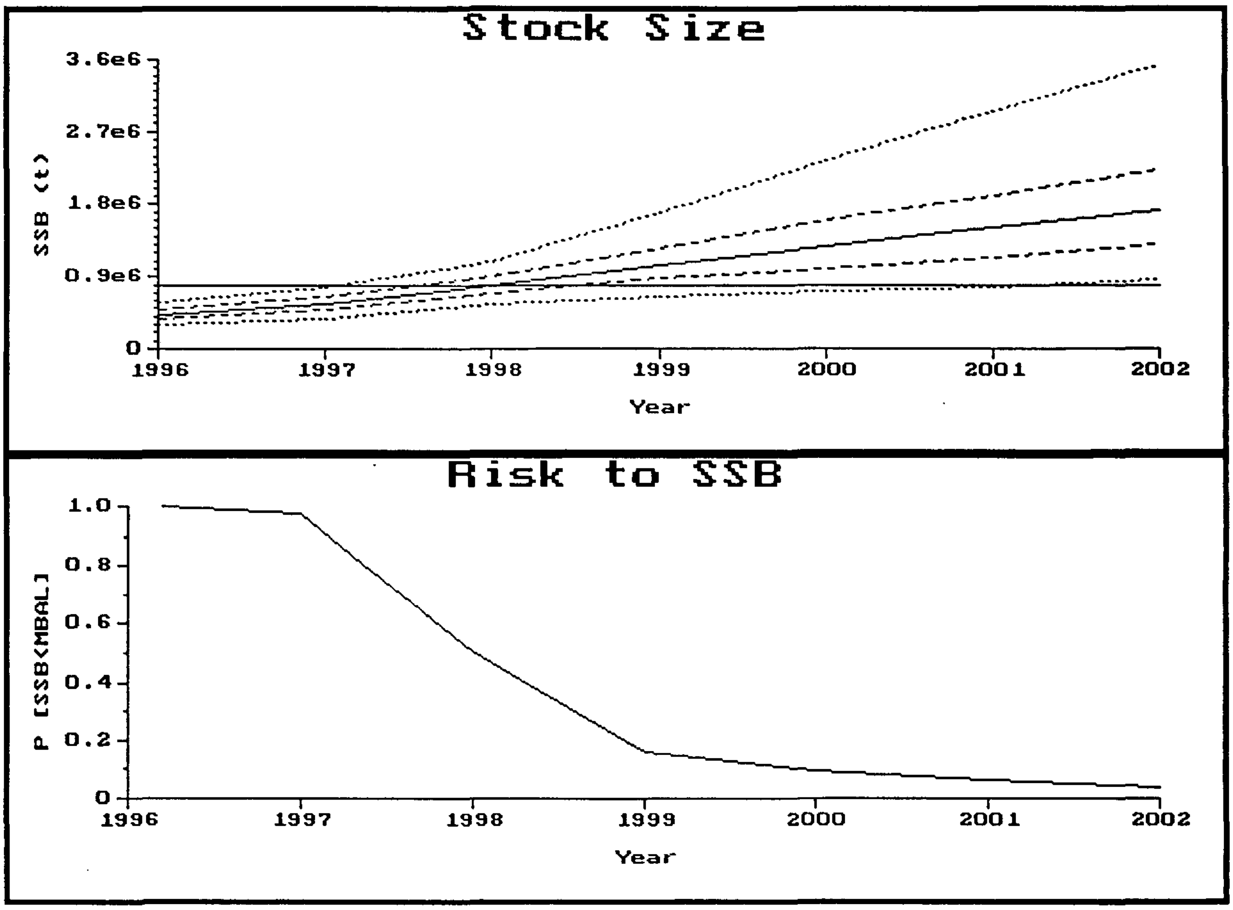


Figure 2.11.4 North Sea Herring. Medium-term projections assuming fishing at F=0.3 by the human consumption fleet in the North Sea (Fleet A), with zero fishing mortality by the other fleets Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality bt fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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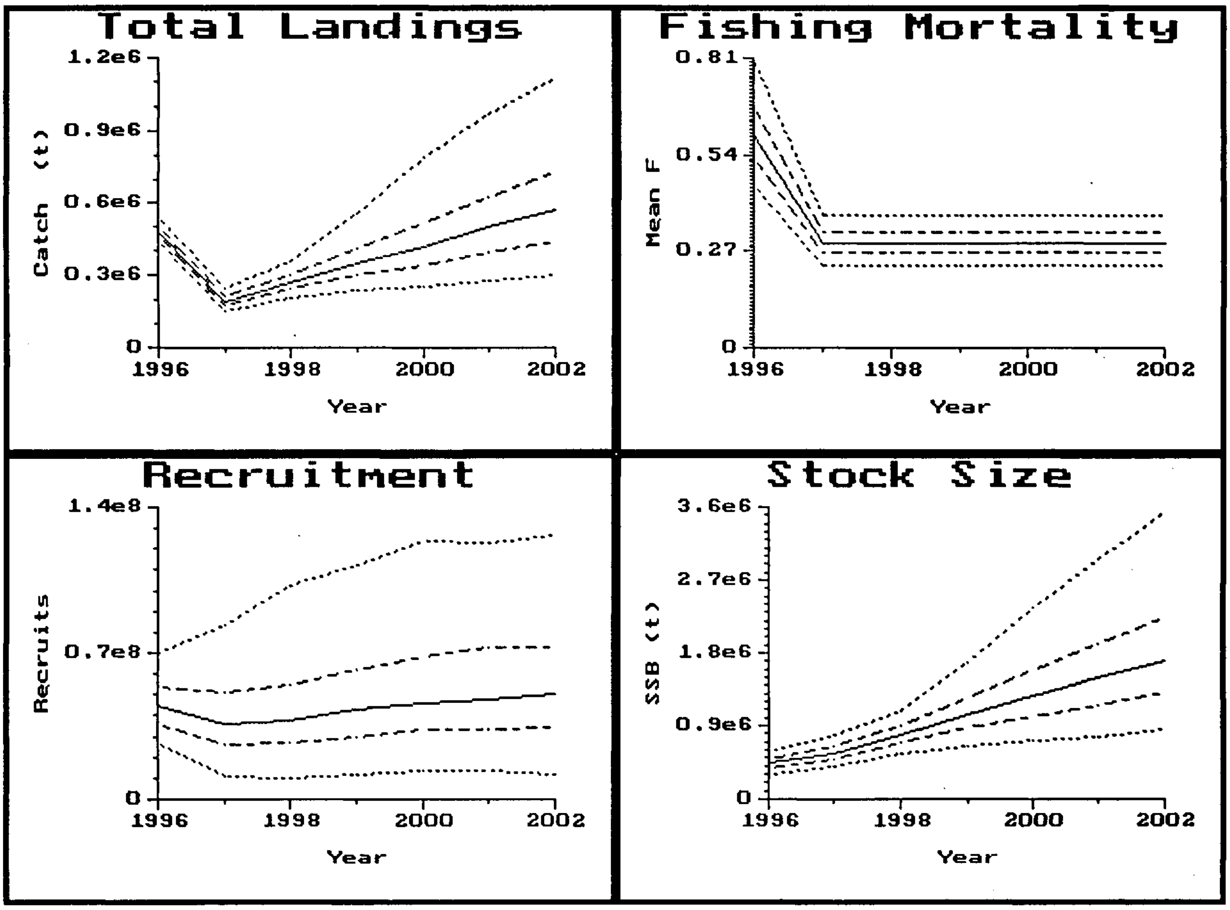

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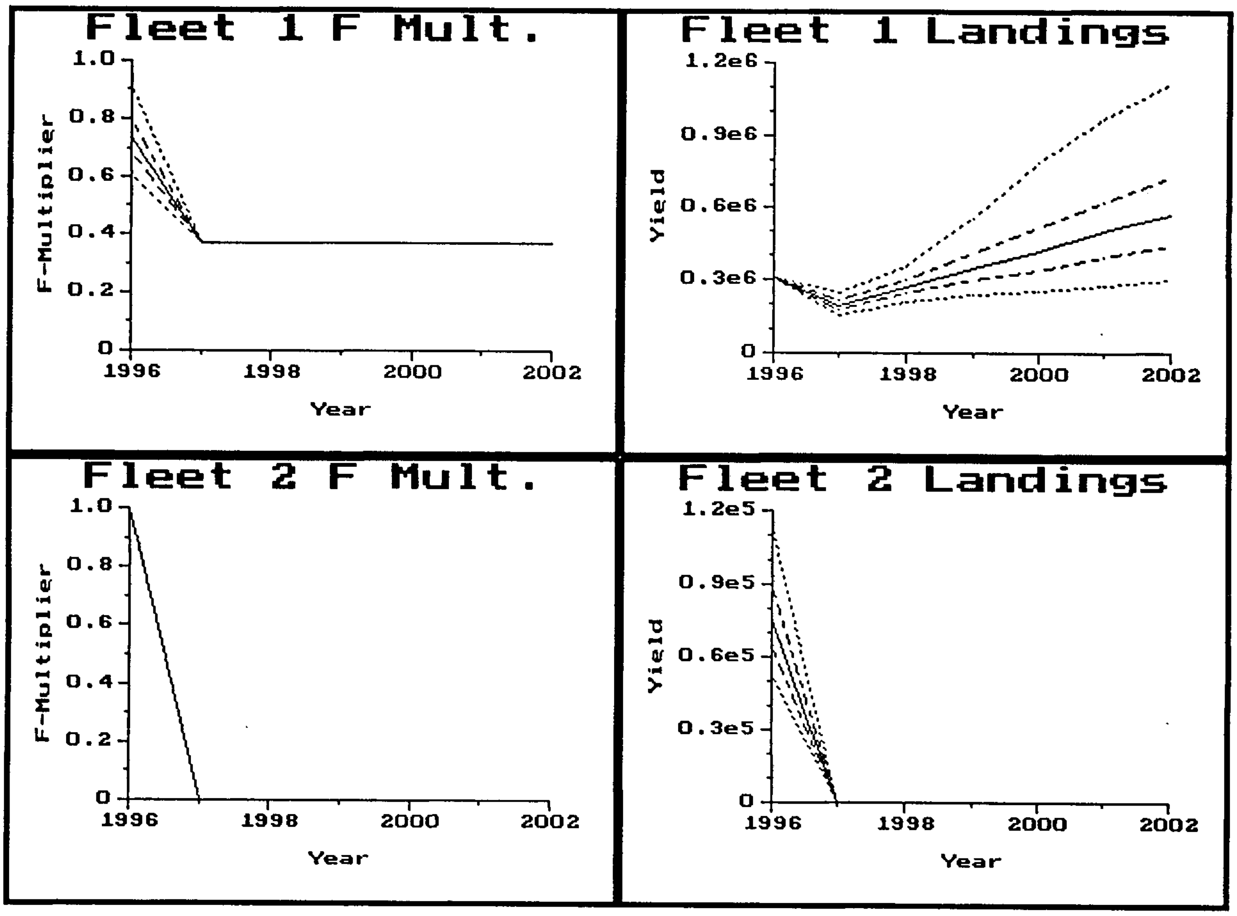

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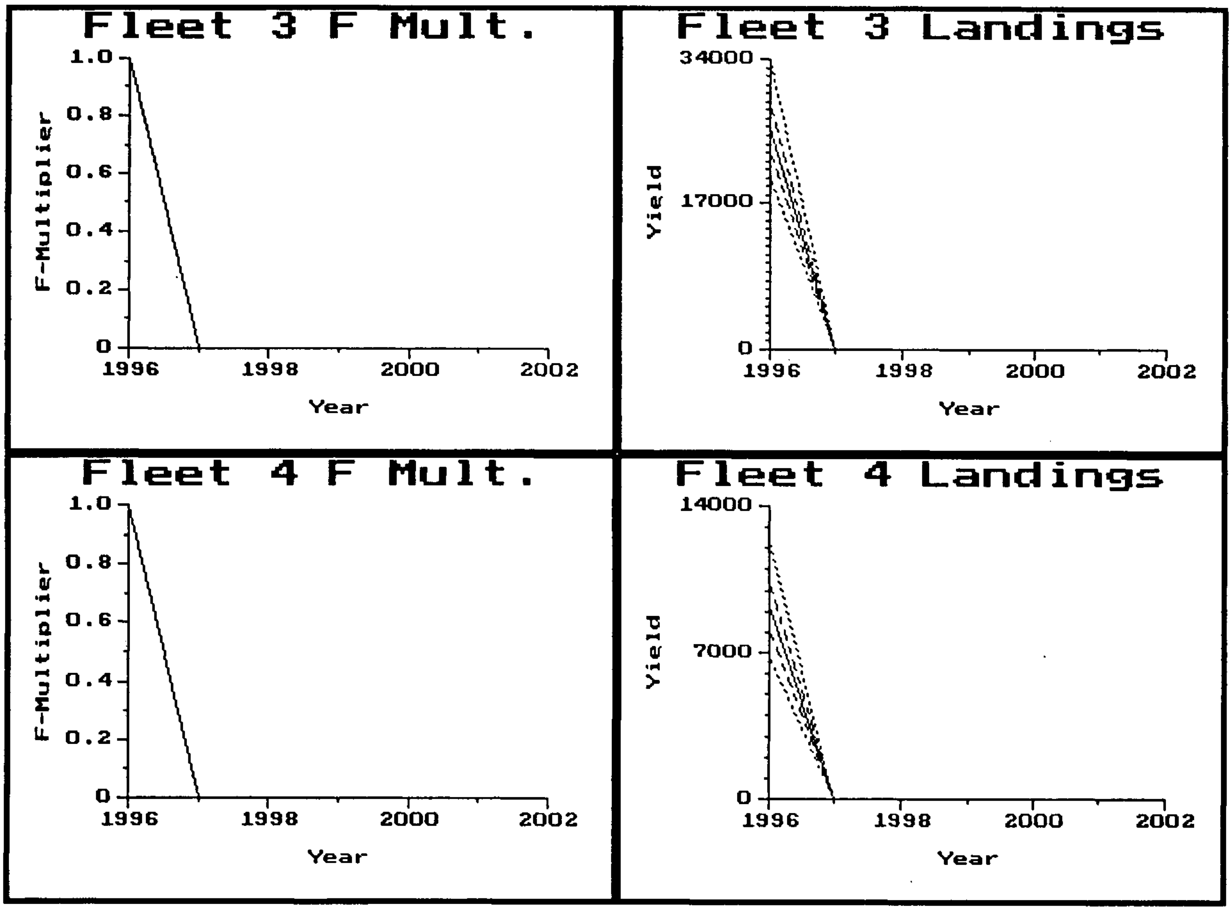

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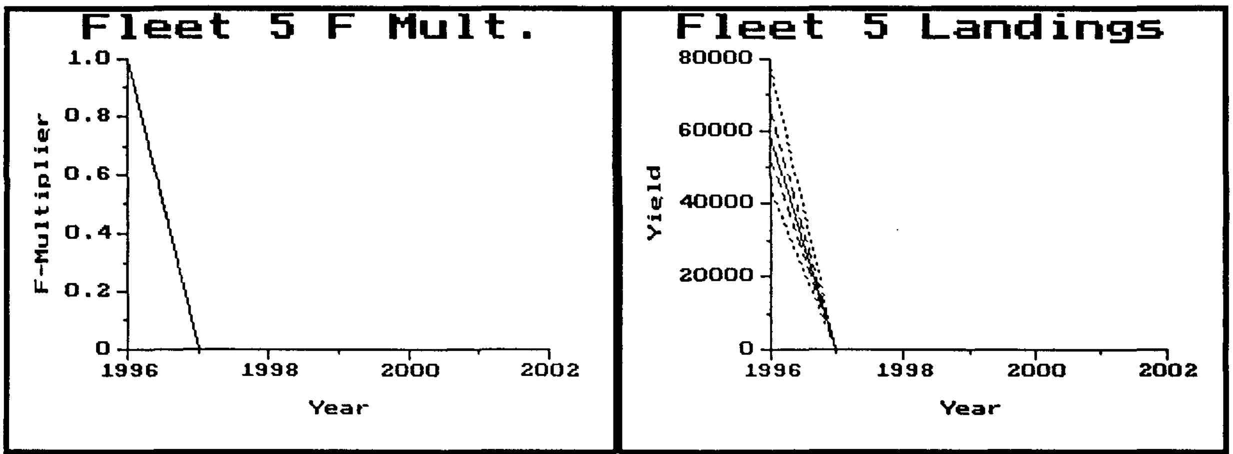
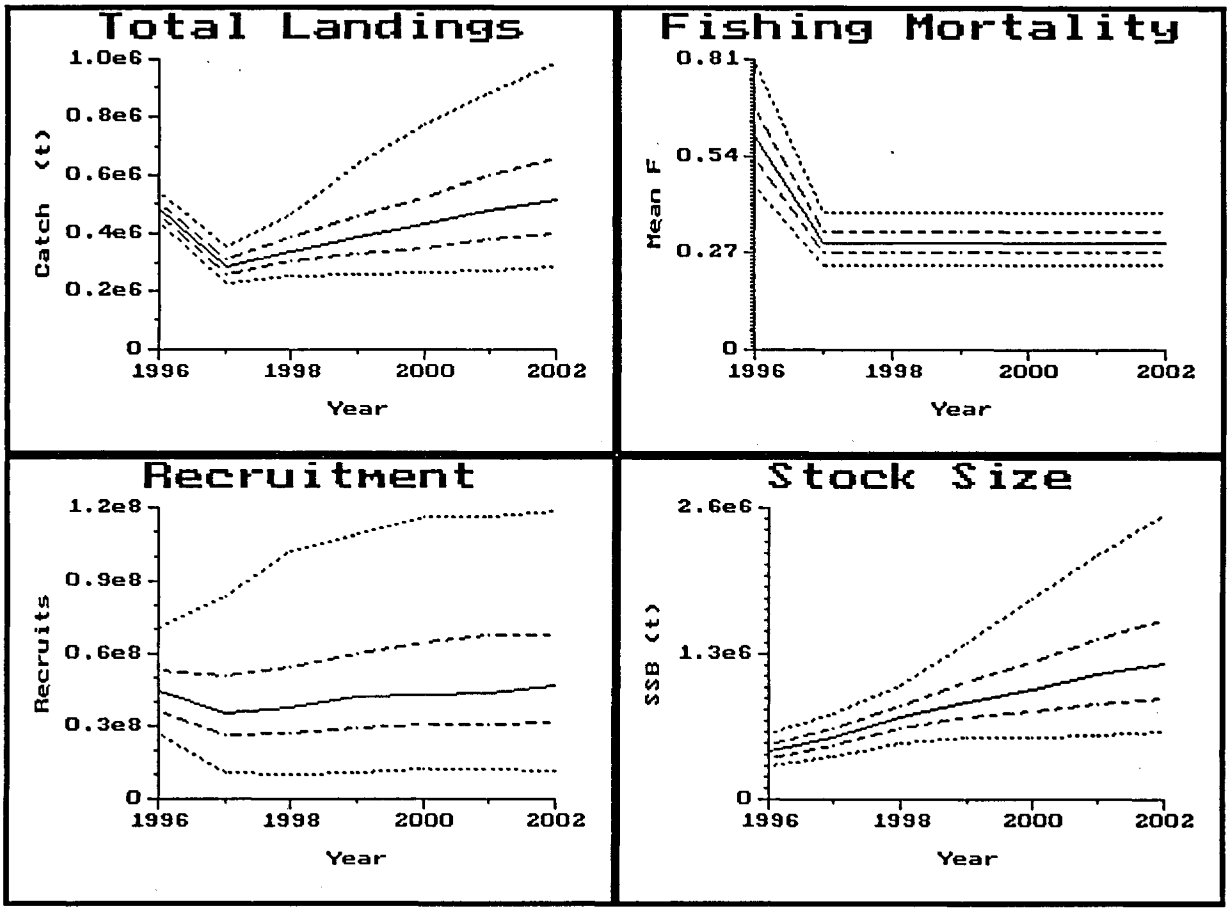


Figure 2.11.5 North Sea Herring. Medium-term projections assuming fishing at F=0.3 by the human consumption fleet in the North Sea (Fleet A), with an assumption of 50% reduction in fishing mortality by the other fleets, relative to 1995. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality bt fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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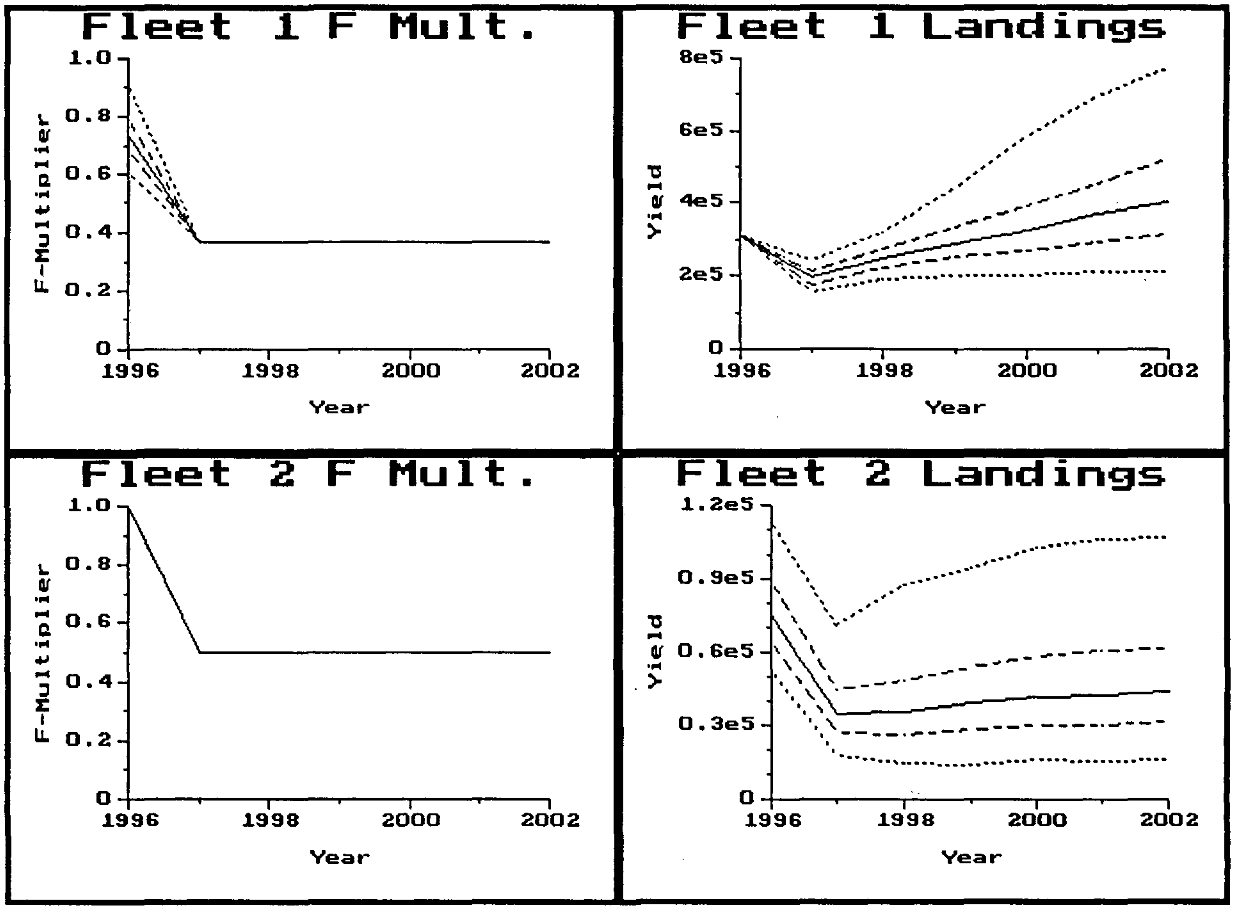

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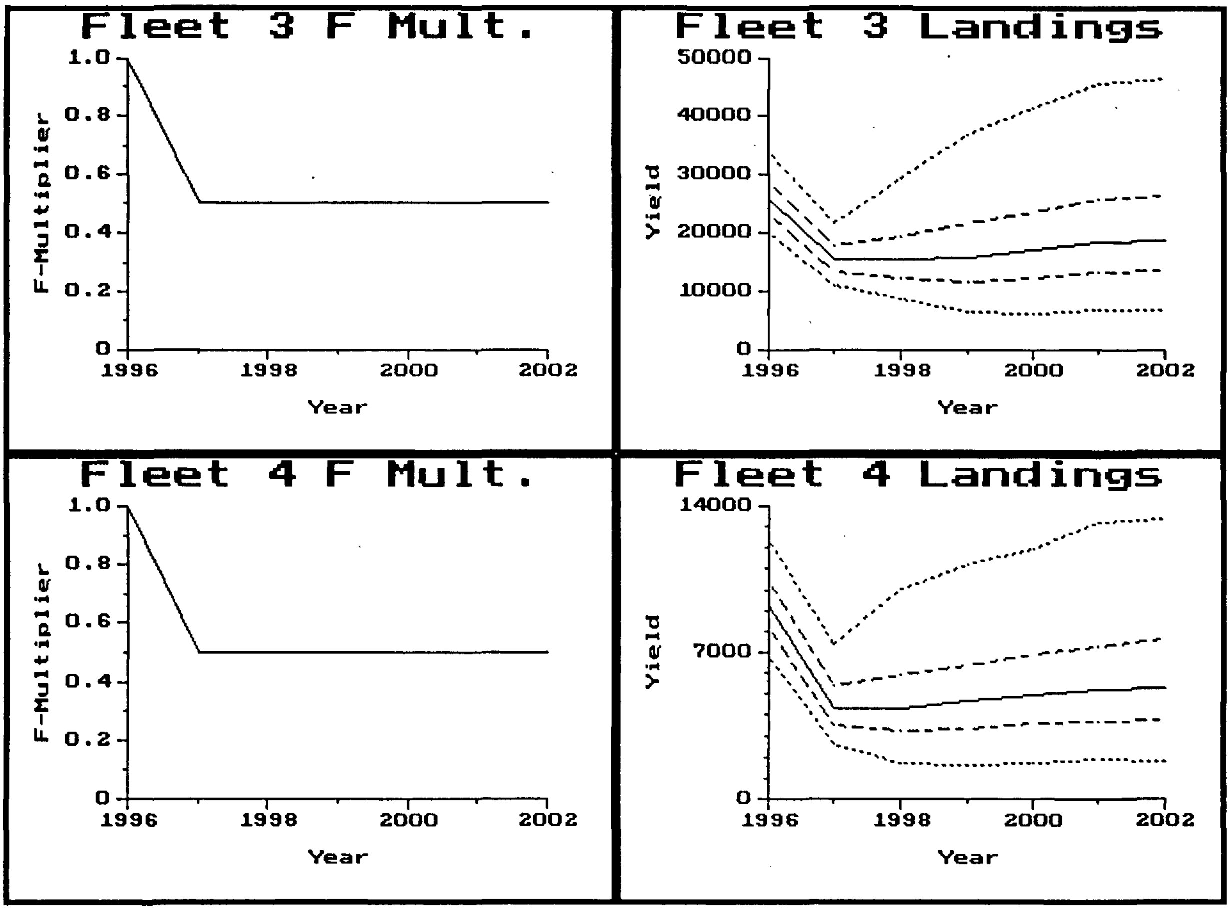

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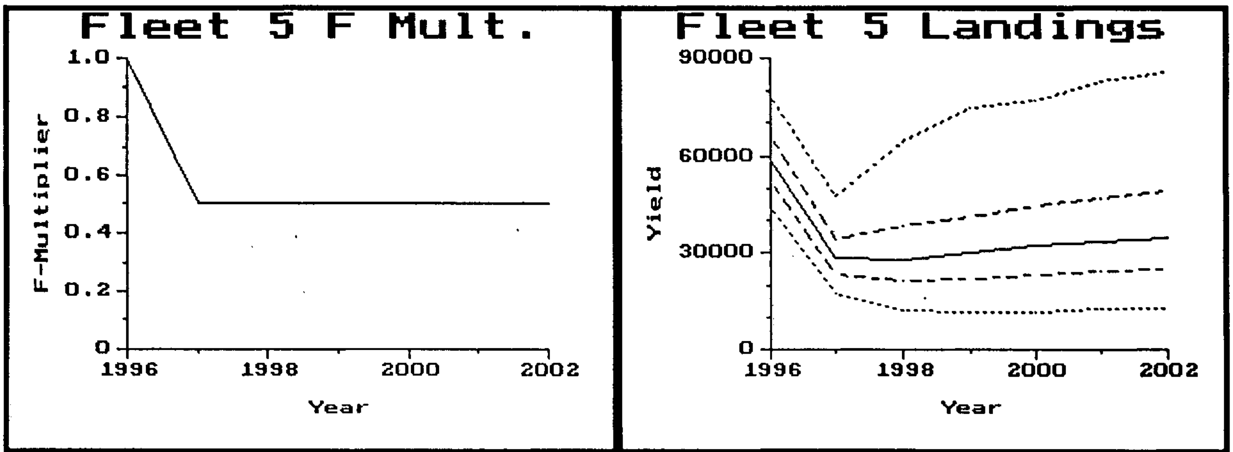

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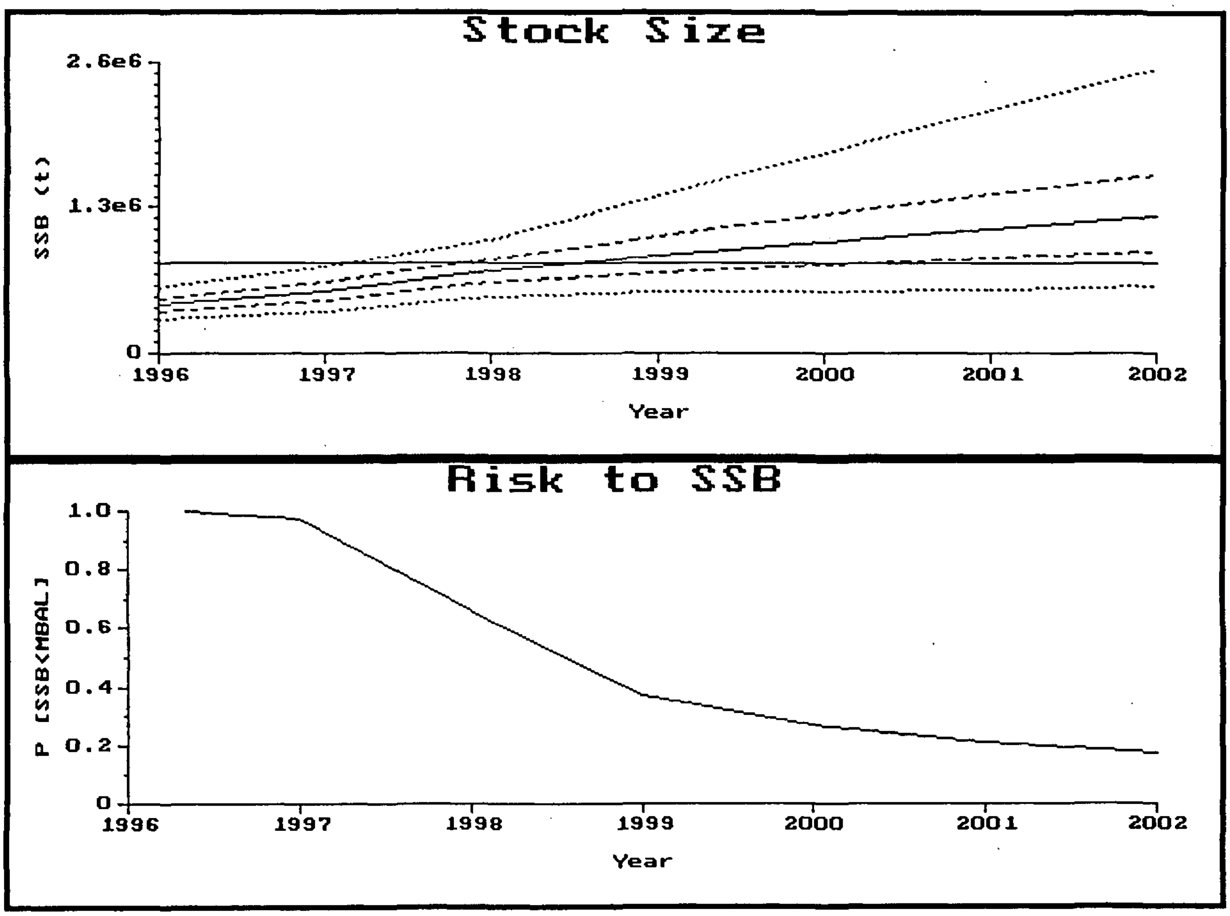
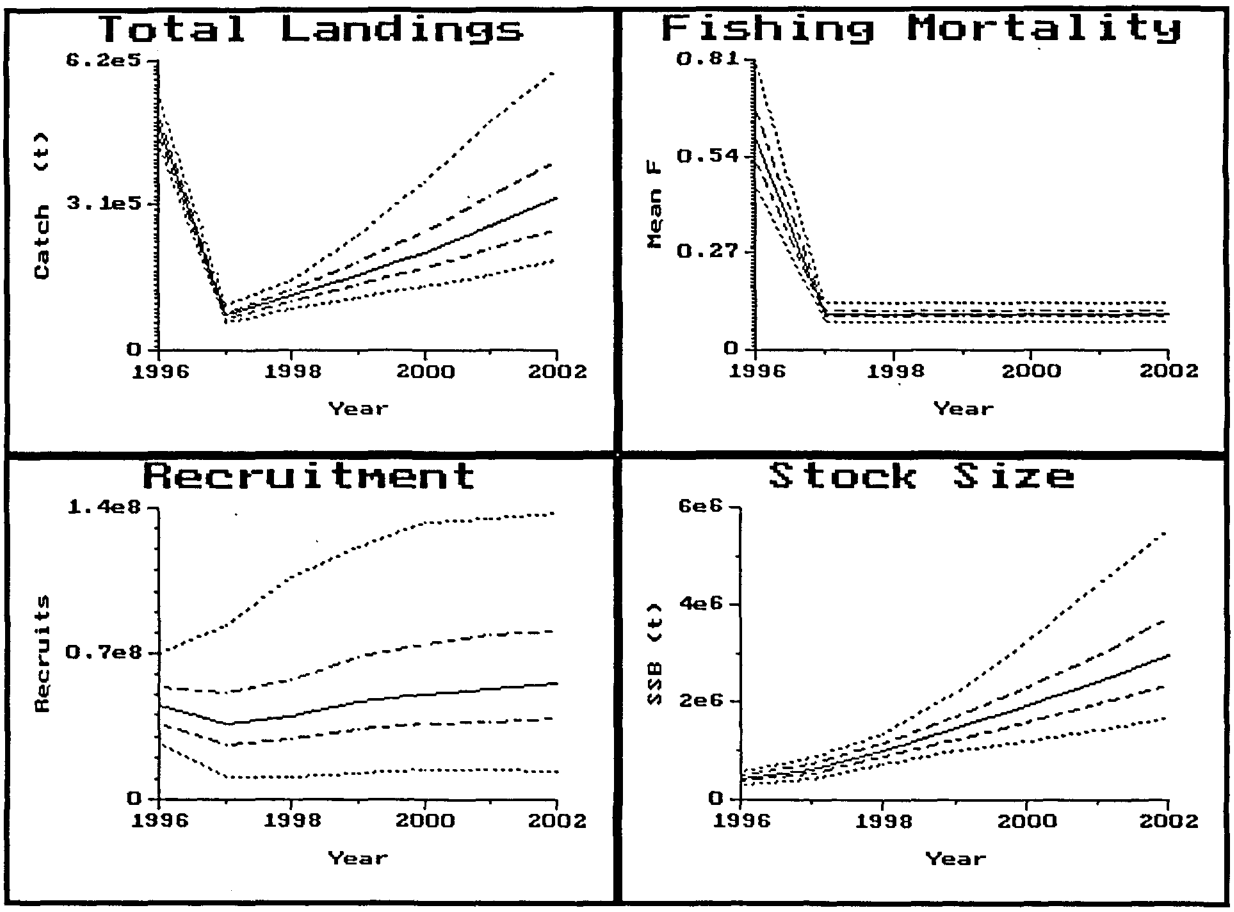


Figure 2.11.6 North Sea Herring. Medium-term projections assuming fishing at F=0.1 by the human consumption fleet in the North Sea (Fleet A), with an assumption of 50% reduction in fishing mortality by the other fleets, relative to 1995. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality bt fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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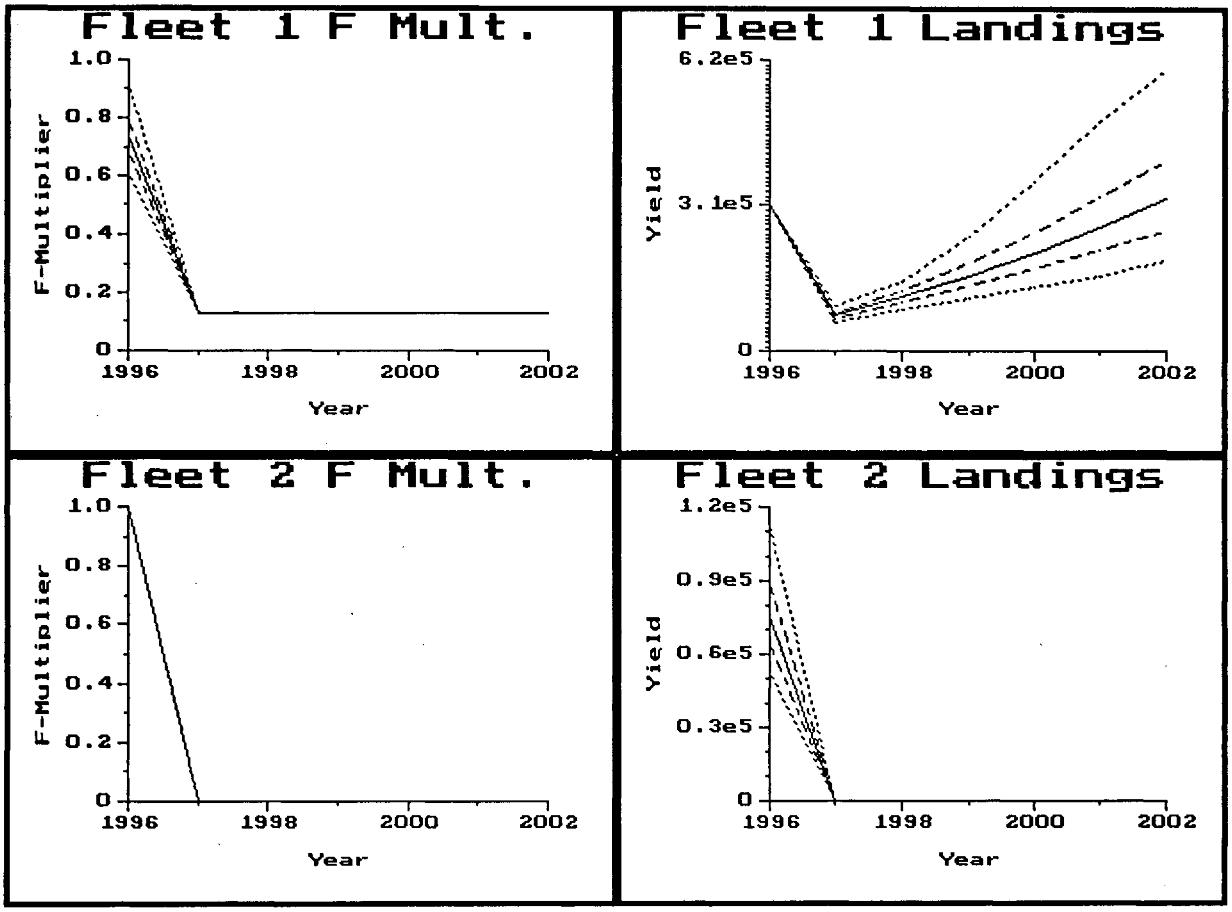

