REPORT OF THE

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62ºN

ICES Headquarters
14–23 March 2000

PARTS 1 AND 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

PART 2

Section			Page

1 INTRODUCTION

1.1 Participants

Fredrik Arrhenius	Sweden
Marinelle Basson	UK
Jørgen Dalskov	Denmark
Mark Dickey-Collas	UK
Paul Fernandes	UK
Joachim Gröger	Germany
Tomas Gröhsler	Germany
Ciarán Kelly	Ireland
John Molloy	Ireland
Henrik Mosegaard	Denmark
Hildrun Müller (part time)	Germany
Peter Munk	Denmark
Richard Nash (part time)	UK
Martin Pastoors	The Netherlands
Norbert Rohlf (part time)	Germany
John Simmonds (Chair)	UK
Dankert Skagen	Norway
Else Torstensen	Norway
Sieto Verver	The Netherlands
Lotte Askgaard Worsøe	Denmark
Christopher Zimmermann	Germany

1.2 Terms of Reference

The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: E.J. Simmonds, UK) will meet at ICES Headquarters from 14–23 March 2000 to:

a) assess the status of and provide catch options (by fleet where possible) for 2001 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), for 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); in the case of North Sea autumn-spawning herring the forecasts should be provided by fleet for a range of fishing mortalities that have a high probability of rebuilding or maintaining the stock above 1.3 mill tonnes by spawning time in 2001;

b) assess the status of and provide catch options for 2001 for the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;

c) identify major deficiencies in the assessments.

The Working Group was also asked to consider aspects of quality control of data and assessment procedures. The stock assessments are documented in chapters 2 to 10 inclusive. Issues of catch data management are discussed in Section 1.5 and quality control and major deficiencies in the assessments are discussed in Section 1.6 for all stocks.

1.3 Summary of the report of the Planning Group for Herring Surveys (PGHERS)

The Planning Group for Herring Surveys met at the Institute of Marine Research in Bergen, Norway, from 1 to 4 February 2000 in order to:

- coordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Divisions VIaN and IIIa, and the Western Baltic;
- combine the survey data to provide estimates of abundance for the population within the area;
- complete the revision of the existing manual of the North Sea Acoustic Survey (Doc. ICES C.M.1994/H:3);
- conduct a workshop on echogram scrutiny.

The report of the Planning Group was made available to the Working Group (ICES 2000).

1.3.1 Review of Larvae Surveys

In the North Sea, seven units and time periods were covered during the 1999 larvae surveys. No estimation of larvae abundance was available to the planning group. The data was presented to the Herring Assessment Working Group, see Section 2.5.

The final results on the larval abundance in the Western Baltic were presented to the HAWG, see Section 3.5.1.

1.3.2 Coordination of Larvae Surveys for 2000/2001

In the period 2000/2001 additional effort by Norway in the second part of September will contribute to the larvae surveys. Along with Germany and the Netherlands, this will give a more complete coverage. It would be highly preferable to allocate some ship-time for sampling in the first half of September in the Orkney/Shetland area. If this is not possible, some effort should be made to carry out duplicate sampling. This will give more reliable estimates of larvae abundance, for comparison of sampling efficiency and catchability, as well as spatial and temporal changes in larvae distribution within one sampling period and unit.

1.3.3 Review acoustic surveys in 1999 from the North Sea/west of Scotland, Western Baltic and the Sounds

In the North Sea/Skagerrak /West of Scotland, five acoustic surveys were carried out during late June and July 1999. Individual survey reports and preliminary estimates of abundance for the population within the area were presented. Final combined survey results were presented to the Herring Assessment Working Group (see Section 2.4).

Sprat data were available from RV Tridens and RV Solea. No catches of sprat were reported from RV G.O.Sars and RV Scotia. The acoustic estimate of sprat was very low, mainly due to inappropriate coverage of the south-eastern area.

In the Western Baltic, a joint German-Danish acoustic survey was carried out in September-October 1999. Preliminary estimates of abundance and biomass from herring and sprat were presented to the planning group. The biomass of herring reached the same level as in 1998. High density of young sprat in the southeast part of the Arkona basin increased the total sprat abundance by 140%.

1.3.4 Inter-ship calibration

An inter-ship calibration of the acoustic equipment was performed between the RV Scotia and the RV Tridens. The intercalibration did not show any significant difference from a 1:1 relationship between the two vessels recordings.

1.3.5 Plan for an international survey for Western Baltic spring-spawning herring

Division IIIa will be covered in July 2000 in the same way as prior to 1999. For the acoustic survey in October, the coverage in the Sound (Sub-division 23) will be intensified with RV Solea. As no additional ship-time will be available for a total coverage of Sub Division IIIa in October, the planning group concluded that additional effort should be made to gain ship-time, preferably by a Danish or Swedish vessel.

1.3.6 Revision of the manual

A revision of the existing manual of the North Sea Acoustic Survey (Doc. ICES C.M. 1994/H:3) was carried out. The planning group noted that some sections; i.e., survey design and sampling methods, could not be revised as the relevant studies are still in process. In future, small updates and revisions to the manual should be an ongoing function within the group, with publication into an appendix to the report at longer intervals.

1.3.7 Echogram Scrutiny Workshop

A second international scrutiny workshop was held as part of the meeting. Germany, the Netherlands, Norway and Scotland supplied data sets from their respective national survey areas. Initial analysis at the workshop indicated that in most cases where trawl data were available there was remarkable consistency between groups analysing a particular survey. The initial CV values calculated for the four survey data sets, was 3.4–47.5. No detailed analysis has been carried out thus far on the results of the echogram scrutinising exercise.

The immediate conclusions from the workshop were that:

- Good scrutiny is only possible with good trawl data and;
- The most difficult scrutiny problems are found where there are fewest herring.

The PG recommends that participating nations should try, where possible, to exchange staff between surveys, ideally at a senior level. This should greatly contribute to a consistency of approach and enhance the quality of the coordinated survey.

A full analysis of the workshop results will be carried out in the near future and presented as a working document at the appropriate ICES Working Groups and at an appropriate theme session at the ICES ASC.

1.3.8 The Planning Group for Herring Surveys recommends that:

The Planning Group for Herring Surveys should meet in IJmuiden, The Netherlands, from 22 to 26 January 2001 under the chairmanship of P.G. Fernandes (UK, Scotland) to:

a) coordinate the timing, area allocation and methodologies for acoustic and larval survey for herring in the North Sea, Division VIaN and IIIa and Western Baltic;

b) combine the survey data to provide estimates of abundance for the population within the area;

c) examine aspects of the depth dependence of target strength for herring, specifically:

- review the available literature on the depth dependence of target strength in herring;
- report on investigations on the depth distribution of herring schools around Shetland for the years 1991–1997;
- determine methods to evaluate the depth distribution of herring in past surveys for the whole of the North Sea.

d) The Planning Group recommends that efforts should be made to cover the whole Sub-Division IIIa during the October survey on Baltic Spring Spawning Herring. Ideally, Swedish and/or Danish vessels should join FRV Solea in these efforts.

e) The Planning Group recommends that nations participating in the acoustic surveys should try, where possible, to exchange staff between surveys, to ensure a consistent scrutinising and evaluation approach, and consistent quality.

1.4 HAWG Recomendations

1.4.1 The creation of a Study Group on the evaluation of current assessment procedures for North Sea herring to operate initially by correspondence.

Assessments of North Sea herring have been carried out by using ICA since 1995. The choice of the separable period, which is a predominant feature of the assessment model, has caused considerable problems in assessing the state of the stock. Substantial management changes have been implemented in the middle of 1996 which have caused changes in the fishing pattern, and therefore the assumption of separability could not be maintained. Several ad-hoc solutions have been proposed to this problem but more attention is needed.

The assessments of this stock has over the years consistently overestimated the stock size. This problem is not specific for North Sea herring and is part of a general assessment problem, in particular when the perception of the current state of the stock is sensitive to the choice of a separable period

The short term prediction program used for North Sea herring is known/notorious for its complexity, because it attempts to combine spatial information on the stock with information of the selection patterns by fleet. The prediction program is implemented as an Excel spreadsheet and is considered to be error-prone. The spatial information needed for the predictions is derived from survey information which is converted into 'split-factors'. The Study Group should evaluate the usefulness of estimating these splitfactors and the procedures for generating fleet based selection patterns. The current prediction procedures should be contrasted with more simple approaches and also the medium term prediction program (ICP) that is currently used for this stock and which could be adapted to give probabilistic short term prognoses.

In 1997 a management plan has been accepted by the EU and Norway. Efforts will be made to maintain the SSB above the Blim (800 000 t). An SSB reference point of 1.3 million t has been set, above which the TACs will be based on an F = 0.25 for adult herring and F = 0.12 for juveniles. If the SSB falls below 1.3 million t, other measures will be agreed and implemented taking account of scientific advice. The basis for this management plan was an analysis of the state of this stock and the predicted developments given different management scenario's. As such, the advice was dependent on the assessment procedures applicable when the advice was provided. If the assessment procedures for this stock are re-evaluated, the effects of this evaluation on the management of this stock should also be taken into account.

1.4.2 The Planning Group for Herring Surveys (PGHERS) Chair: P.G. Fernandes (UK, Scotland)) will meet at RIVO, IJmuiden, The Netherlands from 22 to 26 January 2001 to:

a) coordinate the timing, area allocation and methodologies for acoustic and larval survey for herring in the North Sea, Division VIaN and IIIa and Western Baltic;

b) combine the survey data to provide estimates of abundance for the population within the area;

c) examine aspects of the depth dependence of target strength for herring, specifically:

d) review the available literature on the depth dependence of target strength in herring;

- report on investigations on the depth distribution of herring schools around Shetland for the years 1991–1997;
- determine methods to evaluate the depth distribution of herring in past surveys for the whole of the North Sea.

1.4.3 Exchange Studies on Sprat and Herring Otoliths

IBTS(February)-indices do not fully reflect strong and weak cohorts for sprat, as demonstrated at this and previous Working Groups. The 1:2-group ratio does not adequately reflect the age structure of the stock. This may be due to difficulties in age reading and a prolonged spawning and recruitment season combined with overwintering of autumn spawned larvae.

The HAWG recognises a need for more information of the effect of spawning seasons and recruitment from a possible autumn spawning components (overwintering larvae) on ageing and thus the allocation to year classes. Studies on microstructures in sprat otoliths from sprat in the North Sea and Division IIIa are therefore recommended.

Some uncertainty in the ageing of herring around the North Sea and adjacent areas has been noted. The importance of ensuring accurate ageing cannot be over stressed.

There is a need to set up routine otilth exchanges in order to keep quality control of this important aspect of data collection.

1.4.4 Recommendations on landings data collection

The Working Group recommends:

- to develop an input application for commercial landings and sampling data for the 2001 working group meeting either by ICES (which would have the advantage of a general usage by all working groups) or by the ongoing EU-project on market sampling (EMAS). Any future format should provide an opportunity to clearly track changes of official landings made by Working Group members to compensate misreported or unallocated landings or discards; data entry should be possible on the most disaggregated level; the application should produce standard outputs and allow for a splitting of catch and weight at age data; and a data exchange to the evaluation routines already created (i.e., DISFAD) has to be ensured.

- that national institutes prepare national fleet descriptions and fishing practices (current status and changes over the last ten years), preferably as working documents, for the next Working Group, to ease the work of species co-ordinators in making decisions for filling-in of missing data, and to document possible changes in fishing patterns.

- That national catch and sampling data from the at least four previous years either within ICES or at the national institutes should be provided to for next year's Working Group

1.4.5 Appointment of New Chair

The Working Group unanimously recommends that Marinelle Basson be appointed Chair of the Herring Assessment Working Group South of 62ºN for the period 2001 - 2003.

1.5 Commercial catch data input, quality control, and long-term data storage

Input spreadsheet

In the light of the development of the ICES Code of Practise for Data Handling, for the 1998 and 1999 catches the working group members used a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel Working Group (MHSA). This worksheet was further adapted to the special needs of the Herring Assessment Working Group, and for this year, some problems were corrected and summarising and evaluation routines were implemented to reduce the risk of erroneous data input. The majority of commercial catch data of multinational fleets was provided on these spreadsheets and further processed with the SALLOCL-application (Patterson 1997). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set, which allows to recalculate data in the future, choosing the same (subjective) decisions made today. Ideally, all data for the various areas should be provided on the standard spreadsheet and processed similarly, resulting in a single output file for all stocks covered by this working group.

The quality of the input data has significantly improved over the last years, and the provided input format was used by all but one nation. However, a number of problems were encountered, some of them attributable to the notorious error-prone handling of spreadsheets. The Working Group discussed most of them extensively and decided to cope with these in the following way for next year:

- Obeying the deadline for sending the national data to the species co-ordinators (14 days prior to the Working Group) proved to be crucial for the data handling at the Working Group. National institutes are again urged to send their data in time, so that all consistency checked catch data is available and primary processing (like the splitting of North Sea Autumn Spawners and Western Baltic Spring Spawners in IIIa) is finished at the first day of the Working Group.

- National data for all areas should be provided on one single workbook sent in copy to the different species co-ordinators rather than using different versions for each stock/area. This is especially important when figures of transfers between areas have to be changed during the consistency checks.

- Information on sampling of commercial catches should only be provided for areas and quarters where sampling was actually conducted, and catches of unsampled areas/quarters should never be raised within the input spreadsheet, as this makes it almost impossible to track decisions made by the persons responsible for the national data. Raising and filling-in should be exclusively done within the SALLOCL-program, as only this procedure ensures a proper documentation. However, national institutes are required to provide species co-ordinators with suggestions how to fill in their national data, and the co-ordinators will usually follow these instructions.

- The direction of transfers and target area(s) of misreported or unallocated catches should be clearly stated. A future input application should allow multiple entries for the same area, to cover each fraction of misreported catches (fractions that are transferred to a specific area) reported in a separate line

- The Working Group decided to use the ICES separation of Areas, Divisions and Sub-Divisions as presented in Figure 1.5.1 for reporting of official catches and Working Group estimates, even if these do not in all cases match the official definitions (as unfortunately used e.g., for the EU-Norway agreements). i.e., the divide between the Skagerrak (IIIa) and the North Sea (IVa East) should follow statistical rectangles rather than a straight line between Lindesnæs (N) and Hanstholm (DK).

Future developments

The working group repeats its opinion that an input file based on a stand-alone database application (e.g., an MS Access runtime version) would be most preferable, because it is less error-prone than a spreadsheet, and results can easily be interpreted. It is again recommended to develop an input application for the 2001 working group meeting either by ICES (which would have the advantage of a general usage by all working groups) or by the ongoing EU-project on market sampling (EMAS). Any future format should provide an opportunity to clearly track changes of official landings made by Working Group members to deal with misreported or unallocated landings or discards. However, if a database input is not be available for next year's Working Group, it was decided to use the spreadsheet again for the interim period. Obvious errors in the spreadsheet formulae will be corrected intersessionally, but there will be no more general developments on this sheet.

The Working Group recommends that the national institutes prepare national fleet descriptions and fishing practices (current status and changes over the last ten years), preferably as working documents, for the next Working Group. The Working Group will then prepare a short overview to be included in the report. The aim is to ease the work of species co-ordinators in making decisions for filling-in of missing data, and to document possible changes in fishing patterns. Future developments should then be documented yearly together with the catch data; however, the short fleet description table on the input spreadsheet was virtually not used by any nation in this year.

The Working Group considered the need of a long-term data storage for commercial catches and sampling, and the documentation of any primary data processing of these data. From this year on, last (consistency checked) versions of the input files together with standard outputs and a documentation of filling-in decisions made by the co-ordinators. Ideally in the SALLOC-formats, will be stored in a separate "Archive" folder. This will be updated yearly, and the complete collection (which is supposed to be kept confidential as it will contain data on misreporting and unallocated catches) will be available for Working Group members on request. As there is very little historical information available at present, Working Group members are asked to provide as much as possible national catch and sampling data delivered to the Working Group in previous years to the next Working Group, in any available format. Table 1.5.1 gives an overview over data available so far, and the source of the data. If it is needed to re-enter catch data, members are encouraged to use the latest-version input spreadsheets.

On the Herring 2000-conference held in February in Anchorage, Alaska, it was decided to ask ICES for possibilities to establish and maintain a web-page providing information on (in a final stage) all herring stocks in the world. The page should contain scientific (and agreed) information on parameters like catches, biomass, SSB, recruitment, weights/numbers/lengths at age etc. and should ease an evaluation of possible synchroneous changes or fluctuations in these parameters. It was considered that it would be little additional effort to obtain these data within the ICES environment (from the HAWG, NPBW-Working Group and BFAS-Working Group reports), and that it would therefore be valuable to start here. The Working Group discussed this matter and decided to support any Herring 2000's initiative for assessed herring fisheries, if formally forwarded to ICES.

1.6 Quality control and major deficiencies with the assessment

1.6.1 Introduction

To address TOR (3) in this section we discuss both the general difficulties with the assessments and particular problems by stock. In addressing these issues we have used a check list from American national research council report on improving fish stock assessments (1998) and modified for use here see Table 1.6.1. This list provides both a framework for dealing with quality control and for looking for deficiencies in the assessments, we have therefore coupled these two objectives. This approach leads to detailed investigation of the internal process of the assessment, highlighting a wide range of areas with potential problems, but with rather poor information on the impact of these on the outcome of the assessment. However, establishing the general sensitivity of assessments to a particular problem requires extensive investigation which is outside the scope of a Working Group but this type of investigation needs to be carried out before it is possible to conclude that the area with known difficulties is important to the outcome of the assessment. These considerations need to be born in mind when reviewing this section. Here we present a detailed breakdown of the assessment reviewed under the following two areas:

- Input data, both that they are appropriate and representative, and how to standardise and document the data assembly and aggregation procedures.

- Choice of assessment and prediction tools and model formulations, including the justification for including or excluding data.

As a practical aid, the Working Group then suggests a list of points to consider for each stock. This list is an extension and modification of one proposed by NRC (1998). All points are not relevant to all stocks, but the list is meant to cover a range of points that would be worth considering. This Working Group checklist is included as Table 1.6.1, and has been applied to each of the stocks as described in the respective sections and the results are tabulated in Tables 1.6.2 to 1.6.8.

In this general section, we give a brief overview of the assumptions that are commonly made when translating data into an assessment, for herring in particular, and indicate problems that may violate these assumptions.

1.6.2 Assumptions about data

Stock units. A basic assumption in all currently used assessment models is that the stock unit is a closed entity, in the sense that fish are recruited to the stock at recruitment age only, and only leave the stock by death. This is not necessarily the case, because the definition of stock units may be connected to management areas, there may be mixing of fish from several stocks in an area, and it may be difficult to separate fish from different stocks in commercial catches as well as survey catches. This is a common problem with a migratory fish like herring. To some extent, as for North Sea autumn spawners and Baltic spring spawners, separation is done on biological characteristics, but this is work demanding and can hardly be justified for smaller stocks. In some cases it may be justified to merge stocks, e.g., the North Sea stock as considered by the Working Group is probably composed of several substocks.

Catches. In general, the reported catches are assumed to cover all mortality apart from the assumed and fixed natural mortality. If more fish is removed that reported as catches, a VPA- type model will underestimate a smaller stock, The mortalities will largely be determined by the age composition in the catches and survey data, and will in general be less affected by underreporting of catches. Accordingly, the management advise may be fairly adequate, at least in relative terms, provided the relative extent of underreporting is stable. If not, there will be an inconsistency in the mortality signal in the catches and in catch independent data which may have unpredictable effects on the assessment. Misreporting by area, i.e., by stock, implies underreporting in one area and over-reporting in the other. The effect of this will be worse for the smaller stock. If misreporting is sufficiently concealed, there is also a risk that samples are referred to the wrong stock.

Age distribution of catches. This includes both catches in numbers and weight at age in the catch. Common sources of error are age reading errors, and samples not being representative for the age composition in the total catch. Age reading errors can be random, with would lead to biased assessments as the older (and presumably smaller) age groups gain relatively more than the younger ones loose. There may also be a tendency to allocate individuals to dominating year classes, in particular at older age. The compilation of catch numbers and weights at age is a long sequence of processes, where the responsibility for the early stages is at the national institutes while the Working Group is responsible for merging the national data. In order to be able to trace errors in the data and evaluate their statistical properties, detailed documentation of the sampling procedures, including intensity of sampling and selection criteria for sampling will be needed, also at national level. For the time being, the information available to the Working Group in this field is fragmentary, and highly dependent on the membership of the Working Group.

Catch per unit of effort is commonly used as an index of the stock abundance. In addition to the problems associated with the catches, the effort measure must be adequate as a measure of the partial fishing mortality generated by the fleet, which implies e.g., that the effort is directed towards the stock in question in a consistent way. There is sometimes a conflict between measures that relate to the operating costs, which are of prime interest to economists, and those that relate to exploitation (check reference – LTM??) For pelagic stocks, where variation in the catch rate is more related to variations in local concentration of fish than to the absolute amount, CPUE measures are often considered of limited value.

Surveys should either cover the whole area of abundance, or there should be very strong evidence that the amount measured in the survey area is proportional to the whole stock. Survey coverage is a problem with some of the herring stocks, either because surveys which each cover restricted areas are not sufficiently coordinated, or because fish in some years migrate out of the survey area. The interpretation of the survey results in the assessment model is usually that the survey index is a relative measure of abundance at each age. The design of the survey, and the way the final survey index is calculated, should take this into account, and the pitfalls are numerous. Some common ones are noted in the checklist.

1.6.3 Assumptions about models

Most age-based assessment models either reconstruct the cohorts directly from the catch at age data, assuming that these are correct (‘VPA type models’), or compare the data with a parametric population model where some internal structure in the mortalities, e.g., that the fishing mortalities are separable, is assumed (‘statistical catch at age models’). The choice between these types is not always rational, and often due to the analyst’s experience and to tradition. In general, the statistical type of models offer more flexibility with respect to model formulations, and to put emphasis on the data that are considered to be most reliable. For the years backwards in time, the stock estimates even by most statistical type models become increasingly dependent on the catch data, making the difference between these categories smaller than it may appear at first sight.

For this Working Group, the statistical type, represented by ICA, has become the standard tool. For this model, the most important underlying assumptions are:

- Fishing mortality is separable for a range of recent years, which may be split into two periods with different selection patterns.
- Survey indices are generally treated as relative (or optionally absolute) measures of abundance (at age if age disaggregated indices), with a constant catchability over years.
- Natural mortality is assumed to be known.
- The model is fitted to the data by non-linear minimisation of a sum of squares of log residuals. By treating this as a likelihood estimate, it is implicitly assumed that the errors in the data are independent and log-normally distributed.
- Variances of the data are not estimated as parameters, but are computed as (Sum of squares)/(degrees of freedom). Variances of the parameters are derived from the Hessian matrix.
- The weighting is as a standard that each of the catch at age observations, and each set of indices are given the same weight. In practise, this implies that relatively large weight is given to the catch data. Weighting may be specified by the analyst, but with some limitations, and weighting by inverse variance is possible.
- For the years prior to the separable period, a conventional VPA is made.

The effects of violations to these assumptions are hardly fully understood, but may clearly become severe, in particular on the estimates for the most recent years. Changes in exploitation pattern may lead to wrong estimates of the strength of recent year classes. Wrong assumptions about the relation between abundance indices and the stock abundance may give very misleading stock estimates in recent years, in particular if recent indices have extreme values. Different values for natural mortality will lead to different estimates of the stock numbers, but the effect is to some extent a scaling effect. If some absolute measure of abundance is included, wrong natural mortality will lead to conflict between mortality and abundance. If natural mortality varies over time, the variations in the stock because of this will be concealed by assuming a constant natural mortality. The effect of wrong assumptions on the distribution function for the errors in the data is not well understood. Different objective functions may implicitly give different weights to different data. Clearly, statistical inferences may become less meaningful if the underlying assumptions are violated..

Even without other data than the catches, it is often possible to find a distinct minimum for the objective function, although the model in principle is over-parameterised. The result, in particular if the survey data are sparse, is a trade-off between the quasi-result suggested by the catches, and the signal in the surveys.

Apart from this, if giving different weight to different sources of information gives widely different stock estimates, the obvious reason is that some of the assumptions about relation between observations and the stock are violated. Therefore, if such problems are encountered, the first to consider should be whether the observations represent what they are supposed to represent. The choice to exclude certain information from the assessment model is at present based on either a priori information on the quality of the information or alternatively on the compatibility of the information within the total model setup. The latter method bears the risk that information is excluded simply because the information is incompatible with the specific model setup and could still carry information within a different model setup.

Common practise is to be consistent from year to year in model assumptions. This should not preclude changing practise if the previous assumptions turn out to be inadequate, but requires a proper demonstration that the new practise is more appropriate.

Although there are theoretical solutions to the weighting problem, such as inverse variance weights, it is important that the weighs must also estimated appropriately. The distribution properties of data are often poorly known and difficult to establish. For example the selecting the an appropriate measure of variance and obtaining it with sufficient precision may difficult.

1.6.4 Assumtions in predictions

Predictions are made routinely in the short term (one or two years) the medium term (the life span of the species). Current practise is to ignore variance in the estimates of the current stock size and mortality and in the short term predictions, but to include both present and future uncertainty in medium term predictions.

Predictions are done as projections of the stock numbers forwards in time, reducing them by given mortalities. Weights and maturity at age are assumed, based on values from recent years. New year classes are added with assumed recruitment values. Stochastic predictions are generally made by bootstrap methods. The elements that are considered stochastic differ between methods, as do assumptions about their distributions and possible autocorrelations, and the method for achieving the distributions. Studies on the quality of various stochastic prediction methods in terms of bias and probability coverage are in progress. Such studies may indicate quality tests for the predictions that should be incorporated in the routine quality control.

ICES is commonly requested to give catch options by fleet. Standard practise is to calculate fleetwise partial fishing mortalities, and to apply these to the predicted stock numbers. Alternatively, the partial fishing mortalities may be used as selection patterns, and the contribution from the various fleets scaled to give each fleet a certain share of the total catch. Although the consequence for the stock of a certain share between fleets can be evaluated on biological grounds, there is in general no biological basis for recommending a certain share between fleets. The practical difficulties of partitioning catches among fleets provides a wide range of solutions with different biological and economic considerations which are not currently properly described and therefore being poorly implemented.

1.6.5 Diagnostics

The currently available diagnostics include plots and tables of the residuals, plots and tables of the fit of the model to each set of data, estimates of the parameter variances and statistics for the residuals (SSQ and variance).

The Working Group considers that some more diagnostics might be useful.

- Tables of the significant terms in the Jacobian matrix, i.e., the matrix of partial derivatives of each observation term with respect to each parameter. The rationale is that the sum across observations for each parameter is zero at the optimum. Accordingly, deviating terms will have been compensated by other terms being moved in opposite direction. It would be even more helpful if the second derivatives could be displayed in addition. The terms with large second derivatives will be those that can compensate for deviations. The usage of this diagnostic will be to trace the impact of each observation on the parameter estimates.

- Tables or graphs of correlations between parameters. With a large number of parameters, some simplified design, aiming at showing strong correlations, is preferable. This may serve as a warning that the model may be over-parameterised.

- Very often, several model choices (e.g., weightings, number of years for the separable constraint, use of various data sources etc.) may appear equally plausible. The sum of squares are often not comparable, because different numbers of parameters and observations are included. The problem is made worse by the fact that the models with different numbers of parameters are not nested. Alternative criteria for choosing the best alternative, like the Akaike information criterium, should be considered by people with sufficient insight in such matters.

- To control the assumption of a given (i.e., lognormal) distribution of the noise in the data, it would be useful to display the resulting distribution of the residuals, and compare it with the one assumed.

- Retrospective analysis has become a useful tool for analysing the consistency between results for recent years, which are to a large extent determined by the fishery independent information, and the estimates for previous years, which are mainly determined by the catches. Such analysis is more problematic with ICA than with VPA-type methods, because it may involve redefining the separable period. At present, in ICA one will have to do separate assessments with separate data sets. A more versatile routine for retrospective analysis with ICA would be appreciated.

1.6.6 Reference Points

The issue of the influence of the above factors contributing to the setting of reference points will also be important, however, the consequences of this are not currently know.

–

Table 1.5.1: Available disaggregated data for the HAWG per March 2000
X: Multiple spreadsheets (usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad and Alloc-outputs (ascii/txt)

Stock	Catchyear	Format			Comments
		X	W	D	
Baltic Sea: IIIa and SD 22-24					
her_3a22	1995				
	1996				
	1997				
	1998				
	1999	X			provided by Jørgen Dalskov, Mar. 2000
Celtic Sea and VIIj					
her_irls	1995				
	1996				
	1997				
	1998		W		provided by Ciaran Kelly, Mar. 2000
	1999		W		provided by Ciaran Kelly, Mar. 2000
Clyde					
her_clyd	1995				
	1996				
	1997				
	1998				
	1999	X	W		provided by Mark Dickey-Collas, Mar. 2000
Irish Sea					
her_nirs	1995				
	1996				
	1997				
	1998	X			provided by Mark Dickey-Collas, Mar. 2000
	1999	X			provided by Mark Dickey-Collas, Mar. 2000
North Sea					
her_47d3, her_nsea	1995				
	1996				
	1997				
	1998	X	W		provided by Yves Verin, Mar.2000
	1999		W	D	provided by Christopher Zimmermann, Mar.2000
West of Scotland (VIa(N))					
her_vian	1995				
	1996				
	1997				
	1998				
	1999		(W)	D	provided by Paul Fernandes, Mar.2000 (1)
West of Ireland					
her_irlw	1995				
	1996				
	1997				
	1998		W		
	1999		W		provided by Ciaran Kelly, Mar. 2000
Sprat in all Areas					
spr_nsea	1995				
spr_kask	1996				
spr_ech	1997				
	1998				
	1999		W		provided by Else Torstensen, Mar. 2000

(1) W included in the North Sea

Table 1.6.1 Checklist for stock assessments

Stock:
Author:
Date:

1. General

Step	*Item*	*Considerations*
1.1	Stock definition	What is the spatial definition of the stock
1.2	Stock structure	Should the assessment be spatially structured?
1.3	Single/multi-species	Choose single-species or multi-species assessment. Use tagging, micro-constituents, genetics and/or other morphometrics to define stock structure?

2. Data

Step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Are removals included in the assessment? Are biases and sampling designs documented. Are discards included and if so, how?
2.2	Indices of abundance	For all indices, consider whether an index is absolute or relative, sampling design, standardisation, functional form of relationship between index and population abundance. What portion of the stock is indexed (spawning stock, vulnerable biomass)?
	Catch per unit effort	What portions of the fleet should be included and how should data be standardised? How are zero catches treated? What assumptions are made about areas not fished? Spatial mapping of CPUE is informative.
	Gear surveys (trawl, longline)	Is gear saturation a problem? Does survey design cover entire range of the stock? How is gear selectivity assessed?
	Acoustic surveys	Validation of species mix and target strength?
	Egg surveys	Estimation of egg mortality, towpath of nets and fecundity of females?
	Larvae surveys	
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Consider sampling design, sample size, high-grading selectivity and ageing errors.
2.4	Tagging information	Consider both tag loss and shedding and tag return rates. Was population uniformly tagged or were samples recovered?
2.5	Environmental data	How should such data be used in the assessment? What are dangers of searching databases for correlates?
2.6	Fishery information	Are people familiar with the fishery? Who have spent time on fishing boats, consulted and involved in discussions of the value of different data-sources.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	What model is currently used? What are the main assumptions? Are alternative models considered?
3.2	spatially explicit or not	
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Are these parameters assumed to be constant or are they estimated? If they are estimated, are prior distributions assumed? Are they assumed to be time-invariant.
	recruitment	Is a relationship between spawning stock and recruitment assumed? If so, what variance is allowed? Is depensation considered as a possibility? are environmentally driven reductions or increases in recruitment considered?

Table 1.6.1 (Cont'd)

3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	If the model is in the form of a weighted sum of squares, how are the terms weighted? If the model is in the form of maximum likelihood, are variances estimated or assumed known?
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	How is uncertainty in model parameters or between alternative models calculated? What is actually presented, a distribution or only confidence bounds?
3.6	Retrospective evaluation	Are retrospective patterns evaluated and presented? Are historical realisations of assessments evaluated?

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	What model is currently used? What are the main assumptions? Are alternative models considered?
5.2	Spatially explicit or not	
5.3	Key model parameters	What is the source of the parameters
5.4	Recruitment	How is recruitment incorporated into the prediction model
5.5	Evaluation of uncertainty	How is uncertainty in model parameters incorporated? How are results presented? Is uncertainty in model parameters visible at output level, and if so, how?
5.6	Evaluation of predictions	Are predictions evaluated post-hoc? If so, how? Which performance indicators are applied to evaluate predictions.

5. Management advice / evaluation

step	*Item*	*Considerations*
5.1	Alternative hypothesis	What alternatives are considered: parameters for a single model or different structural models? How are alternative hypothesis weighted? What assumptions are used regarding future recruitment, environment changes, stochasticity and other factors? Is the relationship between spawners and recruitment considered? If so, do future projections include autocorrelation and depensation?
5.2	Alternative actions	What alternative harvest strategies are considered? What tactics are assumed to be used in implementation? How do future actions reflect potential changes in future population size? Is implementation error considered? Are errors autocorrelated? How does implementation uncertainty relate to uncertainty in the assessment model?
5.3	Performance indicators	What is the real 'objective' of the fishery? What are the best indicators of performance? What is the time frame for biological, social and economic indices? How is 'risk' measured? Are standardised reference points appropriate? Has overfishing been defined formally?
5.4	Presentation of results	How are uncertainties in parameters and model structure presented? Can decision tables be used to summarise uncertainty and consequences? Is there explicit consideration of the trade-off between difference performance indicators? Do decision makers have a good understanding of the uncertainty in the assessment and the trade-offs involved in making a policy choice?

Table 1.6.2. Checklist North Sea herring assessments

1. General

step	*Item*	*Considerations*
1.1	Stock definition	Assessments are performed for autumn spawning herring in the combined areas IV, VIId and IIIa. Although the stock is assessed as one single stock, there are clear indications that it consists of several substocks. It is attempted to post-hoc separate Downs herring (IVc, VIId) from the rest of the stock by means of catch composition and survey data.
1.2	Stock structure	See above
1.3	Single/multi-species	Single species assessments, but North Sea herring is also included in the multi-species model, from which estimates of natural mortality have been derived that are used in the single species assessment model.

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, misreporting	Catch estimation based on official landings statistics and augmented by national collected additional information on misreporting and discarding. Discard information only available for some countries, but nevertheless used in the assessment. Misreporting is corrected by re-allocating catches from official reported areas to areas where catches were taken, based on additional information. Separation between Baltic Spring spawners and North Sea autumn spawners difficult, and currently based on otolith microstructure analysis (since 1996).
2.2	Indices of abundance	
	Catch per unit effort	CPUE information not available and not used for this assessment.
	Gear surveys (trawl, longline)	<u>IBTS survey.</u> International coordinated survey using standardised gear (GOV trawl). Covers the whole North Sea and the Skagerrak. Period of survey: 1st and 3rd quarter (in some years also 2nd and 3rd quarter. Provides herring indices for 1 to 5+ ringers. <u>MIK index:</u> Fine meshed ring net (MIK) survey carried out during the IBTS 1st quarter survey at night, aimed at catching 0-ringer herring. Covers the whole North Sea.
	Acoustic surveys	<u>North Sea acoustic survey.</u> International acoustic survey carried out by four research vessels in July. Area covered: most of the continental shelf north of 54°N in the North Sea and Ireland to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Swedish and Danish coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually and a combined report is prepared.
	Egg surveys	No egg survey used
	Larvae surveys	<u>North Sea larval survey.</u> Internationally co-ordinated conducted since 1972. In last years only The Netherlands and Germany continued to participate in this program. Newly hatched larvae less than 10 mm in length are used to calculate larval abundance. Each larvae abundance index (LAI) unit is defined for area and time. To estimate larval abundance, the mean number of larvae per square metre for each 30x30 nautical mile rectangles is estimated and raised by the corresponding surface area of the rectangle. Within each unit rectangle estimates are summed to give unit abundance.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	<u>Catch at age</u>: derived from national sampling programmes. Sampling programmes are highly different by country and sometimes by fishery. Sampling procedures can be divided into: separate length and age sampling or representative age sampling. Total number of samples taken: 291. Total number of fish aged:11000. Total number of fish measures 41000. <u>Weight at age in the stock</u>: derived from the North Sea acoustic survey (July, august). Only presented as point estimates without variances. <u>Weight at age in the catch</u>: derived from the total international catch at age data. In some countries, weight at age is derived from general length-weight relationships, others use direct measurements. <u>Maturity at age</u>: derived from the North Sea acoustic survey (July, August). Only presented as point estimates without variances.

Table 1.6.2 (Cont'd)

step	*Item*	*Considerations*
2.4	Tagging information	No tagging information directly used in the assessment. Tagging information is the basis of the hypothesis of mixing Baltic spring spawners and North Sea autumn spawners in the Skagerrak and Kattegat area.
2.5	Environmental data	No environmental data used in the assessment. Hypothesis have been put forward on the relationship between environmental conditions and recruitment
2.6	Fishery information	Several people involved in the assessment of this stock are familiar with the fishery. There are several observer on board programs currently running. Because of the characteristics of the fleets it is sometimes difficult to have observers on board because of the long duration of the average trips. Sometimes anecdotecal information on the fishery is used in the judgement of the assessment.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Current assessment model: ICA; a statistical catch at age model that assumes that fishing mortality can be separated into selection at age and mortality by year. Age structured assessment model. ICA used to assess this stock since 1995. Alternative models are sometimes explored (e.g. XSA) but not as real 'competitors' to ICA. Alternative model structure is often explored (e.g. multiple selection periods, different weighting, etc). Previously applied models: not documented yet.
3.2	spatially explicit or not	no
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over year, different over ages. Source of estimates by age: 1981 stomach sampling analysis (MSVPA), as reported in ICES 1984 (for 0 and 1 wr). Source of estimates for higher ages unknown at present. Selection at age: two separable periods estimated, with minimal differences for ages>3. Selection at final age set to 1. Total numbers of parameters estimated:14. Fishing mortality at reference age 4 by year: 1999 assessment; 7 separable years, hence 7 parameters estimated. Population in final year: 9 parameters. Population at final age for separable years: 7 parameters. Recruitment for survivors year: 1 parameter. Total number of parameters: 55 Total number of observations: 313 Number of observations per parameter: 5.7
	recruitment	Relationship between spawning stock and recruitment assumed (Beverton & Holt) and included in the weighted sum of squares with a low arbitrary weight of 0.1 Depensation is not considered. Environmentally driven reductions or increases in recruitment are not considered.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of a weighted sum of squares. Terms are weighted by manually set weights. Each survey is assumed to contribute a weight of 1 (because of correlating between ages), in the recruitment model has a weight of 0.1 and each catch at age observation in the separable period contributes a weight of 1.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Maximum likelihood estimates of parameters are given including upper and lower 95% confidence limits. Total variance for the model and model components given, both weighted and unweighted. Several test statistics given (skewness, kurtosis, partial chi-square. Historic uncertainty analysis based on Monte Carlo evaluation of the parameter distributions.

Table 1.6.2 (Cont'd)

step	*Item*	*Considerations*
3.6	Retrospective evaluation	Currently no retrospective analysis is carried out. Two reasons: because it is not directly available within ICA and because the assumptions concerning the separable period have been very variable over recent years. It is recognised that the retrospective analysis is severely lacking. Historic realisations of assessments are routinely presented and from a direct overview on the changes in perception concerning the state of the stock. Currently only historic realisations of SSB are presented. It is recommended that also fishing mortality and recruitment plots should be presented.
3.7		• reference age not well determinated • selection at final age not well determinated • duration of separable period not well determined • weighting for catch data much higher than for survey data • weighting for survey indices not related to variability in the data • correlation structure of parameters not properly assessed and presented • stock identity not evaluated • catchability of surveys us assumed constant over the years • area misreporting of catch is a major problem • split between Baltic spring spawners and North Sea autumn spawners • relationship between number of parameters, number of datapoints and total SSQ not addressed • simpler assessment models currently not evaluated

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model, by fleet and area fished (see 5.2)
4.2	Spatially explicit or not	By North Sea (fleets A,B) and IIIa (fleets C,D&E); not same as TAC areas (separate TAC for IVc+VIId, separate predictions not done). The spatial aspect is included to allow variable proportion of NS autumn spawners in IIIa from year to year. NB many difficulties arise from this spatial aspect which involves the calculation of 'local' fleet-specific fishing mortalities (see 5.3)
4.3	Key model (input) parameters	<u>Stock weights at age</u>: from last year in assessment (already smoothed, see assessment data description) <u>Mortality at age</u>: same as for assessment (i.e. from multispecies model) <u>Maturity at age</u>: average of the two most recent years used <u>Catch weights at age BY FLEET</u>: average of last two years <u>Proportion of m and f before spawning</u>: 0.67 for both (assumes spawning starts around September) <u>Fishing mortalities by age</u>: From ICA (no adjustment if youngest age class is NOT downweighted in fit) <u>Numbers at age</u>: from ICA, final year in assessment; ages 0 to 9+ <u>Fishing mortalities by fleet, area (and age):</u> 0-1 ringers: stock numbers from ICA, split between NS and IIIa (see below), and catches by fleet to get local F's by fleet 2+ ringers: Fs from ICA apportioned to fleets by observed catches at age (for each fleet) to get fleetwise F's <u>Proportions of NS stock in NS ('split factor')</u>: There are <u>4 values</u> input for this parameter: (a) IBTS 1-ringer proportion in last assessment year (y) is used for 1-ringers in y (b) IBTS 1-ringer proportion in y+1 is used for 1-ringers in y+1, AND for 0-ringers in y. (c) GLM (between MIK index and IBTS 1-ringer proportion) is applied to MIK index in y+1 to predict proportion for 1-ringers in y+2, AND for 0-ringers in y+1 (d) GLM, as in (c), is applied to the Average MIK index for 1981 to year y to predict proportion for 1-ringers in y+3 (not relevant), AND for 0-ringers in y+2 (relevant)

Table 1.6.2 (Cont'd)

step	*Item*	*Considerations*
4.4	Recruitment	Recent average recruitment (arithmetic, recent 10 years) is used, (unless there is some strong reason for using something else, e.g. if SSB is very low, we may use a prediction from the stock-recruit relationship)
4.5	Evaluation of uncertainty	Uncertainty in model parameters is NOT incorporated, though sometimes a limited number of sensitivity analyses may be performed, usually with regard to a single parameter, e.g. predicted area split factor or recruitment.
4.6	Evaluation of predictions	Predictions are not evaluated post-hoc (this is tricky to do in terms of catches, but some evaluation in terms of population numbers at age should be done).
4.7	Major Deficiencies	Prediction of 'split factor': choice of model is a difficulty; simplest models are NOT constrained between 0 and 1; potential problems if MIK index (for prediction) lies outside the range of data used in fitting. Are we just adding noise by incorporating this 'area split'? Localised fleetwise Fs: catches by area, 0-1 ringers in particular, are on a given year class, and these are used to get localised fleet Fs which are then applied to the future year classes which may be of a very different magnitude. There is a conceptual problem with this approach, and in practice it leads to inflated or unrealistically low local fleet F's which can lead to unrealistic catch at age predictions. Assessment/Prediction mismatch: The prediction model contains more detail (by fleet) than the assessment model (not by fleet). In particular, stock estimates are based on a separable model which is then treated in a non-separable way in the short term predictions. Catch options: no unique solution for catches by fleet when management objectives are stated in terms of F_{adult} and $F_{juvenile}$. Need to impose further constraints (e.g. maintain proportions of catches between fleets), to find unique solution. No stochasticity/uncertainty not reflected in short term predictions. Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year Software: Implemented in a spreadsheet, which is most convenient given that we need flexible additional constraints, but error prone. Two optimisations need to be run. This should be changed, either to one optimisation or to 'buttons' to deal with the minimisation.

5. Prediction model(s) – MEDIUM TERM

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Age structured and by fleet, but not by area fished in the way taken into account by the short term prediction model.
5.2	Spatially explicit or not	No
5.3	Key model parameters	Model parameters largely as in short term prediction (double-check), but : 1. 'split factors' are NOT used 2. F at reference age, Selection at age, fitted N in the last assessment year (y) and expected recruitment in y+1 are from ICA with the associated Var-covariance matrix Fleetwise F's from fleet catch numbers at age are considered to be reasonable, because the estimated overall selection pattern is not altered, but simply apportioned between fleets.

Table 1.6.2 (Cont'd)

step	*Item*	*Considerations*
5.4	Recruitment	A Beverton-Holt SR relationship is fitted without autocorrelation in errors. A non-parametric bootstrap method is used to generate recruitments for the starting dataset. Uncertainty in future recruitments around the SR relationship was modelled by randomly drawing values from the historic time-series of log-residuals. (also see 5.5). The values drawn are used to back-calculate SSB and R for the whole historic period and the SR relationship is then refitted for each realisation (or draw) of a parameter set.
5.5	Evaluation of uncertainty	Projections are based on Monte-Carlo pseudo datasets of parameters noted in point 2, 5.3, to initiate projections (errors are multivariate)
5.6	Evaluation of predictions	Predictions are not evaluated post-hoc
5.7	Major Deficiencies	Mismatch between short and medium term projections poses the question as to how realistic estimates of probabilities (e.g. P(SSB<Bpa)) from medium term predictions are.

Table 1.6.3 Checklist for Western Baltic Spring Spawner herring in Division IIIa and Sub-division 22-24 assessments

1. General

step	*Item*	*Considerations*
1.1	Stock definition	In recent years it has been tried without success to perform a full assessment of herring in Division IIIa and Sub-divisions 22-24. Although herring in the area is treated as a single stock, it is becoming apparent that it consists of local stocks and is influenced by a mixing with other stocks: • North Sea autumn and winter spawners in the Skagerrak, Kattegat and to a lower degree in the Sound; • Local autumn spawners in the whole area; • Local winter/spring spawners in the Skagerrak; • Central Baltic Spring spawners in SD 24 and SD 22. Further problems are caused by the age specific migration pattern of the main Western Baltic Spring Spawning stock.
1.2	Stock structure	Herring in Division IIIa and in parts of Division IVa East are split into North Sea and WBSS and transferred to each stock according to age specific proportions.
1.3	Single/multi-species	Single species assessment, but the part in SD 22 to 24 is also included in the multi-species model for SD 25-29 +32, from which estimates of predation mortality have been derived and that are used in the single species assessment model

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Some landings reported to have been taken in the Skagerrak are believed to be misreported landings from the North Sea and is therefore transferred to the North Sea.
2.2	Indices of abundance	All indices are used as index values. The following proportion of the stock is indexed by the following indices: Acoustic in Division IIIa+IVa: ages 2-6 Acoustic in SD 22+24: ages 0-2 GBTS SD 24 February: ages 1-2 GBTS SD 24 November: ages 0-1
	Catch per unit effort	CPUE information is not available and not used for this
	Gear surveys (trawl, long-line)	IBTS Survey in Division IIIa in Quarter I and III: ages 0-8+ GBTS Survey in SD 22 and 24 in Nov./December: ages 0-3+ GBTS Survey in SD 24 in February: ages 0-8+
	Acoustic surveys	North Sea acoustic survey in July, Division IIIa: ages 0-8+; German/Danish Acoustic Survey in the Baltic in Sept./Oct., southern Kattegat and SD 22-24: ages 0-8+
	Egg surveys	No egg survey used
	Larvae surveys	German Larvae Survey in the Greifswalder Bodden (recruitment index)
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Catch at age derived from national sampling programs The weight at age in the stock was assumed to be constant for the period 1991 to 1999. The unweighted mean of the calculated following two values was taken as the weight at age in the stock for this period: - unweighted mean of the German bottom trawl survey in Sub-division 24, February, 1991-1999, - unweighted mean of the mean catch at age data, first quarter, 1991-1999. Weight at age in the catch derived from the total international catch at age data. Weight at age is derived from direct measurements. Maturity at age was assumed to be constant for the last years, but no reference to the origin of these data can be found.
2.4	Tagging information	No tagging information is directly used in the assessment. Tagging information (Biester 1979) is the basis of the hypothesis of spawning and feeding migration of spring spawners from the Rügen area to the Skagerrak and of mixing of Baltic spring spawners and North Sea autumn/winter spawners in the Skagerrak and Kattegat area.

Table 1.6.3 (Cont'd)

step	*Item*	*Considerations*
2.5	Environmental data	No environmental data are used in the assessment.
2.6	Fishery information	Information on the fishery carried out in this area was available as well as information from fishermen and fishermen's organization. Therefore, it is believed that for recent years all relevant information on the fishery has been taken into account.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA has been used to assess the stock since 1995. However, during this time period no final assessment has been presented.
3.2	spatially explicit or not	Changes in proportions of age-classes in the different areas reflect primarily differences in age-, maturity- and size specific migrations rates, therefore spatially explicitly approach should be preferred.
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over years, different over ages. Predation mortality (M2) from MSVPA is added to the 0- and 1 group Selection at age: The Reference F at age 4 and the selection 1 for the oldest age-group. A linear catchability was assumed and kept constant for all indices.
	recruitment	The larval 0-ringer and November 0-ringer indices for the year-classes 1977 to 1999 shows some similar year-to year variability. No stock-recruitment relationship is assumed.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	See Table 1.6.2.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	
3.6	Retrospective evaluation	This has not been done.

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	No prediction is given.
5.2	Spatially explicit or not	See above
5.3	Key model parameters	See above
5.4	Recruitment	See above
5.5	Evaluation of uncertainty	See above
5.6	Evaluation of predictions	See above

Table 1.6.4 Checklist for stock assessments Stock: Celtic Sea and Div VIIj Herring Stock

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is believed to be distributed over ICES Divs VIIaS, VIIg –k. A portion of the juveniles are present in VIIa North and possibly in VIIb
1.2	Stock structure	The assessment would need to be spatially structured if the juvenile component is exploited in Division VII North.
1.3	Single/multi-species	A single species assessment is carried out.

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment Biases and sampling designs are not documented and the sampling programme needs to be properly designed. Discards are not included in the assessment. An estimate of discards was included for a number of years when the “roe” fishery was very important and there was no demand for “non roe type” herring. The estimate varied between 10%-20% and was not based on any data but merely on a perception of what was happening in the fishery.
2.2	Indices of abundance	The only index of abundance now available is that obtained from the acoustic surveys which have been carried out for a number of years. The age disaggregated biomass is treated as an proportionate index of stock size.. A linear form of relationship is assumed between the index and population abundance. Up to 1999 the index was based on both components (autumn and winter) of the spawning stock. At present the survey strategy is being redesigned to cover the prespawning population. There is no index available on recruitment and data from recruit and groundfish surveys needs to be evaluated.
	Catch per unit effort	Not applicable
	Gear surveys (trawl, longline)	Gear saturation is not a problem. The acoustic surveys have not covered the entire distribution of the stock and therefore need to be redesigned.
	Acoustic surveys	There are problems with species mix and species identification because of the large sprat population in the area.
	Egg surveys	Egg surveys for estimation of population size is not carried out on herring. Egg surveys to map and locate the spawning beds have been successfully carried out on some of the important spawning grounds. Fecundity estimates were carried out on this stock in the 80’s
	Larvae surveys	Larvae surveys were successfully carried out on this stock in the late 70’s and 80’s and were used as an index of stock size.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Sampling at present seems adequate but would need to be properly evaluated and structured.
2.4	Tagging information	Tagging experiments were carried out in the Irish Sea in 1990 and indicated a movement of young fish between there and the Celtic Sea
2.5	Environmental data	No work has been carried out on the effects of environment and recruitment. Data is available which should be evaluated.
2.6	Fishery information	There is good co-operations and information exchange between scientists and fishermen, arising from time spent at sea and in discussions with fishermen while sampling.

Table 1.6.4 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	The model at present in use is ICA. No other models are at presently being considered.
3.2	spatially explicit or not	
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is based on values from other fisheries and may not be appropriate.
	recruitment	There does not appear to be a relationship between stock and recruitment. No effects of the environment on recruitment has been considered.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	See North Sea Section
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	
3.6	Retrospective evaluation	Historical realization of assessments is available.

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Current IFAP prediction. Based on one fleet. Natural mortality, maturity ogive etc are all assumed to be constant.
5.2	Spatially explicit or not	Not spatially explicit.
5.3	Key model parameters	Historical VPA files. Updated each year.
5.4	Recruitment	Recruitment is assumed as geometric mean over 10 years.
5.5	Evaluation of uncertainty	Not evaluated.

Table 1.6.5. Checklist for the west of Scotland (VIaN) herring stock assessments.

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is distributed over ICES Division VIa(North). Some of the larger adults which are typically found close to the shelf break may be caught in division Vb.
1.2	Stock structure	
1.3	Single/multi-species	A single species assessment is carried out.

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment. Biases and sampling designs are not documented. Discards are not included. Slippage and high grading are not recorded. This fishery has a strong tradition of misreporting. It is believed that the shortfall between the TAC and the catch is used to misreport catches from other areas (from IVa to the east and from VIaS to the south). Information about the level of misreporting has been forthcoming in recent years, but only from certain countries (Scotland & the Netherlands).
2.2	Indices of abundance	An age disaggregated index is available from the acoustic survey. The youngest age class (1) is poorly sampled because they tend to occur in shallow or surface waters. The relationship between the index and abundance is assumed to be linear. A larvae survey was available from 1973-1993. The relationship between this index and abundance is assumed to be of a power form.
	Catch per unit effort	
	Gear surveys (trawl, longline)	
	Acoustic surveys	The stock is highly contagious in its spatial distribution, which explains some of the high variability in the time series. Effort stratification has improved with knowledge of the distribution and this may be less of a problem henceforth. The survey uses the same target strength as for the North Sea surveys and there is no reason to suppose why this should be any different. Species identification is generally not a great problem. The 1997 survey was invalidated due to its unusual timing (June as oppose to July).
	Egg surveys	
	Larvae surveys	No longer carried out.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches is extremely poor (particularly in 1999). This is particularly the case for the freezer trawler fishery which takes the larger component of the stock based around the shelf break. The lack of samples is due in part to the fact that national vessels tend to land in foreign ports, avoiding national sampling programs. The same fleet is thought to high grade. The long length of fishing trips makes observer programs difficult. Even when samples are taken, ageing is limited for most nations.
2.4	Tagging information	
2.5	Environmental data	Data is available from the acoustic survey.
2.6	Fishery information	Familiarity with the Scottish fishery is good. The acoustic survey is usually carried out on a chartered commercial fishing vessel where much knowledge is imparted both ways over a period of three weeks.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA. An experimental survey-data-at-age model was formulated at the 2000 HAWG. In 1999 and 1998 a Bayesian modification to ICA was used to account the uncertainty in misreporting.
3.2	spatially explicit or not	No.

Table 1.6.5(Cont'd)

step	*Item*	*Considerations*
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Assumed from values used in the North Sea. Time-invariant.
	recruitment	No stock recruitment relationship is assumed.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	See North Sea
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Bayesian assessment done in 1998 & 1999.
3.6	Retrospective evaluation	

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	IFAP. ICP.
5.2	Spatially explicit or not	No.
5.3	Key model parameters	Default.
5.4	Recruitment	Recruitment is assumed as a geometric mean over historic time series of 1 year olds.
5.5	Evaluation of uncertainty	
5.6	Evaluation of predictions	

Table 1.6.6 Checklist for stock assessments Stock: Herring VIaS VIIbc

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is assessed as one single stock which may consist of separate autumn & winter components, however this is not the conclusion of most recent analysis.
1.2	Stock structure	No spatial structure in the assessment
1.3	Single/multi-species	Single species assessment

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches mainly taken by one country, catch estimation is based on official landings augmented by information on misreporting. There is no information on discarding.
2.2	Indices of abundance	There are no indices currently available for use, however a groundfish survey by Ireland in the 4th quarter is being evaluated and an acoustic survey in VIaS VIIbc is planned for 2000. Acoustic surveys carried out in 1994-96 and 1999 did not provide useable data for an index.
	Catch per unit effort	
	Gear surveys (trawl, longline)	
	Acoustic surveys	An acoustic survey is to be carried out in 2000. Acoustic surveys carried out in 1994-96 and 1999 did not provide useable data for an index.
	Egg surveys	Fecundity estimates are available for autumn and winter spawners.
	Larvae surveys	Larval surveys carried out from 1983-1989 but discontinued, as they did not provide a useable index of SSB.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Sampling is adequate but the current maturity Ogive is based on other areas and may not be appropriate. This is currently under review
2.4	Tagging information	Tagging was carried out in 1991 which showed a movement of fish from VIaS into VIIb and a minor movement to VIIj. Fish tagged in the Clyde have been recovered in VIaS.
2.5	Environmental data	Environmental data is available for the area from meteorological stations, but has not been analysed with respect to the fishery.
2.6	Fishery information	There is good information from the fishery and feedback from the fishermen which allows reallocation of the catches.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Separable VPA with a range of terminal F's
3.2	spatially explicit or not	
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	There is no tuning index so a range of values of terminal F are used to show the development of the stock.
	recruitment	There is currently no information on recruitment but Irish groundfish survey information is being evaluated
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Statistical implications in SVPA

Table 1.6.6 (Cont'd)

step	*Item*	*Considerations*
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	
3.6	Retrospective evaluation	

4. Prediction model(s)

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Aged based short term prediction
4.2	Spatially explicit or not	
4.3	Key model parameters	
4.4	Recruitment	Recruitment is taken as a geometric mean numbers of 1 year olds over the previous 10 years.
4.5	Evaluation of uncertainty	No
4.6	Evaluation of predictions	No

Table 1.6.7 Checklist for stock assessments Stock: NIRISH (VIIaN) - HERRING

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is contained within the northern Irish Sea (Division VIIa(N)) generally between July and November with at least two distinct spawning grounds (Manx and Mourne). Where the stock is during the rest of the year is still unknown. The stock is assessed as a single stock even though it consists of at least two sub-stocks, if not more. There is the possibility that the stock may be part of fisheries in adjacent areas and that there may be a winter/spring spawning component in the area, however, this probably occurs in the catches but is not considered for assessment purposes. There are also juveniles from neighboring spawning stocks in the area which have in the past and possibly still do contribute to some of the juvenile catches.
1.2	Stock structure	Ideally yes need spatial context but in reality not used at present.
1.3	Single/multi-species	At present a single-species assessment. Insufficient data for a multi-species assessment in Division VIIa . Some data exist on vertebral counts to distinguish stock components, however, in recent years these data are lacking. There is a significant sprat population in the Irish Sea which can cause problems with acoustic assessments in the area.

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Fish may be caught in adjacent management areas and catches being either misreported into or out of Division VIIa(N). Unfortunately these practices have probably changed over the years which makes retrospective corrections difficult. Discards are not accounted for (lack of data).
2.2	Indices of abundance	All abundance indices are considered relative. Indices currently in use/available are: Stock structure – age disaggregated acoustic survey, groundfish surveys; Adult stock biomass – acoustic survey, larvae surveys; Recruitment – groundfish surveys. Proportion of the stock indexed varies from one sub-population (Douglas Bank larvae surveys) to the whole stock (acoustic and groundfish surveys)
	Catch per unit effort	CPUE is not utilised.
	Gear surveys (trawl, longline)	Groundfish surveys probably cover the whole range of the juveniles in this area. This survey also includes some Celtic Sea juveniles, especially in the western Irish Sea. Gear selectivity not considered.
	Acoustic surveys	Species mix through trawl samples using standard techniques. Target strength taken as the ICES standards. The acoustic surveys assume the whole of the Division VIIa(N) spawning stock is in the Irish Sea by the time of the survey (September). In recent years there has been a shift in the timing of the herring arriving back in the Irish Sea and there is the possibility that these surveys do not cover the whole of the spawning stock. There is also the possibility that there may be a certain degree of inter-annual variation in timing which will add noise/inaccuracies to this data series. There may be errors in the estimation of the relative numbers of 1-ringers due to the presence of Celtic Sea juveniles in the area.
	Egg surveys	Egg surveys not undertaken. Fecundity estimates not made in recent history for VIIa(N) herring.

Table 1.6.7 (Cont'd)

	Larvae surveys	Larvae mortality is estimated from otolith microstructure data. Sampling equipment towpaths etc monitored electronically. Potential problems with Douglas Bank surveys as they are conducted during the hatching period. Part of the variability in this index is the variability in hatching and/or spawning dates. The survey is also confined to the spawning area so larvae which drift out of the area are not assessed. The North Irish Sea larvae survey (DARD) covers the whole potential area for Irish Sea larvae, The PEML survey is restricted to the area east of the Isle of Man and more indicative of north-eastern (primarily Manx) Irish Sea herring. Both surveys rely on growth and mortality data to estimate production at spawning from data collected in November/December (a 3-4 month back-calculation period).
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Sampling designs set up with the intention of minimizing bias and providing full age disaggregated data for the landings. Otolith exchange program in place to monitor potential ageing problems. In 1999 2,718 fish were measured and 1,600 fish were aged (including maturity states) There have not been any recent studies specifically aimed at re-assessing the maturity-at-age for this stock. A recent problem is an increase in landings to foreign ports. Some of this may also be misreporting. However, sampling of these catches is very poor.
2.4	Tagging information	No tagging studies undertaken in recent years.
2.5	Environmental data	No clear protocols for use of environmental data at present. There are quite a few environmental data sets for the Irish Sea area, however, these data need to be used with caution and in an informed way. These data sets are held by PEML (Port Erin), DARD (Belfast), CEFAS (Lowestoft), MI (Dublin) etc. We suspect their use may be most valuable in short-term predictions, however, the problem of predicting environmental conditions over the longer term will continue to be a problem, at least until we have the capability to forecast the environment. The use of environmental data must not be divorced from the accompanying biological and ecological data.
2.6	Fishery information	In general people are familiar with the fishery. The Northern Irish specifically consult with the industry regularly and there has been collaborative studies undertaken with the fishery (surveys on Douglas Bank in 1995).

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	The ICA model (as with all other herring stocks south of 62^{o}N) is currently used.
3.2	spatially explicit or not	No
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: assumed fixed and values 'borrowed' from the North Sea. The values vary over age. Selection at age: Separable model utilised with selection at 4-rings set to 1.
	recruitment	No assumptions concerning recruitment.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Weighted sum of squares with surveys and catch at age data in the separable period (with the exception of 1-ringers (0.1)) given a weighting of 1.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, bootstrapping etc.	See section 1.6.1.2
3.6	Retrospective evaluation	Yes, as quality control sheets,

4. Prediction model(s)

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age structured prediction model (ICES).
4.2	Spatially explicit or not	No.
4.3	Key model parameters	What is the source of the parameters ICA assessments and Stock weights at age: from the year of assessment Natural mortality at age: as for assessment Maturity at age: as for assessment Catch weights at age: As for assessment year Proportion of m and f before spawning: as for assessments i.e. mprop 0.75 and fprop 0.90. Exploitation pattern: from the current assessment Numbers at age: from ICA in the final year of assessment, ages 1-8+
4.4	Recruitment	Geometric mean over the last 10 years.
4.5	Evaluation of uncertainty	None.
4.6	Evaluation of predictions	None

Table 1.6.8. Checklist for stock assessments

Stock: North Sea Sprat

1. General

step	*Item*	*Considerations*
8.1	Stock definition	Sprat in the North Sea is considered as one single stock. Sprat spawning more or less through out the year, with reported autumn spawning, indicates that there are sub-stocks.
8.2	Stock structure	
8..3	Single/multi-species	No age-based assessment has been made since early 80s, due to low or no biological sampling by area and by season. Genetics and/or studies of otolith microstructures could be used to define stock structure.

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	The estimation of landing data are based on official landing statistics along with additional national information about misreporting.
2.2	Indices of abundance	IBTS(February)-indices.
	Catch per unit effort	Not available.
	Gear surveys (trawl, longline)	International Bottom Trawl Survey in the North Sea and Div. IIIa carried out in February.
	Acoustic surveys	The North Sea acoustic surveys have included sprat in the surveys the last years. However, the surveys have not covered the south-south eastern areas, which are expected to be the most important sprat areas.
	Egg surveys	No egg surveys
	Larvae surveys	No larval surveys
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Catch at age: Derived from national sampling programmes. The sampling programmes are highly different by country and by fisheries. The following sampling procedures are used: separate length sampling, length and age sampling or representative age and length sampling. In 1999, total number of samples were 67 number of fish aged: 1 596, number measured 7 124. At present the number of fish used for ageing is low, with regards to sub-areas and seasons covered. Though it should be mentioned that within seasons the fishery is carried out in limited areas. Weight at age in the catch: From national sampling of commercial landings. No maturity data available.
2.4	Tagging information	No
2.5	Environmental data	No
2.6	Fishery information	Members of the WG are familiar with the sprat fishery.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	The CEDA-package (Schaefer Production model) is used with total catches and an index of biomass as inputs. The indices of biomass are calculated from the total IBTS-February indices (no/h) weighted by mean weights at age in the commercial landings. This is a dynamic, NOT equilibrium, production model
3.2	spatially explicit or not	
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	rate of increase (or production) r; carrying capacity K; catchability coefficient for index; proportion of stock to K at start of catch time-series
	Recruitment	

Table 1.6.8 (Cont'd)

3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	observation errors only. There is a choice of error models; lognormal errors were used. Estimates are maximum likelihood.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Bootstrap estimates of distributions of parameters can be obtained (not done)
3.6	Retrospective evaluation	not done

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	The CEDA-package (Schaefer Production model) is used with parameter estimates obtained from the fit to data, then forward-projected under different scenarios of total future catches. Direct regression of the total catches and the total IBTS(February) indices. SHOT-estimates using various IBTS(February)-indices and the total catches as inputs.
5.2	Spatially explicit or not	
5.3	Key model parameters	
5.4	Recruitment	
5.5	Evaluation of uncertainty	
5.6	Evaluation of predictions	

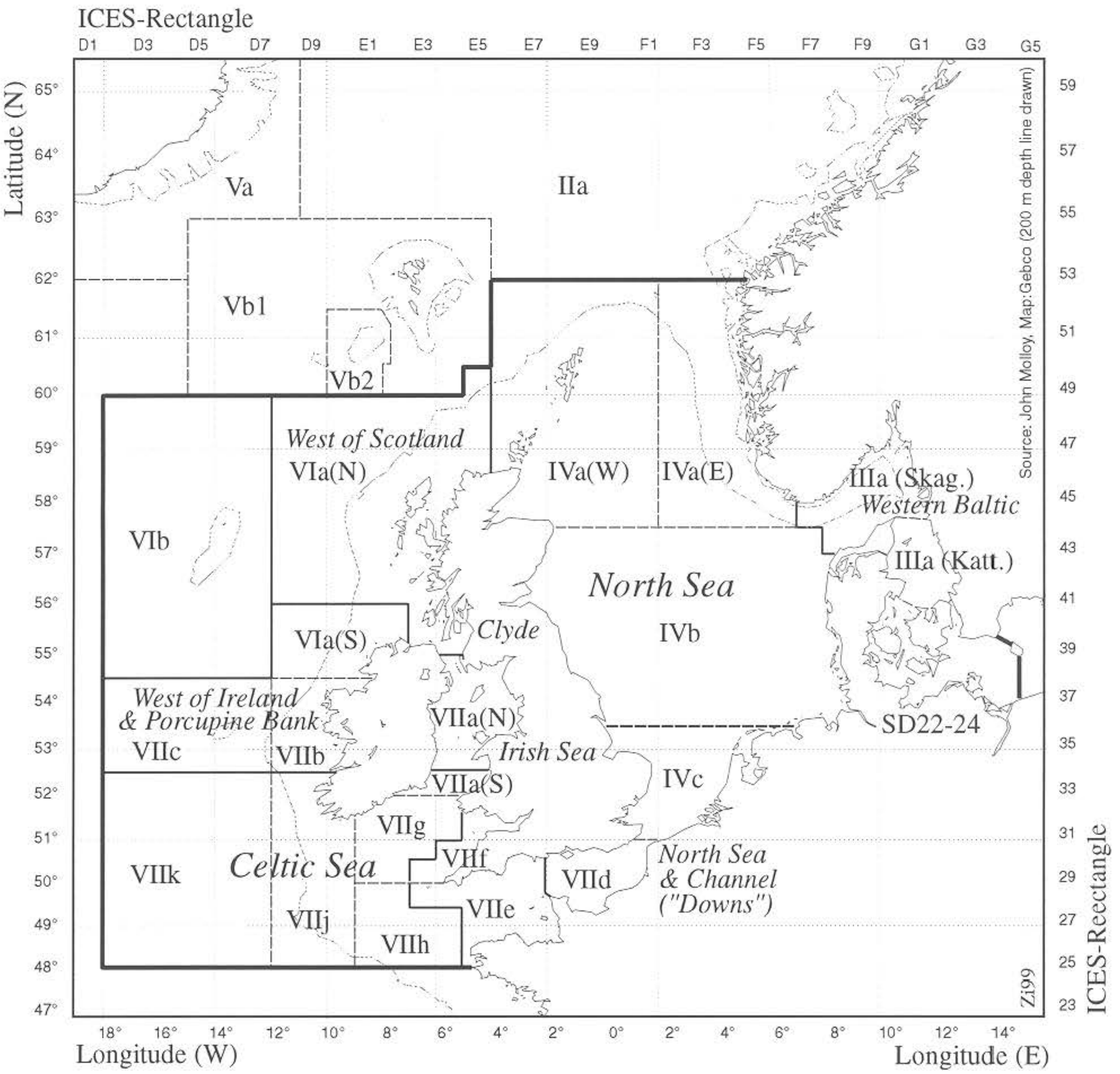


Fig. 1.5.1: ICES areas as used for the assessment of herring stocks south of 62°N. Area names in italics indicate the separation used for long term storage of commercial catch and sampling data.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1999 and 2000

In 1996, the regulations were changed to reduce the fishing mortality by 1/2 for the adult part of the stock and by 75% for the juveniles. In 1997, the regulations were altered again to reduce the fishing mortality on the adult stock to 0.25 and for juveniles to less than 0.1 to aim of rebuilding the SSB up to 1.1 million t in 1998.

According to the EU and Norway agreement adopted in December 1997, efforts should be made to maintain the SSB above the MBAL (Minimum Biologically Acceptable Level) of 800,000 tonnes. An SSB reference point of 1.3 million has been set above which the TACs will be based on an F = 0.25 for adult herring and F = 0.12 for juveniles. If the SSB falls below 1.3 million tonnes, other measures will be agreed and implemented taking account of scientific advice.

ACFM recommended for 2000 that the management for 1999 should be continued to ensure the rebuilding of the spawning stock biomass. The measures consist of adoption of a $F_{2–6}$ of 0.2 and a $F_{0–1} < 0.1$ until the spawning biomass is rebuilt to a precautionary level of 1.3 million tonnes. It was expected that fishing at a *status quo* level would lead to an increase of the SSB to 1.35 million t in 2000.

The final TACs adopted by the management bodies for 1999 were 265,000 t for Divisions IV and VIId, whereof not more than 25,000 t should be caught in Divisions IVc and VIId. This TAC was kept constant for 2000. Catches of herring in the Thames estuary are not included in the TAC. The bycatch ceiling set for fleet B in the North Sea was 30,000 t for 1999 and increased to 36,000 t for 2000.

2.1.2 Catches in 1999

Total landings and estimated catches are given in the Table 2.1.1 for the North Sea and for each Division in Tables 2.1.2 to 2.1.5. Misreported landings transferred from Division VIa North (herring actually caught in Division IVa but reported to Division VIa) and unallocated landings (including misreportings from other areas than VIa) are given separately. Total working group catches per statistical rectangle and quarter are shown in Figures. 2.1.1 a-c. Most nations provided their catch data (either official landings or working group catch) by statistical rectangle; catches of the Faroe Islands were allocated on advice of the Faroes National Institute.

The total catch in 1999 as used by the Working Group amounted to 335,800 t. It increased slightly (by about 2%) as compared to last years catch. By area, the highest increase in catches was reported from Divisions IVc and VIId (Table 2.1.5: 11%), while the greatest decrease had occurred in Division IVa(E) (Table 2.1.3: -20%). Official catches from the North Sea and VIId increased by almost 6%.

Landings of herring taken as by-catch in the Danish small meshed fishery (15,000 t, Table 2.1.6) have in 1999 again been much lower than the by-catch ceiling set for Denmark. In 1999 the Danish sprat fishery was carried out mainly in August and September with minor by-catches of herring, less than 3%. The sprat quota limit was reached in September; the sprat fishery was closed by 20 September and first reopened in the beginning of December.

TACs for Sub-area IV and Division VIId have been significantly exceeded in several years. This excess of the catches over the TACs for the years 1993 to 1999 is shown in the text table below, where estimates of misreporting are included in the Working Group Landings. It should be noted that prior to 1996 the TAC applies only to the human consumption fishery in Sub-area IV and Division VIId, while from then on the by-catch for herring to be taken in the small mesh-fishery is included.

Year	1993	1994	1995	1996	1997	1998	1999
TAC (‘000 t)	430	440	440	200[1]	183[1]	276[1]	295[1]
Official landings (‘000 t)	409	414	415	136	155	265	280
Working Group catch (‘000 t)	521	465	534	263	234[2]	328	336
Excess of landings over TAC (‘000 t)	91	25	94	63	51	52	41

[1]*including by-catch ceiling*

[2] *figure altered in 2000 on the basis of a re-evaluation of misreported catches from VIa North.*

2.2 Biological Composition of the catch

Biological information (numbers, weight, length, catch (SOP) at age and relative age composition) on the catch as obtained by sampling of commercial catches is given for the whole year and per quarter in Tables 2.2.1 to 2.2.5. Where available, data is displayed separately for herring caught in the North Sea (including a minor amount of Western Baltic Spring Spawners taken in IVa East), IVa East (total; Western Baltic Spring Spawners (WBSS) only – see Section 2.2.2; North Sea Autumn Spawners only), Divisions IVa West, IVb, VIId/IVc as well as for North Sea Autumn Spawners (NSAS) caught in Division IIIa, and the total NSAS stock, including catches made in Division IIIa.

Biological information for North Sea Autumn Spawners caught in Division IIIa was obtained using splitting procedures described in Section 3.2. The total catches (SOP figures), mean weights and numbers at age by fleet are given in Table 2.2.6. Note that fleet D includes the former fleet E from this year on.

Data on catch numbers at age and SOP catches are shown for the period 1990–1999 in Tables 2.2.7 (herring caught in the North Sea), 2.2.8 (WBSS taken in the North Sea, see below), 2.2.9 (NSAS caught in Division IIIa) and 2.2.10 (total numbers of NSAS). Mean weights at age are given for the same period (1990–1999) separately for the different Divisions where NSAS are caught (Table 2.2.11).

2.2.1 Catch in numbers at age

North Sea catches in numbers at age over the years 1990–1999 are given in Table 2.2.7. The total number of herring taken in the North Sea in 1999 (3.1 billion) has increased by 20% as compared to last year; the numbers of North Sea Autumn spawners has increased by 29%. Catches of 0-ringer NSAS have raised by factor 7 and amount to almost half of the total NSAS catch numbers, compared to less than 10% in 1998. This change is mainly driven by 20-fold higher catches of this age group in Division IIIa, which is primarily due to the poor 1997 year class and a very high 1998 year class. Figure 2.2.1. shows the relative proportions on the total catch numbers for different periods (1960–1999, 1980–1999 for the total area, and 1999 for different Divisions).

The following Table summarises the total catch in tonnes of North Sea autumn spawners. After the splitting of the North Sea Autumn Spawners in Division IIIa and the Western Baltic Spring Spawners caught in the North Sea, the amount of the total catch used for the assessment was 372 000 tonnes:

Area	Allocated	Unallocated	Discards	Total
IVa West	119,092	27,514	654	147,260
IVa East	58,544	-1,965	-	56,579
IVb	77,525	-313	873	78,085
IVc/VIId	30,597	20,042	3,242	53,881
	Total catch in the North Sea			335,805
	IIIa Autumn Spawners transferred to the North Sea (SOP)			41,268
	Baltic Spring Spawners transferred to IIIa (SOP)			4,732
	Total Catch used for the assessment			**372,341**

2.2.2 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 (e.g., Thames estuary) are caught in small quantities regulated by a local TAC. These catches are given in Table 2.1.1 and 2.1.5.

Western Baltic and Division IIIa spring spawners (WBSS) are taken in the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1 and listed as IIIa type. Table 2.2.8 specifies the estimated catch numbers of WBSS caught in the North Sea, which are transferred from the North Sea assessment to the assessment of Division IIIa/Western Baltic in 1990–1999. These transfers are preliminary, as the method for splitting the catch in IIIa is under review and small differences of may be found in catches moved in the past and the new estimates of North Sea autumn spawners in IIIa, these amounts are not important for the North Sea assessment.

The method of separating these fish, as described in former reports from this Working Group (ICES 1990/Assess:14) 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, two samples that have been taken in May and two in June 1998 were used for the second quarter. For the third quarter, nine samples taken in July were used (Figure 2.2.2).

The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 1999 are as follows:

Quarter	2 wr (%)	3 wr (%)	4+ wr (%)	No of rectangles sampled	Catch in the transfer area (t)	Catch of BSSH in the North Sea (t)
Q 2	10	45	68	4	4,904	2,014
Q 3	40	100	90	9	3,244	2,718
total					8,148	**4,732**

The quarterly age distribution in Sub-division IVa East was applied to the catches of the second and third quarters in the whole area. The numbers of spring spawners by age were obtained by applying the estimated proportion by age.

2.2.3 Revision of the catch at age for North Sea herring 1997

From 1983 to 1996 there were unallocated catches added to the North Sea (Table 2.1.1). In 1997 the amount of unallocated catch was reduced because it was believed that the area misreporting had been reduced due to changes in the licensing regulations (ICES 1998a). In 1998 and 1999, the amount of area misreporting was believed to be at similar levels to 1996. However, there was no firm information concerning 1997. It is possible that some area misreporting did occur in 1997 and in order to investigate the effect, a Bayesian assessment of VIa North herring was carried out at the 1999 Working Group. This assessment indicated that approximately 25,000 tonnes of catch was probably not caught in VIa North in 1997. It is believed that this catch is misreported from IVa to VIa North in the same manner as 1996, 1998 and 1999. Thus a correction has been made to the catch tables for the North Sea and VIa North and an additional 24,724 tonnes were added to the total catch in 1997, increasing the catch from 247,000 to 273,000 tonnes. A similar amount of catch was transferred at the 1999 Working Group in order to estimate the importance of this effect. Preliminary investigations on this change were carried out in 1999 (ICES 1999a), and the influence on the SSB and F was found to be small. The values of proportion at age and mean weight at age used for the additional catch were taken from the sample data for the fleet and area where the misreported herring were thought to have been caught. The original and revised catch at age, mean weights and biomass are given in Table 2.2.12.

2.2.4 Quality of catch and biological data

As in the previous years, it was in 1999 possible to get reliable information on misreportings and unallocated catches from several countries fishing on herring in the North Sea and adjacent areas. Catches made in IVa were mainly misreported to VIa North and IIa, but misreporting also occurred within Area IV, to IIIa and from VIId to IV.

Only the Netherlands provided estimates of discards, but discards are known to occur in the fisheries of most countries and they could represent a significant amount of the total catch, which is so far not included in the assessment. In this respect, there is still a need to improve the quality of the catch data for the North Sea herring.

In general, sampling of commercial landings for age, length and weight was slightly higher than last year (Table 2.2.13). Still, only two countries sampled 100% of their catch, while four of them contributed no samples. The sampling level was low in some fisheries, and in others no samples were taken in some quarters, especially in the second and third quarter in the Southern North Sea (Divisions IVc and VIId). This introduces uncertainties in the biological composition of the catches, which affects the quality of the assessment. There is a need for an increased sampling effort, especially to assure that catches landed abroad are reasonably sampled.

2.3 Recruitment

2.3.1 The IBTS index of 1-ringer recruitment

The 1-ringer index of recruitment is based on the IBTS, 1st quarter (trawl catches at daytime February 2000). The index is calculated for the entire survey area, weighting statistical rectangles as described in the Working Group report of 1995 (ICES 1995).

The indices based on surveys from the period 1979 to 2000 (estimates of the strength of year classes 1977 to 1998) are given in Table 2.3.1. and the temporal trend in indices is illustrated in Figure 2.3.1. The estimate of the 1998 year class, based on the 2000 survey, is high. It represents a marked increase from last years estimate of the 1997 year class, which was estimated as extraordinary weak.

Figure 2.3.2 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February during 1998,1999 and 2000. In 2000 large concentrations of 1-ringers were distributed in the central North Sea and in the Skagerrak/Kattegat area. (Division IIIa). This picture differs from the two preceding years, the abundance in division IIIa was much lower during these surveys, and no concentrations were observed in the central North Sea.

2.3.2 The MIK index of 0-ringer recruitment.

The 0-ringer index is based on catches by a fine-meshed ring net (the MIK) at night-time during the February survey of the IBTS. Index values are calculated as described in the Working Group report of 1996 (ICES 1996a). The index estimate of the abundance of 0-ringers in 2000, the 1999 year class, is estimated to 137.1 (Table 2.3.2).

This estimate of the 1999 year class is of intermediate magnitude, and is a decrease from the extraordinary high index of the preceding 1998 year class. The spatial distribution of the 0-ringers follows the trend of a north-westerly displacement which has been observed during the last years (Figure 2.3.3). Compared to the observations of the 1998 year class, larvae of the 1999 year class are less abundant in the central North Sea and in the division IIIa.

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

The relationship between the two indices is illustrated in Figure 2.3.4. and described by the inserted linear regression. The comparison between the indices for the 1998 year class reveals a relation that is in accordance with the long-term trend. Both indices indicate a very strong 1998 year class.

2.3.4 Trends in recruitment as estimated by the assessment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn spawners is illustrated by Figure 2.3.5. Recruitment estimates are based on the present 2000 ICA assessment. The figure illustrates the decline during the sixties and the seventies, followed by the marked increase in the early eighties. From the high year class 1985 a new decline was observed, while recruitment of 1-ringers during the last six years has fluctuated around a level, without obvious trends of increase or decrease.

The last three ICA estimates of 1-ringer recruitment are 14.0, 6.5 and 36.6 billions for year classes 1996 to 1998 respectively, while the estimates for 0-ringers are 18.0, 101.6 and 52.4 for year classes 1997 to 1999 respectively.

2.3.5 Separate recruitment indices of the Downs herring

At last years meeting of the HAWG it was recommended that trials should be made to separate the Downs herring from the indices of recruitment (ICES 1999a). The Downs herring hatch later than the other autumn spawned herring and generally appears as a smaller sized group during the IBTS.

Polymodal length distributions of the 1-ringers during some years (Figure 2.3.6) indicate that the group could be separated as 1-ringers smaller than 13 cm. However during other years a mode of smaller herring is less evident in accumulated length distributions. The spatial distribution pattern of 1-ringers less than 13 cm is illustrated for the 2000 sampling in Figure 2.3.7. During this year the small herring were predominantly distributed in the German Bight area and in Division IIIa. The relative abundance of 1-ringer herring less than 13 cm is estimated from a standard retrieval of the IBTS database, i.e., the standard index is calculated for herring< 13 cm only. Table 2.3.3 and Figure 2.3.8 show the time series of abundance indices for these small 1-ringers for either the total area or the area excluding division IIIa. The proportion 1-ringers in the total catches that are smaller than 13 cm is in the order of 20%, however the proportion varies and reach 57% for year class 1996 (Table 2.3.3). The contribution of small 1-ringers from division IIIa also varies significantly (Table 2.3.3), two prominent peaks in the abundance estimates (year classes 1986 and 1991) are due to high relative abundance in IIIa (Figure 2.3.8). Some of the variability in small 1-ringers in division IIIa might be due to a variable inclusion of small herring from local stocks of Kattegat winter spawners.

The 0-ringed Downs herring are not distributed widely from their spawning area when sampled during the 1st quarter IBTS, and most of these larvae are concentrated within a few statistical rectangles (Figure 2.3.7). Because of the restricted area of distribution, the standard 2–4 MIK hauls per rectangle have not covered the group with sufficient precision, and the sporadic catches of these larvae have not been included in the standard 0-ringer index. At the 1999 meeting of the IBTS working group it was decided to increase the intensity of the MIK sampling in the relevant rectangles and this procedure was implemented from the IBTS in 2000. The samples of 0-ringers from the Channel show a distinct mode in the length distribution which separate them from larvae of other origin (see Figure 2.3.6, example for sampling year 1999). This separation of catches with modes below 20 mm is used when calculating the preliminary indices shown in Figure 2.3.8. However, these estimates are based on very few positive hauls, and indices would have to be based on the coming MIK series with more detailed sampling in the relevant area.

2.4 Acoustic Surveys in the VIa $_{north}$ and the North Sea July 1999

Methods

Five surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and Ireland to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Swedish and Danish coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually and a combined report has been prepared from the data from all five surveys Simmonds *et al* (2000/WD). Procedures and TS values are the same as for the 1998 surveys (Simmonds *et al*. 1999). The results for the five surveys have been combined. Stock estimates have been calculated by age and maturity stage by ICES statistical rectangle for the whole survey area. Where survey areas overlap, the estimated abundance at age and maturity stage is obtained by a weighted mean dependant on the length of cruise track in each survey. The survey areas for each vessel are given in Figure 2.4.1

Kings Cross	13–30 July 1999	56° N to 60° N, west of 3°W
GO Sars	29 June - 18 July 1999	57° N to 61° 45'N, 2°E to 12^{o}E
Scotia	1 - 24 July 1999	58° N to 61° 45'N between 4° 30'W and 2°E
Tridens	29 June –15 July 1999	54° 30'N to 58°N west of 2°E
RV Solea	30 June - 15 July 1999	55°N to 56° 30'N east of 4°E

Results

The combined data gives estimates of immature and mature (spawning) herring for ICES areas VIa$_{north}$, IVa, IVb and parts of IIIa. The numbers biomass and mean weights at age estimated from the survey are given in Tables 2.4.1 to 2.4.3 inclusive for Autumn spawning herring. The data from all areas have been split between autumn spawners, in the North Sea and West of Scotland, and spring spawning Baltic stocks. The total SSB of autumn spawning herring from the North Sea was 1,500,000 tonnes and for IVa$_{north}$ 419,000 tonnes. Stock estimates by number and biomass are shown in Tables 2.4.1 and 2.4.2 respectively for areas VIa$_{north}$, IIIa, IVa and IVb separately; mean weights at age are shown in Table 2.4.3. The results of the surveys, (numbers, biomass, mean weight and maturity at age) are summarised by stock in Table 2.4.4. Figure 2.4.2 shows the distribution of abundance (numbers and biomass) of mature autumn spawning herring for all areas surveyed. Figure 2.4.3 shows the distribution of autumn spawning herring split by age; 1 ring, 2 ring and 3 ring and older herring. Contour map distributions of juvenile and adult autumn spawning herring are shown in Figures 2.4.4 and 2.4.5 respectively. The 1999 survey was conducted without the participation of RV Dana. The survey by RV GO Sars was extended into the area normally covered by RV Dana, but the time allocated was insufficient for coverage of the Kattegat. This has a negligible impact on the evaluation of the North Sea stock. However, there is a small but significant impact on the results for IIIa. This is discussed in detail in Section 3.5.3 The separation of Western Baltic spring spawning herring from North Sea herring is carried out for these surveys differently for RV Dana (by Otolith Microstructure) and RV GO Sars (vertebrate counts). In 1999 RV Dana did not participate and separation was only required for the survey by RV GO Sars. The vertebrate count method usually used for the GO Sars survey was used again in 1999. For comparison the distribution of Mature Western Baltic spring spawning herring can be compared for 1999 with the survey conducted by RV Dana and RV GO Sars combined in 1998 in Figures 3.5.2 and 3.

2.5 Larvae surveys

Internationally co-ordinated herring larvae surveys have been conducted in the North Sea and adjacent waters since 1972. In last years only The Netherlands and Germany continued to participate in this program. Five cruises covering seven survey units were carried out in the 1999/2000 period. The data coordination and analysis were carried out by IfM Kiel and BFA Hamburg/Rostock.

There are no modifications to the methodology used in 1998. Newly hatched larvae less than 10 mm in length (11 mm for the Southern North Sea) were used to calculate larval abundance. Each larvae abundance index (LAI) unit is defined for area and time. To estimate larval abundance, the mean number of larvae per square metre obtained from the ichthyoplankton hauls for each 30x30 nautical mile rectangles was estimated and raised by the corresponding surface area of the rectangle. Within each unit rectangle estimates are summed to give unit abundance. Estimates of larval abundance by sampling unit and time are given in Table 2.5.1.

Compared to 1998, a decrease in abundance is observed in the Orkney/Shetland and Buchan area. The abundance in Orkney/Shetland is approximately half of last years estimate, but comparable to the mean of last 10 years. In Buchan area the LAI has decreased almost to 15% of the long term mean. In the Southern North Sea (SNS) the abundance is comparable to the average level, while the situation in the Central North Sea (CNS) can not be compared to former years because of the sparse sampling in this area in the 90s.

The traditional LAI and LPE (Larval Production Estimates) rely on a complete coverage of the survey areas. Due to the substantial decline in ship time and sampling effort since the end of the 80s, these indices have not be calculated in this form since 1994. Instead, a multiplicative model was used for calculating a Multiple Larvae Abundance Index (MLAI, Patterson & Beveridge, 1995). In this approach, the larvae abundances are calculated for a series of sampling units. The total time series of data is used to estimate the year and sampling unit effects on the abundance values. The unit effects are used to fill unsampled units so that an abundance index can be estimated for each year.

The unit effects are normalised such that the first sampling unit is used as a reference (Orkney/Shetland 01–15.09.72) and the parameters for the other sampling units are redefined as log differences from the reference unit.

The model was fitted to the log difference in abundance of larvae less than 10 mm in length (11 mm for the Southern North Sea). The analysis of variance and the parameter estimates are given in Table 2.5.2, including year effects and standard errors. The updated normalised log MLAI, the re-scaled, un-logged and unlogged/100 MLAI used in the assessment are shown in Table 2.5.3. Both the LAI per unit as well as the MLAI from the larvae surveys in period 1999/2000 indicate that the SSB has not increased in 1999/2000 as anticipated.

2.6 International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Survey (IBTS) started out as a young herring fish survey in 1966 with the objective of obtaining annual recruitment indices for the combined North Sea herring stocks. It has been carried out every year since and it was realised that the survey could provide recruitment indices not only for herring, but for roundfish species as well. Later, when catch data from the survey were examined in detail it also turned out that the data from the first quarter also gave an indication of the status of the adult herring. It is the time series from the first quarter and from 1983 onwards, after fishing gear and survey practices were standardised, which has shown the most consistent results and which has therefore been used in the assessments of the herring.

Table 2.6.1 shows the time series of the abundance at age obtained from the first quarter coverage of the IBTS. The timeseries is used for two age disaggregated indices, as 1 ringers, discussed in Section 2.3 recruitment and 2–5+ ring, presented here. The values shown in Table 2.6.1 have been updated for all years, after recalculation, from the ICES IBTS database. The average change from previous years for age 2 and 3 was +2%, while the values for age group 4 and 5+, increased with 7% and 6%. The IBTS data series is available for years 1971 to 1999, the years used in the 2–5+ series are from 1983 to 2000 inclusive which is consistent with earlier assessments. Standardisation of fishing gear among participating vessels was implemented in 1983 but there were some adjustments following flume tank measurements and standardisation was completed by 1985, the data should be evaluated to indicate which years are the most appropriate.

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 1999 (weighted by the numbers caught) are presented by ICES division and by quarter in Table 2.2.11.

Table 2.7.1 presents the mean weights at age in the catch during the 3rd quarter in Divisions IVa and IVb for 1987 to 1997. 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 six years of summer acoustic surveys are shown in the same table. (From Table 2.4.3 for the 1999 values). The mean weights at age in the acoustic survey in 1999 are below the average over 7 years for all ages but particularly low for 2 ring herring. In 1998, the 2 ring herring were at a seven year low level and the older age classes were close to a 8 year high. In 1999 the weight at age for 3 ring and older is only 7 g above the seven year low, and 25 g below the 7 year mean. However, the 2 ring herring are the lowest for the period. This is best illustrated in Figure 2.7.1 showing the weights at age in the stock estimated from the acoustic survey. The source of these changes in mean weight were examined in detail by examining weights at age and abundance at age in different parts of the survey area and where available the condition of herring for a number of fixed lengths.

Condition Factor: For the NW of the area, where long term weight length relationships are available from the Scotia survey, the weight of a selected number of fixed lengths of herring are shown in Figure 2.7.2. The lengths chosen are those that give long term mean weights equal to the long term mean weights at age in the same part of the survey area. While condition appears rather stable from 1984 to 1994 fluctuations do occur in the last few years. There is no strong evidence of condition factor effecting the mean weight at age in 2 ring herring but there are indications that condition is a major factor affecting mean weight at age of older herring in the last few years.

Spatial changes in mean weight and abundance in the acoustic surveys: For 1999, as in previous years, the differences in mean weight at age in the acoustic survey is dependant on both the mean weight at age and the proportions at age in the different parts of the North Sea. The variability in this can be seen from the comparisons of proportions of the population and the mean weights at age 1 to 3 ring comparing 1998 and 1999

Proportions of the stock in acoustic survey areas 1998 and 1999

	1998			1999		
	1	2	3	1	2	3
NW	0.00014	0.209	0.779	0.013	0.305	0.786
NE	0.12972	0.094	0.034	0.536	0.173	0.147
SW	0.43264	0.553	0.168	0.102	0.164	0.064
SE	0.43749	0.143	0.017	0.348	0.358	0.002

Mean weight at age in the acoustic survey areas 1998 and 1999

	1998			1999		
	1	2	3	1	2	3
NW	71.1	146.7	218.2	98.4	133.7	175.4
NE	65.0	103.5	145.9	56.8	92.2	168.0
SW	53.8	94.0	132.3	44.3	62.3	70.0
SE	20.1	35.0	78.9	5.6	39.0	83.5

For 1999 compared with 1998 the differences in distribution of 3 ring herring are small, and for 4 ring and older herring the proportions in each area are similar. Most of the older herring are found in the North West in both years and the differences in mean weight is due primarily to a change in condition factor in 1999 (Figures 2.7.1 and 2). For 2 ring herring there are little differences in condition factor, but some small differences in growth in some areas but mostly differences in distribution. Most of the 2 ring herring (55%) were found in the South West in 1998 with a mean weight of 94 g with only 14% in the South East with a mean weight of 35 g, in contrast in 1999 35% were found in the South East with slightly higher mean weight (39 g) but only 10% in the South West with a reduced mean weight of 62 g per fish. While the northern distribution increased from 30% in 1998 to 47% in 1999 the mean weight here also fell this time by about 10 g per fish. These changes in mean weight by area need to be confirmed, but the only other source of data are market samples from catches where mean weights at age are derived from measurements of weights on individuals sampled, and not assumed relationships.

Mean weights in the catch: The overall mean weights in the catch in 1999 do not show such a severe change as the survey mean weights in 1999, however, the inter annual variability in mean weight at age in the catch is similar to that of the surveys over the same period (Table 2.7.1.). There are also systematic differences between average mean weights at age in the catch and average survey mean weights at age, (see Table 2.7.3.). Comparing weights at age in the catch with weight at age in the survey can only be done on an area and quarterly basis. Only for area IVa west is the weight at age in the catch well established. The change in weight at age from 1998 to 1999 can be compared for the 3rd quarter in this area, with the acoustic survey (see Figure 2.7.3). This shows a reduction in mean weight at age between 1998 and 1999 in both the survey and the catch from 3 to 5 ring, with some variability at older ages. There are however, much greater reduction in weight at age for 2 ring in the survey. One possible reason for this is that there is some evidence for grading or directed fishing which might reducing the numbers of small 2 ring herring from the catch.

Conclusions: The overall impression is that herring are growing more slowly in 1998 at 2 ring and remaining more in the south east, and that older herring have lost condition in the North West occupying a the same area as last year with only a slightly more easterly and northerly distribution. Interestingly although 2 ring growth is slower, the proportion maturing is higher, see Section 2.7.3.

This year effect in the mean weight at age in the observed values in the population is considerable and the issue of the correct values to be used in the assessment was addressed in detail in 1996 (ICES 1996/Assess:10). In this report the cause of the year effect was thought to be the result of differences in the estimates of abundance in different parts of the survey area, coupled with the spatial variability in mean weight at age.

As these effects in 1999 are substantial and supported by different sources of data they are assumed to be real. There is slow growth, and reduced migration from the nursery areas at 2 ring. There is loss of condition in the older herring. However, the precision of the area estimates of numbers may still have an influence. Again as was suggested in 1996 a running mean over 3 years, (2 years in the final year) seems to be reasonable compromise as a method for estimating mean weights at age in the assessment, and this method, was used again this year.

Implications for the future: The historic record of weight at age were examined to see if there were cohort effects, but examination of earlier incidence of loss in condition in the older herring did not seem to give lower weight the following year (Figures 2.7.1 & 2). The population is currently increasing in numbers, while the last few years have seen an increase in variability in condition factor in the North West of the area, this was not observed during the previous rise in stock in the mid 80s. While similar condition factor and mean weights at age of 3 ring and older herring have been observed previously this is the lowest 2 ring mean weight observed. The estimation of appropriate mean weight at age in the next few years was addressed but no conclusions could be drawn.

2.7.2 Maturity Ogive

The percentage of North Sea autumn spawning herring (at age) that spawned in 1999 was estimated from the acoustic survey. This was determined from samples of herring from the research vessel catches examined for maturity stage, and raised by the local abundance. All herring at maturity stage between 3 and 6 inclusive in June or July were assumed to spawn in the autumn. The method and justification for the use of values derived from a single years data was described fully in ICES (1996/Assess:10). The maturity in 1999 was the highest recorded for 2 ring herring (over the last 10 years). The proportion of 3 ring was one of the lowest for the period. The percentages are given in Table 2.7.2.

2.8 Stock assessment

2.8.1 Data exploration and preliminary modelling

Catch-at-age data

Catch-numbers at age (Section 2.2) were available for the period 1947–1999. The year range 1960 to 1999 was chosen for the assessment, because of large discrepancies in the sum of products in earlier years. The catch numbers at age have been changed for 1997 because of the inclusion of misreported catches from VIa North (see Section 2.2.3).

Survey indices available

The following survey indices were available:

- MIK 0-wr index. Available and used since 1977 as a recruitment index (Section 2.3)
- Acoustic 2–9+ wr index. Available since 1984, used since 1984 (Section 2.4)
- IBTS 1–5+ wr index. Available since 1971. Separated into a 1 wr index (used since 1979) and a 2–5+ wr index (used since 1983). See Sections 2.3 and 2.6.
- Multiplicative larvae abundance index (MLAI). Available since 1973, used since 1979 as an SSB index (Section 2.5).

Data exploration by abundance index

The consistency of survey indices by age is shown in Figure 2.8.1. Recruitment indices (MIK 0-wr and IBTS 1-wr) are fairly consistent. The IBTS and Acoustic indices for 2 and 3-wr are, however, not very consistent.

Correlation coefficient matrices for the acoustic survey, the IBTS survey and the catch data are shown in Table 2.8.1 and show that in general there is a substantial correlation between ages. This correlation will include both autocorrelation due to recruitment and correlated errors in the measurement process. The table shows that the correlation coefficients in the survey indices are generally higher than in the catch data, so that the inference would be that there are correlated errors in the surveys.

The Working Group routinely attempts to evaluate the consistency of the different sources of information. One possible method of evaluation is to fit the model to the tuning indices separately and to plot the maximum likelihood estimates of terminal fishing mortality at reference age (4) and the 95% confidence intervals (Figure 2.8.2). All model runs were carried out with a separable period of 4 years and with default weighting of 1 for each survey. Below, comments will be provided for each of the separate tuning indices.

The **multiplicative larvae abundance index (MLAI)** index for larvae smaller than 10 mm was tested using the year range of 1979 to 1999 and assuming a power relationship of index value to stock abundance as in last year's assessment. The indicated F at reference age 4 is at the same level as in last years assessment. The multiplicative larvae abundance index (MLAI) was used in the final assessment.

The **acoustic survey index** is available from 1984 onwards but has only been used for the period 1989 to 1999. The reasons for using this restricted period are discussed in ICES 1995 and 1996a. The Working group considered that it was no longer needed to test the longer time-series or the SSB index derived from the survey. The estimated fishing mortality in the final year was only 2% different from last year. The age disaggregated acoustic index (ACOU) was used in the final assessment.

The **IBTS survey indices** for the 1- to 5+-ringers and for the 2- to 5+-ringers indicate the highest F compared to the other indices (as in last year). The confidence intervals are fairly wide for these indices. In earlier years, the IBTS indices have always been split into two sets: the IBTS 1-ringer indices and the IBTS indices for 2–5+-ringers. By applying the IBTS 1-ringers as a separate index they get the same weight as the combined 2–5+ ringer index. Although the Working Group considered that this procedure in itself is not justified by the data because the errors in all the IBTS age information are considered to be correlated, the same procedure has been applied for this years assessment. The Working Group recommends that the whole issue of survey weighting should be addressed intersessionally, and that any revisions on the use of the IBTS indices should come from that analysis. Therefore, both the IBTS 1 wr index and the 2–5+ wr index were used in the assessment.

The **MIK 0-wr** index has also been tested in a separate model fit. The index appears to fit well to the historic recruitment information. This index is not included in Figure 2.8.3 as it is a poor predictor of adult stock size. The MIK index was used in the final assessment.

The spawning stock biomass that is derived by fitting the ICA model to the indices separately is shown in Figure 2.8.3. These estimates are compared to spawning stock biomass of the final assessment. The three indices are very much in agreement concerning the development in the stock.

In summary, the following indices were used in the final assessment:

- acoustic survey 1989–1999 (2–9+ wr)
- IBTS 1983–2000 (2–5+ wr)
- IBTS 1979–2000 (1-wr)
- MIK 1977–2000 (0-wr)
- MLAI< 10 1979–1999 (biomass index).

The above indices have been used for the assessment during the last five years.

Choice of period of separable constraint

The standard ICA model includes the assumption of the exploitation pattern being constant over recent years. The regulations in 1996 and later years affected the various components of the fishery differently. The TACs for fleets A and C (the human consumption fleet in the North Sea and Division IIIa) were reduced to 50%. By-catch ceilings for the other fleets (B, D and E) were implemented corresponding to a reduction in fishing mortality of 75% compared to 1995. These fleets exploit juvenile herring as by-catch. As a result a single separability assumption is likely to be violated for the recent years.

At the 1999 meeting of this Working Group, the length of the separable period was investigated using an XSA analysis. This analysis has not been repeated this year. The Working Group did consider the possibility of shortening the separable period to 3 or 4 years, but has refrained from implementing this change as it is expected that the assessment methodology will be re-evaluated intersessionally whereby both the survey weighting and the length of the separable period will be addressed. Therefore, the Working Group decided to extend the separable period to 8 years, divided up into two periods: from 1992 to 1996 and from 1997 to 1999.

2.8.2 Stock assessment

Assessment of the stock was carried out by fitting the integrated catch-at-age model (ICA) including a separable constraint over a eight-year period as explained above (Patterson and Melvin 1996; Patterson, 1999; Deriso *et al.* 1985; Gudmundsson, 1986).

Details on input parameters and model setup for the final ICA assessment are presented in Tables 2.8.2 and 2.8.3. The ICA program operates by minimising the following general objective function:

$$\sum \lambda_c \left(C - \hat{C}\right)^2 + \sum \lambda_i \left(I - \hat{I}\right)^2 + \sum \lambda_r \left(R - \hat{R}\right)^2$$

which is the sum of the squared differences for the catches (separable model), the indices (catchability model) and the stock-recruitment model.

ICA offers the possibility to estimate two separate separable periods. As is was found in last years analysis, that the change in exploitation pattern in 1996 and 1997 had mainly affected the younger ages, the estimation routine was adapted so that the selection on the older ages was forced to be equal, while the selection on the juveniles was allowed to change abruptly between 1996 and 1997. The forcing was accomplished by introducing a penalty function on the difference between the two selection patterns $\hat{S}_1$ and $\hat{S}_2$ from ages 3 and higher, and using an arbitrary high weight of 10. The penalty function was added to the objective function:

$$\sum \lambda_c \left(C - \hat{C}\right)^2 + \sum \lambda_i \left(I - \hat{I}\right)^2 + \sum \lambda_r \left(R - \hat{R}\right)^2 + \sum \lambda_s \left(\hat{S}_1 - \hat{S}_2\right)^2$$

A special version of ICA was compiled to enable the addition of the penalty function to the objective function (ICAHER). This version is currently not available on the IFAP system (but is expected to be included soon), but it is available in the directory that contains the final run.

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

$$\sum_{a=0,y=1992}^{a=8,y=1999} \lambda_a (\ln(\hat{C}_{a,y}) - \ln(C_{a,y}))^2 +$$

$$\sum_{y=1979}^{y=1999} \lambda_{mlai} \cdot (\ln(q_{mlai} . S\hat{S}B_y^K) - \ln(MLAI_y))^2 +$$

$$\sum_{a=2,y=1983}^{a=5+,y=2000} \lambda_{a,ibtsa} (\ln(q_{a,ibtsa} \cdot \hat{N}_{a,y}) - \ln(IBTS_{a,y}))^2 +$$

$$\sum_{y=1979}^{y=2000} \lambda_{ibtsy} (\ln(q_{ibtsy} \cdot \hat{N}_{1,y}) - \ln(IBTS_{1,y}))^2 +$$

$$\sum_{a=2,y=1989}^{a=9+,y=1999} \lambda_{a,acoust} (\ln(q_{a,acoust} \cdot \hat{N}_{a,y}) - \ln(ACOUST_{a,y}))^2 +$$

$$\sum_{y=1977}^{y=2000} \lambda_{mik} (\ln(q_{mik} \cdot \hat{N}_{0,y}) - \ln(MIK_y))^2 +$$

$$\sum_{y=1960}^{y=1999} \lambda_{ssr} (\ln(\hat{N}_{0,y+1}) - \ln\left(\frac{\alpha . S\hat{S}B_y}{\beta + S\hat{S}B_y}\right))^2 +$$

$$\sum_{a=3}^{a=8} \lambda_s \cdot (\ln(\hat{S}_{1,a}) - \ln(\hat{S}_{2,a}))^2$$

with the following variables:

a,y	age and year
C	Catch at age
$\hat{C}$	Estimated catch at age in the separable model
$\hat{N}$	Estimated population numbers
$S\hat{S}B$	Estimated spawning stock size
mlai	MLAI index (biomass index)
acoust	Acoustic index (age disaggregated)
ibtsa	IBTS index (2–5+ ringers)
ibtsy	IBTS index (1 ringers)
mik	MIK index (0-ringers)
q	Catchability
k	power of catchability model
α, β	parameters to the Beverton stock-recruit model
$S_{1,a}$	estimated selection at age in the first selection period
$S_{2,a}$	estimated selection at age in the second selection period
λ	Weighting factor

Weighting

All catch data (within the separable period) where weighted with a weight of one. Each of the separate survey indices where also weighted with a weight of one, because errors were assumed to be correlated by age for both the acoustic survey and the age-disaggregated IBTS (2–5+) index. The stock-recruitment model was weighted by 0.1 as in last years assessment, in order to prevent bias in the assessment due to this model component. The change in selection pattern was weighted with an arbitrary weight of 10 to force the selection on older ages to be similar.

Results

The ICA output is presented in Table 2.8.4 and Figures 2.8.4–2.8.12. Uncertainty analysis of the final assessment is presented in Figure 2.8.13 (see below). Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.8.14.

The spawning stock at spawning time 1999 was estimated at 905 thousand tonnes, and increased compared to the SSB in 1998. However, the SSB in 1998 was substantially reduced in the current assessment (701 thousand tonnes) compared to last years assessment (878 thousand tonnes). The increase in the 1999 SSB compared to the 1998 SSB in this assessment is around 29% compared to an predicted increase in last years Working Group of 35%. The differences in SSB are mainly due to the downward correction of the 1996 year class (0 wr in 1997) which is now estimated as 39 billion individuals vs. 51 billion as estimated in last years assessment. Fishing mortality on 2–6 wr herring in 1999 was estimated at around 0.38, and the fishing mortality in 1998 was estimated at 0.45, slightly higher than the estimate from last year. Fishing mortality on 1-wr herring is estimated around 0.07.

Like last year, the diagnostics of the model fit show relatively high residuals in the 1996 juvenile catches which indicates that the fitted selection pattern did not conform to the catch data on juveniles for that year. However, the overall level of residuals was thought to be acceptable. The weighted analysis of variance of the Working Group 2000 final assessment is below compared with the Working Group 1999 analysis, and gives rise to the conclusion that both model fits are largely comparable.

Weighted analysis of variance

```
WG 1999 SSQ Data Parms d.f. Variance
--------------------------------------------------------------------------------
Catches at age 1.9818 63 36 27 0.0734
MLAI < 10 mm 2.0686 20 2 18 0.1149
ACO89: acoustic survey 2–9+ 0.1274 80 8 72 0.0018
IBTSA: 2–5+ 1.5607 68 4 64 0.0244
IBTSY: 1-wr 1.7863 21 1 20 0.0893
MIK: MIK 0-wr 4.0415 23 1 22 0.1837
Stock-recruit model 0.1392 38 2 36 0.0039
--------------------------------------------------------------------------------
Total for model 11.7057 313 55 258 0.0454
WG 2000 SSQ Data Parms d.f. Variance
--------------------------------------------------------------------------------
Catches at age 2.5662 72 38 34 0.0755
MLAI 2.1945 21 2 19 0.1155
Acoustic survey 2–9+ wr 0.1902 88 8 80 0.0024
IBTSA: 2–5+ wr 1.5716 72 4 68 0.0231
IBTSY 1-wr 1.8459 22 1 21 0.0879
MIK 0-wr 4.1924 24 1 23 0.1823
Stock-recruit model 0.1466 39 2 37 0.0040
--------------------------------------------------------------------------------
Total for model 12.7074 338 57 281 0.0452
```

The sensitivity of the assessment was explored using a covariance matrix method where 1000 random draws were taken from the parameter-distributions of the ICA model. Using these random parameter vectors, the historical assessment uncertainty was calculated and plotted in Figure 2.8.12. Estimates of fishing mortality at 2–6 wr and recruitment at 0-wr are highly sensitive to the parameter estimates, notably in the years 1990–1996. The median fishing mortality (2–6 wr) in 1999 estimated from this analysis was 0.40 with 25 and 75 percentiles of 0.30 and 0.53. Median SSB in 1999 was estimated at 938 with 25 and 75 percentiles 785 and 1087 thousand tonnes. There appears to be a relatively good agreement between the point estimates of the final assessment and the median values of the Monte Carlo evaluations

2.9 Herring in Division IVc and VIId

The evaluation of this stock component has been based on the herring larvae surveys in the area. The time series of the herring larvae surveys in the southern North Sea and eastern Channel show low values in 1995 and a spawning stock biomass on a very low level, comparable to that in 1980 when the herring fishery was closed (ICES 1996a). In May 1997 ACFM recommended that: "the effort should be reduced in this area as recommended for the total North Sea**"**. In the middle of 1996 the TAC for human consumption herring was revised to half the agreed TAC. However, the advice that no directed fishing for herring should be allowed in Division IVc and VIId in 1996 and 1997 was not followed by EU regulations neither in 1996 nor in 1997. In 1999 the TAC was kept on the same level of 25,000 tonnes as 1998 (Figure 2.9.1). Since 1998 (see Figure 2.9.1) ACFM catches have overshoot the agreed TAC's considerably. In the last four years, in which the TAC was half as low as in the period 1991–1995, catches were twice as high as the TAC. Considerable catches taken in Divisions IVc and VIId were misreported to other Divisions.

Figure 2.9.2 shows the age composition of the herring in Divisions IVc and VIId in the Dutch catches from December 1980–1999. Figure 2.9.3 shows information on the larvae abundance over the same period and the changes in the mean age in the Dutch herring catches in December. In general it is thought that the spawning stock biomass decreases when in the preceding year age 3 w-r has been more abundant than age 2 w-r (compare larvae abundance in Figure 2.9.3 with the age composition in Figure 2.9.2). In these cases a weak recruitment at age 2 appears to be recruited to the Downs spawning stock. Year classes 1990 and 1991 appear to have been weak and seem to have contributed to the fast decline in the spawning stock biomass. Year classes 1992 and 1993 appear to have been at least average and probably explain the increase in spawning stock in 1996. Both the larval index and the mean age show a steady increase from 1996 up until 1998. In 1999 only the mean age increases, as the larval index decreases.

For the management advice of Downs herring it is important to know what year class strength will recruit to the adult spawning component. The IBTS survey supplies recruitment indices of 1-ringers, but these indices are for the whole North Sea herring population. Part of these 1-ringers will recruit to the Downs herring. As discussed in Section 2.3.5, an analysis of the 1-ringer length distribution was carried out. This analysis indicates that at present there is no satisfactory splitting method available between Downs and North Sea Herring 1-ringers when only based on IBTS length distributions.

Although some information on the development of this stock component is available, this information is insufficient for management purposes. As management of North Sea herring as a single unit is not affected by this stock component, the need for separate management of Downs herring is questioned.

2.10 Short term projection by area and fleet

Short term projections have been done as last year. There have been no changes in the basis of input parameters, but details are outlined below for completeness.

Fleet Definitions

The fleet definitions are the same as last year with fleets D and E still combined (called D in this report, but D&E in last year's report), because there are no separate quotas for the two fleets. The fleet definitions are:

North Sea

Fleet A: Directed herring fisheries with purse seiners and trawlers

Fleet B: All other vessels where herring is taken as by-catch

Division IIIa

Fleet C: Directed herring fisheries with purse seiners and trawlers

Fleet D: By-catches of herring caught in the small-mesh fisheries

Input Data for Short Term Projections

All the input data for the short term projections are summarised in Table 2.10.1.

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 2000. The ICA estimates of all age groups from 0–9+ are used (Table 2.8.4).

Catches by fleet in reference year: 1999 data from input files Table 2.2.6.

Stock Numbers:

For 1999 the total stock number was taken from ICA (Population Abundance year 1999, Table 2.8.4).

For 2000 the total stock number was taken from ICA (Population Abundance year 2000, Table 2.8.4).

For 2001 0-ringer the stock number was set to 44 000 million as used in the past four years. This value is very close to the estimate of 42 100 million obtained from the Beverton-Holt stock-recruit relationship in ICES 1998 C (Study Group on the stock-recruitment relationship in North Sea Herring), at an SSB of around 900 thousand tonnes.

Fishing Mortalities: fishing mortalities for age classes 2 and older are taken from Table 2.8.4 for 1999. Fishing mortalities for 0 and 1 ringers are calculated (see below).

Mean Weights at age in the stock: the averages of the last 2 years' mean weights (1998 and 1999) were used (Table 2.8.4). Note that weights used in the assessment are already smoothed.

Maturity at age: The average maturity at age for 1998 and 1999 was used (Table 2.7.4)

Mean weights in the catch by fleet: A mean of the last two years was taken i.e., 1998 and 1999, (Table 2.2.6)

Natural Mortality: Unchanged from last year ICES (1999/ACFM:12) Table 2.8.4.

Proportion of M and F before spawning: Unchanged from last year ICES (1998/ACFM:12) Table 2.8.4.

Split factors: Proportions North Sea autumn spawners in the North Sea and Division IIIa in 2000–2001

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 below.

The split factor used for the short term predictions distinguishes the proportions of North Sea autumn spawners being present in the North Sea and Division IIIa. Some of the split factors are directly estimated from surveys, other values are estimated from a general linear model (GLM) which relates the proportion of 1-ringers in Division IIIa to the MIK index of 0-ringers. This is discussed in detail below.

In general the split-factor is estimated from proportions of the IBTS 1-ringers in the North Sea and in Division IIIa, and not from the 0-ringers. It is then assumed that the split-factor that applies to a year class as 1-ringers, also applied to that same year class as 0-ringers. The assumption is that the spatial distribution occurs as 0-ringers. 1-ringers remain in the area where they ended up as 0-ringers, and only migrate back to the North sea from Division IIIa as 2-ringers. This assumption and the origin of the split-factors used in the short-term predictions are illustrated in the text table below.

Year	0-ringer distribution	1-ringer distribution
1999 (last yr in ICA)	This split-factor (0-ringers in 1999) is equal to the split-factor of IBTS 1-ringers in 2000	This split-factor (1-ringers in 1999) is obtained from the proportions estimated for the 1-ringers in the IBTS in 1999
2000 (Assessment year)	This split-factor is equal to the regressed 1-ringer distribution of 2000, i.e., obtained from the MIK value for 2000 (yr class 1999) and the GLM	This split-factor is obtained from the proportions estimated for the 1-ringers in the IBTS in 2000
2001	This split-factor is equal to that of 1-ringers in 2002, i.e., estimated by taking the average MIK index for the year classes 1981 the GLM to predict the split.	This split-factor is obtained from the MIK value for 2000(yr class 1999), and a general linear model (GLM) to predict the split.
		This split-factor (1-ringers in 2002) is estimated by taking the average MIK index for the year classes 1981 and the GLM to predict the split-factor.

Summary of Proportions North Sea autumn spawners in the North Sea used in projections:

	0-ringers	1-ringers
1998	0.654	0.63
1999	0.69	0.654
2000	0.69	0.69

The value of 1-ringers in 2001 and 0-ringers in 2000 (0.69) was determined by a general linear model between the MIK index and the IBTS 1-ringer proportion in Division IIIa (see comments below). The MIK index of 0-ringers in 2000 is 137.1 which predicts a proportion of 0.31 in Division IIIa (1–0.31 = 0.69 in the North Sea).

The value of 0-ringers in 2001 and 1-ringers in 2002 (0.69) was estimated from the general linear model and an average MIK index over 1981–1999 (137.6), which gives an estimated proportion of 0.31 in Division IIIa.

Comments on the General Linear Model

Over the last two years, results from fitting two general linear models relating the proportion of North Sea autumn spawners in Division IIIa to the MIK index of 0-ringers were presented (ICES CM 1998/ACFM:14 and CM 1999/ACFM:12). The models were re-fitted with the new observations for 1999.

Table 2.10.2 shows the observed values and the two models: one with Gamma errors and an inverse link function, and one with Gamma errors and an identity link. The details of these models are discussed in O'Brien and Darby (1997, Working Document to HAWG) and Basson (1997, and 1998 Working Documents to HAWG). The analysis was done in Splus, and summary results are given in Table 2.10.3 for completeness. Results are not very different from those presented last year. For the range of MIK-observations, the two models lead to reasonably similar estimates of the proportion in Division IIIa. Both models are, however, likely to break down when used for prediction with an MIK index that lies outside the range of observed values. Problems are likely to be particularly acute if the predicted value is close to 0 or 1. The MIK index for 2000 is very close to the mean (137.1, compared to a mean of 137.6) The standard errors of the predicted values are therefore reasonable: 0.027 for the model with identity link (linear model), and 0.025

for the model with inverse link (curvilinear model). The predicted values from the two models are also quite similar (0.31 for the identity link; 0.29 for the inverse link). In the absence of any knowledge of a mechanistic relationship, the Working Group again used the linear model for prediction purposes. Model choice does not make a big difference to the predicted value this year.

Comments on the short-term projections

The same spreadsheet used last year was used again, and the procedure is again described for completeness. The process is in two steps. The first is to compute local partial fishing mortalities for each fleet, corresponding to the stock in the area where the fleet operates. This is done using stock numbers and fleetwise catches in a reference year, which would be the last assessment year. The next step is to project the stock forwards, starting with the stock numbers at the start of the first prediction year from the assessments, and applying the local fishing mortalities, each raised by an F-factor. Catches by fleet, the ensuing overall fishing mortality, and the SSB are computed and presented.

The area-specific stock numbers and fishing mortalities apply only to 0- and 1- ringers. Older fish are treated as one uniform stock, because North Sea autumn spawners have been assumed to leave Division IIIa as 2- ringers.

The computation of local partial fishing mortalities in the reference year is done as follows:

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- Stock numbers N1(a) at the end of the year are computed in each area j using Pope's approximation:
  N1j(a) = N0j(a)*exp(-M(a)) - Cj(a)*exp(-M(a)/2) where Cj(a) is the total catch at age in the area.
- Total local mortality Zj(a) is computed as log(N0j(a)/N1j(a)) and the total fishing mortality as Fj(a) = Zj(a)-M(a)
- Fleetwise partial F's are obtained by dividing the total area F proportional to the catches
- For ages 2 and older, the total F according to the input is divided between the fleets proportional to the catches.

In the prediction itself, the local partial F's are manipulated by F-factors, which apply to all ages, i.e., the fishing pattern is kept. The process is as follows:

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- The local (area j) partial F's, as adjusted by the f-factors are used to compute the catches at age by fleet using
  Cj(a) = N0j(a)*(1-exp(-Z(j(a)))/Zj(a)
- Stock numbers N1(a) at the end of the year for the whole stock are computed in each area j using Pope's approximation:
  N1(a) = N0(a)*exp(-M(a)) - C(a)*exp(-M(a)/2) where C(a) is the total catch at age by all fleets.
- Total mortality Z (a) for the whole stock is computed as log(N0 (a)/N1(a)) and the total fishing mortality as
  F(a) = Z(a)-M(a)
- Yield is obtained by multiplying catches at age with fleet-specific weights at age

SSB is obtained by first computing the stock numbers at spawning time as Nsp(a) = exp(-Z(a)*prop), where prop is the proportion of the mortality before spawning. These stock numbers are multiplied with weight at age in the stock, and summed over all ages.

In 1997 and 1998 fleets C, D took some catches of age 3 and older North Sea autumn spawners, and this was again the case in 1999. In the present version of the programme (as used in the past 2 years), these catches are included.

Prediction for 2000 and management option tables for 2001
Assumptions and Predictions for 2000

In recent years, there have been some overshoot of the overall TAC for North Sea autumn spawners. A catch constraint, based on TACs and recent observed overshoots of the set TACs, was therefore used for projections in 2000.

There are two steps involved in calculating the fleet-specific catch constraints. First, for fleets C and D operating in Division IIIa where the official TACs applies to autumn spawners and spring spawners, we assumed that the proportion of autumn spawners in the TAC would be similar to proportions observed in recent catches. The rounded, average proportion based on catches in 1997–1999 are 0.5 for fleet C and 0.6 for fleet D. The second step is to increase or decrease these TACs by expected levels of overshoot/undershoot. Fleet-specific catches in 1999 show that there was again about 20% overshoot in the A fleet. The B and C fleets, however, indicated a 50% 'under'-shoot. The low catch for fleet C is thought to be partly due to area misreporting, which contributes to the overshoot for fleet A. Fleet D had an 85% overshoot on the expected catch of North Sea autumn spawners. Given that there are no changes in regulations which may change the way in which the fleets operate, the observed over/undershoot ratios in 1999 were used to calculate likely overshoot values for 2000. The resulting expected catches used as catch constraints for 2000 are shown in Table 2.10.4.

The overall overshoot is 5% (identical to the observed overall overshoot in 1999), compared to an overall overshoot of 19% observed in 1998.

Management Option Tables for 2001

Table 2.10.5 gives management options for 2001 based on a catch constraint in 2000. (The upper table is based on TACs with overshoot in 2000, the lower table on TAC only, for comparison). The method for estimating the expected catches by fleet was described above. Scenarios for 2001 were again constructed in such a way that the ratios between the expected catches by fleets in 2001 were maintained as given by the TACs (or TAC plus overshoot) in 2000. Fishing mortalities were used as constraints.

It is important to note that, in addition to constraints on fishing mortalities, some constraints in terms of relative catches between fleets are required to ensures that a unique solution for F-factors by fleet are obtained. The form of the constraints are, however, also important. If one or both fishing mortalities are constrained to be less than or equal to some target value, AND ratios between pairs or a subset of the fleet are maintained (e.g., fleets A:C and B:D, or fleets B,C,D only) then there may be multiple solutions of catches by fleet. So, if the ratios between pairs or a subset of the fleets are maintained, fishing mortalities have to be constrained to be equal to some target value to ensure a unique solution. If, on the other hand, the proportions between all 4 fleets are to be maintained, then it is possible to constrain fishing mortalities to be less than or equal to some target value.

The 9 scenarios for 2000 are listed in table 2.10.5. SSB is projected to be around 900 thousand tonnes in 2000. For all the scenarios, projected SSB in 2001 increases to above 1.3 million tonnes. It is, however, important to note that SSB in 2001 is dominated by strong incoming year class (2-ringers in 2001), which is not yet well estimated. This year class contributes around 43% to SSB in 2001, compared to a contribution of only 12% by the 2-ringers in 2000.

When comparing scenarios VI and VIb, note that although there is only a very small difference between projected total catches in 2001, there is a difference in the SSB. Under the TAC constraint in 2000 (Scenario VIb) the SSB in 2001 is projected to be 1499 thousand tonnes. Under the scenario IV, the projected SSB in 2001 is 1462 thousand tonnes. This gain in SSB (by adhering to the TAC in 2000) is mainly in ages 4 and 5, which are taken almost exclusively by fleet A.

The Working Group is concerned about the tendency of over-estimating projected SSB (see Figure 2.12.1). As noted in Section 2.8, this is usually because of downward revisions of the stock sizes in recent years in subsequent assessments. This issue is of particular relevance this year given (a) the very high estimate of recruitment in 1999, i.e., the last year in the assessment, and (b) given that current estimated SSB is between Blim and Bpa. The sensitivity of short term predictions to the input of population size estimates from ICA was therefore explored. Of main concern is the case where population sizes are lower than the ones used in the prediction. Estimates of the lower 95% levels of population numbers at age in 1999, and recruitment (0-ringers) in 2000 are available from the ICA assessment. Ignoring covariances between parameter estimates, these lower 95% levels were used as proxies for the 2.5 th percentiles of the population estimates. Fishing mortalities were re-calculated from these population numbers, the observed catch numbers at age and natural mortality. Population numbers in 2000, at ages older than 0, were then calculated from numbers in 1999 and the recalculated F's. Table 2.10.6 shows a comparison of projections done with the proxy 2.5 th percentiles and with the point estimates of population sizes for scenario I in Table 2.10.5. The comparison shows that SSB in 2001 could still be below Bpa = 1.3 million tonnes. Although it is not possible to associate a confidence level with these calculations, it is informative to compare the 5 th percentiles of SSB from the medium term projections, which takes full account of the estimated covariances between parameter-estimates, for a similar scenario: 525 thousand tonnes in 2000, and 866 thousand tonnes in 2001.

Limited investigations of the effect of the predicted split factor values showed that it is mainly the catches by fleet rather than the SSB that are affected. Further investigations are being planned intersessionally.

Intersessional Evaluation of Short Term Projections

The Working Group has been asked to investigate whether the inclusion of the area split factor provides an improvement in the short term projections. The area split factor is included because it is recognised that the proportion of the North sea stock of 0 and 1-ringers in IIIa varies from year to year. This can affect the fleet-specific catches (of autumn spawners) for given levels of exploitation, particularly for fleets C and D which fish in IIIa.

In order to evaluate this issue, the first question is whether we can predict the proportion (split factor) sufficiently well to improve the overall projections. This, however, needs to be done within the context of the short term projections to be meaningful. One problems in evaluating the projections is that this cannot be done with regard to predicted and subsequently observed catches because the catches are driven by the TACs which are based on the projections in the first place.

An alternative way of evaluating the projections is to consider the population numbers at age, and the age structure in catches by fleet. One approach could be as follows:

1. do an assessment up to year y

2. start at year y-n, (n may be 5–10 years, for example) and do 2-year ahead population projections with and without the split factor, starting from year y-n, y-n+1 etc. up to y-2

3. the fleet-specific total catch in weight should be used, and appropriate F's by age and fleet found to give the observed total catches. This would differ for the two methods:

   - partial F's with no split factor;
   - LOCAL partial F's (ages 0–1) based on split factor and partial F's for older ages

4. compare how close the projections from the two methods are to the assessment, in terms of the numbers at age in the population, and the numbers at age in the catches by FLEET.

The above evaluation should be done with the range of split factors in mind, and attempts should be made to include years where split factors (observed and or predicted) are towards the ends of the range, rather than just for years where values are in the middle of the range.

Initially the evaluation should be based on the current version of the split-factor short term projection, which does, however, have known shortcomings. After the evaluation there will be a need to reconsider the way forward. If the split-factor method performs poorly mainly because prediction of the split factor is poor, then one may consider using the standard projection procedure. If there are other factors (e.g., the way in which local fleetwise F's for 0 and 1 ringers are calculated) that appear to be the main cause of poor projections, modified versions of the current method may be considered. When developing new approaches, evaluations should, of course, also be performed.

2.11 Medium-Term Projections

Medium term projections were repeated this year mainly for two purposes. The first was to compare the short-term predictions with stochastic predictions not taking the migrations into account. The second was to illustrate the implications of the reduction in weights in the stock that has been observed in recent years.

The method used for the calculation of stochastic medium-term projections was the same used in last years' assessment and follows the procedure described in ICES (1996a). It is summarised here again for convenience. The model parameters (comprising the fishing mortality at reference age, the selections at age, the fitted populations in 1999 and the expected recruitment in 2000) as well as their variance-covariance matrix is estimated by the ICA assessment procedure on a logarithmic scale. The projection method is based on drawing Monte-Carlo pseudo-data sets of parameters to initiate the projections. Recruitment, however, is treated differently. A Beverton-Holt stock-recruit relationship with no autocorrelation is fitted (Figure 2.11.1). A non-parametric bootstrap method was used to generate recruitments in the pseudo-data sets used for the projections: Uncertainty in future recruitments around the stock-recruitment relationship was modelled by randomly drawing values from the historic time-series of log residuals. The 'ICP' (Version 1.4w) programme was used to implement the method.

Medium term projections were made with the following assumptions about the fishing mortality from 2001 onwards.

1. F(0–1) = 0.03; F(2–6) = 0.20
2. F(0–1) = 0.12; F(2–6) = 0.25
3. F(0–1) = 0.04; F(2–6) = 0.38 (F = F1999)

The assumptions used in the predictions were kept as consistent with those for the short term prediction as possible. However, area distribution and migration was not taken into account. For 2000, the catches were constrained to the values assumed in the short-term prediction, using the adjustment according to the previously experienced deviations from the agreed TAC's. The following assumptions were made in the medium-term projections:

- The mean maturity ogive as measured in 1998 −1999 has been assumed to hold for the years 1999 and thereafter.
- The natural mortality that was used for the assessment has been assumed to hold for the years 1999 and thereafter.
- The proportions of F and M before spawning in the projections were as used in the assessment.
- The weight at age in the stock for forecasting purposes was taken as the value from 1999
- The weights at age in the catches by fleet were taken as the mean values from 1998 and 1999
- The projections start from the populations on 1 January 2000 (ages 1–9+) and recruitment on 1 January 2000 (age 0) calculated in the assessment procedure.
- The overall exploitation pattern as estimated for the second separable period (1996–1999) by ICA, was assumed to hold for 2000 and thereafter.
- The relative fishing mortality by fleet and at age as estimated for 1999 was assumed to hold in future years.
- Future F-levels were obtained by calculating one F-multiplier for fleet A and one common for the fleets B-D. The F = F1999 option implied setting the multipliers to 1.

An example of the projection file (for run 1) is provided as Table 2.11 1. The stock-recruitment relationship is shown in Figure 2.11.1. The medium-term projection scenarios modelled are given in detail in Figures 2.11.2–2.11.13. The results indicate that by maintaining the advise for 2000 in future years, a gradual increase in stock size and landings can be expected. If the agreed regime of F(0–1) = 0.12 and F(2–6) + 0.25 is implemented from 2001 onwards, both the expected landings and the SSB tend to remain stable from 2002 onwards. The risk of SSB falling below Blim increases gradually, however. Maintaining the present fishing mortalities, with a lower F on the juveniles and a higher F on the adults than the agreed values, gives largely the same result, i.e., the increased F at older age is compensated by the lower F at young age. The rapid increase in SSB is to a large extent due to the 1998 year class, which so far is believed to be very large.

2.12 Quality of the assessment

The Working Group addressed the ToR 3 by setting up a table for each stock that contains descriptions of the available data and the methods used to assess and evaluate the state of the stock. For North Sea herring this Table is 1.6.2. In this section issues will be addressed specific to this years assessment.

Comparisons of recent assessments are shown in Figure 2.12.1. There appears to be a pattern of readjustment in both fishing mortality (upwards) and spawning stock biomass (downwards) in recent working groups perceptions of the stock. Also the estimate of the SSB in 1999 (905 thousand tonnes) is considerably lower that predicted during last years assessment (1190). It was found that the estimated recruitment for the 1996 year class (0-wr in 1997) was substantially lower in the current assessment (39 billion against 51 in last years assessment). Furthermore, average fishing mortality for ages 2–6 (wr) in 1998 is now estimated at 0.46 whereas last year it was estimated at 0.35. The reasons for the downward revisions of recruitment are not fully understood but seem to be a general problem in not only this assessment.

A retrospective analysis was carried out using a 4 year separable period that shifted backwards over time (Figure 2.12.2). The conclusion from the analysis is that, contrary to the historic performance of assessment, there is good consistency within the model itself, and no retrospective patterns are obvious.

The restrictions on the fishery for juveniles were introduced in the middle of 1996. A large part of the 1-ringer catch was already taken by then, while the catch of 0-ringers, was small. Ideally, the selection pattern of the first period should therefore apply to the 1-ringers caught in 1996, while that for the second period should apply to the 0-ringers caught in 1996. This arrangement is not possible with the presently available software.

Another source of uncertainty are the catches from the North -Western part of the North Sea. This problem is discussed in Section 5.1.3. Last year, all catches reported in 1997 from Division VIa North were assumed to have been taken there, while in other years substantial parts of these landings had been transferred to Division IVa. In the current assessment a revision of the catch data was implemented whereby around 25000 tonnes of the 1997 landings were reallocated from area VIa North to the North Sea. The basis for this reallocation was the Bayesian analysis carried out for the VIa North stock in last years assessment.

The issue of survey weighting within the ICA model has been explored by the Working Group and had also been addressed at other occasions (e.g., ICES 1998a, ICES 2000a, Kolody and Patterson 1999). Since all elements in the objective function of the ICA are weighted by a factor lambda (e.g., Section 2.8.2), it is important to assess the adequacy of the (arbitrary weights) currently used and the effects of these weightings on the final results of the assessment. Current procedure is to attach weights of 1 to the catch data within the separable period (8 separable years times 9 ages equals a weight of 72), weights of 1 for each of the survey indices (where the errors within the survey are assumed to be correlated) and a weight of 0.1 for the stock-recruitment model. The Working Group did some experiments with different arbitrary weights on either the survey indices or the catch data and found that the model was very sensitive to these changes, some of which may be caused by diverging mortality signals in the surveys compared to the catches. The Working Group recommends that a study-group be set up and meet by correspondence to address the issue of survey weighting before the next meeting of the Working Group.

The current practice to separate the IBTS 1-wr index from the 2–5+ wr index has been investigated. In the light of the discussion above and the assumption that the error within a survey are correlated the Working Group found that there is no acceptable a priori reasoning to separate this survey into two separate indices. This issue should, however, also be addressed by the aforementioned study-group.

2.13 Management considerations

The current assessment shows that the spawning stock biomass increased between 1998 and 1999 by around 200,000 t to a level of 905 600 t. However, the estimate of SSB in 1998 has been reduced by 177,000 t in the current assessment. The present value for SSB in 1999 is 264 000 t below the value predicted for 1999 last year. The expected SSB in 2000 is now 908 000 tonnes, and the probability that the stock will actually be below B_{pa} = 800 000 tonnes is approximately 33%. The reason for this reduction in the estimates, is mainly because recent observations indicate that the 1996 year class is smaller than previous estimates. In addition, the weights at age in the stock are lower than in previous years.

The 1997 year class which will start to contribute to the spawning stock as 2-ringers in 2000, is estimated to be low. The survey results indicate consistently that the 1998 year class is large, however, since this year class has not yet fully entered the fishery, the estimate of its abundance is still quite uncertain. If this year class is as large as it presently is estimated, it will give a rapid rise in SSB from 2001 onwards.

The adopted management regimes for protecting the juveniles (w.ring 0 and 1) have kept the Fs well below the ACFM advice of $F_{0\text{–}1} < 0.1$. On the other hand the estimated level of F on the adult stock (w.ring 2–6) have consistently been in the order of 0.4, while the ACFM advise has been 0.2. This is due both to reduced stock estimates and higher catches than the TAC's.

The reason for the consistent overestimates of the stock, which is a common problem with many stocks, (van Beek and Pastoors, 1999) is not fully understood. Given this, and the uncertainties about the incoming year classes, the agreed Fs on juveniles and adults of 0.12 and 0.25 respectively (EU-Norway agreement) should not be implemented until the spawning stock clearly has exceeded 1.3 mill t. The medium term predictions (see Section 2.11) indicate that the present rebuilding regime would be satisfactory, if the TAC on adults were not overfished. Because the overfishing of adults is counteracted by far lower catches of juveniles than corresponding to the bycatch TAC's. the medium term effect of current practise is still better, but only marginally, than the regime agreed for the situation where SSB is above B_{pa} = 1.3 million tonnes.

The Working Group continues to be aware of the important misreporting of catches in several parts of the North Sea and adjacent areas and has included allowance for this within the short term projections. Catches taken in the period 1984 to 1999 in Division IV and reported in areas VIa North, IIa and IIIa, were included in the catch-in-numbers used for the assessment of this stock. However, there is not much evidence for the extent of this misreporting and the catch reallocation is carried out with limited confidence.

The level of discards and slippage is largely unknown. However, several discard sampling programs have recently been started to address this issue.

The situation for the stock in the southern North Sea and the eastern English Channel ('Downs herring') is uncertain because limited information is available. The biological basis for a separate management for this area is weak, and the practicality of a separate assessment is questionable. Since the herring in this area is assessed as part of the North Sea stock, the need for a separate management may be questioned.

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1988–1999. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes

.

Country	1988	1989	1990	1991	1992	1993
Belgium	4	434	180	163	242	56
Denmark	263,006	210,315[2]	159,280	194,358	193,968	164,817
Faroe Islands	810	1,916	633	334	-	-
France	8,384	29,085	23,480	24,625	16,587	12,627
Germany, Fed.Rep.	13,824	38,707	43,191	41,791	42,665	41,669
Netherlands	82,267	84,178	69,828	75,135	75,683	79,190
Norway[4]	222,719	221,891[2]	157,85[2]	124,991	116,863	122,815
Sweden	1,819	4,774	3,754	5,866	4,939	5,782
UK (England)	8,097	7,980	8,333	11,548	11,314	-
UK (Scotland)	64,108	68,106	56,812	57,572	56,171	19,853
UK (N.Ireland)	-	-	-	92	-	55,531
Unallocated landings	33,411	26,749[2]	21,081	24,435	25,867	18,410
Misreporting from VIa North	11,763	19,013	25,266	22,079	22,594	24,397
Total landings	710,212	713,148[2]	569,688	582,969	566,892	544,917
Discards	-[3]	4,000	8,660	4,617	4,950	3,470
Total catch	**710,212**	**771,148**	**578,348**	**587,606**	**571,842**	**548,417**
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type (WBSS)	23,306	19,869	8,357	7,894	7,854	8,928
Thames estuary [5]	250	2,283	1,136	252[5]	202	201

Country	1994	1995	1996	1997	1998	1999[1]
Belgium	144	12	-	-	1	2
Denmark[2]	121,559	153,361	67,496	38,431	58,924	61,268
Faroe Islands[2]	-	-	-	-	25	1,977
France[2]	27,941	29,504	12,500	14,524	20,783	26,962
Germany	38,394	43,798	14,215	13,381	22,259	26,764
Netherlands	76,155	78,491	35,276	35,129	50,654	54,318
Norway[4]	125,522	131,026	43,739	38,745	68,523	70,718
Sweden	5,425	5,017	3,090	2,253	3,221	3,241
Russia	-	-	-	1,619	-	-
UK (England)	14,216	14,676	6,881	3,421	7,635	10,598
UK (Scotland)	49,919	44,802	17,473	22,914	32,403	29,911
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	5,749	33,594	24,475	27,583	27,722	21,653
Misreporting from VIa North	30,234	32,146	38,254	29,763[6]	32,446	23,625
Total landings	495,258	566,427	263,399	227,763	324,596	331,036
Discards	2,510	-	1,469	6,005	3,918	4,769
Total catch	**497,768**	**566,427**	**264,868**	**233,769[6]**	**328,514**	**335,805**
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type (WBSS)	13,228	10,315	855	979	7,833	4,732
Thames estuary [5]	215	203	168	202	88	88

[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, included in the North Sea catch figure for UK (England).
[6]Altered in 2000 on the basis of a Bayesian assessment on misreporting into VIa (North) (see Sec.5.1.3)

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	1990	1991	1992	1993	1994
Denmark	9,037	5,980	10,751	10,604	20,017
Faroe Islands	633	334	-	-	-
France	2,581	3,393	4,714[4]	3,362	11,658
Germany	20,422	20,608	21,836	17,342[4]	18,364
Netherlands	29,729	29,563	29,845	28,616	16,944
Norway	24,239	37,674	39,244	33,442	56,422
Sweden	-	1,130	985	1,372	2,159
UK (N. Ireland)	-	92	-	-	-
UK (England)	3,337	4,873	4,916	4,742	3,862
UK (Scotland)	46,431	42,745	39,269	36,628[4]	44,687
Unallocated landings	4,621	5,492	4,855	-8,271[5]	2,944
Misreporting from VIa North	25,266	22,079	22,593	24,397	30,234
Total Landings	166,296	173,963	179,008	152,234	207,561
Discards	750	883	850	825	550
Total catch	**167,046**	**174,846**	**179,858**	**153,059**	**208,111**

Country	1995	1996	1997	1998	1999
Denmark	17,748	3,237	2,667	4,634	15,359
Faroe Islands	-	-	-	25	1,977
France	10,427	3,177	361	4,757	6,369
Germany	17,095	2,167	-	7,752	11,206
Netherlands	24,696	2,978	6,904	11,851	17,038
Norway	56,124	22,187	16,485	27,218	30,585
Sweden	1,007	2,398	1,617	245	859
Russia	-	-	1,619	-	-
UK (N. Ireland)	-	-	-	-	-
UK (England)	3,091	2,391	-	4,306	7,163
UK (Scotland)	40,159	12,762	17,120	30,552	28,537
Unallocated landings	26,018	9,959	7,574	15,952	3,889
Misreporting from VIa North	32,146	38,254	29,763[6]	32,446	23,625
Total Landings	228,511	99,510	84,110	139,738	146,606
Discards	-	356	1,138	730	654
Total catch	**228,511**	**99,866**	**85,248[6]**	**140,468**	**147,260**

[1]Included in Division IVb.
[2]Any discards prior to 1990 were included in unallocated.
[3]Preliminary.
[4]Including IVa East.
[5]Negative unallocated catches due to misreporting from other areas.
[6]Altered in 2000 on the basis of a Bayesian assessment on misreporting into VIa (North) (see Sec.5.1.3)

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

Country	**1995**	**1996**	**1997**	**1998**	**1999**
Denmark	45,257	19,166	22,882	25,750	18,259
Faroe Islands	-	-	-		-
France	+	-	3		115
Netherlands	-	-	-		1,965
Norway[1]	62,224	18,256	18,490	41,260	37,433
Sweden	2,081	693	427	1,259	772
UK (Scotland)	-	-	-		-
Germany	-	-	4,576		-
Unallocated landings	-	-	-		-1,965[4]
Total landings	109,562	38,115	46,378	68,269	56,579
Discards[2]	-	-	-	-	-
Total catch	**109,562**	**38,115**	**46,378**	**68,269**	**56,579**

[1]Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
[2]Any discards prior to 1990 would have been included in unallocated.
[3]Included in IVa West.
[4]Negative unallocated catches due to misreporting from other areas.

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	**1990**	**1991**	**1992**	**1993**	**1994**
Denmark	105,614	138,555	125,229	109,994	55,060
Belgium	-	3	13	-	-
France	10,289	4,120	2,313	2,086	5,492
Faroe Islands	-	-	-	-	-
Germany	17,165	20,479	20,005	23,628	14,796
Netherlands	28,402	26,266	26,987	31,370	39,052
Norway	12,207	9,852	16,240	33,158	28,442
Sweden	1,276	4,622	3,446	3,699	2,256
UK (England)	3,200	2,715	3,026	3,804	7,337
UK (Scotland)	10,381	14,587	16,707	18,904	5,101
Unallocated landings[3]	-15,616	3,180	-13,637	-16,415	-26,988
Total landings	172,914	224,376	200,329	210,228	130,548
Discards[1]	2,560	1,072	1,900	245	460-
Total catch	**175,474**	**225,448**	**202,229**	**210,473**	**131,008**

Country	1995	1996[6]	1997	1998	1999
Denmark	87,917	43,749	11,636	26,667	26,211
Belgium	-	-	-		1
France	7,639	2,373	6,069	8,944	7,634
Faroe Islands	-	-	-		-
Germany	21,707	11,052	7,456	13,591	13,529
Netherlands	30,065	18,474	14,697	27,408	22,825
Norway	12,678	3,296	3,770	45	2,700
Sweden	1,929	-	209	1,717	1,610
UK (England)	9,688	2,757	2,033	1,767	1,641
UK (Scotland)	4,654	4,449	5,461	1,851	1,374
Unallocated landings[3]	10,831	-8,826	-1,615	-11,270	-313
Total landings	165,355	77,324	49,716	70,720	77,212
Discards[1]	-	592	1,855	1,188	873
Total catch	**165,455**	**77,916**	**51,571**	**71,908**	**78,085**

[1]Any discards prior to 1990 were included in unallocated.
[2]Includes catch in Division IVa.
[3]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	**1990**	**1991**	**1992**	**1993**	**1994**
Belgium	180	163	229	56	144
Denmark	265	948	4,296	995	2,695
France	9,718	17,112	9,560	7,171	10,777
Germany	-	704	824	649	4,964
Netherlands	11,697	19,306	18,851	19,204	20,159
UK (England)	1,796	3,960	3,372	11,307	3,016
UK (Scotland)	-	67	-	-	131
Unallocated landings	32,076	15,763	34,649	43,096	29,792
Total landings	55,732	58,023	71,781	82,478	71,678
Discards[1]	5,350	2,662	2,200	2,400	2,400
Total catch	**61,082**	**60,685**	**73,981**	**84,878**	**74,078**
Coastal spring spawners included above[2]	1,136	252	202	201	215

Country	**1995**	**1996**	**1997**	**1998**	**1999**
Belgium	12	-	1	1	1
Denmark	2,441	1,344	1,246	1,873	1,439
France	11,433	6,950	8,091	7,081	12,844
Germany	4,996	997	1,349	916	2,029
Netherlands	23,730	13,824	13,528	11,395	12,490
UK (England)	1,896	1,733	1,388	1,562	1,794
UK (Scotland)	-	262	333		-
Unallocated landings	18,397	23,934	21,624	23,040	20,042
Total landings	62,905	49,044	47,559	45,868	50,639
Discards[1]	-	521	3,012	2,000	3,242
Total catch	**62,905**	**49,565**	**50,571**	**47,868**	**53,881**
Coastal spring spawners included above[2]	203	168	143	88	88

[1]Any discards prior to 1990 would have been included in unallocated.
[2]Landings from the Thames estuary area, included in the North Sea catch figure for UK (England).

Table 2.1.6: Herring in Sub-area IV, Division VIId and Division IIIa.

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
TAC (IV and VIId)	Sub-Area IV and Division VIId											
Recommended Divisions IVa, b[1]	484	373/ 332	363[6]	352	290[7]	296[7]	389[11]	156	159	254	265	265
Recommended Divisions IVc, VIId	30	30	50-60[6]	54	50	50	50	-[14]	-[14]	-[14]	-[14]	-[14]
Expected catch of spring spawners				10	8							
Agreed Divisions IVa,b[2]	484	385	370[6]	380	380	390	390	263/ 131[13]	134	229	240	240
Agreed Div. IVc, VIId	30	30	50[6]	50	50	50	50	50/ 25[13]	25	25	25	25
CATCH (IV and VIId)												
National landings Divisions IVa,b[3]	639	499	495	481	463	421	456	176	144	241	255	
Unallocated landings Divisions IVa,b	-21	-11	8	-9	-25	-24	15	39	36[16]	37	25	
Discard/slipping Divisions IVa,b[4]	3	4	2	3	1	1	0	1	3	2	2	
Total catch Divisions IVa,b[5]	621	492	505	475	439	394	471	216	183[16]	281	282	
National landings Divisions IVc, VIId[3]	30	24	42	37	40	42	45	25	26	23	31	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	18	24	22	23	20	
Discard/slipping Divisions IVc, VIId	1	5	3	2	2	2	-	1	3	2	3	
Total catch Divisions IVc, VIId	79	61	61	74	85	74	63	50	51	48	54	
Total catch IV and VIId as used by ACFM[5]	700	553	566	549	524	468	534	265	234[16]	329	336	
CATCH BY FLEET/STOCK (IV and VIId)[10]												
North Sea autumn spawners directed fisheries (Fleet A)	Not available		443	441	438	439	506	226	220[16]	306	316	
North Sea autumn spawners industrial (Fleet B)	Not available		134	124	101	38	65	38	13	14	15	
North Sea autumn spawners total (Fleets A+B)	749	569	580	564	539	485	556	265	233[16]	320	331	
Baltic-IIIa-type spring spawners	20	8	8	8	9	13	10	0.9	0.9	8	5	
Coastal-type spring spawners	2.3	1.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	
TAC (IIIa)	Division IIIa											
Predicted catch of autumn spawners				96	153	102	77	98	48	35	58	
Recommended spring spawners	84	67	91	90	93–113	-[9]	-[12]	-[12]	-[15]	-[15]	-[15]	
Recommended mixed clupeoids	80	60	0	0	0	-	-	-	-	-	-	
Agreed herring TAC	138	120	104.5	124	165	148	140	120	80	80	80	
Agreed mixed clupeoid TAC	80	65	50	50	45	43	43	43	40	40	50	
CATCH (IIIa)												
National landings	192	202	188	227	214	168	157	115	83	120[16]	86	
Catch as used by ACFM	162	195	191	227	214	168	157	115	83	120[16]	86	
CATCH BY FLEET/STOCK (IIIa)[10]												
Autumn spawners human consumption (Fleet C)	Not available		26	47	44	42	21	23	34		20	
Autumn spawners mixed clupeoid (Fleet D)	Not available		13	23	25	12	6	12	4			
Autumn spawners other industrial landings (Fleet E)	Not available		38	82	63	32	43	7	2		21	
Autumn spawners total	91	77[8]	77	152	132	86	70	42	40	65	41	
Spring spawners human consumption (Fleet C)	Not available		68	53	68	59	59	69	34	43	30	
Spring spawners mixed clupeoid (Fleet D)	Not available		5	2	1	1	2	1	1			
Spring spawners other industrial landings (Fleet E)	Not available		40	20	12	24	29	3	1	3	15	
Spring spawners total	71	118	113	75	81	84	90	73	37	46	35	
North Sea autumn spawners Total as used by ACFM	840	646	657	716	671	571	626	307	273[16]	385	372	

[1]Includes catches in directed fishery and catches of 1-ringers in small mesh fishery up to 1992. [2]IVa,b and EC zone of IIa. [3]Provided by Working Group members. [4]One country only. [5]Includes spring spawners not included in assessment. [6]Revised during 1991. [7]Based on F=0.3 in directed fishery only; TAC advised for IVc, VIId subtracted. [8]Estimated. [9]130-180 for spring spawners in all areas. [10] Based on sum-of-products (number x mean weight at age). [11]*Status quo* F catch for fleet a. [12]The catch should not exceed recent catch levels. [13] During the middle of 1996 revised to 50% of its original agreed TAC. [14] Included in IVa,b. [15] Managed in accordance with autumn spawners. Weights in '000t. [16] Figure altered in 2000.

Table 2.2.1: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 1999. Catch in numbers (millions) at age (CANUM), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBBS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	954.5	0.0	0.0	0.0	0.0	935.2	34.0	0.0	935.2	34.0	1923.6	969.2
1	243.2	2.9	0.0	2.9	13.6	59.6	4.8	0.1	76.1	4.9	324.1	81.0
2	146.5	93.1	3.3	89.7	186.0	152.3	12.4	60.1	428.1	72.6	647.2	504.0
3	46.8	172.0	14.3	157.7	452.4	257.2	34.6	123.2	867.2	157.9	1071.9	1039.4
4	11.8	54.0	5.6	48.4	112.6	23.1	22.6	78.4	184.0	100.9	296.8	290.6
5	5.6	32.4	3.6	28.7	58.2	14.3	5.6	25.1	101.2	30.7	137.5	135.6
6	0.9	16.3	1.4	14.8	37.7	12.2	0.6	2.1	64.7	2.8	68.4	68.9
7	1.1	5.6	0.6	5.1	17.1	0.9	0.4	2.6	23.0	3.0	27.2	26.6
8	0.6	2.5	0.4	2.1	3.8	2.6	0.0	0.0	8.5	0.0	9.0	8.9
9+	0.0	0.5	0.1	0.4	2.9	0.0	0.0	0.0	3.3	0.0	3.3	3.4
Sum	1411.0	379.2	29.3	349.9	884.2	1457.3	115.1	291.6	2691.3	406.7	4509.0	3127.4
Quarter: 1												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	108.1	0.1	0.0	0.1	0.0	13.4	4.5	0.1	13.5	4.6	126.3	18.1
2	71.3	4.7	0.0	4.7	1.3	13.4	2.8	1.2	19.4	4.1	94.7	23.4
3	12.4	30.3	0.0	30.3	10.5	5.0	15.6	6.9	45.8	22.5	80.7	68.3
4	1.3	14.3	0.0	14.3	10.7	2.5	10.5	4.6	27.5	15.1	43.9	42.6
5	1.2	6.8	0.0	6.8	7.1	1.1	1.7	0.7	15.0	2.4	18.5	17.3
6	0.2	4.4	0.0	4.4	4.9	0.8	0.3	0.1	10.1	0.4	10.7	10.6
7	0.1	1.3	0.0	1.3	2.2	0.2	0.0	0.0	3.7	0.0	3.8	3.7
8	0.1	0.1	0.0	0.1	0.4	0.0	0.0	0.0	0.5	0.0	0.6	0.5
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	194.6	62.0	0.0	62.0	37.0	36.4	35.5	13.7	135.4	49.2	379.2	184.6
Quarter: 2												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.9	0.9	0.9
1	43.7	1.8	0.0	1.8	9.0	36.3	0.2	0.0	47.1	0.2	91.0	47.4
2	20.7	50.1	1.2	48.9	51.5	45.9	0.0	0.2	146.3	0.3	167.2	147.8
3	13.5	50.9	5.6	45.3	38.4	25.6	0.2	1.3	109.3	1.5	124.3	116.4
4	1.6	17.7	2.9	14.8	11.0	8.2	0.2	0.9	33.9	1.0	36.5	37.9
5	0.5	10.5	1.7	8.7	3.4	2.0	0.0	0.1	14.2	0.2	14.8	16.1
6	0.1	4.1	0.7	3.4	1.9	0.2	0.0	0.0	5.5	0.0	5.7	6.2
7	0.1	1.5	0.3	1.3	1.0	0.2	0.0	0.0	2.5	0.0	2.5	2.7
8	0.1	1.1	0.2	0.9	0.0	0.0	0.0	0.0	0.9	0.0	1.0	1.1
9+	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0	0.4	0.0	0.4	0.4
Sum	80.2	137.9	12.7	125.3	116.4	118.5	1.6	2.6	360.1	4.1	444.4	376.9
Quarter: 3												
0	590.9	0.0	0.0	0.0	0.0	833.8	0.6	0.0	833.8	0.6	1425.3	834.4
1	70.4	0.2	0.0	0.2	0.7	3.7	0.0	0.0	4.6	0.0	75.0	4.6
2	50.3	24.6	2.1	22.5	89.8	72.0	0.3	0.2	184.3	0.5	235.1	186.9
3	15.0	41.6	8.7	32.9	295.2	157.4	0.6	0.4	485.6	1.0	501.5	495.3
4	4.6	14.1	2.7	11.5	79.9	7.1	0.4	0.3	98.5	0.6	103.8	101.8
5	1.6	10.0	1.9	8.1	41.1	9.2	0.1	0.1	58.3	0.2	60.2	60.4
6	0.6	4.1	0.8	3.3	26.3	9.6	0.0	0.0	39.2	0.0	39.8	40.0
7	0.3	1.6	0.3	1.3	11.3	0.4	0.0	0.0	13.0	0.0	13.4	13.4
8	0.2	1.1	0.2	0.9	2.9	2.4	0.0	0.0	6.2	0.0	6.4	6.4
9+	0.0	0.2	0.0	0.2	2.7	0.0	0.0	0.0	2.9	0.0	2.9	2.9
Sum	734.0	97.7	16.7	81.0	549.8	1095.5	2.0	1.0	1726.4	3.0	2463.3	1746.1
Quarter: 4												
0	363.6	0.0	0.0	0.0	0.0	101.4	32.5	0.0	101.4	32.5	497.5	133.9
1	20.9	0.8	0.0	0.8	3.9	6.1	0.0	0.0	10.9	0.0	31.8	10.9
2	4.3	13.6	0.0	13.6	43.5	21.0	9.3	58.4	78.2	67.7	150.1	145.9
3	6.0	49.2	0.0	49.2	108.2	69.1	18.2	114.6	226.5	132.8	365.4	359.4
4	4.3	7.8	0.0	7.8	11.0	5.3	11.5	72.6	24.2	84.2	112.6	108.3
5	2.2	5.1	0.0	5.1	6.6	2.0	3.8	24.1	13.7	28.0	44.0	41.7
6	0.1	3.8	0.0	3.8	4.6	1.5	0.3	2.0	9.8	2.3	12.1	12.1
7	0.6	1.2	0.0	1.2	2.5	0.1	0.4	2.6	3.8	3.0	7.4	6.8
8	0.2	0.2	0.0	0.2	0.5	0.2	0.0	0.0	0.9	0.0	1.1	0.9
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	402.2	81.7	0.0	81.7	180.9	206.8	76.1	274.3	469.4	350.4	1222.0	819.8

Table 2.2.2: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 1999. Mean weight at age (kg) in the catch (WECA), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Total IV & IIIa all	Herring caught in the North Sea
Quarters: 1-4											
0	**0.010**	**0.000**	**0.000**	**0.000**	**0.008**	**0.010**	**0.000**	**0.008**	**0.010**	**0.009**	**0.009**
1	**0.044**	**0.080**	**0.000**	**0.081**	**0.044**	**0.038**	**0.039**	**0.052**	**0.038**	**0.046**	**0.051**
2	**0.085**	**0.124**	**0.128**	**0.126**	**0.120**	**0.103**	**0.115**	**0.123**	**0.113**	**0.114**	**0.122**
3	**0.114**	**0.143**	**0.148**	**0.161**	**0.152**	**0.122**	**0.148**	**0.155**	**0.142**	**0.151**	**0.153**
4	**0.142**	**0.162**	**0.166**	**0.189**	**0.154**	**0.136**	**0.161**	**0.177**	**0.155**	**0.168**	**0.169**
5	**0.164**	**0.191**	**0.194**	**0.224**	**0.214**	**0.174**	**0.192**	**0.213**	**0.188**	**0.205**	**0.207**
6	**0.189**	**0.207**	**0.218**	**0.247**	**0.227**	**0.185**	**0.216**	**0.233**	**0.209**	**0.232**	**0.233**
7	**0.206**	**0.225**	**0.226**	**0.256**	**0.205**	**0.214**	**0.214**	**0.247**	**0.214**	**0.241**	**0.243**
8	**0.205**	**0.233**	**0.236**	**0.266**	**0.286**	**0.000**	**0.000**	**0.262**	**-**	**0.258**	**0.262**
9+	**0.000**	**0.272**	**0.272**	**0.294**	**0.345**	**0.000**	**0.000**	**0.291**	**-**	**0.291**	**0.291**
Quarter: 1											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.028	0.079	0.000	0.081	0.017	0.038	0.039	0.017	0.038	**0.027**	**0.023**
2	0.074	0.126	0.000	0.121	0.051	0.059	0.059	0.074	0.059	**0.073**	**0.071**
3	0.100	0.117	0.000	0.122	0.112	0.086	0.086	0.118	0.086	**0.106**	**0.107**
4	0.104	0.142	0.000	0.146	0.139	0.103	0.103	0.143	0.103	**0.128**	**0.129**
5	0.157	0.178	0.000	0.174	0.176	0.127	0.127	0.176	0.127	**0.168**	**0.169**
6	0.159	0.185	0.000	0.185	0.173	0.150	0.150	0.184	0.150	**0.182**	**0.183**
7	0.099	0.201	0.000	0.189	0.197	0.000	0.000	0.194	-	**0.192**	**0.194**
8	0.170	0.227	0.000	0.188	0.000	0.000	0.000	0.197	-	**0.192**	**0.197**
9+	0.000	0.272	0.000	0.304	0.000	0.000	0.000	0.278	-	**0.278**	**0.278**
Quarter: 2											
0	0.000	0.000	0.000	0.000	0.000	0.010	0.000	-	0.010	**0.010**	**0.010**
1	0.047	0.078	0.000	0.077	0.050	0.038	0.039	0.056	0.038	**0.052**	**0.056**
2	0.084	0.125	0.125	0.115	0.096	0.059	0.059	0.113	0.059	**0.109**	**0.113**
3	0.105	0.144	0.144	0.146	0.121	0.086	0.086	0.139	0.086	**0.136**	**0.139**
4	0.116	0.159	0.159	0.166	0.130	0.103	0.103	0.155	0.103	**0.153**	**0.154**
5	0.145	0.191	0.191	0.216	0.163	0.127	0.127	0.193	0.127	**0.191**	**0.192**
6	0.144	0.216	0.216	0.263	0.173	0.150	0.150	0.229	0.150	**0.226**	**0.229**
7	0.148	0.227	0.227	0.274	0.164	0.000	0.000	0.240	-	**0.236**	**0.240**
8	0.187	0.228	0.228	0.297	0.277	0.000	0.000	0.230	-	**0.227**	**0.230**
9+	0.000	0.272	0.272	0.302	0.320	0.000	0.000	0.288	-	**0.287**	**0.288**
Quarter: 3											
0	0.009	0.000	0.000	0.000	0.008	0.010	0.000	0.008	0.010	**0.008**	**0.008**
1	0.062	0.076	0.000	0.084	0.053	0.000	0.000	0.058	-	**0.062**	**0.058**
2	0.101	0.129	0.129	0.137	0.144	0.116	0.116	0.139	0.116	**0.131**	**0.139**
3	0.129	0.151	0.151	0.169	0.160	0.152	0.152	0.165	0.152	**0.164**	**0.165**
4	0.151	0.174	0.174	0.200	0.176	0.165	0.165	0.195	0.165	**0.192**	**0.195**
5	0.179	0.197	0.197	0.238	0.232	0.194	0.194	0.230	0.194	**0.228**	**0.230**
6	0.209	0.219	0.219	0.263	0.233	0.221	0.221	0.251	0.221	**0.250**	**0.251**
7	0.226	0.225	0.225	0.269	0.217	0.214	0.214	0.263	0.214	**0.261**	**0.262**
8	0.219	0.243	0.243	0.286	0.286	0.000	0.000	0.279	-	**0.276**	**0.279**
9+	0.000	0.272	0.272	0.293	0.352	0.000	0.000	0.292	-	**0.292**	**0.292**
Quarter: 4											
0	0.012	0.000	0.000	0.000	0.012	0.010	0.000	0.012	0.010	**0.012**	**0.012**
1	0.057	0.085	0.000	0.091	0.065	0.000	0.000	0.076	-	**0.064**	**0.076**
2	0.095	0.112	0.000	0.118	0.130	0.116	0.116	0.120	0.116	**0.118**	**0.118**
3	0.126	0.150	0.000	0.147	0.146	0.152	0.152	0.147	0.152	**0.149**	**0.149**
4	0.153	0.181	0.000	0.174	0.168	0.165	0.165	0.175	0.165	**0.167**	**0.167**
5	0.161	0.198	0.000	0.195	0.204	0.194	0.194	0.198	0.194	**0.193**	**0.195**
6	0.178	0.209	0.000	0.216	0.226	0.221	0.221	0.215	0.221	**0.216**	**0.216**
7	0.214	0.250	0.000	0.249	0.250	0.214	0.214	0.249	0.214	**0.232**	**0.234**
8	0.216	0.205	0.000	0.205	0.284	0.000	0.000	0.224	-	**0.223**	**0.224**
9+	0.000	0.000	0.000	0.273	0.335	0.000	0.000	0.291	-	**0.291**	**0.291**

Table 2.2.3: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 1999. Mean length at age (cm) in the catch, by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Herring caught in the North Sea
Quarters: 1-4										
0	**n.d.**	**0.0**	**n.d.**	**0.0**	**10.9**	**11.5**	**0.0**	**10.9**	**11.5**	**10.9**
1	**n.d.**	**21.2**	**n.d.**	**21.2**	**17.4**	**15.6**	**18.3**	**18.2**	**15.7**	**18.1**
2	**n.d.**	**23.8**	**n.d.**	**24.3**	**23.6**	**22.8**	**23.5**	**23.9**	**23.4**	**23.8**
3	**n.d.**	**25.7**	**n.d.**	**26.3**	**26.0**	**24.2**	**25.1**	**26.1**	**24.9**	**25.9**
4	**n.d.**	**26.8**	**n.d.**	**27.7**	**26.7**	**25.3**	**25.9**	**27.3**	**25.8**	**26.8**
5	**n.d.**	**28.3**	**n.d.**	**29.3**	**28.9**	**27.1**	**27.4**	**28.9**	**27.3**	**28.6**
6	**n.d.**	**29.3**	**n.d.**	**30.3**	**29.3**	**28.0**	**28.3**	**29.9**	**28.2**	**29.8**
7	**n.d.**	**29.9**	**n.d.**	**30.8**	**30.0**	**28.4**	**28.4**	**30.6**	**28.4**	**30.3**
8	**n.d.**	**30.0**	**n.d.**	**31.1**	**29.4**	**0.0**	**0.0**	**30.3**	**-**	**30.3**
9+	**n.d.**	**32.0**	**n.d.**	**31.8**	**33.8**	**0.0**	**0.0**	**31.8**	**-**	**31.8**
Quarter: 1										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	21.0	n.d.	20.8	14.1	15.6	18.3	14.2	15.7	**14.5**
2	n.d.	23.6	n.d.	24.7	19.7	20.3	20.3	21.0	20.3	**20.9**
3	n.d.	25.3	n.d.	25.5	25.3	23.1	23.1	25.4	23.1	**24.6**
4	n.d.	26.9	n.d.	27.2	27.0	24.6	24.6	27.0	24.6	**26.2**
5	n.d.	28.9	n.d.	28.9	29.2	26.3	26.3	28.9	26.3	**28.6**
6	n.d.	29.5	n.d.	29.6	29.0	27.8	27.8	29.5	27.8	**29.4**
7	n.d.	30.3	n.d.	29.8	30.4	0.0	0.0	30.0	-	**30.0**
8	n.d.	29.8	n.d.	30.0	0.0	0.0	0.0	30.0	-	**30.0**
9+	n.d.	32.0	n.d.	31.2	0.0	0.0	0.0	31.8	-	**31.8**
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	11.5	0.0	-	11.5	**11.5**
1	n.d.	20.7	n.d.	20.4	17.9	15.5	18.3	18.5	15.7	**18.5**
2	n.d.	23.5	n.d.	22.9	21.7	20.3	20.3	22.7	20.3	**22.7**
3	n.d.	24.9	n.d.	24.8	23.6	23.1	23.1	24.6	23.1	**24.6**
4	n.d.	25.8	n.d.	25.9	24.9	24.6	24.6	25.6	24.6	**25.6**
5	n.d.	27.4	n.d.	28.5	26.4	26.3	26.3	27.5	26.3	**27.5**
6	n.d.	28.7	n.d.	30.1	28.6	27.8	27.8	29.1	27.8	**29.1**
7	n.d.	29.2	n.d.	30.8	28.0	0.0	0.0	29.7	-	**29.7**
8	n.d.	29.8	n.d.	31.9	32.3	0.0	0.0	29.9	-	**29.9**
9+	n.d.	32.0	n.d.	31.2	33.8	0.0	0.0	31.6	-	**31.6**
Quarter: 3										
0	n.d.	0.0	n.d.	0.0	10.7	11.5	0.0	10.7	11.5	**10.7**
1	n.d.	20.6	n.d.	21.6	19.1	0.0	0.0	19.5	-	**19.5**
2	n.d.	23.9	n.d.	24.7	25.0	23.6	23.6	24.7	23.6	**24.7**
3	n.d.	25.8	n.d.	26.4	26.2	25.2	25.2	26.3	25.2	**26.3**
4	n.d.	27.0	n.d.	27.9	27.8	26.0	26.0	27.8	26.0	**27.8**
5	n.d.	28.1	n.d.	29.6	29.4	27.4	27.4	29.3	27.4	**29.3**
6	n.d.	29.0	n.d.	30.5	29.3	28.3	28.3	30.1	28.3	**30.1**
7	n.d.	29.5	n.d.	31.0	30.5	28.4	28.4	30.8	28.4	**30.8**
8	n.d.	30.3	n.d.	31.6	29.4	0.0	0.0	30.5	-	**30.5**
9+	n.d.	32.0	n.d.	31.8	33.8	0.0	0.0	31.9	-	**31.9**
Quarter: 4										
0	n.d.	0.0	n.d.	0.0	12.7	11.5	0.0	12.7	11.5	**12.4**
1	n.d.	22.4	n.d.	22.7	20.4	0.0	0.0	21.4	-	**21.4**
2	n.d.	24.6	n.d.	24.8	25.2	23.6	23.6	24.9	23.6	**24.3**
3	n.d.	26.7	n.d.	26.4	26.4	25.2	25.2	26.5	25.2	**26.0**
4	n.d.	28.3	n.d.	27.8	27.8	26.0	26.0	28.0	26.0	**26.4**
5	n.d.	29.4	n.d.	28.9	29.0	27.4	27.4	29.1	27.4	**27.9**
6	n.d.	30.1	n.d.	30.2	29.7	28.3	28.3	30.1	28.3	**29.7**
7	n.d.	31.1	n.d.	31.0	31.3	28.4	28.4	31.0	28.4	**29.9**
8	n.d.	29.3	n.d.	29.3	29.3	0.0	0.0	29.3	-	**29.3**
9+	n.d.	0.0	n.d.	31.6	33.8	0.0	0.0	32.2	-	**32.2**

Table 2.2.4: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caugh in the North Sea 1999. Catches (tonnes) at age (SOP figures), by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	9.6	0.0	0.0	0.0	0.0	7.9	0.3	0.0	7.9	0.3	17.8	8.2
1	10.7	0.2	0.0	0.2	1.1	2.6	0.2	0.0	4.0	0.2	14.8	4.2
2	12.5	11.5	0.4	11.1	23.5	18.2	1.3	6.9	52.8	8.2	73.5	61.8
3	5.3	24.5	2.1	22.4	72.7	39.0	4.2	18.2	134.1	22.4	161.9	160.8
4	1.7	8.7	0.9	7.8	21.3	3.6	3.1	12.6	32.7	15.7	50.0	50.2
5	0.9	6.2	0.7	5.5	13.0	3.1	1.0	4.8	21.6	5.8	28.3	28.8
6	0.2	3.4	0.3	3.1	9.3	2.8	0.1	0.5	15.1	0.6	15.9	16.3
7	0.2	1.3	0.1	1.1	4.4	0.2	0.1	0.5	5.7	0.6	6.6	6.6
8	0.1	0.6	0.1	0.5	1.0	0.7	0.0	0.0	2.2	0.0	2.3	2.4
9+	0.0	0.1	0.0	0.1	0.9	0.0	0.0	0.0	1.0	0.0	1.0	1.0
Sum	41.2	56.6	4.7	51.9	147.2	78.0	10.3	43.5	277.0	53.8	372.0	340.3
Quarter: 1												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	3.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.2	3.4	0.4
2	5.3	0.6	0.0	0.6	0.2	0.7	0.2	0.1	1.4	0.2	6.9	1.7
3	1.2	3.6	0.0	3.6	1.3	0.6	1.3	0.6	5.4	1.9	8.6	7.3
4	0.1	2.0	0.0	2.0	1.6	0.3	1.1	0.5	3.9	1.6	5.6	5.5
5	0.2	1.2	0.0	1.2	1.2	0.2	0.2	0.1	2.6	0.3	3.1	2.9
6	0.0	0.8	0.0	0.8	0.9	0.1	0.0	0.0	1.9	0.1	2.0	1.9
7	0.0	0.3	0.0	0.3	0.4	0.0	0.0	0.0	0.7	0.0	0.7	0.7
8	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	9.9	8.5	0.0	8.5	5.6	2.2	3.0	1.3	16.3	4.3	30.5	20.6
Quarter: 2												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	2.1	0.1	0.0	0.1	0.7	1.8	0.0	0.0	2.7	0.0	4.7	2.7
2	1.7	6.3	0.2	6.1	5.9	4.4	0.0	0.0	16.5	0.0	18.2	16.8
3	1.4	7.3	0.8	6.5	5.6	3.1	0.0	0.1	15.2	0.1	16.8	17.0
4	0.2	2.8	0.5	2.4	1.8	1.1	0.0	0.1	5.2	0.1	5.5	6.3
5	0.1	2.0	0.3	1.7	0.7	0.3	0.0	0.0	2.7	0.0	2.8	3.4
6	0.0	0.9	0.1	0.7	0.5	0.0	0.0	0.0	1.3	0.0	1.3	1.6
7	0.0	0.4	0.1	0.3	0.3	0.0	0.0	0.0	0.6	0.0	0.6	0.7
8	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.3
9+	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Sum	5.5	20.1	2.0	18.1	15.6	10.8	0.1	0.2	44.5	0.3	50.3	48.8
Quarter: 3												
0	5.3	0.0	0.0	0.0	0.0	6.7	0.0	0.0	6.7	0.0	12.0	6.7
1	4.4	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.3	0.0	4.6	0.3
2	5.1	3.2	0.3	2.9	12.3	10.4	0.0	0.0	25.5	0.1	30.7	26.1
3	1.9	6.3	1.3	5.0	50.0	25.2	0.1	0.1	80.2	0.2	82.3	83.0
4	0.7	2.5	0.5	2.0	16.0	1.3	0.1	0.0	19.2	0.1	20.1	20.3
5	0.3	2.0	0.4	1.6	9.8	2.1	0.0	0.0	13.5	0.0	13.8	14.3
6	0.1	0.9	0.2	0.7	6.9	2.2	0.0	0.0	9.9	0.0	10.0	10.2
7	0.1	0.4	0.1	0.3	3.1	0.1	0.0	0.0	3.4	0.0	3.5	3.6
8	0.0	0.3	0.1	0.2	0.8	0.7	0.0	0.0	1.7	0.0	1.8	1.8
9+	0.0	0.1	0.0	0.1	0.8	0.0	0.0	0.0	0.8	0.0	0.8	0.9
Sum	17.9	15.5	2.7	12.8	99.7	48.9	0.2	0.2	161.3	0.4	179.6	167.1
Quarter: 4												
0	4.4	0.0	0.0	0.0	0.0	1.2	0.3	0.0	1.2	0.3	5.9	1.5
1	1.2	0.1	0.0	0.1	0.4	0.4	0.0	0.0	0.8	0.0	2.0	0.8
2	0.4	1.5	0.0	1.5	5.1	2.7	1.1	6.8	9.4	7.9	17.6	17.2
3	0.8	7.4	0.0	7.4	15.9	10.1	2.8	17.4	33.3	20.2	54.3	53.5
4	0.7	1.4	0.0	1.4	1.9	0.9	1.9	12.0	4.2	13.9	18.8	18.1
5	0.4	1.0	0.0	1.0	1.3	0.4	0.7	4.7	2.7	5.4	8.5	8.1
6	0.0	0.8	0.0	0.8	1.0	0.3	0.1	0.4	2.1	0.5	2.6	2.6
7	0.1	0.3	0.0	0.3	0.6	0.0	0.1	0.5	1.0	0.6	1.7	1.6
8	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.2	0.2
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	7.9	12.5	0.0	12.5	26.3	16.1	7.0	41.8	55.0	48.8	111.7	103.8

Table 2.2.5: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 1999. Percentage age composition (based on numbers, 3+ group summarised), by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	**67.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**64.2%**	**29.5%**	**0.0%**	**34.7%**	**8.4%**	**42.7%**	**31.0%**
1	**17.2%**	**0.8%**	**0.0%**	**0.8%**	**1.5%**	**4.1%**	**4.1%**	**0.0%**	**2.8%**	**1.2%**	**7.2%**	**2.6%**
2	**10.4%**	**24.5%**	**11.3%**	**25.6%**	**21.0%**	**10.5%**	**10.8%**	**20.6%**	**15.9%**	**17.8%**	**14.4%**	**16.1%**
3	**3.3%**	**45.4%**	**48.8%**	**45.1%**	**51.2%**	**17.6%**	**30.1%**	**42.3%**	**32.2%**	**38.8%**	**23.8%**	**33.2%**
4	**0.8%**	**14.2%**	**19.1%**	**13.8%**	**12.7%**	**1.6%**	**19.6%**	**26.9%**	**6.8%**	**24.8%**	**6.6%**	**9.3%**
5	**0.4%**	**8.5%**	**12.4%**	**8.2%**	**6.6%**	**1.0%**	**4.9%**	**8.6%**	**3.8%**	**7.6%**	**3.0%**	**4.3%**
6	**0.1%**	**4.3%**	**4.9%**	**4.2%**	**4.3%**	**0.8%**	**0.6%**	**0.7%**	**2.4%**	**0.7%**	**1.5%**	**2.2%**
7	**0.1%**	**1.5%**	**1.9%**	**1.4%**	**1.9%**	**0.1%**	**0.4%**	**0.9%**	**0.9%**	**0.7%**	**0.6%**	**0.9%**
8	**0.0%**	**0.7%**	**1.3%**	**0.6%**	**0.4%**	**0.2%**	**0.0%**	**0.0%**	**0.3%**	**0.0%**	**0.2%**	**0.3%**
9+	**0.0%**	**0.1%**	**0.3%**	**0.1%**	**0.3%**	**0.0%**	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.1%**	**0.1%**
Sum 3+	**4.7%**	**74.7%**	**88.7%**	**73.5%**	**77.4%**	**21.3%**	**55.5%**	**79.3%**	**46.5%**	**72.6%**	**35.8%**	**50.3%**
Quarter: 1												
0	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
1	55.6%	0.2%	-	0.2%	0.0%	36.8%	12.8%	0.6%	10.0%	9.4%	**33.3%**	**9.8%**
2	36.6%	7.6%	-	7.6%	3.4%	36.8%	7.9%	9.1%	14.3%	8.3%	**25.0%**	**12.7%**
3	6.3%	48.9%	-	48.9%	28.3%	13.8%	44.0%	50.5%	33.8%	45.8%	**21.3%**	**37.0%**
4	0.7%	23.1%	-	23.1%	28.8%	6.8%	29.6%	33.7%	20.3%	30.7%	**11.6%**	**23.1%**
5	0.6%	11.0%	-	11.0%	19.1%	3.0%	4.7%	5.2%	11.0%	4.8%	**4.9%**	**9.4%**
6	0.1%	7.0%	-	7.0%	13.4%	2.2%	0.9%	0.9%	7.5%	0.9%	**2.8%**	**5.7%**
7	0.0%	2.1%	-	2.1%	6.0%	0.6%	0.0%	0.0%	2.7%	0.0%	**1.0%**	**2.0%**
8	0.1%	0.2%	-	0.2%	1.0%	0.0%	0.0%	0.0%	0.4%	0.0%	**0.2%**	**0.3%**
9+	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
Sum 3+	**7.8%**	**92.3%**	-	**92.3%**	**96.6%**	**26.4%**	**79.2%**	**90.3%**	**75.7%**	**82.3%**	**41.7%**	**77.5%**
Quarter: 2												
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.7%	0.0%	0.0%	21.3%	**0.2%**	**0.2%**
1	54.4%	1.3%	0.0%	1.4%	7.7%	30.7%	14.4%	0.6%	13.1%	5.9%	**20.5%**	**12.6%**
2	25.8%	36.4%	9.8%	39.0%	44.2%	38.8%	2.7%	9.1%	40.6%	6.7%	**37.6%**	**39.2%**
3	16.8%	36.9%	44.2%	36.1%	33.0%	21.6%	15.2%	50.5%	30.4%	37.0%	**28.0%**	**30.9%**
4	2.0%	12.9%	23.3%	11.8%	9.4%	6.9%	10.1%	33.7%	9.4%	24.6%	**8.2%**	**10.1%**
5	0.6%	7.6%	13.7%	7.0%	2.9%	1.7%	1.6%	5.2%	3.9%	3.8%	**3.3%**	**4.3%**
6	0.1%	2.9%	5.3%	2.7%	1.6%	0.2%	0.3%	0.9%	1.5%	0.6%	**1.3%**	**1.6%**
7	0.1%	1.1%	2.0%	1.0%	0.9%	0.2%	0.0%	0.0%	0.7%	0.0%	**0.6%**	**0.7%**
8	0.1%	0.8%	1.4%	0.7%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	**0.2%**	**0.3%**
9+	0.0%	0.1%	0.3%	0.1%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.1%**	**0.1%**
Sum 3+	**19.8%**	**62.3%**	**90.2%**	**59.5%**	**48.1%**	**30.6%**	**27.1%**	**90.3%**	**46.3%**	**66.1%**	**41.7%**	**48.0%**
Quarter: 3												
0	80.5%	0.0%	0.0%	0.0%	0.0%	76.1%	31.6%	0.0%	48.3%	20.8%	**57.9%**	**47.8%**
1	9.6%	0.2%	0.0%	0.3%	0.1%	0.3%	0.0%	0.0%	0.3%	0.0%	**3.0%**	**0.3%**
2	6.8%	25.2%	12.5%	27.8%	16.3%	6.6%	14.6%	21.3%	10.7%	16.9%	**9.5%**	**10.7%**
3	2.0%	42.6%	52.3%	40.6%	53.7%	14.4%	28.6%	41.8%	28.1%	33.1%	**20.4%**	**28.4%**
4	0.6%	14.5%	16.0%	14.2%	14.5%	0.6%	18.1%	26.5%	5.7%	21.0%	**4.2%**	**5.8%**
5	0.2%	10.2%	11.3%	10.0%	7.5%	0.8%	6.0%	8.8%	3.4%	7.0%	**2.4%**	**3.5%**
6	0.1%	4.2%	4.6%	4.1%	4.8%	0.9%	0.5%	0.7%	2.3%	0.6%	**1.6%**	**2.3%**
7	0.0%	1.7%	1.8%	1.6%	2.1%	0.0%	0.6%	0.9%	0.8%	0.7%	**0.5%**	**0.8%**
8	0.0%	1.1%	1.3%	1.1%	0.5%	0.2%	0.0%	0.0%	0.4%	0.0%	**0.3%**	**0.4%**
9+	0.0%	0.2%	0.3%	0.2%	0.5%	0.0%	0.0%	0.0%	0.2%	0.0%	**0.1%**	**0.2%**
Sum 3+	**3.1%**	**74.6%**	**87.5%**	**71.9%**	**83.5%**	**17.0%**	**53.8%**	**78.7%**	**40.8%**	**62.3%**	**29.6%**	**41.2%**
Quarter: 4												
0	90.4%	0.0%	-	0.0%	0.0%	49.0%	42.7%	0.0%	21.6%	9.3%	**40.7%**	**16.3%**
1	5.2%	1.0%	-	1.0%	2.2%	3.0%	0.0%	0.0%	2.3%	0.0%	**2.6%**	**1.3%**
2	1.1%	16.7%	-	16.7%	24.0%	10.2%	12.2%	21.3%	16.7%	19.3%	**12.3%**	**17.8%**
3	1.5%	60.2%	-	60.2%	59.8%	33.4%	23.9%	41.8%	48.3%	37.9%	**29.9%**	**43.8%**
4	1.1%	9.5%	-	9.5%	6.1%	2.6%	15.2%	26.5%	5.1%	24.0%	**9.2%**	**13.2%**
5	0.6%	6.2%	-	6.2%	3.7%	1.0%	5.0%	8.8%	2.9%	8.0%	**3.6%**	**5.1%**
6	0.0%	4.6%	-	4.6%	2.5%	0.7%	0.4%	0.7%	2.1%	0.6%	**1.0%**	**1.5%**
7	0.2%	1.5%	-	1.5%	1.4%	0.1%	0.5%	0.9%	0.8%	0.8%	**0.6%**	**0.8%**
8	0.0%	0.3%	-	0.3%	0.3%	0.1%	0.0%	0.0%	0.2%	0.0%	**0.1%**	**0.1%**
9+	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
Sum 3+	**3.3%**	**82.3%**	-	**82.3%**	**73.8%**	**37.9%**	**45.1%**	**78.7%**	**59.4%**	**71.4%**	**44.4%**	**64.6%**

Table 2.2.6 Total catch of Herring in the North Sea and Div. IIIa: North Sea Autumn Spawners (NSAS)
Catch in numbers (millions) and mean weight (kg) at age by fleet, and SOP catches ('000 t).

1997	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D+E**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0			363.5	0.014	8.9	0.021	84.8	0.019	**457.1**	**0.015**
1	18.4	0.080	156.9	0.033	249.0	0.032	102.6	0.022	**526.9**	**0.032**
2	445.9	0.118	23.8	0.061	156.0	0.084	54.5	0.035	**680.3**	**0.101**
3	419.5	0.148	4.8	0.085	67.3	0.130	4.2	0.099	**495.8**	**0.144**
4	245.6	0.192	0.6	0.137	11.8	0.170	0.5	0.110	**258.5**	**0.191**
5	85.9	0.230	2.6	0.151	5.5	0.183	0.2	0.142	**94.2**	**0.225**
6	22.8	0.230	0.1	0.146	1.7	0.192	0.1	0.168	**24.7**	**0.227**
7	10.8	0.228			0.7	0.194	0.0	0.192	**11.5**	**0.226**
8	9.0	0.224			0.9	0.201	0.0	0.217	**9.9**	**0.222**
9+	8.9	0.297							**8.9**	**0.297**
TOTAL	1,266.8		552.3		501.7		246.9		**2,567.7**	
SOP catch	**195.3**		**12.8**		**33.6**		**6.4**		**248.0**	

1998	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D+E**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0			208.2	0.018	18.8	0.029	34.79	0.027	**261.9**	**0.020**
1	19.2	0.073	231.6	0.032	649.5	0.060	105.65	0.033	**1,005.9**	**0.051**
2	1024.6	0.120	32.8	0.058	141.2	0.082	22.11	0.064	**1,220.7**	**0.113**
3	497.3	0.146	1.7	0.134	25.6	0.119	1.28	0.096	**525.9**	**0.144**
4	252.7	0.184	4.5	0.131	18.2	0.163	1.11	0.157	**276.5**	**0.182**
5	157.3	0.221	0.8	0.198	2.7	0.178	0.32	0.193	**161.2**	**0.220**
6	81.5	0.237	0.6	0.210	3.1	0.196	0.00	0.127	**85.2**	**0.236**
7	15.1	0.250	0.1	0.232	1.2	0.179	0.00	0.258	**16.4**	**0.245**
8	9.4	0.275	0.2	0.285	0.5	0.226	0.00	0.205	**10.0**	**0.273**
9+	9.5	0.286							**9.5**	**0.286**
TOTAL	2,066.7		480.4		860.8		165.3		**3,573.2**	
SOP catch	**306.5**		**14.3**		**58.6**		**6.3**		**385.6**	

1999	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0	0.9	0.009	968.3	0.009	24.0	0.018	930.5	0.010	**1,923.6**	**0.009**
1	36.9	0.066	44.1	0.039	105.3	0.052	137.9	0.037	**324.1**	**0.046**
2	479.7	0.124	21.0	0.067	87.3	0.091	59.2	0.076	**647.2**	**0.114**
3	1004.7	0.153	20.4	0.128	36.5	0.117	10.4	0.103	**1,071.9**	**0.151**
4	280.7	0.170	4.3	0.149	8.3	0.139	3.5	0.148	**296.8**	**0.168**
5	130.9	0.208	1.0	0.178	3.6	0.164	2.0	0.164	**137.5**	**0.206**
6	66.6	0.233	0.8	0.174	0.9	0.194	0.0	0.031	**68.4**	**0.232**
7	25.8	0.244	0.2	0.200	0.3	0.207	0.8	0.206	**27.2**	**0.242**
8	8.5	0.264	0.0	0.000	0.3	0.214	0.2	0.190	**9.0**	**0.260**
9+	3.3	0.292							**3.3**	**0.292**
TOTAL	2,038.0		1,060.1		266.5		1,144.5		**4,509.0**	
SOP catch	**315.8**		**15.2**		**20.2**		**21.1**		**372.2**	

Fleet D contains the former fleet E from 1999 on.

Table 2.2.7: Catch at age (numbers in millions) of herring caught in the North Sea, 1990-1999.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	888	1557	616	784	872	386	82	56	29	12	**5283**
1991	1658	1301	801	568	563	507	207	40	26	13	**5684**
1992	7874	705	995	424	344	351	370	149	39	24	**11274**
1993	7254	1385	792	614	315	222	230	191	88	42	**11133**
1994	3834	497	1438	504	355	117	98	78	71	46	**7038**
1995	6795	583	1486	919	259	126	59	43	55	73	**10398**
1996	1796	738	549	600	197	60	21	11	8	18	**3997**
1997	364	175	472	426	248	89	23	11	9	9	**1825**
1998	208	251	1068	512	269	165	85	16	10	10	**2594**
1999	969	81	504	1039	291	136	69	27	9	3	**3127**

Table 2.2.8: Catch at age (numbers in millions) of Baltic Spring spawning Herring taken in the North Sea, and transfered to the assessement of the spring spawning stock in IIIa, 1990-1999.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
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	11.0	14.9	4.0	2.9	1.9	0.5	0.2	**57.8**
1996			0.0	2.8	0.8	0.4	0.1	0.1	0.1	0.2	**4.4**
1997			2.2	1.3	1.5	0.4	0.2	0.1	0.1	0.1	**5.9**
1998			11.0	13.0	11.8	6.6	3.2	0.4	0.4	0.5	**47.1**
1999			3.3	14.3	5.6	3.6	1.4	0.6	0.4	0.1	**29.3**

Table 2.2.9: Catch at age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to assessement of North Sea Autumn Spawners, 1990 - 1999.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	398	1424	284								**2106**
1991	712	823	330								**1865**
1992	2408	1587	284	27	27	16	12	5	1		**4367**
1993	2911	2404	377								**5692**
1994	542	1240	305								**2087**
1995	1723	1070	126								**2919**
1996	632	870	159	32							**1692**
1997	94	352	211	71	12	6	2	1	1		**749**
1998	50	708	157	26	19	3	3	1	0	0	**967**
1999	954	243	147	47	12	6	1	1	1	0	**1411**

Table 2.2.10: Catch at age (numbers in millions) of the total North Sea Autumn Spawning stock as used for the assessment, 1990 - 1999.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	1286	2982	888	769	850	383	79	54	29	12	**7331**
1991	2370	2124	1125	553	545	498	204	39	25	13	**7496**
1992	10281	2292	1279	441	360	359	374	152	39	23	**15598**
1993	10165	3789	1165	603	303	214	224	186	86	41	**16776**
1994	4377	1737	1735	476	338	106	89	74	68	45	**9045**
1995	8518	1653	1590	908	245	122	56	41	54	73	**13259**
1996	2428	1608	708	629	196	59	20	11	8	18	**5685**
1997	457	527	680	496	258	94	25	12	10	9	**2568**
1998	258	959	1214	525	276	161	85	16	10	10	**3514**
1999	1924	324	647	1072	297	138	68	27	9	3	**4509**

Table 2.2.11: Comparison of mean weights (kg) at age in the catch of adult herring in the North Sea in 1990 - 1999, and North Sea Autumn Spawners caught in Div IIIa in 1997-1999.

		Age (Winter Rings)							
Div.	**Year**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
IIIa	1997	0.071	0.129	0.167	0.182	0.191	0.194	0.202	-
	1998	0.080	0.118	0.163	0.179	0.196	0.179	0.226	-
	1999	0.085	0.114	0.142	0.164	0.189	0.206	0.205	-
IVa	1990	0.123	0.154	0.177	0.194	0.229	0.234	0.251	0.295
	1991	0.146	0.164	0.181	0.198	0.214	0.231	0.263	0.275
	1992	0.149	0.184	0.189	0.208	0.223	0.240	0.243	0.285
	1993	0.133	0.156	0.193	0.210	0.234	0.249	0.268	0.319
	1994	0.135	0.171	0.201	0.223	0.246	0.258	0.278	0.295
	1995	0.142	0.172	0.208	0.220	0.260	0.253	0.284	0.290
	1996	0.133	0.162	0.200	0.213	0.239	0.253	0.254	0.291
	1997	0.126	0.159	0.197	0.234	0.241	0.245	0.232	0.304
	1998	0.125	0.161	0.192	0.226	0.242	0.254	0.274	0.291
	1999	0.125	0.156	0.180	0.212	0.235	0.249	0.253	0.291
IVa(E)	1998	0.115	0.147	0.171	0.199	0.218	0.236	0.269	0.232
	1999	0.124	0.143	0.162	0.191	0.207	0.225	0.233	0.272
IVa(W)	1998	0.129	0.170	0.206	0.244	0.263	0.263	0.284	0.300
	1999	0.126	0.161	0.189	0.224	0.247	0.256	0.266	0.294
IVb	1990	0.102	0.145	0.194	0.219	0.250	0.272	0.259	0.277
	1991	0.119	0.173	0.196	0.220	0.225	0.277	0.257	0.263
	1992	0.081	0.179	0.198	0.213	0.232	0.255	0.272	0.313
	1993	0.102	0.146	0.199	0.220	0.236	0.261	0.275	0.306
	1994	0.122	0.150	0.177	0.205	0.237	0.251	0.255	0.245
	1995	0.135	0.174	0.197	0.205	0.261	0.266	0.272	0.282
	1996	0.106	0.178	0.213	0.238	0.243	0.268	0.270	0.263
	1997	0.122	0.153	0.201	0.228	0.245	0.227	0.270	0.296
	1998	0.116	0.151	0.182	0.218	0.230	0.220	0.299	0.277
	1999	0.120	0.152	0.154	0.214	0.227	0.205	0.286	0.345
IVa & IVb	1990	0.113	0.152	0.181	0.198	0.232	0.238	0.252	0.290
	1991	0.131	0.167	0.184	0.203	0.217	0.239	0.262	0.272
	1992	0.100	0.183	0.191	0.209	0.224	0.243	0.250	0.290
	1993	0.116	0.152	0.195	0.212	0.234	0.251	0.269	0.317
	1994	0.131	0.164	0.192	0.218	0.245	0.258	0.277	0.292
	1995	0.140	0.173	0.205	0.216	0.260	0.256	0.283	0.289
	1996	0.126	0.165	0.203	0.219	0.240	0.258	0.259	0.281
	1997	0.125	0.157	0.198	0.232	0.243	0.236	0.236	0.302
	1998	0.122	0.159	0.191	0.224	0.241	0.250	0.275	0.290
	1999	0.123	0.155	0.177	0.213	0.233	0.247	0.262	0.291
IVc & VIId	1990	0.118	0.131	0.152	0.171	0.195	0.216	0.208	0.231
	1991	0.123	0.165	0.184	0.200	0.212	0.196	0.237	0.161
	1992	0.100	0.183	0.191	0.209	0.224	0.243	0.250	0.290
	1993	0.113	0.139	0.152	0.174	0.182	0.191	0.211	0.216
	1994	0.117	0.145	0.172	0.191	0.209	0.224	0.229	0.218
	1995	0.114	0.130	0.161	0.177	0.203	0.208	0.184	0.241
	1996	0.118	0.140	0.154	0.178	0.181	0.201	0.186	0.250
	1997	0.099	0.133	0.159	0.180	0.156	0.193	0.165	0.158
	1998	0.125	0.161	0.192	0.226	0.242	0.254	0.274	0.291
	1999	0.113	0.142	0.155	0.188	0.209	0.214	0.000	0.000
Total North Sea Catch	1990	0.114	0.149	0.177	0.193	0.229	0.236	0.250	0.287
	1991	0.130	0.166	0.184	0.203	0.217	0.235	0.259	0.271
	1992	0.103	0.175	0.189	0.207	0.223	0.237	0.249	0.287
	1993	0.115	0.145	0.189	0.204	0.228	0.244	0.256	0.310
	1994	0.130	0.159	0.181	0.214	0.240	0.255	0.273	0.281
	1995	0.136	0.167	0.196	0.200	0.247	0.249	0.278	0.287
	1996	0.123	0.160	0.192	0.207	0.211	0.252	0.255	0.281
	1997	0.115	0.147	0.192	0.228	0.230	0.228	0.224	0.297
	1998	0.118	0.146	0.183	0.220	0.237	0.250	0.275	0.286
	1999	0.122	0.153	0.169	0.207	0.233	0.243	0.262	0.291

Table 2.2.12: Changes in catch at age of North Sea Herring 1997 including IIIa transfers

W-ring	0	1	2	3	4	5	6	7	8	9	total
Numbers (millions), mean weight (g) and catch (t) at age for catch 1997 assuming misreporting as assumed in 1998 & 1999 and used in 1998 & 1999 WG assessments											
Numbers 1997 used in 1999	457.1	526.9	680.3	495.8	258.5	94.2	24.6	11.5	10.1	8.9	**2568**
Catch 1997 used in 1999	7314	16862	68706	71394	49373	21186	5587	2603	2238	2641	**247903**
Mean weight (g) 1997	16	32	101	144	191	225	227	226	222	297	**97**
Additional Numbers (millions) and catch (tonnes) at age now assumed as misreported in 1997 from VIa to IVa from Bayesian assessment											
Additional Numbers in 1997	0	0.0	57.8	31.0	26.5	12.8	3.4	0.7	0.9	2.6	**136**
Additional Catch in 1997	0	1.2	8025.5	5675.0	5795.9	3204.3	834.2	179.8	235.7	772.4	**24724**
New numbers (millions), weight (g) and catch (t) at age for North Sea herring including IIIa transfers for 1997 used in the WG assessment in 2000											
New Numbers for 1997	457.1	526.9	738.1	526.8	285.0	106.9	28.1	12.2	10.9	11.5	**2704**
New Catch 1997	7314	16863	76731	77069	55169	24390	6421	2783	2473	3414	**272627**
New mean weight (g) 1997	16	32	104	146	194	228	229	228	226	296	**101**

Table 2.2.13 Sampling of commercial landings of Herring in the North Sea (Div. IV and VIId) in 1999 by quarter. Sampled catch might exceed the official landings due to sampling of discards, unallocated and misreported catches.

Country (Fleet)	Quarter	Sampled Catch	Landings (t)	No. of samples	No. of fish measured	No. of fish aged
Denmark (A)	1	86%	9074	2	401	103
Denmark (A)	2	0%	387	0	0	0
Denmark (A)	3	33%	8008	1	193	48
Denmark (A)	4	59%	28567	6	975	270
	total	**60%**	**46036**	**9**	**1569**	**421**
Denmark (B)	1	100%	1811	12	291	151
Denmark (B)	2	74%	2085	12	23	23
Denmark (B)	3	99%	8280	24	1036	565
Denmark (B)	4	60%	3056	6	27	28
	total	**88%**	**15232**	**54**	**1377**	**767**
Faroes	1	0%	1227	0	0	0
Faroes	4	0%	750	0	0	0
	total	**0%**	**1977**	**0**	**0**	**0**
France	1	0%	1738	0	0	0
France	2	0%	273	0	0	0
France	3	0%	11580	0	0	0
France	4	0%	13371	0	0	0
	total	**0%**	**26962**	**0**	**0**	**0**
Germany	1	99%	386	10	3567	341
Germany	2	0%	2548	0	0	0
Germany	3	48%	19970	29	15733	419
Germany	4	0%	3860	0	0	0
	total	**38%**	**26764**	**39**	**19300**	**760**
Netherlands	1	100%	2935	21	525	525
Netherlands	2	100%	3629	20	500	500
Netherlands	3	100%	23957	36	900	900
Netherlands	4	100%	23797	8	200	200
	total	**100%**	**54318**	**85**	**2125**	**2125**
Norway	1	0%	2112	0	0	0
Norway	2	100%	30492	29	2828	2753
Norway	3	52%	21443	10	962	962
Norway	4	100%	16671	2	169	162
	total	**83%**	**70718**	**41**	**3959**	**3877**
Sweden	2	0%	1777	0	0	0
Sweden	3	0%	1464	0	0	0
	total	**0%**	**3241**	**0**	**0**	**0**
UK (England)	1	0%	63	0	0	0
UK (England)	2	0%	8	0	0	0
UK (England)	3	0%	8808	0	0	0
UK (England)	4	0%	1719	0	0	0
	total	**0%**	**10598**	**0**	**0**	**0**
UK (Scotland)	2	100%	2660	4	985	314
UK (Scotland)	3	100%	26003	72	12175	3401
UK (Scotland)	4	100%	1248	2	407	119
	total	**100%**	**29911**	**78**	**13567**	**3834**
Period Total	1	69%	19346	46	4785	1121
Period Total	2	86%	43859	67	4338	3592
Period Total	3	69%	129515	174	31001	6297
Period Total	4	69%	93039	25	1779	780
Total for Stock		**71%**	**285759**	**312**	**41903**	**11790**

Table 2.3.1 IBTS 1-ringer indices (1st quarter)*

Year class	Year of sampling	1-ringer index
1977	1979	156
1978	1980	342
1979	1981	518
1980	1982	799
1981	1983	1231
1982	1984	1443
1983	1985	2083
1984	1986	2543
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	1186
1994	1996	1735
1995	1997	4069
1996	1998	2067
1997	1999	715
1998	2000	3632

*recalculated series for HAWG 2000

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. in10^9
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
1996	0.003	0.004	0.935	0.135	0.436	0.379	0.039	0.032	148.1
1997	0.042	0.021	0.338	0.064	0.178	0.035	0.023	0.083	53.1
1998	0.100	0.056	1.150	0.592	0.998	0.265	0.280	0.127	244.0
1999	0.045	0.011	0.799	0.200	0.514	0.220	0.107	0.026	137.1

Table 2.3.3 Indices of 1-ringers, estimation of the small sized component (Downs herring)

Year class	Year of sampling	All 1-ringers (no/hour)	Small<13cm 1-ringers (no/hour)	Proportion of small vs. all sizes	Small<13cm 1-ringers excluding IIIa (no/hour)	Proportion "small excl. in IIIa" vs. all sizes	Proportion of small in IIIa vs small in all areas
1977	1979	156	11.07	0.07	11.87	0.08	0
1978	1980	342	112.85	0.33	112.47	0.33	0.07
1979	1981	518	57.57	0.11	48.34	0.09	0.22
1980	1982	799	175.36	0.22	184.03	0.23	0.02
1981	1983	1231	188.6	0.15	180.2	0.15	0.11
1982	1984	1443	330.25	0.23	278.5	0.19	0.21
1983	1985	2083	295.46	0.14	276.2	0.13	0.13
1984	1986	2543	585.93	0.23	372.45	0.15	0.41
1985	1987	3684	640.27	0.17	526.85	0.14	0.23
1986	1988	4530	2365.73	0.52	697.49	0.15	0.72
1987	1989	2313	548.79	0.24	488.36	0.21	0.17
1988	1990	1016	69.01	0.07	60.07	0.06	0.19
1989	1991	1159	299.97	0.26	305.38	0.26	0.05
1990	1992	1162	120.9	0.10	125.44	0.11	0.03
1991	1993	2943	754.89	0.26	163.09	0.06	0.8
1992	1994	1667	266.99	0.16	224.91	0.13	0.21
1993	1995	1186	386.34	0.33	379.98	0.32	0.08
1994	1996	1735	537.1	0.31	408.92	0.24	0.29
1995	1997	4069	1179.9	0.29	932.95	0.23	0.26
1996	1998	2067	1168.12	0.57	1231.57	0.60	0.02
1997	1999	715	141.15	0.20	138.77	0.19	0.08
1998	2000	3632	1062.18	0.29	936.11	0.26	0.18

Table 2.4.1 Numbers (millions) of autumn spawning herring by ICES Area by age class and maturity for 2 and 3 ring herring

ICES Area	IIIa	IVa	IVb	VIan
0	1856.57	0.00	170.02	0.00
1	2562.92	1047.25	3449.66	487.00
2i	124.81	703.62	89.05	125.24
2m	43.67	1889.76	2096.85	168.66
3i	13.18	394.19	0.00	30.42
3m	24.14	3893.96	50.95	1235.36
4	6.79	1009.27	19.58	393.79
5	16.88	439.49	13.77	280.75
6	0.72	259.96	28.80	126.41
7	4.87	104.61	19.44	78.85
8	0.36	28.84	22.40	25.17
9+	0.00	50.67	32.00	32.28
Immature	4557.47	2145.06	3708.73	642.66
Mature	97.41	7676.55	2283.79	2341.26
Total	4654.88	9821.61	5992.53	2983.92

Table 2.4.2 Biomass (thousands of tonnes) of autumn spawning herring by ICES Area by age class and maturity for 2 and 3 ring herring

ICES Area	IIIa	IVa	IVb	VIan
0	8.17	0.00	0.29	0.00
1	140.58	72.63	61.67	26.14
2I	10.38	72.35	6.22	16.44
2m	4.61	244.20	87.54	23.89
3I	1.36	54.29	0.00	5.02
3m	2.71	685.52	5.45	205.38
4	0.69	211.64	2.40	74.08
5	2.46	106.34	1.98	56.91
6	0.16	73.04	3.98	27.69
7	0.84	31.39	2.82	17.75
8	0.05	8.61	3.20	5.91
9+	0.00	16.51	4.94	7.92
Immature	152.32	199.26	67.88	47.61
Mature	11.51	1377.23	112.32	419.52
Total	172.00	1576.50	180.49	467.12

Table 2.4.3 Mean weight of autumn spawning herring by ICES Area by age class and maturity for 2 and 3 ring herring

ICES Area	IIIa	IVa	IVb	VIan
0	4.40		1.70	
1	54.85	69.35	17.88	53.68
2I	83.15	102.82	69.82	131.29
2m	105.67	129.22	41.75	141.64
3I	103.19	137.73		165.06
3m	112.30	176.05	106.94	166.25
4	101.00	209.69	122.40	188.12
5	145.69	241.97	143.61	202.70
6	218.00	280.95	138.33	219.01
7	172.13	300.03	145.30	225.13
8	142.00	298.51	142.86	234.72
9+		325.86	154.50	245.25
Immature	80.40	103.30	43.85	116.68
Mature	142.40	245.29	124.46	202.85
Total	112.94	206.56	98.64	179.35

Table 2.4.4 Combined output from all surveys by population for North Sea autumn spawners, and West of Scotland herring July 1999. Numbers (millions), Biomass, (Thousands of tonnes) Fraction mature, mean weight at age. Total numbers and biomass mature and immature herring

North Sea	Numbers	Biomass	Maturity	Weight (g)	West of Scotland	Numbers	Biomass	Maturity	Weight (g)
0	2026.6	8.5	0.00	4	**0**	0.0	0.0	0.00	
1	7059.8	274.9	0.00	39	**1**	487.0	26.1	0.00	54
2	4947.8	425.3	0.81	86	**2**	293.9	40.3	0.57	137
3	4376.4	749.3	0.91	171	**3**	1265.8	210.4	0.98	166
4	1035.6	214.7	1.00	207	**4**	393.8	74.1	1.00	188
5	470.1	110.8	1.00	236	**5**	280.7	56.9	1.00	203
6	289.5	77.2	1.00	267	**6**	126.4	27.7	1.00	219
7	128.9	35.0	1.00	272	**7**	78.9	17.8	1.00	225
8	51.6	11.9	1.00	230	**8**	25.2	5.9	1.00	235
9+	82.7	21.5	1.00	260	**9+**	32.3	7.9	1.00	245
Immature	10411.3	419.5			**Immature**	642.7	47.6		
Mature	10057.8	1501.1			**Mature**	2341.3	419.5		
Total	20469.0	1929.0			**Total**	2983.9	467.1		

Table 2.4.5 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1999. 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 1999 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.
For 1999 the Kattegat was excluded from the results because it was not surveyed.

	Numbers (millions)															
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Age (ring)																
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,189	9,416	4,690	7,060
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	4,550	6,363	6,899	4,948
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,823	3,287	2,565	4,376
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,640	1,036
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	310.9	692.1	982	470
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.8	259.2	445.2	289.5
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	128.9
8	39	23	6	11	23	44	134	112	155	178	220	110	133.0	78.3	45.2	51.6
9+	41	19	8	20	14	22	43	56	163	116	132	84	206.0	158.3	121.4	82.7
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	18,786	22,028	17,558	18,442
Z(2+/3+)		0.92	0.57	1.02	0.81	0.11	0.11	0.57	0.37	0.74	1.21	0.53	0.43	0.40	0.75	0.69
Smoothed Z(2+/3+)		0.75	0.80	0.91	0.46	0.11	0.34	0.47	0.55	0.97	0.87	0.48	0.41	0.57	0.72	0.56
SSB('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1,445	1,780	1,830	1,501

Z(2+/3+) is total mortality all herring 2 ring and older to 3 ring and older the following year

Smoothed z(2+/3+) mortality is calculated as an average over 3 years

Table 2.5.1: Estimated abundances of herring larvae < 10 mm long, by standard sampling area and time periods
The number of larvae are expressed as mean number per ICES rectangle * 10^9

Year	Orkney and Shetland		Buchan		Central North Sea				Southern North Sea/Eastern Channel		
	1-15 Sept.	16-30 Sept.	1-15 Sept.	16-30 Sept.	1-15 Sept.	16-30 Sept.	1-15 Oct.	16-31 Oct.	16-31 Dec.	1-15 Jan.	16-31 Jan.
1972	1133	4583	30		165	88	134	22	2	46	
1973	2029	822	3	4	492	830	1213	152			1
1974	758	421	101	284	81		1184			10	
1975	371	50	312			90	77	6	1	2	
1976	545	81		1	64	108		10		3	
1977	1133	221	124	32	520	262	89	3	1		
1978	3047	50		162	1406	81	269	2	33	3	
1979	2882	2362	197	10	662	131	507	7		111	89
1980	3534	720	21	1	317	188	9	13	247	129	40
1981	3667	277	3	12	903	235	119		1456		70
1982	2353	1116	340	257	86	64	1077	23	710	275	54
1983	2579	812	3647	768	1459	281	63		71	243	58
1984	1795	1912	2327	1853	688	2404	824	433	523	185	39
1985	5632	3432	2521	1812	130	13039	1794	215	1851	407	38
1986	3529	1842	3278	341	1611	6112	188	36	780	123	18
1987	7409	1848	2551	670	799	4927	1992	113	934	297	146
1988	7538	8832	6812	5248	5533	3808	1960	206	1679	162	112
1989	11477	5725	5879	692	1442	5010	2364	2	1514	2120	512
1990		10144	4590	2045	19955	1239	975		2552	1204	
1991	1021	2397		2032	4823	2110	1249		4400	873	
1992	189	4917		822	10	165	163		176	1616	
1993		66		174		685	85		1358	1103	
1994	26	1179				1464	44		537	595	
1995		8688					43		74	230	164
1996		809		184		564			337	675	691
1997		3611		23					9374	918	355
1998		8528		1490	205	66			1522	953	170
1999		4064		185		134	181		804	1260	344

Table 2.5.2: Parameter estimates obtained on fitting the multiplicative model to the estimates of larval abundance by area and time-period. Model fitted to abundances of larvae < 10 mm in length (11 mm for the Southern North Sea).

a) Analysis of variance of the model fit

	DF	Sum of Squares	Mean Square	F Value	P
Model	37	143.2	3.87	8.216	0.0001
Error	202	95.2	0.4711		
C Total	239	238.4			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.823923	0.5582	Reference: 1972 Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.3575	0.6940	1987	1.4737	0.6133
1974	-0.1547	0.7434	1988	2.7201	0.5999
1975	-1.2223	0.7555	1989	2.6888	0.6137
1976	-1.3228	0.7415	1990	2.9251	0.6366
1977	-0.4146	0.7110	1991	2.2852	0.6899
1978	-0.2135	0.7216	1992	1.5259	0.7291
1979	0.4892	0.6947	1993	1.2277	0.7061
1980	0.1270	0.6916	1994	0.8322	0.7437
1981	0.5478	0.6890	1995	1.0123	0.7337
1982	0.8629	0.6247	1996	1.6825	0.7729
1983	1.1137	0.6406	1997	1.8891	0.7248
1984	1.7171	0.6222	1998	2.1950	0.6813
1985	2.1333	0.6001	1999	2.0292	0.6856
1986	1.4709	0.6199			

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.7058	0.3365
Buchan 01-15 Sep	-1.6527	0.4286
Buchan 16-30 Sep	-2.4681	0.3754
CNS 01-15 Sep	-1.6551	0.4088
CNS 16-30 Sep	-1.4299	0.3705
CNS 01-15 Oct	-2.1013	0.3917
CNS 16-31 Oct	-4.1679	0.5317
SNS 12-31 Dec	-2.0068	0.4089
SNS 01-15 Jan	-2.5373	0.3435
SNS 16-31 Jan	-3.8068	0.3971

Table 2.5.3: updated MLAI time-series obtained from a multiplicative model

Reference: **6.823923** (Orkney/Shetland, 1st-15th September 1972)

Year	**MLAI**	MLAIrefer	un-logged	unlogged/100
1973	0.3575	7.1814	1314.8	13.1
1974	-0.1547	6.6692	787.8	7.9
1975	-1.2223	5.6016	270.9	2.7
1976	-1.3228	5.5011	245.0	2.4
1977	-0.4146	6.4093	607.5	6.1
1978	-0.2135	6.6104	742.8	7.4
1979	0.4892	7.3131	1499.9	15.0
1980	0.1270	6.9509	1044.1	10.4
1981	0.5479	7.3718	1590.5	15.9
1982	0.8629	7.6868	2179.4	21.8
1983	1.1137	7.9376	2800.7	28.0
1984	1.7171	8.5410	5120.7	51.2
1985	2.1333	8.9572	7763.6	77.6
1986	1.4709	8.2948	4003.0	40.0
1987	2.0289	8.8529	6994.4	69.9
1988	2.7201	9.5440	13961.0	139.6
1989	2.6888	9.5127	13530.4	135.3
1990	2.9251	9.7490	17137.4	171.4
1991	2.2852	9.1091	9037.0	90.4
1992	1.5259	8.3499	4229.6	42.3
1993	1.2277	8.0517	3139.0	31.4
1994	0.8321	7.6560	2113.4	21.1
1995	1.0123	7.8362	2530.6	25.3
1996	1.6826	8.5065	4946.7	49.5
1997	1.8891	8.7130	6081.5	60.8
1998	2.1950	9.0189	8257.6	82.6
1999	2.0292	8.8531	6995.9	70.0

Table 2.6.1 The IBTS time series of herring abundance at age as estimated in the first quarter
The years 1983-1999 have been updated after recalculation form the ICES IBTS database
* preliminary data

	age 2			age 3		
Year	original	recalculated	+/-	original	recalculated	+/-
1983	109	**128**	17%	42	**43**	2%
1984	161	**158**	-2%	75	**62**	-17%
1985	716	**695**	-3%	256	**280**	9%
1986	661	**762**	15%	235	**269**	14%
1987	838	**880**	5%	117	**115**	-2%
1988	4100	**4393**	7%	783	**851**	9%
1989	775	**868**	12%	411	**373**	-9%
1990	580	**448**	-23%	322	**291**	-10%
1991	794	**763**	-4%	283	**268**	-5%
1992	377	**380**	1%	181	**181**	0%
1993	762	**782**	3%	236	**209**	-11%
1994	1090	**1094**	0%	199	**199**	0%
1995	1285	**1174**	-9%	152	**233**	53%
1996	194	**194**	0%	43	**43**	0%
1997	437	**490**	12%	181	**190**	5%
1998	743	**743**	0%	90	**90**	0%
1999	425	**425**	0%	509	**509**	0%
2000		**204** *			**121** *	

	age 4			age 5+		
Year	original	recalculated	+/-	original	recalculated	+/-
1983	14	**14**	0%	34	**27**	-21%
1984	32	**28**	-13%	7	**10**	43%
1985	26	**44**	69%	36	**29**	-19%
1986	57	**78**	37%	17	**27**	59%
1987	56	**59**	5%	44	**50**	14%
1988	55	**61**	11%	26	**26**	0%
1989	86	**104**	21%	10	**10**	0%
1990	271	**272**	0%	70	**72**	3%
1991	250	**240**	-4%	170	**162**	-5%
1992	63	**64**	2%	102	**102**	0%
1993	45	**44**	-2%	64	**64**	0%
1994	64	**64**	0%	40	**40**	0%
1995	46	**31**	-33%	9	**6**	-33%
1996	13	**13**	0%	9	**9**	0%
1997	34	**40**	18%	14	**23**	64%
1998	20	**20**	0%	19	**19**	0%
1999	101	**101**	0%	38	**38**	0%
2000		**116** *			**11** *	

Table 2.7.1: Herring in the North Sea: Mean weight at age in the third quarter, in Division IVa and IVb.

Age	Mean weights at age (winter rings) in the catch (g)																	
	Third quarter (Divisions IVa and IVb)									July acoustic Survey								
(WR)	1991	1992	1993	1994	1995	1996	1997	1998	1999	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	73	51	53	55	52	10	38	42	58	65	78	69	60	58	44	44	47	39
2	164	127	145	131	151	126	125	132	139	158	142	115	138	132	118	119	96	86
3	189	200	161	164	190	165	157	172	165	198	209	147	209	180	196	166	196	171
4	210	215	179	192	221	203	198	208	195	224	219	202	220	200	253	227	237	207
5	229	235	199	218	231	219	232	240	230	236	243	225	251	195	262	236	275	236
6	246	252	221	245	277	240	243	262	251	260	255	277	289	228	299	239	307	267
7	276	276	239	258	276	258	236	270	263	275	272	286	315	257	305	246	289	272
8	296	286	240	277	316	259	236	288	279	298	312	305	323	302	324	269	308	230
9+	293	330	283	292	316	281	302	315	292	317	311	340	346	324	335	329	363	260

Table 2.7.2 Maturity at age 2, 3 and 4+ for Autumn Spawning herring in the North Sea

Year \Age (W ring)	2	3	>3
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	47.1	62.9	100
1994	72.1	85.8	100
1995	72.6	95.4	100
1996	60.5	97.5	100
1997	65.1	94.2	100
1998	67.0	89.0	100
1999	81.0	91.0	100

Table 2.8.1 Correlation coefficient matrix of the acoustic survey (1989-1999), the IBTS survey (1983-2000) and the catch at age data (1960-1999)

Acoustic survey

	2	3	4	5	6	7	8	9
2	1							
3	0.33	1						
4	-0.11	0.36	1					
5	-0.24	-0.26	0.65	1				
6	-0.19	-0.47	0.12	0.72	1			
7	-0.38	-0.63	-0.15	0.40	0.82	1		
8	-0.56	-0.73	-0.26	0.05	0.32	0.68	1	
9	0.45	-0.29	-0.43	-0.23	0.08	0.11	0.34	1

IBTS survey

	1	2	3	4	5
1	1				
2	0.50	1			
3	0.26	0.81	1		
4	-0.23	-0.04	0.24	1	
5	-0.28	-0.05	0.06	0.63	1

Catch at age data

	0	1	2	3	4	5	6	7	8	9
0	1									
1	0.21	1								
2	-0.10	0.45	1							
3	-0.19	0.38	0.38	1						
4	-0.12	0.22	0.44	0.35	1					
5	-0.10	0.16	0.19	0.23	0.23	1				
6	0.10	0.18	0.38	0.34	0.36	0.36	1			
7	0.05	0.23	0.26	0.65	0.31	0.41	0.55	1		
8	-0.11	0.11	0.35	0.37	0.72	0.25	0.35	0.43	1	
9	-0.19	-0.03	0.42	0.47	0.30	0.56	0.43	0.47	0.49	1

Table 2.8.2 Model setup and data used for the final ICA assessments for the years 1997-2000

Assessment year			**2000**	**1999**	**1998**	**1997**
First data year			1960	1960	1960	1960
Last data year			1999	1998	1997	1996
No of years for separable constraint ?			8	7	6	5
Reference age for separable constraint			4	4	4	4
Constant selection pattern model (Y/N)			s1 (92-96), s2(97-99)-constrained	s1 (92-96), s2(97-98)-constrained	s1 (92-95), s2(96-97)-constrained	yes
S to be fixed on last age			1 / 1	1 / 1	1 / 1	1
First age for calculation of reference F			2	2	2	2
Last age for calculation of reference F			6	6	6	6
Shrink the final populations			no	no	no	no
Tuning indices	*survey*	*age*				
Year ranges for survey indices	MLAI		1979-1999	79-98	77-96	77-96
	Acoustic survey	2-9+	1989-1999	89-98	89-97	89-96
	IBTSA	2-5+	1983-2000	83-99	83-98	83-97
	IBTSY	1	1979-2000	79-99	79-98	79-97
	MIK	0	1977-2000	77-99	77-98	77-97
Catchability models	MLAI		power	power	power	power
	Acoustic survey	2-9+	linear	linear	linear	linear
	IBTSA	2-5+	linear	linear	linear	linear
	IBTSY	1	linear	linear	linear	linear
	MIK	0	linear	linear	linear	linear
Model weighting						
Relative weights in catch at age matrix			all 1	all 1	all 1	all 1, except age 0 (96)=0.01 and age 1(96)=0.01
Total weight catch at age matrix			72	63	54	43
Survey indices weights	MLAI		1.0	1.0	1.0	1.0
	Acoustic survey	2	0.125	0.125	0.125	0.125
	Acoustic survey	3	0.125	0.125	0.125	0.125
	Acoustic survey	4	0.125	0.125	0.125	0.125
	Acoustic survey	5	0.125	0.125	0.125	0.125
	Acoustic survey	6	0.125	0.125	0.125	0.125
	Acoustic survey	7	0.125	0.125	0.125	0.125
	Acoustic survey	8	0.125	0.125	0.125	0.125
	Acoustic survey	9+	0.125	0.125	0.125	0.125
	IBTSA	2	0.25	0.25	0.25	0.25
	IBTSA	3	0.25	0.25	0.25	0.25
	IBTSA	4	0.25	0.25	0.25	0.25
	IBTSA	5+	0.25	0.25	0.25	0.25
	IBTSY	1	1.0	1.0	1.0	1.0
	MIK	0	1.0	1.0	1.0	1.0
Stock recruitment weight			0.1	0.1	0.1	0.1
Parameters to be estimated			57	55	53	44
Number of observations			338	313	289	265

Table 2.8.3 Log file of the run-time commands for the final ICA assessment.

```
Integrated Catch at Age Analysis (Version 1.4 w. constrained separability)
--------------------------------------------------------------------------
 Enter the name of the index file -->index
canum
weca
 Stock weights in 2000  used for the year 1999
west
 Natural mortality in 2000  used for the year 1999
natmor
 Maturity ogive in 2000  used for the year 1999
matprop
 Name of age-structured index file (Enter if none) : -->fleet
 Name of the SSB index file (Enter if none) -->ssb
 No of years for separable constraint ?--> 8
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->n
 Enter last year in which selection is constant--> 1996
 Gradual or Abrupt change in selection (G/A) ?-->a
 S to be fixed on last age ?-->    1.000000000000000
 S for last age in later selection pattern ?-->    1.000000000000000
 First age for calculation of reference F ?--> 2
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->y
 Is the last age of Acoustic survey 2-9+ wr a plus-group (Y/N) ?-->y
 Is the last age of IBTSA: 2-5+ wr a plus-group (Y/N) ?-->y
 Is the last age of IBTSY 1-wr a plus-group (Y/N) ?-->n
 Is the last age of MIK 0-wr 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   MLAI  is to be A/L/P ?-->p
 Model for Acoustic survey 2-9+ wr  is to be A/L/P ?-->L
 Model for IBTSA: 2-5+ wr  is to be A/L/P ?-->L
 Model for IBTSY 1-wr  is to be A/L/P ?-->L
 Model for MIK 0-wr  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->y
Enter the time lag in years between spawning and the stock size
 of fish aged 0  years on 1 January.
This will probably be 0 unless the stock is an autumn-spawning herring
 in which case it will probably be 1  years.
 Enter the lag in years (rounded up)--> 1
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+-------------------
    0.05        58.7409219646
    0.10        28.5623853226
    0.15        22.0716550880
    0.20        20.2123593597
    0.25        19.9049192541
    0.30        20.3090176481
    0.35        21.1034767372
    0.40        22.1343311774
    0.45        23.3158889862
    0.50        24.5957542120
    0.55        25.9402050581
    0.60        27.3268706438
    0.65        28.7410023695
    0.70        30.1730960339
    0.75        31.6176291172
    0.80        33.0722308177
    0.85        34.5372358642
    0.90        36.0157463482
    0.95        37.5139785654
    1.00        39.0421701865
Lowest SSQ is for F =     0.242
-----------------------------------------------------------------
No of years for separable analysis : 8
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 1999
Number of indices of SSB : 1
```

Table 2.8.3 (Cont'd)

```
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 57
Number of observations : 338

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1996
Abrupt change in selection specified.

-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   MLAI-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 2-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 3-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 4-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 5-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 6-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 7-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 8-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 9-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 2-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 3-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 4-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 5-->    1.000000000000000
 Enter weight for IBTSY 1-wr  at age 1-->    1.000000000000000
 Enter weight for MIK 0-wr  at age 0-->    1.000000000000000
 Enter weight for stock-recruit model-->    0.100000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for Acoustic survey 2-9+ wr-->    1.000000000000000
  Enter value for IBTSA: 2-5+ wr-->    1.000000000000000
  Enter value for IBTSY 1-wr-->    1.000000000000000
  Enter value for MIK 0-wr-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
  1.000
Aged index weights
Acoustic survey 2-9+ wr
 Age   :       2     3     4     5     6     7     8     9
 Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
IBTSA: 2-5+ wr
 Age   :       2     3     4     5
 Wts :     0.250 0.250 0.250 0.250
IBTSY 1-wr
 Age   :       1
 Wts :     1.000
MIK 0-wr
 Age   :       0
 Wts :     1.000
 Stock-recruit weight           0.100
F in 1999  at age 4  is 0.422215  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->y
 Sample from Covariances or Bayes MCMC (C/B) ?-->c
 Use default percentiles (Y/N)  ?-->y
 How many samples to take  ?--> 1000
 Enter SSB reference level (e.g. MBAL, Bpa..) [t]-->   8.0000000000000000E+05
Succesful exit from ICA
```

Table 2.8.4 Output of the final ICAHER assessment for North Sea autumn spawning herring in area IV and subdivisions VIId and IIIa.

Output Generated by ICA Version 1.4

Herring IV, VIId, IIIa

Catch in Number (millions)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	195.	1269.	142.	443.	497.	157.	375.	645.	839.	112.	898.
1	2393.	336.	2147.	1262.	2972.	3209.	1383.	1674.	2425.	2503.	1196.
2	1142.	1889.	270.	2961.	1548.	2218.	2570.	1172.	1795.	1883.	2003.
3	1967.	480.	797.	177.	2243.	1325.	741.	1365.	1494.	296.	884.
4	166.	1456.	335.	158.	148.	2039.	450.	372.	621.	133.	125.
5	168.	124.	1082.	81.	149.	145.	890.	298.	157.	191.	50.
6	113.	158.	127.	230.	95.	152.	45.	393.	145.	50.	61.
7	126.	61.	145.	22.	256.	118.	65.	68.	163.	43.	8.
8	129.	56.	86.	42.	26.	413.	96.	82.	14.	27.	12.
9	142.	88.	87.	51.	58.	78.	236.	173.	92.	25.	12.

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	684.	750.	289.	996.	264.	238.	257.	130.	542.	1263.	9520.
1	4379.	3341.	2368.	846.	2461.	127.	144.	169.	159.	245.	872.
2	1147.	1441.	1344.	773.	542.	902.	45.	5.	34.	134.	284.
3	663.	344.	659.	362.	260.	117.	186.	6.	10.	92.	57.
4	208.	131.	150.	126.	141.	52.	11.	5.	10.	32.	40.
5	27.	33.	59.	56.	57.	35.	7.	0.	2.	22.	29.
6	31.	5.	31.	22.	16.	6.	4.	0.	0.	2.	23.
7	27.	0.	4.	5.	9.	4.	2.	0.	1.	1.	19.
8	0.	1.	1.	2.	3.	1.	1.	0.	1.	0.	6.
9	12.	0.	1.	1.	1.	0.	0.	0.	0.	0.	1.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	11957.	13297.	6973.	4211.	3725.	8229.	3165.	3058.	1303.	2387.	10331.
1	1116.	2449.	1818.	3253.	4801.	6836.	7867.	3146.	3020.	2139.	2303.
2	299.	574.	1146.	1326.	1267.	2137.	2233.	1594.	899.	1133.	1285.
3	230.	216.	441.	1182.	841.	668.	1091.	1364.	779.	557.	443.
4	34.	105.	202.	369.	466.	467.	384.	809.	861.	549.	362.
5	14.	26.	81.	125.	130.	246.	256.	212.	388.	501.	361.
6	7.	23.	23.	44.	62.	75.	128.	124.	80.	205.	376.
7	8.	13.	25.	20.	21.	24.	38.	61.	54.	39.	152.
8	4.	11.	11.	13.	14.	8.	15.	20.	29.	26.	39.
9	1.	12.	19.	16.	15.	8.	9.	9.	12.	13.	23.

AGE	1993	1994	1995	1996	1997	1998	1999
0	10265.	4499.	8426.	2429.	457.	258.	1924.
1	3827.	1785.	1635.	1608.	527.	959.	324.
2	1176.	1783.	1573.	709.	738.	1214.	647.
3	609.	489.	898.	629.	527.	525.	1072.
4	306.	348.	242.	196.	285.	276.	297.
5	216.	109.	121.	59.	107.	161.	138.
6	226.	92.	55.	20.	28.	85.	68.
7	188.	76.	41.	11.	12.	16.	27.
8	87.	70.	54.	8.	11.	10.	9.
9	42.	47.	72.	18.	12.	10.	3.

x 10 ^ 6

Predicted Catch in Number

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	7967.5	8698.0	5241.7	7571.7	4059.6	557.6	297.2	1379.4
1	1854.6	3714.9	2857.4	2296.3	1264.7	766.3	757.3	289.9
2	1232.5	1390.3	1968.6	1969.0	658.8	694.9	1178.4	845.8
3	637.3	713.0	549.8	1020.5	423.3	440.0	785.4	971.2
4	423.3	326.2	245.9	249.9	190.5	256.9	272.9	349.5
5	411.0	223.1	115.8	115.2	47.9	118.7	163.8	124.7
6	333.7	218.4	79.9	54.8	22.2	29.8	75.5	74.7
7	136.7	175.9	77.8	37.7	10.4	13.4	18.4	33.4
8	39.4	89.9	79.2	45.8	9.3	7.9	10.5	10.4

x 10 ^ 6

Table 2.8.4 North Sea herring ICAHER output (continued).

Weights at age in the catches (Kg)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000
2	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600
3	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600
4	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100
5	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700
8	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100
9	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.00700
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.04900
2	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.12600	0.11800
3	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.17600	0.14200
4	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.21100	0.18900
5	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.24300	0.21100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.22200
7	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700
8	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100
9	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.01000	0.01000	0.01000	0.00900	0.00600	0.01100	0.01100	0.01700	0.01900	0.01700	0.01000
1	0.05900	0.05900	0.05900	0.03600	0.06700	0.03500	0.05500	0.04300	0.05500	0.05800	0.05300
2	0.11800	0.11800	0.11800	0.12800	0.12100	0.09900	0.11100	0.11500	0.11400	0.13000	0.10200
3	0.14900	0.14900	0.14900	0.16400	0.15300	0.15000	0.14500	0.15300	0.14900	0.16600	0.17500
4	0.17900	0.17900	0.17900	0.19400	0.18200	0.18000	0.17400	0.17300	0.17700	0.18400	0.18900
5	0.21700	0.21700	0.21700	0.21100	0.20800	0.21100	0.19700	0.20800	0.19300	0.20300	0.20700
6	0.23800	0.23800	0.23800	0.22000	0.22100	0.23400	0.21600	0.23100	0.22900	0.21700	0.22300
7	0.26500	0.26500	0.26500	0.25800	0.23800	0.25800	0.23700	0.24700	0.23600	0.23500	0.23700
8	0.27400	0.27400	0.27400	0.27000	0.25200	0.27700	0.25300	0.26500	0.25000	0.25900	0.24900
9	0.27500	0.27500	0.27500	0.29200	0.26200	0.29900	0.26300	0.25900	0.28700	0.27100	0.28700

AGE	1993	1994	1995	1996	1997	1998	1999
0	0.01000	0.00600	0.00900	0.01600	0.01600	0.02000	0.00900
1	0.03300	0.05600	0.04800	0.01000	0.03200	0.04900	0.04600
2	0.11500	0.13000	0.13600	0.12300	0.10400	0.11300	0.11400
3	0.14500	0.15900	0.16700	0.16000	0.14600	0.14400	0.15100
4	0.18900	0.18100	0.19600	0.19200	0.19400	0.18200	0.16800
5	0.20400	0.21400	0.20000	0.20700	0.22800	0.22000	0.20500
6	0.22800	0.24000	0.24700	0.21100	0.22900	0.23600	0.23200
7	0.24400	0.25500	0.24900	0.25200	0.22800	0.24500	0.24100
8	0.25600	0.27300	0.27800	0.25400	0.22600	0.27300	0.25800
9	0.31000	0.28100	0.28700	0.28100	0.29600	0.28600	0.29100

Table 2.8.4 North Sea herring ICAHER output (continued).

Weights at age in the stock (Kg)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700
4	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300
5	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900
6	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600
7	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900
8	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600
9	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700
4	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300
5	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900
6	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600
7	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900
8	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600
9	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.01500	0.01500	0.01300	0.01000	0.00700	0.00600	0.00800	0.01200	0.01500	0.01400	0.01200
1	0.05000	0.05700	0.05600	0.06100	0.05100	0.04900	0.04400	0.05200	0.05900	0.06900	0.07100
2	0.15500	0.15000	0.13800	0.13000	0.12300	0.12400	0.12300	0.12600	0.13800	0.14200	0.13800
3	0.18700	0.19000	0.18700	0.18300	0.17600	0.17200	0.17100	0.17400	0.18500	0.19700	0.18500
4	0.22300	0.23000	0.23200	0.23200	0.22200	0.21800	0.21500	0.21200	0.21300	0.21600	0.21500
5	0.23900	0.24300	0.24700	0.25200	0.25000	0.24900	0.24800	0.24400	0.24000	0.23700	0.23500
6	0.27600	0.28200	0.27500	0.27300	0.26500	0.27100	0.27500	0.27000	0.26600	0.25700	0.26400
7	0.29900	0.31100	0.32100	0.31500	0.29600	0.28100	0.28300	0.28400	0.28100	0.27600	0.27800
8	0.30600	0.33800	0.34100	0.33200	0.29600	0.29100	0.30400	0.29800	0.29700	0.29500	0.30500
9	0.31200	0.34700	0.36500	0.39200	0.36400	0.34700	0.33700	0.33100	0.33200	0.31500	0.32300

AGE	1993	1994	1995	1996	1997	1998	1999
0	0.00900	0.00800	0.00600	0.00400	0.00600	0.00600	0.00700
1	0.06900	0.06200	0.05400	0.04900	0.04500	0.04300	0.04300
2	0.13200	0.12800	0.12900	0.12300	0.11100	0.10000	0.09100
3	0.18800	0.17900	0.19500	0.18100	0.18600	0.17800	0.18400
4	0.21400	0.20700	0.22400	0.22700	0.23900	0.22400	0.22200
5	0.24000	0.22400	0.23600	0.23100	0.25800	0.24900	0.25600
6	0.27400	0.26500	0.27200	0.25500	0.28200	0.27100	0.28700
7	0.29100	0.28600	0.29200	0.26900	0.28000	0.26900	0.28000
8	0.31300	0.31000	0.31600	0.29800	0.30000	0.26900	0.26900
9	0.33200	0.33700	0.33500	0.32900	0.34200	0.31700	0.31100

Natural Mortality (per year)

AGE	1960	1961	1962	1963	....	1994	1995	1996	1997	1998	1999
0	1.0000	1.0000	1.0000	1.0000	....	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	....	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	....	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	....	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 2.8.4 North Sea herring ICAHER output (continued).

Proportion of fish spawning

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.8200	0.8200	0.8200	0.7000	0.7500	0.6300	0.6600	0.7900	0.7300	0.6400	0.5100
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	0.9400	0.9700	0.9700	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1993	1994	1995	1996	1997	1998	1999
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.4700	0.7200	0.7300	0.6100	0.6500	0.6700	0.8100
3	0.6300	0.8600	0.9500	0.9800	0.9400	0.8900	0.9100
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.4 North Sea herring ICAHER output (continued).

INDICES OF SPAWNING BIOMASS

MLAI

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	15.00	10.44	15.90	21.79	28.01	51.21	77.64	40.03	69.94	139.61	135.30

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	171.37	90.37	42.30	31.39	21.13	25.31	49.47	60.81	82.58	69.96

AGE-STRUCTURED INDICES

Acoustic survey 2-9+ wr (thousands)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	3726.0	2971.0	2834.0	4179.0	3710.0	3280.0	3799.0	4550.6	6363.0	6898.6	4947.8
3	3751.0	3530.0	1501.0	1633.0	1885.0	957.0	2056.0	2823.1	3287.0	2564.6	4376.4
4	1612.0	3370.0	2102.0	1397.0	909.0	429.0	656.0	1087.3	1696.0	1640.2	1035.6
5	488.0	1349.0	1984.0	1510.0	795.0	363.0	272.0	310.9	692.0	982.4	470.1
6	281.0	395.0	748.0	1311.0	788.0	321.0	175.0	98.7	259.0	445.2	289.5
7	120.0	211.0	262.0	474.0	546.0	328.0	135.0	82.8	79.0	170.3	128.9
8	44.0	134.0	112.0	155.0	178.0	220.0	110.0	132.9	78.0	45.2	51.6
9	22.0	43.0	56.0	163.0	116.0	132.0	84.0	206.0	158.0	121.4	82.7

IBTSA: 2-5+ wr

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	128.0	158.0	695.0	762.0	880.0	4393.0	868.0	448.0	763.0	380.0	782.0
3	43.0	62.0	280.0	269.0	115.0	851.0	373.0	291.0	268.0	181.0	209.0
4	14.0	28.0	44.0	78.0	59.0	61.0	104.0	272.0	240.0	64.0	44.0
5	27.0	10.0	29.0	27.0	50.0	26.0	10.0	72.0	162.0	102.0	64.0

AGE	1994	1995	1996	1997	1998	1999	2000
2	1094.0	1174.0	194.0	490.0	743.0	425.0	204.0
3	199.0	233.0	43.0	190.0	90.0	509.0	121.0
4	64.0	31.0	13.0	40.0	20.0	101.0	116.0
5	40.0	6.0	9.0	23.0	19.0	38.0	11.0

IBTSY 1-wr

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	156.0	342.0	518.0	799.0	1231.0	1443.0	2083.0	2542.0	3684.0	4530.0	2313.0

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1016.0	1159.0	1162.0	2943.0	1667.0	1186.0	1735.0	4069.0	2067.0	715.0	3632.0

MIK 0-wr

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	17.10	13.10	52.10	101.10	76.70	133.90	91.80	115.00	181.30	177.40	270.90

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	168.90	71.40	25.90	69.90	200.70	190.10	101.70	127.00	106.50	148.10	53.10

AGE	1999	2000
0	244.00	137.10

Table 2.8.4 North Sea herring ICAHER output (continued).

Fishing Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0257	0.0186	0.0049	0.0148	0.0126	0.0071	0.0215	0.0256	0.0348	0.0082	0.0351
1	0.2546	0.1290	0.0896	0.1240	0.3084	0.2461	0.1852	0.2979	0.3002	0.3291	0.2680
2	0.4248	0.6124	0.2494	0.2973	0.3888	0.7753	0.5919	0.4221	1.3263	0.7841	0.9727
3	0.3161	0.3390	0.6182	0.2743	0.4120	0.7384	0.7082	0.8042	1.8707	0.9105	1.2657
4	0.3191	0.3869	0.3983	0.2222	0.3682	0.7754	0.5711	0.9244	1.0701	0.8718	1.3217
5	0.2423	0.3717	0.4903	0.1397	0.2993	0.6536	0.8314	0.8257	1.2338	1.0502	0.8701
6	0.2851	0.3356	0.7087	0.1612	0.2171	0.4983	0.3842	1.0002	1.1674	1.8998	1.0684
7	0.5071	0.2211	0.5181	0.2256	0.2428	0.4022	0.3637	1.4665	1.5435	1.2725	4.0605
8	0.4109	0.3934	0.4839	0.2455	0.3975	0.6690	0.5864	0.9353	1.3626	1.1525	1.5909
9	0.4109	0.3934	0.4839	0.2455	0.3975	0.6690	0.5864	0.9353	1.3626	1.1525	1.5909

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0339	0.0583	0.0459	0.0746	0.1495	0.1423	0.0957	0.0447	0.0832	0.1249	0.4798
1	0.6018	0.5775	0.6735	0.4483	0.6844	0.2344	0.2862	0.1958	0.1633	0.1125	0.2831
2	0.8822	0.8112	1.0195	1.0269	1.2879	1.3192	0.2083	0.0232	0.0923	0.3543	0.3217
3	1.2141	0.8005	1.3292	0.9664	1.4954	1.3408	1.3340	0.0389	0.0635	0.4058	0.2657
4	1.2224	0.7985	0.9850	0.9834	1.3427	1.6875	0.3680	0.0933	0.0854	0.2813	0.2898
5	1.0621	0.5454	0.9484	1.1761	1.7985	1.4573	1.0744	0.0138	0.0465	0.2374	0.3819
6	2.5097	0.4952	1.3500	1.0690	1.2402	0.9116	0.5721	0.0634	0.0103	0.0593	0.3702
7	2.5062	0.0871	0.7402	0.7309	1.9448	1.3520	0.5204	0.0427	0.3404	0.0833	0.7888
8	1.6530	0.7283	1.1960	1.0593	1.6285	1.3134	0.7058	0.1064	0.1561	0.2539	0.4716
9	1.6530	0.7283	1.1960	1.0593	1.6285	1.3134	0.7058	0.1064	0.1561	0.2539	0.4716

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.3328	0.3978	0.2252	0.0851	0.0622	0.1616	0.1235	0.1240	0.0604	0.1151	0.2200
1	0.2236	0.2501	0.2039	0.3803	0.3152	0.3740	0.5813	0.4256	0.4245	0.3179	0.2931
2	0.2578	0.2996	0.3118	0.4009	0.4547	0.4052	0.3581	0.3998	0.3701	0.5161	0.5691
3	0.5027	0.3198	0.4245	0.6620	0.5156	0.4973	0.3993	0.4142	0.3716	0.4422	0.6729
4	0.2360	0.4288	0.5254	0.7220	0.5673	0.5757	0.5658	0.5526	0.4747	0.4615	0.6788
5	0.1457	0.2596	0.6086	0.6377	0.5322	0.5890	0.6365	0.6235	0.4952	0.4956	0.6627
6	0.1311	0.3204	0.3319	0.6881	0.6765	0.5918	0.6198	0.6454	0.4505	0.4706	0.6376
7	0.1868	0.3439	0.6165	0.4914	0.7221	0.5277	0.6048	0.6012	0.5814	0.3687	0.5829
8	0.2964	0.3851	0.4989	0.6724	0.6380	0.6107	0.6797	0.6370	0.5626	0.5282	0.6788
9	0.2964	0.3851	0.4989	0.6724	0.6380	0.6107	0.6797	0.6370	0.5626	0.5282	0.6788

AGE	1993	1994	1995	1996	1997	1998	1999
0	0.2765	0.2499	0.3049	0.1340	0.0228	0.0263	0.0217
1	0.3684	0.3329	0.4062	0.1785	0.0768	0.0885	0.0730
2	0.7153	0.6463	0.7886	0.3466	0.2426	0.2796	0.2305
3	0.8458	0.7643	0.9325	0.4099	0.4408	0.5081	0.4188
4	0.8532	0.7710	0.9406	0.4134	0.4444	0.5122	0.4222
5	0.8329	0.7526	0.9183	0.4036	0.4344	0.5007	0.4128
6	0.8014	0.7242	0.8835	0.3883	0.4182	0.4821	0.3974
7	0.7327	0.6621	0.8078	0.3551	0.3807	0.4388	0.3617
8	0.8532	0.7710	0.9406	0.4134	0.4444	0.5122	0.4222
9	0.8532	0.7710	0.9406	0.4134	0.4444	0.5122	0.4222

Table 2.8.4 North Sea herring ICAHER output (continued).

Population Abundance (1 January) (Billions)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	12.12	108.91	46.29	47.66	62.80	34.90	27.87	40.26	38.70	21.59	41.09
1	16.49	4.35	39.33	16.95	17.27	22.81	12.75	10.03	14.44	13.75	7.88
2	3.78	4.70	1.41	13.23	5.51	4.67	6.56	3.90	2.74	3.93	3.64
3	7.96	1.83	1.89	0.81	7.28	2.77	1.59	2.69	1.89	0.54	1.33
4	0.64	4.75	1.07	0.83	0.50	3.95	1.08	0.64	0.99	0.24	0.18
5	0.82	0.42	2.92	0.65	0.60	0.32	1.64	0.55	0.23	0.31	0.09
6	0.48	0.58	0.26	1.62	0.51	0.41	0.15	0.65	0.22	0.06	0.10
7	0.33	0.32	0.38	0.12	1.25	0.37	0.22	0.09	0.22	0.06	0.01
8	0.40	0.18	0.24	0.20	0.08	0.88	0.23	0.14	0.02	0.04	0.02
9	0.44	0.28	0.24	0.25	0.18	0.17	0.56	0.30	0.13	0.04	0.02

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	32.34	20.87	10.17	21.78	2.97	2.81	4.42	4.69	10.66	16.84	38.02
1	14.60	11.50	7.24	3.57	7.44	0.94	0.90	1.48	1.65	3.61	5.47
2	2.22	2.94	2.37	1.36	0.84	1.38	0.27	0.25	0.45	0.52	1.19
3	1.02	0.68	0.97	0.63	0.36	0.17	0.27	0.16	0.18	0.30	0.27
4	0.31	0.25	0.25	0.21	0.20	0.07	0.04	0.06	0.13	0.14	0.16
5	0.04	0.08	0.10	0.08	0.07	0.05	0.01	0.02	0.05	0.11	0.09
6	0.03	0.01	0.04	0.04	0.02	0.01	0.01	0.00	0.02	0.04	0.08
7	0.03	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.02	0.04
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
9	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	65.04	62.06	53.71	81.05	97.26	86.09	42.66	41.07	34.97	34.39	62.70
1	8.66	17.15	15.34	15.78	27.38	33.62	26.94	13.87	13.35	12.11	11.28
2	1.52	2.55	4.91	4.60	3.97	7.35	8.51	5.54	3.33	3.21	3.24
3	0.64	0.87	1.40	2.67	2.28	1.87	3.63	4.41	2.75	1.71	1.42
4	0.17	0.32	0.52	0.75	1.13	1.12	0.93	1.99	2.38	1.55	0.90
5	0.11	0.12	0.19	0.28	0.33	0.58	0.57	0.48	1.04	1.34	0.89
6	0.06	0.09	0.08	0.09	0.13	0.17	0.29	0.27	0.23	0.57	0.74
7	0.05	0.05	0.06	0.05	0.04	0.06	0.09	0.14	0.13	0.13	0.32
8	0.01	0.04	0.03	0.03	0.03	0.02	0.03	0.04	0.07	0.07	0.08
9	0.00	0.04	0.05	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.05

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	55.69	36.75	44.47	50.65	39.05	18.08	101.61	52.39
1	18.51	15.54	10.53	12.06	16.30	14.04	6.48	36.58
2	3.09	4.71	4.10	2.58	3.71	5.55	4.73	2.22
3	1.36	1.12	1.83	1.38	1.35	2.16	3.11	2.78
4	0.59	0.48	0.43	0.59	0.75	0.71	1.06	1.68
5	0.41	0.23	0.20	0.15	0.35	0.44	0.39	0.63
6	0.41	0.16	0.10	0.07	0.09	0.21	0.24	0.23
7	0.35	0.17	0.07	0.04	0.04	0.05	0.12	0.15
8	0.16	0.15	0.08	0.03	0.02	0.03	0.03	0.07
9	0.08	0.09	0.12	0.06	0.03	0.02	0.01	0.02

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.4 North Sea herring ICAHER output (continued).

Predicted SSB Index Values

MLAI

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	8.58	10.60	16.04	23.14	36.95	59.33	61.35	61.89	73.81	97.63	111.19

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	101.68	84.91	60.99	37.88	41.78	39.29	36.93	47.71	59.84	78.73

Predicted Age-Structured Index Values

Acoustic survey 2-9+ wr Predicted (thousands)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	6135.3	3751.9	3334.6	3269.3	2880.0	4553.6	3662.8	2941.8	4479.6	6566.4	5744.2
3	6014.0	3845.9	2292.7	1680.7	1463.0	1262.1	1876.5	1887.3	1818.2	2795.8	4233.3
4	2896.9	3615.8	2374.2	1216.6	730.4	615.4	501.7	924.1	1156.1	1058.1	1658.6
5	742.7	1733.8	2240.7	1350.2	571.3	331.4	264.6	265.2	608.9	724.2	674.8
6	436.2	413.4	1011.1	1191.9	608.8	249.0	137.2	133.4	165.9	362.6	438.6
7	230.1	212.7	247.3	532.9	536.6	264.7	103.4	68.0	81.6	96.9	214.7
8	76.1	128.3	121.9	143.6	255.2	251.4	116.6	57.0	45.2	51.6	62.8
9	44.0	68.7	80.3	110.1	153.5	191.8	238.0	144.4	85.2	60.6	26.0

IBTSA: 2-5+ wr Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	355.8	685.5	634.9	543.7	1013.5	1180.4	764.8	461.8	436.7	437.9	410.5
3	83.5	132.9	245.9	214.5	175.7	346.2	419.4	263.4	161.8	130.8	122.6
4	20.7	33.4	47.2	72.4	71.7	59.8	128.5	155.2	101.3	56.9	36.8
5	11.8	14.1	16.7	19.6	29.4	34.3	32.8	52.4	75.2	71.5	47.8

AGE	1994	1995	1996	1997	1998	1999	2000
2	630.3	538.6	358.5	522.3	777.7	666.3	312.3
3	102.1	163.1	131.4	128.2	202.9	295.8	264.5
4	30.0	26.2	38.6	49.0	46.1	69.6	109.7
5	27.3	18.9	12.2	19.2	26.2	27.7	39.1

IBTSY 1-wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	189.9	418.4	620.3	989.4	1954.2	1757.5	1768.2	3094.4	3771.7	2945.0	1546.1

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1487.6	1367.9	1277.8	2077.8	1752.0	1176.5	1386.4	1897.4	1632.2	754.7	4260.6

MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11.45	12.23	27.69	43.50	93.95	163.70	154.95	137.03	210.43	253.23	221.37

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	110.23	106.09	91.06	88.96	160.04	141.17	93.47	112.32	130.71	102.17	47.29

AGE	1999	2000
0	265.90	137.10

Table 2.8.4 North Sea herring ICAHER output (continued).

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0805	0.0480	0.0122	0.0666	0.0342	0.0092	0.0376	0.0277	0.0325	0.0094	0.0265
1	0.7978	0.3335	0.2250	0.5582	0.8378	0.3174	0.3243	0.3223	0.2805	0.3775	0.2028
2	1.3311	1.5830	0.6261	1.3382	1.0561	1.0000	1.0364	0.4567	1.2394	0.8994	0.7359
3	0.9905	0.8763	1.5520	1.2348	1.1191	0.9524	1.2400	0.8699	1.7482	1.0444	0.9576
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7592	0.9607	1.2310	0.6286	0.8129	0.8430	1.4557	0.8933	1.1531	1.2046	0.6583
6	0.8933	0.8674	1.7792	0.7257	0.5896	0.6427	0.6726	1.0820	1.0910	2.1791	0.8084
7	1.5889	0.5716	1.3008	1.0155	0.6596	0.5187	0.6367	1.5864	1.4424	1.4596	3.0721
8	1.2876	1.0168	1.2148	1.1048	1.0796	0.8629	1.0267	1.0118	1.2734	1.3220	1.2037
9	1.2876	1.0168	1.2148	1.1048	1.0796	0.8629	1.0267	1.0118	1.2734	1.3220	1.2037

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0278	0.0730	0.0466	0.0759	0.1114	0.0843	0.2601	0.4790	0.9751	0.4441	1.6556
1	0.4923	0.7232	0.6837	0.4559	0.5097	0.1389	0.7778	2.0985	1.9134	0.4001	0.9769
2	0.7217	1.0158	1.0350	1.0443	0.9592	0.7817	0.5661	0.2483	1.0816	1.2597	1.1101
3	0.9932	1.0024	1.3494	0.9827	1.1138	0.7946	3.6247	0.4172	0.7437	1.4427	0.9168
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8689	0.6830	0.9628	1.1960	1.3395	0.8636	2.9194	0.1478	0.5444	0.8440	1.3178
6	2.0531	0.6201	1.3706	1.0871	0.9237	0.5402	1.5546	0.6791	0.1205	0.2108	1.2774
7	2.0502	0.1091	0.7515	0.7433	1.4485	0.8012	1.4141	0.4577	3.9876	0.2962	2.7217
8	1.3523	0.9121	1.2142	1.0773	1.2129	0.7783	1.9178	1.1406	1.8287	0.9026	1.6272
9	1.3523	0.9121	1.2142	1.0773	1.2129	0.7783	1.9178	1.1406	1.8287	0.9026	1.6272

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.4102	0.9278	0.4287	0.1179	0.1096	0.2808	0.2183	0.2244	0.1273	0.2495	0.3241
1	0.9475	0.5833	0.3881	0.5267	0.5556	0.6497	1.0274	0.7702	0.8942	0.6888	0.4318
2	1.0922	0.6988	0.5936	0.5553	0.8016	0.7039	0.6329	0.7235	0.7796	1.1182	0.8383
3	2.1300	0.7460	0.8081	0.9170	0.9089	0.8638	0.7058	0.7495	0.7827	0.9582	0.9913
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6175	0.6055	1.1584	0.8832	0.9381	1.0231	1.1250	1.1283	1.0432	1.0739	0.9763
6	0.5557	0.7472	0.6317	0.9531	1.1924	1.0280	1.0954	1.1679	0.9489	1.0196	0.9393
7	0.7916	0.8020	1.1734	0.6807	1.2728	0.9167	1.0690	1.0880	1.2248	0.7990	0.8588
8	1.2559	0.8981	0.9496	0.9313	1.1246	1.0608	1.2014	1.1527	1.1851	1.1445	1.0000
9	1.2559	0.8981	0.9496	0.9313	1.1246	1.0608	1.2014	1.1527	1.1851	1.1445	1.0000

AGE	1993	1994	1995	1996	1997	1998	1999
0	0.3241	0.3241	0.3241	0.3241	0.0513	0.0513	0.0513
1	0.4318	0.4318	0.4318	0.4318	0.1728	0.1728	0.1728
2	0.8383	0.8383	0.8383	0.8383	0.5460	0.5460	0.5460
3	0.9913	0.9913	0.9913	0.9913	0.9919	0.9919	0.9919
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9763	0.9763	0.9763	0.9763	0.9776	0.9776	0.9776
6	0.9393	0.9393	0.9393	0.9393	0.9412	0.9412	0.9412
7	0.8588	0.8588	0.8588	0.8588	0.8567	0.8567	0.8567
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.4 North Sea herring ICAHER output (continued).

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1960	12119020	3909647	2029214	696200	0.3431	0.3175	84
1961	108914620	4482917	1772910	696700	0.3930	0.4091	88
1962	46286600	4498448	1210383	627800	0.5187	0.4930	85
1963	47657780	4725327	2279347	716000	0.3141	0.2190	116
1964	62795290	4874216	2103885	871200	0.4141	0.3371	93
1965	34900620	4406778	1510399	1168800	0.7738	0.6882	86
1966	27866290	3354952	1317790	895500	0.6795	0.6174	93
1967	40263190	2829617	934967	695500	0.7439	0.7953	85
1968	38701490	2526698	418644	717800	1.7146	1.3336	79
1969	21587110	1908039	426776	546700	1.2810	1.1033	103
1970	41091380	1923272	375728	563100	1.4987	1.0997	103
1971	32336790	1851208	267219	520100	1.9463	1.3781	93
1972	20869970	1551239	289235	497500	1.7201	0.6902	108
1973	10167630	1158570	234674	484000	2.0624	1.1264	104
1974	21778480	915861	163420	275100	1.6834	1.0444	103
1975	2968680	686585	84075	312800	3.7205	1.4329	107
1976	2807950	366399	81505	174800	2.1446	1.3433	104
1977	4416080	219872	53064	46000	0.8669	0.7114	83
1978	4688170	235994	71826	11000	0.1531	0.0465	82
1979	10664350	393769	115006	25100	0.2182	0.0596	99
1980	16839640	643614	139993	70764	0.5055	0.2676	91
1981	38016390	1174379	205871	174879	0.8495	0.3259	99
1982	65038030	1862848	289615	275079	0.9498	0.2547	102
1983	62061860	2622090	447758	387202	0.8648	0.3256	92
1984	53712580	2731977	695878	428631	0.6160	0.4404	94
1985	81052850	3166902	717973	613780	0.8549	0.6221	95
1986	97262400	3367546	723764	671488	0.9278	0.5493	87
1987	86086830	3859770	852780	792058	0.9288	0.5318	98
1988	42664820	3655384	1106447	887686	0.8023	0.5159	85
1989	41065090	3351255	1248953	787899	0.6308	0.5271	96
1990	34966250	3166623	1149110	645229	0.5615	0.4324	95
1991	34394100	2976655	971648	658008	0.6772	0.4772	98
1992	62695030	2991069	714005	716799	1.0039	0.6442	100
1993	55692560	2960852	458257	671397	1.4651	0.8097	97
1994	36751200	2380372	502026	568234	1.1319	0.7317	95
1995	44469980	1976951	474149	639146	1.3480	0.8927	98
1996	50654910	1584598	447538	306157	0.6841	0.3924	99
1997	39047430	1957880	568037	272627	0.4799	0.3961	100
1998	18082370	2005231	701465	380178	0.5420	0.4565	99
1999	101611330	2439618	905645	372341	0.4111	0.3763	100

No of years for separable analysis : 8
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 1999
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 57
Number of observations : 338

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1996
Abrupt change in selection specified.

Table 2.8.4 North Sea herring ICAHER output (continued).

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.6788	11	0.5462	0.8435	0.6075	0.7584	0.6830
2	1993	0.8532	10	0.6949	1.0475	0.7684	0.9474	0.8579
3	1994	0.7710	10	0.6241	0.9523	0.6922	0.8587	0.7754
4	1995	0.9406	10	0.7634	1.1590	0.8456	1.0463	0.9460
5	1996	0.4134	12	0.3256	0.5250	0.3660	0.4670	0.4165
6	1997	0.4444	13	0.3399	0.5808	0.3876	0.5094	0.4485
7	1998	0.5122	14	0.3840	0.6833	0.4422	0.5933	0.5178
8	1999	0.4222	16	0.3051	0.5843	0.3577	0.4983	0.4281
Separable Model: Selection (S1) by age 1992 1996								
9	0	0.3241	13	0.2472	0.4249	0.2823	0.3721	0.3272
10	1	0.4318	13	0.3295	0.5659	0.3761	0.4957	0.4359
11	2	0.8383	13	0.6494	1.0822	0.7359	0.9550	0.8455
12	3	0.9913	11	0.7845	1.2527	0.8798	1.1171	0.9984
	4	1.0000		Fixed : Reference Age				
13	5	0.9763	11	0.7796	1.2224	0.8704	1.0949	0.9827
14	6	0.9393	10	0.7616	1.1585	0.8440	1.0454	0.9447
15	7	0.8588	10	0.6946	1.0618	0.7706	0.9570	0.8638
	8	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1997 to 1999								
16	0	0.0513	21	0.0334	0.0789	0.0412	0.0639	0.0526
17	1	0.1728	21	0.1137	0.2627	0.1395	0.2140	0.1768
18	2	0.5460	20	0.3663	0.8137	0.4454	0.6692	0.5574
19	3	0.9919	12	0.7831	1.2564	0.8792	1.1190	0.9991
	4	1.0000		Fixed : Reference Age				
20	5	0.9776	11	0.7790	1.2269	0.8707	1.0977	0.9842
21	6	0.9412	10	0.7611	1.1639	0.8446	1.0489	0.9468
22	7	0.8567	10	0.6913	1.0618	0.7679	0.9559	0.8619
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 1999								
23	0	101611333	16	73081603	141278552	85884453	120218068	103058075
24	1	6479538	14	4851193	8654450	5590024	7510595	6550568
25	2	4727806	12	3667471	6094702	4153247	5381849	4767659
26	3	3109968	12	2446079	3954044	2751370	3515304	3133396
27	4	1062665	12	823651	1371038	933127	1210186	1071682
28	5	386192	15	287752	518308	332358	448745	390568
29	6	238566	15	175012	325200	203688	279417	241565
30	7	115452	16	84237	158234	98301	135596	116955
31	8	31706	17	22443	44792	26581	37818	32202
Separable model: Populations at age								
32	1992	83546	26	50132	139232	64381	108417	86432
33	1993	163461	19	110848	241047	134075	199287	166702
34	1994	153868	17	108891	217422	128985	183551	156281
35	1995	78349	16	56817	108039	66502	92306	79409
36	1996	28675	17	20376	40353	24088	34135	29114
37	1997	23126	15	16920	31609	19718	27123	23422
38	1998	27401	15	20147	37267	23422	32056	27741
Recruitment in year 2000								
39	1999	52391691	27	30792874	89140404	39948557	68710598	54353589
SSB Index catchabilities								
MLAI								
Power model fitted. Slopes (Q) and exponents (K) at age								
40	1 Q	2.927	10	2.586	3.972	2.872	3.575	3.224
41	1 K	.3149E-04	10	.8401E-04	.1290E-03	.9332E-04	.1162E-03	.1100E-03

Table 2.8.4 North Sea herring ICAHER output (continued).

Age-structured index catchabilities

Acoustic survey 2-9+ wr

Linear model fitted. Slopes at age :

42	2	Q	1.627	22	1.306	3.199	1.627	2.569	2.098
43	3	Q	1.913	22	1.536	3.767	1.913	3.024	2.469
44	4	Q	2.080	22	1.668	4.107	2.080	3.294	2.688
45	5	Q	2.317	23	1.855	4.594	2.317	3.679	2.999
46	6	Q	2.417	23	1.933	4.816	2.417	3.851	3.135
47	7	Q	2.397	23	1.909	4.837	2.397	3.852	3.126
48	8	Q	2.638	24	2.084	5.450	2.638	4.307	3.473
49	9	Q	3.421	23	2.726	6.889	3.421	5.490	4.456

IBTSA: 2-5+ wr

Linear model fitted. Slopes at age :

50	2	Q	.1506E-03	12	.1333E-03	.2194E-03	.1506E-03	.1942E-03	.1724E-03
51	3	Q	.1028E-03	12	.9093E-04	.1498E-03	.1028E-03	.1326E-03	.1177E-03
52	4	Q	.6992E-04	12	.6183E-04	.1021E-03	.6992E-04	.9033E-04	.8013E-04
53	5	Q	.3769E-04	12	.3327E-04	.5532E-04	.3769E-04	.4885E-04	.4327E-04

IBTSY 1-wr

Linear model fitted. Slopes at age :

54	1	Q	.1332E-03	5	.1257E-03	.1590E-03	.1332E-03	.1501E-03	.1417E-03

MIK 0-wr

Linear model fitted. Slopes at age :

55	0	Q	.2973E-05	5	.2813E-05	.3529E-05	.2973E-05	.3338E-05	.3156E-05

Parameters of the stock-recruit relationship

56	1	a	.8448E+08	40	.5744E+08	.2775E+09	.8448E+08	.1887E+09	.1369E+09
57	1	b	.6909E+06	66	.3638E+06	.4994E+07	.6909E+06	.2629E+07	.1685E+07

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.2598	0.1657	-0.1528	0.1070	-0.5136	-0.1987	-0.1415	0.3326
1	0.2166	0.0297	-0.4704	-0.3397	0.2403	-0.3744	0.2359	0.1116
2	0.0417	-0.1672	-0.0989	-0.2247	0.0729	0.0602	0.0298	-0.2676
3	-0.3644	-0.1577	-0.1171	-0.1280	0.3966	0.1802	-0.4026	0.0987
4	-0.1578	-0.0657	0.3463	-0.0325	0.0278	0.1036	0.0122	-0.1636
5	-0.1312	-0.0343	-0.0605	0.0485	0.2139	-0.1040	-0.0163	0.0977
6	0.1184	0.0343	0.1383	0.0106	-0.0840	-0.0597	0.1194	-0.0888
7	0.1088	0.0663	-0.0180	0.0829	0.0562	-0.0926	-0.1171	-0.2081
8	-0.0050	-0.0294	-0.1234	0.1553	-0.1602	0.3221	-0.0485	-0.1433

SPAWNING BIOMASS INDEX RESIDUALS

MLAI

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.5584	-0.0151	-0.0087	-0.0601	-0.2770	-0.1472	0.2354	-0.4357	-0.0538	0.3577	0.1962

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.5220	0.0623	-0.3659	-0.1879	-0.6817	-0.4398	0.2924	0.2427	0.3221	-0.1181

Table 2.8.4 North Sea herring ICAHER output (continued).

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 2-9+ wr

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	-0.499	-0.233	-0.163	0.245	0.253	-0.328	0.037	0.436	0.351	0.049	-0.149
3	-0.472	-0.086	-0.424	-0.029	0.253	-0.277	0.091	0.403	0.592	-0.086	0.033
4	-0.586	-0.070	-0.122	0.138	0.219	-0.361	0.268	0.163	0.383	0.438	-0.471
5	-0.420	-0.251	-0.122	0.112	0.330	0.091	0.028	0.159	0.128	0.305	-0.361
6	-0.440	-0.046	-0.301	0.095	0.258	0.254	0.244	-0.301	0.446	0.205	-0.415
7	-0.651	-0.008	0.058	-0.117	0.017	0.214	0.266	0.197	-0.032	0.564	-0.510
8	-0.548	0.044	-0.084	0.076	-0.360	-0.133	-0.058	0.846	0.545	-0.133	-0.196
9	-0.694	-0.469	-0.360	0.392	-0.280	-0.374	-1.042	0.356	0.617	0.695	1.157

IBTSA: 2-5+ wr

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-1.022	-1.468	0.090	0.338	-0.141	1.314	0.127	-0.030	0.558	-0.142	0.644
3	-0.664	-0.762	0.130	0.226	-0.424	0.899	-0.117	0.100	0.505	0.325	0.534
4	-0.389	-0.175	-0.071	0.075	-0.195	0.021	-0.212	0.561	0.862	0.117	0.178
5	0.830	-0.347	0.555	0.323	0.531	-0.276	-1.188	0.318	0.767	0.355	0.293

Age	1994	1995	1996	1997	1998	1999	2000
2	0.551	0.779	-0.614	-0.064	-0.046	-0.450	-0.426
3	0.667	0.357	-1.117	0.393	-0.813	0.543	-0.782
4	0.759	0.167	-1.089	-0.202	-0.836	0.372	0.056
5	0.383	-1.150	-0.304	0.179	-0.321	0.317	-1.268

IBTSY 1-wr

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	-0.1969	-0.2016	-0.1803	-0.2137	-0.4621	-0.1972	0.1639	-0.1967	-0.0235	0.4306	0.4028

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.3813	-0.1657	-0.0950	0.3481	-0.0497	0.0080	0.2243	0.7629	0.2361	-0.0540	-0.1596

MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.401	0.068	0.632	0.843	-0.203	-0.201	-0.523	-0.175	-0.149	-0.356	0.202

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.427	-0.396	-1.257	-0.241	0.226	0.298	0.084	0.123	-0.205	0.371	0.116

Age	1999	2000
0	-0.086	0.000

Table 2.8.4 North Sea herring ICAHER output (continued).

```
 PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 ---------------------------------------------------
 Separable model fitted from 1992  to 1999
 Variance                         0.0755
Skewness test stat.              -1.9279
Kurtosis test statistic           0.3781
Partial chi-square                0.1954
Significance in fit               0.0000
Degrees of freedom                    41

 PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES
 ---------------------------------------------

 DISTRIBUTION STATISTICS FOR MLAI (Power catchability model assumed, Last age is a plus-group)

 Variance                         0.1155
Skewness test stat.              -0.2926
Kurtosis test statistic          -0.6480
Partial chi-square                0.6160
Significance in fit               0.0000
Number of observations                21
Degrees of freedom                    19
Weight in the analysis            1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
------------------------------------------------------------

DISTRIBUTION STATISTICS FOR Acoustic survey 2-9+ wr (linear catchability relationship assumed)

 Age                          2         3         4         5         6         7         8         9
 Variance                0.0113    0.0135    0.0152    0.0081    0.0124    0.0147    0.0192    0.0577
Skewness test stat.     -0.1167    0.3449   -0.5927   -0.5673   -0.2982   -0.6840    1.2837    0.2424
Kurtosis test statisti  -0.7771   -0.4933   -0.7723   -0.7265   -0.9891   -0.1069    0.2115   -0.7354
Partial chi-square       0.0074    0.0092    0.0108    0.0060    0.0098    0.0122    0.0173    0.0519
Significance in fit      0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
Number of observations       11        11        11        11        11        11        11        11
Degrees of freedom           10        10        10        10        10        10        10        10
Weight in the analysis   0.1250    0.1250    0.1250    0.1250    0.1250    0.1250    0.1250    0.1250

DISTRIBUTION STATISTICS FOR IBTSA: 2-5+ wr (linear catchability relationship assumed)

 Age                          2         3         4         5
 Variance                0.1104    0.0925    0.0596    0.1073
Skewness test stat.     -0.4434   -0.7463   -0.5820   -1.4113
Kurtosis test statisti   0.0760   -0.9936    0.1844   -0.4209
Partial chi-square       0.2929    0.3084    0.2610    0.5583
Significance in fit      0.0000    0.0000    0.0000    0.0000
Number of observations       18        18        18        18
Degrees of freedom           17        17        17        17
Weight in the analysis   0.2500    0.2500    0.2500    0.2500

DISTRIBUTION STATISTICS FOR IBTSY 1-wr (linear catchability relationship assumed)

 Age                          1
 Variance                0.0879
Skewness test stat.      1.6104
Kurtosis test statisti   0.2067
Partial chi-square       0.2492
Significance in fit      0.0000
Number of observations       22
Degrees of freedom           21
Weight in the analysis   1.0000

DISTRIBUTION STATISTICS FOR MIK 0-wr (linear catchability relationship assumed)

 Age                          0
 Variance                0.1823
Skewness test stat.     -1.3586
Kurtosis test statisti   1.6156
Partial chi-square       1.0004
Significance in fit      0.0000
Number of observations       24
Degrees of freedom           23
Weight in the analysis   1.0000
```

Table 2.8.4 North Sea herring ICAHER output (continued).

ANALYSIS OF VARIANCE

Unweighted Statistics

	SSQ	Data	Parameters	d.f.	Variance
Total for model	62.7782	338	57	281	0.2234
Catches at age	2.5662	72	38	34	0.0755
MLAI	2.1945	21	2	19	0.1155
Acoustic survey 2-9+ wr	12.1700	88	8	80	0.1521
IBTSA: 2-5+ wr	25.1448	72	4	68	0.3698
IBTSY 1-wr	1.8459	22	1	21	0.0879
MIK 0-wr	4.1924	24	1	23	0.1823
Stock-recruit model	14.6643	39	2	37	0.3963

Weighted Statistics

	SSQ	Data	Parameters	d.f.	Variance
Total for model	12.7074	338	57	281	0.0452
Catches at age	2.5662	72	38	34	0.0755
MLAI	2.1945	21	2	19	0.1155
Acoustic survey 2-9+ wr	0.1902	88	8	80	0.0024
IBTSA: 2-5+ wr	1.5716	72	4	68	0.0231
IBTSY 1-wr	1.8459	22	1	21	0.0879
MIK 0-wr	4.1924	24	1	23	0.1823
Stock-recruit model	0.1466	39	2	37	0.0040

Table 2.10.1

Short term deterministic prediction for North sea herring

Modified from a previous spreadsheet made by Per Sparre, 1995, assuming migration of juv. herring
D.W.Skagen, IMR, Bergen, Norway Last update 6/3-98

NBNBNB
The values of SPLIT factors
are based on the identity link model

Start with filling in the **pink** fields in this **INPUT** sheet
Then, go to the sheet **PREDICT** to adjust the F-mulitpliers for each fleet and see the results
Reference F's based on input from the reference year are computed in Ref.F
The background computations are done in Calculate

Reference year: **1999**
(=last assessment year, used for calculating fishing pattern and partial F's)

Data for 1999 =Reference year

Note: For ages 0-1 F's are generated from the entered stock numbers and catches.
For older ages, F's are entered (and presumably taken from the assessment)

Age	Stock numbers	Fishing mortality	Nat. mort	Catches in numbers by fleet: North Sea A	B	IIIa C	D	E	Fraction of Stock in North sea (The remainder is in the IIIa. Only for 0-1 ringers, the older are treated as one stock)
0	101610		1	0.9	968.3	24.0	930.5		0.654
1	6480		1	36.9	44.1	105.3	137.9		0.63
2		0.2305	0.3	479.7	21.0	87.3	59.2		
3		0.4188	0.2	1004.7	20.4	36.5	10.4		
4		0.4222	0.1	280.7	4.3	8.3	3.5		
5		0.4128	0.1	130.9	1.0	3.6	2.0		
6		0.3974	0.1	66.6	0.8	0.9	0.0		
7		0.3617	0.1	25.8	0.2	0.3	0.8		
8		0.4222	0.1	8.5	0.0	0.3	0.2		
9+		0.4222	0.1	3.3	0.0	0.0	0.0		

Data for 2000

The prediction starts with these stock numbers at 1. Jan.

Age	Stock numbers	Nat. mort	Weight in sp.stock	Fraction mature	Weight in catch by fleet: A	B	C	D	E	Fraction of Stock in North sea (The remainder is in the IIIa)
0	52390	1	0.007	0	9.0	13.6	23.4	18.4		0.69
1	36580	1	0.043	0	69.3	35.7	55.9	35.4		0.654
2	2220	0.3	0.091	0.74	122.0	62.5	86.7	70.4		
3	2780	0.2	0.184	0.9	149.5	131.4	117.9	99.7		**Proportions before spawning**
4	1680	0.1	0.222	1	177.1	139.9	151.3	152.7		**F** 0.67
5	630	0.1	0.256	1	214.2	188.4	170.9	178.3		**M** 0.67
6	230	0.1	0.287	1	235.5	192.2	195.0	79.2		
7	150	0.1	0.28	1	247.2	215.9	192.9	232.0		
8	70	0.1	0.269	1	269.3	142.5	219.9	197.4		
9+	20	0.1	0.311	1	288.8	0.0	0.0	0.0		

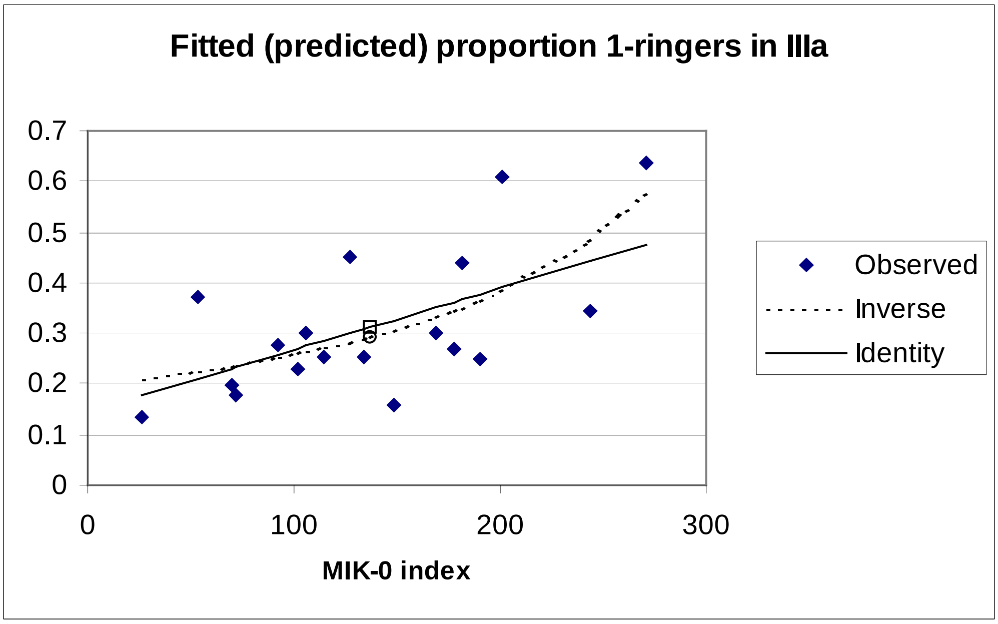
Data for 2001

Age	Recruits	Nat. mort	Weight in sp.stock	Fraction mature	Weight in catch by fleet: A	B	C	D	E	Fraction of Stock in North sea (The remainder is in the IIIa)
0	44000	1	0.007	0	9.0	13.6	23.4	18.4		0.69
1		1	0.043	0	69.3	35.7	55.9	35.4		0.69
2		0.3	0.091	0.74	122.0	62.5	86.7	70.4		
3		0.2	0.184	0.9	149.5	131.4	117.9	99.7		**Proportions before spawning**
4		0.1	0.222	1	177.1	139.9	151.3	152.7		**F** 0.67
5		0.1	0.256	1	214.2	188.4	170.9	178.3		**M** 0.67
6		0.1	0.287	1	235.5	192.2	195.0	79.2		
7		0.1	0.28	1	247.2	215.9	192.9	232.0		
8		0.1	0.269	1	269.3	142.5	219.9	197.4		
9+		0.1	0.311	1	288.8	0.0	0.0	0.0		

Table 2.10.2

North Sea Herring - Split factors for Short term predictions

Year-class	MIK-0	IBTS 1-ring Prop.IIIa	Fitted (Predicted in bold) Proportion 1-ringers in IIIa: Inverse link	(se)	Identity link	(se)
1981	133.9	0.254	0.29	0.025	0.31	0.026
1982	91.8	0.276	0.25	0.025	0.26	0.024
1983	115.0	0.255	0.27	0.025	0.29	0.024
1984	181.3	0.439	0.35	0.031	0.37	0.038
1985	177.4	0.267	0.34	0.030	0.36	0.037
1986	270.9	0.636	0.58	0.143	0.48	0.070
1987	168.9	0.3	0.33	0.028	0.35	0.035
1988	71.4	0.177	0.24	0.025	0.23	0.027
1989	25.9	0.134	0.21	0.026	0.18	0.040
1990	69.9	0.199	0.23	0.026	0.23	0.028
1991	200.7	0.611	0.38	0.039	0.39	0.045
1992	190.1	0.25	0.36	0.034	0.38	0.041
1993	101.7	0.23	0.26	0.025	0.27	0.024
1994	126.9	0.45	0.28	0.025	0.30	0.025
1995	106.2	0.3	0.26	0.025	0.27	0.024
1996	148.1	0.16	0.31	0.025	0.33	0.029
1997	53.1	0.37	0.22	0.026	0.21	0.032
1998	244.0	0.346	0.48	0.083	0.44	0.060
1999	137.1		0.29	0.025	0.31	0.027
Average	137.6		**0.29**	0.025	**0.31**	0.027



(The open symbols show predicted values)

Table 2.10.3. North Sea Herring – Split Factor model results.

Data are as in Table 2.10.2; Models were fitted in Splus

```
Model: Gamma errors, Inverse link
summary(modgin)
Call: glm(formula = prop3a ~ mik0, family = Gamma(link = inverse), data = splitdat, subset = 1:17)
Deviance Residuals:
       Min          1Q       Median          3Q         Max
 -0.5962222  -0.2650335  -0.1157085     0.1344845   0.5660496

Coefficients:
               Value  Std. Error   t value
(Intercept)  5.26577881 0.691071101  7.619735
       mik0 -0.01378387 0.003727759 -3.697629

(Dispersion Parameter for Gamma family taken to be 0.1204686 )
    Null Deviance: 3.141007 on 16 degrees of freedom
Residual Deviance: 1.720605 on 15 degrees of freedom
Number of Fisher Scoring Iterations: 4
Correlation of Coefficients:
     (Intercept)
mik0 -0.9287429

Model: Gamma errors, Identity link
summary(modgid)
Call: glm(formula = prop3a ~ mik0, family = Gamma(link = identity), data = splitdat, subset = 1:17)
Deviance Residuals:
        Min         1Q    Median        3Q       Max
 -0.6523648 -0.2421715 -0.141844 0.1587973 0.6363859
Coefficients:
               Value   Std. Error  t value
(Intercept) 0.138529314 0.0500342597 2.768689
       mik0 0.001310251 0.0004357545 3.006855
(Dispersion Parameter for Gamma family taken to be 0.1285742 )
    Null Deviance: 3.141007 on 16 degrees of freedom
Residual Deviance: 1.838576 on 15 degrees of freedom
Number of Fisher Scoring Iterations: 3
Correlation of Coefficients:
     (Intercept)
mik0 -0.8738587
```

Table 2.10.4

Calculation of over/undershoot ratios from 1999 data.

OVER/UNDERshoot ratios from 1999 data				
Fleet	A	B	C	D
TAC 1999	265000	30000	80000	19000
Catch of Autumn spawners in 1999	315770	15205	20180	21088
Catch of Spring spawners in 1999	0	0	30498	14723
Expected proportion Autumn spawners in TAC[1]	1	1	0.5	0.6
Expected catch of autumn spawners in 1999	265000	30000	40000	11400
Catch of Autumn spawners in 1999	315770	15205	20180	21088
Overshoot ratio (catch/expectd catch) in 1999 (rounded)	1.2	0.5	0.5	1.8

Calculation of catch constraints to use for 2000 in short term projections

CATCH Constraints for 2000						
	A	B	C	D	TOTAL	
TAC in 2000	265000	36000	80000	21000	402000	
Expected proportion Autumn spawners in TAC[1]	1	1	0.5	0.6		
Expected Catch of Autumn spawners in 2000 TAC	**265000**	**36000**	**40000**	**12600**	**353600**	< use for TAC constraint in 2000[2]
Expected catch of Spring spawners in 2000 TAC	0	0	40000	8400		
Overshoot ratio from 1999 data	1.2	0.5	0.5	1.8		
Overshoot on expected catch of Autumn spawners	53000	-18000	-20000	10400	25400	
TAC+Overshoot of Autumn spawners (rounded)	**318000**	**18000**	**20000**	**23000**	**379000**	<use for TAC+ Overshoot constraint in 2000

[1] Based on average (1997-1999) proportions of North sea autumn spawners to Baltic spring spawners in catches by fleet.

[2] Note that this is referred to as a 'TAC constraint', but actually represents the expected catch of North Sea autumn spawners, particularly for fleets C and D.

Table 2.10.5

2000 Based on TAC+Over/undershoot constraint

Predictions for 2000, based on TAC+Overshoot Constraint in 2000 (in '000t)

Fjuv (0-1 ring)	Fad (2-6 ring)	Fleet F's FB-E	FA	Fleet Yields in '000t A	B	C	D	TOTAL Yield	SSB 2000
0.04	0.33	0.03	0.32	318	18	20	23	379	908

Prediction summary: Yields for 2001 (in '000t)

Scenario	Fjuv (0-1 ring)	Fad (2-6 ring)	Fleet F's FB-E	FA	Fleet Yields in '000t A	B	C	D	TOTAL Yield	SSB 2001
I	0.03	0.20	0.03	0.19	276	16	17	20	329	1473
II	0.05	0.20	0.05	0.18	262	27	30	34	352	1469
III	0.10	0.20	0.10	0.15	223	54	60	69	407	1457
IV	0.12	0.25	0.12	0.19	276	64	71	82	494	1411
V	0.05	0.20	0.05	0.18	266	29	17	37	348	1470
VI	0.10	0.20	0.10	0.16	238	61	15	78	393	1462
VII	0.12	0.25	0.12	0.20	294	72	18	93	478	1417
VIII	0.05	0.38	0.04	0.36	493	24	31	30	578	1327

	CONSTRAIN F	**Maintain catch ratios**
I	Fjuv < or = 0.1, Fad=0.2	maintain catch proportions in ALL fleets
II	Fjuv=0.05, Fad=0.2	maintain catch proportions for fleets B,C,D
III	Fjuv=0.1, Fad=0.2	maintain catch proportions for fleets B,C,D
IV	Fjuv=0.12, Fad=0.25	maintain catch proportions for fleets B,C,D
V	Fjuv=0.05, Fad=0.2	maintain catch ratios for fleets A:C and B:D
VI	Fjuv=0.1, Fad=0.2	maintain catch ratios for fleets A:C and B:D
VII	Fjuv=0.12, Fad=0.25	maintain catch ratios for fleets A:C and B:D
VIII	F1999 from ICA	maintain catch ratios for fleets A:C and B:D

2000 Based on TAC constraint

Predictions for 2000, based on TAC Constraint in 2000 (in '000t)

Fjuv (0-1 ring)	Fad (2-6 ring)	Fleet F's FB-E	FA	Fleet Yields in '000t A	B	C	D	TOTAL Yield	SSB 2000
0.05	0.28	0.04	0.26	265	36	40	13	354	941

Prediction summary: Yields for 2001 (in '000t)

Scenario	Fjuv (0-1 ring)	Fad (2-6 ring)	Fleet F's FB-E	FA	Fleet Yields in '000t A	B	C	D	TOTAL Yield	SSB 2001
VI.b	0.10	0.20	0.10	0.16	235	91	35	32	394	1499

	CONSTRAIN F	Maintain catch ratios
VI.b	Fjuv= 0.1, Fad=0.2	maintain catch ratios for fleets A:C and B:D

Table 2.10.6

NORTH SEA HERRING SHORT TERM PREDICTIONS **SENSITIVITY TO POPULATION SIZE INPUT**

year	Fjuv (0-1 ring)	Fad (2-6 ring)	Fleet F's FB-E	FA	Fleet Yields in '000t A	B	C	D	TOTAL Yield	(in '000t) SSB	year	
2000	0.05	0.52	0.05	0.50	318	18	20	23	379	**559**	2000	**LOWER 95% ESTIMATE**
2001	0.03	0.20	0.03	0.19	155	10	11	13	189	**940**	2001	**OF POPULATION SIZE**
2000	0.04	0.33	0.03	0.32	318	18	20	23	379	**908**	2000	**POINT ESTIMATE**
2001	0.03	0.20	0.03	0.19	276	16	17	20	329	**1473**	2001	**OF POPULATION SIZE**

Predictions for 2000, based on TAC+Overshoot Constraint
Predictions for 2001 based on Fjuv=0.09, Fad=0.2; maintain proportions for fleets A:C and B:D

Table 2.11.1 Projection input file, North Sea herring 2000 WG

Number of Fleets and projection years

4	10

Catch Ratio by Fleet (1999)

	A	B	C	D&E
0	0.0005	0.5034	0.0125	0.4837
1	0.1137	0.1360	0.3249	0.4253
2	0.7412	0.0324	0.1349	0.0915
3	0.9373	0.0190	0.0340	0.0097
4	0.9459	0.0145	0.0278	0.0119
5	0.9520	0.0074	0.0262	0.0145
6	0.9750	0.0114	0.0133	0.0004
7	0.9493	0.0090	0.0128	0.0289
8	0.9380	0.0000	0.0387	0.0233
9	1.0000	0.0000	0.0000	0.0000

Retention Ogive for each fleet by age valid for all years

0	1	1	1	1
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1

Exploitation Constraint by Year

2000	318000	18000	20000	23000
2001	-1	-1	-1	-1
2002	-1	-1	-1	-1
2003	-1	-1	-1	-1
2004	-1	-1	-1	-1
2005	-1	-1	-1	-1
2006	-1	-1	-1	-1
2007	-1	-1	-1	-1
2008	-1	-1	-1	-1
2009	-1	-1	-1	-1

Mean Weight at age in the catches of each fleet

0	0.0090	0.0136	0.0234	0.0184
1	0.0693	0.0357	0.0559	0.0354
2	0.1220	0.0625	0.0867	0.0704
3	0.1495	0.1314	0.1179	0.0997
4	0.1771	0.1399	0.1513	0.1527
5	0.2142	0.1884	0.1709	0.1783
6	0.2355	0.1922	0.1950	0.0792
7	0.2472	0.2159	0.1929	0.2320
8	0.2693	0.1425	0.2199	0.1974
9	0.2888	0.0000	0.0000	0.0000

Mean weights at age in the discard by fleet

0	0.0090	0.0136	0.0234	0.0184
1	0.0693	0.0357	0.0559	0.0354
2	0.1220	0.0625	0.0867	0.0704
3	0.1495	0.1314	0.1179	0.0997
4	0.1771	0.1399	0.1513	0.1527
5	0.2142	0.1884	0.1709	0.1783
6	0.2355	0.1922	0.1950	0.0792
7	0.2472	0.2159	0.1929	0.2320
8	0.2693	0.1425	0.2199	0.1974
9	0.2888	0.0000	0.0000	0.0000

Table 2.11.1 continued

First year for F-constraint

2001

Target Multiplier by fleet and by year

2001	-0.521	-0.658	-0.658	-0.658
2002	-0.521	-0.658	-0.658	-0.658
2003	-0.521	-0.658	-0.658	-0.658
2004	-0.521	-0.658	-0.658	-0.658
2005	-0.521	-0.658	-0.658	-0.658
2006	-0.521	-0.658	-0.658	-0.658
2007	-0.521	-0.658	-0.658	-0.658
2008	-0.521	-0.658	-0.658	-0.658
2009	-0.521	-0.658	-0.658	-0.658

CV of Target F-Multipliers

2001	0.0001	0.0001	0.0001	0.0001
2002	0.0001	0.0001	0.0001	0.0001
2003	0.0001	0.0001	0.0001	0.0001
2004	0.0001	0.0001	0.0001	0.0001
2005	0.0001	0.0001	0.0001	0.0001
2006	0.0001	0.0001	0.0001	0.0001
2007	0.0001	0.0001	0.0001	0.0001
2008	0.0001	0.0001	0.0001	0.0001
2009	0.0001	0.0001	0.0001	0.0001

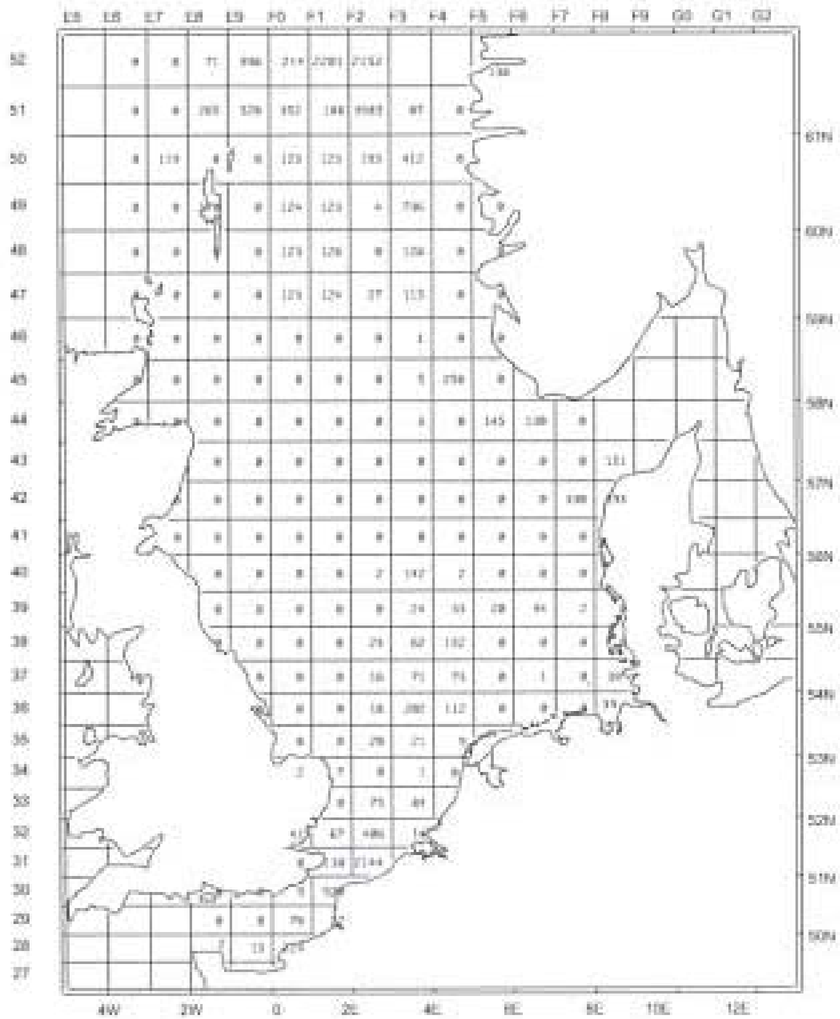


Fig. 2.1.1: Herring catches (in tonnes) in the North Sea in 1999 by statistical rectangle. Working group estimates (if available). **a:** 1st quarter.

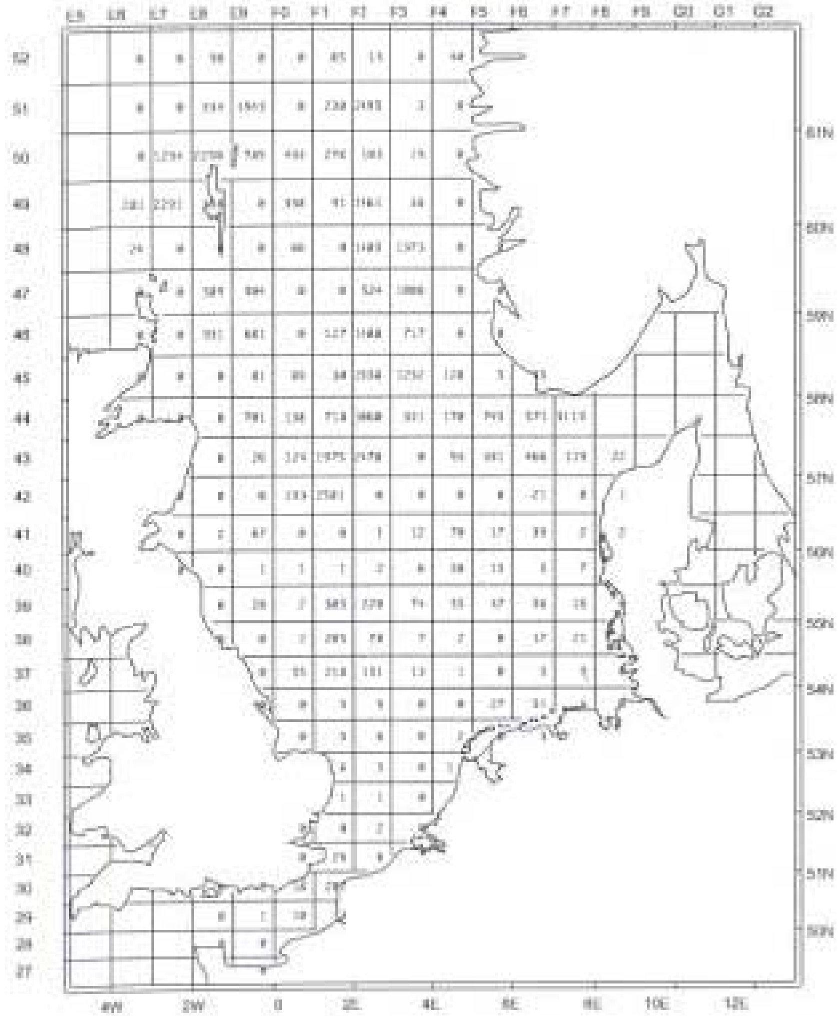


Fig. 2.1.1 (cont'd): Herring catches (in tonnes) in the North Sea in 1999 by statistical rectangle. Working group estimates (if available). **b:** 2nd quarter.

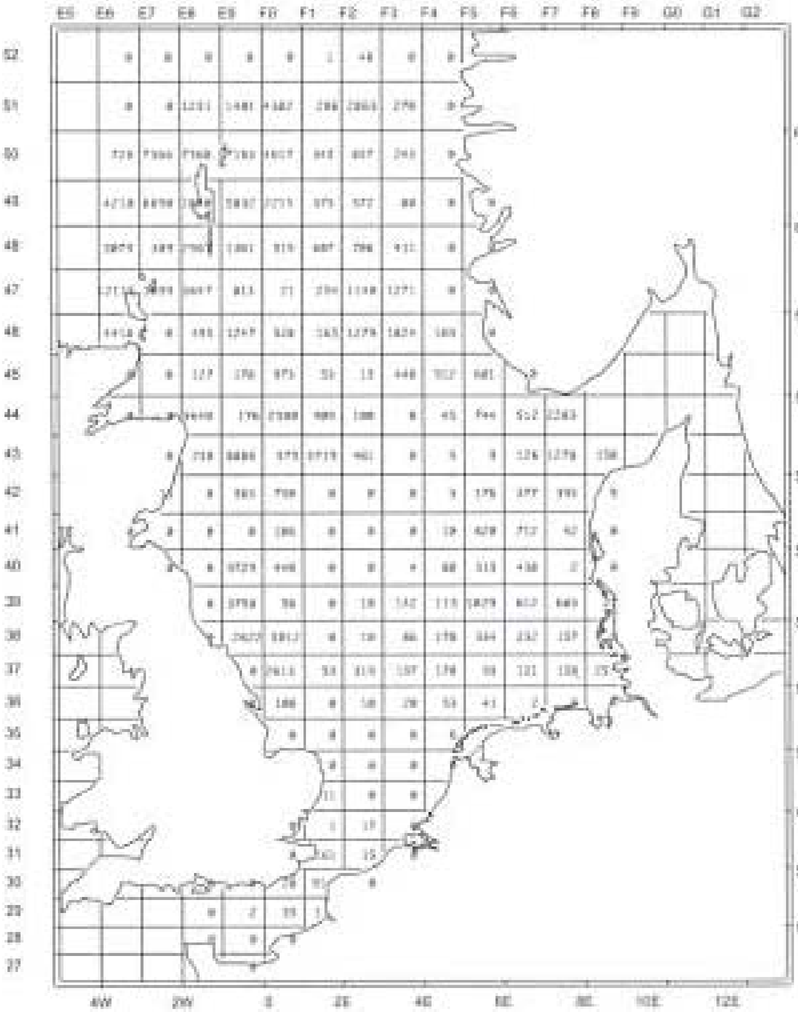


Fig. 2.1.1 (cont'd): Herring catches (in tonnes) in the North Sea in 1999 by statistical rectangle. Working group estimates (if available). **c:** 3rd quarter.