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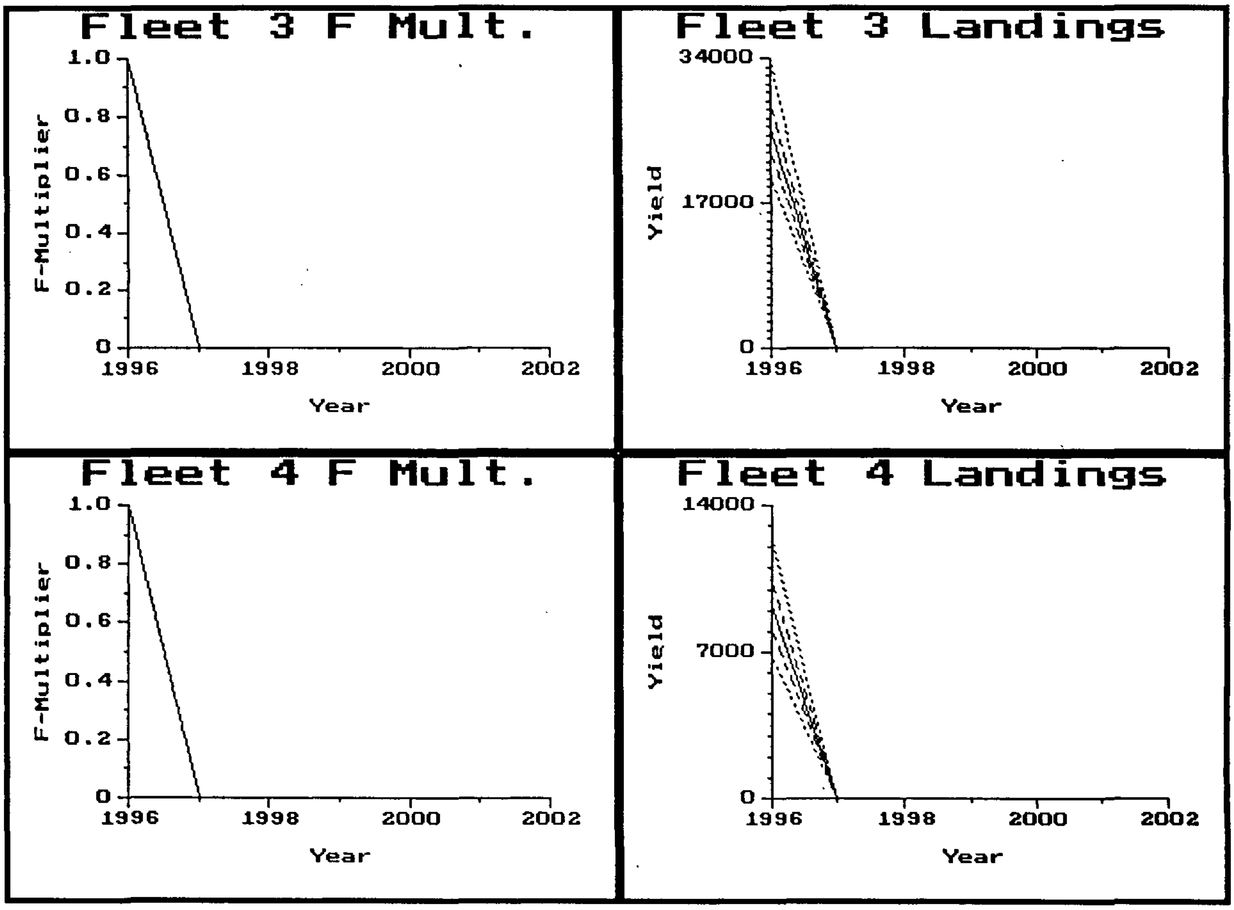

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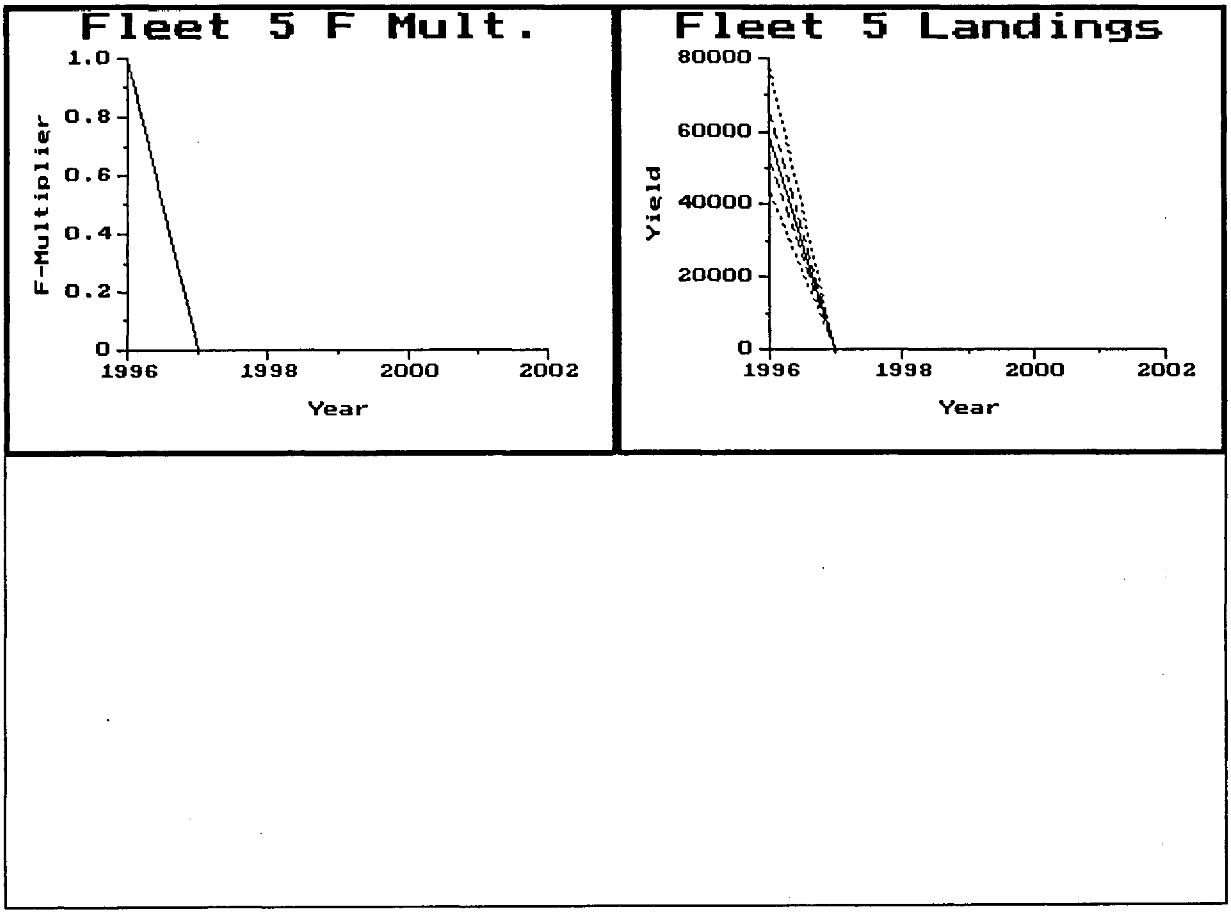

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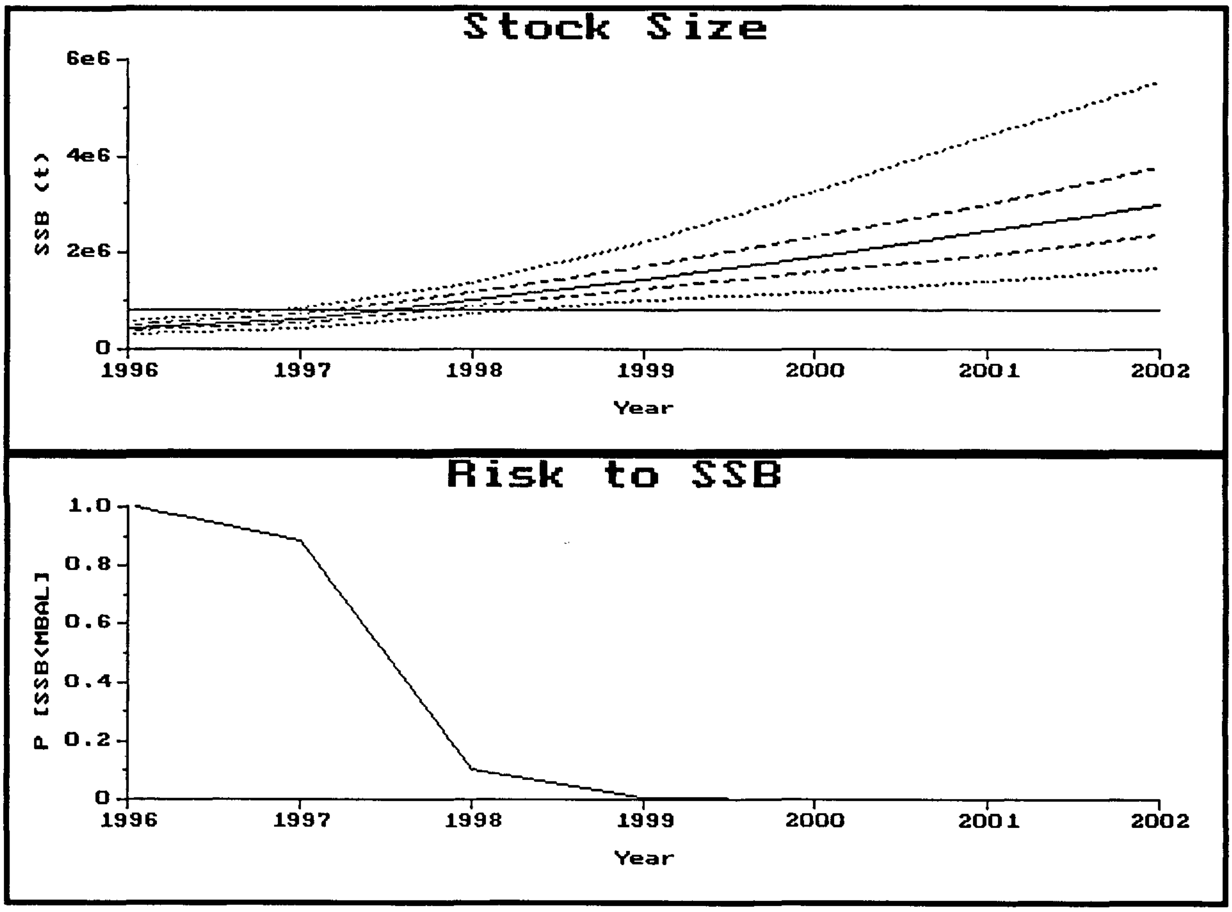
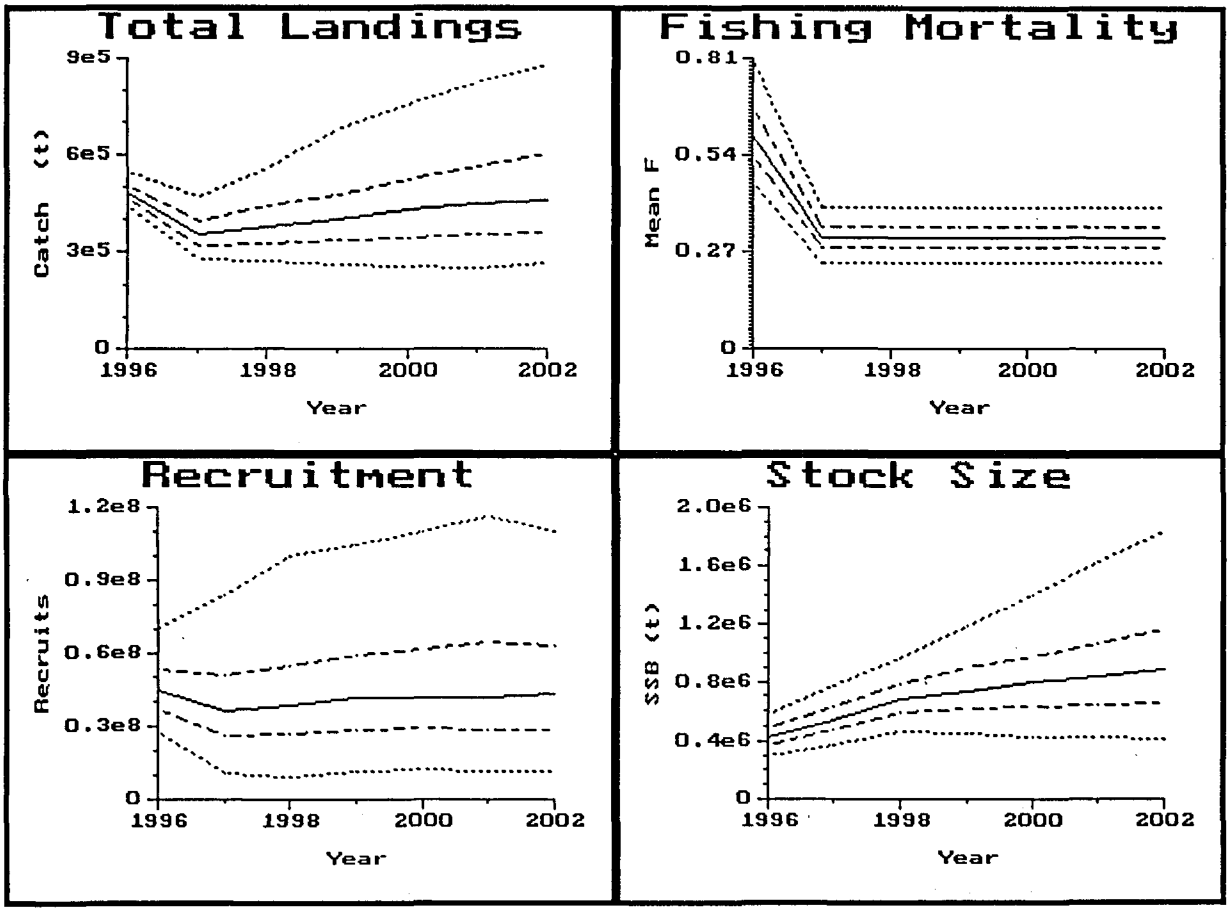


Figure 2.11.7 North Sea Herring. Medium-term projections assuming fishing at F=0.3 by the human consumption fleet in the North Sea (Fleet A), with an assumption *status quo* fishing mortality by the other fleets, relative to 1995. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles, fine line indicates the 50th. percentile. First panel, total landings, fishing mortality (Mean from ages 2 to 6), recruitment at age 0, and spawning stock size at spawning time. Second, third and fourth panels, partial fishing mortality bt fleet relative to the partial fishing mortality estimated for that fleet in 1995. Fifth panel, trajectory of spawning stock size, and the corresponding estimates of risk that the spawning stock may fall below 800 000t.



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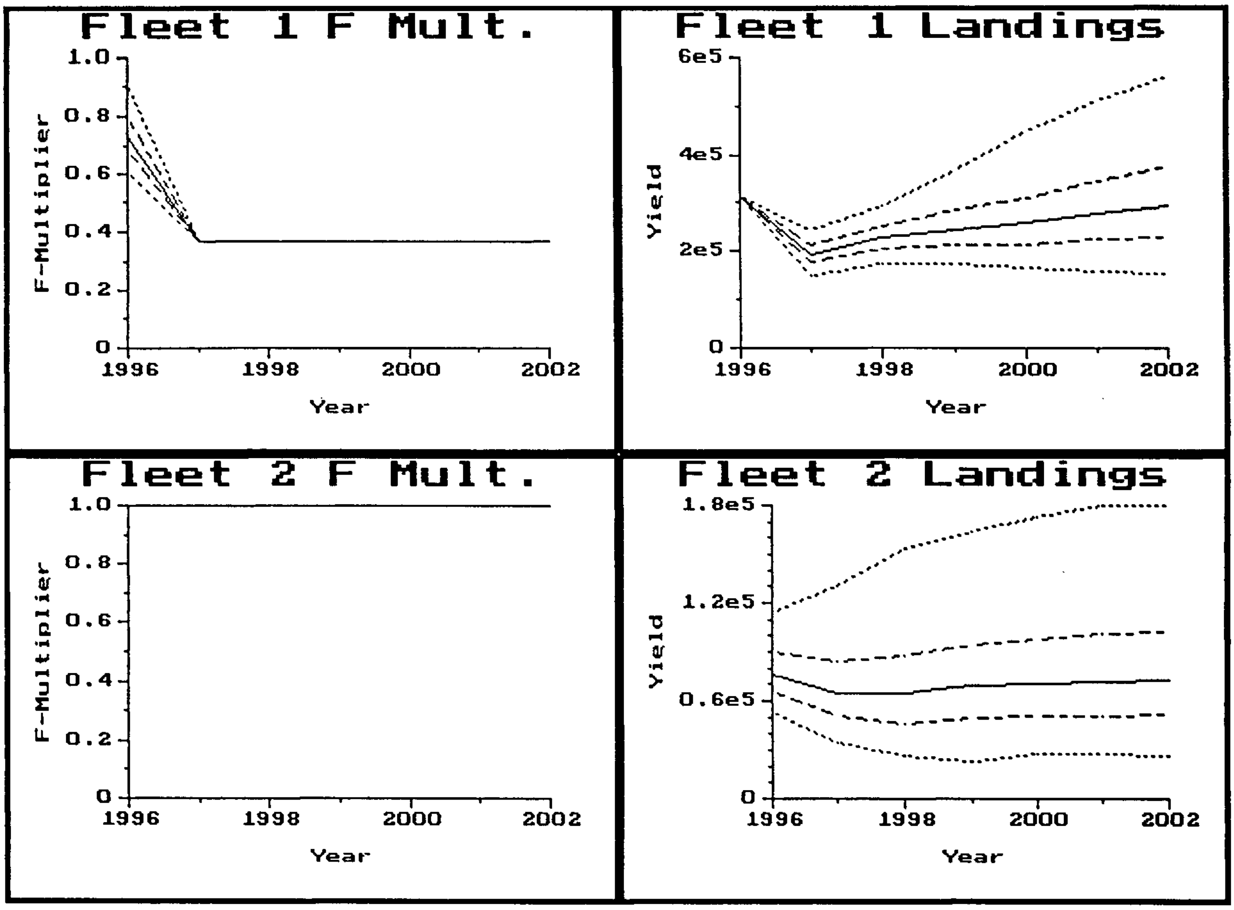

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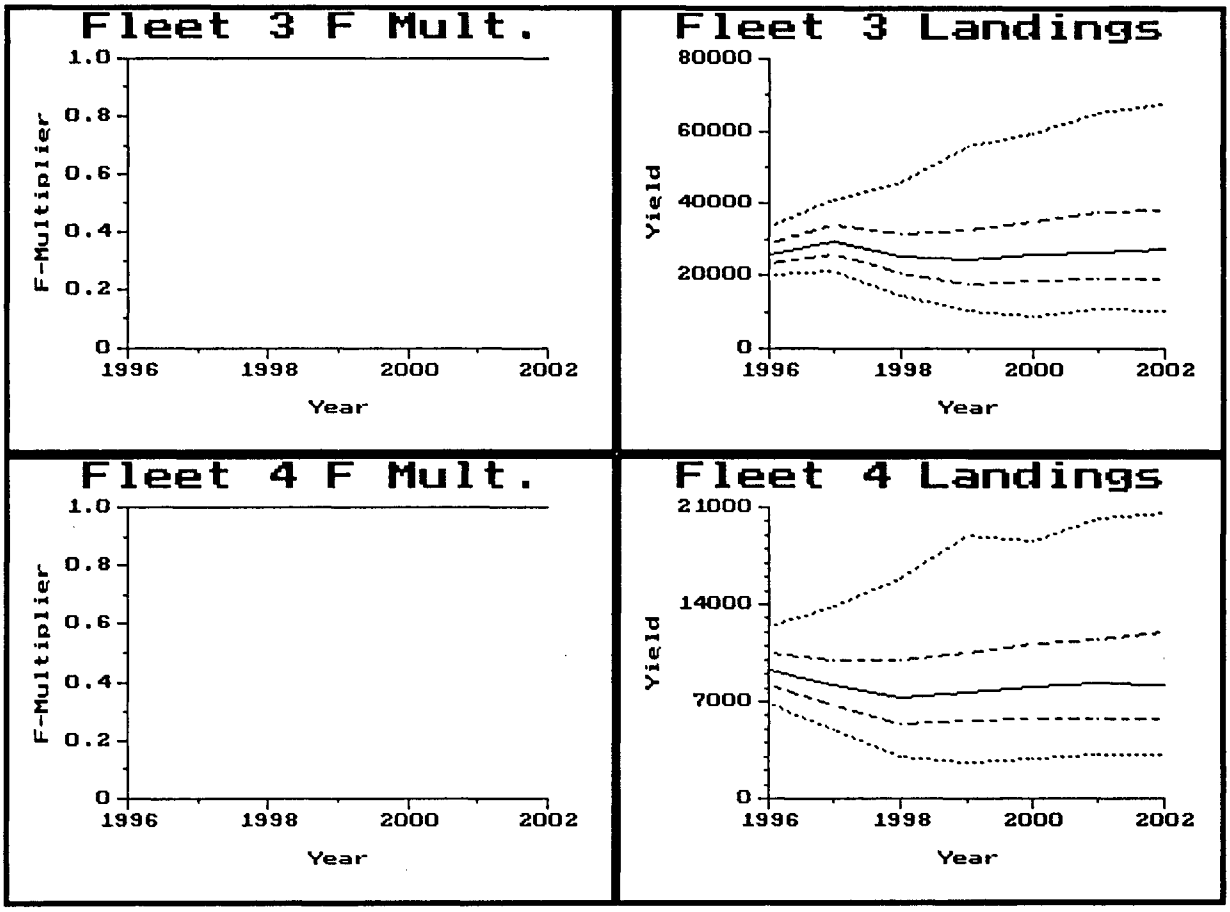

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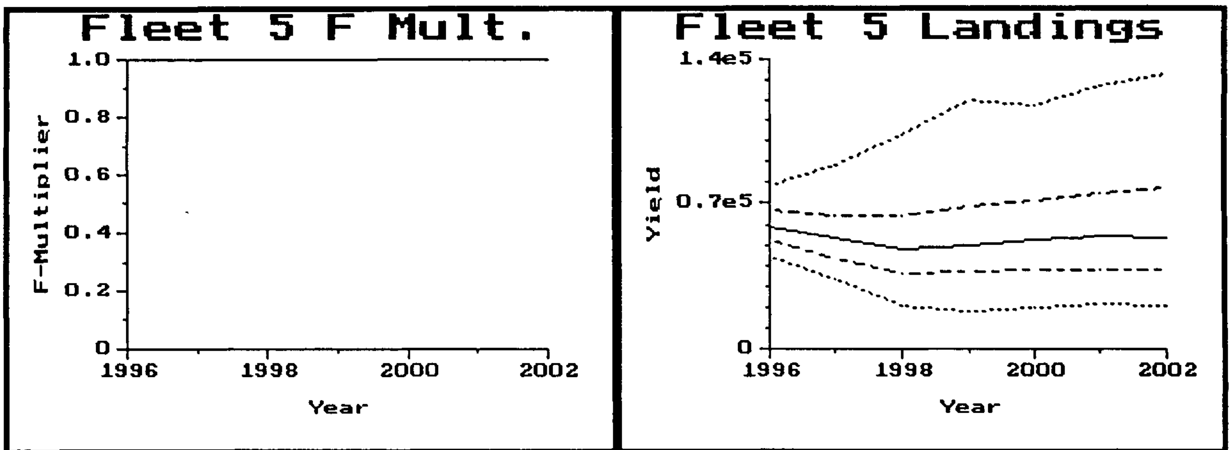

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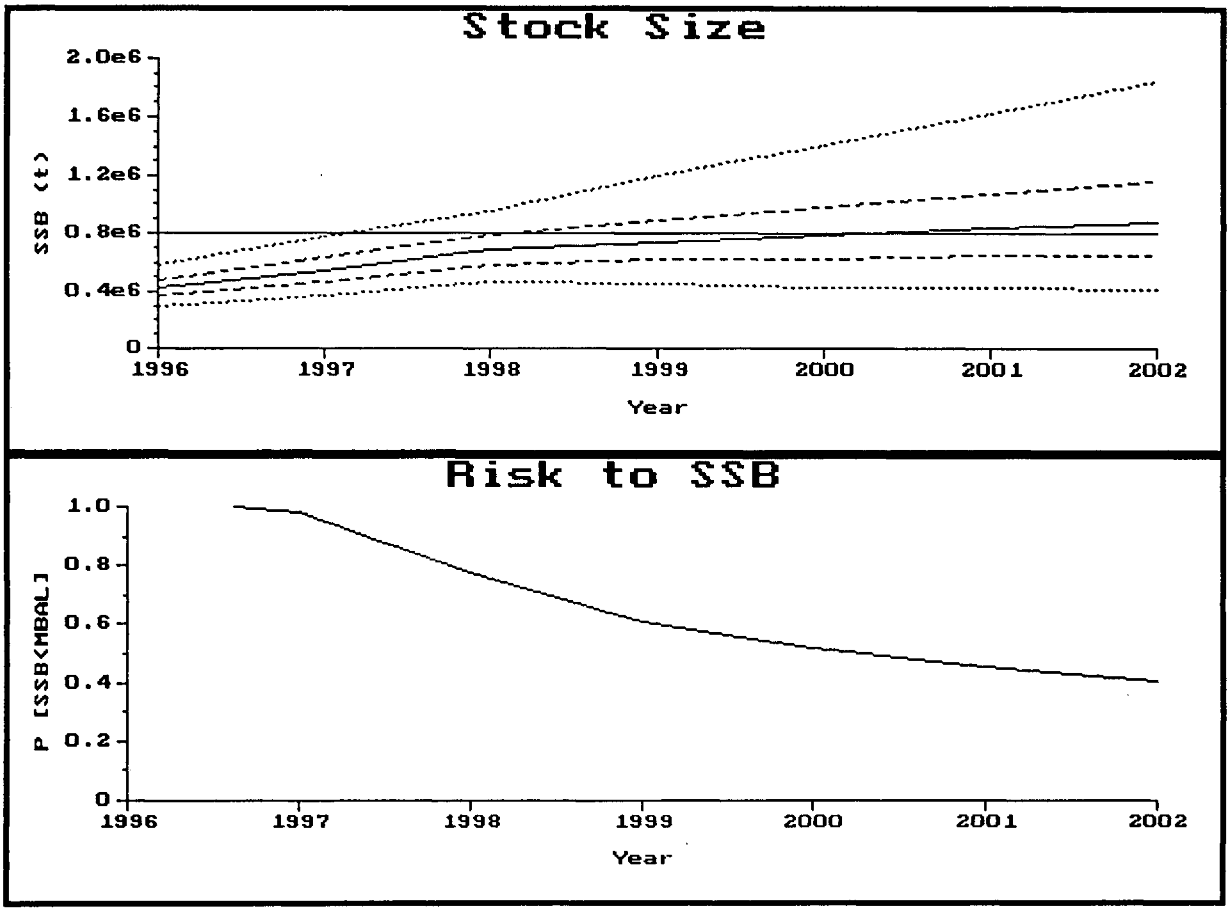