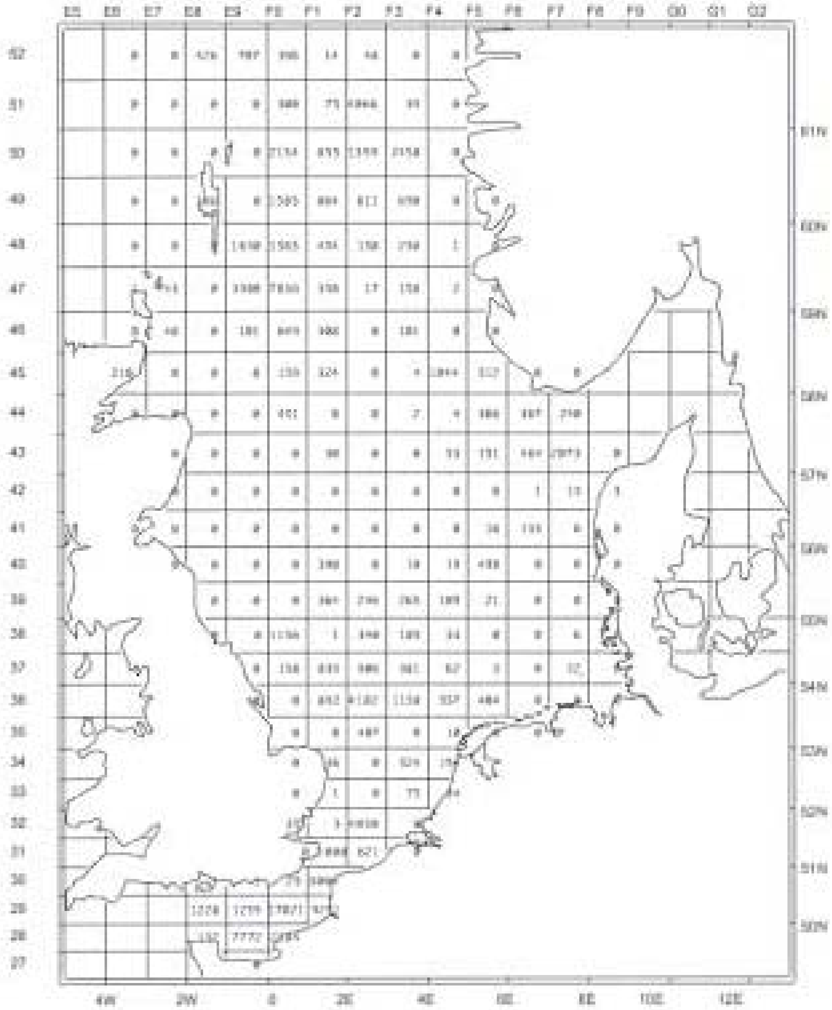


Fig. 2.1.1 (cont'd): Herring catches (in tonnes) in the North Sea in 1999 by statistical rectangle. Working group estimates (if available). **d:** 4th quarter.

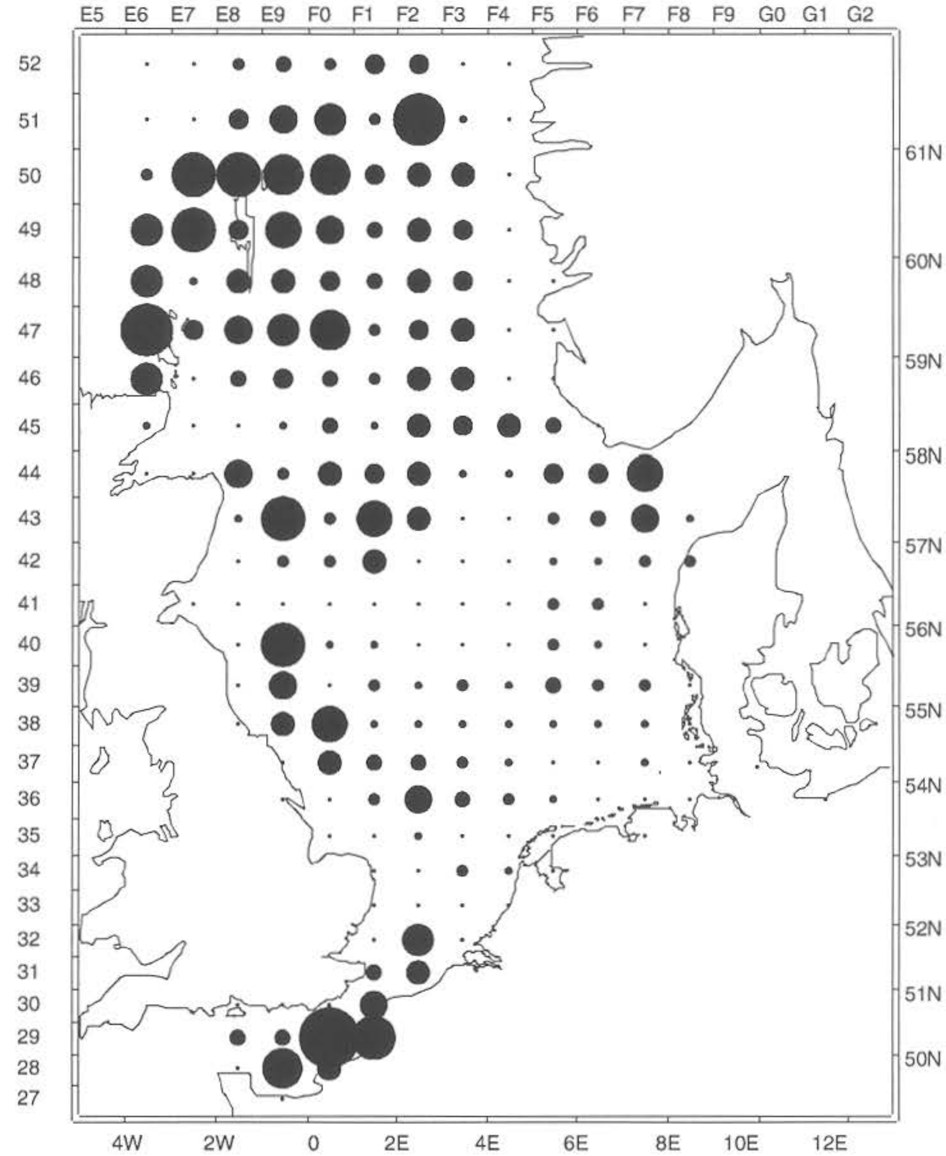


Fig. 2.1.1 (cont'd): Herring catches (circle area is proportional to catch) in the North Sea in 1999 by statistical rectangle. Working group estimates (if available). **e:** all quarters.

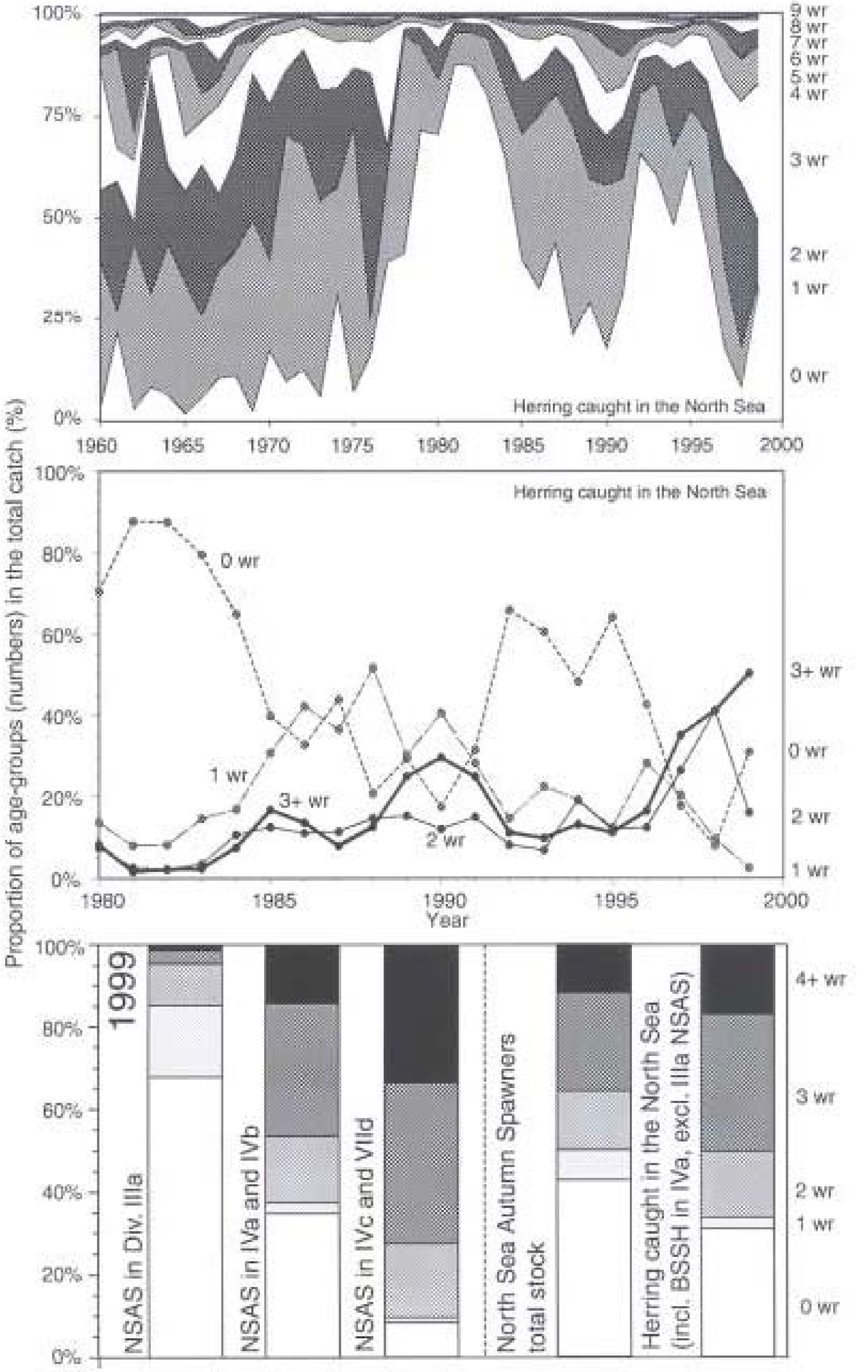


Fig. 2.2.1: Porportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960-1999, and middle panel, 1980-1999), and in the total catch of North Sea Autumn Spawners in 1999 (lower panel).

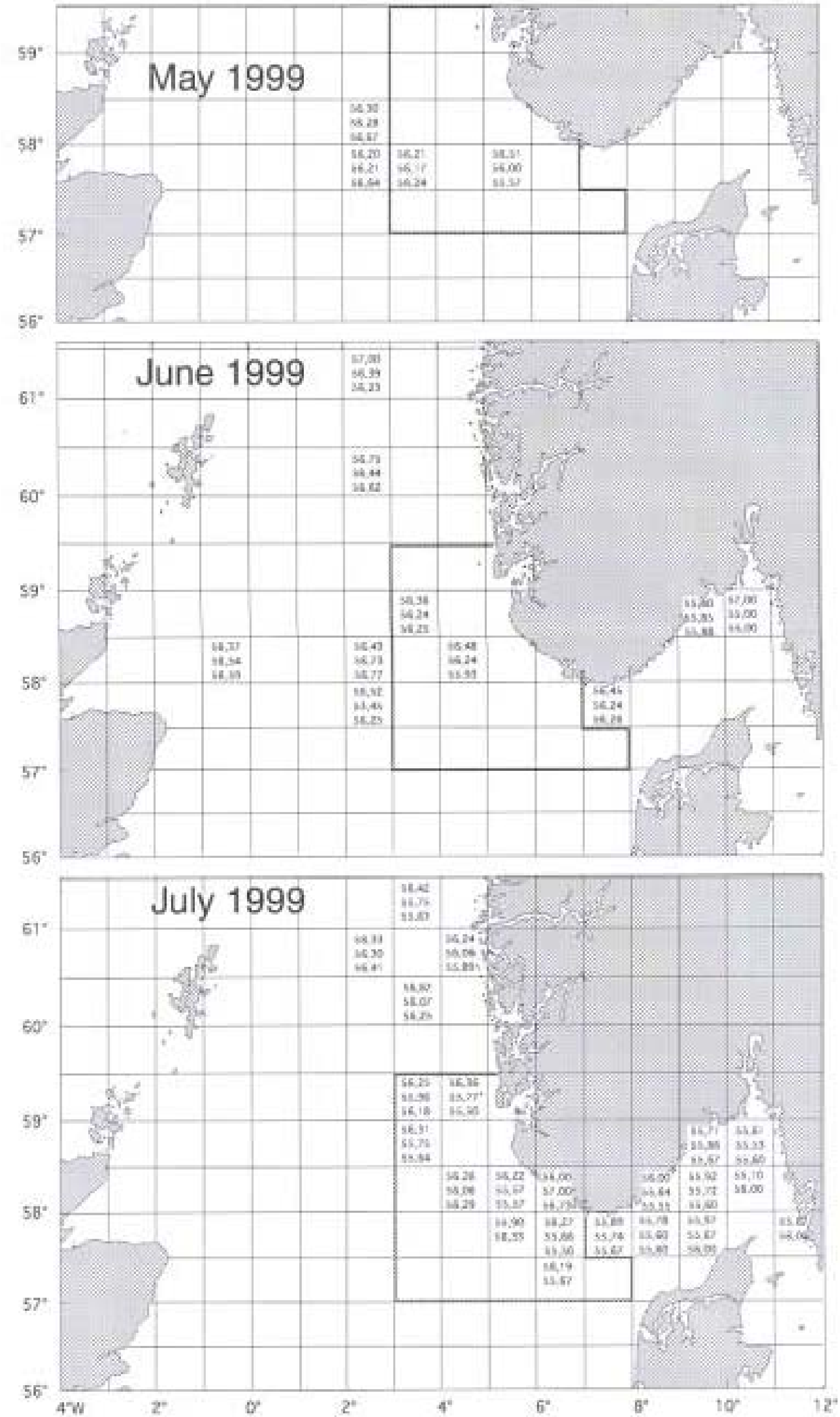


Fig. 2.2.2: Mean vertebrae counts of 2, 3 and 4+ herring in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 1999. The transfer area (Baltic Spring Spawners transfered to the assessment of IIIa herring) is indicated.

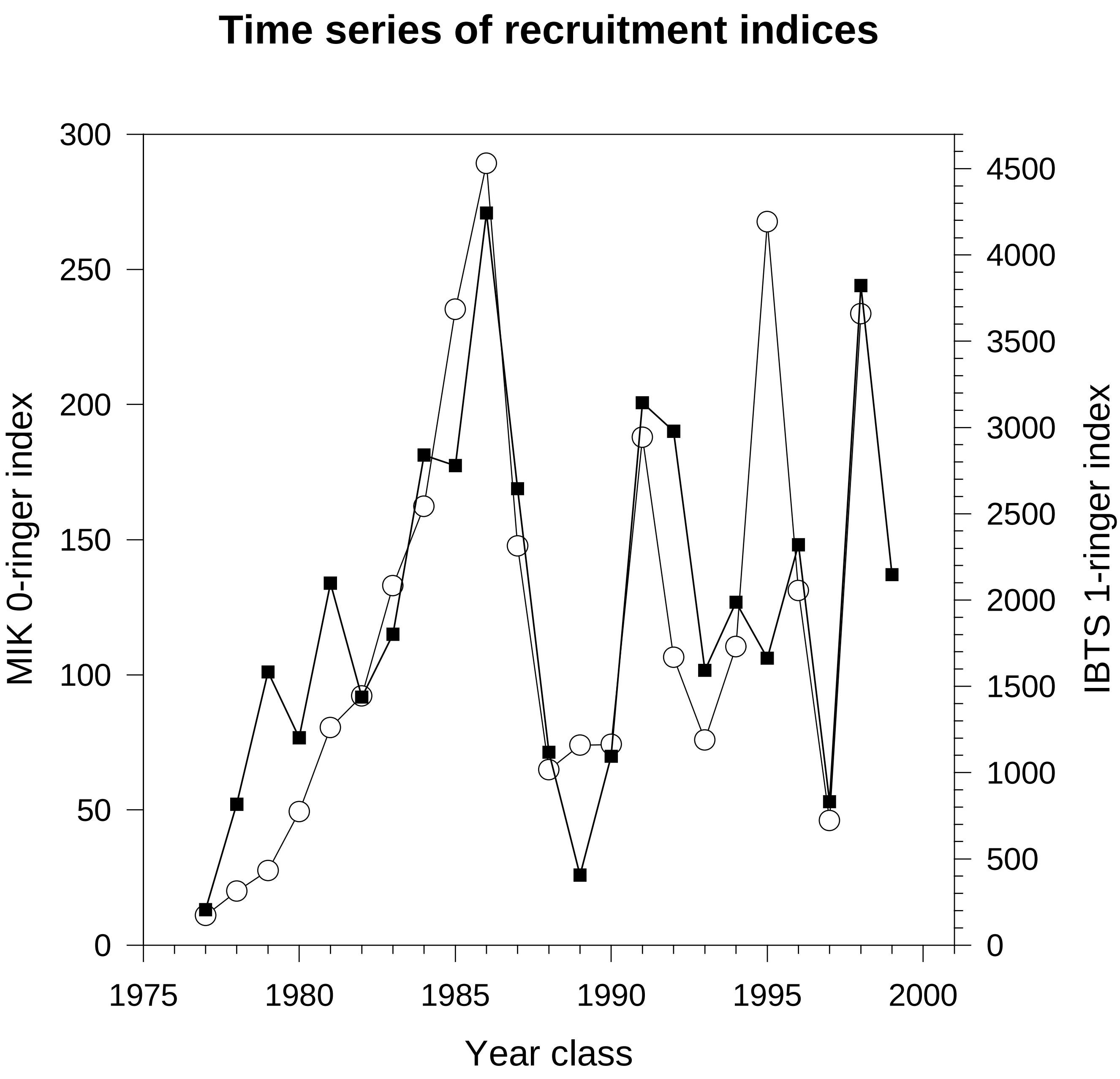


Figure 2.3.1 Time series of the 0-ringer and the 1-ringer indices, 0-ringers are illustrated by filled squares, 1-ringers by open circles.

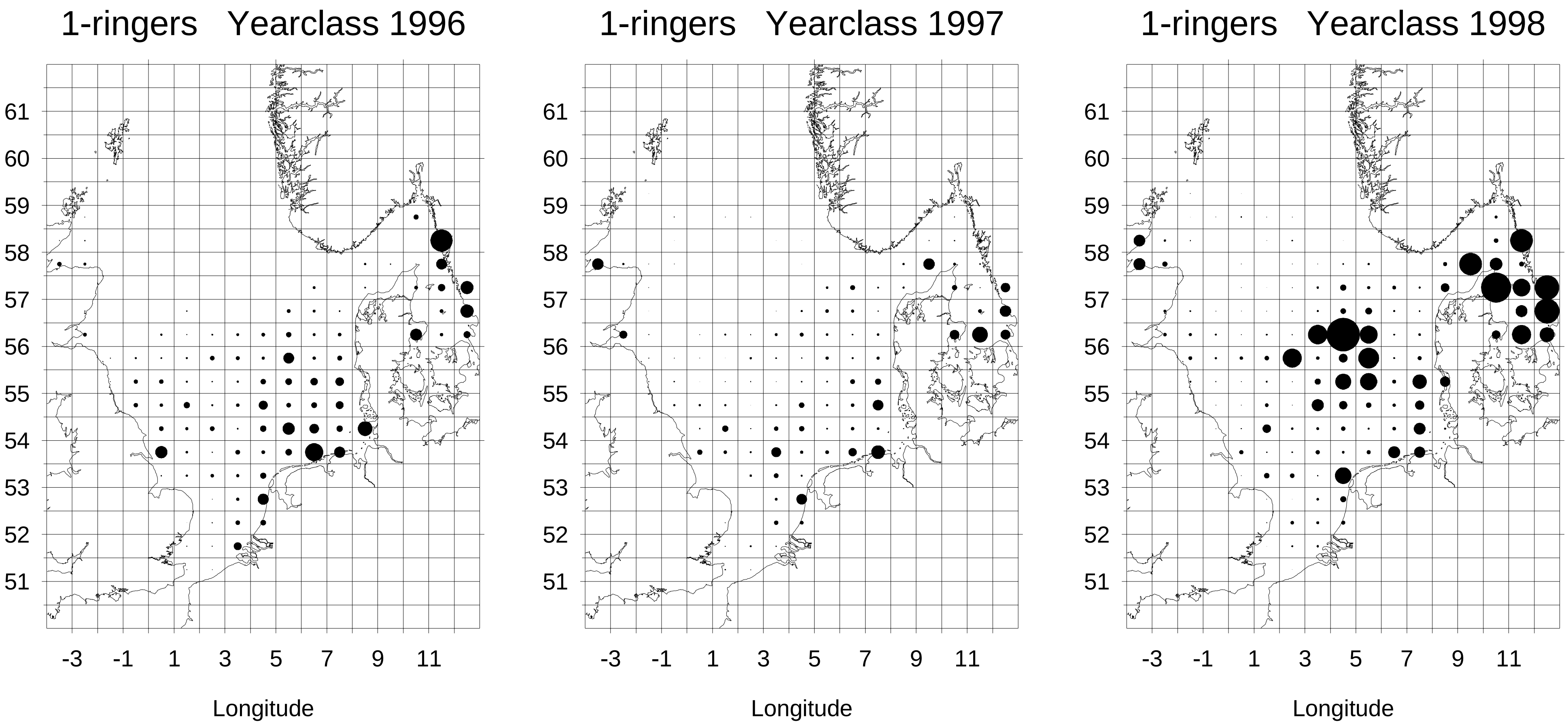


Figure 2.3.2 Distribution of 1-ringer herring, year classes 1996-1998. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000.

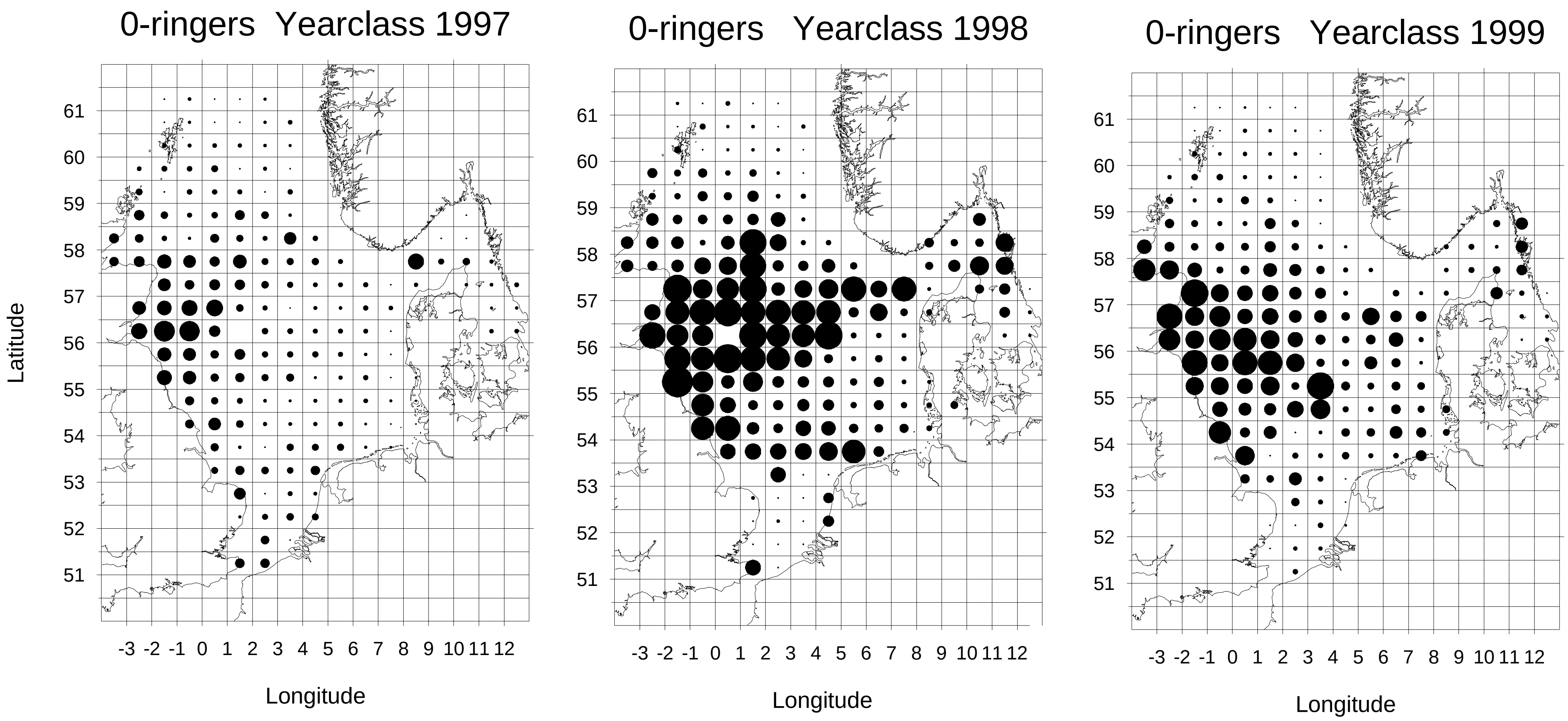


Figure 2.3.3 Distribution of 0-ringer herring, year classes 1997-1999. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

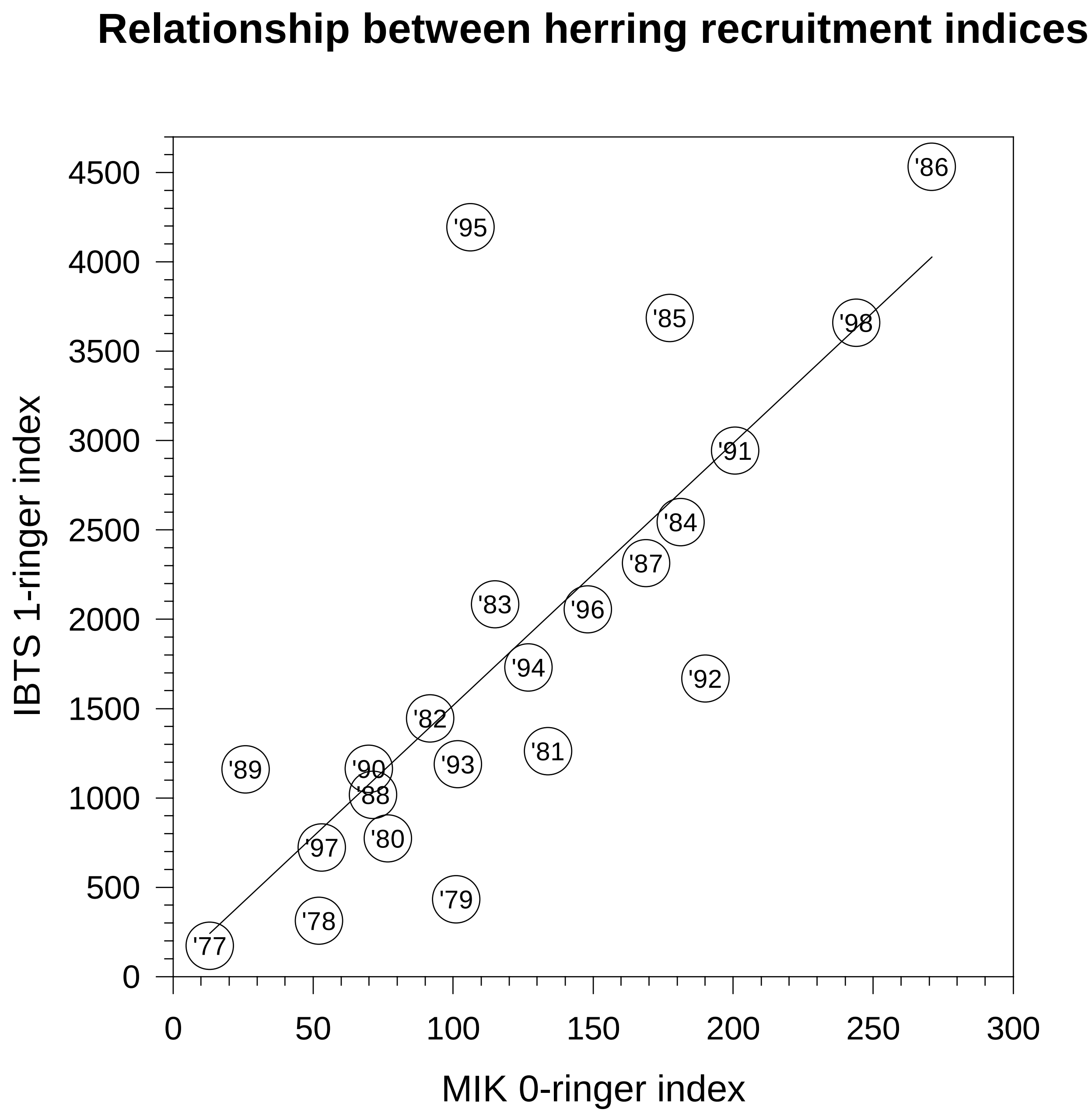


Figure 2.3.4 Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 1998. Numbers in symbols indicate year class.

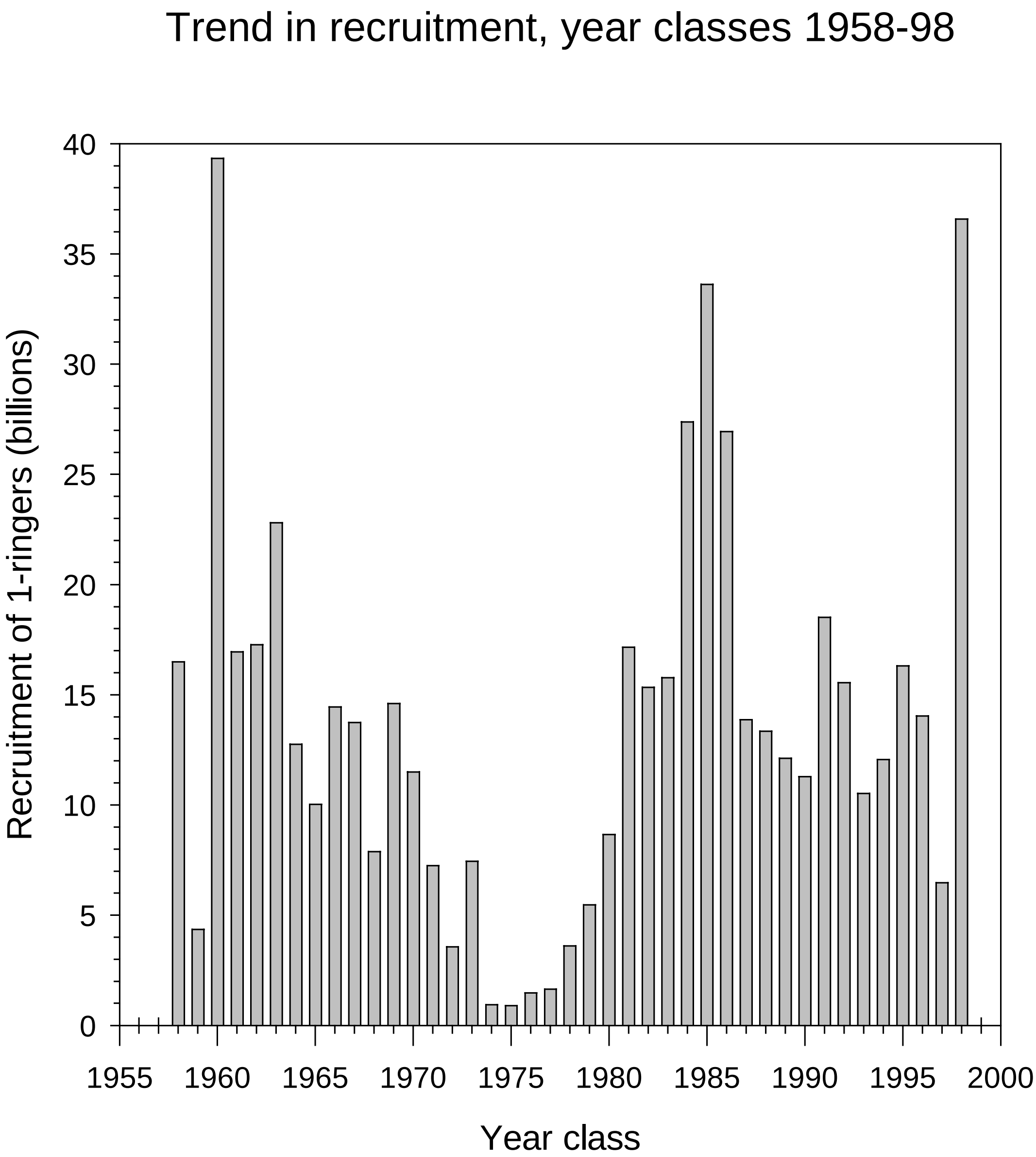


Figure 2.3.5 Recruitment of 1-ringer North Sea autumn spawners. Estimates from the ICA assessment in 2000.

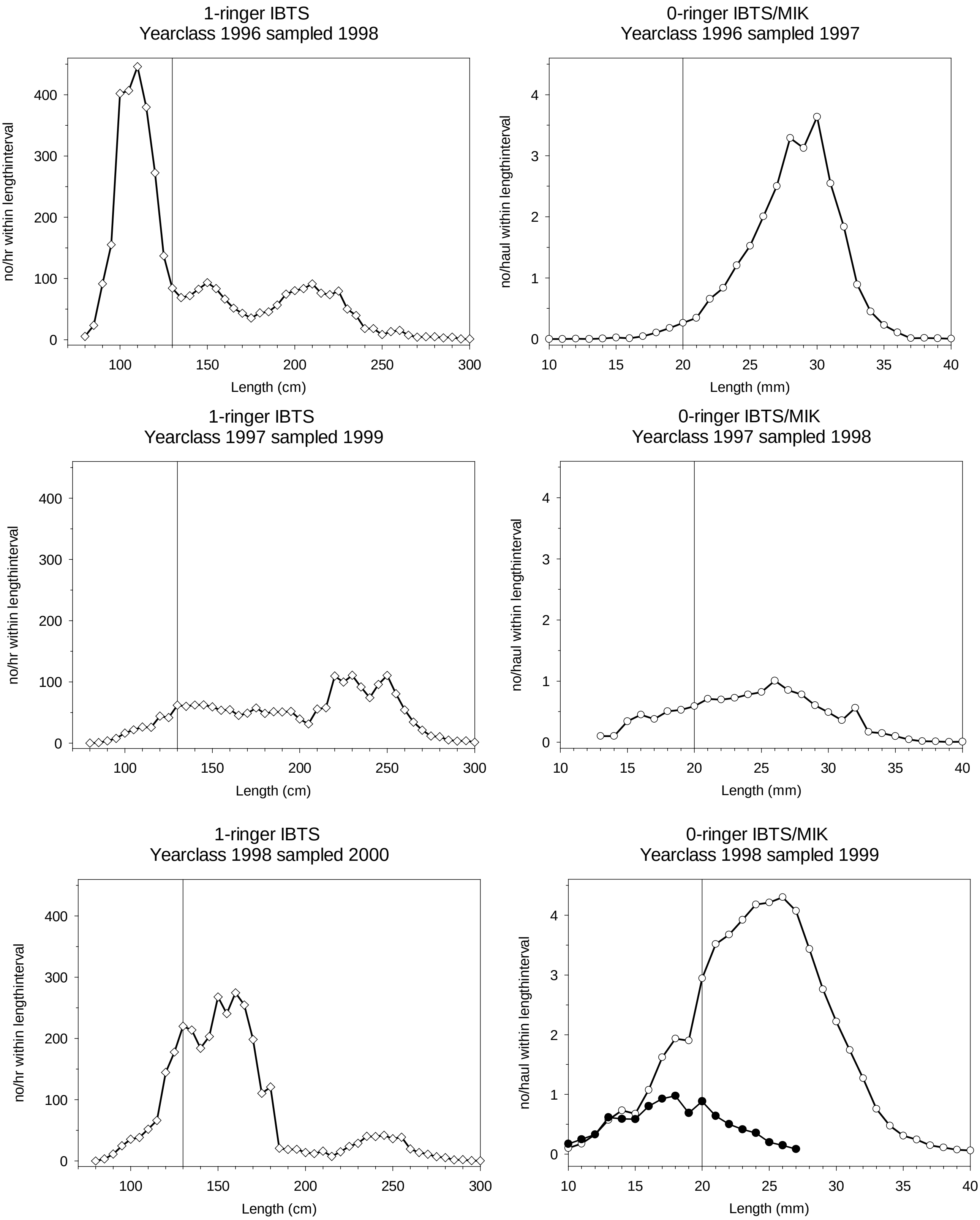


Figure 2.3.6 Length distributions of 1-ringers and 0-ringers. 1-ringers sampled during the 1998-2000 IBTS, separation at 13 cm is indicated. 0-ringers sampled during the 1997-1999 IBTS, separation at 20 mm is indicated. Length distribution of sampled larvae (mean <20mm) from the Channel area is inserted in graph for 1999 sampling.

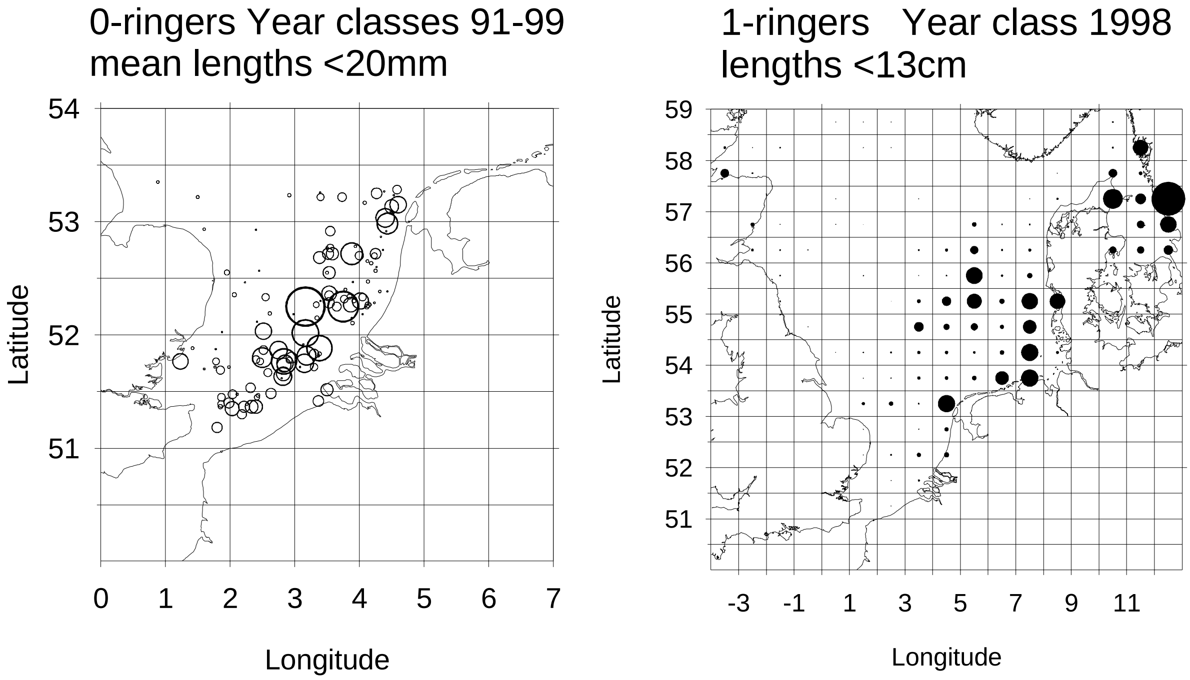


Figure 2.3 7 Distrubution of small 0- and 1 ringers. O-ringer abundance as measured during sampling 1992-2000, larvae <20mm in Southern Bight only. 1-ringer abundance as measured during the sampling in 2000, herring <13 cm.

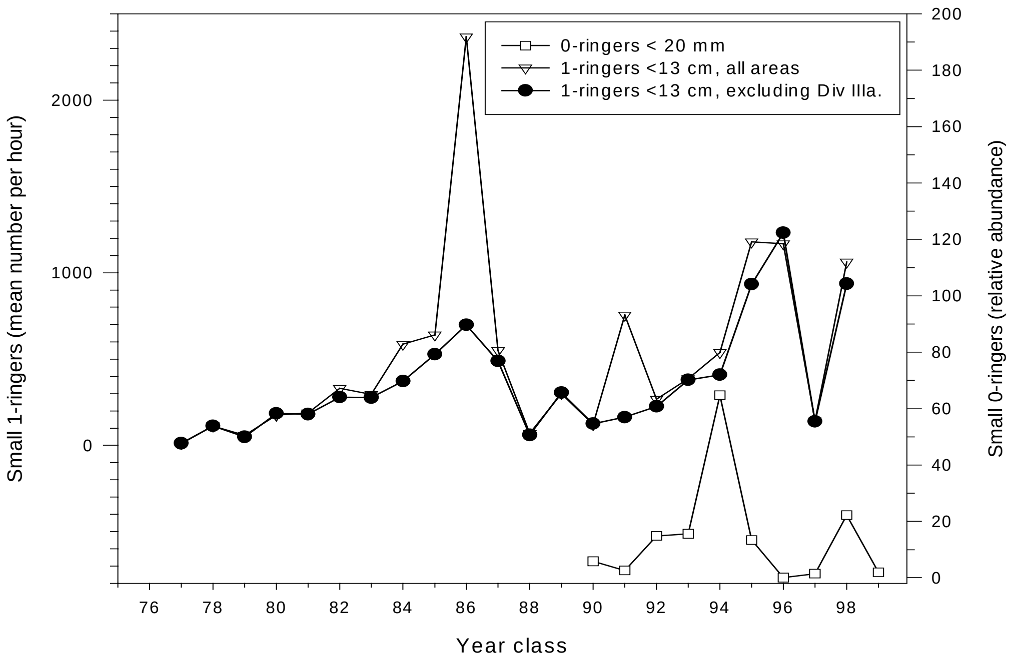


Figure 2.3.8. Abundance estimates of small 0-ringers (< 20 mm) and 1-ringers (< 13 cm), from the IBTS sampling year classes 77-99.

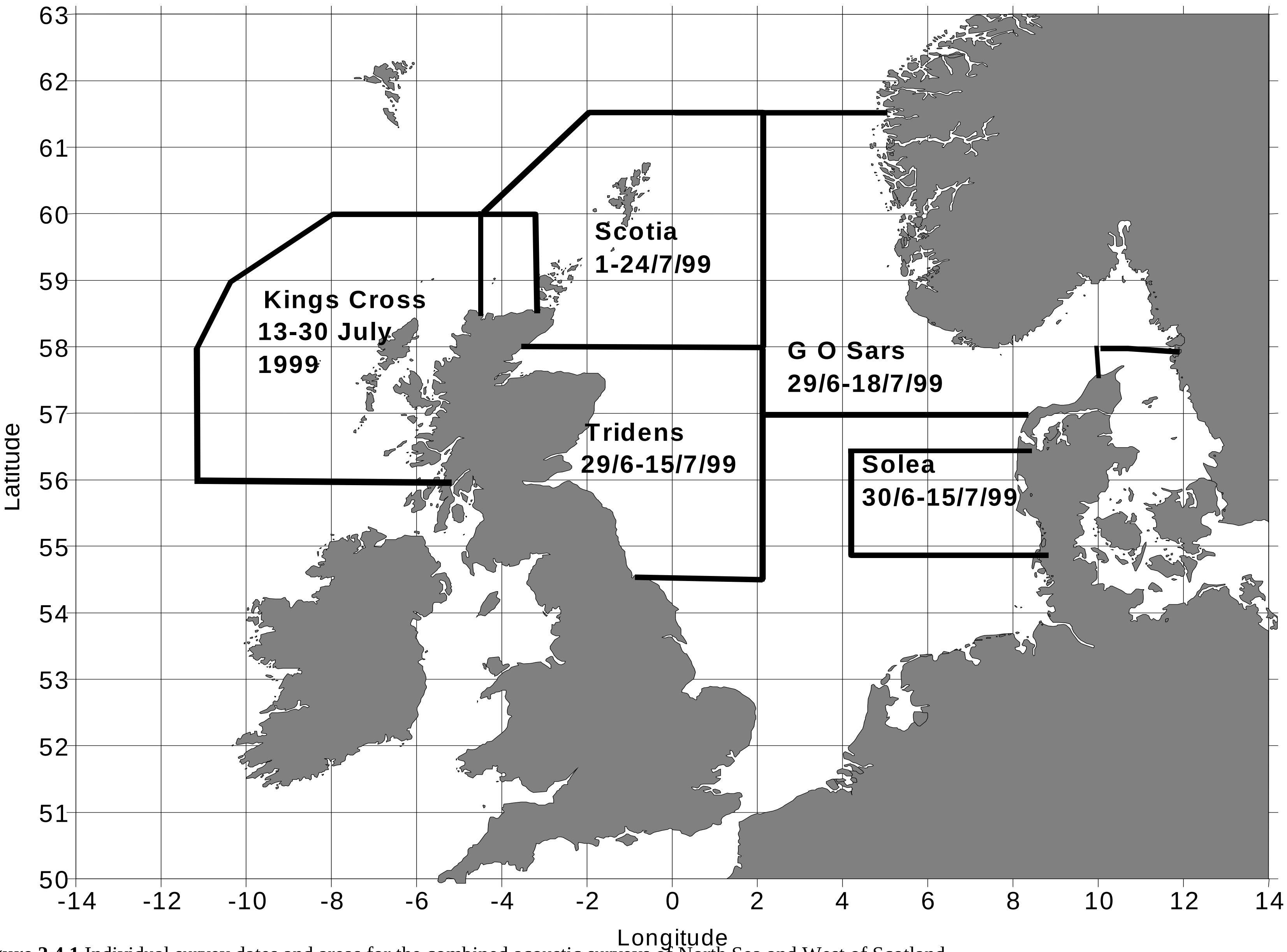


Figure 2.4.1 Individual survey dates and areas for the combined acoustic surveys of North Sea and West of Scotland.

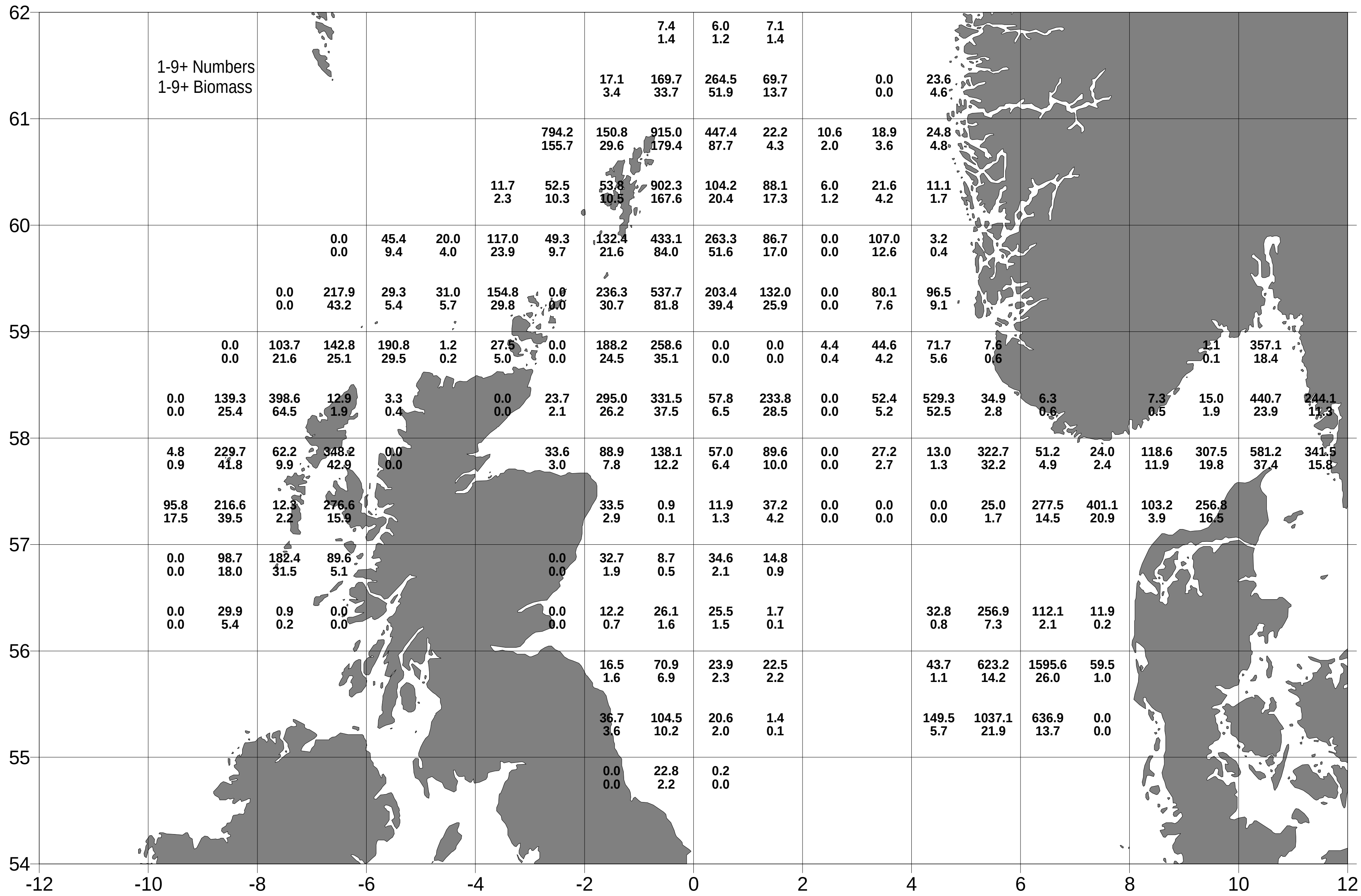


Figure 2.4.2 Numbers (millions) and Biomass (thousands of tonnes) by stat square from the combined acoustic survey July 1999.

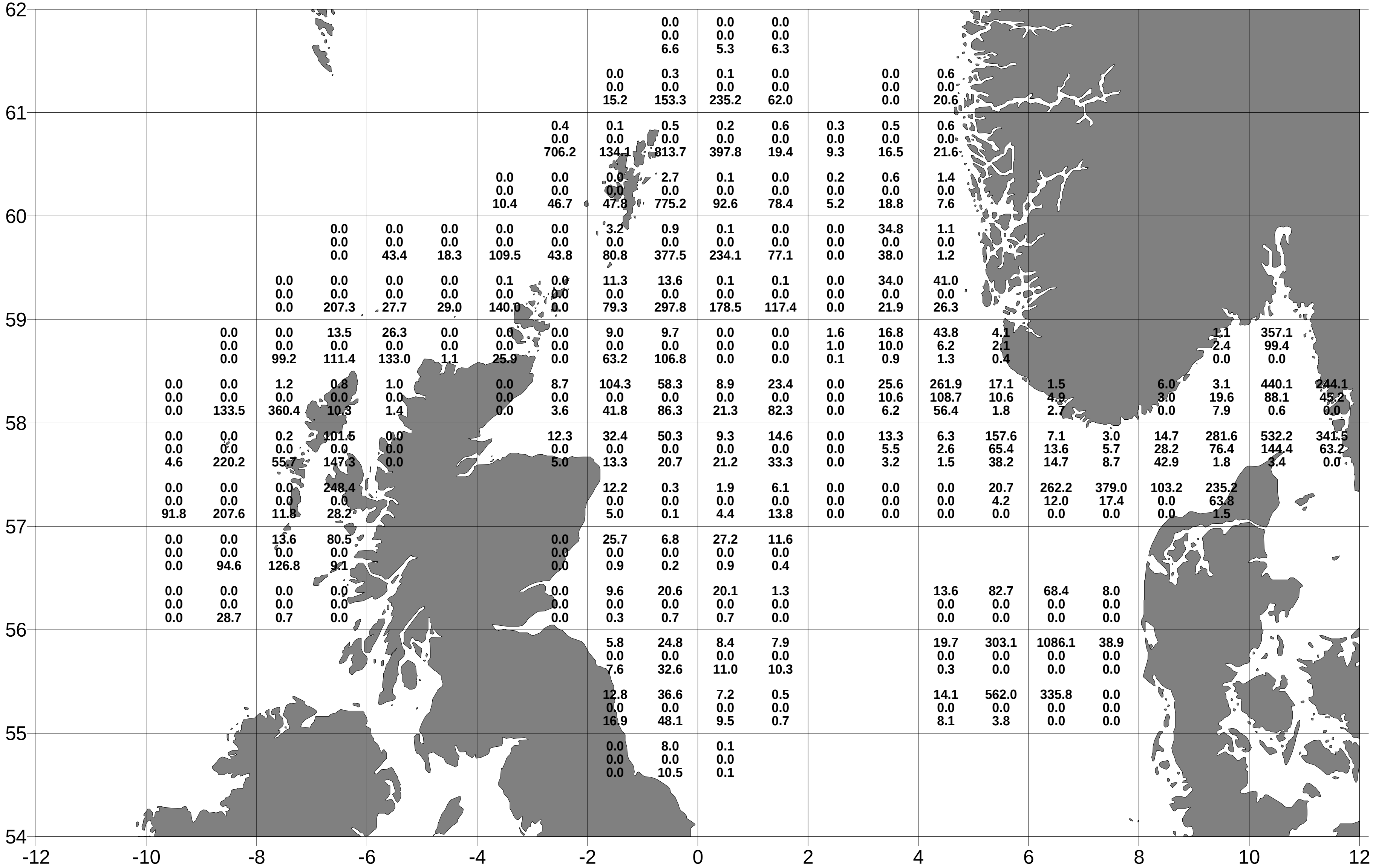


Figure 2.4.3 Numbers of autumn spawning herring 1 ring, 2 ring and 3ring & older by stat square from the combined acoustic survey July 1999.

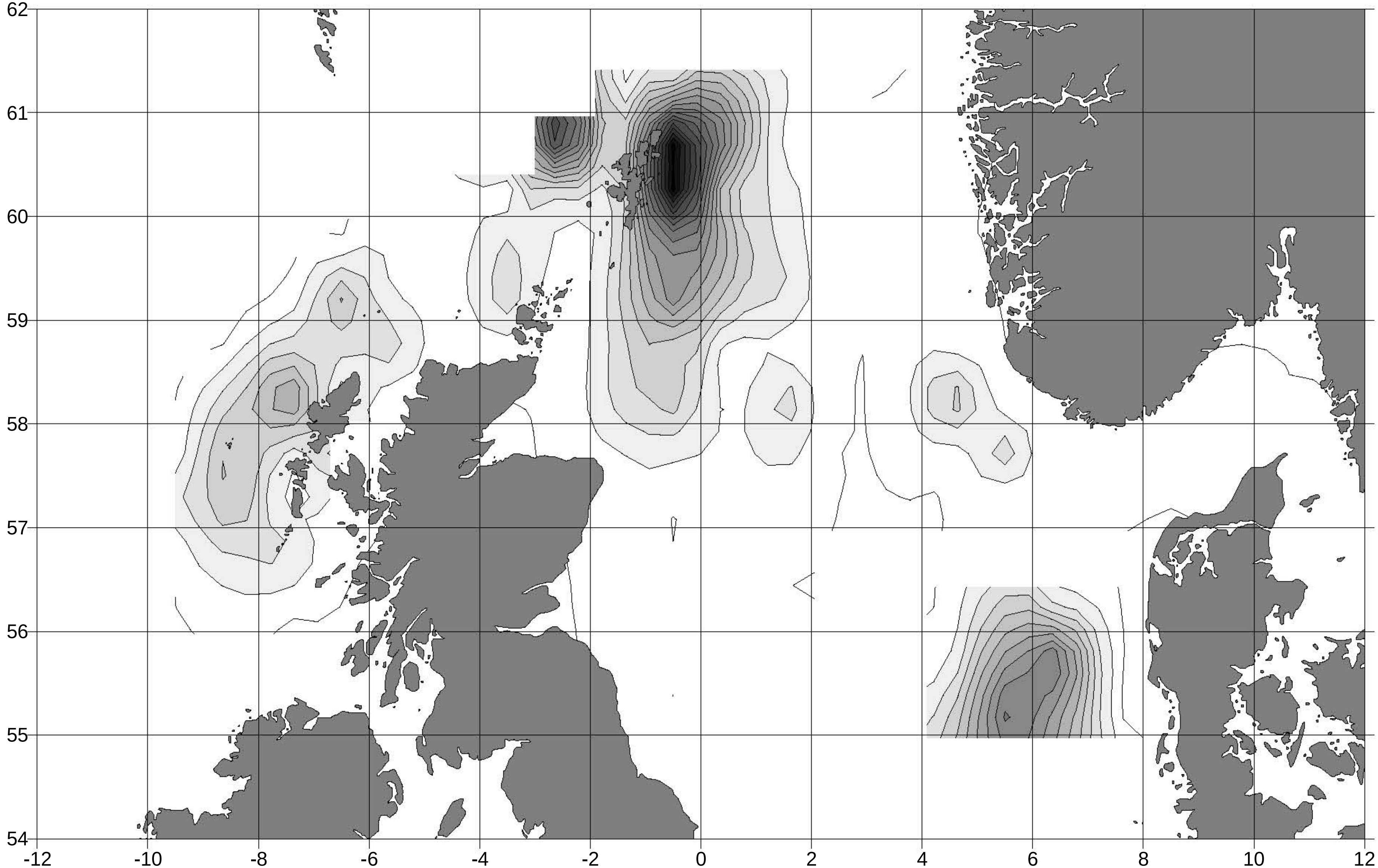


Figure 2.4.4 Distribution of mature autumn spawning herring from the combined acoustic survey July 1999

121

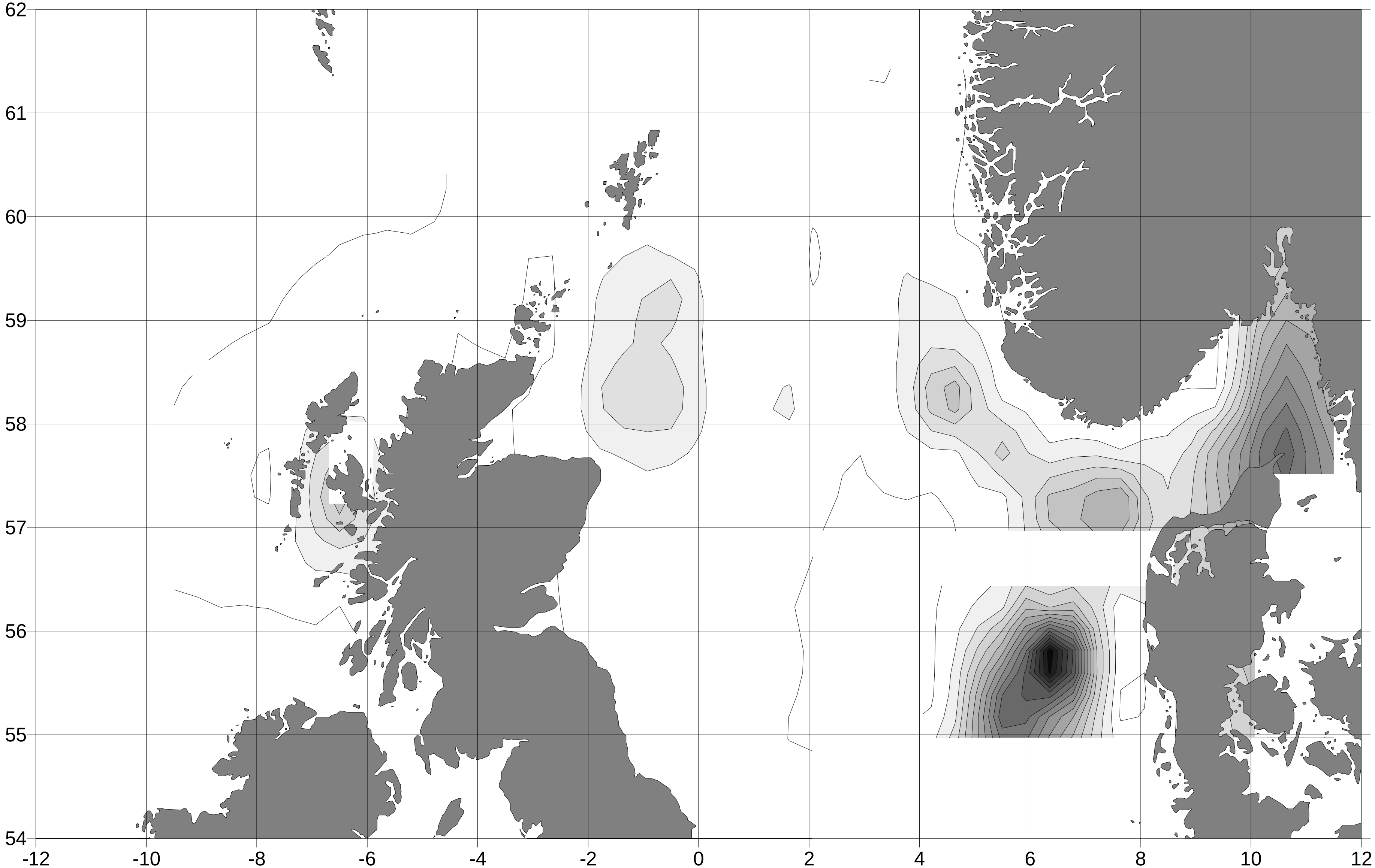


Figure 2.4.5 Distribution of juvenile autumn spawning herring from the combined acoustic survey July 1999

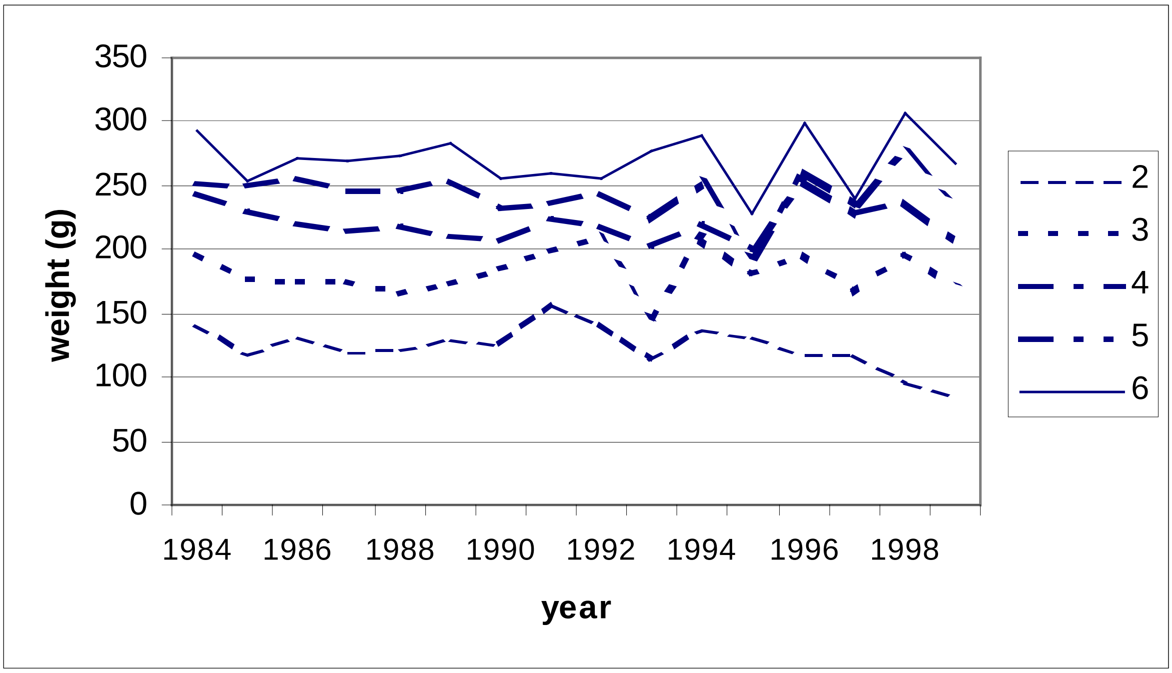


Figure 2.7.1 Weight at age in the population from combined North Sea acoustic survey July 1984 to 1999.

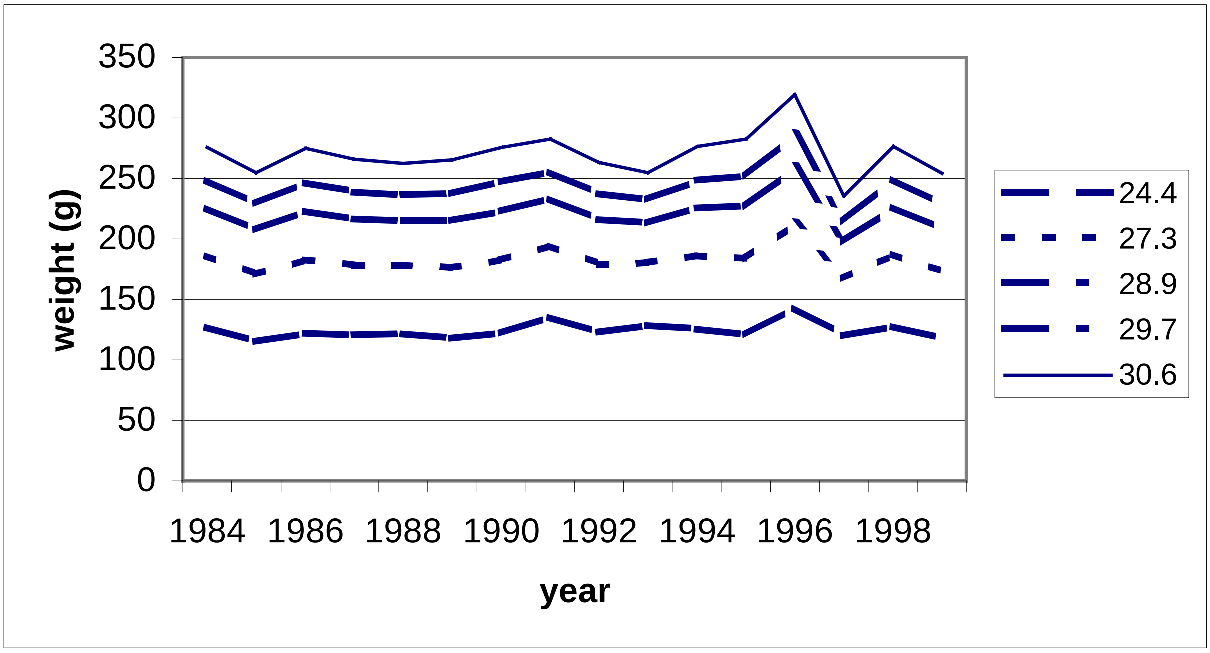


Figure 2.7.2 Weight at length for selected lengths from weight length relationships derived from the R V Scotia acoustic surveys for 1984 to 1999

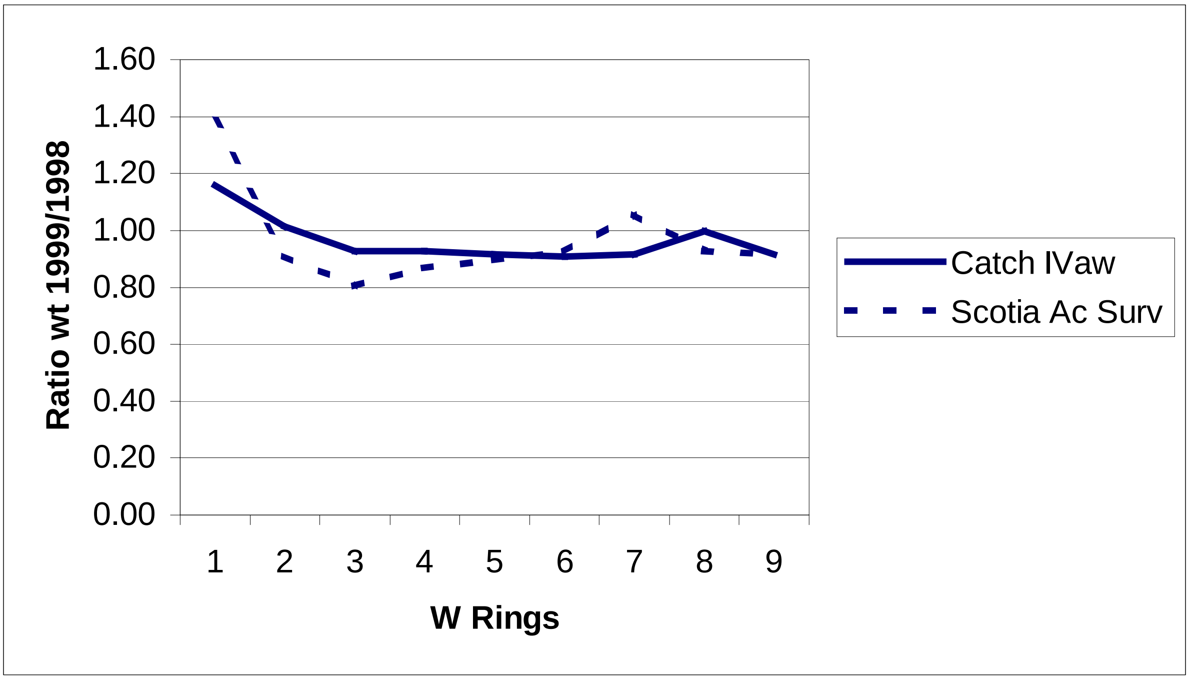


Figure 2.7.3 Ratio of weight at age in 1999/1998 for RV Scotia July acoustic survey in IVa west and in the catch in 3rd quarter in IVa west.

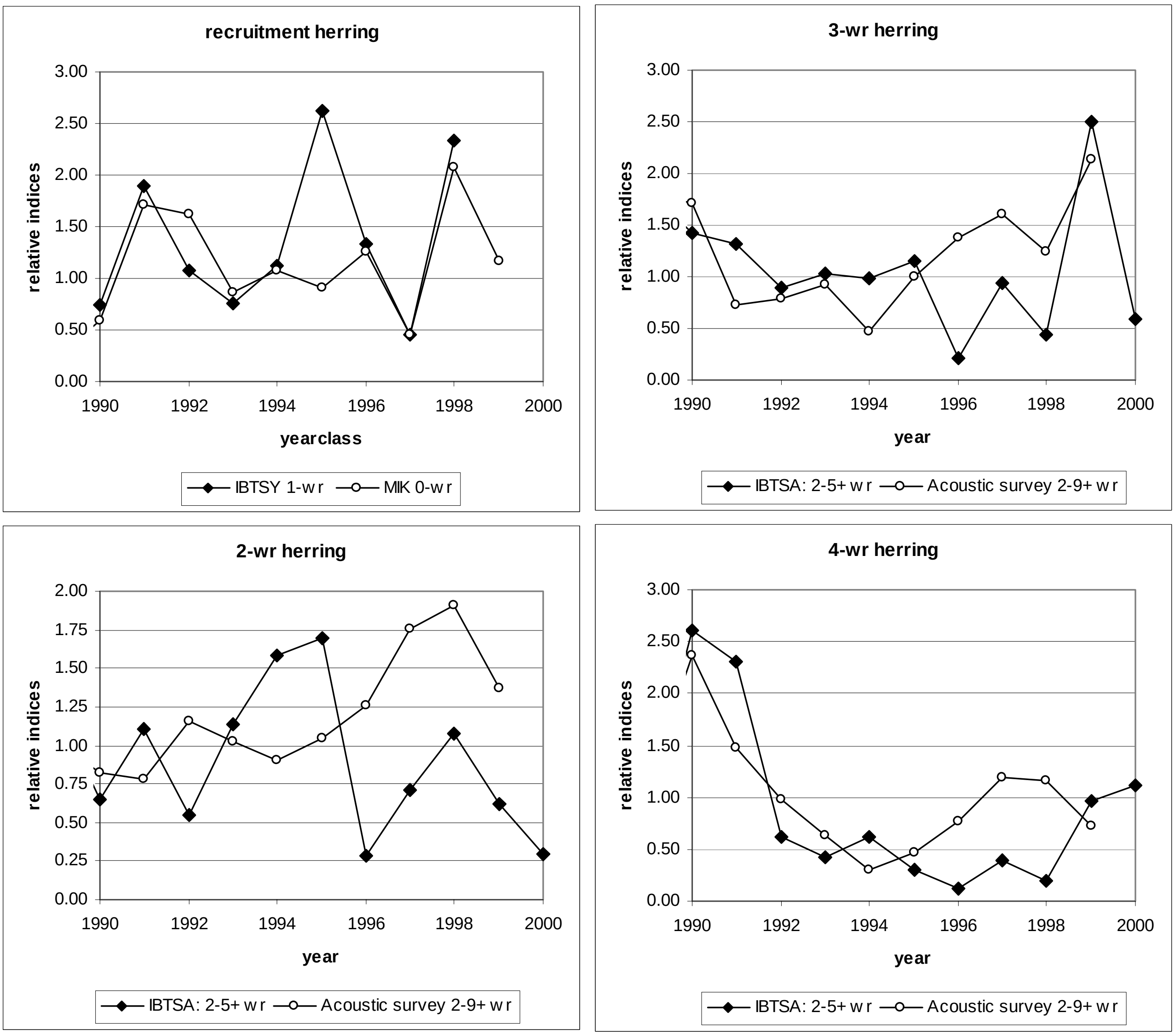


Figure 2.8.1 Comparison of survey indices used for the North Sea autumn spawning herring. All indices scaled to the mean of the indices for the years 1990-1996. Top left graph shows recruitment indices (shown as year classes). All other graphs show relative abundances by year for the different age groups.

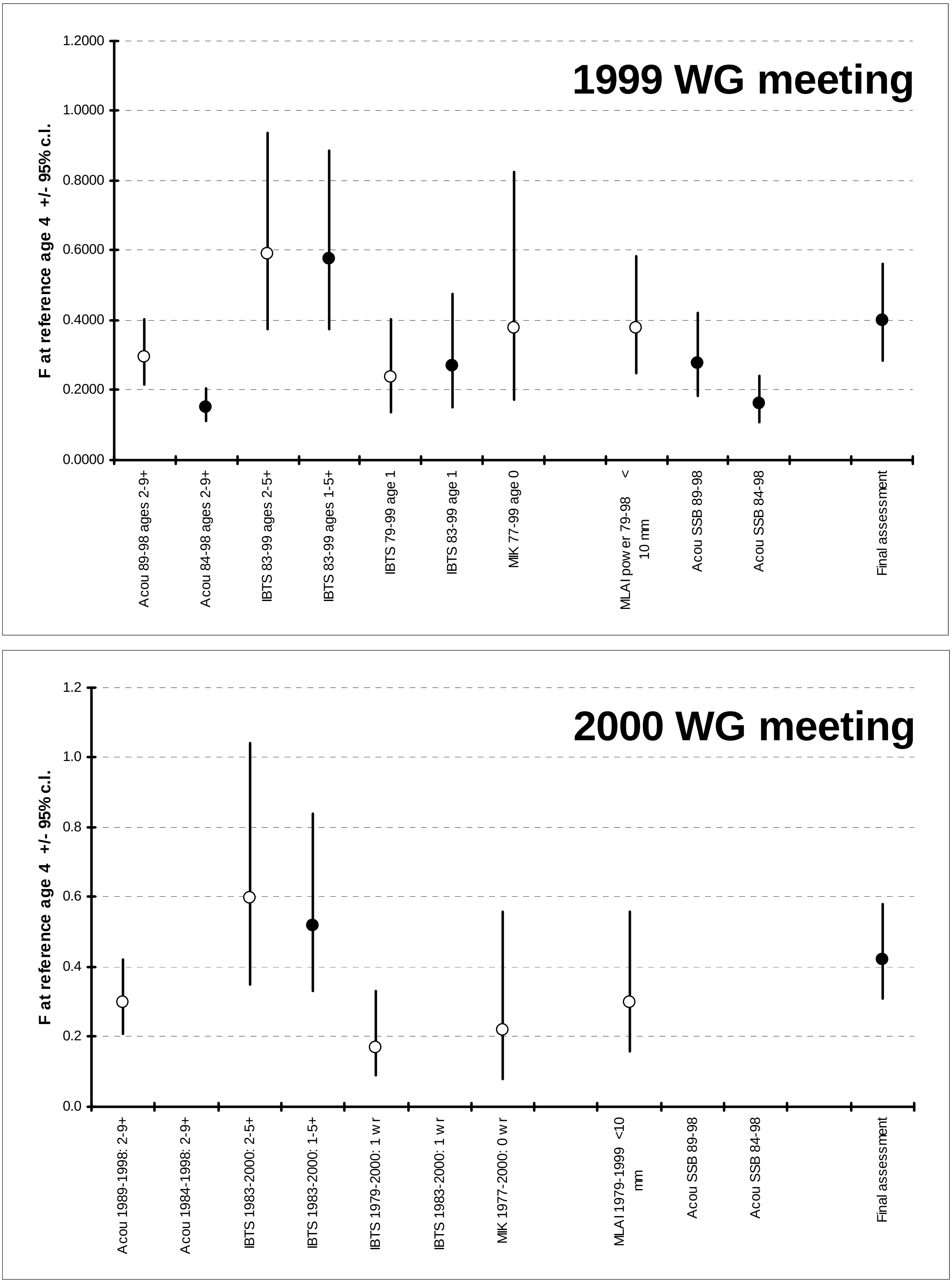


Figure 2.8.2 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of fishing mortality (+/- 95 c.l.) in the ICA model fitted to the separate indices and the catch at age matrix using a 4 year separable period (2000WG). Final assessment using two separable periods over 8 years. Each index is given an equal weight. The open circles indicate, which indices are used in the final assessment. The upper panel refers to last years assessment and the lower panel to this years assessment.

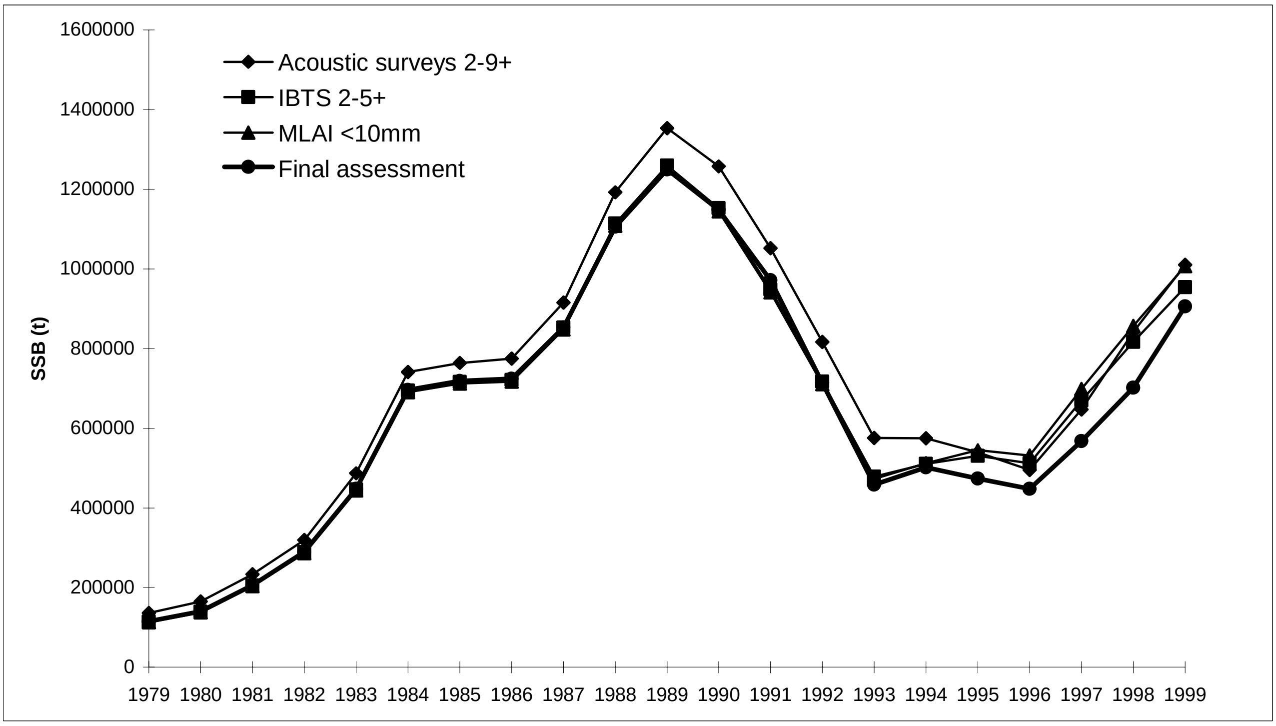


Figure 2.8.3 SSB estimates obtained from ICA model fits with separate indices (4 year separable period) and with all indices combined (final assessment, using 2 separable periods over 8 years in total).

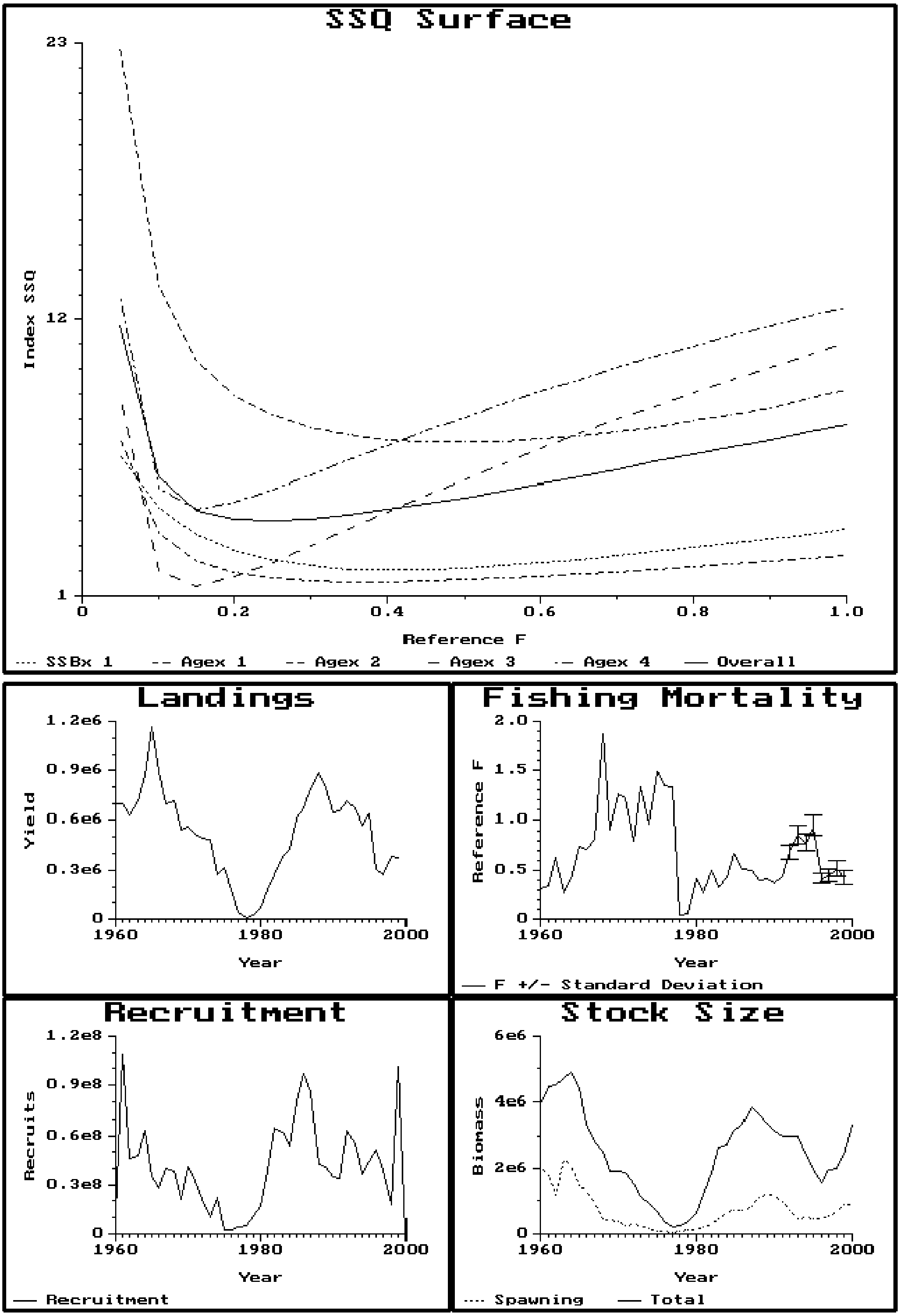


Figure 2.8.4 Autumn spawning herring in area IV and divisions VIId and IIIa. Upper panel: **Upper panel**: sum of squares (SSQ) surfaces for the tuning indices from a separable analysis. SSBx1 refers to the MLAI estimate of spawning biomass, the age-indices 1 to 4 refer to the acoustic index (1), the IBTS 2-5+ index (2), the IBTS 1-ringer index (3) and the MIK 0-ringer index (4). **Lower panel**: summary of landings, estimated fishing mortality at reference age 4 (wr), recruitment of 0-ringers and total biomass and spawning biomass at spawning time.

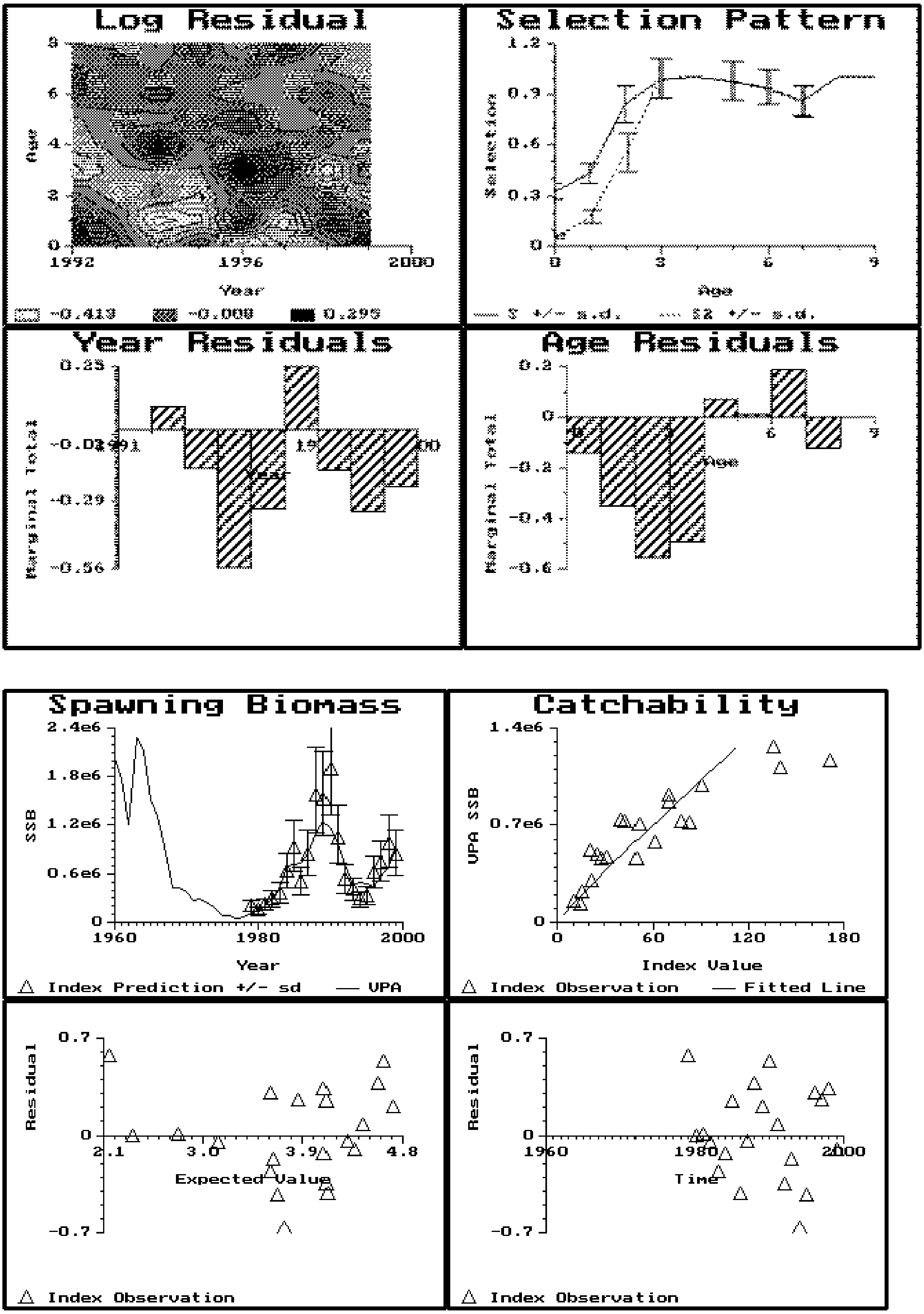
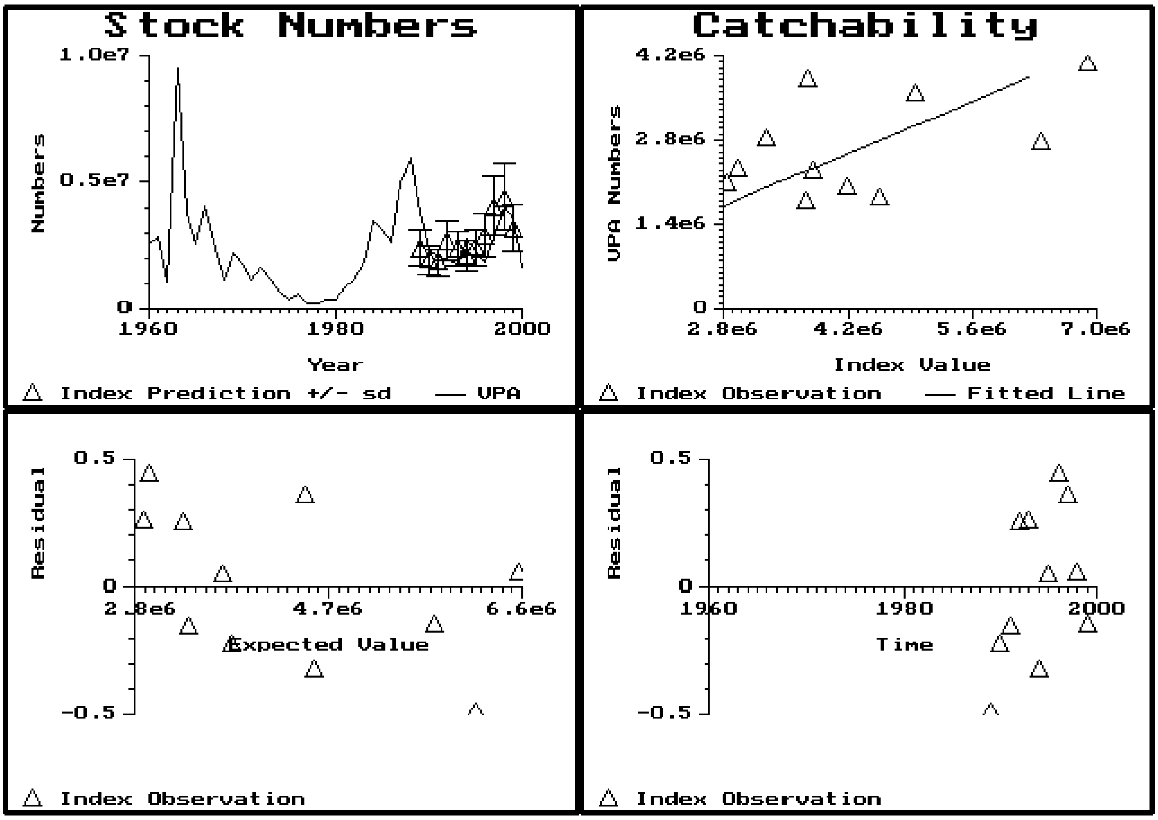


Figure 2.8.5 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: selection patterns diagnostics. Top left: contour plot of selection pattern residuals. Top right: two estimated selection patterns S1 (1992-1996) and S2 (1997-1999). Bottom: marginal totals of residuals by year and age. **Lower panel**: diagnostics of the fit of the **MLAI** spawning stock biomass against the estimated SSB. Top left: spawning biomass from the fitted populations (line) and the predicted spawning biomasses from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of spawning biomass from the fitted populations and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).



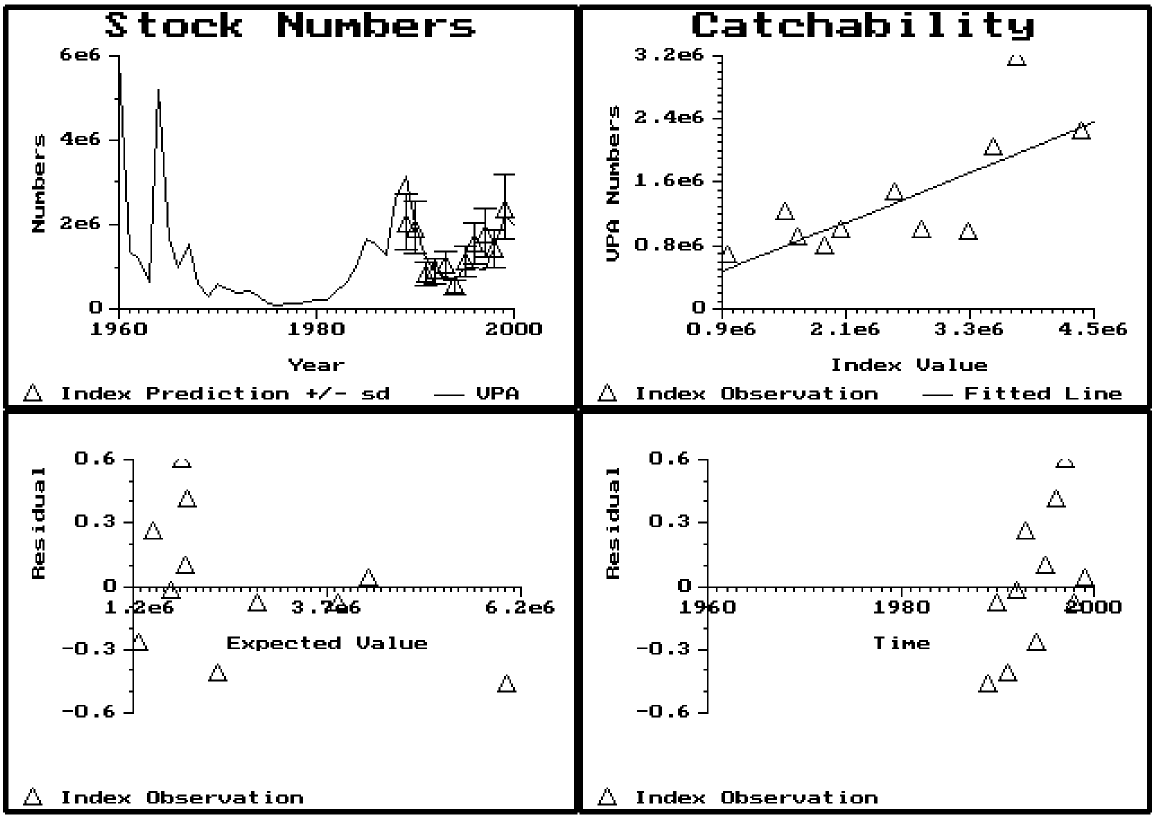


Figure 2.8.6 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **acoustic 2-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 3-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

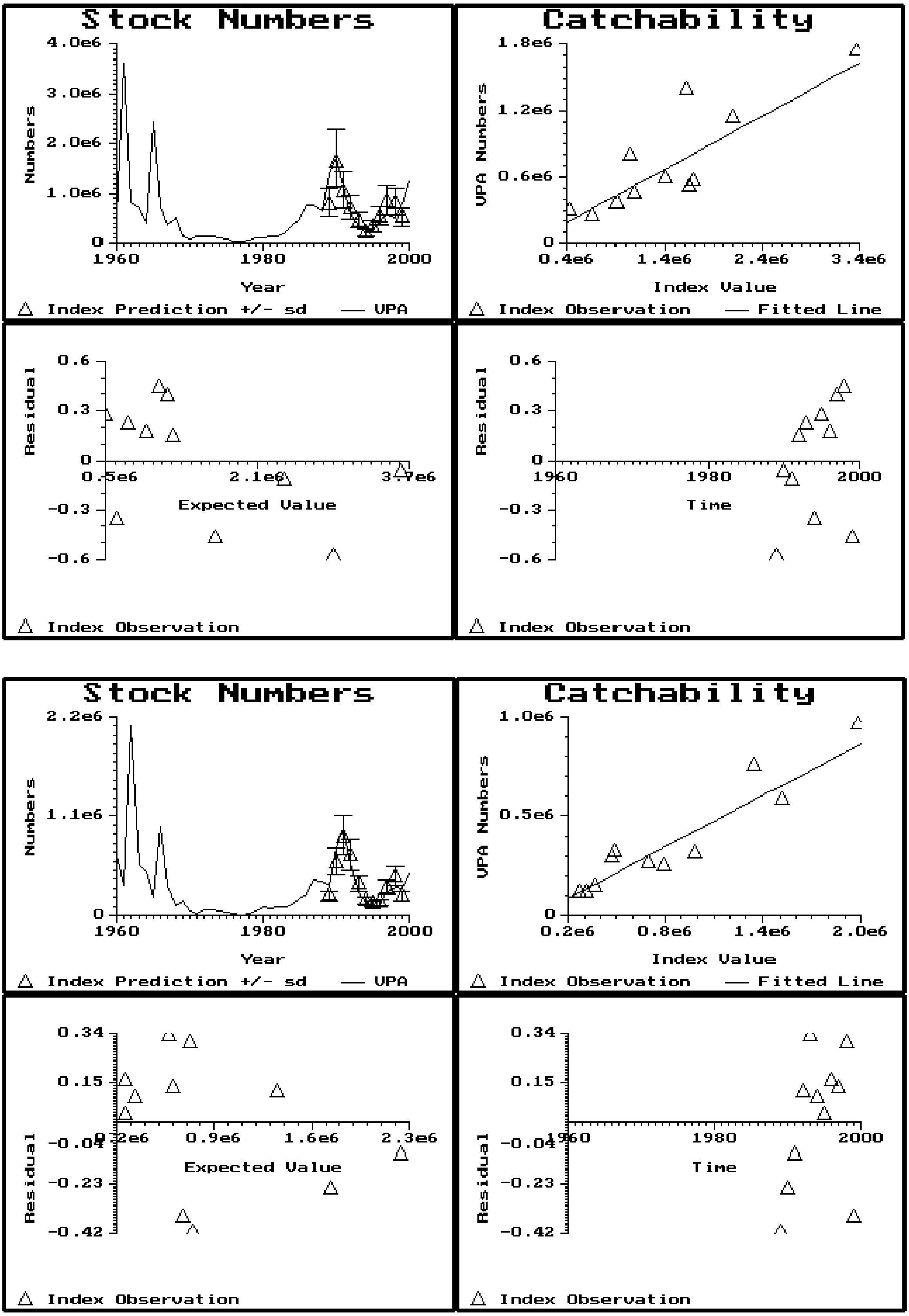


Figure 2.8.7 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **acoustic 4-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 5-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

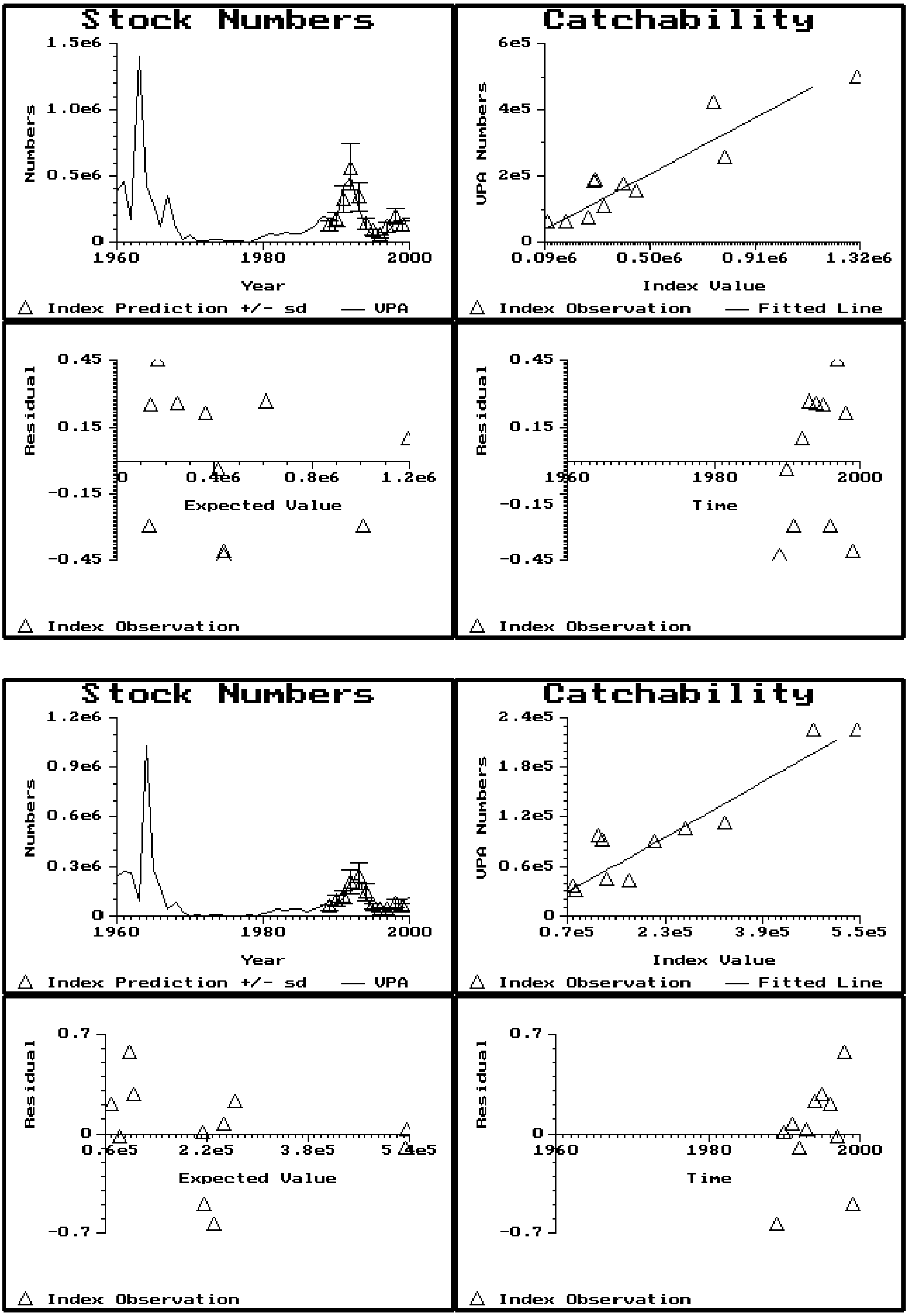


Figure 2.8.8 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **acoustic 6-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 7-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

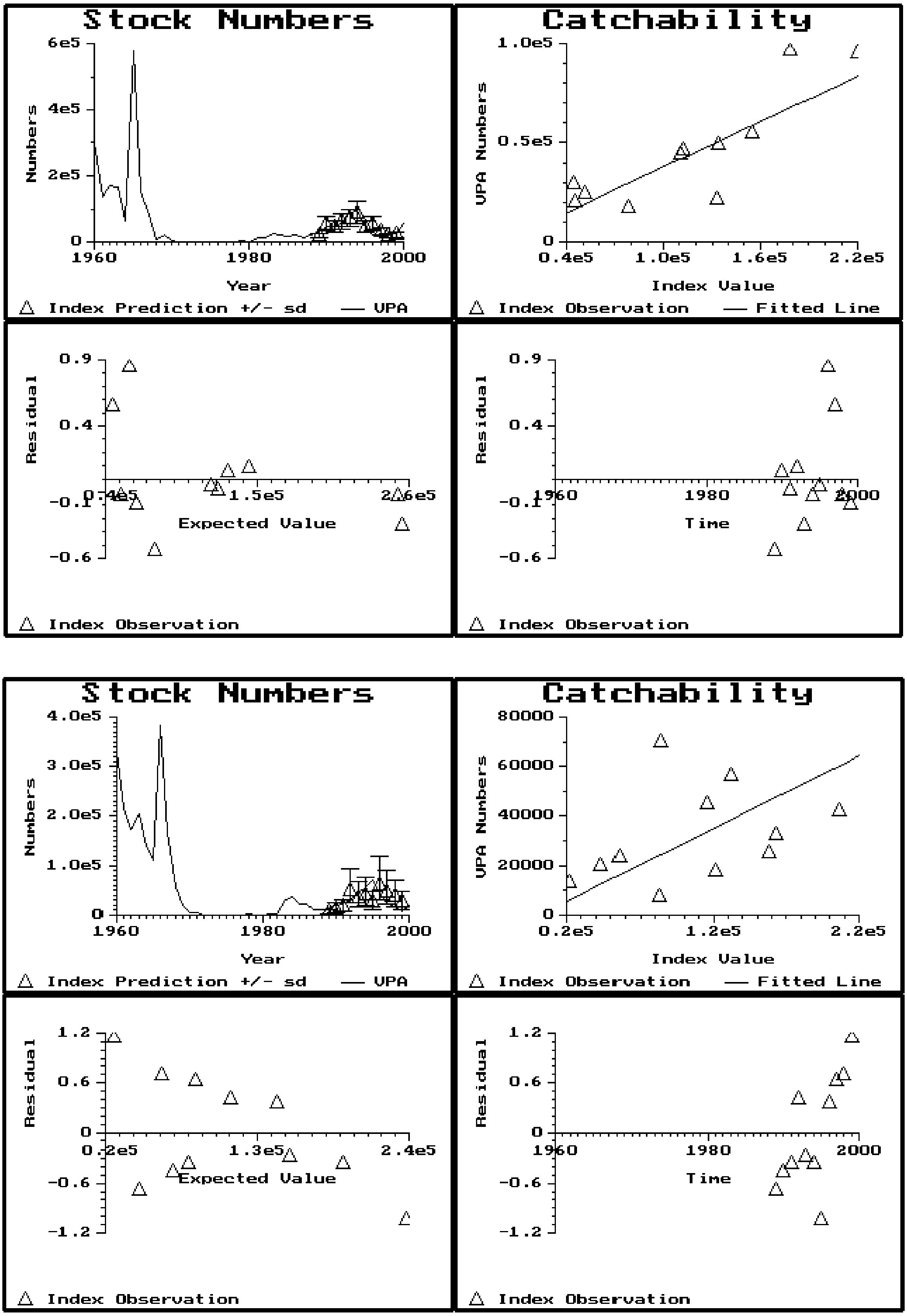


Figure 2.8.9 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **acoustic 8-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 9+-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

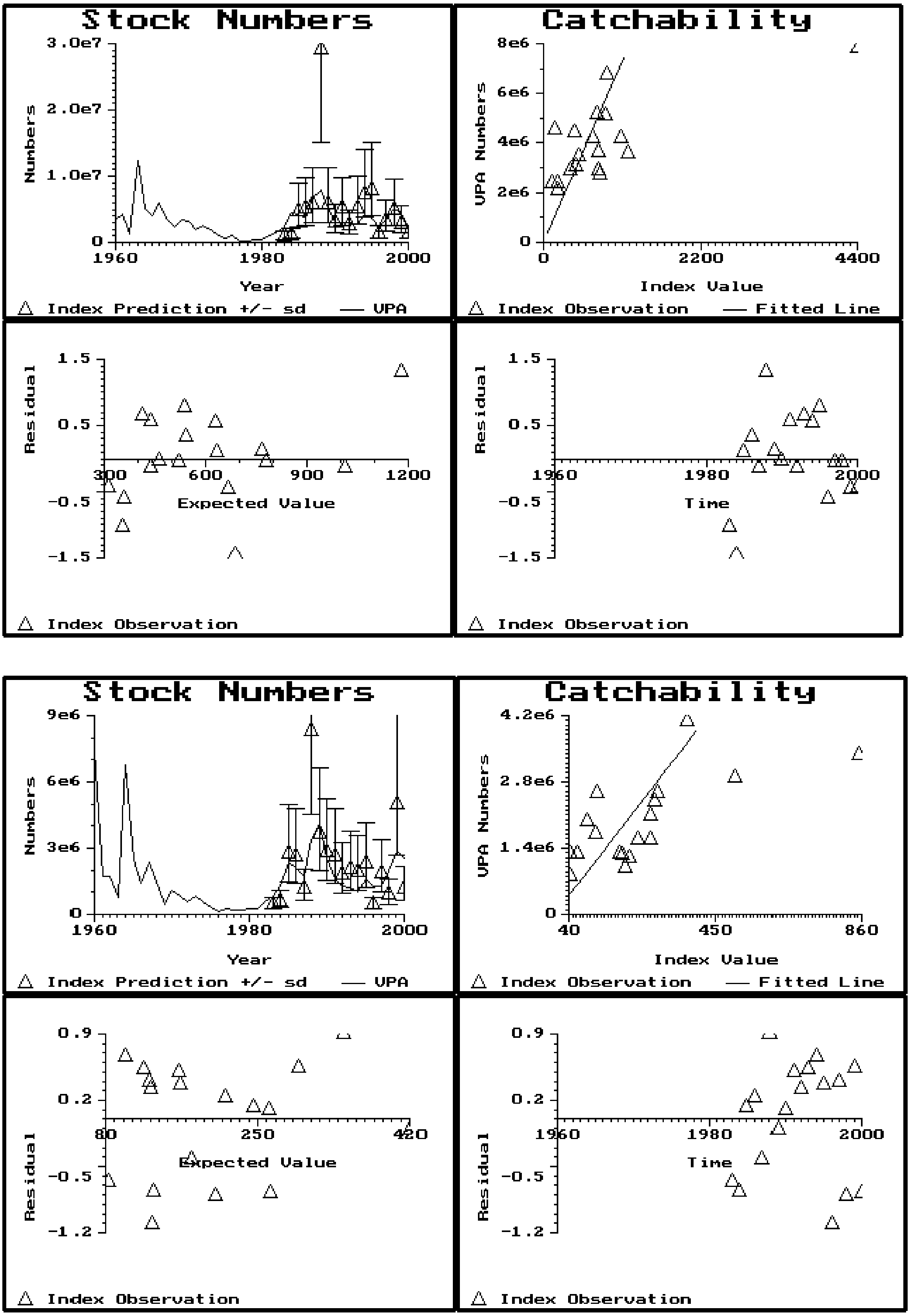


Figure 2.8.10 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **IBTS 2-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **IBTS 3-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

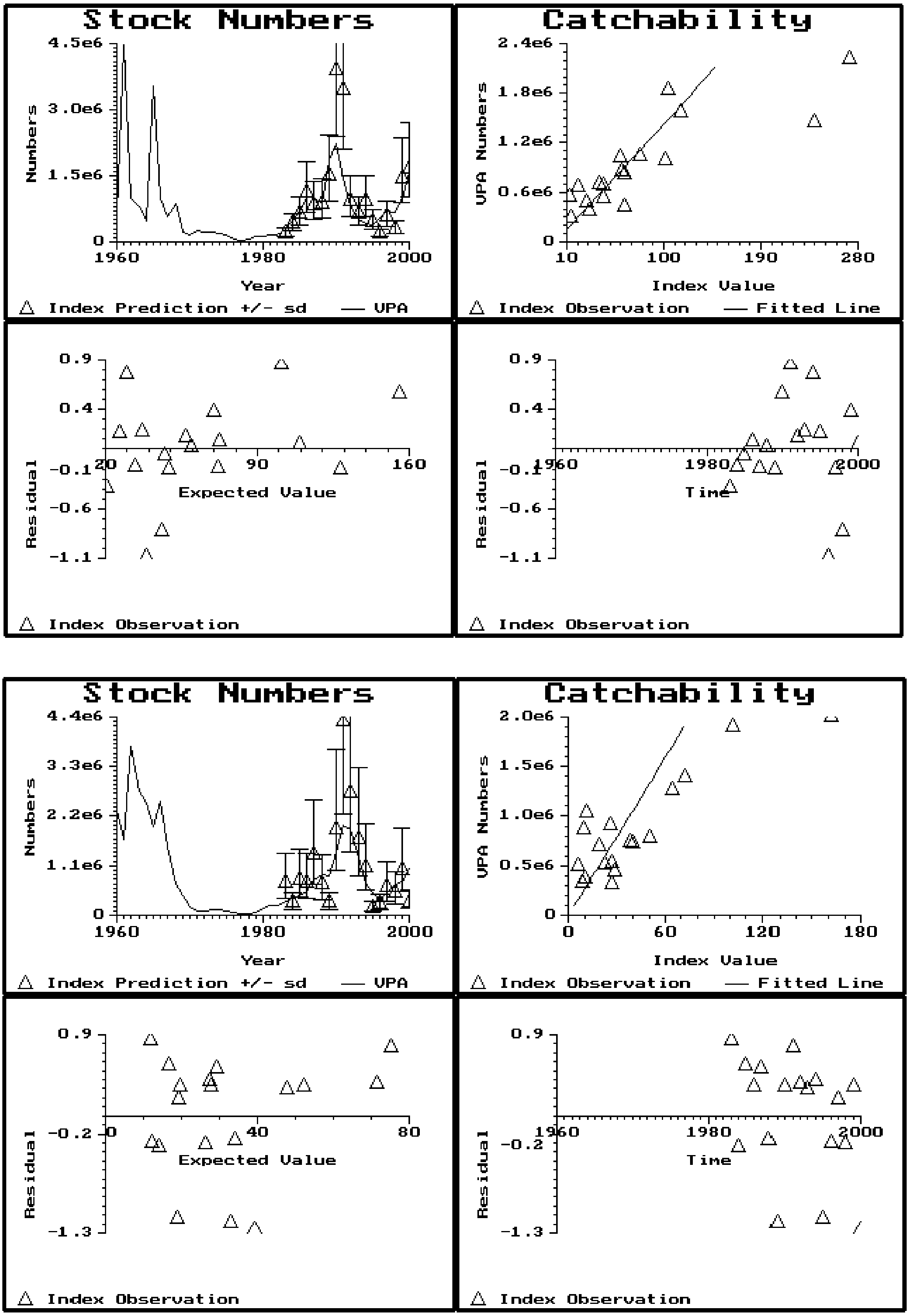


Figure 2.8.11 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **IBTS 4-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **IBTS 5+-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

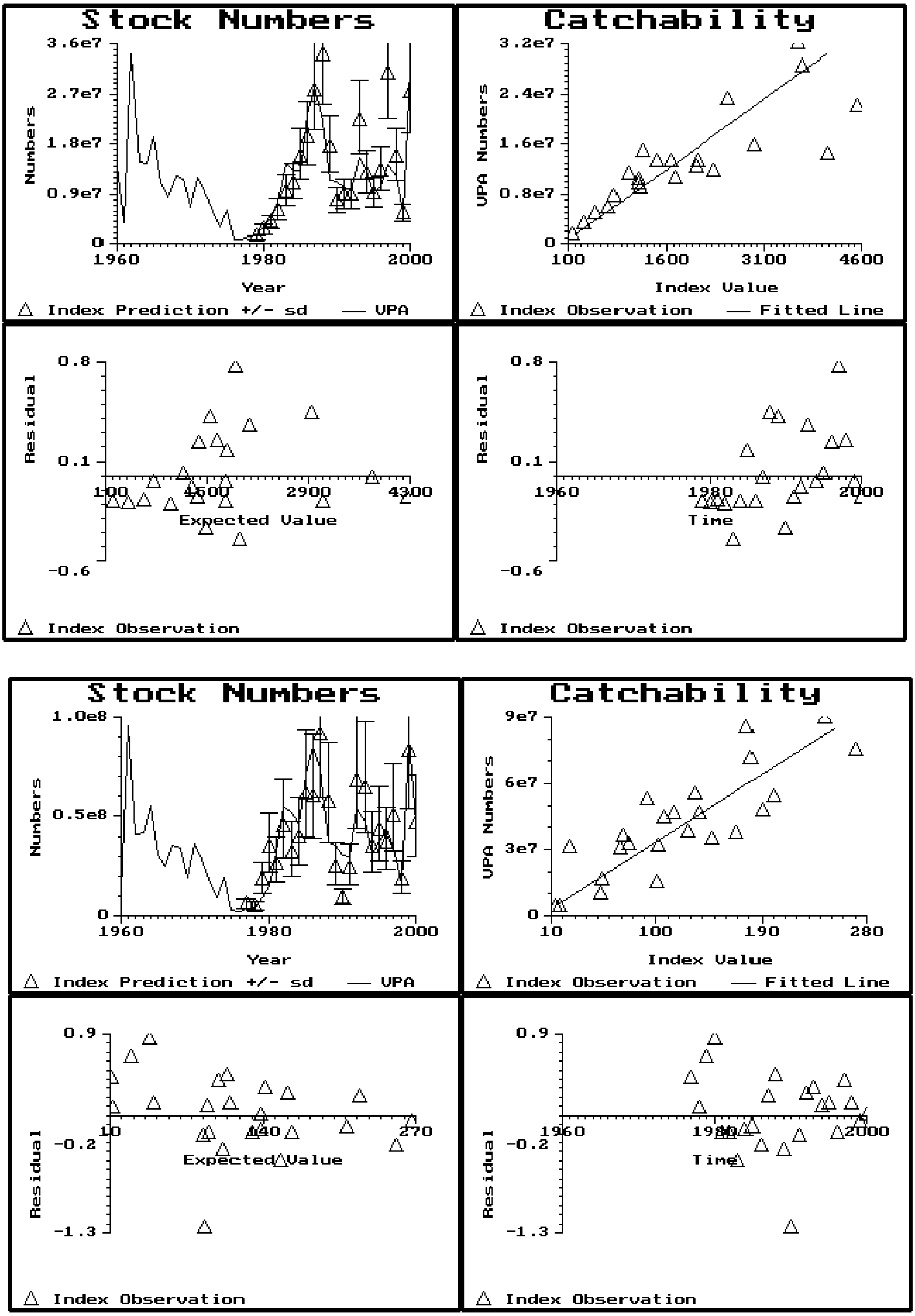


Figure 2.8.12 Autumn spawning herring in Area IV and Divisions VIId and IIIa. **Upper panel**: diagnostics of the fit of the **IBTS 1-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **MIK 0-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

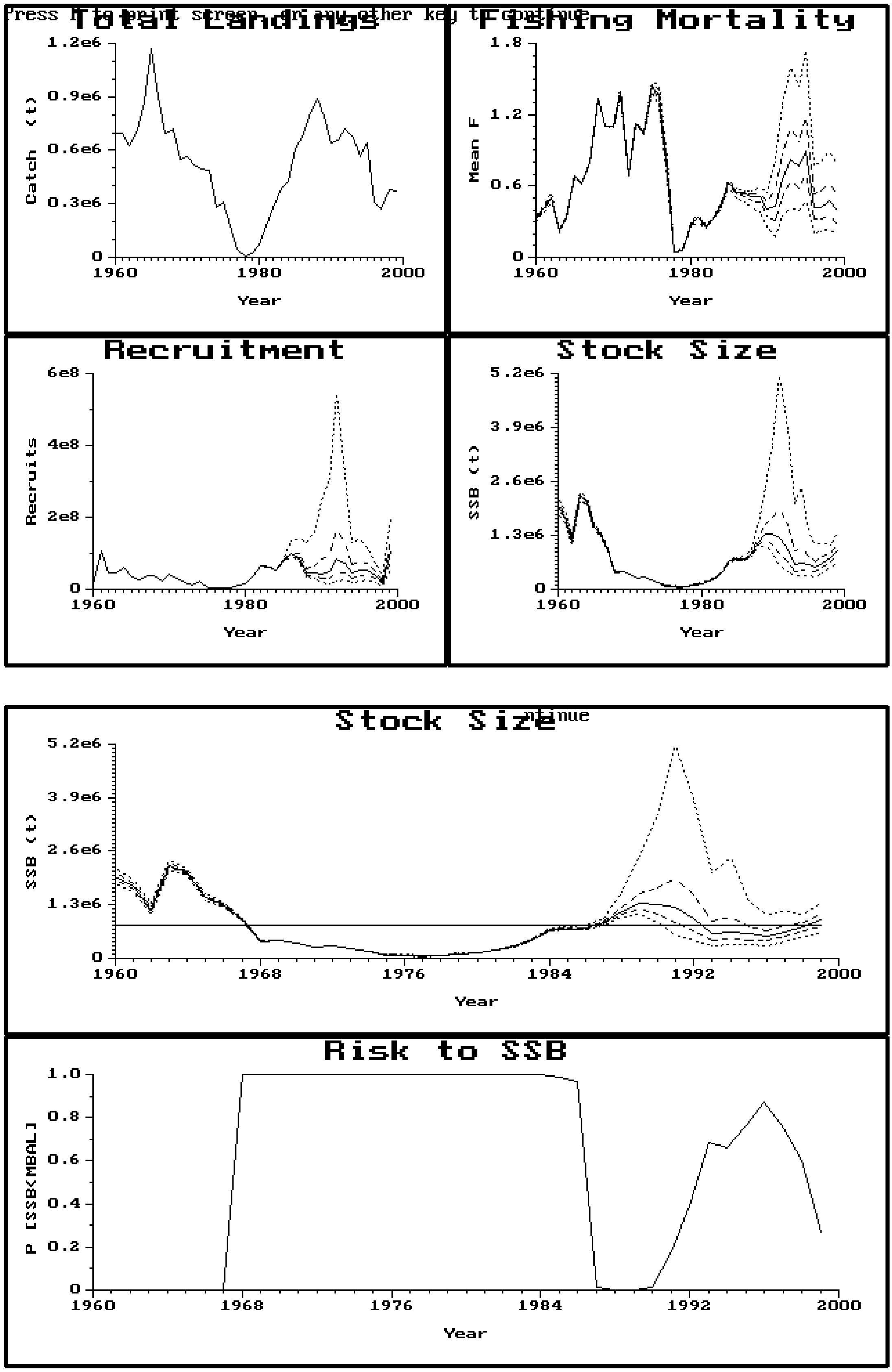


Figure 2.8.13 Autumn spawning herring in Area IV and Divisions VIId and IIIa. Evaluation of assessment uncertainty using a covariance matrix method with 1000 random draws from the estimated parameter distributions **Upper panel**: summary of landings, estimated mean fishing mortality (age 2-6), recruitment of 0-ringers and spawning biomass. Shown are the 5, 25, 50, 75 and 95 percentiles. **Lower panel**: distribution of spawning stock biomass in relation to B_{lim} (800.000 tonnes) and the risk of SSB being below B_{lim}.

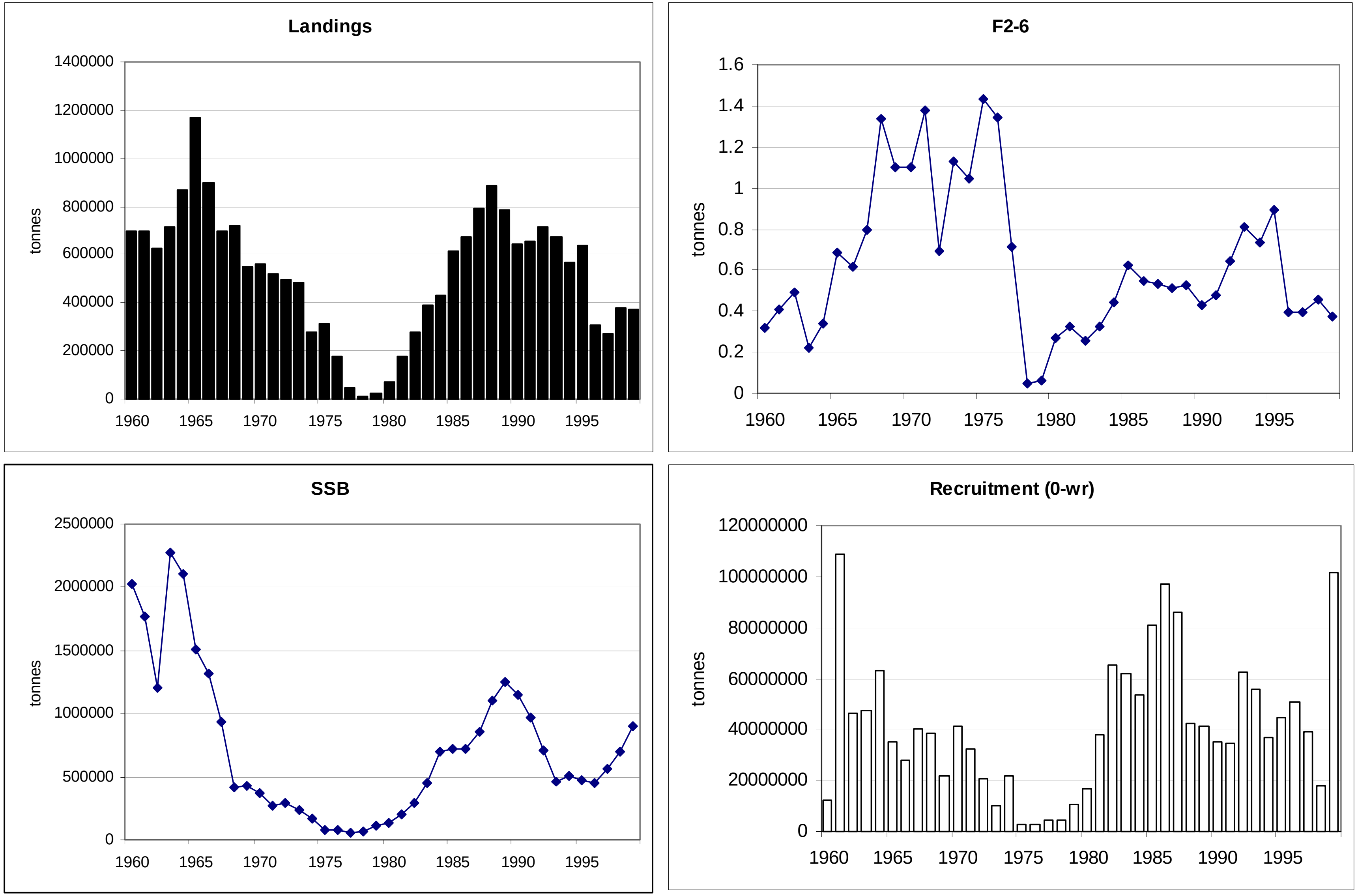


Figure 2.8.14 North Sea autumn spawning herring. Long term trends in landings (top left), fishing mortality on ages 2-6 (top right), spawning stock biomass (bottom left) and recruitment as 0-ringers (bottom right).

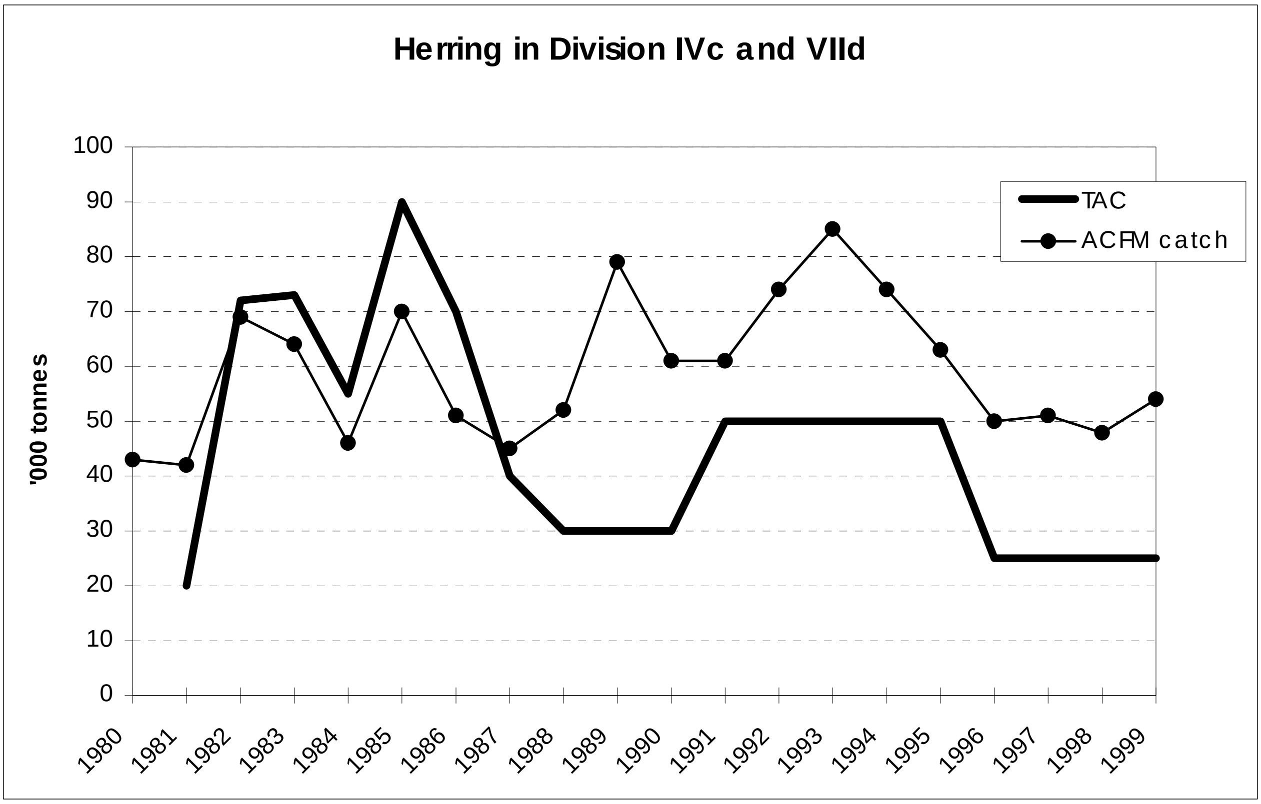


Figure 2.9.1 The agreed TAC for Divisions IVc and VIId compared to the ACFM catch in that area. In 1996 the agreed TAC was reduced by 50% in the middle of the year.

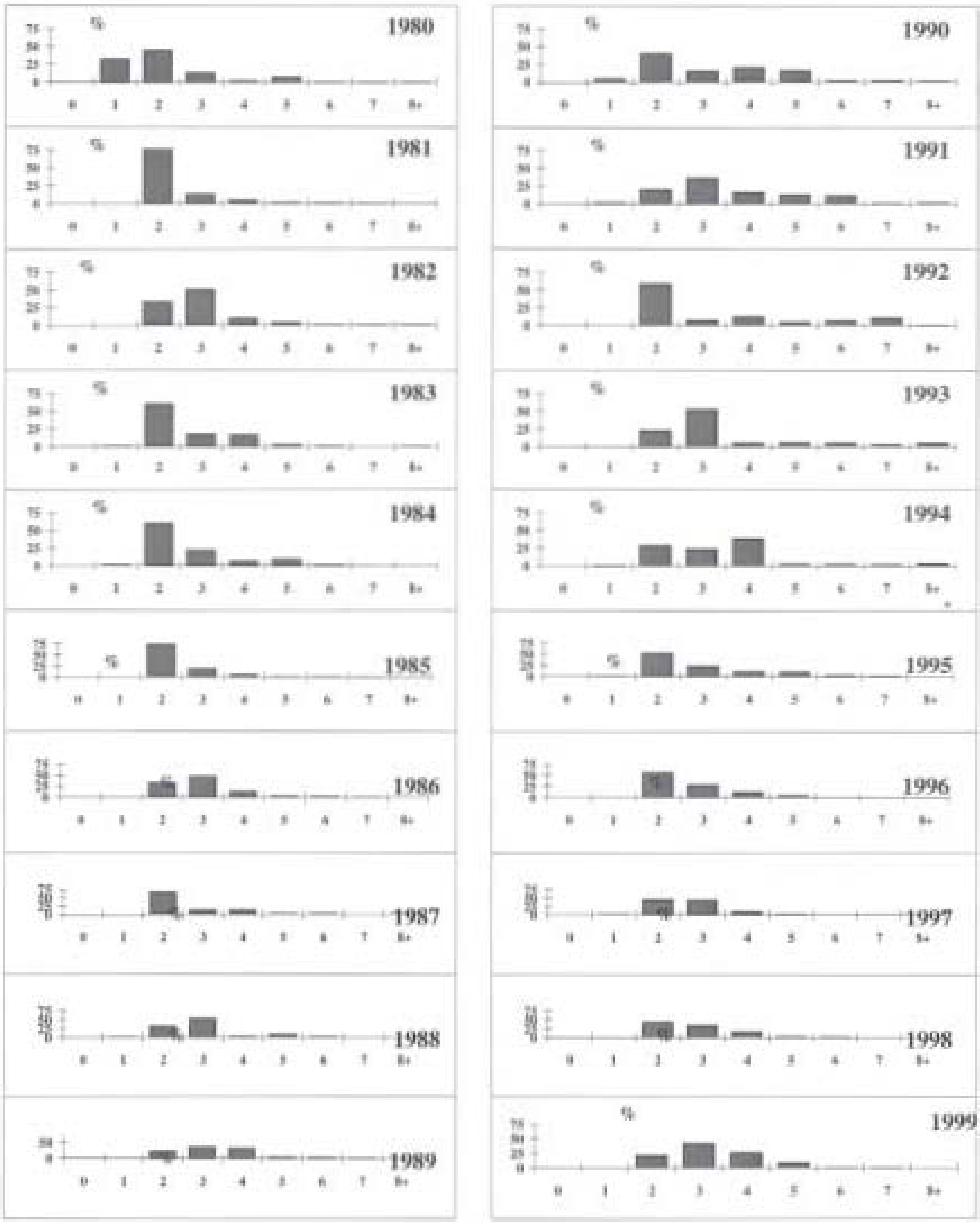


Figure 2.9.2 The age composition (winter-ring) of herring in Divisions IVc and VIId in the Dutch catches from December 1980-1999.

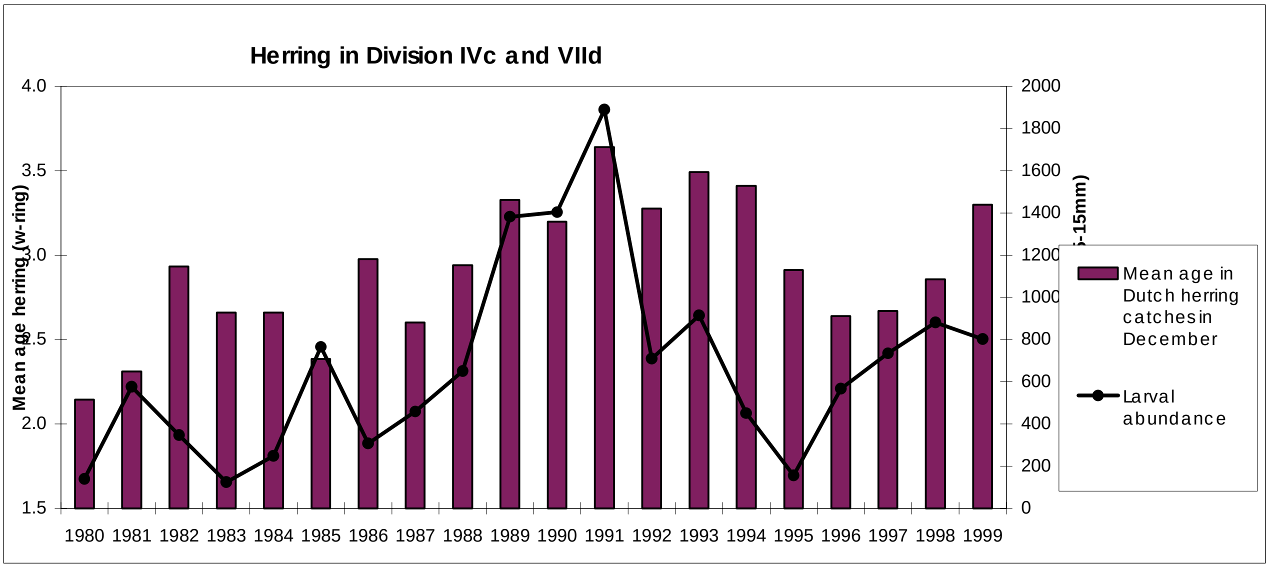


Figure 2.9.3 Changes in the herring larval abundance compared to changes in the mean age (winter-ring) in the Dutch herring catches in December.

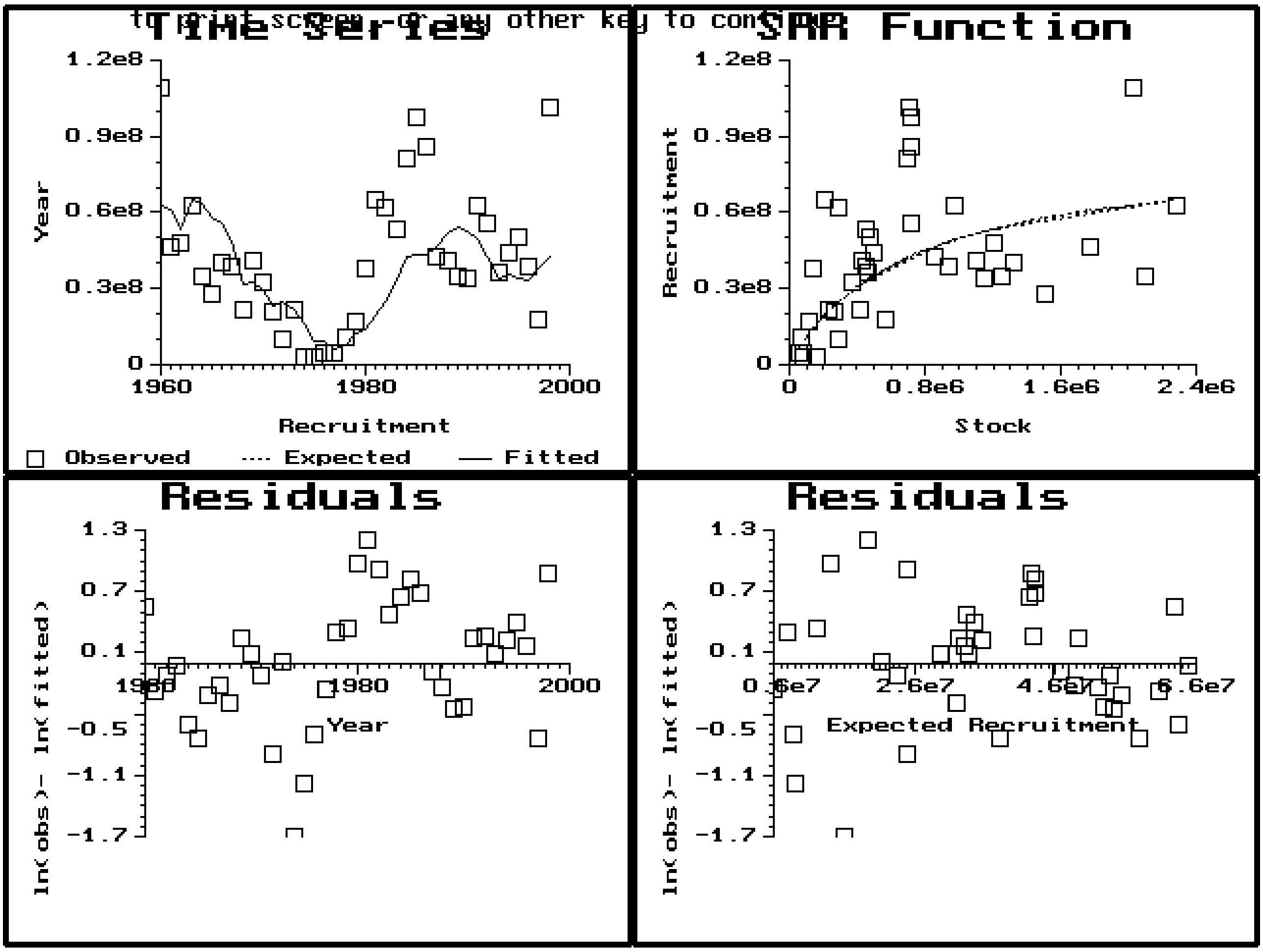


Figure 2.11.1 Stock and recruitment, fitted Beverton and Holt stock recruit relationship, residuals over time and abundance.

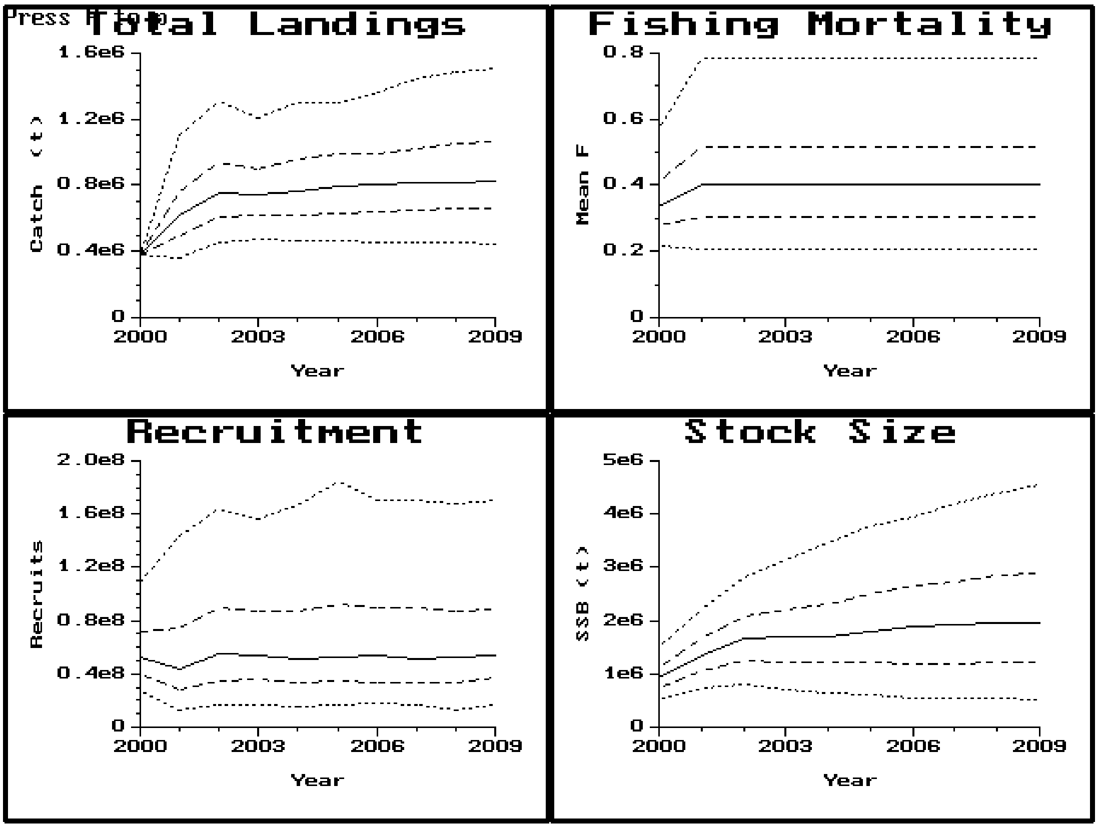


Figure 2.11.2 Medium term projections assuming F_{0-1} = 0.03, F_{2-6} = 0.20, Total landings, Fishing mortality, Recruitment and stock size.

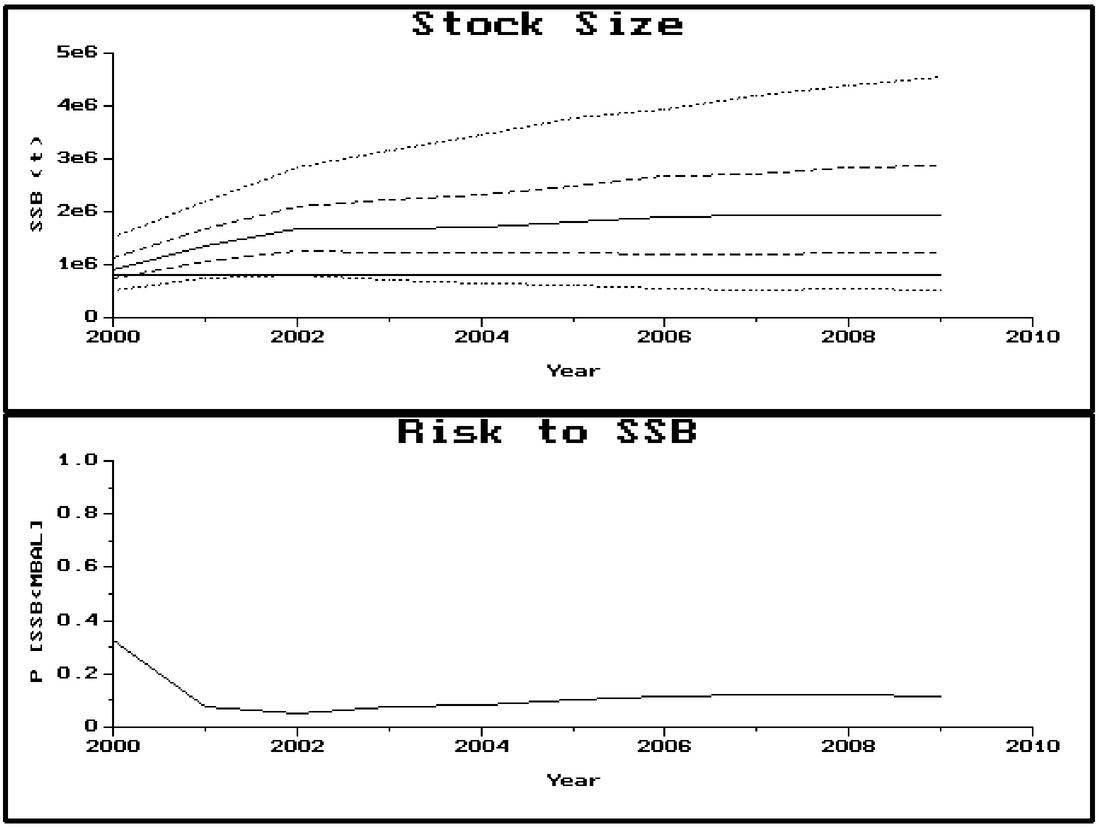


Figure 2.11.3 Medium term projections assuming F_{0-1} = 0.03, F_{2-6} = 0.20, 95,75,50,25,5 percentiles stock size and risk to SSB.

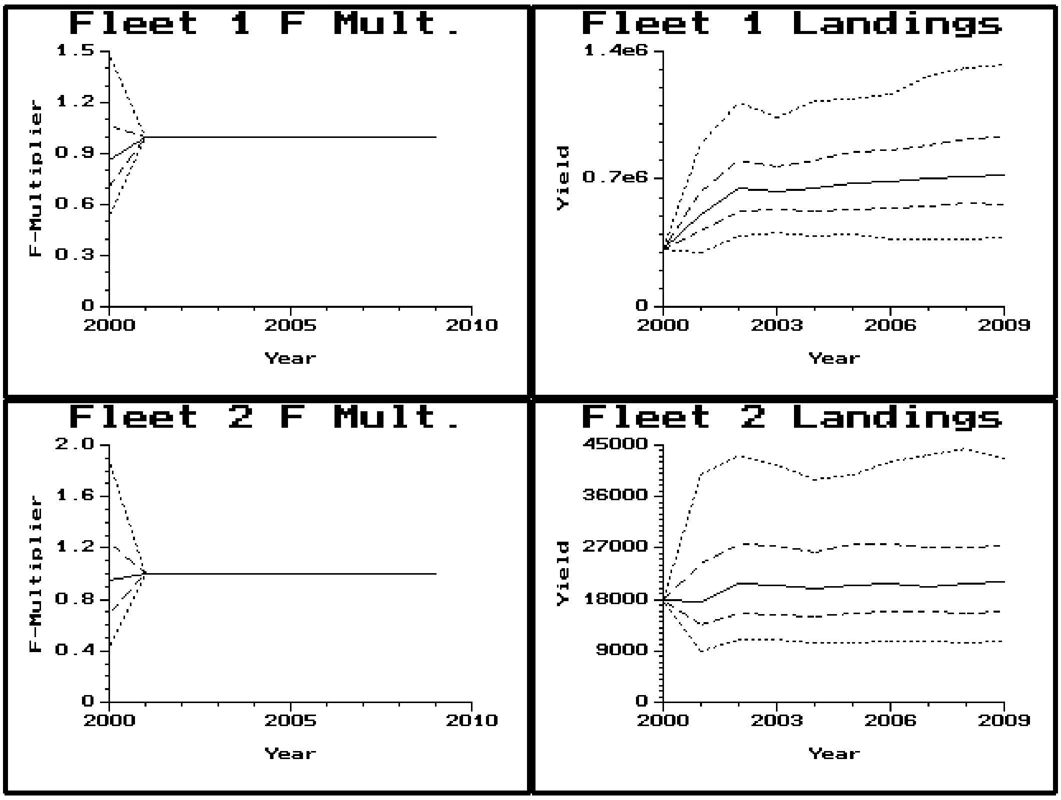


Figure 2.11.4 Medium term projections assuming F_{0-1} = 0.03, F_{2-6} = 0.20, Fleet F and Landings, 95,75,50,25.5 percentiles.

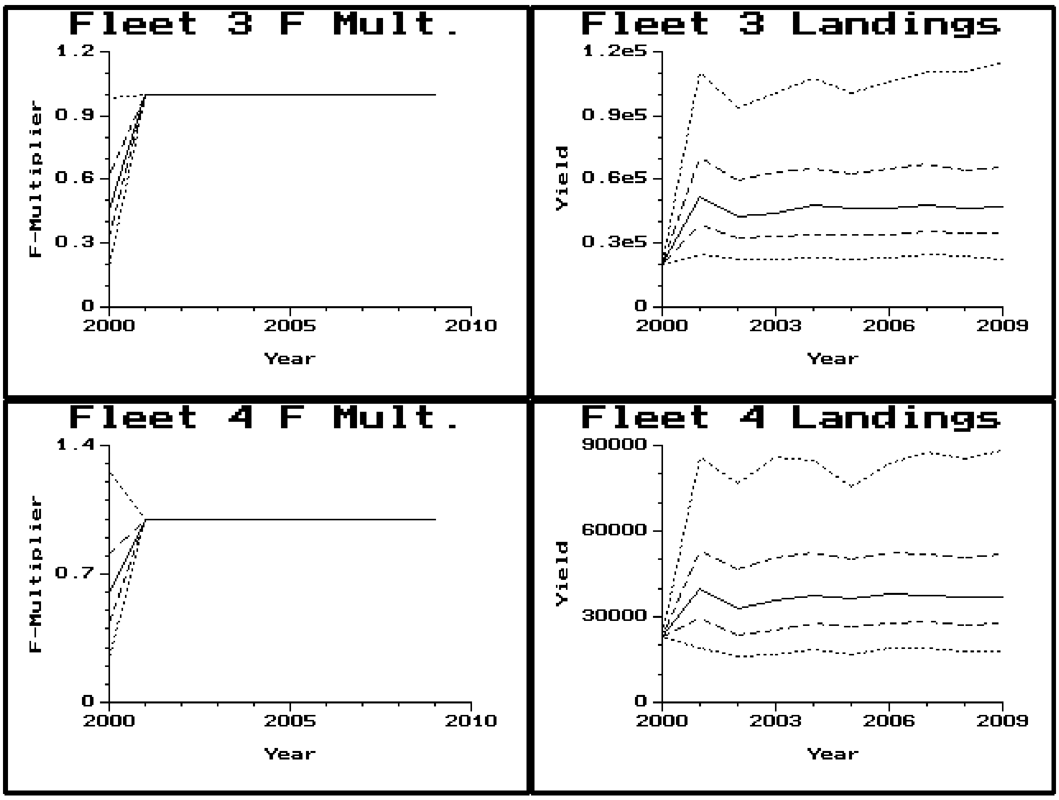


Figure 2.11.5 Medium term projections assuming F_{0-1} = 0.03, F_{2-6} = 0.20, Fleet F and Landings, 95,75,50,25.5 percentiles.

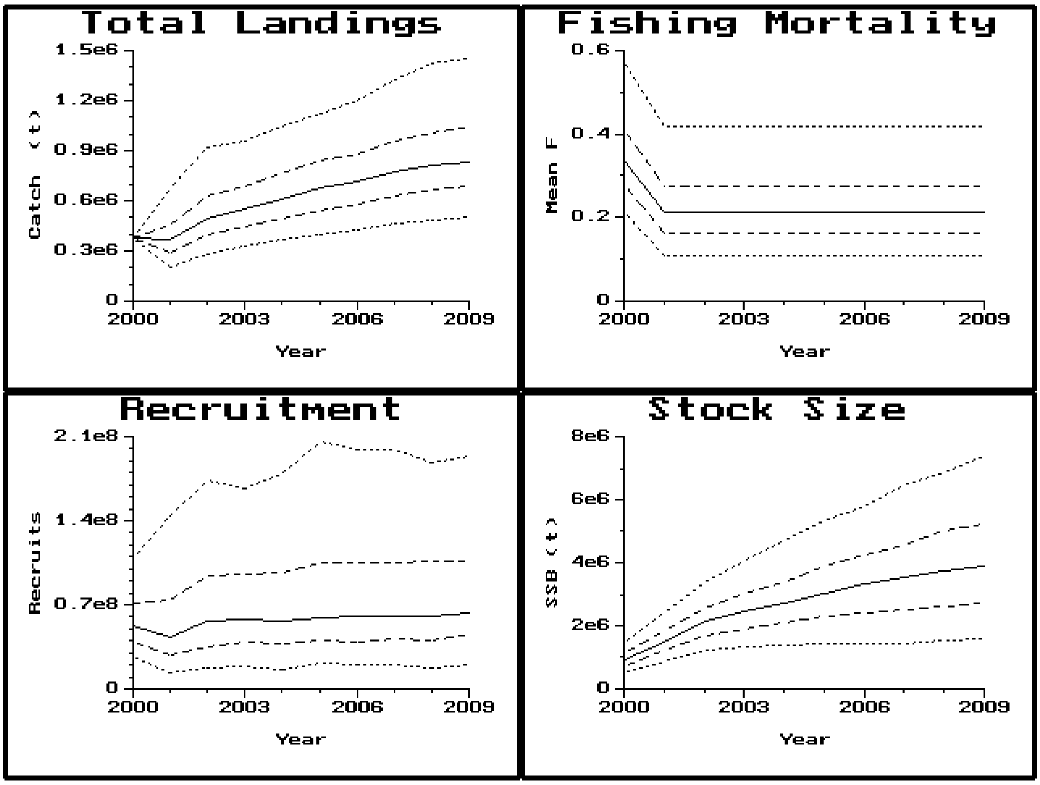


Figure 2.11.6 Medium term projections assuming $F_{0-1} = 0.04$, $F_{2-6} = 0.20$, Total landings, Fishing mortality, Recruitment and stock size.

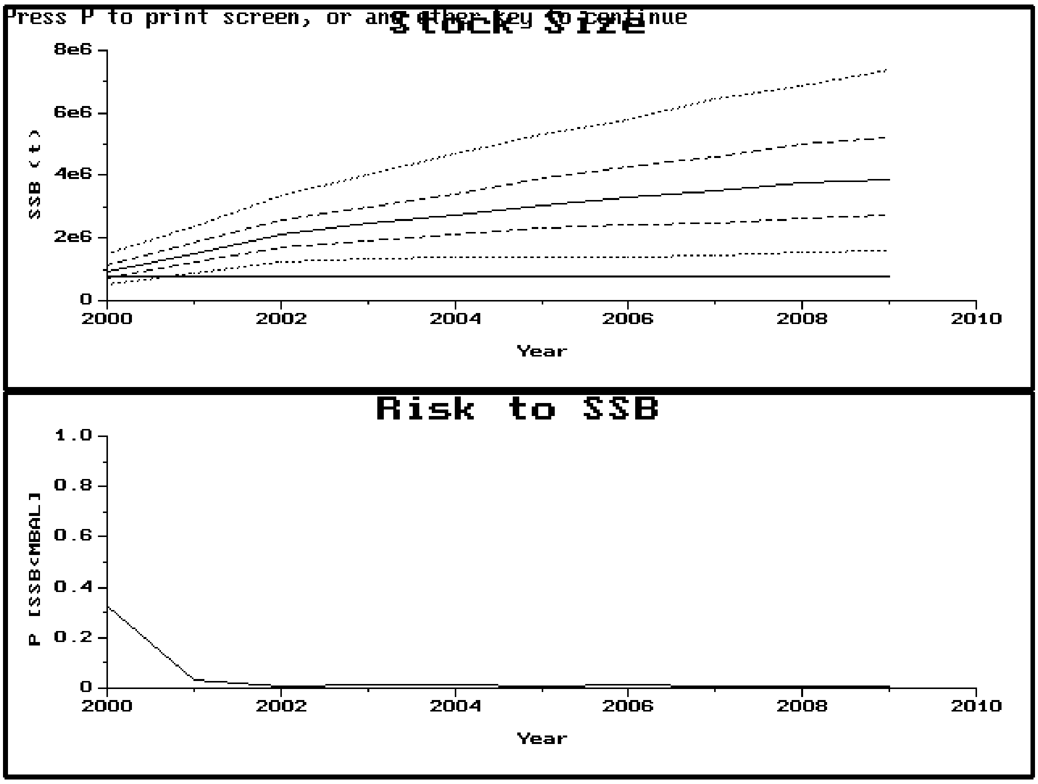


Figure 2.11.7 Medium term projections assuming $F_{0-1} = 0.04$, $F_{2-6} = 0.20$, 95,75,50,25,5 percentiles stock size and risk to SSB.

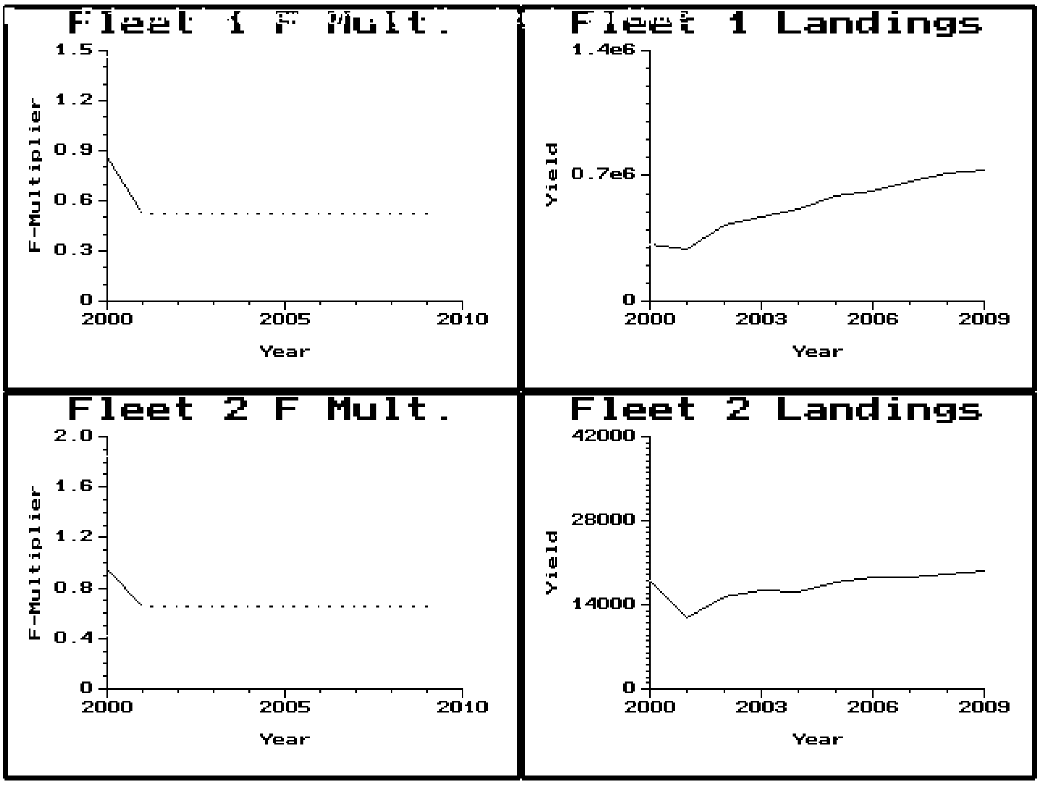


Figure 2.11.8 Medium term projections assuming $F_{0\text{-}1}$ = 0.04, $F_{2\text{-}6}$ = 0.20, Fleet F and Landings, 95,75,50,25.5 percentiles.

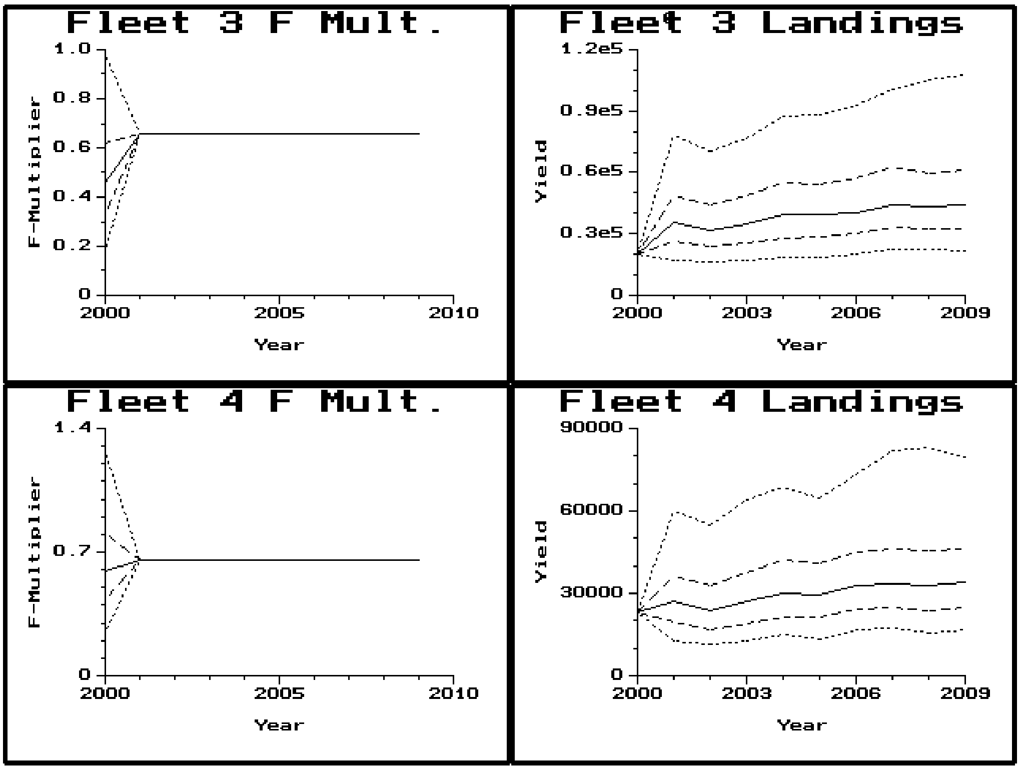


Figure 2.11.9 Medium term projections assuming $F_{0\text{-}1}$ = 0.04, $F_{2\text{-}6}$ = 0.20, Fleet F and Landings, 95,75,50,25.5 percentiles.

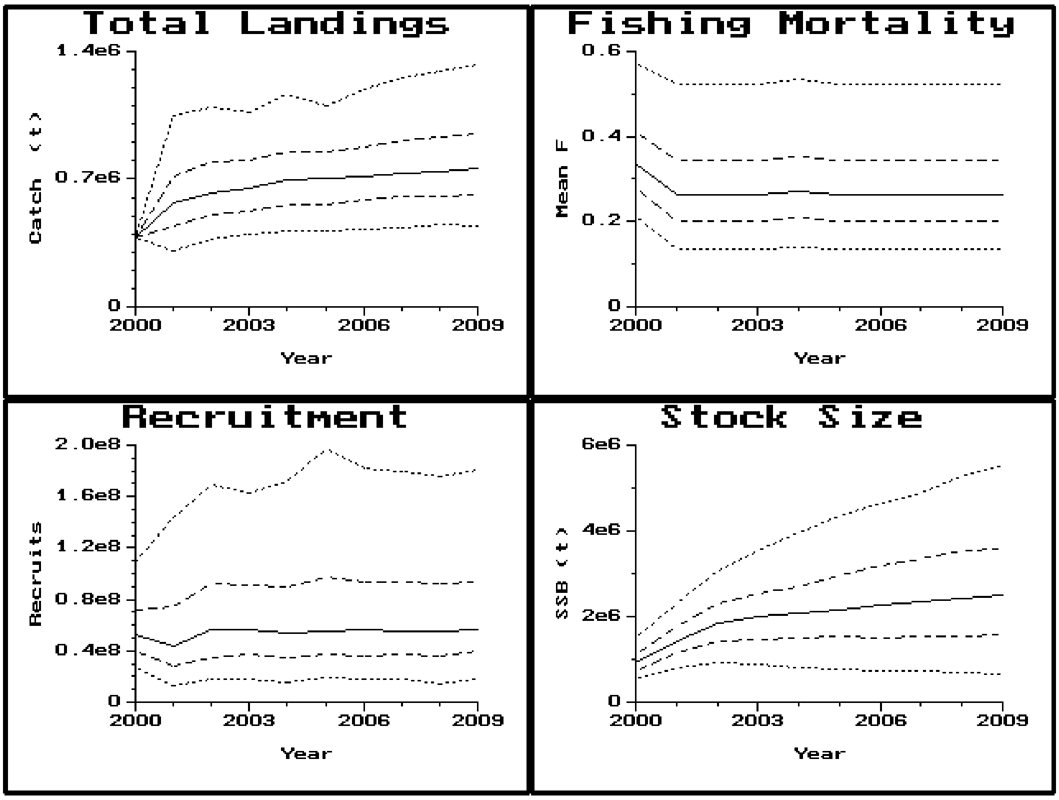


Figure 2.11.10 Medium term projections assuming F_{0-1} = 0.12, F_{2-6} = 0.25, Total landings, Fishing mortality, Recruitment and stock size.

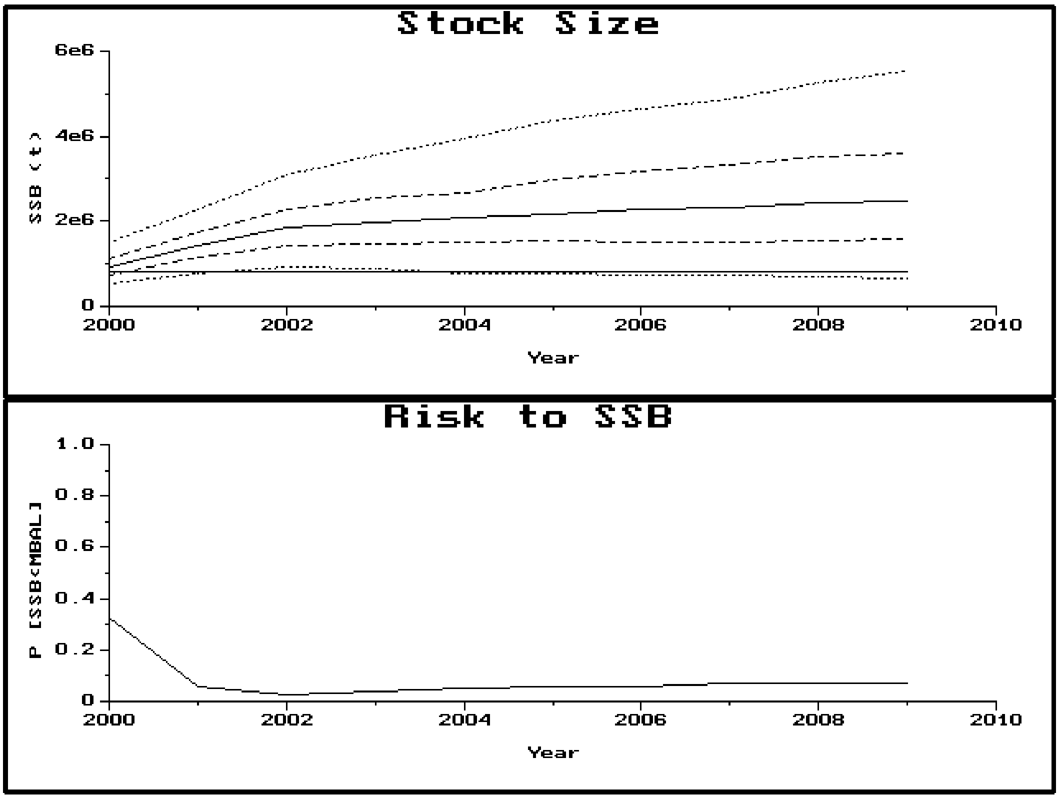


Figure 2.11.11 Medium term projections assuming F_{0-1} = 0.12, F_{2-6} = 0.25, 95,75,50,25,5 percentiles stock size and risk to SSB.

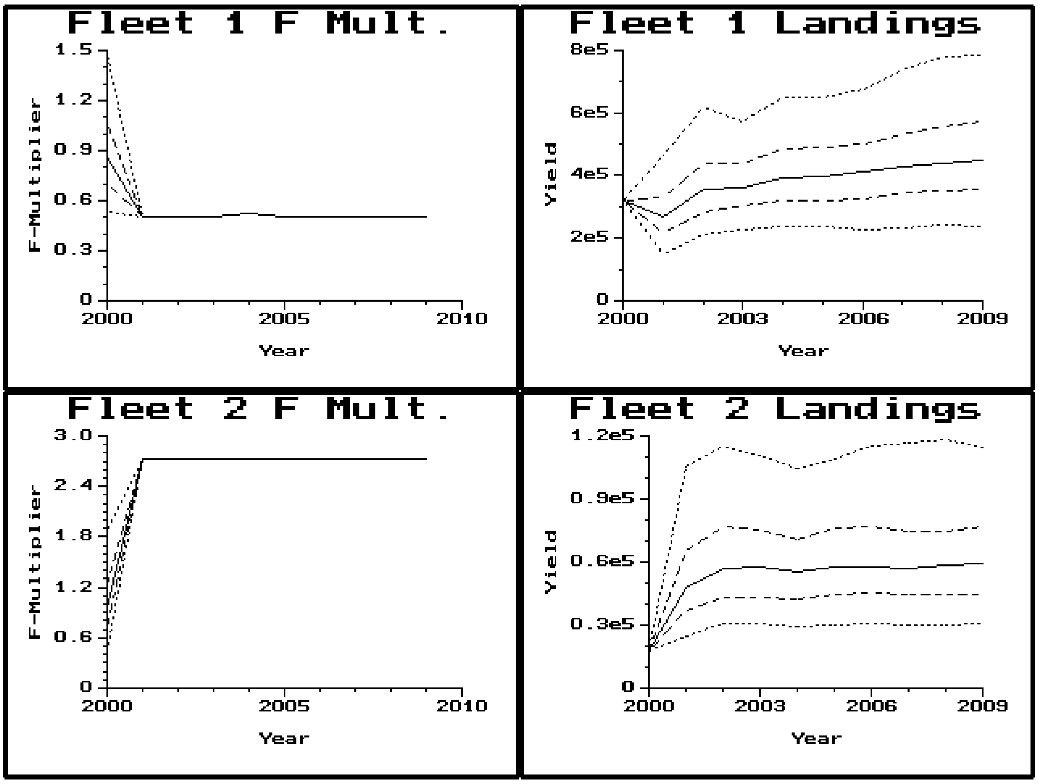


Figure 2.11.12 Medium term projections assuming $F_{0-1} = 0.12$, $F_{2-6} = 0.25$, Fleet F and Landings, 95,75,50,25.5 percentiles.

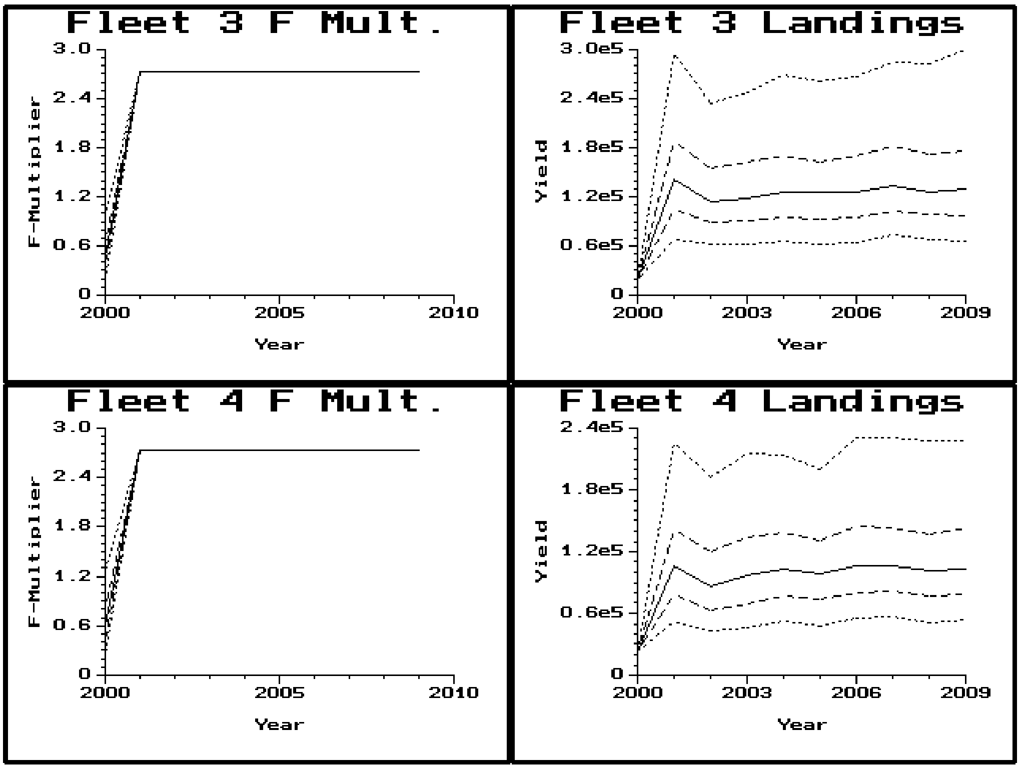


Figure 2.11.13 Medium term projections assuming $F_{0-1} = 0.12$, $F_{2-6} = 0.25$, Fleet F and Landings, 95,75,50,25.5 percentiles.

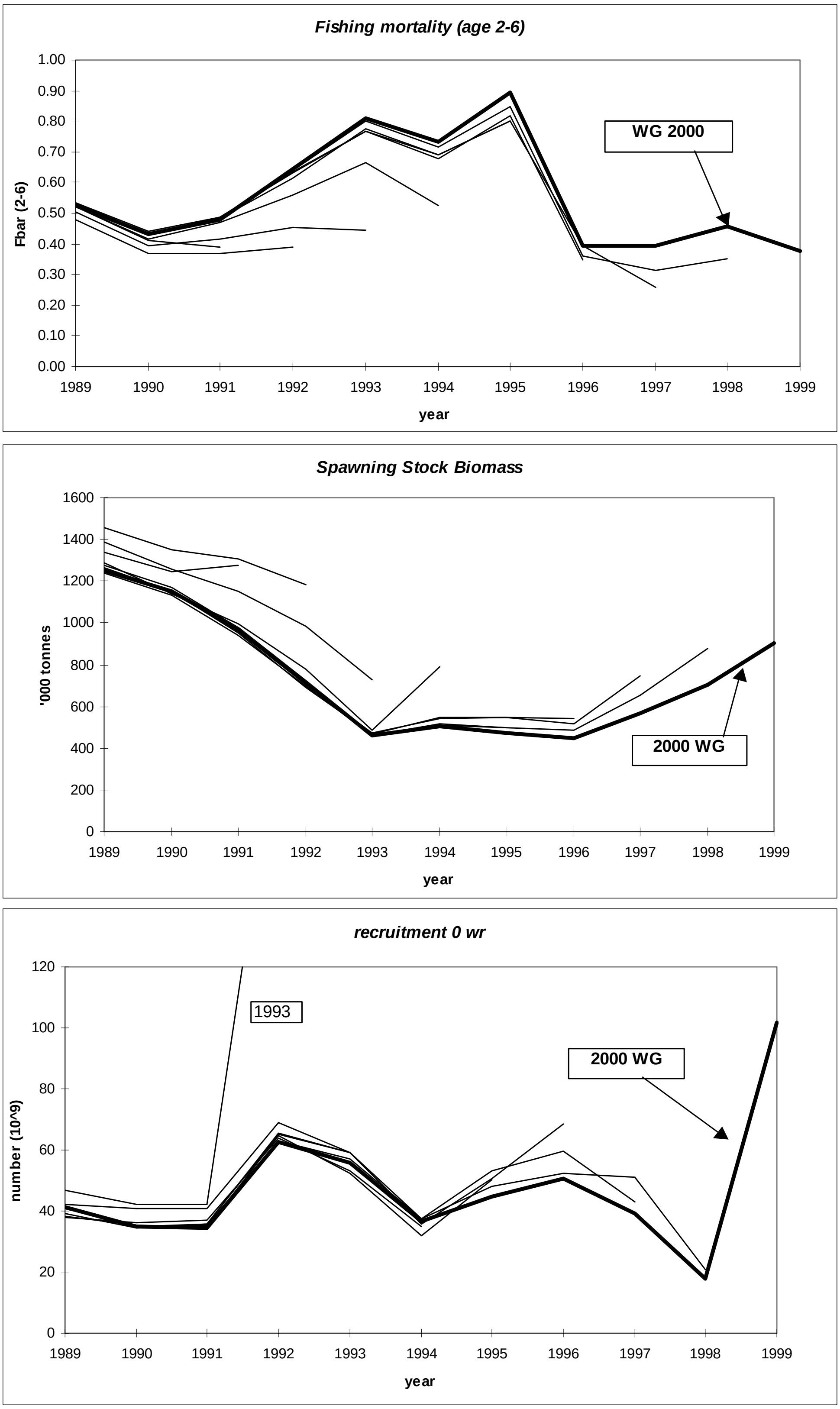


Figure 2.12.1 North Sea autumn spawning herring results of assessments in subsequent years for fishing mortality, SSB and recruitment as 0-wr.

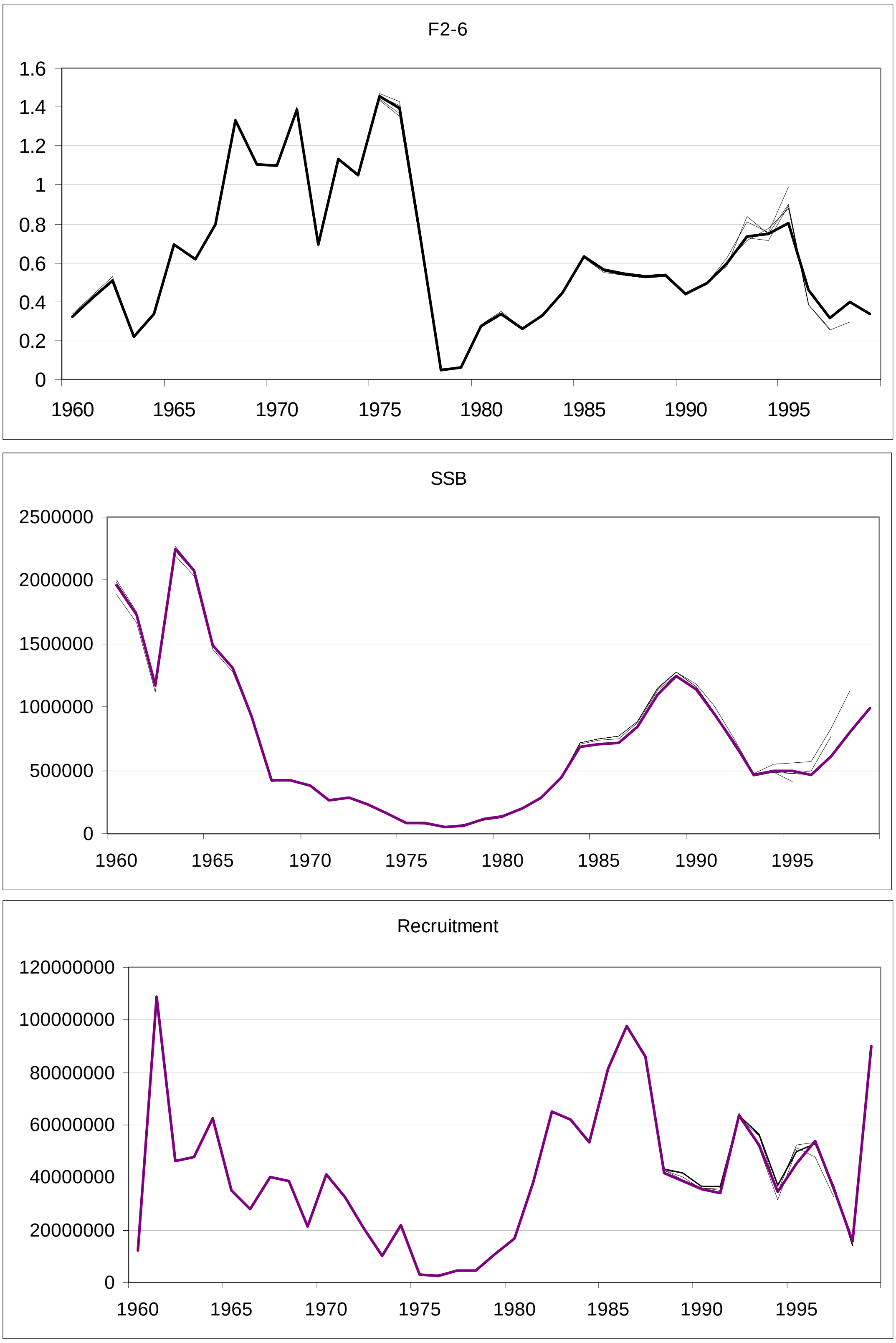


Figure 2.12.2 Retrospective analysis of North Sea autumn spawning herring using 4 year separable periods shifted backwards over time.

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

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1999 and 2000

ACFM at its May 1999 meeting repeated that the state of the stock is uncertain due to problems with splitting in proportions of spring and autumn spawners in the historical data and the lack of a coordinated comprehensive survey. Neglecting the precise levels of SSB and F the trends seen from 1991 – 1996 have changed. The SSB in 1997 was above the 1996 estimate and the F in 1997 was below those seen in recent years.

ACFM recommended that the fisheries on herring in Division IIIa should continue to be managed in accordance with the management advice given on autumn-spawning herring in the North Sea. If a catch limit is required in Sub-divisions 22–24, ACFM advised that it should not exceed recent catches in that area in the order of 60,000 t.

The EU and Norway agreement on a herring TAC’s set for 1999 was 80,000 t in Division IIIa for the human consumption fleet and a TAC or by-catch ceiling of 19,000 t to be taken in the small meshed fishery.

For 2000 the EU and Norway agreed record on the herring TAC’s in Division IIIa are 80,000 t for the human consumption fishery and that by-catches of herring taken in industrial and sprat fisheries was limited to 21,000 t.

As in previous years no special TAC for 1999 was set by the International Baltic Sea Fishery Commission (IBSFC) on the stock component in the Western Baltic area. For the Baltic there was for 1999 a TAC of 570,000 t for all the Sub-divisions 22–32. The TAC was reduced to 490,000 t for the same area in 2000.

Introduction to landing statistics

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.

3.1.2 Total Landings

Landings from 1985 to 1999 are given in Table 3.1.1. In 1999 the total landings decreased to 137,000 tons in Division IIIa and Sub-divisions 22–24 compared with 1998 where the landings were 171,000 tons. The landing figure for 1999 is the lowest in the time series 1986 – 1999. In 1999 35,000 tons were taken in the Kattegat, about 51,000 t from the Skagerrak and 51,000 t from Sub-divisions 22–24. These landings represent an decrease of 33,000 t compared to 1998.

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 values for the North Sea. A part of Swedish landings have been misreported as caught in the triangle (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK). This amount is included in the values for Kattegat and Skagerrak. Some Danish landings, reported as taken in this triangle, may have been taken outside this area. These landings are listed under Kattegat.

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

In 1999 the landing data are calculated by fleet according to the fleet definitions used when setting TACs. In the autumn 1998 the EU and Norway have agreed on setting TACs for only two fleets, and this agreement was also in force for 1999. Therefore, the HAWG in 1998 has decided to merge Fleet D and Fleet E and only present data according to these new fleet definitions. See (ICES 1999)

The fleet definitions used for 1998 and 1999 and henceforth are:

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

- Fleet D+E, now described as Fleet D: All fisheries in which trawlers (with mesh sizes less than 32 mm) and small purse seiners, fishing for sprat along the Swedish coast and in the Swedish fjords, participate. For most of the landings taken by this fleet, herring is landed as by-catch.

All Norwegian landings for 1999 and all landings from fisheries with mesh sizes of min. 32 mm are categorised in Fleet C. Danish and Swedish by-catches of herring from the sprat fishery and the Norway pout and blue-whiting fisheries are listed under fleet D.

In Sub-divisions 22–24 most of the catches are taken in a directed fishery for herring and some as by-catch in a directed sprat fishery. All landings from Sub-divisions 22–24 are treated as one fleet. The landings of the autumn spawning component in Division IIIa plus the entire spring spawning stock could therefore be split into three fleets:

- C: Fleet using 32 mm mesh size in Division IIIa.
- D: Fleets using mesh size less than 32 mm Division IIIa.
- F: Landings from Sub-divisions 22–24.

In the table below the landings are given for 1996 to 1999 in thousands of tonnes by fleet and quarter. The landings figures in the text table below are SOP figures.

Year	Quarter	Fleet C	Fleet D	Fleet F	Total
1996	1	13.9	12.1	9.3	35.3
	2	12.5	2.2	23.9	38.6
	3	46.2	3.2	10.1	39.5
	4	19.4	8.3	13.5	41.2
	Total	92.0	25.8	56.8	174.6
1997	1	11.7	2.5	17.4	31.6
	2	16.9	1.3	27.2	45.4
	3	22.6	1.1	7.8	31.5
	4	21.7	4.2	15.1	41.0
	Total	72.9	9.1	67,5	149.5
1998	1	17.6	3.1	18.5	39.2
	2	8.2	0.9	16.9	26.0
	3	44.2	2.0	14.7	60.9
	4	34.3	2.6	13.6	50.5
	Total	104.3	8.6	63.7	176.6
1999	1	12.1	10.4	20.6	43.1
	2	12.0	3.1	13.4	28.5
	3	21.1	10.2	5.3	36.6
	4	5.5	12.1	10.8	28.4
	Total	50.7	35.8	50.1	136.6

The landings from fleets C-F are SOP figures.

3.2 Stock composition

Catches of herring in the Kattegat, the Skagerrak and the Eastern part of the North Sea are taken from a mixture of two main spawning stocks (ICES 1991/Assess 15): the Western Baltic spring spawners and the North Sea autumn spawners. In addition, several local stocks have been identified (Jensen, 1957). These have however been considered to be less abundant and therefore of minor importance to the herring fisheries (ICES 1991/Assess 15).

The North Sea autumn spawners (NSAS) enter Skagerrak and Kattegat as larvae and migrate back to the North Sea at an age of 2–3 years (Rosenberg & Palmén, 1982). The Western Baltic spring spawners (WBSS) spawn around the Baltic Island Rügen. They migrate through the Belt Sea, to the Kattegat and the Skagerrak as adults after spawning (Biester, 1979) and the juveniles starts migration to the same areas as 1- and 2-ringers.

The herring stocks in the Kattegat and the Skagerrak have been identified within samples by a number of different methods. Some of them have not been fully documented in earlier WG-reports. In a number of scientific papers the average counts in number of vertebrae in herring samples have been considered (Rosenberg & Palmén, 1982; Gröger & Gröhsler, 1995 and 1996). NSAS have a mean number of 56.5 vertebrae while the WBSS has traditionally been considered to have a mean number of 55.8 vertebrae (ICES 1992/H:5), a more recent investigation (Gröger & Gröhsler

2000, Gröger & Gröhsler WD 2000) points to a somewhat lower value of 55.63. The most abundant local spring spawning herring, the Skagerrak spring spawners (SSS), are represented by a higher mean number, 57.0 vertebrae.

Following the tradition from Heinke (1898), several other morphometric and metric variables have been used to separate herring stocks (Rosenberg & Palmén, 1982). The use of most of these variables was evaluated by an ICES workshop in 1992 (ICES 1992/H:5). This group concluded that a simple modal length analysis of the relevant 1–2 age groups would be precise enough for routine assessment purposes.

However, modal length analysis has proved to be an imprecise measure requiring a large sampling effort. Experience within the Herring Assessment Working Group showed that the separation procedure often failed. The amounts of herring catches that were allocated to the NSAS stock have varied between 30 to 50% of total annual landings during the last 10 years. There was an apparently very high among years variation in the proportion of spring spawners applied for the Skagerrak in quarters 3 and 4 (ICES 1999/ACFM 12, Table 2.1). Errors in the estimate of these proportions clearly affected the quality of the assessment of the WBSS stock. A more precise measure was needed.

Otolith microstructure analysis has also been tested to separate spring and autumn spawned larvae (Moksness & Fossum, 1991) and adults (Zhang & Moksness, 1993). Otolith growth in the larval stage (which can be inferred by microscopically examine the otolith centre) is significantly slower for autumn spawners. The processing speed of the method can be accelerated by image analysis and training (Mosegaard & Popp-Madsen 1996). The disadvantage of a lower number of measurements is outweighed by a very high precision. Efficient grinding methods have opened up the possibility to include all ages in a routine examination. From 1996 the method using otolith micro-structure to separate Baltic spring spawners from North Sea autumn spawners has therefore increasingly been applied to the Division IIIa samples.

For the HAWG 2000 the years from 1991 to 1998 have been reworked applying different splitting methods for different years in the series. For the years 1991 to 1997 a new Discriminant analysis technique based on VS counts has been applied (see Section 3.4.1), for 1998 the split presented in last years Working Group report (ICES 1999/ACFM:12) has been adopted, and for the present year a combination of traditional VS- and otolith based methods has been applied (see the following Sections 3.2.1 and 3.2.2).

3.2.1 Treatment of spring spawning herring in the North Sea

The split was performed on age classes 1, 2, 3, and 4+ WR using proportion of spring spawners f(sp) calculated from VS-counts using the equation f(sp) = [56.5-VS(sample]/[56.5–55.8] where VS (sample) was the sample mean vertebral count (ICES 1992/H:5). For commercial landings in May, June and July from the North Sea in 1999, the proportion of spring spawners was calculated using samples from Norwegian commercial landings. For the actual split see Section 2.2.2.

3.2.2 Treatment of autumn spawners in Division IIIa

For commercial landings in 1999 the split of the Danish landings was conducted using an age-class stratified random subsample of herring where analysis of individual otolith microstructure determined the spawning type (Mosegaard and Popp-Madsen 1996). A total of 1761 otoliths from the year 1999 were analysed for spawning type. Distributed on quarters the following numbers were analysed Q1:398, Q2:79, Q3:676 and Q4:608. By areas, 18% were from the Sub-divisions 22–24, 51% from the Kattegat, 29% from the Skagerrak and 2% from the transfer area in the eastern part of the North Sea. Samples from the small mesh fishery constituted 41% of the analyses, 46% from the human consumption fishery, and the remaining 12% came from Danish and Swedish research vessels from two different cruises.

Data were disaggregated by area (Kattegat and Skagerrak), age group (0–4+ WR) and quarter (1–4).

Despite a reasonable coverage of the fishery, some of the age, area and season combinations had to be estimated as an average of the proportions in adjacent areas, age groups or years.

Skagerrak 1st quarter, year class 3 and 4: Values were based on Swedish IBTS data averaged over 1996 to 1998.

Skagerrak 2nd quarter, all year classes: Values were based on Norwegian VS counts split by the traditional method (fraction WBSS, f(sp) = [56.5-VS(sample)]/[56.5–55.8] where VS (sample) is the sample mean vertebral count (ICES 1992/H:5)).

All other quarters and age classes were split using otolith microstructure split factor.

The resulting split for the Skagerrak and the Kattegat is summarised in Table 3.2.1 as% autumn spawners and spring spawners by age in each quarter.

3.2.3 Autumn spawners in the fishery in Sub-divisions 22 and 24

In the western Baltic a small percentage of the herring landings consisted of autumn spawned individuals. Compared to the 1997 years assessment (ICES 1998/ACFM 14) the magnitude of the problem in 1998 and 1999 was minor. Juvenile autumn spawned herring of the age groups 0, 1 and 2 comprised about 11% in numbers of the landings. The small size at age however, indicated that the herring were local autumn spawners rather than originating from the North Sea stock. Since this problem is of limited influence and since it only affects the younger age classes (0 to 2 WR), the landings were treated as coming from the Western Baltic spring spawning stock. The existence of varying proportions of autumn spawners in subdivisions 22–24 however, indicates a potential problem for the assessment that should be kept in mind.

3.2.4 Accuracy and precision in stock identification

3.2.4.1 Stock identification and splitting methods for the years 1991–1996

During the last decade the HAWG has encountered a suite of overpowering difficulties in the assessment of the Western Baltic Spring Spawning (WBSS) stock, as it was impossible to separate the WBSS from some North Sea stock component (autumn spawner) in Division IIIa (Skagerrak, Kattegat, Sound), where both stocks are mixing. For this year the HAWG decided to use a splitting rule for the period 1991 to 1996 which was considered as best out of a set of sub-optimal splitting options. This was due to persistent lack of sufficient microstructure information from these years. Following Gröger & Gröhsler (2000, WD 2000), the splitting function used is based on the method of discriminant analysis and two representative German reference samples (learning samples) of vertebra counts (VS), which were taken in 1995 in the North Sea and the Western Baltic Sea to derive the characteristics of the two mixing stocks in question.

As the corresponding vertebra count (VS) frequency distributions are unimodal and only slightly skewed, a strong deviation from normality did not need to be considered. The two associated VS sample means (North Sea: 56.53, Baltic Sea: 55.60) appear significantly different (ANOVA: F = 304.26, p_F = 0.0001). Although the two CVs indicate a small sample variation (North Sea: 1.23%, Baltic Sea: 1.47%), the associated two VS sample variances (Baltic Sea: 0.67, North Sea: 0.48) are significantly different (Levene-s test: F_{Levene} = 7.40, $p_{F,Levene}$ = 0.0067; see Levene 1960). Thus, the splitting functions used are expressed as two quadratic Maximum Likelihood (ML) distance functions, taking into account the two heterogeneous (non-pooled) sample (group) variances:

$$\hat{d}_{Baltic\ Sea}(VS_{new}) = -(VS_{new} - 55.60)^2 \times 0.746 + 0.200$$

$$\hat{d}_{North\ Sea}(VS_{new}) = -(VS_{new} - 56.53)^2 \times 1.042 + 0.367$$

(3.4.2.1)

Both distance functions are transformed into so called posterior probabilities which are used to predict the probabilities of Baltic or North Sea membership and the corresponding herring fractions, respectively:

$$\hat{p}_{Baltic\ Sea}(\overline{VS}_{new}) = \frac{e^{(d_{Baltic\ Sea}(\overline{VS}_{new}))}}{e^{(d_{Baltic\ Sea}(\overline{VS}_{new}))} + e^{(d_{North\ Sea}(\overline{VS}_{new}))}}$$

$$\hat{p}_{North\ Sea}(\overline{VS}_{new}) = 1 - \hat{p}_{Baltic\ Sea}(\overline{VS}_{new}) \quad .$$

(3.4.2.2)

The above probability model could be well fitted to given observed probabilities (= estimated proportions of vertebra counts), which were derived from the learning samples: compared to alternative options, the sum of squared deviations was smallest (= 0.01). Based on Swedish routine survey data a table was constructed (see Table 3.2.2) containing the predicted splitting factors in terms of Baltic Sea herring fractions per year (1991 – 1997), quarter (I – IV), area

(Skagerrak and Kattegat) and age group (winter rings 1 – 4+). For this 16913 data records were selected in total (for 1991 n = 2371, 1992 n = 1546, 1993 n = 2970, 1994 n = 3320, 1995 n = 3389, 1996 n = 2144).

The introduction of otolith microstructure analysis in 1996/7 enables an accurate and precise split between three groups, autumn, winter and spring spawners, however, different spring spawning populations are not resolved with the present level of analysis. VS counts have been analysed for the different spawning types identified by otolith microstructure. In a few cases the mean VS counts for the identified fraction of 1 or 2 group spring spawners significantly diverge from the expected average of 55.6 (assuming a standard deviation of 0.82). The three significant values are 1st quarter, age 2 in both Skagerrak and Kattegat, as well as 3rd quarter, age 1 in Skagerrak (see Table 3.4.2 in ICES 1999/ACFM:12). The higher VS counts indicate proportions of local spring spawners in these samples between 30 and 50% (with a higher mean VS of 57).

An effort was made to compare proportions of spring spawners from the Discriminant function method based on VS counts with otolith microstructure based spawning type, for the years 1991 to 1996 (Figure 3.4.1).

The data were disaggregated by year, sub-division, age-group, and quarter. The sub-divisions were Kattegat and Skagerrak, age-classes were 1, 2, 3, and 4+; and quarters 1 and 3.

3.2.4.2 Splitting by otolith microstructure in the years 1997–1999

From 1997 the split by otolith microstructure has been performed on both commercial and survey sampling. In each year some age-classes in some quarters in Skagerrak and the transfer area of the NS have been split by VS-counts applying the traditional method described in Section 3.2.1.

3.2.4.3 The influence of different splitting methods

The proportion WBSS estimated from otolith microstructure was regressed versus the discriminant transformation of proportions by VS count, by years (1991–1996), age-classes (1–4+), area (Skagerrak and Kattegat), and quarter (1 and 3). Both data sets came from the Swedish IBTS cruises (1991–1997).

Figure 3.4.1 shows the scatter of the two methods also reflecting a quite narrowed range of discriminant method compared with the otolith microstructure estimates. Further a quite large difference in the median fraction estimated by the two methods was found, where the $\text{fraction}_{\text{Otolith}} = 0.69$ and $\text{fraction}_{\text{Discriminant}} = 0.45$.

3.3 Catch in numbers and mean weights at age

The Swedish landings from Fleet D from the Skagerrak were sampled in quarter 1 and 3 (see Table 3.4.1 in section on quality of sampling). Danish samples were used for quarter 2 and 4. Sampling of the human consumption landings was generally acceptable in the Skagerrak and the Kattegat. In Sub-divisions 22–24 the Danish fishery was sampled in all quarters, while there were samples from the Swedish fishery and therefore Danish sampled were used to estimate catch in numbers and mean weight at age for the Swedish landings. German landings were sampled in quarter 1 and 2. These 2 quarters were the most important and the landings in quarter 3 and 4 were only 5 and 91 tons respectively. In Sub-division 23 only Danish samples were available for quarter 1, 3 and 4. Danish samples from Kattegat were used in all quarters to estimate catch in numbers for Fleet D for this Sub-division. Polish data on landings in numbers and mean weight at age for Sub-Division 24 were not available for the WG and therefore Danish samples were used.

Tables 3.3.1, 3.3.2 and 3.3.9 show the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-division 22 - 24 by fleets.

Based on the proportions of spring- and autumn spawners (see Section 3.2.3) in the landings, number and mean weights by age and spawning stock are calculated (Tables 3.3.7 - 3.3.8). The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Tables 3.3.10 and 3.3.13 (see also Tables 2.2.1–2.2.5). The landings of spring spawners taken in Division IIIa and the North Sea in 1999 were estimated to be about 50,000 tons (Table 3.3.14) compared to about 54,000 t in 1998 and 38,000 t in 1997. This decrease in landings is due to the lower fishery in especially Kattegat.

The landings of North Sea autumn spawners in Division IIIa amounted to 41,000 t compared to 59,000 t in 1998 and 40,000 t in 1997 (Table 3.3.12). The total catch in number and mean weight at age of Baltic spring spawners in the North Sea, Division IIIa and in Sub-divisions 22–24 for 1988–1998 are given in Tables 3.3.13 and 3.3.14.

Data for 1998 was revised and details can be found in Table 3.3.15.

3.4 Quality of catch data and biological sampling data

The sampling intensity of the landings in 1999 was acceptable and above the recommended level. Danish landings were sampled in the most important quarters for the Skagerrak, the Kattegat and for Sub-divisions 22 and 24. In 1999 the sampling intensity has improved for Sub-division 23 where samples were taken from the Danish fishery in three most important quarters. Swedish landings from the human consumption fishery were sampled in all quarters and in contradistinction to the Swedish landings for industrial purposes from the Skagerrak and the Kattegat, where samples only were taken in quarter 1 and 3 for Skagerrak and quarter 1 for Kattegat. From the Norwegian landings from the Skagerrak only 3 sample was taken in the second quarter but no samples from the third quarter where landings amounted to 3,000 tons.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Divisions IIIa, IIIb and IIIc were 137,000 tons from which 278 samples were taken, 76,700 fish were measured and 13,700 fish were aged. For comparison the figures for 1998 were 173,000 tons from which 234 samples were taken, 36,000 fish were measured and 12,000 fish were aged. Despite the high sampling level, still the distribution over seasons, areas and fishing fleets needs to be improved.

Sampling of the Danish landings for industrial purposes were at the same high level in 1999 as in the three previous years. The number of samples and number of fish investigated were considered to be at adequate level. Again in 1999 there have been difficulties in getting samples from the Danish directed herring human consumption fishery in Skagerrak. There is uncertainty about where the Danish landings for human consumption, reported from Division IIIa (quarters 1, 2 and 4), were actually taken. Most of the landings from quarter 1, 2 and 4 supposed to have been taken in the North Sea and were therefore transferred to the North Sea.

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. The lack of sampling of discards creates problems, which need to be resolved for the assessment.

There is an unknown effect of variability in the stock composition in Div IIIa due to uncertainty of the splitting factor between the North Sea autumn spawners and the Baltic spring spawners. There is at present no information about the importance of local herring stocks (i.e., the Kattegat autumn spawners and the Skagerrak winter spawners) and their possible influence on the stock assessment. Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter, there is an unequal coverage of some areas and times of the year.

3.5 Fishery-independent estimates

3.5.1 German bottom trawl surveys in Sub-divisions 22 and 24

The following trawl surveys are conducted every year:

- German bottom trawl survey (GBTS) in Sub-divisions 22 and 24 in November/December,
- German bottom trawl survey (GBTS) in Sub-division 24 in January/February.

The German bottom trawl surveys have been conducted in Sub-divisions 22 and 24 since 1978 by the Institut für Hochseefischerei, Hamburg. Depending on the availability of research vessels they were conducted either in November/December or in January/February. Since 1992 the surveys are carried out both in November/December and January/February by the Institute for Baltic Sea Fishery Rostock (IOR). The main purpose of these surveys have been to provide recruitment indices for cod. In the first year, the survey stations were randomly located. However, in subsequent years a fixed station grid was used. The survey in Sub-division 22 is only covering the Mecklenburger Bucht (20 stations), which is considered as one depth stratum. Sub-division 24 is divided into four depth strata (31 stations). Trawling is conducted by means of the herring bottom trawl ‘HG 20/25’. From each station the catch in number at age by species is estimated (cod, herring, sprat and flounder). In Sub-division 22 the arithmetic mean catch at age per half hour haul values are used as indices. The calculated indices at age in Sub-division 24 are stratified means weighted by the area of the depth stratum. Schulz and Vaske (1988) give details of the survey design and the gear (HG 20/25) as well as some results for the period 1978 to 1985.

Abundance indices for 0, 1, 2, and 3+ ringed herring obtained by bottom-trawl surveys carried out in November/ December of each year in Sub-divisions 24 and 22 are given in Tables 3.5.1 and 3.5.2. Combined estimates for the total area are calculated by weighting each single survey estimate by the survey areas of each Sub-division. The resulting time index series is shown in Table 3.5.3. In Sub-division 24 the 1999 estimates are slightly above and in Sub-division 22 far below the average of the recorded time period for all age groups.

Abundance indices for 1 to 8+ ringed herring from bottom-trawl surveys conducted each year in January/February in Sub-division 24 are given in Table 3.5.4. In 1999 the total numbers are the highest recorded mean catch in numbers of the 1 ringer for the reported time period.

3.5.2 International Bottom Trawl Survey in Division IIIa

Results from the annual IBTS surveys in Division IIIa are available since 1980. The surveys are conducted during the 1st quarter (February) using standard gear and a depth stratified survey design (Addendum to ICES 1996b). From 1990 to 1995 standard surveys were also implemented during the 2 nd (April), 3rd (September) and 4 th (November) quarters. Since 1995 only the surveys in the 1st and the 3rd have been continued. These survey indices were split into components of autumn and spring spawners by modal length analysis from 1990 to 1995. The index from the 1st and 3rd quarter surveys were decomposed according to spawner type (autumn and spring spawner) by results from otolith microstructure analysis for 1996 to 1999.

The derived estimates of the relative density of spring spawning herring in the Skagerrak and the Kattegat for 1st and 3rd quarter are presented in Table 3.5.5 and Table 3.5.6.

3.5.3 Summer Acoustic survey in Division IIIa

The summer acoustic survey is part of an annual survey covering the North Sea and Division IIIa in July-August by R/V “Dana” and G.O. SARS”. In 1999 the survey in Division IIIa was only conducted by R/V “G.O. SARS” and covered only the Skagerrak area. The data-set from 1999 has been presented in Table 3.5.7. Due to incomplete coverage of the distribution area of the Western Baltic spring spawning stock, it is mostly likely underestimated for this year.

For exploratory purposes to get an overview of the proportion of the Western Baltic spring spawning stock found in Kattegat and not surveyed in 1999, the results of three former years were compared. Percentages of the surveyed Western Baltic spring spawning herring (1996–1998) found within the Kattegat are shown in Figure 3.5.1. It shows that the proportion per age class has steadily decreased from 1996 to 1998. It also shows that more than 80% of mature Western Baltic spring spawning herring in the surveyed area is to be found in the North Sea and Skagerrak during this time of the year. The spatial distribution of the WBSS herring in 1998 and 1999 (Figure 3.5.2–3) indicates that the main distribution was in the North Sea-Skagerrak area in both years. Further details of the survey in 1999 are given in Simmonds *et al*. (WD 2000). To estimate an index value for the whole region (North Sea, Skagerrak and Kattegat), estimated biomass,% maturity and mean weight at age for Baltic Spring Spawning herring for the 1999 July Acoustic Survey were projected using the same proportions as in 1998 in order to provide estimates also for the Kattegat. The results are presented in Table 3.5.8.

3.5.4 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 September 25 th to October 16 th 1999. The survey covered the Sub-divisions 22, 23, 24 and the southern part of the Kattegat. As in last years, most investigations were performed at night. Due to bad weather conditions the investigations for the last two days in 1999 were done during day time. The acoustic equipment used was an echosounder EK500 connected to the Bergen-Integrator BI500. The 38 kHz transducer (38–26) was installed in a towed body. The lateral distance of the towed body to the ship was set to 30 m in order to minimise possible escape reactions of fish. The cruise track was 874 nm long, and 45 trawl hauls were carried out to identify the targets. The total number of fish calculated from the echo soundings was separated into species and age groups according to the trawl catches.

The acoustic backscattering strength (S_A values) for each stratum were converted into fish numbers using the TS-length regressions:

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

The result for 1999 is presented in Table 3.5.9. The data series have been recalculated and revised for 1994–1998. The revision followed procedures recommended in the Baltic international acoustic survey manual (ICES 1999). In 1999 the total estimated stock size of herring in Sub-divisions 22–24 was 175,000 t, which is below the average for the whole time period of about 217,200 t.

3.5.5 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. These are the Greifswalder Bodden (area: 510.2 km^2, volume: 2,960 x 106 m^2, mean depth: 5.8 m, maximum 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 CLUPEA during daylight in 10 consecutive cruises. At each station herring larvae samples are taken by means of 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. Since 1996 a HYDROBIOS-Bongo (meshsize: 0.335 mm) was used.

For the calculation of the number of larvae per station and area unit, the methods of Smith and Richardson (1977) and Klenz (1993) were used and projected to length-classes. To get the index for the estimation of the year class strength, the number of larvae with a mean total length of TL = 30 mm (larvae after metamorphosis) were calculated, taking growth and mortality of the larvae cohorts into consideration.

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989), Müller & Klenz (1994) and Müller (WD 2000). The estimated numbers of larvae for the period 1977 to 1999 are summarised in Table 3.5.10. The 1998 estimate of the larval index is the highest recorded value for the 0-group in the whole time period.

3.6 Recruitment estimates

Indices of 0-ringer abundance were available from larval surveys during the spawning season on the main spawning area (Table 3.5.10) and from the German Bottom Trawl Surveys during November-December in Sub-divisions (SD) 22–24 (Table 3.5.1). Indices of 1-ringer abundance were available from the German Bottom Trawl Surveys during November-December in SD 22 and 24 (Table 3.5.1, 3.5.2, 3.5.3) and from German Bottom Trawl Surveys during January-February in SD 24 (Table 3.5.4). Log transformed indices were compared by year class in Figure 3.6.1 The larval 0-ringer and November 0-ringer indices for the year classes 1977 to 1999 showed some similar year-to-year variability (correlation R-square = 0.44). The SD 24 November 0-ringer and the January 1-ringer showed co-variation (correlation R-square = 0.34) whereas the SD 24 November 0-ringer and the SD 24 November 1-ringer indices for the year classes 1978 to 1999 showed no co-variation. The indices illustrated in Figure 3.6.1 show the following general time trends: Poor recruitment of year classes 1980–82 was followed by an increase to a high level of recruitment for year classes 1983–88. From year class 1990 the recruitment declined until 1992 when recruitment was low. An increase in year classes 1993–1994 is indicated. The year class 1996 was below average but the estimates of the recent three years are high and for 1998 and 1999 comparable to historical high levels of recruitment. The high larval index of the 1998 year class was followed by high values of 0-ringers in the bottom trawl survey in Sub-division 24 in November in 1998, also the 0-ringers in the part of the acoustic survey in Sub-division 24 in October was high. This year class was observed at a high level again as 1-ringers in the February Bottom Trawl Survey. The larval index from 1999 is also among the highest and is supported by the second highest November 1999 Bottom Trawl 0-ringer index in the last 9 years. The larval index also comes out as the highest 0-ringer value during the latest 8 years in the October 1999 acoustic survey in Subdivisions 22–24 (Table 3.5.9). Overall there is a strong indication of high recruitment of the 1998 year class in 1999 and some evidence that the 1999 year class may also recruit into a relatively strong year class as 1-ringers in year 2000.

3.7 Data exploration

The landings data used in the ICA final run were comprised of catches from the period from 1991 to 1999. From 1991 to 1996 the catch data were decomposed into spring and autumn spawners by a revised split-factor based on vertebral counts (see Section 3.2). From 1997 to 1999 the latest years split-factor based on otolith microstructure (see Section 3.2.4.2) was used retaining the catch data from 1998. Since only the catch data in division IIIa from 1991–1997 could be revised, no transfer of Western Baltic spring spawners from the North Sea into division IIIa could be performed. This problem should be considered further before next years HAWG.

Catch at age and survey data are presented in Tables 3.3.10, 3.5.1 - 3.5.8 and 3.5.10.

The weight at age in the stock was assumed to be constant for the period 1991 to 1999. The unweighted mean of the calculated following two values was taken as the weight at age in the stock for this period:

- unweighted mean of the German bottom trawl survey in Sub-division 24, February, 1991–1999,
- unweighted mean of the mean catch at age data, first quarter, 1991–1999.

For all analysis carried out from 1991 to 1999 natural mortality (M1) was assumed to be equal to 0.2 for all age-groups (ICES 1999a). This year the predation mortality (M2) of 0.1 and 0.16, calculated as a mean for the years 1977–1995 from the MSVPA (ICES 1997), was added to M1 for the 0- and 1-group, respectively for the whole period.

The maturity ogive used and proportions of F and M before spawning was assumed constant between years. F-prop. was set to be 0.1 and M-prop. 0.25 for all age groups. The maturity ogive used was the same as that used at the working group meeting in 1999:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	0.2	0.75	0.9	1	1	1	1

The following parameter setting were used initially:

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

Eight surveys with age disaggregated data were available as indices of abundance:

- **Index 1**: Acoustic. survey in Division IIIa, July 1989–99, 0–8+ ringers (without the Kattegat area)
- **Index 1a**: Acoustic. survey in Division IIIa, July 1989–99, 0–8+ ringers (including the Kattegat area)
- **Index 2**: Acoustic. survey in SD 22, 23 and 24, Oct. 1989–99, 0–8+ ringers
- **Index 2a**: Acoustic. survey in SD 22+24, Oct. 1994–99, 0–8+ ringers (1989–1993 data not available)
- **Index 3**: Larvae survey in SD 24 (Greifswalder Bodden), March-June 1977–99, 0-group
- **Index 4**: German bottom trawl survey (GBTS) in SD 22, Nov. 1979–99, 0–3+ ringers
- **Index 5**: German bottom trawl survey (GBTS) in SD 24, Nov. 1978–99, 0–3+ ringers
- **Index 6**: German bottom trawl survey (GBTS) in SD 24, February 1979–99, 1–8+ ringers
- **Index 7**: IBTS in Div. IIIa, Quarter 1, 1980–99, 2–3+ ringers
- **Index 8**: IBTS in Div. IIIa, Quarter 3, 1991–99, 1–5 ringers

Since the historical data from 1991 to 1996 were updated (see Section 3.4.2) all age groups were included in the first analyses (in contrast to last year's attempt to perform an assessment on 3–8+ ringers). The ICA software was used to conduct trial runs for each of these indices.

These outputs were scrutinised (with regard to estimated reference F's and confidence limits, residual patterns etc.) and compared with assumed knowledge of the stock characteristics such as age specific migration pattern, survey targeting of different components etc.

From this a screening of indices and age-classes was performed to come up with a subset of indices for the combined index runs. Considering the information about the migration pattern, i.e., the part of the stock, which is available at the survey time in the surveyed area, the following age range was used for the different indices:

- **Index 1a**: Acoustic. survey in Division IIIa, 2–8+ ringers (including the Kattegat area)
- **Index 2**: Acoustic. survey in SD 22, 23 and 24, 0–8+ ringers
- **Index 3**: Larvae survey in SD 24 (Greifswalder Bodden), 0-group
- **Index 5**: German bottom trawl survey (GBTS) in SD 24, Nov., 0–1 ringers (0–2 ringers)
- **Index 6**: German bottom trawl survey (GBTS) in SD 24, February, 1–8+ ringers
- **Index 7**: IBTS in Div. IIIa, Quarter 1, 1980–99, 2–3+ ringers
- **Index 8**: IBTS in Div. IIIa, Quarter 3, 1991–99, 2–5 ringers

From a series of runs with these indices combined the output as well as the biological knowledge was considered to select a set of indices for the final run. Index 1a (acoustic in Division IIIa) was chosen starting with age 2 to cover the area for all years excluding 0–1-ringers which were considered to be mostly present in SD22+24, further the oldest age-classes (7–8+) were down-weighed due to a noisy catchability pattern reflecting the poor coverage of the oldest fish in this survey. Index 2a (acoustic SD 22 +24) was preferred to index 2 (acoustic SD 22+23+24) due to uncertain coverage of old age classes and variable occurrence in the Sound. The index 3 (larval survey) was excluded due to the extremely high values for 1998 and 1999. Index 4 (GBTS in SD22 Nov.) was excluded since a preliminary run with all indices showed conflicting correspondence with the VPA (no catchability pattern for any age-classes), biologically this could be explained by a variable abundance of herring in the accessible depth strata of this shallow subdivision at this time of the year. In index 6 (GBTS SD24 February) the older age-classes (3–8+) were down-weighed since the catchability pattern was noisy, biologically explained by different spawning period initiation in different years. The quarter 1 IBTS index 7 was excluded due to a assumed poor and variable coverage of the stock. The quarter 3 IBTS index 8 was excluded due to a coverage of the stock during the migration (possible multiple coverage) and a noisy catchability relationship. With the above combination of age indices two periods of separable constraints from 1992–1996 and from 1997–1999 were applied on two accounts:

- the management measures introduced in Division IIIa after 1996 to reduce catches on the North Sea stock
- the two different methods of separating North Sea autumn spawners from Western Baltic spring spawners applied on data until 1996 and from 1997–1999.

For the final run (ICA run20) the following set up was used:

- **Index 1a**: Acoustic. survey in Division IIIa, 2–6 ringers(7–8+ down-weighed) (incl. the Kattegat area)
- **Index 2a**: Acoustic. survey in SD 22+24, 0–2 ringers
- **Index 5**: German bottom trawl survey (GBTS) in SD 24, Nov., 0–1 ringers.
- **Index 6**: German bottom trawl survey (GBTS) in SD 24, February, 1–2 ringers (3–8+ down-weighed)
- When down-weighing of individual age classes a coefficient of 0.01 was used.
- The range of years for separable constraint (= 8 years divided into two periods: 1992–1996 and 1997–1999)

Details on input parameters for the ICA run 20 are presented in Table 3.7.1. Input data are shown in Tables 3.7.2 - 3.7.6d, outputs are given in Tables 3.7.7 - 3.7.16 and in Figures 3.7.1,3.72,3.73 & 3.7.4a-l.

The combined SSQ indicates a minimum as the average between the two acoustic indices (Figure 3.7.1). Annual Fs were gradually increasing to 0.65 up till 1997 with a following decrease the last two years to around 0.38 in 1999 (Figure 3.7.2). Landings and SSB decline from 1992 to 1996 after when landings level out and SSB for 1999 shows a small increase probably driven by mature 2-ringers from the large 1997 year class. The SSB have decreased by 60% from 1992 to 1999. The selection pattern for the period up to 1996 shows high fishing mortality from age 1 and an apparent full recruitment from age 2. The second period exhibits a linear increase from low F values on the youngest age-classes to a full recruited fishery by age 4. This change in F-pattern can be explained by the reduced landings of juveniles due to the by-catch ceilings and the different split applied before 1997 estimating higher proportions of 1 and 2-ringer spring spawners in Division IIIa.

The diagnostic plots (Figure 3.7.4a - 3.7.4L) show the age-groups not down-weighed in the ICA. The catchability patterns by age vary among indices, the best fits with intercepts close to origin are found among the youngest age-classes except for the Division IIIa acoustic survey, which suggest that this cruise may cover older ages reasonably well. Not all indices show the increased estimate of recruitment for 1999.

The working group concluded that the data exploration by the ICA software could not resolve the apparent incompatibility between surveys and catch data to the following reasons:

- Absence of an operative migration model.
- No survey fully covering the stock at any particular time.
- A limited time series of revised catch data (1991–1999).
- Currently the estimates of recruitment of the 1998 and 1999 year classes are uncertain. These are indicated by the larval survey to be exceptional. The validity of the larval survey cannot currently be confirmed, however, in the future comparisons should be made between assessment and larval survey to test the validity of the latter.
- A fully revised split of the catch data with the same method for all years.
- Some conflict between survey indices.

The working group agreed that the above shortcomings exhibited by the analyses prohibit a conclusive assessment of the stock.

3.8 State of the stock

Despite the failure to contribute a conclusive assessment the survey and catch data provide some information on stock development. Runs of the ICA model have been performed on all age groups. It should be noted that the landing data, landings in numbers for the period 1991 to 1996 have been changed (see Section 3.2.4.1)

Last year’s Working Group report indicated that the Western Baltic stock might have declined continuously until 1996 when the SSB seemed to level off. The ICA runs presented during this working group meeting indicate that the declined trends should have continued until 1998. The estimate of the SSB in 1999 may have increased with a corresponding decrease in fishing mortality.

The total landings have stabilised for the last three years after long term decrease. Recruitment estimates for 1998 and 1999 show an increase compared to the rather stable level 1991-1997. This increase is by a factor of 2 (1998 year class) and 3 (1999 year class), see Figure 3.8.1. The more or less constant catch and SSB with a declining F for the last three years could be explained by the management measures taken to reduce quotas in order to protect North Sea autumn spawners.

Overall these analyses indicate that the stock is stable after a decline during the 1990’s. Recruitment indices suggest that reproduction has been rather stable during the period 1991 to 1997 followed by a significant increase in 1998 and 1999. If the estimated fishing mortality for 1999 continues in the coming years, the stock does not seem to be in any immediate danger. However, the assessment cannot provide an accurate indication about the development of the total stock. Thus, as a consequence, projections for the Western Baltic spring spawning herring were not carried out in this year's working group.

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1986 - 1999**
Landings in thousands of tonnes.
(Data provided by Working Group members 2000).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Skagerrak										
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9
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
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0
Kattegat										
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0
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
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6
Sub. Div. 23										
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4

Year	1995	1996	1997	1998 [2]	1999 [1]
Skagerrak					
Denmark	43.7	28.7	14.3	10.3	10.1
Faroe Islands					
Norway	16.7	9.4	8.8	8.0	7.4
Sweden	48.5	32.7	32.9	46.9	33.6
Total	108.9	70.8	56.0	65.2	51.1
Kattegat					
Denmark	16.9	17.2	8.8	24.8	17.9
Sweden	30.8	27.0	18.0	29.9	17.4
Total	47.7	44.2	26.8	54.7	35.3
Sub. Div. 22+24					
Denmark	36.8	34.4	30.5	30.1	32.5
Germany	13.4	7.3	12.8	9.0	9.8
Poland	7.3	6.0	6.9	6.5	5.3
Sweden	15.8	9.0	14.5	4.3	2.6
Total	73.3	56.7	64.7	49.9	50.2
Sub. Div. 23					
Denmark	0.9	0.7	2.2	0.4	0.5
Sweden	0.2	0.3	0.1	0.3	0.1
Total	1.1	1.0	2.3	0.7	0.6
Grand Total	231.0	172.7	149.8	170.5	137.2

[1] Preliminary data.
[2] Revised data for 1998

Table 3.2.1
Proportion of North Sea autumn spawners (NSAS) and Baltic spring spawners (WBSS) given in % in Skagerrak and Kattegat by age and quarter.
Year: 1999

		Skagerrak		Kattegat	
QUARTER	**W-rings**	**North Sea Autumn Spawner**	**Western Baltic Spring Spawner**	**North Sea Autumn Spawner**	**Western Baltic Spring Spawner**
	1	100%(est.)	0%(est.)	57%(97)	43%(73)
	2	77%(est.)	23%(est.)	40%(38)	60%(56)
	3	43%(6.)	57%(8.)	16%(5)	84%(26)
1	4	36%(5)	64%(9)	4%(1)	96%(27)
	5	36%(est.)	64%(est.)	4%(est.)	96%(est.)
	6	36%(est.)	64%(est.)	4%(est.)	96%(est.)
	7	36%(est.)	64%(est.)	4%(est.)	96%(est.)
	8+	36%(est.)	64%(est.)	4%(est.)	96%(est.)
	1	64%(32)	36%(18)	38%(10)	62%(16)
	2	29%(21)	71%(50)	43%(est.)	57%(est.)
	3	47%(36)	53%(40)	10%(est.)	90%(est.)
2	4	18%(5)	82%(22)	1%(est.)	99%(est.)
	5	18%(est.)	82%(est.)	1%(est.)	99%(est.)
	6	18%(est.)	82%(est.)	1%(est.)	99%(est.)
	7	18%(est.)	82%(est.)	1%(est.)	99%(est.)
	8+	18%(est.)	82%(est.)	1%(est.)	99%(est.)
	0	100%(87)	0%(0)	89%(103)	11%(13)
	1	95%(est.)	5%(est.)	26%(12)	74%(35)
	2	78%(53)	22%(15)	12%(7)	88%(52)
	3	38%(41)	62%(66)	6%(2)	94%(32)
3	4	39%(24)	61%(38)	0%(0)	100%(11)
	5	39%(est.)	61%(est.)	0%(est.)	100%(est.)
	6	39%(est.)	61%(est.)	0%(est.)	100%(est.)
	7	39%(est.)	61%(est.)	0%(est.)	100%(est.)
	8+	39%(est.)	61%(est.)	0%(est.)	100%(est.)
	0	100%(119)	0%(0)	90%(190)	10%(22)
	1	96%(22)	4%(1)	40%(8)	60%(12)
	2	18%(2)	82%(9)	44%(7)	56%(9)
	3	8%(1)	92%(12)	23%(3)	77%(10)
4	4	100%(est.)	0%(est.)	9%(1)	91%(10)
	5	100%(est.)	0%(est.)	9%(est.)	91%(est.)
	6	100%(est.)	0%(est.)	9%(est.)	91%(est.)
	7	100%(est.)	0%(est.)	9%(est.)	91%(est.)
	8+	100%(est.)	0%(est.)	9%(est.)	91%(est.)

est**.**: The values are taken from the HAWG report from 1998,
except for the age-classes 5 to 8+, where the values from year-class 4+ is used.

Skagerrak 1st quarter, year-class 3 and 4: Values are based on Sweedish data averaged over 1996 to 1998.

Skagerrak 2nd quarter, all year-classes: Values are based on Norwegian VS counts. All other figures are calculated by using otolith microstructure.

Table. 3.2.2 Results of the discriminant analysis based on Swedish routine survey data 1991 - 1997. Results in fractions of WBSS per year, quarter, area and age group (1 - 4+ wr).

		Skagerrak				Kattegat				Sound			
	W-rings	**1**	**2**	**3**	**4+**	**1**	**2**	**3**	**4+**	**1**	**2**	**3**	**4+**
Year	**Quarter**												
1991	**I**	0.32	0.33	0.50	0.28	0.42	0.42	0.62	0.55	0.51	0.45	0.52	0.54
	II	0.29	0.36	0.41	0.43	0.32	0.49	0.59	0.63	0.45	0.43	0.62	0.48
	III	0.42	0.50	0.32	0.81	0.37	0.56	0.50	0.62	0.50	0.78	0.60	0.66
	IV												
1992	**I**	0.34	0.40	0.41	0.35	0.41	0.43	0.45	0.56				
	II												
	III	0.42	0.50	0.5	0.56	0.50	0.59	0.56	0.63	0.51	0.62	0.63	0.63
	IV												
1993	**I**	0.34	0.29	0.25	0.32	0.30	0.46	0.48	0.56	0.43	0.42	0.60	0.56
	II	0.32	0.41	0.43	0.60	0.37	0.57	0.59	0.60	0.34	0.62	0.59	0.56
	III	0.36	0.56	0.72	0.32	0.41	0.57	0.53	0.59	0.46	0.56	0.65	0.57
	IV												
1994	**I**	0.34	0.37	0.60	0.55	0.40	0.36	0.52	0.54	0.46	0.46	0.53	0.56
	II	0.35	0.32	0.33	0.55	0.40	0.44	0.60	0.49	0.39	0.48	0.74	0.55
	III	0.32	0.50	0.62	0.64	0.39	0.47	0.62	0.57	0.46	0.43	0.50	0.61
	IV												
1995	**I**	0.36	0.34	0.32	0.67	0.45	0.46	0.30	0.42	0.45	0.53	0.45	0.58
	II	0.33	0.37	0.46	0.55	0.43	0.43	0.49	0.61	0.49	0.50	0.50	0.52
	III	0.35	0.32	0.57	0.54	0.42	0.48	0.61	0.6	0.60	0.48	0.68	0.63
	IV												
1996	**I**	0.35	0.40	0.39	0.49	0.33	0.50	0.39	0.44	0.50	0.62	0.55	0.64
	II												
	III	0.32	0.58	0.49	0.54	0.39	0.61	0.50	0.42	0.61	0.61	0.50	0.57
	IV												
1997	**I**	0.33	0.26	0.45	0.51	0.35	0.35	0.58	0.52	0.48	0.56	0.60	0.60
	II												
	III												
	IV												

Table 3.3.1
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.
Division: Skagerrak Year: 1999 Country: All

		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	16.44	30	22.75	36	39.20	34
	2	17.83	78	25.91	78	43.74	78
	3	9.09	106	5.70	106	14.79	106
	4	1.48	135	0.62	70	2.10	116
	5	2.04	179	0.33	123	2.37	172
	6	0.37	182	0.02		0.38	173
	7	0.08	203			0.08	203
	8+	0.19	227			0.19	227
	Total	47.51		55.33		55.33	
	SOP		3,546		3,544		7,090
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	42.62	51	8.78	42	51.40	49
	2	44.57	92	13.56	79	58.14	89
	3	24.35	106	3.22	104	27.57	106
	4	7.94	120	0.55	70	8.50	116
	5	2.59	148	0.18	123	2.76	147
	6	0.63	144	0.01	123	0.64	144
	7	0.37	148			0.37	148
	8+	0.42	187			0.42	187
	Total	123.48		26.31		26.31	
	SOP		10,373		1,833		12,206
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			205.48	8	205.48	8
	1	42.59	67	33.45	60	76.04	64
	2	44.82	107	15.79	90	60.61	102
	3	32.55	133	4.54	111	37.09	130
	4	10.67	149	1.30	164	11.97	151
	5	3.48	180	0.74	176	4.23	179
	6	1.47	209			1.47	209
	7	0.57	231	0.32	216	0.89	226
	8+	0.50	219	0.08	216	0.57	219
	Total	136.64		261.70		261.70	
	SOP		14,713		6,078		20,791
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.01	40	66.07	11	66.07	11
	1	11.95	83	57.03	61	68.98	65
	2	6.18	99	24.75	89	30.93	91
	3	6.80	142	8.37	111	15.17	125
	4	1.66	136	2.52	164	4.17	153
	5	0.75	132	1.43	176	2.18	161
	6	0.06	190			0.06	190
	7	0.02	190	0.62	216	0.64	215
	8+			0.15	216	0.15	216
	Total	27.43		160.93		160.93	
	SOP		2,920		8,182		11,101
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.01	40	271.54	9	271.54	9
	1	113.60	57	122.02	55	122.02	55
	2	113.41	96	80.01	84	80.01	84
	3	72.79	121	21.83	108	21.83	108
	4	21.74	137	5.00	142	5.00	142
	5	8.86	166	2.68	166	2.68	166
	6	2.53	188	0.03	43	0.03	43
	7	1.03	199	0.94	216	0.94	216
	8+	1.10	208	0.23	216	0.23	216
	Total	335.06		504.26		504.26	
	SOP		31,551		19,636		51,188

Table 3.3.2
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.
Division: Kattegat Year: 1999 Country: ALL

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	14.63	33	106.33	23	120.96	24
	2	44.59	74	48.52	66	93.10	70
	3	26.21	100	10.99	80	37.19	94
	4	9.61	118	5.16	31	14.77	87
	5	6.08	162	3.21	40	9.29	120
	6	0.35	171	0.46	34	0.81	93
	7	0.01		1.21	35	1.23	34
	8+	0.18	210	0.88	41	1.06	69
	Total	101.65		176.77		278.41	
	SOP		8,597		6,880		15,477
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	1.84	39	26.46	39	28.29	39
	2	5.32	69	3.57	57	8.88	64
	3	4.41	93	0.99	68	5.40	88
	4	3.51	111			3.51	111
	5	1.73	110			1.73	110
	6	0.25	155			0.25	155
	7	0.57	140			0.57	140
	8+	0.21	179			0.21	179
	Total	17.84		31.02		48.85	
	SOP		1,584		1,299		2,883
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.09	14	433.92	9	434.02	9
	1	42.08	54	2.18	34	44.26	53
	2	25.50	85			25.50	85
	3	12.91	103			12.91	103
	4	3.15	138			3.15	138
	5	1.03	127			1.03	127
	6	0.09	184			0.09	184
	7						
	8+	0.01				0.01	
	Total	84.87		436.10		520.98	
	SOP		6,370		4,110		10,480
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	26.54	18	307.25	12	333.80	12
	1	16.32	46	4.68	43	21.00	45
	2	4.28	101			4.28	101
	3	4.11	131			4.11	131
	4	1.40	159			1.40	159
	5	0.62	178			0.62	178
	6	0.15	122			0.15	122
	7	0.08	134			0.08	134
	8+	0.07	224			0.07	224
	Total	53.58		311.93		365.51	
	SOP		2,575		3,886		6,461
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	26.64	18	741.18	10	767.82	11
	1	74.87	48	139.65	27	214.52	34
	2	79.68	79	52.08	65	131.76	73
	3	47.64	103	11.98	79	59.62	98
	4	17.67	123	5.16	31	22.83	102
	5	9.46	150	3.21	40	12.67	122
	6	0.83	159	0.46	34	1.30	114
	7	0.67	136	1.21	35	1.88	71
	8+	0.47	193	0.88	41	1.35	94
	Total	257.93		955.82		1,213.75	
	SOP		19,126		16,174		35,301

Table 3.3.3

Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: Skagerrak Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1	16.44	30	22.75	36	39.20	34
	2	13.73	78	19.95	78	33.68	78
	3	3.91	106	2.45	106	6.36	106
	4	0.53	135	0.22	70	0.76	116
	5	0.74	179	0.12	123	0.85	172
	6	0.13	182	0.01	0	0.14	173
	7	0.03	203			0.03	203
	8+	0.07	227			0.07	227
	Total	35.57		45.50		81.08	
	SOP		2,234		2,680		4,913
2	1	27.28	51	5.62	42	32.90	49
	2	12.93	92	3.93	79	16.86	89
	3	11.44	106	1.51	104	12.96	106
	4	1.43	120	0.10	70	1.53	116
	5	0.47	148	0.03	123	0.50	147
	6	0.11	144	0.00	123	0.11	144
	7	0.07	148			0.07	148
	8+	0.08	187			0.08	187
	Total	53.80		11.20		65.00	
	SOP		4,056		715		4,770
3	0			205.48	8	205.48	8
	1	33.12	67	26.02	60	59.14	64
	2	34.93	107	12.31	90	47.24	102
	3	12.47	133	1.74	111	14.21	130
	4	4.13	149	0.50	164	4.63	151
	5	1.36	180	0.29	176	1.65	179
	6	0.58	209			0.58	209
	7	0.22	231	0.12	216	0.35	226
	8+	0.19	219	0.03	216	0.22	219
	Total	87.00		246.49		333.49	
	SOP		8,667		4,744		13,411
4	0	0.01	40	63.19	11	63.20	11
	1	2.17	83	10.37	61	12.54	65
	2	0.48	99	1.90	89	2.38	91
	3	2.27	142	2.79	111	5.06	125
	4	1.66	136	2.52	164	4.17	153
	5	0.75	132	1.43	176	2.18	161
	6	0.06	190			0.06	190
	7	0.02	190	0.62	216	0.64	215
	8+			0.15	216	0.15	216
	Total	7.41		82.97		90.38	
	SOP		891		2,635		3,526
Total	0	0.01	40	268.67	9	268.68	9
	1	79.01	54	64.76	50	143.78	52
	2	62.06	97	38.09	83	100.15	92
	3	30.09	120	8.49	108	38.59	117
	4	7.75	140	3.34	155	11.09	145
	5	3.31	164	1.87	171	5.18	167
	6	0.88	195	0.01	26	0.89	194
	7	0.33	210	0.74	216	1.08	214
	8+	0.34	214	0.18	216	0.51	214
	Total	183.78		386.16		569.94	
	SOP		15,847		10,773		26,621

Table 3.3.4

Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: Kattegat Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1	8.34	33	60.61	23	68.95	24
	2	18.02	74	19.61	66	37.64	70
	3	4.23	100	1.77	80	6.00	94
	4	0.34	118	0.18	31	0.53	87
	5	0.22	162	0.11	40	0.33	120
	6	0.01	171	0.02	34	0.03	93
	7	0.00	0	0.04	35	0.04	34
	8+	0.01	210	0.03	41	0.04	69
	Total	31.17		82.39		113.55	
	SOP		2,106		2,830		4,936
2	1	0.70	39	10.05	39	10.75	39
	2	2.29	69	1.53	57	3.82	64
	3	0.44	93	0.10	68	0.54	88
	4	0.04	111			0.04	111
	5	0.02	110			0.02	110
	6	0.00	155			0.00	155
	7	0.01	140			0.01	140
	8+	0.00	179			0.00	179
	Total	3.49		11.69		15.17	
	SOP		233		485		717
3	0	0.08	14	385.29	9	385.38	9
	1	10.74	54	0.56	34	11.30	53
	2	3.03	85			3.03	85
	3	0.76	103			0.76	103
	4						
	5						
	6						
	7						
	8+						
	Total	14.61		385.85		400.46	
	SOP		920		3,602		4,522
4	0	23.89	18	276.53	12	300.42	12
	1	6.53	46	1.87	43	8.40	45
	2	1.88	101			1.88	101
	3	0.95	131			0.95	131
	4	0.13	159			0.13	159
	5	0.06	178			0.06	178
	6	0.01	122			0.01	122
	7	0.01	134			0.01	134
	8+	0.01	224			0.01	224
	Total	33.46		278.40		311.86	
	SOP		1,074		3,398		4,472
Total	0	23.97	18	661.82	10	685.80	11
	1	26.31	45	73.09	26	99.40	31
	2	25.22	77	21.15	65	46.37	72
	3	6.37	104	1.87	80	8.24	99
	4	0.50	127	0.18	31	0.69	102
	5	0.29	162	0.11	40	0.40	127
	6	0.03	146	0.02	34	0.04	105
	7	0.01	131	0.04	35	0.06	58
	8+	0.01	212	0.03	41	0.05	96
	Total	82.72		758.32		841.05	
	SOP		4,332		10,315		14,647

Table 3.3.5

Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***

Division: Skagerrak Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1						
	2	4.10	78	5.96	78	10.06	78
	3	5.18	106	3.25	106	8.43	106
	4	0.95	135	0.40	70	1.34	116
	5	1.31	179	0.21	123	1.52	172
	6	0.23	182	0.01	0	0.24	173
	7	0.05	203			0.05	203
	8+	0.12	227			0.12	227
	Total	11.94		9.83		21.77	
	SOP		1,312		864		2,176
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	15.34	51	3.16	42	18.51	49
	2	31.65	92	9.63	79	41.28	89
	3	12.91	106	1.71	104	14.61	106
	4	6.51	120	0.45	70	6.97	116
	5	2.12	148	0.14	123	2.26	147
	6	0.51	144	0.01	123	0.52	144
	7	0.30	148			0.30	148
	8+	0.34	187			0.34	187
	Total	69.69		15.10		84.79	
	SOP		6,317		1,118		7,435
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0						
	1	9.46	67	7.43	60	16.90	64
	2	9.89	107	3.48	90	13.37	102
	3	20.08	133	2.80	111	22.88	130
	4	6.54	149	0.80	164	7.34	151
	5	2.13	180	0.45	176	2.58	179
	6	0.90	209			0.90	209
	7	0.35	231	0.19	216	0.54	226
	8+	0.30	219	0.05	216	0.35	219
	Total	49.64		15.21		64.85	
	SOP		6,046		1,334		7,380
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.00	40	2.87	11	2.87	11
	1	9.78	83	46.66	61	56.44	65
	2	5.71	99	22.85	89	28.55	91
	3	4.54	142	5.58	111	10.11	125
	4						
	5						
	6						
	7						
	8+						
	Total	20.02		77.96		97.98	
	SOP		2,029		5,547		7,575
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.00	40	2.87	11	2.87	11
	1	34.58	64	57.26	60	91.84	62
	2	51.34	94	41.92	85	93.26	90
	3	42.70	122	13.34	109	56.04	119
	4	14.00	135	1.65	115	15.65	133
	5	5.55	168	0.81	152	6.36	166
	6	1.65	185	0.02	50	1.67	183
	7	0.70	193	0.19	216	0.89	198
	8+	0.76	206	0.05	216	0.81	207
	Total	151.28		118.10		269.39	
	SOP		15,704		8,863		24,567

Table 3.3.6

Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***

Division: Kattegat Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	6.29	33	45.72	23	52.01	24
	2	26.56	74	28.90	66	55.47	70
	3	21.98	100	9.21	80	31.20	94
	4	9.26	118	4.97	31	14.24	87
	5	5.86	162	3.10	40	8.96	120
	6	0.33	171	0.45	34	0.78	93
	7	0.01	0	1.17	35	1.18	34
	8+	0.17	210	0.85	41	1.02	69
	Total	70.48		94.38		164.86	
	SOP		6,491		4,050		10,541
2	1	1.14	39	16.40	39	17.54	39
	2	3.03	69	2.03	57	5.06	64
	3	3.96	93	0.89	68	4.86	88
	4	3.48	111			3.48	111
	5	1.71	110			1.71	110
	6	0.25	155			0.25	155
	7	0.57	140			0.57	140
	8+	0.21	179			0.21	179
	Total	14.35		19.33		33.68	
	SOP		1,351		814		2,165
3	0	0.01	14	48.63	9	48.64	9
	1	31.34	54	1.62	34	32.96	53
	2	22.47	85			22.47	85
	3	12.15	103			12.15	103
	4	3.15	138			3.15	138
	5	1.03	127			1.03	127
	6	0.09	184			0.09	184
	7						
	8+	0.01	0			0.01	
	Total	70.26		50.25		120.51	
	SOP		5,450		507		5,958
4	0	2.65	18	30.73	12	33.38	12
	1	9.79	46	2.81	43	12.60	45
	2	2.40	101			2.40	101
	3	3.17	131			3.17	131
	4	1.27	159			1.27	159
	5	0.56	178			0.56	178
	6	0.14	122			0.14	122
	7	0.07	134			0.07	134
	8+	0.06	224			0.06	224
	Total	20.12		33.53		53.65	
	SOP		1,501		488		1,989
Total	0	2.66	18	79.35	10	82.02	11
	1	48.56	49	66.56	28	115.12	37
	2	54.46	80	30.94	65	85.40	74
	3	41.27	102	10.11	79	51.37	98
	4	17.17	123	4.97	31	22.14	102
	5	9.17	149	3.10	40	12.27	122
	6	0.80	159	0.45	34	1.25	114
	7	0.65	136	1.17	35	1.82	71
	8+	0.46	193	0.85	41	1.31	94
	Total	175.21		197.50		372.70	
	SOP		14,794		5,859		20,653

Table 3.3.7

Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: IIIa Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1	24.78	31	83.37	27	108.15	28
	2	31.75	76	39.56	72	71.31	74
	3	8.14	103	4.22	95	12.36	100
	4	0.88	128	0.41	52	1.28	104
	5	0.95	175	0.23	82	1.19	157
	6	0.14	181	0.02	25	0.17	159
	7	0.03	199	0.04	35	0.07	99
	8+	0.07	226	0.03	41	0.10	170
	Total	66.74		127.89		194.63	
	SOP		4,339		5,510		9,849
2	1	27.97	50	15.68	40	43.65	47
	2	15.21	88	5.47	72	20.68	84
	3	11.88	105	1.61	102	13.50	105
	4	1.46	119	0.10	70	1.56	116
	5	0.48	147	0.03	123	0.51	145
	6	0.12	144	0.00	123	0.12	144
	7	0.07	148			0.07	148
	8+	0.08	187			0.08	187
	Total	57.28		22.89		80.17	
	SOP		4,289		1,199		5,488
3	0	0.08	14	590.77	9	590.85	9
	1	43.87	64	26.57	60	70.44	62
	2	37.96	105	12.31	90	50.26	101
	3	13.23	131	1.74	111	14.97	129
	4	4.13	149	0.50	164	4.63	151
	5	1.36	180	0.29	176	1.65	179
	6	0.58	209			0.58	209
	7	0.22	231	0.12	216	0.35	226
	8+	0.19	219	0.03	216	0.22	219
	Total	101.62		632.34		733.95	
	SOP		9,586		8,346		17,933
4	0	23.90	18	339.72	12	363.62	12
	1	8.70	56	12.24	59	20.94	57
	2	2.36	101	1.90	89	4.26	95
	3	3.21	139	2.79	111	6.00	126
	4	1.78	138	2.52	164	4.30	153
	5	0.80	135	1.43	176	2.24	161
	6	0.07	178			0.07	178
	7	0.03	174	0.62	216	0.64	214
	8+	0.01	224	0.15	216	0.16	216
	Total	40.86		361.37		402.23	
	SOP		1,965		6,033		7,998
Total	0	23.98	18	930.49	10	954.47	10
	1	105.32	52	137.86	37	243.18	44
	2	87.28	91	59.24	76	146.52	85
	3	36.47	117	10.37	103	46.83	114
	4	8.25	139	3.53	148	11.78	142
	5	3.60	164	1.99	164	5.59	164
	6	0.91	194	0.02	31	0.93	189
	7	0.35	207	0.79	206	1.13	206
	8+	0.35	214	0.21	190	0.56	205
	Total	266.51		1,144.49		1,410.99	
	SOP		20,180		21,088		41,268

Table 3.3.8
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***
Division: IIIa Year: 1999 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1	6.29	33	45.72	23	52.01	24
	2	30.66	75	34.86	68	65.52	71
	3	27.16	101	12.46	87	39.63	96
	4	10.21	119	5.37	34	15.58	90
	5	7.17	165	3.31	45	10.48	127
	6	0.57	175	0.46	33	1.03	112
	7	0.06	157	1.17	35	1.23	41
	8+	0.29	217	0.85	41	1.14	86
	Total	82.42		104.21		186.62	
	SOP		7,803		4,914		12,717
2	1	16.48	50	19.57	39	36.05	44
	2	34.68	90	11.66	75	46.34	86
	3	16.87	103	2.60	92	19.47	101
	4	9.99	117	0.45	70	10.44	115
	5	3.83	131	0.14	123	3.98	131
	6	0.76	148	0.01	123	0.77	147
	7	0.87	143			0.87	143
	8+	0.55	184			0.55	184
	Total	84.03		34.43		118.47	
	SOP		7,668		1,933		9,601
3	0	0.01	14	48.63	9	48.64	9
	1	40.80	57	9.06	55	49.86	57
	2	32.36	92	3.48	90	35.84	92
	3	32.23	122	2.80	111	35.03	121
	4	9.69	146	0.80	164	10.49	147
	5	3.16	162	0.45	176	3.61	164
	6	0.99	207			0.99	207
	7	0.35	231	0.19	216	0.54	226
	8+	0.31	212	0.05	216	0.36	212
	Total	119.90		65.46		185.36	
	SOP		11,497		1,841		13,338
4	0	2.65	18	33.60	12	36.25	12
	1	19.57	65	49.47	60	69.04	62
	2	8.10	100	22.85	89	30.95	92
	3	7.70	138	5.58	111	13.28	126
	4	1.27	159			1.27	159
	5	0.56	178			0.56	178
	6	0.14	122			0.14	122
	7	0.07	134			0.07	134
	8+	0.06	224			0.06	224
	Total	40.14		111.49		151.63	
	SOP		3,530		6,035		9,565
Total	0	2.67	18	82.23	10	84.89	11
	1	83.14	56	123.82	43	206.96	48
	2	105.80	87	72.85	77	178.66	83
	3	83.97	113	23.44	96	107.41	109
	4	31.17	128	6.63	52	37.79	115
	5	14.72	156	3.91	63	18.63	137
	6	2.45	176	0.47	35	2.92	154
	7	1.35	166	1.36	60	2.71	113
	8+	1.22	201	0.90	50	2.12	137
	Total	326.49		315.60		642.09	
	SOP		30,498		14,723		45,220

Table 3.3.9
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter.
Division: 22-24 Year: 1999 Country: ALL

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
1	1	129.63	23			32.41	12	162.04	21
	2	33.77	43			49.17	48	82.95	46
	3	3.47	49			63.91	81	67.38	79
	4	0.12	94			27.41	116	27.53	115
	5	0.27	142			19.16	156	19.43	156
	6	0.36	170			6.38	166	6.74	167
	7	0.51	179			1.97	196	2.47	193
	8+	0.17	189			1.02	213	1.19	210
	Total	168.29				201.44		369.73	
	SOP		4,848				15,739		20,587
2	1	65.68	23			48.49	20	114.17	22
	2	18.77	41			50.25	49	69.02	47
	3	3.08	51			38.20	74	41.28	73
	4	0.36	69			14.01	107	14.37	106
	5	0.15	79			11.81	142	11.95	141
	6	0.06	82			4.11	126	4.17	125
	7	0.05	76			3.40	167	3.44	166
	8+					2.48	137	2.48	137
	Total	88.14				172.74		260.88	
	SOP		2,487				10,879		13,366
3	0	177.46	10			103.40	6	280.86	8
	1	45.91	33			25.68	27	71.59	31
	2	4.34	58	0.06	144	1.86	71	6.26	63
	3	0.68	62	0.31	161			0.99	93
	4			0.32	167	0.53	85	0.85	116
	5			0.44	182	1.06	52	1.51	90
	6			0.12	187			0.12	187
	7					0.53	62	0.53	62
	8+			0.02	221			0.02	221
	Total	228.39		1.27		133.08		362.73	
	SOP		3,486		218		1,613		5,317
4	0	197.71	15			49.69	13	247.40	14
	1	30.93	48			47.11	41	78.03	44
	2	0.46	83	0.03	159	19.96	76	20.44	77
	3			0.18	168	14.12	117	14.30	117
	4			0.13	187	4.21	107	4.34	109
	5			0.14	201	0.68	171	0.82	176
	6			0.03	222			0.03	222
	7			0.02	213			0.02	213
	8+								
	Total	229.10		0.53		135.75		365.38	
	SOP		4,409		99		6,282		10,790
Total	0	375.17	12			153.09	8	528.26	11
	1	272.14	28			153.70	26	425.84	27
	2	57.34	43	0.09	149	121.24	54	178.67	50
	3	7.23	51	0.48	163	116.23	83	123.95	82
	4	0.48	75	0.45	173	46.16	112	47.10	112
	5	0.42	120	0.59	186	32.71	148	33.71	148
	6	0.42	157	0.16	194	10.49	151	11.07	151
	7	0.55	171	0.02	213	5.90	167	6.46	168
	8+	0.17	189	0.02	221	3.50	159	3.68	161
	Total	713.91		1.80		643.02		1,358.73	
	SOP		15,230		317		34,513		50,060

Table 3.3.10
Landings in numbers (mill.), mean weight (g.) and SOP (t)
by age and quarter from. Western Baltic Spring Spawners
(values from the North Sea, see Table 2.2.1-2.2.5)
Division: IV + IIIa + 22-24 Year: 1999

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1			52.01	24	162.04	21	214.05	22
	2			65.52	71	82.95	46	148.47	57
	3			39.63	96	67.38	79	107.01	86
	4			15.58	90	27.53	115	43.12	106
	5			10.48	127	19.43	156	29.91	146
	6			1.03	112	6.74	167	7.76	159
	7			1.23	41	2.47	193	3.71	142
	8+			1.14	86	1.19	210	2.33	149
	Total	0.00		186.62		369.73		556.35	
	SOP		0		12,717		20,587		33,304

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	0.00	77.60	36.05	44	114.17	22	150.22	27
	2	1.24	124.90	46.34	86	69.02	47	116.59	63
	3	5.59	143.90	19.47	101	41.28	73	66.34	87
	4	2.95	159.20	10.44	115	14.37	106	27.76	115
	5	1.74	190.60	3.98	131	11.95	141	17.67	144
	6	0.67	216.30	0.77	147	4.17	125	5.61	139
	7	0.26	226.90	0.87	143	3.44	166	4.56	165
	8+	0.18	279.05	0.55	184	2.48	137	3.21	153
	Total	12.62		118.47		260.88		391.97	
	SOP		2,014		9,601		13,366		24,980

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.00	0.00	48.64	9	280.86	8	329.50	8
	1	0.00	76.20	49.86	57	71.59	31	121.45	41
	2	2.08	128.60	35.84	92	6.26	63	44.18	89
	3	8.73	150.70	35.03	121	0.99	93	44.75	126
	4	2.67	173.70	10.49	147	0.85	116	14.00	150
	5	1.89	196.90	3.61	164	1.51	90	7.00	157
	6	0.77	219.20	0.99	207	0.12	187	1.89	210
	7	0.30	224.90	0.54	226	0.53	62	1.38	162
	8+	0.25	248.26	0.36	212	0.02	221	0.63	227
	Total	16.69		185.36		362.73		564.78	
	SOP		2,718		13,338		5,317		21,373

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0			36.25	12	247.40	14	283.65	14
	1			69.04	62	78.03	44	147.07	52
	2			30.95	92	20.44	77	51.40	86
	3			13.28	126	14.30	117	27.58	122
	4			1.27	159	4.34	109	5.61	120
	5			0.56	178	0.82	176	1.38	177
	6			0.14	122	0.03	222	0.17	142
	7			0.07	134	0.02	213	0.09	148
	8+			0.06	224			0.06	224
	Total	0.00		151.63		365.38		517.02	
	SOP		0		9,565		10,790		20,355

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0			84.89	11	528.26	11	613.15	11
	1			206.96	48	425.84	27	632.80	34
	2	3.32	127	178.66	83	178.67	50	360.64	67
	3	14.32	148	107.41	109	123.95	82	245.67	97
	4	5.61	166	37.79	115	47.10	112	90.50	117
	5	3.62	194	18.63	137	33.71	148	55.97	147
	6	1.45	218	2.92	154	11.07	151	15.43	158
	7	0.56	226	2.71	113	6.46	168	9.74	156
	8+	0.43	261	2.12	137	3.68	161	6.23	160
	Total	29.31		642.09		1,358.73		2,030.13	
	SOP		4,732		45,220		50,060		100,012

Table 3.3.11 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of Western Baltic Spring spawners in Division IIIa and the North Sea in the years 1987 - 1999

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	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	777.10	395.91	314.46	226.37	103.34	79.18	12.90	4.30	1.74	1,915.29
1991	Mean W.	26.5	49.4	74.4	95.1	129.0	141.5	162.4	176.7	185.9	
	SOP	20,614	19,572	23,386	21,519	13,327	11,200	2,094	760	323	112,794
	Number	2407.51	1092.90	399.42	140.20	116.88	56.56	40.42	13.62	6.66	4274.17
1992	Mean W.	12.3	52.3	83.5	108.7	128.8	157.2	171.7	181.7	183.4	
	SOP	29,675	57,211	33,342	15,237	15,051	8,894	6,941	2,474	1,221	170,046
	Number	2956.70	954.93	295.39	162.91	51.97	31.38	20.13	10.85	3.20	4487.48
1993	Mean W.	12.6	35.6	86.6	128.4	142.8	164.9	191.3	197.3	214.2	
	SOP	37,338	33,993	25,591	20,917	7,423	5,176	3,853	2,141	686	137,117
	Number	542.23	616	218.71	128.45	76.48	43.98	23.60	7.36	2.80	1659.12
1994	Mean W.	16.5	54.2	97.1	120.9	148.8	164.5	187.2	201.8	199.5	
	SOP	8,947	33,343	21,239	15,532	11,380	7,236	4,417	1,485	558	104,137
	Number	1803.91	708.16	162.48	74.77	49.24	28.82	9.01	7.21	2.65	2846.24
1995	Mean W.	12.8	36.7	98.0	149.1	164.2	187.4	208.7	226.5	224.7	
	SOP	23,058	25,999	15,918	11,148	8,085	5,399	1,881	1,634	595	93,717
	Number	656.04	737.42	550.24	104.00	47.56	27.76	12.36	6.22	5.37	2146.96
1996	Mean W.	10.8	25.3	77.6	128.7	173.5	183.6	200.5	198.3	210.0	
	SOP	7,110	18,681	42,680	13,381	8,253	5,096	2,478	1,232	1,128	100,039
	Number		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Mean W.		63.8	82.4	131.3	174.5	190.6	195.6	205.9	210.2	
	SOP	0	1,729	7,313	18,695	5,612	2,560	911	306	492	37,618
	Number	37.33	178.27	362.87	113.87	69.18	14.29	9.86	2.39	2.50	790.56
1998	Mean W.	27.8	49.6	73.2	107.3	140.1	169.1	190.6	183.2	228.5	
	SOP	1,038	8,838	26,555	12,223	9,690	2,415	1,879	438	571	63,647
	Number	84.89	206.96	181.98	121.73	43.4	22.25	4.37	3.37	2.55	671.50
1999	Mean W.	11.0	48.0	83.4	113.5	121.5	145.9	175.0	132.2	158.3	
	SOP	934	9,934	15,185	13,822	5,272	3,247	765	446	404	50,008

There may be minor corrections in data from 1987 and 1988.
Data for 1991-1996 is revised using results of the discriminant analysis.
Data for 1998 is revised.

Table 3.3.12 Transfers of North Sea autumn spawners from Div. IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes) 1988 - 1999.

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number	1830.00	5792.00	292.00							7,914.00
1988	Mean W.	12.0	28.0	57.0							
	SOP	21960	162176	16,644							200,780
	Number	1028.2	1170.5	654.80							2,853.50
1989	Mean W.	16.2	33.4	53.3							
	SOP	16656.8	39094.7	34,901							90,652
	Number	397.9	1424.30	283.70							2,105.90
1990	Mean W.	31.0	34.1	55.4							
	SOP	12334.9	48,569	15,717							76,621
	Number	712.30	822.70	330.20							1,865.20
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	164.0	171.7	184.7	197.5	202.7	219.8	
	SOP	29612.4	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
	Number	2956.7	2,351.10	350.01							5,657.81
1993	Mean W.	12.7	27.5	86.6							
	SOP	37550.1	64,655	30,311							132,516
	Number	542.23	1,240	305.19							2,087.07
1994	Mean W.	16.5	43	77.3							
	SOP	8946.8	53,181	23,591							85,719
	Number	1722.84	1069.58	126.37							2,918.79
1995	Mean W.	12.5	32.8	102.7							
	SOP	21,536	35,082	12,978							69,596
	Number	632.07	869.53	159.35	31.52						1692.47
1996	Mean W.	11.0	22.7	73.0	121.2						
	SOP	6,953	19,738	11,633	3,820						42,144
	Number	93.61	351.60	210.56	71.48	12.29	5.66	1.77	0.69	0.91	748.57
1997	Mean W.	19.0	29.0	71.0	129.0	167.0	182.0	191.0	194.0	202.0	
	SOP	1,779	10,196	14,950	9,221	2,052	1,030	338	134	184	39,884
	Number	53.62	755.14	163.30	26.90	19.30	3.06	3.11	1.18	0.48	1026.08
1998	Mean W.	27.7	56.4	79.7	117.6	162.9	179.2	196.3	178.8	226.2	
	SOP	1,484	42,558	13,020	3,163	3,144	548	610	211	108	64,846
	Number	954.47	243.18	146.52	46.83	11.78	5.59	0.93	1.13	0.56	1410.99
1999	Mean W.	10.2	43.6	85.3	114.0	142.1	164.0	189.4	206.3	204.7	
	SOP	9,729	10,591	12,494	5,339	1,674	916	177	234	115	41,268

There are minor corrections for the years previous to 1991.
Data for 1998 is revised.
Data for 1991-1997 is not revised. The descriminant analysis is only used to estimate Western Baltic Spring Spawners.
Therefore, SOP for NSAS and WBSS can not be compared with the total landings of herring in Division IIIa for the years 1991-96.

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 1988 - 1999**

	Rings	0	1	2	3	4	5	6	7	8+	Total
Year	Area					Numbers in millions					
	North Sea +Div. IIIa			2,075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Sub-Division 22-24	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			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Sub-Division 22-24	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		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	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	777.10	395.91	314.46	226.37	103.34	79.18	12.90	4.30	1.74	1,915.29
1991	Sub-Division 22-24	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	2407.5	1092.90	399.42	140.20	116.88	56.56	40.42	13.62	6.66	4,274.17
1992	Sub-Division 22-24	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	2956.70	954.93	295.39	162.91	51.97	31.38	20.13	10.85	3.20	4,487.48
1993	Sub-Division 22-24	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	542.23	616	218.71	128.45	76.48	43.98	23.60	7.36	2.80	1,659.12
1994	Sub-Division 22-24	202.58	96.29	103.84	161.01	136.06	90.84	74.02	35.11	24.47	924.22
	North Sea +Div. IIIa	1803.91	708.16	162.48	74.77	49.24	28.82	9.01	7.21	2.65	2,846.24
1995	Sub-Division 22-24	490.99	1,358.18	233.95	128.88	104.01	53.57	38.82	20.87	13.22	2,442.49
	North Sea +Div. IIIa	656.04	737.42	550.24	104.00	47.56	27.76	12.36	6.22	5.37	2,146.96
1996	Sub-Division 22-24	5.30	413.09	85.05	124.32	104.76	99.79	53.24	24.16	19.60	929.31
	North Sea +Div. IIIa		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Sub-Division 22-24	350.83	595.19	130.62	96.86	45.13	28.96	35.15	19.46	21.83	1,324.02
	North Sea +Div. IIIa	37.33	178.27	362.87	113.87	69.18	14.29	9.86	2.39	2.50	790.56
1998	Sub-Division 22-24	513.49	444.56	111.23	83.21	88.29	33.80	14.95	13.19	11.96	1,314.67
	North Sea +Div. IIIa	84.89	206.96	181.98	121.73	43.40	22.25	4.37	3.37	2.55	671.50
1999	Sub-Division 22-24	528.26	425.84	178.67	123.95	47.10	33.71	11.07	6.46	3.68	1,358.74

Data for the North Sea + Div. IIIa for 1991 to 1996 revised.

Data for 1998 was revised

Table 3.3.14 **Mean weight (g) and SOP (tons) of spring spawners in Division IIIa + the North Sea and in Sub-Divisions 22-24 in the years 1987 - 1999**

Year	Rings / Area	0	1	2	3	4	5	6	7	8+	SOP Tons
					Mean weight (g)						
	North Sea +Div. IIIa			47.3	77.0	138.3	156.0	166.0	149.0	209.0	151,832
1988	Sub-Division 22-24	11.0	16.9	29.1	83.8	108.5	124.8	142.2	143.7	135.8	92,908
	North Sea +Div. IIIa			56.5	79.9	125.5	151.6	167.3	189.2	204.8	91,145
1989	Sub-Division 22-24	13.5	17.5	43.6	70.5	105.9	122.0	125.5	137.8	131.5	91,002
	North Sea +Div. IIIa		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	125,915
1990	Sub-Division 22-24	13.8	24.2	44.5	75.5	95.9	121.1	142.6	138.7	145.8	73,978
	North Sea +Div. IIIa	26.5	49.4	74.4	95.1	129.0	141.5	162.4	176.7	185.9	112,794
1991	Sub-Division 22-24	11.5	31.5	58.5	78.8	98.5	120.9	138.6	152.2	179.0	82,390
	North Sea +Div. IIIa	12.3	52.3	83.5	108.7	128.8	157.2	171.7	181.7	183.4	170,046
1992	Sub-Division 22-24	19.1	23.3	44.8	77.4	99.2	123.3	152.9	166.2	184.2	84,874
	North Sea +Div. IIIa	12.6	35.6	86.6	128.4	142.8	164.9	191.3	197.3	214.2	137,117
1993	Sub-Division 22-24	16.2	24.5	44.5	73.6	94.1	122.4	149.4	168.5	169.1	80,358
	North Sea +Div. IIIa	16.5	54.2	97.1	120.9	148.8	164.5	187.2	201.8	199.5	104,137
1994	Sub-Division 22-24	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9	66,425
	North Sea +Div. IIIa	12.8	36.7	98.0	149.1	164.2	187.4	208.7	226.5	224.7	93,717
1995	Sub-Division 22-24	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.4	74,157
	North Sea +Div. IIIa	10.8	25.3	77.6	128.7	173.5	183.6	200.5	198.3	210.0	100,039
1996	Sub-Division 22-24	12.1	22.9	45.3	73.6	91.2	115.3	119.4	137.8	181.3	56,817
	North Sea +Div. IIIa		63.8	82.4	131.3	174.5	190.6	195.6	205.9	210.2	37,618
1997	Sub-Division 22-24	30.4	24.7	58.4	101.0	120.7	155.2	181.3	197.1	208.8	67,513
	North Sea +Div. IIIa	27.8	49.6	73.2	107.3	140.1	169.1	190.6	183.2	228.5	63,647
1998	Sub-Division 22-24	13.3	26.3	52.0	78.6	102.9	125.3	150.0	162.1	179.4	50,716
	North Sea +Div. IIIa	11.0	48.0	83.4	113.5	121.5	145.9	175.0	132.2	158.3	50,008
1999	Sub-Division 22-24	11.0	27	50	82	112	148	151	168	161	50,020

Data for the North Sea + Div. IIIa for 1991 to 1996 revised.
There may be minor corrections in data from 1988.
Data for 1998 was revised

Table 3.3.15 ***REVISED***

Landings in numbers (mill.), mean weight (g.) and SOP (t)
by age and quarter from. Western Baltic Spring Spawners
Division: IV + IIIa + 22-24 Year: 1998

Quarter	W-rings	Division IV Numbers	Division IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Sub-division 22-24 Numbers	Sub-division 22-24 Mean W.	Total Numbers	Total Mean W.
1	1			21.85	23	244.83	22	266.67	22
	2			139.20	57	32.87	51	172.08	56
	3			38.59	89	30.44	75	69.03	83
	4			28.78	117	32.12	108	60.90	112
	5			2.15	124	14.34	135	16.49	133
	6			0.63	162	7.34	168	7.97	168
	7			0.18	159	5.93	169	6.11	168
	8+			0.15	207	4.56	184	4.70	184
	Total	0.00		231.52		372.43		603.94	
	SOP		0		15,676		17,804		33,480
2	1			33.23	26	112.23	24	145.47	24
	2	5.10	116	42.20	71	55.51	45	102.81	60
	3	3.60	136	9.83	91	35.48	73	48.90	81
	4	2.60	154	4.55	124	39.17	102	46.32	107
	5	0.90	176	0.93	153	14.87	130	16.70	134
	6	0.30	198	0.27	177	5.45	155	6.02	158
	7	0.10	205	0.13	161	6.29	165	6.53	165
	8+	0.10	239	0.26	202	5.4	176	5.71	179
	Total	12.70		91.39		274.36		378.46	
	SOP		1,744		5,574		16,524		23,842
3	0			1.71	25	223.14	11	224.85	11
	1			65.35	51	58.64	42	123.98	47
	2	5.90	130	130.74	78	14.89	64	151.53	79
	3	9.40	159	39.74	108	11.63	82	60.77	111
	4	9.20	180	17.77	152	9.52	83	36.50	141
	5	5.70	209	4.22	139	2.30	93	12.22	163
	6	2.90	235	5.45	171	1.21	89	9.56	180
	7	0.30	253	1.24	196	0.69	91	2.23	171
	8+	0.90	243	1.09	225	0.86	174	2.85	215
	Total	34.30		267.32		322.88		624.50	
	SOP		6,085		22,651		8,247		36,983
4	0			35.62	28	290.35	15	325.97	16
	1			57.84	71	28.86	41	86.70	61
	2			39.72	101	7.96	82	47.68	98
	3			12.72	126	5.66	131	18.38	128
	4			6.28	160	7.47	110	13.75	133
	5			0.39	176	2.29	66	2.68	82
	6			0.32	176	0.94	61	1.26	90
	7			0.45	113	0.27	140	0.72	123
	8+					1.18	181	1.18	181
	Total	0.00		153.33		345.00		498.32	
	SOP		0		11,916		8,140		20,057
Total	0			37.33	28	513.49	13	550.82	14
	1			178.27	50	444.56	26	622.83	33
	2	11.00	124	351.87	72	111.23	52	474.10	68
	3	13.00	153	100.87	101	83.21	79	197.08	95
	4	11.80	174	57.38	133	88.29	103	157.46	119
	5	6.60	205	7.69	139	33.80	125	48.09	138
	6	3.20	232	6.66	171	14.95	150	24.81	166
	7	0.40	241	1.99	172	13.19	162	15.58	165
	8+	1.00	243	1.50	219	11.96	179	14.45	188
	Total	47.00		743.56		1,314.67		2,105.22	
	SOP		7,829		55,818		50,716		114,362

Table 3.4.1 **Herring in Division IIIa, IIIb and IIIc.**
Samples of commercial catches by quarter and Sub-Div. for 1999 available to the Working Group.

	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
Skagerrak	Denmark	1	0.2	9	148	122
		2		6	14	14
		3	8.1	34	2,839	1,039
		4	1.8	8	792	293
		Total	10.1	57	3,793	1,468
	Norway	1				
		2	4.5	3	300	297
		3	2.8			
		4				
			7.3	3	300	297
	Sweden	1	6.9	10	2436	574
		2	7.6	8	1894	467
		3	9.8	8	877	373
		4	9.3	5	1014	257
		Total	33.6	31	6,221	1,671
Kattegat	Denmark	1	8.1	10	1,616	526
		2	1.6	4	586	190
		3	5.1	4	716	223
		4	3.1	9	1,234	556
		Total	17.9	27	4,152	1,495
	Sweden	1	7.4	6	1332	472
		2	1.2	3	795	187
		3	5.4	2	795	227
		4	3.4	5	1800	464
		Total	17.4	16	4,722	1,350
Sub-Division 22	Denmark	1	4.6	1	187	119
		2	2.3			
		3	3.5	4	586	384
		4	4.4	4	412	273
		Total	14.8	9	1,185	776
	Germany	1	0.3	10	3,704	497
		2	0.2	3	1,195	211
		3				
		4				
		Total	0.5	13	4,899	708
Sub-Division 23	Denmark	1	0.2	1	102	51
		2	0.1			
		3	0.1	1	85	57
		4	0.1	2	166	113
		Total	0.5	4	353	221
	Sweden	1		+	1,163	277
		2				
		3		1	362	176
		4		1	269	48
		Total	0.0	2	1,794	501
Sub-Division 24	Denmark	1	10.1	4	1,097	202
		2	2.3	2	600	101
		3	0.3	1	280	139
		4	4.6	3	732	197
		Total	17.3	10	2,709	639
	Germany	1	4.4	48	17,611	2,024
		2	4.9	46	23,856	1,777
		3				
		4	0.1			
		Total	9.4	94	41,467	3,801
	Poland	1	0.6			
		2	3.5		No data available	
		3	0.6			
		4	0.4			
		Total	5.1	0	0	0
	Sweden	1	0.6	4	1,163	277
		2	0.1			
		3	0.7	+	257	71
		4	1.2	8	1,669	451

Table 3.5.1 **German Bottom Trawl Survey in Sub-Div. 24.**
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	8,665.90	240.47	103.36	10.33	9,020.06	89.61
1981	Nov.	332.63	96.79	60.05	21.30	510.77	16.36
1982	Dec.	695.71	108.21	70.63	34.72	909.27	24.57
1983	Dec.	1,995.97	387.11	63.71	46.11	2,492.90	46.68
1984	Nov.	1,581.66	377.15	88.03	24.26	2,071.10	39.79
1985	Nov.	3,085.64	340.92	169.95	74.76	3,671.27	45.99
1986	Dec.	2,984.47	368.35	46.41	69.30	3,468.53	44.42
1989	Nov.	2,881.81	319.38	48.99	55.12	3,305.30	47.76
1990	Nov.	103.92	14.79	21.69	32.90	173.30	7.09
1991	Nov.	117.38	134.20	103.14	144.63	499.35	27.16
1992	Nov.	233.85	88.05	57.15	113.58	492.63	19.86
1993	Nov.	1,116.34	25.09	50.01	476.29	1,667.30	53.97
1994	Nov.	1,020.49	13.21	73.47	583.23	1,690.40	79.34
1995	Nov.	635.09	33.22	47.97	324.98	1,041.27	47.53
1996	Nov.	514.52	36.12	49.04	349.44	949.12	25.82
1997	Nov.	627.20	66.33	93.57	126.50	913.60	18.30
1998	Nov.	4,651.43	273.67	146.42	563.65	5,635.18	88.85
1999	Nov.	2,629.67	310.92	62.25	43.34	3,046.18	49.36

Table 3.5.2 **German Bottom Trawl Survey in Sub-Div. 22.**
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
1981	Nov.	1,033.40	118.85	28.35	9.10	1,189.70	17.69
1982	Dec.	354.00	239.45	44.50	26.20	664.15	19.97
1983	Dec.	7,917.00	834.70	80.10	29.50	8,861.30	117.51
1984	Nov.	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
1985	Nov.	3,506.20	958.80	219.80	25.25	4,710.05	83.38
1986	Nov.	6,863.75	175.35	16.55	5.60	7,061.25	54.18
1989	Nov.	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
1992	Nov.	572.68	87.68	19.16	17.26	696.78	13.13
1993	Nov.	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
1994	Nov.	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65
1995	Nov.	1,226.63	158.75	29.00	123.31	1,537.69	31.17
1996	Nov.	8.76	193.71	101.24	57.76	361.47	15.23
1997	Nov.	11,289.45	2,196.45	257.75	159.90	13,903.55	209.24
1998	Nov.	3,042.10	597.05	113.40	112.50	3,865.05	70.79
1999	Nov.	1,060.72	76.91	76.22	128.08	1,341.93	25.62

Table 3.5.3 **German Bottom Trawl Survey in Sub-Div. 22 and 24.**
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Sum weighted by area of sub-division :		
Area of 24	2325	sq.nm
Area of 22	485	sq.nm
Total	**2810**	**sq.nm**

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	7784.9	433.5	109.2	9.9	8337.5	89.1
1981	Nov.	453.6	100.6	54.6	19.2	628.0	16.6
1982	Dec.	636.7	130.9	66.1	33.2	867.0	23.8
1983	Dec.	3017.9	464.4	66.5	43.2	3592.1	58.9
1984	Nov.	2447.2	628.0	98.8	27.1	3201.0	58.4
1985	Nov.	3158.2	447.6	178.6	66.2	3850.6	52.4
1986	Nov.	3654.0	335.0	41.3	58.3	4088.6	46.1
1989	Nov.	4211.8	513.6	60.9	58.8	4845.1	70.0
1992	Nov.	292.3	88.0	50.6	97.0	527.9	18.7
1993	Nov.	2376.9	304.5	264.7	549.1	3495.2	96.7
1994	Nov.	1216.8	65.7	335.0	538.9	2156.4	89.1
1995	Nov.	737.2	54.9	44.7	290.2	1126.9	44.7
1996	Nov.	427.2	63.3	58.0	299.1	847.7	24.0
1997	Nov.	2467.5	434.0	121.9	132.3	3155.6	51.3
1998	Nov.	4373.7	329.5	140.7	485.8	5329.7	85.7
1999	Nov.	2358.9	270.5	64.7	58.0	2752.0	45.3

Table 3.5.4 **German Bottom Trawl Survey in January/February in Sub-Div. 24.**
Mean catch at age in numbers per haul.

Year	Winter rings								Total
	1	2	3	4	5	6	7	8+	numbers
1979	1597.6	702.2	106.5	23	4.9	0	0.5	0	2434.7
1981	1038.7	642.8	67.9	54.9	13	1.4	0.4	0.6	1819.7
1984	4865.4	1094.8	153.7	32	11.4	0.8	0.6	0	6158.7
1985	3018.3	3253.6	1012.2	307.8	87.9	38.8	8.8	0.8	7728.2
1986	7585.8	514	386.7	85.4	20	10.5	3.6	0.9	8606.9
1987	712.9	338.1	154.7	201.7	51.2	21.2	2.6	0.9	1483.3
1988	5031.7	2553	291.6	31.8	20.9	4.4	1.6	0.2	7935.2
1989	6654.5	2099.3	612.6	103.7	21.8	6.1	5.7	1.3	9505
1990	4568.5	1393.1	124.4	52.1	4.4	8.5	0.8	0.2	6152
1991	1961	636.2	261.4	87.1	34.5	8.8	2	2.1	2993.1
1992	2778.1	820.6	251.2	79.7	26.8	9.7	3.1	1.1	3970.3
1993	959.9	371.2	94.8	61.3	44.4	13.9	5.6	1	1552.1
1994	996.3	214.9	201.9	329.5	130.6	75.8	30.3	21	2000.3
1995	1949	91.7	328.7	131.1	83.6	24.4	27.9	11.3	2647.7
1996	1221.7	188.9	83.3	87.9	86.7	41.4	33.3	35.22	1778.42
1997	1163.14	206	395.75	163.51	61.19	32.57	23.16	28.42	2073.74
1998	2253.7	836.29	321.07	74.41	33.1	15.45	10.2	7.14	3551.36
1999	10035.64	1378.91	656.86	337.99	116.68	1.7	15.24	0.28	12543.3

Table 3.5.5 International Bottom Trawl Survey in Division IIIa in quarter 1. Mean catch of spring spawning herring at age in number per haul.

Year	Winter rings	
	2	3+
1980	307	162
1981	1318	349
1982	445	196
1983	946	240
1984	1419	445
1985	1867	2037
1986	1562	1897
1987	2921	1199
1988	7834	7084
1989	0	3989
1990	3192	508
1991	480	3392
1992	771	1268
1993	203	264
1994	0	1148
1995	0	344
1996	1870	0
1997	1039	668
1998	3583	1830
1999	2414	1154

Table 3.5.6 International Bottom Trawl Survey in Division IIIa in quarter 3. Mean catch of spring spawning herring at age in number per haul.

Year	Winter rings				
	1	2	3	4	5
1991	214	214	234	80	88
1992	0	333	199	156	52
1993	0	333	44	44	61
1994	0	190	213	83	66
1995	1198	234	168	172	69
1996	3240	1625	128	55	34
1997	149	649	436	68	65
1998	539	294	72	64	10
1999	1813	528	135	133	15

Table 3.5.7. Acoustic surveys on the Spring Spawning HERRING in the North Sea / Division IIIa in 1989-1999 (July).

Year	1989	1990	1991	1992*	*1993**	1994*	1995*	1996*	1997	1998	1999**
	Numbers in millions										
W-rings											
0		31		3,853	372	964					
1		135		277	103	5	2,199	1,091	128	138	861
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682	914
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901	450
4	317	319	866	1,593	598	501	1,270	141	166	282	121
5	81	110	350	556	434	239	255	119	67	111	23
6	51	24	88	197	154	186	174	37	69	51	2
7	16	10	72	122	63	62	39	20	80	31	1
8+	4	5	10	20	13	34	21	13	77	53	1
Total	**2,288**	**2,680**	**5,177**	**10,509**	**5,779**	**3,339**	**6,867**	**2,673**	**2,088**	**3,248**	**2,374**
3+ group	**1,183**	**1,017**	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**598**
	Biomass ('000 tonnnes)										
W-rings											
0	0.0	0.5	0.0	34.3	1	8.7					
1	0.0	6.8	0.0	26.8	7	0.4	77.4	52.9	4.7	7.1	47.1
2	86.2	122.8	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1	81.2
3	83.5	59.8	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8	51.2
4	54.2	41.2	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2	13.2
5	16.0	15.8	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1	2.8
6	11.4	3.8	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9	0.4
7	3.4	1.8	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8	0.3
8+	0.9	0.8	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0	0.1
Total	255.7	252.7	597.9	756.1	436.5	325.8	506.2	215.1	207.5	297.0	196.3
3+ group	169.5	123.2	420.9	560.3	291.0	292.3	319.9	75.2	150.6	153.7	68.0
	Mean weight (g)										
W-rings											
0		17		8.9	4.0	9.0					
1		50		96.8	66.3	80.0	35.2	48.5	36.9	51.9	54.7
2	78	82	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9	88.8
3	117	109	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1	113.9
4	171	129	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7	108.8
5	198	144	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7	122.3
6	211	159	216	185.7	169.6	205.0	157.2	157.3	143.1	135.8	178.1
7	215	176	181	199.7	256.9	212.0	172.9	166.8	185.6	156.4	179.3
8+	226	156	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0	180.6
Total	111.6	95.8	115.6	123.9	75.8	100.2	73.7	80.5	99.4	91.4	82.7

* revised in 1997

**Division IIIa only Skagerrak

Table 3.5.8 **Estimated biomass, % maturity and mean weight at age for Spring Spawning herring for 1999 July Acoustic Survey including the Kattegat area**

Baltic	Numbers	Biomass	Maturity	weight(g)	factor
0	0	0	0		
1	1367.4	74.8	0	54.7	63%
2	1142.9	101.6	0.3	88.9	80%
3	522.7	59.5	0.58	113.8	86%
4	134.8	14.7	1	109.1	90%
5	28.3	3.4	1	120.0	81%
6	2.8	0.5	1	179.9	79%
7	1.5	0.3	1	179.9	99%
8	0	0	1		99%
9+	0.7	0.1	1	181.7	100%
Total	3201.1	254.9			
3+ group	690.8	78.5			

Table 3.5.9 **Acoustic survey on the Spring Spawning Herring in Sub-divisions 22-24 in 1989-1999 (September/October).**

Year	1989	1990	1991	1992	1993	1994*	1995*	1996*	1997*	1998*	1999*
	Numbers in millions										
W-rings											
0	3,825	21,157	7,359	3,412	1,079	4,396	4,116	1,392	2,629	2,780	4,963
1	2,137	1,785	3,224	1,658	452	395	1,217	1,055	1,398	542	1,306
2	213	892	1,764	657	409	785	330	519	493	635	285
3	161	146	1,437	282	536	517	355	405	345	406	214
4	102	79	461	156	417	418	360	279	152	249	149
5	23	19	174	37	133	176	267	286	112	113	49
6	4	8	44	25	56	56	131	110	94	60	9
7	3	4	24	4	32	21	39	44	32	25	1
8+	1	2	21		14	2	28	18	46	8	2
Total	6,469	24,092	14,508	6,231	3,129	6,766	6,843	4,108	5,301	4,817	6,976
3+ group	294	258	2,161	504	1,189	1,190	1,179	1,142	781	860	423
	Biomass ('000 tonnes)										
W-rings											
0	**	287.7	**	53.2	15.8	49.4	43.9	12.0	25.7	25.3	56.1
1	**	65.9	**	61.3	16.1	13.7	42.8	31.9	43.0	21.6	48.4
2	**	56.2	**	39.6	18.2	36.4	22.2	25.3	29.3	46.1	21.9
3	**	12.3	**	20.6	33.5	37.8	30.4	28.4	32.1	35.8	25.4
4	**	7.6	**	14.4	26.5	40.2	40.9	19.6	21.1	27.1	15.2
5	**	1.9	**	4.6	14.1	22.3	29.6	34.0	16.0	11.7	6.4
6	**	0.9	**	3.3	8.0	11.3	15.2	14.6	13.3	6.4	0.9
7	**	0.4	**	0.7	3.2	4.7	8.7	5.5	5.2	3.7	0.3
8+	**	0.2	**		2.4	0.6	6.6	2.8	10.1	1.7	0.4
Total	**	438.5	**	197.7	137.9	216.5	240.3	174.1	195.8	179.5	175.0
3+ group	**	23.4	**	43.6	87.8	117.0	131.3	104.9	97.8	86.5	48.6
	Mean weight (g)										
W-rings											
0	**	13.6	**	15.6	14.7	11.2	10.7	8.6	9.8	9.1	11.3
1	**	36.9	**	37.0	35.7	34.7	35.2	30.3	30.7	39.9	37.1
2	**	63.0	**	60.2	44.5	46.3	67.4	48.6	59.4	72.6	76.9
3	**	84.5	**	73.0	62.6	73.1	85.6	70.2	92.9	88.2	118.4
4	**	96.6	**	92.1	63.4	96.2	113.3	70.3	138.9	109.0	102.2
5	**	101.4	**	125.6	106.2	126.7	110.9	118.8	142.3	103.2	130.7
6	**	112.2	**	132.0	142.6	203.9	116.2	132.1	142.4	106.0	111.0
7	**	100.6	**	168.1	101.1	224.1	222.1	125.6	161.2	151.9	227.2
8+	**	102.5	**		164.1	269.7	239.7	157.3	222.8	232.2	217.9
Total	**	18.2	**	31.7	44.1	32.0	35.1	42.4	36.9	37.3	25.1

* revised in 2000 in accordance to the 'Manual for the Baltic International Acoustic Survey'
ICES CM 1999/H:1 Ref.: D: Appendix IV

** no data available

Table 3.5.10 Estimation of the herring 0-Group (TL =30 mm) Greifswalder Bodden and adjacent waters (March/April to June)

Year	Number in Millions
1977	2000
1978	100
1979	2200
1980	360
1981	200
1982	180
1983	1760
1984	290
1985	1670
1986	1500
1987	1370
1988	1223
1989	63
1990	57
1991	236
1992	18
1993	199
1994	788
1995	171
1996	31
1997	54
1998	2553
1999	1945

1977-1987 taken from Brielmann 1989
1988-1990, 1992-1998 taken from Klenz 1999
1991 taken from Müller & Klenz 1994
1999 taken from Müller (WD 2000)

Table 3.7.1 WESTERN BALTIC HERRING: Input parameters for ICA (Run 20)

```
                         Integrated Catch at Age Analysis
                         --------------------------------

                                 Version 1.4 w

                                 K.R.Patterson
                          Fisheries Research Services
                               Marine Laboratory
                                    Aberdeen

                                  24 August 1999

 Type * to change language
 Enter the name of the index file -->index
canum
weca
 Stock weights in 2000  used for the year 1999
west
 Natural mortality in 2000  used for the year 1999
natmor
 Maturity ogive in 2000  used for the year 1999
matprop
 Name of age-structured index file (Enter if none) : -->fleet
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 8
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->n
 Enter last year in which selection is constant--> 1996
 Gradual or Abrupt change in selection (G/A) ?-->a
 S to be fixed on last age ?-->    1.000000000000000
 S for last age in later selection pattern ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->y
 Is the last age of FLT08: German Bott. Trawl S. SD 24 Feb/a a plus-group (Y-->y
 Is the last age of FLT10: German Bott.Trawl S. SD 24 Nov/De a plus-group (Y-->n
 Is the last age of FLT14: Acoustic Survey in Sub div 22+24 a plus-group (Y/-->n
 Is the last age of FLT15: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/-->y
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 FLT08: German Bott. Trawl S. SD 24 Feb/a  is to be A/L/P ?-->L
 Model for FLT10: German Bott.Trawl S. SD 24 Nov/De  is to be A/L/P ?-->L
 Model for FLT14: Acoustic Survey in Sub div 22+24  is to be A/L/P ?-->L
 Model for FLT15: Acoustic Survey in Div IIIa+IVaE  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface

    F                 SSQ
+--------+-------------------
    0.05        30.8760025924
    0.10        25.7093878963
    0.15        24.9851538723
    0.20        25.2092371393
    0.25        25.7606016753
    0.30        26.4646223779
    0.35        27.2513806152
    0.40        28.0853371128
    0.45        28.9463217624
    0.50        29.8221945580
    0.55        30.7053797333
    0.60        31.5916016680
    0.65        32.4786594691
    0.70        33.3656977628
    0.75        34.2530766387
    0.80        35.1420218389
    0.85        36.0345764339
    0.90        36.9335199221
    0.95        37.8426759195
    1.00        38.7669112776
Lowest SSQ is for F =     0.154
-----------------------------------------------------------------
```