Figure 2.13.1 : Herring North Sea catches (tonnes). January 1995

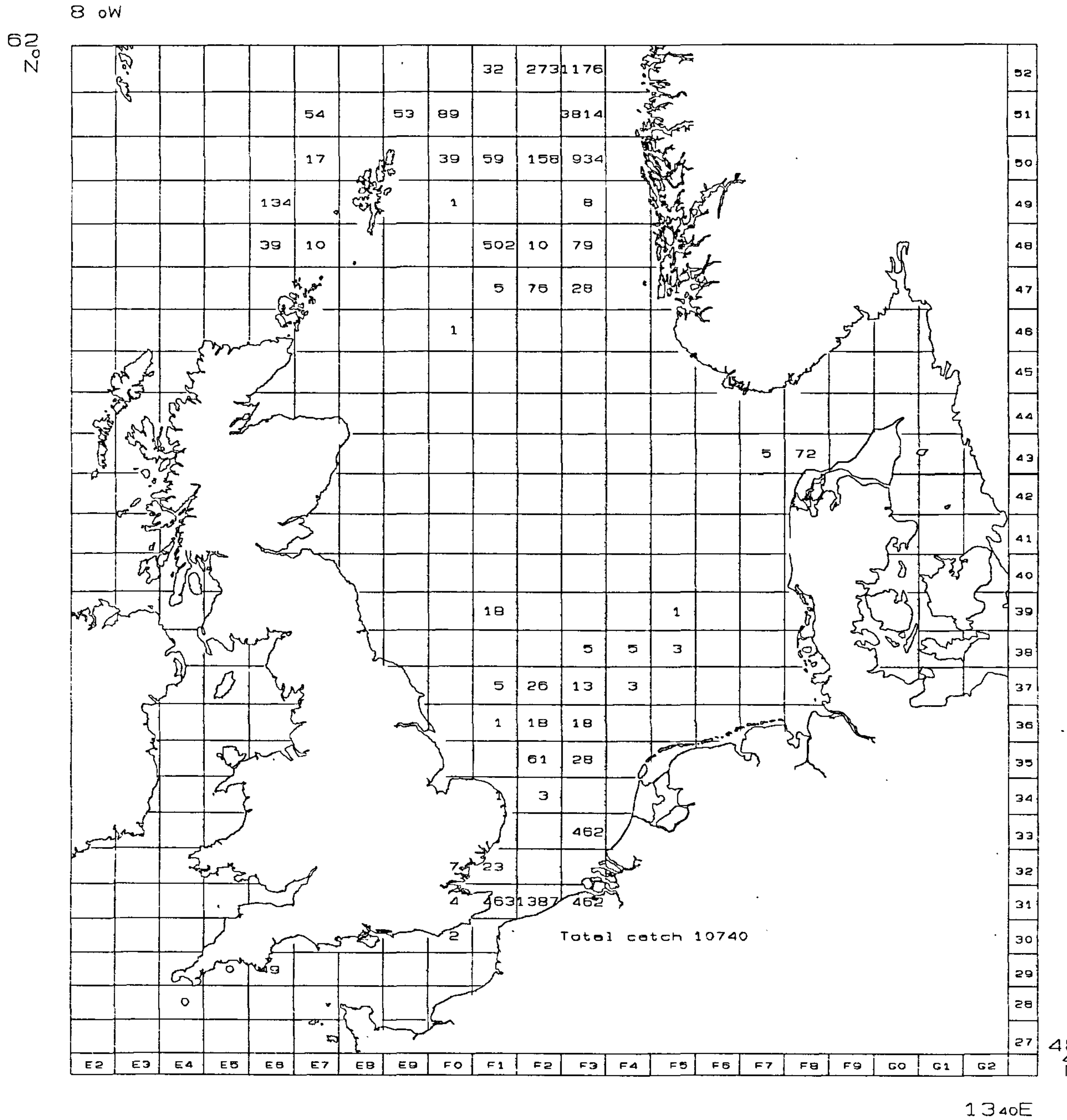


Figure 2.13.2 : Herring North Sea catches (tonnes). February 1995

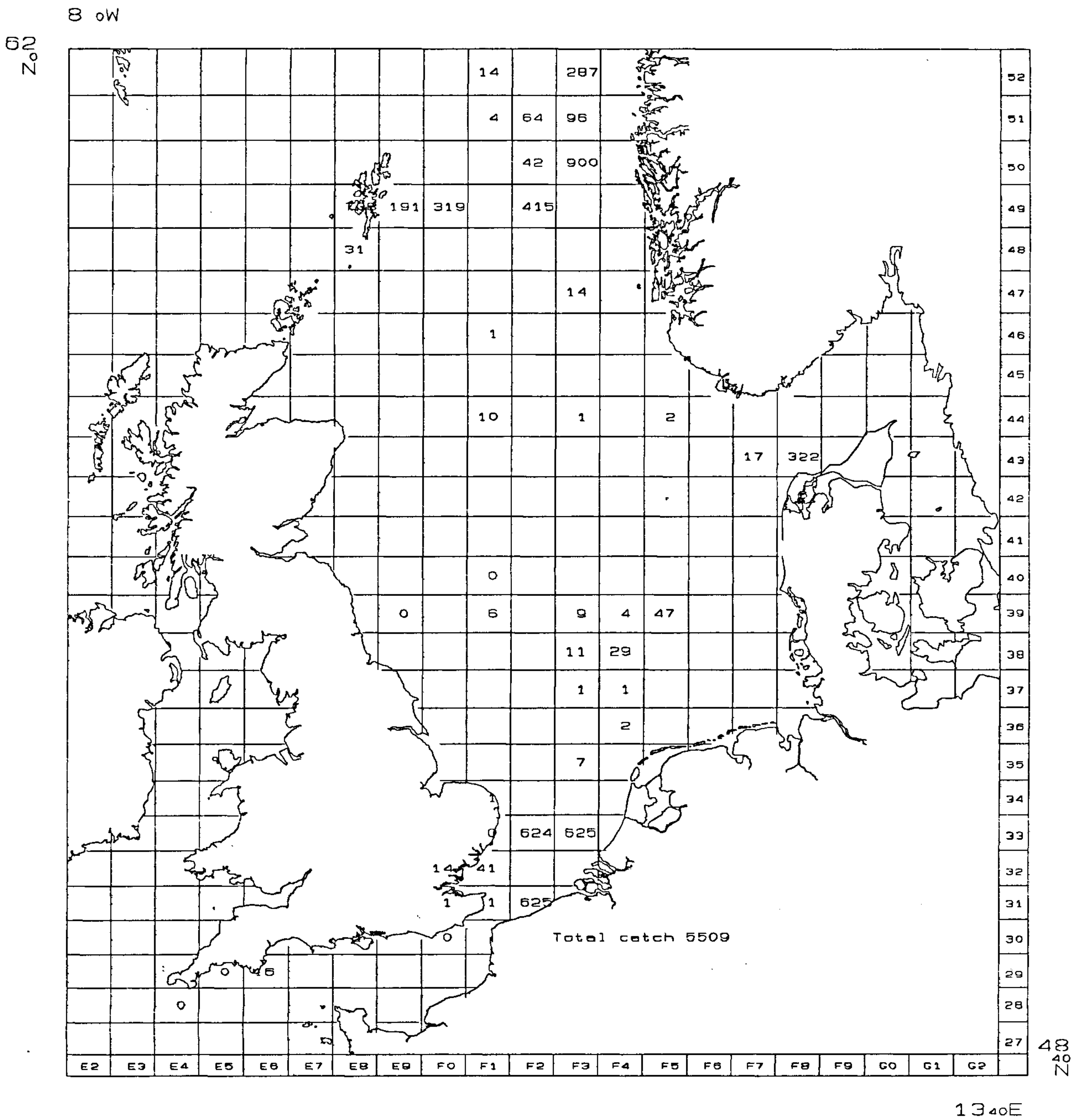


Figure 2.13.3 : Herring North Sea catches (tonnes). March 1995

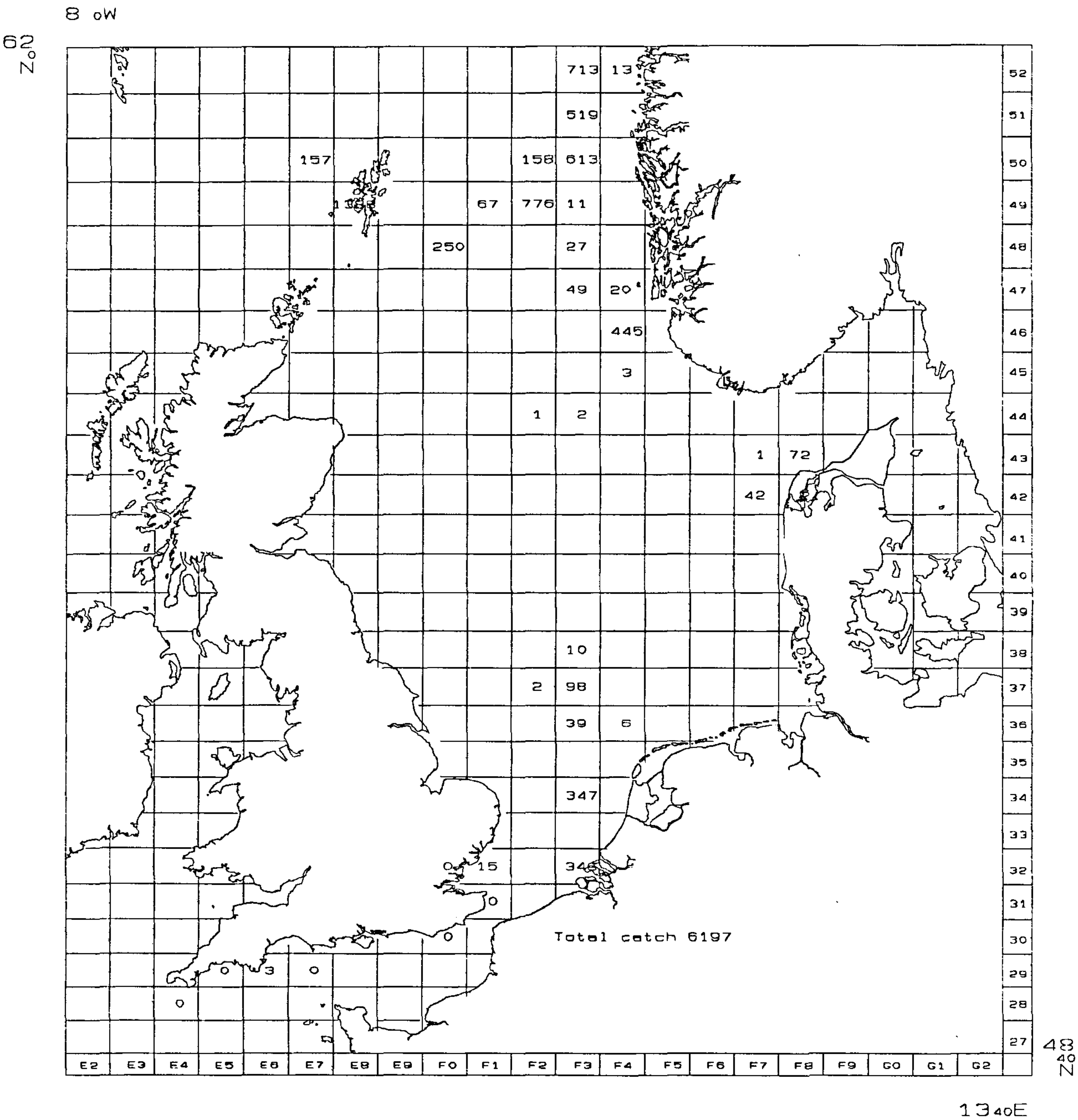


Figure 2.13.4 : Herring North Sea catches (tonnes). April 1995

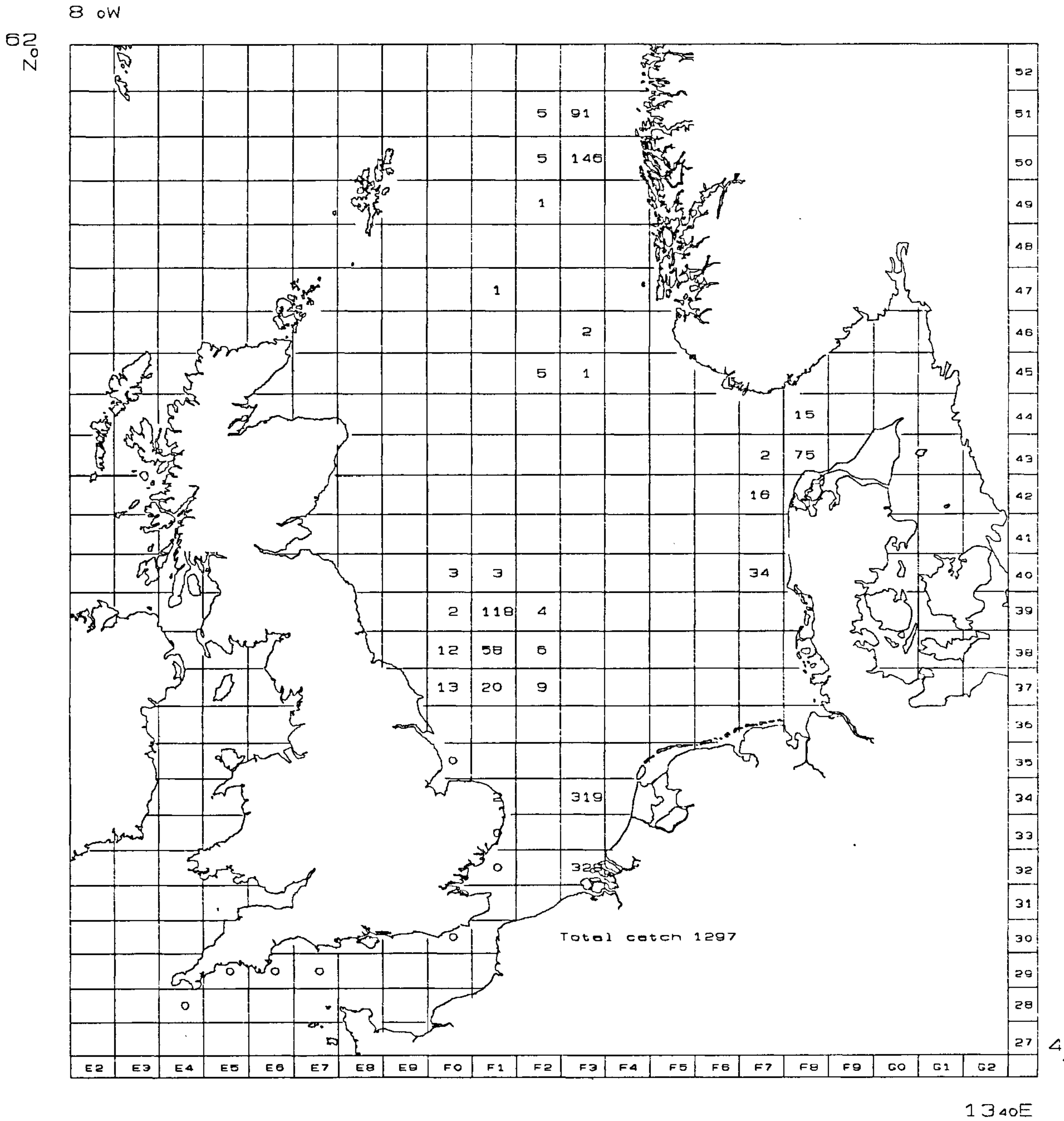


Figure 2.13.5 : Herring North Sea catches (tonnes). May 1995

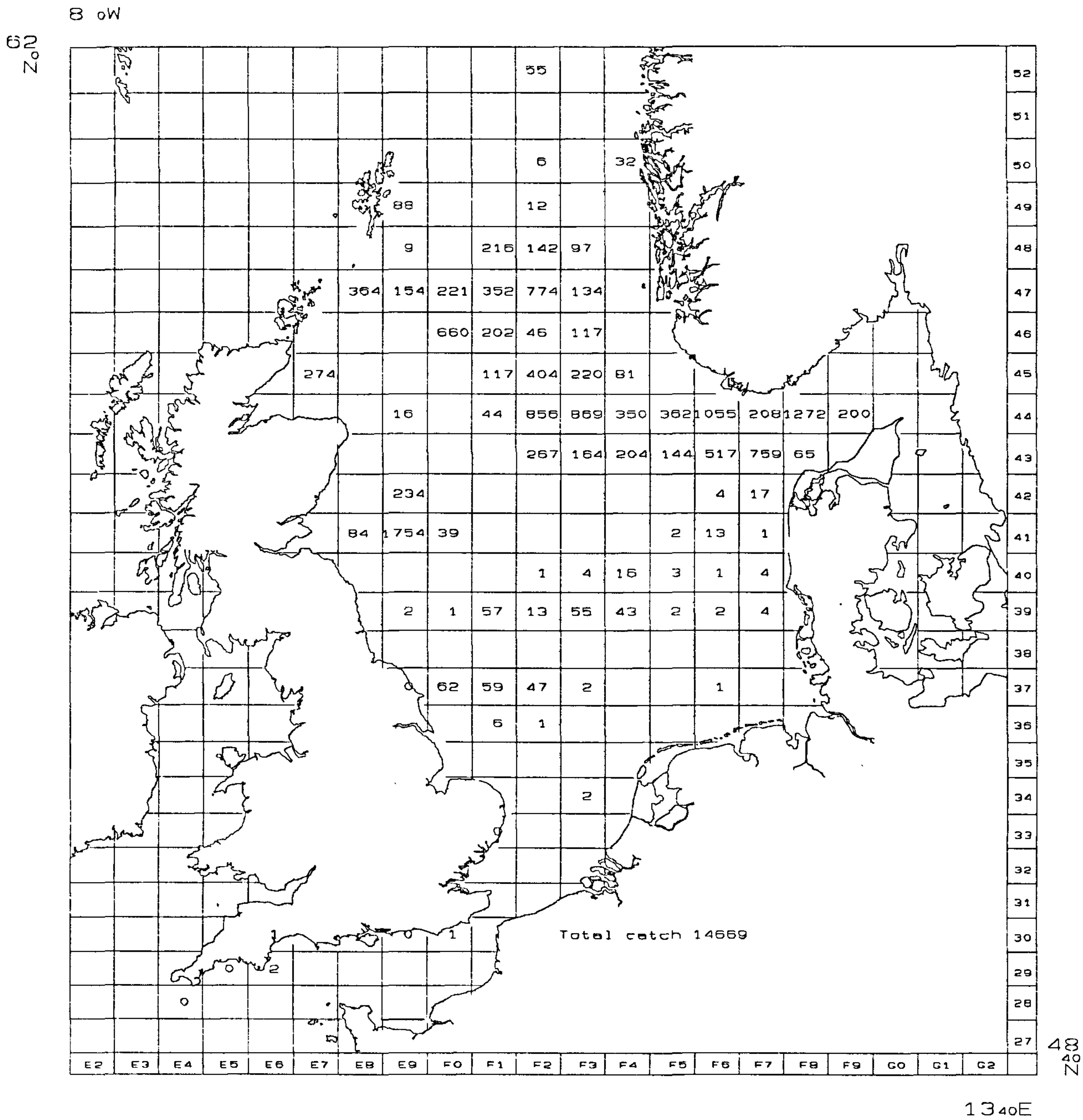


Figure 2.13.6 : Herring North Sea catches (tonnes). June 1995

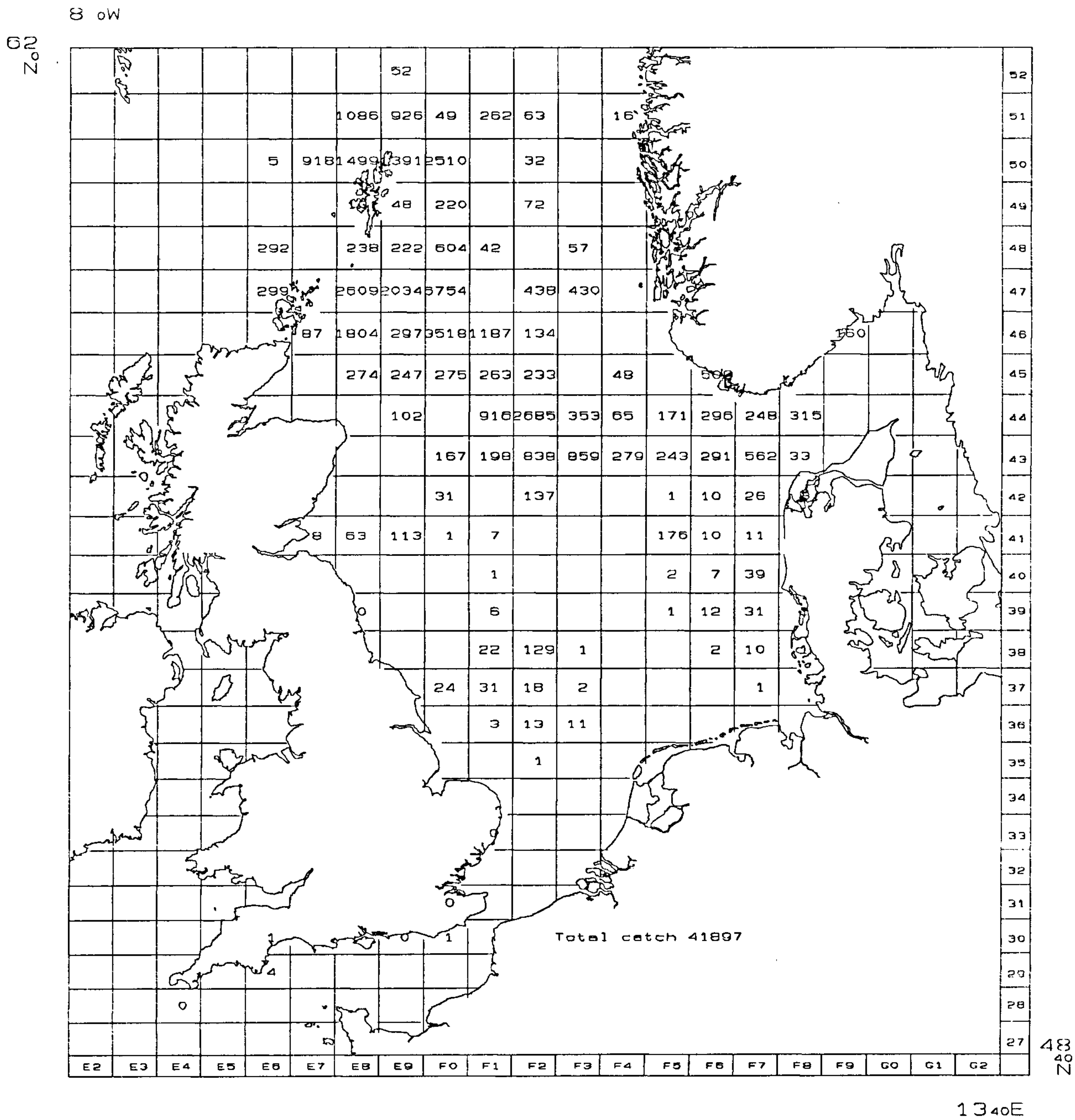


Figure 2.13.7 : Herring North Sea catches (tonnes). July 1995

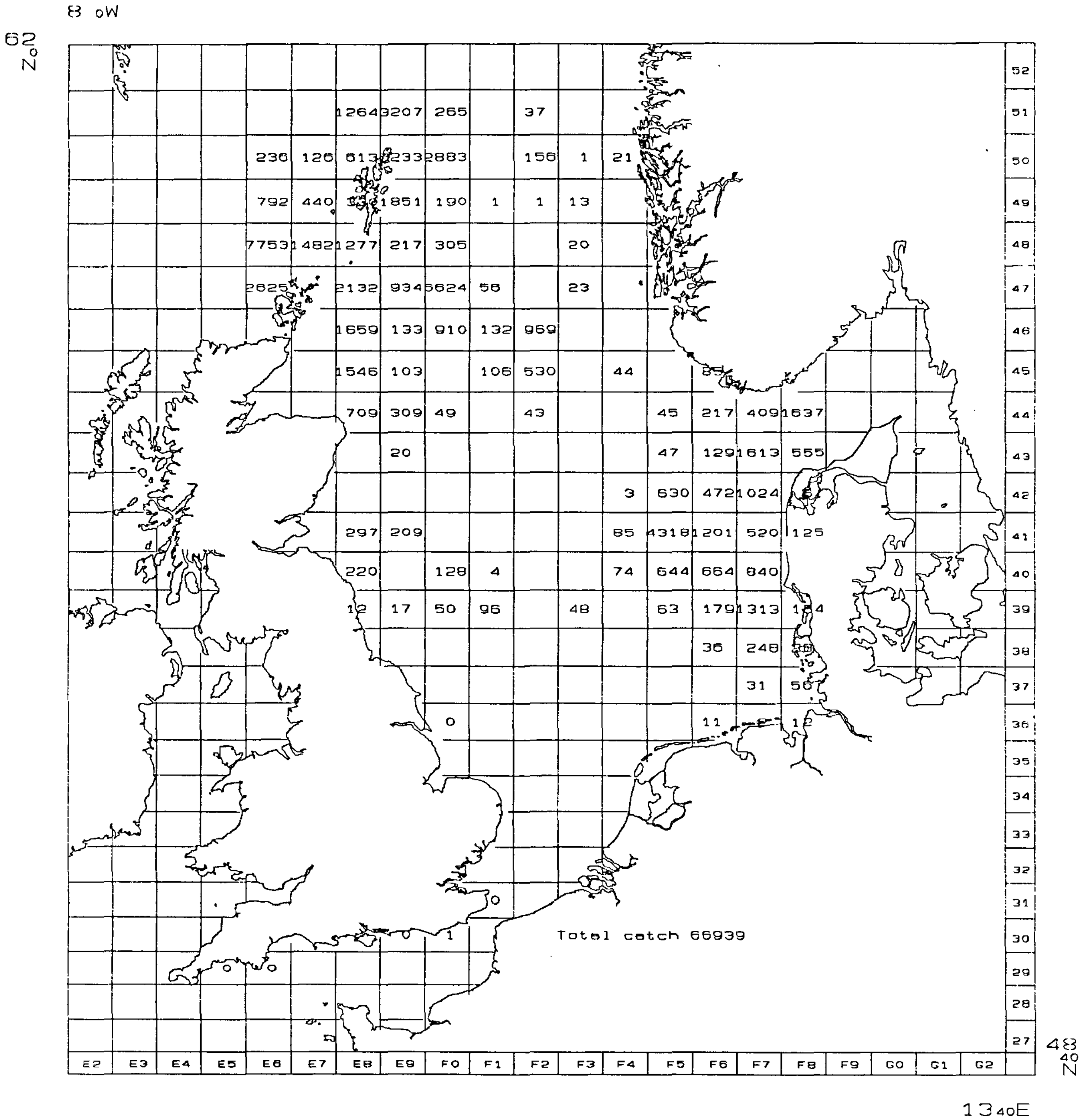


Figure 2.13.8 : Herring North Sea catches (tonnes). August 1995

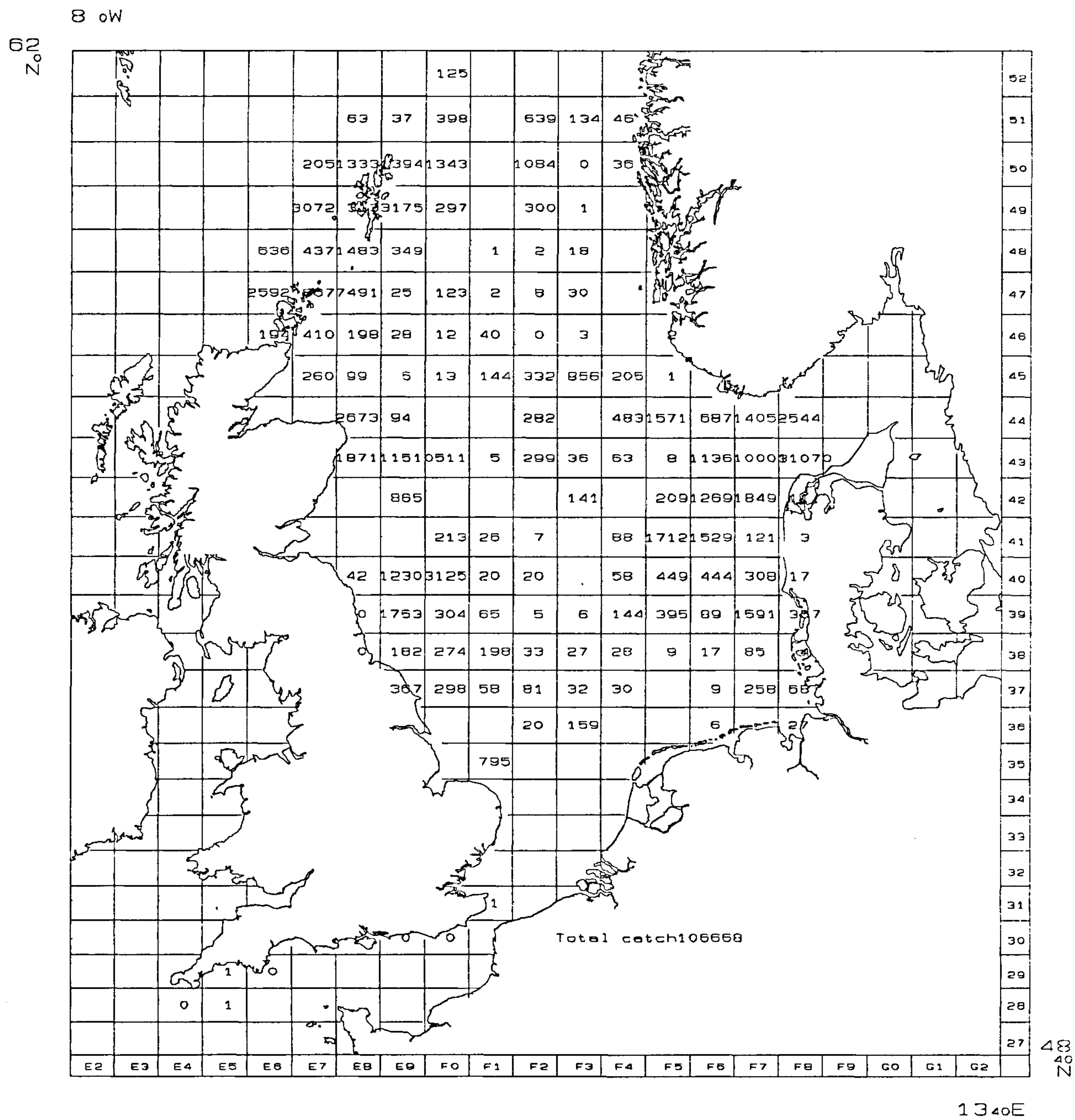


Figure 2.13.9 : Herring North Sea catches (tonnes). September 1995

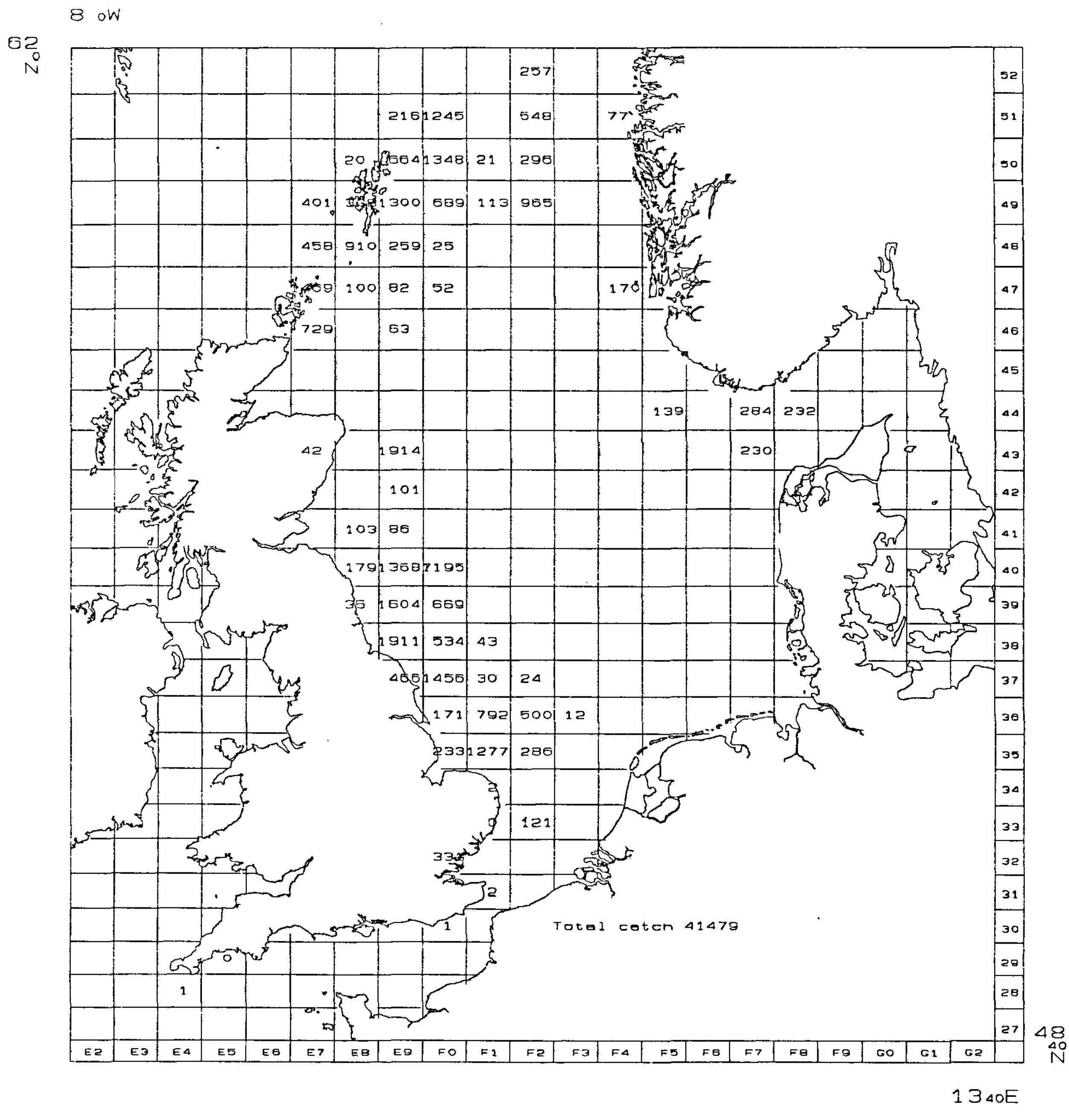


Figure 2.13.10 : Herring North Sea catches (tonnes). October 1995

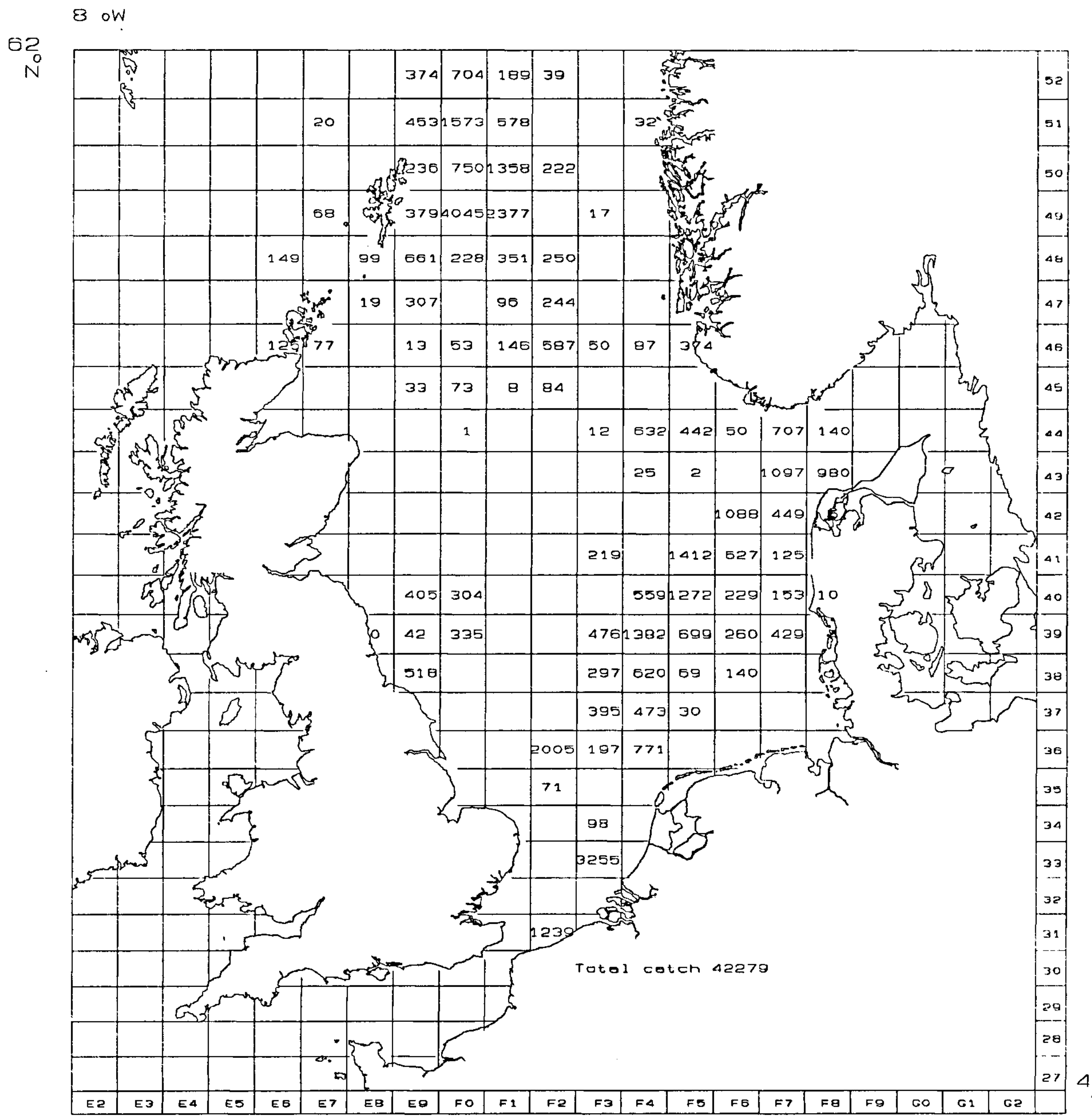


Figure 2.13.11 : Herring North Sea catches (tonnes). November 1995

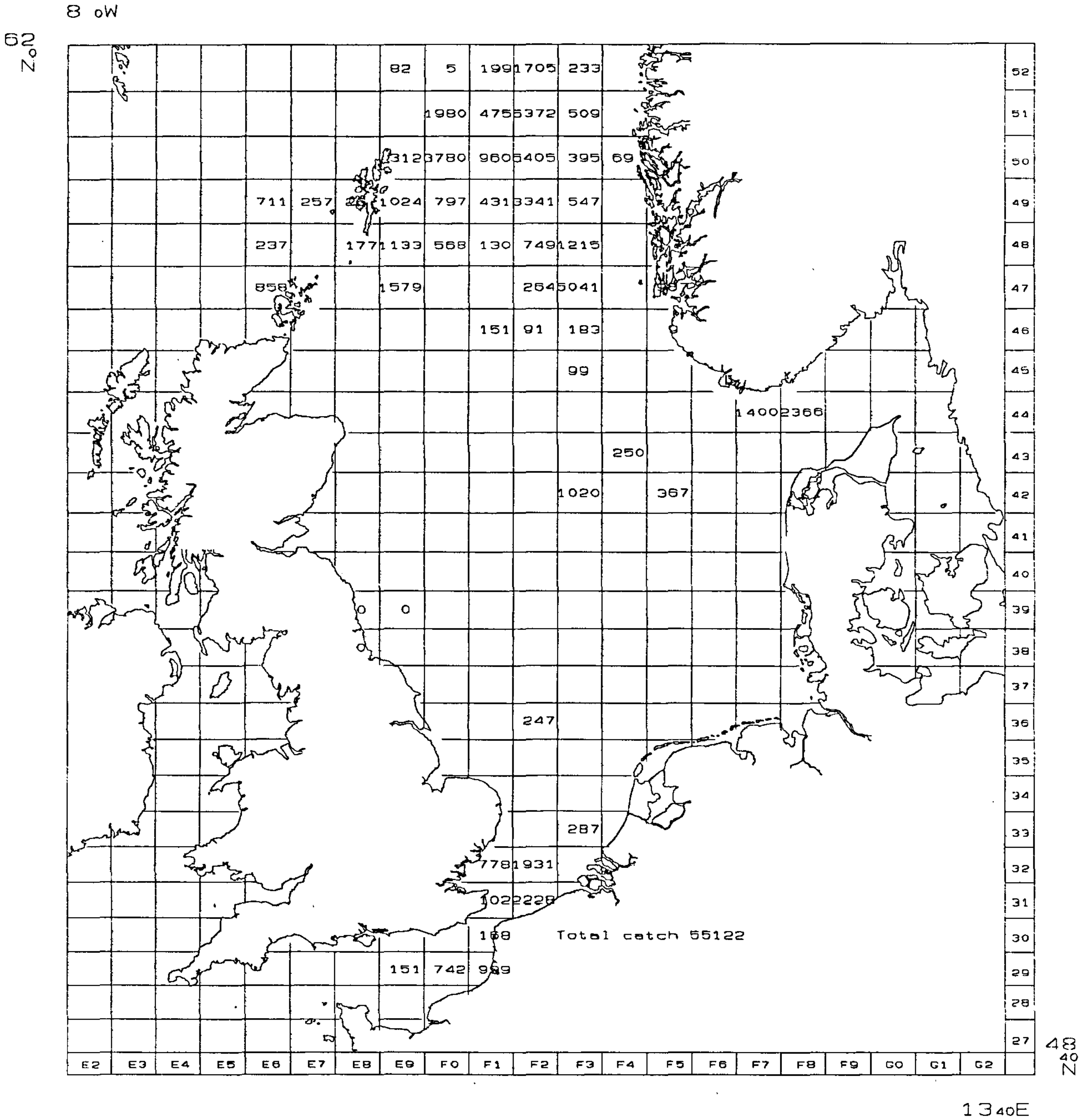
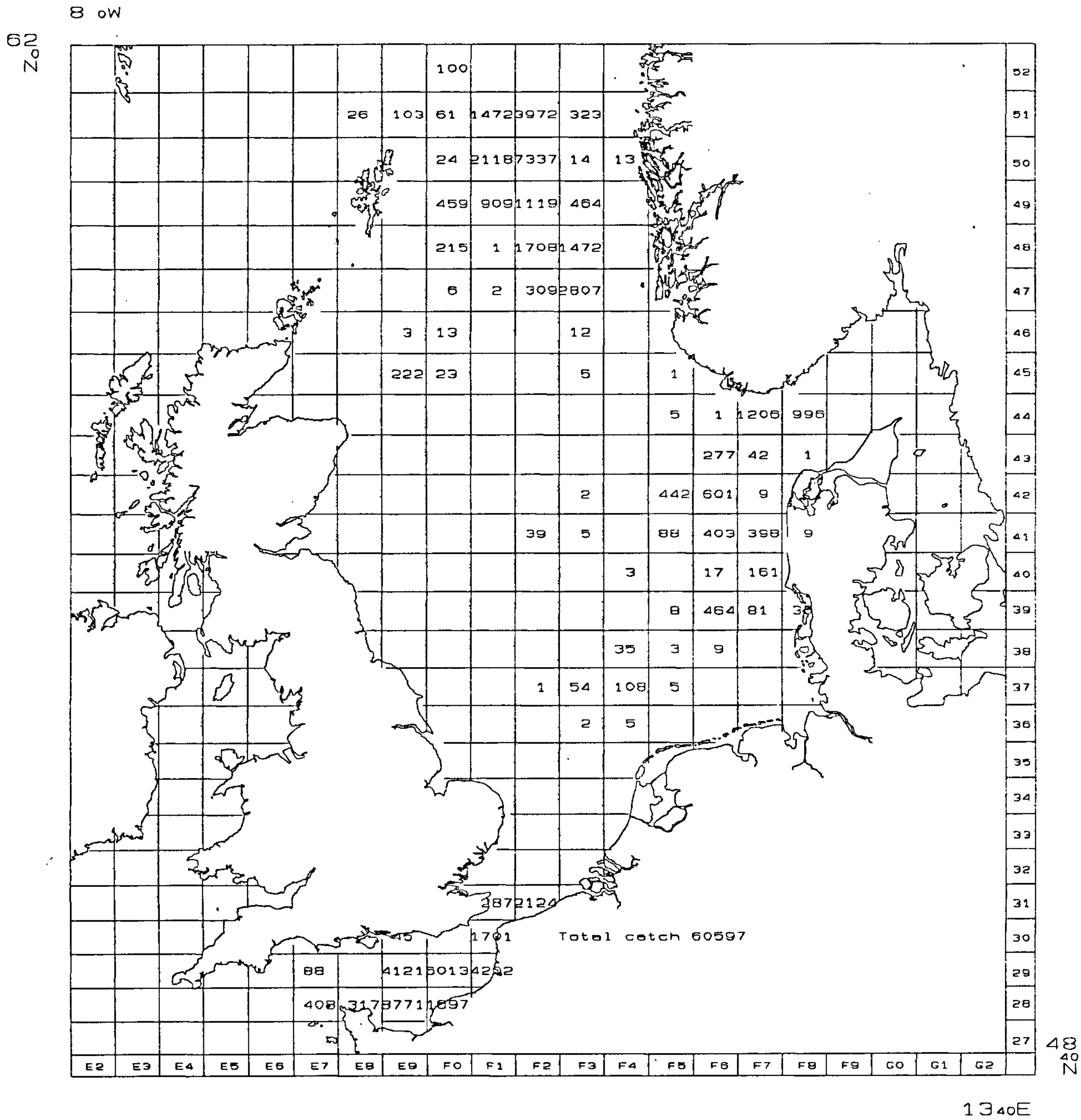


Figure 2.13.12 : Herring North Sea catches (tonnes). December 1995



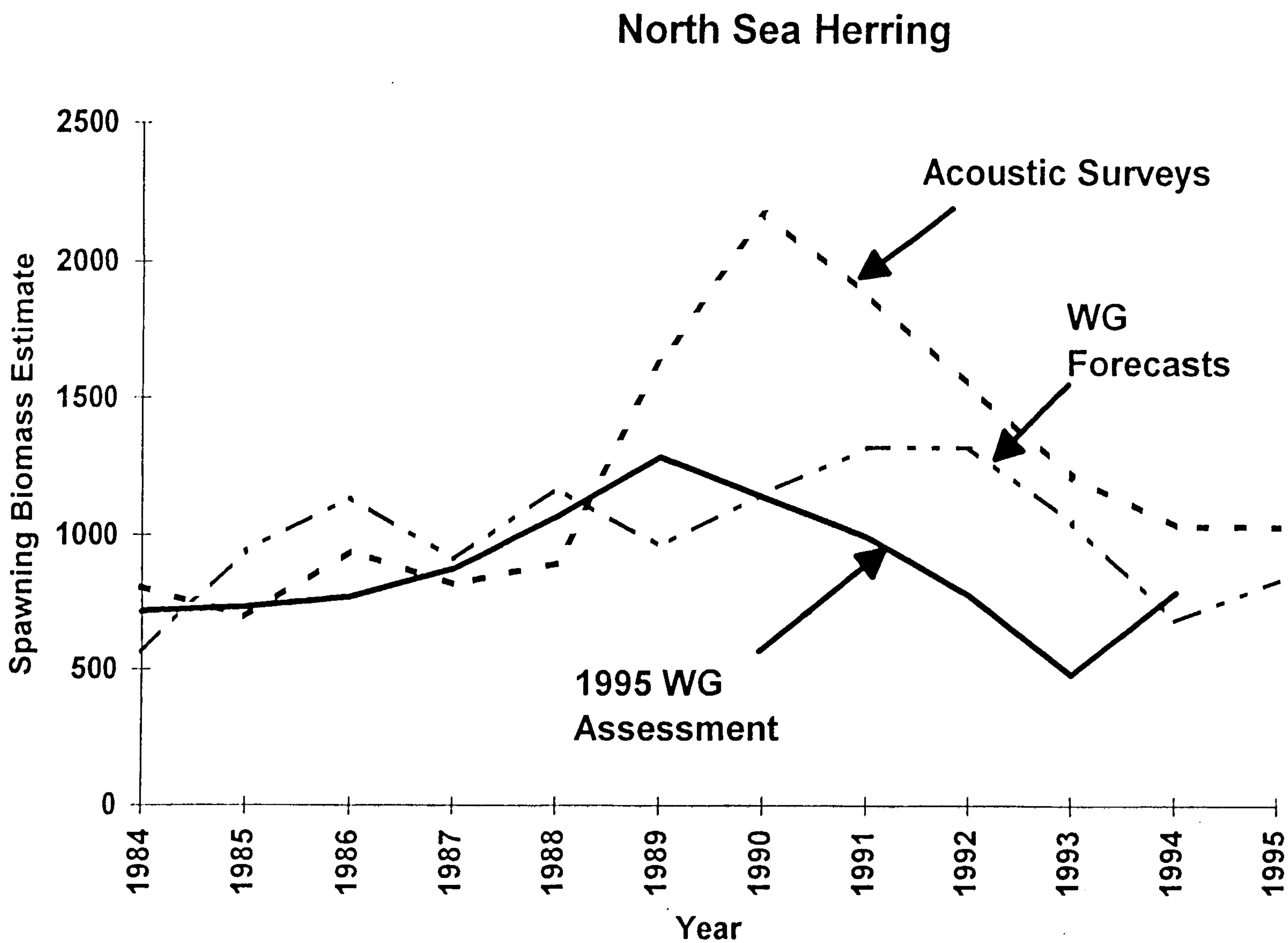


Figure 2.14.1 Discrepancy between the predicted and estimated spawning stock biomass. Solid line represents the spawning stock biomasses estimated at the 1995 Working Group meeting. The broken line 'WG Forecasts' represent the forecasts made by the Herring Assessment Working Group from 1982 - 1993. The 'Acoustic Surveys' have indicated a spawning stock biomasses over the period 1989 - 1995, which are double those calculated than those calculated by the assessment.

3 HERRING IN DIVISION IIIA AND SUB-DIVISIONS 22-24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1995 and 1996

ACFM stated in 1994 that the state of the stock was uncertain as the information available provided conflicting evidence.

In 1994 ACFM did not recommend a TAC for Division IIIa in 1995, but advised that if a precautionary TAC was required, it should not exceed recent catch levels.

The TAC for 1995 on herring agreed between the EU, Norway and Sweden for Division IIIa was 140,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

As in earlier years no special TAC was set by the International Baltic Sea Fishery Commission (IBSFC) for the stock component in the Western Baltic area in 1995. In the Baltic there is a TAC for all the Sub-divisions 22-32.

ACFM stated again in 1995 that the state of the stock was uncertain as available information was conflicting. Landings increased and the stock size appeared large but uncertainties in data sources precluded an analytical assessment.

The management advice was that, if a precautionary TAC was required, it should be established such that the catch does not exceed recent catch levels.

The 1996 agreed herring TAC between the EU, Norway and Sweden to be taken in Division IIIa was 120,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

3.1.2 Introduction to landing statistics

The landings of herring caught in Division IIIa are a mixture of North Sea autumn spawners and Baltic spring spawners. Spring-spawning herring in the eastern part of the North Sea, Skagerrak, Kattegat and Sub-Divisions 22, 23 and 24 are considered to be one stock. This section gives the landings of both North Sea autumn spawners and Baltic spring spawners, but the stock assessment applies only to the spring spawners.

3.1.3 Total Landings

Landings from 1985 to 1995 are given in Table 3.1.1. In 1995 the total landings decreased to around 231,000 t in Division IIIa and Sub-Divisions 22-24, of which 48,000 t were from the Kattegat, about 109,000 t from the Skagerrak and 74,000 t from Sub-Divisions 22-24. This represents a decrease of 60,000 t compared to 1993, but is at the same level as in 1994.

In 1995 catches of juvenile herring in Division IIIa increased from 1994 to 1995, but the level is still lower than in the years prior to 1994. Also in 1995 there has been a large sprat and sandeel fishery in this Division Again this year the sprat dominated the mixed clupeoid landings especially in the second half of the year.

Misreporting of fishing grounds still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea in quarters 1, 2 and 4. These landings are included in the figures for the North Sea.

No estimates of discards were available to the Working Group. The magnitude of discards may be at a high level, especially in the summer period when there is a special demand for high quality herring to the Dutch market.

The herring catches in Division IIIa are taken mainly in three types of fisheries (see also Anon, 1992a):

- **A directed fishery for herring (fleet C)** in which trawlers (with 32 mm mesh size) and purse seiners participate.

- The **"Mixed clupeoid fishery" (fleet D)** is carried out under a special "Sprat" TAC for all species caught in this fishery. Danish boats are obliged to use a 32 mm mesh (since 1 Jan 1991). The Swedish fishery includes purse seiners fishing for sprat along the coast and trawlers using small-meshed gear (less than 32 mm). The Norwegian fishery is a purse seine sprat fishery for the canning industry.

- Catches of herring also occur as **by-catches in other fisheries (fleet E)**, such as the Norway pout and sandeel fisheries. This fleet also include some by-catches in fleet C.

The management arrangement for the herring and sprat fisheries in this area is under revision.

Attempts have been made to separate the landings in these fisheries. The category "Mixed clupeoids" only refers to Denmark since it was not possible to separate the Norwegian and Swedish "Mixed" landings from other industrial landings. All Swedish landings for industrial purposes are counted under "Landings for industrial purposes" and the Norwegian landings are under "Landings for Human consumption". The landings in the different fisheries for the period 1991-1995 in thousands of tonnes are shown in the text table below:

	Human Consumption	Mixed clupeoids	Landings for oil and meal	Total
1991 Kattegat	32	13	24	69
Skagerrak	62	6	54	122
Div.IIIa	94	19	78	191
1992 Kattegat	24	11	24	59
Skagerrak	75	14	79	168
Div.IIIa	99	25	103	227
1993 Kattegat	18	12	16	46
Skagerrak	94	15	60	169
Div.IIIa	112	27	76	215
1994 Kattegat	18	8	12	38
Skagerrak	81	5	43	129
Div. IIIa	99	13	55	167
1995 Kattegat	18	5	24	47
Skagerrak	58	3	48	109
Div.IIIa	76	8	72	156

In Sub-Divisions 22-24 all the catches are taken in a directed fishery for herring which is treated in this section as one fleet.

The landings from this stock could therefore be split into four fleets:

C: Human consumption fleet in Division IIIa.
D: Mixed clupeoid fleet in Division IIIa.
E: Landings for industrial purposes in Division IIIa.
F: Landings from Sub-Divisions 22-24.

In the text table below the 1995 landings are given in thousands of tonnes by fleet and quarter.

Quarter/	Fleet C	Fleet D	Fleet E	Fleet F	Total
1	11.3	4.6	9.2	25.1	50.2
2	10.5	0.0	10.9	32.2	53.6
3	33.9	1.5	40.8	7.8	84.0
4	21.1	2.1	11.1	9.1	43.4
Total	76.8	8.2	72.0	74.2	231.2

The landings from fleets C-F are SOP figures.

3.2 Stock Composition

3.2.1 Spring spawners in the North Sea

The separation of catches from the NE North Sea into spring and autumn spawners is described in Section 2.2.3. The total amount of spring spawners of Division IIIa Baltic origin taken in the North Sea was estimated to be 9,500 t in the 1995 catches. Table 2.2.3 presents numbers and mean weights at age.

3.2.2 Stock Composition in Division IIIa

The mixing of spring- and autumn-spawning herring has been described in earlier reports of this Working Group (Anon., 1990b). Landings in Division IIIa were allocated to spawning stock using Danish and Swedish vertebral counts averaged over ICES rectangles within Sub-division and raised by the relative survey area of each Sub-division (Skagerrak and Kattegat). The combined and weighted mean vertebral count was used to split the stock into autumn and spring spawners according to the procedure described in Section 2.2.3. Age-group 3+ refers to all age classes of 3 years and older.

The resulting split is summarised below:

Age Group	Quarter	Skagerrak Spring Spawners	Autumn Spawners	Kattegat Spring Spawners	Autumn Spawners
0	3	0%	100%	0%	100%
	4	10%	90%	22%	78%
1	1	0%	100%	25%	75%
	2	0%	100%	24%	76%
	3	46%	54%	41%	59%
	4	22%	78%	69%	31%
2	1	27%	73%	50%	50%
	2	6%	94%	50%	50%
	3	89%	11%	79%	21%
	4	52%	48%	81%	19%
3+	1	46%	54%	100%	0%
	2	60%	40%	100%	0%
	3	100%	0%	100%	0%
	4	100%	0%	100%	0%

All landings from Sub-divisions 22-24 are assumed to be Baltic spring spawners.

3.3 Catch in numbers and mean weight at age

The sampling intensity of the landings increased in 1995. The Swedish catches for industrial purposes from the Skagerrak were sampled in the first three quarters (see Table 3.4.1). For the Kattegat, Danish samples were used to estimate the catch in numbers in the Swedish industrial landings in the same quarters. The sampling of the human consumption landings was generally acceptable in the Skagerrak and Kattegat. Since no Danish samples were taken in Sub-Division 24, samples from Sub-Division 22 were used to estimate the catch in numbers. No Swedish or Danish commercial samples were taken from Sub-Division 23, the Sound, in quarter 1, 2 and 3. Samples from Sub-Division 24 were used to calculate the catch in numbers and mean weight in this area. The Polish and German landings were sampled.