Table 3.7.1 continued

```
No of years for separable analysis : 8
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 1999
Number of indices of SSB : 0
Number of age-structured indices : 4

Parameters to estimate : 55
Number of observations : 237

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1996
Abrupt change in selection specified.

-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 1-->    1.000000000000000
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 2-->    1.000000000000000
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 3-->   1.0000000000000000E-02
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 4-->   1.0000000000000000E-02
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 5-->   1.0000000000000000E-02
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 6-->   1.0000000000000000E-02
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 7-->   1.0000000000000000E-02
 Enter weight for FLT08: German Bott. Trawl S. SD 24 Feb/a  at age 8-->   1.0000000000000000E-02
 Enter weight for FLT10: German Bott.Trawl S. SD 24 Nov/De  at age 0-->    1.000000000000000
 Enter weight for FLT10: German Bott.Trawl S. SD 24 Nov/De  at age 1-->    1.000000000000000
 Enter weight for FLT14: Acoustic Survey in Sub div 22+24  at age 0-->    1.000000000000000
 Enter weight for FLT14: Acoustic Survey in Sub div 22+24  at age 1-->    1.000000000000000
 Enter weight for FLT14: Acoustic Survey in Sub div 22+24  at age 2-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 2-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 3-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 4-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 5-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 6-->    1.000000000000000
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 7-->   1.0000000000000000E-02
 Enter weight for FLT15: Acoustic Survey in Div IIIa+IVaE  at age 8-->   1.0000000000000000E-02
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for FLT08: German Bott. Trawl S. SD 24 Feb/a-->    1.000000000000000
  Enter value for FLT10: German Bott.Trawl S. SD 24 Nov/De-->    1.000000000000000
  Enter value for FLT14: Acoustic Survey in Sub div 22+24-->    1.000000000000000
  Enter value for FLT15: Acoustic Survey in Div IIIa+IVaE-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT08: German Bott. Trawl S. SD 24 Feb/a
 Age   :       1     2     3     4     5     6     7     8
 Wts :     0.125 0.125 0.001 0.001 0.001 0.001 0.001 0.001
FLT10: German Bott.Trawl S. SD 24 Nov/De
 Age   :       0     1
 Wts :     0.500 0.500
FLT14: Acoustic Survey in Sub div 22+24
 Age   :       0     1     2
 Wts :     0.333 0.333 0.333
FLT15: Acoustic Survey in Div IIIa+IVaE
 Age   :       2     3     4     5     6     7     8
 Wts :     0.143 0.143 0.143 0.143 0.143 0.001 0.001
F in 1999  at age 4  is 0.461455  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->N
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table. 3.7.2 WESTERN BALTIC HERRING. Input to ICA. Catch in number (millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	799.4	2443.5	3001.6	744.8	2294.9	661.3	350.8	550.8	613.1
1	1183.6	1303.6	1114.1	711.8	2066.3	1150.5	622.3	622.8	632.8
2	501.0	680.2	475.5	322.5	396.4	635.3	219.4	474.1	360.6
3	426.3	331.0	359.0	289.5	203.6	228.3	239.2	197.1	245.7
4	236.2	296.4	218.8	212.5	153.3	152.3	77.3	157.5	90.5
5	155.9	161.4	182.5	134.8	82.4	127.5	42.4	48.1	56.0
6	41.9	124.4	81.9	97.6	47.8	65.6	39.8	24.8	15.4
7	11.3	48.4	53.1	42.5	28.1	30.4	20.9	15.6	9.7
8	3.8	20.7	19.5	27.3	15.9	25.0	24.2	14.4	6.2

Table. 3.7.3 WESTERN BALTIC HERRING. Input to ICA. Mean weight in catch (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.02600	0.01200	0.01300	0.01600	0.01200	0.01100	0.03000	0.01400	0.01100
1	0.03800	0.04800	0.03400	0.05100	0.02300	0.02400	0.02600	0.03300	0.03400
2	0.06900	0.06800	0.07100	0.08300	0.06500	0.07300	0.06800	0.06800	0.06700
3	0.08900	0.09100	0.09800	0.09600	0.09800	0.09900	0.11900	0.09500	0.09700
4	0.11600	0.11100	0.10600	0.11400	0.11300	0.11700	0.14300	0.11900	0.11700
5	0.13400	0.13500	0.13000	0.13300	0.14700	0.13000	0.16600	0.13800	0.14700
6	0.15100	0.15900	0.16000	0.14700	0.16100	0.13500	0.18300	0.16600	0.15800
7	0.16600	0.17100	0.17400	0.16300	0.20200	0.15000	0.19800	0.16500	0.15600
8	0.17400	0.18400	0.18400	0.17700	0.21000	0.18700	0.20900	0.18800	0.16000

Table. 3.7.4 WESTERN BALTIC HERRING. Input to ICA . Mean weight in stock (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700	0.01700
2	0.04300	0.04300	0.04300	0.04300	0.04300	0.04300	0.04300	0.04300	0.04300
3	0.07100	0.07100	0.07100	0.07100	0.07100	0.07100	0.07100	0.07100	0.07100
4	0.10100	0.10100	0.10100	0.10100	0.10100	0.10100	0.10100	0.10100	0.10100
5	0.12900	0.12900	0.12900	0.12900	0.12900	0.12900	0.12900	0.12900	0.12900
6	0.16100	0.16100	0.16100	0.16100	0.16100	0.16100	0.16100	0.16100	0.16100
7	0.16900	0.16900	0.16900	0.16900	0.16900	0.16900	0.16900	0.16900	0.16900
8	0.19300	0.19300	0.19300	0.19300	0.19300	0.19300	0.19300	0.19300	0.19300

Table. 3.7.5 WESTERN BALTIC HERRING. Input to ICA . Natural mortality

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000
1	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Table. 3.7.6 a WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT08: German Bottom Trawl Survey in SD 24, February, Ages 0-8+(Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	1961.	2778.	960.	996.	1949.	1222.	1163.	2254.	10036.
2	636.	821.	371.	215.	92.	189.	206.	836.	1379.
3	261.	251.	95.	202.	329.	83.	396.	321.	657.
4	87.	80.	61.	330.	131.	88.	164.	74.	338.
5	35.	27.	44.	131.	84.	87.	61.	33.	117.
6	9.	10.	14.	76.	24.	41.	33.	16.	2.
7	2.	3.	6.	30.	28.	33.	23.	10.	15.
8	2.	1.	1.	21.	11.	87.	28.	7.	999990.

Table. 3.7.6 b WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT10: German Bottom trawl Survey in SD 24, Ages 0-1 (Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	117.0	234.0	1116.0	1021.0	635.0	515.0	627.0	4651.0	2630.0
1	134.0	88.0	25.0	13.0	33.0	36.0	66.0	274.0	311.0

Table. 3.7.6 c WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT14: Acoustic Survey in SD 22+24, Ages 0-2 (Catch: Number in millions)

AGE	1993	1994	1995	1996	1997	1998	1999
0	1075.0	4356.0	4046.0	1388.0	2592.0	2771.0	4658.0
1	448.0	365.0	1177.0	961.0	1357.0	473.0	1129.0
2	398.0	740.0	286.0	355.0	388.0	357.0	230.0

Table. 3.7.6 d WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT15: Acoustic Survey in Div. IIIa+IVaE, Ages 0-8+ (Catch: Number in millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	1864.0	2092.0	2768.0	413.0	1887.0	1005.0	715.0	1682.0	1142.9
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0	522.7
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0	134.8
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0	28.3
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0	2.8
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0	1.5
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0	0.7

Table. 3.7.7 WESTERN BALTIC HERRING. Output from ICA.
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.13069	0.30895	0.34387	0.29341	0.32718	0.39731	0.05685	0.06057	0.04299
1	0.36903	0.57402	0.63890	0.54514	0.60788	0.73817	0.18907	0.20144	0.14297
2	0.31987	0.42905	0.47755	0.40747	0.45437	0.55175	0.33620	0.35820	0.25422
3	0.34668	0.45244	0.50357	0.42968	0.47913	0.58182	0.49763	0.53019	0.37628
4	0.36025	0.47350	0.52701	0.44968	0.50143	0.60890	0.61027	0.65020	0.46146
5	0.36725	0.52713	0.58671	0.50061	0.55823	0.67787	0.62813	0.66922	0.47496
6	0.23835	0.53785	0.59864	0.51079	0.56958	0.69166	0.62643	0.66741	0.47367
7	0.32003	0.47350	0.52701	0.44968	0.50143	0.60890	0.61027	0.65020	0.46146
8	0.32003	0.47350	0.52701	0.44968	0.50143	0.60890	0.61027	0.65020	0.46146

Table. 3.7.8 WESTERN BALTIC HERRING. Output from ICA.
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	7529.	6039.	5261.	7566.	6611.	5780.	6116.	12686.	17250.	8047.
1	4800.	4894.	3285.	2764.	4180.	3531.	2878.	4280.	8845.	12242.
2	2009.	2013.	1672.	1052.	972.	1380.	1024.	1445.	2123.	4650.
3	1596.	1194.	1073.	849.	573.	505.	651.	599.	827.	1348.
4	857.	924.	622.	531.	452.	290.	231.	324.	289.	465.
5	556.	489.	471.	301.	277.	224.	129.	103.	138.	149.
6	217.	315.	236.	215.	149.	130.	93.	57.	43.	71.
7	45.	140.	151.	106.	105.	69.	53.	41.	24.	22.
8	15.	60.	52.	82.	44.	60.	58.	33.	18.	22.

Table. 3.7.9 WESTERN BALTIC HERRING. Output from ICA. STOCK SUMMARY

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	7528780	485122	273484	195132	0.7135	0.3281	99
1992	6038700	497031	284511	254935	0.8960	0.4977	100
1993	5261380	401123	236438	217629	0.9204	0.5540	99
1994	7566350	313327	190480	170562	0.8954	0.4727	99
1995	6610990	285310	150024	167874	1.1190	0.5271	100
1996	5779630	257664	123533	156856	1.2697	0.6401	100
1997	6116020	214356	104627	105131	1.0048	0.5906	100
1998	12685650	245757	98136	114362	1.1653	0.6293	100
1999	17250180	361857	110457	100012	0.9054	0.4466	99

Table. 3.7.10 WESTERN BALTIC HERRING. Output from ICA. PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.4735	15	0.3516	0.6377	0.4068	0.5512	0.4790
2	1993	0.5270	14	0.3955	0.7022	0.4552	0.6101	0.5327
3	1994	0.4497	14	0.3367	0.6005	0.3880	0.5212	0.4546
4	1995	0.5014	14	0.3758	0.6690	0.4328	0.5809	0.5069
5	1996	0.6089	14	0.4582	0.8091	0.5267	0.7040	0.6153
6	1997	0.6103	19	0.4162	0.8949	0.5020	0.7419	0.6220
7	1998	0.6502	22	0.4215	1.0029	0.5212	0.8111	0.6663
8	1999	0.4615	26	0.2749	0.7747	0.3543	0.6011	0.4779
Separable Model: Selection (S1) by age 1992 1996								
9	0	0.6525	16	0.4688	0.9081	0.5512	0.7724	0.6618
10	1	1.2123	15	0.8923	1.6471	1.0368	1.4175	1.2272
11	2	0.9061	16	0.6532	1.2570	0.7668	1.0708	0.9189
12	3	0.9555	16	0.6850	1.3329	0.8063	1.1324	0.9694
	4	1.0000		Fixed : Reference Age				
13	5	1.1133	15	0.8202	1.5111	0.9526	1.3011	1.1269
14	6	1.1359	14	0.8505	1.5172	0.9800	1.3167	1.1484
	7	1.0000		Fixed : Last true age				
Separable Model: Selection (S2) by age from 1997 to 1999								
15	0	0.0932	27	0.0543	0.1599	0.0707	0.1227	0.0968
16	1	0.3098	25	0.1865	0.5147	0.2391	0.4014	0.3204
17	2	0.5509	24	0.3420	0.8875	0.4319	0.7027	0.5675
18	3	0.8154	22	0.5222	1.2733	0.6496	1.0236	0.8368
	4	1.0000		Fixed : Reference Age				
19	5	1.0293	19	0.6971	1.5197	0.8437	1.2556	1.0498
20	6	1.0265	19	0.7038	1.4970	0.8467	1.2444	1.0457
	7	1.0000		Fixed : Last true age				
Separable model: Populations in year 1999								
21	0	17250187	27	10100451	29460956	13127902	22666908	17905540
22	1	8845466	19	6053596	12924924	7289309	10733838	9012616
23	2	2122562	17	1514594	2974573	1786828	2521379	2154260
24	3	826764	18	580718	1177059	690411	990046	840302
25	4	288514	20	191821	433947	234273	355312	294838
26	5	138461	24	86044	222808	108621	176497	142600
27	6	43096	27	25212	73663	32783	56652	44738
28	7	23736	30	13117	42952	17538	32124	24848
Separable model: Populations at age								
29	1992	140119	30	76913	255266	103179	190285	146836
30	1993	150832	23	95243	238865	119296	190704	155039
31	1994	106360	20	70529	160394	86249	131161	108722
32	1995	105386	20	70878	156695	86078	129026	107567
33	1996	69105	19	47103	101384	56831	84031	70439
34	1997	53258	20	35758	79323	43462	65261	54369
35	1998	40805	24	25455	65409	32074	51912	42004

Table. 3.7.11 WESTERN BALTIC HERRING. Output from ICA.
Age-structured index catchabilities

FLT08: German Bott. Trawl S. SD 24 Feb/a

Linear model fitted. Slopes at age :

36	1	Q	.5195E-03	27	.3997E-03	.1166E-02	.5195E-03	.8969E-03	.7085E-03
37	2	Q	.2820E-03	27	.2171E-03	.6313E-03	.2820E-03	.4861E-03	.3842E-03
38	3	Q	.3222E-03	265	.2510E-04	.8438	.3222E-03	.6572E-01	.1578
39	4	Q	.3005E-03	265	.2340E-04	.7872	.3005E-03	.6130E-01	.1472
40	5	Q	.2574E-03	265	.2004E-04	.6754	.2574E-03	.5257E-01	.1264
41	6	Q	.1352E-03	266	.1051E-04	.3553	.1352E-03	.2764E-01	.6651E-01
42	7	Q	.1803E-03	266	.1400E-04	.4762	.1803E-03	.3698E-01	.8924E-01
43	8	Q	.1732E-03	282	.1155E-04	.7322	.1732E-03	.4882E-01	.1554

FLT10: German Bott.Trawl S. SD 24 Nov/De

Linear model fitted. Slopes at age :

44	0	Q	.1601E-03	15	.1382E-03	.2524E-03	.1601E-03	.2178E-03	.1890E-03
45	1	Q	.3945E-04	14	.3416E-04	.6148E-04	.3945E-04	.5324E-04	.4635E-04

FLT14: Acoustic Survey in Sub div 22+24

Linear model fitted. Slopes at age :

46	0	Q	.5002E-03	20	.4102E-03	.9221E-03	.5002E-03	.7562E-03	.6283E-03
47	1	Q	.4038E-03	20	.3326E-03	.7345E-03	.4038E-03	.6050E-03	.5045E-03
48	2	Q	.4515E-03	20	.3717E-03	.8222E-03	.4515E-03	.6769E-03	.5643E-03

FLT15: Acoustic Survey in Div IIIa+IVaE

Linear model fitted. Slopes at age :

49	2	Q	.1309E-02	25	.1023E-02	.2800E-02	.1309E-02	.2188E-02	.1749E-02
50	3	Q	.1670E-02	25	.1304E-02	.3585E-02	.1670E-02	.2799E-02	.2235E-02
51	4	Q	.1486E-02	26	.1155E-02	.3228E-02	.1486E-02	.2510E-02	.1999E-02
52	5	Q	.1082E-02	26	.8362E-03	.2397E-02	.1082E-02	.1852E-02	.1468E-02
53	6	Q	.8017E-03	28	.6127E-03	.1837E-02	.8017E-03	.1404E-02	.1103E-02
54	7	Q	.8056E-03	249	.7365E-04	1.287	.8056E-03	.1176	.2171
55	8	Q	.6011E-03	248	.5508E-04	.9534	.6011E-03	.8736E-01	.1607

Table. 3.7.12 WESTERN BALTIC HERRING. Output from ICA.
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.5589	0.8109	-0.8101	0.3565	-0.9163	0.1821	-0.1579	-0.0235
1	-0.2784	-0.1172	-0.2723	0.2966	-0.2618	0.4591	0.0050	-0.3880
2	0.0593	-0.1986	0.0044	0.2016	0.1710	-0.1941	0.1785	-0.1844
3	-0.1814	-0.0778	0.0669	0.0220	0.1131	0.0255	-0.1338	0.0382
4	-0.0714	-0.0624	0.1909	-0.0619	0.2279	-0.2236	0.1040	-0.0735
5	-0.1266	-0.0477	0.2200	-0.2754	0.2312	-0.2648	0.0454	0.1573
6	0.0362	-0.1736	0.2189	-0.2145	0.0983	0.0015	-0.0163	0.0381
7	0.0018	-0.0626	0.1885	-0.3019	0.0513	-0.0617	-0.1372	0.1951

Table. 3.7.13 WESTERN BALTIC HERRING. Output from ICA.
Aged Index Residuals: log(Observed Index) - log(Expected Index)

FLT08: German Bott. Trawl S. SD 24 Feb/a

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.132	0.223	-0.433	-0.235	0.030	-0.251	-0.165	0.101	0.862
2	0.181	0.448	-0.155	-0.246	-1.010	-0.629	-0.270	0.789	0.891
3	-0.610	-0.346	-1.204	-0.225	0.663	-0.576	0.723	0.600	0.975
4	-1.015	-1.160	-1.029	0.808	0.051	0.109	0.961	-0.168	1.443
5	-1.338	-1.449	-0.916	0.614	0.258	0.520	0.709	0.330	1.273
6	-1.128	-1.358	-0.725	1.052	0.270	0.959	1.066	0.848	-0.985
7	-1.338	-2.046	-1.420	0.529	0.475	1.075	0.975	0.413	1.337
8	-0.222	-2.258	-2.109	0.467	0.454	2.229	1.130	0.309	*******

FLT10: German Bott.Trawl S. SD 24 Nov/De

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	-1.926	-0.843	0.890	0.390	0.082	0.073	-0.109	1.169	0.275
1	0.475	0.229	-0.569	-1.139	-0.562	-0.183	0.109	1.147	0.492

FLT14: Acoustic Survey in Sub div 22+24

Age	1993	1994	1995	1996	1997	1998	1999
0	-0.380	0.615	0.703	-0.176	0.120	-0.540	-0.342
1	-0.174	-0.281	0.526	0.596	0.706	-0.735	-0.637
2	-0.098	0.930	0.096	0.039	0.254	-0.156	-1.064

Table. 3.7.13 continued

FLT15: Acoustic Survey in Div IIIa+IVaE

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	-0.019	0.163	0.659	-0.824	0.804	-0.117	-0.293	0.232	-0.604
3	0.017	0.304	0.098	-0.023	0.490	-0.740	0.113	0.352	-0.611
4	-0.035	0.570	0.019	-0.048	1.075	-0.613	-0.221	-0.003	-0.744
5	-0.188	0.504	0.331	0.130	0.311	-0.164	-0.219	0.541	-1.245
6	-0.409	0.211	0.292	0.523	0.856	-0.478	0.436	0.660	-2.092
7	1.009	0.499	-0.202	0.083	-0.340	-0.518	1.129	0.473	-2.132
8	0.404	-0.170	-0.425	0.029	0.207	-0.512	1.302	1.514	-2.350

Table. 3.7.14 WESTERN BALTIC HERRING. Output from ICA. PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1992 to 1999	
Variance	0.1524
Skewness test stat.	-1.6281
Kurtosis test statistic	4.8650
Partial chi-square	0.3309
Significance in fit	0.0000
Degrees of freedom	35

Table. 3.7.15 WESTERN BALTIC HERRING. Output from ICA. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT08: German Bott. Trawl S. SD 24 Feb/a
Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8
Variance	0.0180	0.0503	0.0007	0.0011	0.0012	0.0013	0.0020	0.0029
Skewness test stat.	1.5865	-0.0133	-0.1512	0.1392	-0.5810	-0.2031	-0.7379	-0.4030
Kurtosis test statisti	0.6348	-0.6347	-0.8284	-0.7968	-0.7676	-1.0772	-0.7758	-0.4862
Partial chi-square	0.0181	0.0683	0.0010	0.0018	0.0023	0.0039	0.0067	0.0093
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9	8
Degrees of freedom	8	8	8	8	8	8	8	7
Weight in the analysis	0.1250	0.1250	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013

DISTRIBUTION STATISTICS FOR FLT10: German Bott.Trawl S. SD 24 Nov/De
Linear catchability relationship assumed

Age	0	1
Variance	0.4268	0.2387
Skewness test stat.	-1.1033	-0.0474
Kurtosis test statisti	0.1459	-0.4268
Partial chi-square	0.5106	0.4648
Significance in fit	0.0001	0.0001
Number of observations	9	9
Degrees of freedom	8	8
Weight in the analysis	0.5000	0.5000

DISTRIBUTION STATISTICS FOR FLT14: Acoustic Survey in Sub div 22+24
Linear catchability relationship assumed

Age	0	1	2
Variance	0.0818	0.1215	0.1169
Skewness test stat.	0.5195	0.0230	-0.3623
Kurtosis test statisti	-0.7321	-0.8963	0.1137
Partial chi-square	0.0624	0.1082	0.1150
Significance in fit	0.0000	0.0000	0.0000
Number of observations	7	7	7
Degrees of freedom	6	6	6
Weight in the analysis	0.3333	0.3333	0.3333

DISTRIBUTION STATISTICS FOR FLT15: Acoustic Survey in Div IIIa+IVaE
Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.0411	0.0250	0.0439	0.0434	0.1167	0.0014	0.0018
Skewness test stat.	0.0150	-0.9782	0.7363	-1.5486	-1.7948	-1.2246	-0.8396
Kurtosis test statisti	-0.5797	-0.3738	-0.1184	0.5697	0.7554	0.3256	0.2201
Partial chi-square	0.0468	0.0307	0.0590	0.0735	0.2757	0.0039	0.0065
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.0014	0.0014

Table. 3.7.16 WESTERN BALTIC HERRING. Output from ICA.
ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	115.1574	237	55	182	0.6327
Catches at age	4.4189	64	35	29	0.1524
Aged Indices					
FLT08: German Bott. Trawl S. SD 24 Feb	61.2712	71	8	63	0.9726
FLT10: German Bott.Trawl S. SD 24 Nov/	10.6470	18	2	16	0.6654
FLT14: Acoustic Survey in Sub div 22+2	5.7634	21	3	18	0.3202
FLT15: Acoustic Survey in Div IIIa+IVa	33.0569	63	7	56	0.5903

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.0982	237	55	182	0.0445
Catches at age	4.4189	64	35	29	0.1524
Aged Indices					
FLT08: German Bott. Trawl S. SD 24 Feb	0.0684	71	8	63	0.0011
FLT10: German Bott.Trawl S. SD 24 Nov/	2.6618	18	2	16	0.1664
FLT14: Acoustic Survey in Sub div 22+2	0.6404	21	3	18	0.0356
FLT15: Acoustic Survey in Div IIIa+IVa	0.3088	63	7	56	0.0055

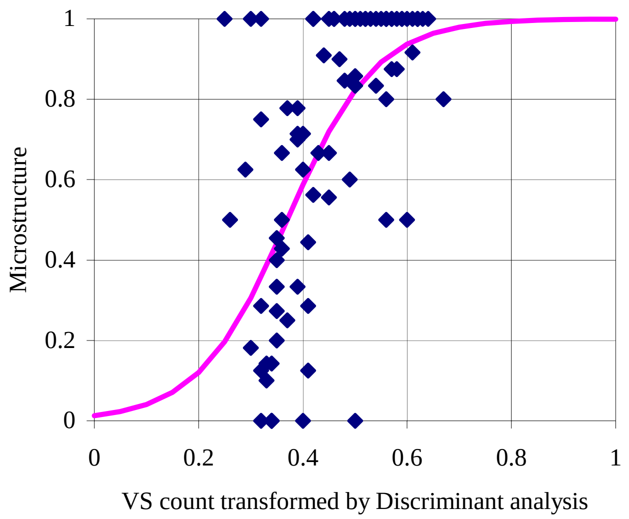
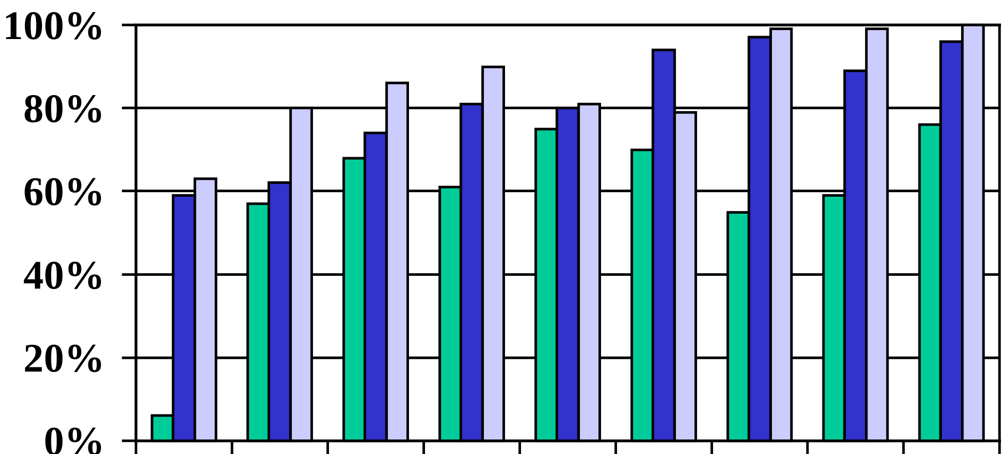


Figure 3.4.1 Estimated proportions Baltic spring spawners from 1991-1997 by year, age, Subdiv, and Quarter Fitted logistic equation gives fractionOto=1/(1+exp(a+b*fractionDiscrim)), R-square=0.61



	1	2	3	4	5	6	7	8	9
1996	6%	57%	68%	61%	75%	70%	55%	59%	76%
1997	59%	62%	74%	81%	80%	94%	97%	89%	96%
1998	63%	80%	86%	90%	81%	79%	99%	99%	100%

Figure 3.5.1 Percentage of the Western Baltic spring spawning herring (1996-1998) found within the Kattegat area. NS herring acoustic survey July 1999.

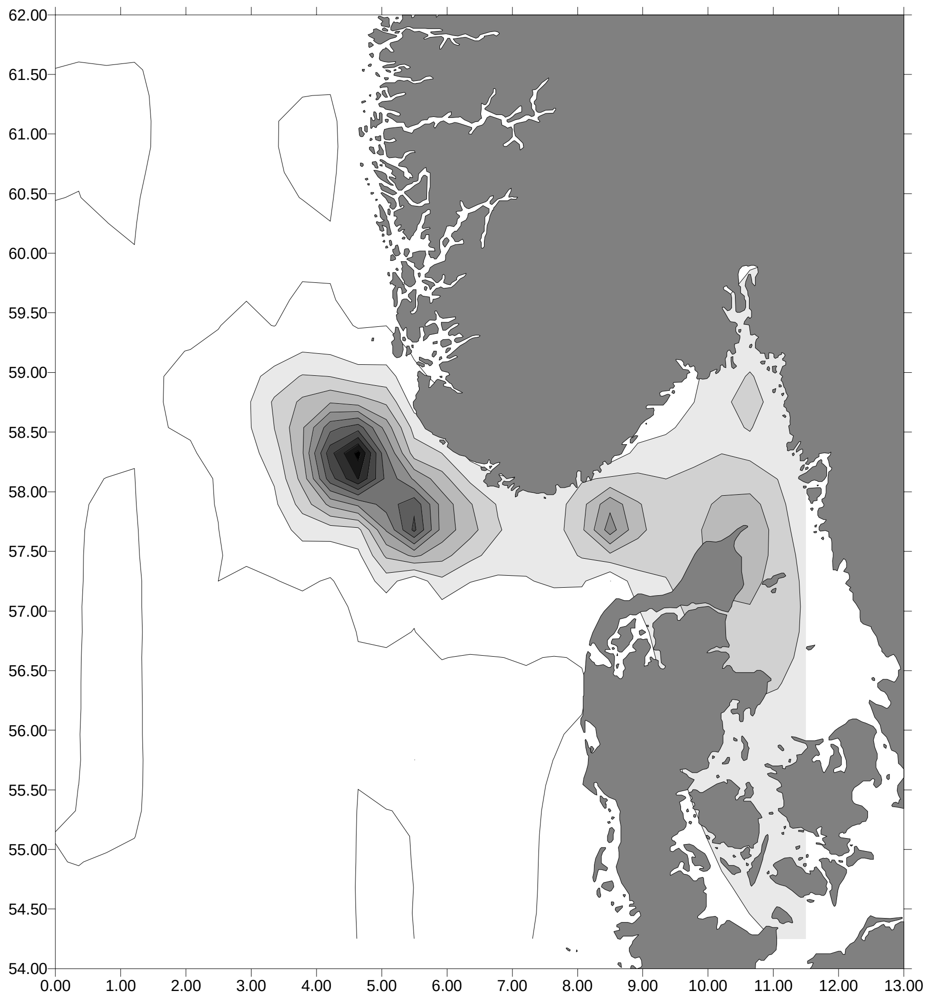


Figure 3.5.2 Spatial distribution of Western Baltic Spring Spawning herring during the July Acoustic Survey 1998

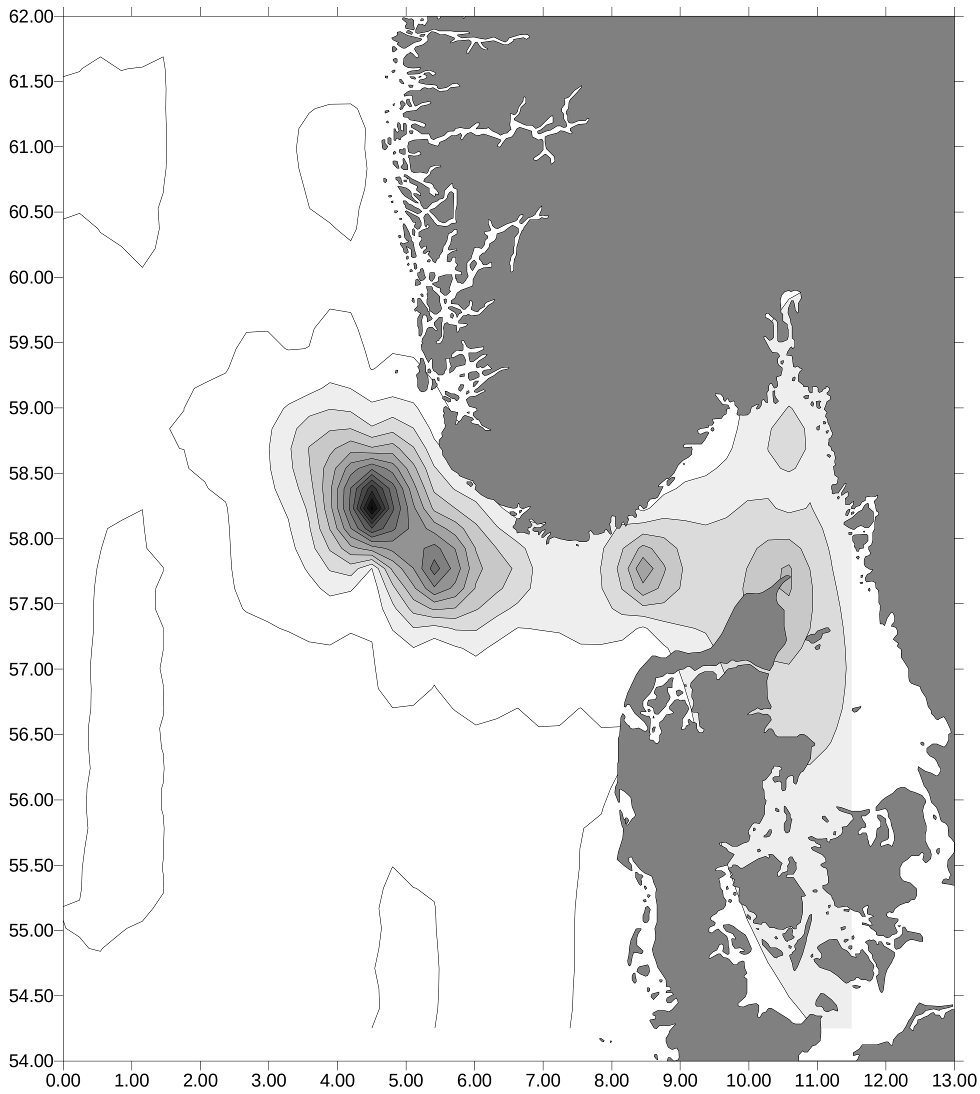


Figure 3.5.3 Spatial distribution of Western Baltic Spring Spawning herring during the July Acoustic Survey 1999.

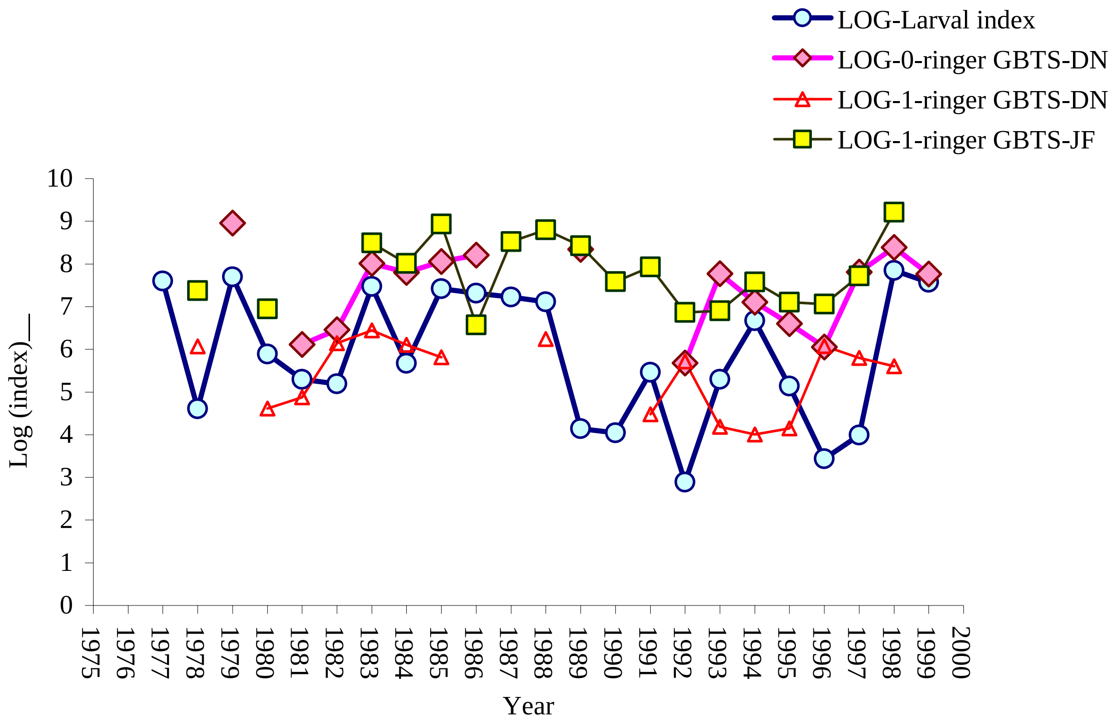


Figure 3.6.1: Recruitment indices (natural log) adjusted to year-class, versus time. GBTS = German Bottom Trawl Survey, ND=November/December, JF=January/February

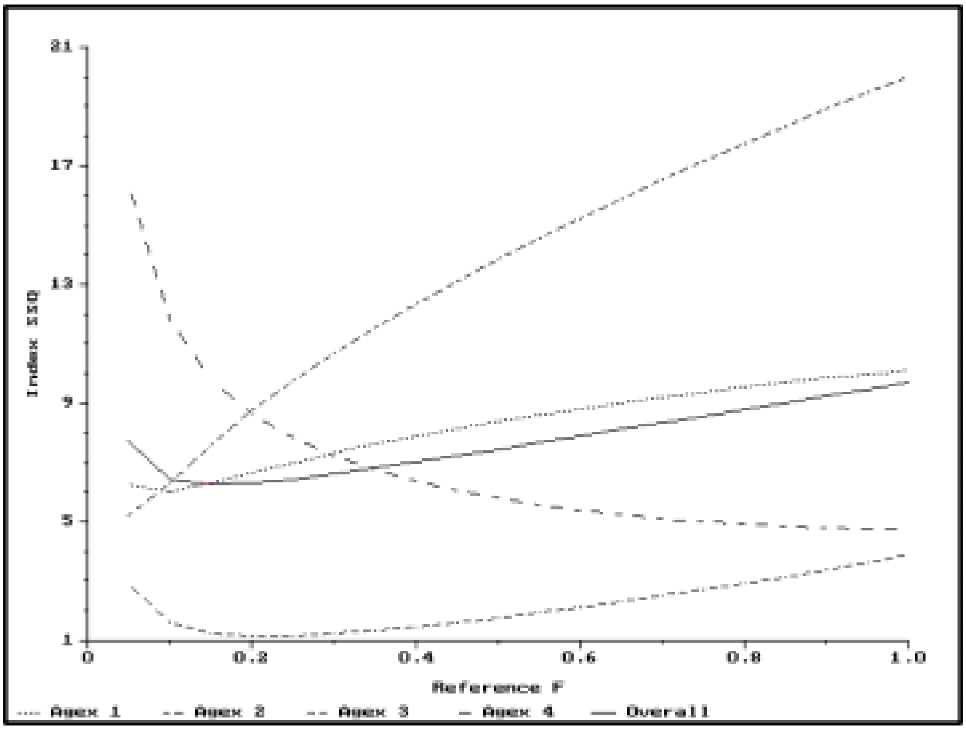


Figure 3.7.1 Western Baltic Herring. Output from ICA:
Index sum of squares of deviations between model and observations
(survey index) as a function of the reference F in 1999.
INDEX 1: German Bottom Trawl Survey in Sub-division 24, February, Ages 1-2
INDEX 2: German Bottom Trawl Survey In Sub-division 24, Novemb., Ages 0-1
INDEX 3: Acoustic Survey in Sub-divisions 22+24, Sept./Oct., Ages 0-2
INDEX 4: Acoustic Survey in Div. IIIa+IvaE, July, Ages 2-6

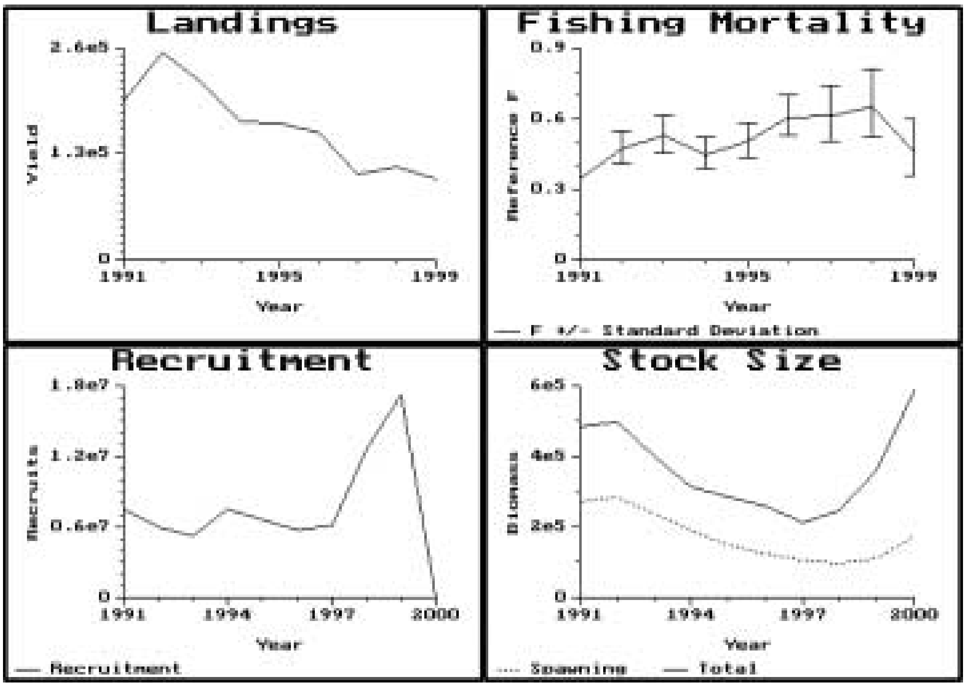


Figure 3.7.2 Western Baltic Herring. Out put from ICA: Stock Summary

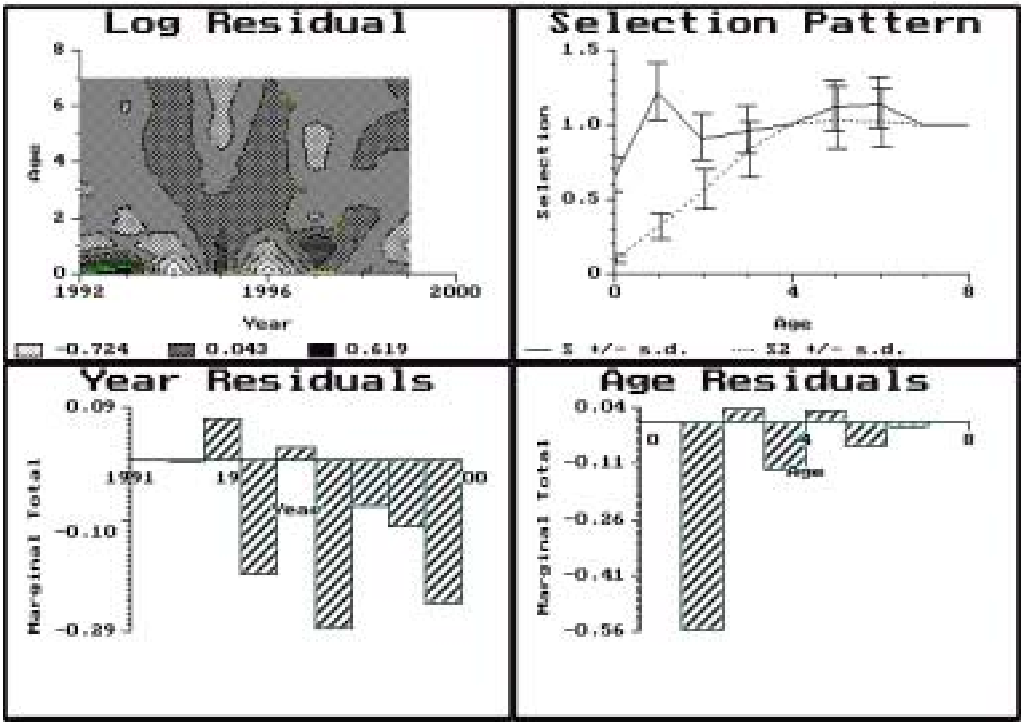


Figure 3.7.3 Western Baltic Herring. Output from ICA: Separable Model Diagnostics.

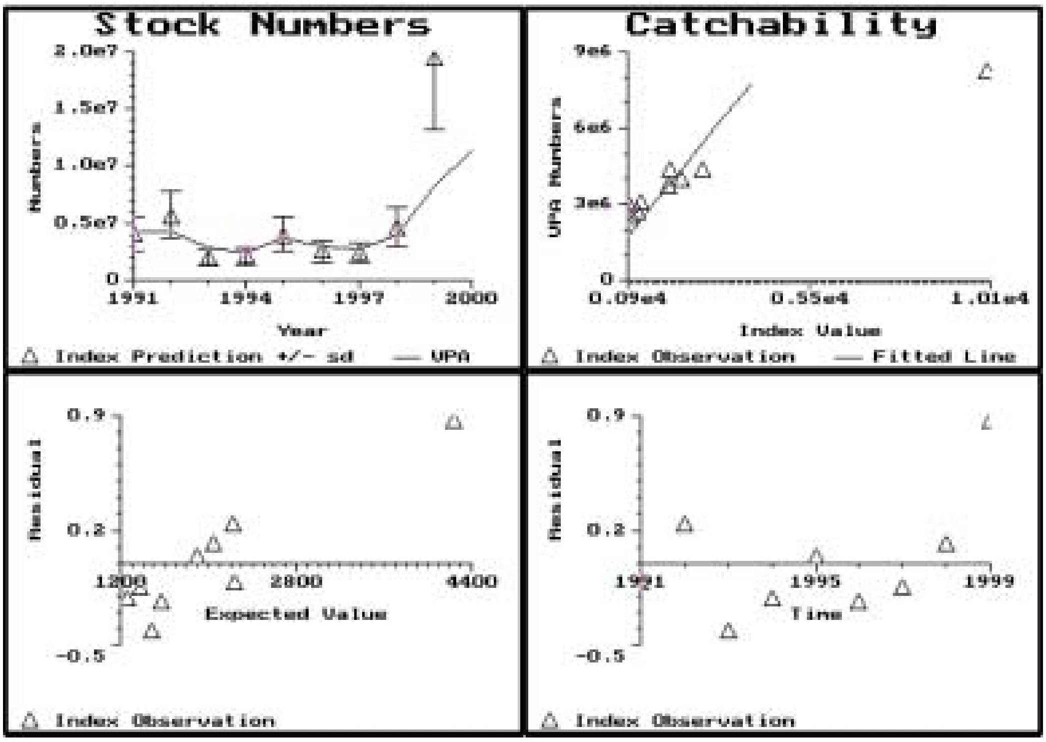


Figure 3.7.4a Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: German Bottom Trawl Survey in Sub-division 24, February, Age group 1

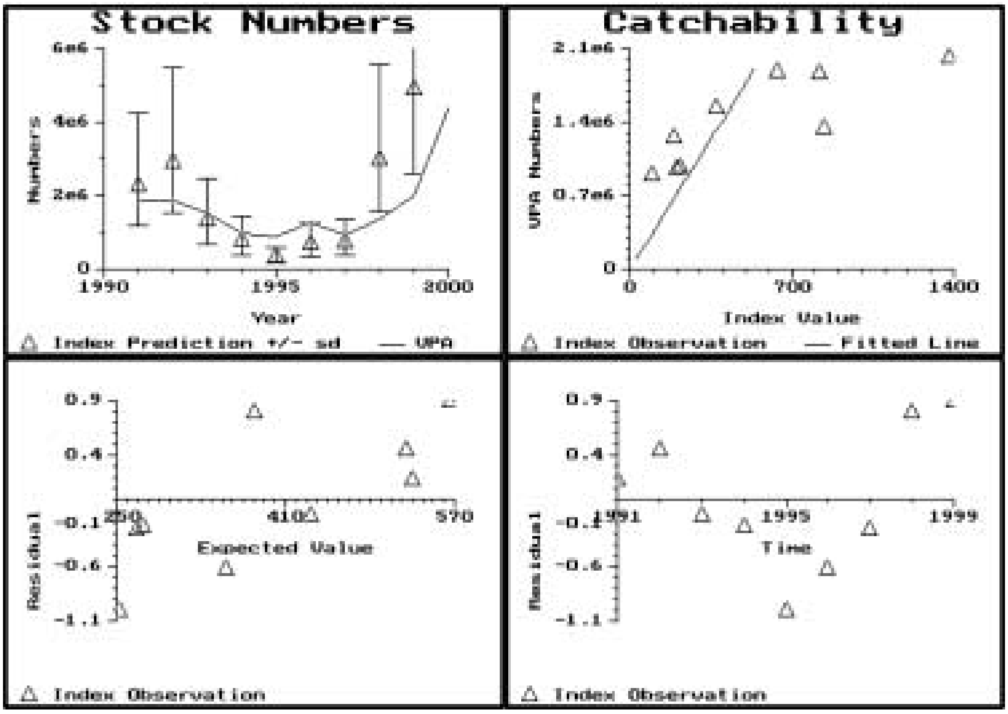


Figure 3.7.4b Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: German Bottom Trawl Survey in Sub-division 24, February, Age group 2

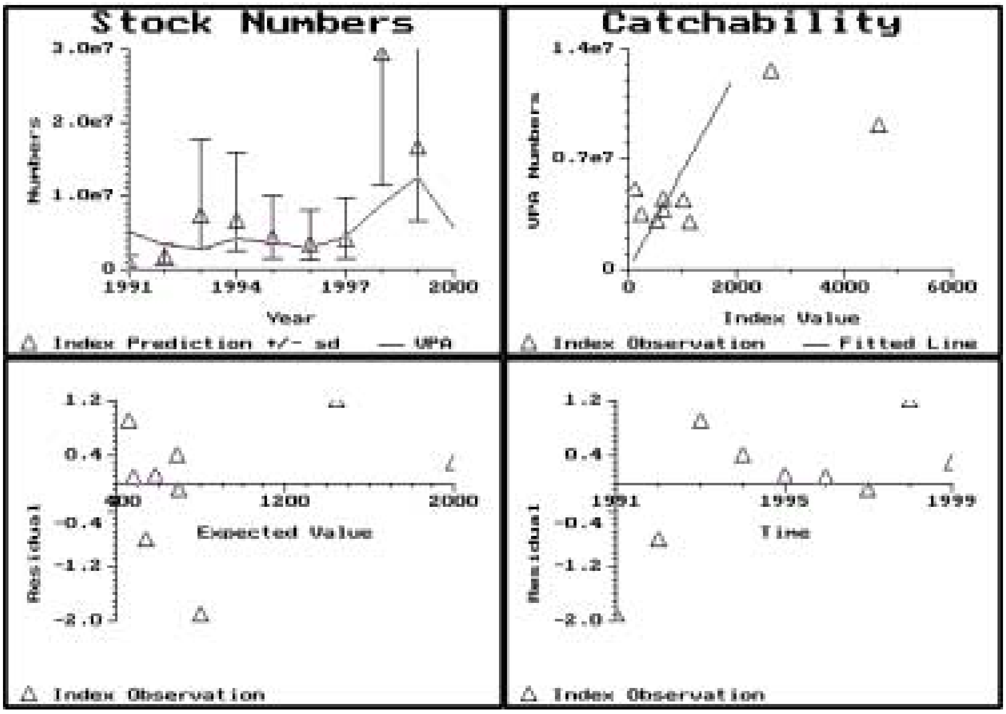


Figure 3.7.4c Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 2: German Bottom Trawl Survey in Sub-division 24, Novemb., Age group 0

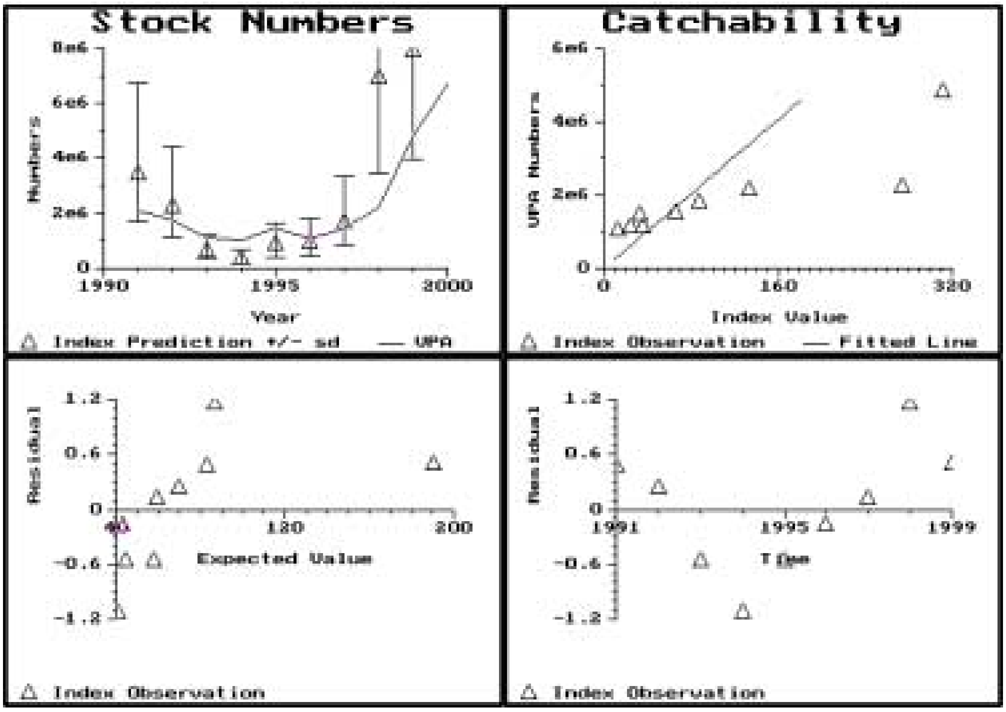
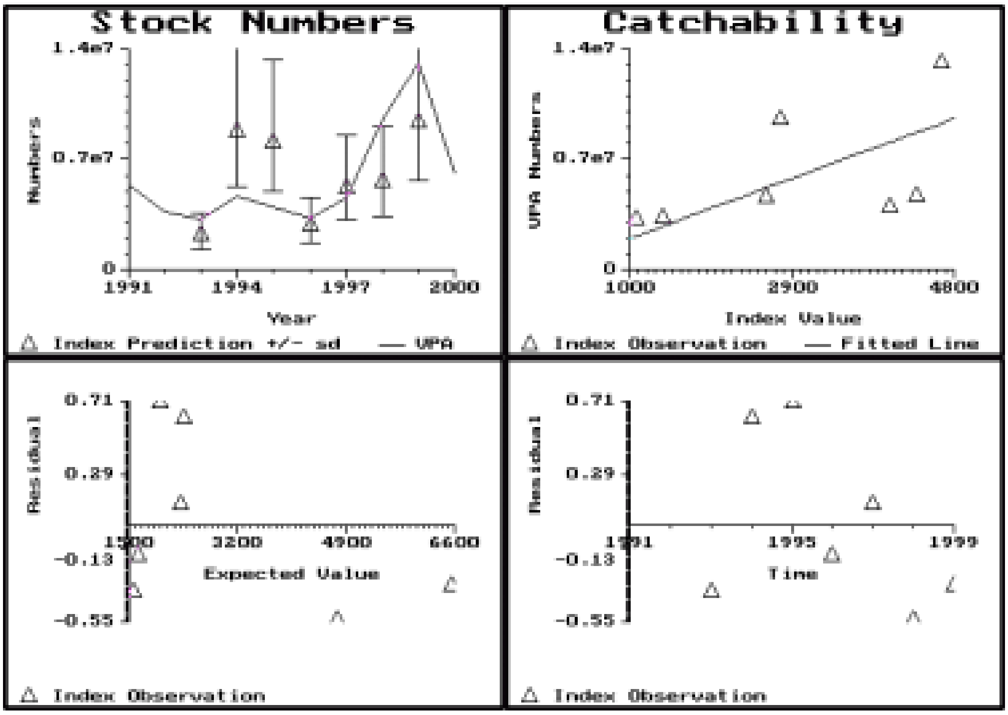


Figure 3.7.4d Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 2: German Bottom Trawl Survey in Sub-division 24, November, Age group



1

Figure 3.7.4e Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 3: Acoustic Survey in Sub-division 22+24, Sept./Oct. Age group 0

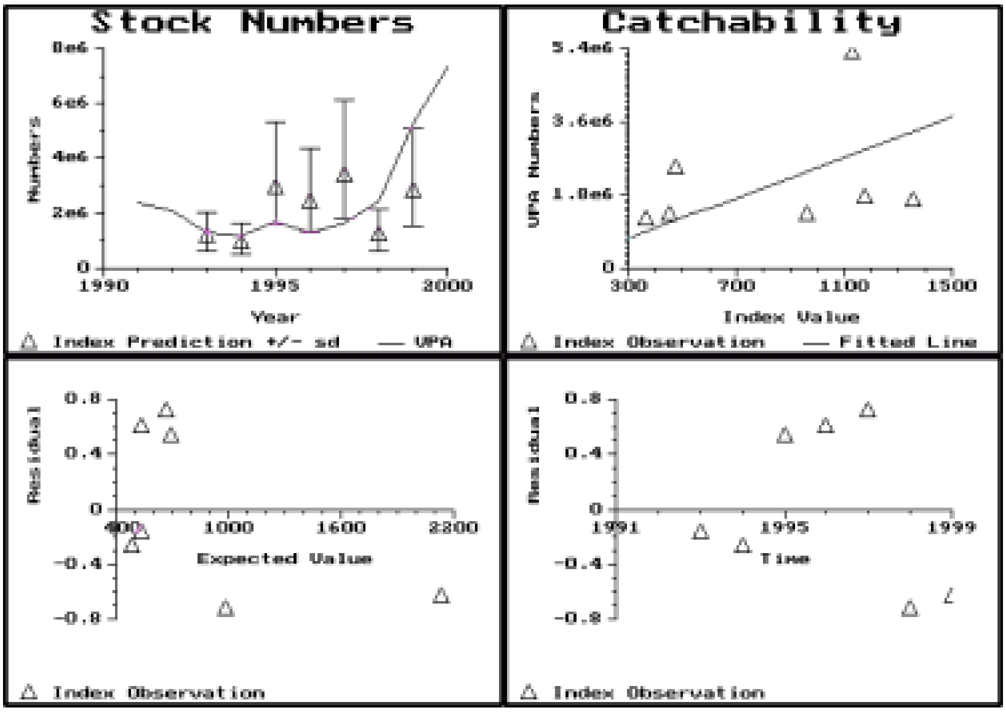


Figure 3.7.4f Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 3: Acoustic Survey in Sub-division 22+24, Sept./Oct. Age group 1

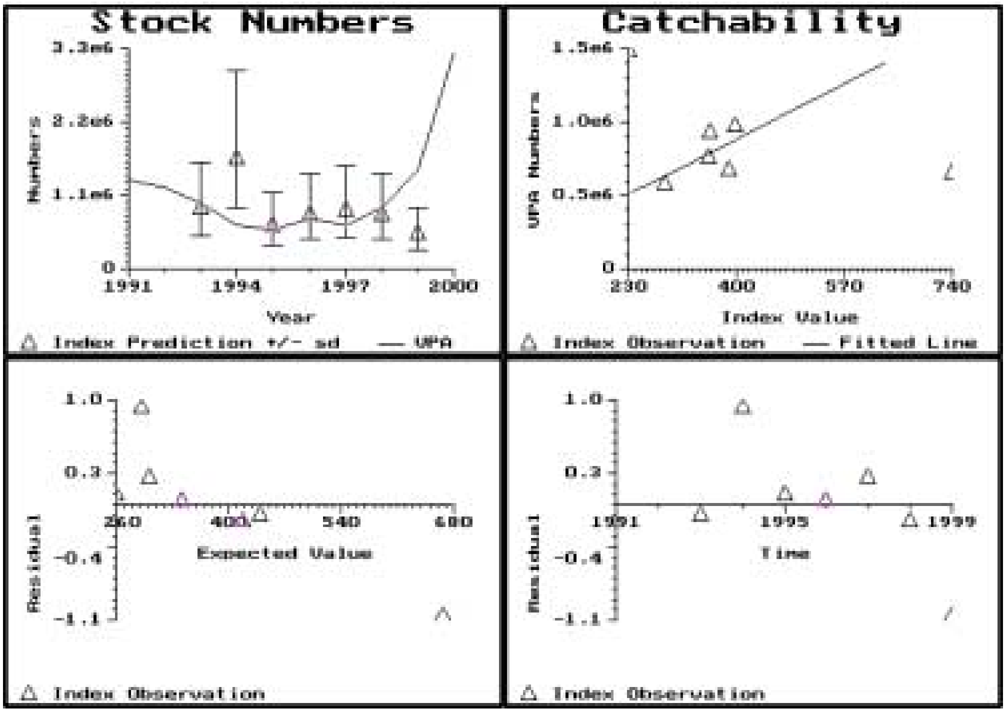


Figure 3.7.4g Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 3: Acoustic Survey in Sub-division 22+24, Sept./Oct. Age group 2

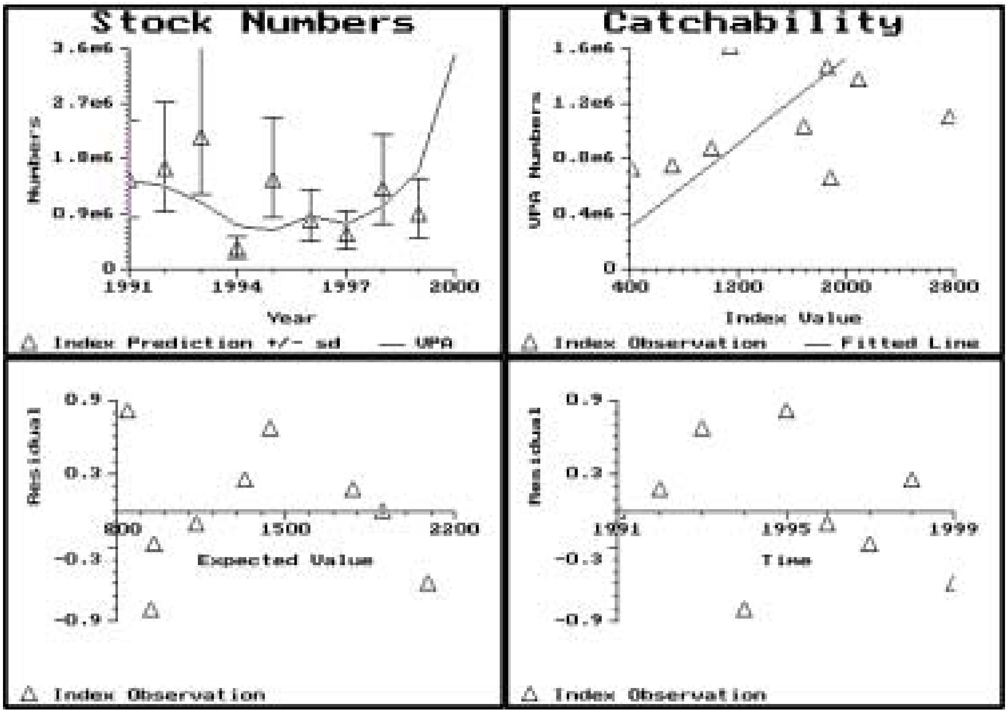


Figure 3.7.4h Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 4: Acoustic Survey in Division IIIa+IVaE July, Age group 2

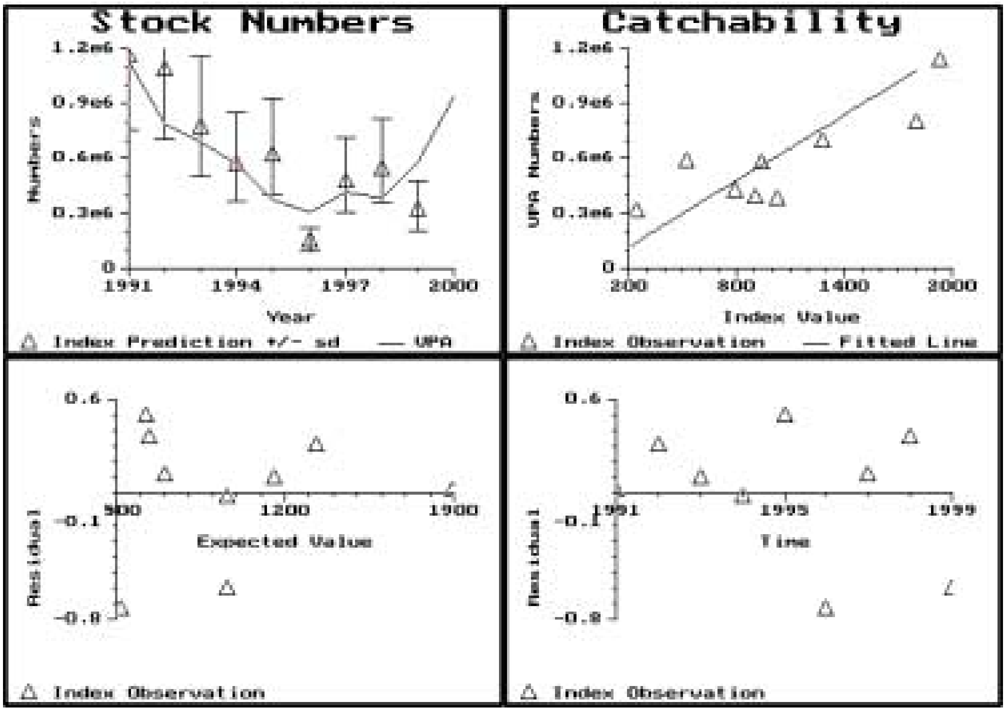


Figure 3.7.4i Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 4: Acoustic Survey in Div. IIIa+IvaE July, Age group 3

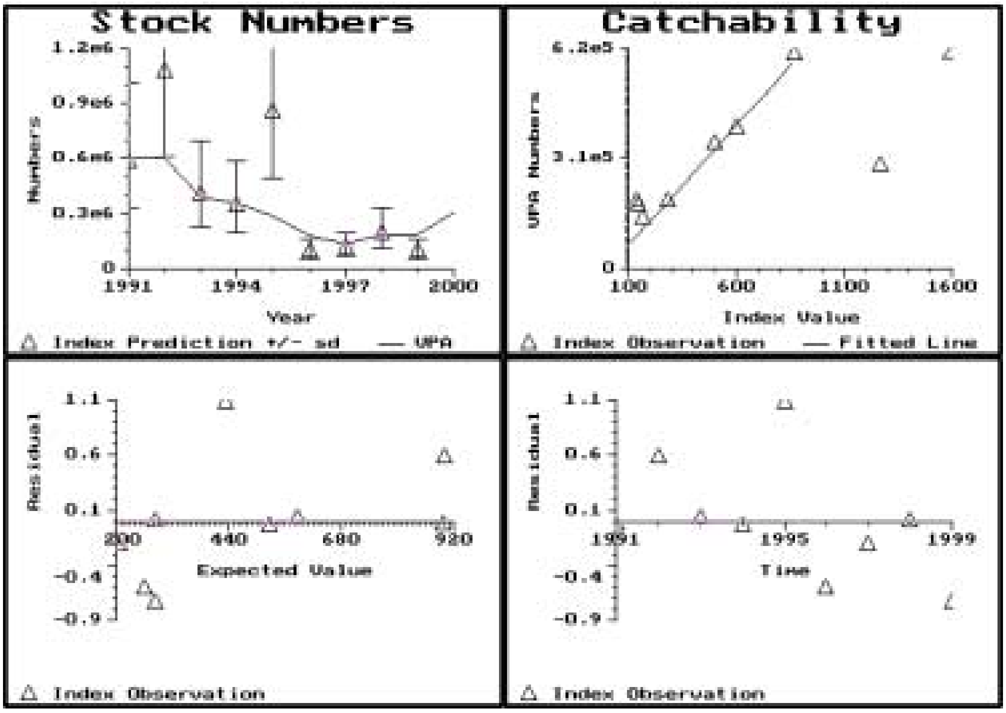


Figure 3.7.4j Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 4: Acoustic Survey in Division IIIa+IVaE July, Age group 4

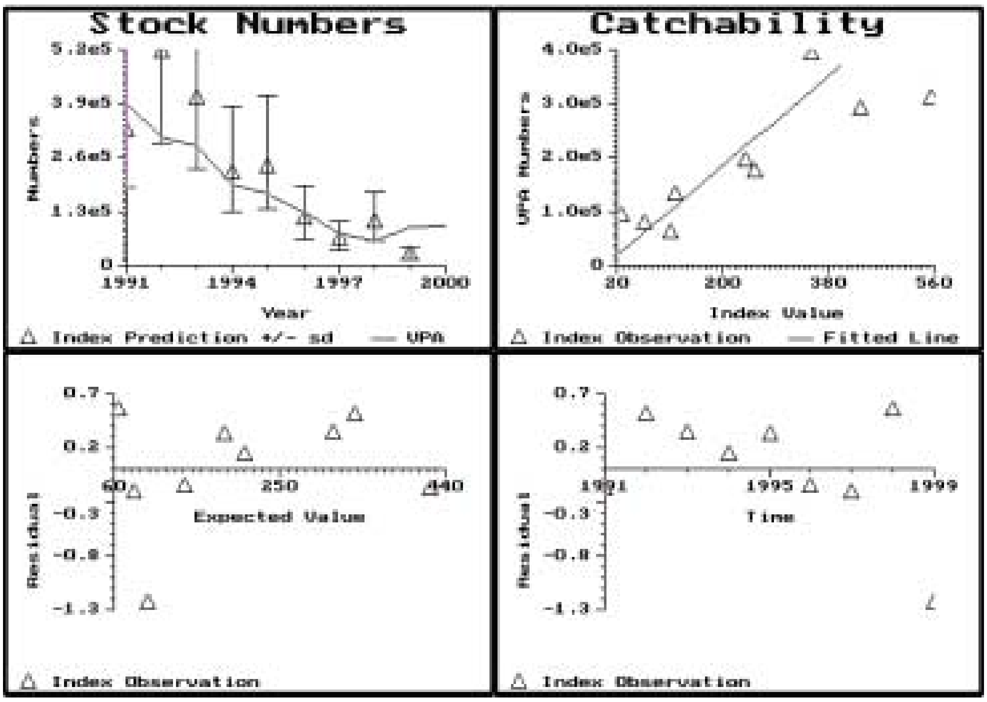


Figure 3.7.4k Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 4: Acoustic Survey in Div. IIIa+IVaE July, Age group 5

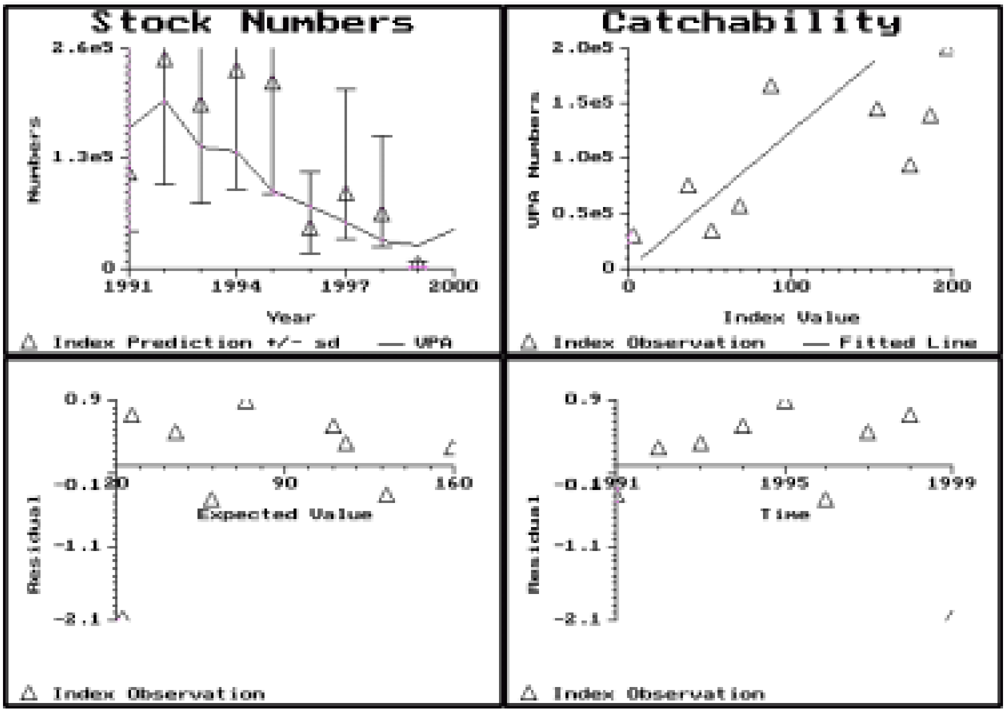


Figure 3.7.4l Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 4: Acoustic Survey in Division IIIa+IVaE July, Age group 6

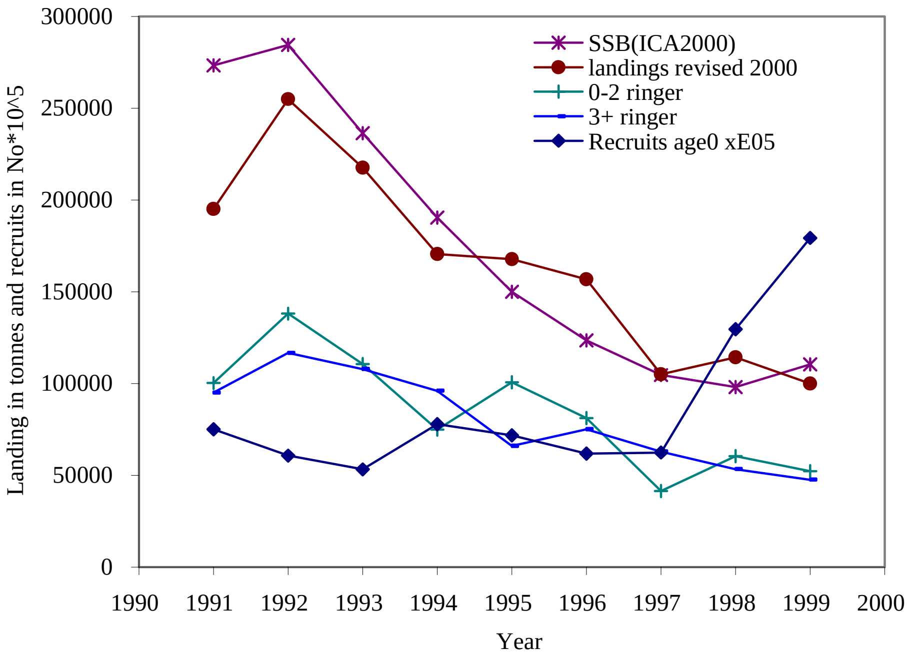


Figure 3.8.1: Trends in landings by age groups, estimates of SSB and number of recruits from the ICA run 17.

4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU are shown in Figure 1.5.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the Irish catch which constitutes over 95% of the total catch is taken from the inshore waters along the Irish coast.

4.2 The Fishery in 1999–2000

4.2.1 Advice and management applicable to 1999 and 2000

In 1999 ACFM considered that this stock was within safe biological limits, that the SSB was high and likely to be underestimated and to be well above the proposed Bpa. Fishing mortality had decreased in recent years. ACFM advised that the F in 2000 should not be greater than 0.3 and that this would correspond to a catch of around 20,000 t. The TAC subsequently set by the EU was 21,000 t which was the same as that in the previous year.

The spawning box closure system, which was first introduced in the late eighties and which is described in ICES (1989/Assess:15) was again continued during the 1999/2000 season - the box closed being that in Division VIIa South. This box was closed for a fortnight in January 2000. The entire Irish fishery was again closed from mid-February 1999 through to early October 1999.

The total Irish quota was subdivided into boat quotas on a week by week basis. All vessels were again regulated by licences which restrict landings to specific ports and to specific times. The total catch that was permitted to be taken in the Irish fishery was 8,000 t in the January –February period and the remainder of the national quota,(about 10,000 t) in the October to December period.

4.2.2 The fishery in 1999/2000

As has been the case for a number of years the major portion of the catch in this area was taken by the Irish fishery during the spawning season which normally lasts from October to February.

As in recent years the main feature of the fishery during 1999/2000 was the continuing poor marketing conditions which prevailed throughout the whole season. As a result the number of vessels participating in the fishery further decreased. The average number participating during the 1999/2000 season was about 24, compared with 38 in the previous season. Over 100 vessels participated in this fishery during the early sixties.

The fishery when it opened in October 1999 was marked by a scarcity of shoals in the southwestern areas. Fishermen reported that shoals during the October to December period were much further off shore than normal and were thought to be spawning in deeper water rather than on the traditional spawning areas. During January and February shoals were located on the usual spawning grounds in Divisions VIIaS and VIIg. Spawning also took place in February in Bantry Bay on one of the smaller spawning grounds which has not been used for a number of years.

4.2.3 The catch data

The estimated national catches from 1988–1999 for the combined areas by year and by season (1 April–31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The total catches for the fishery over the longer period from 1958 to 1999 are shown in Figure 4.2.1. The reported catch, including some unallocated landings, taken during the 1999/2000 season was about 18,500 t compared with 18,000 t during the previous season. A small revision was made to the 1998/99 catches which had the effect of decreasing the total catch by approximately 400 t.

<u>Discards</u>

The level of discards in this fishery is believed to have decreased considerably in recent years. This is because the decline in the demand for “roe” fish for the Japanese market has reduced the incentive to discard herring that are unsuitable for this particular market.

There were no reports of discards from the fishery in 1999/200 and no adjustments were necessary for the landings. This was in contrast to some of the years before 1997 when some landings were increased by 10%-20% to allow for discards.

4.2.4 Quality of catch and biological data

Since 1997 there has been a major increase in the monitoring of landings from this fishery and the management measures were again tightly enforced throughout the season. As a result the accuracy of the landing figures in recent years is believed to have increased significantly.

Biological sampling of the catches throughout the area continues to be satisfactory and at a high level. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age, including discards, per season from 1958 to 1999 are shown in Table 4.4.2. The age composition in 1999/200 was dominated by 3 w ring herring (1995/1996 year class) which constituted about 28% of the catch. 2 w. ring herring (1996/1997 year class) and 5 w. ring herring 1993/94 year class) constituted 27% and 12% respectively. In recent years there appears to have been a gradual improvement of the age structure of the catches in numbers at age. The numbers of 1 w.ring herring constituted over 11% of the catch in numbers which is the highest number recorded since the strong 1992 year class recruited in 1994. These young fish were mainly taken in the catches from Division VIIj and did not appear to be evenly distributed throughout the Celtic Sea.

A small revision was made to the 1998/1999 catches in numbers at age because of the catch revision.

4.3 Mean weights at age

As the major portion of the catch from this fishery continues to be taken during the spawning season the mean weights at age in the catches have traditionally been taken as the mean weights in the stock at spawning time (1 October). The mean weights during 1999/200 were very similar to those in recent seasons.

It is apparent that herring in the Celtic Sea experienced an increase in growth rate during the mid seventies (Figure. 4.3.1). However a change in mean weight at age is not reflected in the current values used by the Working Group up to 2000. At present the matrix for weight at age in the stock uses a fixed value for each year class from the start of the time series (1958) until 1983. The discrepancy between the estimated sustainable exploitation rates (based stock and recruitment data) and the historical perception of the stock (from the assessment summary), may be due to this problem with the stock weights at age.

In an effort to rectify this problem old working group reports were examined for the actual stock weights at age. The basis for the calculation of these values had changed, where previously they were calculated from Irish and Dutch data as of April 1, the new proposed values were estimated from a mean of weights at age in the catch from the fishery on the spawning grounds over the period October to February. This latter method is consistent with the calculations over the period 1983 to 1999. However no data on mean weight at age were available for the period 1958 to 1973. In order to generate mean weights for this period a length weight regression was calculated for the entire period of extant data. Length weight relationships for herring have been shown to be robust spatially and temporally for herring in the North Sea (Hammer *et al* 1996) and the spread of data in the case of Celtic Sea herring showed no trends or biases across time or age. The weights at age derived from the regression improved the SOP values for catch weights in most years for the recalculated series, thus the WG agreed to update the “west” file (mean weights at age in the stock) based on these values.

Maturity at age

The maturity at age for this stock has been assumed to be constant throughout the whole time period (50% of fish are assumed to be mature at age 1 and 100% mature at age 2). It is now apparent that the stock has undergone growth changes and also considerable changes in abundance during this time period. Both these factors may have had effects on the maturity ogive and this needs to be investigated before biological reference points are finalised. Work on examining the historical data is currently being carried out and the results will be presented when available.

4.4 Stock assessments

4.4.1 Acoustic surveys

A series of acoustic surveys have been carried out on this stock from 1990–1996. The series was interrupted in 1997 when no surveys were possible but was resumed in 1998. Prior to 1999 the surveys were carried out during the spawning season which lasts from October to February/March and two surveys were carried out when possible in October and in January. The objective of the surveys was to estimate the size of the spawning stock of the autumn and winter spawning components separately. In most years it has been possible to do this with some confidence and therefore the size of both components has been combined to give the size of the total spawning stock. However in some years the surveys were thought to have missed out important parts of either component and there have always been difficulties in adequately covering the distribution of the stock. This was because of weather conditions or because of the difficulty of timing the surveys to coincide with the arrival of the shoals on the spawning grounds.

During the 1998/99 season two surveys were again carried out. However, only the results of the first survey (November, 1998) were available to the Working Group at the time of the meeting in 1999 (ICES 1999 ACFM 12). For various reasons that are explained in the report of the 1999 Working Group the results of the autumn survey in 1998 were considered as an underestimate of the spawning stock. Because of the unavailability of a research vessel it was not possible to carry out the second survey at the desired time i.e., mid January.

The first survey therefore was carried out in February 1999. This survey was considered to have missed the main winter spawning as most of the adult fish taken were spents. Samples from the commercial fishery and reports from the fishery also indicated that the main spawning had taken place in January. The total stock biomass that was estimated from this survey was 14,600 t. and the spawning stock biomass to be 14,200 t. The age distribution was dominated by 2, 3,and 4 w.ring fish which together constituted over 72% of the total stock in numbers at age. The age distribution of the stock from all acoustic surveys carried out since 1990 is shown in Table 4.4.1

During the 1999/2000 season two further surveys were carried out on this stock. The results were presented in a working document (Molloy and Kelly, W.D 2000).

Because of the difficulties in combining the results of the autumn and winter surveys to give one overall estimate of the size of the total Celtic Sea stock it was decided to carry out a survey during the summer on the off shore feeding grounds. It was hoped that this survey would result in an estimate of the total spawning stock. The survey that took place in July 1999 was hampered by unusual bad weather and it was not possible to cover the entire distribution of the stock. Most of the herring were found in a mixture which was very difficult to evaluate and no typical herring schools wee located. Most of the biomass was located in a relatively small area in the Celtic Sea The total stock size was estimated at around 58,000 t, of which about 22,500 t were mature. This estimate of adult stock biomass is very low when compared with catches of 18,000 t of adult fish which were taken over the subsequent season. Over 90% of the herring seen during the July survey were either 0 1 or 2 w.ring fish. The age distribution of these fish was completely different from samples taken from the commercial fishery and this is shown in Figure 4.4.1. It was therefore concluded that this survey did not cover the main adult component of the stock and therefore could not be taken as a realistic estimate of the spawning stock biomass. An estimate of Zbar (3–7) from this survey series was compared to estimates derived from the catch, the assessment in 1999 and an index from the UK groundfish survey in February/March (Figure 4.4.2). This crude comparison shows an very high Zbar (3–7) from the July 1999 acoustic survey (1.4). This was considered unrealistic as up to 1998 the acoustic survey had showed the same trend of decreasing Zbar (3–7) as the catch and assessment, and when compared to the index from the UK groundfish survey in February/March 1999, which showed a continued decrease in 1999.

It was not possible to carry out a survey in November 1999 to correspond with the one that was carried out in November 2000 and which gave an estimate of SSB of 110,000 t.

A further survey was however carried out in January 2000. Although this survey was carried out at what was considered to the appropriate time and good coverage was obtained, the amount of herring observed was small. Reports from the commercial fishery at the time suggested that shoals were less abundant than in the January to February period during the 98/99 season, and from the commercial samples that some spawning had in fact taken place earlier than usual. The majority of fish sampled during the acoustic survey were spent fish (stage 7) compared with mainly full and spawning fish sampled from the commercial catches during January and February. The proportions of immature mature and spent fish from the acoustic survey and from the commercial catch during January and February are given in Figure 4.4.3. The total stock estimated was 29,700 t while the spawning stock was estimated at around 26,200 t. This estimate is not considered to be realistic because the main spawning concentrations were not located during the acoustic survey.

Recent Working Groups have used the results of the acoustic surveys in the ICA programme but stated that the results of the 1996/97 surveys and 1998/99 surveys should be taken as a minimum estimates. In 1998 the Working Group decided to use the age dissaggregated data but only over the years 2–5 as a relative index in the ICA programme. It was clear that the 1996 survey had failed to estimate the older fish in the population because of the small proportion of older fish recorded by the survey relative to the catch. The 1999 W.G decided that, even with an incomplete index for the 1998/99 surveys, the same procedure as that adopted in 1998 should again be carried out in 1999, i.e., an ICA run in which the age dissaggregated data over the ages 2–5 should be used as a relative index of stock size. This resulted in an estimate of SSB of around 82,000 t.

4.4.2 Results of Assessment

The various estimates of SSB, obtained from the acoustic surveys carried out in 1999 and 2000, are very low compared with the perception of the state of the stock in recent years which has been estimated to be at least 80,000 t. In addition the biological characteristics of the fish seen on the surveys was incompatible with samples obtained from the commercial samples as discussed above. Nevertheless, in order to be consistent with the assessment approach adopted in recent years, ICA runs were carried out using the age disaggregated data obtained from the July survey and the January survey. The results from both runs gave estimates of SSB in 1999 which are unrealistically low and fishing mortalities in 1999 which are extremely high. This view would suggest that the stock has collapsed within the last year. The results from these runs are shown in Figure 4.4.4.

As the survey indices show completely incompatible biological information with that from the commercial fisheries and as there is no indication of a stock collapse, either from Zbar (3–7) from the UK index ground fish surveys or from any of the predictions made in recent assessments, the Working Group decided that the estimates of SSB obtained from the July 1999 and January 2000 surveys are not indicative of the true size of the current SSB. Therefore an additional ICA run was carried out in which the index from these surveys was omitted. The input data for the ICA runs are shown in Table 4.4.2. Because of the absence of complete survey indices in 1997 and 1999 this final run was carried out in which the Fs were shrunk over the last four years, with a minimum C.V.of the mean taken as 0.2 and a separable period of 7 years. The separable period used in the 1999 assessment was 6 years.

The results of the assessment and the diagnostics are shown in are shown in Table 4.4.3 and Figures 4.4.5 – 4.4.10. These results indicate that the SSB in 1999 was over 117,000 t. compared with an estimate of 72,000 t for 1998 and 1997. The main reason for this large increase is the very high number of 1 w.ring herring (1997 year class) that are in the population in 1999. This high number is not very accurately estimated as it is only based on the high catches of this age group in 1999/2000. As mentioned earlier in the text these young fish were not present throughout the Celtic Sea and Division VIIj and their abundance in the catches may not be indicative of a high incoming recruitment. However, there was some evidence from the July 1999 acoustic survey that substantial numbers of young herring were present in part of Division VIIa S and VIIg. The estimates of SSB for 1997 and 1998 of around 72,000 t are very similar to those estimated by the 1999 Assessment Working Group (72,000 t in 1997 and 82,000 t in 1998).

The value of F estimated for 1999 is 0.34, which is the same as that estimated for 1998 and F has decreased in recent years and is the lowest value recorded since the mid 1960's. Estimates of F estimated by the 1999 Working Group were 0.38 and 0.32 for 1997 and 1998 respectively.

The number of 1 w.ring herring in the stock, show that recruitment was high in 1994 and 1995.

4.5 Recruitment estimates

At present there are no recruitment estimates for this stock that can be used for predictive purposes. The numbers of 1 w.ring fish estimated from the ICA suggest that a number of good year classes have recruited to the stock in recent years and that the 1992/93 and 1993/94 year classes appear to have been particularly strong.

Some data were available about the abundance of young herring in the Celtic Sea from English ground fish surveys carried out in March from 1988 to 1999. However, the data are not available as age indices for all years and the number of herring caught is sometimes very small. At present it does not appear possible to use the data as a reliable index but further evaluation of the time series would be advisable. There are some data available from the July 1999 acoustic survey to indicate that the 1997 year class may be good as substantial numbers of them were taken in Divisions VIIa South and VIIg.

In this stock a proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea until they are mature. Therefore neither the numbers of 1 w.ring fish in the stock as estimated from the acoustic surveys nor the numbers in the catches give a reliable indication of year class strength. The relationship between the numbers of 1 w.ring herring taken per hour in the Northern Irish ground fish surveys and the numbers of 1. w.ring herring estimated by ICA for the Celtic Sea was examined in a working document (Armstrong *et al.*,1999, W.D) and the results suggest that these surveys may be a useful indicator of recruitment when a longer time series is established.

4.6 Short term Projection

Inputs

Because of the uncertainty about the current stock size and the lack of information on recruitment it was decided that projections over a medium or long term basis would be unrealistic. A short term projection was therefore carried out under the following assumptions.

Because of the uncertainty about the strength of the 2 w.ring herring in the population estimated for the I January 2000, it was decided to replace the number with the geometric mean of the numbers in the populations from 1982–1997. The estimated number was 196.3 million and this was used in the prediction instead of the value of 794.9 million that was calculated from the final ICA run. Similarly the number of 1 w.ring fish was also based on the geometric mean from 1982–1997. This value was 558 million fish. The geometric mean was calculated over the more recent period (1982–1997) rather than over the entire time period (1958–1997) because the longer period contained a period when the stock collapsed and the fishery was closed. It was therefore considered more appropriate to use a period when the stock was more stable in which to estimate recruitment. In any event the value was nearly identical to the one used previously of 559 million fish.

The mean weights used in the catches and in the stock were based on the average values over the period 1995–1999.The calculated SSB for 2000 was taken as 73,700 t and a catch in 2000 that is equal to the TAC of 21,000 t. All other values were similar to those of recent years. The input data used for the predictions are shown in Table 4.6.1.

Results of Predictions

The overall results of the predictions indicate that the perception of the development of the stock is very similar to that presented in recent reports. There appears to be very little increase in SSB in 2001 corresponding to different catches and that recent catches of around 18,000 t-19,000 t are at the appropriate level for the stock.

A catch of 11,400 t will result in an SSB of 75,000 t while a catch of 23,600 t will result in a SSB of 72,000.This would suggest that recruitment at the average levels will only produce small increases in SSB.

If the TAC in 2001 is set at the same level as that for 2000 (21,000 t) then the SSB in 2002 will be about 72,000 t which is slightly lower that that at in 2000. A catch in 2001 of around 19,000 t will produce a SSB in 2002 that is equal to that in 2000.

If F in 2001 is set to correspond to F med = 0.3 then the resultant catch in 2001will be between 16,000 t and 17,000 t. and the SSB will be 74,000 t.

The results are shown in Tables 4.6.2.-4.6.4. Plots of yield per recruit and stock and recruitment for Celtic Sea and VIIj herring are shown in Figures 4.6.1 and 4.6.2.

4.7 Biological reference points and management considerations

Biological reference points were discussed in detail last year’s report (ICES 1999a) and in the report of the previous year (ICES 1998a). There has been a period of recruitment failure in the stock from around 1970 to the early 1980’s, when recruitments were in the order of 100 million-300 million individuals, as opposed to 400 million to 1000 millions in most other years. This recruitment failure apparently was not induced by a low SSB. Rather, it started when the SSB was at a high level and recruitment returned to normal while the SSB was at its lowest. Overall, the recruitment does not appear to be strongly dependent on the SSB.

In the periods with good recruitment, the fishing mortalities have mostly been in the range 0.35 - 0.6, and the stock seems to have tolerated this fishing mortality well. This fishing mortality is higher than that which most herring stocks will tolerate. The background for this may be partly because the recruits per SSB is quite high, except in the period with poor recruitment, and partly because the fishery is almost exclusively on mature fish, which gives a favourable SSB per recruit.

The 1998 Working Group suggested a B_{lim} at 26,000 tonnes, which is the lowest SSB observed and is just below the biomass level which gave rise to the first strong year classes after the collapse. Assuming a 30% CV on the current SSB estimates leads to a B_{pa} of 40,000 t. The Working Group also proposed an Fpa = 0.4 as being appropriate to the present position where the stock was at a reasonably high level. The Bpa = 40,000 t was accepted by ACFM but it considered that the Fpa = 0.4 was too high and it proposed that it should be equal to F med = 0.29.

The 1999 Working Group re-examined the Fpa and suggested that it might be appropriate to have different Fpa for periods of high and low recruitments. On this basis it was suggested that an Fpa = 0.3 would be appropriate for a period of high recruitment and an Fpa = 0.2 for a period of low recruitment. It was also pointed out that the mean weights at age should be re evaluated for the earlier time period and that values of F lower than the proposed Fpa = 0.29 had only been evident in 4 years out of 40 years in the time series. ACFM did not accept the proposal of two different Fpa and asked that the biological reference points be re evaluated after the examination of the weight at age data.

The present Working Group therefore re examined the stock recruit relationship over the 1958 to 1999 period using the new SSB estimated on the revised stock weights for the 1958 to 1983 period. The new stock recruitment plot is shown in Figure4.6.2.The F med value which has been proposed as appropriate for Fpa is calculated as 0.29 which is identical to the previous proposed value. It was therefore concluded that the revised stock weights have had no effect on the stock recruitment relationship.

It has also been suggested that the catches of juvenile fish taken in the industrial fishery in the Irish Sea (Division VIIa North) may also have had an effect on the stock recruit relationship. This is because these catches contain an unknown proportion of Celtic Sea recruits and these have never been included in the catch in number at age for the Celtic Sea. The Working Group examined the numbers at age taken in the industrial fishery which were presented in an earlier working group report (ICES 1980 H:4). It was concluded that the numbers, although substantial in some years, were unlikely to have had any major effect on the Celtic Sea recruitment. The data are shown in Figure4.7.1. However it was decided to examine the stock recruitment relationship over the period after the industrial fishery ceased and when the Celtic Sea stock had recovered after the collapse that cause it’s closure from 1977 to 1982. Accordingly a new stock recruitment plot was calculated over the period 1982 to 1999. This plot is shown in Figure 4.7.2. The F med for this period is very different from that calculated for the earlier period (1958–1997) and was estimated as F = 0.44. This is very similar to the value proposed by the 1998 Working Group of 0.40. This would imply that an Fpa = 0.44 would be appropriate for periods when the stock is high as a result of good recruitments. It would also imply that the biological characteristics of this stock are such that it can withstand higher rates of fishing mortality than other stocks as suggested by earlier working groups. This is partially due to the fact that 50% of the age 1 fish are mature and these spawning fish are not fully selected by the fishery. As the period of low recruitment is strongly correlated with the juvenile fishery in the Irish Sea and appears to be atypical of the 40 years history of the stock the inclusion of this period for the management of the stock in it’s current state seems inappropriate. While a Fpa = 0.44 seems high, an Fpa = 0.29 is rather low and fishing mortalities below this value have only been observed in 3 out of the 40 years time period.

4.8 Management considerations

The most recent assessment, although not as precise as the previous ones, indicates that the stock is currently at a high level. Catches have been stable in recent years and the Fs have decreased to low values for this stock. The present situation in the fishery in which markets are depressed and fishing effort has decreased means that an opportunity now exists to allow the stock to increase and at the same time to effect an improvement in the age composition of the stock. This has already started to improve as indicated in the age structure of the 1999/2000 catches. If this were achieved it would mean that the stock would be in a better position to withstand a reduced recruitment period if it should come about and a consequential severe reduction in catches may not be necessary.

The TAC set for the fishery in recent years has appeared to be appropriate for the state of the stock. Catches at this level can be sustained as long as recruitment remains high. If the recruitment decreases then catches should be reduced to about 16,000 t corresponding to the Fpa = 0.29. The Working Group stresses the importance of obtaining information on recruitment and therefore it is important to evaluate all information that is available from surveys in the area. It is also essential that the acoustic surveys should be maintained and the timing and coverage at which they are carried out should be re-evaluated

Protection of Spawning Grounds

The main Irish fishery takes place on the spawning grounds along the Irish coast. The spawning grounds are well known and are mainly located in shallow inshore waters. In recent years a number of these spawning grounds have come under threat from possible extraction of gravel, dumping of harbour silt and dredge spoil and from the location of fish farms. It is extremely important for the survival of the stock that these spawning grounds are adequately protected.

The Working Group therefore recommends that gravel extraction or dumping of dredge spoils or silt or the location of fish farms should not be permitted in areas that are known to contain herring spawning grounds.

Table 4.2.1 Celtic Sea and Division VIIj herring landings by calendar year (t), 1988–1999. (Data provided by Working Group members.)

These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400	-	-2,600	700	18,800
1998	+	-	19,300	1,200	-	-200	0	20,300
1999[1]		200	17,900	1300	+	-1300	0	18,100

[1] Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989–1999/2000. (Data provided by Working Group members. 1998/99 figures are preliminary.).
These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	0	20,500
1998/1999	+	-	17,700	1,200	-	-700	-0	18,200
1999/2000[1]		200	18,300	1300	+	-1300	0	18,500

[1] Preliminary

Table 4.2.3 Celtic Sea, Division VIIj (1999–2000). Sampling intensity of commercial catches.

Country		Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t	Estimates of discards
Ireland	Q 4	10,030	35	1196	6648	119	No
	Q 1	8,225	31	595	5684	72	No
Netherlands	Q3	1,300	0	0	0	0	No

Table 4.4.1 Total stock numbers at age (10^6) estimated using combined acoustic surveys estimates from November and January and July 1999 and February 2000

W.Rs	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996*	1998*	July1999	Jan 2000
0	204.8	213.8	141.8	258.8	41.3	5.1	2.8	-	13.2	-
1	131.6	62.6	426.9	217.1	38.0	279.5	133.6	21.43	397.6	22.87
2	249.0	195.2	117.0	437.9	127.2	550.7	757.0	157.13	207.6	96.6
3	108.6	94.7	87.8	58.7	160.3	138.4	249.9	149.62	48.2	85.13
4	152.5	54.0	49.6	63.4	10.5	93.5	50.6	201.48	8.0	16.25
5	32.4	84.8	22.2	26.0	10.6	7.9	41.9	108.53	0.9	21.37
6	14.9	22.1	24.2	16.3	6.5	9.2	1.1	31.71	1.2	7.65
7	6.1	5.3	9.6	24.6	1.6	8.4	14.2	29.80	0.1	1.61
8	2.5	6.1	1.8	2.3	2.6	9.2	0.5	3.95	0.1	0.86
9+	1.5	-	1.1	1.7	0.5	4.7	1.8	1.28	0.0	0.04
Total	903.9	738.6	882.0	1,106.8	399.1	1106.5	1,253.4	704.9	676.9	252.38
TSB (000't)	103.0	84.4	88.5	104.0	51.8	134.6	151.3	110.9	58.0	29,7
SSB (000't)	91.0	77.0	71.0	90.0	50.6	114.0	145.8	110.5	22.5	26,2

* November survey only, likely to be an underestimate of stock size.

Table 4.4.2 Herring in the Celtic Sea & VIIj

Output Generated by ICA Version 1.4

Herring Celtic VIIj (run: ICACJK14/I14)

Catch in Number

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	1.64	1.20	2.84	2.13	0.77	0.30	7.53	0.06
2	3.74	25.72	72.25	16.06	18.57	51.94	15.06	70.25
3	33.09	2.27	24.66	32.04	19.91	13.03	17.25	9.37
4	25.75	19.26	3.78	5.63	48.06	4.18	6.66	15.76
5	12.55	11.02	13.70	2.03	8.07	20.69	1.72	3.40
6	23.95	5.83	4.43	5.07	3.58	2.69	8.72	4.54
7	16.09	17.82	6.10	2.83	8.59	1.39	1.30	12.13
8	9.38	3.75	4.38	1.52	3.81	2.49	0.58	1.38
9	5.58	7.35	4.15	4.95	5.32	2.79	2.19	7.49

x 10 ^ 6

Catch in Number

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	7.09	7.60	12.20	9.47	1.32	12.66	8.42	23.55
2	19.56	39.99	54.79	93.28	37.26	23.31	137.69	38.13
3	59.89	20.06	39.60	55.04	50.09	37.56	17.86	55.80
4	9.92	49.11	11.54	33.15	26.48	41.90	15.84	7.01
5	13.21	9.22	22.60	12.22	18.76	18.76	14.53	9.65
6	5.60	9.44	4.93	17.84	7.85	10.44	4.64	5.32
7	3.59	3.94	4.17	4.76	6.35	4.28	3.01	3.35
8	8.75	6.51	1.31	2.17	2.17	4.94	2.37	2.33
9	3.84	6.76	4.94	3.47	3.37	2.24	1.02	1.21

x 10 ^ 6

Catch in Number

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	5.51	12.77	13.32	8.16	2.80	11.34	7.16	39.36
2	42.81	15.43	11.11	12.52	13.38	13.91	30.09	21.29
3	17.18	17.78	7.29	8.61	11.95	12.40	11.73	21.86
4	22.53	7.33	7.01	5.28	5.58	8.64	6.58	5.50
5	4.22	9.01	2.87	1.58	1.58	2.89	2.81	4.44
6	3.74	3.52	4.79	1.90	1.48	1.32	2.20	3.44
7	2.98	1.64	1.98	1.04	0.54	1.28	1.18	0.80
8	0.90	1.14	1.24	0.38	0.86	0.55	1.26	0.31
9	0.83	1.19	1.77	0.47	0.48	0.64	0.56	0.87

x 10 ^ 6

Catch in Number

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	15.34	13.54	19.52	17.92	4.16	5.98	2.31	8.26
2	42.73	102.87	92.89	57.05	56.75	67.00	82.03	42.41
3	8.73	26.99	41.12	36.26	42.88	43.08	30.96	68.40
4	4.82	3.23	16.04	16.03	32.93	23.01	9.40	19.60
5	1.50	1.86	2.45	2.31	8.79	14.32	5.96	8.21
6	1.89	0.33	1.08	0.23	1.13	2.72	3.05	3.84
7	1.67	0.37	0.38	0.09	0.10	1.18	0.87	2.59
8	0.34	0.93	0.23	0.17	0.03	0.30	0.30	0.77
9	0.60	0.31	0.18	0.13	0.01	0.46	0.09	0.68

x 10 ^ 6

Table 4.4.2 (Cont'd)

Catch in Number

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	2.70	1.91	10.41	1.61	12.13	9.45	3.48	3.85
2	41.76	63.85	26.75	94.06	35.77	79.16	61.92	37.44
3	24.63	38.34	35.02	9.37	61.74	22.59	38.24	53.04
4	35.26	16.92	27.59	10.22	3.29	36.54	7.94	31.44
5	8.12	28.41	10.14	4.49	3.02	3.69	16.11	8.32
6	3.81	4.87	18.06	2.79	4.77	3.42	2.08	6.14
7	1.67	2.59	3.02	5.93	1.71	2.65	1.59	1.15
8	0.69	0.95	6.29	0.85	1.71	1.86	1.51	0.83
9	0.46	0.59	0.69	0.51	0.47	0.84	1.02	0.60

x 10 ^ 6

Catch in Number

AGE	1998	1999
1	5.82	14.27
2	41.51	34.07
3	27.10	36.09
4	28.27	14.64
5	13.18	15.52
6	3.75	8.88
7	2.67	1.86
8	0.60	2.01
9	0.39	0.55

x 10 ^ 6

Predicted Catch in Number

AGE	1993	1994	1995	1996	1997	1998	1999
1	3268.	7397.	10072.	3813.	4262.	3622.	14274.
2	69564.	29854.	95303.	79917.	40980.	37663.	35726.
3	9990.	43772.	26702.	50734.	60480.	25550.	27042.
4	8591.	4687.	29445.	10493.	28888.	28297.	13910.
5	6711.	4081.	3202.	11730.	6044.	13643.	15510.
6	3597.	3838.	3333.	1541.	8108.	3437.	8983.
7	4349.	1798.	2750.	1397.	934.	4035.	1987.
8	855.	2325.	1374.	1234.	904.	497.	2496.

x 10 ^ 3

Weights at age in the catches (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.09600	0.08700	0.09300	0.09800	0.10900	0.10300	0.10500	0.10300
2	0.11500	0.11900	0.12200	0.12700	0.14600	0.13900	0.13900	0.14300
3	0.16200	0.16600	0.15600	0.15600	0.17000	0.19400	0.18200	0.18000
4	0.18500	0.18500	0.19100	0.18500	0.18700	0.20500	0.21500	0.21200
5	0.20500	0.20000	0.20500	0.20700	0.21000	0.21700	0.22500	0.23200
6	0.21700	0.21000	0.20700	0.21200	0.22700	0.23000	0.23000	0.24300
7	0.22700	0.21700	0.22000	0.22000	0.23200	0.23700	0.23700	0.24300
8	0.23200	0.23000	0.22500	0.23500	0.23700	0.24500	0.24500	0.25600
9	0.23000	0.23100	0.23900	0.23500	0.24000	0.25100	0.25300	0.26000

Weights at age in the catches (Kg)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.12200	0.11900	0.11900	0.12200	0.12800	0.11700	0.13200	0.12500
2	0.15400	0.15800	0.16600	0.16400	0.16200	0.16600	0.17000	0.17400
3	0.19100	0.18500	0.19600	0.20000	0.20000	0.20000	0.19400	0.20500
4	0.21200	0.21700	0.21500	0.21700	0.22500	0.22500	0.22000	0.21500
5	0.23700	0.24300	0.23500	0.23700	0.24000	0.24500	0.24500	0.24500
6	0.24800	0.25100	0.24800	0.24500	0.25300	0.25300	0.25900	0.26200
7	0.24000	0.25600	0.25600	0.26400	0.26400	0.26200	0.26400	0.26200
8	0.25300	0.25900	0.26200	0.26400	0.27600	0.26700	0.27000	0.28500

AGE								
9	0.25700	0.26400	0.26600	0.26200	0.27200	0.28300	0.28500	0.28500

Table 4.4.2 (Cont'd)

Weights at age in the catches (Kg)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.14100	0.13700	0.13700	0.13400	0.12700	0.12700	0.11700	0.11500
2	0.18000	0.18700	0.17400	0.18500	0.18900	0.17400	0.17400	0.17200
3	0.21000	0.21500	0.20500	0.21200	0.21700	0.21200	0.20700	0.21000
4	0.22500	0.24000	0.23500	0.22200	0.24000	0.23000	0.23700	0.24500
5	0.23700	0.25100	0.25900	0.24300	0.27900	0.25300	0.25900	0.26700
6	0.25900	0.26000	0.27000	0.26700	0.27600	0.27300	0.27600	0.27600
7	0.26200	0.27000	0.27900	0.25900	0.29100	0.29100	0.27000	0.29700
8	0.28800	0.27900	0.28800	0.29200	0.29700	0.27900	0.27000	0.30900
9	0.27000	0.28400	0.29300	0.29800	0.30200	0.28400	0.27500	0.31500

Weights at age in the catches (Kg)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.11500	0.10900	0.09300	0.10400	0.11200	0.09600	0.09700	0.10600
2	0.15400	0.14800	0.14200	0.14000	0.15500	0.13800	0.13200	0.12900
3	0.19400	0.19800	0.18500	0.17000	0.17200	0.18600	0.16800	0.15100
4	0.23700	0.22000	0.21300	0.20100	0.18700	0.19200	0.20300	0.16900
5	0.26200	0.27600	0.21300	0.23400	0.21500	0.20400	0.20900	0.19400
6	0.27300	0.28200	0.24500	0.24800	0.24800	0.23100	0.21500	0.19900
7	0.27900	0.27600	0.24600	0.25600	0.27600	0.25500	0.23700	0.21000
8	0.28800	0.31900	0.26300	0.26000	0.28400	0.26700	0.25700	0.22100
9	0.29300	0.32500	0.26200	0.26300	0.33200	0.28400	0.28300	0.24000

Weights at age in the catches (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.09900	0.09200	0.09600	0.09200	0.09700	0.08800	0.08800	0.09300
2	0.13700	0.12800	0.12300	0.12900	0.13500	0.12600	0.11800	0.12400
3	0.15300	0.16800	0.15000	0.15500	0.16800	0.15100	0.14700	0.14100
4	0.16700	0.18200	0.17700	0.18000	0.17900	0.17800	0.15900	0.15700
5	0.18800	0.19000	0.19100	0.20100	0.19000	0.18800	0.18500	0.17200
6	0.20800	0.20600	0.19400	0.20400	0.21000	0.19800	0.19600	0.19200
7	0.20900	0.22900	0.21200	0.21000	0.21800	0.20700	0.20700	0.20600
8	0.22900	0.23600	0.22800	0.22500	0.21700	0.22700	0.21900	0.21600
9	0.25100	0.25100	0.24800	0.24000	0.22700	0.22700	0.23100	0.22000

Weights at age in the catches (Kg)

AGE	1998	1999
1	0.09900	0.09000
2	0.12100	0.12000
3	0.15300	0.14900
4	0.16300	0.16700
5	0.17300	0.18000
6	0.18500	0.18300
7	0.19900	0.20200
8	0.20400	0.20900
9	0.22500	0.20800

Weights at age in the stock (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.09600	0.08700	0.09300	0.09800	0.10900	0.10300	0.10500	0.10300
2	0.11500	0.11900	0.12200	0.12700	0.14600	0.13900	0.13900	0.14300
3	0.16200	0.16600	0.15600	0.15600	0.17000	0.19400	0.18200	0.18000
4	0.18500	0.18500	0.19100	0.18500	0.18700	0.20500	0.21500	0.21200
5	0.20500	0.20000	0.20500	0.20700	0.21000	0.21700	0.22500	0.23200
6	0.21700	0.21000	0.20700	0.21200	0.22700	0.23000	0.23000	0.24300
7	0.22700	0.21700	0.22000	0.22000	0.23200	0.23700	0.23700	0.24300
8	0.23200	0.23000	0.22500	0.23500	0.23700	0.24500	0.24500	0.25600

9	0.23000	0.23100	0.23900	0.23500	0.24000	0.25100	0.25300	0.26000

Table 4.4.2 (Cont'd)

Weights at age in the stock (Kg)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.12200	0.11900	0.11900	0.12200	0.12800	0.11700	0.13200	0.12500
2	0.15400	0.15800	0.16600	0.16400	0.16200	0.16600	0.17000	0.17400
3	0.19100	0.18500	0.19600	0.20000	0.20000	0.20000	0.19400	0.20500
4	0.21200	0.21700	0.21500	0.21700	0.22500	0.22500	0.22000	0.21500
5	0.23700	0.24300	0.23500	0.23700	0.24000	0.24500	0.24500	0.24500
6	0.24800	0.25100	0.24800	0.24500	0.25300	0.25300	0.25900	0.26200
7	0.24000	0.25600	0.25600	0.26400	0.26400	0.26200	0.26400	0.26200
8	0.25300	0.25900	0.26200	0.26400	0.27600	0.26700	0.27000	0.28500
9	0.25700	0.26400	0.26600	0.26200	0.27200	0.28300	0.28500	0.28500

Weights at age in the stock (Kg)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.14100	0.13700	0.13700	0.13400	0.12700	0.12700	0.11700	0.11500
2	0.18000	0.18700	0.17400	0.18500	0.18900	0.17400	0.17400	0.17200
3	0.21000	0.21500	0.20500	0.21200	0.21700	0.21200	0.20700	0.21000
4	0.22500	0.24000	0.23500	0.22200	0.24000	0.23000	0.23700	0.24500
5	0.23700	0.25100	0.25900	0.24300	0.27900	0.25300	0.25900	0.26700
6	0.25900	0.26000	0.27000	0.26700	0.27600	0.27300	0.27600	0.27600
7	0.26200	0.27000	0.27900	0.25900	0.29100	0.29100	0.27000	0.29700
8	0.28800	0.27900	0.28800	0.29200	0.29700	0.27900	0.27000	0.30900
9	0.27000	0.28400	0.29300	0.29800	0.30200	0.28400	0.27500	0.31500

Weights at age in the stock (Kg)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.11500	0.10900	0.09300	0.10400	0.11200	0.09600	0.09700	0.10600
2	0.15400	0.14800	0.14200	0.14000	0.15500	0.13800	0.13200	0.12900
3	0.19400	0.19800	0.18500	0.17000	0.17200	0.18600	0.16800	0.15100
4	0.23700	0.22000	0.21300	0.20100	0.18700	0.19200	0.20300	0.16900
5	0.26200	0.27600	0.21300	0.23400	0.21500	0.20400	0.20900	0.19400
6	0.27300	0.28200	0.24500	0.24800	0.24800	0.23100	0.21500	0.19900
7	0.27900	0.27600	0.24600	0.25600	0.27600	0.25500	0.23700	0.21000
8	0.28800	0.31900	0.26300	0.26000	0.28400	0.26700	0.25700	0.22100
9	0.29300	0.32500	0.26200	0.26300	0.33200	0.28400	0.28300	0.24000

Weights at age in the stock (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.09900	0.09200	0.09600	0.09200	0.09700	0.08800	0.08800	0.09300
2	0.13700	0.12800	0.12300	0.12900	0.13500	0.12600	0.11800	0.12400
3	0.15300	0.16800	0.15000	0.15500	0.16800	0.15100	0.14700	0.14100
4	0.16700	0.18200	0.17700	0.18000	0.17900	0.17800	0.15900	0.15700
5	0.18800	0.19000	0.19100	0.20100	0.19000	0.18800	0.18500	0.17200
6	0.20800	0.20600	0.19400	0.20400	0.21000	0.19800	0.19600	0.19200
7	0.20900	0.22900	0.21200	0.21000	0.21800	0.20700	0.20700	0.20600
8	0.22900	0.23600	0.22800	0.22500	0.21700	0.22700	0.21900	0.21600
9	0.25100	0.25100	0.24800	0.24000	0.22700	0.22700	0.23100	0.22000

Weights at age in the stock (Kg)

AGE	1998	1999
1	0.09900	0.09000
2	0.12100	0.12000
3	0.15300	0.14900
4	0.16300	0.16700
5	0.17300	0.18000
6	0.18500	0.18300
7	0.19900	0.20200
8	0.20400	0.20900

9	0.22500 0.20800

Table 4.4.2 (Cont'd)

Natural Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 4.4.2 (Cont'd)

Natural Mortality (per year)

AGE	1998	1999
1	1.0000	1.0000
2	0.3000	0.3000
3	0.2000	0.2000
4	0.1000	0.1000
5	0.1000	0.1000
6	0.1000	0.1000
7	0.1000	0.1000
8	0.1000	0.1000
9	0.1000	0.1000

Proportion of fish spawning

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.4.2 (Cont'd)

Proportion of fish spawning

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1998	1999
1	0.5000	0.5000
2	1.0000	1.0000
3	1.0000	1.0000
4	1.0000	1.0000
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000

AGE-STRUCTURED INDICES

FLT02: celtic combined acc data (Catch:

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	249.00	195.20	117.00	437.90	127.20	550.70	757.00	*******
3	108.60	94.70	87.80	58.70	160.30	138.40	249.90	*******
4	152.50	54.00	49.60	63.40	10.50	93.50	50.60	*******
5	32.40	84.80	22.20	26.00	10.60	7.90	41.90	*******

FLT02: celtic combined acc data (Catch:

AGE	1998	1999
2	157.13	*******
3	149.62	*******
4	201.48	*******
5	108.53	*******

Weighting factors for the catches in number

AGE	1993	1994	1995	1996	1997	1998	1999
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.4.2 (Cont'd)

Predicted Age-Structured Index Values

FLT02: celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	288.74	186.62	79.17	383.57	191.11	447.87	517.06	*******
3	122.20	149.67	70.28	42.40	217.50	95.62	254.94	*******
4	165.44	54.59	50.60	34.10	21.75	98.75	49.24	*******
5	24.38	69.21	21.31	25.14	17.83	10.17	51.81	*******

FLT02: celtic combined acc data (Catch: Predicted

AGE	1998	1999
2	286.57	*******
3	152.19	*******
4	157.23	*******
5	71.15	*******

Table 4.4.3 Herring in the Celtic Sea & VIIj

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 7	SoP (%)
1958	320460	105393	72898	22978	0.3152	0.4528	89
1959	1007850	146559	77172	15086	0.1955	0.3760	88
1960	325420	112036	77719	18283	0.2352	0.3750	88
1961	244030	97025	71362	15372	0.2154	0.1957	128
1962	486370	123901	76669	21552	0.2811	0.4385	98
1963	275700	99783	69898	17349	0.2482	0.2925	99
1964	1025660	170958	88568	10599	0.1197	0.1823	97
1965	360710	147887	106365	19126	0.1798	0.2468	86
1966	649430	178112	108507	27030	0.2491	0.3324	103
1967	682710	183458	110699	27658	0.2498	0.4744	90
1968	842110	205731	119099	30236	0.2539	0.3948	100
1969	450650	172152	111702	44389	0.3974	0.5599	99
1970	238770	122260	85163	31727	0.3725	0.5211	99
1971	869850	168779	84158	31396	0.3731	0.7381	96
1972	270530	118782	75171	38203	0.5082	0.6472	100
1973	311770	93947	54708	26936	0.4924	0.7291	95
1974	136580	62579	39938	19940	0.4993	0.6977	97
1975	152010	50349	29804	15588	0.5230	0.6434	107
1976	205740	51295	27224	9771	0.3589	0.6643	94
1977	173570	48294	27785	7833	0.2819	0.4468	100
1978	134750	44773	28237	7559	0.2677	0.3931	91
1979	237360	54783	29238	10321	0.3530	0.5053	100
1980	145790	45007	27312	13130	0.4807	0.7332	107
1981	409230	70129	31231	17103	0.5476	0.8681	101
1982	660320	104420	45248	13000	0.2873	0.7719	101
1983	731920	129948	62404	24981	0.4003	0.6457	104
1984	566970	112436	62033	26779	0.4317	1.0381	99
1985	582790	116661	63842	20426	0.3199	0.4949	102
1986	535590	124500	69761	25024	0.3587	0.5412	100
1987	1040970	161372	78876	26200	0.3322	0.7198	99
1988	416120	120666	78810	20447	0.2594	0.3906	100
1989	518900	123789	73492	23254	0.3164	0.5212	100
1990	453280	110931	69357	18404	0.2653	0.3949	99
1991	188710	82828	58691	25562	0.4355	0.5065	101
1992	909270	129560	59776	21127	0.3534	0.7663	95
1993	352260	92995	59110	18618	0.3150	0.4477	100
1994	818510	134936	69588	19300	0.2773	0.3945	99
1995	863270	143085	77666	23305	0.3001	0.5074	100
1996	463700	115336	74687	18816	0.2519	0.4061	100
1997	515180	116773	72251	20496	0.2837	0.4317	99
1998	515470	117685	72149	18041	0.2501	0.3431	99
1999	2186140	263814	116667	18485	0.1584	0.3432	99

No of years for separable analysis : 7
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 1999
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 31
Number of observations : 88

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	**1993**	**0.4825**	**14**	**0.3651**	**0.6376**	**0.4185**	**0.5562**	**0.4874**
2	**1994**	**0.4254**	**14**	**0.3231**	**0.5599**	**0.3697**	**0.4894**	**0.4296**
3	**1995**	**0.5505**	**13**	**0.4204**	**0.7210**	**0.4797**	**0.6318**	**0.5558**
4	**1996**	**0.4215**	**15**	**0.3136**	**0.5665**	**0.3625**	**0.4901**	**0.4263**
5	**1997**	**0.4386**	**17**	**0.3134**	**0.6138**	**0.3695**	**0.5206**	**0.4451**
6	**1998**	**0.3665**	**20**	**0.2447**	**0.5488**	**0.2983**	**0.4503**	**0.3743**
7	**1999**	**0.3381**	**27**	**0.1979**	**0.5779**	**0.2573**	**0.4445**	**0.3510**

Table 4.4.3 (Cont'd)

Separable Model: Selection (S) by age

8	1	0.0307	37	0.0146	0.0644	0.0210	0.0448	0.0330
9	2	0.7372	15	0.5472	0.9932	0.6332	0.8583	0.7458
	3	1.0000		Fixed : Reference Age				
10	4	0.9768	13	0.7458	1.2793	0.8512	1.1209	0.9861
11	5	0.8940	13	0.6914	1.1558	0.7841	1.0192	0.9017
12	6	0.9802	12	0.7662	1.2539	0.8644	1.1114	0.9879
13	7	0.9562	12	0.7435	1.2298	0.8410	1.0872	0.9641
	8	1.0000		Fixed : Last true age				

Separable model: Populations in year 1999

14	1	2186139	99	313427	15248211	811521	5889195	3572122
15	2	186251	36	91213	380310	129394	268091	199024
16	3	103409	24	64052	166948	80988	132036	106543
17	4	51821	23	32723	82065	40987	65519	53266
18	5	62319	22	40158	96709	49803	77982	63905
19	6	33369	21	21739	51220	26816	41523	34176
20	7	7537	23	4739	11986	5948	9550	7751
21	8	9114	24	5639	14732	7134	11644	9392

Separable model: Populations at age

22	1993	2337	29	1302	4194	1734	3149	2443
23	1994	7026	23	4431	11143	5554	8890	7224
24	1995	3393	20	2260	5093	2758	4174	3467
25	1996	3757	19	2551	5533	3083	4577	3831
26	1997	2666	19	1820	3904	2194	3239	2717
27	1998	1697	21	1111	2592	1367	2106	1737

Age-structured index catchabilities

FLT02: celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

28	2	Q	.2771E-02	13	.2429E-02	.4159E-02	.2771E-02	.3646E-02	.3209E-02
29	3	Q	.2937E-02	13	.2573E-02	.4417E-02	.2937E-02	.3869E-02	.3403E-02
30	4	Q	.2523E-02	13	.2208E-02	.3807E-02	.2523E-02	.3332E-02	.2927E-02
31	5	Q	.2132E-02	14	.1863E-02	.3232E-02	.2132E-02	.2824E-02	.2478E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1993	1994	1995	1996	1997	1998	1999
1	-0.7091	0.4947	-0.0637	-0.0926	-0.1019	0.4739	0.0000
2	0.3017	0.1807	-0.1856	-0.2551	-0.0903	0.0973	-0.0474
3	-0.0638	0.3439	-0.1672	-0.2826	-0.1313	0.0590	0.2885
4	0.1737	-0.3543	0.2159	-0.2784	0.0847	-0.0008	0.0513
5	-0.4016	-0.2995	0.1407	0.3175	0.3194	-0.0346	0.0003
6	-0.2541	0.2179	0.0258	0.2983	-0.2777	0.0861	-0.0119
7	0.3103	-0.0484	-0.0368	0.1269	0.2064	-0.4111	-0.0635
8	0.0000	-0.3103	0.3025	0.1995	-0.0895	0.1825	-0.2155

AGE-STRUCTURED INDEX RESIDUALS

FLT02: celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.1481	0.0450	0.3906	0.1325	-0.4071	0.2067	0.3812	*******
3	-0.1180	-0.4577	0.2226	0.3253	-0.3052	0.3698	-0.0200	*******
4	-0.0815	-0.0109	-0.0200	0.6201	-0.7284	-0.0546	0.0272	*******
5	0.2845	0.2031	0.0411	0.0336	-0.5199	-0.2525	-0.2122	*******

Table 4.4.3 (Cont'd)

```
FLT02: celtic combined acc data (Catch:
        ---------------------------------------
------+----------------
Age   |    1998    1999
------+----------------
  2   | -0.6009 *******
  3   | -0.0171 *******
  4   |  0.2480 *******
  5   |  0.4222 *******
------+----------------

  PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------

 Separable model fitted from 1993  to 1999
 Variance                           0.0819
Skewness test stat.                -0.3828
Kurtosis test statistic            -1.4007
Partial chi-square                  0.2717
Significance in fit                 0.0000
Degrees of freedom                      29


 PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
 ------------------------------------------------------------
DISTRIBUTION STATISTICS FOR FLT02: celtic combined acc data (Catch:
Linear catchability relationship assumed
 Age                        2         3         4         5
 Variance              0.0812    0.0544    0.0882    0.0609
Skewness test stat.   -0.6086   -0.2056   -0.4441   -0.3444
Kurtosis test statisti -0.5866  -0.6733    0.3199   -0.5497
Partial chi-square     0.1048    0.0825    0.1848    0.1316
Significance in fit    0.0000    0.0000    0.0000    0.0000
Number of observations      8         8         8         8
Degrees of freedom          7         7         7         7
Weight in the analysis 0.6250    0.6250    0.6250    0.6250

 ANALYSIS OF VARIANCE
-------------------------
Unweighted Statistics

Variance
                                        SSQ     Data    Parameters d.f. Variance
Total for model                        6.4583      88          31   57   0.1133
Catches at age                         3.2702      56          27   29   0.1128

 Aged Indices
FLT02: celtic combined acc data (Catch 3.1881      32           4   28   0.1139


 Weighted Statistics
Variance
                                        SSQ     Data    Parameters d.f. Variance
Total for model                        3.6199      88          31   57   0.0635
Catches at age                         2.3746      56          27   29   0.0819

 Aged Indices
FLT02: celtic combined acc data (Catch 1.2454      32           4   28   0.0445

Conventional VPA with Fishing Mortality Shrinkage
Fs shrunk over    4 years
Minimum CV of the mean taken as   0.20000