Based on these data the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-Divisions 22, 23 and 24 by the fleets listed in Section 3.1.3 were compiled and are given in Tables 3.3.1 - 3.3.3.

Based on the above proportions, the catches in number and mean weights by age group for spring- and autumn- spawning herring in each of the three fisheries in Division IIIa are given in Tables 3.3.4 - 3.3.8. The landings of spring spawners taken in Division IIIa in 1995 were thus estimated to be about 86,000 t (Tables 3.3.8, 3.3.10, 3.3.11 and 3.3.13 - 3.3.14) compared to about 84,000 t in 1994 and 80,000 t in 1993.

The landings of North Sea autumn spawners in Division IIIa amounted to 70,000 tons in 1995 compared to 86,000 t in 1994 (Tables 3.3.9 and 3.3.12) which are very close to the projected catch based on a *status quo* fishing mortality option in the 1995 forecast (Anon., 1995d). The 1995 landings represent a significant reduction compared to 1992 and 1993 when 152,000 t and 132,000 t were taken.

Table 3.3.8 gives the total catch in number-at-age of Division IIIa/Baltic spring spawners in the North Sea, Division IIIa and in Sub-Divisions 22-24 by quarter for 1995. The totals for 1987-1995 are given in Tables 3.3.11 and 3.3.13.

Table 3.3.10 gives the total landings in numbers and mean weights at age by fleet for the Division IIIa/Baltic spring-spawning herring caught in the North Sea, Division IIIa and in Sub-Division 22-24 in 1995. The total landings in 1995 of 173 000 t were close to the 1994 landings of 164 000 t.

3.4 Quality of catch and biological sampling data

The data on landings has improved since 1993 and 1994. Danish landings were sampled in all quarters for the Skagerrak, Kattegat and Sub-Division 22. No samples were taken from the Sound (Sub-Division 23) and Sub-Division 24. Swedish landings from the human consumption fishery were sampled in all quarters. Landings for industrial purposes from the Skagerrak have been sampled for the quarters 1, 2 and 3 and from the Kattegat only the second quarter was sampled. From the Norwegian landings from the Skagerrak only 2 samples were taken.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Division IIIa, IIIb and IIIc were 231,000 t, from which 337 samples were taken, 61,000 herring measured and 15,500 aged. The figures for 1994 were 296 samples, 51,000 herring measured and 15,000 aged. The sampling intensity by quarter seen over all landings is acceptable, with a mean of more than one sample per 1000 t landed. The distribution over seasons, areas and fishing fleets needs to be improved.

Sampling of the Danish catches for industrial purposes was at almost the same level as in previous years. The number of samples and number of fish investigated were considered to be at a reasonable level. Again in 1995 there have been difficulties in getting samples from the Danish human consumption fishery in the Skagerrak.

There is uncertainty about where the Danish catches for human consumption reported from Division IIIa (quarters 1, 2 and 4) were actually taken. These landings were most likely to have been taken in the North Sea and were therefore transferred to the North Sea.

In 1994 Sweden established a new sampling programme for the industrial landings from Division IIIa. This sampling programme met the requirement of the agreed level of one sample per 1000 t landed. Swedish sampling in the Kattegat was adequate but sampling of landings by Swedish vessels in Denmark still needs to be improved.

Norway only collected 2 biological samples from the fishery in Division IIIa in 1995. The Norwegian and Danish fishery for human consumption takes place in the area around the border line between the North Sea and Skagerrak and misreporting is known to occur.

Due to market conditions, technical regulations and quotas, discarding occurs in the purse seine fleets and in some fleets in the trawl fishery in Division IIIa, especially in June, July and August. Lack of sampling of discards creates problems for the assessment which need to be resolved.

Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter the coverage of different fisheries, areas and seasons is not adequate.

For reasons discussed in Section 1.7 the Working Group recommends that adequate sampling is conducted for all fisheries in Division IIIa and Sub-divisions 22-24.

Each nation should provide information on the level of sampling to determine species composition in all fisheries in which herring are caught.

3.5 Fishery-independent stock estimates of Western Baltic spring-spawning stock

3.5.1 Summer Acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. As in previous years the survey was conducted by R/V DANA. The echo integration survey from 28 June to 12 July covered the North Sea east of 4^0E between 57^0N and 59^0N, the Skagerrak and the Kattegat. Acoustic data were collected using a 38 kHz Simrad echosounder with a towed body mounted split-beam transducer. The echointegration data were stored by the echo analysis system ECHOANN (Degnbol *et al.*, 1990).

Pelagic sampling was carried out mainly as pelagic trawling with a Fotö trawl (6 mm in the codend), but also an Expo trawl (16 mm codend) was used on the bottom. The trawl hauls were performed in the time intervals 12.00-18.00 h and 23.00-5.00 h.

The TS relationships used in this survey were:

Clupeids:	TS = 20 log L (cm) - 71.2
Gadoids:	TS = 20 log L (cm) - 67.5

A total of 35 trawl hauls were carried out. Further details of the survey are given in Simmonds et al. (W.D.1996).

The estimated stock sizes of spring spawning herring in 1992, 1993, 1994 and 1995 are summarized in Tables 3.5.1-3.5.4 (the estimates for the years 1992 to 1994 were recalculated in 1996 excluding the Norwegian survey results). Due to very high densities of jellyfish in the Kattegat area in 1995 the total estimated stock size of spring spawning herring in Division IIIa (the Norwegian survey results were included) may represent an overestimation. The total stock estimate for 1995 (434,000 t) is about 30 % higher than the estimate for 1994 (298,000 t).

3.5.2 October Acoustic survey in Western Baltic and the Southern Part of Division IIIa (Kattegat)

A joint German-Danish acoustic survey was carried out with R/V "Solea" from 5 to 20 October 1995. The survey covered the whole of Sub-divisions 22, 23 and 24. Because of bad weather conditions the planned coverage of the southern Kattegat (Division IIIa) was incomplete and therefore the estimate of abundance is not realistic for this area.

All investigations were performed at night as in recent years.

The acoustic equipment used was an echosounder EK500 connected to the Bergen-Integrator BI500. The transducer 38-26 was installed in a towed body. A total of 48 trawl hauls were made with the midwater trawl "Krake" (10 mm bar length in the codend) for biological samples.

The Sa values for each stratum were divided into fish numbers using the TS-Length regressions:

Clupeids:	TS = 20 log L (cm) - 71.2
Gadoids:	TS = 20 log L (cm) - 67.5

The total number of fish was divided into species and age groups according to the trawl results.

The survey results in 1992, 1993, 1994 and 1995 are given in Tables 3.5.1-3.5.4.

3.5.3 Acoustic Monitoring in Sub-Division 23 (the Sound)

A base-line study on the migration of herring was initiated in the autumn 1993. The aim was to monitor the distribution of herring in the Øresund during autumn, winter and spring. For description of changes in distribution patterns the area investigated was divided into 13 sub-areas (Figure 3.5.1). Each subarea is 2.5 NM in a north-south direction. The survey was conducted every 4 weeks in the period September - May.

The acoustic data were obtained with R/V HAVFISKEN using a Simrad EY 200 echosounder combined with the ECHOANN analyser system (Degnbol *et al.*, 1990). A towed body mounted transducer was used. The operating frequency was 38 kHz and the pulse duration 1 ms.

The echointegration was carried out at night between 19.00 h and 06.00 h (except for the first survey which was performed during day and night).

Biological samples were taken by gill net fishing from R/V POSEIDON on the acoustic transects. Gill net fishing was pelagic and benthic using mesh sizes from 19.5 to 60 mm knot to knot. Fishing was done at night (20.00 h to 03.00 h).

For each subarea (Figure 3.5.1) mean target-strength (TS) was estimated for each species/category of species by the TS - length relations:

Clupeids:	TS = 20 log L (cm) - 71.2
Gadoids:	TS = 20 log L (cm) - 67.5

An overall mean TS for each category of fish and subarea was then estimated. The TS contribution from each species was, however, weighted in proportion to their contribution in the gill nets. The mean area backscattering strength (Sa) for each subarea was estimated.

Further details of the surveys in 1993, 1994 and 1995 are given in Pedersen and Staehr (in press).

The survey results concerning the biomass in tonnes per square nautical mile divided by stratum and survey (month) during the period September 1993 to May 1995 are given in Table 3.5.5.

The number of herring per nautical mile divided by age for the whole sound area during the period October 1994 to May 1995 are summarized in Table 3.5.6

3.6 Recruitment

3.6.1 General remarks on the 1996 IBTS February survey in Division IIIa

The 1996 survey was carried out over the same time period as in previous years. Despite bad weather all standard stations were covered. In total 48 hauls were made. The indices of 1, 2 and 3+ ringed herring since 1980 are given in Table 3.6.1.

3.6.2 Abundance of 1-ringed herring

The index of 1-ringers in 1996 was 11,452. Swedish vertebral counts were averaged over ICES-rectangles within each sub-division and raised by the relative survey area of each Sub-division (Skagerrak and Kattegat). The combined and weighted mean vertebral count was used to split 1-ringers into autumn and spring spawners according to the procedure described in Section 2.2.3. The index of spring spawners using this split was thus 988.

3.6.3 Abundance of 2-ringed herring

The index of 2-ringers in 1996 was 3285 which is a relatively high number in the time series since 1977. Separation of autumn and spring spawners was conducted as for 1-ringers giving a high index of 1870 for 2-ringers.

3.6.4 Abundance of 3+ ringed herring

No 3-ringers were caught in the 1996 survey in Division IIIa. However, this survey was not designed to estimate the abundance of adult herring which are known to be concentrated in the Sound and in Sub-division 22-24 at this time of the year.

3.6.5 Abundance indices for Sub-divisions 22-24

Abundance indices for 0, 1, 2, and 3+ ringed herring from bottom-trawl surveys carried out in November/December of each year in Sub-divisions 24 and 22 are given in Tables 3.6.2 and 3.6.3. Combined estimates for the total area are obtained by weighting the single survey estimate by the survey areas of each Sub-division. The resulting index series is shown in Table 3.6.4.

The results of the 1993 survey indicate a strong 1993 year class but the 1994 estimate of this year class as 1-ringers is low. The 1993 and 1994 surveys gave very high catches of 3+ herring in both areas and these indices are the highest recorded since 1978. It appears difficult to follow either strong or weak year classes in the time series and the predictive value of this recruitment index is questionable. The 1995 survey showed low 1995, 1994 and 1993 year classes. In the Sub-Division 24 survey the 3+ group seems to be rather high.

3.7 Larvae surveys

The German herring larvae monitoring started in 1977 and takes place every year from March/April to June in the main spawning grounds of the spring spawning herring in the Western Baltic in the Greifswalder Bodden (area: 510.2 km^2, volume: 2,960 x 10^6 m^3, mean depth: 5.8 m, greatest depth: 13.5 m) and adjacent waters. Since 1977 the same sampling method, sampling strategy and station grid have been used. Usually 35 standard stations are sampled by R/V "Solea" in broad daylight during 10 consecutive cruises. At each station herring larvae samples are taken with a MARMAP-Bongo (diameter: 600 mm, mesh size of both nets: 0.315 mm) by parallel double oblique tows at a speed of 3 knots.

For the calculation of the number of larvae per station and m^2 the methods of Smith and Richardson (1977) and Klenz (1993) were used and extended to length-classes. To get the number of larvae it was estimated at what time the larvae reached the length of TL>=30 mm (larvae after metamorphosis) in dependence of growth, and how many larvae have survived up to that date.

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989) and Mueller & Klenz (1994).

The estimated numbers of larvae for the period 1977 to 1994 are summarized in Table 3.7.

3.8 Data exploration and preliminary modelling

The analysis was based on the ICA program. The choice of the ICA methodology rather than the XSA approach was explained in a previous Working Group report (Anon., 1994).

Catch at age and survey-disaggregated data are presented in Tables 3.8.1 - 3.8.5. The input data used cover the period 1987 and onwards. This restriction to a shorter period was motivated by the fact that splitting of spring and autumn spawners in Divisions IIIa and IVa was not consistently done before 1987. The splitting has substantial effects on the age distributions of the catch and survey estimates (Section 3.10). Although both catch and many survey series extend further back in time, it was agreed that inclusion of these data would bias the results of the assessment.

Natural mortality, maturity ogive, proportions of F and M before spawning were all assumed to remain constant between years. M is assumed to be 0.2 per year, F-prop. 0.1 and M-prop. 0.25 for all age groups. The maturity ogive used was the same as that used at last years Working Group meeting:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	.2	.75	.9	1	1	1	1

Five surveys with disaggregated data and one larvae survey were available as indices of abundance:

Index 1: IBTS in Div IIIa, Feb. 1980-1995, 2 and 3+ ringers
Index 2: German bottom trawl survey (GBTS) in SD 22, Nov. 1979-95, 0-3+ ringers
Index 3: German bottom trawl survey (GBTS) in SD 24, Nov. 1978-95, 0-3+ ringers
Index 4: Acoustic. survey in Div IIIa, July 1989-95, 2-8+ ringers
Index 5: Acoustic. survey in SD 22+24, Oct. 1989-95, 0-8+ ringers
Index 6: Larvae survey in SD 24, March-June 1977-1994

Indices 2 and 3 basically cover the same stock with the same methodology during the same season. These indices were combined by a weighting of the actual survey area. As last year, estimates from the acoustic survey in Division IIIa (Index 4) were questioned due to possible overestimation in the southern part of Division IIIa. However, the time of the survey coincides with a high expectation of a large proportion of the stock in Division IIIa. The old series of index 1 (IBTS, 1st quarter) could not be updated to include 1996 since the splitting procedure used at previous Working Group meetings could not be reconstructed by new members of the Working Group. The index was supplemented with a new IBTS index based on an alternative splitting procedure of the IBTS surveys in quarters 1, 2, 3 and 4, 1991-92 (Section 3.2.2). The quarters were summarized and combined over years to form a separate index. Thus, additional input indices for the ICA were:

Index 1a: IBTS in Division IIIa, all quarters., 1991-1995, 1-5 ringers
Index 2a: German bottom trawl survey (GBTS) in SD 22+24, Nov. 1979-95, 0-3+ ringers

In all ICA runs the following parameters were kept constant:

The weighting factor to all indices (lambda = 1).
The linear catchability model for all indices.
The range of years for separability constraint (=6)
The reference F at age 4 and the selection 1 for oldest age.

Altogether nine runs were made with single indices and one run with multiple indices. The results of the runs were compared by using the estimates and standard deviations of the reference F in 1994 and the SSB in 1995. The estimates of the comparative runs obtained are given below:

Run No.		Index	F and SSB (x 1000 t) in 1995 from ICA Mean F 1995	Lower L.	Upper L.	SSB (x 1000 t) 1995
1	1	IBTS Div. IIIa	7.20	2.33	22.23	40
2	2	GBTS SD 24	0.08	0.05	0.12	1,500
3	3	GBTS SD 22	3.98	2.52	6.29	60
4	4	Acous. sur.IIIa+IVaE	0.15	0.11	0.21	740
5	5	Acous. sur.in SD 22-24	0.010	0.007	0.014	out of range
6	6	LarvaL sur. in SD 24	0.34	0.07	0.58	410[1]
7	1a	IBTS Div. IIIa all Quarters	0.27	0.18	0.39	440
8	2a	GBTS SD 22+24	3.68	2.52	5.34	70
9		**Indices 1a, 2a, 4 and 5**	**0.21**	**0.15**	**0.30**	**690**

[1] only up till 1994

As can be seen, the runs by individual indices estimate both unrealistic and plausible fishing mortalities. The estimated SSB levels also appear very unsDivision The indices appear to give no useful information on stock size.

A closer inspection of the catch at age data indicated a dramatic change in the fishing pattern in 1995 compared with previous years. Numbers of 0- and 1 ringers are considerable higher compared to earlier year classes. These catches were taken in the 1st and 2nd quarter in the SW Baltic. The combination with high index values of the same age groups in the February IBTS index (Index 1) is somewhat surprising but will push the ICA estimate of both recruitment and SSB to extreme levels. The observed changes in fishing pattern may be due to misreporting or inappropriate sampling. These changes violated the selectivity assumption in the ICA program and an additional run was conducted in which catches of 0 and 1 ringers in 1995 were down weighted (weight set to 0.01). This run resulted in a lower estimate of reference F (0.26) and a smaller spawning biomass (540,000 t).

Run number 9 was selected to illustrate the problems in the assessment. This run performed slightly better (minimization of the SSQ detectable) and contained many of the indices. The larval index (number 6) was excluded from the run due to low precision. The old IBTS series (index 1) was rejected due to lack of fit and doubts about the previous splitting procedure.

Inputs from ICA run number 9 are shown in Tables 3.8.1-3.8.5. Outputs from ICA Run number 1 are shown in Tables 3.8.6-3.8.14. The key results of the ICA analysis are also shown in Figures 3.8.1-3.8.7. Figures 3.8.4a-3.8.7d show the tuning diagnostics for each combination of survey index and age group. The graph output labelled "stock numbers" indicates to which degree the survey index reflects the stock numbers estimated from ICA. The vertical lines indicate the stock number predicted from the index, plus/minus the standard deviation of the stock estimate. The graph "Catchability" shows the relationship between index and stock numbers estimated from ICA. This relationship is supposed to be a straight line through the origin. The two lower graphs show the corresponding residuals, which are supposed to be randomly distributed around the X-axis. Inspecting the 25 graphs with tuning diagnostics reveals that none of them are really convincing. It should be noted that age groups below 3 winter rings generally indicate increasing stock sizes during 1995 while older age groups indicate decreasing or variable trends in stock sizes from 1994 to 1995.

3.9 Stock Assessment

Since 1993, the Working Group has encountered severe problems in assessing the status of the spring spawners in Division IIIa and Sub-divisions 22, 23 and 24. These problems can be ascribed to conflicting trends between survey indices and the commercial catch data. Firstly, there are inconsistencies between the survey indices and the estimated catch rates in year classes and yearly development. Some of the indices are internally inconsistent, even demonstrating negative mortality. Furthermore, tuning of the catch data by individual surveys has resulted in conflicting estimates of the SSB and fishing mortalities. These incoherent patterns in the input data and in the assessment results were also observed during the 1995 Working Group meeting.

The overall results of the 1996 assessment indicate an increasing SSB and decreasing fishing mortality from 1987 and onwards. However, the Working Group members feel that both the data on the commercial fishery and on the surveys are questionable. The assessment trials cannot provide an accurate indication about the development of the stock. As a consequence, predictions of the western Baltic herring are not considered.

Estimates of total mortality were obtained by an analysis of the CPUE at age of individual cohorts by surveys. Numbers by available year class estimates were regressed against age within each survey (Figure 3.9.1). These estimates indicated that Z varied from 0.6 (acoustic surveys) to 0.9 (trawl surveys).

3.10 Uncertainties in the Assessment

The sum of squares of deviations between estimated and observed indices (SSQ) as a function of the reference F (in 1995) for run number 9 (index 1a, 2a, 4, 5) is shown in Figure 3.8.1. The estimated reference F should be the one with the minimum index SSQ. As can be seen, there is not a very clear indication of the best reference F in 1995.

Figure 3.8.2 shows the stock summary from ICA. It shows an increasing trend in spawning stock biomass, from about 200 000 t in 1987 to 600 000 t in 1995. Fishing mortality shows the opposite trend, decreasing from about 0.7 in 1988 to about 0.20 in 1995. There is a slight decrease in the landings to around 170,000 t in 1995 indicating a contradiction with the trends in F's and stock size. Proportionally the decrease in landings is much smaller than the decrease in fishing mortality. Recruitments in 1994 and 1995 are the highest in the short time series 1987-95. A recent decrease in fishing mortality cannot be inferred from decreases in mean age in the catches. The dominance of older fish in the catch (Table 3.8.1) in recent years can also be explained by a series of high recruitments in the mid-eighties. As discussed at last years Working Group the observed change in the fishing pattern might also have been caused by an inappropriate sampling of the human consumption and the industrial fisheries in Division IIIa.

The group found it difficult to recognise any trends in the assessment, and it should be stressed that the results from the ICA run are presented only to illustrate the assessment problems. Consequently, no attempt was made to predict the catches of herring in Division IIIa and Sub-divisions 22-24.

Prior to 1988 annual assessments were made separately for Division IIIa and the Baltic (Sub-divisions 22-24). The present perception of a unit stock is based on the assumption that spring spawning herring in the Baltic migrate northwards into Division IIIa and the North Sea after spawning in April-May. The return migration to the Baltic spawning grounds occurs by the end of the winter season. The theory is supported by tagging results (Biester, 1979) and by seasonal and spatial observations of vertebrae counts (Rosenberg & Palmen, 1981). Results from the acoustic estimates from the Baltic Sound (Sub-division 23) suggest that the migration is substantial and rapid (Pedersen & Staehr, in press). Thus, the estimated relative biomass in the Sound remained at 400 t x NM^{-2} from autumn 1993 to April 1994 when the biomass decreased to 20 t x NM^{-2}.

Existing fishery-independent surveys have not been designed to account for the assumed migration patterns. None of the surveys covered the entire distribution of the stock. Thus, changes in the migration rate or timing between years may have violated the validity of the time series of these surveys. The Baltic larval survey at spawning time and the acoustic survey during summer in Division IIIa would be expected to reflect the SSB better than the other surveys. The acoustic surveys are not consistent with the catch at age distributions and the Baltic larval surveys have a very low precision. The Baltic trawl surveys are conducted at times when migration is assumed to occur (IBTS) or when a main part of the stock is assumed to be at least partially absent from the surveyed area (Baltic trawl surveys). From an assessment point of view a call for a coordination or a larger coverage of these surveys may address these problems.

Another cause for concern is the estimates of the proportion of autumn spawners in the total landings in the SW Baltic and Division IIIa. The net transfer of catches of autumn spawners from the Division IIIa to the North Sea stock varies significantly between years.

Division IIIa and Sub-divisions 22-24

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Landings (x 1000 t)	349	308	336	432	286	280	257	311	295	234	231
Fraction Spring Spawners (%)	71	60	52	58	65	73	74	54	57	70	75

This transfer primarily affects the numbers of young (0-2 ringers) spring spawners in the Division IIIa. The present method where mean vertebrae counts are used to allocate spring and autumn spawners appears very dubious. Observations from Division IIIa samples indicate that the estimated standard deviation around the mean VS overlaps the range used to designate stock identity. In view of the important consequences the present splitting method should be reviewed and preferably replaced by other methods. Pilot studies indicate that measurements of otolith increment widths are statistically robust and more cost-efficient (Mosegaard and Madsen, W.D. 1996).

3.11 Management considerations

Compared to recent years there has been a dramatic change in the number of 1-ringers in the catch in 1995 (Table 3.8.1). The reported landings are the highest for the period from 1985 and the second highest for the total period from 1975. Landings of all other age-groups are within the normal range. The majority of 1-ringers (64%) were caught in Sub-divisions 22-24 during the first two quarters of 1995 (Table 3.3.3). For the period from 1991 to 1995 when IBTS surveys were carried out in the first and second quarters, only 1-ringers from the 1995 survey in Division IIIa were considered to have a proportion of spring spawners of about 10%. This is the only indication that the high numbers landed are matched by a correspondingly abundant year-class. Acoustic surveys, IBTS and GBTS carried out later in the year do not indicate the same high abundance of 1-ringers.

ICA runs with individual indices and a combination of indices in most cases indicate either an extremely high recruitment in 1994 and 1995 with an overall rather low fishing mortality or a change in selectivity pattern with an increasing fishing mortality on the early year classes especially in Sub-divisions 22-24.

The Working Group cannot make a clear judgement on how much of the change in landings is due to year class fluctuations and how much is caused by a changing fishing pattern. A robust analysis of the population status requires a more accurate split of the spring and autumn spawning components. A detailed analysis of fishing effort and selectivity, as well as a sequence of year classes with the presumed change in selectivity, is also required to improve model runs.

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1986 - 1995**
Landings in thousands of tonnes.
(Data provided by Working Group members 1996).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995 [1]
Skagerrak											
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9	43.7
Faroe Islands	0.5	0.5									
Norway	4.5	' 1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7	16.7
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4	48.5
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0	108.9
Kattegat											
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6	16.9
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4	30.8
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0	47.7
Sub. Div. 22+24											
Denmark	15.9	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5	36.8
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4	13.4
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3	7.3
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4	15.8
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6	73.3
Sub. Div. 23											
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5	0.9
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3	0.2
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8	1.1
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4	231.0

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Table 3.3.1 Skagerrak 1995

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.54	42.5	56.97	15.8	147.33	24.6	204.84	22.2
2	56.86	84.3	0.99	32	28.51	55.7	86.36	74.2
3	5.72	129.3	0.06	149	1.09	129.0	6.87	129.4
4	0.58	167.1			0.36	144.0	0.94	158.2
5	0.21	183.7					0.21	183.7
6	0.12	198.2					0.12	198.2
7	0.12	203.8					0.12	203.8
8+	0.14	233.9					0.14	233.9
TOTAL	64.29		58.02		177.29		299.60	
Land. (SOP)(t)		5,771		941		5,398		12,110
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	15.62	36.4			168.28	28.9	183.90	29.6
2	23.95	96.4			27.21	60.8	51.16	77.5
3	14.29	154.9			3.58	73.6	17.87	138.7
4	9.08	166.4			3.15	80.2	12.23	144.2
5	2.83	180.9			0.83	94.2	3.66	161.3
6	2.40	195.3			0.08	110.0	2.48	192.6
7	1.43	202.4			0.08	142.0	1.51	199.2
8+	1.98	205.4					1.98	205.4
TOTAL	71.58		0.00		203.21		274.79	
Land. (SOP)(t)		8,280		0		7,137		15,417
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			67.35	13.2	801.26	9.1	868.61	9.4
1	126.12	78.0	4.25	30.1	129.42	58.9	259.79	67.7
2	53.10	138.0	0.36	107.0	61.29	96.3	114.75	115.6
3	35.46	167.8			15.37	109.3	50.83	150.1
4	21.12	185.5			10.95	141.7	32.07	170.5
5	7.06	212.5			29.16	182.0	36.22	188.0
6	3.22	231.1			1.95	205.5	5.17	221.5
7	1.56	282.6					1.56	282.6
8+	0.48	249.0					0.48	249.0
TOTAL	248.12		71.96		1049.40		1369.48	
Land. (SOP)(t)		29,828		1,055		29,758		60,642
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.88	10.6	70.36	15.7	244.97	19.1	319.21	18.2
1	32.82	87.0	2.33	38.2	13.14	53.4	48.29	75.5
2	39.03	132.4	0.15	46.0	2.64	76.2	41.82	128.6
3	22.62	163.8			0.53	127.0	23.15	163.0
4	9.16	168.1			0.53	152.0	9.69	167.2
5	1.65	180.7					1.65	180.7
6	1.30	211.2					1.30	211.2
7	2.40	235.6			1.05	208.5	3.45	227.3
8+	0.18	212.7						
TOTAL	113.04		72.84		262.85		448.55	
Land. (SOP)(t)		14,488		1,201		5,948		21,598
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.88	10.6	137.71	14.5	1046.23	11.4	1187.82	11.8
1	175.10	75.8	63.55	17.6	458.17	36.7	696.82	44.8
2	172.94	113.3	1.50	51.4	119.65	78.1	294.09	98.7
3	78.09	161.5	0.06	149.0	20.57	104.6	98.72	149.6
4	39.94	176.9			14.99	129.2	54.93	163.9
5	11.75	199.9			29.99	179.6	41.74	185.3
6	7.04	214.7			2.03	201.7	9.07	211.8
7	5.51	239.6			1.13	203.8	6.64	233.5
8+	2.78	214.8					2.78	214.8
TOTAL	497.03		202.82		1692.75		2392.60	
Land. (SOP)(t)		58,367		3,197		48,241		109,805

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Table 3.3.2 Kattegat 1995

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	23.06	28.8	252.23	14.3	157.43	21.9	432.72	17.8
2	18.53	71.2	3.58	30.9	10.75	34.8	32.86	54.9
3	9.10	110.2					9.10	110.2
4	7.30	158.8					7.30	158.8
5	3.05	192.5					3.05	192.5
6	1.88	197.0					1.88	197.0
7	0.93	240.4					0.93	240.4
8+	0.79	269.3					0.79	269.3
TOTAL	64.64		255.81		168.18		488.63	
Land. (SOP)(t)		5,539		3,718		3,822		13,078
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	12.62	33.1			102.87	34.6	115.49	34.5
2	6.50	79.7			5.19	46.6	11.69	65.0
3	3.79	101.7					3.79	101.7
4	3.36	111.9					3.36	111.9
5	1.12	150.2					1.12	150.2
6	0.97	151.5					0.97	151.5
7	0.78	153.4					0.78	153.4
8+	0.48	180.9					0.48	180.9
TOTAL	29.62		0.00		108.06		137.68	
Land. (SOP)(t)		2,219		0		3,804		6,023
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			11.99	13.2	368.92	13.2	380.91	13.2
1	13.43	64.9	6.28	30.2	193.39	30.2	213.10	32.4
2	6.37	102.7	0.11	55.3	3.57	55.3	10.05	85.3
3	4.46	138.8					4.46	138.8
4	6.01	165.8	0.04	87	1.19	87.0	7.24	152.4
5	2.25	204.4					2.25	204.4
6	1.39	209.0					1.39	209.0
7	0.62	229.8					0.62	229.8
8+	0.45	227.8					0.45	227.8
TOTAL	34.98		18.42		567.07		620.47	
Land. (SOP)(t)		4,136		357		11,011		15,504
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.75	15.7	43.18	19.1	192.58	16.6	238.51	17.0
1	44.45	61.2	0.88	40.5	55.29	34.9	100.62	46.6
2	9.45	108.7			1.24	43.2	10.69	101.1
3	4.92	149.6					4.92	149.6
4	5.42	196.3					5.42	196.3
5	2.14	210.0					2.14	210.0
6	1.26	230.2					1.26	230.2
7	0.77	229.8					0.77	229.8
8+	0.31	260.0					0.31	260.0
TOTAL	71.47		44.06		249.11		364.64	
Land. (SOP)(t)		6,589		860		5,180		12,629
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.75	15.7	55.17	17.8	561.50	14.4	619.42	14.7
1	93.56	50.0	259.39	14.8	508.98	29.0	861.93	27.0
2	40.85	86.1	3.69	31.6	20.75	41.8	65.29	69.0
3	22.27	123.2					22.27	123.2
4	22.09	162.8	0.04	87.0	1.19	87.0	23.32	158.8
5	8.56	194.5					8.56	194.5
6	5.50	199.6					5.50	199.6
7	3.10	213.8					3.10	213.8
8+	2.03	237.8					2.03	237.8
TOTAL	200.71		318.29		1092.42		1611.42	
Land. (SOP)(t)		18,482		4,935		23,817		47,235

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Table 3.3.3 Sub-Area 22-24 in 1995

Catch in numbers (millions) and mean weight (g) at age by country.

	Sub-Division 22*		Sub-Division 23		Sub-Division 24		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	275.67	11.9	10.20	11.9	381.02	11.9	666.89	11.9
2	51.63	37.1	2.00	37.2	74.53	37.2	128.16	37.2
3	16.80	57.2	0.74	60.0	27.45	60.0	44.99	58.9
4	3.37	133.9	0.30	114.9	11.12	114.9	14.79	119.2
5	7.97	174.0	0.11	138.2	4.18	138.2	12.26	161.5
6	9.35	197.5	0.11	166.9	3.97	166.9	13.43	188.2
7	7.23	211.9	0.07	194.6	2.74	194.6	10.04	207.1
8+	4.01	227.0	0.05	234.0	1.79	234.0	5.85	229.2
TOTAL	376.03		13.57		506.81		896.41	
Land. (SOP)(t)		12,284		333		12,438		25,055
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	329.79	15.9	0.75	16.8	191.92	16.8	522.46	16.2
2	42.28	45.6	0.16	48.0	41.81	48.0	84.25	46.8
3	26.13	76.6	0.13	68.5	32.11	68.5	58.37	72.1
4	29.86	90.4	0.14	75.7	35.56	75.7	65.56	82.4
5	20.30	127.2	0.06	103.1	15.55	103.1	35.91	116.7
6	10.28	150.4	0.04	126.4	9.08	126.4	19.40	139.1
7	6.89	188.9	0.01	173.1	3.45	173.1	10.35	183.6
8+	4.22	186.0	0.01	197.5	2.99	197.5	7.22	190.8
TOTAL	469.75		1.30		332.47		803.52	
Land. (SOP)(t)		18,086		55		14,061		32,203
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	70.39	9.3	1.22	9.3	161.92	9.3	233.53	9.3
1	24.79	34.1	0.39	34.4	51.61	34.4	76.78	34.3
2	2.07	53.8	0.04	63.1	5.88	63.1	7.99	60.7
3	1.68	62.4	0.07	80.6	8.62	80.6	10.36	77.6
4	1.69	71.7	0.07	86.4	9.33	86.4	11.08	84.2
5	0.09	115.6	0.02	103.3	3.26	103.3	3.38	103.6
6	0.54	101.3	0.02	101.7	2.77	101.7	3.33	101.6
7	0.01	144.4			0.33	119.2	0.34	119.8
8+					0.14	161.7	0.14	161.7
TOTAL	101.24		1.84		243.87		346.94	
Land. (SOP)(t)		1,903		44		5,833		7,780
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	133.99	9.3	16.30	9.3	107.17	9.3	257.46	9.3
1	47.18	34.1	5.92	34.0	38.94	34.0	92.04	34.1
2	3.96	54.0	1.27	63.2	8.32	63.2	13.55	60.5
3	3.26	63.1	1.57	78.4	10.33	78.4	15.16	75.1
4	3.28	72.4	1.23	97.5	8.07	97.5	12.58	91.0
5	0.21	115.6	0.24	95.5	1.57	95.5	2.02	97.6
6	1.05	101.5	0.21	103.3	1.40	103.3	2.66	102.6
7	0.02	144.4	0.02	92.7	0.10	92.7	0.14	100.1
8+	0.01	161.7					0.01	161.7
TOTAL	192.96		26.75		175.91		395.62	
Land. (SOP)(t)		3,649		722		4,748		9,118
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	204.38	9.3	17.52	9.3	269.09	9.3	490.99	9.3
1	677.43	16.2	17.26	20.2	663.49	16.4	1358.18	16.3
2	99.94	41.7	3.47	47.5	130.54	43.5	233.95	42.8
3	47.87	68.3	2.50	72.5	78.52	68.1	128.88	68.3
4	38.20	91.9	1.73	98.3	64.08	86.8	104.01	88.9
5	28.57	140.1	0.44	108.0	24.56	108.6	53.57	125.4
6	21.22	167.5	0.38	123.4	17.22	129.9	38.82	150.4
7	14.15	200.6	0.10	176.1	6.62	178.0	20.87	193.3
8+	8.24	205.9	0.06	226.9	4.92	209.7	13.22	207.4
TOTAL	1139.98		43.46		1259.06		2442.49	
Land. (SOP)(t)		35,922		1,154		37,081		74,157

* German landings from Sub-Division 22 and 24 are listed under Sub-Division 22.

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Table 3.3.4 Skagerrak 1995 North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.39	58.8	41.59	15.8	107.55	24.6	149.53	22.2
2	30.72	156.0	0.53	32	15.40	55.7	46.65	121.5
3								
4								
5								
6								
7								
8+								
TOTAL	31.11		42.12		122.95		196.18	
Land. (SOP)(t)		4,815		674		3,499		8,988
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	14.68	36.4			158.18	28.9	172.86	29.6
2	9.58	96.4			10.88	60.8	20.46	77.5
3								
4								
5								
6								
7								
8+								
TOTAL	24.26		0.00		169.06		193.32	
Land. (SOP)(t)		1,458		0		5,237		6,695
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			67.35	13.2	801.26	9.1	868.61	9.4
1	68.10	78.0	2.30	30.1	69.89	58.9	140.29	67.7
2	5.84	138.0	0.04	107.0	6.74	96.3	12.62	115.6
3								
4								
5								
6								
7								
8+								
TOTAL	73.94		69.69		877.89		1021.52	
Land. (SOP)(t)		6,114		963		12,055		19,132
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.49	10.6	63.32	15.7	220.47	19.1	287.28	18.2
1	25.60	87.0	1.82	38.2	10.25	53.4	37.67	75.5
2	18.86	132.4	0.07	46.0	1.27	76.2	20.20	128.6
3								
4								
5								
6								
7								
8+								
TOTAL	47.95		65.21		231.99		345.15	
Land. (SOP)(t)		4,762		1,067		4,855		10,684
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.49	10.6	130.67	14.4	1021.73	11.3	1155.89	11.6
1	108.77	74.4	45.71	17.4	345.87	34.4	500.35	41.5
2	65.00	138.8	0.64	38.2	34.29	66.1	99.93	113.2
3								
4								
5								
6								
7								
8+								
TOTAL	177.26		177.02		1401.89		1756.17	
Land. (SOP)(t)		17,149		2,703		25,646		45,499

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Table 3.3.5 **Kattegat 1995** **North Sea Autumn Spawners**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	17.30	28.8	189.17	14.3	118.07	21.9	324.54	17.8
2	9.27	71.2	1.79	30.9	5.38	34.8	16.44	54.9
3								
4								
5								
6								
7								
8+								
TOTAL	26.57		190.96		123.45		340.98	
Land. (SOP)(t)		1,158		2,760		2,773		6,691
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	9.59	33.1			78.18	34.6	87.77	34.5
2	3.25	79.7			2.60	46.6	5.85	65.0
3								
4								
5								
6								
7								
8+								
TOTAL	12.84		0.00		80.78		93.62	
Land. (SOP)(t)		576		0		2,829		3,405
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			11.99	13.2	368.92	13.2	380.91	13.2
1	7.92	64.9	3.71	30.2	114.10	30.2	125.73	32.4
2	1.34	102.7	0.02	55.3	0.75	55.3	2.11	85.4
3								
4								
5								
6								
7								
8+								
TOTAL	9.26		15.72		483.77		508.75	
Land. (SOP)(t)		651		271		8,357		9,280
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.15	15.7	33.68	19.1	150.21	16.6	186.04	17.0
1	13.78	61.2	0.27	40.5	17.14	34.9	31.19	46.6
2	1.80	108.7			0.24	43.2	2.04	101.0
3								
4								
5								
6								
7								
8+								
TOTAL	17.73		33.95		167.59		219.27	
Land. (SOP)(t)		1,073		654		3,102		4,829
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.15	15.7	45.67	17.6	519.13	14.2	566.95	14.5
1	48.59	44.7	193.15	14.6	327.49	28.5	569.23	25.2
2	15.66	80.0	1.81	31.2	8.97	40.2	26.44	63.1
3								
4								
5								
6								
7								
8+								
TOTAL	66.40		240.63		855.59		1162.62	
Land. (SOP)(t)		3,459		3,686		17,061		24,206

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Table 3.3.6 **Skagerrak 1995** **Baltic Spring Spawners**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.15	42.5	15.38	15.8	39.78	24.6	55.31	22.2
2	26.14	84.3	0.46	32	13.11	55.7	39.71	74.2
3	5.72	129.3	0.06	149	1.09	129.0	6.87	129.4
4	0.58	167.1			0.36	144.0	0.94	158.2
5	0.21	183.7					0.21	183.7
6	0.12	198.2					0.12	198.2
7	0.12	203.8					0.12	203.8
8+	0.14	233.9					0.14	233.9
TOTAL	33.18		15.90		54.34		103.42	
Land. (SOP)(t)		3,165		267		1,899		5,331
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.94	36.4			10.10	28.9	11.04	29.6
2	14.37	96.4			16.33	60.8	30.70	77.5
3	14.29	154.9			3.58	73.6	17.87	138.7
4	9.08	166.4			3.15	80.2	12.23	144.2
5	2.83	180.9			0.83	94.2	3.66	161.3
6	2.40	195.3			0.08	110.0	2.48	192.6
7	1.43	202.4			0.08	142.0	1.51	199.2
8+	1.98	205.4					1.98	205.4
TOTAL	47.32		0.00		34.15		81.47	
Land. (SOP)(t)		6,822		0		1,900		8,722
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			0.00	13.2	0.00	9.1		
1	58.02	78.0	1.95	30.1	59.53	58.9	119.50	67.7
2	47.26	138.0	0.32	107.0	54.55	96.3	102.13	115.6
3	35.46	167.8			15.37	109.3	50.83	150.1
4	21.12	185.5			10.95	141.7	32.07	170.5
5	7.06	212.5			29.16	182.0	36.22	188.0
6	3.22	231.1			1.95	205.5	5.17	221.5
7	1.56	282.6					1.56	282.6
8+	0.48	249.0					0.48	249.0
TOTAL	174.18		2.27		171.51		347.96	
Land. (SOP)(t)		23,714		93		17,703		41,510
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.39	10.6	7.04	15.7	24.50	19.1	31.93	18.2
1	7.22	87.0	0.51	38.2	2.89	53.4	10.62	75.5
2	20.17	132.4	0.08	46	1.37	76.2	21.62	128.6
3	22.62	163.8			0.53	127.0	23.15	163.0
4	9.16	168.1			0.53	152.0	9.69	167.2
5	1.65	180.7					1.65	180.7
6	1.30	211.2					1.30	211.2
7	2.40	235.6			1.05	208.5	3.45	227.3
8+	0.18	212.7					0.18	212.7
TOTAL	65.09		7.63		30.86		103.58	
Land. (SOP)(t)		9,725		134		1,093		10,952
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.39	10.6	7.04	15.7	24.50	19.1	31.93	18.2
1	66.33	78.3	17.84	18.0	112.30	43.9	196.47	53.2
2	107.94	118.4	0.86	61.2	85.36	83.0	194.16	102.6
3	78.09	161.5	0.06	149.0	20.57	104.6	98.72	149.6
4	39.94	176.9			14.99	129.2	54.93	163.9
5	11.75	199.9			29.99	179.6	41.74	185.3
6	7.04	214.7			2.03	201.7	9.07	211.8
7	5.51	239.6			1.13	203.8	6.64	233.5
8+	2.78	214.8					2.78	214.8
TOTAL	319.77		25.80		290.86		636.43	
Land. (SOP)(t)		43,427		493		22,595		66,515