 Shrinkage Diagnostics
 F from model fit    Historic Mean F                          Shrunk estimate
Estimate  Variance  Estimate  Variance  Wt for F from Model
   0.010     0.218     0.012     0.040          0.155             0.012
   0.249     0.084     0.287     0.040          0.322             0.274
   0.338     0.075     0.389     0.040          0.349             0.370
   0.330     0.080     0.380     0.040          0.334             0.363
   0.302     0.080     0.348     0.040          0.332             0.332
   0.331     0.082     0.381     0.040          0.328             0.364
   0.323     0.084     0.372     0.040          0.322             0.356
   0.338     0.075     0.389     0.040          0.349             0.373
   *****     0.908     0.389     0.040          0.042             0.373
```

Table 4.4.3 (Cont'd)

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.0081	0.0019	0.0139	0.0139	0.0025	0.0017	0.0117	0.0003	0.0174	0.0177	0.0231	0.0337	0.0088	0.0232	0.0503
2	0.1265	0.2913	0.2543	0.1705	0.2758	0.4056	0.1879	0.2442	0.1862	0.2183	0.2946	0.4352	0.3106	0.3669	0.6953
3	0.3529	0.1115	0.5388	0.1813	0.3511	0.3386	0.2422	0.1812	0.3617	0.3146	0.3719	0.5829	0.4745	0.6371	0.5738
4	0.5161	0.3388	0.2588	0.2120	0.4256	0.1089	0.2748	0.3446	0.2811	0.5385	0.2852	0.5783	0.5888	0.8947	0.5792
5	0.4309	0.3852	0.3811	0.1934	0.4674	0.2913	0.0538	0.1967	0.4794	0.4048	0.4511	0.4867	0.6724	0.9828	0.8092
6	0.5152	0.3240	0.2347	0.2106	0.5349	0.2478	0.1715	0.1756	0.5025	0.6640	0.3496	0.6856	0.5889	0.8888	0.6142
7	0.7752	0.8050	0.5822	0.2063	0.5763	0.3624	0.1636	0.3386	0.1834	0.7063	0.6165	0.5904	0.4914	0.6584	0.6117
8	0.4480	0.3598	0.4108	0.2470	0.4163	0.2877	0.2236	0.2324	0.3872	0.5156	0.4748	0.6751	0.5216	0.7862	0.8458
9	0.4480	0.3598	0.4108	0.2470	0.4163	0.2877	0.2236	0.2324	0.3872	0.5156	0.4748	0.6751	0.5216	0.7862	0.8458

Fishing Mortality (per year)

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.1259	0.0655	0.1408	0.1070	0.0768	0.0333	0.0780	0.0803	0.1627	0.0373	0.0296	0.0557	0.0496	0.0123	0.0091
2	0.6150	0.6579	0.4702	0.3049	0.2380	0.3011	0.4042	0.5541	0.6726	0.4812	0.6935	0.5210	0.4026	0.3841	0.5002
3	0.7472	0.6823	0.6929	0.4561	0.4393	0.4001	0.5417	0.7739	1.1661	0.7105	0.6983	0.7285	0.4237	0.6521	0.6108
4	0.4402	0.7446	0.6704	0.6187	0.6697	0.5400	0.5355	0.5905	1.0237	0.8512	0.5940	1.2031	0.6720	0.8156	0.8586
5	0.7497	0.4592	0.6709	0.5342	0.2416	0.3800	0.5267	0.2949	0.9113	0.7702	0.8522	1.1337	0.4658	0.8666	0.9297
6	0.7030	0.6502	0.7663	0.8224	0.7233	0.3300	0.5533	0.8747	0.6197	1.2002	0.3300	1.9584	0.2463	0.3867	0.6381
7	1.1198	0.9919	0.5898	1.2494	0.3689	0.4073	0.4703	1.3110	0.8155	0.6181	0.7063	0.6841	0.7590	0.1424	0.7814
8	1.2659	0.9554	1.2509	1.1050	0.7634	0.5194	0.8325	1.0489	1.5620	0.8834	0.7488	1.2093	0.6917	0.5605	0.7105
9	1.2659	0.9554	1.2509	1.1050	0.7634	0.5194	0.8325	1.0489	1.5620	0.8834	0.7488	1.2093	0.6917	0.5605	0.7105

Fishing Mortality (per year)

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0088	0.0255	0.0095	0.0161	0.0183	0.0072	0.0237	0.0174	0.0119	0.0119	0.0180	0.0117
2	0.2856	0.3863	0.2981	0.5817	0.5919	0.3978	0.3838	0.3692	0.2590	0.2946	0.2939	0.2741
3	0.4903	0.4379	0.4358	0.5274	0.8151	0.4565	0.5328	0.4794	0.3267	0.3942	0.3849	0.3705
4	0.2426	0.6300	0.4016	0.5751	0.8728	0.5644	0.2711	0.6658	0.2916	0.4622	0.3577	0.3626
5	0.4952	0.3075	0.5141	0.5787	0.7221	0.2902	0.2859	0.4861	0.6186	0.4964	0.3181	0.3320
6	0.4494	0.6075	0.2044	0.5894	0.7980	0.3899	0.5022	0.5322	0.4940	0.4482	0.3859	0.3642
7	0.3804	0.7582	0.5152	0.1867	0.7977	0.5870	0.3909	0.5115	0.4468	0.4947	0.3181	0.3556
8	0.4033	0.5990	0.4118	0.5536	0.7947	0.4495	0.4777	0.5503	0.4326	0.4549	0.4026	0.3727
9	0.4033	0.5990	0.4118	0.5536	0.7947	0.4495	0.4777	0.5503	0.4326	0.4549	0.4026	0.3727

Population Abundance (1 January)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	320.5	1007.9	325.4	244.0	486.4	275.7	1025.7	360.7	649.4	682.7	842.1	450.7	238.8	869.9	270.5
2	36.3	116.9	370.1	118.1	88.5	178.5	101.3	372.9	132.7	234.8	246.7	302.7	160.3	87.1	312.6
3	122.1	23.7	64.7	212.6	73.8	49.8	88.1	62.2	216.4	81.6	139.8	136.2	145.1	87.0	44.7
4	66.8	70.2	17.4	30.9	145.2	42.5	29.0	56.6	42.5	123.4	48.8	78.9	62.2	73.9	37.7
5	37.5	36.1	45.3	12.1	22.6	85.8	34.5	20.0	36.3	29.0	65.2	33.2	40.1	31.3	27.3
6	62.2	22.1	22.2	28.0	9.1	12.8	58.0	29.6	14.8	20.3	17.5	37.6	18.5	18.5	10.6
7	31.2	33.6	14.4	15.9	20.5	4.8	9.1	44.2	22.5	8.1	9.5	11.2	17.1	9.3	6.9
8	27.2	13.0	13.6	7.3	11.7	10.4	3.0	7.0	28.5	16.9	3.6	4.6	5.6	9.5	4.3
9	16.2	25.5	12.9	23.7	16.4	11.7	11.5	37.9	12.5	17.6	13.7	7.4	8.7	4.3	1.9

x 10 ^ 6

Population Abundance (1 January)

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	311.8	136.6	152.0	205.7	173.6	134.8	237.4	145.8	409.2	660.3	731.9	567.0	582.8	535.6	1041.0
2	94.6	101.1	47.1	48.6	68.0	59.1	47.9	80.8	49.5	127.9	234.0	261.4	197.3	204.0	194.6
3	115.6	37.9	38.8	21.8	26.5	39.7	32.4	23.7	34.4	18.7	58.6	86.7	115.0	97.7	102.9
4	20.6	44.8	15.7	15.9	11.3	14.0	21.8	15.4	9.0	8.8	7.5	23.9	34.2	61.6	41.7
5	19.1	12.0	19.3	7.3	7.7	5.2	7.4	11.5	7.7	2.9	3.4	3.8	6.5	15.8	24.7
6	11.0	8.2	6.9	8.9	3.9	5.5	3.2	3.9	7.8	2.8	1.2	1.3	1.1	3.7	6.0
7	5.2	4.9	3.9	2.9	3.5	1.7	3.6	1.7	1.5	3.8	0.8	0.8	0.2	0.8	2.3
8	3.4	1.5	1.7	1.9	0.7	2.2	1.0	2.0	0.4	0.6	1.8	0.3	0.4	0.1	0.6
9	1.8	1.4	1.7	2.8	0.9	1.2	1.2	0.9	1.1	1.1	0.6	0.3	0.3	0.0	1.0

x 10 ^ 6

Table 4.4.3 (Cont'd)

Population Abundance (1 January)

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	416.1	518.9	453.3	188.7	909.3	352.3	818.5	863.3	463.7	515.2	515.5	2186.1	687.4
2	379.5	151.7	186.1	165.2	68.3	328.5	128.7	294.1	312.1	168.6	187.3	186.3	794.9
3	87.4	211.3	76.4	102.3	68.4	28.0	163.5	64.9	150.6	178.4	93.0	103.4	104.9
4	45.8	43.8	111.6	40.5	49.4	24.8	14.5	78.6	32.9	88.9	98.5	51.8	58.5
5	16.0	32.5	21.1	67.6	20.6	18.7	12.8	10.0	36.5	22.2	50.7	62.3	32.6
6	8.8	8.8	21.6	11.4	34.3	9.1	12.7	8.7	5.6	17.8	12.3	33.4	40.5
7	2.9	5.1	4.3	15.9	5.7	14.0	5.5	6.9	4.6	3.1	10.3	7.5	21.0
8	0.9	1.8	2.2	2.3	12.0	2.3	7.0	3.4	3.8	2.7	1.7	6.8	4.8
9	0.3	1.6	1.4	1.5	1.3	1.5	1.3	2.1	3.1	1.7	1.2	1.9	5.4

x 10 ^ 6

Table 4.6.1

Celic Sea and Division VIIj herring

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	558.200	1.0000	0.5000	0.2000	0.5000	0.092	0.0114	0.092
2	196.300	0.3000	1.0000	0.2000	0.5000	0.122	0.2738	0.122
3	104.900	0.2000	1.0000	0.2000	0.5000	0.148	0.3714	0.148
4	58.500	0.1000	1.0000	0.2000	0.5000	0.165	0.3628	0.165
5	32.600	0.1000	1.0000	0.2000	0.5000	0.180	0.3320	0.180
6	40.500	0.1000	1.0000	0.2000	0.5000	0.191	0.3640	0.191
7	21.000	0.1000	1.0000	0.2000	0.5000	0.204	0.3551	0.204
8	4.800	0.1000	1.0000	0.2000	0.5000	0.215	0.3714	0.215
9+	5.400	0.1000	1.0000	0.2000	0.5000	0.222	0.3714	0.222
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	558.200	1.0000	0.5000	0.2000	0.5000	0.092	0.0114	0.092
2	.	0.3000	1.0000	0.2000	0.5000	0.122	0.2738	0.122
3	.	0.2000	1.0000	0.2000	0.5000	0.148	0.3714	0.148
4	.	0.1000	1.0000	0.2000	0.5000	0.165	0.3628	0.165
5	.	0.1000	1.0000	0.2000	0.5000	0.180	0.3320	0.180
6	.	0.1000	1.0000	0.2000	0.5000	0.191	0.3640	0.191
7	.	0.1000	1.0000	0.2000	0.5000	0.204	0.3551	0.204
8	.	0.1000	1.0000	0.2000	0.5000	0.215	0.3714	0.215
9+	.	0.1000	1.0000	0.2000	0.5000	0.222	0.3714	0.222
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	558.200	1.0000	0.5000	0.2000	0.5000	0.092	0.0114	0.092
2	.	0.3000	1.0000	0.2000	0.5000	0.122	0.2738	0.122
3	.	0.2000	1.0000	0.2000	0.5000	0.148	0.3714	0.148
4	.	0.1000	1.0000	0.2000	0.5000	0.165	0.3628	0.165
5	.	0.1000	1.0000	0.2000	0.5000	0.180	0.3320	0.180
6	.	0.1000	1.0000	0.2000	0.5000	0.191	0.3640	0.191
7	.	0.1000	1.0000	0.2000	0.5000	0.204	0.3551	0.204
8	.	0.1000	1.0000	0.2000	0.5000	0.215	0.3714	0.215
9+	.	0.1000	1.0000	0.2000	0.5000	0.222	0.3714	0.222
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANCJK02
Date and time: 21MAR00:11:15

Table 4.6.2 Celic Sea and Division VIIj herring Single option prediction: Summary table

The SAS System 18:15 Tuesday, March 21, 2000

Celic Sea and Division VIIj herring

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	1.1811	0.4053	139379	21000	1022200	120599	743100	94922	556503	73753
2001	1.2078	0.4145	139990	21000	1018133	119671	739033	93994	551850	72789
2002	1.2300	0.4221	140533	21000	1013142	118669	734042	92991	546793	71806
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK01
Date and time : 21MAR00:18:15
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : TAC constraints

Table 4.6.3 Celic Sea and Division VIIj herring Single option prediction: Detailed tables

The SAS System 18:15 Tuesday, March 21, 2000

Celic Sea and Division VIIj herring

Single option prediction: Detailed tables

Year: 2000	F-factor: 1.1811	Reference F: 0.4053				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0135	4724	435	558200	51354	279100	25677	168827	15532
2	0.3234	47237	5763	196300	23949	196300	23949	158375	19322
3	0.4387	34007	5033	104900	15525	104900	15525	86945	12868
4	0.4285	19471	3213	58500	9653	58500	9653	51077	8428
5	0.3921	10096	1817	32600	5868	32600	5868	28671	5161
6	0.4299	13516	2581	40500	7736	40500	7736	35351	6752
7	0.4194	6870	1401	21000	4284	21000	4284	18369	3747
8	0.4387	1628	350	4800	1032	4800	1032	4182	899
9+	0.4387	1831	407	5400	1199	5400	1199	4705	1045
Total		139379	21000	1022200	120599	743100	94922	556503	73753
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Single option prediction: Detailed tables

(cont.)

Year: 2001	F-factor: 1.2078	Reference F: 0.4145				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0138	4831	444	558200	51354	279100	25677	168817	15531
2	0.3307	49695	6063	202604	24718	202604	24718	163222	19913
3	0.4486	34737	5141	105242	15576	105242	15576	87055	12884
4	0.4382	18769	3097	55387	9139	55387	9139	48265	7964
5	0.4010	10877	1958	34485	6207	34485	6207	30275	5450
6	0.4397	6771	1293	19929	3807	19929	3807	17362	3316
7	0.4289	7941	1620	23841	4863	23841	4863	20814	4246
8	0.4486	4313	927	12492	2686	12492	2686	10863	2336
9+	0.4486	2055	456	5952	1321	5952	1321	5176	1149
Total		139990	21000	1018133	119671	739033	93994	551850	72789
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

(cont.)

Year: 2002	F-factor: 1.2300	Reference F: 0.4221				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0140	4919	453	558200	51354	279100	25677	168809	15530
2	0.3368	50453	6155	202542	24710	202542	24710	162975	19883
3	0.4568	36110	5344	107829	15959	107829	15959	89049	13179
4	0.4462	18917	3121	55019	9078	55019	9078	47867	7898
5	0.4084	10351	1863	32335	5820	32335	5820	28346	5102
6	0.4477	7203	1376	20895	3991	20895	3991	18174	3471
7	0.4368	3927	801	11618	2370	11618	2370	10127	2066
8	0.4568	4921	1058	14048	3020	14048	3020	12196	2622
9+	0.4568	3733	829	10656	2366	10656	2366	9252	2054
Total		140533	21000	1013142	118669	734042	92991	546793	71806
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK01
Date and time : 21MAR00:18:15
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : TAC constraint

Table 4.6.4 Celic Sea and Division VIIj herring Prediction with management option table

12:02 Thursday, March 23, 2000

Celic Sea and Division VIIj herring

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.1811	0.4053	120599	73753	21000	0.6000	0.2059	119671	75161	11438	128272	82831
.	.	.	.	.	0.6500	0.2231	.	74962	12296	127407	81832
.	.	.	.	.	0.7000	0.2402	.	74764	13140	126557	80853
.	.	.	.	.	0.7500	0.2574	.	74567	13972	125720	79891
.	.	.	.	.	0.8000	0.2745	.	74370	14790	124898	78948
.	.	.	.	.	0.8500	0.2917	.	74174	15595	124088	78023
.	.	.	.	.	0.9000	0.3089	.	73978	16387	123292	77115
.	.	.	.	.	0.9500	0.3260	.	73783	17167	122509	76224
.	.	.	.	.	1.0000	0.3432	.	73589	17935	121739	75350
.	.	.	.	.	1.0500	0.3603	.	73395	18691	120981	74492
.	.	.	.	.	1.1000	0.3775	.	73202	19435	120235	73651
.	.	.	.	.	1.1500	0.3947	.	73010	20167	119502	72825
.	.	.	.	.	1.2000	0.4118	.	72819	20888	118781	72015
.	.	.	.	.	1.2500	0.4290	.	72628	21597	118071	71220
.	.	.	.	.	1.3000	0.4461	.	72437	22296	117373	70440
.	.	.	.	.	1.3500	0.4633	.	72247	22984	116686	69674
.	.	.	.	.	1.4000	0.4805	.	72058	23661	116011	68922
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCJK02
Date and time : 23MAR00:17:19
Computation of ref. F: Simple mean, age 2 - 7
Basis for 2000 : TAC constraints

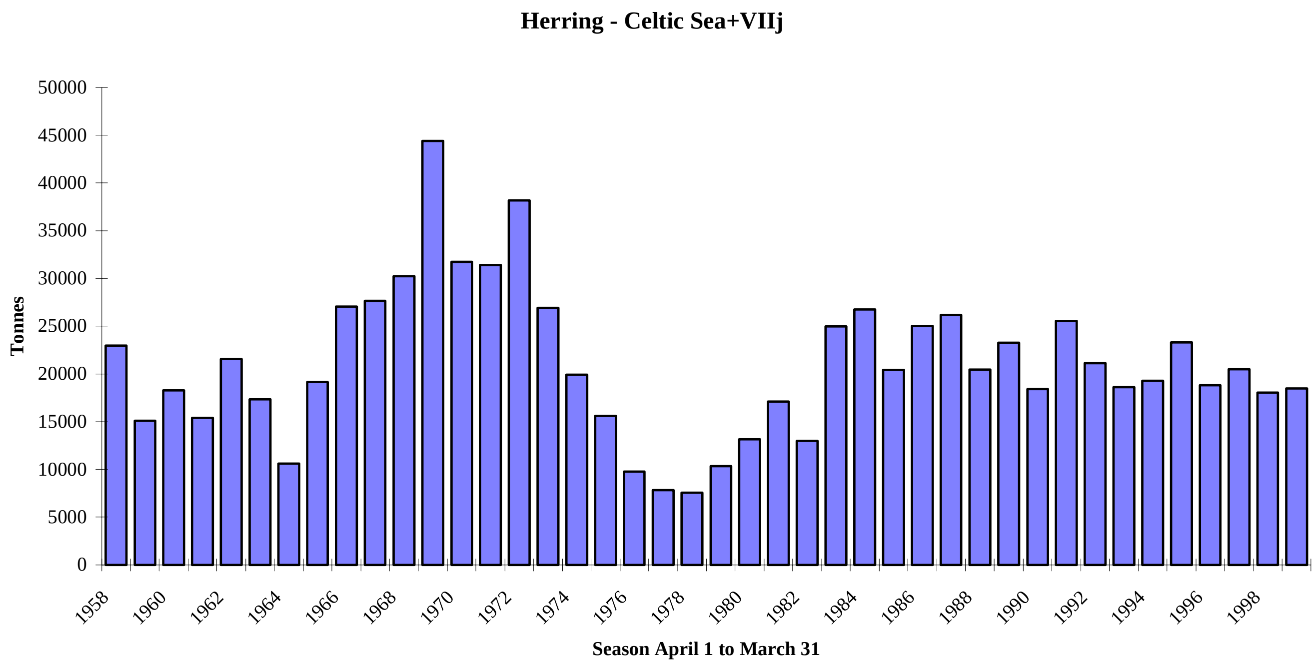


Figure 4.2.1. Herring catches in Celtic Sea and Division VIIj: 1958-1999

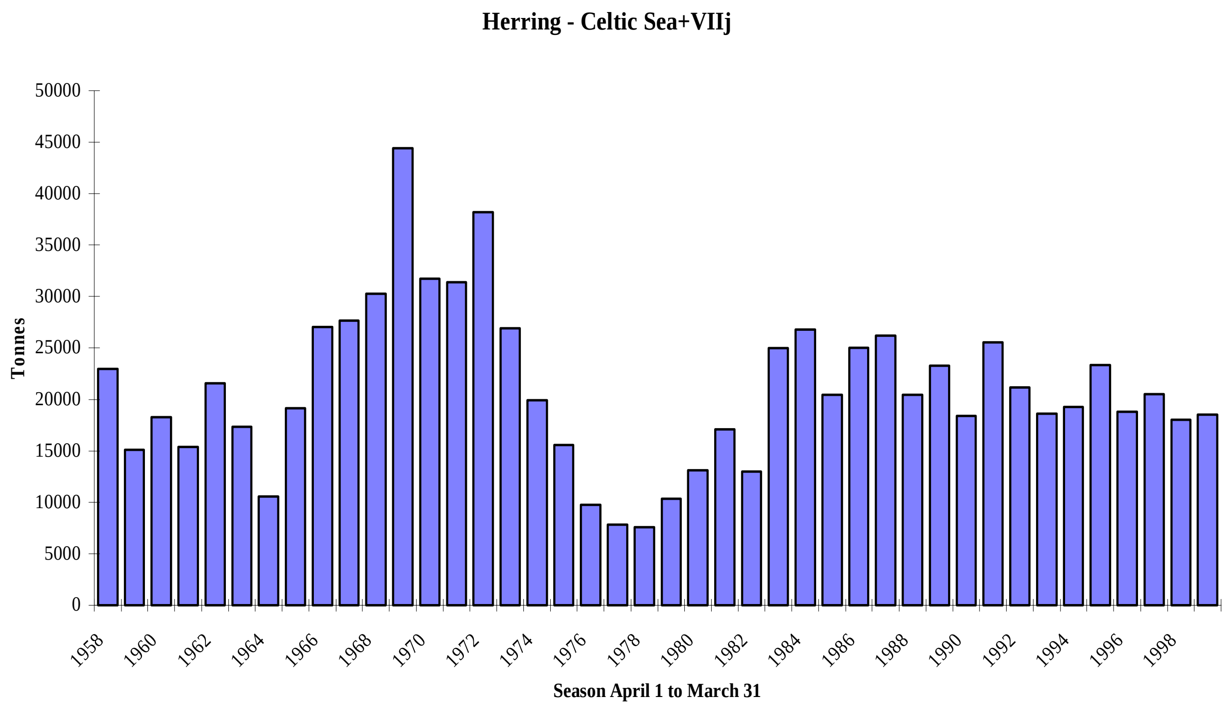


Figure 4.2.2. Herring catches in Celtic Sea and Division VIIj: 1958-1999

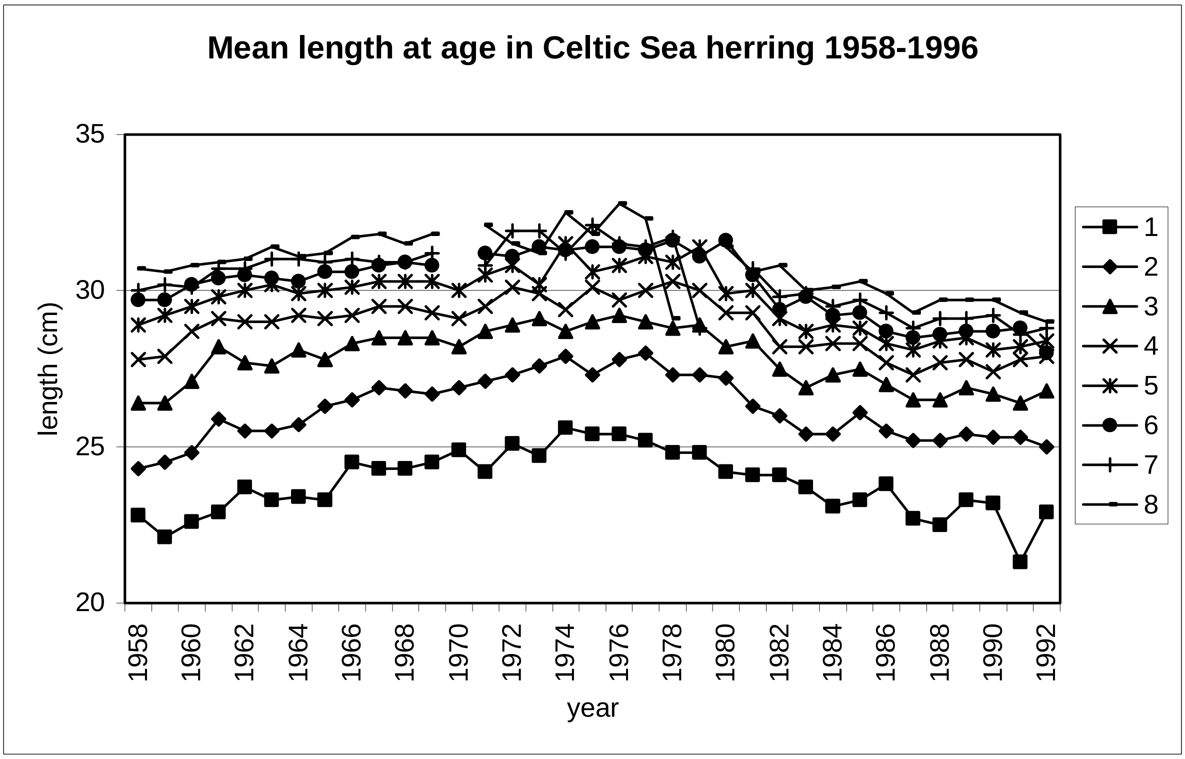
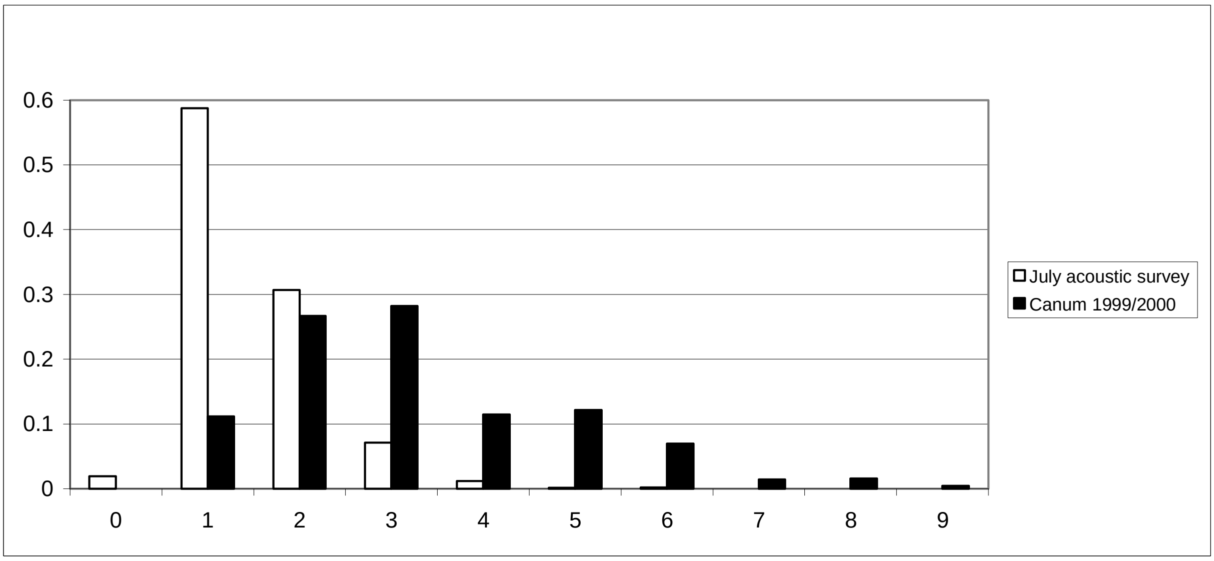


Figure 4.3.1 Plot showing increase in mean length at age in Celtic Sea herring during the increase in growth rate during the seventies.

Figure 4.4.1 Plot showing comparison between age distribution of sampled fish from the July 1999 acoustic survey and the catch in Q4



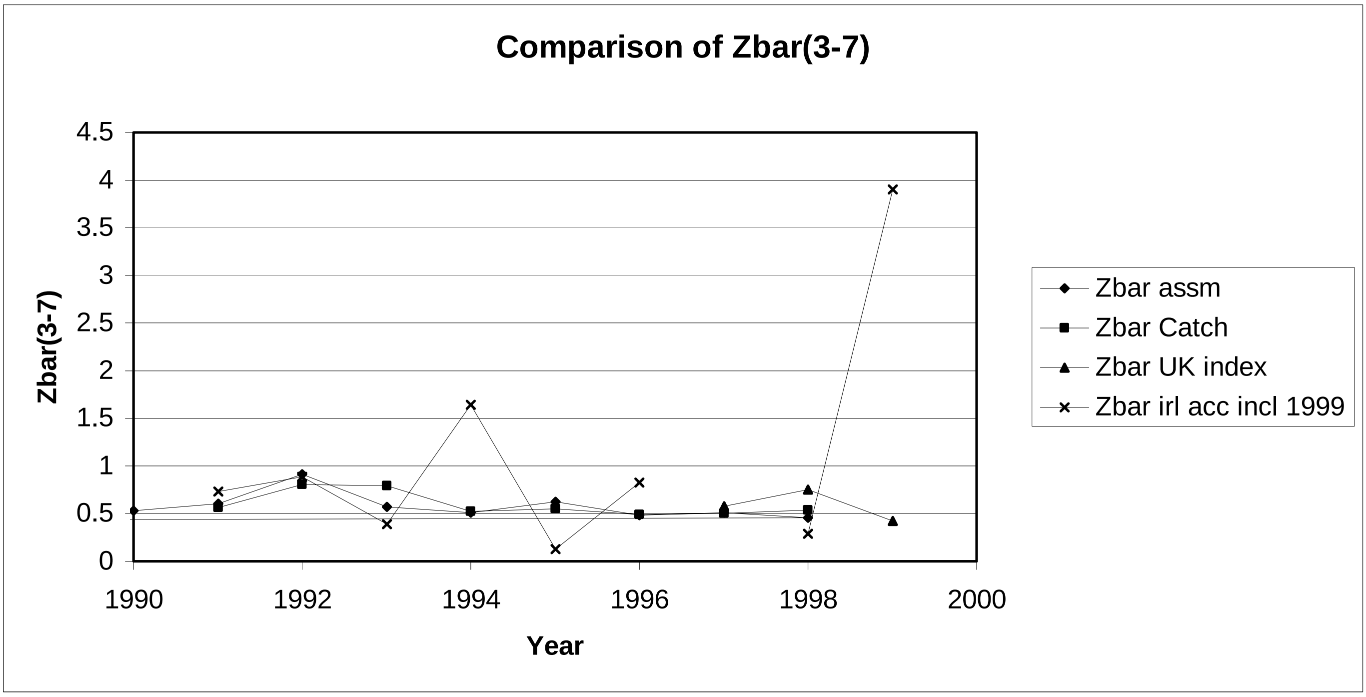


Figure 4.4.2 Comparison of Zbar (3-7)* between the catch and assessment and values derived from the acoustic survey index and a UK survey carried out in the Celtic Sea in quarter 1 over the past three years.

*Zbar (3-7) is calculated across cohorts for all series except the UK survey which was calculated across the years.

Figure 4.4.3 Comparison of maturity stage distributions from the catch and from the January 2000 acoustic survey

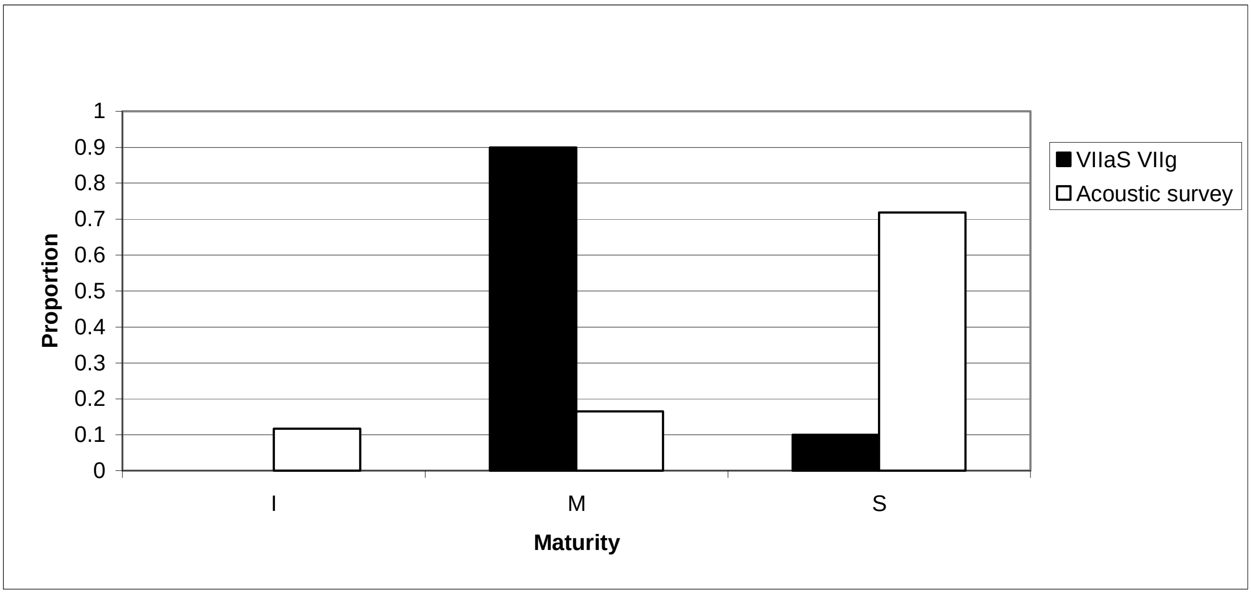
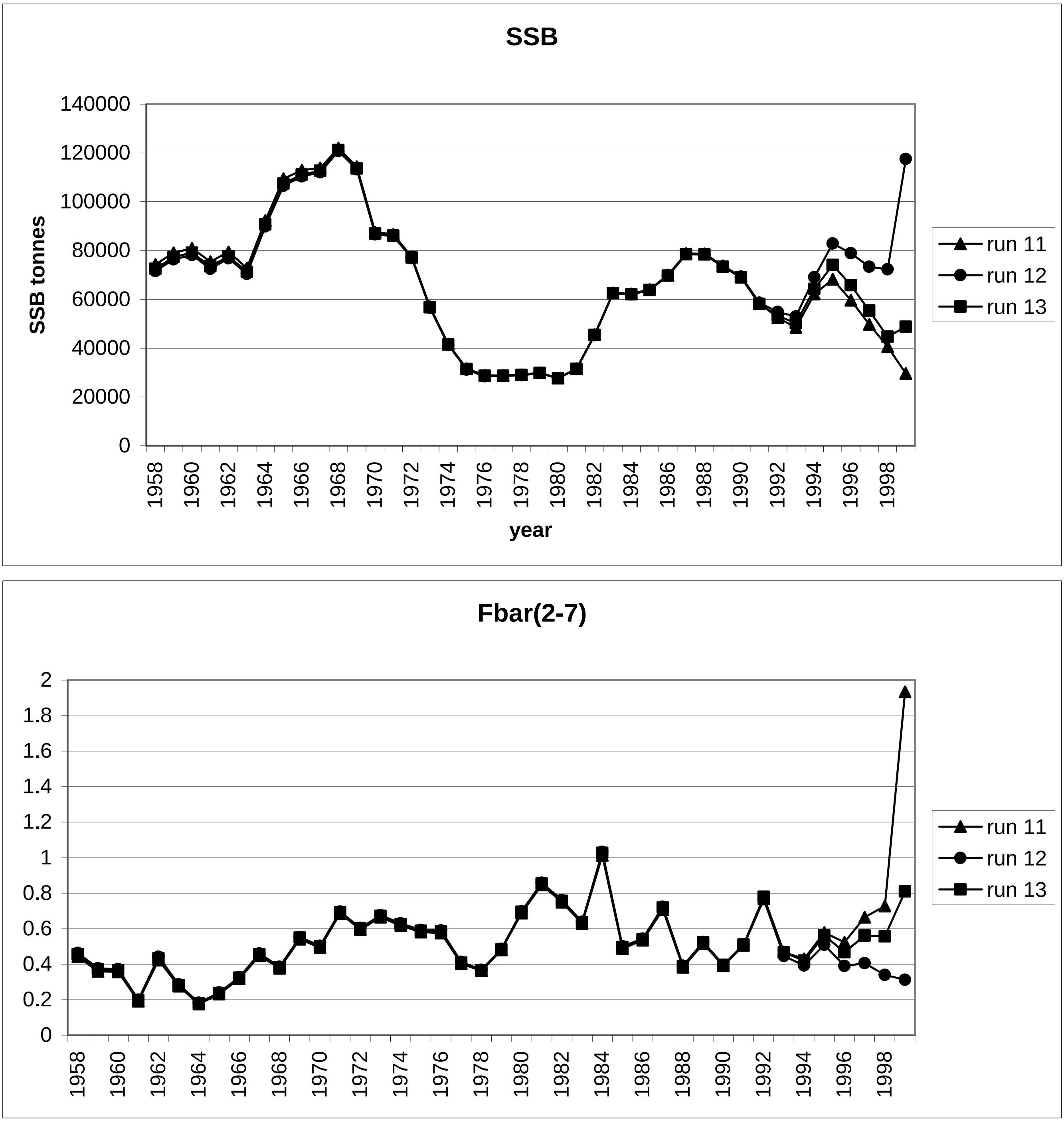


Figure 4.4.4 Comparison of assessments with and without indices from acoustic surveys in 1999



run11	includes revised weights & acoustic index from July 99
run12	includes revised weights no index for 1999
run 13	includes revised weights & acoustic index from January 2000

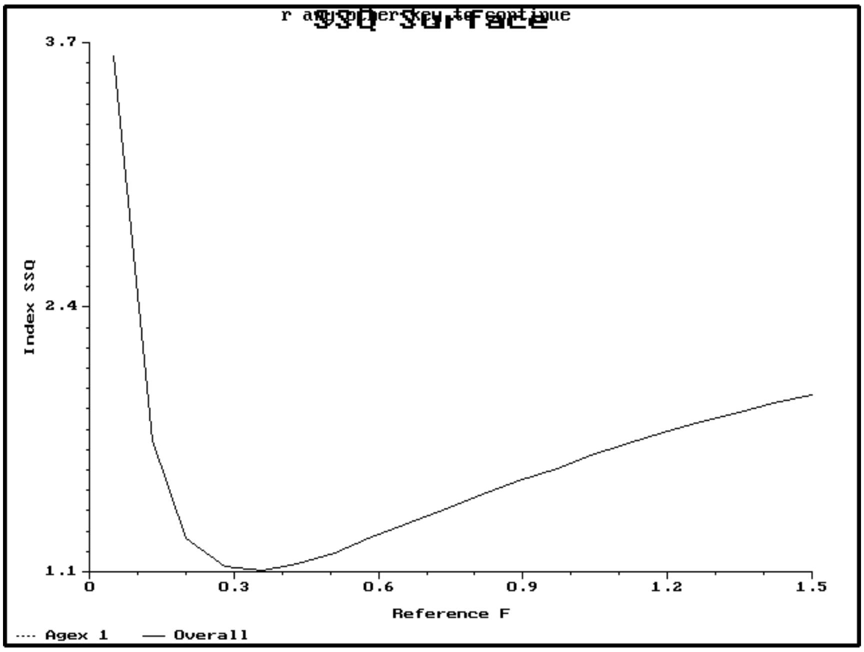


Figure 4.4.5a Herring in Celtic Sea and Division VIIj. SSQ surface for the baseline assessment.

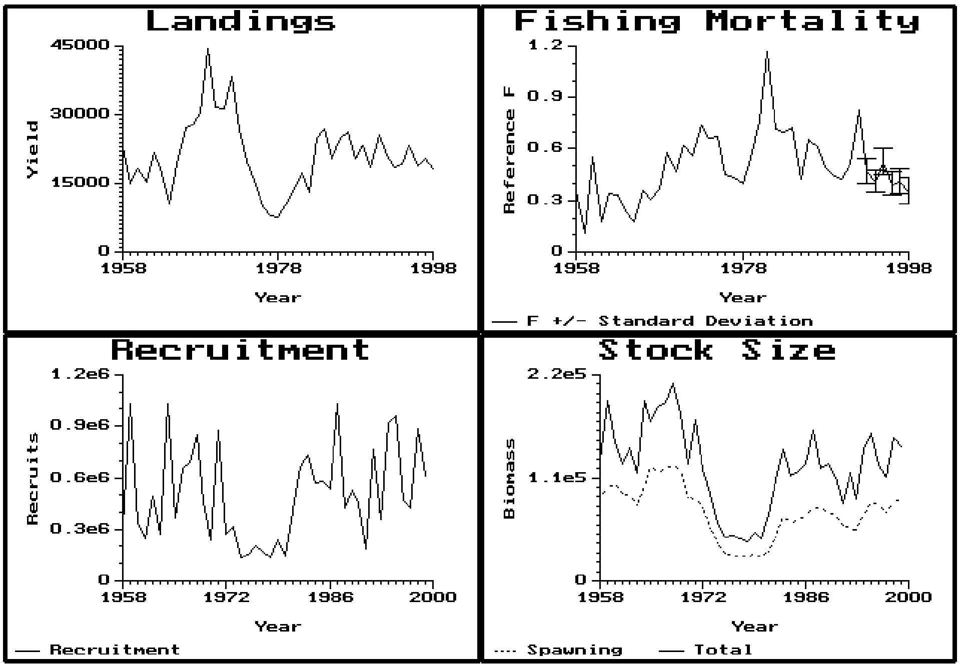


Figure 4.4.5b Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

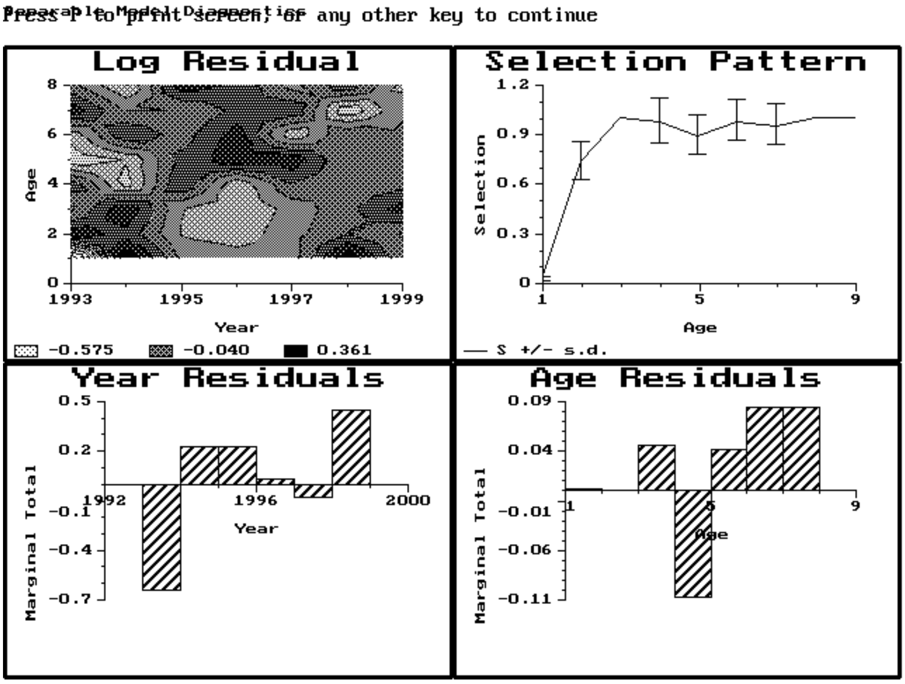


Figure 4.4.6 Herring in Celtic Sea and DivisionVIIj Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

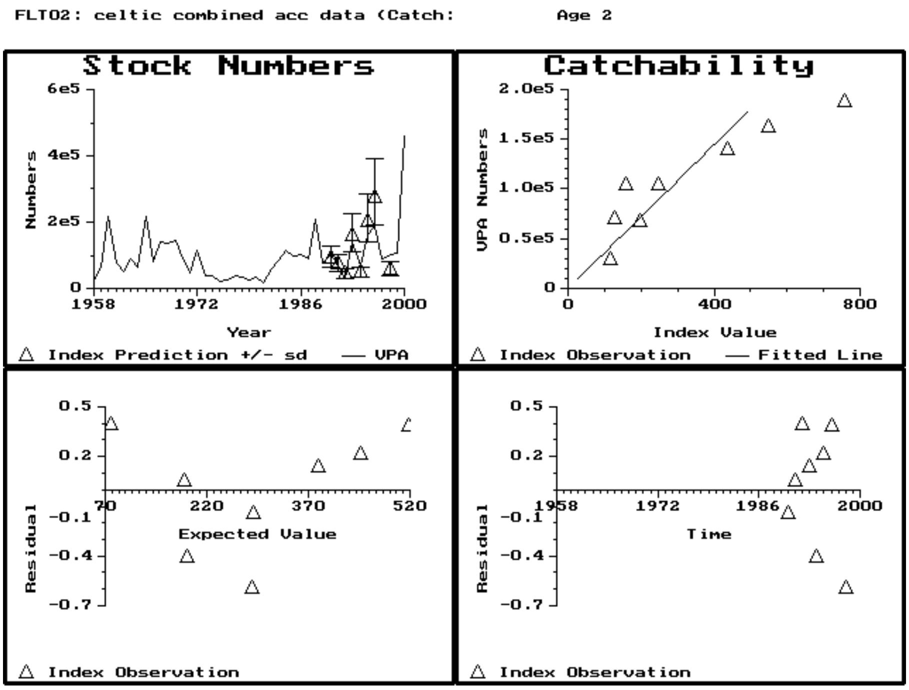


Figure 4.4.7 Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles = /- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

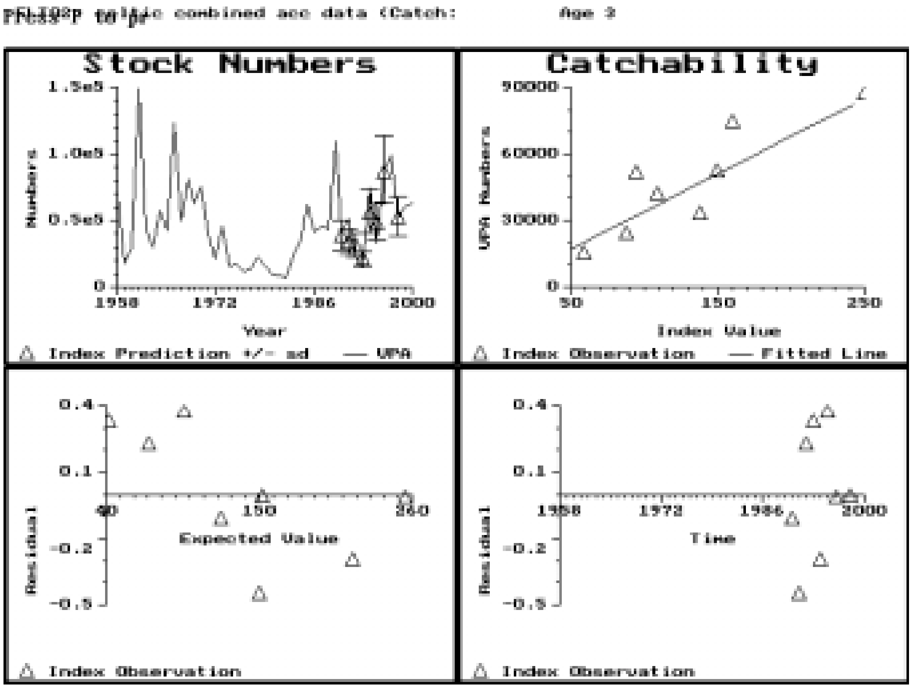


Figure 4.4.8 Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles = /- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

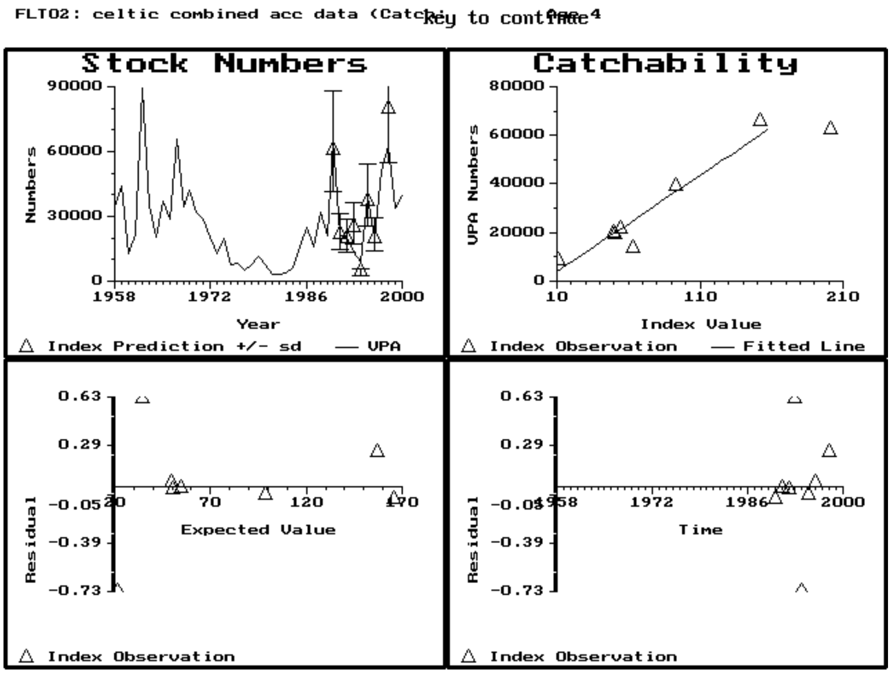


Figure 4.4.9 Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles = /- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

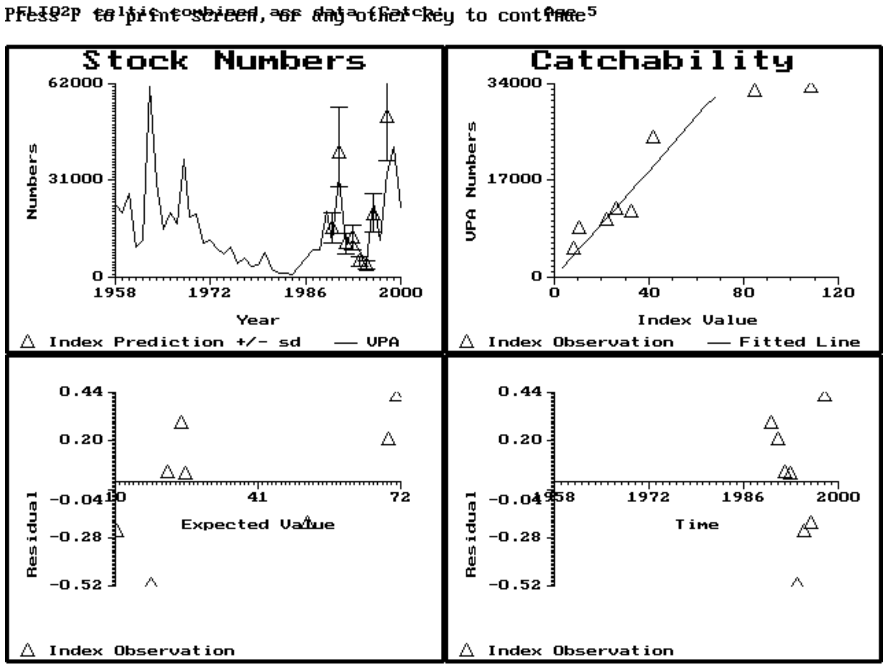


Figure 4.4.10 Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles = /- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

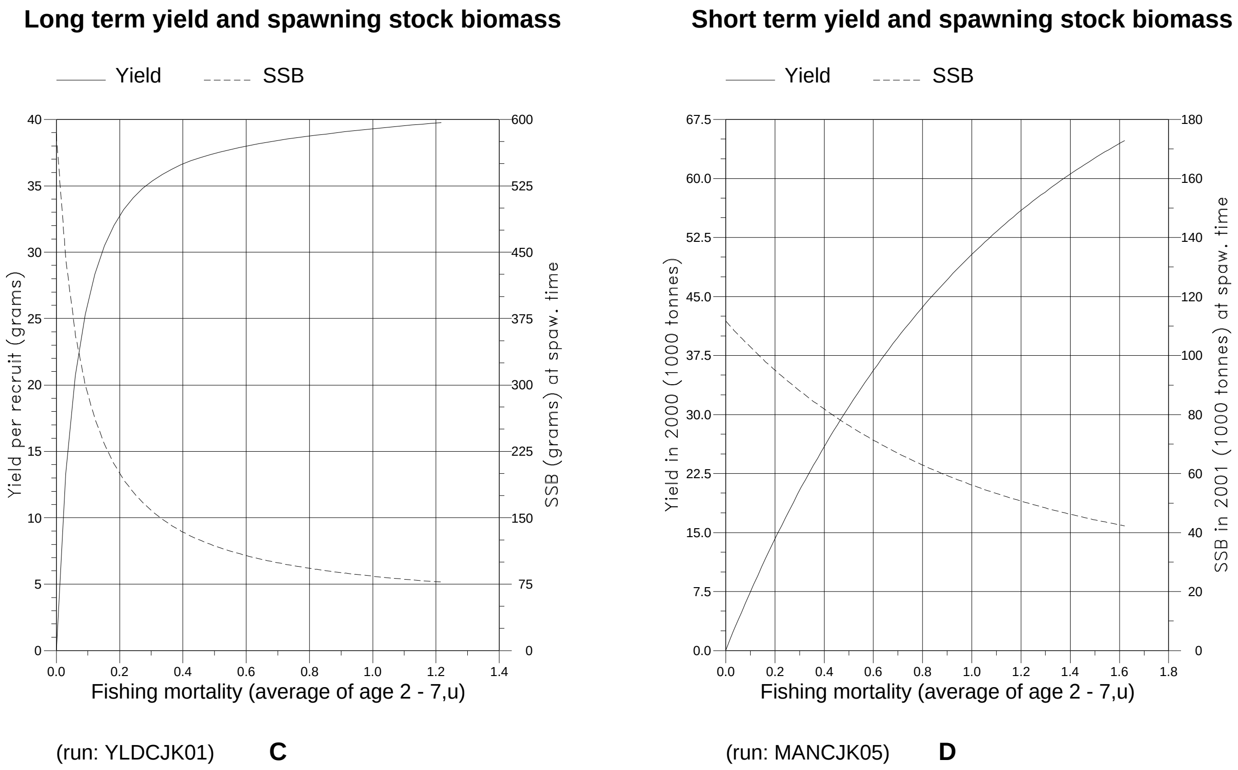


Figure 4.6.1. Long and short term yield and SSB

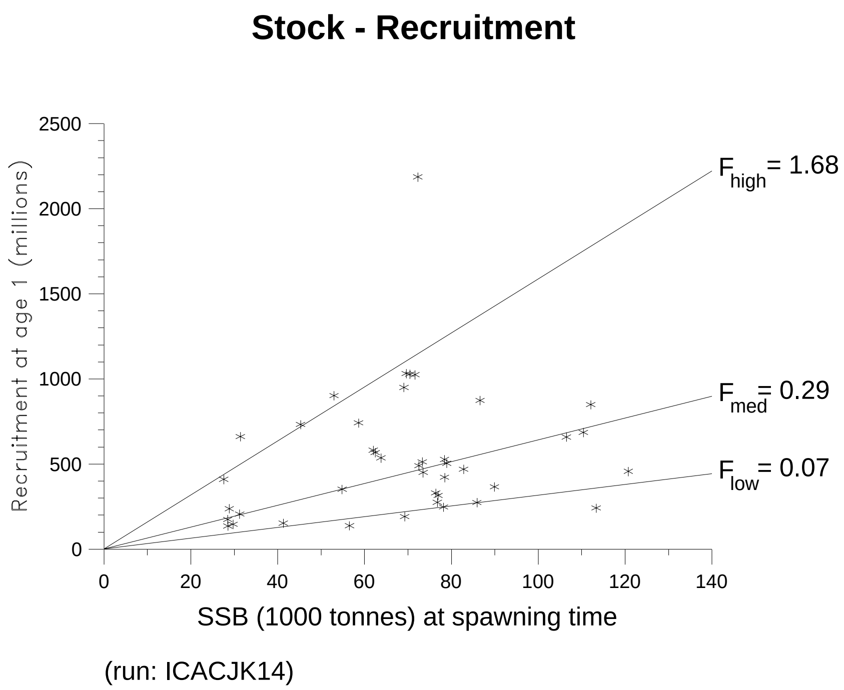


Figure 4.6.2 Stock and recruitment for Celtic Sea and VIIj Herring (full time series)

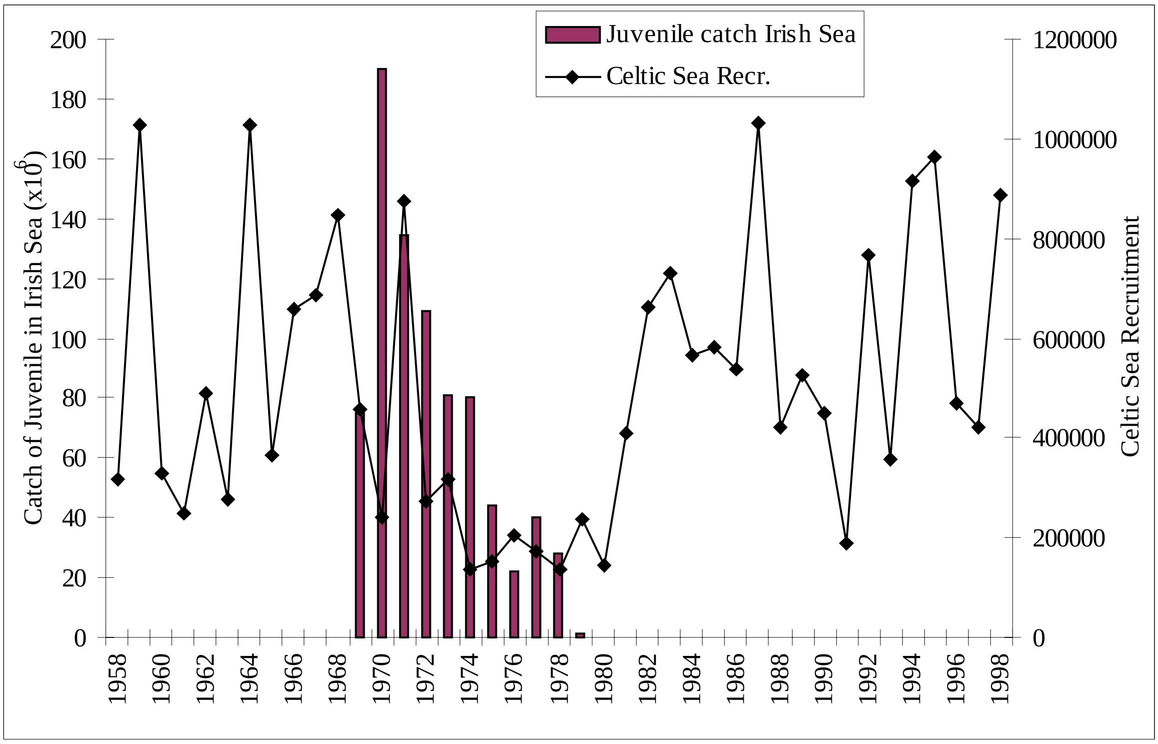


Figure 4.7.1 Catch in numbers of herring in the Irish Sea (aged 0 to 2) by industrial fishery (1969-1979) and recruitment in the Celtic Sea (thousands) from 1958 to 1998.

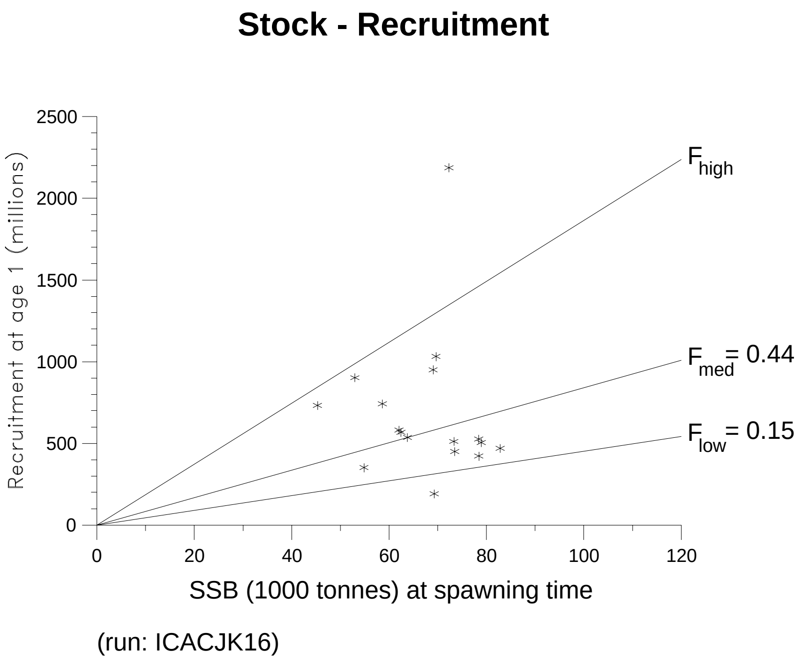


Figure 4.7.2 Stock and recruitment for Celtic Sea and VIIj Herring. Time series 1982–1999, excluding period of industrial fishery in the Irish Sea, when a significant proportion of Celtic Sea recruits may have been taken.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa(North)

5.1.1 ACFM Advice Applicable to 1999 and 2000

ACFM reported in 1999 that the state of the stock was uncertain because indicators of stock status provide conflicting signals and because the catch data are unreliable. Recent estimates indicated that fishing mortality had increased whilst the stock size had declined. Consequently, ACFM recommended that catches in 2000 should not exceed the average of the 1991–1996 period, which was about 28,000 t.

The agreed TAC for 2000 is 42,000 t compared with a TAC in 1999 of 68,000 t.

There are no explicit management objectives for this stock, and because of uncertainties about the historical catch data, the size of the biomass, and about estimates of recruitment and fishing mortality, no biological reference points have been proposed for this stock.

5.1.2 The Fishery

Catches are taken from this area by three more or less distinct fisheries. The Scottish domestic pair trawl fleet operates in shallower, coastal areas, principally fishing in the Minches and around the Island of Barra in the south; younger herring are found in these areas. The Scottish and Norwegian purse seine fleets target herring mostly in the northern North Sea, but also operate in the northern part of VIa(N). An international freezer-trawler fishery has historically operated in deeper water near the shelf edge where older fish are distributed; these vessels are mostly registered in the Netherlands, Germany, France and England.

As a result of perceived problems of misreporting, Scotland introduced a new fishery regulation in 1997 with the intention of improving reporting accuracy. Under this regulation, Scottish vessels fishing for herring are required to hold a license either to fish in the North Sea or in the west of Scotland area. Only one of these options can be held at any one time. During the months of the peak of the Shetland fishery, vessels requiring west coast licenses are required to collect them from west coast ports, and *vice versa* for the North Sea.

5.1.3 Landings Estimates and Allocation of Catches to Area

Serious problems with misreporting of catches from this stock have occurred in the past, with many examples of vessels operating and landing herring catches distant from VIa(N) but reporting catches from that area. Fishery-independent information confirmed that large catches were being reported from areas with low abundances of fish, and informal information from the fishery and from other sources confirmed that most catches of fish recorded between 4°W and 5°W were most probably misreported North Sea catches. The problem was particularly acute during the peak months of the Shetland herring fishery (August to October). Such misreporting was believed to have been significant since 1984, but the extent to which a different licensing scheme introduced in 1997 restricted the opportunities for such misreporting is unknown.

In 1999 the Working Group carried out a Bayesian assessment incorporating uncertainty in the 1997 catches in the range of 30,165 t to 64,995 t. Although new information suggests (contrary to previous opinion) that the extent of misreporting in 1997 may not have been greatly different from that in previous years, this uncertainty in the 1997 catches persists. In 2000 the Working Group used estimates of catches at age for 1997 derived from a re-analysis of the Bayesian assessment (hence the different 1997 WG estimate and catch at age data in the current years’ Tables 5.1.1 and 5.1.4 respectively).

Improved information from the fishery in 1999 has allowed for re-allocation of many catches due to area misreporting (principally from VIa(N) to IVa(W)). This information has been obtained from the Dutch, Irish and Scottish fleets. The extent of misreporting in the German, English, Northern Irish and French fleets is unknown.

For 1999, the preliminary reports of official catches corresponding to the VIa(N) herring stock unit total 61,514 t compared with the TAC of 68,000 t. The Working Group's estimates of unallocated catches are 31,778 t. Of this, 23,623 t are specifically attributed to catches of herring caught in Division IVa by various nations but reported in the area between 4° and 5°W in VIa(N). No herring has been reported as discarded.

The Working Group's best estimate of removals from the stock in 1999 is 29,736 t. Details of estimated national catches from 1970 to 1999 are given in Table 5.1.1.

5.1.4 Age-Composition of Commercial Catches

Age composition data for the commercial catches for 1999 were available from Scotland (quarters 3 and 4) and the Netherlands (quarter 3). A length frequency sample was available from Germany (quarter 1). The number of samples used to allocate an age-distribution for the Scottish catches increased from 12 in 1998 to 34 in 1999, but the number of samples available from the offshore freezer-trawl fishery decreased dramatically from 43 to just one single sample of 25 fish. This is in no small part due to the fact that these vessels are often landing in foreign ports and do not, therefore, get sampled. Catch and sampling effort information by country and by quarter is given in Table 5.1.2.

Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of all sampled fleets in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. The allocation of age-structures to unsampled catches, and the calculation of total international catch at age and mean weight at age in the catches were made using the 'sallocl' programme (Patterson, 1998).

New and historic catch in number at age information is given in Table 5.1.3.

5.1.5 Larvae Surveys

Larvae surveys for this stock have been discontinued since 1994. The historical time-series will however be used in assessment model fitting and has been reproduced for convenience (Table 5.1.4). Documentation of this survey time-series is given in ICES (1994a).

5.1.6 Acoustic Survey

The survey in 1997 recorded an unexpectedly low estimate of abundance. Interpretation of survey results is not straightforward because the survey was completed one month earlier than other surveys in the historical time-series. Therefore, the 1997 survey has been excluded from the stock assessment calculation.

The 1999 acoustic survey was carried out from 10–28 July using a chartered commercial fishing vessel (MFV Christina S.). The total biomass estimate obtained was similar to that of the previous year (467,100 t this year compared to 473,600 in 1998). Herring were found in similar areas, namely south of the Hebrides off Barra Head, west of the Hebrides off Galan Head and along the shelf edge. Further details are available in Simmonds *et al.* (1999) and information on the 1999 combined survey is given in Section 2.4. Estimates of abundance by age and in aggregate spawning stock biomass for 1999 and for previous years are given in Table 5.1.5.

5.1.7 Mean Weights at Age

Weights at age in the catches and from acoustic surveys are given in Table 5.1.6. Due to the different timing of the acoustic survey in 1997 the estimates of weight at age in the stock in that year are not consistent with previous estimates (Table 5.1.6). In order to maintain historically consistent estimates of spawning biomass, these values were not used for assessment purposes and instead mean values over the period 1992 to 1996 were used for 1997.

Catch weights are once again lower in 1999 than in previous years. In 1998 this also occurred and could be explained because samples were available from the fishery in the first quarter whereas in previous years sampling has been concentrated in the third quarter. This explanation is not appropriate this year, however, the same trend is evident in the acoustic survey data.

5.1.8 Maturity Ogive

The earlier timing of the acoustic survey in 1997 also occasioned lower values of maturity to be recorded (Table 5.1.7). As for the weights at age, these values were not used for assessment purposes and a mean value over the years 1992–1996 was used for 1997 and for years prior to 1991. The 1999 ogive is consistent with the mean.

5.1.9 Data Exploration and Preliminary Modelling

5.1.9.1 Deterministic assessment

Previous data exploration (ICES 1998a) pointed to a number of features which remain pertinent to the stock: the age-structure information between the acoustic surveys and the commercial catches was inconsistent; the abundance of older fish in the acoustic surveys appeared to decline (for no obvious reason); and that the exploitation by two fleets, with different selection patterns, in different geographical areas, and limited sampling on both, hindered the interpretation of age-structures from commercial catches and render the use of a constant selection pattern in the model problematic. After minimal success with a variety of approaches attempting to account for these features, the Working Group adopted a Bayesian calculation in 1998 & 1999 to include the uncertainty in the amount of catches taken in the area between 4°-5°W in 1997. The ICA v1.4 software was then used with a modification to include the extra parameters involved and the prior assumptions.

Catches in1997 were available as adjusted according to the Bayesian assessment (and were therefore corrected for misreporting) and the 1999 data were available with significantly more direct information on the level of misreporting, particularly for the area between 4°-5°W. In addition, a successful acoustic survey had been carried out to add to the time series. In 2000 therefore, the Working Group considered that this Bayesian assessment was not applicable and that the use of time was better suited to exploring other methods (see below).

Assessment of the stock was carried out by fitting an integrated catch-at-age model (ICA version 1.4w) including a separable constraint (Patterson & Melvin 1996; Deriso *et al.* 1985; Gudmundsson 1986). An aged-structured index was available from the acoustic survey from 1987, 1991–1996 and 1998–1999 (Section 5.1.6). Indices of spawning stock biomass were available from the acoustic survey (as above) and the larvae survey from 1976–1991 and 1993 (Section 5.1.5).

Catches in number at age were available for the period 1976–1999. Two data sets were created: one based on the allocation of catch in 1999 to age structures in the available sample data; and another based on the allocation of quarter one catches to an age structure calculated using the length frequency information from the German sample in the first quarter (and an age length key from the 1999 summer acoustic survey). ICA runs with these datasets were virtually identical and so further analyses used the original catch in number at age data (without the German length frequency samples).

The Working Group attempted to evaluate the consistency of the different sources of information. The model was fitted to the catch at age matrix and to the following combinations of indices: i) acoustic survey as an aged structured index and the larval survey (as an SSB index); ii) acoustic survey as an aged structured index alone; iii) acoustic survey as an as SSB index alone. Very little difference was found between these exercises and so it was decided to use all available information (combination [i] above).

Two model runs were then performed with different lengths of the separable period (6 and 7 years). This produced quite different estimates of spawning stock biomass and fishing mortality (Figure 5.1.1). The Working Group was unable to decide which of these was the most plausible assessment. The catch in number in 1993 (the extra year included in the 7 year period) was particularly high for 1 year olds when compared to subsequent years but was not exceptional when compared to previous years. The 1993 catch of 2-year-olds was more typical of subsequent years but was high relative to the immediately preceding 4 years. Weights at age for 1993 were not exceptional. The 1993 acoustic survey produced exceptionally large values for all age classes (except age 1).

Details of the results of both of these assessments are given. Input parameters for both runs are given in Table 5.1.8 (ICA.log file for the 6 year separable period). The results of the model run with a 6 year separable period are given in Table 5.1.9 (containing full details of the input data) and Figures 5.1.2 – 5.1.14. The results of the model run with a 7 year separable period are given in Table 5.1.10 (without input data) and Figures 5.1.15 – 5.1.17. The figures showing the age disaggregated residual data for the 7 year separable period are not given as they show similar trends to those of the 6 year separable period and the details are available in Table 5.1.10.

5.1.9.2 An assessment using survey data exclusively

The possibility of estimating fishing mortality and stock numbers for VIaN herring using only survey data was explored. The assessment of this stock has been problematic; this is almost certainly due to the fact that both catch and survey data exhibit high variability. In addition, the catch data may be biased to a variable extent because of area misreporting. This year, the Working Group was urged by ACFM to attempt to assess the stock using only the survey data.

In response to this request, an experimental model, similar to that used by Cook (1995) for haddock, was constructed for VIaN herring. A population was created assuming separable fishing mortalities $F(a,y) = S(a)*f(y)$ and constant (presumably known) natural mortality, with the yearly catch level, the selection pattern, yearly recruitments and population numbers in the first year as parameters.

The survey data that could be used were:

1) *The Scottish west coast acoustic survey*. This series gives abundance indices at ages 1–9+ for years 1987 - 1999, except for years 1988–1990 and 1997. The index at age 1 is not considered to be reliable. The survey indices I(a,y) were assumed to be related to the population numbers N(a,y) by:

$$I(a,y) = q_s(a)*N(a,y) + \varepsilon \qquad (5.1)$$

In addition, an SSB estimate from the survey was computed using the stock numbers derived from the survey indices as $Nsurv = I/q_s$, the observed weights at age in the stock, and the maturities at age.

2. *The Larval abundance index*. This is taken as a measure of SSB. There are data for the years 1976–1993, except for 1992. The relation $LAI(y) = q_l*SSB(y) + \varepsilon$ was assumed.

Data for weights at age and maturity at age were those used for the standard assessment. Since SSB was only used as a relative measure, no correction for the mortality prior to spawning time was made. It is clear that the survey data are highly variable (or 'noisy') and there may be a strong year effect in the noise. In order to smooth some of the effect of this noise, a number of constraints were imposed as follows:

- The selection at age in the fishery was modelled as a logistic function, with 2 parameters to be estimated. This implies almost flat selection at older age.
- The survey catchabilities for the acoustic survey were assumed to be age-independent from age 3 onwards.
- It was suspected that the acoustic estimate for 1993 in particular could be an overestimate. Therefore, a common multiplier was assumed for the catchabilities in the 1993 acoustic survey.
- Survey indices at age 1 were downweighted by a factor of 0.01.

The parameters to be estimated were:

- N(1,y) for all years, age 1 being the youngest age.
- N(a,1987) for all ages
- $q_s(a)$ for ages 1,2 and 3+.
- The parameters α and β in the logistic function $S(a) = 1/(1-\alpha*\exp(\beta-a))$ for the selection at age in the fishery.
- As noted above, the $q_s(a)$ values used for 1993 were multiplied with a common multiplier, which also was estimated as a parameter.

As a first attempt, the parameters were estimated for the years 1987 onwards by minimising the objective function:

$$\sum_{ay} [\log(I(a,y))-\log(N(a,y)/q_s(a))]^2 + \sum_y[\log(\sum_a(LAI(y)/q_l-\log(\sum_a N(a,y)* w(a,y)*mat(a,y))]^2 \qquad (5.2)$$

with data for the years 1987 - 1999 as far as they were available. The minimisation was done using the Solver facility in the Excel spreadsheet.

With this objective function, there is nothing to determine the absolute population values, since all abundance measures are treated as relative. This required an additional constraint - that the total modelled and observed catch in weight, summed over all years (1987 – 1999), should be equal.

Some results with this model formulation are shown in Figure 5.1.18. Altogether, these results cannot be regarded as a reliable estimate of the state of the stock. In particular, the fishing mortalities and the derived catches are noisy. The SSB performs better, and is in reasonable accordance with the observed values.

Next, the SSB estimate derived from the survey was included in the objective function as:

$$\Sigma_y [\log(\Sigma_a(I(a,y)*q_s(a)/w(a,y)*mat(a,y))-\log(\Sigma_a N(a,y)* w(a,y)*mat(a,y))]^2 \quad \textbf{(5.3)}$$

The results are shown in Figure 5.1.19. Including this information, which to some extent is using the same information twice, did not reduce the noise in the results. This term was not included in the following runs.

Then, in an attempt to reduce some of the noise in the fishing mortalities and modelled catches, a penalty function $\Sigma_y[\log(f(y)/f(y+1))]^2$, as suggested by Cook (1995), was included in the objective function, but with a low weight. The results are shown in Figure 5.1.20. This reduced some of the noise in the F and catch estimate, although the strange values in 1992 - 1996 persisted, although somewhat smoothed.

Next, a much higher weight was given to the penalty, to have a strong damping effect on the year to year variations in fishing mortalities. The results are shown in Figure 5.1.21. The modelled catches are far more in accordance with the actually reported yearly catches, but have a trend which is not found in the reported catches.

An alternative to this would be to use the yearly catches C(y) as guidance by including a term:

$$\Sigma_y[\log(C_{obs}(y))-\log(C_{model}(y)]^2 \quad \textbf{(5.4)}$$

in the objective function instead of the penalty term. The results are shown in Figure 5.1.22. This alternative gave a better fit to the survey data than the strong penalty option (SSQ for the acoustic survey was 6.10 compared to 7.88). This may indicate that the variations in the survey data are more compatible with the catches than with the hypothesis that the fishing mortalities are nearly stable. For comparison, the SSQ for the acoustic survey in the baseline run was 3.77.

The overall impression of these runs is that the survey data are too noisy and too sparse to allow a reliable assessment without using catch data. In particular there seems to be stronger year to year fluctuations in the acoustic surveys than can be explained by variations in the mortality. The attempts to smooth the mortalities made here were not convincing: there are no objective criteria for weighting the penalty function and there may be real fluctuations in the mortality that are concealed this way. Further improvement may be possible using other methods to filter the noise in the mortalities, (e.g., by using time series methods) but this would require time beyond that available at the WG.

Some inferences can be made, however, which appear to be relatively stable across options. The SSB appears to have been relatively stable in recent years, and probably somewhat higher in the early part of the period under consideration. The level of SSB in recent years was of the order of 80–100,000 tonnes, except for the run where the yearly catches were included, which gave a SSB near 125,000 tonnes. Secondly, there appears to have been a declining mortality until the mid-1990's, and a rise in the mortality in recent years. This inference is, however, strongly dependent on the assumption that the catchability in this survey is equal for all ages from age 3 onwards.

5.1.10 Stock Assessment

Two deterministic assessments based on ICA have been submitted for consideration. In one, the period for the separable constraint is 6 years. This results in an SSB for 1999 of 83,689 tonnes and a mean fishing mortality (ages 3–6) of 0.248. Examination of the diagnostics reveals that the marginal totals of age residuals on the selection pattern are low ($< \pm 0.2$), but the catchabilities at age of the acoustic survey indices are generally high (mean for ages 3–6 of 5.06). In the other assessment, the period for the separable constraint is 7 years. The SSB for 1999 is 152,499 tonnes and the mean fishing mortality (ages 3–6) is 0.108. Examination of the diagnostics reveals one (age 4) very high marginal total residual on the selection pattern (0.86), but the catchabilities at age of the acoustic survey indices are generally lower (mean for ages 3–6 of 3.19) than those in the 6 year period analysis.

The diagnostics imply that the model fit may be slightly better for the 6-year separable period. However, the catchabilities lend more credence to the 7-year period because they are more in line with those of the North Sea survey (which has a mean value for ages 3–6 of 2.18). There should be no reason to suggest that the acoustic survey on the west coast is any different in this respect to that of the North Sea (similar depth distributions of fish, similar methods, identical equipment).

Both assessments imply that fishing mortality is declining. The value of 0.108 for the 7-year period is close to or lower than the assumed value of natural mortality (M). This means that the assessment is strongly dependent on the assumed value of M and may provide only limited information on the state of the stock.

An estimate of SSB of approximately 97,000 tonnes, derived from the survey based model (Section 5.1.9.2) lies between the two values for the runs reported here (Figure 5.1.1). Despite the problems associated with the latter analysis it provides some evidence to suggest that that the true estimates of SSB and F are likely to be somewhere between the two values from the assessments provided here.

5.1.11 Projections

5.1.11.1 Deterministic short-term projections

Due to uncertainty in the assessment it has not been considered appropriate to provide deterministic short-term projections.

5.1.11.2 Stochastic medium-term projections

No biological reference points are known for this stock, so medium-term projections were not done on the basis of an F_{pa}. Instead a fishing mortality constraint giving a catch equal to the current TAC of 42,000 tonnes in the first year was applied; for the rest of the period the fishing mortality was fixed. The method used to calculate medium-term projections was as described in ICES (1996a); details are also available in Section 2.11. A Monte-Carlo method was used, with a conventional stock projection being used for each iteration. The generation of pseudo-data sets for the projections was performed separately for the population parameters derived from the stock assessment and for the generation of future recruitments. Population parameters (vector of abundance at age in 1999, fishing mortality at reference age in 1999, selection at age) were drawn from a multivariate normal distribution with mean equal to the values estimated in the stock assessment model, and with covariance as estimated in the same model fit. Pseudo recruitments for subsequent years were generated by calculating a simple geometric mean recruitment because of the failure to identify a useable stock-recruit relationship and resampling randomly from the residuals according to a conventional non-parametric bootstrap method. Weights at age were calculated as the mean weights at age from 1995–1999. Weights at age in the stock, maturity ogives and natural mortality were as given in Section 5.1.10. The procedure was implemented using the ICP program, the input parameters are summarised in Table 5.1.11.

Two scenarios were examined: one based on the assessment using a 6 year separable period (Figure 5.1.23) and the other based on the assessment with the 7 year separable period (Figure 5.1.24). In both scenarios target multipliers were given a value of 1.41 (TAC/ current landings = 42000/29736). The extreme percentiles are very poorly estimated due to the large uncertainty and as a consequence are so large that, if plotted, dwarf other values. The 5 th and 95 th percentiles have therefore been omitted from the figures.

Given a constant F exploitation pattern, catches rise and stabilise at 90,000 tonnes for the 6 year separable period scenario and 76,000 tonnes for the 7 year separable period. For the 6 year separable period scenario the spawning stock biomass rises initially due to a high recruitment in 2001, but then decreases over time to stabilise at a value of approximately 220,000 tonnes. In the 7-year separable period the spawning stock biomass rises more slowly to stabilise at 430,000 tonnes. However, in both cases the spawning stock biomasses, even in the first year, are generally higher than the point estimate for the assessment; this indicates that these predictions may be positively biased.

The wide confidence intervals generated in the assessments have evidently been carried through to the projections such that extremely variable stock sizes were generated, particularly over the long term. Nevertheless, the exploitation level implied by this, which is above the TAC, appears to provide a relatively stable stock.

5.1.12 Comments on the Assessment

The assessment provided here is subject to a large degree of uncertainty due to the highly variable nature of the input data. The catch data is variable but more significantly its age composition is very poorly estimated with very few samples, particularly in 1999. The survey data is also quite noisy although in the last two years this has shown signs of stabilising due to improved knowledge of the spatial distribution of fish. The extent of misreporting is still widespread but information is improving in this respect also. However, other deficiencies still persist, in common with the assessments in previous years, such as uncertainties in levels of misreporting from years prior to 1998, and uncertainties in natural mortality, maturity and growth.

5.1.13 Management Considerations

There remains significant uncertainty in the status of the stock. This is driven by high variability in catch and survey data and uncertain age structure due to poor sampling. The current years' assessments indicate that fishing mortalities may have decreased over the last two years to levels more in line with preceding years. This contrasts with the 1999 assessment, however, the uncertainty in both assessments means that these indications should be treated with caution. In conclusion, the acoustic survey, the survey data based assessment, and the integrated catch at age based assessments, imply that the spawning stock biomass may be reasonably stable. The medium term projections imply that exploitation at the current TAC level (which is 25% higher than the current catch) does not present a serious threat to the stock.

Table 5.1.1. Herring in Division VIa (North). Catch in tonnes by country, 1970-1999. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1970	1971	1972	1973	1974	1975
Denmark	0	554	150	932	0	374
Faroes	15100	8100	8094	10003	5371	3895
France	1293	2055	680	2441	411	1244
Germany	11768	6444	3376	9914	8887	6182
Iceland	5595	5416	2066	2532	9566	2633
Netherlands	464	8340	22673	27892	17461	12024
Norway	27250	76721	17400	32557	26218	509
UK	103530	99537	107638	120800	107520	85520
Other	930		2679	3199	2726	1620
Unallocated						
Discards						
Total	165930	207167	164756	210270	178160	114001
Area-Misreported						
WG Estimate	**165930**	**207167**	**164756**	**210270**	**178160**	**114001**
Source (WG)	1982	1982	1982	1982	1982	1982

Country	1976	1977	1978	1979	1980	1981
Denmark	249	626	128	0	0	1580
Faroes	4017	3564	0	0	0	0
France	1481	1548	1435	3	2	1243
Germany	4363	0	26	0	256	3029
Iceland	3273	0	0	0	0	0
Netherlands	16573	8705	5874	0	0	5602
Norway	5183	1098	4462	57	0	3850
UK	53371	25539	10231	0	48	31483
Other	5132	261				
Unallocated						4633
Discards						
Total	93642	41341	22156	60	306	51420
Area-Misreported						
WG Estimate	**93642**	**41341**	**22156**	**60**	**306**	**51420**
Source (WG)	1982	1982	1982	1982	1982	1983

Country	1982	1983	1984	1985	1986	1987
Denmark	0	0	96	0	0	0
Faroes	74	834	954	104	400	0
France	2069	1313	0	20	18	136
Germany	8453	6283	5564	5937	2188	1711
Ireland	0	0	0	0	6000	6800
Netherlands	11317	20200	7729	5500	5160	5212
Norway	13018	7336	6669	4690	4799	4300
UK	38471	31616	37554	28065	25294	26810
Other						
Unallocated	18958	-4059	16588	-502	37840	18038
Discards	0	0	0	0	0	0
Total	**92360**	**63523**	**75154**	**43814**	**81699**	**63007**
Area-Misreported			-19142	-4672	-10935	-18647
WG Estimate	**92360**	**63523**	**56012**	**39142**	**70764**	**44360**
Source (WG)	1984	1985	1986	1987	1988	1989

Table 5.1.1. continued

Country	1988	1989	1990	1991	1992	1993
Denmark	0	0	0	0	0	0
Faroes	0	0	326	482	0	0
France	44	1342	1287	1168	119	818
Germany	1860	4290	7096	6450	5640	4693
Ireland	6740	8000	10000	8000	7985	8236
Netherlands	6131	5860	7693	7979	8000	6132
Norway	456	0	1607	3318	2389	7447
UK	26894	29874	38253	32628	32730	32602
Other						
Unallocated	5229	2123	2397	-10597	-5485	-3753
Discards	0	1550	1300	1180	200	
Total	47354	53039	69959	50608	51578	56175
Area-Misreported	-11763	-19013	-25266	-22079	-22593	-24397
WG Estimate	**35591**	**34026**	**44693**	**28529**	**28985**	**31778**
Source (WG)	1990	1991	1992	1993	1994	1995

Country	1994	1995	1996	1997	1998	1999
Denmark	0	0	0	0	0	0
Faroes	0	0	0	0	0	0
France	274	3672	2297	3093	1903	463
Germany	5087	3733	7836	8873	8253	6752
Ireland	7938	3548	9721	1875	11199	7915
Netherlands	6093	7808	9396	9873	8483	7244
Norway	8183	4840	6223	4962	5317	2695
UK	30676	42661	46639	44273	42302	36446
Other						
Unallocated	-4287	-4541	-17753	-8015	-11748	-8155
Discards	700			62	90	0
Total	54664	61721	64359	64995	65799	61514
Area-Misreported	-30234	-32146	-38254	-29766	-32446	-23623
WG Estimate	24430	29575	26105	35233*	33353	29736
Source (WG)	1996	1997	1997	1998	1999	**New Data**

Other: Official catches by countries other than those named. Unallocated: Catches for which the Working Group has specific reports of an under- or over-reporting of catches. Discards: Estimates of fish discarded or slipped, usually from observer records. Area-Misreported: Catches reported in the area between 4° and 5° W and reallocated to IVa.

*WG estimate for 1997 has been revised according to the Bayesian assessment (see text section 5.1.3).

Table 5.1.2. Herring in VIa(N). Catch and sampling effort by nation participating in the fishery. 'Periods 1-4' refer to quarters of the year.

Total over year

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	3146.70	0	0	0	0.00
France	0.00	463.00	0	0	0	0.00
Germany	0.00	6751.93	0	0	0	0.00
Ireland	0.00	7915.00	0	0	0	0.00
N. Ireland	0.00	1545.74	0	0	0	0.00
Netherlands	174.00	7244.00	1	25	25	100.07
Norway	2695.00	2695.00	0	0	0	100.06
Scotland	15077.00	31753.00	34	6695	1543	100.15
Total VIa(N)	17946.00	61514.36	35	6720	1568	100.14

Sum of Offical Catches : 61514.36

Unallocated Catch : -31778.48

Working Group Catch : 29735.88

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Germany	0.00	159.13	0	0	0	0.00
Ireland	0.00	2570.00	0	0	0	0.00
N. Ireland	0.00	331.70	0	0	0	0.00
Netherlands	0.00	72.00	0	0	0	0.00
Scotland	178.00	178.20	0	0	0	100.03
Period Total	178.00	3311.03	0	0	0	100.03

Sum of Offical Catches : 3311.03

Unallocated Catch : -2605.00

Working Group Catch : 706.03

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	863.94	0	0	0	0.00
Germany	0.00	1781.70	0	0	0	0.00
Ireland	0.00	419.00	0	0	0	0.00
Norway	2695.00	2695.00	0	0	0	100.06
Scotland	0.00	68.03	0	0	0	0.00
Period Total	2695.00	5827.67	0	0	0	100.06

Sum of Offical Catches : 5827.67

Unallocated Catch : -419.00

Working Group Catch : 5408.67

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	1298.88	0	0	0	0.00
France	0.00	463.00	0	0	0	0.00
Germany	0.00	1254.59	0	0	0	0.00
Ireland	0.00	83.00	0	0	0	0.00
N. Ireland	0.00	694.04	0	0	0	0.00
Netherlands	174.00	5717.00	1	25	25	100.07
Scotland	11377.70	27976.12	26	4933	896	100.19
Period Total	11551.70	37486.63	27	4958	921	100.19

```
Sum of Offical Catches :        37486.63

Unallocated Catch :            -22336.48

Working Group Catch :           15150.15
```

Table 5.1.2 continued

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	983.88	0	0	0	0.00
Germany	0.00	3556.51	0	0	0	0.00
Ireland	0.00	4843.00	0	0	0	0.00
N. Ireland	0.00	520.00	0	0	0	0.00
Netherlands	0.00	1455.00	0	0	0	0.00
Scotland	3521.30	3530.65	8	1762	647	100.05
Period Total	3521.30	14889.04	8	1762	647	100.05

Sum of Offical Catches : 14889.04

Unallocated Catch : -6418.00

Working Group Catch : 8471.04

Table 5.1.3. Estimated catches at age of herring in Area VIa(N), 1976-1999. Catches in number in 1997 have been revised according to the Bayesian assessment (see text section 5.1.3).

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	69053	34836	22525	247	2692	36740	13304	81923	2207	40794	33768
2	319604	47739	46284	142	279	77961	250010	77810	188778	68845	154963
3	101548	95834	20587	77	95	105600	72179	92743	49828	148399	86072
4	35502	22117	40692	19	51	61341	93544	29262	35001	17214	118860
5	25195	10083	6879	13	13	21473	58452	42535	14948	15211	18836
6	76289	12211	3833	8	9	12623	23580	27318	11366	6631	18000
7	10918	20992	2100	4	8	11583	11516	14709	9300	6907	2578
8	3914	2758	6278	1	1	1309	13814	8437	4427	3323	1427
9	12014	1486	1544	0	0	1326	4027	8484	1959	2189	1971

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	19463	1708	6216	14294	26396	5253	17719	1728	266	1952	1193
2	65954	119376	36763	40867	23013	24469	95288	36554	82176	37854	55810
3	45463	41735	109501	40779	25229	24922	18710	40193	30398	30899	34966
4	32025	28421	18923	74279	28212	23733	10978	6007	21272	9219	31657
5	50119	19761	18109	26520	37517	21817	13269	7433	5376	7508	23118
6	8429	28555	7589	13305	13533	33869	14801	8101	4205	2501	17500
7	7307	3252	15012	9878	7581	6351	19186	10515	8805	4700	10331
8	3508	2222	1622	21456	6892	4317	4711	12158	7971	8458	5213
9	5983	2360	3505	5522	4456	5511	3740	10206	9787	31108	9883

	1998	1999
1	9092	7635
2	74167	35252
3	34571	93910
4	31905	25078
5	22872	13364
6	14372	7529
7	8641	3251
8	2825	1257
9	3327	1089

Table 5.1.4. Herring in Division VIa (North). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.5. Herring in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age and spawning biomass (SSB, tonnes).

Age	**1987**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997#**	**1998**
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220	792 320	1 221 700
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460	641 860	794 630
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530	286 170	666 780
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110	167 040	471 070
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360	66 100	179 050
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600	49 520	79 270
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380	16 280	28 050
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190	28 990	13 850
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810	24 440	36 770
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300	140 910	375 890

Age	**1999**
1	487 000
2	293 900
3	1 265 800
4	393 800
5	280 700
6	126 400
7	78 900
8	25 200
9+	32 300
SSB:	419 500

*Biomass of 2+ ringers in November.
The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.1.6. Herring in Division VIa (North). Mean weights at age (g).

Weight in the catch																
Age, Rings	**1982-1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
1	90	69	113	73	80	82	79	84	91	89	83	105	81	89	97	76
2	140	103	145	143	112	142	129	118	122	128	142	142	134	136	138	130
3	175	134	173	183	157	145	173	160	172	158	167	180	178	177	159	158
4	205	161	196	211	177	191	182	203	194	197	190	191	210	205	182	175
5	231	182	215	220	203	190	209	211	216	206	195	198	230	222	199	191
6	253	199	230	238	194	213	224	229	224	228	201	213	233	223	218	210
7	270	213	242	241	240	216	228	236	236	223	244	207	262	219	227	225
8	284	223	251	253	213	204	237	261	251	262	234	227	247	238	212	223
9+	295	231	258	256	228	243	247	271	258	263	266	277	291	263	199	226

Weight in the stock from Acoustic surveys									
(Age, Rings)	**Historical**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
1	90	68	75	52	45	45	57	65	54
2	164	152	162	150	144	140	150	138	137
3	208	186	196	192	191	180	189	177	166
4	233	206	206	220	202	209	209	193	188
5	246	232	226	221	225	219	225	214	203
6	252	252	234	233	226	222	233	226	219
7	258	271	254	241	247	229	248	234	225
8	269	296	260	270	260	242	266	225	235
9+	292	305	276	296	293	263	287	249	245

Table 5.1.7 Herring in Division VIa (North). Maturity ogive used in estimates of spawning stock biomass taken from acoustic surveys. Values measured in 1997 were measured in June whilst other values are measured in July.

Year \Age (W ring)	2	3	>3
Mean 92-96	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00
1997	0.41	0.88	1.00
1998	0.85	0.97	1.00
1999	0.57	0.98	1.00

Table 5.1.8. Herring in VIa(N). ICA run log for the maximum-likelihood ICA calculation for the 6 year separable period. Other than the separable period, input parameters were identical for the run with the 7 year period.

```
                         Integrated Catch at Age Analysis

                        --------------------------------

                                 Version 1.4 w

Enter the name of the index file -->index

canum

weca

 Stock weights in 2000  used for the year 1999

west

 Natural mortality in 2000  used for the year 1999

natmor

 Maturity ogive in 2000  used for the year 1999

matprop

 Name of age-structured index file (Enter if none) : -->fleet

 Name of the SSB index file (Enter if none) -->ssb

 No of years for separable constraint ?--> 6

 Reference age for separable constraint ?--> 4

 Constant selection pattern model (Y/N) ?-->y

 S to be fixed on last age ?-->    1.000000000000000

 First age for calculation of reference F ?--> 3

 Last age for calculation of reference F ?--> 6

 Use default weighting (Y/N) ?-->y

 Is the last age of FLT01: West Scotland Summer Acoustic Sur a plus-group (Y-->y

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   INDEX1  is to be A/L/P ?-->p

 Model for FLT01: West Scotland Summer Acoustic Sur  is to be A/L/P ?-->L

 Fit a stock-recruit relationship (Y/N) ?-->n

 Enter lowest feasible F-->   5.0000000000000003E-02

 Enter highest feasible F-->    1.000000000000000

Mapping the F-dimension of the SSQ surface

Lowest SSQ is for F =     0.146

-----------------------------------------------------------------

No of years for separable analysis : 6

Age range in the analysis : 1  . . . 9

Year range in the analysis : 1976  . . . 1999

Number of indices of SSB : 1

Number of age-structured indices : 1


Parameters to estimate : 36

Number of observations : 146

Conventional single selection vector model to be fitted.

-----------------------------------------------------------------

 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M

 Enter weight for   INDEX1-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 1-->    0.100000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 2-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 3-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 4-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 5-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 6-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 7-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 8-->    1.000000000000000

 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 9-->    1.000000000000000

Enter estimates of the extent to which errors

in the age-structured indices are correlated
```

```
across ages. This can be in the range 0 (independence)

to 1 (correlated errors).

  Enter value for FLT01: West Scotland Summer Acoustic Sur-->    1.000000000000000

 Do you want to shrink the final fishing mortality (Y/N) ?-->N

Seeking solution. Please wait.

SSB index weights

  1.000

Aged index weights

FLT01: West Scotland Summer Acoustic Sur

 Age   :       1     2     3     4     5     6     7     8     9

 Wts :     0.011 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111

F in 1999  at age 4  is 0.241354  in iteration 1

 Detailed, Normal or Summary output (D/N/S)-->D

 Output page width in characters (e.g. 80..132) ?--> 132

 Estimate historical assessment uncertainty ?-->n

Succesful exit from ICA
```

Table 5.1.9. Herring in VIa(N). Input data and estimated parameters from weighted least-squares ICA calculation for the 6 year separable period.

Output Generated by ICA Version 1.4   Herring VIa (north) (run: ICAPGF01/I01)

Catch in Number

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	69.05	34.84	22.52	0.25	2.69	36.74	13.30	81.92	2.21	40.79	33.77	19.46	1.71	6.22	14.29
2	319.60	47.74	46.28	0.14	0.28	77.96	250.01	77.81	188.78	68.84	154.96	65.95	119.38	36.76	40.87
3	101.55	95.83	20.59	0.08	0.10	105.60	72.18	92.74	49.83	148.40	86.07	45.46	41.73	109.50	40.78
4	35.50	22.12	40.69	0.02	0.05	61.34	93.54	29.26	35.00	17.21	118.86	32.02	28.42	18.92	74.28
5	25.20	10.08	6.88	0.01	0.01	21.47	58.45	42.53	14.95	15.21	18.84	50.12	19.76	18.11	26.52
6	76.29	12.21	3.83	0.01	0.01	12.62	23.58	27.32	11.37	6.63	18.00	8.43	28.55	7.59	13.30
7	10.92	20.99	2.10	0.00	0.01	11.58	11.52	14.71	9.30	6.91	2.58	7.31	3.25	15.01	9.88
8	3.91	2.76	6.28	0.00	0.00	1.31	13.81	8.44	4.43	3.32	1.43	3.51	2.22	1.62	21.46
9	12.01	1.49	1.54	0.00	0.00	1.33	4.03	8.48	1.96	2.19	1.97	5.98	2.36	3.50	5.52

x 10 ^ 6

Catch in Number

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	26.40	5.25	17.72	1.73	0.27	1.95	1.19	9.09	7.63
2	23.01	24.47	95.29	36.55	82.18	37.85	55.81	74.17	35.25
3	25.23	24.92	18.71	40.19	30.40	30.90	34.97	34.57	93.91
4	28.21	23.73	10.98	6.01	21.27	9.22	31.66	31.91	25.08
5	37.52	21.82	13.27	7.43	5.38	7.51	23.12	22.87	13.36
6	13.53	33.87	14.80	8.10	4.21	2.50	17.50	14.37	7.53
7	7.58	6.35	19.19	10.52	8.80	4.70	10.33	8.64	3.25
8	6.89	4.32	4.71	12.16	7.97	8.46	5.21	2.83	1.26
9	4.46	5.51	3.74	10.21	9.79	31.11	9.88	3.33	1.09

x 10 ^ 6

Predicted Catch in Number

AGE	1994	1995	1996	1997	1998	1999

1	1248.	747.	1137.	2347.	3942.	7581.
2	27756.	43378.	27120.	71781.	91998.	70807.
3	26098.	26108.	42885.	45035.	67967.	40755.
4	8035.	14524.	15316.	42650.	24497.	16835.
5	8609.	5697.	10844.	19277.	29756.	7880.
6	11240.	5014.	3495.	11348.	11147.	7795.
7	13655.	9867.	4634.	5370.	9701.	4485.
8	12103.	7222.	5505.	4383.	2751.	2255.

x 10 ^ 3

260

Table 5.1.9. contd.

259

Weights at age in the catches (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.08000	0.08000	0.08000	0.06900	0.11300	0.07300	0.08000	0.08200	0.07900
2	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.14000	0.14000	0.14000	0.10300	0.14500	0.14300	0.11200	0.14200	0.12900
3	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.17500	0.17500	0.17500	0.13400	0.17300	0.18300	0.15700	0.14500	0.17300
4	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.20500	0.20500	0.20500	0.16100	0.19600	0.21100	0.17700	0.19100	0.18200

AGE															
5	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.23100	0.23100	0.23100	0.18200	0.21500	0.22000	0.20300	0.19000	0.20900
6	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.25300	0.25300	0.25300	0.19900	0.23000	0.23800	0.19400	0.21300	0.22400
7	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.27000	0.27000	0.27000	0.21300	0.24200	0.24100	0.24000	0.21600	0.22800
8	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.28400	0.28400	0.28400	0.22300	0.25100	0.25300	0.21300	0.20400	0.23700
9	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.29500	0.29500	0.29500	0.23100	0.25800	0.25600	0.22800	0.24300	0.24700

Weights at age in the catches (Kg) - value for 1998 age 4 has been corrected in existing data file.

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.08400	0.09100	0.08900	0.08300	0.10600	0.08100	0.08900	0.09700	0.07600
2	0.11800	0.11900	0.12800	0.14200	0.14200	0.13400	0.13600	0.13800	0.13000
3	0.16000	0.18300	0.15800	0.16700	0.18100	0.17800	0.17700	0.15900	0.15800
4	0.20300	0.19600	0.19700	0.19000	0.19100	0.21000	0.20500	0.18200	0.17500
5	0.21100	0.22700	0.20600	0.19500	0.19800	0.23000	0.22200	0.19900	0.19100
6	0.22900	0.21900	0.22800	0.20100	0.21400	0.23300	0.22300	0.21800	0.21000
7	0.23600	0.24400	0.22300	0.24400	0.20800	0.26200	0.21900	0.22700	0.22500

8	0.26100	0.25600	0.26200	0.23400	0.22700	0.24700	0.23800	0.21200	0.22300
9	0.27100	0.25600	0.26300	0.26600	0.27700	0.29100	0.26300	0.19900	0.22600

Weights at age in the stock (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

Table 5.1.9. contd.

Weights at age in the stock (Kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.09000	0.09000	0.07500	0.05200	0.04200	0.04500	0.05700	0.06600	0.05400
2	0.16400	0.16400	0.16200	0.15000	0.14400	0.14000	0.15000	0.13800	0.13700
3	0.20800	0.20800	0.19600	0.19200	0.19100	0.18000	0.18900	0.17600	0.16600
4	0.23300	0.23300	0.20600	0.22000	0.20200	0.20900	0.20900	0.19400	0.18800
5	0.24600	0.24600	0.22600	0.22100	0.22500	0.21900	0.22500	0.21400	0.20300
6	0.25200	0.25200	0.23400	0.23300	0.22700	0.22200	0.23300	0.22600	0.21900
7	0.25800	0.25800	0.25400	0.24100	0.24700	0.22900	0.24800	0.23400	0.22500
8	0.26900	0.26900	0.26000	0.27000	0.26000	0.24200	0.26600	0.22500	0.23500
9	0.29200	0.29200	0.27600	0.29600	0.29300	0.26300	0.28700	0.24900	0.24500

Natural Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999

1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 5.1.9. contd.

Proportion of fish spawning

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.4700	0.9300	0.4800	0.1900	0.7600	0.5700	0.8500	0.5700
3	0.9600	1.0000	0.9600	0.9200	0.9800	0.9400	0.9600	0.9700	0.9800
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	189.0	787.0	332.0	1071.0	1436.0	2154.0	1890.0	668.0	2133.0	2710.0	3037.0	4119.0	5947.0	4320.0	6525.0

INDEX1

	1991	1992	1993
1	4430.0	*******	2941.0

Table 5.1.9. contd.

AGE-STRUCTURED INDICES

FLT01: West Scotland Summer Acoustic Sur

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	249.1	*******	*******	*******	338.3	74.3	2.8	494.2	460.6	41.2	*******	1221.7	487.0
2	578.4	*******	*******	*******	294.5	503.4	750.3	542.1	1085.1	576.5	*******	794.6	293.9
3	551.1	*******	*******	*******	327.9	211.0	681.2	607.7	472.7	802.5	*******	666.8	1265.8
4	353.1	*******	*******	*******	367.8	258.1	653.0	285.6	450.2	329.1	*******	471.1	393.8
5	752.6	*******	*******	*******	488.3	414.8	544.0	306.8	153.0	95.4	*******	179.1	280.7
6	111.6	*******	*******	*******	176.3	240.1	865.2	268.1	187.1	60.6	*******	79.3	126.4
7	48.1	*******	*******	*******	98.7	105.7	284.1	406.8	169.2	77.4	*******	28.1	78.9
8	15.9	*******	*******	*******	89.8	56.7	151.7	173.7	236.6	78.2	*******	13.8	25.2
9	6.5	*******	*******	*******	58.0	63.4	156.2	131.9	201.5	114.8	*******	36.8	32.3

x 10 ^ 3

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.1950	0.0922	0.0397	0.0003	0.0048	0.0355	0.0276	0.0446	0.0031	0.0551	0.0616	0.0148	0.0029	0.0135	0.0528
2	0.7714	0.3541	0.2947	0.0005	0.0007	0.3229	0.6592	0.3907	0.2340	0.2122	0.5515	0.2828	0.2003	0.1311	0.1947
3	1.2161	0.6028	0.2702	0.0007	0.0004	0.4295	0.6037	0.5948	0.5016	0.3104	0.4769	0.3286	0.3101	0.3035	0.2230
4	1.0806	0.9383	0.5292	0.0003	0.0006	0.3979	0.8056	0.4996	0.4447	0.3055	0.4151	0.3092	0.3336	0.2137	0.3292
5	0.8916	0.9458	0.7667	0.0002	0.0003	0.3074	0.7202	0.9710	0.4557	0.3137	0.5642	0.2745	0.2838	0.3270	0.4591
6	1.0775	1.4584	1.0815	0.0015	0.0002	0.3160	0.5725	0.7864	0.6649	0.3331	0.6549	0.4703	0.2219	0.1502	0.3767
7	1.1196	0.8916	0.9923	0.0023	0.0017	0.3128	0.4687	0.7590	0.5987	1.0011	0.1864	0.5368	0.2963	0.1560	0.2651
8	1.0283	0.8612	0.6473	0.0009	0.0006	0.3538	0.6591	0.6604	0.4761	0.3919	0.5019	0.3676	0.2735	0.2110	0.3097
9	1.0283	0.8612	0.6473	0.0009	0.0006	0.3538	0.6591	0.6604	0.4761	0.3919	0.5019	0.3676	0.2735	0.2110	0.3097

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999

1	0.1206	0.0114	0.0505	0.0022	0.0021	0.0021	0.0038	0.0044	0.0022
2	0.1905	0.2705	0.5238	0.1760	0.1664	0.1642	0.2996	0.3471	0.1701
3	0.1876	0.3455	0.3650	0.2805	0.2652	0.2616	0.4776	0.5533	0.2712
4	0.2249	0.2562	0.2386	0.2497	0.2360	0.2329	0.4250	0.4924	0.2414
5	0.2456	0.2428	0.1991	0.2659	0.2513	0.2480	0.4526	0.5244	0.2570
6	0.3987	0.3251	0.2307	0.2309	0.2183	0.2154	0.3931	0.4555	0.2232
7	0.3400	0.2934	0.2752	0.3071	0.2902	0.2864	0.5227	0.6056	0.2968
8	0.2667	0.2942	0.3278	0.2497	0.2360	0.2329	0.4250	0.4924	0.2414
9	0.2667	0.2942	0.3278	0.2497	0.2360	0.2329	0.4250	0.4924	0.2414

Table 5.1.9. contd.

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	606.8	621.0	913.4	1216.9	885.9	1661.2	770.7	2959.3	1130.4	1198.8	889.7	2089.3	940.9	733.0	438.0
2	675.1	183.7	208.3	323.0	447.5	324.4	589.8	275.8	1041.2	414.6	417.4	307.8	757.3	345.1	266.0
3	156.1	231.2	95.5	114.9	239.1	331.3	174.0	226.0	138.2	610.4	248.4	178.1	171.8	459.2	224.3
4	56.0	37.9	103.6	59.7	94.0	195.7	176.5	77.9	102.1	68.5	366.4	126.2	105.0	103.2	277.5

5	44.5	17.2	13.4	55.2	54.0	85.0	118.9	71.4	42.8	59.2	45.7	218.9	83.8	68.0	75.4
6	120.5	16.5	6.0	5.6	50.0	48.8	56.6	52.4	24.5	24.5	39.2	23.5	150.5	57.1	44.4
7	16.9	37.1	3.5	1.9	5.1	45.2	32.2	28.9	21.6	11.4	15.9	18.4	13.3	109.1	44.5
8	6.3	5.0	13.8	1.2	1.7	4.6	29.9	18.2	12.2	10.7	3.8	11.9	9.7	8.9	84.4
9	19.5	2.7	3.4	8.1	8.4	4.7	8.7	18.3	5.4	7.1	5.2	20.4	10.3	19.3	21.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	364.0	734.2	566.7	888.8	562.5	867.6	982.2	1424.2	5582.7	1699.7
2	152.8	118.7	267.0	198.2	326.2	206.5	318.5	360.0	521.6	2049.3
3	162.2	93.6	67.1	117.2	123.1	204.6	129.8	174.9	188.5	326.0
4	146.9	110.1	54.2	38.1	72.5	77.3	129.0	65.9	82.3	117.6
5	180.7	106.2	77.1	38.7	26.9	51.8	55.4	76.3	36.5	58.5
6	43.1	127.9	75.3	57.2	26.8	18.9	36.6	31.9	40.9	25.5
7	27.6	26.2	83.6	54.1	41.1	19.5	13.8	22.3	18.3	29.6

8	30.9	17.8	17.7	57.4	36.0	27.8	13.3	7.4	11.0	12.3
9	20.0	22.7	14.0	48.4	48.8	157.1	29.9	9.0	5.3	11.6

x 10 ^ 6

Weighting factors for the catches in number

AGE	1994	1995	1996	1997	1998	1999
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.1.9. contd.

Predicted SSB Index Values

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	827.1	380.7	327.0	855.9	2687.7	3061.5	2022.5	1027.3	2451.7	3887.4	3073.7	2590.1	3885.4	4982.0	4200.3

INDEX1

	1991	1992	1993
1	2574.3	*******	1362.4

Predicted Age-Structured Index Values

FLT01: West Scotland Summer Acoustic Su Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	345.0	*******	*******	*******	57.6	121.4	92.2	147.5	93.4	144.0	*******	236.1	926.4
2	678.6	*******	*******	*******	349.7	263.0	534.6	456.0	753.6	477.4	*******	773.5	1203.1
3	716.3	*******	*******	*******	690.2	373.9	265.9	480.3	507.9	845.3	*******	642.8	775.5
4	597.1	*******	*******	*******	718.7	531.9	263.9	184.7	352.9	377.1	*******	289.8	400.2
5	915.2	*******	*******	*******	764.3	449.5	332.3	162.2	113.5	218.8	*******	288.7	153.5
6	90.6	*******	*******	*******	171.0	522.4	319.6	242.5	114.3	80.7	*******	123.7	173.8
7	60.5	*******	*******	*******	98.1	94.9	305.3	195.2	149.0	70.9	*******	71.4	66.3
8	35.9	*******	*******	*******	96.6	54.9	53.9	180.9	114.1	88.1	*******	21.2	34.8
9	52.1	*******	*******	*******	53.1	59.6	36.4	129.8	131.5	423.6	*******	21.8	14.3

x 10 ^ 3

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990

1	0.1805	0.0983	0.0750	0.9598	8.4489	0.0892	0.0343	0.0893	0.0070	0.1803	0.1484	0.0480	0.0086	0.0631	0.1603
2	0.7139	0.3774	0.5570	1.5213	1.2662	0.8116	0.8183	0.7821	0.5263	0.6946	1.3286	0.9147	0.6005	0.6137	0.5915
3	1.1253	0.6425	0.5106	2.2099	0.7690	1.0795	0.7494	1.1906	1.1280	1.0161	1.1489	1.0629	0.9293	1.4207	0.6774
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8251	1.0080	1.4489	0.7393	0.4439	0.7726	0.8940	1.9437	1.0247	1.0267	1.3592	0.8880	0.8507	1.5303	1.3948
6	0.9971	1.5543	2.0439	4.4588	0.3321	0.7941	0.7107	1.5741	1.4953	1.0901	1.5776	1.5214	0.6651	0.7030	1.1445
7	1.0361	0.9502	1.8753	6.7857	2.8967	0.7861	0.5818	1.5194	1.3463	3.2768	0.4489	1.7363	0.8881	0.7301	0.8054
8	0.9516	0.9178	1.2233	2.6929	1.1020	0.8892	0.8181	1.3219	1.0707	1.2828	1.2090	1.1890	0.8198	0.9876	0.9407
9	0.9516	0.9178	1.2233	2.6929	1.1020	0.8892	0.8181	1.3219	1.0707	1.2828	1.2090	1.1890	0.8198	0.9876	0.9407

Table 5.1.9. contd.

Fitted Selection Pattern

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.5361	0.0444	0.2118	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089
2	0.8469	1.0556	2.1955	0.7050	0.7050	0.7050	0.7050	0.7050	0.7050
3	0.8341	1.3482	1.5299	1.1236	1.1236	1.1236	1.1236	1.1236	1.1236
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0919	0.9474	0.8346	1.0649	1.0649	1.0649	1.0649	1.0649	1.0649
6	1.7725	1.2687	0.9670	0.9249	0.9249	0.9249	0.9249	0.9249	0.9249
7	1.5114	1.1451	1.1537	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298
8	1.1857	1.1483	1.3739	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.1857	1.1483	1.3739	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1976	606840	263931	73602	93642	1.2723	1.0664	100
1977	620990	163036	52055	41341	0.7942	0.9863	109
1978	913430	170795	48641	22156	0.4555	0.6619	99
1979	1216890	218472	74738	60	0.0008	0.0007	99
1980	885930	254866	124564	306	0.0025	0.0004	99
1981	1661200	364696	132022	51420	0.3895	0.3627	103
1982	770670	305828	109715	92360	0.8418	0.6755	96
1983	2959320	425197	81082	63523	0.7834	0.7129	97
1984	1130360	352146	119557	56012	0.4685	0.5167	105
1985	1198780	347444	146875	39142	0.2665	0.3157	99
1986	889740	313311	132255	70764	0.5351	0.5278	95
1987	2089340	378657	122525	44360	0.3620	0.3457	102
1988	940870	336703	146842	35591	0.2424	0.2873	97
1989	733010	309451	164078	34026	0.2074	0.2486	98
1990	438000	264637	152041	44693	0.2940	0.3470	101

1991	364020	202355	122191	28529	0.2335	0.2642	93
1992	734150	207151	98890	28985	0.2931	0.2924	99
1993	566650	174837	91975	31778	0.3455	0.2583	100
1994	888790	171589	82913	24430	0.2946	0.2568	100
1995	562530	154712	71501	29575	0.4136	0.2427	99
1996	867610	188990	108705	26105	0.2401	0.2395	95
1997	982200	191774	77649	35233	0.4537	0.4371	99
1998	1424150	219893	75582	33353	0.4413	0.5064	100
1999	5582650	444053	83689	29736	0.3553	0.2482	99

Table 5.1.9. contd.

```
      years for separable analysis : 6

Age range in the analysis : 1  . . . 9

Year range in the analysis : 1976  . . . 1999

Number of indices of SSB : 1

Number of age-structured indices : 1


Parameters to estimate : 36

Number of observations : 146
```

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1994	0.2497	23	0.1585	0.3934	0.1980	0.3148	0.2565
2	1995	0.2360	23	0.1502	0.3708	0.1874	0.2972	0.2424
3	1996	0.2329	23	0.1463	0.3706	0.1837	0.2952	0.2395
4	1997	0.4250	25	0.2569	0.7034	0.3287	0.5496	0.4393
5	1998	0.4924	33	0.2567	0.9446	0.3532	0.6865	0.5204
6	1999	0.2414	44	0.1015	0.5741	0.1551	0.3756	0.2661
Separable Model: Selection (S) by age								
7	1	0.0089	27	0.0052	0.0153	0.0067	0.0118	0.0093
8	2	0.7050	24	0.4402	1.1291	0.5544	0.8964	0.7256
9	3	1.1236	22	0.7265	1.7378	0.8995	1.4036	1.1517
	4	1.0000	Fixed : Reference Age					
10	5	1.0649	20	0.7111	1.5947	0.8666	1.3085	1.0877

11	6	0.9249	19	0.6263	1.3659	0.7581	1.1285	0.9434
12	7	1.2298	19	0.8403	1.8000	1.0126	1.4936	1.2533
	8	1.0000		Fixed : Last true age				

Separable model: Populations in year 1999

13	1	5582655	65	1557803	20006395	2910853	10706837	6901280
14	2	521622	46	211425	1286932	329044	826910	580036
15	3	188458	41	84010	422764	124793	284601	205169
16	4	82331	41	36154	187487	54102	125289	89917
17	5	36458	40	16574	80196	24385	54509	39529
18	6	40861	40	18506	90224	27277	61211	44338
19	7	18303	39	8476	39522	12358	27107	19770
20	8	11025	43	4700	25865	7136	17035	12120

Separable model: Populations at age

21	1994	57442	41	25331	130260	37828	87227	62679
22	1995	36029	33	18732	69300	25806	50303	38093
23	1996	27793	30	15421	50089	20578	37536	29076
24	1997	13254	28	7554	23253	9949	17656	13810
25	1998	7403	33	3843	14259	5298	10343	7829

Table 5.1.9. contd.

SSB Index catchabilities

INDEX1

Power model fitted. Slopes (Q) and exponents (K) at age

26	1	Q	9.393	19	8.353	17.89	10.07	14.85	12.46
27	1	K	.1037E-07	19	.1495E-06	.3202E-06	.1801E-06	.2657E-06	.2411E-06

Age-structured index catchabilities

FLT01: West Scotland Summer Acoustic Su

Linear model fitted. Slopes at age :

28	1	Q	.2478	123	.7551E-01	9.664	.2478	2.945	1.838
29	2	Q	2.784	40	1.884	9.268	2.784	6.274	4.539
30	3	Q	4.968	40	3.369	16.45	4.968	11.16	8.081
31	4	Q	5.572	40	3.777	18.48	5.572	12.52	9.067
32	5	Q	4.857	40	3.290	16.14	4.857	10.93	7.913
33	6	Q	4.842	40	3.274	16.18	4.842	10.94	7.909
34	7	Q	4.243	41	2.859	14.33	4.243	9.657	6.966
35	8	Q	3.623	41	2.422	12.54	3.623	8.382	6.017

36 9 Q 3.081 41 2.077 10.39 3.081 7.006 5.055

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1994	1995	1996	1997	1998	1999
1	0.325	-1.032	0.541	-0.677	0.836	0.007
2	0.275	0.639	0.333	-0.252	-0.215	-0.697
3	0.432	0.152	-0.328	-0.253	-0.676	0.835
4	-0.291	0.382	-0.508	-0.298	0.264	0.399
5	-0.147	-0.058	-0.368	0.182	-0.263	0.528
6	-0.327	-0.176	-0.335	0.433	0.254	-0.035
7	-0.261	-0.114	0.014	0.654	-0.116	-0.322
8	0.005	0.099	0.429	0.173	0.027	-0.584

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.476	0.726	0.015	0.224	-0.627	-0.352	-0.068	-0.430	-0.139	-0.361	-0.012	0.464	0.426	-0.143	0.440

Table 5.1.9. contd.

INDEX1

	1991	1992	1993
1	0.543	*******	0.769

AGE-STRUCTURED INDEX RESIDUALS

FLT01: West Scotland Summer Acoustic Su

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.326	*******	*******	*******	1.770	-0.491	-3.509	1.209	1.596	-1.251	*******	1.644	-0.643
2	-0.160	*******	*******	*******	-0.172	0.649	0.339	0.173	0.365	0.188	*******	0.027	-1.409
3	-0.262	*******	*******	*******	-0.744	-0.572	0.941	0.235	-0.072	-0.052	*******	0.037	0.490
4	-0.525	*******	*******	*******	-0.670	-0.723	0.906	0.436	0.244	-0.136	*******	0.486	-0.016
5	-0.196	*******	*******	*******	-0.448	-0.081	0.493	0.637	0.299	-0.831	*******	-0.478	0.603
6	0.208	*******	*******	*******	0.031	-0.777	0.996	0.101	0.492	-0.287	*******	-0.445	-0.319
7	-0.230	*******	*******	*******	0.007	0.107	-0.072	0.735	0.127	0.087	*******	-0.935	0.174
8	-0.814	*******	*******	*******	-0.072	0.032	1.034	-0.041	0.729	-0.120	*******	-0.424	-0.324
9	-2.081	*******	*******	*******	0.089	0.062	1.456	0.016	0.427	-1.306	*******	0.524	0.814

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1994 to 1999

Variance	0.3648
Skewness test stat.	-0.1664
Kurtosis test statistic	-0.6227
Partial chi-square	0.9541
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

Table 5.1.9. contd.

DISTRIBUTION STATISTICS FOR INDEX1

Power catchability relationship assumed

Last age is a plus-group

Variance	0.3407
Skewness test stat.	-1.4216
Kurtosis test statistic	0.6550
Partial chi-square	0.7258
Significance in fit	0.0000
Number of observations	17
Degrees of freedom	15
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: West Scotland Summer Acoustic Su

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0340	0.0386	0.0297	0.0357	0.0315	0.0316	0.0214	0.0357	0.1290
Skewness test stat.	-0.9026	-1.9342	0.4047	0.1147	-0.1670	0.5391	-0.8180	0.7500	-0.9596
Kurtosis test statisti	-0.1816	1.1349	-0.3172	-0.7374	-0.8344	-0.2760	0.6335	-0.2449	-0.1304
Partial chi-square	0.0235	0.0226	0.0184	0.0222	0.0204	0.0202	0.0148	0.0263	0.0939
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8	8	8
Weight in the analysis	0.0111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	63.4072	146	36	110	0.5764

Catches at age	8.3900	48	25	23	0.3648
SSB Indices					
INDEX1	5.1104	17	2	15	0.3407
Aged Indices					
FLT01: West Scotland Summer Acoustic S	49.9068	81	9	72	0.6932

Table 5.1.9. contd.

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	13.8173	146	36	110	0.1256
Catches at age	8.3900	48	25	23	0.3648
SSB Indices					

INDEX1	5.1104	17	2	15	0.3407

Aged Indices

FLT01: West Scotland Summer Acoustic S	0.3169	81	9	72	0.0044

Table 5.1.10. Herring in VIa(N). Input data and estimated parameters from weighted least-squares ICA calculation for the 7 year separable period.

Output Generated by ICA Version 1.4 — Herring VIa (north) (run: ICAPGF03/I03)

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.1918	0.0910	0.0393	0.0003	0.0047	0.0351	0.0269	0.0420	0.0029	0.0522	0.0568	0.0133	0.0023	0.0105	0.0408
2	0.7577	0.3463	0.2900	0.0005	0.0007	0.3157	0.6491	0.3789	0.2185	0.1960	0.5136	0.2570	0.1782	0.1026	0.1482
3	1.1992	0.5820	0.2621	0.0007	0.0004	0.4271	0.5824	0.5780	0.4783	0.2840	0.4271	0.2949	0.2731	0.2617	0.1674
4	1.0664	0.9021	0.4979	0.0003	0.0006	0.3934	0.7971	0.4697	0.4240	0.2848	0.3661	0.2636	0.2877	0.1817	0.2699
5	0.8846	0.9128	0.7018	0.0002	0.0002	0.3007	0.7059	0.9464	0.4135	0.2929	0.5072	0.2310	0.2304	0.2676	0.3684
6	1.0593	1.4208	0.9840	0.0013	0.0002	0.3034	0.5532	0.7541	0.6288	0.2894	0.5870	0.3960	0.1787	0.1166	0.2865
7	1.0919	0.8533	0.9143	0.0019	0.0015	0.2856	0.4416	0.7106	0.5521	0.8834	0.1559	0.4443	0.2325	0.1208	0.1957
8	0.9234	0.8074	0.5911	0.0008	0.0005	0.3051	0.5705	0.5960	0.4234	0.3446	0.3936	0.2923	0.2087	0.1559	0.2263
9	0.9234	0.8074	0.5911	0.0008	0.0005	0.3051	0.5705	0.5960	0.4234	0.3446	0.3936	0.2923	0.2087	0.1559	0.2263

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0931	0.0100	0.0048	0.0029	0.0026	0.0024	0.0041	0.0043	0.0021
2	0.1432	0.1988	0.2699	0.1636	0.1444	0.1361	0.2324	0.2422	0.1168
3	0.1360	0.2414	0.3411	0.2068	0.1825	0.1720	0.2937	0.3062	0.1476
4	0.1588	0.1738	0.2234	0.1354	0.1195	0.1126	0.1923	0.2005	0.0967
5	0.1900	0.1592	0.2376	0.1441	0.1271	0.1199	0.2046	0.2133	0.1028
6	0.2895	0.2341	0.1965	0.1191	0.1051	0.0991	0.1692	0.1764	0.0850
7	0.2345	0.1915	0.2378	0.1441	0.1272	0.1199	0.2047	0.2134	0.1029
8	0.1824	0.1820	0.2234	0.1354	0.1195	0.1126	0.1923	0.2005	0.0967
9	0.1824	0.1820	0.2234	0.1354	0.1195	0.1126	0.1923	0.2005	0.0967

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	616.3	629.1	921.6	1222.5	903.3	1679.3	790.0	3138.4	1214.5	1262.8	963.1	2321.6	1186.2	939.6	563.2

2	683.5	187.2	211.3	326.0	449.6	330.7	596.5	282.9	1107.1	445.5	440.9	334.8	842.8	435.4	342.0
3	157.3	237.3	98.1	117.1	241.4	332.8	178.7	230.9	143.5	659.1	271.3	195.5	191.8	522.4	291.1
4	56.4	38.8	108.6	61.8	95.8	197.5	177.8	81.7	106.1	72.8	406.2	144.9	119.2	119.5	329.2
5	44.8	17.6	14.3	59.7	55.9	86.7	120.6	72.5	46.2	62.8	49.5	254.9	100.7	80.9	90.2
6	121.7	16.7	6.4	6.4	54.0	50.6	58.1	53.9	25.5	27.7	42.4	27.0	183.1	72.4	56.0
7	17.1	38.2	3.7	2.2	5.8	48.9	33.8	30.2	22.9	12.3	18.7	21.3	16.4	138.5	58.3
8	6.8	5.2	14.7	1.3	1.9	5.2	33.2	19.6	13.4	11.9	4.6	14.5	12.4	11.8	111.1
9	20.8	2.8	3.6	9.2	9.5	5.3	9.7	19.8	5.9	7.9	6.3	24.7	13.1	25.5	28.6

x 10 ^ 6

Table 5.1.10. contd. Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	466.4	838.6	972.8	1122.6	715.4	1113.3	1230.5	1724.5	5826.6	1463.0
2	198.9	156.3	305.5	356.2	411.8	262.5	408.6	450.8	631.7	2139.1
3	218.5	127.7	94.9	172.8	224.0	264.1	169.7	239.9	262.1	416.4
4	201.6	156.1	82.1	55.3	115.0	152.8	182.0	103.6	144.6	185.2
5	227.4	155.6	118.7	59.4	43.7	92.4	123.6	135.9	76.7	118.8

6	56.4	170.2	120.1	84.7	46.6	34.8	74.1	91.1	99.3	62.6
7	38.0	38.2	121.8	89.3	68.0	37.9	28.5	56.6	69.1	82.6
8	43.4	27.2	28.6	86.9	69.9	54.2	30.4	21.0	41.4	56.4
9	28.0	34.8	19.6	84.6	91.2	306.6	59.3	19.2	12.4	44.2

x 10 ^ 6

Weighting factors for the catches in number

AGE	1993	1994	1995	1996	1997	1998	1999
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

------+--

Predicted SSB Index Values

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	710.4	352.2	311.4	748.5	2141.2	2425.9	1682.2	914.2	2171.4	3511.5	3015.8	2751.2	4122.7	5645.5	5490.9

INDEX1

	1991	1992	1993
1	3905.2	*******	2491.5

Table 5.1.10. contd.

Predicted Age-Structured Index Values

FLT01: West Scotland Summer Acoustic Su Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	307.5	*******	*******	*******	59.8	111.2	129.3	149.3	95.2	148.1	*******	229.3	775.3
2	567.8	*******	*******	*******	353.0	271.4	515.4	627.1	730.6	467.3	*******	769.1	1133.2
3	555.9	*******	*******	*******	662.1	370.9	265.0	509.0	666.5	788.8	*******	679.3	790.7
4	441.9	*******	*******	*******	641.0	493.6	254.4	177.4	371.6	495.1	*******	324.0	471.5
5	667.1	*******	*******	*******	605.0	419.1	309.9	161.0	119.1	252.7	*******	358.1	211.3
6	61.2	*******	*******	*******	133.4	411.4	294.7	214.4	118.5	88.8	*******	225.4	254.9
7	38.7	*******	*******	*******	75.0	76.7	240.0	182.6	140.1	78.3	*******	112.7	143.7
8	23.1	*******	*******	*******	72.1	45.3	46.8	147.3	119.3	92.7	*******	34.7	71.3
9	36.6	*******	*******	*******	43.4	53.7	29.8	133.3	144.6	487.4	*******	29.5	19.9

x 10 ^ 3

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.1798	0.1008	0.0789	0.9891	8.4452	0.0893	0.0338	0.0895	0.0068	0.1833	0.1551	0.0506	0.0079	0.0579	0.1513
2	0.7105	0.3839	0.5824	1.5603	1.2846	0.8024	0.8143	0.8066	0.5154	0.6882	1.4030	0.9747	0.6193	0.5645	0.5493
3	1.1246	0.6452	0.5265	2.2447	0.7765	1.0857	0.7306	1.2304	1.1280	0.9971	1.1667	1.1186	0.9492	1.4403	0.6202
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8295	1.0119	1.4095	0.7079	0.4370	0.7644	0.8856	2.0148	0.9751	1.0284	1.3855	0.8761	0.8006	1.4730	1.3649
6	0.9934	1.5750	1.9763	4.0719	0.3130	0.7713	0.6940	1.6054	1.4828	1.0161	1.6037	1.5021	0.6211	0.6417	1.0617
7	1.0240	0.9459	1.8364	6.0313	2.6038	0.7261	0.5541	1.5128	1.3020	3.1015	0.4260	1.6853	0.8080	0.6646	0.7252
8	0.8659	0.8951	1.1873	2.4537	0.9641	0.7754	0.7157	1.2689	0.9984	1.2096	1.0751	1.1089	0.7253	0.8581	0.8386
9	0.8659	0.8951	1.1873	2.4537	0.9641	0.7754	0.7157	1.2689	0.9984	1.2096	1.0751	1.1089	0.7253	0.8581	0.8386

Fitted Selection Pattern

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999

1	0.5858	0.0573	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214
2	0.9018	1.1441	1.2082	1.2082	1.2082	1.2082	1.2082	1.2082	1.2082
3	0.8559	1.3896	1.5273	1.5273	1.5273	1.5273	1.5273	1.5273	1.5273
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1963	0.9160	1.0640	1.0640	1.0640	1.0640	1.0640	1.0640	1.0640
6	1.8224	1.3474	0.8796	0.8796	0.8796	0.8796	0.8796	0.8796	0.8796
7	1.4763	1.1020	1.0645	1.0645	1.0645	1.0645	1.0645	1.0645	1.0645
8	1.1483	1.0475	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.1483	1.0475	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.1.10. contd.

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)

1976	616330	267398	75525	93642	1.2399	1.0524	100
1977	629090	166325	54152	41341	0.7634	0.9544	109
1978	921640	174371	51080	22156	0.4337	0.6115	99
1979	1222460	222138	77422	60	0.0008	0.0006	99
1980	903270	259709	127432	306	0.0024	0.0004	99
1981	1679270	370241	135200	51420	0.3803	0.3562	103
1982	789950	312278	113657	92360	0.8126	0.6596	96
1983	3138430	446171	85119	63523	0.7463	0.6871	97
1984	1214460	374461	128280	56012	0.4366	0.4861	105
1985	1262840	371878	161114	39142	0.2429	0.2878	99
1986	963120	340867	149898	70764	0.4721	0.4718	95
1987	2321640	424402	143513	44360	0.3091	0.2964	102
1988	1186150	394949	173849	35591	0.2047	0.2425	97
1989	939600	376963	201790	34026	0.1686	0.2069	98
1990	563150	333601	199151	44693	0.2244	0.2731	101
1991	466380	266847	169440	28529	0.1684	0.1936	93
1992	838630	272552	147707	28985	0.1962	0.2021	99
1993	972820	256690	136923	31778	0.2321	0.2497	100
1994	1122620	260028	140313	24430	0.1741	0.1513	100
1995	715420	237487	131732	29575	0.2245	0.1336	99

1996	1113310	296703	196382	26105	0.1329	0.1259	95
1997	1230490	278794	141344	35233	0.2493	0.2150	99
1998	1724480	310789	141586	33353	0.2356	0.2241	100
1999	5826640	537524	152499	29736	0.1950	0.1080	99

No of years for separable analysis : 7

Age range in the analysis : 1 . . . 9

Year range in the analysis : 1976 . . . 1999

Number of indices of SSB : 1

Number of age-structured indices : 1

Parameters to estimate : 38

Number of observations : 154

Conventional single selection vector model to be fitted.

Table 5.1.10. contd. PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1993	0.2234	25	0.1364	0.3657	0.1737	0.2872	0.2305
2	1994	0.1354	26	0.0810	0.2265	0.1041	0.1760	0.1402
3	1995	0.1195	26	0.0707	0.2021	0.0914	0.1562	0.1239
4	1996	0.1126	27	0.0653	0.1944	0.0853	0.1488	0.1171
5	1997	0.1923	30	0.1061	0.3485	0.1420	0.2605	0.2014
6	1998	0.2005	34	0.1010	0.3978	0.1413	0.2844	0.2131
7	1999	0.0967	40	0.0435	0.2146	0.0643	0.1452	0.1050
Separable Model: Selection (S) by age								
8	1	0.0214	28	0.0123	0.0372	0.0161	0.0283	0.0222
9	2	1.2082	24	0.7498	1.9467	0.9472	1.5411	1.2445
10	3	1.5273	22	0.9840	2.3707	1.2204	1.9114	1.5662
	4	1.0000		Fixed : Reference Age				

11	5	1.0640	20	0.7085	1.5978	0.8646	1.3093	1.0871
12	6	0.8796	20	0.5895	1.3125	0.7172	1.0788	0.8981
13	7	1.0645	20	0.7110	1.5936	0.8664	1.3078	1.0873
	8	1.0000	Fixed : Last true age					

Separable model: Populations in year 1999

14	1	5826648	67	1561938	21735707	2976508	11405925	7301110
15	2	631691	49	237402	1680830	383405	1040762	715552
16	3	262123	45	106876	642877	165851	414278	291071
17	4	144617	44	60502	345675	92711	225582	159640
18	5	76705	40	34585	170120	51089	115164	83308
19	6	99329	38	46618	211641	67525	146114	107009
20	7	69108	36	33823	141201	47996	99506	73856
21	8	41395	35	20817	82316	29150	58785	44021

Separable model: Populations at age

22	1993	28567	45	11741	69504	18148	44965	31663
23	1994	86920	34	44407	170134	61704	122443	92176
24	1995	69937	31	37923	128977	51179	95570	73431
25	1996	54218	29	30259	97149	40264	73009	56672

26	1997	30433	30	16856	54947	22513	41140	31848
27	1998	21023	32	11202	39453	15248	28985	22135

SSB Index catchabilities

INDEX1

Power model fitted. Slopes (Q) and exponents (K) at age

28	1	Q	8.242	20	7.112	15.94	8.666	13.08	10.88
29	1	K	.3652E-07	20	.4867E-06	.1091E-05	.5931E-06	.8953E-06	.8077E-06

Table 5.1.10. contd. Age-structured index catchabilities

FLT01: West Scotland Summer Acoustic Su

Linear model fitted. Slopes at age :

30	1	Q	.1987	137	.5299E-01	11.69	.1987	3.118	2.030
31	2	Q	2.119	46	1.362	8.275	2.119	5.320	3.733
32	3	Q	3.467	45	2.231	13.49	3.467	8.681	6.095
33	4	Q	3.527	45	2.271	13.71	3.527	8.826	6.198
34	5	Q	2.987	45	1.927	11.55	2.987	7.448	5.236
35	6	Q	2.763	45	1.782	10.69	2.763	6.892	4.844
36	7	Q	2.255	45	1.455	8.715	2.255	5.622	3.952
37	8	Q	1.862	46	1.197	7.282	1.862	4.679	3.283
38	9	Q	1.731	46	1.112	6.776	1.731	4.353	3.053

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1993	1994	1995	1996	1997	1998	1999
1	1.801	-0.171	-1.466	0.143	-0.983	0.669	0.005
2	0.416	-0.243	0.538	0.268	-0.277	-0.128	-0.537
3	-0.290	0.314	-0.111	-0.205	-0.118	-0.511	1.055
4	-0.356	-0.104	0.544	-0.520	0.042	0.576	0.681
5	-0.591	-0.022	0.079	-0.280	0.059	-0.084	0.627
6	-0.322	-0.112	-0.051	-0.223	0.465	0.023	-0.024
7	-0.248	-0.082	0.129	0.141	0.719	-0.183	-0.683
8	-0.146	0.148	0.060	0.430	0.027	-0.254	-1.061

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990

1	-1.324	0.804	0.064	0.358	-0.400	-0.119	0.116	-0.314	-0.018	-0.259	0.007	0.404	0.366	-0.268	0.173

INDEX1

	1991	1992	1993
1	0.126	*******	0.166

278

277

Table 5.1.10. contd. AGE-STRUCTURED INDEX RESIDUALS

FLT01: West Scotland Summer Acoustic Su

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.211	*******	*******	*******	1.732	-0.403	-3.847	1.197	1.577	-1.279	*******	1.673	-0.465

2	0.019	*******	*******	*******	-0.181	0.618	0.375	-0.146	0.396	0.210	*******	0.033	-1.350
3	-0.009	*******	*******	*******	-0.703	-0.564	0.944	0.177	-0.344	0.017	*******	-0.019	0.471
4	-0.224	*******	*******	*******	-0.555	-0.648	0.943	0.476	0.192	-0.408	*******	0.374	-0.180
5	0.121	*******	*******	*******	-0.214	-0.010	0.563	0.645	0.250	-0.974	*******	-0.693	0.284
6	0.601	*******	*******	*******	0.279	-0.538	1.077	0.224	0.457	-0.382	*******	-1.045	-0.701
7	0.218	*******	*******	*******	0.275	0.320	0.169	0.801	0.188	-0.012	*******	-1.390	-0.599
8	-0.373	*******	*******	*******	0.219	0.225	1.177	0.165	0.685	-0.171	*******	-0.919	-1.040
9	-1.729	*******	*******	*******	0.292	0.166	1.656	-0.011	0.332	-1.446	*******	0.221	0.487

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1993 to 1999

Variance	0.5079
Skewness test stat.	1.0443
Kurtosis test statistic	3.4840
Partial chi-square	1.7239
Significance in fit	0.0000
Degrees of freedom	29

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Power catchability relationship assumed

Last age is a plus-group

Variance	0.2218
Skewness test stat.	-2.0122
Kurtosis test statistic	2.1270
Partial chi-square	0.4984
Significance in fit	0.0000
Number of observations	17
Degrees of freedom	15
Weight in the analysis	1.0000

Table 5.1.10. contd.

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: West Scotland Summer Acoustic Su

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0369	0.0361	0.0288	0.0315	0.0329	0.0538	0.0448	0.0566	0.1157
Skewness test stat.	-1.1715	-1.8463	0.4715	0.5111	-0.7895	-0.0494	-1.4687	0.0098	-0.5275
Kurtosis test statisti	0.0889	1.0248	-0.2969	-0.5917	-0.4409	-0.7123	0.4425	-0.4932	-0.1769
Partial chi-square	0.0252	0.0212	0.0178	0.0198	0.0211	0.0352	0.0306	0.0416	0.0843
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8	8	8
Weight in the analysis	0.0111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	73.4482	154	38	116	0.6332
Catches at age	14.7277	56	27	29	0.5079
SSB Indices					
INDEX1	3.3272	17	2	15	0.2218
Aged Indices					
FLT01: West Scotland Summer Acoustic S	55.3934	81	9	72	0.7694

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	18.4139	154	38	116	0.1587
Catches at age	14.7277	56	27	29	0.5079
SSB Indices					
INDEX1	3.3272	17	2	15	0.2218
Aged Indices					
FLT01: West Scotland Summer Acoustic S	0.3590	81	9	72	0.0050

Table 5.1.11. Herring in VIa(N). Example ICP log file as used for stochastic projections.

```
                         Medium-Term Projections

                       -----------------------


                                 ICP



                            K.R. Patterson

                      SOAEFD Marine Laboratory

                               Aberdeen





                  Written  December 1997 for ICA v1.4 w






 Enter Random-Number seed--> 120

 Enter the no. of years between spawning and  recruitment at age--> 1

 Change any of the populations (Y/N) ?-->n

 Enter the name of the projection file -->fmult.dat

Population parameters for the projections are set by taking a mean over a

number of the last years of the data set.

 Use mean natural mortality from 1999  back to--> 1995

 Use mean maturity ogive from 1999  back to--> 1995

 Use mean weight at age in the stock from 1999  back to--> 1995

 Enter    the    reference    spawning    stock    size    (e.g.    MBAL,    Bpa)-->
1.000000000000000

 Enter the maximum allowable F-multiplier-->   10.000000000000000

Choose type of stock recruit relation :
```

```
S -     Shepherd        R = a.SSB/(1+SSB/b)^c

B -  Beverton-Holt   R = a.SSB/(1+SSB/b)

R -  Ricker          R = a.SSB.exp(-b.SSB)