Table 3.3.7 **Kattegat 1995** **Baltic Spring Spawning Herring**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	5.76	28.8	63.06	14.3	39.36	21.9	108.18	17.8
2	9.26	71.2	1.79	30.9	5.37	34.8	16.42	54.9
3	9.10	110.2					9.10	110.2
4	7.30	158.8					7.30	158.8
5	3.05	192.5					3.05	192.5
6	1.88	197.0					1.88	197.0
7	0.93	240.4					0.93	240.4
8+	0.79	269.3					0.79	269.3
TOTAL	38.07		64.85		44.73		147.65	
Land. (SOP)(t)		4,380		957		1,049		6,386
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	3.03	28.8			24.69	21.9	27.72	22.7
2	3.25	71.2			2.59	34.8	5.84	55.0
3	3.79	110.2					3.79	110.2
4	3.36	158.8					3.36	158.8
5	1.12	192.5					1.12	192.5
6	0.97	197.0					0.97	197.0
7	0.78	240.4					0.78	240.4
8+	0.48	269.3					0.48	269.3
TOTAL	16.78		0.00		27.28		44.06	
Land. (SOP)(t)		1,993		0		631		2,624
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	5.51	64.9	2.57	30.2	79.29	30.2	87.37	32.4
2	5.03	102.7	0.09	55.3	2.82	55.3	7.94	85.3
3	4.46	138.8					4.46	138.8
4	6.01	165.8	0.04	87	1.19	87.0	7.24	152.4
5	2.25	204.4					2.25	204.4
6	1.39	209.0					1.39	209.0
7	0.62	229.8					0.62	229.8
8+	0.45	227.8					0.45	227.8
TOTAL	25.72		2.70		83.30		111.72	
Land. (SOP)(t)		3,484		86		2,654		6,224
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.60	15.7	9.50	19.1	42.37	16.6	52.47	17.0
1	30.67	61.2	0.61	40.5	38.15	34.9	69.43	46.6
2	7.65	108.7			1.00	43.2	8.65	101.1
3	4.92	149.6					4.92	149.6
4	5.42	196.3					5.42	196.3
5	2.14	210.0					2.14	210.0
6	1.26	230.2					1.26	230.2
7	0.77	229.8					0.77	229.8
8+	0.31	260.0						
TOTAL	53.74		10.11		81.52		145.06	
Land. (SOP)(t)		5,516		206		2,078		7,720
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.60	15.7	9.50	19.1	42.37	16.6	52.47	17.0
1	44.97	55.3	66.24	15.2	181.49	28.3	292.70	29.5
2	25.19	88.9	1.88	32.1	11.78	40.4	38.85	71.4
3	22.27	124.6					22.27	124.6
4	22.09	169.9	0.04	87.0	1.19	87.0	23.32	165.5
5	8.56	200.0					8.56	200.0
6	5.50	207.6					5.50	207.6
7	3.10	235.7					3.10	235.7
8+	2.03	258.7					2.03	258.7
TOTAL	134.31		77.66		236.83		448.80	
Land. (SOP)(t)		15,374		1,249		6,412		23,035

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Table 3.3.8 **Total catch of Spring Spawners by Sub-divisions in 1995.**

Numbers (millions) at age (rings) and SOP (t) by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	SOP
1	North Sea										0
	Skagerrak		55.31	39.71	6.87	0.94	0.21	0.12	0.12	0.14	5,331
	Kattegat		108.18	16.42	9.10	7.30	3.05	1.88	0.93	0.79	6,386
	Sub-div 22-24		666.89	128.16	44.99	14.79	12.26	13.43	10.04	5.85	25,055
	Total		830.38	184.29	60.96	23.03	15.52	15.43	11.09	6.78	36,772
2	North Sea			15.30							2,054
	Skagerrak		11.04	30.70	17.87	12.23	3.66	2.48	1.51	1.98	8,722
	Kattegat		27.72	5.84	3.79	3.36	1.12	0.97	0.78	0.48	2,624
	Sub-div 22-24		522.46	84.25	58.37	65.56	35.91	19.40	10.35	7.22	32,203
	Total		561.22	136.09	80.03	81.15	40.69	22.85	12.64	9.68	45,603
3	North Sea		15.10	5.80	11.30	3.00	2.20	1.50	0.40	0.20	7,413
	Skagerrak		119.50	102.13	50.83	32.07	36.22	5.17	1.56	0.48	41,510
	Kattegat		87.37	7.94	4.46	7.24	2.25	1.39	0.62	0.45	6,224
	Sub-div 22-24	233.53	76.78	7.99	10.36	11.08	3.38	3.33	0.34	0.14	7,780
	Total	233.53	298.75	123.86	76.95	53.39	44.05	11.39	2.92	1.27	62,927
4	North Sea										0
	Skagerrak	31.93	10.62	21.62	23.15	9.69	1.65	1.30	3.45	0.18	10,952
	Kattegat	52.47	69.43	8.65	4.92	5.42	2.14	1.26	0.77		7,720
	Sub-div 22-24	257.46	92.04	13.55	15.16	12.58	2.02	2.66	0.14	0.01	9,118
	Total	341.86	172.09	43.82	43.23	27.69	5.81	5.22	4.36	0.19	27,790
Total Year	North Sea	0.00	15.10	21.10	11.30	3.00	2.20	1.50	0.40	0.20	9,467
	Skagerrak	31.93	196.47	194.16	98.72	54.93	41.74	9.07	6.64	2.78	66,515
	Kattegat	52.47	292.70	38.85	22.27	23.32	8.56	5.50	3.10	1.72	22,954
	Sub-div 22-24	490.99	1358.17	233.95	128.88	104.01	53.57	38.82	20.87	13.22	74,156
	Total	575.39	1862.44	488.06	261.17	185.26	106.07	54.89	31.01	17.92	173,092

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8+
1	North Sea									
	Skagerrak		22.2	74.2	129.4	158.2	183.7	198.2	203.8	233.9
	Kattegat		17.8	54.9	110.2	158.8	192.5	197.0	240.4	269.3
	Sub-div 22-24		11.9	37.2	58.9	119.2	161.5	188.2	207.1	229.2
	Total		13.4	46.7	74.5	133.3	167.9	189.3	209.9	234.0
2	North Sea			134						
	Skagerrak		29.6	77.5	138.7	144.2	161.3	192.6	199.2	205.4
	Kattegat		22.7	55.0	110.2	158.8	192.5	197.0	240.4	269.3
	Sub-div 22-24		16.2	46.8	72.1	82.4	116.7	139.1	183.6	190.8
	Total		16.8	63.9	88.8	94.9	122.8	147.4	189.0	197.7
3	North Sea			169.0	183.0	195.0	208.0	240.0	208.0	248.3
	Skagerrak		67.7	115.6	150.1	170.5	188.0	221.5	282.6	249.0
	Kattegat		32.4	85.3	138.8	152.4	204.4	209.0	229.8	227.8
	Sub-div 22-24	9.3	34.3	60.7	77.6	84.2	103.6	101.6	119.8	161.7
	Total	9.3	45.4	112.6	144.5	151.5	183.4	187.4	242.2	231.8
4	North Sea									
	Skagerrak	18.2	75.5	128.6	163.0	167.2	180.7	211.2	227.3	212.7
	Kattegat	17.0	46.6	101.1	149.6	196.3	210.0	230.2	229.8	
	Sub-div 22-24	9.3	34.1	60.5	75.1	91.0	97.6	102.6	100.1	161.7
	Total	11.3	41.7	102.1	130.6	138.3	162.6	160.4	223.7	210.0
Total Year	North Sea			143.6	183.0	195.0	208.0	240.0	208.0	248.3
	Skagerrak	18.2	53.2	102.6	149.6	163.9	185.3	211.8	233.5	214.8
	Kattegat	17.0	29.5	71.4	124.6	165.5	200.0	207.6	235.6	258.4
	Sub-div 22-24	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.5
	Total	10.5	22.1	73.2	108.8	122.5	156.7	168.7	206.3	214.0

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Table 3.3.9 Total catch of North Sea Autumn Spawners in Division IIIa in1995

Numbers (millions) at age (rings) and SOP (t) by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	SOP
1	Skagerrak		149.53	46.65							8,988
	Kattegat		324.54	16.44							6,691
	Total		474.07	63.09							15,679
2	Skagerrak		172.86	20.46							6,695
	Kattegat		87.77	5.85							3,405
	Total		260.63	26.31							10,100
3	Skagerrak	868.61	140.29	12.62							19,132
	Kattegat	380.91	125.73	2.11							9,280
	Total	1249.52	266.02	14.73							28,412
4	Skagerrak	287.28	37.67	20.20							10,684
	Kattegat	186.04	31.19	2.04							4,829
	Total	473.32	68.86	22.24							15,513
Total Year	Skagerrak	1155.89	500.35	99.93							45,499
	Kattegat	566.95	569.23	26.44							24,205
	Total	1722.84	1069.58	126.37							69,704

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8+
1	Skagerrak		22.2	121.5						
	Kattegat		17.8	54.9						
	Total		19.2	104.1						
2	Skagerrak		29.6	77.5						
	Kattegat		34.5	65.0						
	Total		31.3	74.7						
3	Skagerrak	9.4	67.7	115.6						
	Kattegat	13.2	32.4	85.4						
	Total	10.6	51.0	111.3						
4	Skagerrak	18.2	75.5	128.6						
	Kattegat	17.0	46.6	101.0						
	Total	17.7	62.4	126.1						
Total Year	Skagerrak	11.6	41.5	113.2						
	Kattegat	14.4	25.2	63.1						
	Total	12.5	32.8	102.7						

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Table 3.3.10 **Western Baltic Spring Spawning Herring**

Landings of Herring from the North Sea, Div. IIIa and the Western Baltic area in 1995
Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: HC in the North S C: Human consumption in Div. IIIa. D: Mixed clupeoid fleet in Div IIIa
E: Industrial fishery (for reduction) in Div IIIa F: Div. 22-24 Fisheries

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
1. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1			5.91	29.16	78.44	14.59	79.14	23.24	666.89	11.92	830.38	13.4
2			35.40	80.85	2.25	31.12	18.48	49.62	128.16	37.17	184.29	46.7
3			14.82	117.6	0.06	149.0	1.09	129.0	44.99	58.9	60.96	74.5
4			7.88	159.4			0.36	144.0	14.79	119.2	23.03	133.4
5			3.26	191.9					12.26	161.5	15.52	167.9
6			2.00	197.0					13.43	188.2	15.43	189.3
7			1.05	236.2					10.04	207.1	11.09	209.8
8+			0.93	264.0					5.85	229.2	6.78	234.0
Total	0.00		71.25	105.9	80.75	15.15	99.07	29.8	896.41	28.0	1147.48	32.0
SOP (t)		0		7,546		1,224		2,948		25,055		36,773
2. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1			3.97	30.60			34.79	23.94	522.46	16.2	561.22	16.8
2	15.30	134.0	17.62	91.8			18.92	57.3	84.25	46.8	136.09	63.9
3			18.08	145.6			3.58	73.6	58.37	72.1	80.03	88.8
4			12.44	164.4			3.15	80.2	65.56	82.4	81.15	94.9
5			3.95	184.2			0.83	94.2	35.91	116.7	40.69	122.8
6			3.37	195.8			0.08	110.0	19.40	139.1	22.85	147.4
7			2.21	215.8			0.08	142.0	10.35	183.6	12.64	189.0
8+			2.46	217.9					7.22	190.8	9.68	197.7
Total	15.30	134.0	64.10	137.5	0.00		61.43	41.2	803.52	40.1	944.35	48.3
SOP (t)		2050		8,815		0		2,531		32,203		45,599
3. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									233.53	9.3	233.53	9.3
1			63.53	76.82	4.52	30.16	138.82	42.53	76.78	34.3	283.65	47.8
2	15.10	169.0	52.29	134.6	0.41	95.65	57.37	94.3	7.99	60.7	133.16	116.6
3	5.80	183.0	39.92	164.5			15.37	109.3	10.36	77.6	71.45	141.6
4	11.30	195.0	27.13	181.1	0.04	87.00	12.14	136.3	11.08	84.2	61.69	157.4
5	3.00	208.0	9.31	210.6			29.16	182.0	3.38	103.6	44.85	183.8
6	2.20	240.0	4.61	224.4			1.95	205.5	3.33	101.6	12.09	190.4
7	1.50	208.0	2.18	267.6					0.34	119.8	4.02	232.8
8+	0.60	248.0	0.93	238.7					0.14	161.7	1.67	235.4
Total	39.50	188.1	199.90	136.1	4.97		254.81	79.9	346.94	22.4	846.12	74.4
SOP (t)		7430		27,198		179		20,357		7,780		62,945
4. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			0.99	13.69	16.54	17.65	66.87	17.52	257.46	9.3	341.85	11.3
1			37.89	66.14	1.12	39.45	41.05	36.20	92.04	34.1	172.10	41.7
2			27.82	125.9	0.08	46.00	2.37	62.2	13.55	60.5	43.82	102.1
3			27.54	161.3			0.53	127.0	15.16	75.1	43.23	130.6
4			14.58	178.6			0.53	152.0	12.58	91.0	27.69	138.3
5			3.79	197.2					2.02	97.6	5.81	162.6
6			2.56	220.5					2.66	102.6	5.22	160.5
7			3.17	234.2			1.05	208.5	0.14	100.1	4.36	223.7
8+			0.49	242.6					0.01	161.7	0.50	241.0
Total	0.00		118.83	128.3	17.74		112.39	28.2	395.62	23.0	644.58	43.2
SOP (t)		0.0		15,241		340		3,171		9,118		27,870
Total Year												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			0.99	13.7	16.54	17.7	66.87	17.5	490.99	9.3	575.39	10.5
1			111.30	69.0	84.08	15.8	293.79	34.2	1358.18	16.3	1847.35	22.3
2	30.40	151.4	133.13	112.8	2.74	41.2	97.14	77.8	233.95	42.8	497.36	75.0
3	5.80	183.0	100.36	153.3	0.06	149.0	20.57	104.6	128.88	68.3	255.67	107.2
4	11.30	195.0	62.03	174.4	0.04	87.0	16.18	126.1	104.01	88.9	193.56	125.6
5	3.00	208.0	20.31	200.0			29.99	179.6	53.57	125.4	106.87	157.1
6	2.20	240.0	12.54	211.6			2.03	201.7	38.82	150.4	55.59	169.6
7	1.50	208.0	8.61	238.2			1.13	203.8	20.87	193.3	32.11	206.4
8+	0.60	248.0	4.81	233.3					13.22	207.4	18.63	215.4
Total	54.80	173.0	454.08	129.5	103.46	16.84	527.69	55.0	2442.49	30.4	3582.53	48.3
SOP (t)		9,480		58,800		1,743		29,007		74,157		173,187

Table 3.3.11 **Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea in the year 1987 - 1995.**

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
1987	Mean W.			57.0	85.0	105.6	145.3	154.6	201.2	280.4	
	SOP			43,719	14,204	8,754	4,025	1,438	241	56	72,437
	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181
	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Mean W.			127.2	120.1	148.6	165.3	190.6	204.1	216.5	
	SOP			20,014	29,850	20,360	13,257	8,752	3,010	1,819	97,061
	Number	84.4	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1139.73
1995	Mean W.	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	
	SOP	1,477	19,061	25,716	19,619	13,447	9,907	3,423	2,364	1,091	96,104

There may be minor corrections in data from 1987 and 1988.

Table 3.3.12 **Herring Division IIIa, 1987 - 1995 Transfers of autumn spawners from Div. IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes).**

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number	6238.00	3153.00	117.00							9508.00
1987	Mean W.	8.0	33.0	63.0							
	SOP	49,904	104,049	7,371							161,324
	Number	1830.00	5792.00	292.00							7914.00
1988	Mean W.	12.0	28.0	57.0							
	SOP	21,960	162,176	16,644							200,780
	Number	1,028.20	1,170.50	654.80							2853.50
1989	Mean W.	16.2	33.4	53.3							
	SOP	16,657	39,095	34,901							90,652
	Number	397.90	1,424.30	283.70							2105.90
1990	Mean W.	31.0	34.1	55.4							
	SOP	12,335	48,569	15,717							76,621
	Number	712.30	822.70	330.20							1865.20
1991	Mean W.	25.3	40.7	77.8							
	SOP	18,021	33,484	25,690							77,195
	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
1992	Mean W.	12.3	50.6	94.8	164	171.7	184.7	197.5	202.7	219.8	
	SOP	29,612	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
	Number	2,956.70	2,351.10	350.01							5,658
1993	Mean W.	12.7	27.5	86.6							
	SOP	37,550	64,655	30,311							132,516
	Number	542.23	1,239.65	305.19							2,087
1994	Mean W.	16.5	42.9	77.3							
	SOP	8,947	53,181	23,591							85,719
	Number	1722.84	1069.58	126.37							2918.79
1995	Mean W.	12.5	32.8	102.7							
	SOP	21,536	35,082	12,978							69,596

There are minor corrections for the years previous to 1991.

Table 3.3.13 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1987 - 1995

Year	Area	Rings	0	1	2	3	4	5	6	7	8+	Total
	North Sea +Div. IIIa	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
1987	Sub-Division 22-24	Number	771.20	1,090.00	221.00	220.00	311.00	97.00	28.00	8.00	4.00	2,750.20
	North Sea +Div. IIIa	Number			2,075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Sub-Division 22-24	Number	789.50	861.00	364.00	363.00	142.00	119.00	34.00	10.00	6.00	2,688.50
	North Sea +Div. IIIa	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Sub-Division 22-24	Number	129.70	682.00	285.00	386.00	244.00	59.00	34.00	11.00	4.00	1,834.70
	North Sea +Div. IIIa	Number		140.90	1,006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Sub-Division 22-24	Number	160.50	286.30	162.10	215.10	263.90	105.90	27.00	12.30	4.40	1,237.50
	North Sea +Div. IIIa	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Sub-Division 22-24	Number	22.34	787.65	179.89	184.82	114.88	67.59	25.97	6.14	1.81	1,391.09
	North Sea +Div. IIIa	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Sub-Division 22-24	Number	36.01	210.71	280.77	190.84	179.52	104.87	84.01	34.75	14.04	1,135.52
	North Sea +Div. IIIa	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Sub-Division 22-24	Number	44.85	159.21	180.13	196.06	166.87	151.07	61.80	42.21	16.31	1,018.51
	North Sea +Div. IIIa	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Sub-Division 22-24	Number	202.58	96.29	103.84	161.01	136.06	90.84	74.02	35.11	24.47	924.22
	North Sea +Div. IIIa	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Sub-Division 22-24	Number	490.99	1,358.18	233.95	128.88	104.01	53.57	38.82	20.87	13.22	2,442.49

Table 3.3.14 Mean weight (g) and SOP (tonnes) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1987 - 1995

Year	Area	Rings	0	1	2	3	4	5	6	7	8+	SOP
	North Sea +Div. IIIa	Mean weight			57.0	85.0	105.6	145.3	154.6	201.2	280.4	72,437
1987	Sub-Division 22-24	Mean weight	11.7	15.7	34.8	76.7	98.4	121.9	141.4	151.4	163.4	89,954
	North Sea +Div. IIIa	Mean weight			47.3	77.0	138.3	156.0	166.0	149.0	209.0	151,832
1988	Sub-Division 22-24	Mean weight	11.0	16.9	29.1	83.8	108.5	124.8	142.2	143.7	135.8	92,908
	North Sea +Div. IIIa	Mean weight			56.5	79.9	125.5	151.6	167.3	189.2	204.8	91,145
1989	Sub-Division 22-24	Mean weight	13.5	17.5	43.6	70.5	105.9	122.0	125.5	137.8	131.5	91,002
	North Sea +Div. IIIa	Mean weight		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	125,915
1990	Sub-Division 22-24	Mean weight	13.8	24.2	44.5	75.5	95.9	121.1	142.6	138.7	145.8	73,978
	North Sea +Div. IIIa	Mean weight	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	121,641
1991	Sub-Division 22-24	Mean weight	11.5	31.5	58.5	78.8	98.5	120.9	138.6	152.2	179.0	82,390
	North Sea +Div. IIIa	Mean weight		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	83,234
1992	Sub-Division 22-24	Mean weight	19.1	23.3	44.8	77.4	99.2	123.3	152.9	166.2	184.2	84,874
	North Sea +Div. IIIa	Mean weight		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	89,181
1993	Sub-Division 22-24	Mean weight	16.2	24.5	44.5	73.6	94.1	122.4	149.4	168.5	169.1	80,358
	North Sea +Div. IIIa	Mean weight			127.2	120.1	148.6	165.3	190.6	204.1	216.5	97,061
1994	Sub-Division 22-24	Mean weight	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9	66,425
	North Sea +Div. IIIa	Mean weight	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	96,102
1995	Sub-Division 22-24	Mean weight	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.4	74,157

There may be minor corrections in data from 1987 and 1988.

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Table 3.4.1 **Herring in Division IIIa, IIIb and IIIc.**
Samples of commercial catches by quarter and Sub-Div. for 1995 available to the Working Group.

Skagerrak	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	3.7	17	1584	1213
		2	2.9	14	412	356
		3	29.5	27	2,038	1,934
		4	7.7	24	1,298	1149
		Total	43.8	48	4,060	1,865
	Norway	1				
		2	2.6	1	100	100
		3	6.7	1	100	100
		4	7.4			
			16.7	2	200	200
	Sweden	1	8.5	17	1,697	557
		2	10.4	18	2,548	1,005
		3	22.6	32	2,030	567
		4	7.0	13	2,461	632
		Total	48.5	80	8,736	2,761
Kattegat	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	8.1	6	718	717
		2	1.6	2	240	236
		3	2.4	4	531	531
		4	4.9	7	788	786
		Total	17.0	32	2,504	1,555
	Sweden	1	5.0	24	4,206	752
		2	4.5	38	8,124	1,486
		3	13.2	20	1755	368
		4	8.0	8	1,167	138
		Total	30.7	28	15,252	2,744
Sub-Division 22-24	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	13.0	1	153	153
		2	17.1	3	621	621
		3	1.9			
		4	5.8	2	203	203
		Total	37.8	6	977	977
	Germany	1	6.2	22	4,138	997
		2	7.0	25	5,692	1,598
		3	0.1			
		4	0.1	45	8,750	889
		Total	13.4	92	18,580	3,484
	Poland	1	2.3	3	965	316
		2	4.7	9	4,211	876
		3	+	1	577	98
		4	+	1	119	78
		Total	7.0	14	5,872	1,368
	Sweden	1	3.8			
		2	3.4			
		3	5.7			
		4	2.9	35	5,269	514
		Total	15.8	35	5,269	514

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Table 3.5.1
Acoustic surveys on the Spring-spawning HERRING in
the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1992.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		3,412	3,412
1		1,658	1,658
2	1,789	657	2,446
3	1,758	282	2,040
4	1,590	156	1,746
5	518	37	555
6	146	25	171
7	111	4	115
8+	15		15
Total	5,927	6,231	12,158
3+ group	5,912	504	4,642

Biomass ('000 tonnnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		53.2	53.2
1		61.3	61.3
2	157.8	39.6	197.3
3	191.8	20.6	212.4
4	198.8	14.4	213.1
5	73.3	4.6	77.9
6	24.1	3.3	27.4
7	21.1	0.7	21.8
8+	3.0		3.0
Total	669.8	197.7	867.5

Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		15.6	15.6
1		37.0	37.0
2	88.2	60.2	80.7
3	109.1	73.0	104.1
4	125.0	92.1	122.1
5	141.5	125.6	140.4
6	164.8	132.0	160.0
7	190.2	168.1	189.4
8+	201.5		201.5
Mean weight	113.0	31.7	71.4

Table 3.5.2
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1993.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0		1,414	1,414
1		466	466
2	2,627	393	3,020
3	1,102	518	1,620
4	472	402	874
5	336	145	481
6	124	64	188
7	30	31	61
8+	4	16	20
Total	4,695	3,449	8,144
3+ group	2,068	1,176	3,244
Biomass ('000 tonnnes)			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0		21	21
1		16	16
2	152	18	170
3	93	34	127
4	48	28	76
5	46	16	63
6	19	9	29
7	8	4	12
8+	1	3	3
Total	367	150	517
Mean weight (g)			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0		14.9	14.9
1		35.2	35.2
2	57.9	45.6	56.3
3	84.2	65.8	78.3
4	101.8	69.7	87.0
5	138.1	111.2	130.0
6	157.1	146.2	153.4
7	255.6	125.4	189.4
8+	145.0	171.3	166.0
Mean weight	78.2	43.4	63.4

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Table 3.5.3
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1994. (North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		6,749	6,749
1		457	457
2	349	831	1,180
3	829	525	1,354
4	469	449	918
5	215	195	410
6	156	63	219
7	53	25	78
8+	20	2	22
Total	2,091	9,295	11,386
3+ group	1,742	1,258	3,000

Biomass ('000 tonnnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		77.0	77.0
1	0.0	16.0	16.0
2	38.4	38.1	76.5
3	103.8	38.8	142.6
4	71.9	43.2	115.1
5	37.8	24.9	62.7
6	30.9	12.9	43.9
7	10.9	5.0	15.9
8+	4.5	0.0	4.5
Total	298.1	255.9	554.1

Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		11.4	11.4
1		34.9	34.9
2	110.0	45.8	64.8
3	125.2	73.8	105.3
4	153.2	96.3	125.4
5	176.0	127.7	153.0
6	198.3	206.3	200.6
7	205.4	204.5	205.1
8+	222.8		202.5
Mean weight	142.6	27.5	48.7

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Table 3.5.4
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1995. (North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		4,765	4,765
1		1,315	1,315
2	1,631	353	1,984
3	1,073	354	1,427
4	1,377	375	1,752
5	281	269	550
6	196	133	329
7	47	37	84
8+	42	25	67
Total	4,647	7,626	12,273
3+ group	3,016	1,193	4,209

Biomass ('000 tonnnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		51.5	51.5
1	0.0	44.4	44.4
2	97.4	22.4	119.7
3	100.6	30.6	131.3
4	152.6	41.1	193.7
5	36.8	27.1	63.9
6	30.7	13.9	44.6
7	7.8	7.6	15.4
8+	7.8	5.4	13.2
Total	433.6	244.2	677.8

Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		10.8	10.8
1		33.8	33.8
2	59.7	63.4	60.3
3	93.8	86.6	92.0
4	110.8	109.7	110.6
5	130.8	100.8	116.1
6	156.6	104.4	135.5
7	165.4	206.0	183.3
8+	184.8	217.5	197.0
Mean weight	93.3	32.0	55.2

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Table 3.5.5

Biomass of herring in tonnes per square nautical mile divided by stratum and survey (month) during periode September 1993 to May 1995. Grand total is the total amount of herring in tonnes in the whole Sound area.

Biomass in tonnes per NM**2.															
Survey	S-09-93	S-10-93	S-11-12-93	S-01-94	S-02-94	S-03-94	S-04-94	S-10-94	S-11-94	S-12-94	S-01-95	S-02-95	S-03-95	S-04-95	S-05-95
Strata															
G01	557.74	324.20	-	-	-	-	16.34	312.89	49.73	480.85	142.86	25.80	219.43	32.00	31.49
G02	737.93	453.03	506.01	530.49	149.59	93.59	40.60	487.41	78.85	281.55	169.13	95.15	104.57	37.45	55.32
G03	651.81	551.39	490.77	847.32	1,174.19	142.17	77.28	632.76	64.06	490.83	235.55	107.03	157.63	70.25	45.03
G04	726.00	448.47	256.90	451.08	1,339.29	101.90	40.74	591.81	244.56	371.29	174.97	32.50	229.97	50.33	45.14
G05	407.88	453.94	179.74	313.91	503.28	81.60	20.89	410.60	315.75	127.91	255.39	32.62	82.20	41.26	78.24
G06	568.71	412.26	176.89	281.67	487.33	91.95	26.03	424.05	381.70	204.50	219.35	26.68	34.85	83.82	61.31
G07	541.65	265.61	266.47	218.02	96.93	114.54	12.38	292.39	286.52	195.40	136.77	30.80	60.86	143.87	55.81
G08	398.25	398.70	62.93	211.75	-	-	8.14	390.79	437.33	233.76	124.80	33.97	30.33	27.86	41.74
G09	433.94	420.30	415.38	131.55	130.30	-	4.05	578.28	226.47	211.04	242.11	69.16	29.23	31.21	52.85
G10	414.59	188.62	297.97	71.85	55.85	-	4.52	151.39	403.55	172.25	8.13	16.51	31.87	20.79	88.01
G11	194.88	319.68	257.64	113.86	4.34	-	3.31	57.68	72.88	100.86	7.27	3.81	49.59	8.53	-
G12	157.34	34.68	35.09	3.99	1.74	-	1.38	1.34	4.43	2.93	6.99	0.76	4.03	4.55	0.19
G13	-	-	-	-	-	-	-	1.62	2.87	3.02	-	-	-	-	1.79
MEAN	482.56	355.91	267.80	288.68	394.28	104.29	21.31	333.31	197.59	221.25	143.61	39.57	86.21	45.99	42.64
MIN	157.34	34.68	35.09	3.99	1.74	81.60	1.38	1.34	2.87	2.93	6.99	0.76	4.03	4.55	-
MAX	737.93	551.39	506.01	847.32	1,339.29	142.17	77.28	632.76	437.33	490.83	255.39	107.03	229.97	143.87	88.01
Grand Total	130,241.01	96,741.95	69,504.27	71,711.28	84,533.13	15,291.28	5,342.55	99,723.53	67,146.45	60,499.38	40,369.97	10,738.89	19,673.69	14,651.56	13,589.99

Table 3.5.6

Number of herring per nautical mile (N/NM2) divided by age for the Sound area by survey (Oct. 1994 to May 1995). Total area of the Sound is NM**2.**

Numbers of herring ('000) per (N/NM**2)															
Survey	S-09-93	S-10-93	S-11-12-93	S-01-94	S-02-94	S-03-94	S-04-94	S-10-94	S-11-94	S-12-94	S-01-95	S-02-95	S-03-95	S-04-95	S-05-95
W-rings															
0															
1								64.1	98.3	61.4	9.6				
2								136.1	174.0	219.5	49.8	29.1	61.3	29.6	65.8
3								460.9	347.0	396.4	159.1	33.7	94.6	53.2	106.4
4								375.0	260.9	211.6	176.8	69.5	112.3	83.9	165.8
5								206.3	200.0	199.4	168.8	48.8	88.5	78.1	138.1
6								265.6	119.5	53.4	75.4	21.7	45.4	46.8	82.9
7								197.6	79.8	36.3	54.6	14.4	27.1	23.1	42.7
8								97.9	54.4	14.8	45.3	13.6	22.4	17.2	32.2
9+								28.6	19.7	5.2	21.2	5.0	13.1	10.2	18.0
Total								1,832.1	1,353.6	1,198.0	760.6	235.8	464.7	342.1	651.9

Table 3.6.1 **Recruitment indices for 1-, 2- and 3+ ringed herring from the IBTS in Division IIIa. Indices are given for autumn and spring spawners based on modal length analysis and vertebral counts.**
The indicis are weighted by area of four depth strata.

INDEX							
	Total		Spring spawners			Autumn spawners	
Year	1-ringers	2-ringers	1-ringers	2-ringers	3+ ringers	1-ringers	2-ringers
1980	2,311	387	1,607	307	162	704	80
1981	3,246	1,393	996	1,318	349	2,250	75
1982	2,560	549	1,408	445	196	1,152	104
1983	5,419	1,063	1,522	946	240	3,897	117
1984	6,035	1,947	2,793	1,419	445	3,242	528
1985	7,994	2,473	-*	1,867	2,037	-*	606
1986	21,489	2,738	-*	1,562	1,897	-*	1,175
1987	11,733	3,671	-*	2,921	1,199	-*	949
1988	67,753	10,095	-*	7,834	7,084	-*	2,161
1989	17,451	4,976	-*	0	3,989	-*	4,976
1990	3,544	3,876	0	3,192	508	3,544	684
1991	3,588	3,749	-*	480	3,392	-*	3,269
1992	5,057	1,934	0	771	1,268	5,057	1,163
1993	26,738	3,165	0	203	264	26,738	2,962
1994	8,777	2,333	0	0	1,148	8,777	2,333
1995	7,114	535	0	0	344	7,114	535
1996 [1]	11,452	3,285	988	1,870	0	10,464	1,415

[1] Separation of spring and autumn spawners as described in section 3.6.2

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Table3.6.2. German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey
Mean catch at age in numbers per haul.

Month	Year	Winter rings 0	1	2	3+	Total numbers	Mean catch in kg. Herring
Nov.	1978	592.72	51.04	32.06	11.81	687.63	13.58
Nov.	1979	8,665.90	240.47	103.36	10.33	9,020.06	89.61
Nov.	1981	332.63	96.79	60.05	21.30	510.77	16.36
Dec.	1982	695.71	108.21	70.63	34.72	909.27	24.57
Dec.	1983	1,995.97	387.11	63.71	46.11	2,492.90	46.68
Nov.	1984	1,581.66	377.15	88.03	24.26	2,071.10	39.79
Nov.	1985	3,085.64	340.92	169.95	74.76	3,671.27	45.99
Dec.	1986	2,984.47	368.35	46.41	69.30	3,468.53	44.42
Nov.	1989	2,881.81	319.38	48.99	55.12	3,305.30	47.76
Nov.	1990	103.92	14.79	21.69	32.90	173.30	7.09
Nov.	1991	117.38	134.20	103.14	144.63	499.35	27.16
Nov.	1992	233.85	88.05	57.15	113.58	492.63	19.86
Nov.	1993	1,744.19	37.10	63.87	544.65	2,389.81	66.46
Nov.	1994	1,020.49	13.21	73.47	583.23	1,690.40	79.34
Nov.	1995	635.09	33.22	47.97	324.98	1,041.27	47.53

Table3.6.3. German Bottom Trawl Survey in Sub-Div. 22.
Young Fish survey
Mean catch at age in numbers per haul.

Month	Year	Winter rings 0	1	2	3+	Total Numbers	Mean catch in kg. Herring
Nov.	1979	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
Nov.	1981	1,033.40	118.85	28.35	9.10	1,189.70	17.69
Dec.	1982	354.00	239.45	44.50	26.20	664.15	19.97
Dec.	1983	7,917.00	834.70	80.10	29.50	8,861.30	117.51
Nov.	1984	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
Nov.	1985	3,506.20	958.80	219.80	25.25	4,710.05	83.38
Nov.	1986	6,863.75	175.35	16.55	5.60	7,061.25	54.18
Nov.	1989	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
Nov.	1992	572.68	87.68	19.16	17.26	696.78	13.13
Nov.	1993	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
Nov.	1994	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65
Nov.	1995	1,226.63	158.75	29.00	123.31	1,537.69	31.17

Table3.6.4. German Bottom Trawl Survey in Sub-Div. 22 and 24.
Young Fish survey
Mean catch at age in numbers per haul.
Sum weighted by area of sub-division :

Area of 24 is	2325 sq.nm
Area of 22 is	485 sq.nm
Total	2810 sq.nm

Month	Year	Winter rings 0	1	2	3+	Total Numbers	Mean catch in kg. Herring
Nov.	1979	7784.9	433.5	109.2	9.9	8337.5	89.1
Nov.	1981	453.6	100.6	54.6	19.2	628.0	16.6
Dec.	1982	636.7	130.9	66.1	33.2	867.0	23.8
Dec.	1983	3017.9	464.4	66.5	43.2	3592.1	58.9
Nov.	1984	2447.2	628.0	98.8	27.1	3201.0	58.4
Nov.	1985	3158.2	447.6	178.6	66.2	3850.6	52.4
Nov.	1986	3654.0	335.0	41.3	58.3	4088.6	46.1
Nov.	1989	4211.8	513.6	60.9	58.8	4845.1	70.0
Nov.	1992	292.3	88.0	50.6	97.0	527.9	18.7
Nov.	1993	2896.4	314.5	276.1	605.7	4092.6	107.1
Nov.	1994	1216.8	65.7	335.0	538.9	2156.4	89.1
Nov.	1995	737.2	54.9	44.7	290.2	1126.9	44.7

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Table 3.7

Estimation of the herring O-Group (TL>= 30 mm)

Greifswalder Bodden and adjacent waters

(March/April to June)

Year	Number in Millions
1977	2000[1]
1978	100[1]
1979	2200[1]
1980	360[1]
1981	200[1]
1982	180[1]
1983	1760[1]
1984	290[1]
1985	1670[1]
1986	1500[1]
1987	1370[1]
1988	1223[2]
1989	63[2]
1990	57[2]
1991	236[3]
1992	18[3]
1993	199[3]
1994	788[2]
1995	not yet available

[1]Brielmann 1989

[2]not yet published

[3]Mueller & Klenz 1994

Table. 3.8.1 ***WESTERN BALTIC HERRING. Input to ICA. CATCH NUMBERS AT AGE (Millions)***

	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	771.	611.	130.	161.	87.	36.	45.	203.	575.
1	1440.	861.	1232.	427.	831.	278.	212.	96.	1847.
2	988.	2443.	854.	1168.	532.	539.	366.	261.	497.
3	388.	928.	936.	475.	632.	360.	442.	410.	256.
4	394.	205.	359.	456.	290.	318.	268.	273.	194.
5	125.	152.	88.	168.	176.	174.	214.	171.	107.
6	37.	41.	45.	37.	48.	130.	105.	120.	56.
7	10.	11.	16.	31.	14.	48.	66.	50.	32.
8	4.	6.	6.	7.	5.	22.	22.	33.	19.

Table. 3.8.2 ***WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.***
INDEX 1: Acoustic Survey in Div IIIa+IVaE, Ages 2-8+(Catch: Number)

	1989	1990	1991	1992	1993	1994	1995
2	.111E+04	.104E+04	.186E+04	.179E+04	.263E+04	.349E+03	.163E+04
3	.714E+03	.343E+03	.193E+04	.176E+04	.110E+04	.829E+03	.107E+04
4	.317E+03	.109E+03	.866E+03	.159E+04	.472E+03	.469E+03	.138E+04
5	.807E+02	.453E+02	.350E+03	.518E+03	.336E+03	.215E+03	.281E+03
6	.514E+02	.708E+01	.880E+02	.146E+03	.124E+03	.156E+03	.196E+03
7	.163E+02	.731E+01	.720E+02	.111E+03	.300E+02	.530E+02	.470E+02
8	.420E+01	.194E+01	.100E+02	.150E+02	.400E+01	.200E+02	.420E+02

Table. 3.8.3 ***WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.***
INDEX 2: Acoustic Survey in Sub div 22-24, Ages 0-8+ (Catch: Number)

	1989	1990	1991	1992	1993	1994	1995
0	.383E+04	.212E+05	.736E+04	.341E+04	.141E+04	.675E+04	.477E+04
1	.214E+04	.179E+04	.322E+04	.166E+04	.466E+03	.457E+03	.132E+04
2	.213E+03	.892E+03	.176E+04	.657E+03	.393E+03	.831E+03	.353E+03
3	.161E+03	.146E+03	.143E+04	.282E+03	.518E+03	.525E+03	.354E+03
4	.102E+03	.790E+02	.461E+03	.156E+03	.402E+03	.449E+03	.375E+03
5	.230E+02	.190E+02	.174E+03	.370E+02	.145E+03	.195E+03	.269E+03
6	.400E+01	.800E+01	.440E+02	.250E+02	.640E+02	.630E+02	.133E+03
7	.300E+01	.400E+01	.240E+02	.400E+01	.310E+02	.250E+02	.370E+02
8	.100E+01	.200E+01	.210E+02	-.100E+01	.160E+02	.200E+01	.250E+02

Table. 3.8.4 WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.
INDEX 3: IYFS IIIa Quarter 1-4 combined, Ages 1-5 (Catch: Number)

	1991	1992	1993	1994	1995
1	.705E+03	.980E+02	.352E+03	-.110E+02	.424E+04
2	.190E+04	.821E+03	.269E+04	.297E+03	.673E+03
3	.118E+04	.481E+03	.332E+03	.100E+04	.353E+03
4	.271E+03	.301E+03	.180E+03	.205E+03	.317E+03
5	.254E+03	.279E+03	.223E+03	.244E+03	.145E+03

Table. 3.8.5 WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.
INDEX 4: German Bottom Trawl Survey in Sub div 22+24 combined,
Ages 0-3+ (Catch: Number)

	1989	1990	1991	1992	1993	1994	1995
0	.421E+04	-.100E+01	-.100E+01	.292E+03	.290E+04	.122E+04	.737E+03
1	.514E+03	-.100E+01	-.100E+01	.880E+02	.315E+03	.660E+02	.550E+02
2	.610E+02	-.100E+01	-.100E+01	.510E+02	.276E+03	.335E+03	.450E+02
3	.590E+02	-.100E+01	-.100E+01	.970E+02	.606E+03	.539E+03	.290E+03

Table. 3.8.6 WESTERN BALTIC HERRING. Output from ICA. FISHING MORTALITY

	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.1037	.0722	.0290	.0266	.0192	.0250	.0199	.0150	.0161
1	.1995	.1612	.2033	.1441	.1041	.1351	.1076	.0812	.0868
2	.3713	.6060	.2379	.2930	.2116	.2747	.2188	.1652	.1765
3	.4911	.7192	.4954	.3388	.2447	.3177	.2530	.1911	.2042
4	.6722	.5259	.6873	.3480	.2513	.3263	.2598	.1962	.2097
5	.7348	.6018	.4501	.3981	.2875	.3733	.2973	.2245	.2399
6	.7902	.5724	.3600	.3529	.2549	.3310	.2635	.1990	.2127
7	.5868	.5773	.4530	.3480	.2513	.3263	.2598	.1962	.2097
8	.5868	.5773	.4530	.3480	.2513	.3263	.2598	.1962	.2097

Table. 3.8.7 WESTERN BALTIC HERRING. Output from ICA. NUMBERS AT AGE (Millions)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	8623.	9665.	5004.	5284.	7485.	2939.	2995.	12415.	18937.	6584.
1	8755.	6364.	7362.	3980.	4212.	6012.	2347.	2404.	10013.	15257.
2	3493.	5872.	4435.	4918.	2821.	3108.	4300.	1725.	1815.	7516.
3	1094.	1973.	2622.	2862.	3004.	1869.	1933.	2829.	1198.	1245.
4	878.	548.	787.	1308.	1670.	1926.	1114.	1229.	1913.	799.
5	262.	367.	265.	324.	756.	1063.	1138.	703.	827.	1270.
6	74.	103.	165.	138.	178.	465.	599.	692.	460.	533.
7	23.	27.	47.	94.	80.	113.	273.	377.	464.	305.
8	5.	13.	19.	34.	74.	98.	125.	251.	423.	589.

Table. 3.8.8 WESTERN BALTIC HERRING. Output from ICA. STOCK SUMMARY

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Ref. F Fbar 3- 6
1987	8623.	519374.	205974.	174700.	.8482	.6721
1988	9665.	636328.	246198.	251000.	1.0195	.6048
1989	5004.	613872.	256142.	185700.	.7250	.4982
1990	5284.	668707.	339259.	203900.	.6010	.3594
1991	7485.	773479.	459117.	191500.	.4171	.2596
1992	2939.	833043.	528751.	168000.	.3177	.3371
1993	2995.	816706.	544444.	166631.	.3061	.2684
1994	12415.	818472.	593983.	163435.	.2752	.2027
1995	18937.	982013.	684985.	173187.	.2528	.2166

Table. 3.8.9 WESTERN BALTIC HERRING. Output from ICA. PARAMETER ESTIMATES +/- SD

		Parameter estimate	Parameter+SD	Parameter-SD
Separable Model: Reference F by year				
1	1990	.3480	.2546	.4756
2	1991	.2513	.1833	.3446
3	1992	.3263	.2397	.4442
4	1993	.2598	.1889	.3574
5	1994	.1962	.1416	.2719
6	1995	.2097	.1488	.2954
Separable Model: Selection (S) by age				
7	0	.0766	.0524	.1120
8	1	.4140	.2904	.5903
9	2	.8419	.6008	1.1797
10	3	.9737	.6988	1.3568
	4	1.0000	Fixed : Reference age	
11	5	1.1441	.8338	1.5698
12	6	1.0142	.7381	1.3937
	7	1.0000	Fixed : last true age	
Separable Model: Populations in year 1995				
13	0	18936846.	10377084.	34557311.
14	1	10013033.	6824562.	14691175.
15	2	1814603.	1368312.	2406459.
16	3	1197581.	954575.	1502449.
17	4	1913206.	1658059.	2207616.
18	5	826909.	696517.	981712.
19	6	460049.	373104.	567255.
20	7	464263.	358494.	601238.
Separable Model: Populations at age 7				
21	1990	94071.4451	59960.5157	147587.7365
22	1991	79657.4283	54371.4017	116703.0034
23	1992	113041.0384	82363.7319	155144.4558
24	1993	273150.2271	200626.1084	371891.0125
25	1994	377052.2370	286964.9642	495420.7208

Table. 3.8.10 WESTERN BALTIC HERRING. Output from ICA. Age-structured index catchabilities

Age-Structured Index			1 Linear model fitted. Slopes at age:		
26	2	Q	.54510E-03	.41388E-03	.71793E-03
27	3	Q	.59161E-03	.42934E-03	.81523E-03
28	4	Q	.55726E-03	.39990E-03	.77654E-03
29	5	Q	.43410E-03	.34709E-03	.54291E-03
30	6	Q	.32740E-03	.22929E-03	.46749E-03
31	7	Q	.31631E-03	.19222E-03	.52049E-03
32	8	Q	.12805E-03	.88400E-04	.18548E-03
Age-Structured Index			2 Linear model fitted. Slopes at age:		
33	0	Q	.96503E-03	.65353E-03	.14250E-02
34	1	Q	.36337E-03	.27622E-03	.47802E-03
35	2	Q	.27076E-03	.18563E-03	.39491E-03
36	3	Q	.24438E-03	.17459E-03	.34209E-03
37	4	Q	.26235E-03	.19306E-03	.35651E-03
38	5	Q	.18947E-03	.13203E-03	.27190E-03
39	6	Q	.13397E-03	.90297E-04	.19878E-03
40	7	Q	.11516E-03	.79789E-04	.16621E-03
41	8	Q	.90320E-04	.50418E-04	.16180E-03
Age-Structured Index			3 Linear model fitted. Slopes at age:		
42	1	Q	.13391E-03	.62566E-04	.28660E-03
43	2	Q	.45638E-03	.33406E-03	.62349E-03
44	3	Q	.35321E-03	.28785E-03	.43340E-03
45	4	Q	.20336E-03	.17407E-03	.23757E-03
46	5	Q	.15880E-03	.11588E-03	.21761E-03
Age-Structured Index			4 Linear model fitted. Slopes at age:		
47	0	Q	.24461E-03	.11838E-03	.50542E-03
48	1	Q	.39406E-04	.20817E-04	.74592E-04
49	2	Q	.54798E-04	.32087E-04	.93584E-04
50	3	Q	.69655E-04	.45252E-04	.10722E-03

Table. 3.8.11 WESTERN BALTIC HERRING. Output from ICA.
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch)) and weights (W) used in the analysis.

Age	1990	1991	1992	1993	1994	1995	
0	.24218E+00	-.39563E+00	-.59985E+00	-.17644E+00	.18794E+00	.74385E+00	.10000E+01
1	-.12719E+00	.78760E+00	-.91028E+00	-.24213E-01	-.56982E+00	.89389E+00	.10000E+01
2	.26521E-01	.83290E-01	-.23177E+00	-.74178E+00	.89581E-01	.62233E+00	.10000E+01
3	-.45647E+00	.62699E-01	-.25251E+00	.11581E+00	-.88270E-01	.23991E+00	.10000E+01
4	.26341E+00	-.15387E+00	-.43008E+00	.14580E+00	.31589E+00	-.53090E+00	.10000E+01
5	.54845E+00	.24520E-01	-.55305E+00	-.21884E+00	.28470E+00	-.40661E+00	.10000E+01
6	-.14453E-01	.28049E+00	.89168E-01	-.18112E+00	.54774E-01	-.36603E+00	.10000E+01
7	.21992E+00	-.15487E+00	.52123E+00	.14950E+00	-.20308E+00	-.91123E+00	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

Table. 3.8.12 WESTERN BALTIC HERRING. Output from ICA.
Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1989	1990	1991	1992	1993	1994	1995
2	-.50923E+00	-.64178E+00	.44950E+00	.35123E+00	.37573E+00	-.76316E+00	.73543E+00
3	-.34104E+00	-.12591E+01	.35879E+00	.78700E+00	.24598E+00	-.45807E+00	.66766E+00
4	.23077E+00	-.15543E+01	.21010E+00	.72209E+00	.13425E-01	-.13096E+00	.51189E+00
5	.50763E-01	-.76026E+00	.36861E+00	.47353E+00	-.74357E-01	-.85400E-01	.30073E-01
6	.30214E+00	-.15112E+01	.69556E+00	.29105E+00	-.16936E+00	-.12365E+00	.52127E+00
7	.48969E+00	-.10613E+01	.13320E+01	.14617E+01	-.77039E+00	-.56342E+00	-.88322E+00
8	.97494E+00	-.47771E+00	.33222E+00	.50714E+00	-.10968E+01	-.22749E+00	.23647E-02

Aged Index 2

Age	1989	1990	1991	1992	1993	1994	1995
0	-.49954E-01	.16043E+01	.19396E+00	.36481E+00	-.53906E+00	-.40190E+00	-.11714E+01
1	.98077E-01	.48567E+00	.98823E+00	-.77037E-02	-.35827E+00	-.42287E+00	-.78828E+00
2	-.13791E+01	-.63713E-02	.11661E+01	.13234E+00	-.75101E+00	.86807E+00	-.29393E-01
3	-.82514E+00	-.11357E+01	.10252E+01	-.68304E-01	.45446E+00	.37660E-01	.51359E+00
4	.48427E-02	-.10306E+01	.41196E+00	-.75408E+00	.68673E+00	.64816E+00	.36210E-01
5	-.26166E+00	-.69431E+00	.58410E+00	-.12361E+01	.13391E-02	.72030E+00	.89246E+00
6	-.12597E+01	-.39878E+00	.97556E+00	-.48723E+00	.14390E+00	-.67011E-01	.10993E+01
7	-.78177E-01	-.55796E+00	.13228E+01	-.75897E+00	.35328E+00	-.23509E+00	-.40350E-01
8	.31737E-02	-.23165E-02	.15022E+01	-.10000E+01	.71900E+00	-.21117E+01	-.95695E-01

Aged Index 3

Age	1991	1992	1993	1994	1995
1	.37512E+00	-.19383E+01	.26718E+00	-.10000E+01	.12949E+01
2	.59377E+00	-.30936E+00	.52510E+00	-.79251E+00	-.19192E-01
3	.33192E+00	-.57986E-01	-.49460E+00	.19937E+00	.21186E-01
4	-.73592E-06	-.73063E-06	-.50691E-06	-.23747E-06	.24019E-06
5	.62345E+00	.28836E+00	-.17852E+00	-.71814E-01	-.65657E+00

Aged Index 4

Age	1989	1990	1991	1992	1993	1994	1995
0	.14521E+01	-.10000E+01	-.10000E+01	-.68836E+00	.15822E+01	-.71122E+00	-.16340E+01
1	.95315E+00	-.10000E+01	-.10000E+01	-.67362E+00	.15162E+01	-.95593E-01	-.16994E+01
2	-.96852E+00	-.10000E+01	-.10000E+01	-.75713E+00	.55385E+00	.16101E+01	-.43705E+00
3	-.84694E+00	-.10000E+01	-.10000E+01	-.87644E+00	.95830E+00	.61646E+00	.15212E+00

Table. 3.8.13 WESTERN BALTIC HERRING. Output from ICA.
PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

```
Separable model fitted from 1990 to 1995
Variance                    :     .3549
Skewness test statistic     :    -.6215
Kurtosis test statistic     :    -.2957
Partial chi-square          :     .6664
Probability of chi-square   :    1.0000
Degrees of freedom          :        23
```

Table. 3.8.14 WESTERN BALTIC HERRING. Output from ICA.
PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1
Linear catchability relationship assumed.

Age	:	2	3	4	5	6	7	8
Variance	:	.3768	.5277	.5523	.1591	.5432	1.1614	.4668
Skewness test stat.	:	-.2151	-.6523	-1.5276	-.8706	-1.4219	.4791	-.2112
Kurtosis test stat.	:	-.9217	-.4232	.5077	.0520	.3514	-.8337	-.4234
Partial chi-square	:	.3226	.4595	.5231	.1930	.8954	2.1110	2.9392
Prob. of chi-square	:	.9994	.9983	.9975	.9999	.9893	.9092	.8164
Number of data	:	7	7	7	7	7	7	7
Degrees of freedom	:	6	6	6	6	6	6	6
Weight in analysis	:	.9417	.6726	.6425	2.2310	.6533	.3056	.7602

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2
Linear catchability relationship assumed.

Age	:	0	1	2	3	4	5	6	7	8
Variance	:	.7619	.3585	.7663	.5830	.4489	.6225	.6947	.4708	1.4484
Skewness test stat.	:	.6889	.4251	-.2332	-.3145	-.5542	-.3791	.0274	1.0438	-.7109
Kurtosis test stat.	:	-.0577	-.4400	-.4841	-.5870	-.6410	-.6468	-.5398	.0422	-.0560
Partial chi-square	:	.5269	.2977	.7132	.5804	.4903	.8258	1.3917	1.4340	3.3106
Prob. of chi-square	:	.9975	.9995	.9942	.9967	.9980	.9914	.9664	.9638	.6522
Number of data	:	7	7	7	7	7	7	7	7	6
Degrees of freedom	:	6	6	6	6	6	6	6	6	5
Weight in analysis	:	.4658	.9901	.4631	.6087	.7905	.5701	.5108	.7537	.2450

DISTRIBUTION STATISTICS FOR ln AGED INDEX 3
Linear catchability relationship assumed.

Age	:	1	2	3	4	5
Variance	:	1.8820	.3381	.0996	.0000	.2350
Skewness test stat.	:	-.6134	-.2248	-.6226	-1.0206	-.0511
Kurtosis test stat.	:	-.3563	-.6157	-.3112	-.7988	-.4785
Partial chi-square	:	.8491	.1986	.0617	.0000	.1778
Prob. of chi-square	:	.8377	.9954	.9995	1.0000	.9963
Number of data	:	4	5	5	5	5
Degrees of freedom	:	3	4	4	4	4
Weight in analysis	:	.1886	1.0496	3.5635	*********	1.5102

Table. 3.8.14 WESTERN BALTIC HERRING. Output from ICA. (continued)

DISTRIBUTION STATISTICS FOR ln AGED INDEX 4

Linear catchability relationship assumed.

Age	:	0	1	2	3
Variance	:	2.0654	1.6396	1.1503	.7017
Skewness test stat.	:	.1697	-.1049	.6034	-.0707
Kurtosis test stat.	:	-.7567	-.5916	-.5006	-.7631
Partial chi-square	:	1.1611	1.3108	1.0291	.5263
Prob. of chi-square	:	.8845	.8595	.9053	.9709
Number of data	:	5	5	5	5
Degrees of freedom	:	4	4	4	4
Weight in analysis	:	.1718	.2164	.3085	.5057

Figure 3.5.1 **Acoustic Monitoring in Sub-Division 23 (the Sound) divided into 13 subareas.**

Strata no.	Area NM**2
G1	8
G2	17
G3	20
G4	18
G5	24
G6	27
G7	40
G8	28
G9	29
G10	25
G11	19
G12	16

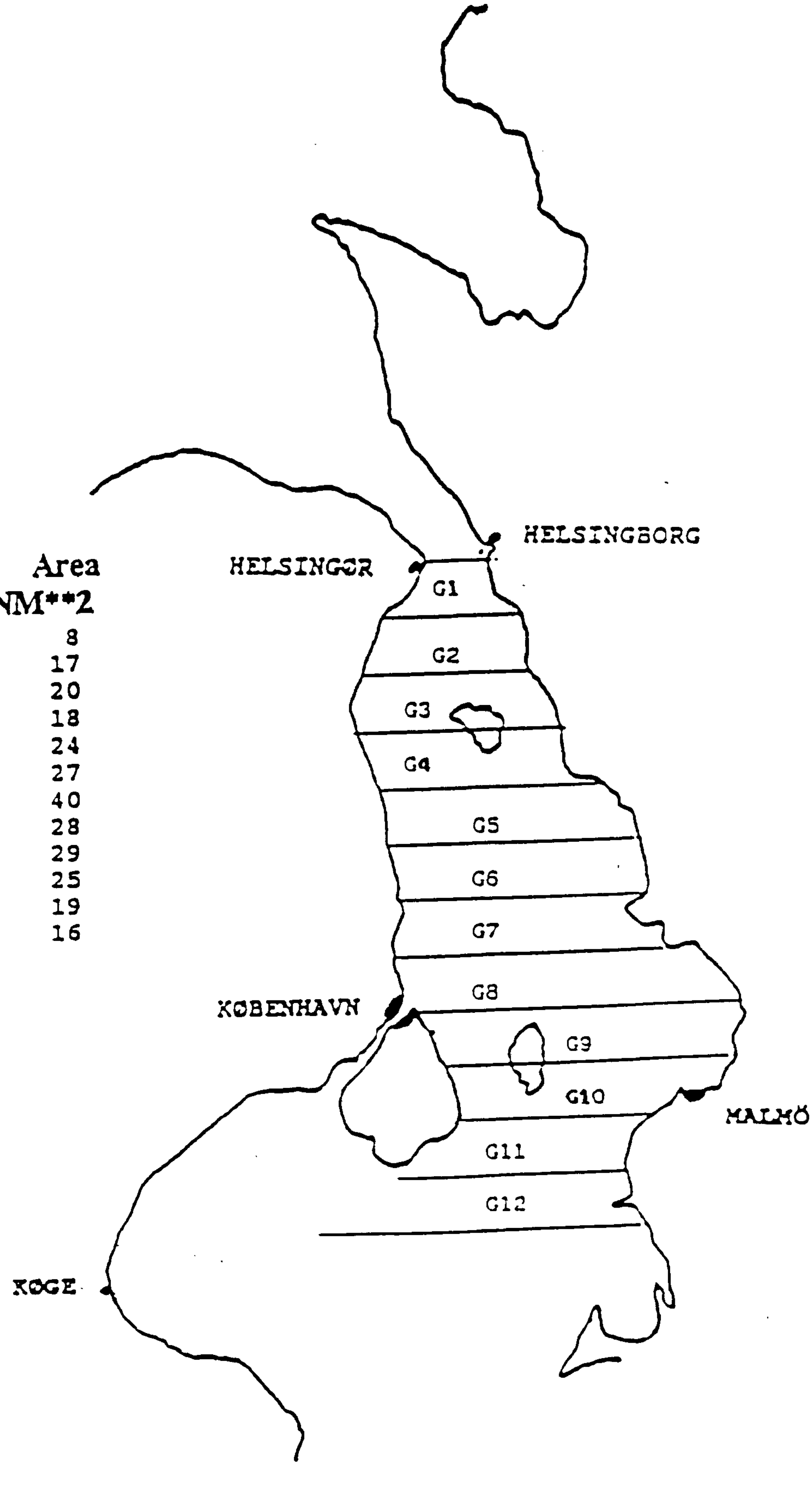


Figure 3.8.1 ***Western Baltic Herring. Output from ICA.***
Index sum of squares of deviations between model and observations

(survey index) as a function of the reference F in 1994
INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age groups 2-8+.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 0-8+.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age groups 1-5.
INDEX 4: 1989-95: German Bottom Trawl Survey in Sub.Div. 22+24, Age groups 0-3+.

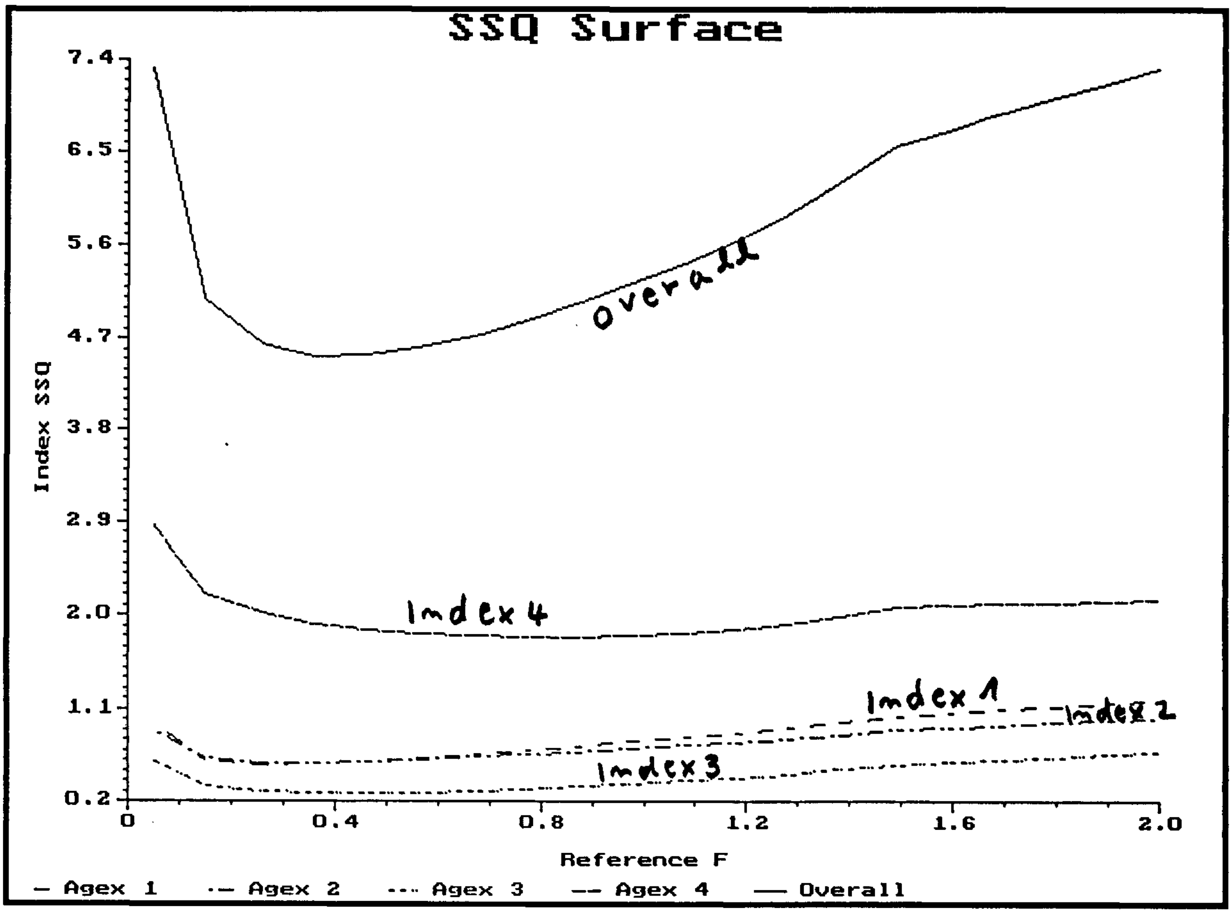


Figure 3.8.2 *Western Baltic Herring. Output from ICA. Stock summary*

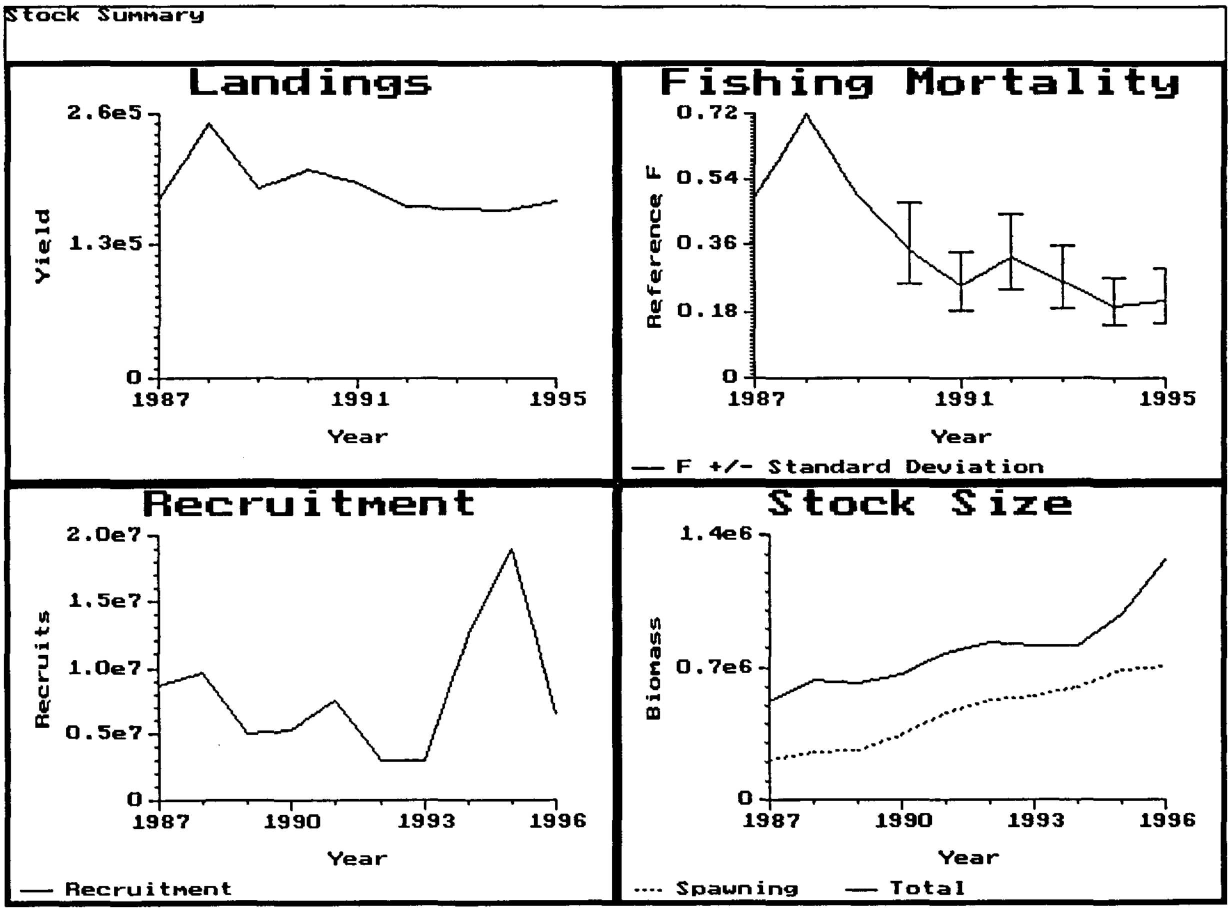


Figure 3.8.3 *Western Baltic Herring. Separable model diagnostics.*

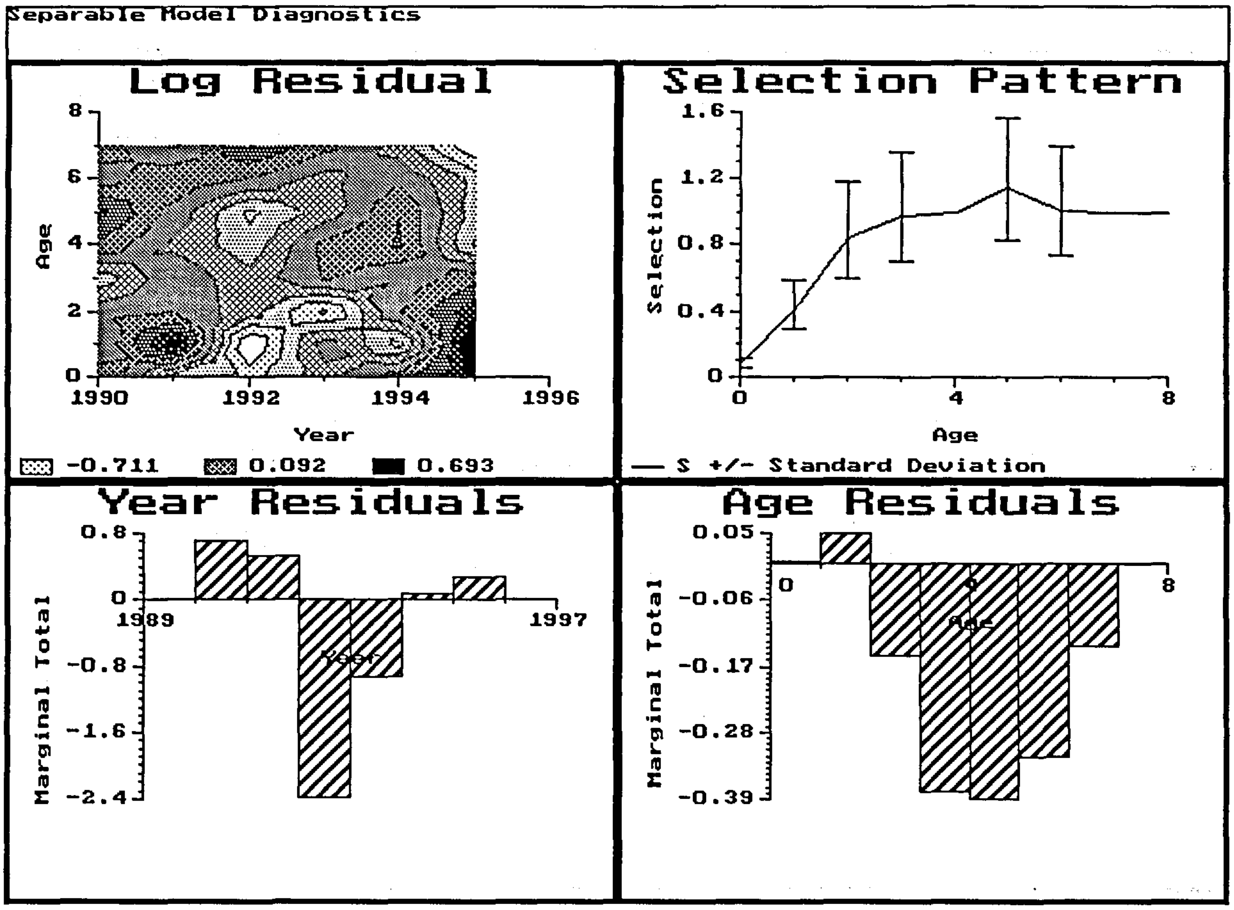


Figure 3.8.4.a Western Baltic Herring. Tuning diagnostics.
INDEX 1: 1989-95: I Acoustic survey in IIIa+IVaE, Age group 2 .

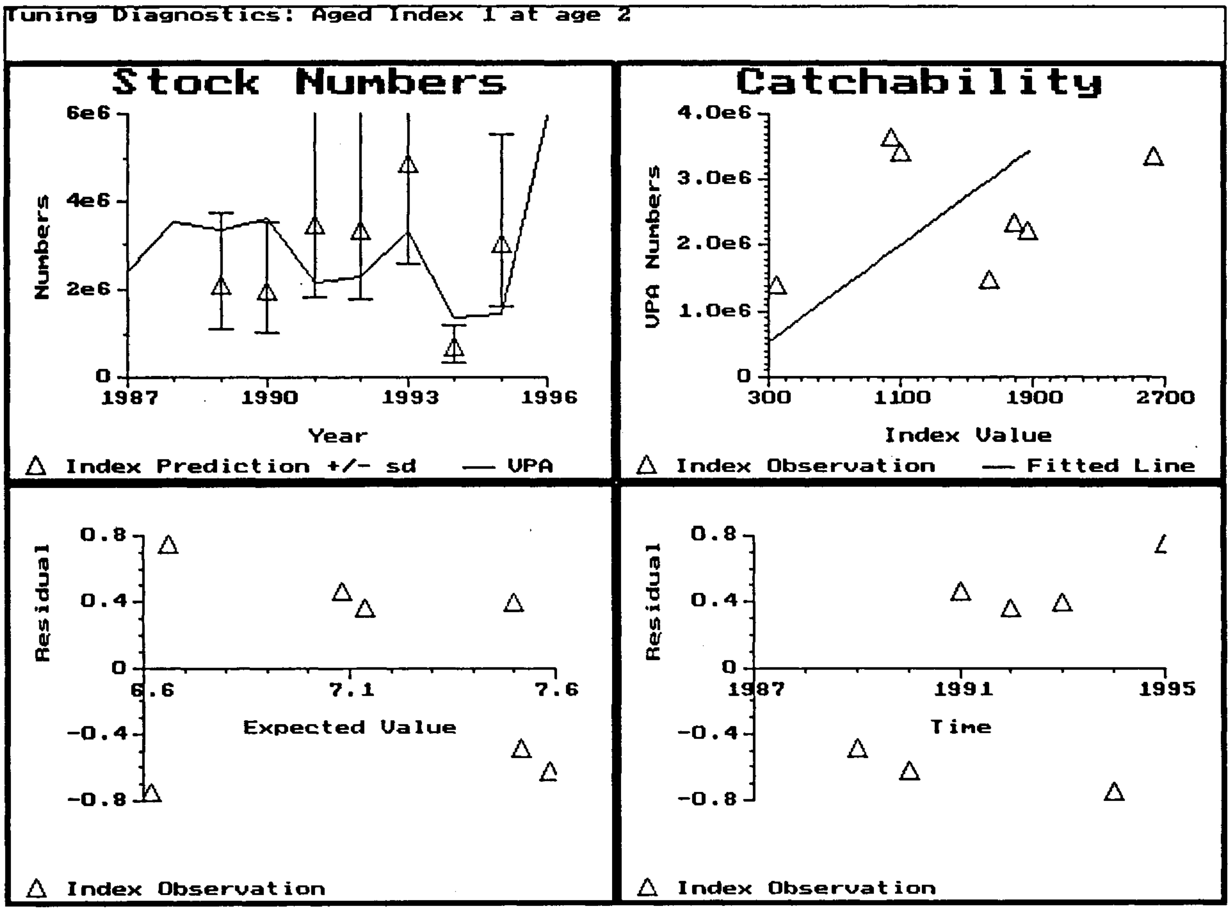


Figure 3.8.4.b Western Baltic Herring. Tuning diagnostics.

INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 3.

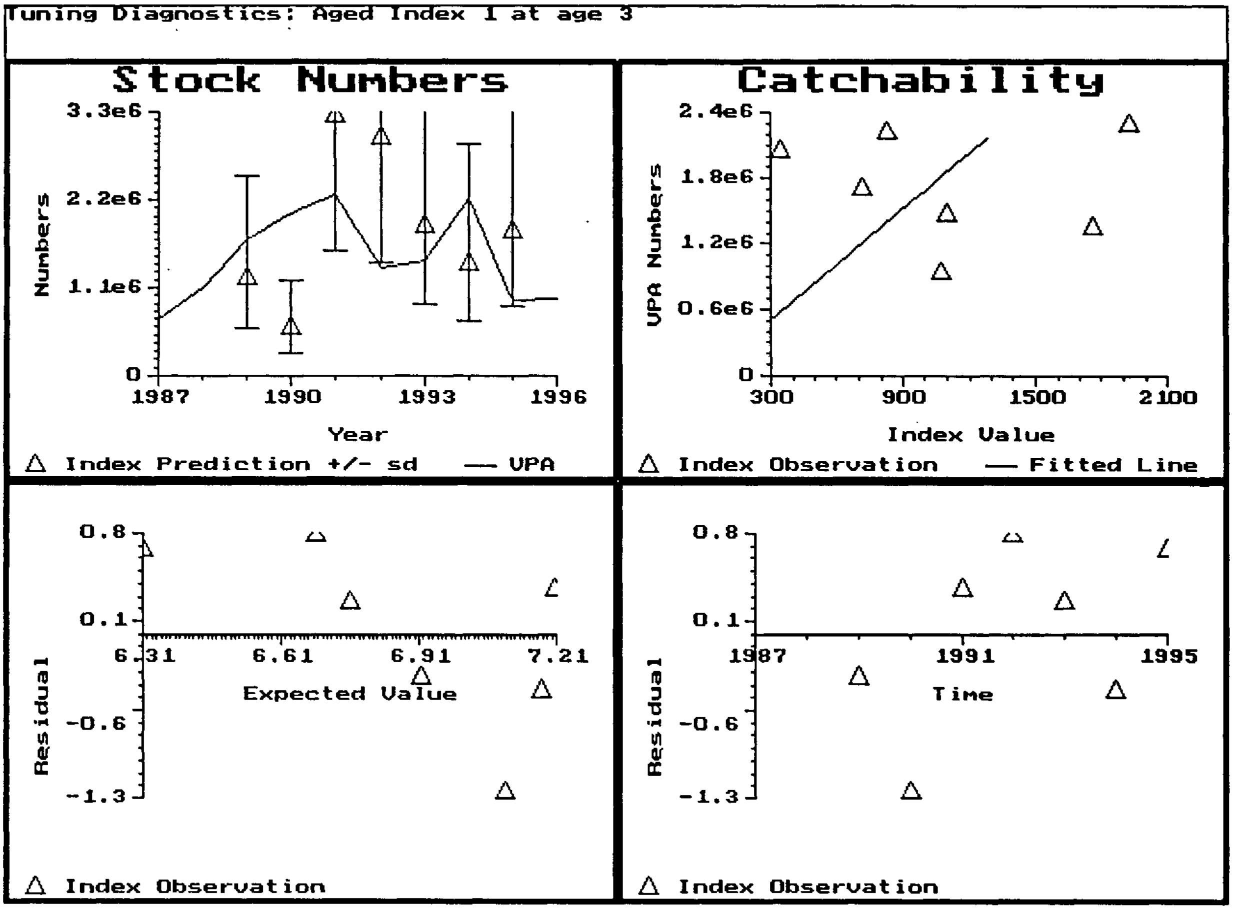


Figure 3.8.4.c Western Baltic Herring. Tuning diagnostics.
INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 4.

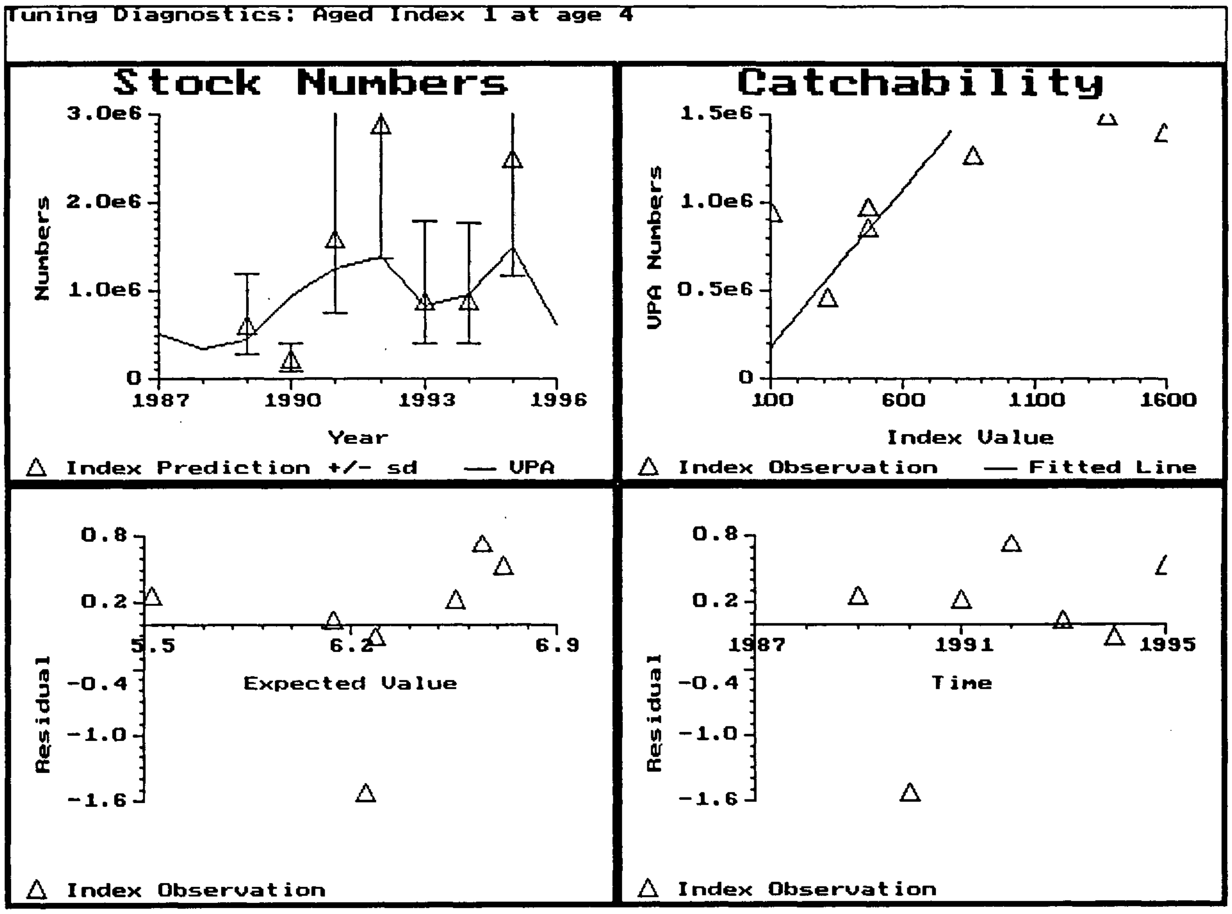


Figure 3.8.4.d ***Western Baltic Herring. Tuning diagnostics.***
INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 5.