O -  Ockham          R = GM over observed SSB range

                            then linear to origin

N -     None            R = Historic Geometric Mean R

 Enter your choice (S/B/R/O/N) ?-->n

 Enter first year of data for stock-recruit model--> 1986

 Enter last year of data for stock-recruit model--> 1999

 Autocorrelated or Independent errors (I/A)-->i

 Use ICA or SRR (I/S) model value for recruitment in 1999-->s

 Use ICA or SRR (I/S) model value for recruitment in 2000-->s

 Use default percentiles (Y/N)  ?-->y

 Use ICA-derived resamples ?-->n

 Enter the number of MC simulations to run--> 500

F-multiplier reset to  10.0000  for fleet   1  in year 1977

F-multiplier reset to  10.0000  for fleet   1  in year 1977
```

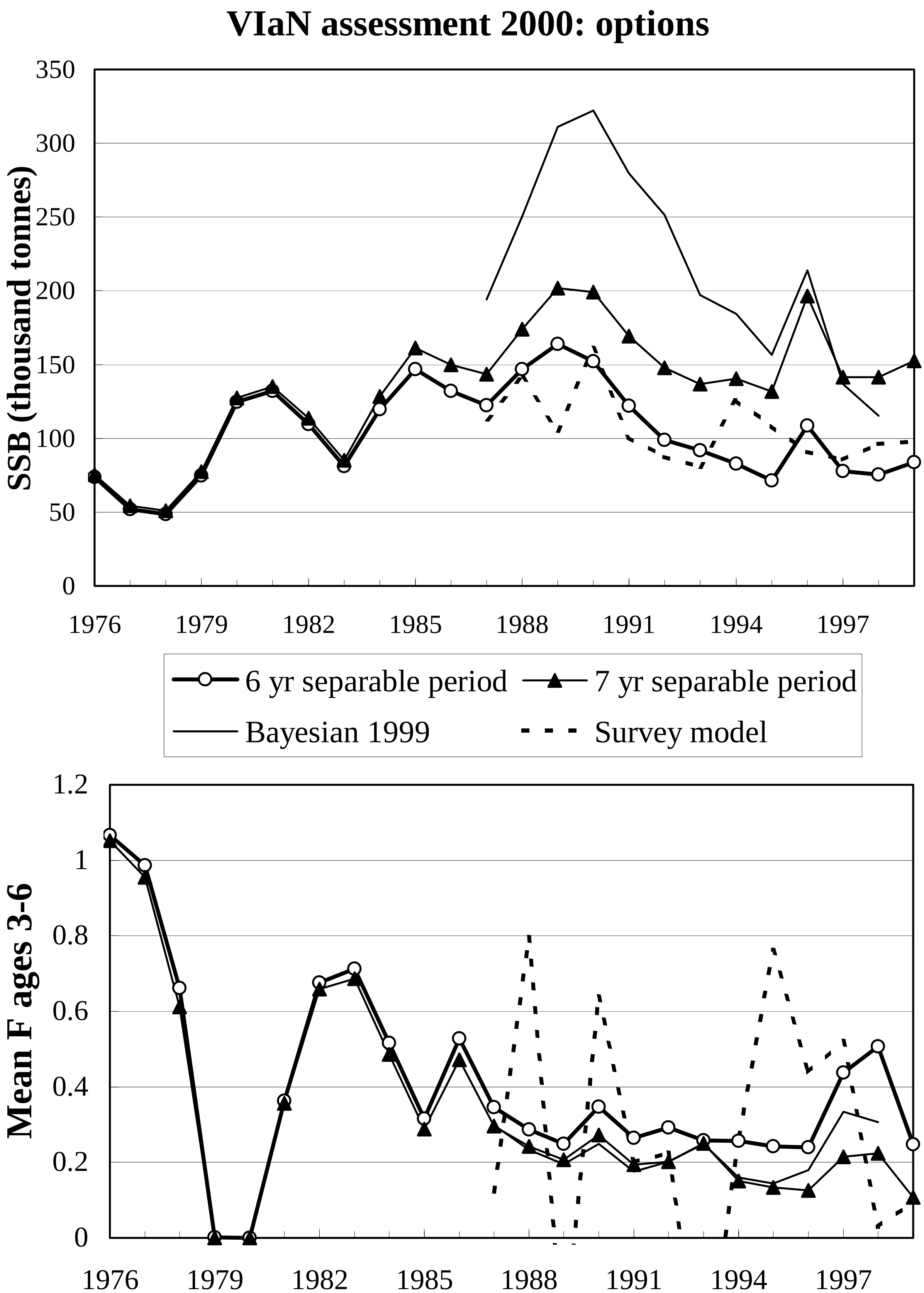


Figure 5.1.1. Comparison of spawning stock biomass (SSB, [top]) and mean fishing mortality (F) over ages 3-6 resulting from Integrated Catch at Age analysis (version 1.4w) model runs using a 6 and 7 year separable period. Also plotted are the results from the 1999 Bayesian assessment and the baseline survey model described in Section 5.1.10.1 (negative values of F derived from the survey model in 1989 and 1993 are not shown).

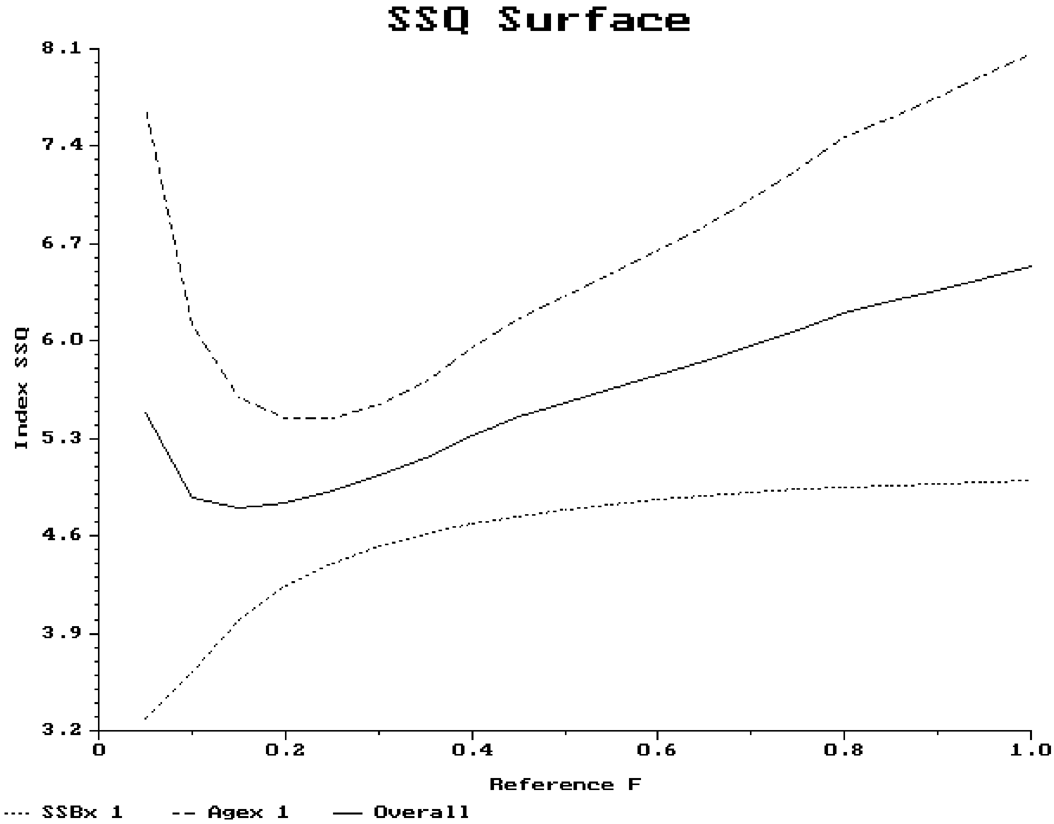


Figure 5.1.2 Herring in VIa(N). SSQ surface for the deterministic calculation of the 6 year separable period. SSBx 1 - larval production estimates from 1973-1993; Agex1- age disaggregated acoustic estimates.

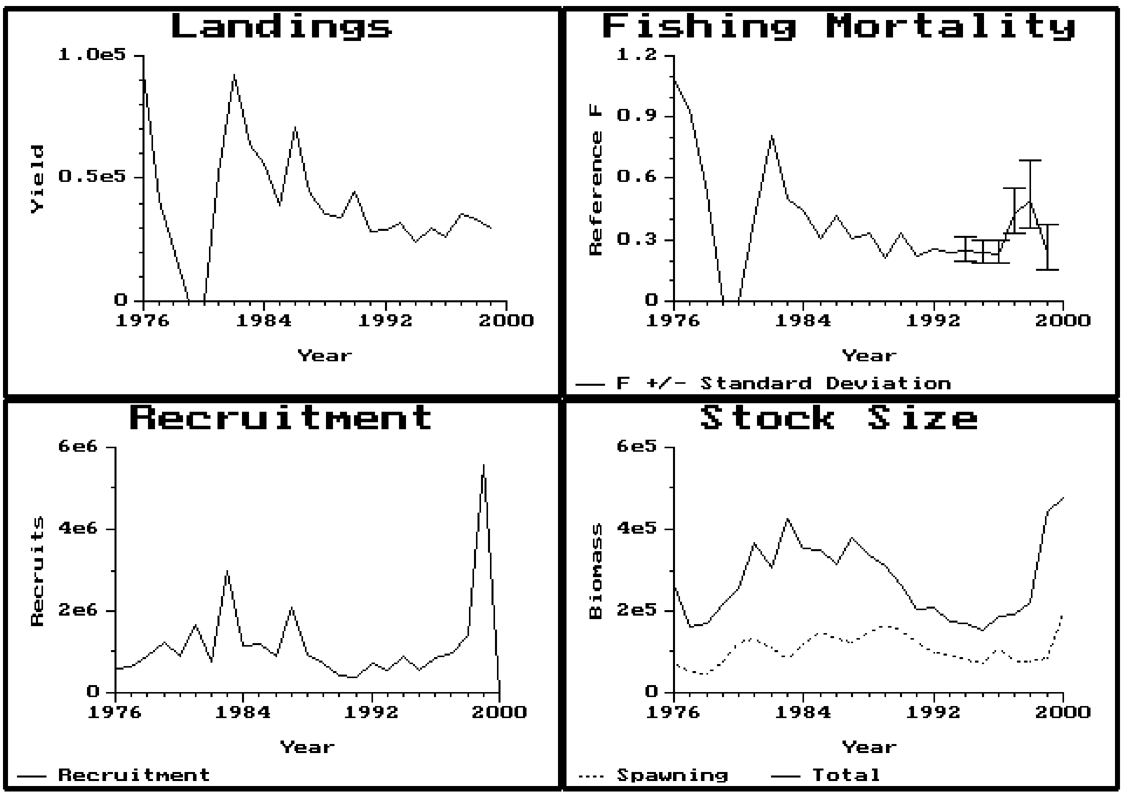


Figure 5.1.3 Herring in VIa(N). Illustration of stock trends from deterministic calculation (6 year separable period). Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock at spawning time.

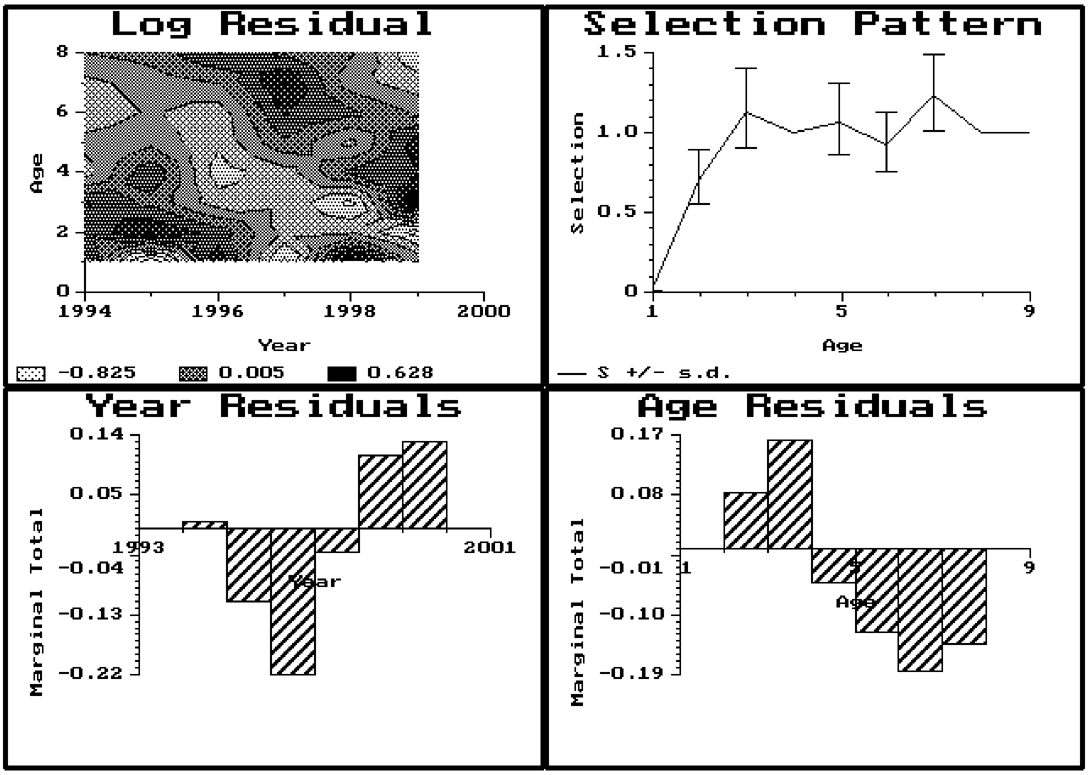


Figure 5.1.4 Illustration of selection patterns diagnostics, from deterministic calculation (6 year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

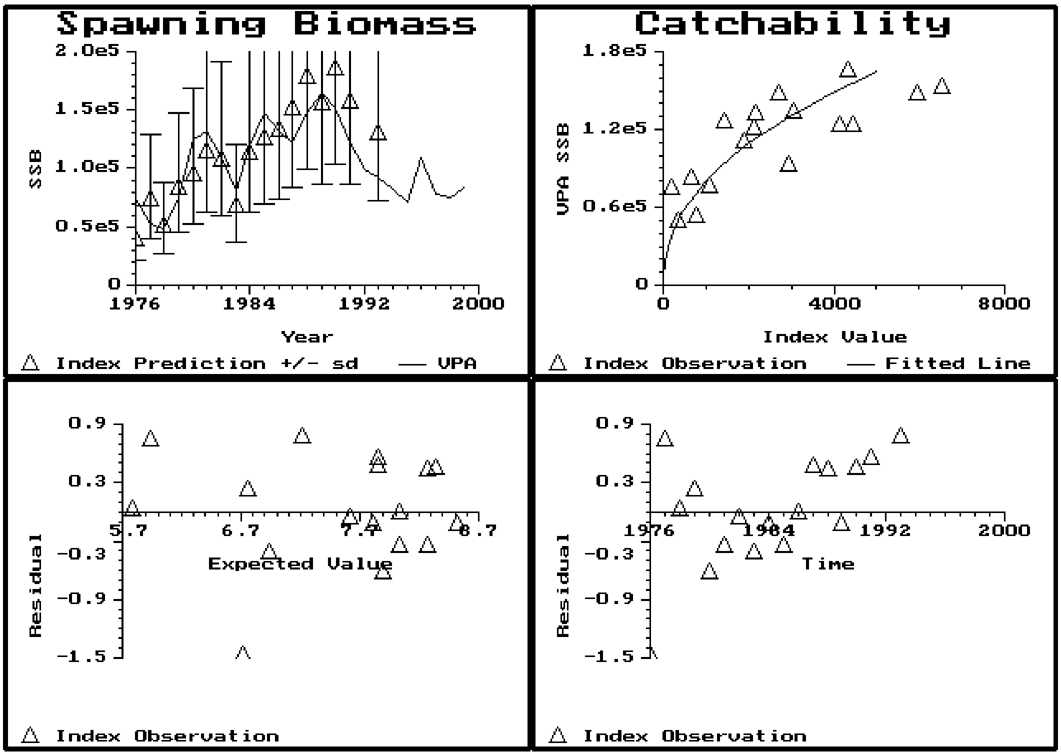


Figure 5.1.5 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the larval index against the estimated spawning biomass. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larval index. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

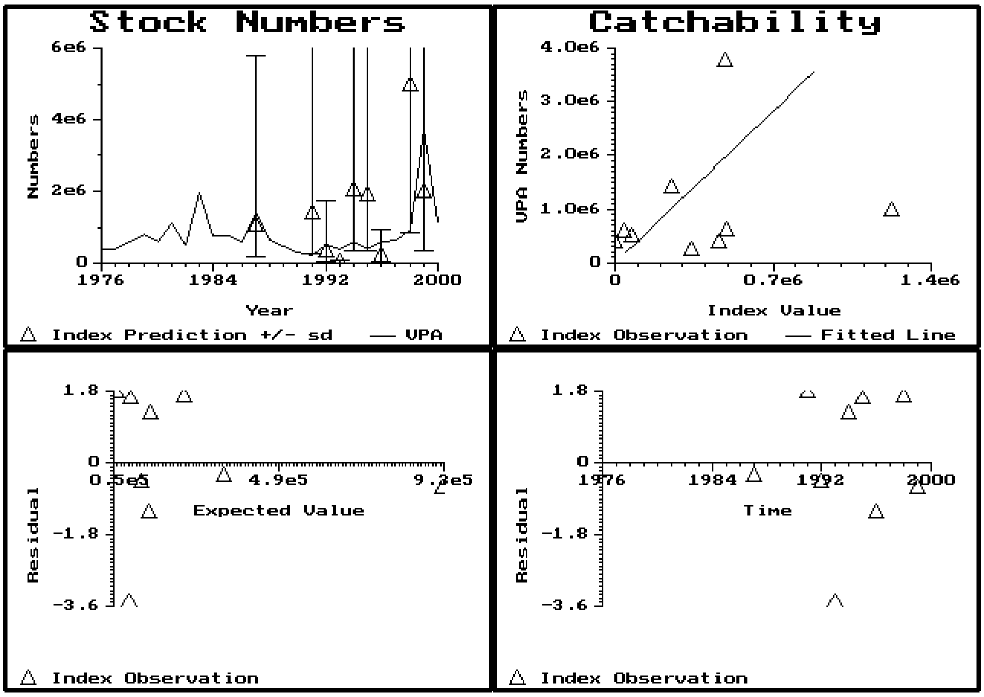


Figure 5.1.6 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 1 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 1 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

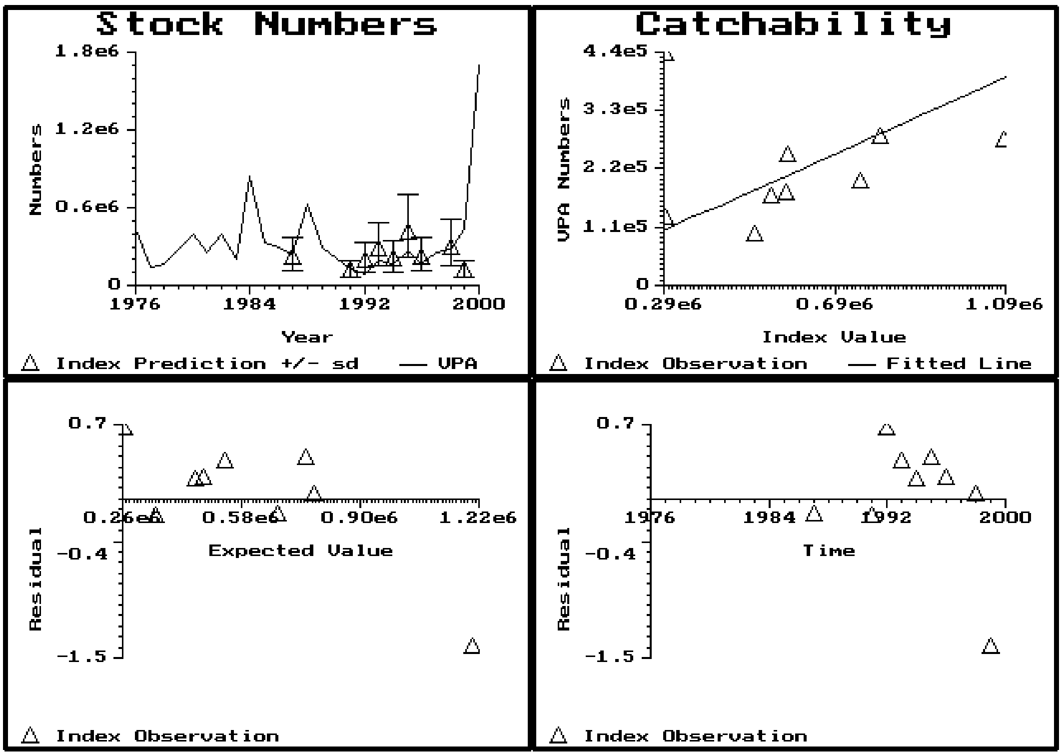


Figure 5.1.7 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 2 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 2 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

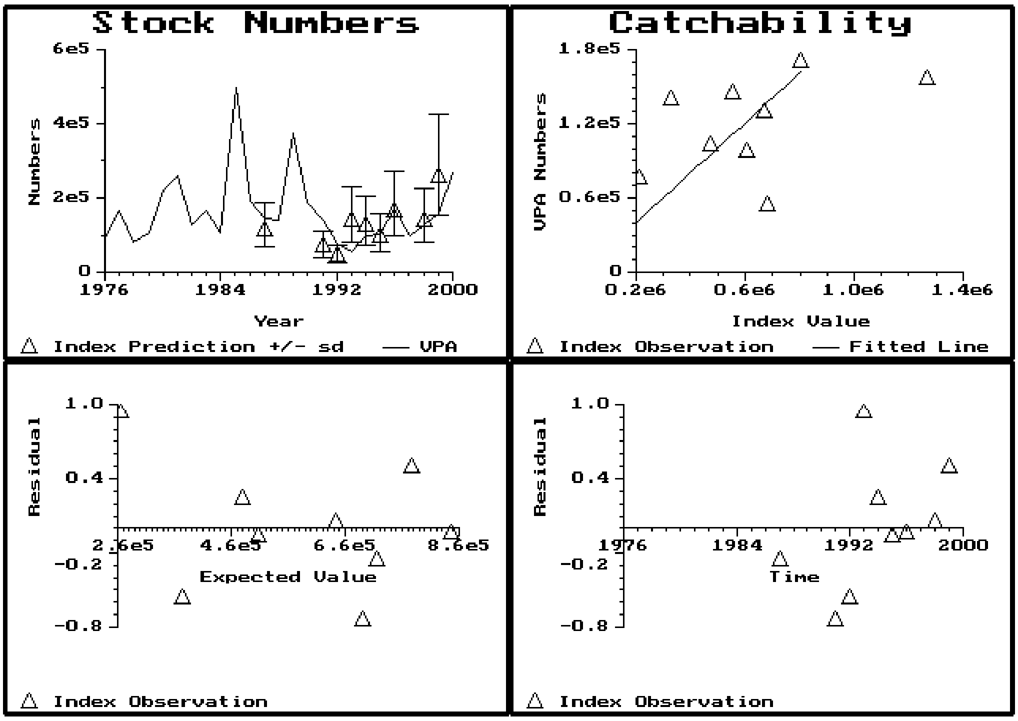


Figure 5.1.8 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 3 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 3 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

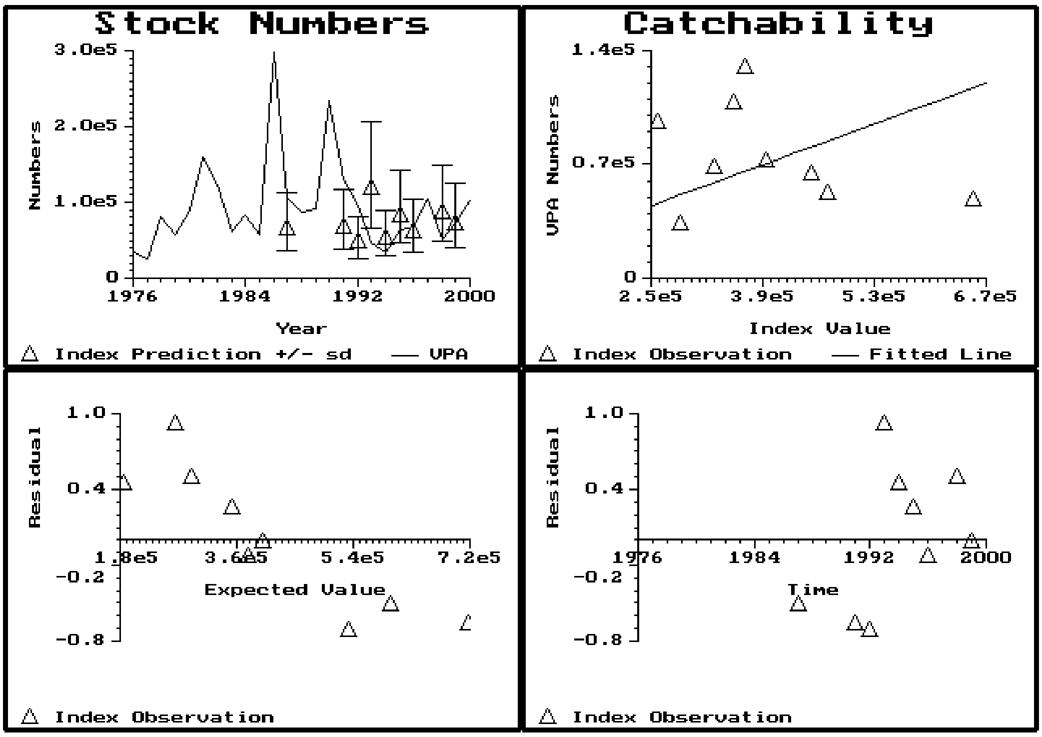


Figure 5.1.9 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 4 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 4 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

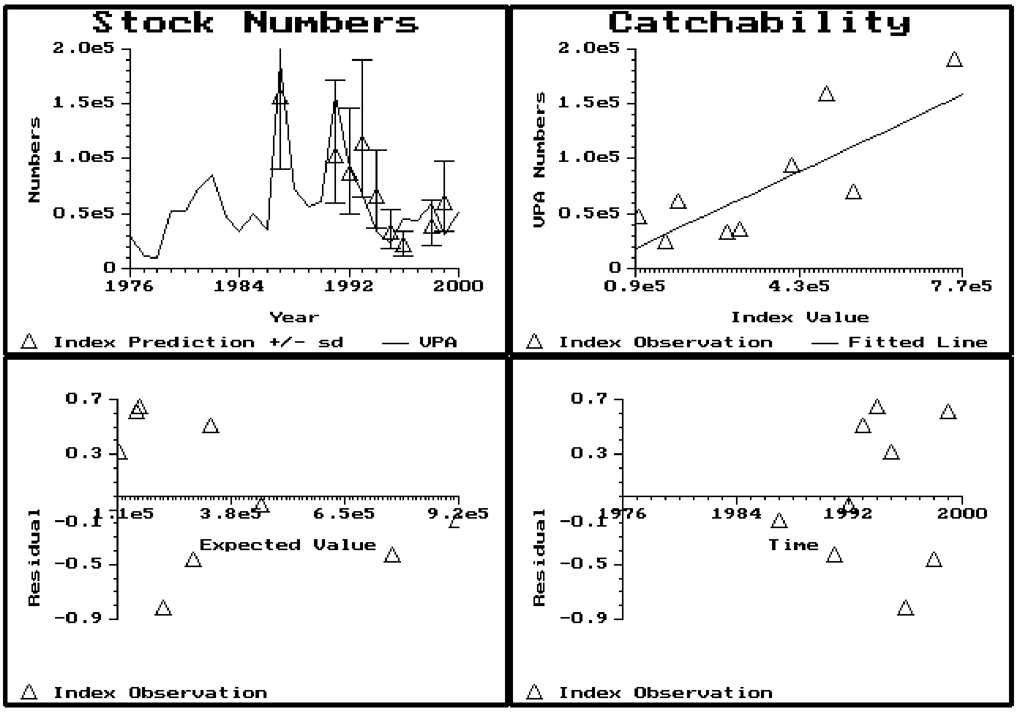


Figure 5.1.10 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 5 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 5 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

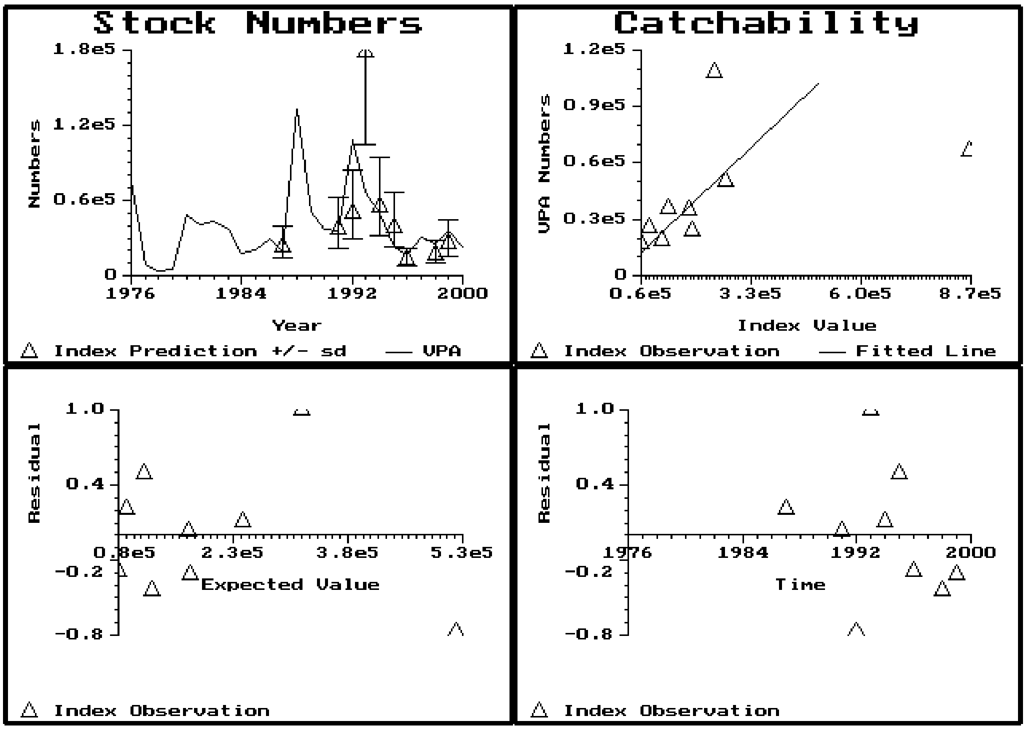


Figure 5.1.11 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 6 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 6 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

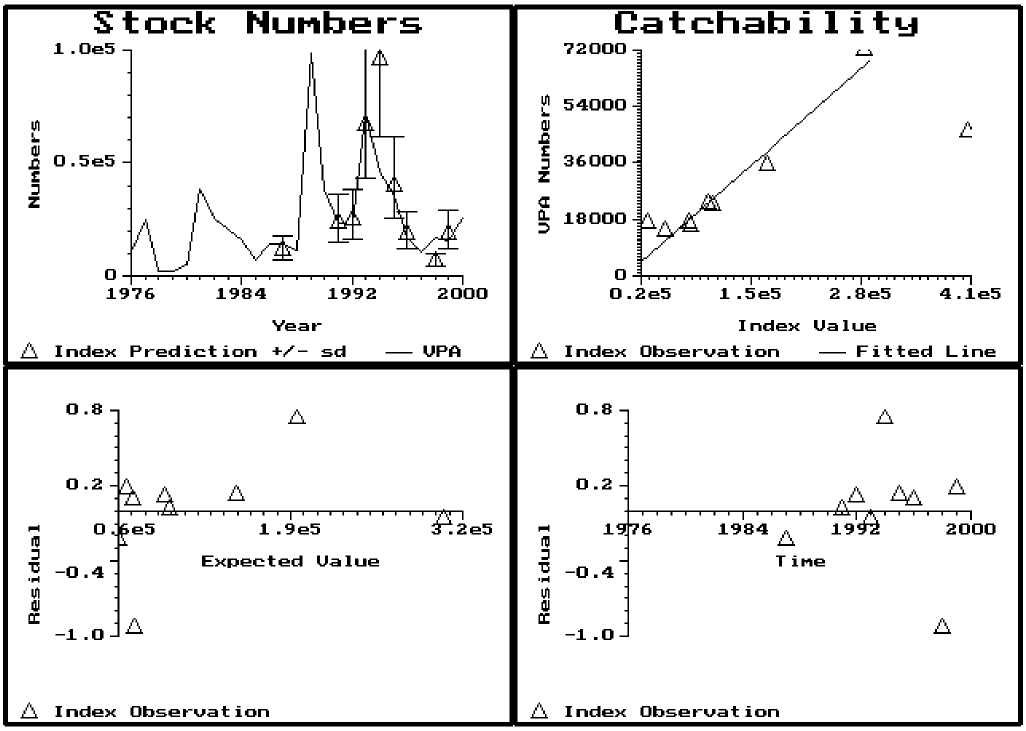


Figure 5.1.12 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 7 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 7 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

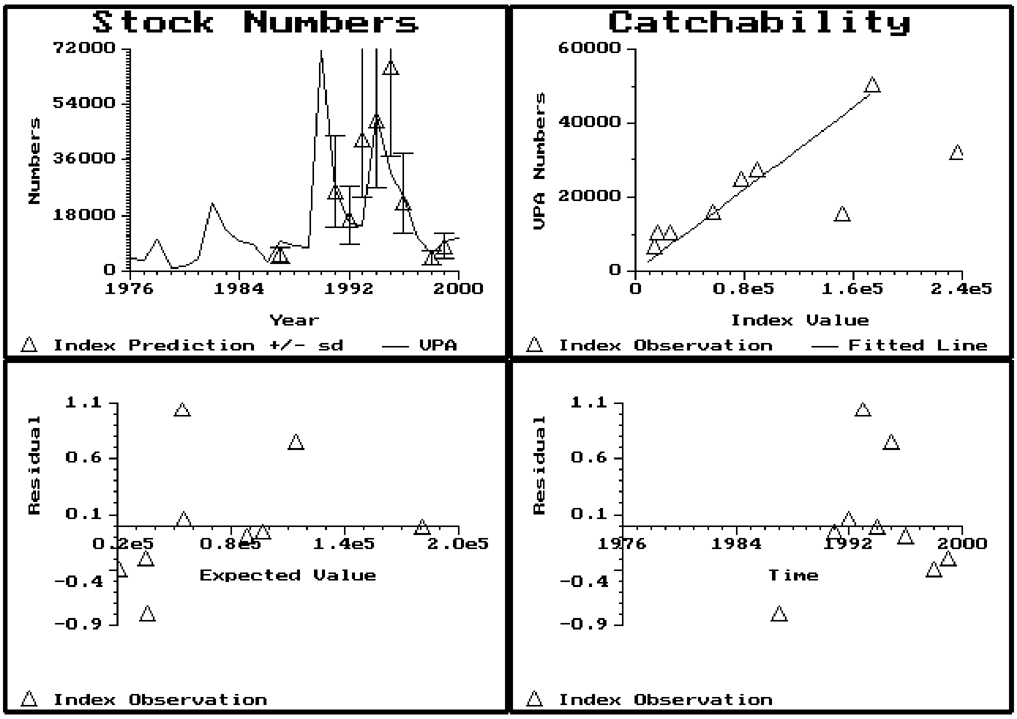


Figure 5.1.13 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 8 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 8 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

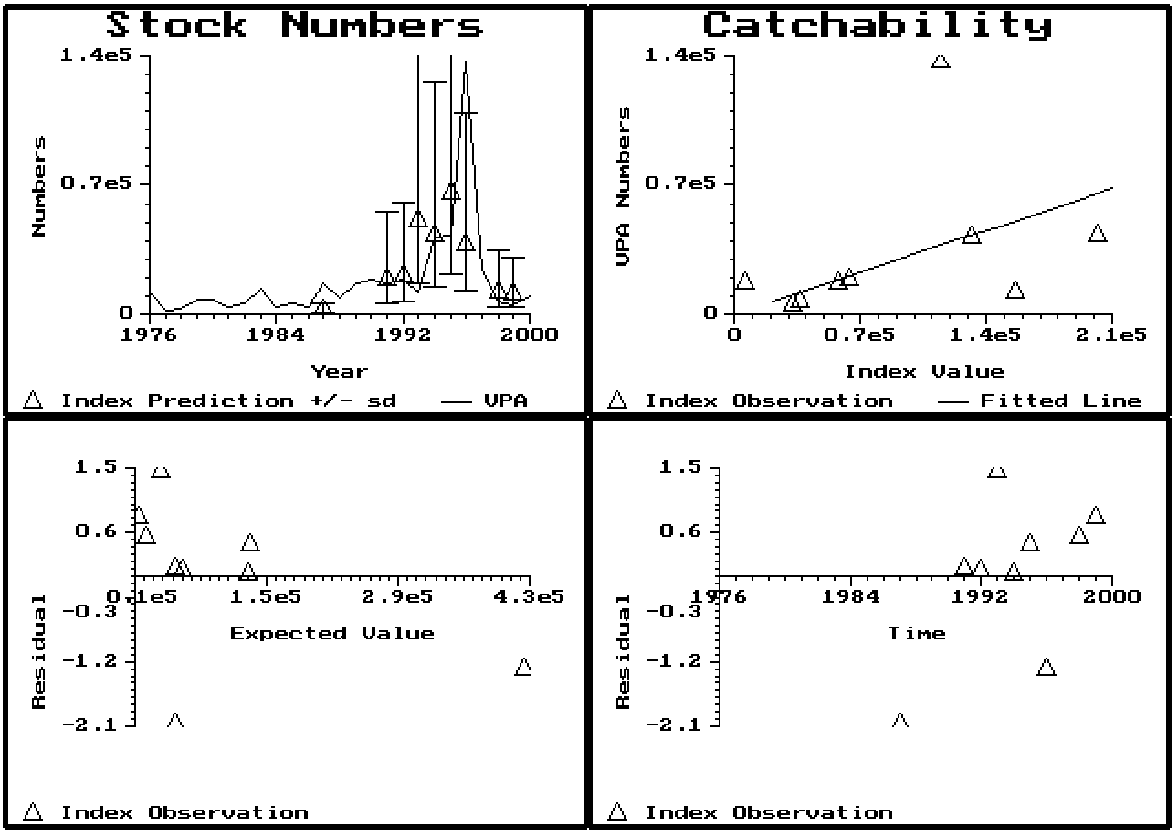


Figure 5.1.14 Herring in VIa(N). Illustration of residuals from deterministic calculation (6 year separable period). Diagnostics of the fit of the age 9 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 9 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

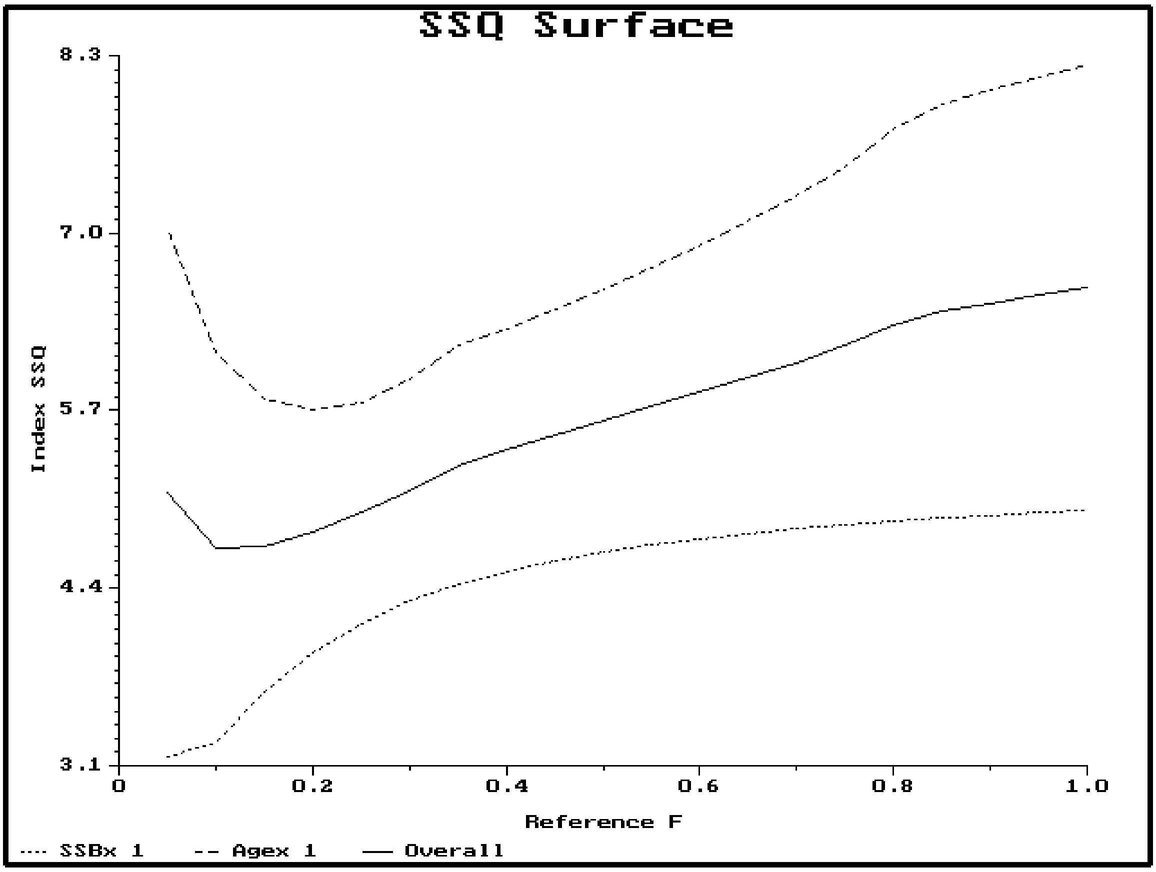


Figure 5.1.15 Herring in VIa(N). SSQ surface for the deterministic calculation of the 7 year separable period. SSBx 1 - larval production estimates from 1973-1993; Agex1- age disaggregated acoustic estimates.

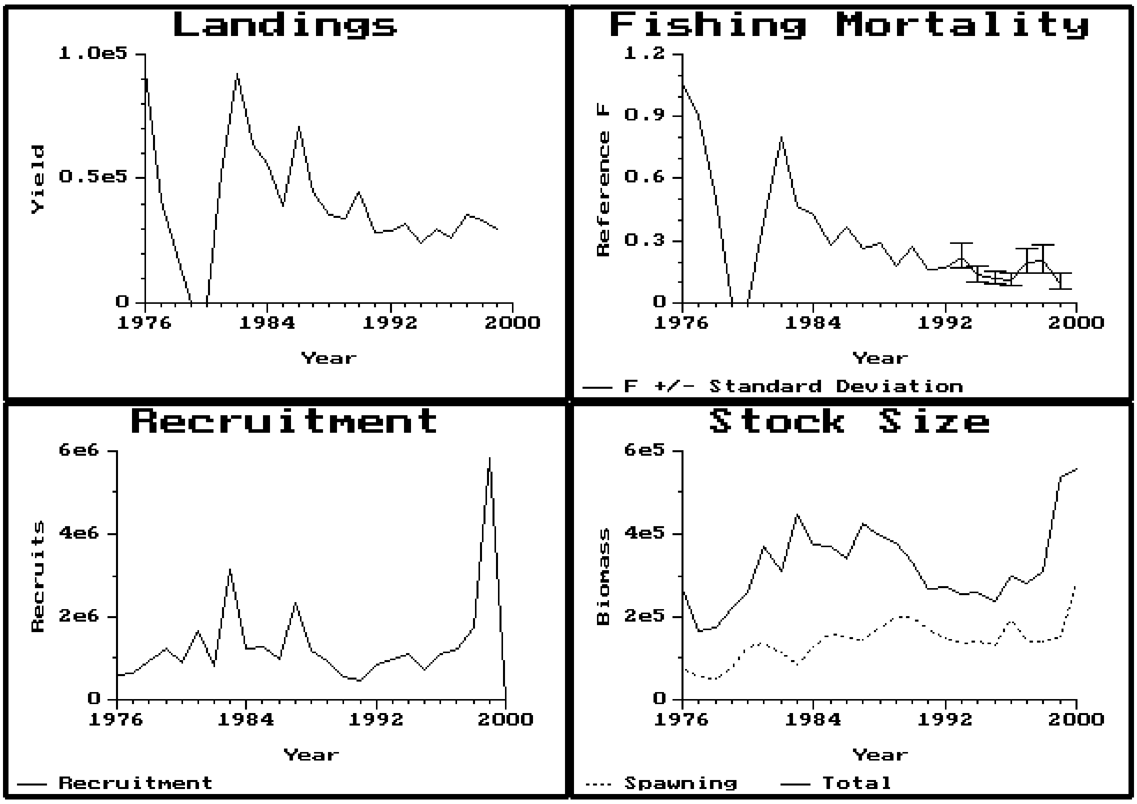


Figure 5.1.16 Herring in VIa(N). Illustration of stock trends from deterministic calculation (7 year separable period). Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock at spawning time.

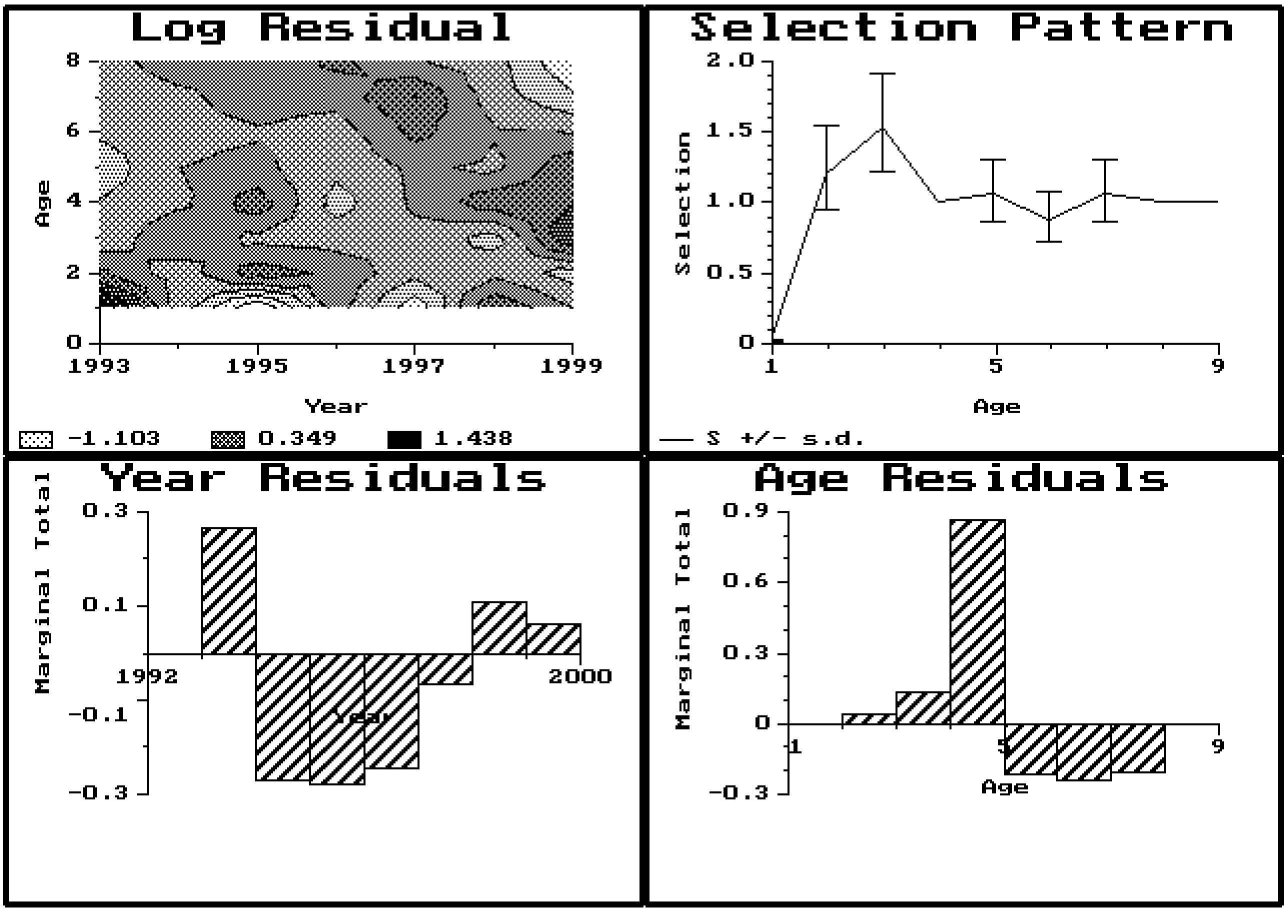


Figure 5.1.17 Illustration of selection patterns diagnostics, from deterministic calculation (7 year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

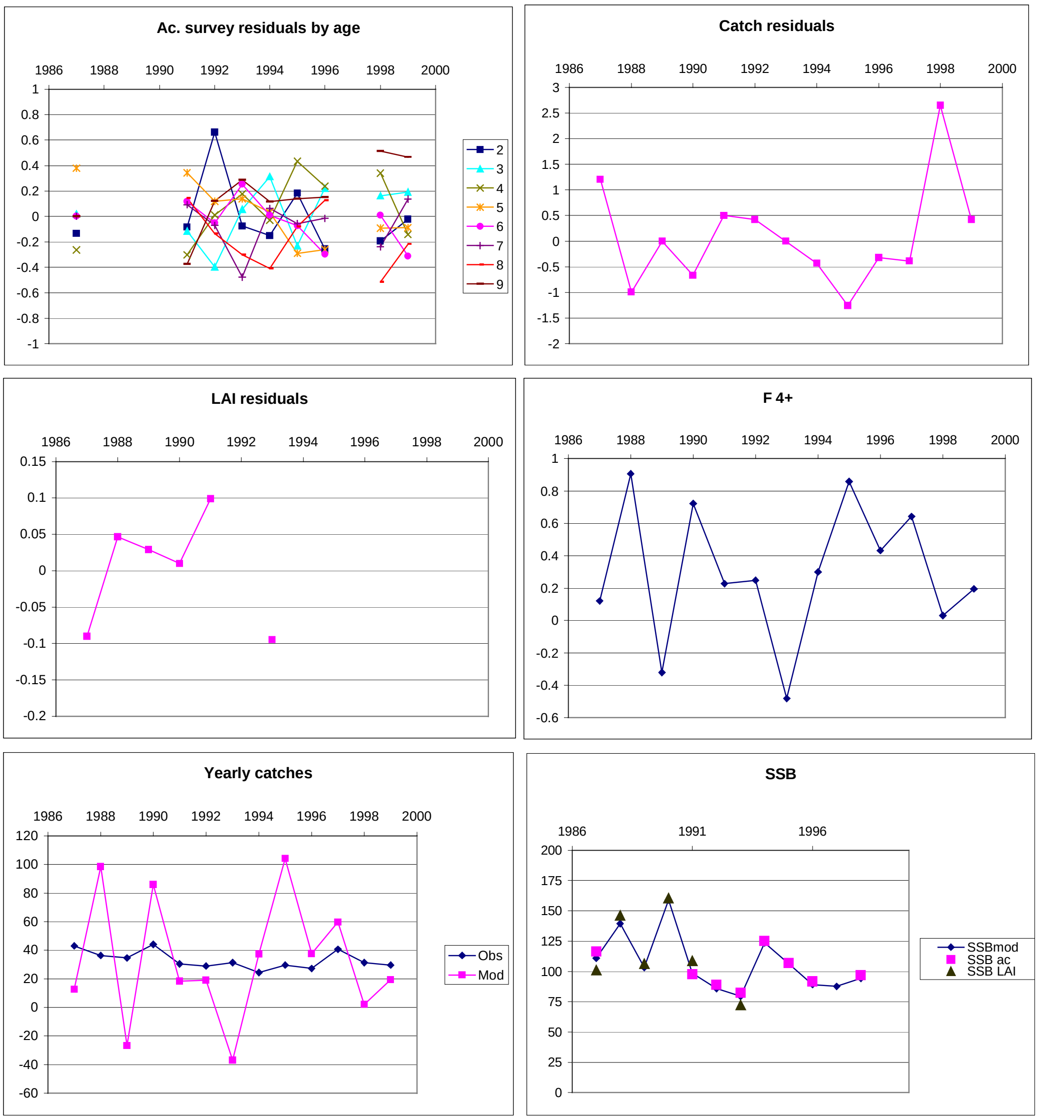


Figure 5.1.18. An experimental survey-data-at-age model for VIa(N) herring. Run 1- baseline run using indices at age from the west coast acoustic survey and the larval index (see Section 5.1.10.1).

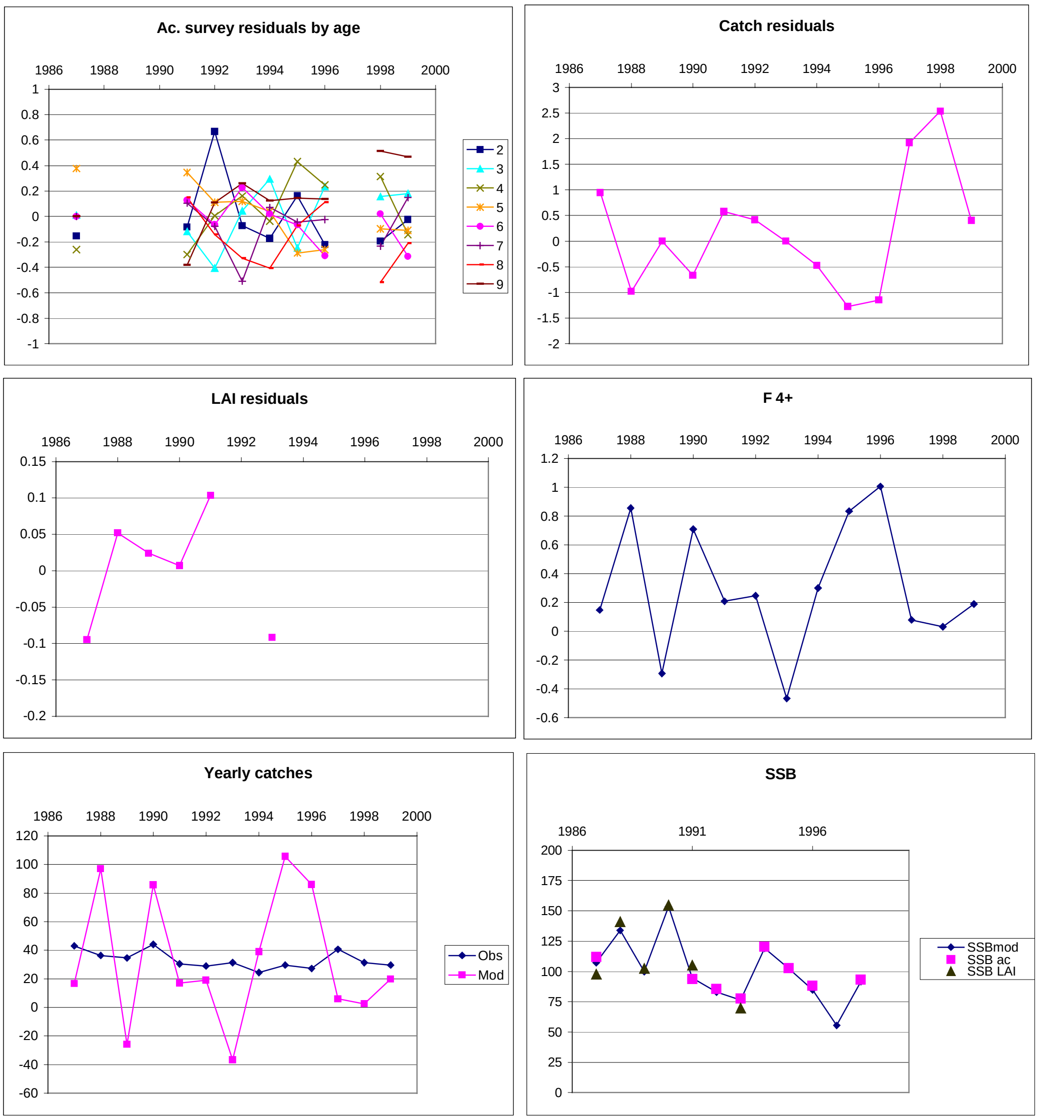


Figure 5.1.19 An experimental survey-data-at-age model for VIa(N) herring. Run 2 – as run 1 but with acoustic estimate of SSB included (see Section 5.1.10.1).

Figure 5.1.20 An experimental survey-data-at-age model for VIa(N) herring. Run 3 – as run 1 but with weak penalty on year-to-year variation in F (see Section 5.1.10.1).

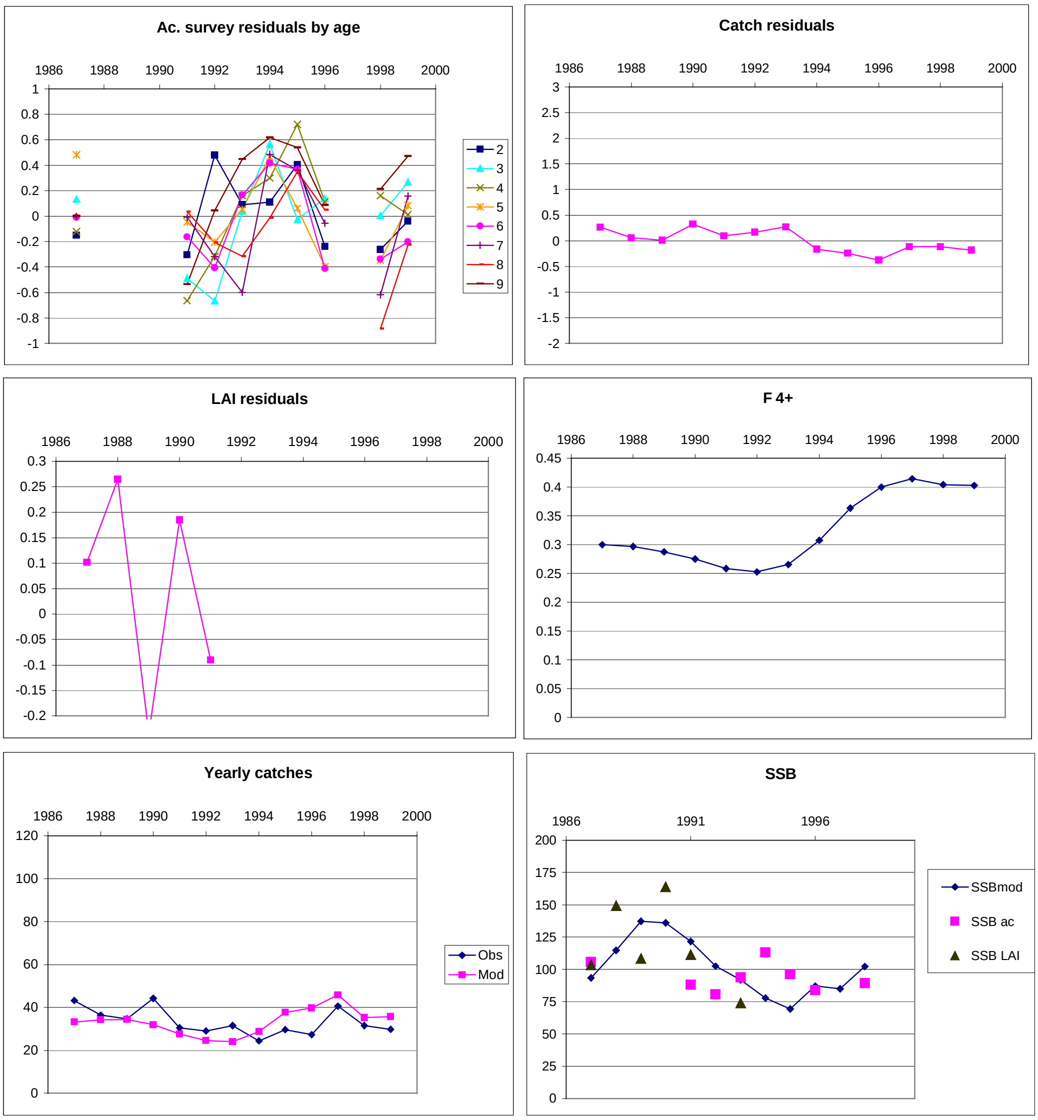


Figure 5.1.21 An experimental survey-data-at-age model for VIa(N) herring. Run 4 – as run 1 but with strong penalty on year-to-year variation in F (see Section 5.1.10.1).

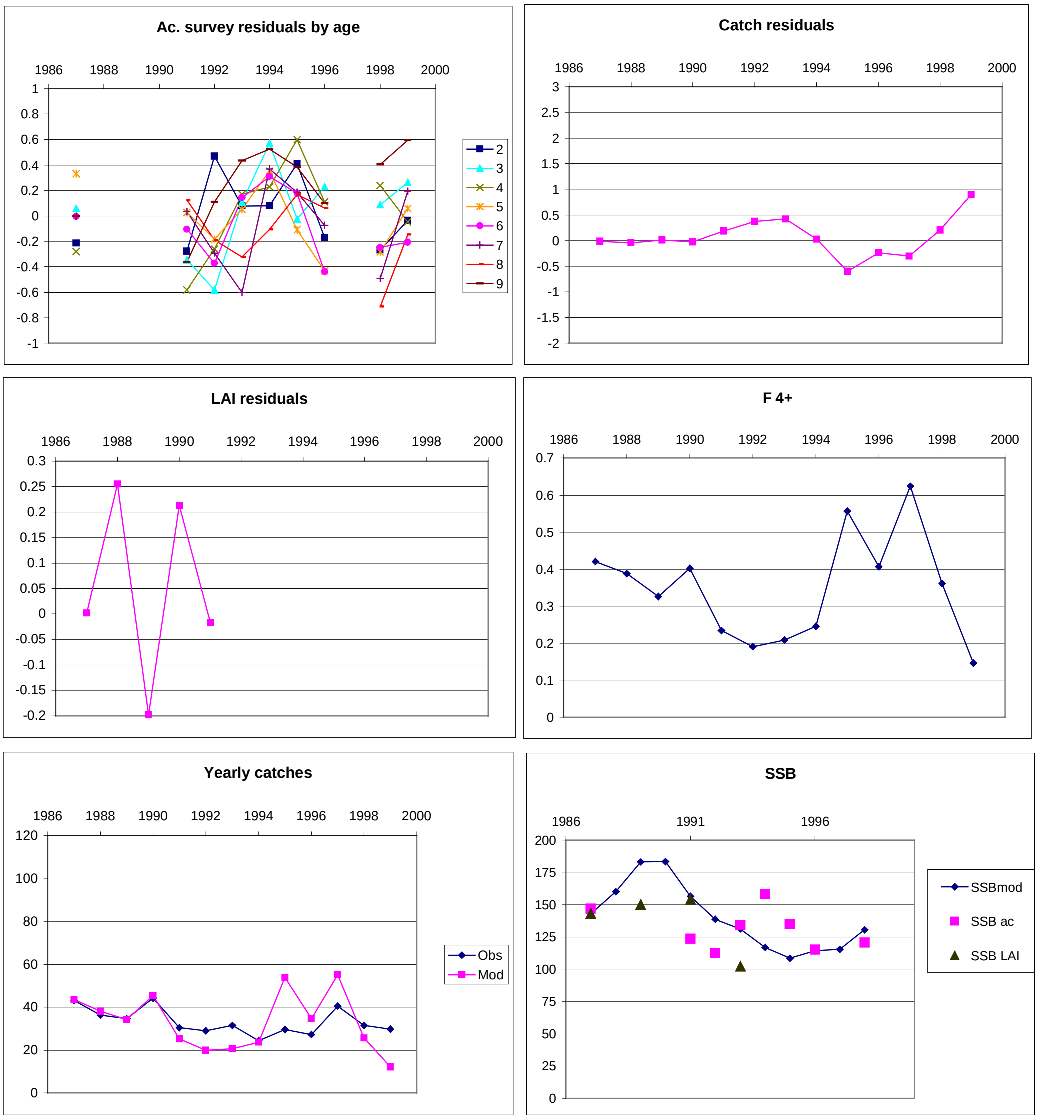


Figure 5.1.22 An experimental survey-data-at-age model for VIa(N) herring. Run 5 – as run 1 but with the total yearly catch included in the objective function (see Section 5.1.10.1)..

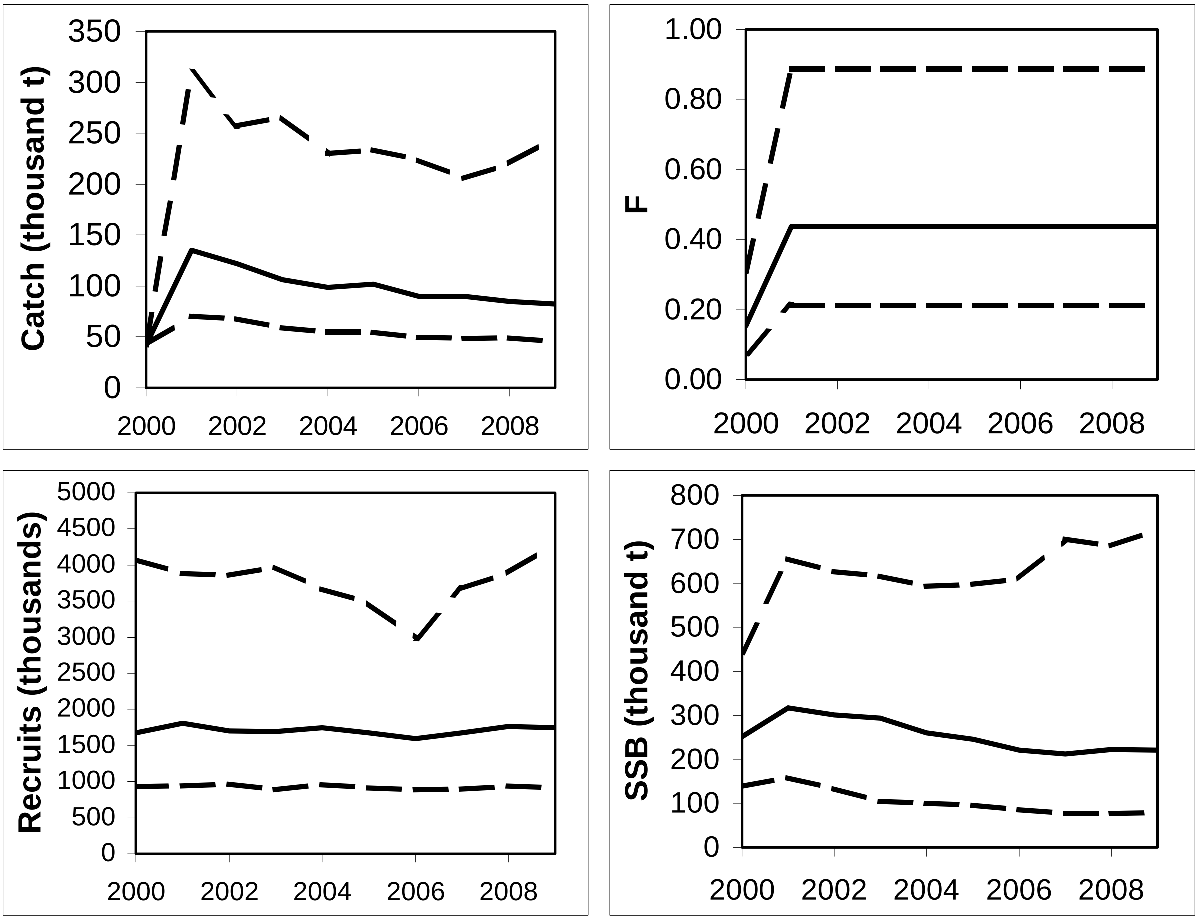


Figure 5.1.23 Herring in VIa(N). Summary results for the medium-term projections for the assessment using a 6 year separable period based on a fishing mortality constrained equal to the equivalent for the TAC of 42,000 tonnes. Upper panel, left: landings; right: mean fishing mortality (over ages 3 –6); Lower panel, left: recruitment; right: spawning stock biomass. Solid line 50th percentile; dashed lines 25th and 75th percentiles; 5th and 95th percentiles not shown as these were beyond displayable range.

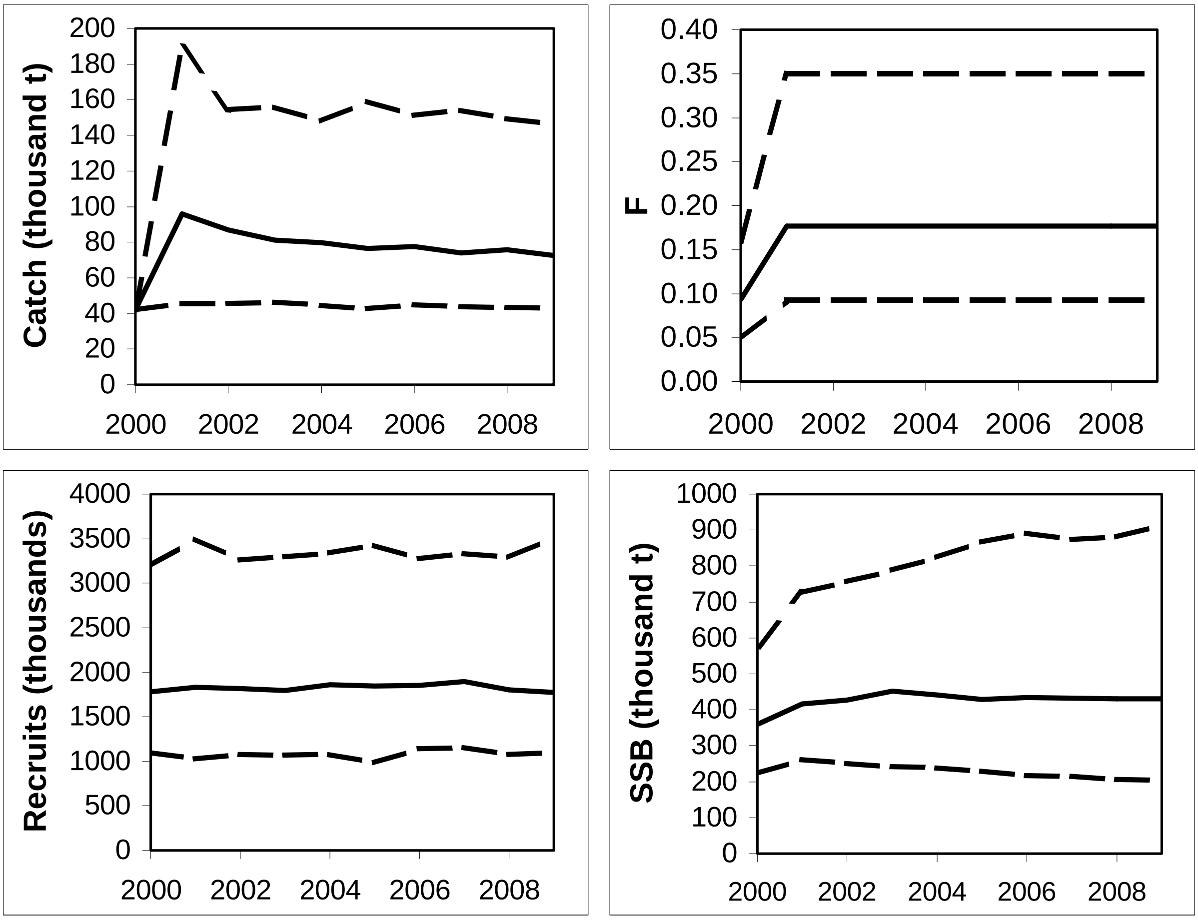


Figure 5.1.24 Herring in VIa(N). Summary results for the medium-term projections for the assessment using a 7 year separable period based on a fishing mortality constrained equal to the equivalent for the TAC of 42,000 tonnes. Upper panel, left: landings; right: mean fishing mortality (over ages 3 –6); Lower panel, left: recruitment; right: spawning stock biomass. Solid line 50th percentile; dashed lines 25th and 75th percentiles; 5th and 95th percentiles not shown as these were beyond displayable range.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1999 and 2000

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks; a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals;
- A ban on herring fishing between 00:00 Saturday morning and 24:00 Sunday night;
- The TACs in 1999 and 2000 were maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 1998

Annual landings from 1955 to 1999 are presented in Table 5.2.1. Landings in 1999 were 256 t which were the lowest since before 1955. Landings by the local fleet were 16 t whilst a total of 240 t were taken by Northern Ireland vessels landing into Northern Ireland. This is the fourth consecutive year, since 1985 that landings from non-local vessels have been reported. Most of the landings were in the third and fourth quarters of the year. The proportions of spring and autumn spawners in these landings could not be estimated.

The sampling levels of the local fishery have been reduced in recent years but are at recommended levels (Table 5.2.2). Samples were taken from the Scottish fleets only.

5.2.3 Weight at age and stock composition

The catch in numbers at age for the period 1970 to 1999 is given in Table 5.2.3. The four ring fish represent a large proportion of the catch. This coincides with a large three ring catch in 1998.

Weights at age are given in Table 5.2.4. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights at age in the catches.

Once again no attempt has been made to apportion catches between spring and autumn-spawning stocks for 1998. The majority of landings were in the last two quarters suggesting that the fishery was based on the autumn spawners. The small landings in the first half of the year (0.5 t) are mainly taken as by-catch in the demersal trawl fishery.

An index of effort was traditionally calculated on the effort of the Scottish trawler fleet and then raised to the rest of the fishery. The structure of the fishery has changed completely over the last four years. It is now dominated by non-Scottish vessels. Hence the impact of Scottish trawler effort and the applicability of an effort based index, derived from Scottish vessels, is thought to be minimal. Hence, the index was not calculated for the 1999 fishery.

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites, no acoustic surveys in the Clyde and no spring trawl surveys were carried out in 1999. Historical estimates from these surveys are tabulated in (ICES 1995 Assess:13).

5.2.5 Stock Assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years therefore no assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa. The management objectives for these two components are necessarily distinct. The absence of fishery independent data from surveys further compounds the problem. Historically the spring spawning stock supported a fishery with catches up to 15,000 tonnes per year in the 1960's. Landings generally began to decline through the 1970's and 1980's with a rapid decline in effort during the late 1980's up to the present time.

A TAC was first set in 1984 (3,000 t) increasing to a maximum of 3,500 tonnes in 1987 subsequently decreasing to 1,000 tonnes by 1993. Estimated catches, including discards, exceeded the TAC for the first four years. This was followed by a decline in catches to 1990. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at below 1,000 tonnes.

In the absence of surveys and with no stock separation of the catches, nothing is currently known about the state of the spring spawning stock. All the management measures, currently in force, need to remain. Catches should remain at a low level until more is known about the dynamics of this stock.

Table 5.2.1 Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955–1999.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
All Catches																	
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096	9,807	7,929	9,433	10,594	7,763	4,088

Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
All Catches										
Total	4,226	4,715	4,061	3,664	4,139	4,847	3,862	1,951	2,081	2,135

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Scotland	2,506	2,530	2,991	3,001	3,395	2,895	1,568	2,135	2,184	713	929	852
Other UK	-	273	247	22	-	-	-	-	-	-	-	-
Unallocated[1]	262	293	224	433	576	278	110	208	75	18	-	-
Discards	1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]
Agreed TAC			3,000	3,000	3,100	3,500	3,200	3,200	2,600	2,900	2,300	1,000
Total	4,021	4,361	5,770	4,800	4,650	3,612	1,923	2,343	2,259	731	929	852

Year	1994	1995	1996	1997	1998	1999
Scotland	608	392	598	371	779	16
Other UK	-	-	283	119	213	240
Unallocated[1]	-	-	-	-	-	-
Discards	-[2]	-[2]	-	-	-	-
Agreed TAC	1,000	1,000	1,000	1,000	1,000	1,000
Total	608	392	881	490	992	256

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery
[2]Reported to be at a low level, assumed to be zero.
[3]Based on sampling.
[4]Estimated assuming the same discarding rate as in 1986.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1999.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local reports
1989	2,135	45	8,368	4,152	" "
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	No information
1992	929	23	4,604	1,579	No information
1993	852	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	392	16	2,727	1,073	No information
1996	881	9	1,915	679	No information
1997	490	3	650	383	No information
1998	992	3	462	196	
1999	256	3	251	126	

Table 5.2.3 Clyde HERRING catch in numbers at age. Spring- and autumn-spawners combined. Thousands of fish.

Age(Rings)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930
5	2306	3432	3007	918	1140	1072	526	1112	634	888
6	741	1090	1114	1525	494	451	638	574	606	341
7	760	501	656	659	700	175	261	409	330	289
8	753	352	282	307	253	356	138	251	298	156
9	227	225	177	132	87	130	178	146	174	119
10+	117	181	132	114	59	67	100	192	236	154

Age(Rings)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	333	312	220	314	4156	1639	678	508	0	845
2	5633	2372	11311	10109	11829	2951	4574	1376	1062	1523
3	1592	2785	4079	5232	5774	4420	4431	3669	1724	9239
4	567	1622	2440	1747	3406	4592	4622	4379	2506	876
5	341	1158	1028	963	1509	2806	2679	3400	2014	452
6	204	433	663	555	587	2654	1847	1983	1319	252
7	125	486	145	415	489	917	644	1427	510	146
8	48	407	222	189	375	681	287	680	234	29
9	56	74	63	85	74	457	251	308	66	16
10+	68	18	53	38	80	240	79	175	16	5

Age(Rings)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	716	42	145	3	399	118	494	275	323	123
2	1004	615	411	418	964	1425	1962	2005	2731	418
3	839	472	493	261	964	186	1189	429	1779	318
4	7533	703	385	268	358	189	273	346	667	393
5	576	1908	1947	1305	534	149	544	18	344	122
6	359	169	333	327	319	130	183	52	77	36
7	329	92	91	78	76	66	208	0	55	36
8	119	113	69	111	57	35	127	5	35	13
9	49	22	32	38	16	15	52	61	55	19
10+	16	9	10	0	17	1	9	*		

* change to 9+ in 1997.

Table 5.2.4 HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age	Weight in the catch														
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-	-	-	-	-	-	-	-	-	-	-	102	90	112	103	87
2	225	149	166	149	156	149	170	143	141	141	92	151	146	142	148	152
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174	174	169
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192	189	184
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231	204	197
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228	218	202
7	340	307	297	236	230	235	234	210	206	229	248	249	257	189	229	220
8	345	291	298	247	225	237	234	222	218	261	240	252	255	286	240	229
9	350	300	298	255	244	219	257	200	201	233	249	242	284	218	246	241
10+	350	300	321	258	230	254	272	203	221	254	294	270	239	*		

* change to 9+ in 1997

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The fishery

6.1.1 Advice and management applicable to 1999 and 2000

The TAC for this area for 1999 was 21,000 t. A precautionary TAC of 28,000 t had been set for the stock for each year from 1992–1998.

In 1999 ACFM considered that this stock was considered to be outside biological limits. Although the assessment of the stock was considered to be imprecise it did indicate that the stock had declined seriously in recent years and was probably below the proposed Bpa. It also indicated that F was at a historical high level and substantially above the proposed Fpa.

ACFM therefore advised that the F in 2000 should be reduced to the proposed Fpa = 0.22, corresponding to a catch of 13,900 t in 2000. ACFM further advised that, if it was not possible to achieve this in a single year, then a multi-annual recovery plan to reduce the fishing mortality as rapidly as possible should be agreed. The TAC set by the EU for 2000 was 13,900 t, which is the lowest ever set for the fishery.

6.1.2 Catch data

The main landings from this fishery in 1999 were again taken by Ireland who took over 95% of the total allocated catches. (Table 6.1.1). Small catches were recorded by the Netherlands. The total catch recorded for 1999 was about 26,100 t which is a decrease of over 13,000 t on the total for 1998 and similar to the catch recorded for 1997.

The total amount of unallocated catches in 1999 was 7,916 t, compared with over 11,000 t in 1998. There is considerable misreporting of catches in this area particularly between Division VIa North and Division VIa South. As has been the case in this fishery for many years the total catch exceeded the TAC.

The main reason for the decrease in the total catch was the decrease that took place in the catches taken in the first quarter of the year and also in the amount of “unallocated”catch. Large catches were taken during this quarter in 1998 due to the use of a annual quota rather than a seasonal quota for the early part of the year.

The catches and landings taken by each country fishing in this area from 1987–1999 are shown in Table 6.1.1 and the total catches from 1970 to 1999 are shown in Figure 6.1.1. There were no estimates of discards reported for 1999 and there are no indications that discarding is a major problem in this fishery even though substantial catches in recent years have been taken in a “roe” fishery. The catches for 1999 are preliminary. It has not been found necessary to make any revisions to the 1998 data.

6.1.3 The fishery in 1999

In common with the other herring fisheries around Ireland during 1999 this fishery was depressed due to very poor markets. This may have caused a decrease in the effort by the Irish fleet throughout the year although the number of Irish vessels that participated in the fishery was the same as in recent years. The fishery in the southern part of Division VIa South and VIIb was poor throughout most of the year, except during the Autumn when good catches were taken off Achill Island and west of Donegal. As in recent years shoals of herring appeared to be very scarce on the traditional spawning grounds, particularly in Division VIIb. Winter/ Spring spawning herring were reported to be plentiful in the first quarter off the north coast (Malin Hd to Tory Is) and again off the west of Donegal (Rosbeg) during quarter 4. During both periods these shoals were not intensively fished because of the poor demand. Fishermen also reported that for the first time for a number of years young herring were abundant throughout Division VIa South.

During 1999 the Irish fishery was divided into two periods. The total catch permitted in the 1st quarter was 12,000 t while the remainder of the quota was retained for the 3rd and 4 th quarters. No directed fishing took place from April to September.

6.1.4 Catch in numbers at age

The catches at age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers at age have been derived mainly from Irish sampling data. The catches during 1999 were mainly dominated by 3 w.ring fish i.e., the 1995 year class which constituted over 35% of the total catch in number at age. 4 w.ring fish, (the 1994 year class) which dominated the catches in 1998, constituted 20% of the 1999 catches while the 2 w.ring fish (1996 year class) constituted nearly 30% of the catches.

6.1.5 Quality of the catch and biological data

The management of the Irish fishery in recent years is believed to have tightened considerably and the accuracy of reported catches in recent years is believed to have improved. Area misreporting of catches is still a problem between Divisions VIaN and.VIaS, but this problem may be eliminated in 2000 due to the introduction of the satellite monitoring system.

The numbers of samples and the biological data, together with the length distribution of the catches taken per quarter by the Irish fleet, are shown in Tables 6.1.3 and 6.1.4 respectively. Sampling of catches throughout 1999 was maintained at a satisfactory rate.

6.2 Mean Weights at Age

The mean weights (kg) at age in the catches in 1999 are based on Irish samples taken throughout the year and are very similar to those of 1998. The mean weights from 1970–1999 are shown in Table 6.2.1.

The mean weights in the stock at spawning time have been calculated from Irish samples taken during the main spawning period that extends from October to February and are also similar to those of the previous season and are shown in Table 6.2.2.

6.3 Ground fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland from 1993 to 1999. More than 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. However, the data has not yet been properly evaluated.

6.4 Stock surveys

A herring acoustic survey was carried out throughout Division VIa (South) and VIIb during October 1999, using the Irish research vessel *R.V Celtic Voyager*. The results are presented in a working document (Molloy and Kelly, W.D. 1999). Acoustic surveys have been carried out on this stock during the period 1994–1996 and the estimates of TSB obtained ranged from 350,000 t in 1994 to less than 35,000 t in 1996. The results from these surveys were always difficult to interpret and have not been used by previous working groups as realistic estimates of stock sizes. The difficulties were mainly due to difficulties in locating shoals at the time at which the surveys were carried out (July) because of lack of information on the distribution of the summer feeding grounds and also difficulties in catching and verifying marks located. A survey was therefore carried out in October 1999 at a time when the shoals were expected to be more densely concentrated in inshore waters prior to spawning.

The survey was considerably hampered by bad weather and problems with the fishing gear and the total area was not adequately covered. Very few herring shoals were located during the survey, apart from some small marks located off the spawning grounds around Achill Is where a commercial fishery was taking place. Reports from fishermen engaged in this fishery indicated that the marks were very small and difficult to locate. The total stock biomass estimated from the survey was 23,800 t and the spawning stock biomass was 22,800 t. The survey was not considered to give a realistic estimate of the total stock size because it did not cover the northern part of the area where in recent years most of the important fishery has taken place. In addition the stock size estimated was considered to be unrealistically low in view of the subsequent catch taken from the fishery which was over 20,000 t in the October to February period.

6.5 State of the Stock

Analytical assessments have not been carried out on this stock for a number of years because of the absence of survey data. Recent Working Groups have therefore only carried out VPA analyses to study the development of the stock and only tentative stock projections have been made. The results of those analyses have indicated that the stock has decreased in recent years from a high level in 1988. This high level was as the result of recruitment of the exceptionally strong 1985 year class which dominated the catches in this area for a long period. The stock is considered to be composed of two spawning components both of which spawn along the Irish coast. A historical examination of the fishery indicates that the winter/spring spawning component dominated the catches in the early part of the century but the autumn spawners dominated in the sixties and seventies. In recent years both components have been present but increasing catches appeared to have been made on the winter/spring spawners.

In 1998 the Working Group carried out an analysis of the relationship between estimates of recruitment and terminal F on the combined components in order to define a range of consistent F's to be used in the assessment. The analysis indicated that either recruitment had been exceptional in 1997 or that there had been a considerable increase in fishing mortality. Indications from the fishery and the catch in numbers at age suggested that the latter was the more likely conclusion.

In 1999 the Working Group carried out a detailed analysis of the development of the two components that constitute the stock. This analysis was considered necessary because of the possibility of the development of a new winter/spring spawning component and the decline of the traditional autumn spawning component. It was considered important to determine if both components were declining at the same extent. The overall conclusions of the analysis suggested that there may not in fact be two separate stock components because of the similarities in recruitment and age distributions. The increase in the winter/spring spawners may be due to a gradual change in spawning time rather than the emergence of a new spawning component.

In the absence of any new data other than that on the age distributions of the 1999 catches the present Working Group therefore carried out separable VPAs on the total stock using a range of terminal F values extending from 0.4 to 0.8. The period of the separable constraint was fixed for 6 years and the selection on the oldest age groups was set equal to that on the reference age 4.

Results of assessment

The results of the various analyses are shown in Fig 6.5.1. The general development of the stock is very similar to that presented in recent working groups. The spawning stock has shown a continuous decline since 1998 when it was at a very high level due to the recruitment of the exceptionally strong 1985 year class. The decline appears to have stopped around 1996 and the most recent trend is dependent on the value of the input F. The SSB may be anywhere between 40,000 t to 80,000 t. The values of F fluctuated between 0.15 to 0.5 between 1970 and 1996 but have continuously increased since the mid 90's. Recruitment has been dominated by two very strong 1985 year class, those of 1981 and 1985 and there has been no strong recruitment in recent years. The development of the stock in recent years is shown in Tables 6.5.1 to 6.5.2. For the purpose of this example the input F in 1999 was assumed to be 0.5.

The results of the various analyses suggest that the value of F (0.60) in 1998, assumed by the 1999 Working Group, was too low compared with the present estimated values for that year which might range between 0.8 and 1.1. Similarly, the value assumed for 1997 (0.6) was too high compared with the present estimated values for those years that may range from 0.46 to 0.55. As these values are now more accurately evaluated then the most appropriate value of F in 1999 would appear to lie somewhere between 0.4 and 0.5.

6.6 Stock Forecasts and Catch Predictions

Because of the difficulty in estimating the size of the current stock it was decided to present a range of catch options, depending on the results of the different SVPA s. The SSBs, derived from the SVPAs, using input F values of 0.4, 0.5 and 0.7 were projected forward to 2002, assuming catches of 13,900 t and 26,100 t in each year. These catches correspond to the TAC in 2000 and to the catch taken in 1999. In 1999 ACFM advised that for this stock the Bpa was 110,000 t and that in order to rebuild the stock to this level in one year it would be necessary to reduce the catch to 13,900 in 2000.

The results, of the predictions derived from using a terminal F of 0.4, are shown in Table 6.6.1 If the TAC of 13,900 is adhered to then the SSB will increase from 86,700 t in 1999 to 92,500 t in 2000, 108,200 t in 2001 and 122,700 t in 2002. Thus the stock in 2001 will be very nearly at Bpa.

If catches in 2000 continue at the 1999 level then the SSB in 2001 will be still below 90,000 t.

The results of the predictions, derived from using a terminal F of 0.5, are shown in Table 6.6.2. If the TAC of 13,900 is adhered to then the SSB will have increased from 68,500 t in 1999 to 98,700 t in 2001.

If catches in 2000 continue at the 1999 level then the SSB in 2001 will be below 66,000 t.

The results of the predictions, derived from using a terminal F of 0.7, are shown in Table 6.6.3. If the TAC of 13,900 is adhered to then the SSB will have increased from 47,800 t in 1999 to 72,000 t in 2001.

If catches in 2000 continue at the 1999 level then the SSB in 2001 will be below 40,000 t.

As stated already it is extremely difficult to determine the state of the stock at present or to predict how it will develop for different catches. It is clear however that in order to reach the proposed Bpa of 110,000 t as quickly as possible it will be necessary to ensure that the TAC set for 2000 is enforced and that a similar low catch is taken in 2001. Catches of the 1999 level of 26,100 will only permit a very slow rebuilding of the stock and the Bpa will not be reached.

The input data, used in the catch options based on populations derived as a result of using the input F values 0.4. 0.5 and 0.7are shown in Tables 6.6.4 to 6.6.6. Because of the uncertainty that surrounds the current stock size it was decided not to carry out stock and recruitment plots or yield per recruit curves.

6.7 Management Considerations

The results of these non-analytical assessments indicate that the spawning stock has declined considerably in recent years and is now at a comparatively low level. This is consistent with observations from fishermen who in recent years have expressed alarm at the scarcity of herring in this area. There has been no substantial recruitment to the stock in recent years and the very strong 1985 year class has now reached the end of it's natural lifespan. The scarcity of herring may be due to a combination of the decline in stock accentuated by a more northerly distribution of the stock in recent years. It is also interesting to note the increasing importance of winter/spring spawning fish in this area. The old traditional fisheries in this area, which were extremely important in the early part of the century, were all based on winter/spring spawning herring compared with the situation that prevailed in the 60's and 70's when the fisheries mainly exploited an autumn spawning component. There is some indication that the present decline in stock size may have been halted and that it may increase in the future. However the rate of the increase will depend on the catches taken from the fishery in the immediate future. Managers should consider the uncertainty of the stock assessment and should restrict catches to the recommended level.

It will not be possible to present a more precise assessment on this stock until a proper series of acoustic surveys have been carried out. It is also important that an index of recruitment should be made available as soon as possible. In this respect it is important that the ground fish surveys carried out by Ireland should be properly evaluated.

Precautionary reference points. The precautionary reference points in relation to this stock are discussed in Section 1.7.of the 1999 Working Group Report. It is clear that recruitment does not show any clear dependence on the SSB and that apart from the very high 1985 year class has been quite stable but at a much lower level. The suggested Floss value is about 0.33 and the Fpa may be about 0.22. The present analysis, although it is uncertain, presents a similar picture of the stock as that shown in recent years. The stock is well below the Bpa (110,000 t) and the fishing mortality is well above the F_{pa}. = 0.22.

6.8 Medium Term Projections and Management considerations

It has not been possible to carry out medium term projections for this stock because of the absence of information. It appears necessary that urgent management measures are required to reduce the catches as soon as possible. More specific advice will not be possible until more information becomes available on stock sizes.

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1988–1999. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1988	1989	1990	1991	1992	1993
France	-	-	+	-	-	-
Germany, Fed.Rep.	-	-	-	-	250	-
Ireland	15,000	18,200	25,000	22,500	26,000	27,600
Netherlands	300	2,900	2,533	600	900	2,500
UK (N.Ireland)	-	-	80	-	-	-
UK (England + Wales)	-	-	-	-	-	-
UK Scotland	-	+	-	+	-	200
Unallocated	13,800	7,100	13,826	11,200	4,600	6,250
Total landings	29,100	28,200	41,439	34,300	31,750	36,550
Discards	-	1,000	2,530	3,400	100	250
Total catch	29,100	29,200	43,969	37,700	31,850	36,800

Country	1994	1995	1996	1997	1998	1999[1]
France	-	-	-	-	-	-
Germany, Fed.Rep.	-	11	-		-	-
Ireland	24,400	25,450	23,800	24,400	25,200	16,325
Netherlands	2,500	1,207	1,800	3,400	2,500	1,868
UK (N.Ireland)	-	-	-		-	-
UK (England + Wales)	50	24	-		-	-
UK (Scotland)	-	-	-		-	-
Unallocated	6,250	1,100	6,900	-700	11,200	7,916
Total landings	33,200	27,792	32,500	27,100	38,900	26,109
Discards	700	-	-	50	-	-
Total catch	33,900	27,792	32,500	27,150	38,900	26,109

[1]Provisional according to text.

Table 6.1.2

The SAS System 14:36 Thursday, April 6, 2000
HER-IRLW: Herring in Divisions VIa (South) and VIIb,c

CANUM01: Catch in Numbers (Total International Catch) (Total) (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	0	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	0	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	46	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	0	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	194	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	823	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	0	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	82	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	4	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	0	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	0	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	0	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	0	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	0	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	0	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	0	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	0	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	0	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	0	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	0	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	0	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	43	4776	24424	69307	31128	9842	15314	8158	12463	6472
1997	0	7458	56329	25946	38742	14583	5977	8351	3418	4264
1998	0	7437	72777	80612	38326	30165	9138	5282	3434	2942
1999	0	2392	51254	61329	34901	10092	5887	1880	1086	949

Table 6.1.3 Divisions VIa (South) and VIIb. Sampling intensity of catches in 1998.

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	9306	17	448	4664	48	No
	2	1069	6	249	1256	227	No
	3	613	9	333	1429	543	No
	4	13253	23	795	4987	60	No
Netherlands	3		0	0	0	0	No

[1]including Division VIa (North).

Table 6.1.4 **Divisions VIa and VIIb**. Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1999

	Q1	Q2	Q3	Q4
19				17
19.5			5	
20				17
20.5	27		8	
21	27			102
21.5	81	11	16	85
22	122	22	5	356
22.5	258	16	42	356
23	611	120	44	1017
23.5	720	164	76	1458
24	1914	425	133	3509
24.5	3190	507	256	4966
25	5879	758	472	10729
25.5	6449	518	563	10526
26	8295	774	764	13831
26.5	6137	747	485	11610
27	6557	709	373	10407
27.5	5064	371	222	6475
28	4765	480	143	4576
28.5	3598	333	39	1847
29	3394	393	29	1339
29.5	1874	278	23	695
30	1806	153	18	322
30.5	747	49	8	186
31	652	16		85
31.5	434		3	
32	299			
32.5	176			17
33	122			
33.5	41			
34	41			
34.5	27			
35	14			
35.5				
36		5		

Table 6.2.1

The SAS System 14:36 Thursday, April 6, 2000
HER-IRLW: Herring in Divisions VIa (South) and VIIb,c

WECA01: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	-1.000	0.090	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	-1.000	0.106	0.141	0.181	0.210	0.226	0.237	0.243	0.247	0.248
1985	-1.000	0.077	0.122	0.161	0.184	0.196	0.206	0.212	0.225	0.230
1986	-1.000	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	-1.000	0.085	0.102	0.150	0.169	0.177	0.193	0.205	0.215	0.220
1988	-1.000	-1.000	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	-1.000	0.080	0.130	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	-1.000	0.094	0.138	0.148	0.160	0.176	0.189	0.194	0.208	0.216
1991	-1.000	0.089	0.134	0.145	0.157	0.167	0.185	0.199	0.207	0.230
1992	-1.000	0.095	0.141	0.147	0.157	0.165	0.171	0.180	0.194	0.219
1993	-1.000	0.112	0.138	0.153	0.170	0.181	0.184	0.196	0.229	0.236
1994	-1.000	0.081	0.141	0.164	0.177	0.189	0.187	0.191	0.204	0.220
1995	-1.000	0.080	0.140	0.161	0.173	0.182	0.198	0.194	0.206	0.217
1996	.	0.085	0.135	0.172	0.182	0.199	0.209	0.220	0.233	0.237
1997	.	0.093	0.135	0.155	0.181	0.201	0.217	0.217	0.231	0.239
1998	0.005	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	.	0.106	0.144	0.145	0.163	0.186	0.195	0.200	0.216	0.222

Table 6.2.2

The SAS System 14:36 Thursday, April 6, 2000
HER-IRLW: Herring in Divisions VIa (South) and VIIb,c

WEST01: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	-1.000	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	-1.000	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	-1.000	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	-1.000	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	-1.000	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	-1.000	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	-1.000	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	-1.000	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	-1.000	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	.	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	.	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239
1998	0.005	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	.	0.104	0.145	0.154	0.174	0.200	0.222	0.230	0.240	0.246

6

Table 6.5.1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
1,	.0005,	.0017,	.0021,	.0189,	.0089,	.0283,	.0379,	.0120,	.0151,	.0093,
2,	.3756,	.0482,	.1158,	.1869,	.1902,	.2452,	.2535,	.2301,	.2417,	.1609,
3,	.2347,	.1260,	.2368,	.3003,	.3134,	.2618,	.3923,	.1887,	.2268,	.1836,
4,	.1681,	.1379,	.1480,	.2952,	.4841,	.3633,	.4591,	.2969,	.2748,	.2469,
5,	.1493,	.1448,	.1836,	.2376,	.5127,	.4561,	.5434,	.3515,	.2715,	.2817,
6,	.1333,	.1982,	.2183,	.2840,	.4363,	.5860,	.5170,	.3757,	.2287,	.3169,
7,	.1573,	.1732,	.3023,	.2827,	.3847,	.5140,	.5597,	.3236,	.2447,	.3402,
8,	.1731,	.1559,	.2783,	.1998,	.5155,	.5893,	.6008,	.2447,	.3252,	.3813,
+gp,	.1731,	.1559,	.2783,	.1998,	.5155,	.5893,	.6008,	.2447,	.3252,	.3813,
0 FBAR 3- 6,	.1714,	.1518,	.1967,	.2793,	.4366,	.4168,	.4779,	.3032,	.2504,	.2573,

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	.0084,	.0037,	.0017,	.0010,	.0045,	.0121,	.0015,	.0060,	.0000,	.0050,
2,	.1344,	.1391,	.0855,	.2123,	.1131,	.0503,	.0708,	.1565,	.0291,	.0425,
3,	.3436,	.2146,	.1587,	.3746,	.2231,	.1363,	.1151,	.3264,	.2594,	.1085,
4,	.3675,	.2638,	.2087,	.3536,	.2124,	.1389,	.1834,	.2708,	.2617,	.2170,
5,	.4192,	.2881,	.2156,	.3404,	.1431,	.1800,	.2095,	.4033,	.2153,	.1903,
6,	.3537,	.4029,	.2665,	.3096,	.1999,	.1992,	.1683,	.3114,	.2917,	.1869,
7,	.4148,	.2353,	.1938,	.3259,	.1404,	.1924,	.2005,	.3855,	.2038,	.2285,
8,	.4418,	.2536,	.3216,	.2137,	.1368,	.2375,	.1490,	.3034,	.1080,	.1644,
+gp,	.4418,	.2536,	.3216,	.2137,	.1368,	.2375,	.1490,	.3034,	.1080,	.1644,
0 FBAR 3- 6,	.3710,	.2923,	.2124,	.3445,	.1946,	.1636,	.1691,	.3280,	.2570,	.1757,

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	FBAR 97-99
AGE											
1,	.0017,	.0021,	.0098,	.0005,	.0225,	.0010,	.0085,	.0123,	.0140,	.0085,	.0116,
2,	.1175,	.1438,	.1008,	.1683,	.3277,	.1424,	.1773,	.2217,	.2732,	.2135,	.2361,
3,	.1708,	.1967,	.2816,	.2221,	.4416,	.3786,	.5009,	.3078,	.6067,	.4165,	.4437,
4,	.2967,	.1488,	.2802,	.4678,	.2431,	.4883,	.6370,	.5523,	.9611,	.5491,	.6875,
5,	.2869,	.2908,	.1976,	.3726,	.4188,	.4220,	.4588,	.6186,	.9998,	.6370,	.7518,
6,	.2450,	.3148,	.3177,	.3013,	.3443,	.5519,	.6229,	.4953,	.8959,	.4654,	.6188,
7,	.2833,	.2564,	.2168,	.4759,	.2832,	.2127,	.5327,	.7348,	.9769,	.4018,	.7045,
8,	.0979,	.2889,	.1965,	.2749,	.3827,	.4474,	.8321,	.3947,	.6800,	.4746,	.5164,
+gp,	.0979,	.2889,	.1965,	.2749,	.3827,	.4474,	.8321,	.3947,	.6800,	.4746,	
0 FBAR 3- 6,	.2499,	.2378,	.2693,	.3409,	.3619,	.4602,	.5549,	.4935,	.8659,	.5170,	

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 9 Relative F at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
1,	.0030,	.0111,	.0108,	.0677,	.0205,	.0679,	.0794,	.0396,	.0603,	.0363,
2,	2.1918,	.3179,	.5887,	.6692,	.4356,	.5882,	.5305,	.7589,	.9652,	.6253,
3,	1.3700,	.8305,	1.2040,	1.0754,	.7177,	.6281,	.8208,	.6225,	.9056,	.7135,
4,	.9808,	.9089,	.7525,	1.0570,	1.1087,	.8717,	.9605,	.9792,	1.0972,	.9597,
5,	.8712,	.9543,	.9335,	.8506,	1.1743,	1.0942,	1.1370,	1.1594,	1.0839,	1.0951,
6,	.7780,	1.3063,	1.1100,	1.0170,	.9993,	1.4060,	1.0817,	1.2390,	.9132,	1.2317,
7,	.9182,	1.1412,	1.5369,	1.0123,	.8810,	1.2333,	1.1710,	1.0672,	.9771,	1.3223,
8,	1.0103,	1.0274,	1.4150,	.7156,	1.1807,	1.4138,	1.2571,	.8069,	1.2984,	1.4821,
+gp,	1.0103,	1.0274,	1.4150,	.7156,	1.1807,	1.4138,	1.2571,	.8069,	1.2984,	1.4821,
0 REFMEAN,	.1714,	.1518,	.1967,	.2793,	.4366,	.4168,	.4779,	.3032,	.2504,	.2573,

Table 6.5.1 ctd.

Table 9 Relative F at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	.0225,	.0126,	.0078,	.0029,	.0234,	.0741,	.0090,	.0183,	.0000,	.0285,
2,	.3623,	.4758,	.4026,	.6161,	.5811,	.3075,	.4190,	.4773,	.1133,	.2418,
3,	.9262,	.7340,	.7474,	1.0872,	1.1461,	.8331,	.6808,	.9951,	1.0093,	.6175,
4,	.9906,	.9024,	.9825,	1.0263,	1.0914,	.8493,	1.0847,	.8257,	1.0180,	1.2354,
5,	1.1300,	.9855,	1.0152,	.9879,	.7355,	1.1001,	1.2392,	1.2297,	.8377,	1.0831,
6,	.9532,	1.3781,	1.2549,	.8987,	1.0271,	1.2174,	.9954,	.9495,	1.1350,	1.0640,
7,	1.1181,	.8048,	.9127,	.9458,	.7213,	1.1759,	1.1857,	1.1756,	.7928,	1.3007,
8,	1.1907,	.8676,	1.5144,	.6203,	.7031,	1.4514,	.8814,	.9252,	.4200,	.9356,
+gp,	1.1907,	.8676,	1.5144,	.6203,	.7031,	1.4514,	.8814,	.9252,	.4200,	.9356,
0 REFMEAN,	.3710,	.2923,	.2124,	.3445,	.1946,	.1636,	.1691,	.3280,	.2570,	.1757,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 9 Relative F at age

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	MEAN 97-99
AGE											
1,	.0069,	.0088,	.0364,	.0014,	.0620,	.0021,	.0153,	.0250,	.0162,	.0164,	.0192,
2,	.4703,	.6046,	.3745,	.4936,	.9053,	.3094,	.3194,	.4492,	.3155,	.4130,	.3926,
3,	.6837,	.8274,	1.0459,	.6515,	1.2202,	.8228,	.9026,	.6237,	.7007,	.8056,	.7100,
4,	1.1875,	.6257,	1.0405,	1.3722,	.6716,	1.0611,	1.1480,	1.1191,	1.1100,	1.0622,	1.0971,
5,	1.1482,	1.2229,	.7339,	1.0928,	1.1571,	.9169,	.8268,	1.2536,	1.1547,	1.2321,	1.2135,
6,	.9806,	1.3240,	1.1798,	.8836,	.9511,	1.1992,	1.1225,	1.0036,	1.0346,	.9002,	.9795,
7,	1.1337,	1.0784,	.8053,	1.3959,	.7823,	.4621,	.9600,	1.4891,	1.1282,	.7772,	1.1315,
8,	.3919,	1.2150,	.7297,	.8064,	1.0574,	.9723,	1.4996,	.7998,	.7853,	.9180,	.8344,
+gp,	.3919,	1.2150,	.7297,	.8064,	1.0574,	.9723,	1.4996,	.7998,	.7853,	.9180,	
0 REFMEAN,	.2499,	.2378,	.2693,	.3409,	.3619,	.4602,	.5549,	.4935,	.8659,	.5170,	

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
1,	412358,	827511,	743614,	541775,	599491,	416637,	703636,	594322,	1071964,	1008024,
2,	128607,	151620,	303911,	272979,	195575,	218578,	148998,	249214,	216031,	388442,
3,	136609,	65444,	107032,	200531,	167755,	119790,	126721,	85661,	146672,	125673,
4,	89833,	88444,	47236,	69155,	121586,	100397,	75485,	70084,	58070,	95715,
5,	29479,	68710,	69717,	36862,	46579,	67798,	63170,	43159,	47124,	39919,
6,	337920,	22975,	53789,	52502,	26301,	25239,	38879,	33194,	27477,	32502,
7,	21496,	267599,	17050,	39125,	35759,	15384,	12710,	20978,	20629,	19779,
8,	11005,	16619,	203630,	11403,	26683,	22024,	8325,	6571,	13734,	14614,
+gp,	12615,	15703,	18580,	295246,	79357,	75220,	36354,	20052,	12548,	13514,
0 TOTAL,	1179921,	1524624,	1564561,	1519577,	1299087,	1061068,	1214279,	1123235,	1614247,	1738182,

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

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	542113,	697381,	716065,	2393125,	974392,	1260272,	956575,	3210250,	523013,	710232,
2,	367389,	197771,	255611,	262991,	879500,	356833,	458043,	351371,	1173918,	192406,
3,	245001,	237934,	127487,	173843,	157564,	581877,	251380,	316121,	222583,	844695,
4,	85637,	142256,	157184,	89057,	97862,	103209,	415695,	183436,	186750,	140591,
5,	67659,	53656,	98871,	115440,	56582,	71603,	81273,	313113,	126606,	130072,
6,	27252,	40255,	36397,	72112,	74321,	44369,	54117,	59639,	189288,	92366,
7,	21423,	17313,	24345,	25229,	47875,	55064,	32896,	41382,	39523,	127935,
8,	12736,	12802,	12381,	18147,	16479,	37645,	41104,	24359,	25465,	29169,
+gp,	15638,	24434,	10956,	23173,	32992,	10757,	16125,	40800,	20151,	21020,
0 TOTAL,	1384847,	1423802,	1439297,	3173117,	2337567,	2521630,	2307208,	4540472,	2507297,	2288485,

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	GMST 70-97	AMST 70-97
AGE													
1,	807649,	508787,	420032,	627549,	832839,	471453,	894129,	963104,	846108,	448716,	0,	763107,	872439,
2,	259976,	296607,	186780,	153014,	230752,	299582,	173273,	326154,	349970,	306942,	163682,	268588,	310569,
3,	136611,	171240,	190308,	125096,	95797,	123182,	192482,	107513,	193585,	197281,	183672,	167450,	199379,
4,	620486,	94283,	115160,	117570,	82021,	50431,	69063,	95500,	64706,	86400,	106501,	107165,	130793,
5,	102394,	417289,	73516,	78741,	66633,	58201,	28002,	33048,	49743,	22392,	45144,	70338,	88758,
6,	97301,	69541,	282304,	54592,	49087,	39662,	34533,	16015,	16108,	16561,	10716,	51812,	70855,
7,	69328,	68908,	45928,	185920,	36548,	31480,	20667,	16761,	8831,	5950,	9409,	34869,	49251,
8,	92114,	47255,	48247,	33456,	104521,	24915,	23027,	10978,	7273,	3008,	3602,	23386,	33907,
+gp,	12719,	32002,	36972,	26225,	33248,	41255,	11958,	13695,	6231,	2629,	3173,		
0 TOTAL,	2198576,	1705912,	1399246,	1402164,	1531446,	1140161,	1447135,	1582767,	1542555,	1089880,	525898,		

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	81788,	120067,	230021,	196995,	140823,	151698,	102828,	174711,	150274,	285246,
3,	102088,	52602,	79877,	143414,	118931,	87911,	85213,	66018,	110192,	97192,
4,	75065,	75412,	40005,	53067,	82210,	73606,	51903,	53719,	45175,	75865,
5,	24944,	58315,	57653,	29401,	30895,	46710,	41047,	31892,	36741,	30910,
6,	289017,	18813,	43459,	40591,	18362,	15939,	25715,	24135,	22045,	24582,
7,	18092,	222841,	13022,	30276,	25844,	10195,	8170,	15794,	16375,	14727,
8,	9164,	14000,	158041,	9328,	17666,	13878,	5206,	5216,	10329,	10586,
+gp,	10506,	13229,	14420,	241510,	52540,	47399,	22732,	15918,	9438,	9789,

Table 6.5.1 ctd.

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	274611,	147365,	197427,	186585,	666861,	282186,	357273,	258775,	941606,	152956,
3,	170209,	180229,	100250,	118294,	118673,	464487,	203537,	222176,	163608,	686975,
4,	62607,	111483,	127819,	65718,	79379,	87941,	343808,	143085,	146561,	113687,
5,	47779,	41370,	80027,	85945,	48076,	59356,	66052,	223488,	102495,	107083,
6,	20109,	28740,	28472,	54804,	60792,	36310,	45213,	45271,	145591,	76213,
7,	15173,	13829,	19995,	18966,	40753,	45268,	26898,	29891,	32245,	102660,
8,	8859,	10101,	9334,	14707,	14061,	30028,	34788,	18590,	22153,	24434,
+gp,	10878,	19280,	8260,	18780,	28150,	8580,	13647,	31137,	17530,	17608,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	196537,	220321,	142788,	111807,	151532,	222736,	125852,	229950,	238362,	217589,
3,	106556,	131269,	137823,	94280,	62324,	83594,	120352,	76509,	112754,	130528,
4,	475657,	79806,	89266,	80365,	65177,	34002,	42148,	61690,	31781,	55928,
5,	79011,	321162,	60226,	57371,	47068,	41025,	19257,	20419,	23807,	13666,
6,	77218,	52666,	213395,	41723,	36450,	25627,	21276,	10748,	8265,	11339,
7,	53627,	54269,	37144,	126399,	28273,	25530,	13526,	9580,	4292,	4251,
8,	80673,	36415,	39555,	26024,	75640,	17265,	12332,	7881,	4313,	2047,
+gp,	11139,	24661,	30311,	20399,	24061,	28588,	6404,	9831,	3695,	1789,

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
	AGE										
	1,	49483,	99301,	89234,	65013,	71939,	49996,	84436,	71319,	128636,	120963,
	2,	21735,	25624,	51361,	46133,	33052,	36940,	25181,	42117,	36509,	65647,
	3,	28688,	13743,	22477,	42111,	35228,	25156,	26611,	17989,	30801,	26391,
	4,	21201,	20873,	11148,	16320,	28694,	23694,	17814,	16540,	13704,	22589,
	5,	7664,	17865,	18126,	9584,	12111,	17627,	16424,	11221,	12252,	10379,
	6,	92252,	6272,	14684,	14333,	7180,	6890,	10614,	9062,	7501,	8873,
	7,	6083,	75731,	4825,	11072,	10120,	4354,	3597,	5937,	5838,	5597,
	8,	3191,	4819,	59053,	3307,	7738,	6387,	2414,	1906,	3983,	4238,
	+gp,	3734,	4648,	5500,	87393,	23490,	22265,	10761,	5936,	3714,	4000,
0	TOTALBIO,	234031,	268876,	276408,	295268,	229552,	193309,	197853,	182026,	242939,	268677,

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
	AGE										
	1,	65054,	83686,	85928,	287175,	116927,	126027,	93744,	311394,	50732,	98012,
	2,	62089,	33423,	43198,	44446,	148636,	53525,	77409,	57625,	192522,	30208,
	3,	51450,	49966,	26772,	36507,	33088,	114048,	52538,	65121,	45852,	141909,
	4,	20210,	33572,	37096,	21018,	23096,	23428,	98935,	42741,	43513,	25588,
	5,	17591,	13951,	25706,	30014,	14711,	17042,	20806,	78905,	31905,	26014,
	6,	7440,	10990,	9936,	19687,	20290,	11137,	14936,	16162,	51297,	20043,
	7,	6063,	4900,	6890,	7140,	13549,	13876,	9211,	11587,	11067,	29041,
	8,	3693,	3713,	3590,	5263,	4779,	10127,	11797,	7210,	7538,	6942,
	+gp,	4629,	7232,	3243,	6859,	9765,	3055,	5031,	12934,	6388,	5150,
0	TOTALBIO,	238219,	241432,	242360,	458108,	384840,	372264,	384408,	603678,	440813,	382907,

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
1,	91264,	51896,	42843,	74051,	81618,	42431,	76895,	90532,	80380,	46667,
2,	39516,	44194,	26896,	25400,	35997,	43140,	23738,	44031,	47596,	44507,
3,	23224,	29796,	31782,	24519,	18393,	22296,	35802,	18170,	28070,	30381,
4,	111687,	17914,	20959,	24102,	17142,	10238,	14227,	18527,	11194,	15034,
5,	20479,	81371,	14262,	16851,	14393,	12630,	6132,	6940,	9501,	4478,
6,	21114,	14325,	55614,	12010,	10946,	8964,	8081,	3587,	3157,	3677,
7,	15599,	15573,	9829,	41460,	8260,	7146,	4815,	3872,	1784,	1369,
8,	21462,	11152,	10518,	8096,	24040,	5955,	5734,	2525,	1615,	722,
+gp,	3243,	7937,	8947,	6766,	8212,	10149,	3025,	3273,	1352,	647,
0 TOTALBIO,	347590,	274159,	221650,	233255,	219002,	162947,	178450,	191456,	184649,	147480,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	13822,	20291,	38874,	33292,	23799,	25637,	17378,	29526,	25396,	48207,
3,	21439,	11046,	16774,	30117,	24976,	18461,	17895,	13864,	23140,	20410,
4,	17715,	17797,	9441,	12524,	19402,	17371,	12249,	12678,	10661,	17904,
5,	6486,	15162,	14990,	7644,	8033,	12145,	10672,	8292,	9553,	8037,
6,	78902,	5136,	11864,	11081,	5013,	4351,	7020,	6589,	6018,	6711,
7,	5120,	63064,	3685,	8568,	7314,	2885,	2312,	4470,	4634,	4168,
8,	2658,	4060,	45832,	2705,	5123,	4025,	1510,	1513,	2995,	3070,
+gp,	3110,	3916,	4268,	71487,	15552,	14030,	6729,	4712,	2794,	2897,
0 TOTSPBIO,	149250,	140473,	145728,	177418,	109211,	98905,	75764,	81642,	85192,	111404,

Table 6.5.1 ctd.

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	46409,	24905,	33365,	31533,	112699,	42328,	60379,	42439,	154423,	24014,
3,	35744,	37848,	21052,	24842,	24921,	91039,	42539,	45768,	33703,	115412,
4,	14775,	26310,	30165,	15509,	18734,	19963,	81826,	33339,	34149,	20691,
5,	12422,	10756,	20807,	22346,	12500,	14127,	16909,	56319,	25829,	21417,
6,	5490,	7846,	7773,	14962,	16596,	9114,	12479,	12268,	39455,	16538,
7,	4294,	3914,	5658,	5367,	11533,	11407,	7531,	8369,	9029,	23304,
8,	2569,	2929,	2707,	4265,	4078,	8077,	9984,	5503,	6557,	5815,
+gp,	3220,	5707,	2445,	5559,	8333,	2437,	4258,	9870,	5557,	4314,
0 TOTSPBIO,	124923,	120215,	123973,	124383,	209394,	198492,	235906,	213876,	308702,	231505,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	29874,	32828,	20562,	18560,	23639,	32074,	17242,	31043,	32417,	31550,
3,	18115,	22841,	23016,	18479,	11966,	15130,	22385,	12930,	16349,	20101,
4,	85618,	15163,	16246,	16475,	13622,	6902,	8683,	11968,	5498,	9731,
5,	15802,	62627,	11684,	12277,	10167,	8902,	4217,	4288,	4547,	2733,
6,	16756,	10849,	42039,	9179,	8128,	5792,	4979,	2407,	1620,	2517,
7,	12066,	12265,	7949,	28187,	6390,	5795,	3152,	2213,	867,	978,
8,	18797,	8594,	8623,	6298,	17397,	4126,	3071,	1813,	957,	491,
+gp,	2840,	6116,	7335,	5263,	5943,	7033,	1620,	2350,	802,	440,
0 TOTSPBIO,	199869,	171282,	137454,	114718,	97252,	85755,	65348,	69012,	63058,	68543,

1

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

	YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
	AGE										
	1,	44374,	86463,	80084,	66063,	70225,	56179,	88421,	76869,	130713,	128992,
	2,	19491,	22311,	46095,	46879,	32265,	41508,	26369,	45395,	37099,	70004,
	3,	25726,	11966,	20172,	42792,	34389,	28267,	27867,	19389,	31298,	28143,
	4,	19012,	18174,	10005,	16584,	28011,	26624,	18655,	17827,	13926,	24088,
	5,	6873,	15555,	16268,	9739,	11822,	19807,	17199,	12094,	12450,	11068,
	6,	82728,	5461,	13179,	14565,	7009,	7742,	11115,	9767,	7622,	9462,
	7,	5455,	65940,	4330,	11251,	9879,	4892,	3767,	6399,	5932,	5969,
	8,	2862,	4196,	52998,	3360,	7554,	7177,	2528,	2054,	4047,	4519,
	+gp,	3349,	4047,	4936,	88805,	22930,	25019,	11269,	6397,	3774,	4266,
0	TOTALBIO,	209869,	234115,	248067,	300039,	224083,	217214,	207191,	196191,	246862,	286511,

Table 14 Stock biomass at age with SOP (start of year) Tonnes

	YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
	AGE										
	1,	62683,	86296,	88511,	288379,	113281,	124087,	93759,	295444,	50694,	98108,
	2,	59826,	34466,	44497,	44632,	144001,	52701,	77422,	54673,	192378,	30237,
	3,	49575,	51524,	27577,	36660,	32057,	112292,	52547,	61785,	45818,	142047,
	4,	19474,	34619,	38211,	21106,	22375,	23068,	98951,	40551,	43480,	25613,
	5,	16950,	14386,	26479,	30140,	14253,	16779,	20809,	74863,	31881,	26040,
	6,	7169,	11332,	10235,	19769,	19657,	10965,	14939,	15334,	51259,	20063,
	7,	5842,	5052,	7097,	7170,	13126,	13662,	9212,	10994,	11058,	29070,
	8,	3559,	3828,	3698,	5285,	4630,	9971,	11799,	6841,	7532,	6949,
	+gp,	4460,	7458,	3340,	6888,	9461,	3008,	5032,	12271,	6383,	5155,
0	TOTALBIO,	229537,	248962,	249646,	460029,	372841,	366534,	384470,	572757,	440482,	383280,
1											

Table 6.5.1 ctd.

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

	YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
	AGE										
	1,	91321,	51748,	42633,	74492,	81455,	44658,	76549,	90678,	80280,	46751,
	2,	39541,	44068,	26764,	25552,	35925,	45404,	23632,	44102,	47536,	44587,
	3,	23238,	29711,	31625,	24665,	18356,	23466,	35641,	18199,	28035,	30436,
	4,	111756,	17863,	20856,	24246,	17108,	10775,	14163,	18557,	11180,	15061,
	5,	20491,	81139,	14192,	16951,	14364,	13293,	6105,	6951,	9489,	4486,
	6,	21127,	14284,	55340,	12082,	10924,	9434,	8044,	3593,	3153,	3683,
	7,	15608,	15529,	9780,	41707,	8243,	7521,	4794,	3878,	1782,	1371,
	8,	21476,	11120,	10466,	8145,	23992,	6267,	5708,	2529,	1613,	723,
	+gp,	3245,	7914,	8903,	6806,	8196,	10681,	3012,	3278,	1350,	648,
0	TOTALBIO,	347805,	273377,	220560,	234646,	218563,	171501,	177647,	191767,	184418,	147746,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

	YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
	AGE										
	1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	2,	12395,	17668,	34888,	33830,	23232,	28807,	18198,	31824,	25806,	51406,
	3,	19225,	9618,	15054,	30603,	24380,	20744,	18739,	14943,	23514,	21765,
	4,	15886,	15496,	8473,	12726,	18939,	19519,	12827,	13664,	10833,	19092,
	5,	5816,	13202,	13453,	7768,	7841,	13646,	11176,	8937,	9707,	8570,
	6,	70756,	4472,	10648,	11260,	4893,	4889,	7352,	7102,	6116,	7156,
	7,	4591,	54911,	3307,	8706,	7140,	3242,	2421,	4818,	4709,	4444,
	8,	2383,	3535,	41133,	2749,	5001,	4522,	1581,	1630,	3044,	3274,
	+gp,	2789,	3409,	3831,	72642,	15181,	15765,	7046,	5078,	2839,	3090,
0	TOTSPBIO,	133841,	122312,	130786,	180285,	106609,	111136,	79340,	87996,	86568,	118798,

Table 6.5.1 ctd.

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	44718,	25681,	34368,	31665,	109185,	41676,	60389,	40265,	154307,	24038,
3,	34441,	39028,	21685,	24946,	24144,	89638,	42546,	43424,	33678,	115524,
4,	14237,	27130,	31072,	15575,	18149,	19655,	81839,	31631,	34123,	20711,
5,	11970,	11092,	21433,	22439,	12110,	13909,	16912,	53434,	25809,	21437,
6,	5290,	8091,	8007,	15024,	16079,	8973,	12481,	11640,	39425,	16554,
7,	4137,	4036,	5829,	5390,	11174,	11232,	7533,	7941,	9022,	23327,
8,	2475,	3021,	2788,	4283,	3951,	7953,	9986,	5221,	6552,	5821,
+gp,	3103,	5885,	2518,	5582,	8073,	2399,	4259,	9365,	5553,	4318,
0 TOTSPBIO,	120370,	123964,	127700,	124904,	202864,	195436,	235944,	202920,	308470,	231731,

1

Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06)

At 17/03/2000 17:54

Traditional vpa Terminal populations from weighted Separable populations

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	29892,	32734,	20460,	18671,	23592,	33758,	17164,	31094,	32377,	31607,
3,	18126,	22776,	22903,	18589,	11942,	15925,	22285,	12951,	16329,	20138,
4,	85671,	15120,	16166,	16573,	13595,	7265,	8644,	11987,	5491,	9749,
5,	15812,	62448,	11626,	12351,	10146,	9370,	4198,	4295,	4542,	2738,
6,	16767,	10818,	41832,	9234,	8112,	6096,	4956,	2411,	1618,	2522,
7,	12073,	12230,	7910,	28355,	6377,	6100,	3137,	2217,	866,	980,
8,	18809,	8570,	8581,	6335,	17362,	4343,	3057,	1815,	956,	492,
+gp,	2842,	6099,	7299,	5294,	5931,	7402,	1613,	2353,	801,	441,
0 TOTSPBIO,	199992,	170794,	136778,	115402,	97058,	90257,	65054,	69124,	62980,	68666,

1

Table 6.5.2
Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06) ,
At 17/03/2000 17:54
Table 16 Summary (without SOP correction)
Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
1970,	412358,	234031,	149250,	20306,	.1361,	.1714,
1971,	827511,	268876,	140473,	15044,	.1071,	.1518,
1972,	743614,	276408,	145728,	23474,	.1611,	.1967,
1973,	541775,	295268,	177418,	36719,	.2070,	.2793,
1974,	599491,	229552,	109211,	36589,	.3350,	.4366,
1975,	416637,	193309,	98905,	38764,	.3919,	.4168,
1976,	703636,	197853,	75764,	32767,	.4325,	.4779,
1977,	594322,	182026,	81642,	20567,	.2519,	.3032,
1978,	1071964,	242939,	85192,	19715,	.2314,	.2504,
1979,	1008024,	268677,	111404,	22608,	.2029,	.2573,
1980,	542113,	238219,	124923,	30124,	.2411,	.3710,
1981,	697381,	241432,	120215,	24922,	.2073,	.2923,
1982,	716065,	242360,	123973,	19209,	.1549,	.2124,
1983,	2393125,	458108,	124383,	32988,	.2652,	.3445,
1984,	974392,	384840,	209394,	27450,	.1311,	.1946,
1985,	1260272,	372264,	198492,	23343,	.1176,	.1636,
1986,	956575,	384408,	235906,	28785,	.1220,	.1691,
1987,	3210250,	603678,	213876,	48600,	.2272,	.3280,
1988,	523013,	440813,	308702,	29100,	.0943,	.2570,
1989,	710232,	382907,	231505,	29210,	.1262,	.1757,
1990,	807649,	347590,	199869,	43969,	.2200,	.2499,
1991,	508787,	274159,	171282,	37700,	.2201,	.2378,
1992,	420032,	221650,	137454,	31856,	.2318,	.2693,
1993,	627549,	233255,	114718,	36763,	.3205,	.3409,
1994,	832839,	219002,	97252,	33908,	.3487,	.3619,
1995,	471453,	162947,	85755,	27792,	.3241,	.4602,
1996,	894129,	178450,	65348,	32534,	.4979,	.5549,
1997,	963104,	191456,	69012,	27225,	.3945,	.4935,
1998,	846108,	184649,	63058,	38895,	.6168,	.8659,
1999,	448716,	147480,	68543,	26109,	.3809,	.5170,
Arith. Mean ,	857437,	276620,	137955,	29901,	.2566,	.3267,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes)		

Table 6.5.2 ctd.
Run title : Herring VIa(S) VIIbc (run: SEPCJK06/S06) ,
At 17/03/2000 17:54
Table 17 Summary (with SOP correction)
Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 6,	
1970,	412358,	209869,	133841,	20306,	.1517,	.8968,	.1714,	
1971,	827511,	234115,	122312,	15044,	.1230,	.8707,	.1518,	
1972,	743614,	248067,	130786,	23474,	.1795,	.8975,	.1967,	
1973,	541775,	300039,	180285,	36719,	.2037,	1.0162,	.2793,	
1974,	599491,	224083,	106609,	36589,	.3432,	.9762,	.4366,	
1975,	416637,	217214,	111136,	38764,	.3488,	1.1237,	.4168,	
1976,	703636,	207191,	79340,	32767,	.4130,	1.0472,	.4779,	
1977,	594322,	196191,	87996,	20567,	.2337,	1.0778,	.3032,	
1978,	1071964,	246862,	86568,	19715,	.2277,	1.0161,	.2504,	
1979,	1008024,	286511,	118798,	22608,	.1903,	1.0664,	.2573,	
1980,	542113,	229537,	120370,	30124,	.2503,	.9636,	.3710,	
1981,	697381,	248962,	123964,	24922,	.2010,	1.0312,	.2923,	
1982,	716065,	249646,	127700,	19209,	.1504,	1.0301,	.2124,	
1983,	2393125,	460029,	124904,	32988,	.2641,	1.0042,	.3445,	
1984,	974392,	372841,	202864,	27450,	.1353,	.9688,	.1946,	
1985,	1260272,	366534,	195436,	23343,	.1194,	.9846,	.1636,	
1986,	956575,	384470,	235944,	28785,	.1220,	1.0002,	.1691,	
1987,	3210250,	572757,	202920,	48600,	.2395,	.9488,	.3280,	
1988,	523013,	440482,	308470,	29100,	.0943,	.9992,	.2570,	
1989,	710232,	383280,	231731,	29210,	.1261,	1.0010,	.1757,	
1990,	807649,	347805,	199992,	43969,	.2199,	1.0006,	.2499,	
1991,	508787,	273377,	170794,	37700,	.2207,	.9971,	.2378,	
1992,	420032,	220560,	136778,	31856,	.2329,	.9951,	.2693,	
1993,	627549,	234646,	115402,	36763,	.3186,	1.0060,	.3409,	
1994,	832839,	218563,	97058,	33908,	.3494,	.9980,	.3619,	
1995,	471453,	171501,	90257,	27792,	.3079,	1.0525,	.4602,	
1996,	894129,	177647,	65054,	32534,	.5001,	.9955,	.5549,	
1997,	963104,	191767,	69124,	27225,	.3939,	1.0016,	.4935,	
1998,	846108,	184418,	62980,	38895,	.6176,	.9988,	.8659,	
1999,	448716,	147746,	68666,	26109,	.3802,	1.0018,	.5170,	
Arith. Mean ,	857437,	274890,	136936,	29901,	.2553		.3267,	
0 Units,		(Thousands),		(Tonnes),		(Tonnes),		(Tonnes),

Table 6.6.1 Herring in Divisions VIa (South) and VIIb,c terminal F 0.4

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.8978	0.3681	158514	26100	1457973	188564	683252	115740	493358	83447
2001	0.8722	0.3576	155627	26100	1478427	192377	703706	119554	512345	86904
2002	0.8647	0.3545	155181	26100	1496437	195813	721716	122990	527106	89754
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK02
Date and time : 22MAR00:12:01
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : TAC constraints

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.4420	0.1812	84190	13900	1457973	188564	683252	115740	544323	92508
2001	0.3731	0.1530	81760	13900	1545686	205621	770965	132797	625074	108209
2002	0.3317	0.1360	80452	13900	1622957	221651	848236	148827	695234	122718
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK02
Date and time : 22MAR00:12:01
Computation of ref. F: Simple mean, age 4-7

Table 6.6.2 Herring in Divisions VIa (South) and VIIb,c terminal F 0.5

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.9868	0.5066	159340	26100	1278185	159806	525899	89091	353949	59666
2001	1.0019	0.5143	159300	26100	1318174	164254	565888	93539	383908	63020
2002	0.9879	0.5071	160827	26100	1344110	167952	591824	97237	403698	65964
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK03
Date and time : 22MAR00:12:17
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : TAC constraints

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.4719	0.2422	84519	13900	1278185	159806	525899	89091	406052	68908
2001	0.3970	0.2038	83009	13900	1385450	177450	633164	106735	498762	84373
2002	0.3420	0.1755	82252	13900	1471647	193628	719361	122913	575236	98747
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK03
Date and time : 22MAR00:12:17
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : TAC constraints

Table 6.6.3 Herring in Divisions VIa (South) and VIIb,c terminal F 0.5

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	1.2158	0.8748	161556	26100	1076187	127545	351007	59378	196967	32859
2001	1.3456	0.9681	168612	26100	1136682	132677	411502	64510	236758	36422
2002	1.2774	0.9191	172373	26100	1168758	136822	443578	68655	260760	39840
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK04
Date and time : 22MAR00:12:25
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : TAC constraints

The SAS System 12:00 Wednesday, March 22, 2000

Herring in Divisions VIa (South) and VIIb,c

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.5387	0.3876	85347	13900	1076187	127545	351007	59378	251831	42524
2001	0.4467	0.3214	85816	13900	1204016	145740	478836	77573	356553	57734
2002	0.3593	0.2585	85718	13900	1298825	162034	573645	93868	439130	71976
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK04
Date and time : 22MAR00:12:25
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : TAC constraints

Table 6.6.4 Herring in Divisions VIa (South) and VIIb,c input table from F 0.4

The SAS System 12:39 Tuesday, March 21, 2000

Herring in Divisions VIa (South) and VIIb,c

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	774721.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0064	0.092
2	215144.00	0.3000	1.0000	0.6700	0.6700	0.139	0.1706	0.138
3	235294.00	0.2000	1.0000	0.6700	0.6700	0.167	0.3366	0.156
4	137647.00	0.1000	1.0000	0.6700	0.6700	0.190	0.4427	0.174
5	59371.000	0.1000	1.0000	0.6700	0.6700	0.207	0.5135	0.192
6	14237.000	0.1000	1.0000	0.6700	0.6700	0.220	0.3666	0.203
7	12602.000	0.1000	1.0000	0.6700	0.6700	0.225	0.3172	0.207
8	4776.000	0.1000	1.0000	0.6700	0.6700	0.236	0.3793	0.222
9+	4181.000	0.1000	1.0000	0.6700	0.6700	0.240	0.3793	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	774721.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0064	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.1706	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.3366	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.4427	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.5135	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.3666	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.3172	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.3793	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.3793	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	774721.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0064	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.1706	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.3366	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.4427	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.5135	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.3666	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.3172	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.3793	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.3793	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANCJK01
Date and time: 21MAR00:12:56

Table 6.6.5 Herring in Divisions VIa (South) and VIIb,c input table from F 0.5

The SAS System 12:39 Tuesday, March 21, 2000

Herring in Divisions VIa (South) and VIIb,c

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	752286.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0085	0.092
2	163682.00	0.3000	1.0000	0.6700	0.6700	0.139	0.2135	0.138
3	183672.00	0.2000	1.0000	0.6700	0.6700	0.167	0.4165	0.156
4	106501.00	0.1000	1.0000	0.6700	0.6700	0.190	0.5491	0.174
5	45144.000	0.1000	1.0000	0.6700	0.6700	0.207	0.6370	0.192
6	10716.000	0.1000	1.0000	0.6700	0.6700	0.220	0.4654	0.203
7	9409.000	0.1000	1.0000	0.6700	0.6700	0.225	0.4018	0.207
8	3602.000	0.1000	1.0000	0.6700	0.6700	0.236	0.4746	0.222
9+	3173.000	0.1000	1.0000	0.6700	0.6700	0.240	0.4746	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	752286.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0085	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.2135	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.4165	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.5491	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.6370	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.4654	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.4018	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.4746	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.4746	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	752286.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0085	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.2135	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.4165	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.5491	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.6370	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.4654	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.4018	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.4746	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.4746	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANCJK03
Date and time: 21MAR00:13:44

Table 6.6.6 Herring in Divisions VIa (South) and VIIb,c input table from F 0.7

The SAS System 12:39 Tuesday, March 21, 2000

Herring in Divisions VIa (South) and VIIb,c

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	725180.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0127	0.092
2	108532.00	0.3000	1.0000	0.6700	0.6700	0.139	0.2983	0.138
3	125541.00	0.2000	1.0000	0.6700	0.6700	0.167	0.5731	0.156
4	70920.000	0.1000	1.0000	0.6700	0.6700	0.190	0.7588	0.174
5	29040.000	0.1000	1.0000	0.6700	0.6700	0.207	0.8776	0.192
6	6780.000	0.1000	1.0000	0.6700	0.6700	0.220	0.6675	0.203
7	5864.000	0.1000	1.0000	0.6700	0.6700	0.225	0.5741	0.207
8	2294.000	0.1000	1.0000	0.6700	0.6700	0.236	0.6653	0.222
9+	2036.000	0.1000	1.0000	0.6700	0.6700	0.240	0.6653	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	725180.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0127	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.2983	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.5731	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.7588	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.8776	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.6675	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.5741	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.6653	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.6653	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

(cont.)

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	725180.00	1.0000	0.0000	0.6700	0.6700	0.094	0.0127	0.092
2	.	0.3000	1.0000	0.6700	0.6700	0.139	0.2983	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.167	0.5731	0.156
4	.	0.1000	1.0000	0.6700	0.6700	0.190	0.7588	0.174
5	.	0.1000	1.0000	0.6700	0.6700	0.207	0.8776	0.192
6	.	0.1000	1.0000	0.6700	0.6700	0.220	0.6675	0.203
7	.	0.1000	1.0000	0.6700	0.6700	0.225	0.5741	0.207
8	.	0.1000	1.0000	0.6700	0.6700	0.236	0.6653	0.222
9+	.	0.1000	1.0000	0.6700	0.6700	0.240	0.6653	0.226
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANCJK04
Date and time: 21MAR00:14:05

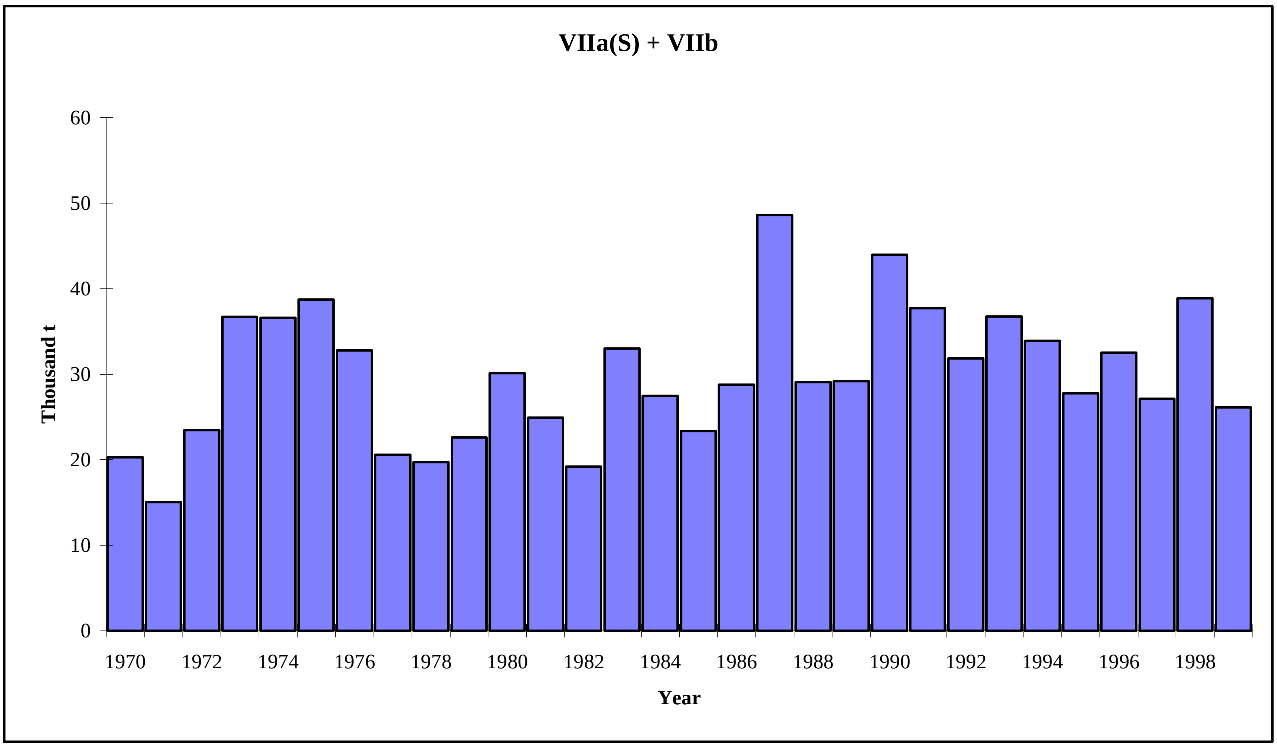
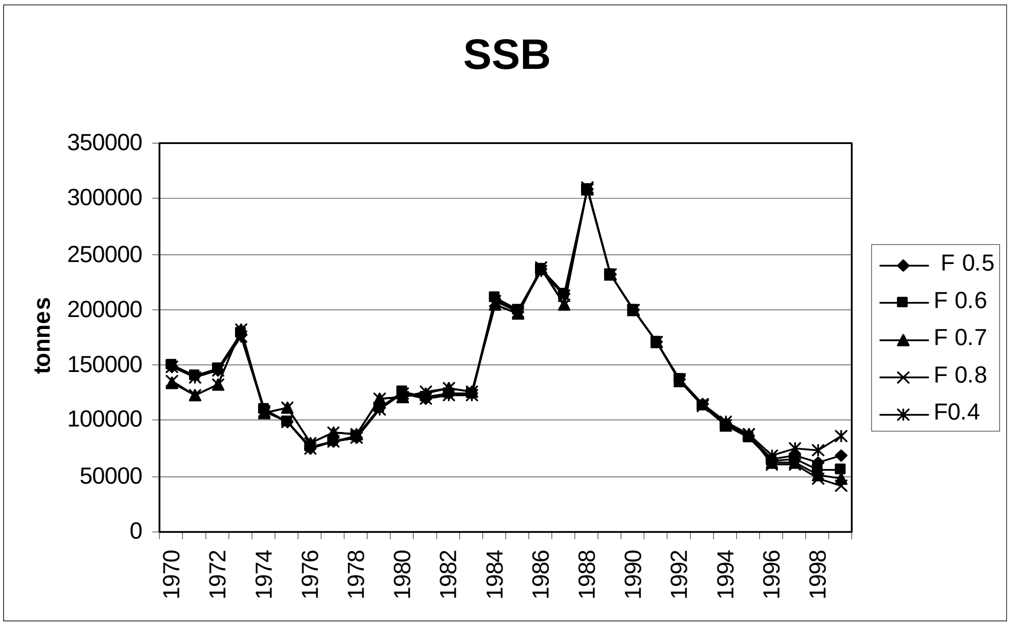
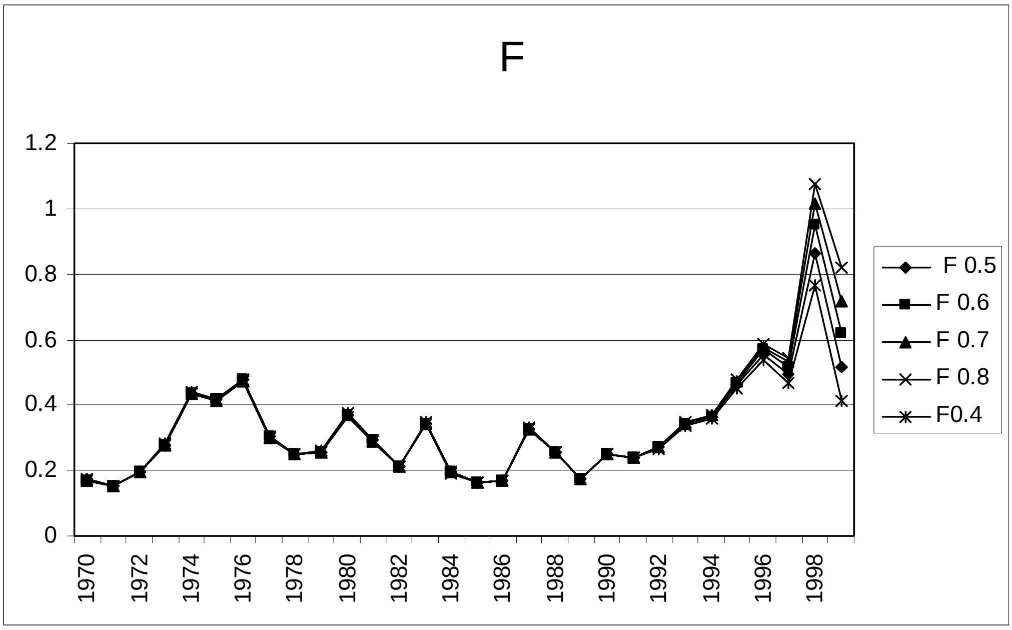
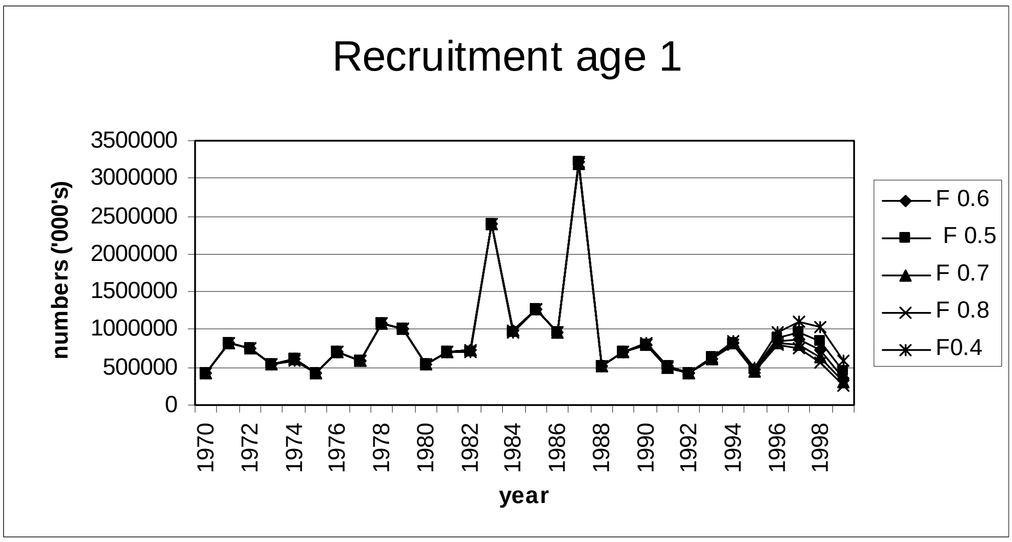


Figure 6.1.1. Herrring VIa(S) + VIIb: Catches.

Figure 6.5.1 SSB, Fbar (3-6) and recruitment for selected values of terminal F in the separable analysis.







7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1999 and 2000

In 1997 the Working Group did not undertake an age based assessment of this stock due to continued uncertainty about the fishing mortality and level of SSB. ACFM undertook an analysis using RCSEP1 (Cook *et al.* 1991) and concluded that the stock seems able to sustain the current fishing mortality. Consequently ACFM forecast a *status quo* fishing mortality which would give a catch of around 6,500 t in 1998. A TAC of 9,000 t was adopted for 1998 and partitioned as 2,340 t to the Republic of Ireland and 6,660 t to the UK, under the assumption that the Republic of Ireland generally does not take its full quota.

In 1998 and 1999, the Working Groups undertook an age based assessment of the stock. However, due to the instability in the assessment, the shrinkage option in ICA was applied in both years. The model estimate of the F was shrunk to the mean of the ten previous years. Consequently in 1998, ACFM recommended that F in 1999 should be reduced to F_{pa} = 0.36 to ensure that the SSB is maintained within the precautionary region. This corresponded to a catch of 4,900t. A TAC of 6,600 t was adopted for 1999 and was partitioned as 1,720t to the Republic of Ireland and 4,880t to the UK. In 1999, ACFM recommended that F was still above F_{pa} = 0.36, and should be reduced. F_{pa} corresponded to a catch of approximately 3,900 t and hence a TAC of 5,350 t was adopted for 2000, with 4,000 t to the UK.

In 1999 the UK fishery opened in the August. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional September, gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, did not take place in 1999. The redefined area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground, Figure 7.1.1) was closed from 21 September to 15 November.

7.1.2 The fishery in 1999

The catches reported from each country, for the period 1985 to 1999 are given in Table 7.1.1 and total catches from 1967 to 1999 in Figure 7.1.2. The additional data from 1967 to 1971 in Figure 7.1.2 were taken from the 1980 HAWG Report. Reported landings for the Irish Sea amounted to 4,127t. The size of the actual catch from the Irish Sea (VIIaN) is unclear. There is evidence that the scale of misreporting has increased in the last two years and the resultant reported catches from 1998 and 1999 do not reflect the actual size of the fishery. In 1993, the Republic of Ireland ceased taking their quota from Division VIIa(N). The number of vessels that specifically target herring in the Irish Sea has fallen to its lowest level in 30 years. According to the reported landings the majority of the catch was taken in the 3^{rd} and 4^{th} quarters. There were no landings from the Mourne gillnet fishery.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries. Working Group landing statistics are assumed to be accurate up to 1997, however there are no reliable estimates of landings from 1998 and 1999. It is likely that the landings lie between 2,000 and 7,000 tonnes. The catch in 1998, as reported in the 1999 WG Report, is now uncertain. The 1998 data in the Tables 7.1.1 and 7.1.3 have been set to values that correspond to official reported landings. However they should be treated as highly unreliable. Biological sampling in this fishery remains fairly high (Table 7.1.2). However, there were very few samples taken in the 4th quarter or from boats that land outside the island of Ireland.

7.1.4 Catch in numbers

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1999. The official catches were used for 1998 and 1999. The predominant year class in 1998 was the 2-ringers (1995 year class) and this was still abundant in 1999 as 3-ringers. The 1992 year class, which was numerically the most abundant year class in the 1995 catches was still abundant in the 1999 catches. The strong 1990 year class had passed into the 8+ group. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1999. The distribution of lengths in 1999 was similar to that in the preceding years but with even less fish over 30cm compared with 1988 and 1989, during which the strong 1979 and 1980 year classes were abundant (see Table 7.1.3).

7.2 Mean length, weight, maturity and natural mortality at age

Mean lengths at age were calculated for the 3rd and 4th quarters using the Northern Ireland data and are given for the years 1985 to 1999 in Table 7.2.1. In general, mean lengths at age have remained fairly stable since 1988.

Mean weights at age in the catch are given in Table 7.2.2. Mean weights at age in 1999 were, in general, comparable to the mean weights in 1998. Mean weights at age in the third-quarter catches have been used as estimates of stock weights at spawning time.

The maturity ogive used since 1994 (ICES 1994a) was used again since there was no evidence to suggest a change: 0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older age classes. These are based on the natural mortality rates determined for herring in the North Sea.

7.3 Research surveys

7.3.1 Acoustic surveys

The information on the time series of acoustic surveys in the Irish Sea is given in Table 7.3.1.

An acoustic survey was undertaken over the central northern Irish Sea (Division VIIa(N)), centred on the spawning area for herring between 6th and 17th September 1999 by the Department of Agriculture and Rural Development (DARD), Northern Ireland, as part of a time series that commenced in 1994. An intensive survey of the Douglas Bank spawning ground was carried out at night using transects spaced at one nautical mile intervals. The survey followed the same methods as described in Armstrong *et al.* (WD 1999a). The survey was carried out using a Simrad EK500 echosounder with a towed 38 and 120 kHz split-beam transducer. Targets were identified where possible by midwater trawling, and appropriate ALKs constructed from catch samples. The majority of adult herring (>22cm) were found to the east of the Isle of Man close to the traditional spawning area for this stock. The estimated SSB of herring in VIIa(N) was 21,970 t (Table 7.3.1). The estimated biomass of sprat (272.2 $x10^3$) was the second highest in the series, after 1995.

The age structure of herring from the acoustic survey is given in Table 7.3.2. There are a number of observations on the acoustic surveys which are pertinent to the interpretation of these data. The strong 1985 year class was probably responsible for the large number of fish in the 8+ group in 1994. The precision of the estimates of abundance for individual year classes is likely to be poor given the high CVs for the age-aggregated biomass estimates. The CV for the 1999 survey is the highest in the series and is due to the highly aggregated nature of the fish on the east of the Isle of Man. The large estimate of 1-ringers in 1995 is not reflected in a corresponding ages in 1996 and 1997. This may reflect survey imprecision or the variable abundance of Celtic Sea juveniles in the Irish Sea. The strong 1990 year class is reflected in the higher numbers of 8+ fish, compared to 1997 and 1998. Although the poor precision of the survey must be noted, the SSB estimates were similar to those prior to 1996.

The fishing industry claims that there has been a change in the pattern of movement of Irish Sea adult herring in recent years, and substantial spawning aggregations were located off the Solway Firth in 1997 and 1998. This may reflect a diversion of spawning effort away from Douglas Bank. In 1999, despite acoustic survey effort being increased to the north of the Isle of Man, there were still no recordings of herring aggregations in this area. The larval survey found newly hatched larvae in this area in November 1998 but not in 1999.

7.3.2 Larvae surveys

Larvae surveys were undertaken by Northern Ireland (Northern Irish Sea) and the Isle of Man (two on Douglas Bank). Despite poor weather conditions, the station grids were fully sampled. The Isle of Man survey on 5 October 1999 had an extremely high abundance of larvae (745 larvae m^{-2}), indicating that the time of the survey corresponded with hatching on the spawning grounds. The following survey, on 25 October 1999 recorded lower abundances and resulted in a production estimate of 3.87 $x10^{11}$. This was close to the survey mean (excluding the 1992 value). This survey was used as part of the series as its date was closer to those in the rest of the Douglas Bank series (Table 7.3.3). There was no DARD survey of the Douglas Bank in 1999. There was good coverage of the north Irish Sea in November. The DARD survey gave a production estimate that was close to the mean of the last 5 years. The distribution of spawning dates, back-calculated from the length at capture, suggested that the majority of the larvae were spawned at the end of September. The two series of production estimates show broad agreement (Figure 7.3.1).

Once again, there were very few Mourne larvae caught in the Northern Irish survey. There were also less larvae found to the west of Solway Firth in 1999 compared to previous years.

7.3.3 Groundfish surveys of Area VIIa(N)

Groundfish surveys, carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 to 1999 Herring Assessment Working Groups to obtain indices for 0 and 1-ringer herring in the Irish Sea (Table 7.4.1). These data indicate a strong 1992 year class (1-ringer in 1994) but the large 1990 year class 1-ringer in 1992, found in the catch at age data, was not apparent (Table 7.4.1). The ground fish survey index, based on these data and used by the 1997 to 1999 Working Groups was a weighted mean abundance of each year class across the surveys. The inverse of the coefficient of variation (CV) from each survey was used as the weighting factor. The rationale for this was to reduce the noise generated by individual indices. The index was recently reanalysed and the coefficients of variation were found to be more variable than the abundance data. Hence the level of variance within each survey heavily influenced the index. When different types of inverse-variance weighting were applied to the abundance data, the ranks of years changed radically, dependent on the method used. The group decided to use of the arithmetic mean abundance data (within strata) of 0 ring and 1 ring fish from each cruise as a prospective index of recruitment strength.

The eastern and western indices were designed to highlight and possibly reduce potential problems associated with juvenile Celtic Sea fish in the Irish Sea. The reliability of trawl indices of herring abundance in the Irish Sea will be affected by mixing of Irish Sea and Celtic Sea juveniles, which co-occur, particularly in the western region. There is a very poor correlation between the eastern Irish Sea 1-ringer index and the western Irish Sea index (Armstrong *et al.* 1999b WD). It is suggested that the eastern Irish Sea index may in fact be a better indicator of variation in recruitment to the Irish Sea spawning stock as it is probably less influenced by the presence of Celtic Sea herring (Armstrong *et al.* 1999b WD).

7.4 Data exploration and preliminary modelling

This year, the preliminary modelling used catch at age data derived from the official landings. New data were added to the Douglas Bank larvae series (DBL), Northern Irish larvae series (NINEL) and the Northern Irish acoustic survey (AC-VIIa(N), and ACAGE). As mentioned in section 7.3.3 the ground fish survey data had to be reworked and the 1-ringer recruitment indices for the whole Irish and the eastern Irish Sea were calculated separately for the March and October surveys (Table 7.4.1). New data were also added from the 1999 surveys. The Division VIIa(N) acoustic survey estimates are not considered as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other stocks

The following survey series were available for inclusion in an assessment using the ICA package:

1. Larval production estimates from Douglas Bank surveys to provide an SSB index: 1989 - 1998 (**DBL**)
2. Larval production estimates from the Northern Ireland surveys in the north-east Irish Sea: 1993 - 1998 (**NINEL**)
3. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1998 (**AC_VIIa(N)**)
4. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1998 (**ACAGE**, table 7.3.2).
5. The arithmetic mean abundance data (within strata) of 0 ring and 1 ring fish from October surveys in the northern Irish Sea as a prospective index of recruitment strength, 1993-2000 (**GFS-octtot**).
6. The arithmetic mean abundance data (within strata) of 0 ring and 1 ring fish from October surveys in the north-eastern Irish Sea as a prospective index of recruitment strength, 1993-2000 (**GFS-octeast**).
7. The arithmetic mean abundance data (within strata) of 1 ring fish from March surveys in the northern Irish Sea as a prospective index of recruitment strength, 1992-1999 (**GFS-martot**).

Initial fits within integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985), were found in 2000 with all indices. The ICA model was fitted using each survey series (1-7). The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2

- Last age for calculation of mean F = 6
- Weighting on 1-ringers = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The indices DBL and GFS-octtot gave a low mean $F_{(2\text{-}6)}$ (<0.2) and ACAGE and AC_VIIa(N) gave mean Fs of 0.31 and 0.35 respectively. The estimates of F using NINEL and GFS-octeast were less precise than the other indices. Overall the precision in the estimation of mean F was much improved, compared to 1998 and 1999. In an attempt to explore further the performance of these tuning indices, many of the indices were combined. The combinations resulted in a similar perception of the state of the stock (Figure 7.4.1).

In 1996 to 1999, data explorations by the working group concluded that there was instability in the assessment. They opted for the shrinkage option in ICA (ICES 1998a). In 1999, at the request of ACFM, the effect of varying the time spans of the shrinkage over 3, 5, 10 and 15 years was explored using minima shrinkage CVs of 0.5 and 0.0. There was little affect on estimates of $F_{(2\text{-}6)}$ or SSB using combinations of CV and numbers of years for shrinkage. This year the working group felt that the level of precision found during the preliminary modelling was greatly improved and that the instability in the assessment was reduced. Hence the shrinkage option was not used. However it should be noted that previous working groups have found that precision in the estimation of F have been highly variable. This variability in the precision has been explained by the use of very short time series of surveys in the age-based assessments. This often resulted in an index appearing to fit the model well in one year and failing to find a solution in the following year. All of the series used in 2000 are now longer (6-11 years) and the working groups have noted improved precision in the estimation of F in both 1999 and 2000.

In view of this historic problem with the indices, they were examined individually with care. All the indices appeared to contain useful information with regards to the state of the stock. As there were no obvious biological or methodological reasons for excluding any index or age within an index it was decided to combine all the available indices in the assessment. So the ACAGE and GFS-octtot, and the two larval series (DBL and NINEL) were used. Whilst these are different from the index used in 1999, which is no longer available (Section 7.3.3), their combination gives a perception of the stock in 1998 very similar to the perception in the assessment in 1999 (ICES 1998a).

As mentioned in sections 7.1.3 and 7.1.4, the actual size of the catch in 1998 and 1999 is uncertain. For this reason three sets of catch at age data were used to investigate the sensitivity of the assessment to the catch in the last two years. The three scenarios were:

1. The official landings were correct (4,905 and 4,217 t in 1998 and 1999 respectively)
2. Area misreporting had occurred and the landings in the Irish Sea were lower than recorded (3,718 and 1,936 t in 1998 and 1999 respectively) in 1998 and 1999 respectively)

The catches at age associated with these options are given in table 7.4.2. ICA was used to model these catches with the four indices chosen as the best solution in earlier explorations (i.e., ACAGE, GFS-octtot, DBL and NINEL). The three options resulted in very similar SSBs in 1999 and in three different values of reference F (Figure 7.4.2), although all were still below 0.3. The historic series of SSB and mean F from all three catch scenarios show a similar perception of the stock, in that F was above F_{pa} in recent years but was now heading below F_{pa} (Figure 7.4.3). The working group felt that short term predictions should be considered for all three catch scenarios.

7.5 Stock assessment

The structural model used for the baseline assessment, based on the results given in Section 7.4, is given as:

$$\begin{aligned}
&\sum\nolimits_{a,y} \left(\ln\left(C_{a,y}\right) - \ln\left(C_{a,y}\right)\right)^2 + \\
&\sum\nolimits_{1,y} \left(\ln\left(Q_{GFS-octtot} N_{1,y}\right) - \ln\left(GFS - octtot_{1,y}\right)\right)^2 + \\
&\sum\nolimits_{1,y} \left(\ln\left(Q_{ACAGE} N_{1,y}\right) - \ln\left(ACAGE_{1,y}\right)\right)^2 + \\
&\sum\nolimits_{1,y} \left(\ln\left(Q_{DBL} SSB_{1,y}\right) - \ln\left(DBL_{1,y}\right)\right)^2 + \\
&\sum\nolimits_{1,y} \left(\ln\left(Q_{NINEL} SSB_{1,y}\right) - \ln\left(NINEL_{1,y}\right)\right)^2
\end{aligned}$$

where:

a,y	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by a separable fishing model
GFS-octtot	Ground Fish Survey juvenile abundance estimates for Irish Sea in October
ACAGE	Age-disaggregated acoustic estimates for the SSB
DBL	Larval production estimates from Douglas Bank survey
NINEL	Larval production estimates from the Northern Ireland surveys in the north-east Irish Sea
SSB	Spawning Stock Biomass in the model
N	Population abundance in the structural model
Q	Coefficients of proportionality for survey indices

The parameter values used in the base line run for ICA are shown in table 7.5.1. The results of the baseline model fit are shown in Figures 7.5.1-7.5.3 (the plots for the indices are not shown due to problems encountered with using two SSB indices in IcaView, the residuals and fitted values are given in table 7.5.2). The run log is given in Table 7.5.1. The SSQ surface for the index shows a minimum at an intermediary level of fishing mortality (Figure 7.5.1). The estimate for $F_{(2-6)}$ for 1999 using the official landing data was 0.26 (Table 7.5.2) with a corresponding SSB estimate of approximately 10,659 t. Scenarios 2 and 3 for catch in 1998 and 1999 (see section 7.4) suggest SSBs of 10,998t and 10,718t, and mean Fs of 0.12 and 0.37 respectively. The assessment (with official landings) shows estimated fishing mortality in the last few years to be similar to the shrunk Fs from the 1999 assessment. SSB was higher than that estimated last year by approximately 2,000 tonnes. The population estimates, fishing mortalities and stock summary tables for catch scenarios 2 and 3 are given in Table 7.5.3. The standard fish stock summary plots from catch scenario 1 are shown in Figure 7.5.4 and the stock recruitment plot with F_{low} (0.16), F_{med} (0.36) and F_{high} (0.57) in Figure 7.5.5.

7.6 Stock and Catch Projection

Short-term predictions were carried out using all the ICA estimates of population numbers and fishing mortalities (Section 7.5). These projections are for illustrative purposes only as the Working Group is very unsure of the actual status of this stock. The numbers of 1-ringers in 2000-2002 were assumed to be a geometric mean of the recruitment over the period 1984–1999 (Table 7.6.1). Mean weights in the catch and in the stock were taken as a mean for the years 1997–1999. The relevant ICA estimates of F at age in 1999 were used for the exploitation pattern.

Due to the uncertainties in the landings data, three starting points were used for the short-term predictions: 1. Assuming the official landings are correct, 2. Area missreporting had occurred, 3. The quota was exceeded. Predictions of stock and yield were made assuming; TAC constraint of the UK landings reaching quota (4,000t) in 2000, and UK landings being maintained at 4,000t or $F_{status\ quo}$ in 1999 for the subsequent two years (2001-2002). Predictions for 2001 and 2002 were made for a range of F-multipliers for only catch scenario 1 as there is no compelling evidence to suggest which option is most likely to reflect the real situation. The short term predictions at $F_{status\ quo}$ for each catch scenario are summarised in table 7.6.2.

Option 1: A UK catch of 4,000t in 2000 suggests an $F_{(2-6)}$ of 0.20 which is a decrease from $F_{(1999)}$ (Table 7.6.3). There would be an increase in SSB. An $F_{status\ quo}$ for the years 2001 to 2002 gives a catch of 5,137 and 4,975t (respectively) and a relatively stable SSB at between 14,000 and 15,000t. Details of stock structure in 2000-2002, assuming a catch of 4,000t in 2000, are given in Table 7.6.4.

Option 2: A UK catch of 4,000t in 2000 suggests an $F_{(2-6)}$ of 0.20 which is an increase from $F_{(1999)}$ (Table 7.6.5). There would be an increase in SSB. An $F_{status\ quo}$ for the years 2001 to 2002 gives a catch of 2,560 and 2,743t (respectively) and an increasing SSB (16,000 to 18,188t).

Option 3: A UK catch of 4,000t in 2000 suggests an $F_{(2-6)}$ of 0.18 which is a decrease from $F_{(1999)}$ (Table 7.6.6). There would be an increase in SSB. An $F_{status\ quo}$ for the years 2001 to 2002 gives a catch of 8,198 and 7,783t (respectively) and a fairly stable SSB (approximately 15,000t).

7.7 Medium-term predictions of stock size

The present assessment is based on the assumption of stability in the stock and on uncertain catches. Therefore, the Working Group decided that there was no real basis for undertaking a meaningful medium term projection of stock size. The current state of herring recruitment to VIIaN is unclear, considering the imprecision in the assessments and the variable mixing of Celtic Sea and western Irish Sea juveniles. Also the historical assessments of recruitment have incorporated both Manx and Mourne components and the contribution of the Mourne component is now thought to be negligible.

7.8 Management considerations

7.8.1 Precision of the assessment

The current time-series of survey data are short and are prone to providing variable perceptions of stock development. The current SSB is higher than perceived by the Working Group in 1999. There have probably been changes in this stock since the early 1990s with the severe reduction in the Mourne component of VIIa(N). The consequence of this is that the SSB in VIIa(N) may be lower than when both components are present. This change in stock dynamics and the variability in the tuning data mean that this assessment should be treated with caution. It is likely, however, that the SSB has declined over recent years and the ecology and behaviour of the stock is in a state of flux.

There is considerable between year variation in SSB indices and the relevant 1999 data are generally close to the mean the each series. The 1-ringer recruit indices do not suggest any recent strong year classes. Therefore, maintaining catch levels, in the short-term, of approximately 5,000t should not be detrimental to the stock.

7.8.2 Reference points

ACFM requested that the working group should reconsider the appropriateness of the current reference points for herring in the Irish Sea. They commented that as the stock had been exploited within or close to the precautionary approach over an extended period, why had the stock not recovered to earlier levels. In 1998, ACFM found F_{med} = 0.36, from the whole series of 1972 to 1997. The present working group has used data from 1988 to 1998 to reassess F_{med}. It was still found to be 0.36. Hence it appears that F_{med} is independent of period over which it is evaluated and if F_{med} is the appropriate level for F_{pa} (as recommended by ACFM) then 0.36 is suitable as F_{pa} for Irish Sea herring.

The recruitment seems more variable in the non-shrunk assessment (this working group) when compared to previous estimates with shrunk Fs (see Figure 7.5.4). At B_{lim} (6,100 t in 1980), the recruitment was close to the geometric mean from 1980 to 1999 (162.3 x 10^3) and there appears to be no SSB effect on the recruitment (Figure 7.8.1). Since 1980, recruitment has been stable, the catches are fairly constant and the SSB appears to have declined. Following an examination of the mean weight of fish in the catch it became apparent that estimates of mean weight of age in the catch have changed since 1972. The data used in ICA suggest that the older fish are now approximately 50g lighter than in the 1970s (Figure 7.8.2). This is likely to give a different perception of the stock in the 1970s compared to the 1990s. The issue of these historic mean weights at age in the catch needs to be evaluated before the next HAWG in 2001.

As the stock dynamics in recent years appear to be different from that in the 1970s, when a juvenile fishery operated in the Irish Sea and fishing effort was higher, the equilibrium SSB at F_{pa} from 1980 to 1999 was evaluated. The yield per recruit at F_{pa} was combined with the geometric mean recruitment from 1980 to 1999 (Figure 7.8.3). The equilibrium SSB of 11,630 tonnes is very close to the recent SSB in the Irish Sea. With the current estimates of population structure, it is unlikely that the SSB will recover to that seen in the 1970s (>35,000 tonnes). The equilibrium SSB is close to B_{pa} (9,500 tonnes). So the working group proposes that the B_{pa} should be lowered to approximately 8,400 tonnes, which corresponds to σ =0.2, in the relationship between B_{lim} and B_{pa} for herring in the Irish Sea.

7.8.3 Spawning and Juvenile Fishing Area Closures

The arrangement of closed boxes in Division VIIa(N) prior to 1999 are discussed in detail in ICES (ICES 1996a). The closed areas consist of: all year juvenile closures along the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man, and along the east coast of Ireland.

There was a change in the closure area and time for the Douglas Bank spawning ground from 21st September- 31st December to 21st September - 15th November for 1999. In view of the uncertainties in the size of the stock in Division VIIa(N) the Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.

Table 7.1.1. Irish Sea HERRING (Division VIIa(N)). Catch in tonnes by country, 1985-1999. 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	1990	1991	1992	1993
Ireland	1,000	1,640	1,200	2,579	1,430	1,699	80	406	0
UK	4,077	4,376	3,290	7,593	3,532	4,613	4,318	4,864	4,408
Unallocated	4,110	1,424	1,333	-	-	-	-	-	-
Total	9,187	7,440	5,823	10,172	4,962	6,312	4,398	5,270	4,408

Country	1994	1995	1996	1997	1998	1999
Ireland	0	0	100	0	0	0
UK	4,828	5,076	5,180	6,651	4,905	4,127
Unallocated	-	-	22	-	-	-
Total	4,828	5,076	5,302	6,651	4,905*	4,127*

* Reliability uncertain.

Table 7.1.2 Irish Sea HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1999.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
1	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
2	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
3	Ireland	0	2		100	-
	UK (N. Ireland)	1676	23	2095	1150	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	388	0	0	0	No
	UK (England & Wales)	0	-	-	-	-
4	Ireland	0	2		100	No
	UK (N. Ireland)	1291	5	423	250	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	772	0	0	0	No
	UK (England & Wales)	0	0	0	0	No

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne VIIa(N)). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432
1998	3069	11879	3875	4450	6674	1030	2049	451
1999	1810	16929	5936	1566	1477	1989	444	622

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1999. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
14	1											
	1											
15	1				95							
	10				169							10
16	13		6		343			21	21	17		19
	16		6	2	275			55	51	94		53
17	29		50	1	779		84	139	127	281	26	97
	44	24	7	4	1,106		59	148	200	525	30	82
18	46	44	224	31	1,263		69	300	173	1,022	123	145
	85	43	165	56	1,662		89	280	415	1,066	206	135
19	247	116	656	168	1,767	39	226	310	554	1,720	317	234
	306	214	318	174	1,189	75	241	305	652	1,263	277	82
20	385	226	791	454	1,268	75	253	326	749	1,366	427	218
	265	244	472	341	705	57	270	404	867	1,029	297	242
21	482	320	735	469	705	130	400	468	886	1,510	522	449
	530	401	447	296	597	263	308	782	1,258	1,192	549	362
22	763	453	935	438	664	610	700	1,509	1,530	2,607	1354	1261
	1,205	497	581	782	927	1,224	785	2,541	2,190	2,482	1099	2305
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362	3,508	2493	4784
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917	3,902	2041	4183
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649	4,714	3695	4165
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077	4,138	2769	3397
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015	5,031	2625	2620
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668	3,971	2797	1817
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480	3,871	3115	1694
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177	2,455	2641	1547
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949	1,711	2992	1475
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267	1,131	1747	867
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906	638	1235	276
	2,916	1,586	582	423	569	944	900	123	564	440	170	169
29	2,659	1,268	302	293	278	473	417	248	210	280	111	61
	1,740	997	144	129	96	160	165	56	79	59	92	
30	1,335	801	146	82	70	83	9	40	32	8	84	
	685	557	57	36	36	15	27	5	0	5	3	
31	563	238	54	12	2	4		1	2			
	144	128	31	3								
32	80	57	29									
	7	7										
33	2	5										
	1	6										
34		0										
		5										

Table 7.2.1 HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2
1997	19.6	23.6	25.1	26.0	26.5	27.1	27.7	28.2
1998	20.8	23.8	25.2	26.1	27.0	26.8	27.2	28.7
1999	19.8	23.6	25.0	26.1	26.5	27.1	27.2	28.0

Table 7.2.2 HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214
1997	64	118	146	165	176	188	204	216
1998	80	123	148	163	181	177	188	222
1999	69	120	145	167	176	188	190	210

Table 7.3.1 Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-1999. Small clupeoids include sprat and 0-ring herring unless otherwise stated. CVs are approximate. Biomass in t. All surveys carried out at 38kHz except December 1996, which was at 120kHz.

Year	Area	Dates	herring biomass (1+ years)	CV	herring biomass (SSB)	CV	small clupeoids biomass	CV
1989	Douglas Bank	25-26 Sept			18000	-	-	-
1990	Douglas Bank	26-27 Sept			26,600	-	-	-
1991	Western Irish Sea	26 July - 8 Aug	12,760	0.23			66,000[1]	0.20
1992	Western Irish Sea + IOM east coast	20 - 31 July	17,490	0.19			43,200	0.25
1994	Area VIIa(N)	28 Aug - 8 Sep	31,400	0.36	26,190	-	68,600	0.10
	Douglas Bank	22-26 Sept			28200	-	-	-
1995	Area VIIa(N)	11-22 Sept	38,400	0.29	19,900	-	348,600	0.13
	Douglas Bank	10-11 Oct		-	9,840	-	-	-
	Douglas Bank	23-24 Oct			1,750	0.51	-	-
1996	Area VIIa(N)	2-12 Sept	24,500	0.24	23,390	0.25	49,120	0.13
	Eastern Irish Sea (closed box)	9-12 Dec	12,800	0.49	11,880	0.49	6,810	0.13
1997	Area VIIa(N)-reduced	8-12 Sept	20,100	0.28	11,300	0.28	46,600	0.20
1998	Area VIIa(N)	8-14 Sept	21,200	0.15	7,760	0.18	228,000	0.11
1999	Area VIIa(N)	6-17 Sept	31,600	0.59	21,970	0.75	272,200	0.10

[1] sprat only

Table 7.3.2 Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996	1997	1998	1999
1	66.8	319.1	11.3	134.1	110.4	157.8
2	68.3	82.3	42.4	50.0	27.3	77.7
3	73.5	11.9	67.5	14.8	8.1	34
4	11.9	29.2	9.0	11.0	9.3	5.1
5	9.3	4.6	26.5	7.8	6.5	10.3
6	7.6	3.5	4.2	4.6	1.8	13.5
7	3.9	4.9	5.9	0.6	2.3	1.6
8+	10.1	6.9	5.8	1.9	0.8	6.3

Table 7.3.3 Irish Sea HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N).

Year	Douglas Bank Isle of Man			North East Irish Sea					
				Isle of Man			Northern Ireland		
	Date	Production	SE	Date	Production	SE	Date	Production	SE
1989	26 Oct	3.39	1.54						
1990	19 Oct	1.92	0.78						
1991	15 Oct	1.56	0.73						
1992	16 Oct	15.64	2.32	20 Nov	128.9				
1993	19 Oct	4.81	0.77	22 Nov	1.1		17 Nov	38.3	18.4
1994	13 Oct	7.26	2.26	24 Nov	12.5		16 Nov	71.2	8.4
1995	19 Oct	1.58	1.68				28 Nov	15.1	9.3
1996				26 Nov	0.3		19 Nov	4.7	1.4
1997	15 Oct	5.59	1.25	1 Dec	35.9		4 Nov	29.1	3.2
1998	6 Nov	2.27	1.43	1 Dec	3.5		3 Nov	5.8	5.9
1999	25 Oct	3.87	0.88				9 Nov	16.7	9.5

SE = Standard error

Table 7.4.1 Tuning indices used for the Irish Sea (VIIa(N)) herring assessment. Values and approximate CVs are given.

Year	GFS-octeast[1]		GFS-octtot[1]		GFS-martot[2]	DBL[3]	NINEL[3]	AC_VIIa(N)[4]
	Age 1	Age 2	Age 1	Age 2	Age 1	SSB	SSB	SSB
1989						3.39 (1.54)		-
1990						1.92 (0.78)		-
1991						1.56 (0.73)		-
1992					156	15.64 (2.32)		-
1993	240	20	177	21	100	4.81 (0.77)	38.3 (0.48)	-
1994	498	4	412	44	198	7.30 (2.26)	71.2 (0.12)	26190 (na)
1995	8	17	194	176	30	1.58 (1.68)	15.1 (0.62)	19900 (na)
1996	35	3	37	55	65	-	4.7 (0.30)	23390 (0.25)
1997	131	2	117	11	102	5.59 (1.25)	29.1 (0.11)	11300 (0.28)
1998	68	0	138	302	109	2.27 (1.43)	5.8 (1.02)	7760 (0.18)
1999	12	13	347	53	8	3.87 (0.88)	16.7 (0.57)	21,970 (0.75)
2000	90	104	186	74				

1. Mean abundance of juveniles (within strata) per 3nm trawl, surveyed when aged 0 in September and 1 in the following September and used as indices for the following years, for either the eastern Irish Sea or total northern Irish Sea. These indices are reworked (see section 7.3.3).
2. Mean abundance of juveniles (within strata) per 3nm trawl, aged 1 in March from the eastern Irish Sea. This index is reworked (see section 7.3.3).
3. Numbers of larvae at 6mm x 10^{11}, a size weighted index.
4. Biomass of SSB, tonnes from acoustic surveys of the northern Irish Sea.

na- not available. GFS-Ground fish survey. DBL- Douglas Bank Larvae. NINEL- North East Larvae. AC- Acoustic.

Table 7.4.2. Catch in numbers in 1998 and 1999 for three scenarios of landings of herring in the Irish Sea. Scenarios described in section 7.4

	1998			**1999**		
Age	scenario 1	scenario 2	scenario 3	scenario 1	scenario 2	scenario 3
1	3069	2326	4320	1810	849	2687
2	11879	9004	16722	16929	7940	25134
3	3875	2937	5455	5936	2784	8813
4	4450	3373	6264	1566	735	2325
5	6674	5059	9395	1477	693	2193
6	1030	781	1450	1989	933	2952
7	2049	1553	2884	444	208	660
8+	451	342	635	622	291	923
total numbers	33476	25375	47126	30774	14433	45688
catch (t)	4905	3718	6905	4127	1936	6127

Table 7.5.1 Herring in Division VIIa(N). Run log of HAWG 2000, Irish Sea run 20.

```
                          Integrated Catch at Age Analysis
                          --------------------------------
                                   Version 1.4 w
                                   K.R.Patterson
                           Fisheries Research Services
                                Marine Laboratory
                                    24 August 1999
  Type * to change language
 Enter the name of the index file -->index
canum
weca
 Stock weights in 2000  used for the year 1999
west
 Natural mortality in 2000  used for the year 1999
natmor
 Maturity ogive in 2000  used for the year 1999
matprop
 Name of age-structured index file (Enter if none) : -->fleet
 Name of the SSB index file (Enter if none) -->ssb
 No of years for separable constraint ?--> 6
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 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 1-->    0.100000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
Enter relative weights by year
 Weight for year 1994-->    1.000000000000000
 Weight for year 1995-->    1.000000000000000
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of FLT01: Northern Ireland acoustic surveys a plus-group (Y-->y
 Is the last age of FLT06: GFS Total Octringers) (Catch: Tho a plus-group (Y-->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   INDEX1  is to be A/L/P ?-->L
 Model for   INDEX2  is to be A/L/P ?-->L
 Model for FLT01: Northern Ireland acoustic surveys  is to be A/L/P ?-->L
 Model for FLT06: GFS Total Octringers) (Catch: Tho  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    2.000000000000000
Mapping the F-dimension of the SSQ surface
     F                  SSQ
+--------+-------------------
    0.05        27.5473812066
    0.15        21.0203095641
    0.26        20.6789600842
    0.36        21.6815091903
    0.46        23.2667918734
    0.56        25.2009670870
    0.67        27.3988639378
    0.77        29.8405647867
    0.87        32.5479145604
    0.97        35.5841748730
    1.08        39.0747013160
    1.18        42.5932220683
    1.28        44.5398204913
    1.38        46.5575198394
    1.49        48.1852357577
    1.59        49.7510389294
```

Table 7.5.1 cont

```
    1.69         51.2969225995
    1.79         52.8327659622
    1.90         54.3726348030
    2.00         55.6552247146
Lowest SSQ is for F =     0.216
------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1972  . . . 1999
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 36
Number of observations : 124

Conventional single selection vector model to be fitted.
 ------------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   INDEX1-->    1.000000000000000
 Enter weight for   INDEX2-->    1.000000000000000
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 1-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 2-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 3-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 4-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 5-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 6-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 7-->    1.0
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 8-->    1.0
 Enter weight for FLT06: GFS Total Octringers) (Catch: Tho  at age 1-->    1.0
 Enter weight for FLT06: GFS Total Octringers) (Catch: Tho  at age 2-->    1.0
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for FLT01: Northern Ireland acoustic surveys-->    1.0
  Enter value for FLT06: GFS Total Octringers) (Catch: Tho-->    1.0
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
  1.000 1.000
Aged index weights
FLT01: Northern Ireland acoustic surveys
 Age   :       1     2     3     4     5     6     7     8
 Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
FLT06: GFS Total Octringers) (Catch: Tho
 Age   :       1     2
 Wts :     0.500 0.500
F in 1999  at age 4  is 0.208298  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->n
 Output page width in characters (e.g. 80..132) ?--> 80
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table 7.5.2. ICA assessment of Irish Sea herring catches from official landings. Output Generated by ICA Version 1.4 Herring Irish Sea (run: ICAMDC20/I20)4. Based on catch scenario 1.

Catch in Number, scenario 1

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	40.64	42.15	43.25	33.33	34.74	30.28	15.54	11.77
2	46.66	32.74	109.55	48.24	56.16	39.04	36.95	38.27
3	26.95	38.24	39.75	39.41	20.78	22.69	13.41	23.49
4	13.18	11.49	24.51	10.84	15.22	6.75	6.78	4.25
5	13.75	6.92	10.65	7.87	4.58	4.52	1.74	2.20
6	6.76	5.07	4.99	4.21	2.81	1.46	1.34	1.05
7	2.66	2.59	5.15	2.09	2.42	0.91	0.67	0.40
8	1.67	2.60	1.63	1.64	1.27	1.12	0.35	0.29

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	5.84	5.05	5.10	1.30	1.17	2.43	4.49	2.23
2	25.76	15.79	16.03	12.16	8.42	10.05	15.27	12.98
3	19.51	3.20	5.67	5.60	7.24	17.34	7.46	6.15
4	8.52	2.79	2.15	2.82	3.84	13.29	8.55	3.00
5	1.98	2.30	0.33	0.45	2.22	7.21	4.53	4.18
6	0.91	0.33	1.11	0.48	0.38	2.65	3.20	2.78
7	0.36	0.29	0.14	0.26	0.23	0.67	1.46	2.33
8	0.23	0.24	0.38	0.06	0.48	0.72	0.88	1.67

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	2.61	1.16	2.31	2.00	12.14	0.65	1.97	3.20
2	21.25	6.38	12.84	9.75	6.88	14.64	7.00	21.33
3	13.34	12.04	5.73	6.74	6.74	3.01	12.16	3.39
4	7.16	4.71	9.70	2.83	6.69	3.02	1.83	5.27
5	4.61	1.88	3.60	5.07	3.26	2.90	2.57	1.20
6	5.08	1.25	1.66	1.49	5.12	1.61	2.10	1.15
7	3.23	1.56	1.04	0.72	1.04	2.18	1.28	0.93
8	4.21	1.96	1.61	0.81	0.39	0.85	1.99	1.45

AGE	1996	1997	1998	1999
1	5.33	9.55	3.07	1.81
2	17.53	21.39	11.88	16.93
3	9.76	7.56	3.88	5.94
4	1.16	7.34	4.45	1.57
5	3.60	1.64	6.67	1.48
6	0.78	2.28	1.03	1.99
7	0.96	0.84	2.05	0.44
8	1.36	1.43	0.45	0.62

x 10 ^ 6

Weights at age in the catches (Kg), scenario 1

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.07400	0.07400	0.07400	0.07400	0.07600	0.08700	0.06800	0.05800
2	0.15500	0.15500	0.15500	0.15500	0.14200	0.12500	0.14300	0.13000
3	0.19500	0.19500	0.19500	0.19500	0.18700	0.15700	0.16700	0.16000
4	0.21900	0.21900	0.21900	0.21900	0.21300	0.18600	0.18800	0.17500
5	0.23200	0.23200	0.23200	0.23200	0.22100	0.20200	0.21500	0.19400
6	0.25100	0.25100	0.25100	0.25100	0.24300	0.20900	0.22800	0.21000
7	0.25800	0.25800	0.25800	0.25800	0.24000	0.22200	0.23900	0.21800
8	0.27800	0.27800	0.27800	0.27800	0.27300	0.25800	0.25400	0.22900

Table 7.5.2. cont.

Weights at age in the catches (Kg) catch scenario 1

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.07000	0.08100	0.09600	0.07300	0.06200	0.08900	0.07000	0.07500
2	0.12400	0.12800	0.14000	0.12300	0.11400	0.12700	0.12300	0.12100
3	0.16000	0.15500	0.16600	0.15500	0.14000	0.15700	0.15300	0.14600
4	0.17000	0.17400	0.17500	0.17100	0.15500	0.17100	0.17000	0.16400
5	0.18000	0.18400	0.18700	0.18100	0.16500	0.18200	0.18000	0.17600
6	0.19800	0.19500	0.19500	0.19000	0.17400	0.19100	0.18900	0.18100
7	0.21200	0.20500	0.20700	0.19800	0.18100	0.19800	0.20200	0.19300
8	0.23200	0.21800	0.21800	0.21700	0.19700	0.21200	0.21200	0.20700

AGE	1996	1997	1998	1999
1	0.06700	0.06400	0.08000	0.06900
2	0.11600	0.11800	0.12300	0.12000
3	0.14800	0.14600	0.14800	0.14500
4	0.16200	0.16500	0.16300	0.16700
5	0.17700	0.17600	0.18100	0.17600
6	0.19900	0.18800	0.17700	0.18800
7	0.20000	0.20400	0.18800	0.19000
8	0.21400	0.21600	0.22200	0.21000

Weights at age in the stock (Kg) catch scenario 1

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.07400	0.07400	0.07400	0.07400	0.07600	0.08700	0.06800	0.05800
2	0.15500	0.15500	0.15500	0.15500	0.14200	0.12500	0.14300	0.13000
3	0.19500	0.19500	0.19500	0.19500	0.18700	0.15700	0.16700	0.16000
4	0.21900	0.21900	0.21900	0.21900	0.21300	0.18600	0.18800	0.17500
5	0.23200	0.23200	0.23200	0.23200	0.22100	0.20200	0.21500	0.19400
6	0.25100	0.25100	0.25100	0.25100	0.24300	0.20900	0.22900	0.21000
7	0.25800	0.25800	0.25800	0.25800	0.24000	0.22200	0.23900	0.21800
8	0.27800	0.27800	0.27800	0.27800	0.27300	0.25800	0.25400	0.22900

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.07000	0.08100	0.07700	0.07000	0.06100	0.08800	0.07300	0.07200
2	0.12400	0.12800	0.13500	0.12100	0.11100	0.12600	0.12600	0.12000
3	0.16000	0.15500	0.16300	0.15300	0.13600	0.15700	0.15400	0.14700
4	0.17000	0.17400	0.17500	0.16700	0.15100	0.17100	0.17400	0.16800
5	0.18000	0.18400	0.18800	0.18000	0.15900	0.18300	0.18100	0.18000
6	0.19800	0.19500	0.19600	0.18900	0.17100	0.19100	0.19000	0.18500
7	0.21200	0.20500	0.20700	0.19500	0.17900	0.19800	0.20300	0.19700
8	0.23200	0.21800	0.21700	0.21400	0.19100	0.21400	0.21400	0.21200

AGE	1996	1997	1998	1999
1	0.06700	0.06300	0.07300	0.06800
2	0.11500	0.11900	0.12100	0.12100
3	0.14800	0.14800	0.15000	0.14500
4	0.16200	0.16700	0.16600	0.16800
5	0.17700	0.17800	0.17900	0.17800
6	0.19500	0.18900	0.19000	0.18900
7	0.19900	0.20600	0.20000	0.19900
8	0.21200	0.21400	0.23000	0.21400

Table 7.5.2. cont. **Natural Mortality (per year) catch scenario 1**

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1996	1997	1998	1999
1	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000

Proportion of fish spawning catch scenario 1

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 7.5.2. cont. **Proportion of fish spawning catch scenario 1**

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1996	1997	1998	1999
1	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS
INDEX1

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	339.0	192.0	156.0	1564.0	481.0	730.0	158.0	480.0	559.0	227.0	387.0

INDEX2 x 10 ^ -3

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	999990.	999990.	999990.	999990.	38300.	71200.	15100.	4700.	29100.	5800.	16700.

AGE-STRUCTURED INDICES
FLT01: Northern Ireland acoustic surveys x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999
1	66.83	319.10	11.34	134.15	110.40	157.80
2	68.29	82.30	42.37	49.98	27.30	77.70
3	73.53	11.90	67.47	14.81	8.10	34.00
4	11.86	29.20	8.95	10.98	9.30	5.10
5	9.30	4.60	26.47	1.75	6.50	10.30
6	7.55	3.50	4.17	4.55	1.80	13.50
7	3.87	4.90	5.91	0.57	2.30	1.60
8	10.12	6.90	5.82	1.91	0.80	6.30

FLT06: GFS Total Octringers) (x 10 ^ 3)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	*******	177.00	412.00	194.00	37.00	117.00	138.00	347.00	186.00
2	*******	21.00	44.00	176.00	55.00	11.00	302.00	53.00	74.00

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.1657	0.1042	0.2134	0.1516	0.2287	0.1562	0.1023	0.1394
2	0.3603	0.3427	0.8230	0.7490	0.7872	0.8509	0.5281	0.7385
3	0.5128	0.6104	1.0040	0.9025	0.9664	0.9794	0.9079	0.8408
4	0.5143	0.4064	0.9900	0.8073	1.0858	0.9682	0.8749	0.7982
5	0.5654	0.4947	0.7181	0.9175	0.8666	1.0332	0.6284	0.6978
6	0.5441	0.3714	0.7117	0.6149	0.8994	0.6665	0.9006	0.8726
7	0.4237	0.3661	0.7004	0.6547	0.7743	0.7393	0.6550	0.6596
8	0.4237	0.3661	0.7004	0.6547	0.7743	0.7393	0.6550	0.6596

Table 7.5.2. cont. **Fishing Mortality (per year) catch scenario 1**

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0574	0.0341	0.0340	0.0085	0.0135	0.0250	0.0406	0.0118
2	1.0280	0.3804	0.2466	0.1788	0.1165	0.2629	0.3772	0.2707
3	1.2564	0.3461	0.2421	0.1349	0.1628	0.3946	0.3390	0.2724
4	0.8212	0.5528	0.3917	0.1731	0.1226	0.4733	0.3266	0.2099
5	0.9888	0.4795	0.1019	0.1164	0.1797	0.3147	0.2592	0.2343
6	0.6192	0.3747	0.3981	0.1908	0.1239	0.3002	0.2004	0.2239
7	0.7515	0.3605	0.2399	0.1329	0.1165	0.2951	0.2406	0.1966
8	0.7515	0.3605	0.2399	0.1329	0.1165	0.2951	0.2406	0.1966

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0308	0.0109	0.0289	0.0425	0.0909	0.0138	0.0311	0.0308
2	0.2550	0.1648	0.2753	0.2810	0.3505	0.2591	0.3937	0.3901
3	0.5282	0.2385	0.2316	0.2418	0.3411	0.2705	0.3123	0.3094
4	0.5522	0.3388	0.2914	0.1629	0.3798	0.2387	0.2202	0.2182
5	0.5040	0.2408	0.4160	0.2176	0.2544	0.2508	0.2617	0.2593
6	0.4373	0.2202	0.3096	0.2703	0.3164	0.1720	0.2119	0.2099
7	0.3892	0.2061	0.2561	0.1909	0.2718	0.1928	0.2202	0.2182
8	0.3892	0.2061	0.2561	0.1909	0.2718	0.1928	0.2202	0.2182

AGE	1996	1997	1998	1999
1	0.0316	0.0451	0.0436	0.0294
2	0.3998	0.5713	0.5524	0.3725
3	0.3171	0.4531	0.4381	0.2954
4	0.2236	0.3195	0.3089	0.2083
5	0.2657	0.3797	0.3671	0.2476
6	0.2152	0.3074	0.2973	0.2004
7	0.2236	0.3195	0.3089	0.2083
8	0.2236	0.3195	0.3089	0.2083

Population Abundance (1 January) x 10 ^ 6 **catch scenario 1**

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	415.43	668.38	349.91	370.17	263.89	327.00	250.82	141.48
2	176.94	129.49	221.56	103.99	117.02	77.24	102.90	83.30
3	73.50	91.42	68.10	72.08	36.43	39.45	24.43	44.95
4	34.30	36.03	40.65	20.43	23.93	11.35	12.13	8.07
5	33.30	18.56	21.72	13.67	8.24	7.31	3.90	4.58
6	16.85	17.12	10.24	9.58	4.94	3.14	2.35	1.88
7	8.06	8.85	10.68	4.55	4.69	1.82	1.46	0.87
8	5.06	8.88	3.38	3.57	2.46	2.24	0.76	0.63

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	164.73	237.32	240.68	242.35	137.75	155.28	178.15	298.72
2	45.28	57.22	84.37	85.58	88.40	50.00	55.71	62.93
3	29.49	12.00	28.97	48.84	53.02	58.28	28.48	28.31
4	15.88	6.87	6.95	18.62	34.95	36.89	32.16	16.61
5	3.29	6.32	3.58	4.25	14.17	27.97	20.79	20.99
6	2.06	1.11	3.54	2.92	3.42	10.71	18.48	14.52
7	0.71	1.00	0.69	2.15	2.19	2.74	7.18	13.68
8	0.45	0.83	1.87	0.50	4.57	2.97	4.30	9.82

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	135.83	168.51	128.06	75.79	219.53	74.69	242.20	147.81
2	108.60	48.46	61.32	45.77	26.72	73.75	27.10	86.37
3	35.56	62.34	30.44	34.50	25.60	13.94	42.16	13.54
4	17.65	17.17	40.21	19.77	22.18	14.90	8.71	25.26
5	12.19	9.19	11.07	27.19	15.20	13.73	10.62	6.32
6	15.03	6.66	6.54	6.61	19.79	10.67	9.66	7.40
7	10.50	8.78	4.84	4.34	4.56	13.05	8.13	7.08
8	13.69	11.02	7.50	4.92	1.73	5.07	10.57	7.77

Table 7.5.2. cont. **Population Abundance (1 January) x 10 ^ 6, catch scenario 1**

AGE	1996	1997	1998	1999	2000
1	82.18	160.25	157.02	229.91	164.67
2	52.73	29.29	56.35	55.30	82.13
3	43.32	26.19	12.26	24.03	28.23
4	8.14	25.83	13.63	6.48	14.64
5	18.38	5.89	16.98	9.06	4.76
6	4.42	12.75	3.64	10.64	6.40
7	5.43	3.22	8.48	2.45	7.88
8	7.14	5.49	1.78	3.47	4.35

STOCK SUMMARY CATCH SCENARIO 1.

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	415420	95454	35546	27350	0.7694	0.4994	112
1973	668380	108606	34230	22600	0.6602	0.4451	100
1974	349910	93722	25471	38640	1.5170	0.8493	99
1975	370160	69780	17540	24500	1.3968	0.7982	102
1976	263890	55057	13255	21250	1.6031	0.9211	99
1977	326990	49922	9822	15410	1.5689	0.8996	95
1978	250820	44014	11325	11080	0.9783	0.7680	92
1979	141480	35846	10126	12338	1.2184	0.7896	92
1980	164720	30024	6175	10613	1.7186	0.9427	97
1981	237320	32508	8637	4377	0.5067	0.4267	90
1982	240680	40475	14465	4855	0.3356	0.2761	98
1983	242340	47214	20804	3933	0.1890	0.1588	98
1984	137750	46115	26260	4066	0.1548	0.1411	96
1985	155280	45033	20038	9187	0.4585	0.3491	102
1986	178140	42392	20150	7440	0.3692	0.3005	97
1987	298710	45295	19721	5823	0.2953	0.2422	103
1988	135820	42235	19039	10172	0.5343	0.4553	105
1989	168510	39694	18384	4949	0.2692	0.2406	100
1990	128050	36128	17402	6312	0.3627	0.3048	101
1991	75780	27464	15536	4398	0.2831	0.2347	100
1992	219530	30135	11324	5270	0.4654	0.3284	101
1993	74690	28820	14964	4409	0.2946	0.2382	101
1994	242200	36773	13441	4828	0.3592	0.2799	102
1995	147810	32790	14081	5076	0.3605	0.2774	99
1996	82180	26006	13223	5301	0.4009	0.2843	100
1997	160250	27066	10666	6651	0.6235	0.4062	100
1998	157020	28219	9885	4905	0.4962	0.3928	100
1999	229900	31750	10659	4127	0.3872	0.2648	99

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 8
Year range in the analysis : 1972 . . . 1999
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 36
Number of observations : 124
Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES catch scenario 1

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1994	0.2202	32	0.1161	0.4175	0.1589	0.3052	0.2322
2	1995	0.2182	32	0.1159	0.4107	0.1580	0.3013	0.2298
3	1996	0.2236	32	0.1194	0.4188	0.1623	0.3080	0.2354
4	1997	0.3195	32	0.1685	0.6057	0.2305	0.4428	0.3370
5	1998	0.3089	34	0.1570	0.6079	0.2187	0.4364	0.3279
6	1999	0.2083	37	0.1005	0.4317	0.1436	0.3021	0.2232
Separable Model: Selection (S) by age								
7	1	0.1412	66	0.0386	0.5158	0.0729	0.2734	0.1756
8	2	1.7881	29	1.0072	3.1744	1.3342	2.3965	1.8664
9	3	1.4182	27	0.8278	2.4296	1.0776	1.8665	1.4727
	4	1.0000	Fixed : Reference Age					
10	5	1.1884	24	0.7358	1.9194	0.9306	1.5178	1.2245
11	6	0.9622	24	0.5969	1.5512	0.7542	1.2277	0.9912
	7	1.0000	Fixed : Last true age					

Table 7.5.2. cont. **Separable model: Populations in year 1999**

12	1	229906	46	91587	577122	143752	367695	256704
13	2	55299	33	28895	105833	39709	77010	58416
14	3	24027	32	12711	45418	17363	33250	25329
15	4	6474	34	3286	12755	4580	9150	6873
16	5	9054	33	4689	17479	6472	12664	9578
17	6	10641	35	5290	21402	7450	15199	11339
18	7	2448	39	1120	5352	1643	3649	2651

Separable model: Populations at age

19	1994	8124	52	2905	22719	4807	13729	9323
20	1995	7074	43	3038	16472	4596	10888	7763
21	1996	5424	39	2517	11690	3666	8026	5857
22	1997	3220	38	1514	6849	2191	4733	3468
23	1998	8480	37	4054	17741	5819	12359	9104

Recruitment in year 2000

24	1999	164665	72	39467	687014	79449	341283	214752

SSB Index catchabilities

INDEX1

Linear model fitted. Slopes at age :

25	1	Q	.2819E-01	18	.2370E-01	.4812E-01	.2819E-01	.4046E-01	.3433E-01

INDEX2

Linear model fitted. Slopes at age :

26	2	Q	.1443E-02	24	.1136E-02	.3019E-02	.1443E-02	.2376E-02	.1910E-02

Age-structured index catchabilities

FLT01: Northern Ireland acoustic surveys

Linear model fitted. Slopes at age :

27	1	Q	1.232	56	.7136	6.642	1.232	3.846	2.560
28	2	Q	2.003	57	1.158	10.83	2.003	6.264	4.167
29	3	Q	1.575	57	.9049	8.705	1.575	5.000	3.316
30	4	Q	1.114	58	.6336	6.346	1.114	3.609	2.383
31	5	Q	.9442	60	.5285	5.651	.9442	3.163	2.075
32	6	Q	.8440	62	.4616	5.424	.8440	2.967	1.928
33	7	Q	.6155	65	.3281	4.283	.6155	2.283	1.469
34	8	Q	.9914	62	.5442	6.302	.9914	3.459	2.251

FLT06: GFS Total Octringers) (Catch: Tho

Linear model fitted. Slopes at age :

35	1	Q	.2495E-02	28	.1897E-02	.5815E-02	.2495E-02	.4420E-02	.3460E-02
36	2	Q	.1853E-02	28	.1415E-02	.4255E-02	.1853E-02	.3250E-02	.2553E-02

RESIDUALS ABOUT THE MODEL FIT **catch scenario 1**

Separable Model Residuals

Age	1994	1995	1996	1997	1998	1999
1	-0.869	0.120	1.193	0.756	-0.326	-0.847
2	-0.094	-0.132	0.145	0.650	-0.567	0.121
3	0.166	0.032	-0.094	-0.142	-0.024	0.059
4	0.107	0.110	-0.293	0.086	0.253	0.299
5	0.096	-0.139	-0.127	-0.079	0.293	-0.248
6	0.179	-0.146	-0.044	-0.344	0.142	0.077
7	-0.181	-0.356	-0.076	-0.001	-0.048	0.011

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.424	-0.938	-1.032	1.589	0.131	0.656	-0.921	0.253	0.620	-0.205	0.253

INDEX2

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	*******	*******	*******	*******	0.573	1.301	-0.297	-1.401	0.637	-0.900	0.082

AGE-STRUCTURED INDEX RESIDUALS

FLT01: Northern Ireland acoustic surveys

Age	1994	1995	1996	1997	1998	1999
1	-0.723	1.334	-1.416	0.397	0.221	0.187
2	0.750	-0.225	-0.388	0.493	-0.780	0.150
3	0.486	-0.202	0.377	-0.535	-0.390	0.264
4	0.441	0.276	0.230	-0.648	-0.183	-0.115
5	0.196	0.009	0.697	-0.796	-0.552	0.447
6	0.157	-0.346	0.349	-0.554	-0.238	0.633
7	-0.017	0.356	0.814	-0.930	-0.513	0.290
8	0.205	0.129	0.046	-0.732	-0.484	0.836

Table 7.5.2. cont. **FLT06: GFS Total Octringers) (Catch: Tho**

Age	1993	1994	1995	1996	1997	1998	1999	2000
1	0.729	0.411	0.151	-0.918	-0.424	-0.240	0.290	0.000
2	-1.443	0.402	0.626	-0.036	-0.926	1.718	-0.142	-0.203

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE) catch scenario 1

Separable model fitted from 1994 to 1999

Variance	0.1085
Skewness test stat.	0.3507
Kurtosis test statistic	1.0399
Partial chi-square	0.2459
Significance in fit	0.0000
Degrees of freedom	19

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Linear catchability relationship assumed

Last age is a plus-group

Variance	0.6501
Skewness test stat.	0.4811
Kurtosis test statistic	-0.3779
Partial chi-square	1.0980
Significance in fit	0.0003
Number of observations	11
Degrees of freedom	10
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR INDEX2

Linear catchability relationship assumed

Variance	0.8822
Skewness test stat.	-0.2013
Kurtosis test statistic	-0.5879
Partial chi-square	1.8278
Significance in fit	0.0025
Number of observations	7
Degrees of freedom	6
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: Northern Ireland acoustic surveys

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8
Variance	0.1137	0.0409	0.0232	0.0198	0.0415	0.0258	0.0501	0.0383
Skewness test stat.	-0.1930	0.0011	-0.0931	-0.5615	-0.2714	0.1743	-0.2870	0.1162
Kurtosis test statisti	-0.4145	-0.6374	-0.8456	-0.4238	-0.6626	-0.6871	-0.5425	-0.4324
Partial chi-square	0.0511	0.0191	0.0113	0.0103	0.0234	0.0149	0.0328	0.0241
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	6	6	6	6	6	6	6	6
Degrees of freedom	5	5	5	5	5	5	5	5
Weight in the analysi	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

DISTRIBUTION STATISTICS FOR FLT06: GFS Total Octringers) (Catch: Tho

Linear catchability relationship assumed

Age	1	2
Variance	0.1348	0.4647
Skewness test stat.	-0.4786	0.3104
Kurtosis test statisti	-0.3517	-0.2086
Partial chi-square	0.2006	0.8047
Significance in fit	0.0000	0.0026
Number of observations	8	8
Degrees of freedom	7	7
Weight in the analysis	0.5000	0.5000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	39.6062	124	36	88	0.4501
Catches at age	5.2906	42	23	19	0.2785
SSB Indices					
INDEX1	6.5012	11	1	10	0.6501
INDEX2	5.2929	7	1	6	0.8822

Table 7.5.2. cont.