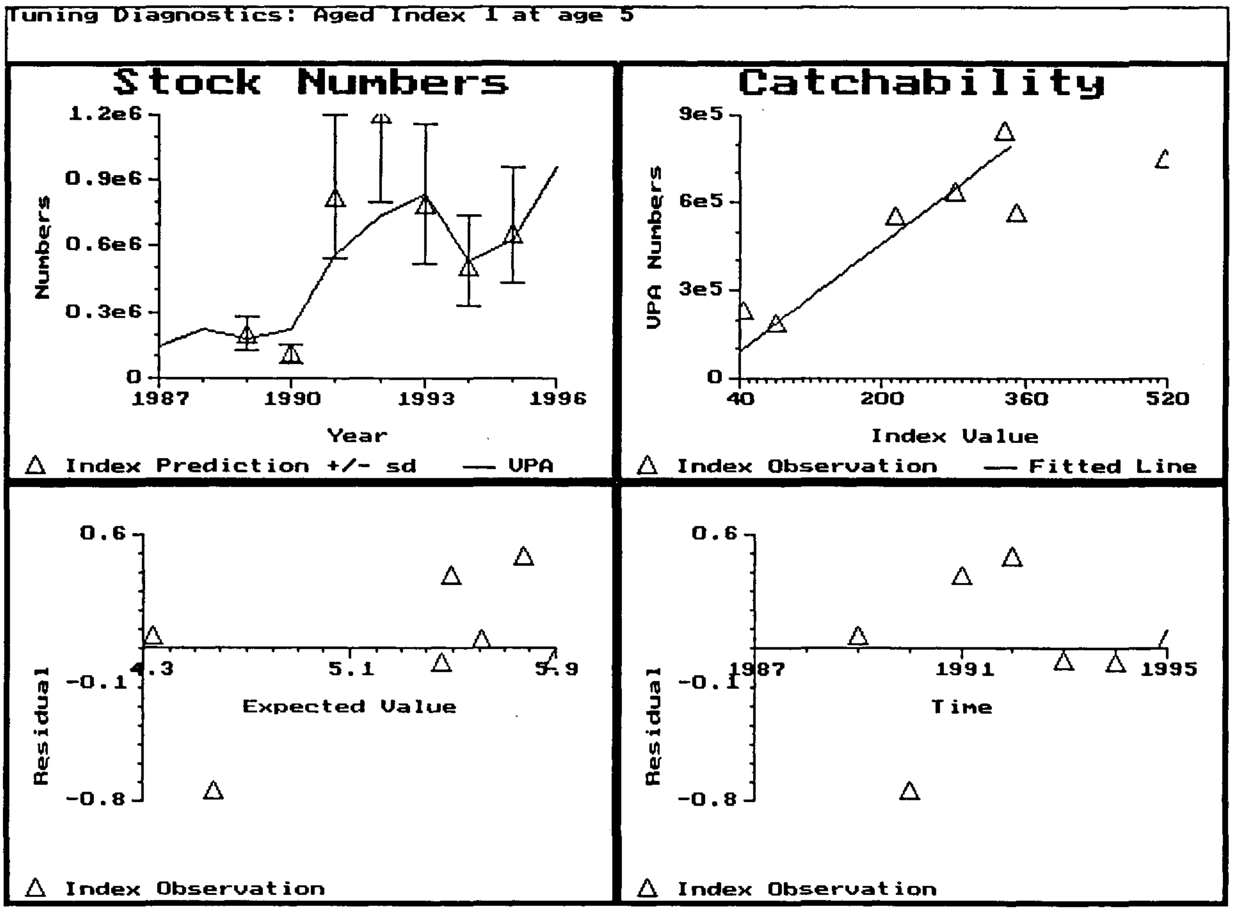


Figure 3.8.4.e Western Baltic Herring. Tuning diagnostics.
INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 6.

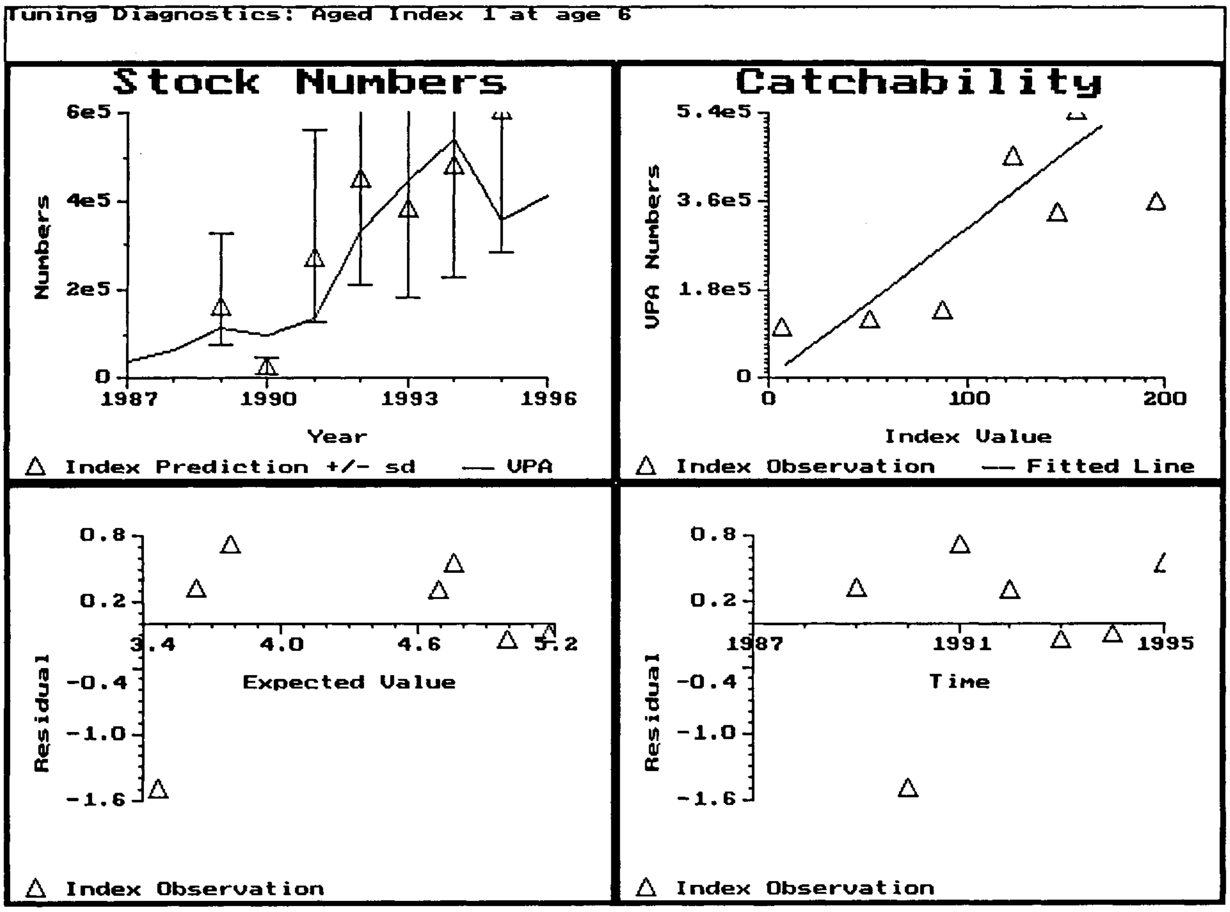


Figure 3.8.4.f Western Baltic Herring. Tuning diagnostics.
INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 7.

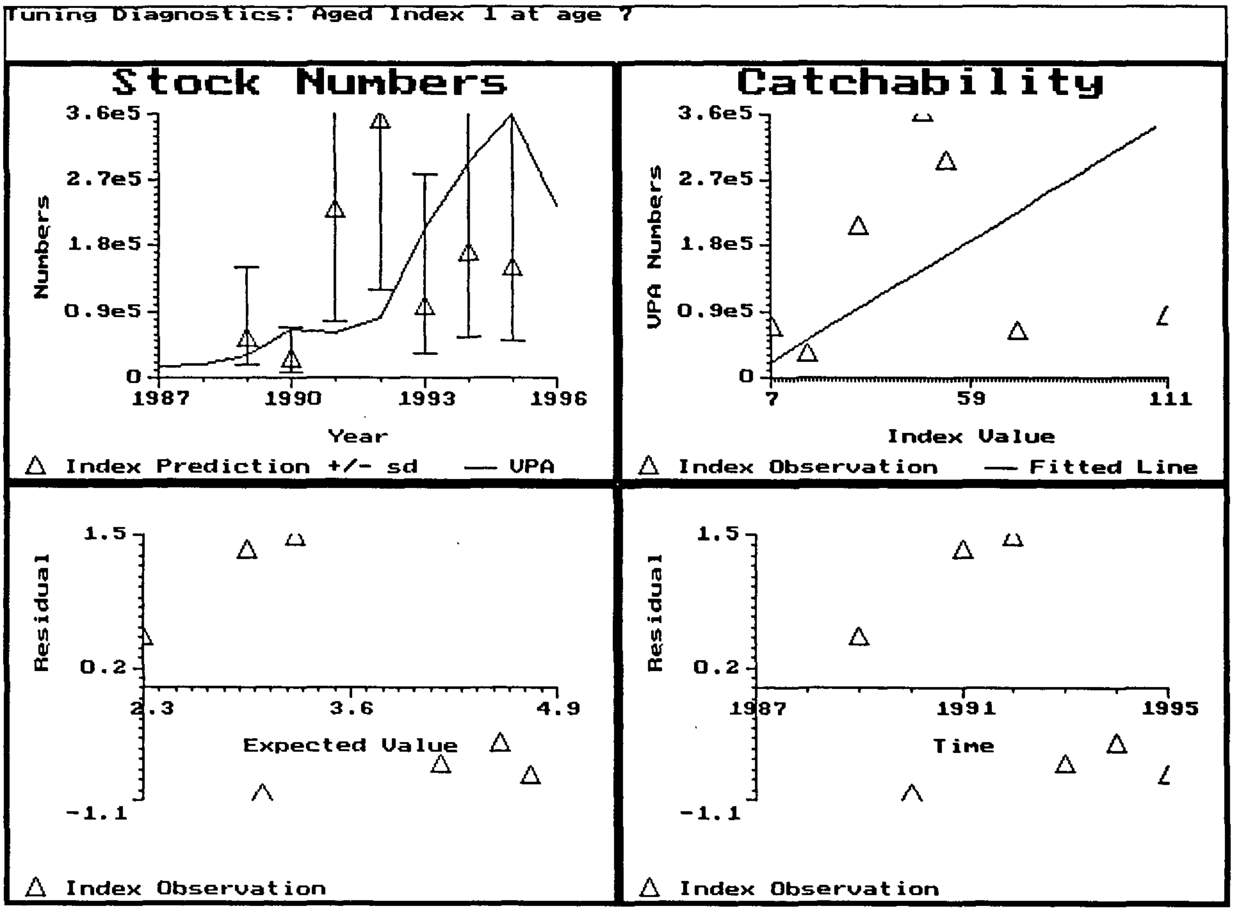


Figure 3.8.4.g Western Baltic Herring. Tuning diagnostics.

INDEX 1: 1989-95: Acoustic survey in IIIa+IVaE, Age group 8+.

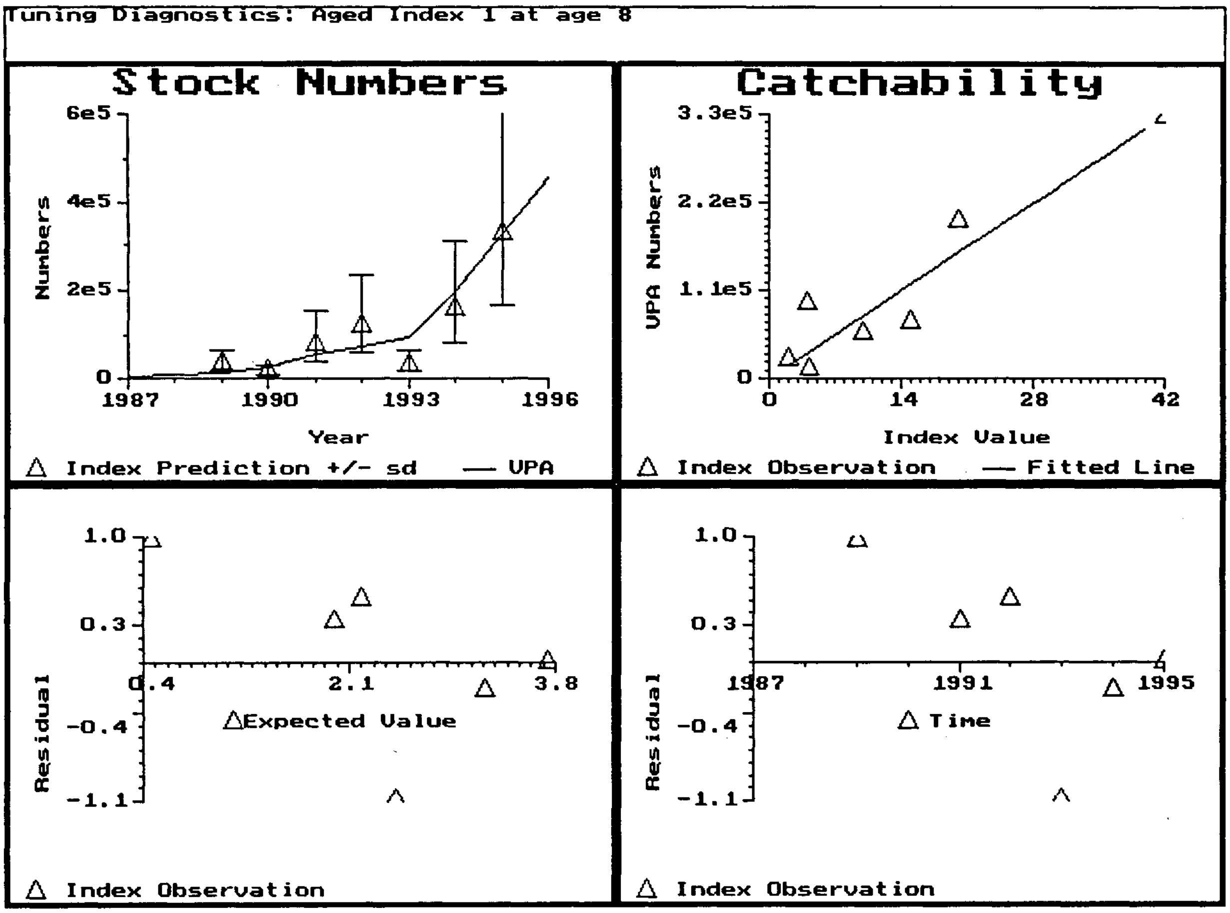


Figure 3.8.5.a Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age group 0.

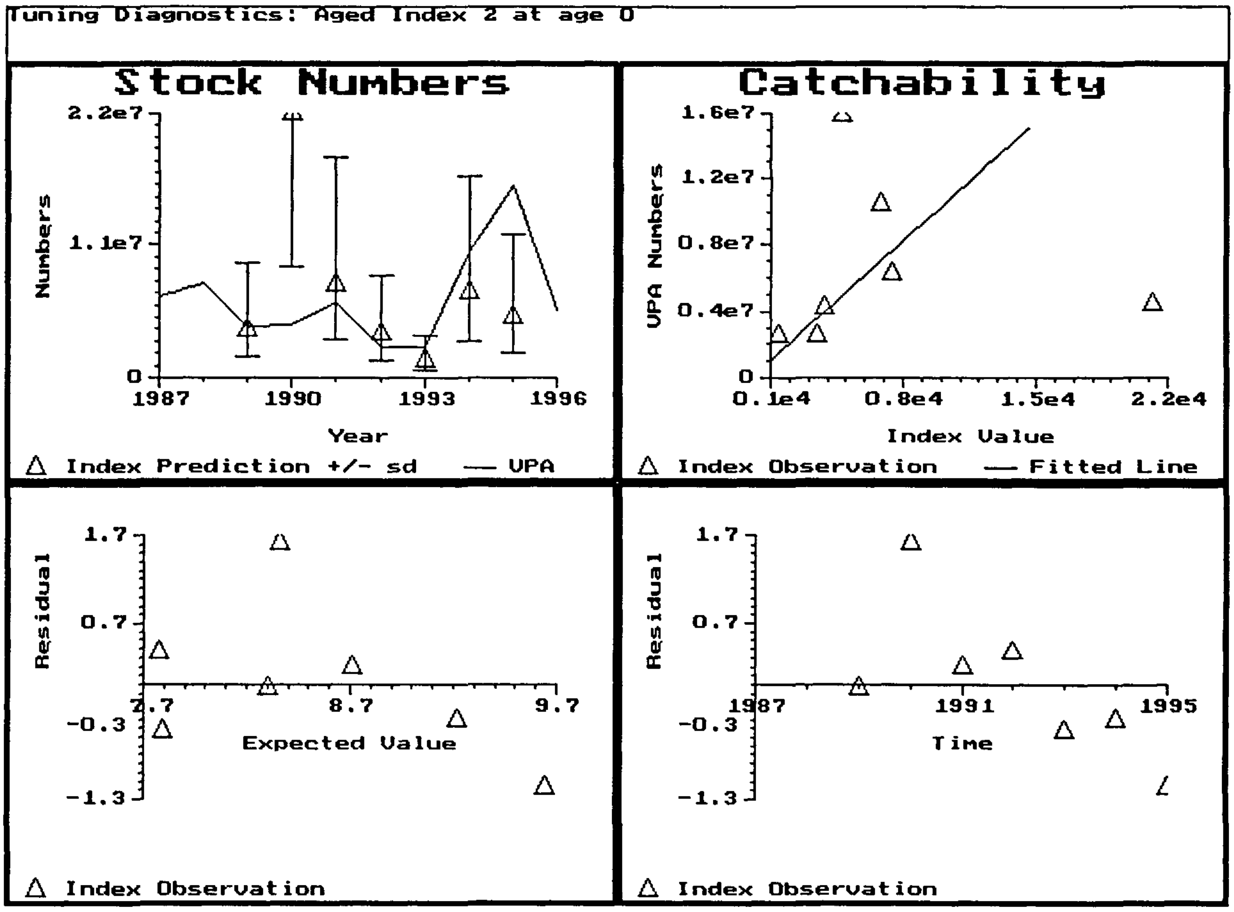


Figure 3.8.5.b Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 1.

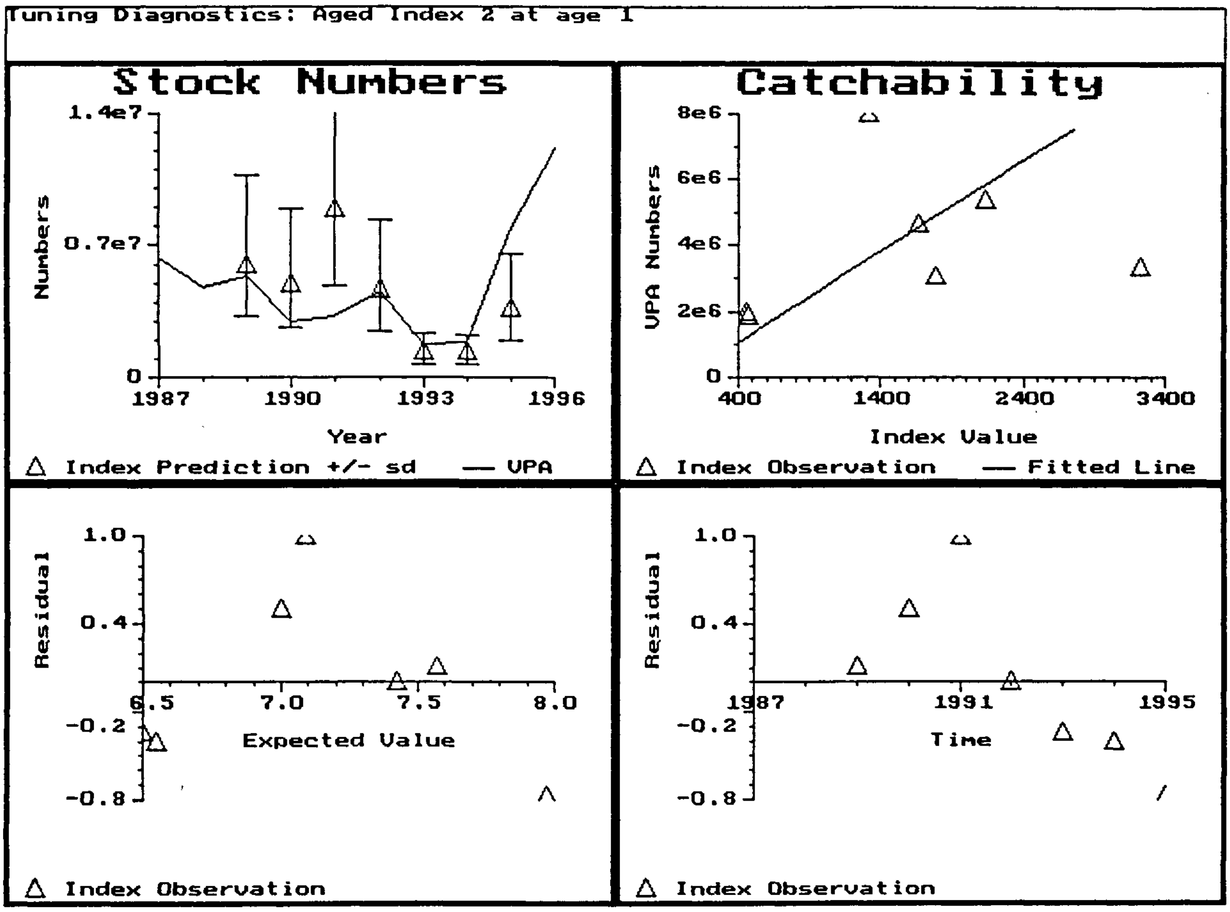


Figure 3.8.5.c ***Western Baltic Herring. Tuning diagnostics.***
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 2.

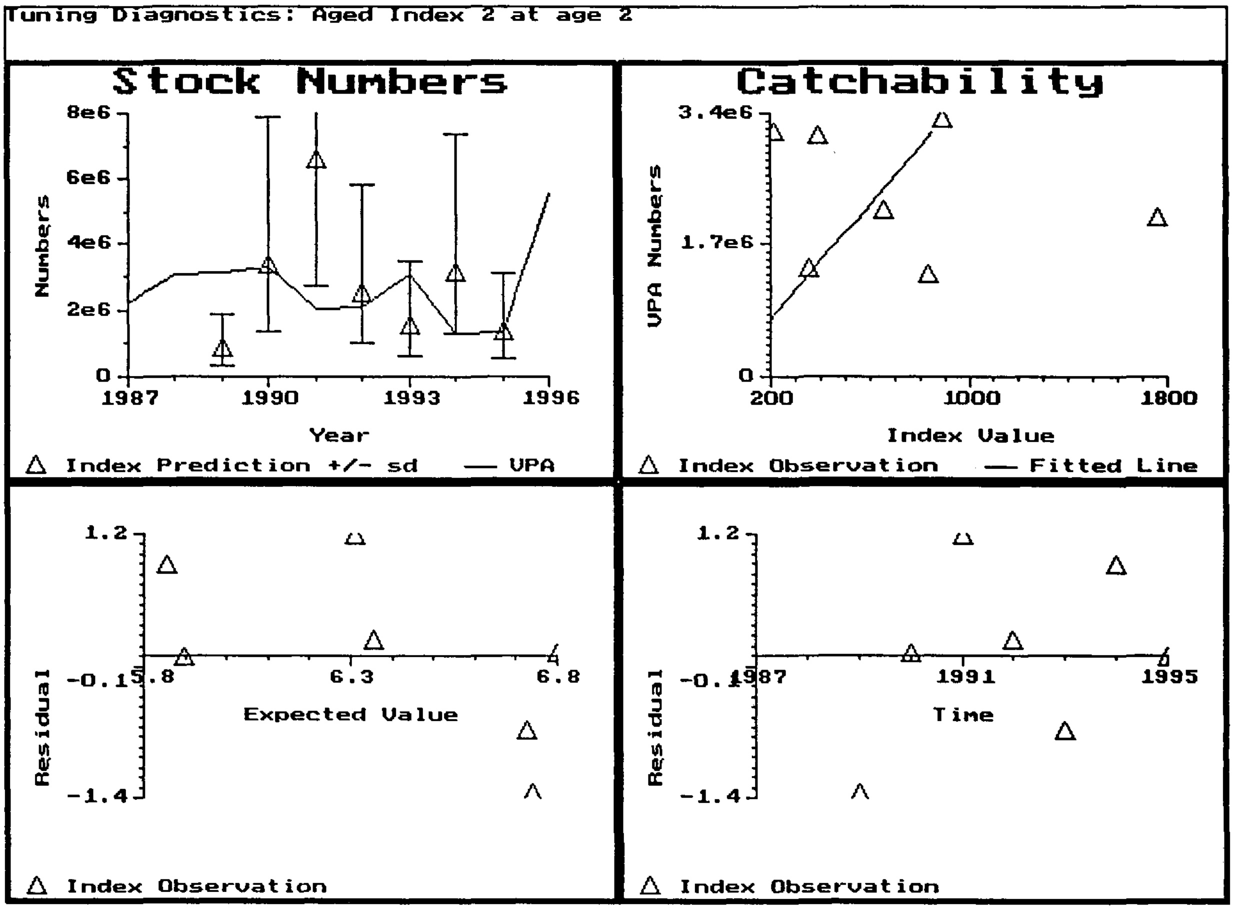


Figure 3.8.5.d Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 3

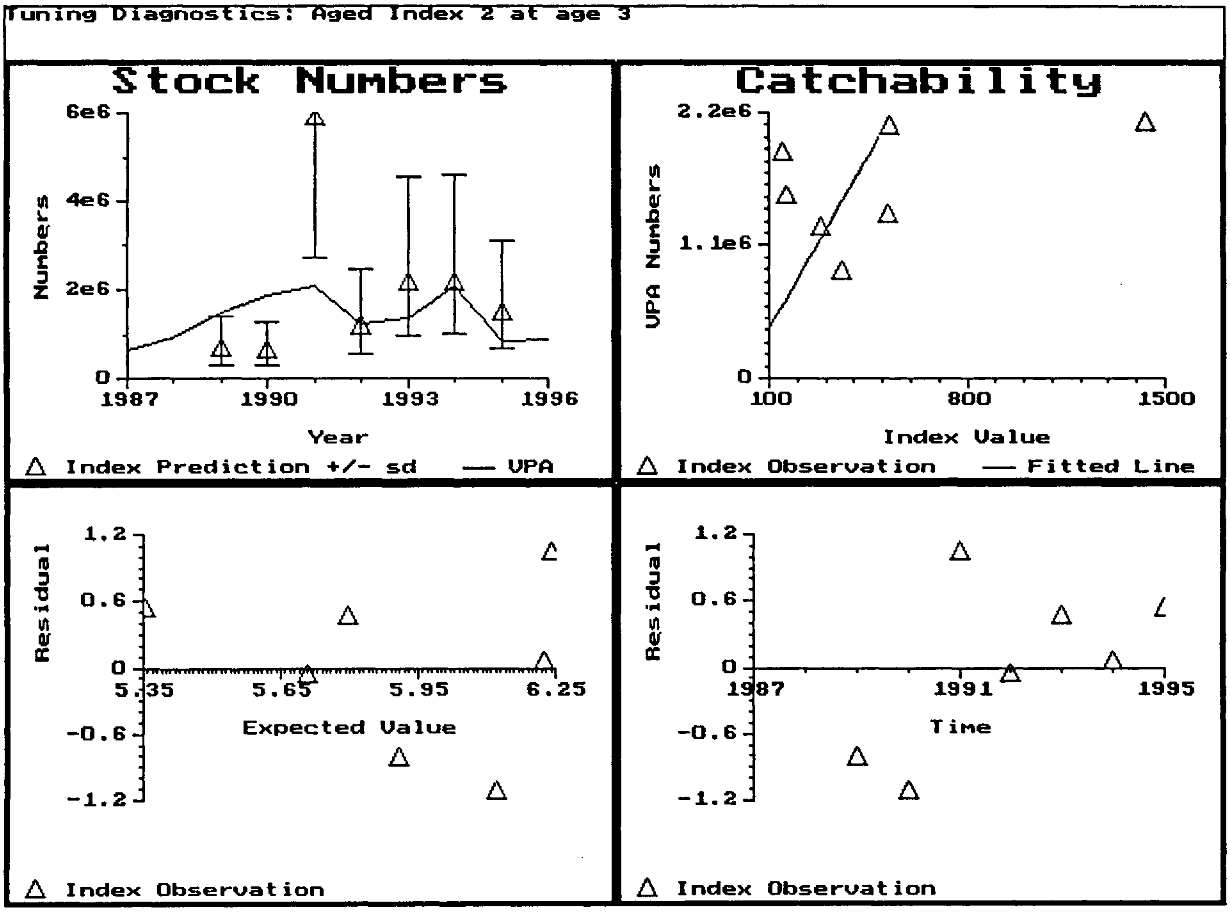


Figure 3.8.5.e Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 4

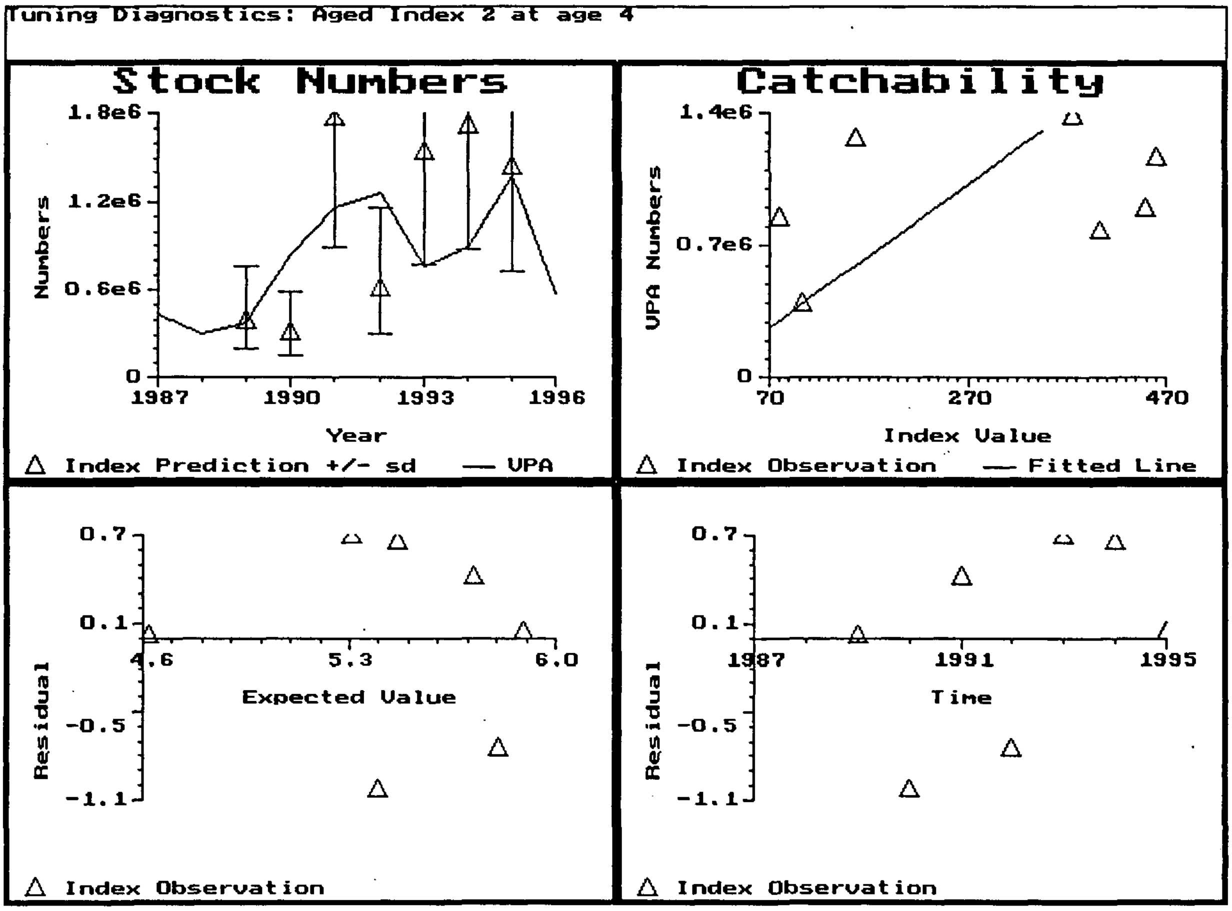


Figure 3.8.5.f Western Baltic Herring. Tuning diagnostics.

INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 5

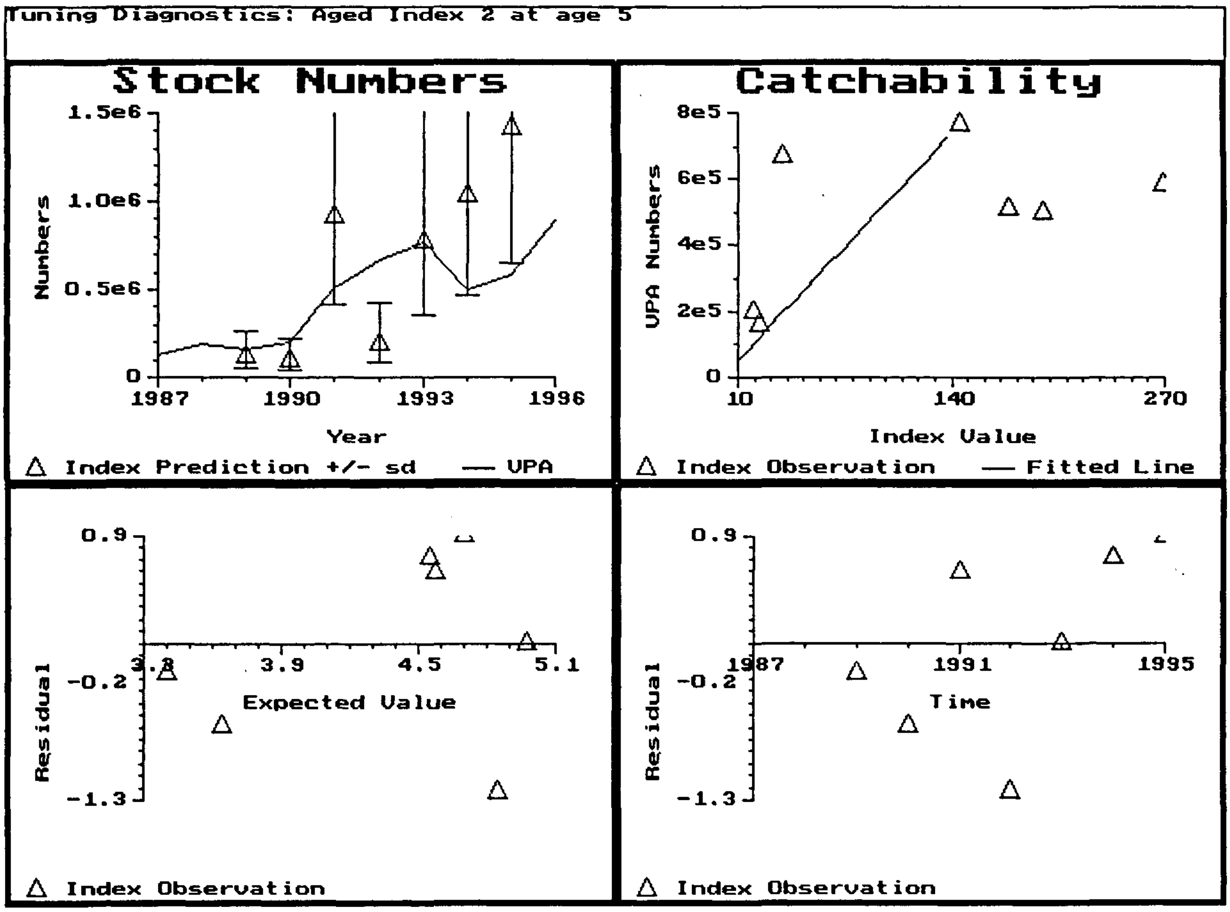


Figure 3.8.5.g ***Western Baltic Herring. Tuning diagnostics.***
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 6

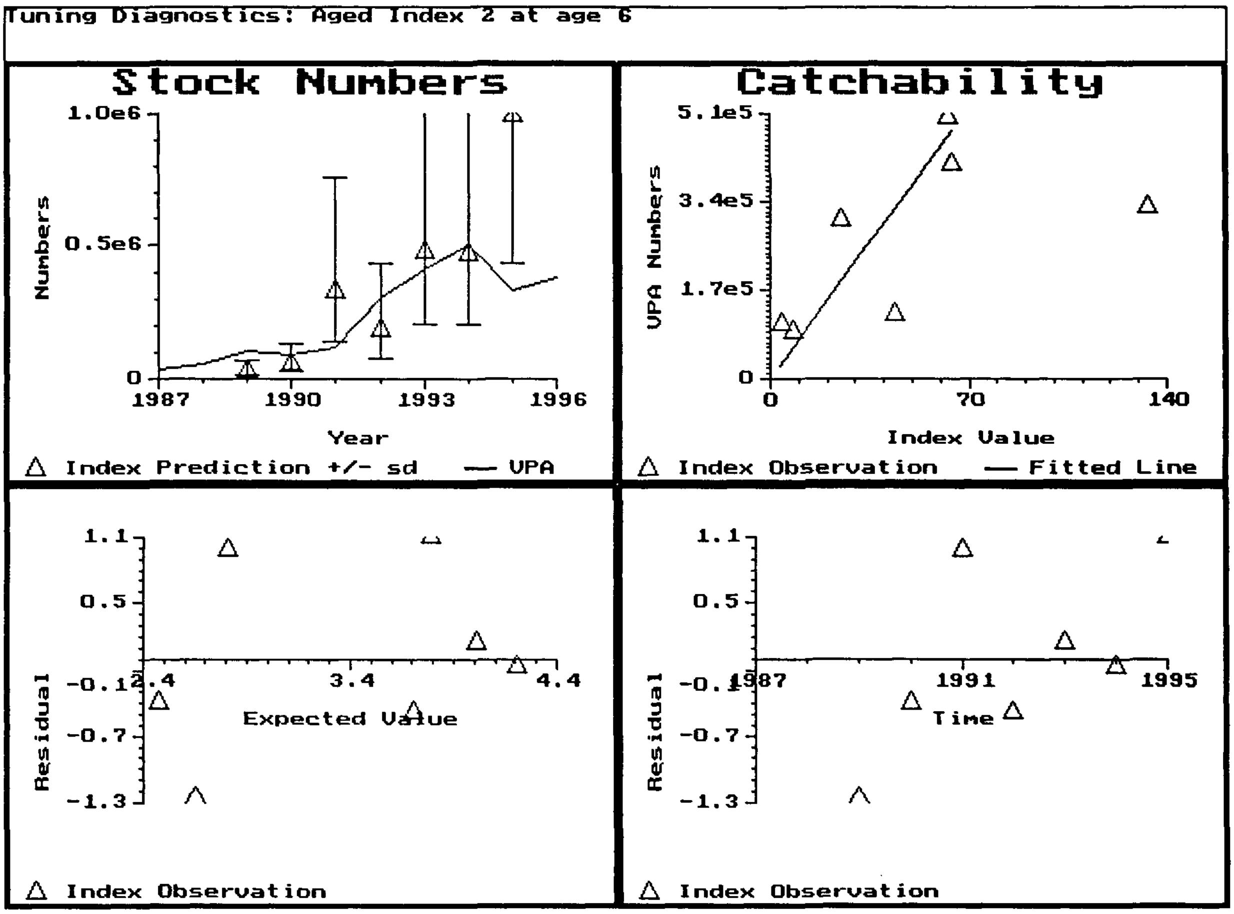


Figure 3.8.5.h Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 7

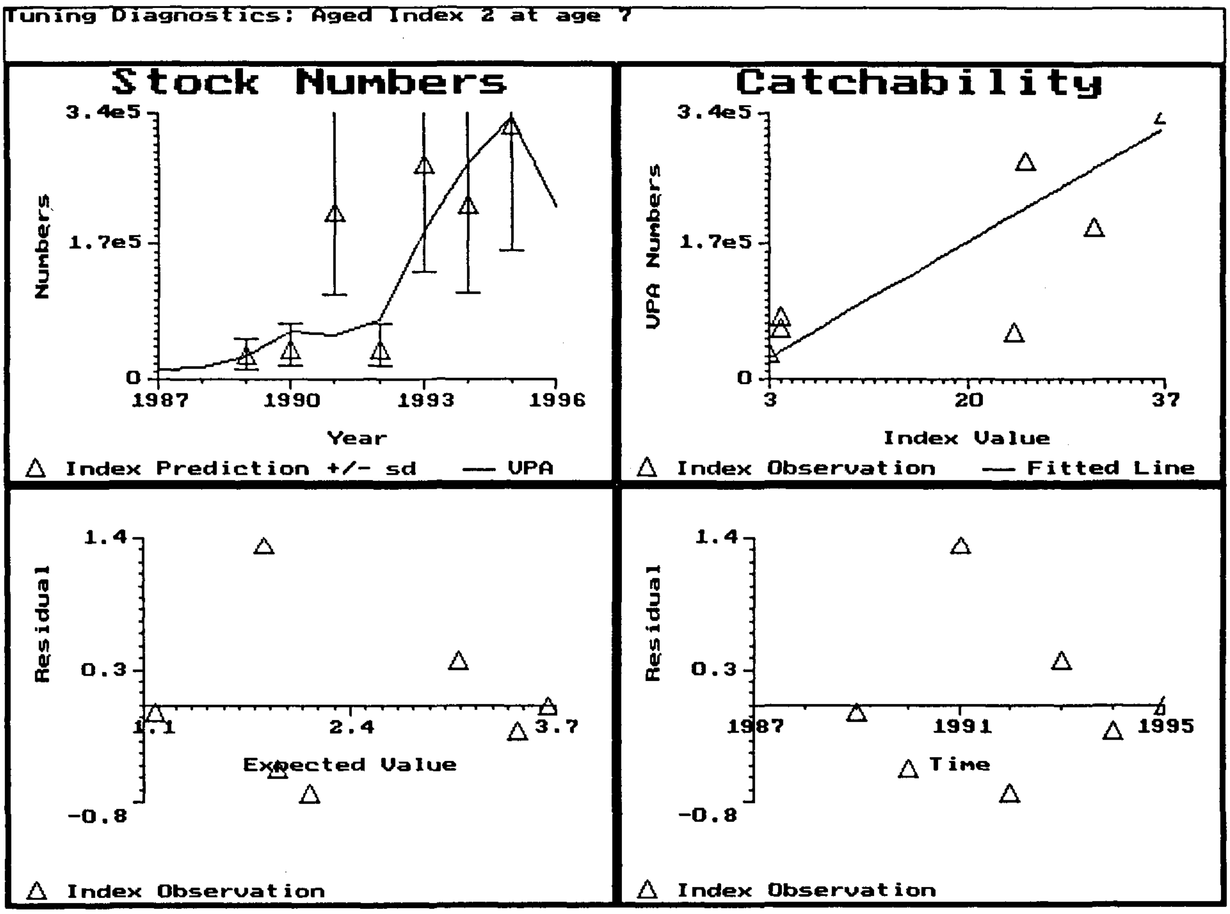


Figure 3.8.5.i Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1989-95: Acoustic survey in Sub.Div 22-24, Age groups 8+

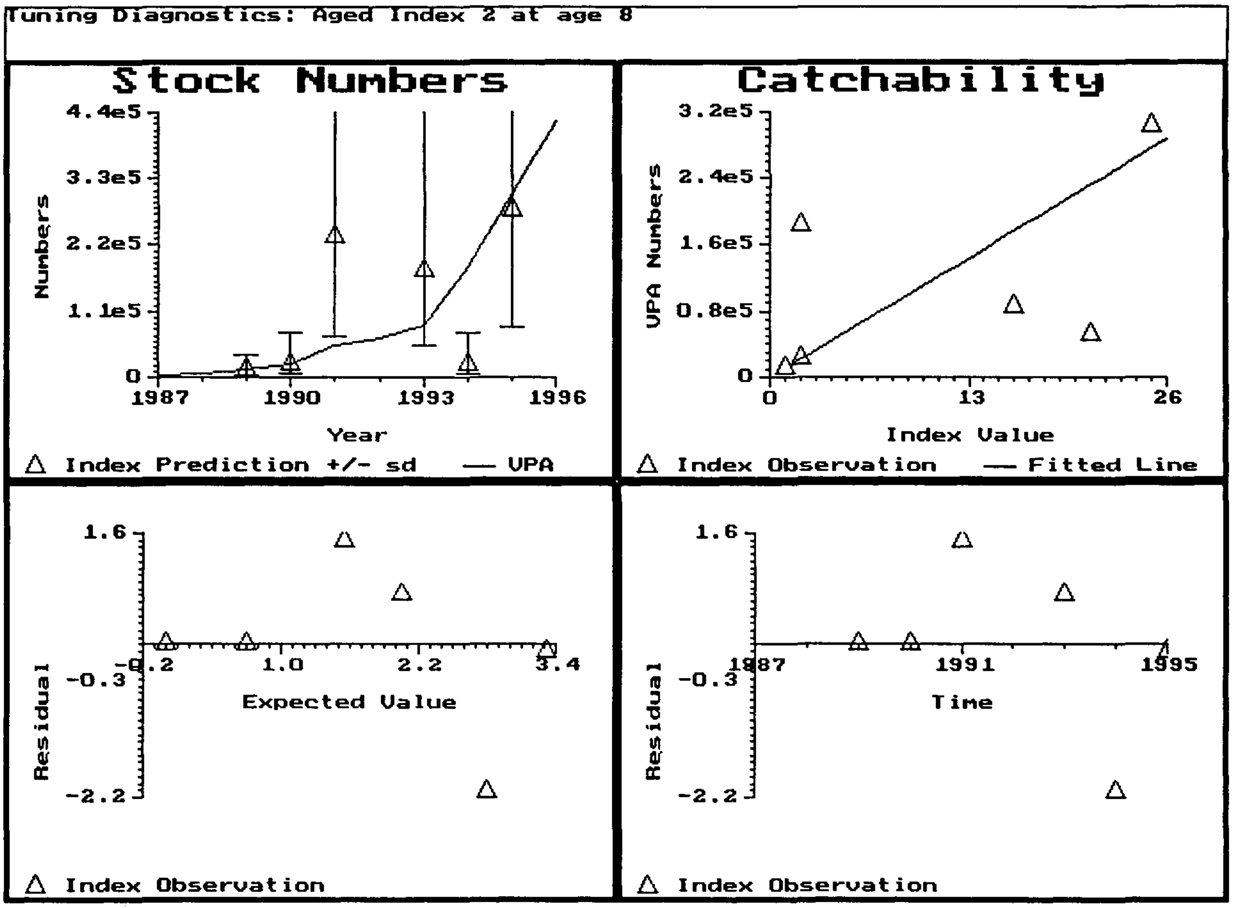


Figure 3.8.6.a Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age group 1.

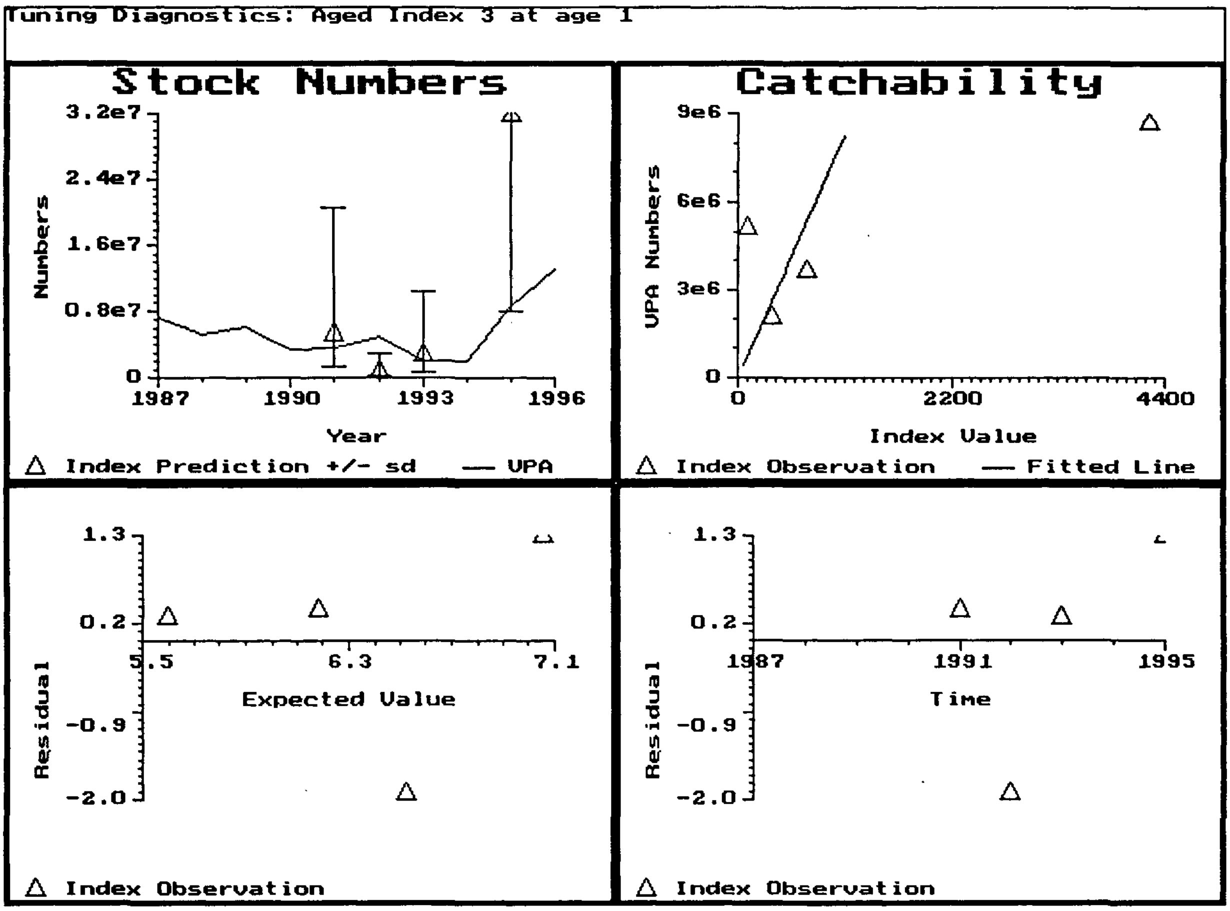


Figure 3.8.6.b Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age group 2.

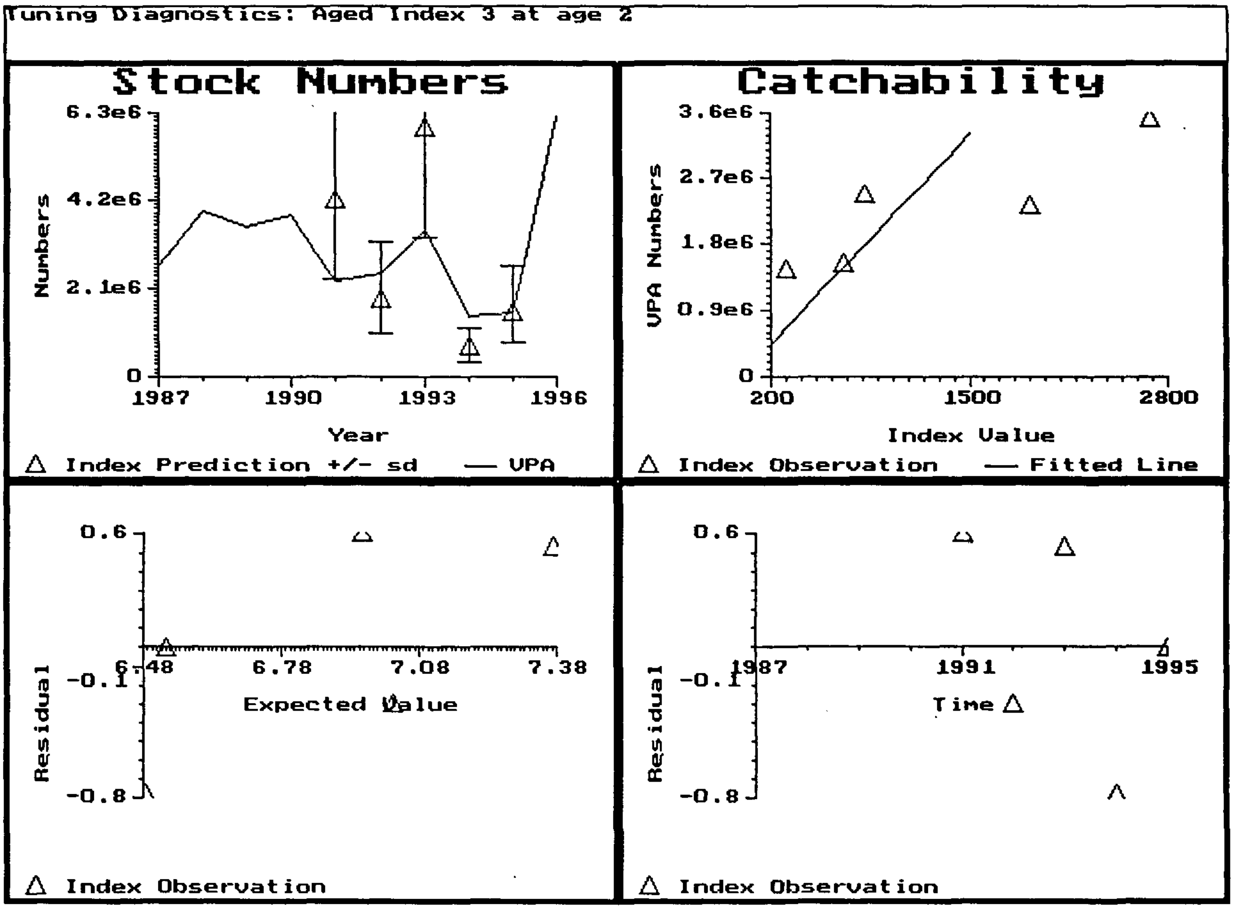


Figure 3.8.6.c Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age group 3.

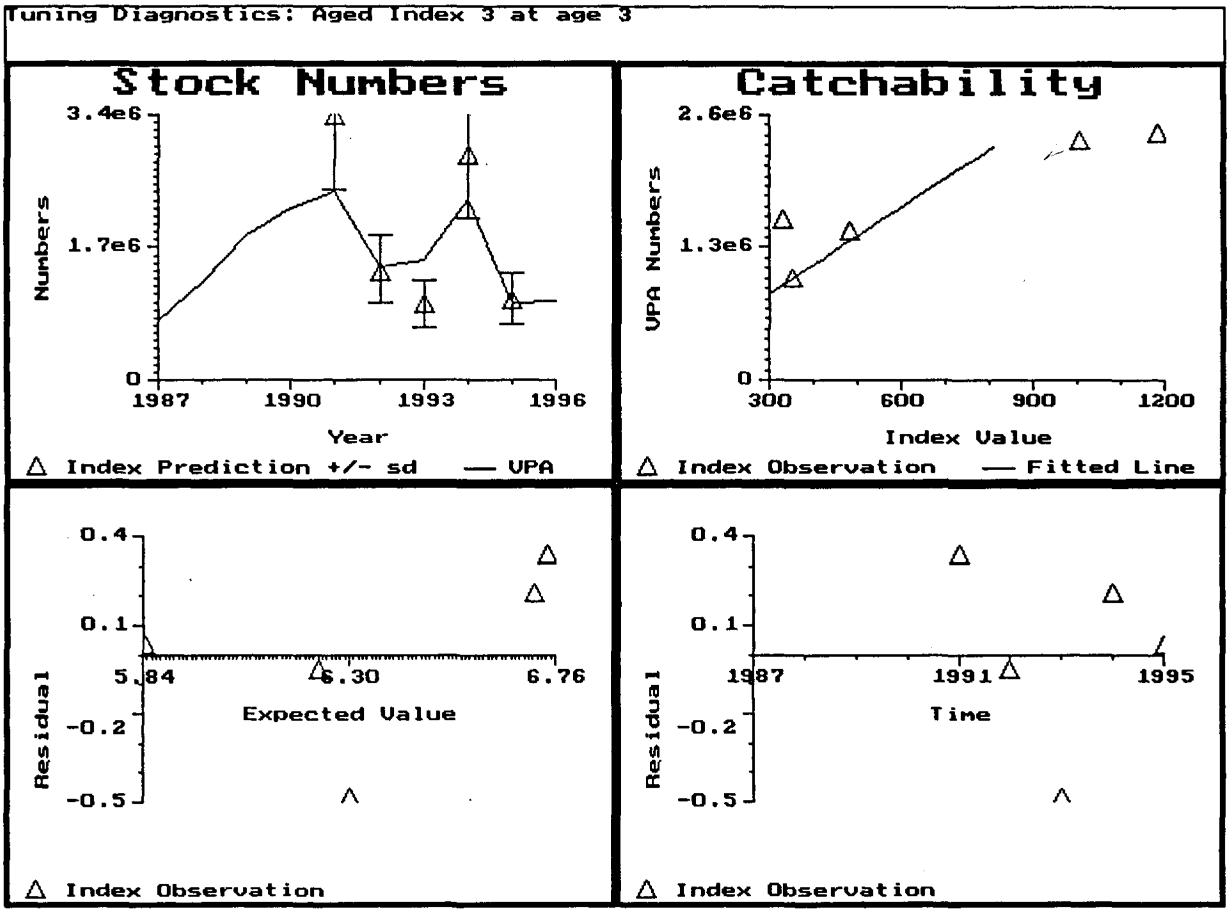


Figure 3.8.6.d Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age group 4.

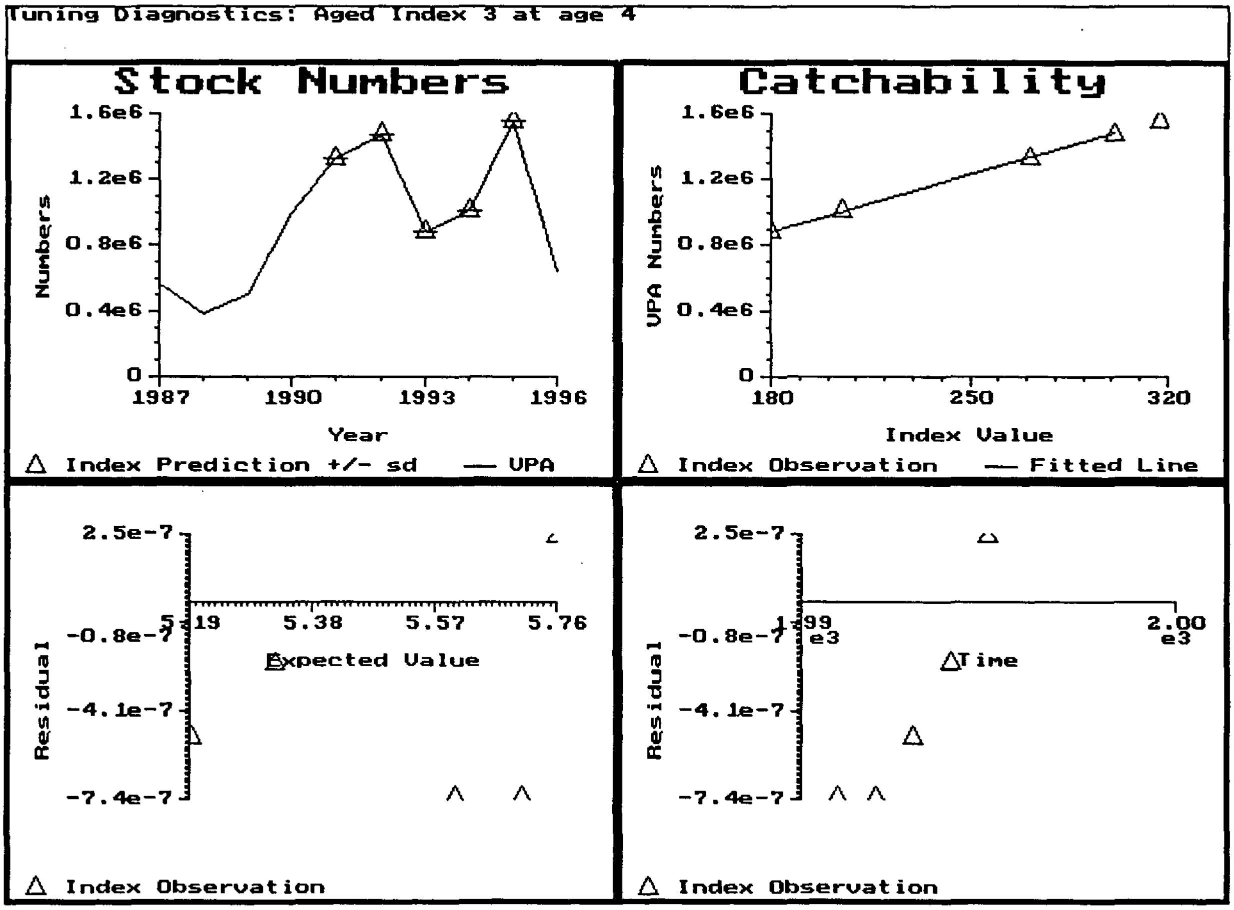


Figure 3.8.6.e Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1991-95: IYFS IIIa for all Quarters (1-4), Age group 5.

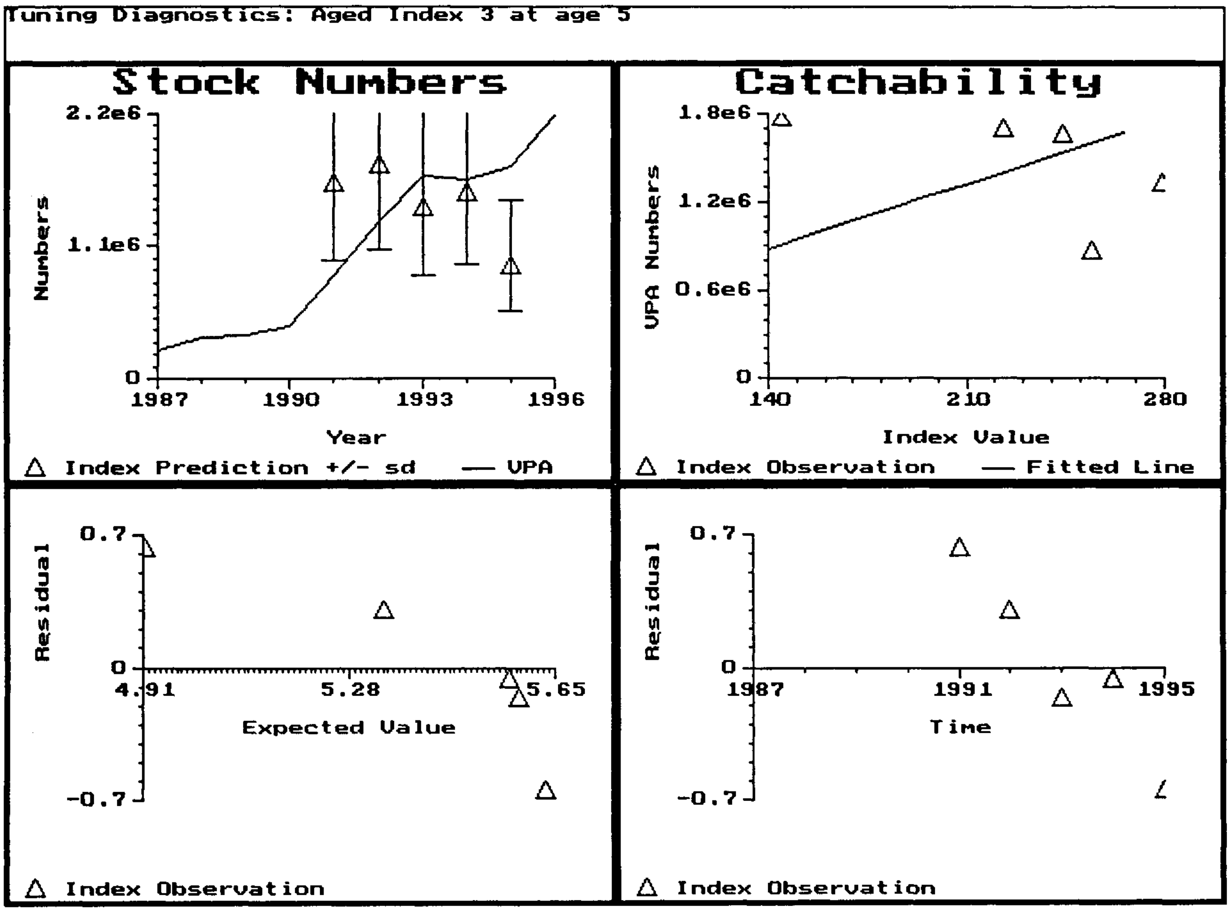


Figure 3.8.7.a Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-95: German Bottom Trawl Survey in Sub.Div. 22+24, Age group 0.

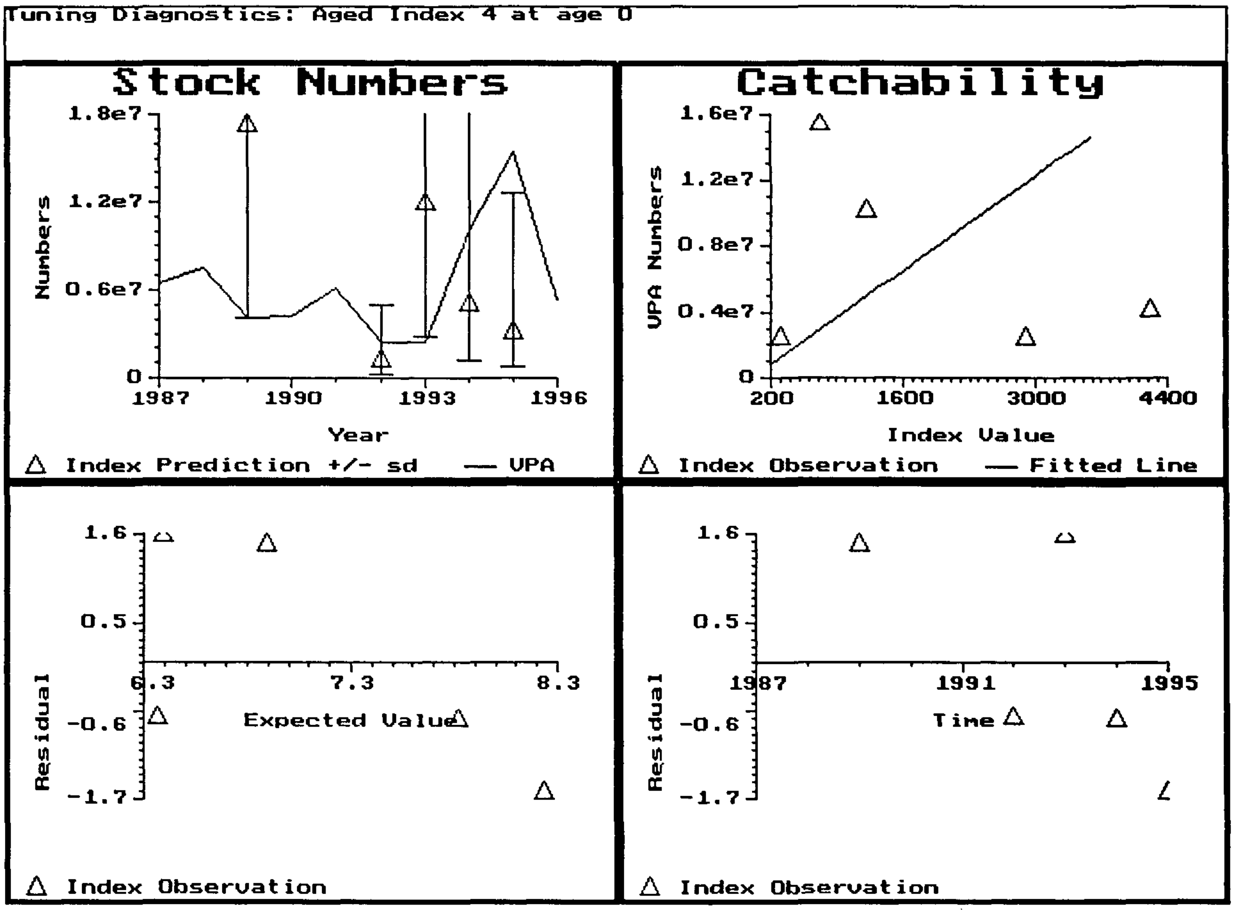


Figure 3.8.7.b Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-95: German Bottom Trawl Survey in Sub.Div. 22+24, Age group 1.

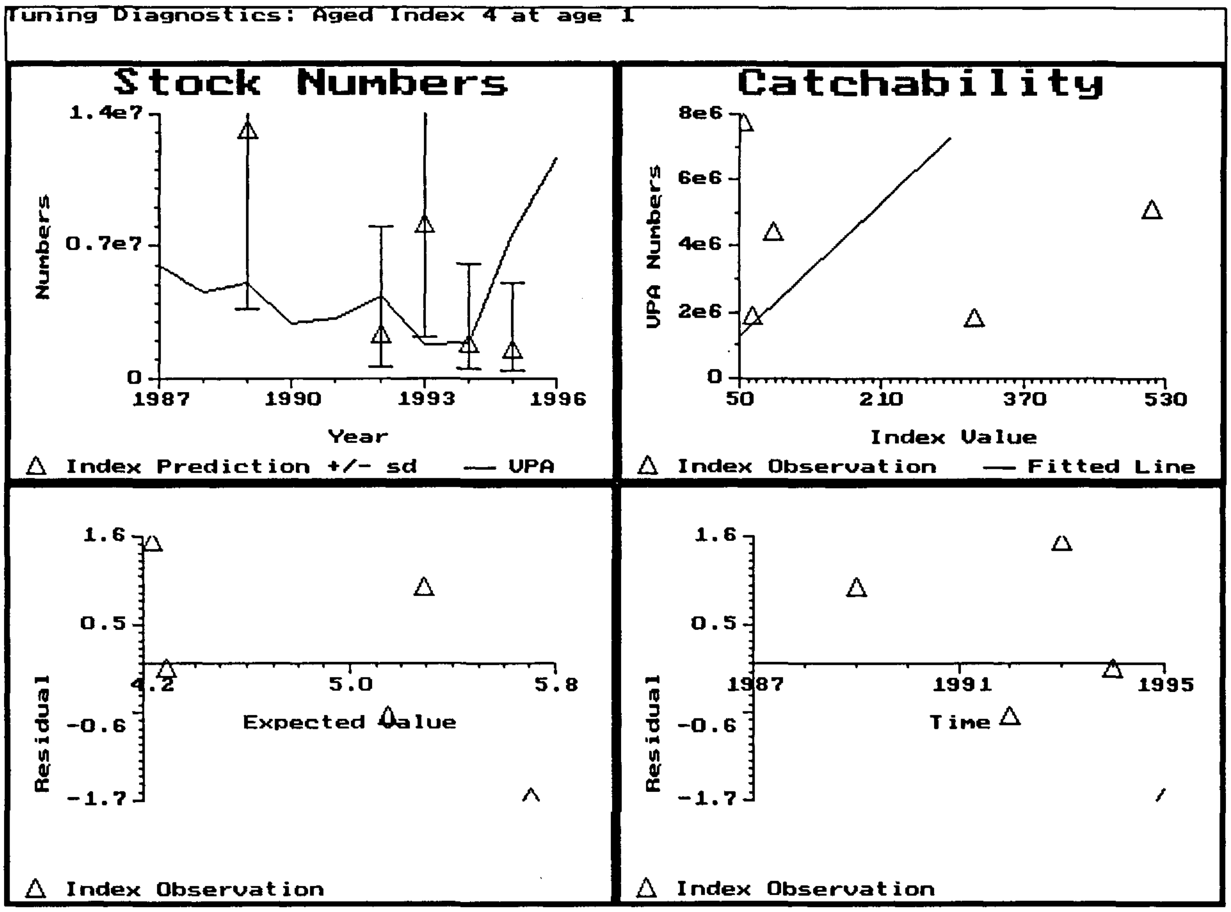


Figure 3.8.7.c Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-95: German Bottom Trawl Survey in Sub.Div. 22+24, Age group 2.

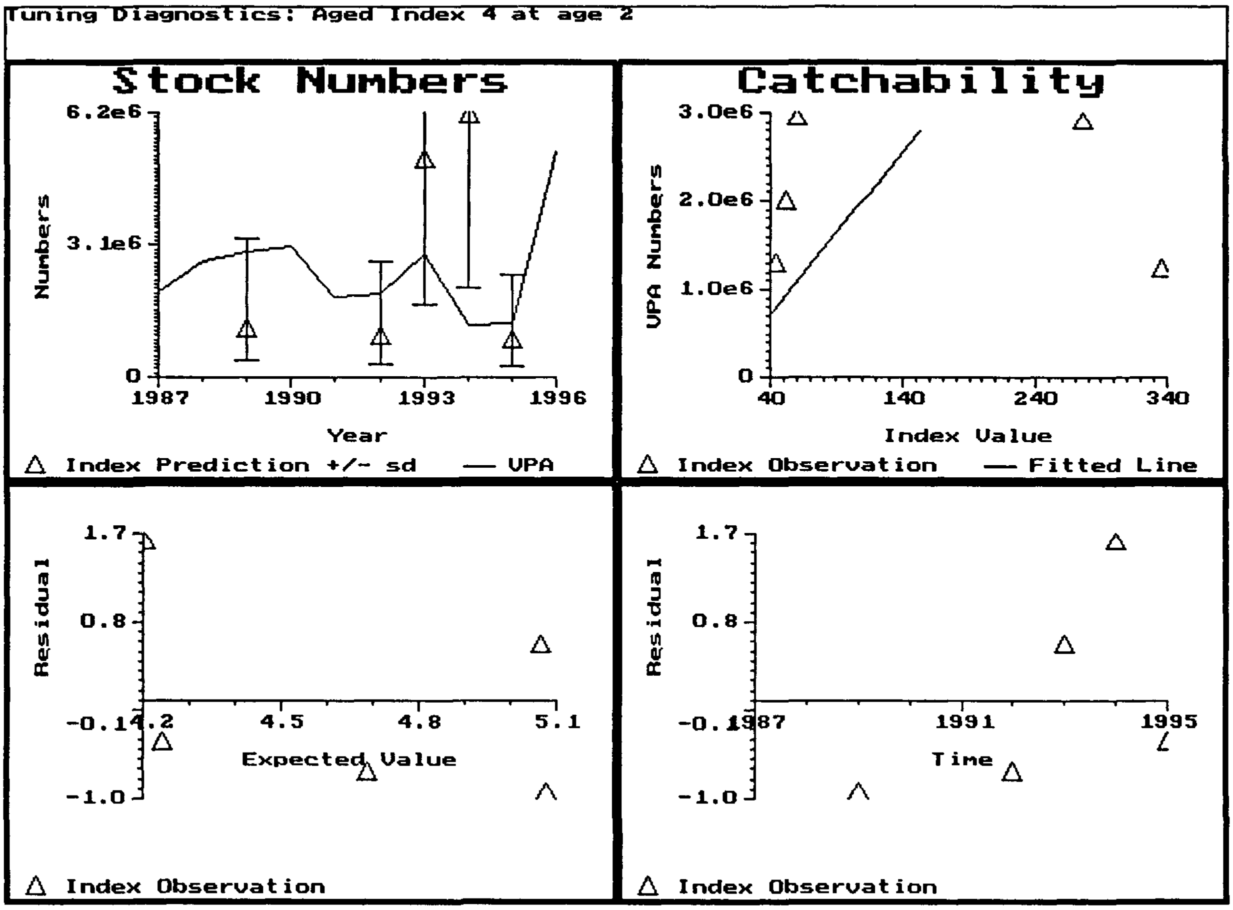


Figure 3.8.7.d Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-95: German Bottom Trawl Survey in Sub.Div. 22+24, Age group 3+.

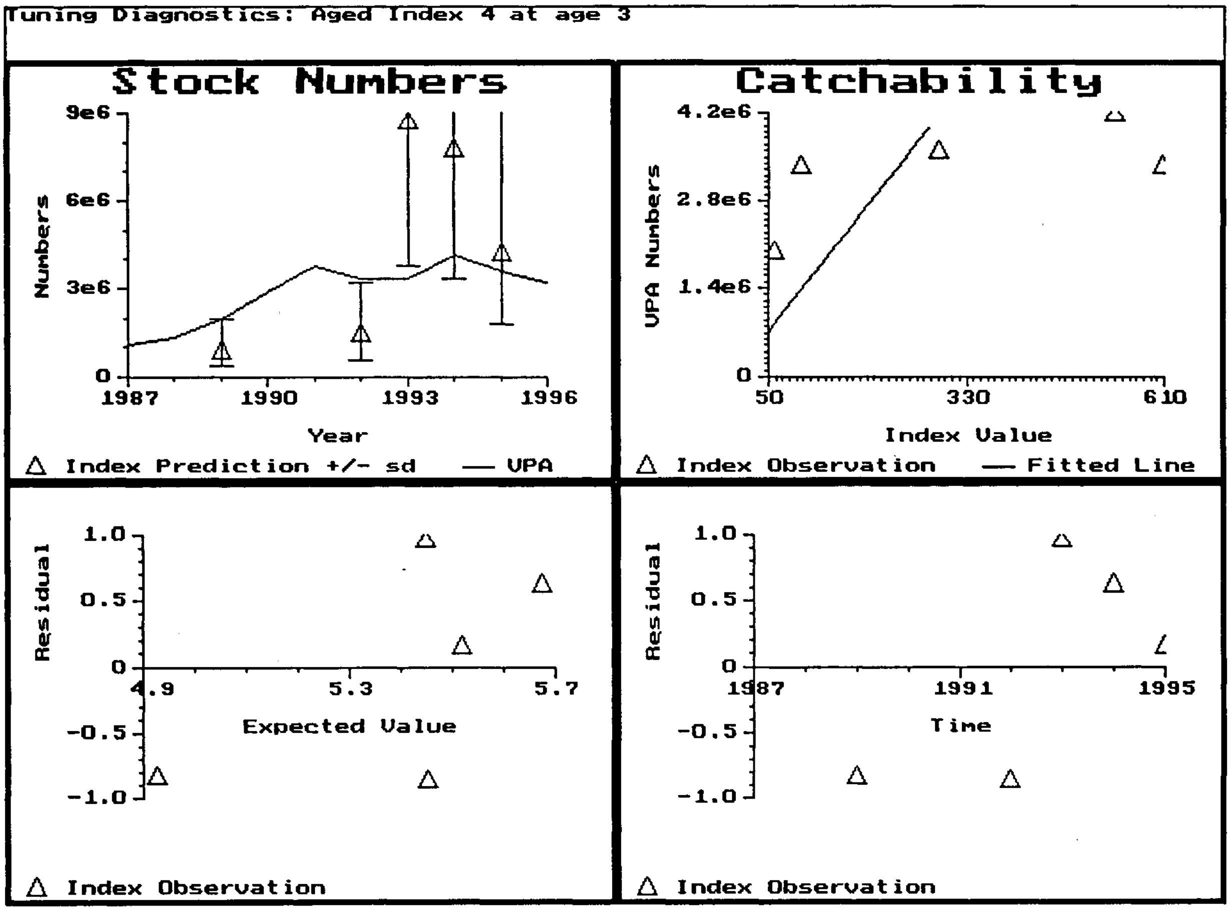
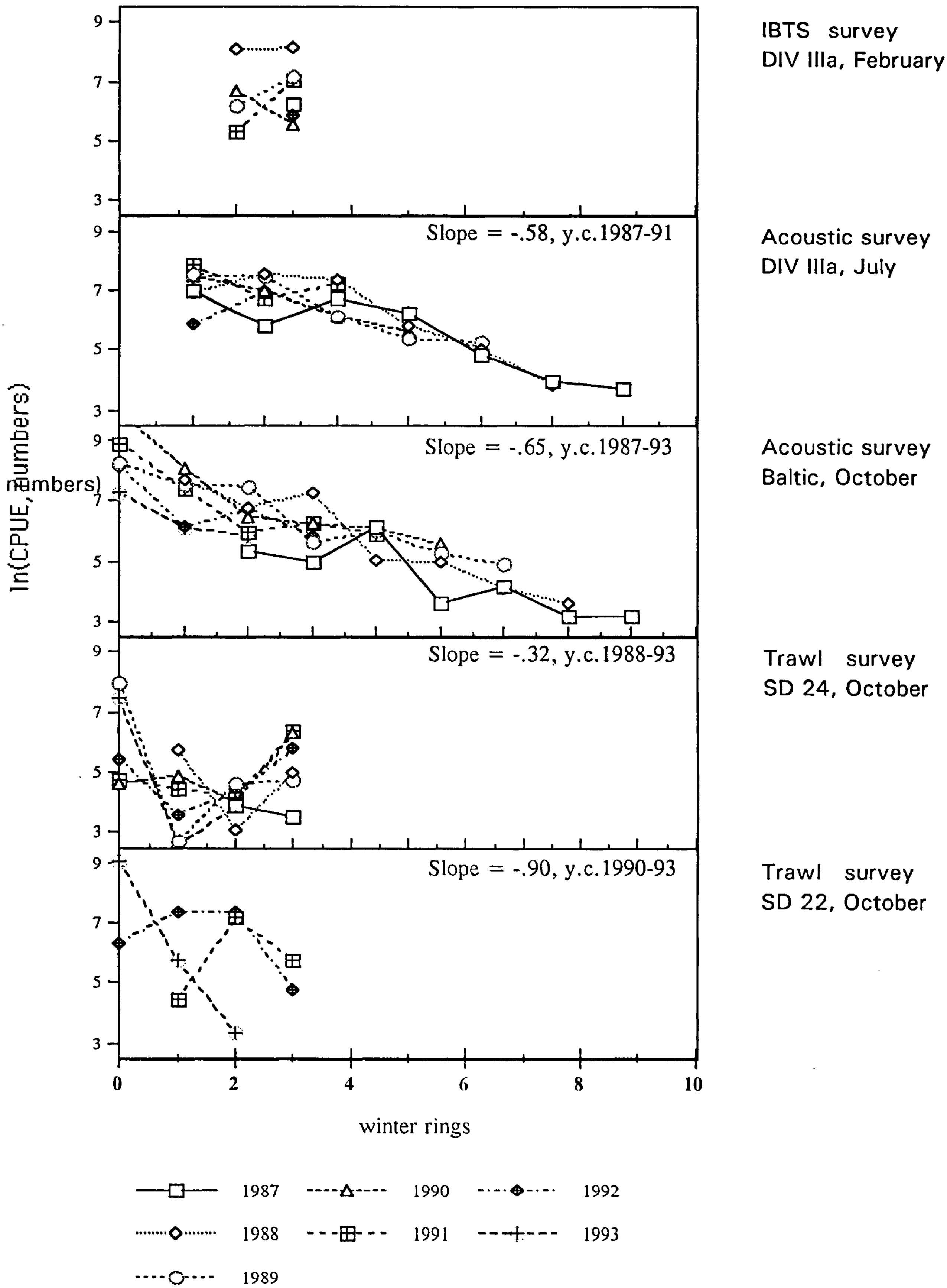


Figure 3.9.1. Age disaggregated indicies in ln(numbers) by age and yearclass for spring spawning herring in Div. IIIa and SD 22,23 and 24 .



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