	SSQ	Data	Parameters	d.f.	Variance
Aged Indices					
FLT01: Northern Ireland acoustic surve	14.1278	48	8	40	0.3532
FLT06: GFS Total Octringers) (Catch: T	8.3936	16	2	14	0.5995
Weighted Statistics					
Variance					
	SSQ	Data	Parameters	d.f.	Variance
Total for model	16.1751	124	36	88	0.1838
Catches at age	2.0618	42	23	19	0.1085
SSB Indices					
INDEX1	6.5012	11	1	10	0.6501
INDEX2	5.2929	7	1	6	0.8822
Aged Indices					
FLT01: Northern Ireland acoustic surve	0.2207	48	8	40	0.0055
FLT06: GFS Total Octringers) (Catch: T	2.0984	16	2	14	0.1499

Table 7.5.3 Fishing mortality, population estimates and stock summaries for Irish Sea herring under catch scenarios 2 and 3. Scenarios described in section 7.4.

Fishing Mortality (per year) Scenario 2

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.1656	0.1041	0.2134	0.1516	0.2286	0.1561	0.1021	0.1391
2	0.3602	0.3426	0.8228	0.7488	0.7868	0.8505	0.5274	0.7373
3	0.5122	0.6101	1.0035	0.9021	0.9657	0.9782	0.9067	0.8387
4	0.5131	0.4057	0.9890	0.8062	1.0847	0.9664	0.8723	0.7957
5	0.5626	0.4929	0.7158	0.9152	0.8638	1.0303	0.6258	0.6933
6	0.5391	0.3686	0.7068	0.6111	0.8939	0.6620	0.8942	0.8650
7	0.4179	0.3610	0.6911	0.6460	0.7647	0.7293	0.6464	0.6496
8	0.4179	0.3610	0.6911	0.6460	0.7647	0.7293	0.6464	0.6496

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0572	0.0340	0.0339	0.0085	0.0135	0.0250	0.0405	0.0119
2	1.0245	0.3783	0.2451	0.1783	0.1162	0.2623	0.3766	0.2706
3	1.2508	0.3439	0.2403	0.1339	0.1621	0.3934	0.3380	0.2719
4	0.8167	0.5469	0.3879	0.1715	0.1216	0.4707	0.3251	0.2091
5	0.9813	0.4745	0.1004	0.1150	0.1777	0.3114	0.2572	0.2329
6	0.6117	0.3692	0.3917	0.1876	0.1222	0.2961	0.1977	0.2218
7	0.7371	0.3535	0.2353	0.1301	0.1142	0.2901	0.2363	0.1934
8	0.7371	0.3535	0.2353	0.1301	0.1142	0.2901	0.2363	0.1934

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0309	0.0110	0.0291	0.0429	0.0925	0.0141	0.0334	0.0335
2	0.2552	0.1654	0.2768	0.2836	0.3552	0.2645	0.4118	0.4128
3	0.5280	0.2388	0.2327	0.2435	0.3454	0.2754	0.3228	0.3236
4	0.5504	0.3385	0.2919	0.1639	0.3835	0.2427	0.2226	0.2231
5	0.5012	0.2397	0.4156	0.2180	0.2562	0.2541	0.2670	0.2677
6	0.4337	0.2184	0.3077	0.2699	0.3173	0.1735	0.2144	0.2149
7	0.3841	0.2038	0.2535	0.1894	0.2713	0.1935	0.2226	0.2231
8	0.3841	0.2038	0.2535	0.1894	0.2713	0.1935	0.2226	0.2231

AGE	1996	1997	1998	1999
1	0.0349	0.0511	0.0383	0.0149
2	0.4296	0.6299	0.4719	0.1841
3	0.3368	0.4938	0.3699	0.1443
4	0.2322	0.3404	0.2550	0.0995
5	0.2786	0.4085	0.3060	0.1193
6	0.2237	0.3280	0.2457	0.0958
7	0.2322	0.3404	0.2550	0.0995
8	0.2322	0.3404	0.2550	0.0995

Population Abundance (1 January) x 10 ^ 6 **Scenario 2**

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	415.52	668.45	349.97	370.27	263.97	327.26	251.08	141.73
2	176.98	129.53	221.58	104.01	117.06	77.26	102.99	83.40
3	73.56	91.45	68.12	72.09	36.44	39.48	24.45	45.03
4	34.36	36.09	40.68	20.45	23.95	11.36	12.15	8.09
5	33.42	18.61	21.76	13.69	8.26	7.32	3.91	4.60
6	16.97	17.23	10.29	9.63	4.96	3.15	2.36	1.89
7	8.16	8.96	10.78	4.59	4.73	1.84	1.47	0.88
8	5.12	8.99	3.41	3.60	2.48	2.26	0.77	0.63

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	165.44	238.58	241.38	242.89	138.01	155.48	178.19	298.46
2	45.37	57.48	84.84	85.84	88.60	50.09	55.79	62.95
3	29.56	12.06	29.17	49.19	53.21	58.43	28.55	28.36
4	15.93	6.93	7.00	18.78	35.23	37.04	32.28	16.67
5	3.30	6.37	3.63	4.30	14.31	28.22	20.93	21.10
6	2.08	1.12	3.59	2.97	3.47	10.84	18.70	14.65
7	0.72	1.02	0.70	2.19	2.23	2.78	7.30	13.89
8	0.46	0.84	1.90	0.51	4.66	3.01	4.37	9.97

Table 7.5.3 cont. Population Abundance (1 January) x 10 ^ 6 **Scenario 2**

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	135.35	167.72	127.08	74.98	215.88	72.70	233.71	141.21
2	108.50	48.28	61.03	45.41	26.42	72.40	26.37	83.15
3	35.58	62.27	30.31	34.28	25.33	13.72	41.17	12.94
4	17.69	17.18	40.15	19.67	22.00	14.68	8.53	24.41
5	12.24	9.23	11.08	27.13	15.10	13.57	10.42	6.18
6	15.13	6.71	6.57	6.62	19.74	10.58	9.52	7.22
7	10.62	8.87	4.88	4.37	4.57	13.01	8.05	6.95
8	13.84	11.13	7.56	4.96	1.73	5.06	10.47	7.62

AGE	1996	1997	1998	1999	2000
1	76.94	138.63	133.56	197.32	148.75
2	50.24	27.33	48.46	47.29	71.51
3	40.77	24.22	10.79	22.39	29.14
4	7.67	23.83	12.10	6.10	15.87
5	17.67	5.50	15.34	8.49	5.00
6	4.28	12.10	3.31	10.22	6.81
7	5.27	3.09	7.89	2.34	8.40
8	6.90	5.20	1.59	3.23	4.56

STOCK SUMMARY Scenario 2

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	415510	95589	35664	27350	0.7669	0.4975	112
1973	668440	108729	34340	22600	0.6581	0.4440	100
1974	349970	93797	25537	38640	1.5131	0.8476	99
1975	370270	69836	17584	24500	1.3933	0.7967	102
1976	263970	55099	13288	21250	1.5991	0.9190	99
1977	327260	49972	9849	15410	1.5646	0.8975	95
1978	251080	44068	11355	11080	0.9758	0.7653	92
1979	141730	35909	10163	12338	1.2139	0.7860	92
1980	165430	30129	6222	10613	1.7055	0.9370	97
1981	238570	32691	8713	4377	0.5023	0.4226	90
1982	241370	40684	14592	4855	0.3327	0.2731	98
1983	242890	47432	20956	3933	0.1877	0.1572	98
1984	138010	46334	26436	4066	0.1538	0.1400	96
1985	155470	45213	20185	9187	0.4551	0.3468	102
1986	178190	42569	20308	7440	0.3664	0.2989	97
1987	298450	45428	19857	5823	0.2932	0.2412	103
1988	135340	42287	19120	10172	0.5320	0.4537	105
1989	167710	39657	18413	4949	0.2688	0.2402	100
1990	127070	36014	17374	6312	0.3633	0.3049	101
1991	74970	27319	15465	4398	0.2844	0.2358	100
1992	215880	29795	11217	5270	0.4698	0.3315	101
1993	72700	28346	14724	4409	0.2994	0.2421	101
1994	233700	35776	13091	4828	0.3688	0.2877	102
1995	141210	31580	13476	5076	0.3767	0.2884	99
1996	76930	24681	12404	5301	0.4273	0.3002	100
1997	138620	24566	9667	6651	0.6880	0.4401	100
1998	133550	24558	9273	3718	0.4009	0.3297	100
1999	197310	28009	10998	1936	0.1760	0.1286	100

Fishing Mortality (per year) Scenario 3

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.1657	0.1042	0.2135	0.1517	0.2288	0.1564	0.1024	0.1397
2	0.3604	0.3429	0.8231	0.7493	0.7877	0.8516	0.5289	0.7401
3	0.5136	0.6108	1.0048	0.9029	0.9673	0.9809	0.9095	0.8435
4	0.5159	0.4074	0.9913	0.8088	1.0872	0.9706	0.8784	0.8015
5	0.5691	0.4972	0.7212	0.9206	0.8704	1.0371	0.6318	0.7038
6	0.5509	0.3753	0.7183	0.6201	0.9070	0.6728	0.9093	0.8827
7	0.4319	0.3733	0.7132	0.6668	0.7876	0.7533	0.6670	0.6734
8	0.4319	0.3733	0.7132	0.6668	0.7876	0.7533	0.6670	0.6734

Table 7.5.3 cont. **Fishing Mortality (per year) Scenario 3**

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0578	0.0344	0.0341	0.0086	0.0135	0.0250	0.0406	0.0118
2	1.0326	0.3831	0.2486	0.1796	0.1169	0.2635	0.3777	0.2706
3	1.2640	0.3491	0.2445	0.1362	0.1636	0.3961	0.3401	0.2730
4	0.8273	0.5607	0.3966	0.1751	0.1240	0.4765	0.3283	0.2108
5	0.9989	0.4863	0.1039	0.1183	0.1822	0.3191	0.2618	0.2359
6	0.6296	0.3821	0.4068	0.1951	0.1262	0.3057	0.2040	0.2267
7	0.7713	0.3703	0.2464	0.1367	0.1196	0.3018	0.2464	0.2010
8	0.7713	0.3703	0.2464	0.1367	0.1196	0.3018	0.2464	0.2010

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0305	0.0108	0.0285	0.0417	0.0884	0.0132	0.0287	0.0280
2	0.2543	0.1634	0.2725	0.2767	0.3431	0.2508	0.3694	0.3600
3	0.5280	0.2377	0.2293	0.2387	0.3340	0.2627	0.2973	0.2897
4	0.5539	0.3386	0.2900	0.1610	0.3731	0.2321	0.2156	0.2101
5	0.5072	0.2419	0.4157	0.2163	0.2506	0.2448	0.2524	0.2459
6	0.4417	0.2222	0.3115	0.2700	0.3140	0.1689	0.2066	0.2013
7	0.3959	0.2090	0.2591	0.1924	0.2714	0.1909	0.2156	0.2101
8	0.3959	0.2090	0.2591	0.1924	0.2714	0.1909	0.2156	0.2101

AGE	1996	1997	1998	1999
1	0.0281	0.0389	0.0517	0.0395
2	0.3617	0.5008	0.6651	0.5089
3	0.2911	0.4030	0.5352	0.4095
4	0.2111	0.2923	0.3881	0.2970
5	0.2471	0.3421	0.4544	0.3476
6	0.2023	0.2801	0.3720	0.2846
7	0.2111	0.2923	0.3881	0.2970
8	0.2111	0.2923	0.3881	0.2970

Population Abundance (1 January) x 10 ^ 6 **Scenario 3**

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	415.31	668.30	349.83	370.03	263.79	326.65	250.48	141.15
2	176.88	129.45	221.53	103.96	116.97	77.20	102.77	83.18
3	73.41	91.39	68.06	72.06	36.41	39.42	24.41	44.86
4	34.22	35.96	40.62	20.40	23.92	11.33	12.10	8.05
5	33.14	18.48	21.65	13.64	8.22	7.30	3.88	4.55
6	16.70	16.97	10.17	9.52	4.92	3.12	2.34	1.87
7	7.94	8.71	10.55	4.49	4.64	1.80	1.44	0.85
8	4.99	8.74	3.34	3.52	2.43	2.21	0.75	0.62

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	163.82	235.70	239.79	241.69	137.45	155.10	178.18	299.45
2	45.15	56.88	83.78	85.26	88.15	49.89	55.65	62.94
3	29.40	11.91	28.73	48.40	52.78	58.10	28.40	28.26
4	15.80	6.80	6.88	18.42	34.58	36.69	32.01	16.55
5	3.27	6.25	3.51	4.19	13.99	27.64	20.61	20.86
6	2.04	1.09	3.48	2.86	3.36	10.55	18.18	14.36
7	0.70	0.98	0.67	2.10	2.13	2.68	7.03	13.41
8	0.45	0.81	1.82	0.48	4.46	2.91	4.21	9.63

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	136.82	169.99	129.74	77.11	225.39	77.66	254.52	157.41
2	108.87	48.82	61.86	46.39	27.21	75.90	28.20	90.98
3	35.57	62.55	30.71	34.90	26.06	14.30	43.76	14.44
4	17.61	17.18	40.38	19.99	22.51	15.28	9.00	26.61
5	12.13	9.16	11.08	27.33	15.40	14.02	10.96	6.57
6	14.91	6.61	6.50	6.62	19.92	10.85	9.93	7.70
7	10.36	8.67	4.79	4.31	4.57	13.17	8.29	7.31
8	13.50	10.88	7.42	4.89	1.73	5.12	10.77	8.04

Table 7.5.3 cont. **Population Abundance (1 January)** x 10 ^ 6 **Scenario 3**

AGE	1996	1997	1998	1999	2000
1	89.97	192.30	185.00	267.64	184.42
2	56.31	32.18	68.04	64.63	94.64
3	47.03	29.05	14.45	25.92	28.78
4	8.85	28.78	15.90	6.93	14.09
5	19.52	6.48	19.44	9.76	4.66
6	4.65	13.79	4.17	11.17	6.24
7	5.70	3.43	9.43	2.60	7.60
8	7.52	5.92	2.07	3.77	4.28

STOCK SUMMARY Scenario 3

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	415310	95271	35387	27350	0.7729	0.5020	112
1973	668300	108440	34083	22600	0.6631	0.4467	100
1974	349830	93620	25382	38640	1.5223	0.8518	99
1975	370020	69706	17481	24500	1.4015	0.8004	102
1976	263790	55000	13211	21250	1.6085	0.9239	99
1977	326640	49857	9785	15410	1.5747	0.9026	95
1978	250480	43942	11286	11080	0.9817	0.7716	92
1979	141150	35764	10077	12338	1.2244	0.7943	92
1980	163810	29887	6113	10613	1.7361	0.9505	97
1981	235700	32272	8539	4377	0.5126	0.4322	90
1982	239790	40207	14300	4855	0.3395	0.2801	98
1983	241690	46937	20608	3933	0.1908	0.1609	98
1984	137450	45838	26034	4066	0.1562	0.1426	96
1985	155090	44812	19851	9187	0.4628	0.3522	102
1986	178180	42180	19953	7440	0.3729	0.3024	97
1987	299450	45158	19556	5823	0.2977	0.2434	103
1988	136820	42223	18957	10172	0.5366	0.4570	105
1989	169990	39824	18384	4949	0.2692	0.2408	100
1990	129740	36372	17492	6312	0.3608	0.3038	101
1991	77100	27745	15691	4398	0.2803	0.2325	100
1992	225390	30714	11526	5270	0.4572	0.3230	101
1993	77660	29596	15381	4409	0.2866	0.2319	101
1994	254520	38296	14016	4828	0.3445	0.2682	102
1995	157400	34595	15014	5076	0.3381	0.2614	99
1996	89960	27985	14465	5301	0.3665	0.2626	100
1997	192290	30786	12175	6651	0.5463	0.3637	100
1998	184990	33177	10652	6905	0.6482	0.4830	100
1999	267640	36112	10718	6127	0.5716	0.3695	99

Table 7.6.1 Input table for short term predictions, catch scenario 1.

The SAS System 14:35 Monday, March 20, 2000
Irish Sea herring (Division VIIa)
Single option prediction: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	150.670	1.0000	0.0800	0.9000	0.7500	0.068	0.0294	0.071
2	82.130	0.3000	0.8500	0.9000	0.7500	0.120	0.3724	0.120
3	28.230	0.2000	1.0000	0.9000	0.7500	0.148	0.2954	0.146
4	14.640	0.1000	1.0000	0.9000	0.7500	0.167	0.2083	0.165
5	4.760	0.1000	1.0000	0.9000	0.7500	0.178	0.2475	0.178
6	6.400	0.1000	1.0000	0.9000	0.7500	0.189	0.2004	0.184
7	7.880	0.1000	1.0000	0.9000	0.7500	0.202	0.2083	0.194
8+	4.350	0.1000	1.0000	0.9000	0.7500	0.219	0.2083	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	150.670	1.0000	0.0800	0.9000	0.7500	0.068	0.0294	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.3724	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.2954	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.2083	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.2475	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.2004	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2083	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2083	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	150.670	1.0000	0.0800	0.9000	0.7500	0.068	0.0294	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.3724	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.2954	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.2083	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.2475	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.2004	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2083	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2083	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRMDC02
Date and time: 20MAR00:15:22

Table 7.6.2 Summary of short term predictions for catch scenarios 1, 2 and 3 at $F_{status\ quo}$. Catch scenarios described in section 7.4.

Scenario	year	F factor	catch in weight (t)	SSB at spawning time (t)
1	2000	0.7609 (UK Quota)	4000	14,156
	2001	1.0	5137	14,761
	2002	1.0	4975	14,958
2	2000	1.6426 (UK Quota)	4000	13,808
	2001	1.0	2560	16,150
	2002	1.0	2743	18,188
3	2000	0.4995 (UK Quota)	4000	15,254
	2001	1.0	8198	15,475
	2002	1.0	7783	15,215

Table 7.6.3. Single option tables for Irish Sea herring, catch scenario 1.
Single option prediction: Detailed tables

Year: 2000	F-factor: **0.7609**	Reference F: 0.2015				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0224	2111	150	150670	10246	12054	820	5580	379
2	0.2834	17632	2116	82130	9856	69811	8377	43197	5184
3	0.2248	5170	755	28230	4178	28230	4178	19848	2937
4	0.1585	2045	337	14640	2445	14640	2445	11777	1967
5	0.1883	779	139	4760	847	4760	847	3728	664
6	0.1525	862	159	6400	1210	6400	1210	5176	978
7	0.1585	1101	214	7880	1592	7880	1592	6339	1280
8+	0.1585	608	131	4350	953	4350	953	3499	766
Total		30307	4000	299060	31325	148124	20421	99143	14156
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001	F-factor: **1.0000**	Reference F: 0.2648				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0294	2766	196	150670	10246	12054	820	5545	377
2	0.3724	14695	1763	54202	6504	46072	5529	26312	3157
3	0.2954	10676	1559	45830	6783	45830	6783	30238	4475
4	0.2083	3309	546	18460	3083	18460	3083	14199	2371
5	0.2475	2364	421	11305	2012	11305	2012	8394	1494
6	0.2004	618	114	3568	674	3568	674	2764	522
7	0.2083	891	173	4972	1004	4972	1004	3824	772
8+	0.2083	1693	366	9444	2068	9444	2068	7264	1591
Total		37012	5137	298452	32375	151705	21973	98539	14761
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2002	F-factor: **1.0000**	Reference F: 0.2648				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0294	2766	196	150670	10246	12054	820	5545	377
2	0.3724	14592	1751	53823	6459	45749	5490	26128	3135
3	0.2954	6446	941	27669	4095	27669	4095	18255	2702
4	0.2083	5006	826	27926	4664	27926	4664	21479	3587
5	0.2475	2836	505	13563	2414	13563	2414	10070	1792
6	0.2004	1382	254	7987	1509	7987	1509	6187	1169
7	0.2083	474	92	2642	534	2642	534	2032	410
8+	0.2083	1899	410	10591	2320	10591	2320	8146	1784
Total		35399	4975	294870	32240	148180	21845	97843	14958
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC02
Date and time : 20MAR00:15:22
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.3 cont.

Irish Sea herring (Division VIIa)

Single option prediction: Detailed tables

Year: 2000	F-factor: **0.7609**	Reference F: 0.2015				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0224	2111	150	150670	10246	12054	820	5580	379
2	0.2834	17632	2116	82130	9856	69811	8377	43196	5184
3	0.2248	5170	755	28230	4178	28230	4178	19848	2937
4	0.1585	2045	337	14640	2445	14640	2445	11777	1967
5	0.1883	779	139	4760	847	4760	847	3728	664
6	0.1525	862	159	6400	1210	6400	1210	5176	978
7	0.1585	1101	214	7880	1592	7880	1592	6339	1280
8+	0.1585	608	131	4350	953	4350	953	3499	766
Total		30307	4000	299060	31325	148124	20421	99142	14156
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001	F-factor: **0.7537**	Reference F: 0.1996				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0222	2091	148	150670	10246	12054	820	5581	380
2	0.2807	11540	1385	54202	6504	46072	5529	28577	3429
3	0.2226	8322	1215	45830	6783	45830	6783	32284	4778
4	0.1570	2556	422	18460	3083	18460	3083	14870	2483
5	0.1865	1834	326	11305	2012	11305	2012	8867	1578
6	0.1510	477	88	3568	674	3568	674	2889	546
7	0.1570	688	134	4972	1004	4972	1004	4005	809
8+	0.1570	1307	282	9444	2068	9444	2068	7607	1666
Total		28815	4000	298451	32375	151705	21973	104680	15669
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2002	F-factor: **0.7429**	Reference F: 0.1967				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0218	2061	146	150670	10246	12054	820	5583	380
2	0.2767	11398	1368	54214	6506	46082	5530	28686	3442
3	0.2195	5436	794	30327	4488	30327	4488	21424	3171
4	0.1548	4103	677	30033	5016	30033	5016	24240	4048
5	0.1839	2285	407	14277	2541	14277	2541	11225	1998
6	0.1489	1119	206	8489	1604	8489	1604	6888	1302
7	0.1548	379	74	2776	561	2776	561	2240	453
8+	0.1548	1523	329	11149	2442	11149	2442	8999	1971
Total		28305	4000	301933	33403	155185	23001	109285	16764
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC01
Date and time : 20MAR00:15:29
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : TAC constraints

Table 7.6.4 Multiple Option table for short term predictions of Irish Sea herring, catch scenario 1.

```
The SAS System                          14:35 Monday, March 20, 2000
   Irish Sea herring (Division VIIa)

                         Prediction with management option table
```

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.7609	0.2015	31326	14156	4000	0.0000	0.0000	32375	18843	0	37522	23638
.	.	.	.	.	0.1000	0.0265	.	18385	580	36922	22567
.	.	.	.	.	0.2000	0.0530	.	17939	1144	36340	21548
.	.	.	.	.	0.3000	0.0794	.	17504	1693	35774	20578
.	.	.	.	.	0.4000	0.1059	.	17081	2226	35225	19653
.	.	.	.	.	0.5000	0.1324	.	16669	2745	34691	18773
.	.	.	.	.	0.6000	0.1589	.	16267	3250	34172	17934
.	.	.	.	.	0.7000	0.1854	.	15875	3742	33668	17135
.	.	.	.	.	0.8000	0.2118	.	15494	4220	33178	16374
.	.	.	.	.	0.9000	0.2383	.	15123	4685	32703	15649
.	.	.	.	.	1.0000	0.2648	.	14761	5137	32240	14958
.	.	.	.	.	1.1000	0.2913	.	14408	5578	31791	14299
.	.	.	.	.	1.2000	0.3178	.	14064	6007	31354	13671
.	.	.	.	.	1.3000	0.3442	.	13730	6424	30929	13072
.	.	.	.	.	1.4000	0.3707	.	13403	6830	30516	12501
.	.	.	.	.	1.5000	0.3972	.	13085	7226	30115	11957
.	.	.	.	.	1.6000	0.4237	.	12776	7611	29725	11438
.	.	.	.	.	1.7000	0.4502	.	12474	7985	29345	10943
.	.	.	.	.	1.8000	0.4766	.	12179	8350	28977	10471
.	.	.	.	.	1.9000	0.5031	.	11893	8706	28618	10021
.	.	.	.	.	2.0000	0.5296	.	11613	9052	28269	9592
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

```
Notes: Run name             : MANMDC01
       Date and time        : 20MAR00:15:30
       Computation of ref. F: Simple mean, age 2 - 6
       Basis for 2000       : TAC constraints
```

Table 7.6.5 Single option short term prediction table and input table for catch scenario 2, Irish Sea herring.

The SAS System 19:30 Tuesday, March 21, 2000

Irish Sea herring (Division VIIa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	1.6426	0.2112	29987	4000	285738	30239	142119	19915	95035	13808
2001	1.0000	0.1286	18400	2560	285415	31101	144744	21131	107009	16150
2002	1.0000	0.1286	19301	2743	297244	33412	156499	23433	117542	18188
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC07
Date and time : 21MAR00:19:31
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

The SAS System 19:30 Tuesday, March 21, 2000

Irish Sea herring (Division VIIa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	1.6426	0.2112	29987	4000	285738	30239	142119	19915	95035	13808
2001	1.6274	0.2093	28746	4000	285414	31101	144744	21131	99297	15006
2002	1.6054	0.2065	28329	4000	288297	31936	147625	21966	102960	15876
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC06
Date and time : 21MAR00:19:34
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : TAC constraints

Table 7.6.5 cont.

The SAS System 19:30 Tuesday, March 21, 2000

Irish Sea herring (Division VIIa)

Single option prediction: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	144.448	1.0000	0.0800	0.9000	0.7500	0.068	0.0149	0.071
2	71.510	0.3000	0.8500	0.9000	0.7500	0.120	0.1841	0.120
3	29.140	0.2000	1.0000	0.9000	0.7500	0.148	0.1443	0.146
4	15.870	0.1000	1.0000	0.9000	0.7500	0.167	0.0995	0.165
5	5.000	0.1000	1.0000	0.9000	0.7500	0.178	0.1193	0.178
6	6.810	0.1000	1.0000	0.9000	0.7500	0.189	0.0958	0.184
7	8.400	0.1000	1.0000	0.9000	0.7500	0.202	0.0995	0.194
8+	4.560	0.1000	1.0000	0.9000	0.7500	0.219	0.0995	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	144.448	1.0000	0.0800	0.9000	0.7500	0.068	0.0149	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.1841	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.1443	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.0995	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.1193	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.0958	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.0995	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.0995	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	144.448	1.0000	0.0800	0.9000	0.7500	0.068	0.0149	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.1841	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.1443	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.0995	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.1193	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.0958	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.0995	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.0995	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRMDC07
Date and time: 21MAR00:19:31

Table 7.6.6 Single option short term prediction table and input table for catch scenario 3, Irish Sea herring.

The SAS System 14:35 Monday, March 20, 2000
Irish Sea herring (Division VIIa)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.4995	0.1845	30834	4000	371687	36826	163006	21897	109432	15254
2001	0.4400	0.1626	29524	4000	389928	40425	184005	25828	129318	18774
2002	0.4011	0.1482	28826	4000	408020	43801	202071	29200	146913	21954
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC03
Date and time : 20MAR00:16:22
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : TAC constraints

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
2000	0.4995	0.1846	30835	4000	371687	36826	163006	21897	109431	15254
2001	1.0000	0.3695	60575	8198	389926	40425	184004	25827	106524	15475
2002	1.0000	0.3695	57145	7783	381543	39507	175845	24937	103302	15215
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC05
Date and time : 20MAR00:16:24
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.6 cont..
Irish Sea herring (Division VIIa)
Single option prediction: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	211.397	1.0000	0.0800	0.9000	0.7500	0.068	0.0396	0.071
2	94.640	0.3000	0.8500	0.9000	0.7500	0.120	0.5088	0.120
3	28.780	0.2000	1.0000	0.9000	0.7500	0.148	0.4095	0.146
4	14.090	0.1000	1.0000	0.9000	0.7500	0.167	0.2969	0.165
5	4.660	0.1000	1.0000	0.9000	0.7500	0.178	0.3476	0.178
6	6.240	0.1000	1.0000	0.9000	0.7500	0.189	0.2846	0.184
7	7.600	0.1000	1.0000	0.9000	0.7500	0.202	0.2969	0.194
8+	4.280	0.1000	1.0000	0.9000	0.7500	0.219	0.2969	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	211.398	1.0000	0.0800	0.9000	0.7500	0.068	0.0396	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.5088	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.4095	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.2969	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.3476	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.2846	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2969	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2969	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	211.398	1.0000	0.0800	0.9000	0.7500	0.068	0.0396	0.071
2	.	0.3000	0.8500	0.9000	0.7500	0.120	0.5088	0.120
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.4095	0.146
4	.	0.1000	1.0000	0.9000	0.7500	0.167	0.2969	0.165
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.3476	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.189	0.2846	0.184
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2969	0.194
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2969	0.216
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRMDC05
Date and time: 20MAR00:16:24

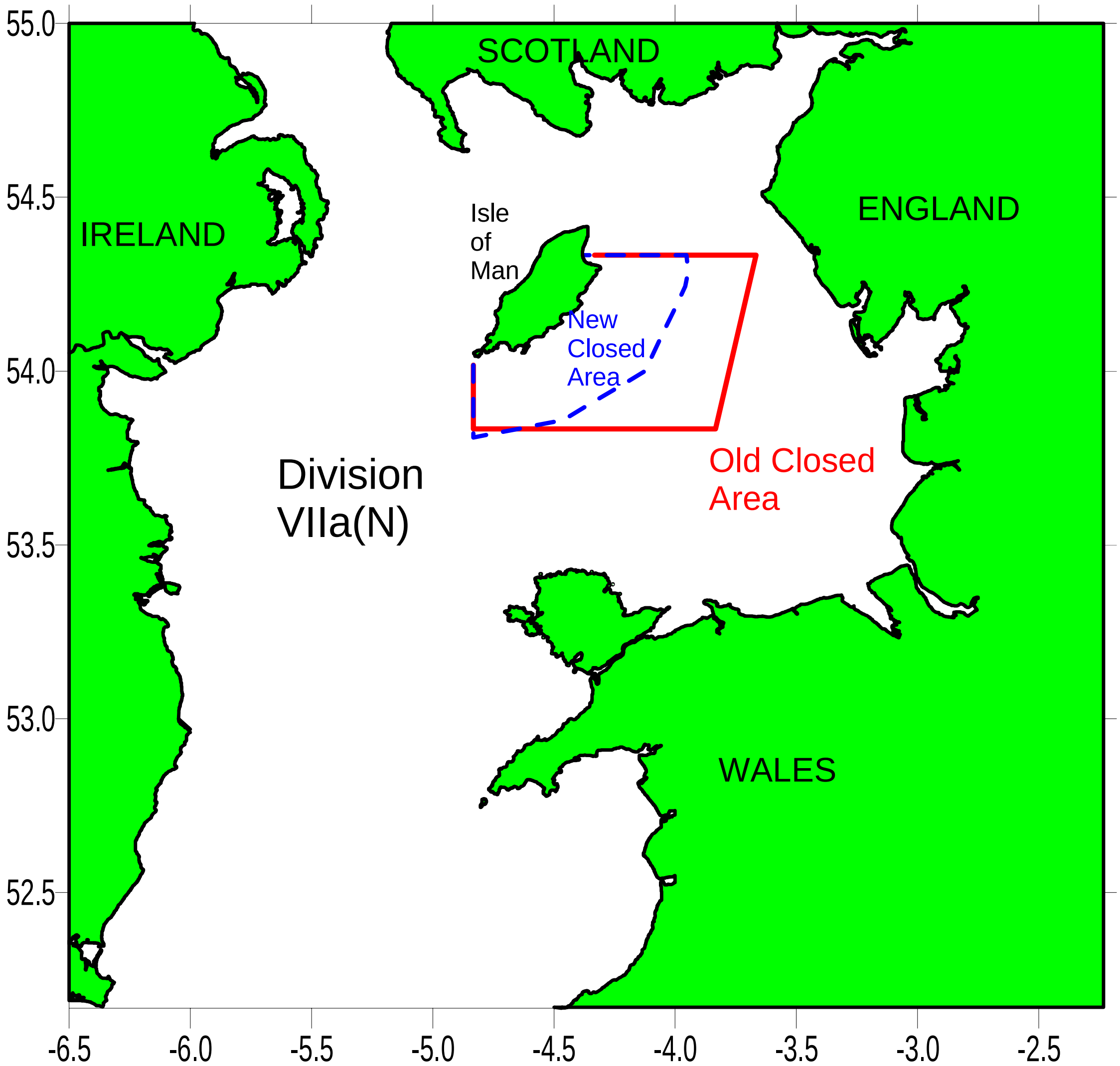


Figure 7.1.1. Re-defined closed area for herring, enforced from 21 September to 15 November.

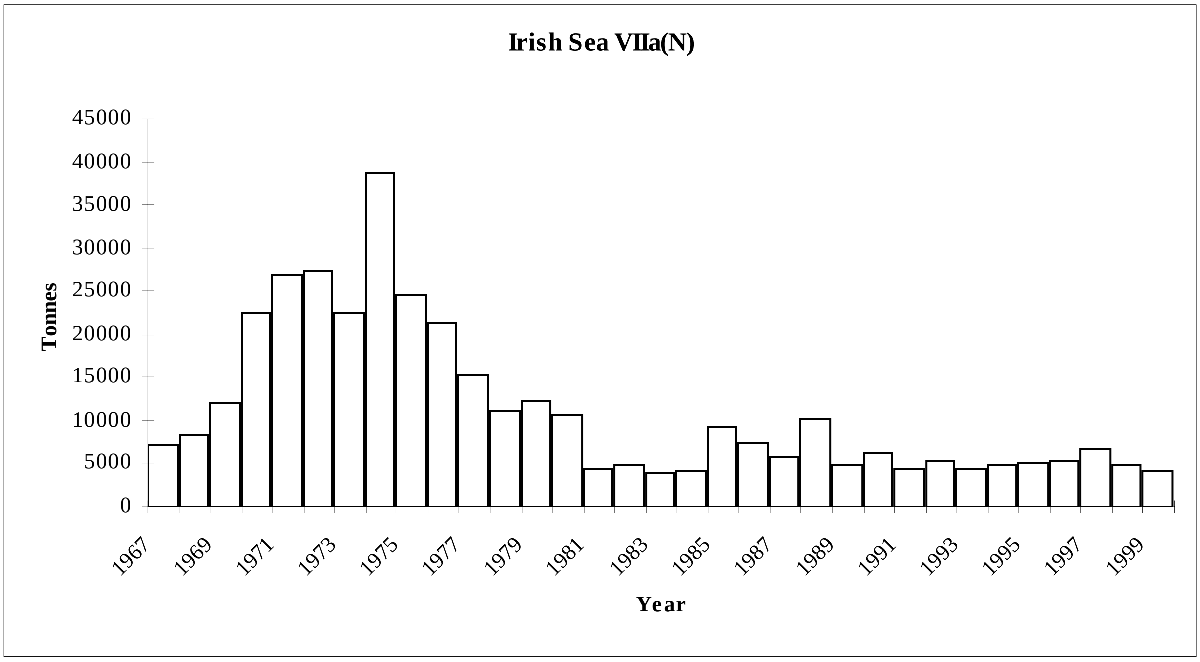


Figure 7.1.2. Landings of herring from VIIa(N) from 1967 to 1999.

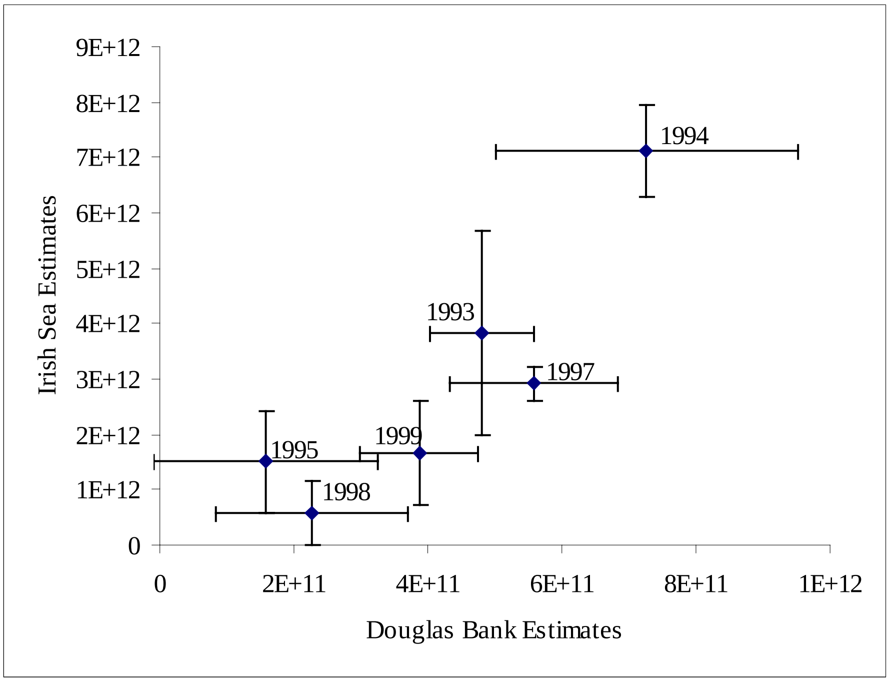


Figure 7.3.1. Comparison of Irish Sea larvae production estimates. Error bars denote 1 standard error (see table 7.3.3).

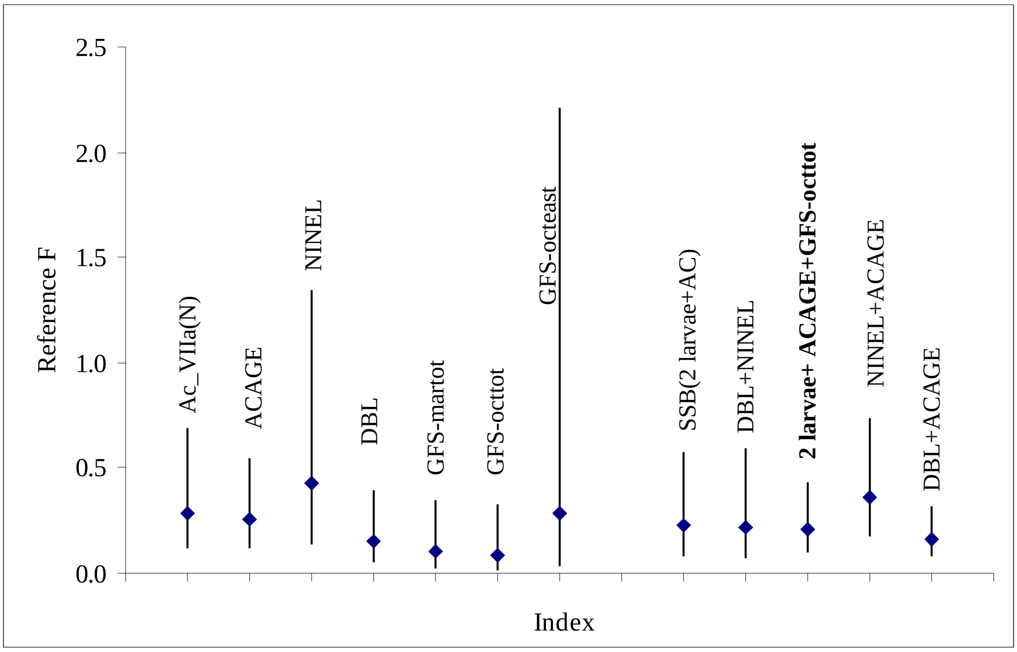


Figure 7.4.1. Results in terms of reference F in 1999 of preliminary modelling with ICA of survey indices described in table 7.4.1. Error bars show the upper and lower 95% confidence limits. The run chosen for the analysis of the different catch scenarios in 1998 and 1999 is shown by the bold label.

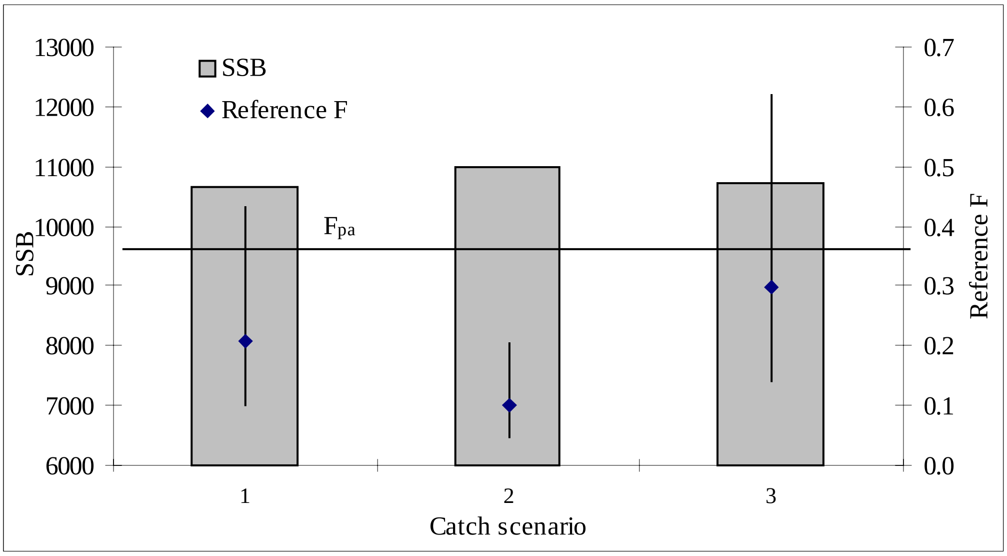


Figure 7.4.2 Results in terms of reference F in 1999 of preliminary modelling with ICA of unceratin catch at age in 1998 and 1999 (see table 7.4.2) Error bars show the upper and lower 95% confidence limits of reference F. F_{pa}=0.36.

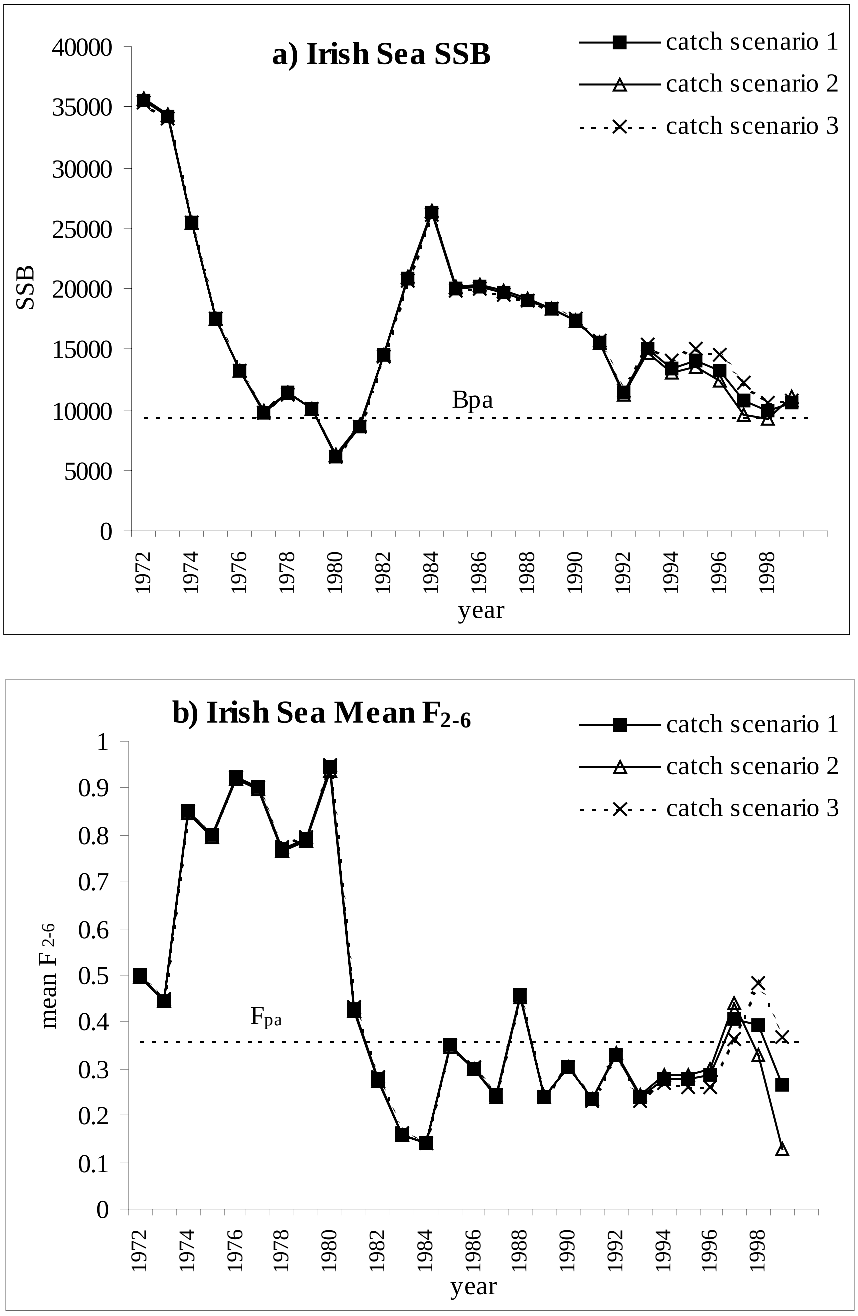


Figure 7.4.3 The effect of three different catch scenarios in 1998 and 1999 on the stock output of ICA, a) SSB of Irish Sea herring b) Mean $F_{(2-6)}$ of Irish Sea herring. Catch scenarios described in Table 7.4.2 and indices used shown in figure 7.4.1.

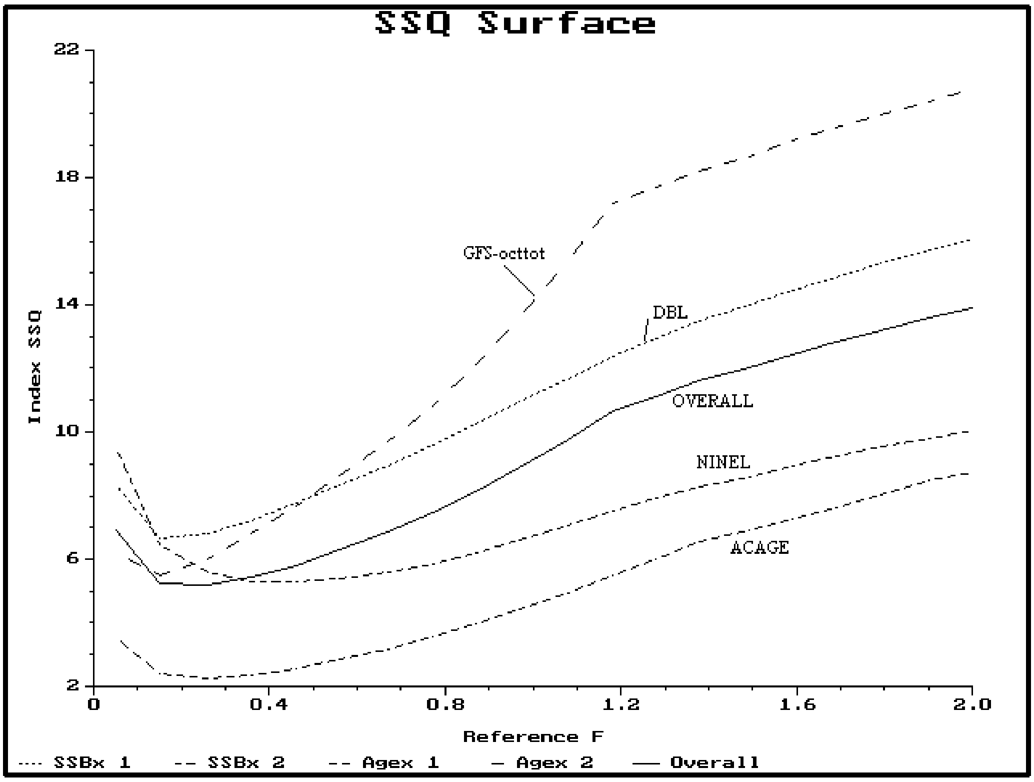


Figure 7.5.1. Herring in VIIa(N). SSQ surface for the baseline assessment. Indices described in Table 7.4.1.

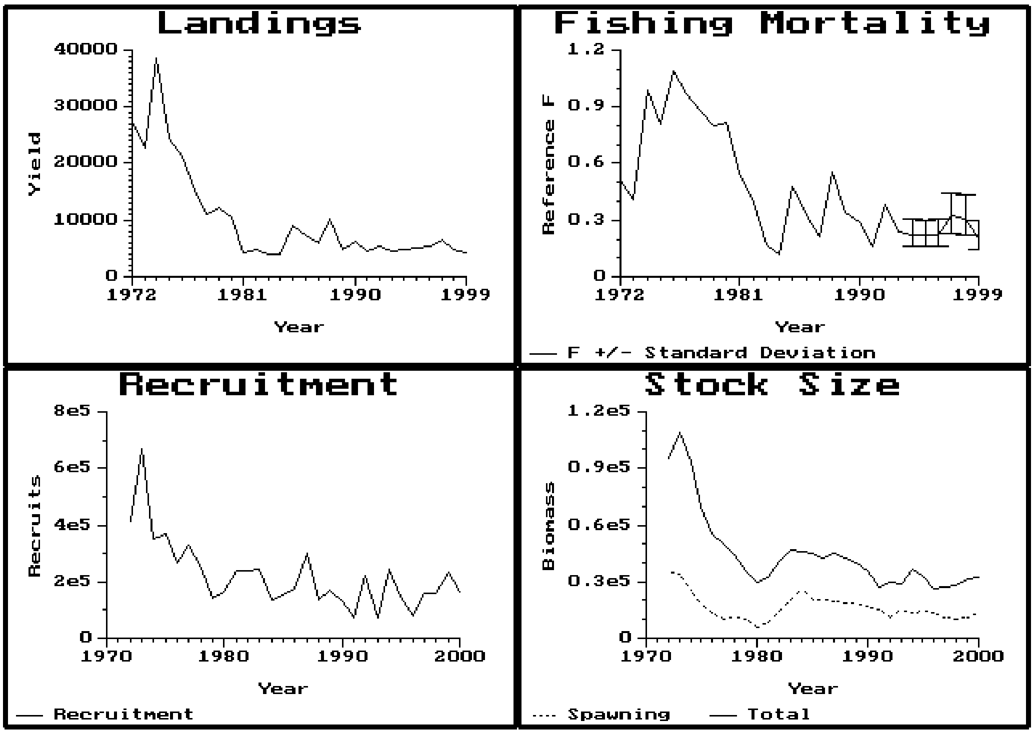


Figure 7.5.2. Herring in VIIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

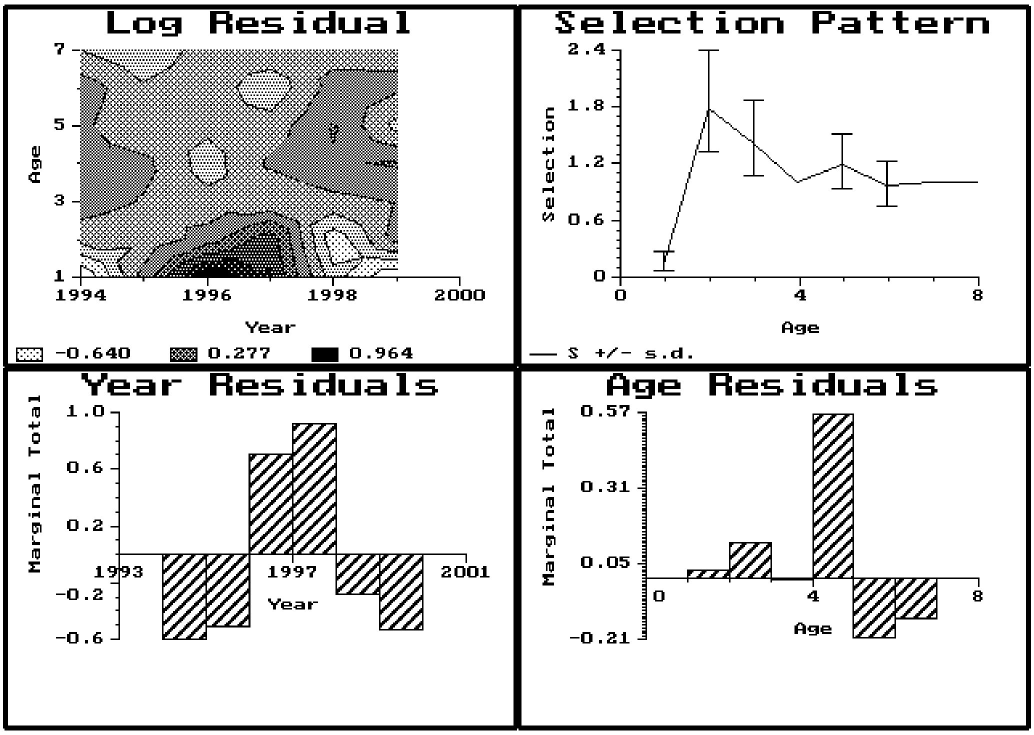


Figure 7.5.3 Herring in VIIa(N). Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

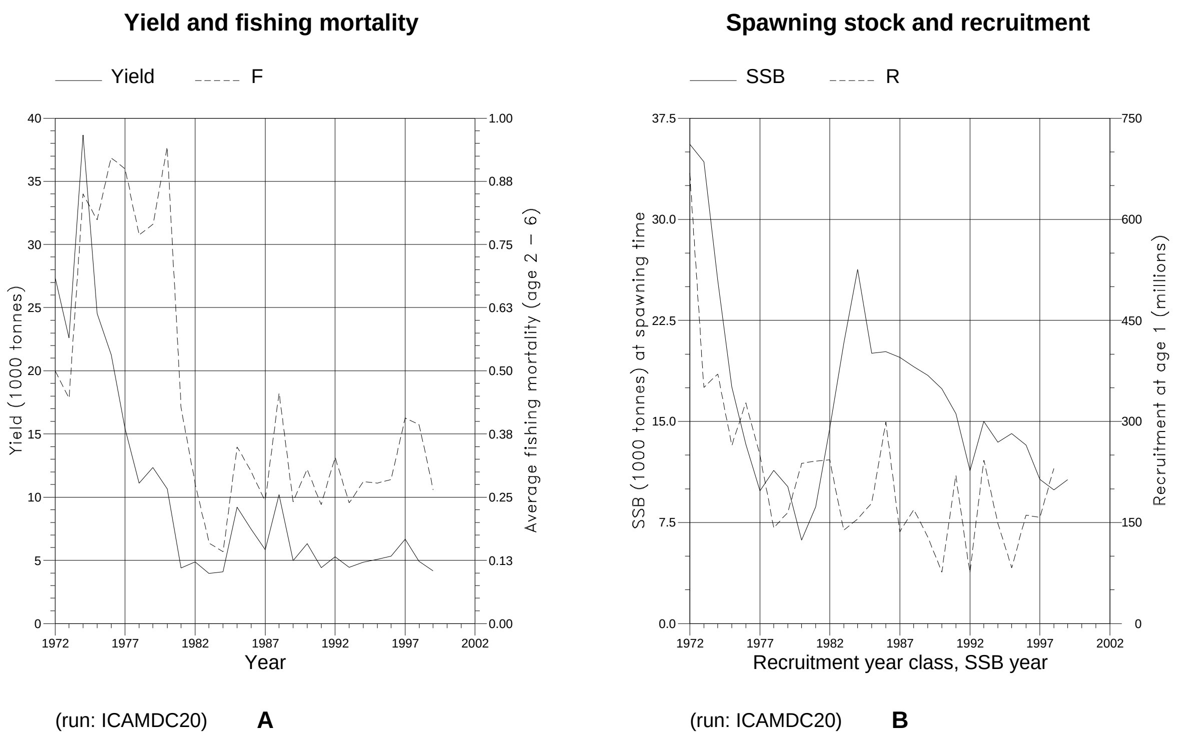


Figure 7.5.4. Herring in Division VIIa(N)

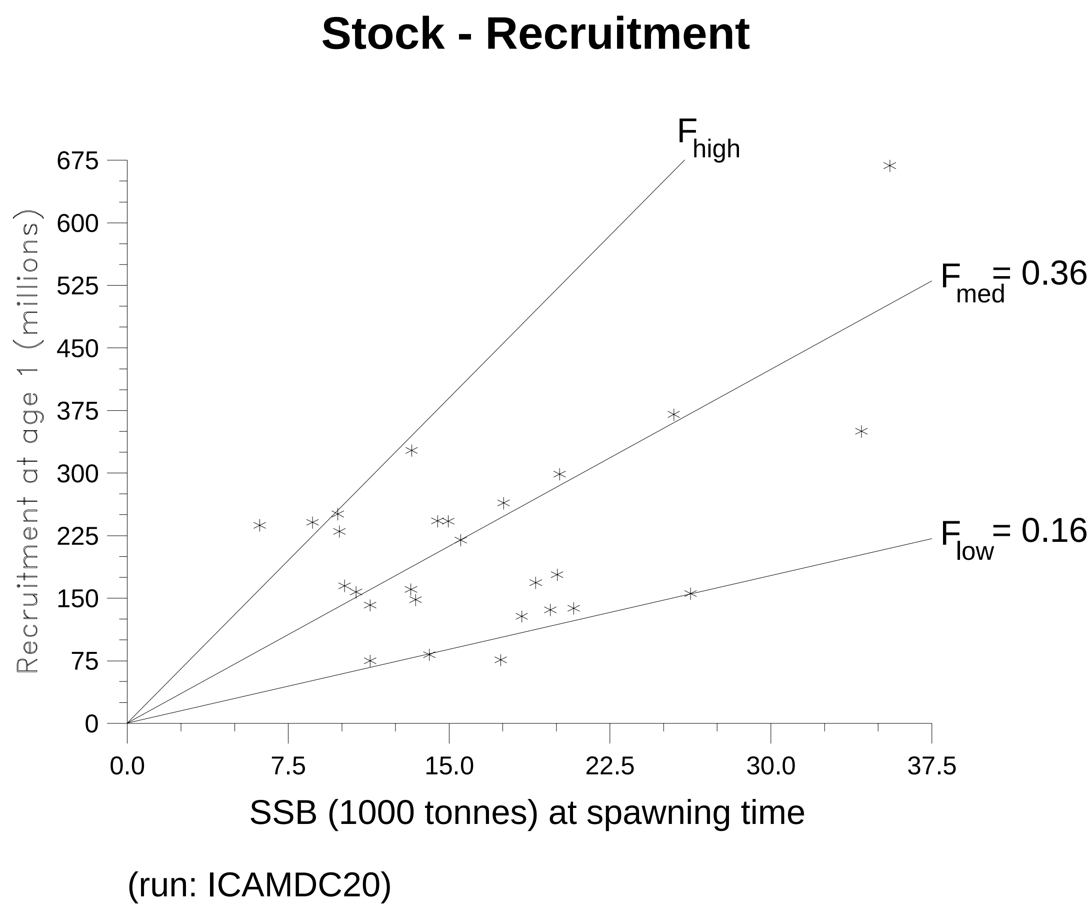


Figure 7.5.5. Herring in Division VIIa(N).

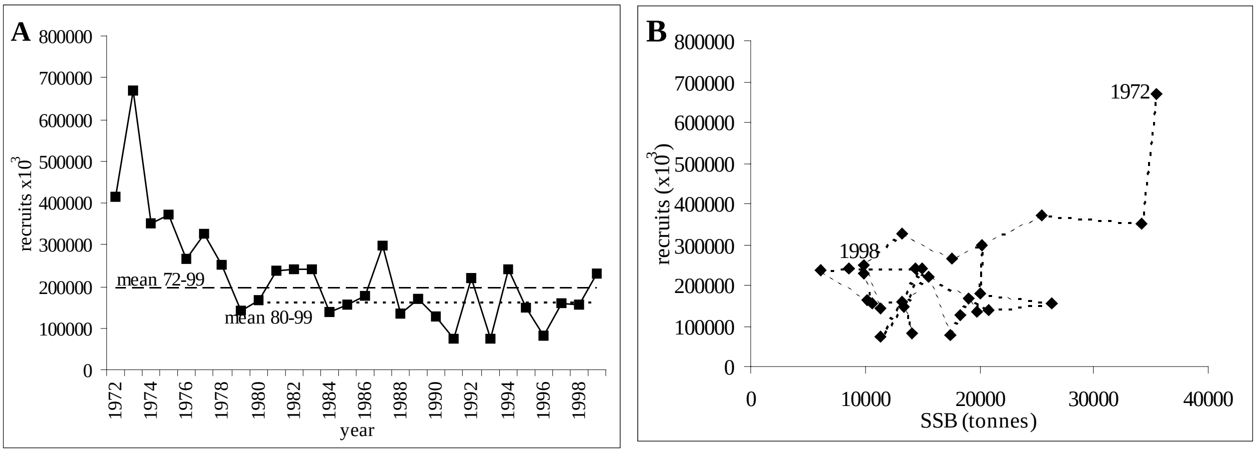


Figure 7.8.1 Numbers of recruits of Irish Sea herring, from catch scenario 1. A) The historic time series since 1972. The dotted lines denote the geometric mean recruitment from 1972 to 1999 and from 1980 to 1999. B) Recruitment in thousands over SSB in tonnes.

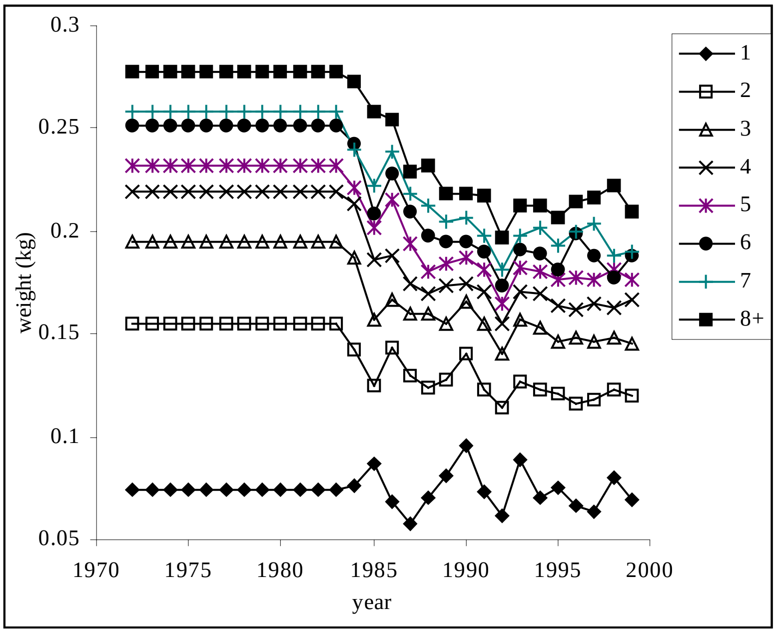


Figure 7.8.2. Mean weights of age in the catch, used for Irish Sea herring assessments from 1972 to 1999.

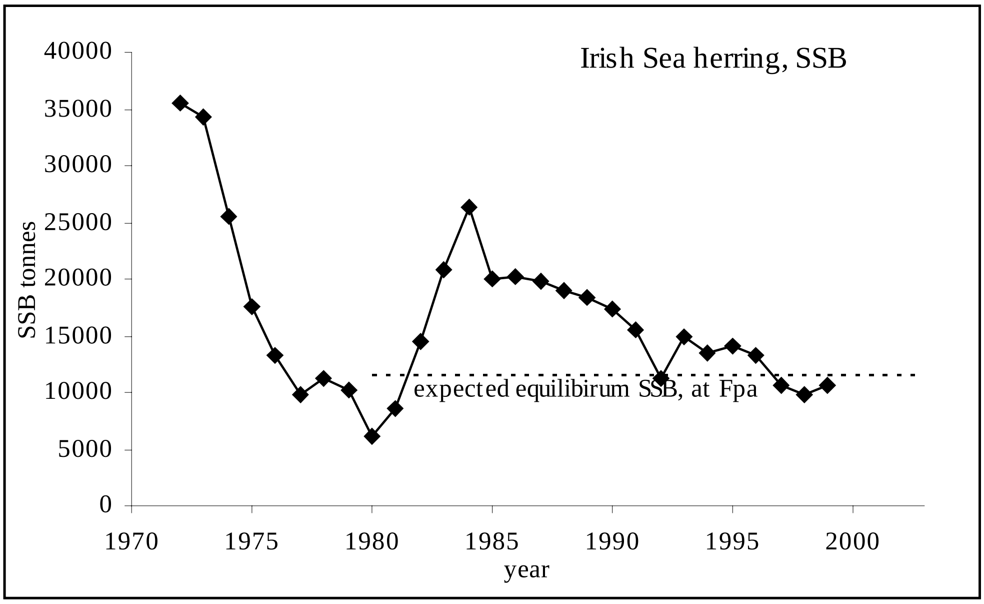


Figure 7.8.3 The SSB of Irish Sea herring estimated from catch scenario 1, showing estimated equilibrium SSB at F_{pa} and mean recruitment between 1980 and 1999.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1999 and 2000

No ACFM advice has been given on sprat TAC in recent years. The TAC set by management was 150 000 t for 1998 [Sub-area IV(EU zone) + Division IIa (EU zone)] and 225 000 t for 1999. For 2000, a management agreement between the EU and Norway set a TAC of 225 000 t.

8.1.2 Total landings in 1999

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1986–1999. As in previous years, sprats from the fjords of western Norway are not included in the landings for the North Sea. Landings from the fjords are presented separately (Table 8.1.2) due to their uncertain stock identity. Table 8.1.3 shows the landings for 1994–1999 by year, quarter, and area in the North Sea. Discrepancies between catch figures in Table 8.1.3 and Table 8.1.1, is caused by national catch data given as total annual catch without any reference to area or/and season, and thus not included in Table 8.1.3

The Danish sprat fishery in the North Sea was carried out mainly in August and September with very high CPUE's. The Danish quota was exceeded mid September and the fishery was closed on the 20 September. The sprat fishery in August and September was conducted with by-catches of herring of less than 3%. Denmark applied for a TAC increase and this was granted in the beginning of December. As this was late in the year, the Danish new revised quota was not taken.

The Norwegian sprat fishery is performed by purse seiners. In 1999, the Norwegian sprat landings were taken in quarter 1 and quarter 4. Changes in the Norwegian regulations were implemented in 1999 and misreporting is no longer thought to be a problem. Also a closure of the fishery was introduced for the second and third quarter.

The quarterly and annual distributions of catches by rectangle for Sub-area IV are shown in Figures 8.1.1–8.1.2.

Landing statistics for Denmark, Norway, UK (Scotland), Sweden, Netherlands and UK (England and Wales) show that 188,000 t sprat were landed from the North Sea in 1999, which was an increase in landings from 1998 of about 15% and 82% higher that the 1997 landing figure. The 1999 landings were lower than during any year from 1993 to 1995.

8.2 Catch Composition

8.2.1 Catches in number

The estimated quarterly catch-at-age in numbers by country for the years 1994 to 1999 is presented in Table 8.2.1. Denmark, Norway and UK (England and Wales) provided age composition data of commercial landings in 1999. In 1999 1-group fish dominated (83%) the landings in both the Danish and the Norwegian fleets.

Catch at age data from commercial landings was available from Denmark in quarter 1, 3 and 4. Danish landings in the second quarter are negligible. As no sampling was available for UK (Scotland), Netherlands and Sweden, the Danish samples were used to estimate catch in numbers and mean weight. Norwegian landings were sampled in quarter 1. Danish samples were used at Norwegian landings in the fourth quarter.

8.2.2 Mean Weight at age

The mean weights (g) at age in catches taken in 1995 - 1999 are presented, by quarter, in Table 8.2.2. Weights were estimated from commercial catch data provided by Working Group members.

8.2.3 Quality of catch and biological data

The sampling intensity for biological samples, i.e., age and weight at age, is given in Table 8.2.3. The total number of samples available in 1997 was low compared to 1996, but increased in 1998 and this sampling level was maintained in 1999. The recommended level of one sample per 1 000 t landed was not reached, but as the fishery was carried out in a limited area, the sampling level can be regarded as adequate. In 1999, Denmark collected 57 samples from commercial landings and these were analysed for length and age. This gives 0.4 sample per 1 000 t landed. These samples were used to estimate age composition and weight at age of sprat. From the Norwegian landings, 14 samples were taken for species composition, which gives 0.7 sample per 1 000 t. Six samples were analysed for lengths and age composition. The number of fish aged per 1 000 t was 31.

The Danish monitoring scheme for species composition in the Danish small meshed fisheries in 1999 was working well and a total of 1085 samples were collected from landings taken in the North Sea. The total landings from the Danish small mesh fishery in 1999 was 790 000 t (all species). The recommended sampling levels were achieved.

The Norwegian sampling for species composition in the Norwegian North Sea sprat fishery followed the monitoring scheme. With a total of 14 samples collected from the landings in Norway, the recommended sampling levels were achieved. Five landings of North Sea sprat by Norwegian vessels in Denmark were sampled for species composition.

No sprat were reported as by-catch in the landings from the Norwegian small meshed fishery targeted at sandeel and Norway pout.

8.3 Recruitment

The IBTS (February) sprat indices (no per hour) are used as an index of abundance. The historical data were revised by the Working Group in 1995 (ICES 1995). The IBTS-indices (sprat standard area IVb) for 1984–2000 are presented in Table 8.3.1 for age groups 1–4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered. The fishing method (gear) was standardised in 1983 and the data in the series are comparable.

There was an increase in the 1-group index from 1996 to 1999. In 2000 there was a decline in the 1-group index but the index is well above the mean of the time series. The abundance of the 1998-year class (2-group) continues to be high and is above the average. After four year with an increase in the total-abundance index, the 2000 index decreased but is still among the highest in the series.

The IBTS data by rectangle are given in Figure 8.3.1 for age groups 1, 2 and 3+. Age 1-group were found to be concentrated in the south-eastern areas of Division IVb and in IVc. The mean lengths (mm) of age-group 1 by rectangle, are presented in Figure 8.3.2.

8.4 Acoustic Survey

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996. In June-July 1998, sprat were mainly detected west of 1°W (R/V Tridens) (Simmonds *et al*, 1999). The acoustic estimates of sprat biomass in 1996–1999 were in the range of 40 000 t (1998) to 210 000 t (1996). In 1999 the acoustic estimate of sprat was very low. The low value was not thought to be representative mainly due to inappropriate coverage of the south-eastern area (ICES 2000), the area expected to have the highest abundance of sprat in the North Sea.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

The IBTS surveys do not fully reflect strong and weak cohorts for sprat, which has also been demonstrated by previous Working Groups (see ICES 1998a). The 1-2 group ratio varies and does not adequately reflect the age structure of the stock. This may be due to difficulties in age reading and/or a possible prolonged spawning and recruitment season. However, the IBTS-survey may still be a useful indicator of the stock biomass and used as a tuning index in production models.

The Biomass dynamic model was fitted using the CEDA program, see ICES (1993) and Holden, Kirkwood and Bravington (1995). The data used were; the total catch for 1972–1998 and the IBTS(February) abundance indices for 1984 to 1998. The IBTS(February) abundance indices used last year, were in no/h. This assumed a constant mean weight in the population which in reality will depend on the stock structure; i.e., numbers at age in each year, and may therefore be quite variable. The IBTS-indices were therefore calculated as a weighted sum of numbers by age using a constant weight-at-age. As no weight-at-age are available from the IBTS-February data, mean weight-at age was calculated from the means in the commercial landings 1995-1999. The calculated mean weight-at-age was used as constants for the whole series of IBTS-indices in the calculation of IBTS- “indices of biomass” (Table 8.5.1). These indices were used as input in the model along with total catches.

The initial state of the stock in 1972 was assumed to be 0.8 of the carrying capacity K. The 1989 IBTS index for sprat was again considered as an outlier, though the longer series seems to smooth out its effect. A new run was done excluding the 1989 data. The run was consistent with the analyses undertaken in the two last years (ICES 1998a, 1999a). This analysis shows that the upward trend in biomass continues. The run seems to be somewhat sensitive to the proportion of K (initial proportion) assigned to 1972. There is, however, no objective way to determine the size of the initial proportion. A range of proportion values (0.25 to 0.8) with similar trends over the range of proportions. The model fits reasonable well, as shown in Figure 8.5.1.

The difficulties in tracking strong and weak year classes may partly be due to difficulties in age determination. IBTS annual length-at-age keys have indicated that the length-groups 9.0–11.0 cm are a transition between the 1–3 age-groups, with potential error in age determinations when a small number of otoliths are considered. Last year the HAWG reviewed the otolith sampling regime of sprat otoliths during the IBTS-survey. In the revision of the survey manual, the IBTSWG in 1999 recommended an increase in number of otoliths in sprat at length above 8.0 cm (ICES 1999). The 2000-IBTS length at age data available indicates an increase in otoliths aged between 8.0 and 11.0 cm, with a reasonable age distribution. There was no time for a further comparison of the whole series of length-at-age keys or by sub-areas.

8.6 Projections of Catch and Stock

The regression of the total catches and total the IBTS indices for 1984–1999, excluding the 1989-index, predicted a yield for 2000 of about 190 000 tonnes ($r^2 = 0.73$), see Figure 8.6.1.

The total IBTS-indices were used in a SHOT-estimate (see ICES 1992). Using the various indices as input (1-group, combined 1-and 2-group and the total IBTS-indices) the estimated landings for 2000 were in the range of 180-200 000 (Table 8.6.1).

Projections, run in the CEDA package, with annual catches of 200 000 t, 225 000 t and 275 000 t as input values, are shown in Figure 8.6.2. These catch levels were chosen based on the current catch level and the projections from the regression and the SHOT-estimate.

The biomass dynamic model has some attractions over the SHOT method for stock and catch projections. First, the biomass dynamic model is based on a production function (the Schaefer function, in this case) with parameters (r, K) which are interpretable in terms of population dynamics. The SHOT procedure, although also based on the concept of production, is more ad-hoc, and the estimated parameters are not as easily interpreted. Second, the biomass dynamic model projections give useful indications of how the stock may evolve under different future catches, and the estimated stock dynamics. Nonetheless, the sprat catches are dominated by young fish and the population is strongly driven by recruitment. Most of the production of the stock is therefore likely to be due to recruitment and the growth of recruits rather than the growth of post-recruits. Care should therefore be taken not to over-interpret the biomass dynamic model.

8.7 Management Considerations

The natural variability in stock abundance is high and the recruitment between years does not appear to be driven directly by fishing effort. Prior to 1993, the sprat was in periods caught with a relative high percentage of herring by-catch. In 1993, 1994 and 1995 the sprat fishery could be conducted with rather low herring by-catch percentages. In some periods in 1997 and 1998 it was stopped with the aim of protecting the juvenile herring and due to high by-catch of herring. In 1999, the fisheries were carried out with a very low percentage of herring by-catch. Therefore, the by-catch of herring is not a limited factor in the current sprat fishery. In 1998 and 1999, the main controlling factor was the TAC limits.

The sprat stock shows signs of being in good condition as both catch and biomass appears to increase and there is indication of a good 1999 year class recruiting to the 2000 fishery. A TAC for 2000 could be within a range of 190-250 000 tonnes. Because the fishery in certain a year is very depended on this years incoming year class, the Working Group is not able to predict catches for 2001.

Attempts to assess this stock have demonstrated the need for a better survey coverage of the south-south-eastern areas of the North Sea and for the addition of directed sprat sampling for age data. There is also a need for better knowledge of spawning seasons and recruitment from a possible autumn spawning. There are indications that larvae from autumn spawning will over-winter as larvae and metamorphose the year after. As sprat is aged by counting winter-rings this will result in incorrect allocation to year classes.

Table 8.1.1 Sprat catches in the North Sea ('000 t) 1986–1999. Catch in fjords of western Norway excluded (Data provided by Working Group members except where indicated).

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	1991	1992	1993	*1994*[2]	*1995*	*1996*	*1997*	*1998*	1999[1]
							Division IVa West							
Denmark	0.6	0.2	0.1	+	-	-	0.3	0.6	-	-	-	-	+	0.7
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
UK (Scotland)	+	+	-	-	+	-	-	-	0.1	+	-	-	-	-
Total	0.6	0.2	0.1	+	+	0.1	0.3	0.6	0.1	+	-	-	+	0.7
							Division IVa East (North Sea) stock							
Denmark	0.2	+	+	+	-	-	-	+	+	+	0.3	+	+	+
Norway	-	-	-	-	-	-	0.54	2.5	+	+	-	-	-	-
Sweden	-	-	-	-	+	2.5	-	-	-	-	-	-	-	-
Total	0.2	+	+	+	+	2.5	0.54	2.5	+	+	0.3	+	+	+
							Division IVb West							
Denmark	0.4	3.4	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8	82.2	21.1	13.2
Norway	-	-	3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3	+	-
UK (England & Wales)	-	-	-	-	-	-	0.5	0.5	-	+	+	-	-	-
UK (Scotland)	-	0.1	-	-	-	-	-	0.5	-	-	-	-	-	0.8
Total	0.4	3.5	4.9	2.1	11.2	13.8	38.8	30.8	31.6	47.0	3.7	84.5	21.1	14.0
							Division IVb East							
Denmark	10.3	28.0	80.7	59.2	59.2	67.0	66.6	136.2	251.7	283.2	74.7	10.9	98.2	147.1
Germany	0.6[3]	-	-	-	-	-	-	-	-	-	-	-	-	
Norway	-	-	0.6	-	0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8	15.3	13.1
Sweden	-	-	-	-	+[2]	+[2]	-	-	-	0.2	0.5	-	1.7	2.1
UK (Scotland)														0.6
Total	10.9	28.0	81.3	59.2	59.8	92.1	76.1	160.3	270.8	298.1	126.1	11.7	115.2	162.9
							Division IVc							
Belgium	+	+	-	+[2]	+[2]	+[2]	-	-	-	-	-	-	-	-
Denmark	0.1	+	0.1	0.5	1.5	1.7	2.5	3.5	10.1	11.4	3.9	5.7	11.8	3.3
France	+	-	-	+[2]	-	+[2]	-	+	+	+	-	-	-	-
Netherlands	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-	-	-	-	-	-	0.2
Norway	-	-	-	-	-	-	-	0.4	4.6	0.4	-	0.1	16.0	5.7
UK (England & Wales)	4.1	0.7	0.6	0.9	0.2	1.8	6.1[1]	2.0	2.9	0.2	2.6	1.4	0.2	1.6
Total	4.2	0.7	1.1	1.8	1.7	3.5	8.6	5.9	17.6	12.0	6.5	7.2	28.0	10.8
							Total North Sea							
Belgium	+	+	-	+[2]	+[2]	+[2]	-	-	-	-	-	-	-	
Denmark	11.6	31.6	82.3	61.7	70.7	78.1	89.2	153.3	280.8	320.6	80.7	98.8	131.1	164.3
France	+	-	-	+[2]	-	+[2]	-	+	+	+	-	-	-	-
Germany	0.6[3]	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-	-	-	-	-	-	0.2
Norway	-	-	4.1	0.1	1.8	29.6	28.4	43.8	36.3	36.1	52.8	3.2	31.3	18.8
Sweden	-	-	-	-	+[2]	2.5	-	-	-	0.2	0.5	-	1.7	2.1
UK (England & Wales)	4.1	0.7	0.6	0.9	0.2	1.8	6.6	2.5	2.9	0.2	2.6	1.4	0.2	1.6
UK (Scotland)	+	0.1	-	-	+	-	-	0.5	0.1	+	-	-	-	1.4
Total	16.3	32.4	87.4	63.1	72.7	112.0	124.3	200.1	320.1	357.1	136.6	103.4	164.3	188.4

[1]Preliminary.
[2]Official statistics.
[3]Includes Division IV a-c.
+Catch recorded, but amount not precisely known.
1994-1998: Minor revision of the data made by the WG 2000.

Table 8.1.2. Sprat catches (' 000 t) in the fjords of western Norway, 1985-1999.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
7.1	2.2	8.3	5.3	2.4	2.7	3.2	3.8	1.9	5.3	3.7	3.3	3.1	2.5	3.2

Table 8.1.3. Sprat catches (tonnes) in the North Sea by quarter*. Catches in fjords of Western Norway excluded.

Year	Quarter	Area					Total
		IVaW	IVaE	IVbW	IVbE	IVc	
**1994	1	0	42	2616	17227	16081	35966
	2	0	0	242	10857	1	11100
	3	0	0	10479	184747		195226
	4	109	0	18224	57959	1503	77796
Total		109	42	31561	270790	17586	320088
1995	1	0	0	17752	16900	7324	41976
	2	0	0	1138	5752	1	6891
	3	0	86	25305	183500	6	208897
	4	0	5	2826	92054	4693	99578
Total		0	91	47021	298206	12024	357342
1996	1	0	459	2471	81020	6103	90053
	2	0	0	615	2102	18	2735
	3	0	0	242	6259	0	6501
	4	0	353	411	36273	386	37423
Total		0	812	3739	125654	6507	136712
1997	1	0	0	1025	147	7089	8261
	2	0	0	189	1054	0	1243
	3	0	3	27487	569	0	28059
	4	0	81	55814	9878	0	65773
Total		0	84	84515	11648	7089	103336
1998	1	0	0	1917	3726	1616	7259
	2	0	4	529	206	4	743
	3	0	0	4926	55155	215	60296
	4	0	0	13712	54433	25984	94129
Total		0	4	21084	113520	27819	162427
1999	1	0	0	450	20862	9071	30383
	2	0	0	108	1048	0	1156
	3	1	17	7840	121186	415	129459
	4	679	31	5550	19731	1167	27158
Total		680	48	13948	162827	10652	188155

* 1994 Data from Denmark and Norway
1995-1996 data from Denmark, Sweden, Norway and the UK
1997-1999 Data from Denmark, Norway and the UK (England and Wales)
** Data revised by the 2000-WG

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1995-1999.

Year	Quarter	Age 0	1	2	3	4	5+	Total
1995	1		5.9	2,990.5	991.4	54.0		4,041.7
	2		2.3	595.1	182.5			779.9
	3	531.3	12,097.4	7,990.0	262.6	3.3		20,884.7
	4		4,541.1	3,309.7	377.8			8,228.6
	Total	531.3	16,646.7	14,885.3	1,814.3	57.3		33,934.8
1996	1		524.7	4,615.4	2,621.9	316.4	11.3	8,089.7
	2		1.9	241.5	32.7	15.5	0.3	291.9
	3		400.5	100.7	22.9	0.3		524.5
	4		1,190.7	1,069.0	339.6	5.6		2,604.8
	Total		2,117.9	6,026.6	3,017.0	337.8	11.5	11,510.8
1997	1		74.4	314.0	229.2	55.3	2.5	675.4
	2		11.3	47.8	34.9	8.4	0.4	102.9
	3		1,991.9					1,991.9
	4	127.6	3,597.2	996.2	117.8	58.1	0.0	4,896.9
	Total	127.6	5,674.8	1,358.1	381.9	121.8	2.8	7,667.1
1998	1		683.2	537.2	18.3	0.1		1,238.8
	2		70.9	55.3	1.8			127.9
	3	74.2	3,356.6	693.3				4,124.2
	4	772.4	4,822.4	2,295.1	483.5	39.5		8,412.8
	Total	846.6	8,933.1	3,580.9	503.6	39.6		13,904
1999	1		728.1	2,226.0	554.2	86.6	9.2	3,604.2
	2		38.6	58.4	18.1	2.6		117.7
	3		12,919.0	38.9				12,957.8
	4	105.0	2,143.2	211.5				2,459.7
	Total	105.0	15,828.9	2,534.8	572.3	89.2	9.2	19,139

Table 8.2.2 North Sea Sprat. Mean weight (g) by quarter and by age for 1995 - 1999.

Year	Quarter	Age 0	1	2	3	4	5+	SOP Tonnes
1995	1		3.0	9.4	12.9	19.4		41,976
	2		3.0	8.4	10.3			6,891
	3	2.4	7.6	13.9	16.4	20.7		208,897
	4		10.5	13.9	16.2			99,578
	Total	2.4	8.4	12.8	13.8	19.5		357,342
1996	1		3.9	9.3	14.9	15.3	16.1	88,807
	2		6.9	8.4	11.6	20.0	15.2	2,735
	3		11.6	14.2	18.2	21.5		6,501
	4		12.1	15.9	17.2	20.5		37,359
	Total		10.0	10.5	15.1	15.6	16.0	135,401
1997	1		8.0	10.0	15.0	17.0	19.0	8,161
	2		8.0	10.0	15.0	17.0	19.0	1,243
	3		14.2					28,285
	4	3.7	11.9	16.4	19.1	19.6		63,083
	Total	3.7	12.7	14.7	16.3	18.2	19.0	100,772
1998	1		5.6	6.0	8.7	15.0		7,232
	2		5.6	6.0	8.3			743
	3	3.7	14.7	15.3				60,149
	4	4.1	10.6	13.8	16.3	14.6		94,173
	Total	4.0	11.7	12.8	16.0	14.7		162,297
1999	1		3.3	8.7	12.5	14.4	16.3	30,168
	2		3.1	10.1	13.6	15.4		993
	3		10.0	18.3				129,383
	4	4.4	11.0	14.4				27,126
	Total	4.4	9.8	9.4	12.5	14.4	16.3	187,670

Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 1998-1999.

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
1998					
Denmark	1	7.2	6	247	0
	2	0.7	11	94	30
	3	60.3	16	1,936	109
	4	62.9	15	2,105	442
	Total	131.1	48	4,382	581
Norway	1	0.2			
	2				
	3				
	4	31.3	16	1,704	1,096
	Total	31.5	16	1,704	1,096
England/Wales	1				
	2				
	3				
	4	0.2	2	657	216
	Total	0.2	2	657	216
Total North Sea		162.8	66	6743	1893
1999					
Denmark	1	14.1	4	724	238
	2	0.1	22	132	
	3	129.4	22	2,413	170
	4	20.7	9	983	129
	Total	164.3	57	4,252	537
Norway	1	13.7	14	649	599
	2				
	3				
	4	5.1			
	Total	18.8	14	649	599
Sweden	1	1.0			
	2	1.0			
	3	0.0			
	4				
	Total	2.1	0	0	0
UK-England/Wales	1	1.6	4	2,223	460
	2				
	3				
	4	0.0			
	Total	1.6	4	2,223	460
UK-Scotland	1				
	2				
	3				
	4	1.4			
	Total	1.4	0	0	0
Total North Sea		188.1	75	7124	1596

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1984-2000, in the standard sprat area (Div. IVb).

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1984	80	251	383.63	393.57	47.43	6.66	0.41	831.70
1985	79	289	675.49	305.00	38.22	4.32	0.90	1023.93
1986	78	285	68.22	104.77	29.38	1.31	0.26	203.94
1987	78	299	758.28	74.68	24.80	3.61	0.21	861.58
1988	78	208	152.29	1410.52	109.66	8.78	0.00	1681.25
1989	79	236	4293.66	445.72	318.65	4.10	13.44	5075.57
1990	78	192	115.16	567.46	149.83	30.79	0.59	863.83
1991	78	179	834.45	104.89	27.84	2.63	1.17	970.98
1992	79	185	1562.20	344.08	38.25	5.51	0.45	1950.49
1993	79	181	1732.54	602.01	84.12	4.35	0.06	2423.08
1994	78	173	4084.89	1397.77	129.96	2.79	0.67	5616.08
1995	79	166	1059.30	2643.93	134.01	3.23	1.12	3841.59
1996	78	146	346.37	483.45	141.96	23.64	0.56	995.98
1997	79	159	887.43	389.35	33.80	3.42	0.15	1314.15
1998	79	197	1650.35	1744.60	286.34	12.14	2.32	3695.75
1999	78	177	4045.34	538.13	56.00	3.85	44.75	4688.07
2000	78	177	2227.35	838.61	71.05	1.73	0.01	3138.75

Table 8.5. 1. North Sea Sprat. IBTS(February) " indices of biomass". by age group 1984-2000. The mean weights are calculated from the means in the commercial landings in quarter 1, 1995-1999.

Year	Age			
	1	2	3+	Total
1984	1687.97	3817.63	779.35	8317.00
1985	2972.16	2958.50	621.19	10239.30
1986	300.17	1016.27	442.59	2039.40
1987	3336.43	724.40	409.27	8615.80
1988	670.08	13682.04	1693.69	16812.50
1989	18892.10	4323.48	4807.52	50755.70
1990	506.70	5504.36	2591.30	8638.30
1991	3671.58	1017.43	452.45	9709.80
1992	6873.68	3337.58	632.20	19504.90
1993	7623.18	5839.50	1265.98	24230.80
1994	17973.52	13558.37	1907.91	56160.80
1995	4660.92	25646.12	1978.55	38415.90
1996	1524.03	4689.47	2376.09	9959.80
1997	3904.69	3776.70	534.39	13141.50
1998	7261.54	16922.62	4301.44	36957.50
1999	17799.50	5219.86	1495.78	46880.70
2000	9800.34	8134.52	1040.90	31387.50
Mean W (g)	4.4	9.7	14.3	10.0

Table 8.6.1. North Sea Sprat. SHOT forecast of landings in 2000 using total landings and total IBTS-indices as input data.

North Sea sprat — **SHOT forecast spreadsheet version 6**

Total index — March 2000

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	77	832		0.77	0.23				100		
1985	50	1024	1024	0.77	0.23	42			65		
1986	16	204	204	0.77	0.23	6	8	18	21		
1987	33	862	862	0.77	0.23	38	34	29	43		
1988	87	1681	1681	0.77	0.23	103	69	61	113	79	61
1989	63	5076	5076	0.77	0.23	56	254	216	82	280	216
1990	71	864	864	0.77	0.23	73	24	33	92	43	33
1991	110	971	971	0.77	0.23	122	32	41	143	53	41
1992	124	1950	1950	0.77	0.23	128	80	87	161	113	87
1993	200	2423	2423	0.77	0.23	223	109	112	260	146	112
1994	324	5616	5616	0.77	0.23	361	295	273	421	355	273
1995	357	3842	3842	0.77	0.23	367	214	239	464	311	239
1996	137	996	996	0.77	0.23	71	62	130	178	168	130
1997	103	1314	1314	0.77	0.23	93	82	122	134	158	122
1998	164	3696	3696	0.77	0.23	182	232	202	213	263	202
1999	188	4688	4688	0.77	0.23	195	286	258	244	335	258
2000		3139	3139	0.77	0.23		184	185		240	185

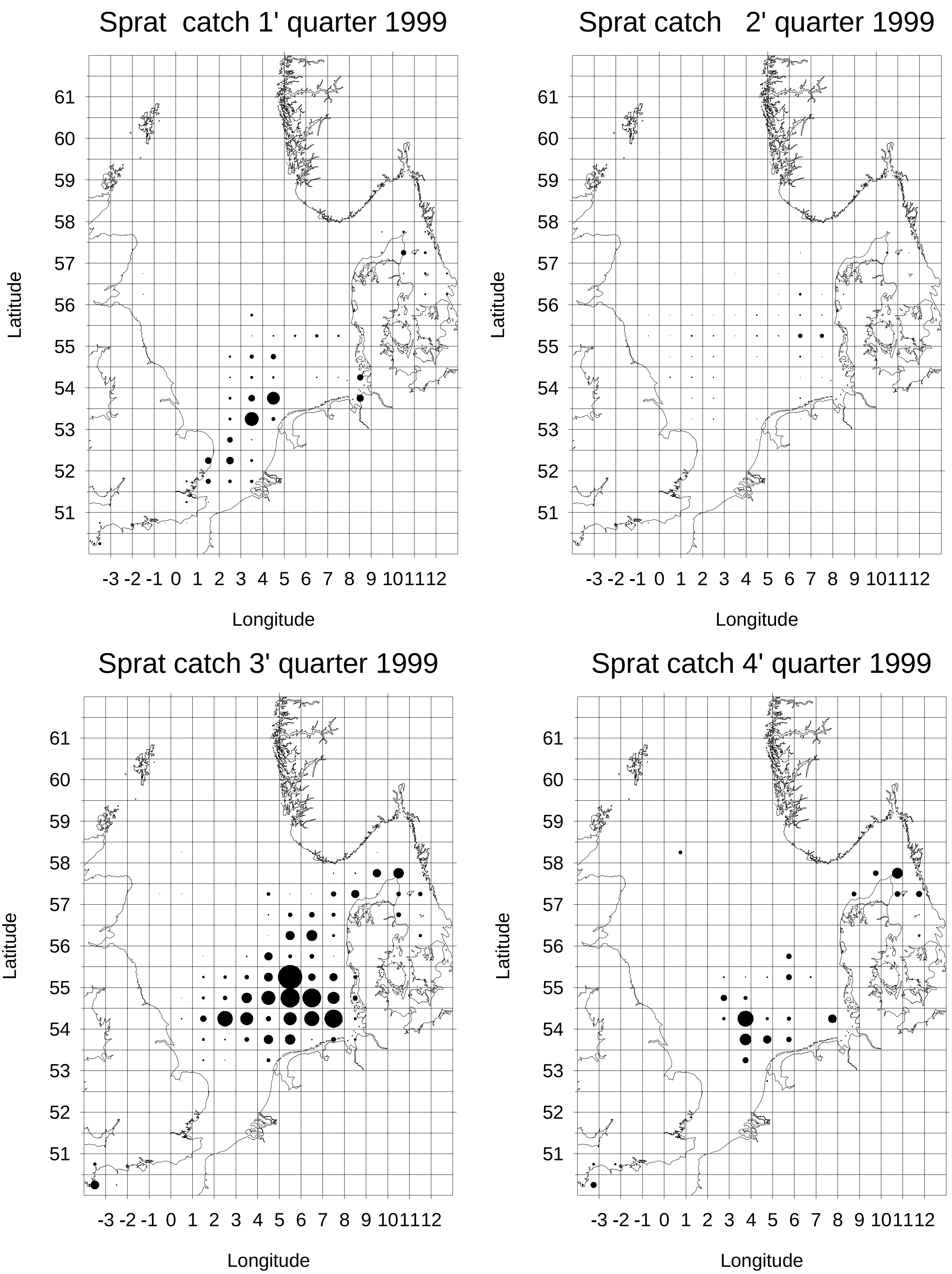


Figure 8.1.1. Distribution of sprat catches taken by quarter in 1999. Areas of filled circles illustrate amount of catch, the area of a circle extending to the border of a rectangle represent 9 000 tonnes.

Sprat catch all quarters 1999

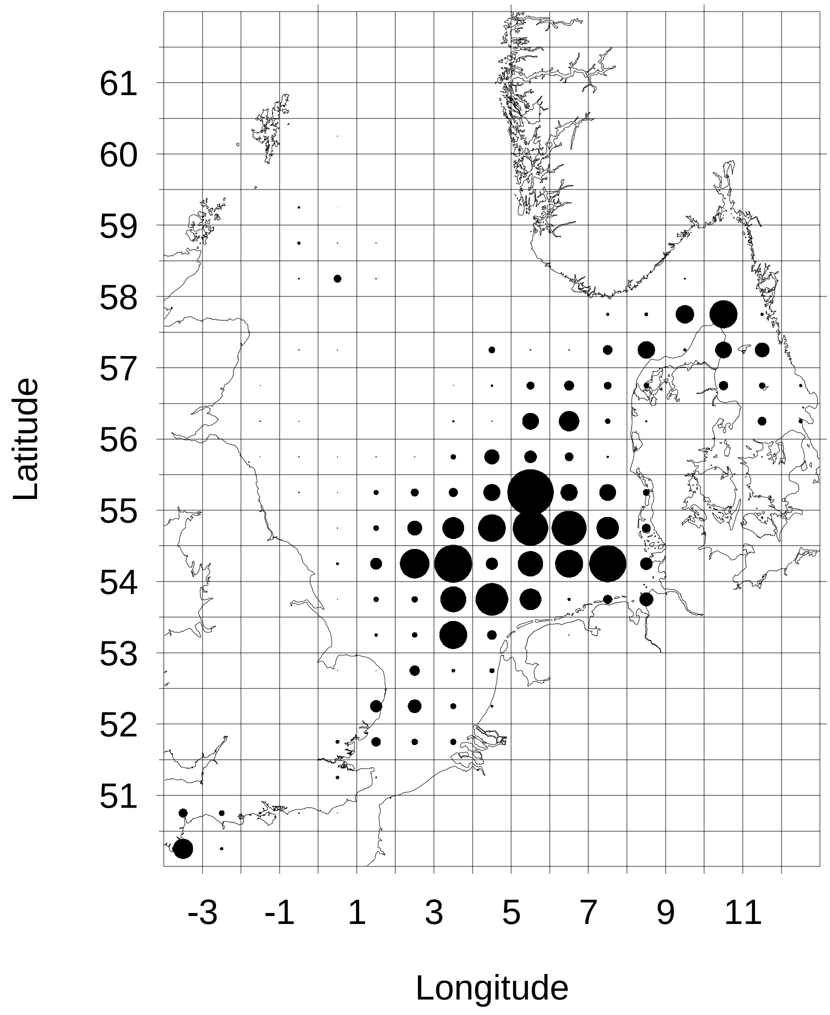
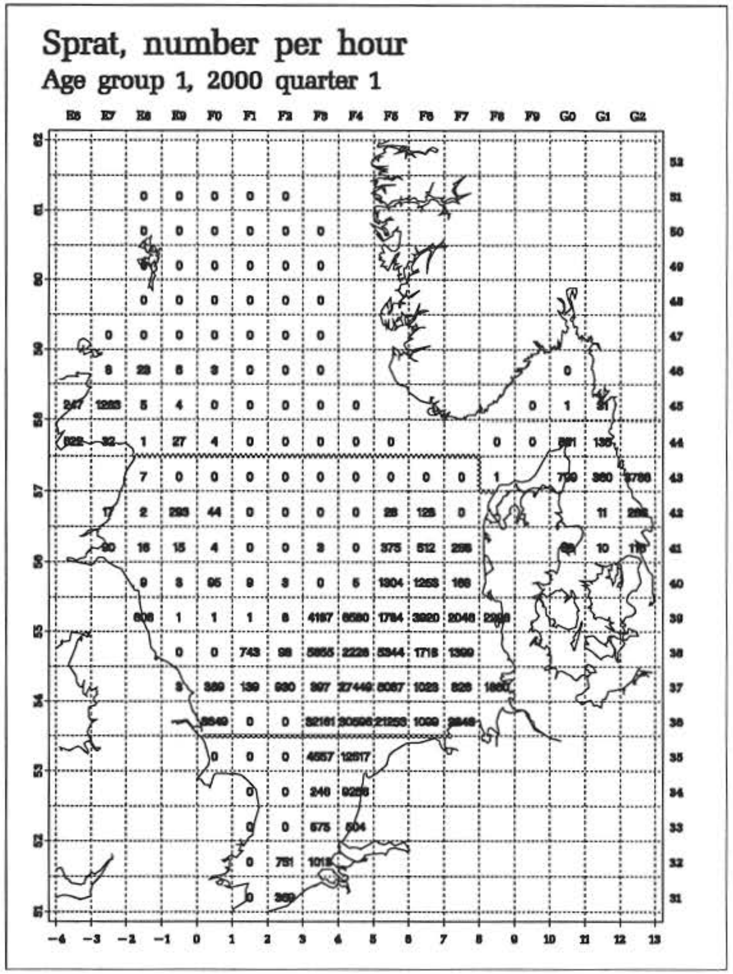


Figure 8.1.2 Distribution of sprat catches taken in all quarter during 1999. Areas of filled circles illustrate amount of catch, the area of a circle extending to the border of a rectangle represent 9 000 tonnes.



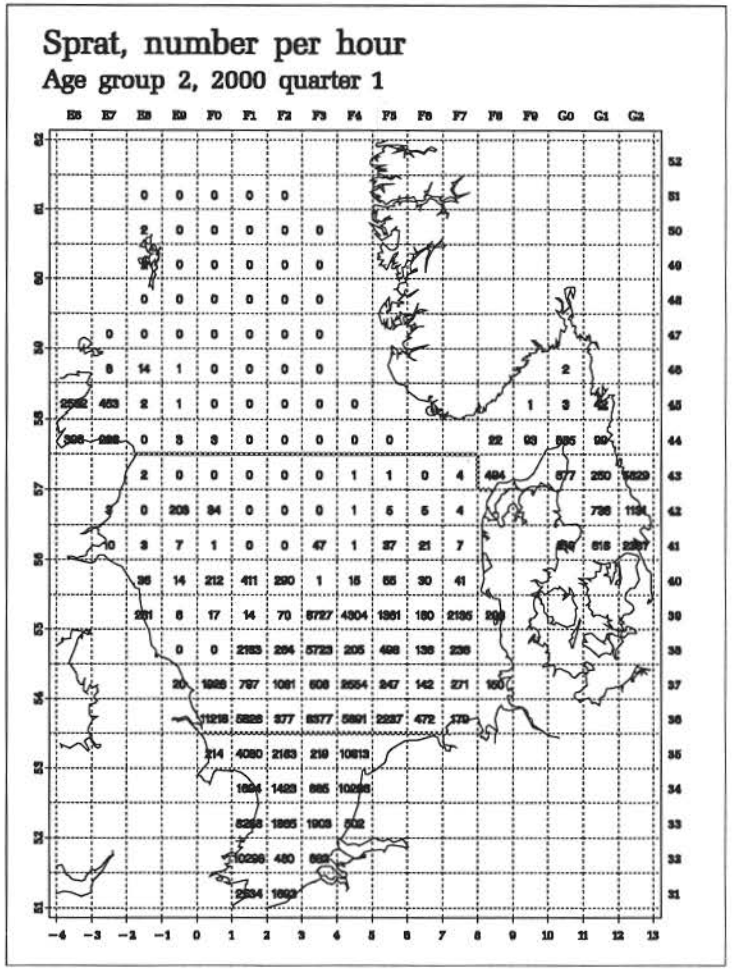


Figure 8.3.1. SPRAT. Distribution by age groups by square in the 2000 IBTS(February) survey

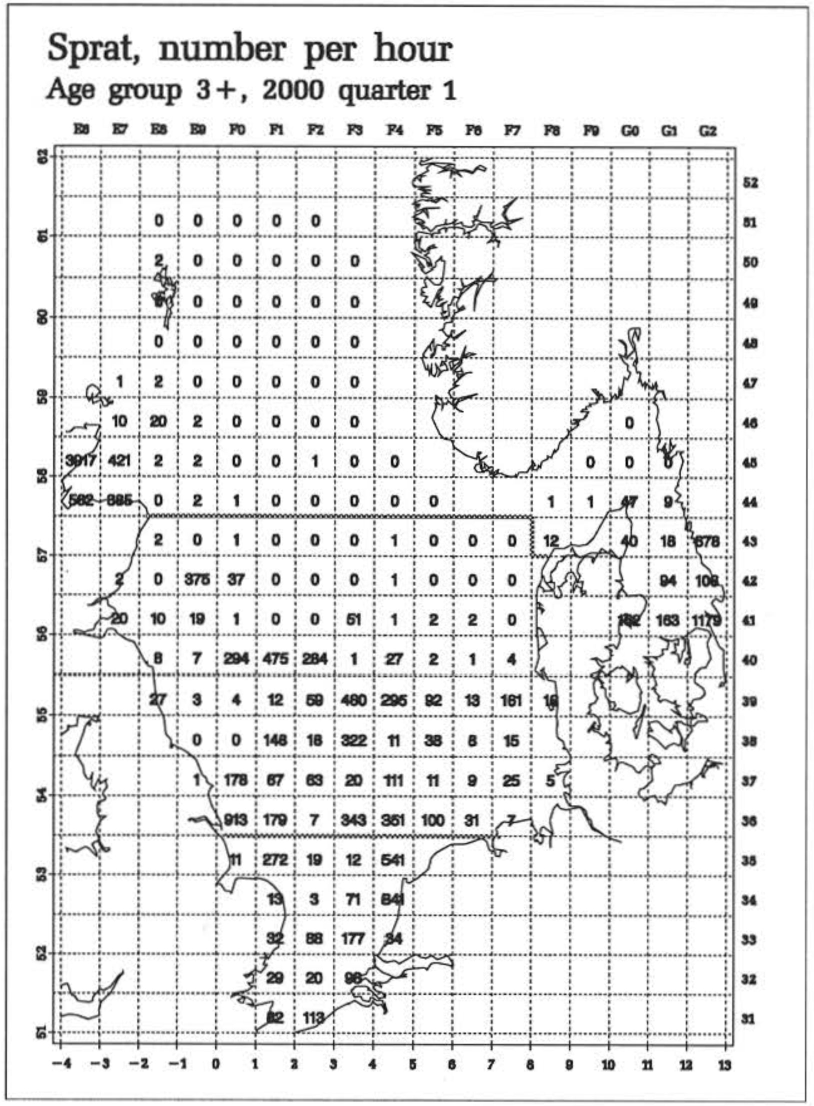


Figure 8.3.1. Continues.

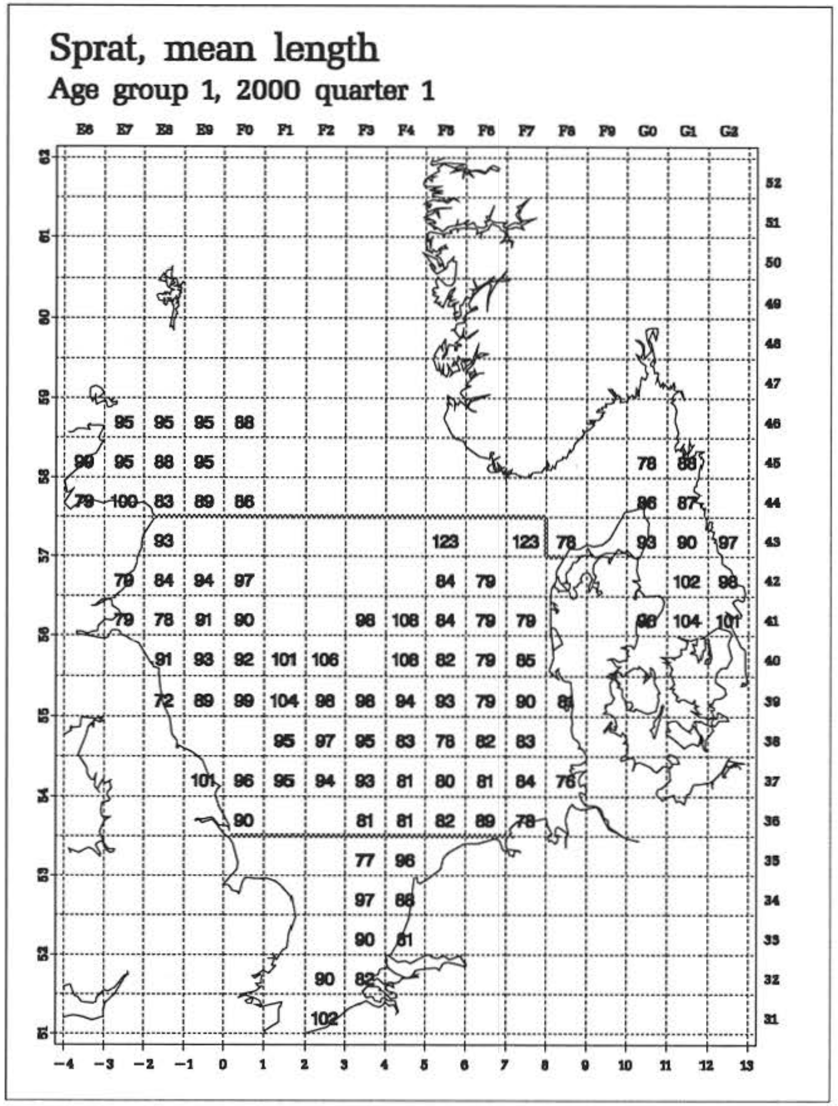


Figure 8.3.2. SPRAT. Mean length (mm) of age group 1 by square in the 2000 IBTS(February) survey

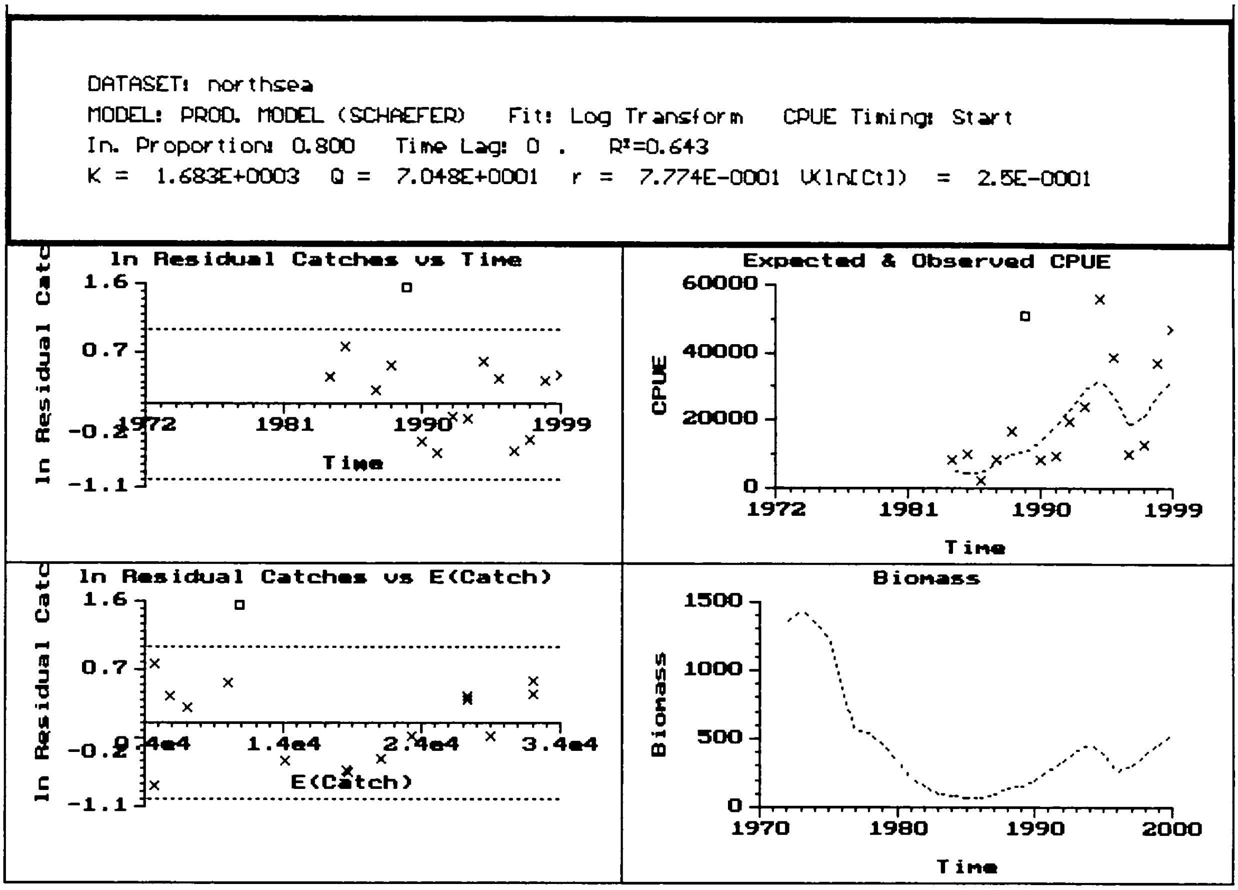
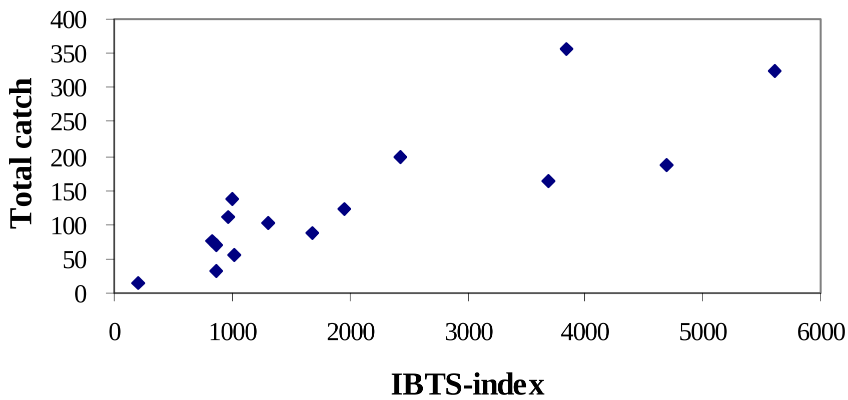


Figure 8.5.1 Schaefer production model output from CEDA Program, fitted for sprat in the North Sea

Fig. 8.6.1. North Sea Sprat. IBTS total indices vs total catches in 1984-1999, the 1989-index excl. (rsq.=0,73)



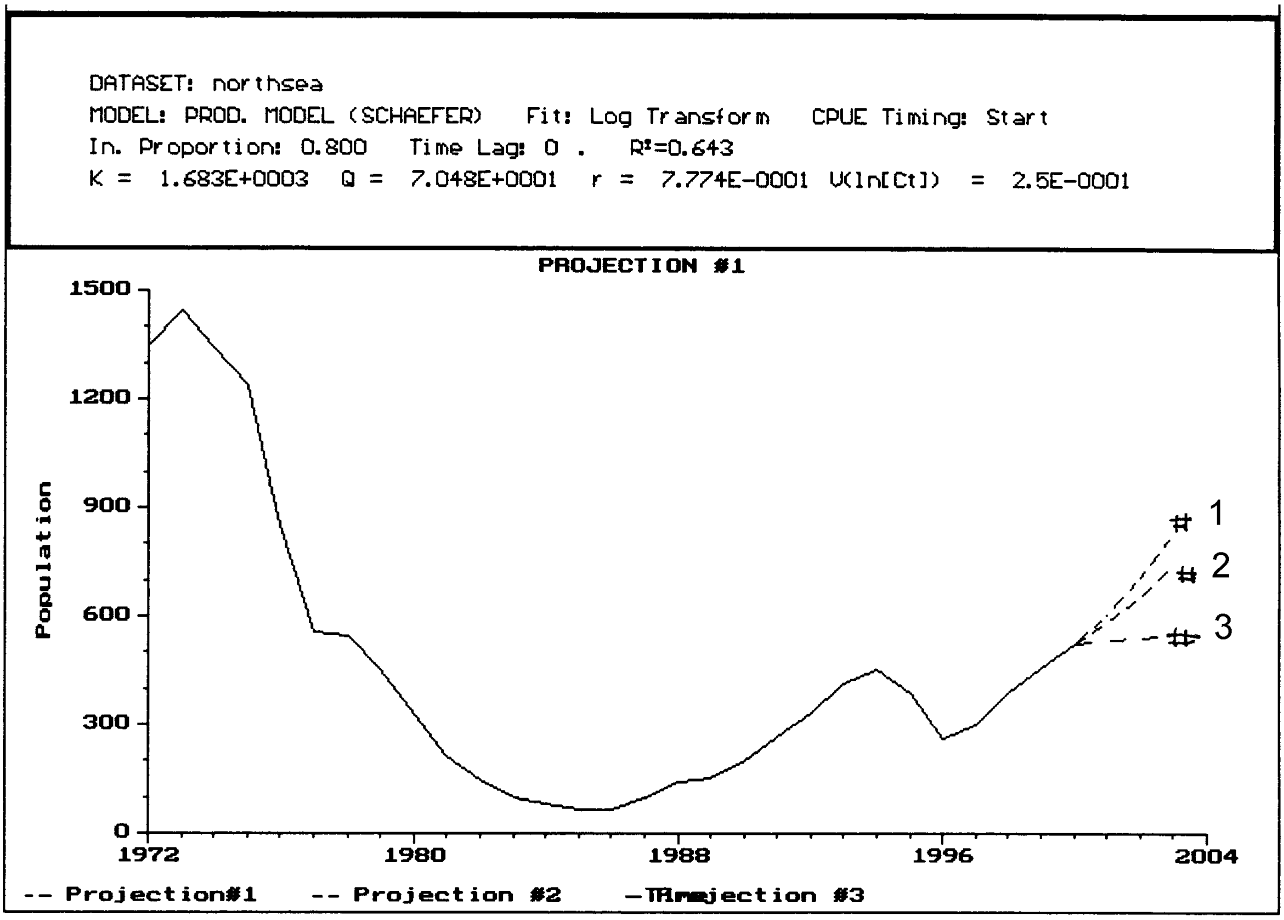


Figure 8.6.2 Projections as output from the CEDA run with the following scenarios: # 1 total catches 200,000 t, # 2 total catches 225,000 t and # 3 total catches of 275,000.

9 SPRAT IN DIVISIONS VIID,E

9.1 The fishery

9.1.1 ACFM advice applicable for 200

The TAC for this fishery was set to 12 000 t for 1998, to 6 300 t for 1999 and 12 000 t for 2000. No ACFM advice has been provided in recent years.

9.1.2 Catches in 1999

Table 9.1.1 shows the nominal landings in 1985–1999. The landings in 1999, as reported by UK(England & Wales), continued the increase from 1997. The landings of 3 559 t were of the highest for the period. The landings are commercial data from English and Welsh vessels landing into England and Wales. Monthly catches for the Lyme Bay sprat fishery show that the catches are mainly taken in third and fourth quarter (Table 9.1.2). Quarterly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.2.

9.2 Catch Composition

Catch compositions and the mean weights for 1991–1998 are given in Table 9.2.1 and Table 9.2.2. No samples were available from 1999 sampling for 1998 is shown in Table 9.2.3.

Table 9.1.1. Nominal catch of sprat (t) in Divisions VIId,e,1985-1998

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*	1998*
Denmark	-	15	250	2,529	2,092	608	-	-	-	-	-	-	-	-
France	14	-	23	2	10	-	-	35	2	1	+			-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.&Wales)	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,177	1,515	1,789	1,621	2,024
Total	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,178	1,515	1,789	1,621	2,024

* Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t). (UK vessels only).

Season	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1991/92	0	0	0	205	450	952	60	358	258	109	51	0	2443
1992/93	0	0	0	302	472	189	294	248	284	158	78	0	2025
1993/94	0	8	0	156	82	302	529	208	417	134	53	0	1889
1994/95	0	0	0	299	834	545	608	232	112	68	0	0	2698
1995/96	0	0	0	154	409	301	307	151	15	80	28	4	1449
1996/97	0	0	0	309	452	586	47	243	239	74	30	0	1980
1997/98	2	0	14	259	625	105	255	19	50	184	45	0	1558
1998/99	0	0	0	337	728	206	56	318					1645

Table 9.2.1. Lyme Bay sprat fishery. Number caught by age group (millions).

Season		0/1	1/2	2/3	3/4	4/5	5/6
1991/92		1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]		0.22	28.23	48.61	12.94	1.56	0
1993/94[2]		0	0.83	44.81	15.7	1.95	0.58
1994/95			No data				
	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	
1998		4.08	81.16	37.52	5.05	0.39	

[1] August to December only (samples in August and December only, so these are best estimates

[2] August to December only (samples in August, September and November only, so these are best estimates

[3] Only September (one sample)

Table 9.2.2 Lyme Bay area SPRAT. 1991–1998 mean weight (g) at age.

Season	Quarter	Age 0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

Season	Quarter	Age 0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-
1997	1		10.0	15.0	19.0	22.0	28.0		
	3		13.0	17.0	19.0	24.0			
	4		17.0	20.0	22.0	23.0			
1998	1		11.0	13.0	18.0	21.0	28.0		15.0

[1]Based on November samples only.
[2]Based on September sample only.

Table 9.2.3 Division VIId,e Sprat. Sampling commercial landings for biological samples in 1998.

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1998 England/Wales					
	1	0.3	2	326	141
	2	0.0	0	0	0
	3	1.1	0	0	0
	4	0.6	0	0	0
	Total	2.0	2	326	141

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 1999 and 2000

No ACFM advice on sprat TAC has been given in recent years. The sprat TAC for 1999 was 50,000 t, with a restriction on by- catches of herring not exceeding 19,000 t. For 2000 the sprat TAC is set at 50,000 t with a by-catch ceiling for TAC for herring set to 21,000 t.

10.1.2 Landings

Prior to 1998 a so-called mixed-clupeoid fishery management regime existed. An EU and Norway agreement changed this regime on management of the herring fisheries in Division IIIa. This agreement implied that a TAC for sprat was set as well as a by-catch ceiling for herring in all small meshed fisheries.

In 1994 and 1995 a substantial sprat fishery was conducted in Division IIIa. In these years there was, for the first time in several years, a directed sprat fishery for industrial purposes in Skagerrak and the northern part of Kattegat. These high sprat catches have not occurred since. A sprat fishery with by-catches of herring is conducted, as well as a fishery carried out with small purse seiners at the West Coast of Sweden and in the Swedish fjords.

The total annual landings for Division IIIa by area and country are given in Table 10.1.1 for 1974 -1999. In 1999, the total landings increased to nearly 27,000 t from a level of about 18,000t in the previous three years. The Norwegian and Swedish landings include the coastal and fjord fisheries. Though the Swedish coastal sprat fishery increased in 1999, these landings continued to be low.

Landings by countries and by quarter are shown in Table 10.1.2. For 1999 the landings were taken in all quarters and evenly distributed in the 1st, 3rd and 4th quarter. In the second quarter less than 1000 t was landed. Denmark has a total ban on the sprat fishery in Div.IIIa from May to September.

10.1.3 Fleet

Fleets from Denmark, Norway and Sweden carry out the sprat fishery in Division IIIa.

The Danish sprat fishery consists of trawlers using a 16mm-mesh size fishing for reduction purposes.

The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

In Sweden the sprat fishery consists of three categories:

1) By-catches in a directed herring trawl fishery with minimum mesh size of 32 mm and by purse seiners.
2) Directed sprat fishery for human consumption carried out by purse seiners.
3) A directed sprat trawl fishery with mainly 16, 18 or 22 mm mesh size, for human consumption and for reduction purposes.

10.2 Catch composition

10.2.1 Catches in number and weight at age

The numbers and the mean weight by age in the landings from 1995 to1999 are presented in Table 10.2.1 and Table 10.2.2, respectively. Landings, for which samples were collected, were raised using a combination of Swedish and Danish samples, without any differentiation in types of fleets.

10.2.2 Quality of catch and biological data

Denmark improved its monitoring system for management and scientific purposes in 1996. The high sampling level has continued since. In 1999 a total of 313 samples from the small meshed fishery for species composition were collected from a total landing of 54,000 t of all species. This high sampling intensity more than meet the required level of one sample per 1,000 t landed.

Denmark has provided biological samples per quarter and area, and Sweden provided biological samples for quarter 1 and 3 from the fishery in Kattegat. These samples were used, for estimation of numbers of sprat at age and the mean weight at age, in all sprat landings (Table 10.2.1 and Table 10.2.2). The quantity of sampling has improved and was considered adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Therefore, data from the industrial landings were used for the estimation of numbers of sprat at age and the mean weight at age. Details on the sampling for biological data per country, area and quarter are shown in Table 10.2.3.

10.3 Recruitment

The IBTS (February) sprat indices for 1984-2000 are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2. The indices are calculated as mean no./hr (cpue) weighted by area where water depths are between 10 and 150 m (ICES 1995).

The 2000- IBTS index of the 1-group as well as the total index, are one of the lowest recorded for the period. The abundance of the 1998-year class sprat (2- group) continued to be relatively good. The age/length key from the IIIa-area in the 2000 IBTS-survey indicates a reasonable separation into age groups. The total sprat index is near the lowest for the period 1984-2000.

10.4 Acoustic Survey

Acoustic estimates of sprat were included in the ICES co-ordinated Herring Acoustic surveys in 1996. In 1996 the total estimates was 7.9 x 10^8 fish or 14,267 tonnes. About 95 % of the biomass were recorded in Kattegat. From the 1997 and 1998 acoustic surveys only single individuals of sprat were caught (ICES 1998d, 1999b). In 1999 only Skagerrak was covered, with no acoustic values allocated to sprat (Simmonds *et.al*. 2000, WD).

10.5 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. Last year a depletion model with an index of recruitment model (CEDA-package) was run. From the experiences with the run of the Biomass dynamic model using the CEDA package last year (ICES 1999a), the Working Group decided not to run the model this year. The data do not allow any assessment, which could be helpful for management.

10.6 Projection of Catch and Stock

There is no relationship between the IBTS (February) index (no/h) and the total catch in the same year (r^2=0.04), the data is shown in Figure 10.6.1. The 1994 and 1995 observations are anomously high. The index is not useful for management in Div. IIIa at present.

The estimated yields for 2000 using various IBTS-indices; i.e.1-group, combined 1-and 2-group and total index, in a SHOT-estimate (Shepherd, 1991) were in the range of 8-10,000 tonnes. The estimate run with a combined 1-and 2-group index is shown in Table 10.6.1. This method does not provide any reliable projection under the present management regime.

10.7 Management Considerations

The natural variability in stock abundance is high and the recruitment between years does not appear to be driven directly by fishing effort. The sprat fishery has mainly been fished together with herring, except for 1994 and 1995 when a directed sprat fishery was carried out with low by-catches of herring. The human consumption fishery takes only a minor part of the total catch.

With the current management regime, where there are by-catch ceilings of herring as well as by-catch percentage limits, the sprat fishery is controlled by these factors.

Attempts to assess this stock have demonstrated the need for improved sprat sampling for age data. There is also a need for better knowledge of spawning seasons and recruitment from possible autumn spawners in the North Sea.

Table 10.1.1 Landings of SPRAT in Division IIIA, 1974–1999. Catch (in tonnes 10^{-3}). (Data provided by Working Group members). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak			Kattegat		Div. IIIa	Division IIIa Total
	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	
1982	10.5	-	1.9	21.4	-	5.9	39.7
1983	3.4	-	1.9	9.1	-	13.0	26.4
1984	13.2	-	1.8	10.9	-	10.2	36.1
1985	1.3	-	2.5	4.6	-	11.3	19.7
1986	0.4	-	1.1	0.9	-	8.4	10.8
1987	1.4	-	0.4	1.4	-	11.2	14.4
1988	1.7	-	0.3	1.3	-	5.4	8.7
1989	0.9	-	1.1	3.0	-	4.8	9.8
1990	1.3	-	1.3	1.1	-	6.0	9.7
1991	4.2	-	1.0	2.2	-	6.6	14.0
1992	1.1	-	0.6	2.2	-	6.6	10.5
1993	0.6	4.7	1.3	0.8	1.7	-	9.1
1994	47.7	32.2	1.8	11.7	2.6	-	96.0
1995	29.1	9.7	0.5	11.7	4.6	-	55.6
1996	7.0	3.5	1.0	3.4	3.1	-	18.0
1997	7.0	3.1	0.4	4.6	0.7	-	15.8
1998	3.9	5.2	1.0	7,3	1.0	-	18.4
1999[1]	6.8	6.4	0.2	10.4	2.9		26.7

[1]Preliminary.

Table 10.1.2. Div. IIIa Sprat. Landings of sprat ('ooo t) by quarter by countries, 1994-1999.
(Data provided by the Working Group members)

	Quarter	Denmark	Norway	Sweden	Total
1994	1	0.3	0.0	0.5	0.8
	2	6.0	0.0	0.3	6.3
	3	37.0	0.1	23.0	60.1
	4	16.1	1.7	11.0	28.8
	Total	59.4	1.8	34.8	96.0
1995					
	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
	Total	40.8	0.5	14.3	55.6
1996					
	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
	Total	10.4	1.0	6.6	18.0
1997					
	1	0.7	-	0.3	1.0
	2	0.4	-	1.2	1.6
	3	2.3	-	0.1	2.4
	4	8.2	0.4	2.2	10.8
	Total	11.6	0.4	3.8	15.8
1998					
	1	4.0	0.1	0.1	4.2
	2	0.9		+	0.9
	3	1.1	0.3	0.4	1.8
	4	5.4	0.7	5.7	11.7
	Total	11.4	1.1	6.1	18.6
1999					
	1	3.5	0.0	4.0	7.5
	2	0.1		0.2	0.3
	3	7.4	0.1	1.9	9.4
	4	6.2	0.1	3.3	9.6
	Total	17.2	0.2	9.3	26.7

+ Catch record, but amount not precisely known.

Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1995-1999.

	Quarter	Age						Total
		0	1	2	3	4	5+	
1995	1		312.04	784.37	53.50	27.29	9.01	1186.20
	2		1248.72	993.29	61.06	15.24	4.77	2323.08
	3		1724.02	133.56	14.17			1871.74
	4		902.76	139.95	29.95	10.58		1083.25
	Total		4187.54	2051.17	158.68	53.12	13.77	6,464.27
1996	1		288.42	546.53	62.11	15.65	5.07	917.78
	2		0.89	414.10	42.76	0.71	0.06	458.51
	3		0.34	1.81	0.30	0.02		2.47
	4		31.19	165.65	27.34	2.03		226.21
	Total		320.84	1128.08	132.51	18.41	5.13	1,604.97
1997	1			3.43	18.31	20.60	4.59	46.94
	2		1.00	2.76	19.56	1.51	0.25	25.07
	3	4.35	209.25	9.51	1.92	6.24		231.26
	4	32.39	644.28	58.31	7.16	28.02		770.16
	Total	36.74	854.53	74.01	46.95	56.37	4.84	1,073.43
1998	1		14.91	103.38	94.00	76.99	6.34	295.61
	2		3.24	21.49	20.59	16.63	1.33	63.28
	3	53.62	26.03	41.84	5.65	0.74		127.88
	4	192.13	253.98	226.55	53.14	29.80		755.61
	Total	245.75	298.16	393.25	173.38	124.17	7.67	1242.38
1999	1	0.0	560.5	158.0	151.2	77.4	6.8	953.9
	2		32.8	1.6	1.7	1.1	0.3	37.6
	3	9.6	741.7	46.7	6.3	5.9		810.0
	4	8.5	645.4	20.5	6.8	0.6	0.3	682.1
	Total	18.0	1,980.4	226.8	166.0	85.0	7.4	2,483.6

Table 10.2.2. Div. IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1995-1999. (1994-1995 Danish and Swedish data, 1996-1997 Danish data, 1998-1999 Danish and Swedish data)

Year	Age							**SOP**
	Quarter	0	1	2	3	4	5+	
1995	1		2.3	8.9	18.8	22.9	26.1	9,519
	2		2.9	7.3	12.4	23.7	27.0	12,054
	3		10.5	18.4	15.5			20,765
	4		11.5	15.6	15.5	18.2		13,262
	Total		7.8	9.2	15.3	22.2	26.4	55,600.3
1996	1		9.2	10.6	14.2	17.4	17.7	9,724
	2		8.6	12.5	15.1	17.4	17.0	5,847
	3		4.2	10.9	15.5	21.0		26
	4		4.2	10.9	15.5	21.0		2,403
	Total		8.7	7.6	14.8	19.6	17.7	18,000.3
1997	1			17.3	18.6	21.8	26.0	968
	2		8.3	17.6	20.0	22.1	31.0	489
	3	4.1	13.6	17.2	21.1			3,062
	4	4.7	14.7	17.5		19.5		11,176
	Total	4.6	14.4	17.5	19.6	20.4	26.3	15,696.2
***1998**	1		6.6	14.0	18.0	19.0	21.3	4,828
	2		6.6	13.9	17.8	18.7	21.0	1,027
	3	4.6	17.7	20.7	22.1	24.7		1,718
	4	4.8	17.5	20.4	22.5	27.5		11,998
	Total	4.8	16.9	18.5	19.6	21.2	21.2	19,570.0
1999	1		4.6	6.4	17.3	13.4	13.1	7,319
	2		5.3	17.1	18.6	22.2	17.8	264
	3	3.0	11.4	12.6	16.8	18.3		9,257
	4	4.8	13.9	17.6	20.8	21.2	23.5	9,521
	Total	3.8	10.2	8.8	17.4	13.9	13.7	26,361.0

* minor revisions made by the 2000 WG

Table 10.2.3 Division IIIa Sprat. Sampling commercial landings for biological samples in 1998-1999.

Country Area	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1998					
Denmark					
Skagerrak	1	0.8	6	642	0
	2	0.7	1	3	0
	3	0.6	9	819	0
	4	1.8	23	2522	273
	Total	3.9	39	3,986	273
Kattegat	1	3.2	4	426	
	2	0.2	2	437	140
	3	0.5	2	171	82
	4	3.5	6	374	97
	Total	7.4	14	1,408	319
Sweden					
Skagerrak	1	0.1			
	2	0.0	1		
	3	0.2	3	16	16
	4	4.8	3	47	46
	Total	5.1	7	63	62
Kattegat	1	0.0	6	39	39
	2	0.0			
	3	0.1			
	4	0.9			
	Total	1.0	6	39	39
Denmark		11.3	53	5394	592
Norway		1.1	0	0	0
Sweden		6.1	13	102	101
	Total	18.5	66	5496	693
1999					
Denmark					
Skagerrak	1	0.2	6	696	75
	2	0.0	0	0	0
	3	4.4	20	2128	177
	4	2.1	6	619	98
	Total	6.8	32	3443	350
Kattegat	1	3.3	6	648	239
	2	0.1	4	159	116
	3	2.9	4	160	65
	4	4.1	9	1413	616
	Total	10.4	23	2380	1036
Norway					
Skagerrak	1	0.0			
	2				
	3	0.1			
	4	0.1			
	Total	0.2	0	0	0
Sweden					
Skagerrak	1	2.9			
	2	0.0			
	3	0.8			
	4	2.7			
	Total	6.4	0	0	0
Kattegat	1	1.1	2	18	18
	2	0.1			
	3	1.1	3	105	104
	4	0.6			
	Total	2.9	5	123	122
Denmark		17.2	55	5823	1386
Norway		0.2	0	0	0
Sweden		9.3	5	123	122
	Total	26.7	60	5946	1508

Table 10.3.1. Div. IIIa Sprat. IBTS(February) indices of sprat per age group 1984-2000. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5779.73	854.30	207.60	80.09	61.47	6983.19
1985	14	38	2397.24	2395.15	368.76	128.50	49.11	5338.76
1986	15	38	664.99	1918.53	1786.59	116.20	31.91	4518.22
1987	16	38	2244.33	2501.38	2224.94	1655.66	78.69	8705.00
1988	13	38	939.91	5461.23	1519.15	2130.02	459.41	10509.72
1989	14	38	437.60	994.37	1077.13	603.41	147.86	3260.37
1990	15	38	502.83	237.76	69.90	65.65	49.04	925.18
1991	14	38	636.17	456.74	493.57	86.03	215.58	1888.09
1992	16	38	6016.26	605.99	272.13	215.45	79.26	7189.09
1993	16	38	1789.73	4623.70	996.75	218.97	260.08	7889.23
1994	16	38	1546.88	614.35	961.44	299.48	67.58	3489.73
1995	17	38	2282.92	1828.84	37.24	47.86	4.53	4201.39
1996	15	38	176.15	5800.45	794.23	135.95	228.51	7135.29
1997	16	41	200.80	409.84	1307.35	147.36	144.17	2209.52
1998	15	39	75.09	1742.73	680.95	1793.92	579.34	4872.03
1999	16	42	4273.15	363.18	269.01	47.77	345.85	5298.96
2000	16	41	213.70	643.96	54.68	50.53	24.01	986.88

Table 10.6.1. Div.IIIa Sprat. SHOT forecast of landings in 2000 using total landings and the 1-and 2-group IBTS-indices as input data.

Div.IIIa sprat SHOT forecast spreadsheet version 6
Total index March 2000

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36	6634		0.77	0.23				47		
1985	20	4792	4792	0.77	0.23	15			26		
1986	11	2584	2584	0.77	0.23	8	16	17	14		
1987	14	4746	4746	0.77	0.23	15	23	20	18		
1988	9	6401	6401	0.77	0.23	8	20	19	12	24	19
1989	10	1432	1432	0.77	0.23	10	4	5	13	6	5
1990	10	741	741	0.77	0.23	10	2	4	13	5	4
1991	14	1093	1093	0.77	0.23	15	3	5	18	6	5
1992	11	6622	6622	0.77	0.23	10	25	22	14	29	22
1993	9	6413	6413	0.77	0.23	8	21	18	12	24	18
1994	96	2161	2161	0.77	0.23	122	6	7	125	9	7
1995	56	4112	4112	0.77	0.23	44	25	41	73	53	41
1996	18	5977	5977	0.77	0.23	7	39	43	23	55	43
1997	16	611	611	0.77	0.23	15	4	7	21	9	7
1998	18	1818	1818	0.77	0.23	19	11	12	23	16	12
1999	27	4636	4636	0.77	0.23	30	29	26	35	34	26
2000		858	858	0.77	0.23		5	10		13	10

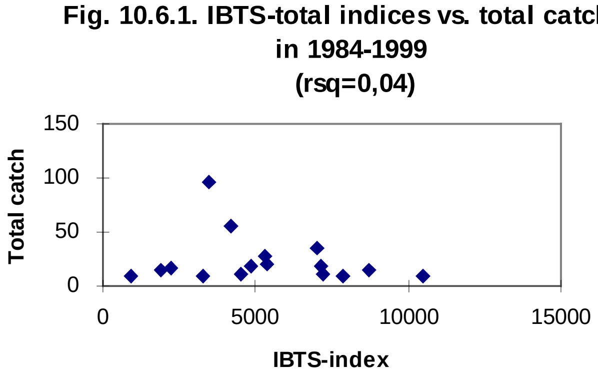


Fig. 10.6.1. IBTS-total indices vs. total catches
in 1984-1999
(rsq=0,04)
Total catch
150
100
50
0
0
5000
10000
15000
IBTS-index

11 REFERENCES

Armstrong, M, Dickey- Collas M, Mc Curdy W, Burns C, Peel J, Mc Aliskey M, and Briggs R. 1998a Catch rates of juvenile herring in Irish Sea (Area VIIaN) groundfish surveys:June 1991- Sept.1998

Armstrong, M, Burns C, Clarke W, Dickey-Collas M, Mc Aliskey M, Mc Curdy W, Peel J, and Snyder R. 1998b Acoustic survey of herring and sprat in the northern Irish Sea (area VIIa N) in September and October 1998, plus corrections to 1995 survey estimates.

Basson, M. 1997. A comparison of two short term projection methods for North Sea herring catches by fleet. Working Document to the Herring Assessment Working Group, Copenhagen, March 1997.

Basson, M. 1998. Some notes on stochastic short term projections, based on split factors, for North Sea herring. Working Document to the Herring Assessment Working Group, Copenhagen, March 1998.

Beek, F.A van, and Pastoors, M.A., 1999. Evaluating ICES catch forecasts: the relationships between implied and realized fishing mortality ICES C.M. 1999/R:4: .

Biester, E. 1979. Der Frühjahrshering Rügens. Doctoral Thesis. Wilhelm-Pieck Universität Rostock.

Brielmann, N. 1989. Quantitative analysis of Ruegen spring-spawning herring larvae for estimating 0-group herring in Sub-divisions 22 and 24. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 190: 271-275.

Cook, R.M., Kunzlik, P.A. and Fryer, R. 1991. On the quality of North Sea stock forecasts. ICES J. Mar. Sci., 48: 1–13

Cook, R.M. 1995. A simple model for the analysis of research vessel data to determine stock trends ICES CM 1995/D:12

Deriso, R.B., Quinn, T.J. and Neal, P.R. 1985. Catch-at-age analysis with auxilliary information. Can. J. Fish. Aquat. Sci. 42: 815-824.

Gröger, J. and Gröhsler, T. 1995. On the discrimination of herring stocks in Division IIIa. ICES CM 1995/J:22.

Gröger, J. and Gröhsler, T. 1996. Information Updated Discrimination of Herring Stocks in Baltic Division IIIa. ICES CM 1996/J:10.

Gröger, J. and Gröhsler, T. 2000a. On the separation of herring stocks in the Western Baltic. Working document HAWG2000. 13 pp.

Gröger, J. and Gröhsler, T. 2000b. Comparative analysis of alternative statistical models for herring stock discrimination based on meristic characters (Applied Ichthyology, accepted in January 2000).

Gudmundsson, G. 1986. Statistical considerations in the analysis of catch at age observations. J. Cons. int. Explor. Mer, 43: 83-90.

Hammer, C., Reid, D.G., and Greenstreet, S.P.R. 1996. The use of weight length relationships for the analysis of acoustic survey data from herring surveys: a source of variability. ICES CM 1996/ H:6

Heinke, F. 1898. Naturgeschichte des Herings. Teil 1. Deutscher Seefischerei-Verein. Band II.

Holden, S., Kirkwood, G. and Bravington, M.V. 1995. Catch Effort Data Analysis. The CEDA Package. User Manual for CEDA version 2.01. MRAG Ltd., London, UK

ICES 1980. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1980/H:4, 103 pp.

ICES 1984. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1984/Assess:12

ICES 1989. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1989/Assess:15.

ICES 1991. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1991/Assess:15.

ICES 1992a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES 1992/Assess: 9, 114 pp.

ICES 1992b. Report of the Workshop on Methods of Forecasting Herring Catches in Div. IIIa and the North Sea. ICES CM 1992/H:5.

ICES 1993. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM1993/Assess:15.

ICES 1994a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1994/Assess:13.

ICES 1994b. Report of the Planning Group for Herring Surveys. ICES CM 1994/H:3

ICES 1995. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1995/Assess:13.

ICES 1996a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1996/Assess:10.

ICES 1996b. Manual for the International Bottom Trawl Surveys. Revision V. Addendum to ICES CM 1996/H:1 (Ref. Assess+G).

ICES 1997a. Report of the Herring Assessment Working Group for the Area south of 62°N. ICES CM 1997/Assess:8.

ICES 1997b. Study Group on Multispecies Model Implementation in the Baltic. ICES CM 1997/J:2 (Ref.:Assess)

ICES 1998a. Report of the Herring Assessment Working Group for the Area south of 62°N. ICES CM 1998/ACFM:14.

ICES 1998b. Report of the Planning Group for Herring Surveys. ICES CM 1998/G:4 Ref. D.

ICES 1998c Report of the Study Group on Stock-recruitment Relationships for North Sea Autumn Spawning Herring. ICES CM 1998/D:2.

ICES 1998d. Report of the Planning Group for Herring Surveys. ICES CM 1998/G:4 Ref. D.

ICES 1999. Report of the international bottom trawl survey working group. ICES CM 1999/D:2

ICES 1999a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1999/ACFM:12

ICES 1999b. Report of the Planning Group for Herring Surveys. 1999. ICES CM 1999/G:7 Ref. D.

ICES 1999c/H:1 (addendum) Manual for the Baltic International Acoustic Survey. Addendum to ICES CM 1999/H:1 (Ref. Appendix IV)

ICES 2000. Report of the planning group for herring surveys. ICES CM 2000/G:02

ICES 2000a. Report of the working group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 2000/ACFM:5

Jensen, A.J.C. 1957. Danish herring investigations in the Skagerrak, Kattegat, Belts and Baltic. Ann. Biol., 14: 191–194.

Klenz, B. 1993. Quantitative Larvenanalyse des Rügenschen Frühjahrsherings in den Laichsaisons 1991 und 1992. Infn. Fischw., 40(3): 118–124.

Klenz, B. 1999. Das deutsche Larvenprogramm im Hauptlaichgebiet des Herings der westlichen Ostsee – Eine Forschungsaufgabe von internationaler Bedeutung. Inf. Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17

Kolody, D. & K. Patterson, 1999. Evaluation of NE Atlantic Mackerel stock assessment models on the basis of simulated long-term management performance. Working document. ICES Working Group on the Assessment of Mackerel, Horse mackerel, Sardine and Anchovy, Copenhagen, 14-23 September 1999

Levene, H. 1960. Robust tests for equality of variances. Contributions probability and statistics, Stanford University Press (1960), pp 278-292.

Moksness, E. and Fossum, P. 1991. Distinguishing spring and autumn spawned herring larvae (*Clupea harengus* L.) by otolith microstructure. ICES J. Mar. Sci., 48: 61-66.

Mosegaard, H. and Popp-Madsen, K. 1996. Racial discrimination of herring stocks, comparing vertebral counts and otolith microstructure analysis. ICES CM 1996/H:17.

Müller, H. and Klenz, B. 1994. Quantitative Analysis of Rügen Spring Spawning Herring Larvae Surveys with Regard to the Recruitment of the Western Baltic and Division IIIa Stock. ICES CM 1994/L:30.

NRC, 1998. Improving fish stock assessments. Committee on fish stock assessment National Academy Press : 177 pp.

Patterson, K.R. and Melvin, G.D. 1996. Integrated Catch at Age Analysis Version 1.2. Scottish Fisheries Research Report. No. 38.

Rosenberg, R. and Palmén, L.-E. 1982. Composition of herring stocks in the Skagerrak-Kattegat and the relations of these stocks with those of the North Sea and adjacent waters. Fish. Res., 1:83–104.

Schulz, N. and Vaske, B. 1988. Methodik, Ergebnisse und statistische Bewertung der Grundtrawlsurveys in der Mecklenburger Bucht, Arkonasee und des noerdlichen Bornholmbeckens in den Jahren 1978–1985 sowie einige Bemerkungen zu den Jahrgangsstaerken des Dorsches (*Gadus morhua*) und des Herings (*Clupea harengus* L.). Fischerei-Forschung, 26(3): 53-67.

Simmonds, E.J., Bailey, M.C., Toresen, R., Torstensen, E., Pedersen, J., Götze, E., Fernandes, P. and Couperus, A.S. 1999. 1998 ICES Coordinated Acoustic Survey of ICES division IIIa, IVa, IVb, and VIa(North). ICES CM/1999:J36

Shepherd, J.G. 1991. Simple Methods for Short Term Forecasting of Catch and Biomass. ICES J. Mar.Sci., 48: 67-78.

Smith, P.E. and Richardson, S.L. 1977. Standard techniques for pelagic fish egg and larva surveys. FAO Fish. Techn. Pap., 175 pp.

Zhang, Z. and Moksness, E. 1993. A chemical way of thinning otoliths of adult Atlantic herring (*Clupea harengus*) to expose the microstructure in the nucleus region. ICES J. Mar. Sci., 50(2): 213-217.

12 WORKING DOCUMENTS

Armstrong *et al.*,1999

Gröger J and Gröhsler T. On the separation of herring stocks in the Western Baltic.

ICES 1999. Quality Assurance of ICES Advisory Functions. Doc. CM. 1999/Del 21.

ICES 1999. Follow-up of the 11^{th} Dialogue Meeting in Nantes 26-27 January 1999. Doc. C.M. 1999/Del:25.

Kelly C and Molloy J**.** Mean weights at age in Celtic Sea herrings.

Molloy J and Kelly C. Herring Acoustic Surveys by Ireland 1999/2000.

Müller H. The German herring larvae survey in the Greifswalder Bodden (ICES Sub-division 24) with regard to the index for the year-class strength of the ”Rügen herring”.

Pastoors M.A. Market sampling and raising procedures for herring in the Netherlands, 1991-1999.

Patterson, K.R. 1998. A programme for calculating catch numbers at age. Working Document for the Working Group on Northern Pelagic and Blue Whiting Fisheries, Copenhagen, April 1998.

Rohlf N. and Gröger J. Report of the herring larvae surveys in the North Sea in 1999/2000.

Simmonds E.J., Toresen E., Torstensen E., Zimmermann C., Götze E., Reid D.G. and Couperus A.S. 1999 ICES coordinated acoustic survey of ICES divisions IIIa, IVa, IVb and VIa (North).

Simmonds, E.J., *et al.*, 2000.